Proactive by Design

PERMANENT SOLUTION STATEMENT
123 PINE STREET
HOLYOKE, MASSACHUSETTS
RTN: 1-20114

May 2017

PREPARED FOR:
City of Holyoke
Office of Planning and Economic Development
20 Korean Veterans Plaza
Holyoke, Massachusetts

GZA GeoEnvironmental, Inc.
1350 Main St. – Suite 1400 | Springfield, MA 01103
413-726-2100

29 Offices Nationwide
www.gza.com

Proactive by Design

GEOTECHNICAL
ENVIRONMENTAL
ECOLOGICAL
WATER
CONSTRUCTION MANAGEMENT

1350 Main Street
Suite 1400
Springfield, MA 01103
T: 413.726.2100
F: 413.732.1249
www.gza.com

May 25, 2017

File No. 15.0166521.00

Massachusetts Department of Environmental Protection
Western Regional Office
Bureau of Waste Site Cleanup
436 Dwight Street
Springfield, Massachusetts 01103

Re: Permanent Solution Statement With No Conditions
123 Pine Street
Holyoke, Massachusetts
Release Tracking Number (RTN) 1-20114

Dear Sir/Madam:

On behalf of the City of Holyoke Office of Planning and Economic Development, ("the City"), GZA GeoEnvironmental, Inc. (GZA) is submitting this Permanent Solution Statement With No Conditions for the above-referenced Massachusetts Contingency Plan (MCP) Disposal Site ("Site"). The report has been prepared in accordance with the requirements of Section 310 CMR 40.1056 of the MCP and is subject to the Limitations included in Appendix A.

If you have any questions or need further information, please contact the undersigned at (413) 726-2104.

Very truly yours,
GZA GEOENVIRONMENTAL, INC.

Adam J. Cote, CHMM
Assistant Project Manager

William R. Norman, LSP
Consultant Reviewer

Guy P. Dalton, LSP
Associate Principal

cc: Marcos Marrero, Office of Planning and Economic Development

Debbie Oppermann, Office of Planning and Economic Development

Attachment: Report

FIGURES

TABLES

APPENDICES

1.00 INTRODUCTION

On behalf of the City of Holyoke Office of Planning and Economic Development, ("the City", "Property Owner" or "Owner"), GZA GeoEnvironmental, Inc. (GZA) has prepared this Permanent Solution Statement (PSS) for the MCP Disposal Site identified as Release Tracking Number (RTN) 1-20114 by the Massachusetts Department of Environmental Protection (MassDEP) (the Site). Site consists of approximately 0.126-acre of land improved with a 15,100-square foot vacant residential apartment building in the eastern-central portion of Holyoke, Massachusetts. The official address associated with the property is 123 Pine Street. A Site Locus Map is attached as Figure 1 and a Site Plan depicting the project limits, the Disposal Site boundary, and the existing approximate property boundaries is attached as Figure 2.

This PSS covers the portion of the property which has been impacted by a release of petroleum hydrocarbons, specifically, No. 2 Fuel Oil, and where Extractable Petroleum Hydrocarbons (EPH) were detected in soil above the applicable Massachusetts Contingency Plan (MCP) RCS-1 Standard. The release is attributed to two former 275-gallon aboveground storage tanks (ASTs), which were removed from the basement of the Site building on July 5, 2016, following the completion of an ASTM Phase I Environmental Site Assessment (ESA) performed by GZA for the City in April 2016.

As documented in this PSS, the Site meets the requirements for a Permanent Solution under the MCP because a condition of No Significant Risk (NSR) of harm to human health, safety, public welfare, and the environment has been achieved. GZA performed a Method 1 Risk Characterization (M1RC) for all of the Site constituents of concern (COCs). The M1RC is attached as Appendix C. Additionally, because one or more Volatile Organic Compounds (VOCs) is present in vadose zone soil adjacent to an occupied structure, GZA also performed a screening-level risk evaluation to estimate risks to future building occupants via the potential vapor intrusion pathway. GZA utilized the Johnson and Ettinger Model to estimate indoor air concentrations (Appendix H) and the MassDEP Shortform[1] to estimate risk to potential future residents (Appendix I) and demonstrate that Method 1 is an appropriate approach to assess risks at the Site. As demonstrated in the M1RC, the calculated Exposure Point Concentrations (EPCs) do not exceed applicable MCP Method 1 standards. Therefore, an Activity and Use Limitation (AUL) or MCP Conditions will not be required to maintain a level of No Significant Risk at the Site.

This report was prepared in accordance with the MCP, specifically, the requirements pertaining to PSS as outlined in 310 CMR 40.1056, and is subject to the Limitations included in Appendix A. A Permanent Solution Statement Transmittal Form (BWSC104) has been submitted electronically to MassDEP, and a copy is included in Appendix B in printed versions of this report.

This report is organized as follows:

1. Section 1.00 provides an introduction and defines the Site and terms used throughout this submittal.
2. Section 2.00 provides relevant project information, including a description of physical features and historical uses, a summary of MCP response actions conducted to date, and the conclusions of the Method 1 risk characterization.
3. Section 3.00 presents the information required by Section 310 CMR 40.1056(2) of the MCP in support of a Permanent Solution.
4. Section 4.00 presents the report conclusions.

[1] Method 3 Risk Assessment for Resident Exposed to Chemicals in Indoor Air – Shortform 2012 (sf12ra), Andrew Friedman, MassDEP

2.00 PROJECT INFORMATION

2.10 SITE LOCATION AND SETTING

The property is located at 123 Pine Street in Holyoke, Massachusetts and consists of approximately 0.126-acre of land referenced as Tax Parcel Map/Block/Lot number 062-03-002 by the City of Holyoke Assessor's office. Coordinates for the Site are: 42°12'33.56" N and 72°36'45.16" W. A Site Locus Map is included as Figure 1.

The property is occupied by a single 15,100 square-foot building, which was previously utilized as the former Alpine Apartments. The remainder of the property consists of grassy areas.

Groundwater at the property is assumed to flow generally to the northeast, towards the Connecticut River. Subsequent references to upgradient and downgradient properties are based on the inferred northeasterly groundwater flow direction.

2.20 SITE HISTORY

Historical fire insurance maps (Sanborn Maps) reviewed as part of GZA's April 2016 Phase I ESA indicate that development at the Site progressed from a two-story dwelling to the four-story Alpine tenement structure sometime between 1895 and 1915. The vacant Alpine building is currently present at the Site.

2.30 MCP RESPONSE ACTIONS

Pre-Release Abatement Measure (RAM) Plan

Soil in the basement at the Site has been impacted by a release of petroleum hydrocarbons, specifically, No. 2 Fuel Oil. The suspected source of the contamination was a release from one of two former aboveground storage tanks (ASTs) which were removed from the Site on July 5 of 2016, following the completion of an ASTM Phase I Environmental Site Assessment (ESA) performed by GZA for the City in April 2016. The Phase I ESA indicated that one of the two former ASTs exhibited corrosion near its base, with oil-stained concrete beneath.

During removal of the ASTs by the City's contractor, Associated Building Wreckers (ABW), one of the tanks began to leak No. 2 fuel oil onto the floor. Prior to removal, the tanks were presumed to be empty based upon a fuel gauge located on top of the tanks which was later determined not to be functional. It was estimated at the time of the release that less than the MCP Reportable Quantity of ten gallons of fuel oil were released to the basement floor. During removal, ABW applied absorbent material to the released fuel oil, which was then removed from the floor and containerized for off-Site disposal. The disposal documentation is provided as Appendix E. On the same day the ASTs were removed by the City's contractor, GZA collected soil samples BSMT-2 and BSMT-3 from the Site (a third sample, BSMT-1, was collected but not analyzed) via hand auger methods. The locations of the samples are shown on Figure 2. The samples were collected from bare earth or beneath compromised portions of the thin concrete basement floor near the former tank locations (and location of release), from depths of approximately three to nine inches below the top of the basement floor. As shown in Table 1, the Extractable Petroleum Hydrocarbon (EPH) analyses performed by ESS Laboratory of Cranston, RI (ESS) via MADEP-EPH and USEPA 8270 methods indicated that sample BSMT-2 exceeded the applicable Reportable Concentrations (RCS-1) for several constituents including C_9-C_{18} Aliphatics (19,990 mg/kg), C_{19}-C_{36} Aliphatics (4,500 mg/kg), C_{11}-C_{12} Aromatics (1,890 mg/kg), 2-methylnaphthalene (43.8 mg/kg), and naphthalene (12.1 mg/kg). Therefore,

these detections represented a 120-day Reportable Condition under the MCP. Although C_9-C_{18} Aliphatics was detected above laboratory method reporting limits (MRLs) in the BSMT-3 sample, the concentration (27.3 mg/kg) was well below the reportable concentration for this constituent. No other EPH constituents were detected above laboratory MRLs in sample BSMT-3. On behalf of the City, GZA notified MassDEP of the reportable condition on November 3, 2016.

On August 18, 2016, GZA returned to the Site to collect additional soil samples "123 Pine - S-4" through "123 Pine – S-7" beneath the basement floor, to continue to delineate the extent of the release. The samples were collected from a depth of three to nine inches below the floor of the basement, except for sample "123 Pine – S-6", which was a continuation of the original BSMT-2 sample, and which was collected from a depth of approximately twelve to eighteen inches below the floor. All of these samples were analyzed by ESS for EPH. As shown on Table 1, samples were compared to the MCP S-1, S-2 and S-3 GW-2 and GW-3 standards. Although there were detections of EPH constituents in two of these samples, none exceeded the aforementioned standards.

Based upon the analytical results described above, the release was estimated to be limited to the BSMT-2 sample area to a depth of approximately nine to twelve inches below the floor of the basement.

Release Abatement Measure (RAM) Plan

GZA submitted a RAM Plan for the Site to MassDEP on behalf of The City of Holyoke Office of Planning and Economic Development on April 24, 2017. This Plan described the proposed excavation and containerization of approximately 1 cubic yard (CY) of soil, as well as describing the planned post-excavation soil sampling at the Site. The objective of the RAM was to remove only those soils that were impacted above the MCP Method 1 S-1 standards. It was not the objective of the RAM to reach non-detectable levels for the remaining Site soils.

RAM Activities

On April 25, 2017, Western Mass Environmental, LLC (WME) performed excavation activities at the Site with oversight by a GZA representative. Excavation was performed by hand methods (shoveling after breaking the concrete using a sledgehammer) and began at the BSMT-2 sample location, in the southeastern portion of the basement (Figure 2). Soil was shoveled into 5-gallon buckets and loaded through a basement window, where a WME worker emptied the buckets into 55-gallon steel drums. During excavation, the areal and vertical extents of the excavation were guided using a photoionization detector (PID) measuring jar headspace of soil collected from the excavation. Background indoor air conditions in the basement ranged from 0.0 ppm to 0.2 ppm, as determined by the PID. Excavation continued laterally and vertically in areas where PID readings above 10 ppm were observed. Excavation at the BSMT-2 location proceeded first to a depth of approximately 16 inches below the basement floor surface grade, where a PID reading of 75 ppm was recorded. Excavation continued to a depth of 2 feet below grade, where the PID did not detect volatile organic compounds (VOCs) above background conditions (two separate screenings from soil at this depth resulted in readings of 0.0 ppm and 0.2 ppm). Soil from the sidewalls of the excavation was screened at a depth of approximately 1 foot below the basement floor, and except for the eastern sidewall which had a PID reading of 84 ppm, all of the PID readings were less than 5 ppm. Therefore, WME continued the excavation approximately 2 feet eastward along the basement wall. The excavation in the eastern portion of the excavation continued vertically to a depth of 4 feet below the basement floor, where a PID reading of 24 ppm was observed. The excavation continued another 4 inches deep (approximately), where sample "E. Exc. Bottom" was collected. Soil above this location along the southern sidewall footing and under the foundation southern basement wall (between 1 and 2 feet below the basement floor) was screened and had a PID reading of 54 ppm. WME shoveled soil under the wall in this location until they encountered the basement footing. In addition to the grab sample previously described, GZA collected a composite sample from the locations shown on Figure 2. Soils

encountered during excavation appeared to consist mainly of sand. The excavation was backfilled with clean soil supplied by WME after the post-excavation samples were collected.

While the excavation was open, GZA collected two post-excavation soil samples: "Exc. Composite" was composited from soil remaining along the excavation sidewalls of the excavation, collected from approximately 1 foot below basement floor grade, as well as from the soil remaining at the excavated BSMT-2 sample location, and "East Exc. Bottom" was a grab from the base of the eastern portion of the excavation, collected approximately 4.25 feet below basement floor grade. Sample locations are shown on Figure 2. The samples were submitted to ESS on a 5-day turnaround time (TAT) for EPH analysis by MassDEP USEPA 8270 methods. The samples were compared to MCP Method 1 S-1, S-2 and S-3/ GW-2 and GW-3 Standards. As shown in Table C-1 of the M1RC (Appendix C), some EPH constituents were detected above laboratory MRLs in both soil samples, though none exceeded the Method 1 S-1, S-2, S-3 / GW-2 or GW-3 Standards. Specifically, the C_9-C_{18} aliphatic hydrocarbon range was detected above laboratory MRLs in both samples, and soil sample "East Exc. Bottom" also contained C_{19}-C_{36} aliphatic hydrocarbons, C_{11}-C_{22} aromatic hydrocarbons and polycyclic aromatic hydrocarbon (PAH) 2-methylnaphthalene, however these analytes were all below applicable MCP Method 1 soil standards. The approximate final excavation dimensions are shown on Figure 2.

In total, WME removed three (3) 55-gallon drums of petroleum-impacted soil and transported the drums to the Veolia TSDF Solvent Recycling & Energy Recovery 10 Day In-Transit Service & Sales Center, in West Carrollton, Ohio.

3.00 PERMANENT SOLUTION DOCUMENTATION

As described in Section 310 CMR 40.1041 of the MCP, Permanent Solutions may be categorized as a Permanent Solution with No Conditions or a Permanent Solution with Conditions. As described in that Section, the category of Permanent Solution can be established based upon the following factors:

1. Oil and/or hazardous material (OHM) concentrations do not exceed an applicable Upper Concentration Limit (UCL) in soil or groundwater unless such levels are consistent with Natural Background (Permanent Solution with No Conditions); or

   OHM above applicable UCLs in soil is located at a depth greater than 15 feet from the ground surface or below an engineered barrier and an evaluation conducted pursuant to 310 CMR 40.0860 indicates it is not feasible to reduce the concentrations to less than or equal the applicable UCLs in soil (Permanent Solution with Conditions).

2. A level of NSR exists and will be maintained for all current and foreseeable future uses of the Site (Permanent Solution with No Conditions); or

   A level of NSR exists and will be maintained for all current and foreseeable future uses of the Site relying on one or more the following (Permanent Solution with Conditions):

   a. Assumed limitations on future Site activities or uses that require an AUL, as specified in 310 CMR 40.1012; or

b. Assumed limitation on current or future Site activities, uses, or conditions that do not require an AUL pursuant to 310 CMR 40.1013.

3. Sites where response actions have eliminated all threats of release and no release of OHM to the environment has occurred (Permanent Solution with No Conditions).

At the Site, none of the detected OHM concentrations exceed applicable UCLs in soil and a level of NSR exists without the implementation of an AUL. Therefore, the Site is eligible for a Permanent Solution With No Conditions.

The following sections provide documentation to support the Permanent Solution in accordance with Section 310 CMR 40.1056(1) and (2) of the MCP. Note that certain clerical documentation requirements under 310 CMR 40.1056(1) are addressed on the BWSC104 *Permanent And Temporary Solution Statement Transmittal* form included in Appendix B of printed versions of this report or previously in this section. These items (a, b, h and i) are not repeated in the following sections.

3.10 RISK CHARACTERIZATION METHOD AND SUPPORTING INFORMATION FOR NO SIGNIFICANT RISK CONCLUSION (40.1056(1)(c) AND 40.1056(2)(f))

Because one or more Volatile Organic Compounds (VOCs) is present in vadose zone soil adjacent to an occupied structure, GZA performed a screening-level risk evaluation to estimate risks to potential future building occupants via the potential vapor intrusion pathway. GZA utilized the Johnson and Ettinger Model to estimate indoor air concentrations (Appendix H) and the MassDEP Shortform to estimate risk to residents (Appendix I) and demonstrate that Method 1 is an appropriate approach to assess risks at the Site.

A Method 1 Risk Characterization was used to evaluate risk at the Site. Information supporting the conclusion that a level of NSR has been achieved is summarized in this Section and presented in Appendix C.

3.20 RELATIONSHIP TO OTHER PERMANENT OR TEMPORARY SOLUTIONS (40.1056(1)(D))

This PSS is being filed for a release which covers only a portion of the property. There are currently no other Permanent or Temporary Solutions filed for this disposal Site. There are no additional response actions needed for any other portions of the disposal Site.

3.30 ACTIVITY AND USE LIMITATION IMPLEMENTATION AND SUPPORTING INFORMATION (40.1056(1)(E) AND 40.1056(2)(H))

An AUL will not be necessary to maintain a condition of NSR at the Site.

3.40 ASSUMPTIONS REGARDING CURRENT OR FUTURE USES THAT DO NOT REQUIRE AN AUL (40.1056(1)(F) AND 40.1056(2)(J))

Based upon the Response Actions completed at the Site, this is a Permanent Solution With No Conditions. As such, this Permanent Solution is not based upon any of the *Limitations, Assumptions or Conditions on Site Activities and Uses That Do Not Require an AUL* (310 CMR 40.1013), which include the following:

(a) the recommendation of Best Management Practices for non-commercial gardening in a residential setting to minimize and control potential risk qualitatively evaluated pursuant to 310 CMR 40.0923(3)(c);

(b) the concentrations of OHM at the disposal site are consistent with Anthropogenic Background levels;

(c) the location of residual contamination within a public way or within a rail right-of-way; or

(d) the absence of an occupied building or structure in an area in which the groundwater would otherwise be classified as GW-2 pursuant to 310 CMR 40.0932(6), and where the residual concentrations of OHM in the groundwater exceed the GW-2 standards published in 310 CMR 40.0974(2).[2]

3.50 ACTIVE EXPOSURE PATHWAY MITIGATION MEASURES (40.1056(1)(G))

No Active Exposure Pathway Mitigation Measures (AEPMMs) are being undertaken at the Site. As demonstrated in the M1RC, none of the Site COCs exceeded the applicable Method 1 standards. As such, no AEPMMs will be necessary to maintain a condition of NSR.

3.60 UCL EXCEEDANCES (40.1056(1)(j)) AND 40.1056(2)(i))

There were no UCL exceedances in the release area covered by this PSS.

3.70 USE OF COMPENDIUM OF ANALYTICAL METHODS (40.1056(1)(k))

Exploration programs completed at the release Site employed the relevant methods and the data were generated pursuant to the MassDEP's *Compendium of Analytical Methods* (CAM). A Representativeness Evaluation and Data Usability Assessment (REDUA) was completed by GZA and is appended to this PSS. This is discussed further in Section 3.140 below.

3.80 DISPOSAL SITE LOCATIONS AND BOUNDARIES (40.1056(2)(a))

The Disposal Site is located at 123 Pine Street in Holyoke, Massachusetts. The Disposal Boundaries for the release area covered by this PSS are shown on Figure 2 along with pertinent Site features. The depicted boundaries are the areas where OHM associated with a release from two former 275-gallon fuel oil ASTs at the Site have come to be located based on explorations, soil screening, and confirmatory sampling and testing completed at the Site.

The excavation area measured approximately 4 feet long beginning just west of the BSMT-2 sample location along the southeastern portion of the southern basement wall. At its greatest width, the excavation measured approximately 2 feet. The excavation measured approximately 4.25-feet deep at the southeastern end and approximately 2 feet deep at it northwestern end.

The disposal Site includes the entirety of the excavation area. Lengthwise, the disposal Site boundaries extend approximately 1.25-feet past the southeastern edge of the excavation, towards the 123 Pine S-4 sample location and approximately 14 inches past the northeastern edge of the excavation area, towards the 123 Pine S-7 sample location. At its greatest width, the disposal Site boundary extends approximately 5-feet to the northeast and includes the BSMT-3 sample location.

[2] Based upon the Response Actions completed at the Site, there does not appear to have been a release to groundwater at the Site.

3.90 CONCEPTUAL SITE MODEL SUMMARY (40.1056(2)(B))

The property has been a dwelling since at least the late 1800's and served as the Alpine apartments beginning sometime between the late 1800's and 1915. Two 275-gallon aboveground storage tanks were previously located in the basement of the building. GZA identified one of the ASTs as a Recognized Environmental Condition (REC) in a Phase I ESA completed for the City in April 2016, due to corrosion observed at its base and stained concrete beneath the tank.

During removal of the ASTs by the City's contractor in July 2016, one of the tanks (which were both thought to be empty; the tank gauges were determined to be faulty), began to leak onto the floor of the basement. The City's contractor applied absorbent material to the floor and pumped out the remaining fuel oil from both tanks, which were removed the same day. Spent absorbent material was containerized and removed from the Site and disposed of as State Regulated Oil Liquid (Oil, Water, and debris). On the same day as the AST removal, GZA collected two soil samples from beneath compromised portions of the basement floor, or exposed earth. Concentrations of EPH constituents C_9-C_{18} Aliphatics, C_{19}-C_{36} Aliphatics, C_{11}-C_{12} Aromatics, 2-methylnaphthalene and naphthalene in one of the samples exceeded RCs. GZA notified MassDEP of this condition on behalf of the City on November 3, 2016.

GZA further delineated the extent of the release with additional soil samples collected in August 2016. The samples ("123 Pine - S-4" through "123 Pine – S-7") were collected from a depth of three to nine inches below the floor of the basement, except for sample "123 Pine – S-6", which was a continuation of the original BSMT-2 sample, and which was collected from a depth of approximately twelve to eighteen inches below the floor. All of the delineation samples were analyzed by ESS for EPH. Although there were detections of EPH constituents in two of these samples, none exceeded the MCP S-1, S-2 and S-3 / GW-2 and GW-3 standards.

On April 25, 2017, WME performed hand excavation activities at the Site beginning at the BSMT-2 sample location, in the southeastern portion of the basement (Figure 2). Using a PID, the areal and vertical extents of the excavation were estimated and the excavation continued eastward from the BSMT-2 location along the basement wall. Excavation continued to a depth of 2 feet below grade at the BSMT-2 location and to approximately 4.25 feet in the eastern part of the excavation. GZA collected grab sample "E. Exc. Bottom" from the deepest part of the excavation and a composite sample from the remaining sidewalls and bottom of the western portion of the excavation, as shown on Figure 2. The excavation was backfilled with clean soil supplied by WME after the post-excavation samples were collected.

The C_9-C_{18} aliphatics hydrocarbon fraction range was present in both samples above laboratory MDLs but well below applicable Method 1 Standards. Soil sample "East Exc. Bottom" also contained EPH fractions C_{19}-C_{36} aliphatic hydrocarbons, C_{11}-C_{22} aromatic hydrocarbons and target analyte 2-methylnaphthalene above MDLs, though well below the applicable Method 1 standards.

The MCP Disposal Site has been defined and its limits are shown on Figure 2. Based on the post-excavation soil samples, the petroleum impact does not extend significantly in any direction from the excavation. Based on the nature, limited size and location of the release, it is likely that contamination is related to releases from the former No. 2 Fuel Oil ASTs.

3.100 DEMONSTRATION THAT SOURCES OF OHM HAVE BEEN ELIMINATED OR CONTROLLED (40.1056(2)(c))

The OHM at the Disposal Site covered under this PSS were from on-Site sources: leaking aboveground storage tanks and the resulting petroleum-impacted soil. As the ASTs and more significantly impacted soils have been removed, there is no longer a significant source of OHM contributing to the Disposal Site and the sources of OHM have been eliminated (in the case of the ASTs) and controlled (in the case of residual impacted soil).

3.110 DEMONSTRATION OF SUBSURFACE MIGRATION CONTROL (40.1056(2)(d))

As described in the M1RC performed for the release area, a condition of No Significant Risk of harm to human health, safety, public welfare, and the environment exists at the Site.

3.120 DEMONSTRATION OF NAPL CONTROL (40.1056(2)(e))

NAPL was not detected in the soil explorations.

3.130 BACKGROUND FEASIBILITY EVALUATION (40.1056(2)(g))

In evaluating the feasibility of achieving background, in accordance with the MassDEP Policy "Conducting Feasibility Evaluations Under the MCP" (Policy No. WSC-04-160) dated July 16, 2004 (Feasibility Guidance), GZA considered the five specific MCP criteria for feasibility:

a. technological feasibility;
b. cost-benefit analysis;
c. availability of individuals with appropriate expertise;
d. availability of off-site land disposal facilities; and
e. site access/control constraints (for off-property sources of OHM).

For this Site, item "b" - the balance between cost and benefit - was the main parameter in the feasibility evaluation. Item "b" incorporates three main issues:

1. The incremental costs of remedial action relative to the incremental benefits of risk reduction, environmental restoration and "monetary and nonpecuniary values";
2. The control of risks to health, safety, public welfare and the environment posed by implementation of the remedial action; and
3. The potential for destruction of wetlands or wildlife habitat or substantial deleterious impact to the environment.

The residual soil contamination at the Site could be addressed by the excavation and off-Site disposal of soil from the release area. Risks to health, safety, public welfare, and the environment during remediation by excavation and off-Site transportation and disposal could be controlled through the use of a RAM Plan. Additionally, there are no wetlands or significant wildlife habitat on the property. Thus, the limiting factor with respect to the feasibility of achieving or approaching background levels at the Site was the incremental cost of implementing the remedy relative to the incremental benefits of risk reduction, environmental restoration and "monetary and nonpecuniary values."

The Feasibility Guidance provides guidance on evaluating when the incremental cost of conducting the remedial action is "substantial and disproportionate" relative to the incremental benefit. An incremental cost exceeding 20 percent (%) of the cost required to achieve NSR is considered to represent infeasibility. As the release Site covered under this PSS currently achieves NSR without the need for additional remediation (*i.e.*, there is no further cost to achieve NSR), any incremental costs to achieve background conditions at the Site would be significantly more expensive (on a percentage basis) than the cost of achieving NSR (which is no cost). This evaluation indicates that remediation to background conditions in this area is therefore infeasible according to the cost-benefit criterion.

Additionally, according to the Feasibility Guidance, "*The benefits of additional remedial actions to achieve or approach background for degradable/nonpersistent contaminants would be considered insufficient to justify the costs of those actions*." Certain residual petroleum hydrocarbons at the Site have been and would continue to be subject to various natural attenuation mechanisms. These mechanisms, including biodegradation, will continue to ultimately reduce residual contaminant concentrations to levels approaching background concentrations over time.

Based on these considerations, it is GZA's opinion that restoration of soil at the Site to background concentrations is not feasible in accordance with 310 CMR 40.0860.

3.140 DATA USABILITY ASSESSMENT AND DATA REPRESENTATIVENESS EVALUATION (40.1056(2)(K))

GZA prepared a REDUA in accordance with the MassDEP's policy entitled "MCP Representativeness Evaluations and Data Usability Assessments" (Policy #WSC-07-350) dated September 19, 2007, as part of this PSS. The REDUA is contained in Appendix G of this PSS. All samples collected at the Site were assessed under the REDUA. A summary of the REDUA findings is provided below.

As described in the REDUA, analytical results for all three sample delivery groups (SDGs) (1606809, 1607072 and 1608558) met the requirements for "Presumptive Certainty," as described in MassDEP policy WSC-CAM-VIIA, *Quality Assurance and Quality Control Guidelines for the Acquisition and Reporting of Analytical Data* (MassDEP, 2010).

Minor deficiencies were noted for the six SDGs based on the review of the laboratory reports. The deficiencies for the data include: (1) sampling containers not compliant with the CAM requirement (8 oz. jars used instead of 4 oz. jars for initial characterization samples) and (2) Surrogate recovery of 1-chlorooctadecane for BSMT-2 was diluted out, though the recoveries of the other three surrogates were within the CAM limits, and soil associated with BSMT-2 has since been removed from the Site.

GZA's REDUA concluded that the data set used to support the PSS is scientifically valid and defensible, of sufficient accuracy, precision and completeness, and representative with regard to spatial and temporal distribution of sampling points. Based on the results of the REDUA, it is GZA's opinion that data set for the Site is adequate to support this PSS.

3.150 REQUIREMENT FOR OPERATION/MAINTENANCE OR MONITORING (40.1056(2)(l))

No AULs or other engineering controls will be required to maintain a condition of NSR at the Site. Therefore, operation/maintenance or monitoring will not be required.

3.160 FINANCIAL ASSURANCE MECHANISMS

A Permanent Solution With No Conditions has been achieved for the Site. Therefore, financial assurance will not be required.

3.170 FILING OF PERMANENT SOLUTION STATEMENT

This PSS is being electronically transmitted to MassDEP accompanied by transmittal form BWSC-104 signed and stamped by the LSP for RTN 1-20114. A copy of the transmittal form is attached in Appendix B of printed versions of this document.

3.180 PUBLIC INVOLVEMENT`

In accordance with Section 310 CMR 40.1403(3)(f) of the MCP, the City of Holyoke's Chief Municipal Officer and Board of Health have been provided letters informing them of the availability of this PSS and describing how they may obtain copies of this report. Copies of the letters are included in Appendix F.

3.190 OWNER NOTIFICATION

This PSS is being prepared on behalf of the Site owner. Therefore, separate notification is not required.

4.00 CONCLUSIONS

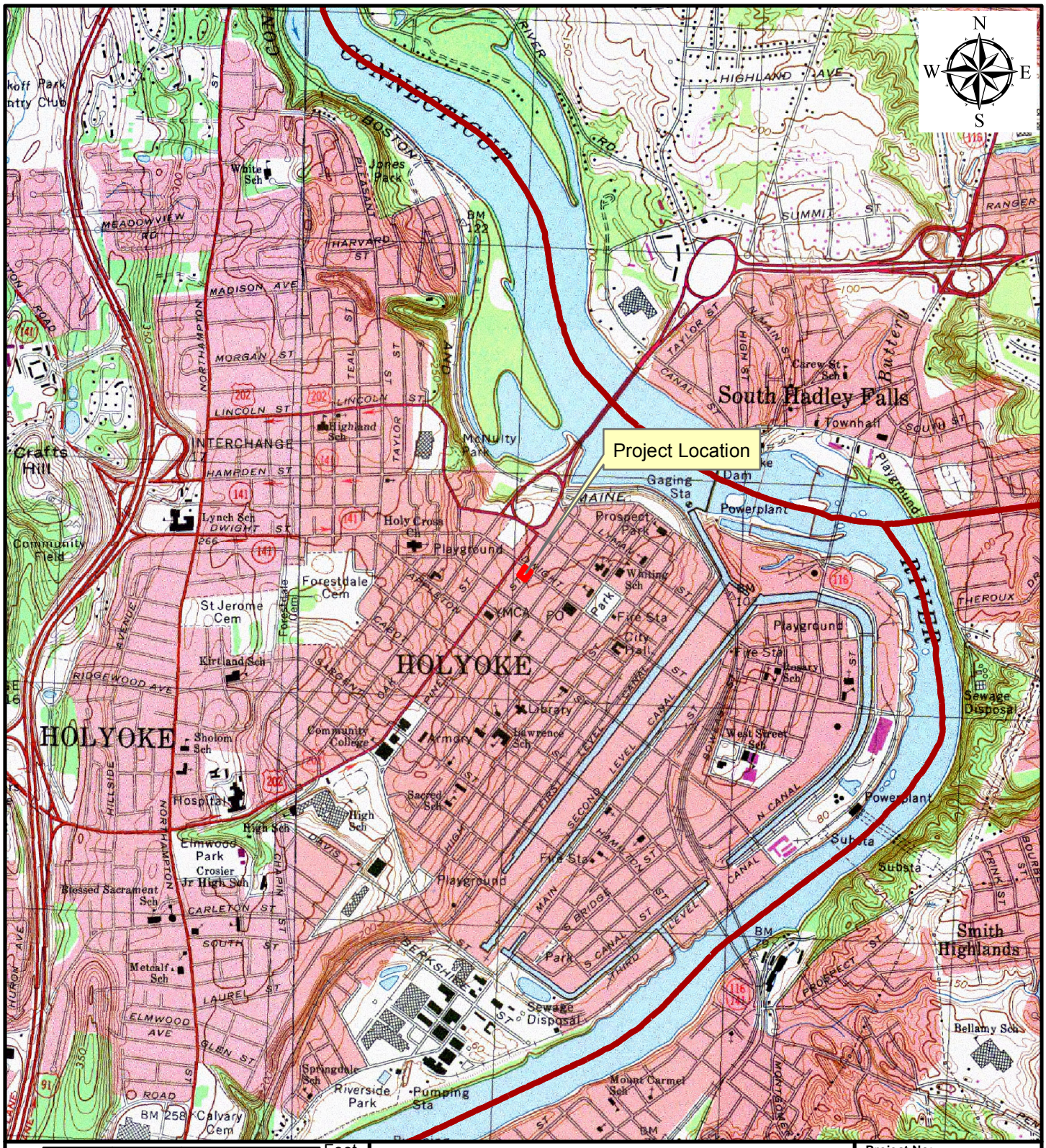
This Permanent Solution Statement has been prepared for the 123 Pine Street Site in Holyoke, Massachusetts designated as RTN 1-20114 by the MassDEP.

Pre-RAM soil data were collected at the Site between July 2016 and August 2016. RAM activities took place on April 25, 2017 and included the removal and off-Site recycling of two full, and one half-full 55-gallon drums (approximately 1.1 tons of soil) impacted by No.2 Fuel Oil from historical ASTs. The ASTs were removed prior to the performance of the RAM. The MCP Disposal Site boundaries are shown on Figure 2.

GZA performed A Method 1 Risk Characterization (M1RC) that utilized all the GZA Site soil data, except for soil samples which were removed during excavation, or which were outside the boundary of the estimated initial limits of soil impacts. The M1RC is appended to this PSS as Appendix C. Results of the M1RC indicate that the calculated EPCs do not exceed applicable MCP Method 1 Standards. Therefore, the results of the risk characterization indicate a condition of No Significant Risk (NSR) of harm to health, public welfare, and the environment exists at the Site. Current and reasonably foreseeable conditions at the Site and in the surrounding environment were evaluated, and no release-related conditions were identified which may pose a threat of physical harm or bodily injury to people; therefore, based on this comparison, a level of NSR to safety also exists at this Site.

This PSS filing supports the completion of response actions associated with RTN 1-20114.

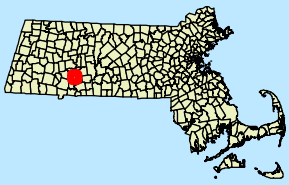
FIGURES



2,000 1,000 0 2,000 Feet

LOCUS MAP

123 Pine Street
Holyoke, Massachusetts

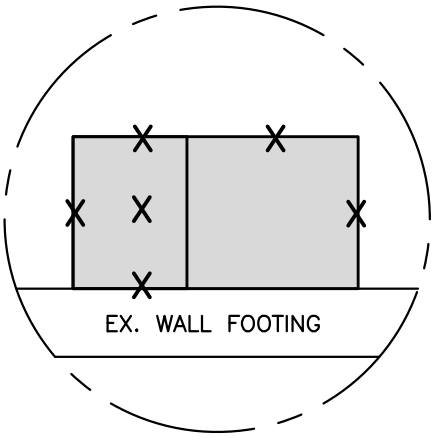


BASE MAP: USGS Topographic Map
Springfield North, 1979; Mount Tom, 1979

Data obtained from the Office of Geographic Information (MassGIS), Commonwealth of Massachusetts, Information Technology Division

GZA GeoEnvironmental, Inc.
Springfield, Massachusetts

Project No:	15.0166521.00
Drawn by:	SRT
Checked by:	AJC
Date:	May 2017
Figure No:	1



DETAIL–EXC. COMPOSITE GRAB LOCATIONS
NTS

LEGEND

- APPROXIMATE REMOVAL AREA
- SAMPLE LOCATION
- ESTIMATED LIMIT OF DISPOSAL SITE
- COMPOSITE SAMPLE GRAB LOCATION
- APPROXIMATE PROPERTY BOUNDARY

N

123 PINE STREET
(FORMER ALPINE APARTMENT BLDG.)

BSMT–3

SEE DETAIL EXC. COMPOSITE GRAB LOCATIONS

123 PINE S–5

123 PINE S–7

SOUTH BASEMENT WALL FOOTING

BSMT–2 & 123 PINE–S–6

E. EXC. BOTTOM

123 PINE S–4

EX. SIDEWALK

EX. CURB

PINE STREET

NO.	ISSUE/DESCRIPTION	BY	DATE

123 PINE STREET
HOLYOKE, MA

PREPARED BY:
GZA GeoEnvironmental, Inc.
Engineers and Scientists
www.gza.com

PREPARED FOR:
CITY OF HOLYOKE, MA
OFFICE OF PLANNING AND ECONOMIC DEVELOPMENT

SITE PLAN

PROJ MGR: AC	REVIEWED BY: GD	CHECKED BY: AC	FIGURE 2
DESIGNED BY: AC	DRAWN BY: EDM	SCALE: NTS	
DATE: MAY 2017	PROJECT NO. 15.0166521.00	REVISION NO. -	

TABLES

TABLE 1
123 Pine Street, Holyoke, MA
Sub-slab Soil Sample Analytical Results Summary
Pre and Post-RAM Data

								Lab Sample ID:	**1607072-01**	**1607072-02**	**ESS 16008558-01**	**ESS 16008558-02**	**ESS 16008558-03**	**ESS 16008558-04**	**ESS 1704760-01**	**ESS 1704760-02**
								Sample Name:	**BSMT-2**	**BSMT-3**	**123 Pine - S-4**	**123 Pine - S-5**	**123 Pine - S-6**	**123 Pine - S-7**	**East Exc. Bottom**	**Exc. Composite**
								Sample Depth:	**3 - 9"**	**3 - 9"**	**3 - 9"**	**3 - 9"**	**12 - 18"**	**3 - 9"**	**4.25'**	**1-2'**
								Sample Date:	**7/5/2016**	**7/5/2016**	**8/18/2016**	**8/18/2016**	**8/18/2016**	**8/18/2016**	**4/25/2017**	**4/25/2017**
MADEP EPH	**RCS-1**	**S-1/GW-2**	**S-1GW-3**	**S-2/GW-2**	**S-2/GW-3**	**S-3/GW-2**	**S-3/GW-3**									
Aliphatics, C_9-C_{18}	1,000	1,000	1,000	3,000	3,000	5,000	5,000		***19,990***	27.3	15.5U	16.3U	384	15.9U	220	19.5
Aliphatics, C_{19}-C_{36}	3,000	3,000	3,000	5,000	5,000	5,000	5,000		***4,500***	16.7U	15.5U	16.4	88.9	15.9U	58.4	17.5U
Aromatics, C_{11}-C_{22}	1,000	1,000	1,000	3,000	3,000	5,000	5,000		***1,890***	16.7U	15.5U	16.3U	83.4	15.9U	75.1	17.5U
Acenaphthene	4	1,000	1,000	3,000	3,000	5,000	5,000		2.97	0.22U	0.41U	0.43U	0.45U	0.42U	0.51U	0.47U
Acenaphthylene	1	600	10	600	10	600	10		1.14U	0.22U	0.21U	0.22U	0.23U	0.21U	0.26U	0.23U
Anthracene	1,000	1,000	1,000	3,000	3,000	5,000	5,000		2.27U	0.44U	0.41U	0.43U	0.45U	0.42U	0.51U	0.47U
Benzo(a)anthracene	7	7	7	40	40	300	300		2.27U	0.44U	0.41U	0.43U	0.45U	0.42U	0.51U	0.47U
Benzo(a)pyrene	2	2	2	7	7	30	30		2.27U	0.44U	0.41U	0.43U	0.45U	0.42U	0.51U	0.47U
Benzo(b)fluoranthene	7	7	7	40	40	300	300		2.27U	0.44U	0.41U	0.43U	0.45U	0.42U	0.51U	0.47U
Benzo(ghi)perylene	1,000	1,000	1,000	3,000	3,000	5,000	5,000		2.27U	0.44U	0.41U	0.43U	0.45U	0.42U	0.51U	0.47U
Benzo(k)fluoranthene	70	70	70	400	400	3,000	3,000		2.27U	0.44U	0.41U	0.43U	0.45U	0.42U	0.51U	0.47U
Chrysene	70	70	70	400	400	3,000	3,000		2.27U	0.44U	0.21U	0.43U	0.45U	0.42U	0.51U	0.47U
Dibenzo(ah)anthracene	0.7	0.7	0.7	4	4	30	30		1.14U	0.22U	0.21U	0.22U	0.23U	0.21U	0.26U	0.23U
Fluoranthene	1,000	1,000	1,000	3,000	3,000	5,000	5,000		2.27U	0.44U	0.41U	0.43U	0.45U	0.42U	0.51U	0.47U
Fluorene	1,000	1,000	1,000	3,000	3,000	5,000	5,000		5.51	0.44U	0.41U	0.43U	0.45U	0.42U	0.51U	0.47U
Indeno(1,2,3-cd)pyrene	7	7	7	40	40	300	300		2.27U	0.44U	0.41U	0.43U	0.45U	0.42U	0.51U	0.47U
Methylnaphthalene, 2-	0.7	80	300	80	500	80	500		***43.8***	0.22U	0.21U	0.22U	0.95	0.21U	0.73	0.23U
Naphthalene	4	20	500	20	1,000	20	3,000		***12.1***	0.44U	0.41U	0.43U	0.45U	0.42U	0.51U	0.47U
Phenanthrene	10	500	500	1,000	1,000	3,000	3,000		7.67	0.44U	0.41U	0.43U	0.45U	0.42U	0.51U	0.47U
Pyrene	1,000	1,000	1,000	3,000	3,000	5,000	5,000		2.27U	0.44U	0.41U	0.43U	0.45U	0.42U	0.51U	0.47U

Notes:

1) All results are mg/kg.
2) The Reportable Concentration (RCS-1) Standards apply to the 7/5/2016 samples while the S-1, S-2, and S-3 Standards apply to the 8/18/2016 samples.
3) U = Constituent was not detected at or above the indicated laboratory method reporting limit (MRL).

4) Blue text indicates the constituent was detected above the laboratory MRL, but below applicable standards.
5) *Bold, highlighted, italicized text* indicates that the constituent exceeded one or more of the applicable standards.

APPENDIX A

LIMITATIONS

USE OF REPORT

1. GZA GeoEnvironmental, Inc. (GZA) prepared this report on behalf of, and for the exclusive use of our Client for the stated purpose(s) and location(s) identified in the Proposal for Services and/or Report. Use of this report, in whole or in part, at other locations, or for other purposes, may lead to inappropriate conclusions; and we do not accept any responsibility for the consequences of such use(s). Further, reliance by any party not expressly identified in the agreement, for any use, without our prior written permission, shall be at that party's sole risk, and without any liability to GZA.

STANDARD OF CARE

2. GZA's findings and conclusions are based on the work conducted as part of the Scope of Services set forth in the Proposal for Services and/or Report and reflect our professional judgment. These findings and conclusions must be considered not as scientific or engineering certainties, but rather as our professional opinions concerning the limited data gathered during the course of our work. Conditions other than described in this report may be found at the subject location(s).

3. GZA's services were performed using the degree of skill and care ordinarily exercised by qualified professionals performing the same type of services, at the same time, under similar conditions, at the same or a similar property. No warranty, expressed or implied, is made. Specifically, GZA does not and cannot represent that the Site contains no hazardous material, oil, or other latent condition beyond that observed by GZA during its study. Additionally, GZA makes no warranty that any response action or recommended action will achieve all of its objectives or that the findings of this study will be upheld by a local, state or federal agency.

4. In conducting our work, GZA relied upon certain information made available by public agencies, Client and/or others. GZA did not attempt to independently verify the accuracy or completeness of that information. Inconsistencies in this information which we have noted, if any, are discussed in the Report.

SUBSURFACE CONDITIONS

5. The generalized soil profile(s) provided in our Report are based on widely-spaced subsurface explorations and are intended only to convey trends in subsurface conditions. The boundaries between strata are approximate and idealized, and were based on our assessment of subsurface conditions. The composition of strata, and the transitions between strata, may be more variable and more complex than indicated. For more specific information on soil conditions at a specific location refer to the exploration logs. The nature and extent of variations between these explorations may not become evident until further exploration or construction. If variations or other latent conditions then become evident, it will be necessary to reevaluate the conclusions and recommendations of this report.

6. Water level readings have been made, as described in this Report, in and monitoring wells at the specified times and under the stated conditions. These data have been reviewed and interpretations have been made in this report. Fluctuations in the level of the groundwater however occur due to temporal or spatial variations in areal recharge rates, soil heterogeneities, the presence of subsurface utilities, and/or natural or artificially induced perturbations. The observed water table may be other than indicated in the Report.

COMPLIANCE WITH CODES AND REGULATIONS

7. We used reasonable care in identifying and interpreting applicable codes and regulations necessary to execute our scope of work. These codes and regulations are subject to various, and possibly contradictory, interpretations. Interpretations and compliance with codes and regulations by other parties is beyond our control.

SCREENING AND ANALYTICAL TESTING

8. GZA collected environmental samples at the locations identified in the Report. These samples were analyzed for the specific parameters identified in the report. Additional constituents, for which analyses were not conducted, may be present in soil, groundwater, surface water, sediment and/or air. Future Site activities and uses may result in a requirement for additional testing.

9. Our interpretation of field screening and laboratory data is presented in the Report. Unless otherwise noted, we relied upon the laboratory's QA/QC program to validate these data.

10. Variations in the types and concentrations of contaminants observed at a given location or time may occur due to release mechanisms, disposal practices, changes in flow paths, and/or the influence of various physical, chemical, biological or radiological processes. Subsequently observed concentrations may be other than indicated in the Report.

INTERPRETATION OF DATA

11. Our opinions are based on available information as described in the Report, and on our professional judgment. Additional observations made over time, and/or space, may not support the opinions provided in the Report.

ADDITIONAL INFORMATION

12. In the event that the Client or others authorized to use this report obtain additional information on environmental or hazardous waste issues at the Site not contained in this report, such information shall be brought to GZA's attention forthwith. GZA will evaluate such information and, on the basis of this evaluation, may modify the conclusions stated in this report.

ADDITIONAL SERVICES

13. GZA recommends that we be retained to provide services during any future investigations, design, implementation activities, construction, and/or property development/ redevelopment at the Site. This will allow us the opportunity to: i) observe conditions and compliance with our design concepts and opinions; ii) allow for changes in the event that conditions are other than anticipated; iii) provide modifications to our design; and iv) assess the consequences of changes in technologies and/or regulations.

CONCEPTUAL SITE MODEL

14. Our opinions were developed, in part, based upon a comparison of site data to conditions anticipated within our Conceptual Site Model (CSM). The CSM is based on available information, and professional judgment. There are rarely sufficient data to develop a unique CSM. Therefore observations over time, and/or space, may vary from those depicted in the CSM provided in this report. In addition, the CSM should be evaluated and refined (as appropriate) whenever significant new information and/or data is obtained.

RISK CHARACTERIZATION

15. Our risk evaluation was performed in accordance with generally accepted practices of appropriate Federal and/or state regulatory agencies, and of other consultants undertaking similar studies at the same time, for similar purposes, and under similar circumstances. The findings of the risk evaluation are dependent on the numerous assumptions and uncertainties inherent in the risk characterization process. Sources of the uncertainty may include Site conditions; Site use; the nature, extent, concentration and distribution of contaminants; and the available toxicity and/or health/risk based regulatory information. Consequently, the findings of the risk characterization are not an absolute

characterization of actual risks; but rather serve to highlight potential incremental risks associated with activities indicated in the Report. Actual risks may be other than indicated in the Report.

APPENDIX B

BWSC-104 (Printed Version of Report Only)

APPENDIX C

METHOD 1 RISK CHARACTERIZATION

APPENDIX C

METHOD 1 RISK CHARACTERIZATION

1.00 INTRODUCTION AND SUMMARY

GZA has completed a Massachusetts Contingency Plan (MCP) Method 1 Risk Characterization (M1RC) for the disposal site (hereafter referred to as the "Site") located at 123 Pine Street in Holyoke, Massachusetts. The Site is listed with the Massachusetts Department of Environmental Protection (MassDEP) under Release Tracking Number (RTN) 1-20114. This M1RC was prepared in conjunction with the Permanent Solution Statement (PSS) that GZA is submitting for the Site. This risk characterization was conducted to establish whether a condition of No Significant Risk (NSR), as defined by the MCP, exists at the Site for current and reasonably foreseeable future land uses and activities. The MCP requires that residual levels of contaminants in impacted media not pose a significant risk to human health, safety, public welfare, or the environment considering both current and future uses of the Site. The risk characterization was completed in accordance with Subpart I of the MCP (310 CMR 40.0000) and the MassDEP (1995) guidance. This risk characterization is subject to the limitations included in Appendix A of the PSS.

The results of the M1RC indicate that soil concentrations at the Site do not exceed promulgated Method 1 Standards. Based on this comparison and the evaluation of risk of harm to safety, a condition of No Significant Risk of harm to health, safety, public welfare, and the environment has been achieved at the Site.

1.10 CONCEPTUAL SITE MODEL

The conceptual site model provides a qualitative framework for presenting the source of release, model assumptions, exposure pathways, receptors, and data that are used to characterize risks at a site.

1.11 Site Description, Site History, and Source of Release

A description of the Site conditions, the release history, and the source of release is described in the main text of the PSS.

1.12 Potential Human and Environmental Receptors and Exposure Points

The Site is currently improved with a 15,100-square foot vacant residential apartment building. The use of the Site is expected to remain residential based on the

current use of the Site and discussions with the current property owner (the City of Holyoke). GZA identified receptors based on the current and potential future uses of the Site. Potential receptors under the current use scenario include emergency/utility workers, Site visitors, and trespassers. Potential receptors under the future use scenario include construction workers, residents, and landscapers in addition to the above-referenced receptors for the current use scenario.

GZA reviewed the Massachusetts Geographical Information System (MassGIS) Priority Resources map for the Site and surrounding properties. According to the MassGIS Priority Resource map, the Site is not located within a protected groundwater resource area (potentially productive aquifer, sole source aquifer, interim well head protection area, Zone II, etc.) (Figure C-1); there are no known public surface or groundwater drinking water supplies within ½ mile of the Site.

The Connecticut River is approximately 2,000 feet northeast of the Site. There are no wetland areas, Natural Heritage and Endangered Species Program (NHESP) Estimated Habitats of Rare Wildlife, Areas of Critical Environmental Concern (ACEC), or habitats of Species of Special Concern, or Threatened or Endangered Species within 500 feet of the Site (Figure C-1).

The environmental media that receptors may contact include indoor air, soil and soil-derived dust.

2.00 ANALYTICAL DATA

2.10 SOIL ANALYTICAL DATA

Soil analytical data used in this risk characterization are presented in Table C-1. All soil data representative of the current Site conditions were included in this risk characterization. The analytical results for soil samples "BSMT-2" and "123 Pine – S-6", which were collected on July 5, 2016 and August 18, 2016, respectively, are not included in Table C-1. Soil associated with these samples has since been excavated and disposed off-Site. The two soil samples referenced above are not representative of the current Site conditions and therefore are not used for this risk characterization. No data were rejected based on the Representative Evaluation and Data Usability Assessments (REDUA; Appendix G of the PSS) and therefore all soil analytical results included in Table C-1 are included in this M1RC.

Extractable petroleum hydrocarbon (EPH) fractions and target analytes were detected in four soil samples collected from the Site. All detected analytes were identified as constituents of concern (COCs) and consequently evaluated in this risk characterization.

2.20 GROUNDWATER ANALYTICAL DATA

Groundwater was not encountered during the Release Abatement Measure (RAM) activities, which were performed at the Site in April 2017. The residual contamination in Site soil is likely related to an above ground storage tank (AST) release. Groundwater is not identified as a medium of concern and no groundwater samples have been collected from the Site.

3.00 SOIL AND GROUNDWATER CATEGORIZATION

The MCP provides standards based on the likely exposures to contamination at or from a site. Soil and groundwater categories for the Site were identified and are described below.

3.10 SOIL CLASSIFICATION

The MCP identifies three soil categories (S-1, S-2, and S-3) to describe the potential for contact with soil at a site. Category S-1 soils represent the highest potential for exposure (such as unrestricted residential exposure to soil) while Category S-3 soils represent the lowest potential for exposure. The potential for exposure to constituents of concern in soil is determined through a qualitative analysis, which considers both the accessibility of soil (*i.e.*, accessible, potentially accessible, or isolated) and the frequency and intensity of potential exposure (low or high).

As defined in the MCP (310 CMR 40.0933(4)(c)), soils located from 0 to 3 feet below ground surface (bgs) in unpaved areas are considered accessible, soils located from 3 to 15 feet bgs in unpaved areas and from 0 to 15 feet bgs in paved areas are considered potentially accessible, and soils located greater than 15 feet bgs or beneath a building or permanent structure are considered isolated. Based on their location under the footprint of a building, soils in the release area are classified as isolated subsurface soils. Any potentially impacted soils that may be present outside the footprint of the building would be classified as potentially accessible soil, due to their depth below grade of approximately seven feet bgs. There are no accessible (surficial) soils associated with this release.

The Site is currently vacant; adults are expected to be present at the Site at high frequency and high intensity (*e.g.*, construction workers) or low frequency and low intensity (*e.g.*, trespassers). Children are expected to be present at the Site at low frequency and low intensity (*e.g.*, trespassers). Based on the characterization of soil and the Soil Category Selection Matrix contained in the MCP (310 CMR 40.0933(9)), potentially accessible soil at the Site is classified as S-2/S-3, and isolated subsurface soil is classified as S-3 under the current use scenario. If the Site is to be redeveloped for residential use in the future,

potentially accessible soils will be classified as S-1 and S-2, while isolated subsurface soils will be classified as S-3.

3.20 GROUNDWATER CLASSIFICATION

Groundwater was not encountered during response actions at the Site. Therefore, groundwater was not considered as part of the M1RC. However, GZA is providing the Site groundwater classification below for reference, and for determining the appropriate Method 1 Soil Standards to apply to the soils data.

Groundwater at the Site is not located in a current or potential drinking water source area and does not meet the MCP criteria (310 CMR 40.0932(4)) for groundwater classification as Category GW-1. GZA confirmed that the Site is:

- not within a Zone II[1] or Interim Wellhead Protection Area (IWPA)[2];
- not within the Zone A[3] of a Class A Surface Water Body;
- not above a medium-yield or high-yield potentially productive aquifer which may be used for potable water supply; and
- within 500 feet of a public water supply distribution pipeline.

There are no private drinking water wells within 500 feet of the Site, and the Site is not located within 400 feet of a Class A Surface Water Body; therefore, contact with constituents in groundwater through drinking water supplies is not a potential exposure pathway at the Site.

According to the MCP (310 CMR 40.0932(6)), groundwater shall be defined to be in category GW-2 if it is located within 30 feet of an existing or planned building or structure that is or will be occupied, and the average annual depth to ground water in that area is 15 feet or less[4]. There are occupied building structures within 30 feet of the Site. Therefore, groundwater located within the Site boundaries is classified as GW-2.

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[1] Zone II means the area of an aquifer that contributes water to a well under the most severe pumping and recharge conditions that can be realistically anticipated, as approved by MassDEP's Division of Water Supply, pursuant to 310 CMR 22.00.

[2] IWPA means: (1) with respect to public water supply wells and wellfields whose pumping rate is 100,000 gallons per day or greater and for which MassDEP has not approved a hydrologically delineated Zone II, the 1/2-mile radius surrounding such a well or wellfield; and (2) with respect to public water supply wells and wellfields whose pumping rate is less than 100,000 gallons per day and for which MassDEP has not approved a hydrologically delineated Zone II, the radius calculated by multiplying the maximum pumping rate in gallons per minute for such a well or wellfield by 32 and adding 400 feet thereto.

[3] Zone A means the area within 400 feet laterally from the bank of a Class A surface drinking water source (as identified in 314 CMR 4.00) or within 200 feet of its tributaries.

[4] Depth to groundwater at the Site is not known. However, the average annual depth is estimated to be less than 15 feet based on other investigations which have occurred in the vicinity, which GZA reviewed.

According to the MCP (310 CMR 40.0932(2)), groundwater at all sites is considered to be a potential source of discharge to surface water and therefore is classified as GW-3.

4.00 IDENTIFICATION OF APPLICABLE STANDARDS

The soil and groundwater categories identified above were used to identify the Method 1 Standards that are applicable to the Site. Soil at the Site currently is classified as S-2 and S-3. Groundwater is classified as GW-2 and GW-3; therefore, Method 1 S-2/GW-2, S-2/GW-3, S-3/GW-2 and S-3/GW-3 soil standards were selected as the applicable standards for soil at the Site under the current use scenario. However, the Site may potentially be redeveloped for residential uses in the future. The S-1/GW-2 and S-1/GW-3 soil standards will be protective in the case of potential future redevelopment of the Site for residential use, along with the existing applicable standards for the Site.

5.00 CHARACTERIZATION OF RISK OF HARM

5.10 HEALTH, PUBLIC WELFARE, AND ENVIRONMENT

In accordance with 310 CMR 40.0971, a Method 1 Risk Characterization approach was selected because the Site conditions met the following criteria: (1) MCP Method 1 Standards have been promulgated for all Site COCs; (2) contamination is limited to soil or groundwater[5]; (3) no Environmental Receptors have been identified for the Site and there are no chemicals detected in samples collected from within two feet of the ground surface that are known to bioaccumulate.

It should be noted that EPH fractions were detected in soil beneath the on-Site building. Two EPH fractions (C_{11}-C_{22} aromatic hydrocarbons and C_9-C_{18} aliphatic hydrocarbons) are considered volatile; therefore, there is potential impact to indoor air of the on-Site building. The potential vapor intrusion pathway was not deemed a complete exposure pathway under the current use condition as the building is currently unoccupied. In accordance with 310 CMR 40.0942(1)(d), "*If one or more Volatile Organic Compounds is present in vadose zone soil adjacent to an occupied structure (within six feet, measured horizontally from the wall of the structure, and within ten feet, measured vertically from the basement floor or foundation slab) then the soil has the potential to result in significant indoor air concentrations of OHM… The MCP Method 1 Standards may be used in combination with a demonstration that the soil concentrations of Oil and Hazardous Material*

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using MassDEP's online *Waste Site / Reportable Releases Look Up*.

[5] There is no evidence that groundwater at the Site has been impacted by the Site release.

are not likely to be a significant contributor to the Cumulative Receptor Risk at the site by the indoor air exposure pathway." GZA performed a screening-level risk evaluation to estimate risks to future building occupants via the potential vapor intrusion pathway.

GZA estimated the soil gas concentrations in the source area using the Johnson and Ettinger model and the equation presented below.

$$EPC_{soil\ \ gas} = EPC_{soil} * H * g_d * C1/(n_m + (K_{oc} * f_{oc} * g_d) + (H * n_v))$$

Where:

$EPC_{soil\ gas}$	=	estimated soil gas exposure point concentration (EPC) (µg/m^3)
EPC_{soil}	=	soil concentration (mg/kg), the maximum concentrations detected in soil were used.
H	=	constituent's Henry's Law constant (dimensionless)
g_d	=	soil bulk density (g/cm^3)
n_m	=	soil water filled porosity (cm^3/cm^3)
C1	=	units conversion factor (µg/mg), 1000
K_{oc}	=	organic carbon partitioning coefficient (cm^3/g)
f_{oc}	=	soil organic carbon fraction (unitless), assumed 0.2%
n_v	=	soil vapor filled porosity (cm^3/cm^3)

The chemical-specific parameters from the MassDEP (2014) *Development of MCP Risk Based Levels for Soil and Groundwater* were adopted for this screening-level risk evaluation, while the soil characteristics parameters for sand included in the USEPA Johnson and Ettinger Model were adopted for this risk evaluation.

The indoor air concentrations were then modeled based on the attenuation factors calculated using the Johnson and Ettinger Model. The detailed discussion and calculations are included in Appendix H. The following assumptions were used in the calculation of attenuation factors for the basement of the on-Site building: (1) the buildings were assumed to be constructed with an 8-foot basement, (2) the distance between the soil source and the bottom of the basement was assumed to be on average 4 feet[6], (3) the air exchange rate in the basement was assumed to be 0.45 air exchange per hour, which is MassDEP's default assumption, (4) the area of the building was assumed to be 60 feet by 50 feet , and 5) the soil beneath the building was assumed to be sand and a default 0.1% crack area was assumed.

GZA then used the Method 3 Risk Assessment for Resident Exposed to Chemicals in Indoor Air – Shortform 2012 (2015 Revision, the "Shortform") to estimate risks to potential future residents, and the risk results are included in Appendix I. As shown in Appendix I the non-cancer hazard index was less than 1/10 of the MCP risk limit (0.015 vs.

[6] The maximum soil concentrations, which were used as the soil EPCs for the risk evaluation, were detected at 4.25 feet below the bottom of the basement.

1), indicating the risks associated the potential vapor intrusion pathway would be minor. Therefore, Method 1 is an appropriate approach to assess risks at the Site.

All detected analytes were identified as COCs for this risk characterization. As shown in Table C-1, the maximum detected concentrations for all COCs were below the applicable Method 1 Standards. Therefore, based on the comparisons of the soil results to the identified Method 1 Standards, a condition of No Significant Risk of harm to health, public welfare, and the environment exists for soil at the Site for current and foreseeable future land uses.

5.20 SAFETY

The purpose of evaluating the risk of harm to safety is to identify release-related conditions at the Site that could pose a threat of physical harm or bodily injury to people. Examples of conditions that constitute a risk of harm to safety are: the presence of rusted or corroded drums or containers; weakened berms; unsecured pits, ponds, lagoons, or other dangerous structures; any threat of fire or explosion, including the presence of explosive vapors resulting from a release of oils and or hazardous materials (OHM); reactive chemicals stored or disposed of in a way that does not reasonably preclude uncontrolled reactions; any uncontained materials which exhibit the characteristics of corrosivity, reactivity, or flammability described in 310 CMR 40.0347; or the presence of ionizing or non-ionizing radiation.

No such safety hazards described above were identified at the Site, nor are they anticipated to occur in the future. Therefore, a condition of No Significant Risk of harm to safety exists at the Site.

6.00 SUMMARY AND CONCLUSIONS

The soil concentrations were below the identified Method 1 Standards. Therefore, a condition of No Significant Risk of harm to health, public welfare, and the environment exists for soil at the Site for current and foreseeable future land uses.

No safety hazards described in 310 CMR 40.0347 were identified at the Site, nor are they anticipated to occur in the future. Therefore, a condition of No Significant Risk of harm to safety exists at the Site.

In summary, a condition of No Significant Risks to human health, safety, public welfare, and the environment exists at the Site for current and foreseeable future land uses.

REFERENCES

Commonwealth of Massachusetts, February 14, 2008. *Massachusetts Contingency Plan*. 310 CMR 40.0000. Massachusetts Department of Environmental Protection (MassDEP), Bureau of Waste Site Cleanup.

Commonwealth of Massachusetts, April 2014. *Final Amendments to the Massachusetts Contingency Plan, 310 CMR 40.0000*. Massachusetts Department of Environmental Protection (MassDEP), Bureau of Waste Site Cleanup.

MassDEP, July 1995. *Guidance for Disposal Site Risk Characterization in Support of the Massachusetts Contingency Plan. Interim Final Policy #WSC/ORS-95-141*. Massachusetts Department of Environmental Protection, Bureau of Waste Site Cleanup and Office of Research and Standards.

J:\0 166500 - 0 166599\15.0166521.00 123 Pine Street Phase I ESA\Reports\Draft Reports\PSS\M1RC\123 Pine St Method 1 RC, DRAFT.doc

Figure C-1

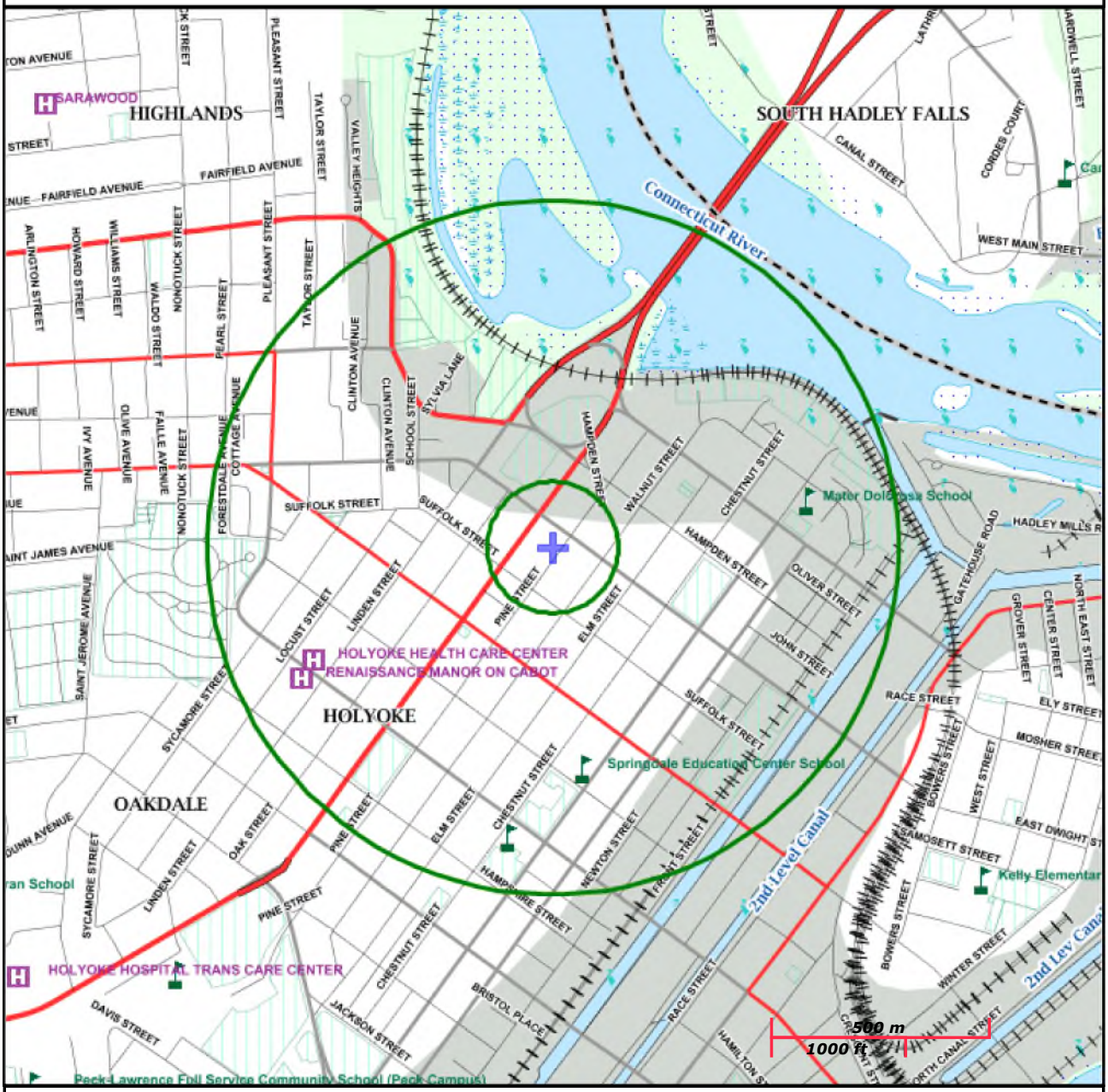
MassDEP - Bureau of Waste Site Cleanup

Phase 1 Site Assessment Map: 500 feet & 0.5 Mile Radii

Site Information:
123 PINE ST HOLYOKE, MA
NAD83 UTM Meters:
4675773mN , 697084mE (Zone: 18)
May 10, 2017

The information shown is the best available at the date of printing. However, it may be incomplete. The responsible party and LSP are ultimately responsible for ascertaining the true conditions surrounding the site. Metadata for data layers shown on this map can be found at: http://www.mass.gov/mgis/.

MassDEP
Commonwealth of Massachusetts
Department of Environmental Protection



Roads: Limited Access, Divided, Other Hwy, Major Road, Minor Road, Track, Trail
Boundaries: Town, County, DEP Region; Train; Powerline; Pipeline; Aqueduct
Basins: Major, PWS; Streams: Perennial, Intermittent, Man Made Shore, Dam
Aquifers: Medium Yield, High Yield, EPA Sole Source
Non Potential Drinking Water Source Area: Medium, High (Yield)
PWS Protection Areas: Zone II, IWPA, Zone A
Hydrography: Open Water, PWS Reservoir, Tidal Flat
Wetlands: Freshwater, Saltwater, Cranberry Bog
FEMA 100yr Floodplain; Protected Open Space; ACEC
Est. Rare Wetland Wildlife Hab; Vernal Pool: Cert., Potential
Solid Waste Landfill; PWS: Com.GW,SW, Emerg., Non-Com.

APPENDIX D

ANALYTICAL DATA REPORTS

CERTIFICATE OF ANALYSIS

Adam Cote
GZA GeoEnvironmental, Inc.
1350 Main Street, Suite 1400
Springfield, MA 01103

RE: 123 Pine Street (15.0166521)
ESS Laboratory Work Order Number: 1607072

This signed Certificate of Analysis is our approved release of your analytical results. These results are only representative of sample aliquots received at the laboratory. ESS Laboratory expects its clients to follow all regulatory sampling guidelines. Beginning with this page, the entire report has been paginated. This report should not be copied except in full without the approval of the laboratory. Samples will be disposed of thirty days after the final report has been delivered. If you have any questions or concerns, please feel free to call our Customer Service Department.

Laurel Stoddard
Laboratory Director

REVIEWED
By ESS Laboratory at 2:11 pm, Jul 18, 2016

Analytical Summary
The project as described above has been analyzed in accordance with the ESS Quality Assurance Plan. This plan utilizes the following methodologies: US EPA SW-846, US EPA Methods for Chemical Analysis of Water and Wastes per 40 CFR Part 136, APHA Standard Methods for the Examination of Water and Wastewater, American Society for Testing and Materials (ASTM), and other recognized methodologies. The analyses with these noted observations are in conformance to the Quality Assurance Plan. In chromatographic analysis, manual integration is frequently used instead of automated integration because it produces more accurate results.

The test results present in this report are in compliance with NELAC Standards, A2LA and/or client Quality Assurance Project Plans (QAPP). The laboratory has reviewed the following: Sample Preservations, Hold Times, Initial Calibrations, Continuing Calibrations, Method Blanks, Blank Spikes, Blank Spike Duplicates, Duplicates, Matrix Spikes, Matrix Spike Duplicates, Surrogates and Internal Standards. Any results which were found to be outside of the recommended ranges stated in our SOPs will be noted in the Project Narrative.

CERTIFICATE OF ANALYSIS

Client Name: GZA GeoEnvironmental, Inc.
Client Project ID: 123 Pine Street

ESS Laboratory Work Order: 1607072

SAMPLE RECEIPT

The following samples were received on July 07, 2016 for the analyses specified on the enclosed Chain of Custody Record.

To achieve CAM compliance for MCP data, ESS Laboratory has performed and reviewed all QA/QC Requirements and Performance Standards listed in each method. Holding times and preservation have also been reviewed. All CAM requirements have been achieved unless noted in the project narrative.

Each method has been set-up in the laboratory to reach required MCP standards. The methods for aqueous VOA and Soil Methanol VOA have known limitations for certain analytes. The regulatory standards may not be achieved due to these limitations. In addition, for all methods, matrix interferences, dilutions, and %Solids may elevate method reporting limits above regulatory standards. ESS Laboratory can provide, upon request, a Data Checker (regulatory standard comparison spreadsheet) electronic deliverable which will highlight these exceedances.

Lab Number	Sample Name	Matrix	Analysis
1607072-01	BSMT-2	Soil	EPH8270, MADEP-EPH
1607072-02	BSMT-3	Soil	EPH8270, MADEP-EPH

CERTIFICATE OF ANALYSIS

Client Name: GZA GeoEnvironmental, Inc.
Client Project ID: 123 Pine Street

ESS Laboratory Work Order: 1607072

PROJECT NARRATIVE

MADEP-EPH Extractable Petroleum Hydrocarbons
1607072-01 **Surrogate recovery(ies) diluted below the MRL (SD).**
1-Chlorooctadecane (% @ 40-140%)

No other observations noted.

End of Project Narrative.

DATA USABILITY LINKS

Definitions of Quality Control Parameters

Semivolatile Organics Internal Standard Information

Semivolatile Organics Surrogate Information

Volatile Organics Internal Standard Information

Volatile Organics Surrogate Information

EPH and VPH Alkane Lists

CERTIFICATE OF ANALYSIS

Client Name: GZA GeoEnvironmental, Inc.
Client Project ID: 123 Pine Street

ESS Laboratory Work Order: 1607072

CURRENT SW-846 METHODOLOGY VERSIONS

Analytical Methods

1010A - Flashpoint
6010C - ICP
6020A - ICP MS
7010 - Graphite Furnace
7196A - Hexavalent Chromium
7470A - Aqueous Mercury
7471B - Solid Mercury
8011 - EDB/DBCP/TCP
8015D - GRO/DRO
8081B - Pesticides
8082A - PCB
8100M - TPH
8151A - Herbicides
8260B - VOA
8270D - SVOA
8270D SIM - SVOA Low Level
9014 - Cyanide
9038 - Sulfate
9040C - Aqueous pH
9045D - Solid pH (Corrosivity)
9050A - Specific Conductance
9056A - Anions (IC)
9060A - TOC
9095B - Paint Filter
MADEP 04-1.1 - EPH / VPH

Prep Methods

3005A - Aqueous ICP Digestion
3020A - Aqueous Graphite Furnace / ICP MS Digestion
3050B - Solid ICP / Graphite Furnace / ICP MS Digestion
3060A - Solid Hexavalent Chromium Digestion
3510C - Separatory Funnel Extraction
3520C - Liquid / Liquid Extraction
3540C - Manual Soxhlet Extraction
3541 - Automated Soxhlet Extraction
3546 - Microwave Extraction
3580A - Waste Dilution
5030B - Aqueous Purge and Trap
5030C - Aqueous Purge and Trap
5035 - Solid Purge and Trap

SW846 Reactivity Methods 7.3.3.2 (Reactive Cyanide) and 7.3.4.1 (Reactive Sulfide) have been withdrawn by EPA. These methods are reported per client request and are not NELAP accredited.

CERTIFICATE OF ANALYSIS

Client Name: GZA GeoEnvironmental, Inc.
Client Project ID: 123 Pine Street

ESS Laboratory Work Order: 1607072

MassDEP Analytical Protocol Certification Form

MADEP RTN: _____

This form provides certification for the following data set: **1607072-01 through 1607072-02**

Matrices: ( ) Ground Water/Surface Water (X) Soil/Sediment ( ) Drinking Water ( ) Air ( ) Other:_____

CAM Protocol (check all that apply below):

( ) 8260 VOC CAM II A	( ) 7470/7471 Hg CAM III B	( ) MassDEP VPH CAM IV A	( ) 8081 Pesticides CAM V B	( ) 7196 Hex Cr CAM VI B	( ) MassDEP APH CAM IX A
( ) 8270 SVOC CAM II B	( ) 7010 Metals CAM III C	(X) MassDEP EPH CAM IV B	( ) 8151 Herbicides CAM V C	( ) 8330 Explosives CAM VIII A	( ) TO-15 VOC CAM IX B
( ) 6010 Metals CAM III A	( ) 6020 Metals CAM III D	( ) 8082 PCB CAM V A	( ) 6860 Perchlorate CAM VIII B	( ) 9014 Total Cyanide/PAC CAM VI A	

Affirmative responses to questions A through F are required for "Presumptive Certainty" status

A	Were all samples received in a condition consistent with those described on the Chain-of-Custody, properly preserved (including temperature) in the field or laboratory, and prepared/analyzed within method holding times?	Yes (X) No ( )
B	Were the analytical method(s) and all associated QC requirements specified in the selected CAM protocol(s) followed?	Yes (X) No ( )
C	Were all required corrective actions and analytical response actions specified in the selected CAM protocol(s) implemented for all identified performance standard non-conformances?	Yes (X) No ( )
D	Does the laboratory report comply with all the reporting requirements specified in the CAM VII A, "Quality Assurance and Quality Control Guidelines for the Acquisition and Reporting of Analytical Data"?	Yes (X) No ( )
E	a. VPH, EPH, APH and TO-15 only: Was each method conducted without significant modification(s)? (Refer to the individual method(s) for a list of significant modifications).	Yes (X) No ( )
	b. APH and TO-15 Methods only: Was the complete analyte list reported for each method?	Yes ( ) No ( )
F	Were all applicable CAM protocol QC and performance standard non-conformances identified and evaluated in a laboratory narrative (including all "No" responses to Questions A through E)?	Yes (X) No ( )

Responses to Questions G, H and I below are required for "Presumptive Certainty" status

G	Were the reporting limits at or below all CAM reporting limits specified in the selected CAM protocols(s)?	Yes (X) No ( )*
	***Data User Note:* Data that achieve "Presumptive Certainty" status may not necessarily meet the data usability and representativeness requirements described in 310 CMR 40. 1056 (2)(k) and WSC-07-350.**	
H	Were **all** QC performance standards specified in the CAM protocol(s) achieved?	Yes ( ) No (X)*
I	Were results reported for the complete analyte list specified in the selected CAM protocol(s)?	Yes (X) No ( )*

All negative responses must be addressed in an attached laboratory narrative.

I, the undersigned, attest under the pains and penalties of perjury that, based upon my personal inquiry of those responsible for obtaining the information, the material contained in this analytical report is, to the best of my knowledge and belief, accurate and complete.

Signature: Laurel Stoddard

Date: July 18, 2016

Printed Name: Laurel Stoddard

Position: Laboratory Director

CERTIFICATE OF ANALYSIS

Client Name: GZA GeoEnvironmental, Inc.
Client Project ID: 123 Pine Street
Client Sample ID: BSMT-2
Date Sampled: 07/05/16 12:40
Percent Solids: 90
Initial Volume: 24.4
Final Volume: 1
Extraction Method: 3546

ESS Laboratory Work Order: 1607072
ESS Laboratory Sample ID: 1607072-01
Sample Matrix: Soil
Units: mg/kg dry

Prepared: 7/7/16 18:10

MADEP-EPH Extractable Petroleum Hydrocarbons

Analyte	Results (MRL)	MDL	Method	Limit	DF	Analyst	Analyzed	Sequence	Batch
C9-C18 Aliphatics1	**19900** (341)		MADEP-EPH		20	ZLC	07/13/16 1:15	CZG0125	CG60715
C19-C36 Aliphatics1	**4500** (341)		MADEP-EPH		20	ZLC	07/13/16 1:15	CZG0125	CG60715
C11-C22 Unadjusted Aromatics1	**1960** (85.2)		EPH8270		5	VSC	07/14/16 17:02	CZG0181	CG60715
C11-C22 Aromatics1,2	**1890** (85.2)		EPH8270			VSC	07/14/16 17:36		[CALC]
2-Methylnaphthalene	**43.8** (5.68)		EPH8270		25	VSC	07/14/16 17:36	CZG0181	CG60715
Acenaphthene	**2.97** (2.27)		EPH8270		5	VSC	07/14/16 17:02	CZG0181	CG60715
Naphthalene	**12.1** (2.27)		EPH8270		5	VSC	07/14/16 17:02	CZG0181	CG60715
Phenanthrene	**7.67** (2.27)		EPH8270		5	VSC	07/14/16 17:02	CZG0181	CG60715
Acenaphthylene	ND (1.14)		EPH8270		5	VSC	07/14/16 17:02	CZG0181	CG60715
Anthracene	ND (2.27)		EPH8270		5	VSC	07/14/16 17:02	CZG0181	CG60715
Benzo(a)anthracene	ND (2.27)		EPH8270		5	VSC	07/14/16 17:02	CZG0181	CG60715
Benzo(a)pyrene	ND (2.27)		EPH8270		5	VSC	07/14/16 17:02	CZG0181	CG60715
Benzo(b)fluoranthene	ND (2.27)		EPH8270		5	VSC	07/14/16 17:02	CZG0181	CG60715
Benzo(g,h,i)perylene	ND (2.27)		EPH8270		5	VSC	07/14/16 17:02	CZG0181	CG60715
Benzo(k)fluoranthene	ND (2.27)		EPH8270		5	VSC	07/14/16 17:02	CZG0181	CG60715
Chrysene	ND (2.27)		EPH8270		5	VSC	07/14/16 17:02	CZG0181	CG60715
Dibenzo(a,h)Anthracene	ND (1.14)		EPH8270		5	VSC	07/14/16 17:02	CZG0181	CG60715
Fluoranthene	ND (2.27)		EPH8270		5	VSC	07/14/16 17:02	CZG0181	CG60715
Fluorene	**5.51** (2.27)		EPH8270		5	VSC	07/14/16 17:02	CZG0181	CG60715
Indeno(1,2,3-cd)Pyrene	ND (2.27)		EPH8270		5	VSC	07/14/16 17:02	CZG0181	CG60715
Pyrene	ND (2.27)		EPH8270		5	VSC	07/14/16 17:02	CZG0181	CG60715

	%Recovery	Qualifier	Limits
Surrogate: 1-Chlorooctadecane	*%*	*SD*	*40-140*
Surrogate: 2-Bromonaphthalene	*48 %*		*40-140*
Surrogate: 2-Fluorobiphenyl	*62 %*		*40-140*
Surrogate: O-Terphenyl	*64 %*		*40-140*

CERTIFICATE OF ANALYSIS

Client Name: GZA GeoEnvironmental, Inc.
Client Project ID: 123 Pine Street
Client Sample ID: BSMT-3
Date Sampled: 07/05/16 12:50
Percent Solids: 92
Initial Volume: 24.5
Final Volume: 1
Extraction Method: 3546

ESS Laboratory Work Order: 1607072
ESS Laboratory Sample ID: 1607072-02
Sample Matrix: Soil
Units: mg/kg dry

Prepared: 7/7/16 18:10

MADEP-EPH Extractable Petroleum Hydrocarbons

Analyte	Results (MRL)	MDL	Method	Limit	DF	Analyst	Analyzed	Sequence	Batch
C9-C18 Aliphatics1	**27.3** (16.7)		MADEP-EPH		1	ZLC	07/13/16 2:03	CZG0125	CG60715
C19-C36 Aliphatics1	ND (16.7)		MADEP-EPH		1	ZLC	07/13/16 2:03	CZG0125	CG60715
C11-C22 Unadjusted Aromatics1	ND (16.7)		EPH8270		1	VSC	07/14/16 15:54	CZG0181	CG60715
C11-C22 Aromatics1,2	ND (16.7)		EPH8270			VSC	07/14/16 15:54		[CALC]
2-Methylnaphthalene	ND (0.22)		EPH8270		1	VSC	07/14/16 15:54	CZG0181	CG60715
Acenaphthene	ND (0.44)		EPH8270		1	VSC	07/14/16 15:54	CZG0181	CG60715
Naphthalene	ND (0.44)		EPH8270		1	VSC	07/14/16 15:54	CZG0181	CG60715
Phenanthrene	ND (0.44)		EPH8270		1	VSC	07/14/16 15:54	CZG0181	CG60715
Acenaphthylene	ND (0.22)		EPH8270		1	VSC	07/14/16 15:54	CZG0181	CG60715
Anthracene	ND (0.44)		EPH8270		1	VSC	07/14/16 15:54	CZG0181	CG60715
Benzo(a)anthracene	ND (0.44)		EPH8270		1	VSC	07/14/16 15:54	CZG0181	CG60715
Benzo(a)pyrene	ND (0.44)		EPH8270		1	VSC	07/14/16 15:54	CZG0181	CG60715
Benzo(b)fluoranthene	ND (0.44)		EPH8270		1	VSC	07/14/16 15:54	CZG0181	CG60715
Benzo(g,h,i)perylene	ND (0.44)		EPH8270		1	VSC	07/14/16 15:54	CZG0181	CG60715
Benzo(k)fluoranthene	ND (0.44)		EPH8270		1	VSC	07/14/16 15:54	CZG0181	CG60715
Chrysene	ND (0.44)		EPH8270		1	VSC	07/14/16 15:54	CZG0181	CG60715
Dibenzo(a,h)Anthracene	ND (0.22)		EPH8270		1	VSC	07/14/16 15:54	CZG0181	CG60715
Fluoranthene	ND (0.44)		EPH8270		1	VSC	07/14/16 15:54	CZG0181	CG60715
Fluorene	ND (0.44)		EPH8270		1	VSC	07/14/16 15:54	CZG0181	CG60715
Indeno(1,2,3-cd)Pyrene	ND (0.44)		EPH8270		1	VSC	07/14/16 15:54	CZG0181	CG60715
Pyrene	ND (0.44)		EPH8270		1	VSC	07/14/16 15:54	CZG0181	CG60715

	%Recovery	Qualifier	Limits
Surrogate: 1-Chlorooctadecane	*80 %*		*40-140*
Surrogate: 2-Bromonaphthalene	*78 %*		*40-140*
Surrogate: 2-Fluorobiphenyl	*73 %*		*40-140*
Surrogate: O-Terphenyl	*75 %*		*40-140*

CERTIFICATE OF ANALYSIS

Client Name: GZA GeoEnvironmental, Inc.
Client Project ID: 123 Pine Street

ESS Laboratory Work Order: 1607072

Quality Control Data

Analyte	Result	MRL	Units	Spike Level	Source Result	%REC	%REC Limits	RPD	RPD Limit	Qualifier
MADEP-EPH Extractable Petroleum Hydrocarbons										
Batch CG60715 - 3546										
Blank										
C19-C36 Aliphatics1	ND	15.0	mg/kg wet							
C9-C18 Aliphatics1	ND	15.0	mg/kg wet							
Decane (C10)	ND	0.5	mg/kg wet							
Docosane (C22)	ND	0.5	mg/kg wet							
Dodecane (C12)	ND	0.5	mg/kg wet							
Eicosane (C20)	ND	0.5	mg/kg wet							
Hexacosane (C26)	ND	0.5	mg/kg wet							
Hexadecane (C16)	ND	0.5	mg/kg wet							
Hexatriacontane (C36)	ND	0.5	mg/kg wet							
Nonadecane (C19)	ND	0.5	mg/kg wet							
Nonane (C9)	ND	0.5	mg/kg wet							
Octacosane (C28)	ND	0.5	mg/kg wet							
Octadecane (C18)	ND	0.5	mg/kg wet							
Tetracosane (C24)	ND	0.5	mg/kg wet							
Tetradecane (C14)	ND	0.5	mg/kg wet							
Triacontane (C30)	ND	0.5	mg/kg wet							
Surrogate: 1-Chlorooctadecane	*1.70*		mg/kg wet	*2.000*		*85*	*40-140*			
Blank										
2-Methylnaphthalene	ND	0.20	mg/kg wet							
Acenaphthene	ND	0.40	mg/kg wet							
Acenaphthylene	ND	0.20	mg/kg wet							
Anthracene	ND	0.40	mg/kg wet							
Benzo(a)anthracene	ND	0.40	mg/kg wet							
Benzo(a)pyrene	ND	0.40	mg/kg wet							
Benzo(b)fluoranthene	ND	0.40	mg/kg wet							
Benzo(g,h,i)perylene	ND	0.40	mg/kg wet							
Benzo(k)fluoranthene	ND	0.40	mg/kg wet							
C11-C22 Aromatics1,2	ND	15.0	mg/kg wet							
C11-C22 Unadjusted Aromatics1	ND	15.0	mg/kg wet							
Chrysene	ND	0.40	mg/kg wet							
Dibenzo(a,h)Anthracene	ND	0.20	mg/kg wet							
Fluoranthene	ND	0.40	mg/kg wet							
Fluorene	ND	0.40	mg/kg wet							
Indeno(1,2,3-cd)Pyrene	ND	0.40	mg/kg wet							
Naphthalene	ND	0.40	mg/kg wet							
Phenanthrene	ND	0.40	mg/kg wet							
Pyrene	ND	0.40	mg/kg wet							
Surrogate: 2-Bromonaphthalene	*1.92*		mg/kg wet	*2.000*		*96*	*40-140*			
Surrogate: 2-Fluorobiphenyl	*1.84*		mg/kg wet	*2.000*		*92*	*40-140*			
Surrogate: O-Terphenyl	*1.97*		mg/kg wet	*2.000*		*98*	*40-140*			
LCS										
C19-C36 Aliphatics1	18.1	15.0	mg/kg wet	16.00		113	40-140			
C9-C18 Aliphatics1	11.7	15.0	mg/kg wet	12.00		97	40-140			

CERTIFICATE OF ANALYSIS

Client Name: GZA GeoEnvironmental, Inc.
Client Project ID: 123 Pine Street

ESS Laboratory Work Order: 1607072

Quality Control Data

Analyte	Result	MRL	Units	Spike Level	Source Result	%REC	%REC Limits	RPD	RPD Limit	Qualifier
MADEP-EPH Extractable Petroleum Hydrocarbons										
Batch CG60715 - 3546										
Decane (C10)	1.1	0.5	mg/kg wet	2.000		57	40-140			
Docosane (C22)	1.7	0.5	mg/kg wet	2.000		87	40-140			
Dodecane (C12)	1.2	0.5	mg/kg wet	2.000		62	40-140			
Eicosane (C20)	1.7	0.5	mg/kg wet	2.000		85	40-140			
Hexacosane (C26)	1.7	0.5	mg/kg wet	2.000		86	40-140			
Hexadecane (C16)	1.6	0.5	mg/kg wet	2.000		79	40-140			
Hexatriacontane (C36)	1.5	0.5	mg/kg wet	2.000		75	40-140			
Nonadecane (C19)	1.7	0.5	mg/kg wet	2.000		85	40-140			
Nonane (C9)	0.9	0.5	mg/kg wet	2.000		46	30-140			
Octacosane (C28)	1.6	0.5	mg/kg wet	2.000		81	40-140			
Octadecane (C18)	1.7	0.5	mg/kg wet	2.000		85	40-140			
Tetracosane (C24)	1.7	0.5	mg/kg wet	2.000		83	40-140			
Tetradecane (C14)	1.4	0.5	mg/kg wet	2.000		70	40-140			
Triacontane (C30)	1.6	0.5	mg/kg wet	2.000		81	40-140			
Surrogate: 1-Chlorooctadecane	*1.74*		mg/kg wet	*2.000*		*87*	*40-140*			
LCS										
2-Methylnaphthalene	1.14	0.20	mg/kg wet	2.000		57	40-140			
Acenaphthene	1.28	0.40	mg/kg wet	2.000		64	40-140			
Acenaphthylene	1.32	0.20	mg/kg wet	2.000		66	40-140			
Anthracene	1.38	0.40	mg/kg wet	2.000		69	40-140			
Benzo(a)anthracene	1.46	0.40	mg/kg wet	2.000		73	40-140			
Benzo(a)pyrene	1.60	0.40	mg/kg wet	2.000		80	40-140			
Benzo(b)fluoranthene	1.56	0.40	mg/kg wet	2.000		78	40-140			
Benzo(g,h,i)perylene	1.57	0.40	mg/kg wet	2.000		79	40-140			
Benzo(k)fluoranthene	1.57	0.40	mg/kg wet	2.000		78	40-140			
C11-C22 Aromatics1,2	ND	15.0	mg/kg wet							
C11-C22 Unadjusted Aromatics1	24.9	15.0	mg/kg wet	34.00		73	40-140			
Chrysene	1.52	0.40	mg/kg wet	2.000		76	40-140			
Dibenzo(a,h)Anthracene	1.53	0.20	mg/kg wet	2.000		76	40-140			
Fluoranthene	1.44	0.40	mg/kg wet	2.000		72	40-140			
Fluorene	1.33	0.40	mg/kg wet	2.000		66	40-140			
Indeno(1,2,3-cd)Pyrene	1.59	0.40	mg/kg wet	2.000		79	40-140			
Naphthalene	1.20	0.40	mg/kg wet	2.000		60	40-140			
Phenanthrene	1.37	0.40	mg/kg wet	2.000		69	40-140			
Pyrene	1.46	0.40	mg/kg wet	2.000		73	40-140			
Surrogate: 2-Bromonaphthalene	*1.86*		mg/kg wet	*2.000*		*93*	*40-140*			
Surrogate: 2-Fluorobiphenyl	*1.81*		mg/kg wet	*2.000*		*91*	*40-140*			
Surrogate: O-Terphenyl	*1.85*		mg/kg wet	*2.000*		*92*	*40-140*			
LCS										
2-Methylnaphthalene Breakthrough	0.0		%				0-5			
Naphthalene Breakthrough	0.0		%				0-5			
LCS Dup										
C19-C36 Aliphatics1	17.9	15.0	mg/kg wet	16.00		112	40-140	1	25	
C9-C18 Aliphatics1	11.1	15.0	mg/kg wet	12.00		92	40-140	5	25	

CERTIFICATE OF ANALYSIS

Client Name: GZA GeoEnvironmental, Inc.
Client Project ID: 123 Pine Street

ESS Laboratory Work Order: 1607072

Quality Control Data

Analyte	Result	MRL	Units	Spike Level	Source Result	%REC	%REC Limits	RPD	RPD Limit	Qualifier
MADEP-EPH Extractable Petroleum Hydrocarbons										
Batch CG60715 - 3546										
Decane (C10)	1.1	0.5	mg/kg wet	2.000		54	40-140	4	25	
Docosane (C22)	1.8	0.5	mg/kg wet	2.000		88	40-140	0.9	25	
Dodecane (C12)	1.2	0.5	mg/kg wet	2.000		59	40-140	5	25	
Eicosane (C20)	1.7	0.5	mg/kg wet	2.000		86	40-140	0.4	25	
Hexacosane (C26)	1.7	0.5	mg/kg wet	2.000		87	40-140	1	25	
Hexadecane (C16)	1.6	0.5	mg/kg wet	2.000		78	40-140	2	25	
Hexatriacontane (C36)	1.5	0.5	mg/kg wet	2.000		77	40-140	3	25	
Nonadecane (C19)	1.7	0.5	mg/kg wet	2.000		86	40-140	0.4	25	
Nonane (C9)	0.9	0.5	mg/kg wet	2.000		44	30-140	3	25	
Octacosane (C28)	1.6	0.5	mg/kg wet	2.000		81	40-140	0.1	25	
Octadecane (C18)	1.7	0.5	mg/kg wet	2.000		84	40-140	0.5	25	
Tetracosane (C24)	1.7	0.5	mg/kg wet	2.000		83	40-140	0.4	25	
Tetradecane (C14)	1.3	0.5	mg/kg wet	2.000		66	40-140	6	25	
Triacontane (C30)	1.6	0.5	mg/kg wet	2.000		81	40-140	0.7	25	
Surrogate: 1-Chlorooctadecane	*1.74*		mg/kg wet	*2.000*		*87*	*40-140*			
LCS Dup										
2-Methylnaphthalene	1.19	0.20	mg/kg wet	2.000		60	40-140	4	30	
Acenaphthene	1.31	0.40	mg/kg wet	2.000		66	40-140	2	30	
Acenaphthylene	1.35	0.20	mg/kg wet	2.000		67	40-140	2	30	
Anthracene	1.42	0.40	mg/kg wet	2.000		71	40-140	3	30	
Benzo(a)anthracene	1.55	0.40	mg/kg wet	2.000		78	40-140	6	30	
Benzo(a)pyrene	1.68	0.40	mg/kg wet	2.000		84	40-140	5	30	
Benzo(b)fluoranthene	1.67	0.40	mg/kg wet	2.000		84	40-140	7	30	
Benzo(g,h,i)perylene	1.63	0.40	mg/kg wet	2.000		82	40-140	4	30	
Benzo(k)fluoranthene	1.62	0.40	mg/kg wet	2.000		81	40-140	3	30	
C11-C22 Aromatics1,2	ND	15.0	mg/kg wet							
C11-C22 Unadjusted Aromatics1	25.5	15.0	mg/kg wet	34.00		75	40-140	2	25	
Chrysene	1.58	0.40	mg/kg wet	2.000		79	40-140	4	30	
Dibenzo(a,h)Anthracene	1.59	0.20	mg/kg wet	2.000		79	40-140	4	30	
Fluoranthene	1.53	0.40	mg/kg wet	2.000		76	40-140	6	30	
Fluorene	1.42	0.40	mg/kg wet	2.000		71	40-140	6	30	
Indeno(1,2,3-cd)Pyrene	1.64	0.40	mg/kg wet	2.000		82	40-140	3	30	
Naphthalene	1.23	0.40	mg/kg wet	2.000		62	40-140	2	30	
Phenanthrene	1.46	0.40	mg/kg wet	2.000		73	40-140	6	30	
Pyrene	1.54	0.40	mg/kg wet	2.000		77	40-140	5	30	
Surrogate: 2-Bromonaphthalene	*1.89*		mg/kg wet	*2.000*		*95*	*40-140*			
Surrogate: 2-Fluorobiphenyl	*1.81*		mg/kg wet	*2.000*		*90*	*40-140*			
Surrogate: O-Terphenyl	*1.93*		mg/kg wet	*2.000*		*96*	*40-140*			
LCS Dup										
2-Methylnaphthalene Breakthrough	0.0		%				0-5		200	
Naphthalene Breakthrough	0.0		%				0-5		200	

CERTIFICATE OF ANALYSIS

Client Name: GZA GeoEnvironmental, Inc.
Client Project ID: 123 Pine Street

ESS Laboratory Work Order: 1607072

Notes and Definitions

U	Analyte included in the analysis, but not detected
SD	Surrogate recovery(ies) diluted below the MRL (SD).
D	Diluted.
ND	Analyte NOT DETECTED at or above the MRL (LOQ), LOD for DoD Reports, MDL for J-Flagged Analytes
dry	Sample results reported on a dry weight basis
RPD	Relative Percent Difference
MDL	Method Detection Limit
MRL	Method Reporting Limit
LOD	Limit of Detection
LOQ	Limit of Quantitation
DL	Detection Limit
I/V	Initial Volume
F/V	Final Volume
§	Subcontracted analysis; see attached report
1	Range result excludes concentrations of surrogates and/or internal standards eluting in that range.
2	Range result excludes concentrations of target analytes eluting in that range.
3	Range result excludes the concentration of the C9-C10 aromatic range.
Avg	Results reported as a mathematical average.
NR	No Recovery
[CALC]	Calculated Analyte
SUB	Subcontracted analysis; see attached report

CERTIFICATE OF ANALYSIS

Client Name: GZA GeoEnvironmental, Inc.
Client Project ID: 123 Pine Street

ESS Laboratory Work Order: 1607072

ESS LABORATORY CERTIFICATIONS AND ACCREDITATIONS

ENVIRONMENTAL

Rhode Island Potable and Non Potable Water: LAI00179
http://www.health.ri.gov/find/labs/analytical/ESS.pdf

Connecticut Potable and Non Potable Water, Solid and Hazardous Waste: PH-0750
http://www.ct.gov/dph/lib/dph/environmental_health/environmental_laboratories/pdf/OutofStateCommercialLaboratories.pdf

Maine Potable and Non Potable Water, and Solid and Hazardous Waste: RI00002
http://www.maine.gov/dhhs/mecdc/environmental-health/water/dwp-services/labcert/documents/AllLabs.xls

Massachusetts Potable and Non Potable Water: M-RI002
http://public.dep.state.ma.us/Labcert/Labcert.aspx

New Hampshire (NELAP accredited) Potable and Non Potable Water, Solid and Hazardous Waste: 2424
http://des.nh.gov/organization/divisions/water/dwgb/nhelap/index.htm

New York (NELAP accredited) Non Potable Water, Solid and Hazardous Waste: 11313
http://www.wadsworth.org/labcert/elap/comm.html

New Jersey (NELAP accredited) Non Potable Water, Solid and Hazardous Waste: RI006
http://datamine2.state.nj.us/DEP_OPRA/OpraMain/pi_main?mode=pi_by_site&sort_order=PI_NAMEA&Select+a+Site:=58715

United States Department of Agriculture Soil Permit: P330-12-00139

Pennsylvania: 68-01752
http://www.depweb.state.pa.us/portal/server.pt/community/labs/13780/laboratory_accreditation_program/590095

ESS Laboratory Sample and Cooler Receipt Checklist

Client: GZA - Springfield, MA - GZA/CMT

Shipped/Delivered Via: ESS Courier

ESS Project ID: 1607072
Date Received: 7/6/2016
Project Due Date: 7/13/2016
Days for Project: 5 Day

1. Air bill manifest present? No
   Air No.: NA
2. Were custody seals present? No
3. Is radiation count <100 CPM? Yes
4. Is a Cooler Present? Yes
   Temp: 3.0 Iced with: Ice
5. Was COC signed and dated by client? Yes
6. Does COC match bottles? Yes
7. Is COC complete and correct? Yes
8. Were samples received intact? Yes
9. **Were labs informed about short holds & rushes?** Yes / No / (NA)
10. Were any analyses received outside of hold time? Yes / (No)

11. Any Subcontracting needed? Yes / (No)
    ESS Sample IDs:
    Analysis:
    TAT:
12. Were VOAs received? Yes / (No)
    a. Air bubbles in aqueous VOAs? Yes / (No)
    b. Does methanol cover soil completely? Yes / No / (NA)

13. Are the samples properly preserved? (Yes) / No
    a. If metals preserved upon receipt: Date: Time: By:
    b. Low Level VOAs brought to freezer: Date: Time: By:

Sample Receiving Notes:

14. Was there a need to contact Project Manager? Yes / (No)
    a. Was there a need to contact the client? Yes / (No)
    Who was contacted? Date: Time: By:

Sample Number	Container ID	Proper Container	Air Bubbles Present	Sufficient Volume	Container Type	Preservative	Record pH (Cyanide and 608 Pesticides)
01	48903	Yes	NA	Yes	8 oz. Jar - Unpres	NP	
02	48902	Yes	NA	Yes	8 oz. Jar - Unpres	NP	

2nd Review
Are barcode labels on correct containers? (Yes) / No

Completed By: Date & Time: 7/6/16 1715 WR 7/7/16
Reviewed By: Date & Time: 7/6/16 2052
Delivered By: 7/6/16 2052

ESS Laboratory

Division of Thielsch Engineering, Inc.

185 Frances Avenue, Cranston RI 02910-2211
Tel. (401)461-7181 Fax (401)461-4486
www.esslaboratory.com

CHAIN OF CUSTODY

ESS Lab # 1607072

Turn Time ✓ Standard Other_____

Regulatory State: (MA) RI CT NH NJ NY ME Other_____

Is this project for any of the following:(please circle)
(MA-MCP) Navy USACE CT DEP Other_____

Reporting Limits - _____

Electonic Deliverables *Excel Access PDF

Co. Name: G2A GeoEnvironmental, Inc.	Project #: 15.0165521	Project Name: 123 Pine St	
Contact Person: Adam Cote	Proj. Location: Holyoke, MA		
Address: 1350 Main Street (Suite 1401)	City, State: Springfield, MA	Zip: 01103	PO #
Tel.	email:		

Analysis: MA EPH

ESS Lab ID	Date	Collection Time	Grab -G Composite-C	Matrix	Sample ID	Pres Code	# of Containers	Type of Container	Vol of Container	MA EPH
	7/5/16	1230	G	S	BSMT-1	1	1	AG	8oz	X
1	↓	1240	G	S	BSMT-2	1	1	AG	8oz	X
2	↓	1250	G	S	BSMT-3	1	1	AG	8oz	X
					Hold Sample BSMT-1					

Container Type: P-Poly G-Glass AG-Amber Glass S-Sterile V-VOA

Matrix: S-Soil SB-Solid D-Sludge WW-Wastewater GW-Groundwater SW-Surface Water DW-Drinking Water O-Oil W-Wipes F-Filter

Cooler Present ✓ Yes ____ No

Seals Intact ____ Yes ____ No NA:____

Cooler Temperature: 3.0 not ice

Internal Use Only

[-] Pickup

[ ] Technician____

Preservation Code: 1-NP, 2-HCl, 3-H2SO4, 4-HNO3, 5-NaOH, 6-MeOH, 7-Asorbic Acid, 8-ZnAct, 9-_____

Sampled by: Adam Cote

Comments:

Relinquished by: (Signature, Date & Time)	Received by: (Signature, Date & Time)	Relinquished by: (Signature, Date & Time)	Received by: (Signature, Date & Time)
Adam Cote	G2A Springfield - Sample Fridge	G2A fridge (Adam Cote) 7-6-16 14:14	7-6-16 14:14
7-6-16 17:07	7/6/16 1715		

* By circling MA-MCP, client acknowledges samples were collected in accordance with MADEP CAM VIIA

Please fax to the laboratory all changes to Chain of Custody

Report Method Blank & Laboratory Control Sample Results

CERTIFICATE OF ANALYSIS

Adam Cote
GZA GeoEnvironmental, Inc.
1350 Main Street, Suite 1400
Springfield, MA 01103

RE: 123 Pine Street (15.0166521.00)
ESS Laboratory Work Order Number: 1608558

This signed Certificate of Analysis is our approved release of your analytical results. These results are only representative of sample aliquots received at the laboratory. ESS Laboratory expects its clients to follow all regulatory sampling guidelines. Beginning with this page, the entire report has been paginated. This report should not be copied except in full without the approval of the laboratory. Samples will be disposed of thirty days after the final report has been delivered. If you have any questions or concerns, please feel free to call our Customer Service Department.

Laurel Stoddard
Laboratory Director

REVIEWED
By ESS Laboratory at 3:33 pm, Aug 26, 2016

Analytical Summary
The project as described above has been analyzed in accordance with the ESS Quality Assurance Plan. This plan utilizes the following methodologies: US EPA SW-846, US EPA Methods for Chemical Analysis of Water and Wastes per 40 CFR Part 136, APHA Standard Methods for the Examination of Water and Wastewater, American Society for Testing and Materials (ASTM), and other recognized methodologies. The analyses with these noted observations are in conformance to the Quality Assurance Plan. In chromatographic analysis, manual integration is frequently used instead of automated integration because it produces more accurate results.

The test results present in this report are in compliance with NELAC Standards, A2LA and/or client Quality Assurance Project Plans (QAPP). The laboratory has reviewed the following: Sample Preservations, Hold Times, Initial Calibrations, Continuing Calibrations, Method Blanks, Blank Spikes, Blank Spike Duplicates, Duplicates, Matrix Spikes, Matrix Spike Duplicates, Surrogates and Internal Standards. Any results which were found to be outside of the recommended ranges stated in our SOPs will be noted in the Project Narrative.

CERTIFICATE OF ANALYSIS

Client Name: GZA GeoEnvironmental, Inc.
Client Project ID: 123 Pine Street

ESS Laboratory Work Order: 1608558

SAMPLE RECEIPT

The following samples were received on August 19, 2016 for the analyses specified on the enclosed Chain of Custody Record.

To achieve CAM compliance for MCP data, ESS Laboratory has performed and reviewed all QA/QC Requirements and Performance Standards listed in each method. Holding times and preservation have also been reviewed. All CAM requirements have been achieved unless noted in the project narrative.

Each method has been set-up in the laboratory to reach required MCP standards. The methods for aqueous VOA and Soil Methanol VOA have known limitations for certain analytes. The regulatory standards may not be achieved due to these limitations. In addition, for all methods, matrix interferences, dilutions, and %Solids may elevate method reporting limits above regulatory standards. ESS Laboratory can provide, upon request, a Data Checker (regulatory standard comparison spreadsheet) electronic deliverable which will highlight these exceedances.

Lab Number	Sample Name	Matrix	Analysis
1608558-01	123 Pine - S-4	Soil	EPH8270, MADEP-EPH
1608558-02	123 Pine - S-5	Soil	EPH8270, MADEP-EPH
1608558-03	123 Pine - S-6	Soil	EPH8270, MADEP-EPH
1608558-04	123 Pine - S-7	Soil	EPH8270, MADEP-EPH

CERTIFICATE OF ANALYSIS

Client Name: GZA GeoEnvironmental, Inc.
Client Project ID: 123 Pine Street

ESS Laboratory Work Order: 1608558

PROJECT NARRATIVE

No unusual observations noted.

End of Project Narrative.

DATA USABILITY LINKS

Definitions of Quality Control Parameters

Semivolatile Organics Internal Standard Information

Semivolatile Organics Surrogate Information

Volatile Organics Internal Standard Information

Volatile Organics Surrogate Information

EPH and VPH Alkane Lists

CERTIFICATE OF ANALYSIS

Client Name: GZA GeoEnvironmental, Inc.
Client Project ID: 123 Pine Street

ESS Laboratory Work Order: 1608558

CURRENT SW-846 METHODOLOGY VERSIONS

Analytical Methods

1010A - Flashpoint
6010C - ICP
6020A - ICP MS
7010 - Graphite Furnace
7196A - Hexavalent Chromium
7470A - Aqueous Mercury
7471B - Solid Mercury
8011 - EDB/DBCP/TCP
8015D - GRO/DRO
8081B - Pesticides
8082A - PCB
8100M - TPH
8151A - Herbicides
8260B - VOA
8270D - SVOA
8270D SIM - SVOA Low Level
9014 - Cyanide
9038 - Sulfate
9040C - Aqueous pH
9045D - Solid pH (Corrosivity)
9050A - Specific Conductance
9056A - Anions (IC)
9060A - TOC
9095B - Paint Filter
MADEP 04-1.1 - EPH / VPH

Prep Methods

3005A - Aqueous ICP Digestion
3020A - Aqueous Graphite Furnace / ICP MS Digestion
3050B - Solid ICP / Graphite Furnace / ICP MS Digestion
3060A - Solid Hexavalent Chromium Digestion
3510C - Separatory Funnel Extraction
3520C - Liquid / Liquid Extraction
3540C - Manual Soxhlet Extraction
3541 - Automated Soxhlet Extraction
3546 - Microwave Extraction
3580A - Waste Dilution
5030B - Aqueous Purge and Trap
5030C - Aqueous Purge and Trap
5035 - Solid Purge and Trap

SW846 Reactivity Methods 7.3.3.2 (Reactive Cyanide) and 7.3.4.1 (Reactive Sulfide) have been withdrawn by EPA. These methods are reported per client request and are not NELAP accredited.

ESS Laboratory
Division of Thielsch Engineering, Inc.

BAL Laboratory
The Microbiology Division of Thielsch Engineering, Inc.

CERTIFICATE OF ANALYSIS

Client Name: GZA GeoEnvironmental, Inc.
Client Project ID: 123 Pine Street

ESS Laboratory Work Order: 1608558

MassDEP Analytical Protocol Certification Form

MADEP RTN: _____

This form provides certification for the following data set: **1608558-01 through 1608558-04**

Matrices: ( ) Ground Water/Surface Water (X) Soil/Sediment ( ) Drinking Water ( ) Air ( ) Other:_____

CAM Protocol (check all that apply below):

( ) 8260 VOC CAM II A	( ) 7470/7471 Hg CAM III B	( ) MassDEP VPH CAM IV A	( ) 8081 Pesticides CAM V B	( ) 7196 Hex Cr CAM VI B	( ) MassDEP APH CAM IX A
( ) 8270 SVOC CAM II B	( ) 7010 Metals CAM III C	(X) MassDEP EPH CAM IV B	( ) 8151 Herbicides CAM V C	( ) 8330 Explosives CAM VIII A	( ) TO-15 VOC CAM IX B
( ) 6010 Metals CAM III A	( ) 6020 Metals CAM III D	( ) 8082 PCB CAM V A	( ) 6860 Perchlorate CAM VIII B	( ) 9014 Total Cyanide/PAC CAM VI A	

Affirmative responses to questions A through F are required for "Presumptive Certainty" status

A	Were all samples received in a condition consistent with those described on the Chain-of-Custody, properly preserved (including temperature) in the field or laboratory, and prepared/analyzed within method holding times?	Yes (X) No ( )
B	Were the analytical method(s) and all associated QC requirements specified in the selected CAM protocol(s) followed?	Yes (X) No ( )
C	Were all required corrective actions and analytical response actions specified in the selected CAM protocol(s) implemented for all identified performance standard non-conformances?	Yes (X) No ( )
D	Does the laboratory report comply with all the reporting requirements specified in the CAM VII A, "Quality Assurance and Quality Control Guidelines for the Acquisition and Reporting of Analytical Data"?	Yes (X) No ( )
E	a. VPH, EPH, APH and TO-15 only: Was each method conducted without significant modification(s)? (Refer to the individual method(s) for a list of significant modifications).	Yes (X) No ( )
	b. APH and TO-15 Methods only: Was the complete analyte list reported for each method?	Yes ( ) No ( )
F	Were all applicable CAM protocol QC and performance standard non-conformances identified and evaluated in a laboratory narrative (including all "No" responses to Questions A through E)?	Yes (X) No ( )

Responses to Questions G, H and I below are required for "'Presumptive Certainty" status

G	Were the reporting limits at or below all CAM reporting limits specified in the selected CAM protocols(s)?	Yes (X) No ( )*
	***Data User Note:* Data that achieve "Presumptive Certainty" status may not necessarily meet the data usability and representativeness requirements described in 310 CMR 40. 1056 (2)(k) and WSC-07-350.**	
H	Were **all** QC performance standards specified in the CAM protocol(s) achieved?	Yes (X) No ( )*
I	Were results reported for the complete analyte list specified in the selected CAM protocol(s)?	Yes (X) No ( )*

All negative responses must be addressed in an attached laboratory narrative.

I, the undersigned, attest under the pains and penalties of perjury that, based upon my personal inquiry of those responsible for obtaining the information, the material contained in this analytical report is, to the best of my knowledge and belief, accurate and complete.

Signature: _____ Date: August 26, 2016

Printed Name: Laurel Stoddard Position: Laboratory Director

CERTIFICATE OF ANALYSIS

Client Name: GZA GeoEnvironmental, Inc.
Client Project ID: 123 Pine Street
Client Sample ID: 123 Pine - S-4
Date Sampled: 08/18/16 10:15
Percent Solids: 98
Initial Volume: 24.6
Final Volume: 1
Extraction Method: 3546

ESS Laboratory Work Order: 1608558
ESS Laboratory Sample ID: 1608558-01
Sample Matrix: Soil
Units: mg/kg dry

Prepared: 8/22/16 12:49

MADEP-EPH Extractable Petroleum Hydrocarbons

Analyte	Results (MRL)	MDL	Method	Limit	DF	Analyst	Analyzed	Sequence	Batch
C9-C18 Aliphatics1	ND (15.5)		MADEP-EPH		1	ZLC	08/24/16 7:58	CZH0398	CH62218
C19-C36 Aliphatics1	ND (15.5)		MADEP-EPH		1	ZLC	08/24/16 7:58	CZH0398	CH62218
C11-C22 Unadjusted Aromatics1	ND (15.5)		EPH8270		1	VSC	08/24/16 4:01	CZH0424	CH62218
C11-C22 Aromatics1,2	ND (15.5)		EPH8270			VSC	08/24/16 4:01		[CALC]
2-Methylnaphthalene	ND (0.21)		EPH8270		1	VSC	08/24/16 4:01	CZH0424	CH62218
Acenaphthene	ND (0.41)		EPH8270		1	VSC	08/24/16 4:01	CZH0424	CH62218
Naphthalene	ND (0.41)		EPH8270		1	VSC	08/24/16 4:01	CZH0424	CH62218
Phenanthrene	ND (0.41)		EPH8270		1	VSC	08/24/16 4:01	CZH0424	CH62218
Acenaphthylene	ND (0.21)		EPH8270		1	VSC	08/24/16 4:01	CZH0424	CH62218
Anthracene	ND (0.41)		EPH8270		1	VSC	08/24/16 4:01	CZH0424	CH62218
Benzo(a)anthracene	ND (0.41)		EPH8270		1	VSC	08/24/16 4:01	CZH0424	CH62218
Benzo(a)pyrene	ND (0.41)		EPH8270		1	VSC	08/24/16 4:01	CZH0424	CH62218
Benzo(b)fluoranthene	ND (0.41)		EPH8270		1	VSC	08/24/16 4:01	CZH0424	CH62218
Benzo(g,h,i)perylene	ND (0.41)		EPH8270		1	VSC	08/24/16 4:01	CZH0424	CH62218
Benzo(k)fluoranthene	ND (0.41)		EPH8270		1	VSC	08/24/16 4:01	CZH0424	CH62218
Chrysene	ND (0.41)		EPH8270		1	VSC	08/24/16 4:01	CZH0424	CH62218
Dibenzo(a,h)Anthracene	ND (0.21)		EPH8270		1	VSC	08/24/16 4:01	CZH0424	CH62218
Fluoranthene	ND (0.41)		EPH8270		1	VSC	08/24/16 4:01	CZH0424	CH62218
Fluorene	ND (0.41)		EPH8270		1	VSC	08/24/16 4:01	CZH0424	CH62218
Indeno(1,2,3-cd)Pyrene	ND (0.41)		EPH8270		1	VSC	08/24/16 4:01	CZH0424	CH62218
Pyrene	ND (0.41)		EPH8270		1	VSC	08/24/16 4:01	CZH0424	CH62218

	%Recovery	Qualifier	Limits
Surrogate: 1-Chlorooctadecane	*68 %*		*40-140*
Surrogate: 2-Bromonaphthalene	*57 %*		*40-140*
Surrogate: 2-Fluorobiphenyl	*73 %*		*40-140*
Surrogate: O-Terphenyl	*69 %*		*40-140*

CERTIFICATE OF ANALYSIS

Client Name: GZA GeoEnvironmental, Inc.
Client Project ID: 123 Pine Street
Client Sample ID: 123 Pine - S-5
Date Sampled: 08/18/16 10:32
Percent Solids: 94
Initial Volume: 24.4
Final Volume: 1
Extraction Method: 3546

ESS Laboratory Work Order: 1608558
ESS Laboratory Sample ID: 1608558-02
Sample Matrix: Soil
Units: mg/kg dry

Prepared: 8/22/16 12:49

MADEP-EPH Extractable Petroleum Hydrocarbons

Analyte	Results (MRL)	MDL	Method	Limit	DF	Analyst	Analyzed	Sequence	Batch
C9-C18 Aliphatics1	ND (16.3)		MADEP-EPH		1	ZLC	08/24/16 8:45	CZH0398	CH62218
C19-C36 Aliphatics1	**16.4** (16.3)		MADEP-EPH		1	ZLC	08/24/16 8:45	CZH0398	CH62218
C11-C22 Unadjusted Aromatics1	ND (16.3)		EPH8270		1	VSC	08/24/16 4:38	CZH0424	CH62218
C11-C22 Aromatics1,2	ND (16.3)		EPH8270			VSC	08/24/16 4:38		[CALC]
2-Methylnaphthalene	ND (0.22)		EPH8270		1	VSC	08/24/16 4:38	CZH0424	CH62218
Acenaphthene	ND (0.43)		EPH8270		1	VSC	08/24/16 4:38	CZH0424	CH62218
Naphthalene	ND (0.43)		EPH8270		1	VSC	08/24/16 4:38	CZH0424	CH62218
Phenanthrene	ND (0.43)		EPH8270		1	VSC	08/24/16 4:38	CZH0424	CH62218
Acenaphthylene	ND (0.22)		EPH8270		1	VSC	08/24/16 4:38	CZH0424	CH62218
Anthracene	ND (0.43)		EPH8270		1	VSC	08/24/16 4:38	CZH0424	CH62218
Benzo(a)anthracene	ND (0.43)		EPH8270		1	VSC	08/24/16 4:38	CZH0424	CH62218
Benzo(a)pyrene	ND (0.43)		EPH8270		1	VSC	08/24/16 4:38	CZH0424	CH62218
Benzo(b)fluoranthene	ND (0.43)		EPH8270		1	VSC	08/24/16 4:38	CZH0424	CH62218
Benzo(g,h,i)perylene	ND (0.43)		EPH8270		1	VSC	08/24/16 4:38	CZH0424	CH62218
Benzo(k)fluoranthene	ND (0.43)		EPH8270		1	VSC	08/24/16 4:38	CZH0424	CH62218
Chrysene	ND (0.43)		EPH8270		1	VSC	08/24/16 4:38	CZH0424	CH62218
Dibenzo(a,h)Anthracene	ND (0.22)		EPH8270		1	VSC	08/24/16 4:38	CZH0424	CH62218
Fluoranthene	ND (0.43)		EPH8270		1	VSC	08/24/16 4:38	CZH0424	CH62218
Fluorene	ND (0.43)		EPH8270		1	VSC	08/24/16 4:38	CZH0424	CH62218
Indeno(1,2,3-cd)Pyrene	ND (0.43)		EPH8270		1	VSC	08/24/16 4:38	CZH0424	CH62218
Pyrene	ND (0.43)		EPH8270		1	VSC	08/24/16 4:38	CZH0424	CH62218

	%Recovery	Qualifier	Limits
Surrogate: 1-Chlorooctadecane	*65 %*		*40-140*
Surrogate: 2-Bromonaphthalene	*49 %*		*40-140*
Surrogate: 2-Fluorobiphenyl	*70 %*		*40-140*
Surrogate: O-Terphenyl	*65 %*		*40-140*

CERTIFICATE OF ANALYSIS

Client Name: GZA GeoEnvironmental, Inc.
Client Project ID: 123 Pine Street
Client Sample ID: 123 Pine - S-6
Date Sampled: 08/18/16 10:43
Percent Solids: 89
Initial Volume: 24.9
Final Volume: 1
Extraction Method: 3546

ESS Laboratory Work Order: 1608558
ESS Laboratory Sample ID: 1608558-03
Sample Matrix: Soil
Units: mg/kg dry

Prepared: 8/22/16 12:49

MADEP-EPH Extractable Petroleum Hydrocarbons

Analyte	Results (MRL)	MDL	Method	Limit	DF	Analyst	Analyzed	Sequence	Batch
C9-C18 Aliphatics1	**384** (17.0)		MADEP-EPH		1	ZLC	08/24/16 9:32	CZH0398	CH62218
C19-C36 Aliphatics1	**88.9** (17.0)		MADEP-EPH		1	ZLC	08/24/16 9:32	CZH0398	CH62218
C11-C22 Unadjusted Aromatics1	**84.4** (17.0)		EPH8270		1	VSC	08/24/16 5:14	CZH0424	CH62218
C11-C22 Aromatics1,2	**83.4** (17.0)		EPH8270			VSC	08/24/16 5:14		[CALC]
2-Methylnaphthalene	**0.95** (0.23)		EPH8270		1	VSC	08/24/16 5:14	CZH0424	CH62218
Acenaphthene	ND (0.45)		EPH8270		1	VSC	08/24/16 5:14	CZH0424	CH62218
Naphthalene	ND (0.45)		EPH8270		1	VSC	08/24/16 5:14	CZH0424	CH62218
Phenanthrene	ND (0.45)		EPH8270		1	VSC	08/24/16 5:14	CZH0424	CH62218
Acenaphthylene	ND (0.23)		EPH8270		1	VSC	08/24/16 5:14	CZH0424	CH62218
Anthracene	ND (0.45)		EPH8270		1	VSC	08/24/16 5:14	CZH0424	CH62218
Benzo(a)anthracene	ND (0.45)		EPH8270		1	VSC	08/24/16 5:14	CZH0424	CH62218
Benzo(a)pyrene	ND (0.45)		EPH8270		1	VSC	08/24/16 5:14	CZH0424	CH62218
Benzo(b)fluoranthene	ND (0.45)		EPH8270		1	VSC	08/24/16 5:14	CZH0424	CH62218
Benzo(g,h,i)perylene	ND (0.45)		EPH8270		1	VSC	08/24/16 5:14	CZH0424	CH62218
Benzo(k)fluoranthene	ND (0.45)		EPH8270		1	VSC	08/24/16 5:14	CZH0424	CH62218
Chrysene	ND (0.45)		EPH8270		1	VSC	08/24/16 5:14	CZH0424	CH62218
Dibenzo(a,h)Anthracene	ND (0.23)		EPH8270		1	VSC	08/24/16 5:14	CZH0424	CH62218
Fluoranthene	ND (0.45)		EPH8270		1	VSC	08/24/16 5:14	CZH0424	CH62218
Fluorene	ND (0.45)		EPH8270		1	VSC	08/24/16 5:14	CZH0424	CH62218
Indeno(1,2,3-cd)Pyrene	ND (0.45)		EPH8270		1	VSC	08/24/16 5:14	CZH0424	CH62218
Pyrene	ND (0.45)		EPH8270		1	VSC	08/24/16 5:14	CZH0424	CH62218

	%Recovery	Qualifier	Limits
Surrogate: 1-Chlorooctadecane	*60 %*		*40-140*
Surrogate: 2-Bromonaphthalene	*50 %*		*40-140*
Surrogate: 2-Fluorobiphenyl	*64 %*		*40-140*
Surrogate: O-Terphenyl	*55 %*		*40-140*

CERTIFICATE OF ANALYSIS

Client Name: GZA GeoEnvironmental, Inc.
Client Project ID: 123 Pine Street
Client Sample ID: 123 Pine - S-7
Date Sampled: 08/18/16 10:54
Percent Solids: 96
Initial Volume: 24.6
Final Volume: 1
Extraction Method: 3546

ESS Laboratory Work Order: 1608558
ESS Laboratory Sample ID: 1608558-04
Sample Matrix: Soil
Units: mg/kg dry

Prepared: 8/22/16 12:49

MADEP-EPH Extractable Petroleum Hydrocarbons

Analyte	Results (MRL)	MDL	Method	Limit	DF	Analyst	Analyzed	Sequence	Batch
C9-C18 Aliphatics1	ND (15.9)		MADEP-EPH		1	ZLC	08/24/16 10:20	CZH0398	CH62218
C19-C36 Aliphatics1	ND (15.9)		MADEP-EPH		1	ZLC	08/24/16 10:20	CZH0398	CH62218
C11-C22 Unadjusted Aromatics1	ND (15.9)		EPH8270		1	VSC	08/24/16 5:51	CZH0424	CH62218
C11-C22 Aromatics1,2	ND (15.9)		EPH8270			VSC	08/24/16 5:51		[CALC]
2-Methylnaphthalene	ND (0.21)		EPH8270		1	VSC	08/24/16 5:51	CZH0424	CH62218
Acenaphthene	ND (0.42)		EPH8270		1	VSC	08/24/16 5:51	CZH0424	CH62218
Naphthalene	ND (0.42)		EPH8270		1	VSC	08/24/16 5:51	CZH0424	CH62218
Phenanthrene	ND (0.42)		EPH8270		1	VSC	08/24/16 5:51	CZH0424	CH62218
Acenaphthylene	ND (0.21)		EPH8270		1	VSC	08/24/16 5:51	CZH0424	CH62218
Anthracene	ND (0.42)		EPH8270		1	VSC	08/24/16 5:51	CZH0424	CH62218
Benzo(a)anthracene	ND (0.42)		EPH8270		1	VSC	08/24/16 5:51	CZH0424	CH62218
Benzo(a)pyrene	ND (0.42)		EPH8270		1	VSC	08/24/16 5:51	CZH0424	CH62218
Benzo(b)fluoranthene	ND (0.42)		EPH8270		1	VSC	08/24/16 5:51	CZH0424	CH62218
Benzo(g,h,i)perylene	ND (0.42)		EPH8270		1	VSC	08/24/16 5:51	CZH0424	CH62218
Benzo(k)fluoranthene	ND (0.42)		EPH8270		1	VSC	08/24/16 5:51	CZH0424	CH62218
Chrysene	ND (0.42)		EPH8270		1	VSC	08/24/16 5:51	CZH0424	CH62218
Dibenzo(a,h)Anthracene	ND (0.21)		EPH8270		1	VSC	08/24/16 5:51	CZH0424	CH62218
Fluoranthene	ND (0.42)		EPH8270		1	VSC	08/24/16 5:51	CZH0424	CH62218
Fluorene	ND (0.42)		EPH8270		1	VSC	08/24/16 5:51	CZH0424	CH62218
Indeno(1,2,3-cd)Pyrene	ND (0.42)		EPH8270		1	VSC	08/24/16 5:51	CZH0424	CH62218
Pyrene	ND (0.42)		EPH8270		1	VSC	08/24/16 5:51	CZH0424	CH62218

	%Recovery	Qualifier	Limits
Surrogate: 1-Chlorooctadecane	*68 %*		*40-140*
Surrogate: 2-Bromonaphthalene	*59 %*		*40-140*
Surrogate: 2-Fluorobiphenyl	*73 %*		*40-140*
Surrogate: O-Terphenyl	*65 %*		*40-140*

CERTIFICATE OF ANALYSIS

Client Name: GZA GeoEnvironmental, Inc.
Client Project ID: 123 Pine Street

ESS Laboratory Work Order: 1608558

Quality Control Data

Analyte	Result	MRL	Units	Spike Level	Source Result	%REC	%REC Limits	RPD	RPD Limit	Qualifier
MADEP-EPH Extractable Petroleum Hydrocarbons										
Batch CH62218 - 3546										
Blank										
C19-C36 Aliphatics1	ND	15.0	mg/kg wet							
C9-C18 Aliphatics1	ND	15.0	mg/kg wet							
Decane (C10)	ND	0.5	mg/kg wet							
Docosane (C22)	ND	0.5	mg/kg wet							
Dodecane (C12)	ND	0.5	mg/kg wet							
Eicosane (C20)	ND	0.5	mg/kg wet							
Hexacosane (C26)	ND	0.5	mg/kg wet							
Hexadecane (C16)	ND	0.5	mg/kg wet							
Hexatriacontane (C36)	ND	0.5	mg/kg wet							
Nonadecane (C19)	ND	0.5	mg/kg wet							
Nonane (C9)	ND	0.5	mg/kg wet							
Octacosane (C28)	ND	0.5	mg/kg wet							
Octadecane (C18)	ND	0.5	mg/kg wet							
Tetracosane (C24)	ND	0.5	mg/kg wet							
Tetradecane (C14)	ND	0.5	mg/kg wet							
Triacontane (C30)	ND	0.5	mg/kg wet							
Surrogate: 1-Chlorooctadecane	*1.42*		mg/kg wet	*2.000*		*71*	*40-140*			
Blank										
2-Methylnaphthalene	ND	0.20	mg/kg wet							
Acenaphthene	ND	0.40	mg/kg wet							
Acenaphthylene	ND	0.20	mg/kg wet							
Anthracene	ND	0.40	mg/kg wet							
Benzo(a)anthracene	ND	0.40	mg/kg wet							
Benzo(a)pyrene	ND	0.40	mg/kg wet							
Benzo(b)fluoranthene	ND	0.40	mg/kg wet							
Benzo(g,h,i)perylene	ND	0.40	mg/kg wet							
Benzo(k)fluoranthene	ND	0.40	mg/kg wet							
C11-C22 Aromatics1,2	ND	15.0	mg/kg wet							
C11-C22 Unadjusted Aromatics1	ND	15.0	mg/kg wet							
Chrysene	ND	0.40	mg/kg wet							
Dibenzo(a,h)Anthracene	ND	0.20	mg/kg wet							
Fluoranthene	ND	0.40	mg/kg wet							
Fluorene	ND	0.40	mg/kg wet							
Indeno(1,2,3-cd)Pyrene	ND	0.40	mg/kg wet							
Naphthalene	ND	0.40	mg/kg wet							
Phenanthrene	ND	0.40	mg/kg wet							
Pyrene	ND	0.40	mg/kg wet							
Surrogate: 2-Bromonaphthalene	*1.85*		mg/kg wet	*2.000*		*92*	*40-140*			
Surrogate: 2-Fluorobiphenyl	*1.95*		mg/kg wet	*2.000*		*97*	*40-140*			
Surrogate: O-Terphenyl	*1.64*		mg/kg wet	*2.000*		*82*	*40-140*			
LCS										
C19-C36 Aliphatics1	13.9	15.0	mg/kg wet	16.00		87	40-140			
C9-C18 Aliphatics1	7.8	15.0	mg/kg wet	12.00		65	40-140			

CERTIFICATE OF ANALYSIS

Client Name: GZA GeoEnvironmental, Inc.
Client Project ID: 123 Pine Street

ESS Laboratory Work Order: 1608558

Quality Control Data

Analyte	Result	MRL	Units	Spike Level	Source Result	%REC	%REC Limits	RPD	RPD Limit	Qualifier
MADEP-EPH Extractable Petroleum Hydrocarbons										
Batch CH62218 - 3546										
Decane (C10)	0.9	0.5	mg/kg wet	2.000		45	40-140			
Docosane (C22)	1.6	0.5	mg/kg wet	2.000		82	40-140			
Dodecane (C12)	1.0	0.5	mg/kg wet	2.000		51	40-140			
Eicosane (C20)	1.5	0.5	mg/kg wet	2.000		74	40-140			
Hexacosane (C26)	1.5	0.5	mg/kg wet	2.000		74	40-140			
Hexadecane (C16)	1.3	0.5	mg/kg wet	2.000		66	40-140			
Hexatriacontane (C36)	1.4	0.5	mg/kg wet	2.000		69	40-140			
Nonadecane (C19)	1.5	0.5	mg/kg wet	2.000		74	40-140			
Nonane (C9)	0.7	0.5	mg/kg wet	2.000		37	30-140			
Octacosane (C28)	1.5	0.5	mg/kg wet	2.000		74	40-140			
Octadecane (C18)	1.4	0.5	mg/kg wet	2.000		71	40-140			
Tetracosane (C24)	1.5	0.5	mg/kg wet	2.000		75	40-140			
Tetradecane (C14)	1.1	0.5	mg/kg wet	2.000		55	40-140			
Triacontane (C30)	1.5	0.5	mg/kg wet	2.000		75	40-140			
Surrogate: 1-Chlorooctadecane	*1.44*		mg/kg wet	*2.000*		*72*	*40-140*			
LCS										
2-Methylnaphthalene	1.24	0.20	mg/kg wet	2.000		62	40-140			
Acenaphthene	1.36	0.40	mg/kg wet	2.000		68	40-140			
Acenaphthylene	1.36	0.20	mg/kg wet	2.000		68	40-140			
Anthracene	1.54	0.40	mg/kg wet	2.000		77	40-140			
Benzo(a)anthracene	1.60	0.40	mg/kg wet	2.000		80	40-140			
Benzo(a)pyrene	1.69	0.40	mg/kg wet	2.000		84	40-140			
Benzo(b)fluoranthene	1.65	0.40	mg/kg wet	2.000		82	40-140			
Benzo(g,h,i)perylene	1.67	0.40	mg/kg wet	2.000		83	40-140			
Benzo(k)fluoranthene	1.73	0.40	mg/kg wet	2.000		86	40-140			
C11-C22 Aromatics1,2	ND	15.0	mg/kg wet							
C11-C22 Unadjusted Aromatics1	26.8	15.0	mg/kg wet	34.00		79	40-140			
Chrysene	1.66	0.40	mg/kg wet	2.000		83	40-140			
Dibenzo(a,h)Anthracene	1.65	0.20	mg/kg wet	2.000		83	40-140			
Fluoranthene	1.58	0.40	mg/kg wet	2.000		79	40-140			
Fluorene	1.45	0.40	mg/kg wet	2.000		73	40-140			
Indeno(1,2,3-cd)Pyrene	1.63	0.40	mg/kg wet	2.000		82	40-140			
Naphthalene	1.22	0.40	mg/kg wet	2.000		61	40-140			
Phenanthrene	1.55	0.40	mg/kg wet	2.000		78	40-140			
Pyrene	1.62	0.40	mg/kg wet	2.000		81	40-140			
Surrogate: 2-Bromonaphthalene	*1.82*		mg/kg wet	*2.000*		*91*	*40-140*			
Surrogate: 2-Fluorobiphenyl	*1.87*		mg/kg wet	*2.000*		*94*	*40-140*			
Surrogate: O-Terphenyl	*1.72*		mg/kg wet	*2.000*		*86*	*40-140*			
LCS										
2-Methylnaphthalene Breakthrough	0.0		%				0-5			
Naphthalene Breakthrough	0.0		%				0-5			
LCS Dup										
C19-C36 Aliphatics1	13.6	15.0	mg/kg wet	16.00		85	40-140	2	25	
C9-C18 Aliphatics1	7.8	15.0	mg/kg wet	12.00		65	40-140	0.2	25	

CERTIFICATE OF ANALYSIS

Client Name: GZA GeoEnvironmental, Inc.
Client Project ID: 123 Pine Street

ESS Laboratory Work Order: 1608558

Quality Control Data

Analyte	Result	MRL	Units	Spike Level	Source Result	%REC	%REC Limits	RPD	RPD Limit	Qualifier
MADEP-EPH Extractable Petroleum Hydrocarbons										
Batch CH62218 - 3546										
Decane (C10)	0.9	0.5	mg/kg wet	2.000		45	40-140	1	25	
Docosane (C22)	1.5	0.5	mg/kg wet	2.000		73	40-140	12	25	
Dodecane (C12)	1.0	0.5	mg/kg wet	2.000		50	40-140	0.8	25	
Eicosane (C20)	1.5	0.5	mg/kg wet	2.000		73	40-140	2	25	
Hexacosane (C26)	1.5	0.5	mg/kg wet	2.000		73	40-140	2	25	
Hexadecane (C16)	1.3	0.5	mg/kg wet	2.000		65	40-140	3	25	
Hexatriacontane (C36)	1.4	0.5	mg/kg wet	2.000		69	40-140	0.6	25	
Nonadecane (C19)	1.4	0.5	mg/kg wet	2.000		72	40-140	2	25	
Nonane (C9)	0.7	0.5	mg/kg wet	2.000		37	30-140	0.7	25	
Octacosane (C28)	1.5	0.5	mg/kg wet	2.000		73	40-140	2	25	
Octadecane (C18)	1.4	0.5	mg/kg wet	2.000		69	40-140	2	25	
Tetracosane (C24)	1.5	0.5	mg/kg wet	2.000		73	40-140	2	25	
Tetradecane (C14)	1.1	0.5	mg/kg wet	2.000		53	40-140	3	25	
Triacontane (C30)	1.5	0.5	mg/kg wet	2.000		74	40-140	2	25	
Surrogate: 1-Chlorooctadecane	*1.41*		mg/kg wet	*2.000*		*71*	*40-140*			
LCS Dup										
2-Methylnaphthalene	1.18	0.20	mg/kg wet	2.000		59	40-140	4	30	
Acenaphthene	1.29	0.40	mg/kg wet	2.000		65	40-140	5	30	
Acenaphthylene	1.31	0.20	mg/kg wet	2.000		65	40-140	4	30	
Anthracene	1.49	0.40	mg/kg wet	2.000		74	40-140	4	30	
Benzo(a)anthracene	1.50	0.40	mg/kg wet	2.000		75	40-140	7	30	
Benzo(a)pyrene	1.63	0.40	mg/kg wet	2.000		82	40-140	3	30	
Benzo(b)fluoranthene	1.65	0.40	mg/kg wet	2.000		82	40-140	0.1	30	
Benzo(g,h,i)perylene	1.61	0.40	mg/kg wet	2.000		80	40-140	4	30	
Benzo(k)fluoranthene	1.51	0.40	mg/kg wet	2.000		75	40-140	14	30	
C11-C22 Aromatics1,2	ND	15.0	mg/kg wet							
C11-C22 Unadjusted Aromatics1	25.1	15.0	mg/kg wet	34.00		74	40-140	6	25	
Chrysene	1.56	0.40	mg/kg wet	2.000		78	40-140	6	30	
Dibenzo(a,h)Anthracene	1.58	0.20	mg/kg wet	2.000		79	40-140	4	30	
Fluoranthene	1.49	0.40	mg/kg wet	2.000		74	40-140	6	30	
Fluorene	1.36	0.40	mg/kg wet	2.000		68	40-140	7	30	
Indeno(1,2,3-cd)Pyrene	1.56	0.40	mg/kg wet	2.000		78	40-140	5	30	
Naphthalene	1.17	0.40	mg/kg wet	2.000		59	40-140	4	30	
Phenanthrene	1.46	0.40	mg/kg wet	2.000		73	40-140	6	30	
Pyrene	1.54	0.40	mg/kg wet	2.000		77	40-140	5	30	
Surrogate: 2-Bromonaphthalene	*1.61*		mg/kg wet	*2.000*		*80*	*40-140*			
Surrogate: 2-Fluorobiphenyl	*1.96*		mg/kg wet	*2.000*		*98*	*40-140*			
Surrogate: O-Terphenyl	*1.62*		mg/kg wet	*2.000*		*81*	*40-140*			
LCS Dup										
2-Methylnaphthalene Breakthrough	0.0		%				0-5		200	
Naphthalene Breakthrough	0.0		%				0-5		200	

CERTIFICATE OF ANALYSIS

Client Name: GZA GeoEnvironmental, Inc.
Client Project ID: 123 Pine Street

ESS Laboratory Work Order: 1608558

Notes and Definitions

U	Analyte included in the analysis, but not detected
ND	Analyte NOT DETECTED at or above the MRL (LOQ), LOD for DoD Reports, MDL for J-Flagged Analytes
dry	Sample results reported on a dry weight basis
RPD	Relative Percent Difference
MDL	Method Detection Limit
MRL	Method Reporting Limit
LOD	Limit of Detection
LOQ	Limit of Quantitation
DL	Detection Limit
I/V	Initial Volume
F/V	Final Volume
§	Subcontracted analysis; see attached report
1	Range result excludes concentrations of surrogates and/or internal standards eluting in that range.
2	Range result excludes concentrations of target analytes eluting in that range.
3	Range result excludes the concentration of the C9-C10 aromatic range.
Avg	Results reported as a mathematical average.
NR	No Recovery
[CALC]	Calculated Analyte
SUB	Subcontracted analysis; see attached report

CERTIFICATE OF ANALYSIS

Client Name: GZA GeoEnvironmental, Inc.
Client Project ID: 123 Pine Street

ESS Laboratory Work Order: 1608558

ESS LABORATORY CERTIFICATIONS AND ACCREDITATIONS

ENVIRONMENTAL

Rhode Island Potable and Non Potable Water: LAI00179
http://www.health.ri.gov/find/labs/analytical/ESS.pdf

Connecticut Potable and Non Potable Water, Solid and Hazardous Waste: PH-0750
http://www.ct.gov/dph/lib/dph/environmental_health/environmental_laboratories/pdf/OutofStateCommercialLaboratories.pdf

Maine Potable and Non Potable Water, and Solid and Hazardous Waste: RI00002
http://www.maine.gov/dhhs/mecdc/environmental-health/water/dwp-services/labcert/documents/AllLabs.xls

Massachusetts Potable and Non Potable Water: M-RI002
http://public.dep.state.ma.us/Labcert/Labcert.aspx

New Hampshire (NELAP accredited) Potable and Non Potable Water, Solid and Hazardous Waste: 2424
http://des.nh.gov/organization/divisions/water/dwgb/nhelap/index.htm

New York (NELAP accredited) Non Potable Water, Solid and Hazardous Waste: 11313
http://www.wadsworth.org/labcert/elap/comm.html

New Jersey (NELAP accredited) Non Potable Water, Solid and Hazardous Waste: RI006
http://datamine2.state.nj.us/DEP_OPRA/OpraMain/pi_main?mode=pi_by_site&sort_order=PI_NAMEA&Select+a+Site:=58715

United States Department of Agriculture Soil Permit: P330-12-00139

Pennsylvania: 68-01752
http://www.depweb.state.pa.us/portal/server.pt/community/labs/13780/laboratory_accreditation_program/590095

ESS Laboratory Sample and Cooler Receipt Checklist

Client: GZA - Springfield, MA - GZA/CMT

Shipped/Delivered Via: ESS Courier

ESS Project ID: 1608558
Date Received: 8/19/2016
Project Due Date: 8/26/2016
Days for Project: 5 Day

1. Air bill manifest present? No
   Air No.: NA
2. Were custody seals present? No
3. Is radiation count <100 CPM? Yes
4. Is a Cooler Present? Yes
   Temp: 1.6 Iced with: Ice
5. Was COC signed and dated by client? Yes
6. Does COC match bottles? Yes
7. Is COC complete and correct? Yes
8. Were samples received intact? Yes
9. **Were labs informed about short holds & rushes?** Yes / No / (NA)
10. Were any analyses received outside of hold time? Yes / (No)

11. Any Subcontracting needed? Yes / (No)
    ESS Sample IDs:
    Analysis:
    TAT:
12. Were VOAs received? Yes / (No)
    a. Air bubbles in aqueous VOAs? Yes / No
    b. Does methanol cover soil completely? Yes / No / NA

13. Are the samples properly preserved? (Yes) / No
    a. If metals preserved upon receipt: Date: Time: By:
    b. Low Level VOAs brought to freezer: Date: Time: By:

Sample Receiving Notes:

14. Was there a need to contact Project Manager? Yes / (No)
    a. Was there a need to contact the client? Yes / No
    Who was contacted? Date: Time: By:

Sample Number	Container ID	Proper Container	Air Bubbles Present	Sufficient Volume	Container Type	Preservative	Record pH (Cyanide and 608 Pesticides)
01	62338	Yes	NA	Yes	4 oz. Jar - Unpres	NP	
02	62337	Yes	NA	Yes	4 oz. Jar - Unpres	NP	
03	62336	Yes	NA	Yes	4 oz. Jar - Unpres	NP	
04	62335	Yes	NA	Yes	4 oz. Jar - Unpres	NP	

2nd Review
Are barcode labels on correct containers? (Yes) / No

Completed By: Date & Time: 8/19/16 1442
Reviewed By: Adam Bys Iso Date & Time: 8/19/16 1450
Delivered By: Adam Bys Iso 8/19/16 1450

ESS Laboratory

Division of Thielsch Engineering, Inc.

185 Frances Avenue, Cranston, RI 02910-2211
Tel. (401) 461-7181 Fax (401) 461-4486
www.esslaboratory.com

CHAIN OF CUSTODY

ESS Lab # 1608558

Turn Time ✓ Standard Other_____

Regulatory State: MA RI CT NH NJ NY ME Other_____

Is this project for any of the following:(please circle)
MA-MCP Navy USACE CT DEP Other_____

Reporting Limits - _____

Electonic Deliverables Excel Access PDF

Co. Name: GZA GeoEnvironmental	Project #: 15.0166521.00	Project Name: 123 Pine Street, Holyoke, MA	
Contact Person: Adam Cote	Address: 1350 Main Street - Suite 1400		
City: Springfield	State: MA	Zip: 01103	PO #: —
Tel.: 413-726-2100	Fax: —	email: adam.cote@gza.com	

ESS Lab ID	Date	Collection Time	Grab -G Composite-C	Matrix	Sample ID	Pres Code	# of Containers	Type of Container	Vol of Container	Analysis: MA-EPH w/ HC Ranges + Targets									
1	8/18/16	10:15	G	S	123 Pine - S-4	1	1	AG	4oz	X									
2	↓	10:32	↓	↓	123 Pine - S-5	1	1	↓	↓	X									
3	↓	10:43	↓	↓	123 Pine - S-6	1	1	↓	↓	X									
4	↓	10:54	↓	↓	123 Pine - S-7	1	1	↓	↓	X									

Container Type: P-Poly G-Glass AG-Amber Glass S-Sterile V-VOA

Matrix: S-Soil SD-Solid D-Sludge WW-Wastewater GW-Groundwater SW-Surface Water DW-Drinking Water O-Oil W-Wipes F-Filter

Cooler Present ✓ Yes ____ No

Seals Intact ____ Yes ____ No NA: ✓

Cooler Temperature: 1.6 Ice

Internal Use Only

[✓] Pickup

[ ] Technician___

Preservation Code: 1-NP, 2-HCl, 3-H2SO4, 4-HNO3, 5-NaOH, 6-MeOH, 7-Asorbic Acid, 8-ZnAct, 9-_____

Sampled by : D. Harris

Comments:

Relinquished by: (Signature, Date & Time)	Received by: (Signature, Date & Time)	Relinquished by: (Signature, Date & Time)	Received by: (Signature, Date & Time)
8/18/16 1330	GZA Fridge 8/18/16 1330	8/19/16	8/19/16 12:30
8/19/16 14:30	8/19/16 1437		

* By circling MA-MCP, client acknowledges samples were collected in accordance with MADEP CAM VIIA

Please fax to the laboratory all changes to Chain of Custody

1 (White) Lab Copy
2 (Yellow) Client Receipt

CERTIFICATE OF ANALYSIS

Adam Cote
GZA GeoEnvironmental, Inc.
1350 Main Street, Suite 1400
Springfield, MA 01103

RE: 123 Pine Street (15.0166521.00)
ESS Laboratory Work Order Number: 1704760

This signed Certificate of Analysis is our approved release of your analytical results. These results are only representative of sample aliquots received at the laboratory. ESS Laboratory expects its clients to follow all regulatory sampling guidelines. Beginning with this page, the entire report has been paginated. This report should not be copied except in full without the approval of the laboratory. Samples will be disposed of thirty days after the final report has been delivered. If you have any questions or concerns, please feel free to call our Customer Service Department.

Laurel Stoddard
Laboratory Director

REVIEWED
By ESS Laboratory at 4:53 pm, May 03, 2017

Analytical Summary
The project as described above has been analyzed in accordance with the ESS Quality Assurance Plan. This plan utilizes the following methodologies: US EPA SW-846, US EPA Methods for Chemical Analysis of Water and Wastes per 40 CFR Part 136, APHA Standard Methods for the Examination of Water and Wastewater, American Society for Testing and Materials (ASTM), and other recognized methodologies. The analyses with these noted observations are in conformance to the Quality Assurance Plan. In chromatographic analysis, manual integration is frequently used instead of automated integration because it produces more accurate results.

The test results present in this report are in compliance with TNI and relative state standards, and/or client Quality Assurance Project Plans (QAPP). The laboratory has reviewed the following: Sample Preservations, Hold Times, Initial Calibrations, Continuing Calibrations, Method Blanks, Blank Spikes, Blank Spike Duplicates, Duplicates, Matrix Spikes, Matrix Spike Duplicates, Surrogates and Internal Standards. Any results which were found to be outside of the recommended ranges stated in our SOPs will be noted in the Project Narrative.

CERTIFICATE OF ANALYSIS

Client Name: GZA GeoEnvironmental, Inc.
Client Project ID: 123 Pine Street

ESS Laboratory Work Order: 1704760

SAMPLE RECEIPT

The following samples were received on April 27, 2017 for the analyses specified on the enclosed Chain of Custody Record.

To achieve CAM compliance for MCP data, ESS Laboratory has reviewed all QA/QC Requirements and Performance Standards listed in each method. Holding times and preservation have also been reviewed. All CAM requirements have been performed and achieved unless noted in the project narrative.

Each method has been set-up in the laboratory to reach required MCP standards. The methods for aqueous VOA and Soil Methanol VOA have known limitations for certain analytes. The regulatory standards may not be achieved due to these limitations. In addition, for all methods, matrix interferences, dilutions, and %Solids may elevate method reporting limits above regulatory standards. ESS Laboratory can provide, upon request, a Data Checker (regulatory standard comparison spreadsheet) electronic deliverable which will highlight these exceedances.

Lab Number	Sample Name	Matrix	Analysis
1704760-01	East Exc. Bottom	Soil	EPH8270, MADEP-EPH
1704760-02	Exc. Composite	Soil	EPH8270, MADEP-EPH

CERTIFICATE OF ANALYSIS

Client Name: GZA GeoEnvironmental, Inc.
Client Project ID: 123 Pine Street

ESS Laboratory Work Order: 1704760

PROJECT NARRATIVE

No unusual observations noted.

End of Project Narrative.

DATA USABILITY LINKS

To ensure you are viewing the most current version of the documents below, please clear your internet cookies for www.ESSLaboratory.com. Consult your IT Support personnel for information on how to clear your internet cookies.

Definitions of Quality Control Parameters

Semivolatile Organics Internal Standard Information

Semivolatile Organics Surrogate Information

Volatile Organics Internal Standard Information

Volatile Organics Surrogate Information

EPH and VPH Alkane Lists

CERTIFICATE OF ANALYSIS

Client Name: GZA GeoEnvironmental, Inc.
Client Project ID: 123 Pine Street

ESS Laboratory Work Order: 1704760

CURRENT SW-846 METHODOLOGY VERSIONS

Analytical Methods

1010A - Flashpoint
6010C - ICP
6020A - ICP MS
7010 - Graphite Furnace
7196A - Hexavalent Chromium
7470A - Aqueous Mercury
7471B - Solid Mercury
8011 - EDB/DBCP/TCP
8015C - GRO/DRO
8081B - Pesticides
8082A - PCB
8100M - TPH
8151A - Herbicides
8260B - VOA
8270D - SVOA
8270D SIM - SVOA Low Level
9014 - Cyanide
9038 - Sulfate
9040C - Aqueous pH
9045D - Solid pH (Corrosivity)
9050A - Specific Conductance
9056A - Anions (IC)
9060A - TOC
9095B - Paint Filter
MADEP 04-1.1 - EPH / VPH

Prep Methods

3005A - Aqueous ICP Digestion
3020A - Aqueous Graphite Furnace / ICP MS Digestion
3050B - Solid ICP / Graphite Furnace / ICP MS Digestion
3060A - Solid Hexavalent Chromium Digestion
3510C - Separatory Funnel Extraction
3520C - Liquid / Liquid Extraction
3540C - Manual Soxhlet Extraction
3541 - Automated Soxhlet Extraction
3546 - Microwave Extraction
3580A - Waste Dilution
5030B - Aqueous Purge and Trap
5030C - Aqueous Purge and Trap
5035 - Solid Purge and Trap

SW846 Reactivity Methods 7.3.3.2 (Reactive Cyanide) and 7.3.4.1 (Reactive Sulfide) have been withdrawn by EPA. These methods are reported per client request and are not NELAP accredited.

ESS Laboratory
Division of Thielsch Engineering, Inc.

BAL Laboratory
The Microbiology Division of Thielsch Engineering, Inc.

CERTIFICATE OF ANALYSIS

Client Name: GZA GeoEnvironmental, Inc.
Client Project ID: 123 Pine Street

ESS Laboratory Work Order: 1704760

MassDEP Analytical Protocol Certification Form

MADEP RTN: _____

This form provides certification for the following data set: **1704760-01 through 1704760-02**

Matrices: ( ) Ground Water/Surface Water (X) Soil/Sediment ( ) Drinking Water ( ) Air ( ) Other:_____

CAM Protocol (check all that apply below):

( ) 8260 VOC CAM II A	( ) 7470/7471 Hg CAM III B	( ) MassDEP VPH (GC/PID/FID) CAM IV A	( ) 8082 PCB CAM V A	( ) 9014 Total Cyanide/PAH CAM VI A	( ) 6860 Perchlorate CAM VIII B
( ) 8270 SVOC CAM II B	( ) 7010 Metals CAM III C	( ) MassDEP VPH (GC/MS) CAM IV B	( ) 8081 Pesticides CAM V C	( ) 7196 Hex Cr CAM VI B	( ) MassDEP APH CAM IX A
( ) 6010 Metals CAM III A	( ) 6020 Metals CAM III D	(X) MassDEP EPH CAM IV B	( ) 8151 Herbicides CAM V C	( ) Explosives CAM VIII A	( ) TO-15 VOC CAM IX B

Affirmative responses to questions A through F are required for "Presumptive Certainty" status

A	Were all samples received in a condition consistent with those described on the Chain-of-Custody, properly preserved (including temperature) in the field or laboratory, and prepared/analyzed within method holding times?	Yes (X) No ( )
B	Were the analytical method(s) and all associated QC requirements specified in the selected CAM protocol(s) followed?	Yes (X) No ( )
C	Were all required corrective actions and analytical response actions specified in the selected CAM protocol(s) implemented for all identified performance standard non-conformances?	Yes (X) No ( )
D	Does the laboratory report comply with all the reporting requirements specified in the CAM VII A, "Quality Assurance and Quality Control Guidelines for the Acquisition and Reporting of Analytical Data"?	Yes (X) No ( )
E	VPH, EPH, APH and TO-15 only: a. Was each method conducted without significant modification(s)? (Refer to the individual method(s) for a list of significant modifications).	Yes (X) No ( )
	b. APH and TO-15 Methods only: Was the complete analyte list reported for each method?	Yes ( ) No ( )
F	Were all applicable CAM protocol QC and performance standard non-conformances identified and evaluated in a laboratory narrative (including all "No" responses to Questions A through E)?	Yes (X) No ( )

Responses to Questions G, H and I below are required for '"Presumptive Certainty" status

G	Were the reporting limits at or below all CAM reporting limits specified in the selected CAM protocols(s)?	Yes (X) No ( )*
	***Data User Note:** Data that achieve "Presumptive Certainty" status may not necessarily meet the data usability and representativeness requirements described in 310 CMR 40. 1056 (2)(k) and WSC-07-350.*	
H	Were **all** QC performance standards specified in the CAM protocol(s) achieved?	Yes (X) No ( )*
I	Were results reported for the complete analyte list specified in the selected CAM protocol(s)?	Yes (X) No ( )*

All negative responses must be addressed in an attached laboratory narrative.

I, the undersigned, attest under the pains and penalties of perjury that, based upon my personal inquiry of those responsible for obtaining the information, the material contained in this analytical report is, to the best of my knowledge and belief, accurate and complete.

Signature: Laurel Stoddard

Date: May 03, 2017

Printed Name: Laurel Stoddard

Position: Laboratory Director

ESS Laboratory
Division of Thielsch Engineering, Inc.

BAL Laboratory
The Microbiology Division of Thielsch Engineering, Inc.

CERTIFICATE OF ANALYSIS

Client Name: GZA GeoEnvironmental, Inc.
Client Project ID: 123 Pine Street
Client Sample ID: East Exc. Bottom
Date Sampled: 04/25/17 10:35
Percent Solids: 79
Initial Volume: 24.7
Final Volume: 1
Extraction Method: 3546

ESS Laboratory Work Order: 1704760
ESS Laboratory Sample ID: 1704760-01
Sample Matrix: Soil
Units: mg/kg dry

Prepared: 4/28/17 16:19

MADEP-EPH Extractable Petroleum Hydrocarbons

Analyte	Results (MRL)	MDL	Method	Limit	DF	Analyst	Analyzed	Sequence	Batch
C9-C18 Aliphatics1	**220** (19.2)		MADEP-EPH		1	DPS	04/30/17 1:54	C7D0490	CD72823
C19-C36 Aliphatics1	**58.4** (19.2)		MADEP-EPH		1	DPS	04/30/17 1:54	C7D0490	CD72823
C11-C22 Unadjusted Aromatics1	**75.8** (19.2)		EPH8270		1	ZLC	05/01/17 22:23	C7E0011	CD72823
C11-C22 Aromatics1,2	**75.1** (19.2)		EPH8270			ZLC	05/01/17 22:23		[CALC]
2-Methylnaphthalene	**0.73** (0.26)		EPH8270		1	ZLC	05/01/17 22:23	C7E0011	CD72823
Acenaphthene	ND (0.51)		EPH8270		1	ZLC	05/01/17 22:23	C7E0011	CD72823
Naphthalene	ND (0.51)		EPH8270		1	ZLC	05/01/17 22:23	C7E0011	CD72823
Phenanthrene	ND (0.51)		EPH8270		1	ZLC	05/01/17 22:23	C7E0011	CD72823
Acenaphthylene	ND (0.26)		EPH8270		1	ZLC	05/01/17 22:23	C7E0011	CD72823
Anthracene	ND (0.51)		EPH8270		1	ZLC	05/01/17 22:23	C7E0011	CD72823
Benzo(a)anthracene	ND (0.51)		EPH8270		1	ZLC	05/01/17 22:23	C7E0011	CD72823
Benzo(a)pyrene	ND (0.51)		EPH8270		1	ZLC	05/01/17 22:23	C7E0011	CD72823
Benzo(b)fluoranthene	ND (0.51)		EPH8270		1	ZLC	05/01/17 22:23	C7E0011	CD72823
Benzo(g,h,i)perylene	ND (0.51)		EPH8270		1	ZLC	05/01/17 22:23	C7E0011	CD72823
Benzo(k)fluoranthene	ND (0.51)		EPH8270		1	ZLC	05/01/17 22:23	C7E0011	CD72823
Chrysene	ND (0.51)		EPH8270		1	ZLC	05/01/17 22:23	C7E0011	CD72823
Dibenzo(a,h)Anthracene	ND (0.26)		EPH8270		1	ZLC	05/01/17 22:23	C7E0011	CD72823
Fluoranthene	ND (0.51)		EPH8270		1	ZLC	05/01/17 22:23	C7E0011	CD72823
Fluorene	ND (0.51)		EPH8270		1	ZLC	05/01/17 22:23	C7E0011	CD72823
Indeno(1,2,3-cd)Pyrene	ND (0.51)		EPH8270		1	ZLC	05/01/17 22:23	C7E0011	CD72823
Pyrene	ND (0.51)		EPH8270		1	ZLC	05/01/17 22:23	C7E0011	CD72823

	%Recovery	Qualifier	Limits
Surrogate: 1-Chlorooctadecane	*72 %*		*40-140*
Surrogate: 2-Bromonaphthalene	*99 %*		*40-140*
Surrogate: 2-Fluorobiphenyl	*86 %*		*40-140*
Surrogate: O-Terphenyl	*77 %*		*40-140*

CERTIFICATE OF ANALYSIS

Client Name: GZA GeoEnvironmental, Inc.
Client Project ID: 123 Pine Street
Client Sample ID: Exc. Composite
Date Sampled: 04/25/17 10:40
Percent Solids: 88
Initial Volume: 24.5
Final Volume: 1
Extraction Method: 3546

ESS Laboratory Work Order: 1704760
ESS Laboratory Sample ID: 1704760-02
Sample Matrix: Soil
Units: mg/kg dry

Prepared: 4/28/17 16:19

MADEP-EPH Extractable Petroleum Hydrocarbons

Analyte	Results (MRL)	MDL	Method	Limit	DF	Analyst	Analyzed	Sequence	Batch
C9-C18 Aliphatics1	**19.5** (17.5)		MADEP-EPH		1	DPS	04/30/17 2:41	C7D0490	CD72823
C19-C36 Aliphatics1	ND (17.5)		MADEP-EPH		1	DPS	04/30/17 2:41	C7D0490	CD72823
C11-C22 Unadjusted Aromatics1	ND (17.5)		EPH8270		1	ZLC	05/01/17 23:00	C7E0011	CD72823
C11-C22 Aromatics1,2	ND (17.5)		EPH8270			ZLC	05/01/17 23:00		[CALC]
2-Methylnaphthalene	ND (0.23)		EPH8270		1	ZLC	05/01/17 23:00	C7E0011	CD72823
Acenaphthene	ND (0.47)		EPH8270		1	ZLC	05/01/17 23:00	C7E0011	CD72823
Naphthalene	ND (0.47)		EPH8270		1	ZLC	05/01/17 23:00	C7E0011	CD72823
Phenanthrene	ND (0.47)		EPH8270		1	ZLC	05/01/17 23:00	C7E0011	CD72823
Acenaphthylene	ND (0.23)		EPH8270		1	ZLC	05/01/17 23:00	C7E0011	CD72823
Anthracene	ND (0.47)		EPH8270		1	ZLC	05/01/17 23:00	C7E0011	CD72823
Benzo(a)anthracene	ND (0.47)		EPH8270		1	ZLC	05/01/17 23:00	C7E0011	CD72823
Benzo(a)pyrene	ND (0.47)		EPH8270		1	ZLC	05/01/17 23:00	C7E0011	CD72823
Benzo(b)fluoranthene	ND (0.47)		EPH8270		1	ZLC	05/01/17 23:00	C7E0011	CD72823
Benzo(g,h,i)perylene	ND (0.47)		EPH8270		1	ZLC	05/01/17 23:00	C7E0011	CD72823
Benzo(k)fluoranthene	ND (0.47)		EPH8270		1	ZLC	05/01/17 23:00	C7E0011	CD72823
Chrysene	ND (0.47)		EPH8270		1	ZLC	05/01/17 23:00	C7E0011	CD72823
Dibenzo(a,h)Anthracene	ND (0.23)		EPH8270		1	ZLC	05/01/17 23:00	C7E0011	CD72823
Fluoranthene	ND (0.47)		EPH8270		1	ZLC	05/01/17 23:00	C7E0011	CD72823
Fluorene	ND (0.47)		EPH8270		1	ZLC	05/01/17 23:00	C7E0011	CD72823
Indeno(1,2,3-cd)Pyrene	ND (0.47)		EPH8270		1	ZLC	05/01/17 23:00	C7E0011	CD72823
Pyrene	ND (0.47)		EPH8270		1	ZLC	05/01/17 23:00	C7E0011	CD72823

	%Recovery	Qualifier	Limits
Surrogate: 1-Chlorooctadecane	*76 %*		*40-140*
Surrogate: 2-Bromonaphthalene	*100 %*		*40-140*
Surrogate: 2-Fluorobiphenyl	*89 %*		*40-140*
Surrogate: O-Terphenyl	*87 %*		*40-140*

CERTIFICATE OF ANALYSIS

Client Name: GZA GeoEnvironmental, Inc.
Client Project ID: 123 Pine Street

ESS Laboratory Work Order: 1704760

Quality Control Data

Analyte	Result	MRL	Units	Spike Level	Source Result	%REC	%REC Limits	RPD	RPD Limit	Qualifier
MADEP-EPH Extractable Petroleum Hydrocarbons										
Batch CD72823 - 3546										
Blank										
C19-C36 Aliphatics1	ND	15.0	mg/kg wet							
C9-C18 Aliphatics1	ND	15.0	mg/kg wet							
Decane (C10)	ND	0.5	mg/kg wet							
Docosane (C22)	ND	0.5	mg/kg wet							
Dodecane (C12)	ND	0.5	mg/kg wet							
Eicosane (C20)	ND	0.5	mg/kg wet							
Hexacosane (C26)	ND	0.5	mg/kg wet							
Hexadecane (C16)	ND	0.5	mg/kg wet							
Hexatriacontane (C36)	ND	0.5	mg/kg wet							
Nonadecane (C19)	ND	0.5	mg/kg wet							
Nonane (C9)	ND	0.5	mg/kg wet							
Octacosane (C28)	ND	0.5	mg/kg wet							
Octadecane (C18)	ND	0.5	mg/kg wet							
Tetracosane (C24)	ND	0.5	mg/kg wet							
Tetradecane (C14)	ND	0.5	mg/kg wet							
Triacontane (C30)	ND	0.5	mg/kg wet							
Surrogate: 1-Chlorooctadecane	*1.40*		mg/kg wet	*2.000*		*70*	*40-140*			
Blank										
2-Methylnaphthalene	ND	0.20	mg/kg wet							
Acenaphthene	ND	0.40	mg/kg wet							
Acenaphthylene	ND	0.20	mg/kg wet							
Anthracene	ND	0.40	mg/kg wet							
Benzo(a)anthracene	ND	0.40	mg/kg wet							
Benzo(a)pyrene	ND	0.40	mg/kg wet							
Benzo(b)fluoranthene	ND	0.40	mg/kg wet							
Benzo(g,h,i)perylene	ND	0.40	mg/kg wet							
Benzo(k)fluoranthene	ND	0.40	mg/kg wet							
C11-C22 Aromatics1,2	ND	15.0	mg/kg wet							
C11-C22 Unadjusted Aromatics1	ND	15.0	mg/kg wet							
Chrysene	ND	0.40	mg/kg wet							
Dibenzo(a,h)Anthracene	ND	0.20	mg/kg wet							
Fluoranthene	ND	0.40	mg/kg wet							
Fluorene	ND	0.40	mg/kg wet							
Indeno(1,2,3-cd)Pyrene	ND	0.40	mg/kg wet							
Naphthalene	ND	0.40	mg/kg wet							
Phenanthrene	ND	0.40	mg/kg wet							
Pyrene	ND	0.40	mg/kg wet							
Surrogate: 2-Bromonaphthalene	*1.71*		mg/kg wet	*2.000*		*85*	*40-140*			
Surrogate: 2-Fluorobiphenyl	*1.56*		mg/kg wet	*2.000*		*78*	*40-140*			
Surrogate: O-Terphenyl	*1.61*		mg/kg wet	*2.000*		*81*	*40-140*			
LCS										
C19-C36 Aliphatics1	16.5	15.0	mg/kg wet	16.00		103	40-140			
C9-C18 Aliphatics1	11.3	15.0	mg/kg wet	12.00		94	40-140			

CERTIFICATE OF ANALYSIS

Client Name: GZA GeoEnvironmental, Inc.
Client Project ID: 123 Pine Street

ESS Laboratory Work Order: 1704760

Quality Control Data

Analyte	Result	MRL	Units	Spike Level	Source Result	%REC	%REC Limits	RPD	RPD Limit	Qualifier
MADEP-EPH Extractable Petroleum Hydrocarbons										
Batch CD72823 - 3546										
Decane (C10)	1.3	0.5	mg/kg wet	2.000		64	40-140			
Docosane (C22)	1.8	0.5	mg/kg wet	2.000		88	40-140			
Dodecane (C12)	1.4	0.5	mg/kg wet	2.000		70	40-140			
Eicosane (C20)	1.7	0.5	mg/kg wet	2.000		87	40-140			
Hexacosane (C26)	1.7	0.5	mg/kg wet	2.000		87	40-140			
Hexadecane (C16)	1.7	0.5	mg/kg wet	2.000		84	40-140			
Hexatriacontane (C36)	1.7	0.5	mg/kg wet	2.000		84	40-140			
Nonadecane (C19)	1.8	0.5	mg/kg wet	2.000		88	40-140			
Nonane (C9)	1.0	0.5	mg/kg wet	2.000		52	30-140			
Octacosane (C28)	1.7	0.5	mg/kg wet	2.000		85	40-140			
Octadecane (C18)	1.7	0.5	mg/kg wet	2.000		84	40-140			
Tetracosane (C24)	1.7	0.5	mg/kg wet	2.000		87	40-140			
Tetradecane (C14)	1.5	0.5	mg/kg wet	2.000		77	40-140			
Triacontane (C30)	1.7	0.5	mg/kg wet	2.000		83	40-140			
Surrogate: 1-Chlorooctadecane	*1.46*		mg/kg wet	*2.000*		*73*	*40-140*			
LCS										
2-Methylnaphthalene	1.29	0.20	mg/kg wet	2.000		65	40-140			
Acenaphthene	1.64	0.40	mg/kg wet	2.000		82	40-140			
Acenaphthylene	1.77	0.20	mg/kg wet	2.000		88	40-140			
Anthracene	1.70	0.40	mg/kg wet	2.000		85	40-140			
Benzo(a)anthracene	1.75	0.40	mg/kg wet	2.000		87	40-140			
Benzo(a)pyrene	1.79	0.40	mg/kg wet	2.000		90	40-140			
Benzo(b)fluoranthene	1.79	0.40	mg/kg wet	2.000		89	40-140			
Benzo(g,h,i)perylene	1.72	0.40	mg/kg wet	2.000		86	40-140			
Benzo(k)fluoranthene	1.95	0.40	mg/kg wet	2.000		98	40-140			
C11-C22 Aromatics1,2	ND	15.0	mg/kg wet							
C11-C22 Unadjusted Aromatics1	29.3	15.0	mg/kg wet	34.00		86	40-140			
Chrysene	1.86	0.40	mg/kg wet	2.000		93	40-140			
Dibenzo(a,h)Anthracene	1.73	0.20	mg/kg wet	2.000		86	40-140			
Fluoranthene	1.73	0.40	mg/kg wet	2.000		87	40-140			
Fluorene	1.66	0.40	mg/kg wet	2.000		83	40-140			
Indeno(1,2,3-cd)Pyrene	1.71	0.40	mg/kg wet	2.000		85	40-140			
Naphthalene	1.48	0.40	mg/kg wet	2.000		74	40-140			
Phenanthrene	1.69	0.40	mg/kg wet	2.000		85	40-140			
Pyrene	1.88	0.40	mg/kg wet	2.000		94	40-140			
Surrogate: 2-Bromonaphthalene	*1.53*		mg/kg wet	*2.000*		*76*	*40-140*			
Surrogate: 2-Fluorobiphenyl	*1.65*		mg/kg wet	*2.000*		*82*	*40-140*			
Surrogate: O-Terphenyl	*1.71*		mg/kg wet	*2.000*		*86*	*40-140*			
LCS										
2-Methylnaphthalene Breakthrough	0.0		%				0-5			
Naphthalene Breakthrough	0.0		%				0-5			
LCS Dup										
C19-C36 Aliphatics1	15.5	15.0	mg/kg wet	16.00		97	40-140	6	25	
C9-C18 Aliphatics1	10.3	15.0	mg/kg wet	12.00		86	40-140	9	25	

CERTIFICATE OF ANALYSIS

Client Name: GZA GeoEnvironmental, Inc.
Client Project ID: 123 Pine Street

ESS Laboratory Work Order: 1704760

Quality Control Data

Analyte	Result	MRL	Units	Spike Level	Source Result	%REC	%REC Limits	RPD	RPD Limit	Qualifier
MADEP-EPH Extractable Petroleum Hydrocarbons										
Batch CD72823 - 3546										
Decane (C10)	1.2	0.5	mg/kg wet	2.000		59	40-140	8	25	
Docosane (C22)	1.8	0.5	mg/kg wet	2.000		91	40-140	4	25	
Dodecane (C12)	1.3	0.5	mg/kg wet	2.000		65	40-140	8	25	
Eicosane (C20)	1.6	0.5	mg/kg wet	2.000		81	40-140	6	25	
Hexacosane (C26)	1.6	0.5	mg/kg wet	2.000		82	40-140	6	25	
Hexadecane (C16)	1.6	0.5	mg/kg wet	2.000		78	40-140	7	25	
Hexatriacontane (C36)	1.6	0.5	mg/kg wet	2.000		80	40-140	6	25	
Nonadecane (C19)	1.7	0.5	mg/kg wet	2.000		83	40-140	6	25	
Nonane (C9)	1.0	0.5	mg/kg wet	2.000		49	30-140	7	25	
Octacosane (C28)	1.6	0.5	mg/kg wet	2.000		79	40-140	7	25	
Octadecane (C18)	1.6	0.5	mg/kg wet	2.000		78	40-140	6	25	
Tetracosane (C24)	1.6	0.5	mg/kg wet	2.000		82	40-140	6	25	
Tetradecane (C14)	1.4	0.5	mg/kg wet	2.000		72	40-140	7	25	
Triacontane (C30)	1.6	0.5	mg/kg wet	2.000		78	40-140	6	25	
Surrogate: 1-Chlorooctadecane	*1.34*		mg/kg wet	*2.000*		*67*	*40-140*			
LCS Dup										
2-Methylnaphthalene	1.27	0.20	mg/kg wet	2.000		63	40-140	2	30	
Acenaphthene	1.55	0.40	mg/kg wet	2.000		78	40-140	6	30	
Acenaphthylene	1.73	0.20	mg/kg wet	2.000		86	40-140	2	30	
Anthracene	1.80	0.40	mg/kg wet	2.000		90	40-140	6	30	
Benzo(a)anthracene	1.86	0.40	mg/kg wet	2.000		93	40-140	6	30	
Benzo(a)pyrene	1.84	0.40	mg/kg wet	2.000		92	40-140	2	30	
Benzo(b)fluoranthene	1.89	0.40	mg/kg wet	2.000		94	40-140	5	30	
Benzo(g,h,i)perylene	1.78	0.40	mg/kg wet	2.000		89	40-140	3	30	
Benzo(k)fluoranthene	2.13	0.40	mg/kg wet	2.000		107	40-140	9	30	
C11-C22 Aromatics1,2	ND	15.0	mg/kg wet							
C11-C22 Unadjusted Aromatics1	30.3	15.0	mg/kg wet	34.00		89	40-140	3	25	
Chrysene	1.98	0.40	mg/kg wet	2.000		99	40-140	6	30	
Dibenzo(a,h)Anthracene	1.80	0.20	mg/kg wet	2.000		90	40-140	4	30	
Fluoranthene	1.82	0.40	mg/kg wet	2.000		91	40-140	5	30	
Fluorene	1.78	0.40	mg/kg wet	2.000		89	40-140	7	30	
Indeno(1,2,3-cd)Pyrene	1.77	0.40	mg/kg wet	2.000		89	40-140	4	30	
Naphthalene	1.44	0.40	mg/kg wet	2.000		72	40-140	2	30	
Phenanthrene	1.77	0.40	mg/kg wet	2.000		88	40-140	4	30	
Pyrene	1.91	0.40	mg/kg wet	2.000		96	40-140	1	30	
Surrogate: 2-Bromonaphthalene	*1.63*		mg/kg wet	*2.000*		*82*	*40-140*			
Surrogate: 2-Fluorobiphenyl	*1.65*		mg/kg wet	*2.000*		*83*	*40-140*			
Surrogate: O-Terphenyl	*1.77*		mg/kg wet	*2.000*		*89*	*40-140*			
LCS Dup										
2-Methylnaphthalene Breakthrough	0.0		%				0-5		200	
Naphthalene Breakthrough	0.0		%				0-5		200	

CERTIFICATE OF ANALYSIS

Client Name: GZA GeoEnvironmental, Inc.
Client Project ID: 123 Pine Street

ESS Laboratory Work Order: 1704760

Notes and Definitions

U	Analyte included in the analysis, but not detected
ND	Analyte NOT DETECTED at or above the MRL (LOQ), LOD for DoD Reports, MDL for J-Flagged Analytes
dry	Sample results reported on a dry weight basis
RPD	Relative Percent Difference
MDL	Method Detection Limit
MRL	Method Reporting Limit
LOD	Limit of Detection
LOQ	Limit of Quantitation
DL	Detection Limit
I/V	Initial Volume
F/V	Final Volume
§	Subcontracted analysis; see attached report
1	Range result excludes concentrations of surrogates and/or internal standards eluting in that range.
2	Range result excludes concentrations of target analytes eluting in that range.
3	Range result excludes the concentration of the C9-C10 aromatic range.
Avg	Results reported as a mathematical average.
NR	No Recovery
[CALC]	Calculated Analyte
SUB	Subcontracted analysis; see attached report
RL	Reporting Limit
EDL	Estimated Detection Limit

CERTIFICATE OF ANALYSIS

Client Name: GZA GeoEnvironmental, Inc.
Client Project ID: 123 Pine Street

ESS Laboratory Work Order: 1704760

ESS LABORATORY CERTIFICATIONS AND ACCREDITATIONS

ENVIRONMENTAL

Rhode Island Potable and Non Potable Water: LAI00179
http://www.health.ri.gov/find/labs/analytical/ESS.pdf

Connecticut Potable and Non Potable Water, Solid and Hazardous Waste: PH-0750
http://www.ct.gov/dph/lib/dph/environmental_health/environmental_laboratories/pdf/OutofStateCommercialLaboratories.pdf

Maine Potable and Non Potable Water, and Solid and Hazardous Waste: RI00002
http://www.maine.gov/dhhs/mecdc/environmental-health/dwp/partners/labCert.shtml

Massachusetts Potable and Non Potable Water: M-RI002
http://public.dep.state.ma.us/Labcert/Labcert.aspx

New Hampshire (NELAP accredited) Potable and Non Potable Water, Solid and Hazardous Waste: 2424
http://des.nh.gov/organization/divisions/water/dwgb/nhelap/index.htm

New York (NELAP accredited) Non Potable Water, Solid and Hazardous Waste: 11313
http://www.wadsworth.org/labcert/elap/comm.html

New Jersey (NELAP accredited) Non Potable Water, Solid and Hazardous Waste: RI006
http://datamine2.state.nj.us/DEP_OPRA/OpraMain/pi_main?mode=pi_by_site&sort_order=PI_NAMEA&Select+a+Site:=58715

United States Department of Agriculture Soil Permit: P330-12-00139

Pennsylvania: 68-01752
http://www.dep.pa.gov/Business/OtherPrograms/Labs/Pages/Laboratory-Accreditation-Program.aspx

ESS Laboratory Sample and Cooler Receipt Checklist

Client: GZA - Springfield, MA - GZA/MM

Shipped/Delivered Via: ESS Courier

ESS Project ID: 1704760
Date Received: 4/27/2017
Project Due Date: 5/3/2017
Days for Project: 4 Day

1. Air bill manifest present? No
   Air No.: NA
2. Were custody seals present? No
3. Is radiation count <100 CPM? Yes
4. Is a Cooler Present? Yes
   Temp: 2.4 Iced with: Ice
5. Was COC signed and dated by client? Yes
6. Does COC match bottles? Yes
7. Is COC complete and correct? Yes
8. Were samples received intact? Yes
9. **Were labs informed about short holds & rushes?** Yes / No / NA
10. Were any analyses received outside of hold time? Yes / No

11. Any Subcontracting needed? Yes / No
    ESS Sample IDs:
    Analysis:
    TAT:
12. Were VOAs received? Yes / No
    a. Air bubbles in aqueous VOAs? Yes / No
    b. Does methanol cover soil completely? Yes / No / NA
13. Are the samples properly preserved? Yes / No
    a. If metals preserved upon receipt: Date: Time: By:
    b. Low Level VOA vials frozen: Date: Time: By:

Sample Receiving Notes:

14. Was there a need to contact Project Manager? Yes / No
    a. Was there a need to contact the client? Yes / No
    Who was contacted? Date: Time: By:

Sample Number	Container ID	Proper Container	Air Bubbles Present	Sufficient Volume	Container Type	Preservative	Record pH (Cyanide and 608 Pesticides)
01	125201	Yes	NA	Yes	4 oz. Jar - Unpres	NP	
02	125200	Yes	NA	Yes	4 oz. Jar - Unpres	NP	

2nd Review
Are barcode labels on correct containers? Yes / No

Completed By: Date & Time: 4/27/17 1832
Reviewed By: Date & Time: 4/27/17 1838
Delivered By: 4/27/17 1838

4 DAY TAT PER Michelle Miranda.

ESS Laboratory

Division of Thielsch Engineering, Inc.

185 Frances Avenue, Cranston, RI 02910-2211
Tel. (401) 461-7181 Fax (401) 461-4486
www.esslaboratory.com

CHAIN OF CUSTODY

ESS Lab # 170760

Turn Time 5 DAY Standard Other_____

Regulatory State (MA) RI CT NH NJ NY ME Other_____

Is this project for any of the following:(please circle)
MA-MCP Navy USACE CT DEP Other_____

Reporting Limits - _____

Electonic Deliverables Excel Access PDF

Co. Name GZA GeoEnvironmental, Inc.	Project # 15.0166521.00	Project Name 123 Pine St - Holyoke	
Contact Person Adam Cote	Address 1350 Main St - (Suite 1400)		
City Springfield	State MA	Zip 01103	PO #
Tel.	Fax.	email:	

Analysis: MA EPH w/Target

ESS Lab ID	Date	Collection Time	Grab -G Composite-C	Matrix	Sample ID	Pres Code	# of Containers	Type of Container	Vol of Container	MA EPH w/Target
1	4-25-17	1035	G	SO	East Exc. Bottom	1	1	G	4oz	X
2	4-25-17	1040	C	SO	Exc. Composite	1	1	G	4oz	X

Container Type: P-Poly G-Glass AG-Amber Glass S-Sterile V-VOA

Matrix: S-Soil SD-Solid D-Sludge WW-Wastewater GW-Groundwater SW-Surface Water DW-Drinking Water O-Oil W-Wipes F-Filter

Cooler Present ✓ Yes ____ No

Seals Intact ____ Yes ____ No NA:___

Cooler Temperature: 2-4 iced

Internal Use Only
[ ] Pickup
[ ] Technician___

Preservation Code: 1-NP, 2-HCl, 3-H2SO4, 4-HNO3, 5-NaOH, 6-MeOH, 7-Asorbic Acid, 8-ZnAct, 9-_____

Sampled by : Adam Cote

Comments: Please watch for tiny bits of glass in "bottom" sample. Had to transfer contents to new jar because of broken container.

Relinquished by: (Signature, Date & Time)	Received by: (Signature, Date & Time)	Relinquished by: (Signature, Date & Time)	Received by: (Signature, Date & Time)
Adam Cote	GZA Sample Fridge 4/25/17	[illegible] 4/27/17 1410	[illegible] 4/27/17 1410
Relinquished by: (Signature, Date & Time) 4/27/17 1500	Received by: (Signature, Date & Time) 4/27/17 1505	Relinquished by: (Signature, Date & Time)	Received by: (Signature, Date & Time)

* By circling MA-MCP, client acknowledges samples were collected in accordance with MADEP CAM VIIA

Please fax to the laboratory all changes to Chain of Custody

1 (White) Lab Copy
2 (Yellow) Client Receipt

APPENDIX E

SOIL DISPOSAL DOCUMENTATION

Please print or type. (Form designed for use on elite (12-pitch) typewriter.)

Form Approved. OMB No. 2050-0039

UNIFORM HAZARDOUS WASTE MANIFEST

1. Generator ID Number: MAD 045 323 854
2. Page 1 of: 2
3. Emergency Response Phone: 413-313-7452
4. Manifest Tracking Number: 006949354 FLE

GENERATOR

5. Generator's Name and Mailing Address: ASSOCIATED BUILDING WRECKERS, 352 ALBANY STREET, SPRINGFIELD, MA 01104
Generator's Site Address (if different than mailing address):
Generator's Phone: (413) 732-3179

6. Transporter 1 Company Name: Western Mass Environmental, LLC
U.S. EPA ID Number: MAC300010147

7. Transporter 2 Company Name: VEOLIA ES TECHNICAL SOLUTIONS
U.S. EPA ID Number: NJD080631369

8. Designated Facility Name and Site Address: VEOLIA ES TECHNICAL SOLUTIONS, 4301 INFIRMARY ROAD, WEST CARROLLTON, OH
U.S. EPA ID Number: OHD 043945293
Facility's Phone: (937) 859-6101

9a. HM	9b. U.S. DOT Description (including Proper Shipping Name, Hazard Class, ID Number, and Packing Group (if any))	10. Containers No.	10. Containers Type	11. Total Quantity	12. Unit Wt./Vol.	13. Waste Codes		
	1 NRHE REGULATED OIL LIQUID, N.O.S. (OIL, WATER, DEBRIS) NONE, NA, NA	001	DM	400	P	MA01		
	2							
	3							
	4							

14. Special Handling Instructions and Additional Information
ER-WME- RAY Marciniak SRLF LIQUID - NH

15. GENERATOR'S/OFFEROR'S CERTIFICATION: I hereby declare that the contents of this consignment are fully and accurately described above by the proper shipping name, and are classified, packaged marked and labeled/placarded, and are in all respects in proper condition for transport according to applicable international and national governmental regulations. If export shipment and I am the Primary Exporter, I certify that the contents of this consignment conform to the terms of the attached EPA Acknowledgment of Consent.
I certify that the waste minimization statement identified in 40 CFR 262.27(a) (if I am a large quantity generator) or (b) (if I am a small quantity generator) is true.

Generator's/Offeror's Printed/Typed Name: Kevin White
Signature: Kevin White
Month: 09 Day: 08 Year: 16

TRANSPORTER / INT'L

16. International Shipments: ☐ Import to U.S. ☐ Export from U.S. Port of entry/exit:
Transporter signature (for exports only): Date leaving U.S.

17. Transporter Acknowledgment of Receipt of Materials

Transporter 1 Printed/Typed Name: Michael Walsh
Signature:
Month: 09 Day: 08 Year: 16

Transporter 2 Printed/Typed Name: John M. Kwiatkowski Jr.
Signature:
Month: 9 Day: 14 Year: 16

DESIGNATED FACILITY

18. Discrepancy

18a. Discrepancy Indication Space: ☐ Quantity ☐ Type ☐ Residue ☐ Partial Rejection ☐ Full Rejection
Manifest Reference Number:

19b. Alternate Facility (or Generator)
U.S. EPA ID Number:
Facility's Phone:

18c. Signature of Alternate Facility (or Generator)
Month: Day: Year:

19. Hazardous Waste Report Management Method Codes (i.e., codes for hazardous waste treatment, disposal, and recycling systems):
1. H141 2. 3. 4.

20. Designated Facility Owner or Operator: Certification of receipt of hazardous materials covered by the manifest except as noted in Item 18a
Printed/Typed Name: B. Harry Blankenship
Signature:
Month: 9 Day: 19 Year: 16

EPA Form 8700-22 (Rev. 3-05) Previous editions are obsolete

DESIGNATED FACILITY TO DESTINATION STATE (IF REQUIRED)

Please print or type. (Form designed for use on elite (12-pitch) typewriter)

Form Approved OMB No. 2050-0039

UNIFORM HAZARDOUS WASTE MANIFEST (Continuation Sheet)

21 Generator ID Number: MAD095323854

22 Page: 2

23. Manifest Tracking Number: 006949354 FLE

24. Generator's Name: Associated Building Wreckers

25 Transporter 3 Company Name: Freehold Cartage Inc

U.S. EPA ID Number: NJD 054126164

26 Transporter ____ Company Name

U.S. EPA ID Number

27a. HM	27b U.S. DOT Description (including Proper Shipping Name, Hazard Class, ID Number, and Packing Group (if any))	28 Containers No.	28 Containers Type	29. Total Quantity	30. Unit Wt./Vol.	31 Waste Codes

Daily Transporter 1

32. Special Handling Instructions and Additional Information

GENERATOR

TRANSPORTER

33 Transporter 3 Acknowledgment of Receipt of Materials

Printed/Typed Name: BECKY DREW | Signature: Becky Drew | Month: 9 | Day: 16 | Year: 16

34 Transporter ___ Acknowledgment of Receipt of Materials

Printed/Typed Name | Signature | Month | Day | Year

DESIGNATED FACILITY

35 Discrepancy

36. Hazardous Waste Report Management Method Codes (i.e., codes for hazardous waste treatment, disposal, and recycling systems)

Please print or type. (Form designed for use on elite (12-pitch) typewriter.)

Form Approved. OMB No. 2050-0039

UNIFORM HAZARDOUS WASTE MANIFEST

1. Generator ID Number	2. Page 1 of	3. Emergency Response Phone	4. Manifest Tracking Number
MA6132226610	1	413-319-7450	016994148 JJK

GENERATOR

5. Generator's Name and Mailing Address
CITY OF HOLYOKE OFFICE FOR COMMUNITY DEVELOPMEN
20 KOREAN VETERANS PLAZA
HOLYOKE MA 01040
Generator's Phone: 413 322 6610

Generator's Site Address (if different than mailing address)
123 PINE STREET
HOLYOKE MA 01040

6. Transporter 1 Company Name
Western Mass Environmental LLC
U.S. EPA ID Number
MAG300010147

7. Transporter 2 Company Name
Veolia ES Technical Solutions
U.S. EPA ID Number
OHD000651000

8. Designated Facility Name and Site Address
VEOLIA ES TECHNICAL SOLUTIONS, LLC
4501 INFIRMARY ROAD
WEST CARROLLTON OH 45449
Facility's Phone: 937 859 1611
U.S. EPA ID Number
OHD000204503

9a. HM	9b. U.S. DOT Description (including Proper Shipping Name, Hazard Class, ID Number, and Packing Group (if any))	10. Containers No.	10. Containers Type	11. Total Quantity	12. Unit Wt./Vol.	13. Waste Codes		
	1. STATE REGULATED SOLID, N.O.S. (OIL, DEBRIS, SOIL) NONE, NA, NA	003	DM	1100	P	MA01		
	2.							
	3.							
	4.							

14. Special Handling Instructions and Additional Information
E/R - WME - Ray Mecdniak SRNE'SOLID_WI

15. **GENERATOR'S/OFFEROR'S CERTIFICATION:** I hereby declare that the contents of this consignment are fully and accurately described above by the proper shipping name, and are classified, packaged, marked and labeled/placarded, and are in all respects in proper condition for transport according to applicable International and national governmental regulations. If export shipment and I am the Primary Exporter, I certify that the contents of this consignment conform to the terms of the attached EPA Acknowledgment of Consent.
I certify that the waste minimization statement identified in 40 CFR 262.27(a) (if I am a large quantity generator) or (b) (if I am a small quantity generator) is true.

Generator's/Offeror's Printed/Typed Name: Ray Edmund Mecdniak — Signature — Month 01 Day 25 Year 17

INT'L

16. International Shipments ☐ Import to U.S. ☐ Export from U.S. Port of entry/exit:
Transporter signature (for exports only): Date leaving U.S.:

TRANSPORTER

17. Transporter Acknowledgment of Receipt of Materials

Transporter 1 Printed/Typed Name: Corey Desaute — Signature — Month 1 Day 25 Year 17

Transporter 2 Printed/Typed Name: Robert Wilmoth — Signature — Month 1 Day 26 Year 17

DESIGNATED FACILITY

18. Discrepancy

18a. Discrepancy Indication Space ☐ Quantity ☐ Type ☐ Residue ☐ Partial Rejection ☐ Full Rejection

Manifest Reference Number:

18b. Alternate Facility (or Generator) — U.S. EPA ID Number

Facility's Phone:

18c. Signature of Alternate Facility (or Generator) — Month Day Year

19. Hazardous Waste Report Management Method Codes (i.e., codes for hazardous waste treatment, disposal, and recycling systems)

1.	2.	3.	4.

20. Designated Facility Owner or Operator: Certification of receipt of hazardous materials covered by the manifest except as noted in Item 18a

Printed/Typed Name — Signature — Month Day Year

APPENDIX F

PUBLIC NOTICES

Proactive by Design

GEOTECHNICAL
ENVIRONMENTAL
ECOLOGICAL
WATER
CONSTRUCTION MANAGEMENT

1350 Main Street
Suite 1400
Springfield, MA 01103
413.726.2100
www.gza.com

May 25, 2017
File No. 15.0166521.00

The Honorable Alex Morse
Office of the Mayor
536 Dwight Street
Holyoke, Massachusetts 01040

Re: Notice of Permanent Solution Statement With No Conditions (PSNCS)
123 Pine Street
Holyoke, Massachusetts 01040
Release Tracking Number (RTN) 1-20114

Dear Mayor Morse:

Notice is hereby given that the City of Holyoke Office of Planning and Economic Development ("the City") recently filed with the Massachusetts Department of Environmental Protection (MassDEP), a Permanent Solution With No Conditions Statement (PSNCS) Submittal with respect to property that the City owns at 123 Pine Street, Holyoke, MA ("the Property"). The property consists of approximately 0.126-acre of land improved by a 15,100-square foot vacant residential apartment building.

The PSNCS is filed for the Property pursuant to the Permanent Solution Statement (PSSS) provisions of the Massachusetts Contingency Plan ("MCP") at 310 CMR 40.1000.

In accordance with 310 CMR 40.1403(3)(f), the City is notifying you of the PSS Submittal. A copy of the PSNCS that the City has filed with the MassDEP is available on-line through MassDEP's electronic file viewing system, which can be accessed at the following URL: http://public.dep.state.ma.us/wsc_viewer/main.aspx .

Very truly yours,
GZA GEOENVIRONMENTAL, INC.

Adam Cote, CHMM
Assistant Project Manager

William Norman, LSP
Consultant/Reviewer

Guy P. Dalton, LSP
Associate Principal/Office Manager

cc: Debbie Oppermann, Marcos Marrero, City of Holyoke Office of Planning and Economic Development

Proactive by Design

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1350 Main Street
Suite 1400
Springfield, MA 01103
413.726.2100
www.gza.com

May 25, 2017
File No. 15.0166521.00

Mr. Brian Fitzgerald
City of Holyoke Board of Health
City Hall Annex
20 Korean Veterans Plaza (Room 306)
Holyoke, Massachusetts 01040

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APPENDIX G

DATA USABILITY ASSESSMENT AND DATA REPRESENTATIVENESS EVALUATION

APPENDIX G
DATA USABILITY AND REPRESENTATIVENESS EVALUATION

Consistent with the requirements of the MCP (310 CMR 40.1056(1)(k) and 40.1056(2)(k)), a Representativeness Evaluation and Data Usability Assessment (REDUA) was performed to support this Permanent Solution Statement (PSS) with No Conditions. The REDUA was conducted for the soil data used for Site characterization.

GZA evaluated the sample results included in three sample delivery groups (SDGs), as shown in Table G-1. The laboratory reports for three SDGs are included in Appendix D of the PSS GZA is submitting for the Site. The data used to support the PSS were generated by ESS Laboratory (Cranston, Rhode Island) pursuant to the MassDEP's *Compendium of Analytical Methods* (CAM). As stated in the MassDEP (2010) policy WSC-CAM-VIIA, to achieve Presumptive Certainty, parties must:

(a) Use the analytical method specified for the selected CAM protocol;

(b) Incorporate all required analytical QC[1] elements specified for the selected CAM protocol;

(c) Implement, as necessary, required corrective actions and analytical response actions for all non-conforming analytical performance standards;

(d) Evaluate and narrate, as necessary, all identified CAM protocol non-compliances; and

(e) Comply with all the reporting requirements specified in WSC-CAM-VII A, including retention of reported and unreported analytical data and information for a period of ten (10) years.

All analytical results evaluated in this REDUA met the requirements for "Presumptive Certainty," as described in MassDEP policy WSC-CAM-VIIA, *Quality Assurance and Quality Control Guidelines for the Acquisition and Reporting of Analytical Data* (MassDEP, 2010). CAM Compliant data (data with "Presumptive Certainty") are data of known accuracy, precision, and sensitivity. As such, the accuracy, precision, and sensitivity of CAM Compliant data do not require additional evaluation in an Analytical Data Usability Assessment.

Minor deficiencies were noted for SDG 1607072 based on the review of the laboratory reports. Surrogate recovery of 1-chlorooctadecane for BSMT-2 was diluted out. The recoveries of the other three surrogates were within the CAM limits. Further, soil associated with BSMT-2 has since been removed from the Site and therefore the BSMT-2 results were not used to characterize the current Site conditions. The soil samples in SDG 1607072 were collected using 8-oz jars instead of 4-oz glass as specified by the CAM. This is not expected to significantly impact the EPH and target analyte results. A detailed discussion of the analytical deficiencies is provided in Table G-2. Based on the review of the laboratory reports, GZA concluded that the deficiencies would not affect the data usability and that all data identified for the Site were considered usable to support the Permanent Solution.

Overall, it is GZA's opinion that the data used to support the site characterization are valid and defensible to support the Permanent Solution with respect to accuracy, precision, and completeness; furthermore, these data are sufficiently representative of conditions at the Site and may be used to support the Permanent Solution.

[1] Quality Control.

Table G-1
Data Used in Risk Characterization
123 Pine Street
Holyoke, Massachusetts

SDG[1]	Sample ID[2]	Sample Collection Date	Sample Matrix	Laboratory	Analysis	CAM Data Quality Category[3]
1607072	BSMT-2 and BSMT-3	7/5/2016	Soil	ESS	EPH and target analytes	CAM Compliant
1608558	123 Pine-S-4, 123 Pine-S-5, 123 Pine-S-6, and 123 Pine-S-7	8/18/2016	Soil	ESS	EPH and target analytes	CAM Compliant
1704760	East Exc.Bottom and Exc.Composite	4/25/2017	Soil	ESS	EPH and target analytes	CAM Compliant

Notes:

1. Sample Delivery Groups (SDGs) that have one or more samples that are included in the data set for Site characterization are listed in the table.
2. All samples in the SDG used for Site characterization are listed. Note that the results for BSMT-2 and 123 Pine-S-6 were not used to support the Site characterization as associated soil has since been removed from the Site.
3. CAM = Compendium of Quality Control Requirements and Performance Standards for Selected Analytical Protocols, WSC-10-320.
See Table 2 in MassDEP, 2007 "MCP Representativeness Evaluations and Data Usability Assessments" for data quality category definitions.

Abbreviations
EPH= extractable petroleum hydrocarbon; MassDEP=Massachusetts Department of Environmental Protection.

Laboratories
ESS=ESS Laboratory, Cranston, RI.

Table G-2
SUMMARY OF ANALYTICAL DEFICIENCIES FOR CAM-COMPLIANT DATA
123 Pine Street
Holyoke, Massachusetts

SDG	Analytical Deficiency	Results Affected	Data Usable?	Rationale
1607072	Surrogate 1-chlorooctadecane recovery for BSMT-2 was diluted out.	The EPH results for BSMT-2.	Yes	The other surrogate recoveries were within the CAM limits. The associated EPH results were considered estimated but usable. Note that soil associated with BSMT-2 has been removed and therefore the BSMT-2 results were not used to characterize the current Site conditions.
	The soil samples were collected using 8-oz jars instead of 4-oz jars required by CAM.	The EPH and target analyte results in this SDG.	Yes	The size of the container is not expected to significantly impact the analytical results.
1608558	No analytical deficiencies were noted.			
1606809	No analytical deficiencies were noted.			

Abbreviations:
MCP=Massachusetts Contingency Plan; EPH=extractable petroleum hydrocarbon; SDG=sample delivery group.
CAM = Compendium of Quality Control Requirements and Performance Standards for Selected Analytical Protocols, WSC-10-320.

APPENDIX H

CALCULATION OF SITE- AND CONTAMINANT-SPECIFIC ATTENUATION FACTORS (α) WITH SUPPORTING TABLES

CALCULATION OF SITE- AND CONTAMINANT-SPECIFIC ATTENUATION FACTORS (α)

1.00 INTRODUCTION

An attenuation factor, α relates the indoor air concentration to the soil gas concentration beneath the on-Site building foundation. GZA used the vapor transport model developed by Johnson and Ettinger (1991) to calculate site-specific attenuation factors for the building located at 123 Pine Street in Holyoke, Massachusetts. The model integrates site-specific information (i.e., building size and ventilation rates, and soil characteristics) and chemical-specific information (i.e., diffusion through air and water). This Attachment describes how this information was used to calculate an α for each contaminant of concern for the inhalation pathway, and subsequently, how α was used to estimate indoor air concentrations of volatile constituents detected in soil beneath the on-Site building foundation.

Section 2 describes the modeling assumptions used to calculate the site- and chemical-specific attenuation factors. Section 3 presents the equations used to calculate input values for the modeling parameters introduced in Section 2. Section 4 presents the equation used to estimate indoor air concentrations based on the attenuation factor. Section 5 discusses the uncertainties inherent in the model.

2.00 MODEL FOR ESTIMATING THE ATTENUATION FACTORS

The Johnson and Ettinger model used to derive the attenuation factors considers a mass balance whereby the mass transport rate of contaminants in soil gas under the building is equal to the mass transport rate through a crack in the basement or foundation slab, which is also equal to the mass transport rate into air circulating through the building. The mathematical model can be divided into three primary components. The first describes the diffusion of the contaminant from soil gas under the building to soil gas beneath the foundation (see Section 2.10). The second component models transport from the soil gas into the buildings (see Section 2.20), and the third dilutes the mass flow through the crack by the building air exchange rate (see Section 2.30).

2.10 DIFFUSIVE TRANSPORT FROM THE SOURCE TO SOIL BENEATH THE STRUCTURE

The diffusion of a contaminant from soil gas under the building to the foundation is presented in the following equation (Equation 11 from Johnson and Ettinger) and described graphically in the following Figure 1 (adapted from Johnson and Ettinger).

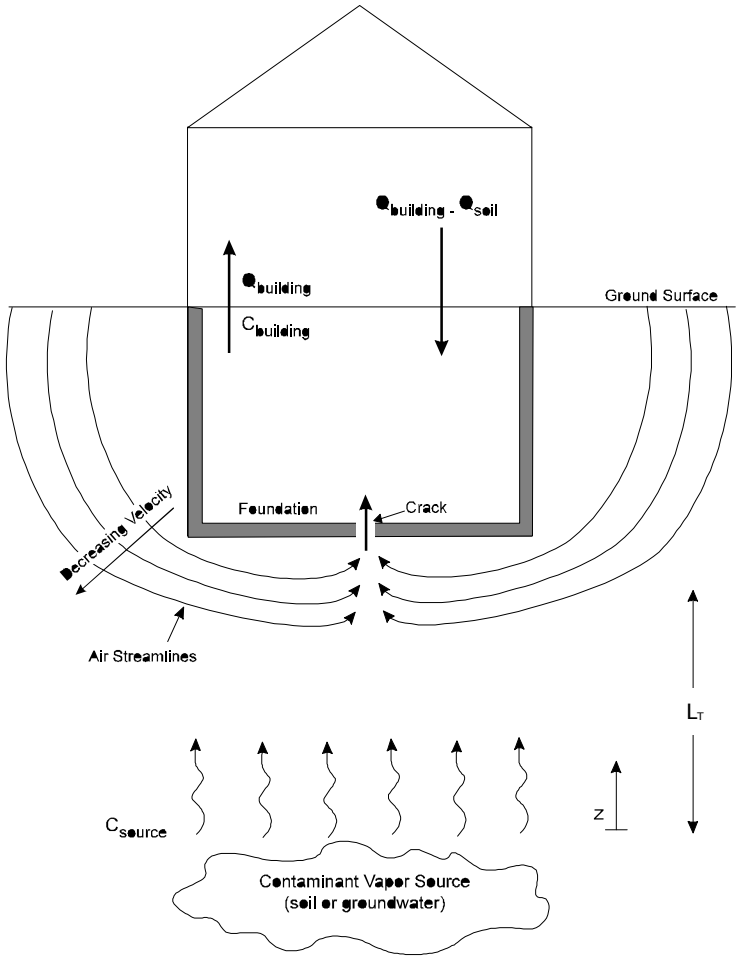

Figure No. 1 - V

$$E_1 = A_B\ CF\ (C_{source} - C_{soil})\ D_T^{eff}/L_T$$

where,

E_1	=	the mass-transport rate toward the structure (g/s),
A_B	=	the cross-sectional area through which the vapors pass (m^2),
C_{source}	=	the vapor concentration at the contaminant source (g/cm^3),
C_{soil}	=	the vapor concentration beneath the structure (g/cm^3),
L_T	=	the distance from contaminant source to foundation (cm),
D_T^{eff}	=	the "overall" effective porous media diffusion coefficient based on vapor phase concentrations for the region between the source and the foundation (cm^2/s), and
CF	=	units conversion factor (10,000 cm^2/m^2).

This is a basic diffusion equation of the type $D \times \delta c/\delta x \times A$, where D is the diffusion coefficient based on the effective value for the contaminant diffusion through unsaturated soil (Equations 4 and 5 from Johnson and Ettinger), $\delta c/\delta x$ is the concentration gradient, and A is the cross-sectional area.

Section 3 presents the equations used to calculate input values for these modeling parameters.

2.20 TRANSPORT FROM SOIL GAS INTO BUILDING

The following equation (Equation 14 from Johnson and Ettinger) predicts the entry rate of a contaminant through a crack whereby the concentration under the foundation is C_{soil}, the concentration in the building is $C_{building}$, and constant velocity occurs through the crack. Transport of contaminants from soil gas under a foundation is assumed to occur by a combination of convective and diffusive transport mechanisms. Convection, in this instance, is defined as movement of contaminant mass with the flow of the moving air. Diffusion, in this case, is defined as the movement of contaminant mass due to a concentration gradient. The steady-state, one dimensional solution for vapor transport through a crack (or porous medium) with a constant uniform convective velocity (Q_{soil}/A_{crack}) is used to predict the total rate of contaminant intrusion into a building.

$$E_2 = (Q_{soil})(C_{soil}) - [Q_{soil}(C_{soil} - C_{building})/[(1 - \exp (Q_{soil}L_{crack}/D_{crack}A_{crack}\ CF)]]$$

where,

E_2	=	entry rate of contaminant into the building (g/s),
Q_{soil}	=	convective volumetric flow rate of soil gas into the building (cm^3/s),
C_{soil}	=	soil gas contaminant concentration (g/cm^3),
$C_{building}$	=	contaminant vapor concentration in the building (g/cm^3),
L_{crack}	=	thickness of the foundation (cm),
D_{crack}	=	effective vapor-pressure diffusion coefficient through the crack (cm^2/s),
A_{crack}	=	area of cracks or openings through which contaminant vapors enter the building (m^2), and
CF	=	units conversion factor (10,000 cm^2/m^2).

Section 3 presents the equations used to calculate input values for these modeling parameters.

2.30 INDOOR CONTAMINANT VAPOR CONCENTRATION

The flux of contaminant entering the building through the crack is diluted only by the ventilation of air exchanged in the building. Using Equation 17 from Johnson and Ettinger, which assumes no other contaminant sinks (such as walls or furniture),

$$E_3 = Q_{building}\ C_{building}$$

where,

E_3	=	the mass transport rate of contaminant vapors circulating through the building (g/s),
$Q_{building}$	=	the ventilation rate in the basement or building (cm^3/s), and
$C_{building}$	=	the concentration of the contaminant in the vapor in the building (g/cm^3)

Using the three different equations for E_1, E_2, and E_3 presented in preceding sections of this appendix results in an equation for the attenuation factor (presented as Equation 21 in Johnson and Ettinger) that considers the following relationship:

$$E_1 = E_2 = E_3$$

where,

E_1	=	the mass-transport rate toward the structure (g/s) (see Section 2.10)
E_2	=	the entry rate of contaminant into the building (g/s) (see Section 2.20)
E_3	=	the flow rate of contaminant in the building air (g/s) (see Section 2.30)

or that the mass transport rate from the contaminant source is equal to the mass flux of contaminants through the crack into the building which is also equal to the flow rate of contaminants leaving the building. The attenuation factor used to estimate the correlation between contaminants in the soil gas beneath the building and contaminants inside a building above the soil gas may be expressed as $C_{building}/C_{source}$, and is based on a relationship between three dimensionless groups of variables. It is this correlation that GZA models in the following sections.

Section 3 presents the equations used to calculate input values for these modeling parameters.

3.00 MODEL PARAMETERS

The intent of the Johnson and Ettinger model is to estimate the concentration of contaminants that could volatilize into indoor air using attenuation factors that are calculated from parameters specific to the site building, the site hydrogeology, and the chemicals detected at the site. Equation parameters and the values used in calculating the site-specific attenuation factor α for each contaminant of concern at the site building are shown in Tables 1 though 3.

3.10 CALCULATION OF EFFECTIVE POROUS MEDIA DIFFUSION COEFFICIENT

The first part of the model calculates the "overall" effective porous medium diffusion coefficient (D_t). The input parameters for this part of the calculation are related to the type of soil at the site and the diffusion properties of the contaminants. (Site-specific values for these parameters are shown in Table 1.) They are interrelated according to the following relationships taken from Equations 4 through 7 in Johnson and Ettinger:

$$D_t = D_{water}\varepsilon_m^{3.33}/\varepsilon_T^2$$

where,

D_t	=	Effective porous medium diffusion coefficient
D_{water}	=	Molecular diffusivity in water. (cm^2/sec)
ε_m	=	Moisture filled porosity, and
ε_T	=	Total soil porosity.

$$D_t = D^{air}\varepsilon_v^{3.33}/\varepsilon_T^2$$

where,

ε_v	=	Vapor filled porosity,
D_{air}	=	Molecular diffusivity in air (cm^2/sec), and
ε_T	=	$\varepsilon_v + \varepsilon_m$.

Additionally,

$$\varepsilon_m = \theta_m \rho_b$$

where,

ρ_b	=	Dry soil bulk density (g/cm^3)
θ_m	=	Moisture content, water volume/dry soil weight (g H_2O/g soil or cm^3 H_2O/g soil)
ε_m	=	Moisture filled porosity

and,

$$\varepsilon_v = \varepsilon_T - \theta_m \rho_b$$

3.20 CALCULATION OF CONVECTIVE SOIL GAS FLOW RATE

The second component of the model calculates the vapor flow (Q_{soil}) through the hypothetical crack in the building foundation, using Equation 24 from Johnson and Ettinger, where:

$$Q_{soil} = 2\pi\Delta P k_v X_{crack}\, CF/\, \mu \ln [Z_{crack}/r_{crack}],$$

where, $r_{crack}/Z_{crack} << 1$, and

ΔP	=	Pressure difference between source and indoor air (Pa) (assumed to be 1 Pa, equivalent to 1×10^{-5} atm or 10 g/cm- s^2),
k_v	=	Soil intrinsic permeability (cm^2),
X_{crack}	=	Total basement crack length. Unless measurements are made of each crack in the building, the entire wall/foundation seam perimeter is used. (m),
μ	=	Vapor dynamic viscosity (g/cm-s),
Z_{crack}	=	Depth from ground surface to crack (m),
r_{crack}	=	Radius of basement crack such that $r_{crack} = \eta A_B/2X_{crack}$ (m) (Note that the 2 in the denominator that makes this a radius is in Equation 24 in Johnson & Ettinger.),
A_B	=	Foundation soil contact area (m^2) (does not explicitly appear in the equation),
η	=	Ratio of A_{crack}/A_B, where A_{crack} is the open area of the basement crack, and
CF	=	units conversion factor (100 cm/m).

Site-specific values for these parameters are shown in Table 2.

3.30 INDOOR CONTAMINANT VAPOR CONCENTRATION

The final part of the model dilutes the flux of contaminant entering the building by the air exchange rate in the building (See Table 3.)

The model combines three dimensionless variable groups that we have defined as A, B, and C. The variable groups combine many of the factors discussed previously and are presented below.

A = $Q_{soil} \times L_{crack} / D_{crack} \times A_{crack}$ (where A is equivalent to the Peclet number; higher values for A indicate a higher tendency for convection transport to dominate over diffusion.)

B = $D_t \times A_B \times CF / Q_{building} \times L_t$ (where B is an attenuation factor for diffusion dominated transport.)

C = $Q_{soil} / Q_{building}$ (where C is a dilution factor.)

The attenuation factor, α, is then calculated by the following from Equation 21 presented in Johnson and Ettinger:

$$\alpha = Be^A / [e^A + B + B/C(e^A - 1)]$$

The input parameters for this part of the calculation include:

Q_{soil} = Vapor flow through the hypothetical crack in the building foundation (cm^3/s) (eq. 24),

L_{crack} = Foundation thickness (cm),

D_{crack} = Vapor diffusion coefficient through the crack (cm^2/s),

A_{crack} = The open area of the basement crack (cm^2),

D_t = Effective porous medium diffusion coefficient (cm^2/s),

A_B = Foundation soil contact area (m^2),

$Q_{building}$ = Ventilation rate in the building or basement (cm^3/s),

L_T = Distance from contaminant source to foundation (cm),

e = 2.718, and

CF = units conversion factor (10,000 cm^2/m^2).

4.00 UNCERTAINTIES

The uncertainties associated with the model are related to the representativeness of the assumptions made. The greater the assumptions deviate from the actual conditions, the lower the reliability of the model. While errors in assumptions about overall air exchange rates may be significant, it is likely that these errors would err on the side of protection of public health. Difficulties with the model implementation are of less significance than modest changes in air exchange rates, for example.

The model is conservative in that it is likely to produce higher air concentrations than those that may eventually occur. It is sensitive to variations in permeability and building ventilation. Sink or removal mechanisms such as wall and surface adsorption or absorption, which would reduce airborne contamination, have not been included in this model. The degree of removal would be chemical-dependent, with the more reactive compounds preferentially removed; data are not available regarding how much of each compound would be lost.

GZA's model computations were verified against the value of α (5×10^{-4}) in Figure 4 (in Johnson and Ettinger) for a permeability of 10^{-7} cm^2 and η=0.001. The other input parameters are identified in the Johnson and Ettinger paper and the MassDEP (2014) Development of MCP Risk-Based Levels for Soil and Groundwater.

6.00 REFERENCES

Fitzpatrick, N.A. and J.J. Fitzgerald. 1996. "An Evaluation of Vapor Intrusion Into Buildings through a Study of Field Data," Presented at the 11th Annual Conference on Contaminated Soils, University of Massachusetts at Amherst, October 1996.

Johnson, P.C. and R.A. Ettinger. 1991. Heuristic model for predicting the intrusion rate of contaminant vapors into buildings. *Environmental Science & Technology*. **25** (8): 1445-1452.

Massachusetts Department of Environmental Protection (MassDEP). 1995. *Guidance for Disposal Site Risk Characterization - In Support of the Massachusetts Contingency Plan.* Office of Research and Standards, July.

Massachusetts Department of Environmental Protection (MassDEP). 2014. Development of MCP Risk-Based Levels for Soil and Groundwater.

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TABLE H-1
CALCULATION OF "OVERALL" EFFECTIVE POROUS MEDIA DIFFUSION COEFFICIENT
123 Pine Street
Holyoke, Massachusetts

Constituent	Dry Soil Bulk Density[1] (g/cm^3) g_d	Total Porosity[1] n_t	Moisture Filled Porosity [1] n_m	Vapor Filled Porosity [1] n_v	Molecular Diffusivity in Air [2] (cm^2/s) **Dair**	Vapor Porous Media Diffusion Coeff.[3] (cm^2/s) **Dv**	Molecular Diffusivity in Water [2] (cm^2/s) **Dwater**	Water Porous Media Diffusion Coeff.[3] (cm^2/s) **Dm**	"Overall" Effective Porous Media Diffusion Coeff.[3] (cm^2/s) **Dt**
C11-C22 Aromatic Fraction	1.66	0.375	0.054	0.321	0.060	9.70E-03	1.0E-06	4.27E-10	0.0097
C19-C36 Aliphatic Fraction	1.66	0.375	0.054	0.321	NA	NA	NA	NA	NC
C9-C18 Aliphatic Fraction	1.66	0.375	0.054	0.321	0.070	1.13E-02	5.0E-06	2.14E-09	0.011

Notes:
1. The value for sand was adopted from USEPA's Johnson and Ettinger (1991) Model for Subsurface Vapor Intrusion into Buildings (SL-ADV-Feb04.xls), February, 2004.
2. Contaminant-specific values were adopted from MassDEP (2014) Development of MCP Risk-Based Levels for Soil and Groundwater.
3. Diffusion coefficient was calculated per Equations 3 through 5 in the Johnson and Ettinger (1991) Heuristic Model for Predicting the Intrusion Rate of Contaminant Vapors Into Buildings: $Dv = Dair * n_v^{3.33}/n_t^2$; $Dm = Dwater*n_m^{3.33}/n_t^2$; $Dt = Dair*n_v^{3.33}/n_t^2 + Dwater/H*n_m^{3.33}/n_t^2$, where H = Henry's Law Constant.

NA = Not Available; NC = Not Calculated.

TABLE H-2
CALCULATION OF VOLUMETRIC FLOW RATE OF SOIL GAS INTO THE BUILDING
123 Pine Street
Holyoke, Massachusetts

Foundation Soil Contact Area[1] (m^2) **Ab**	n [2] **Acr/Ab**	Crack Area (m^2) **Acrack**	Total Crack Length[3] (m) **Xcrack**	Radius of Crack[4] (cm) **r_cr**	Depth of Enclosed Space Below Grade[5] (m) **Zcrack**	Pressure Difference Source to Indoor Air[6] 1 Pa = 10 g/cm-s^2 (Pa) **dP**	Soil Intrinsic Permeability[7] (cm^2) **k_v**	Vapor Dynamic Viscosity[8] (g/cm-s) **u**	Volumetric Flow Rate of Soil Gas into Building [9] (cm^3/s) **Qsoil**
442	0.001	0.44	67	0.7	2.44	4	1.0E-07	1.8E-04	142

Notes:

1. Foundation Soil Contact Area (Ab) is based on approximate area exposed to soil, i.e., the footprint of the building.
2. n = Acrack/Ab, assumed to be 0.001. According to the USEPA's User's Guide for Evaluating Subsurface Vapor Intrusion into Buildings (2004), the back-calculated values for a slab/wall edge crack based on soil gas-entry rates reported in Nazaroff (1992), Revzan et al. (1991), and Nazaroff et al. (1985) range from approximately 0.0001 to 0.001.
3. Total Crack Length (Xcrack) is based on the approximate total floor/wall seam perimeter distance of the building.
4. Radius of crack (r_cr) = Acrack/Xcrack.
5. The depth of the basement was used as the depth of the enclosed space below grade.
6. Pressure Difference (Source to Indoor Air) is assumed to be 4 Pa (MassDEP, 2013).
7. Soil Intrinsic Permeability for this site with fine to coarse sand and some fine to medium gravel is assumed to be 1.0E-07 cm^2 from Johnson & Ettinger, 1991 table for fine to medium sand.
8. Vapor Dynamic Viscosity was assumed to be 1.8E-04 g/cm-s (Johnson & Ettinger, 1991).
9. The following equation was used to calculate the volumetric flow rate of soil gas into the building as in Equation 15 of the USEPA's User's Guide for Evaluating Subsurface Vapor Intrusion into Buildings (2004): $Qsoil = 2*\pi*dP*k\_v*Xcrack/(u*\ln(2*Zcrack/r\_cr))$

Abbreviations:
cm^2 = square centimeter; m^2 = square meter; m = meter; cm = centimeter; s = second; g = gram; s^2 = square second; cm^3 = cubic centimeter; Pa = Pascal.

TABLE H-3
CALCULATION OF CONTAMINANT-SPECIFIC ATTENUATION FACTORS
123 Pine Street
Holyoke, Massachusetts

	"Overall" Effective Porous Media Diffusion Coeff. (cm^2/s) **Dt**	Foundation Soil Contact Area (m^2) **Ab**	Building Ventilation Rate[1] (cm^3/s) **Qbuilding**	Distance from Contaminant Source to Foundation[2] (cm) **Lt**	Volumetric Flow Rate of Soil Gas into Building (cm^3/s) **Qsoil**	Foundation Thickness[3] (cm) **Lcrack**	Effective Vapor-Pressure Diffusion Coefficient Through the Crack (cm^2/s) **Dcrack**	Acr/Ab **n**	Basement Crack Area (m^2) **Acrack**	Advective Dominated Constant =Effective Peclet Number[4] **A**	Diffusion Dominated Constant[5] **B**	Qsoil/Qbuilding **C**	Attenuation factor = Cbuidling/ Csource[6] alpha
C11-C22 Aromatic Fraction	9.70E-03	442	8.5E+04	122	1.4E+02	15	9.70E-03	0.001	0.442	49.55	4.14E-03	1.67E-03	1.19E-03
C19-C36 Aliphatic Fraction	NC	442	8.5E+04	122	1.4E+02	15	NC	0.001	0.442	NC	NC	1.67E-03	NC
C9-C18 Aliphatic Fraction	1.13E-02	442	8.5E+04	122	1.4E+02	15	1.13E-02	0.001	0.442	42.47	4.83E-03	1.67E-03	1.24E-03

Notes:
1. Building ventilation rate (Qbuilding) is based on the approximate volume of one floor of the building assuming an 8-foot ceiling and 0.45 air change per hour.
2. Distance from Contaminant Source to Foundation (Lt) is based on the depth from slab to soil source (assumed 4 feet).
3. Foundation Thickness (Lcrack) is thickness of slab which is assumed to be 6 inches or 15 cm .
4. The following equation was used to calculate the effective Peclet number as in Equation 17 of the USEPA's User's Guide for Evaluating Subsurface Vapor Intrusion into Buildings (2004): A = Qsoil*Lcrack/(Dcrack*Acrack)
5. The following equation was used to calculate the diffusion dominated constant as in Equation 18 of the USEPA's User's Guide for Evaluating Subsurface Vapor Intrusion into Buildings (2004): B = Dt*Ab/(Qbuilding*Lt)
6. The following equation was used to calculate alpha as in Equation 13 of the USEPA's User's Guide for Evaluating Subsurface Vapor Intrusion into Buildings (2004): alpha = B*EXP(A)/(EXP(A)+B+B/C*(EXP(A)-1))

Abbreviations:
cm^2 = square centimeter; m^2 = square meter; cm^3 = cubic centimeter; cm = centimeter; s = second.

TABLE H-4
ESTIMATING SOIL GAS CONCENTRATIONS FROM SOIL CONCENTRATIONS
123 Pine Street
Holyoke, Massachusetts

Constituent	Soil Concentration [1] (mg/kg) Csoil	Henry's Law Constant [2] (dimensionless) H	Dry Soil Bulk Density [3] (g/cm^3) g_d	Soil Water Filled Porosity [3] (cm^3/cm^3) n_m	Soil Vapor Filled Porosity [3] (cm^3/cm^3) n_v	Organic Carbon Partitioning Coefficient [2] (cm^3/g) K_{oc}	Soil Organic Carbon Fraction (unitless) f_{oc}	Source Soil gas Concentration ($\mu g/m^3$) C_{source}	Attenuation Factor (a)	Dilution Factor (d)	Estimated Indoor Air Concentration ($\mu g/m^3$) C_{air}
C11-C22 Aromatic Fraction	75	0.03	1.7	0.054	0.321	5,012	0.002	224	1.19E-03	10	2.66E-02
C19-C36 Aliphatic Fraction	58	NA	1.7	0.054	0.321	NA	0.002	NC	NC	10	NC
C9-C18 Aliphatic Fraction	220	69	1.7	0.054	0.321	680,000	0.002	11,053	1.24E-03	10	1.37E+00

The following equation was used to estimate soil gas concentrations based on concentrations detected in soil:

$$C_{source} = \frac{C_{soil} * H * g_d}{n_m + (K_{oc} * f_{oc} * g_d) + (H * n_v)}$$

This equation was adopted from USEPA's *Johnson and Ettinger (1991) Model for Subsurface Vapor Intrusion into Buildings (SL-ADV-Feb04.xls), February, 2004.*
http://www.epa.gov/oswer/riskassessment/airmodel/johnson_ettinger.htm

Notes:
1. The soil exposure point concentration is the maximum detected concentration from all soil samples obtained from within the disposal site boundaries.
2. Constituent-specific values were obtained from MassDEP, Development of MCP Risk Based Levels for Soil and Groundwater, February 2014.
3. Soil parameters for sand were adopted from USEPA's Johnson and Ettinger (1991) Model for Subsurface Vapor Intrusion into Buildings (SL-ADV-Feb04.xls), February, 2004.

APPENDIX I

METHOD 3 RISK ASSESSMENT FOR RESIDENT EXPOSED TO CHEMICALS IN INDOOR AIR – MASSDEP SHORTFORM

Method 3 Risk Assessment for Resident Exposed to Chemicals in Indoor Air - Shortform 2012 (sf12ra)

Index

Tab	
EPCs	Table RA-1: Select chemicals and enter Exposure Point Concentrations (EPCs). Estimated risks are presented to the right.
C Eq	Table RA-2: Equations to calculate cancer risks.
NC Eq	Table RA-3: Equations to calculate noncancer risks.
Exp	Table RA-4: Definitions and exposure factors.
Chem	Table RA-5: Chemical-specific data.

Spreadsheets designed by Andrew Friedmann, MassDEP
Questions and Comments may be addressed to:
Lydia Thompson
Massachusetts Department of Environmental Protection
Office of Research and Standards
One Winter Street
Boston, MA 02108 USA
Telephone: (617) 556-1165
Fax: (617) 556-1006
Email: Lydia.Thompson@state.ma.us

Resident - Indoor Air: Table RA-1
Exposure Point Concentration (EPC)
Based on Resident Ages 1-31 (Cancer) and 1-8 (Noncancer)

ShortForm Version 10-12

Vlookup Versionv0315

ELCR (all chemicals) =

HI (all chemicals) = 1.48E-02

****Do not insert or delete any rows****

Click on empty cell below and select OHM using arrow.

Oil or Hazardous Material		EPC ($\mu g/m^3$)	$ELCR_{air}$	HQ_{air}
AROMATICS	C11 to C22	2.7E-02		5.3E-04
ALIPHATICS	C9 to C18	1.4E+00		6.9E-03
AROMATICS	C11 to C22	2.7E-02		5.3E-04
ALIPHATICS	C9 to C18	1.4E+00		6.9E-03

MassDEP ORS
Contact: Lydia Thompson
Lydia.Thompson@state.ma.us
617-556-1165

Resident - Indoor Air: Table RA-2

Equations to Calculate Cancer Risk for Resident (Age 1-31 years)

Cancer Risk from Inhalation

$$ELCR_{air} = LADE_{(1\text{-}31)} * URF$$

$$LADE = \frac{[OHM]_{air} * EF * ED * EP}{AP_{lifetime}}$$

Vlookup Versionv0315

Parameter	Value	Units
URF	OHM specific	$(\mu g/m^3)^{-1}$
LADE	age/OHM specific	$\mu g/m^3$
$[OHM]_{air}$	OHM specific	$\mu g/m^3$
EF	1.00	event/day
ED	1	day/event
EP	30	years
$AP_{lifetime}$	70	years

MassDEP ORS
Contact: Lydia Thompson
Lydia.Thompson@state.ma.us
617-556-1165

Resident - Indoor Air: Table RA-3

Equations to Calculate Noncancer Risk for Resident Child (Age 1-8 years)

Vlookup Versionv0315

Noncancer Risk from Inhalation

$$HQ_{air} = \frac{ADE}{RfC}$$

$$ADE = \frac{[OHM]_{air} * EF * ED * EP * C}{AP}$$

Parameter	Value	Units
RfC	OHM specific	mg/m^3
ADE	OHM specific	mg/m^3
$[OHM]_{soil}$	OHM specific	$\mu g/m^3$
EF	1.00	event/day
ED	1	day/event
EP	7	years
C	0.001	mg/ug
AP	7	year

MassDEP ORS
Contact: Lydia Thompson
Lydia.Thompson@state.ma.us
617-556-1165

Resident - Indoor Air: Table RA-4
Definitions and Exposure Factors

Vlookup Versionv0315

Parameter	Value	Units	Notes
ELCR - Excess Lifetime Cancer Risk	chemical specific	dimensionless	
URF - Unit Risk Factor	chemical specific	$(\mu g/m^3)^{-1}$	see Table RA-5
LADE - Lifetime Average Daily Exposure	chemical specific	$\mu g/m^3$	see Table RA-2
HQ - Hazard Quotient	chemical specific	dimensionless	
RfC - Reference Concentration	chemical specific	mg/m^3	see Table RA-5
ADE - Average Daily Exposure	chemical specific	mg/m^3	see Table RA-3
EPC - Exposure Point Concentration	chemical specific	$\mu g/m^3$	see Table RA-1
EF - Exposure Frequency	1.00	event/day	
ED - Exposure Duration	1	day/event	
$EP_{(1-8)}$ - Exposure Period age group 1-8 (noncancer)	7	years	
$EP_{(1-31)}$ - Exposure Period for age group 1-31 (cancer)	30	years	
$AP_{(noncancer)}$ - Averaging Period for noncancer	7	years	
$AP_{(lifetime)}$ - Averaging Period for lifetime	70	years	

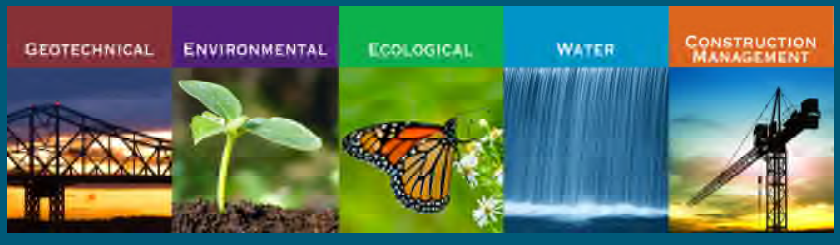
MassDEP ORS
Contact: Lydia Thompson
Lydia.Thompson@state.ma.us
617-556-1165

Resident - Indoor Air: Table RA-5
Chemical-Specific Data

Vlookup Versionv0315

Oil or Hazardous Material		URF $(ug/m^3)^{-1}$	RfC mg/m^3
AROMATICS	C11 to C22		5.00E-02
ALIPHATICS	C9 to C18		2.00E-01
AROMATICS	C11 to C22		5.00E-02
ALIPHATICS	C9 to C18		2.00E-01

MassDEP ORS
Contact: Lydia Thompson
Lydia.Thompson@state.ma.us
617-556-1165



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