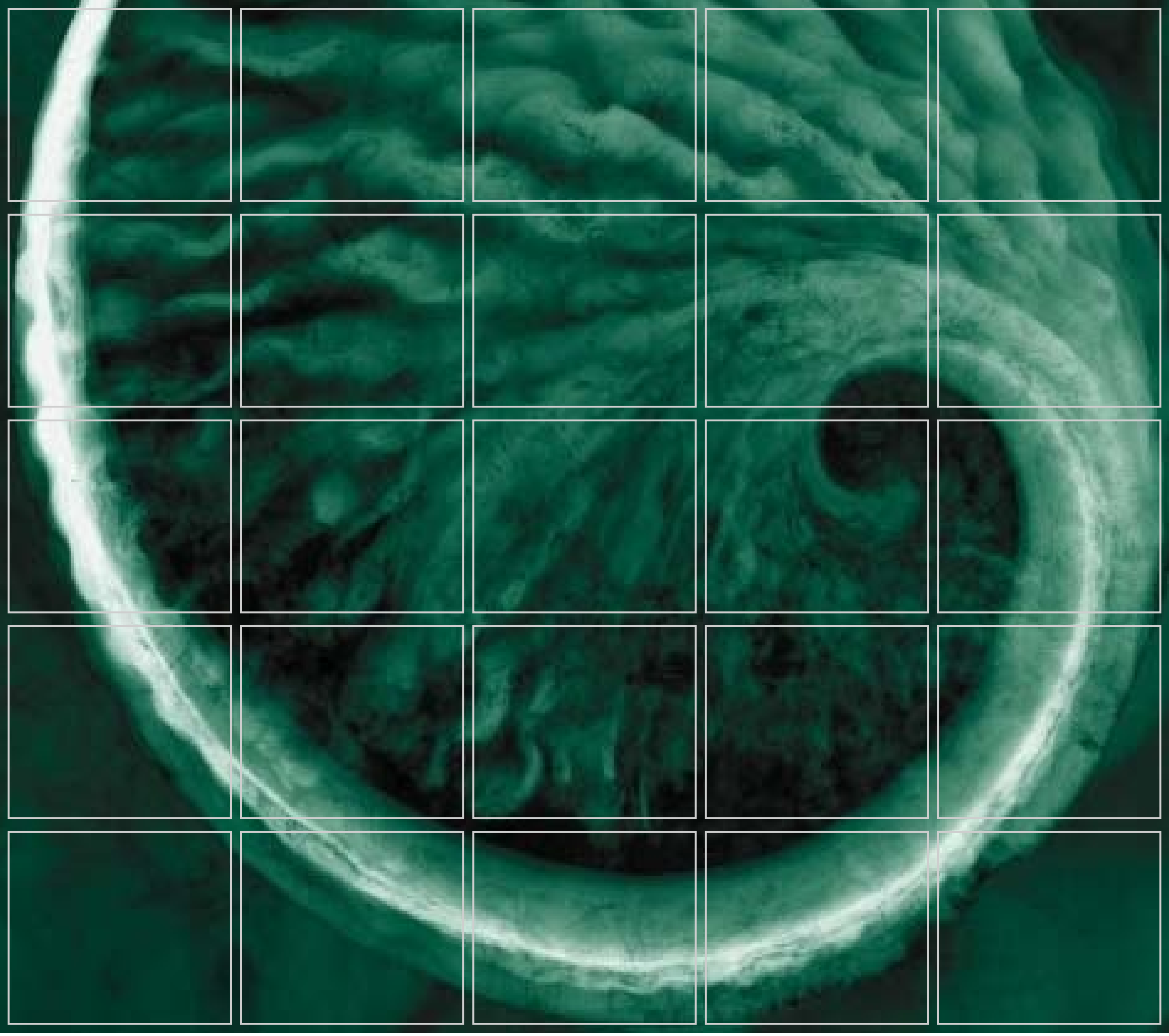

Joslyn Clark Controls, Inc.

Human Health Risk Assessment Report
Former Josyln Clark Controls Facility

2013 W. Meeting Street
Lancaster, South Carolina

September 23, 2013

Delivering sustainable solutions in a more competitive world

ERM

RISK ASSESSMENT REPORT

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Human Health Risk Assessment Report Former Joslyn Clark Controls Facility

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September 23, 2013

Project No. 0208239

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1.0 INTRODUCTION

On behalf of Joslyn Clark Controls, Inc. (Joslyn Clark), ERM NC, Inc. (ERM) conducted a Human Health Risk Assessment (HHRA) for the Joslyn Clark facility in Lancaster, South Carolina (the subject property). This HHRA characterizes both carcinogenic and non-carcinogenic risks associated with the current and future land use, specifically related to the TCE-impacted groundwater originating from inside the plant building.

This report presents a brief background of the Joslyn Clark facility and a description of the investigation activities completed. Results of the human health risk assessment using data from past investigations are provided herein.

1.1 SITE DESCRIPTION AND BACKGROUND

The subject property is located at 2013 W. Meeting Street, Lancaster, Lancaster County, South Carolina. The general location of the property and the physiographic features of the surrounding area are illustrated on Figure 1.

The subject property consists of 23 acres of land and is developed with two buildings. The now vacant former manufacturing building was constructed in 1964 and consists of approximately 180,000 square feet of floor space. The now vacant former warehouse/storage building was constructed in 1967 and consists of approximately 14,400 square feet of floor space. The subject property has been used to manufacture electrical control equipment for fire safety purposes since its construction in 1964. Figure 2 illustrates the general site plan and property layout.

The principal raw materials for manufacturing onsite included sheet metal, copper wire, pre-manufactured metal and plastic components, electrostatic paint, and oil-based paint. Joslyn Clark's primary production included the fabrication of metal cabinets, which were populated with various electrical, plastic, and metal components purchased from other off-site manufacturers. The Joslyn Clark facility had been a regulated source of air emissions, industrial wastewater discharge, and hazardous waste.

Land use in the vicinity of the subject property is residential, commercial, and wooded undeveloped property. The abutting properties and nearby land use include:

- North: W. Meeting Street bounds the property to the north. Properties beyond W. Meeting street include a mobile home park, a vehicle maintenance garage, commercial buildings, and a retail gasoline station to the northwest;
- East: Northwest Apartments are on the eastern adjoining property. Synteen Technical Fabrics, Inc., is located east-northeast of the property, across W. Meeting Street;
- South: An unused Lancaster & Chester Railroad bounds the property to the south. Wooded undeveloped land is located beyond; and
- West: Mostly wooded undeveloped land with some residential to the northwest.

The closest residences (multi-family) are located adjacent to the subject property to the east (Northwest Apartments). Another residential community (a mobile home park) is located across W. Meeting Street to the north. No visual evidence of environmental concerns was observed on immediately surrounding properties.

Potable water and sewer are provided by the Lancaster Water and Sewer District. There are no groundwater wells located within ½ mile downgradient of the site.

1.2 GEOLOGICAL AND HYDROGEOLOGICAL CONDITIONS

According to the Phase I assessment, the Lancaster area, including the subject site, is located within the Western Piedmont Physiographic Province of South Carolina. According to the Geologic Map of South Carolina (1997) and *The Geology of the Carolinas, Horton and Zullo, 1991*, the Lancaster area is located within the Charlotte Belt and is specifically underlain by mica gneiss.

According to the US Department of Agriculture (USDA) Natural Resources Conservation Service (NRCS) Web Soil Survey (http://websoilsurvey.nrcs.usda.gov/app/), the subject property is underlain by Georgeville silt and silty clay loam. Georgeville soils are well drained, have moderate infiltration rates, and do not meet the requirements for hydric soil.

The occurrence and movement of groundwater in the Piedmont province is within two separate, but interconnected, water bearing zones. A shallow water-bearing zone occurs within the saprolite zone, and a deeper zone occurs within the underlying bedrock. Groundwater in the shallow saprolite zone occurs in the interstitial pore space of the saprolite. The depth to groundwater in the saprolitic zone can range from 20 to 45 feet along ridges and upland areas. In low lying stream valleys, the groundwater level will approach the local surface water elevations in stream channels. Groundwater flow in this zone is typically governed by water table conditions. This means that groundwater will flow under unconfined conditions and generally mimic topography. Therefore, groundwater movement will be from upland areas (recharge zones) to nearby surface streams (discharge zones).

The occurrence and movement of groundwater in the deeper water-bearing zone within crystalline bedrock is controlled by secondary joints, fractures, and faults within the bedrock. Groundwater within the bedrock zone may be under confined or unconfined conditions. The occurrence and movement of groundwater is difficult to predict on a small scale due to the erratic nature of the secondary openings that control groundwater flow in bedrock. Small surface water features generally do not provide an indication of the direction of groundwater movement in bedrock. However, on a regional scale, the direction of groundwater movement will generally be from upland areas to major surface streams downgradient.

Based on the groundwater elevations obtained from onsite monitor wells, groundwater flow is to the south, towards Cane Creek under a hydraulic gradient of 0.0106.

1.3 PREVIOUS INVESTIGATIONS

Previous site assessment activities have included:

- A Phase I Environmental Site Assessment (ESA) was conducted by ERM in January 2009 that identified potential environmental concerns related to a former metal plating operation and a former degreasing operation which used trichloroethylene (TCE) as a solvent.
- Phase II ESA activities conducted in 2009 included the installation of 15 soil borings and seven permanent monitoring wells (MW-1 through MW-7) to assess areas of potential environmental concern identified in the Phase 1 ESA. TCE was detected in several soil

samples at low concentrations. TCE was also detected in four monitoring wells at concentrations ranging from 7.7 µg/L to 2,700 µg/L, which is above the established South Carolina Maximum Contaminant Level (MCL) of 5.0 µg/L.

- During January of 2011, Joslyn Clark conducted a sensitive receptor survey (SRS). The SRS indicated that the closest water supply well to the site was located at a trailer park about 645 feet upgradient from the Joslyn Clark site and according to the property owner, was not in use. The next closest water well was almost 3,500 feet from the Joslyn Clark site, also in the general upgradient direction.
- Phase III ESA activities were conducted in 2011 to further delineate the volatile organic compound (VOC) plume in groundwater and collect additional soil samples. Three additional shallow monitoring wells (MW-8, MW-9 and MW-10) were installed to further evaluate the horizontal extent of the VOC plume. Two deep wells (MW-3D and MW-10D) were installed to evaluate the vertical extent of the VOC impacted groundwater at the site. Groundwater samples collected during the Phase III activities showed multiple chlorinated compounds, with TCE and PCE being the most prevalent.
- A passive soil gas survey (SGS) took place on November 27-29, 2012 with the installation of 60 soil gas points in the northwest portion of the manufacturing building. Twenty-five (25) VOCS were identified in the soil gas samples. The highest VOC concentrations were found at the two locations in the northwest portion of the building, in the vicinity of the former wastewater treatment room, and the former paint booth and sump (southwestern portion of the building).
- During March and April 2013, ERM conducted a Remedial Investigation at the facility in order to further characterize the source of the observed TCE plume originating inside the building and to collect additional information to facilitate subsequent groundwater remediation activities. Activities included the installation of five soil borings, one temporary well and three permanent monitoring wells inside the building (MW-11, MW-11I, and MW-11D). The results of these activities included:
    - The passive soil gas study indicated that PCE and TCE vapors are present within the pore space of the soil in the vicinity of the former wastewater treatment room and former paint booth and sump (southwestern portion of the building). Confirmatory samples collected from these areas did not identify the presence of chlorinated VOCs in soil.

- 1, 4-Dioxane was detected in soil samples collected from each of the five borings at the shallow (3-5 foot) and deep (13-15 foot intervals. The concentrations ranged from 0.404 mg/kg to 0.992 mg/kg, which exceeded the risk-based protection of groundwater standard of 0.00014 mg/kg, but not the residential soil screening level of 4.9 mg/kg. 1, 4-Dioxane was detected in only two groundwater samples, temporary well GP-19 (0.95 ug/L) and shallow well MW-11 (0.787 ug/L).
- The vertical extent of VOC-affected groundwater has not been completed defined; however, the bulk of the VOC mass in groundwater is at the shallow depths, further delineation of the vertical extent of TCE-affected groundwater is not necessary for remedial purposes.
- The horizontal extent of the TCE-affected groundwater at the site is delineated and the TCE plume is confined to the subject property.

Figure 3 illustrates the locations of all soil borings installed at the site. Figure 4 presents a groundwater isoconcentration map for TCE in groundwater using the data from the most recent comprehensive groundwater analytical sampling event (April 2013). Figure 3 also illustrates the locations of the onsite groundwater monitor wells. It should be noted that monitor well MW-9 was installed proximal to the two former off-site wastewater lagoons. The former lagoons are not associated with the Joslyn Clark site. As such, MW-9 is not included in the risk assessment, except in the sense that it is understood that vapor intrusion issues will need to be considered if any building structures are planned for the MW-9 area.

2.0 HUMAN HEALTH RISK ASSESSMENT

This HHRA was conducted by ERM in accordance with numerous US EPA guidance documents and was prepared using the US EPA Risk Assessment Guidance for Superfund: Volume I, Human Health Evaluation Manual (Part D, Standardized Planning, Reporting, and Review of Superfund Risk Assessments), dated December 2001. Specific procedures detailed in the US EPA Region 4 Human Health Risk Assessment Bulletins, Supplement to RAGS (US EPA 2000) were also used for preparing the RA. As such, this RA follows the format developed by the US EPA to standardize reporting of human health risk assessments (HHRA) through the preparation of standard tables and worksheets.

2.1 HAZARD IDENTIFICATION

2.1.1 Selection of Chemicals of Potential Concern

Based on previous environmental investigations and historical operations, data collected from soil and groundwater were compiled for comparison to EPA Regional Screening Levels for Industrial Soil and Tap Water (EPA, May 2013). The screening levels are calculated to be protective of receptors with routine exposures to soil, groundwater, and air, using typical default exposure assumptions. The maximum concentrations detected at the site were compared to each constituent's respective screening level.

It is important to note that the available screening levels do not consider potential exposures resulting from the migration of vapors from subsurface into excavations/trenches. Site-specific screening levels to evaluate this potentially complete exposure pathway were developed.

The results of the screening analysis for chemicals of potential concern (COPCs) are summarized below and provided in ***Appendix A, Tables A-1 through A-8***. The constituents with concentrations greater than the applicable screening levels were retained for further analysis.

2.1.1.1 Onsite Soil – Direct Contact

Soil to a depth of 20 feet below ground surface (bgs) was compiled for use in comparison to risk-based screening levels. The soil screening analysis indicated that one metal (thallium) was retained for further evaluation as having a maximum concentration of 3.3 mg/kg which is greater than US

EPA's Regional Screening Levels for industrial soil. It is important to note that thallium was detected in only one sample (GP-3) collected from beneath the building near (but outside of) the former footprint of the plating room at a depth of 4-8 feet below ground surface. Also, thallium is not known to have been used at the Josyln Clark site. The soil screening analysis is provided in ***Appendix A, Table A-1***.

2.1.1.2 *Groundwater – Direct Contact*

As described above, MW-9 is located west of the asphalt parking lot and proximal to the off-site former wastewater lagoons that are not associated with the Site. As such, this well is not included in the groundwater screening analysis , except in the sense that it is understood that vapor intrusion issues will need to be considered if any building structures are planned for the MW-9 area. Historical groundwater analytical results indicate that several VOCs and metals are retained for further evaluation as having reported maximum concentrations greater than US EPA's Regional Screening Levels for tap water. The VOCs include chloroform, 1,1-dichloroethane, 1,1-dichloroethene, cis-1, 2-dichloroethene, tetrachloroethene, 1,1,2-trichloroethene, and trichloroethene. Seven metals were retained for further evaluation including aluminum, antimony, arsenic, cobalt, iron, manganese, and vanadium. The groundwater screening analysis is provided in ***Appendix A, Table A-2***.

It is important to note that since groundwater is not used for potable purposes in the area and the depth to groundwater is greater than 20 feet at the site; there is no potential direct contact exposure with groundwater and further analysis of groundwater COPCs is not warranted.

2.1.1.3 *Subsurface Vapors*

US EPA's Regional Screening Levels for tap water do not consider the potential for inhalation of VOC vapors originating from ground water that may migrate into buildings and into subsurface excavation/trenches. As such, to evaluate the vapor migration pathway into buildings, groundwater concentrations were compared to target groundwater screening levels that would not contribute to unacceptable indoor air concentrations.

As noted above, groundwater data from MW-9 is not included in this analysis. In addition, groundwater data from MW-4, MW-5 and MW-8 were excluded from this analysis because these monitoring wells are located outside of the groundwater contaminant plume and no VOCs were detected in the wells during previous sampling events.

No VOCs were reported in the monitoring well located upgradient of the contaminant plume (MW-1) at the northern boundary of the Site. Likewise, no VOCs were detected in MW-10/10D, located at the southern boundary of the Site and downgradient of the contaminant plume. As such, VOCs present in the groundwater plume have not migrated off-site.

The methodology used to calculate the target groundwater concentrations are provided in ***Appendix A, Table A-3***.The comparison of the groundwater data is provided in ***Appendix A, Table A-4***. Four VOCs were retained for further evaluation including chloroform, 1,1-dichloroethane, tetrachloroethene, and trichloroethene.

For the evaluation of VOC vapors migrating into subsurface excavations/ trenches, all detected VOCs were retained. The methodology used to estimate the vapor concentrations present in subsurface excavation/trenches is provided in ***Appendix A, Table A-5***.

2.1.1.4 Surface Water and Sediment

The are no surface water bodies near the subject property. As such, no surface water or sediment samples were collected.

2.2 EXPOSURE ASSESSMENT

2.2.1 Site Conceptual Model

Table 1 identifies the plausible receptors and exposure pathways evaluated by the risk assessment. The following site-specific factors influence potential exposure:

- Current site conditions are detailed in Section 1.1. The site is currently an inactive industrial manufacturing site. Future land use will be designated as non-residential;
- Potable water to the subject site and the surrounding neighborhoods is provided by the Lancaster Water and Sewer District;
- No VOCs were detected in MW-1 located upgradient of the contaminant plume, thus no further assessment of off-site receptors is warranted;

- No VOCs were detected in MW-10/10D located downgradient of the contaminant plume, thus no further assessment of off-site receptors is warranted;

- Ground water was not encountered within 20 feet of the ground surface at the Site;

- Disturbance due to the commercial/industrial setting of the site and the surrounding properties preclude the establishment of suitable ecological habitat at the Site. As such, no further assessment of risk to ecological receptors is warranted;

- Land use in the vicinity of the subject property is residential, commercial, and wooded undeveloped property. The abutting properties and nearby land use include:

    - North: W. Meeting Street bounds the property to the north. Properties beyond W. Meeting street include a mobile home park, a vehicle maintenance garage, commercial buildings, and a retail gasoline station to the northwest;

    - East: Northwest Apartments are on the eastern adjoining property. Synteen Technical Fabrics, Inc., is located east-northeast of the property, across W. Meeting Street;

    - South: An unused Lancaster & Chester Railroad bounds the property to the south. Wooded undeveloped land is located beyond; and

    - West: Mostly wooded undeveloped land with some residential to the northwest.

Human receptor populations under current conditions are detailed in the following sections.

2.2.2 *Potentially Complete Exposure Pathways*

The identification of potential human receptors is based on several factors, including local land use and groundwater use. This information provides the basis to identify individuals working or engaging in activities on the site, both currently and potentially in the future.

While considering the site conditions described above, the potentially complete pathways of exposure include: contact (i.e., incidental ingestion and dermal contact) with exposed surface soil, or subsurface soil while conducting subsurface activities (e.g., soil excavation); and inhalation of either vapors from soil that may migrate into indoor air or an open excavation, or particulates (i.e., dust) from soil. Vapors originating from groundwater may migrate into the building or into construction excavation/trenches. Potential inhalation of the vapors could occur while working in the building or participating in construction activities.

Overall, except for the potential for vapor migration into the building, the potential for human exposure with impacted environmental media at the site is minimal, if occurring at all. Nonetheless, the risk assessment is considering all potential human receptor populations who may visit the site and the anticipated exposure pathways by which they could contact environmental media. The plausible receptors and exposure pathways considered by the risk assessment under current and future conditions are described below.

2.2.2.1 Current Conditions

- Site/Maintenance workers – Site workers or maintenance workers could be exposed to constituents in exposed surface soil via incidental ingestion, dermal contact and inhalation of vapors and released particulates while conducting limited outdoor maintenance activities.

2.2.2.2 Future Conditions

- Facility workers – Future facility workers could be exposed to constituents in exposed surface soil via incidental ingestion, dermal contact and inhalation of vapors and released particulates while conducting limited outdoor maintenance activities. Facility workers could also be exposed to vapors originating from groundwater into the indoor air of the existing building.

- Construction/utility workers - Construction/utility workers may contact impacted media while conducting construction/utility maintenance activities, specifically those requiring subsurface disturbance. Construction/utility workers may contact exposed surface soils and subsurface soils via incidental ingestion, dermal contact, and inhalation of vapor or particulate emissions in outdoor air. Contact with ground water while conducting subsurface activities is not likely because depth to groundwater is greater than 20 feet below ground surface; however, there is potential for exposure of vapors that may be present in utility trenches or construction excavations.

The subject site will remain as non-residential land use with the current structures to be used for industrial/commercial activities. Utilities will be provided by the municipality and the regional electrical power supplier, Duke Power. There will be no ground water use on site.

2.2.3 *Exposure Point Concentrations*

The exposure point concentration (EPC) was calculated as the Upper Confidence Limit (UCL) on the mean of the analytical data, as recommended and calculated by the US EPA software program ProUCL (Version 4.00.02) (US EPA, 2010). The US EPA ProUCL provides rigorous parametric and nonparametric statistical methods that can be used on full data sets without or without non-detects. Based on appropriate data distribution and the associated skewness, ProUCL provides recommendations about an appropriate UCL computation method that may be used to estimate the mean concentration of a COPC.

Exposure point concentrations (EPCs) were developed for use in estimating potential risks and hazards for all potentially exposed receptor populations at the site. Determination of EPCs typically relies on the use of various approved statistical methodologies aimed at calculating the 95% upper confidence level on the mean.

Soil EPCs are provided in ***Appendix A, Tables A-6 through A-9***. Soil data collected from the ground surface to a depth of 20 feet below ground surface were compiled and used to evaluate the soil pathways of exposure.

Groundwater EPCs are provided in ***Appendix A, Table A-10***. While direct contact with groundwater is not anticipated, the concentrations of VOCs in groundwater are used to estimate potential hazard/risk for vapors that could migrate into the building and vapors that can migrate into subsurface excavation/trenches. Procedures used to estimate vapor concentrations are described below. For both pathways, the methodology used to estimate VOC concentrations are based on mathematical models that could over or under estimate the actual conditions.

Migration of Vapor into Buildings. US EPA's tap water screening levels do not consider the potential for inhalation of VOCs originating from groundwater that may migrate into structures. As such, site-specific applicable standards protective of inhalation exposures associated with constituents volatilizing from shallow groundwater were developed based on the approach presented in the Office of Solid Waste & Emergency Response (OSWER) *Draft Guidance for Evaluating the Vapor*

Intrusion into Indoor Air Pathway from Groundwater and Soils (Subsurface Vapor Intrusion Guidance) (US EPA, 2002c; 2012). The development of groundwater screening levels and the resultant values are provided in ***Appendix A, Table A-3***. The comparison of groundwater concentrations to applicable standards protective of inhalation exposures is provided in ***Appendix A, Table A-4***. For the potential inhalation pathway of exposure for VOCs that could migrate into structures, chloroform, 1,2-dichloroethane, tetrachloroethene, and trichloroethene were retained as COPCs.

Vapors in an Excavation or Trench. For this inhalation pathway, there are no well-established models available for estimating migration of volatiles from groundwater into the breathing zone within a trench. The US EPA does not provide guidance for evaluating hazards or risks of air inside a trench. To evaluate this pathway, ERM used a box model approach to estimate dispersion of the VOCs measured in soil gas samples within the air in the trench (Virginia DEQ, 2012). The air concentration in the trench was estimated using the equation and parameter definitions as presented in ***Appendix A, Table A- 5***. All other parameters were conservative values used to assess this pathway.

Summary statistics for all COPCs retained for each receptor population evaluated quantitatively within this assessment are presented in ***Appendix A, Tables A-6 through A-10***. These tables list the COPCs, the arithmetic mean of the data, the ProUCL-recommended UCL, the EPC value, statistic, and rationale for the reasonable maximum exposure (RME) evaluation. The EPC was defined as the lower of the ProUCL-recommended UCL or the maximum-detected concentration for each COPC.

2.2.4 Exposure Parameters

Appropriate intake parameters were identified for each of the exposure scenarios discussed above. Where US EPA Region 4 (2000) has specified intake parameters for the above-mentioned receptors, these values were adopted. If specific inputs were not available, US EPA guidance and other sources were used to develop reasonable exposure assumptions. This guidance included the *Exposure Factors Handbook* (US EPA 1997a), the *Standard Default Exposure Factors Guidance* (US EPA, 1991b), the *Supplemental Guidance for Developing Soil Screening Levels for Superfund Sites* (US EPA, 2002a), *RAGS Part E Guidance* (US EPA, 2004b) and the *Updated Dermal Exposure Assessment Guidance* (US EPA Region III, 2003).

The estimation of dermal intake from constituents present in water requires the incorporation of a constituent-specific permeability coefficient that reflects the movement of a constituent across the skin and into the bloodstream. The estimation of dermal intake from constituents present in soil requires the incorporation of constituent-specific factors for dermal absorption from soil. Constituent-specific dermal permeability coefficients and dermal absorption factors (DABS) used in this risk assessment, as well as other pertinent defaults with respect to assessing dermal risk, were obtained from *RAGS Part E Guidance* (US EPA, 2004b) and the *Updated Dermal Exposure Assessment Guidance* (US EPA Region III, 2003).

The exposure parameters used for each exposure scenario are summarized in ***Appendix A, Tables A-11 through A-16*** for each receptor population in the various media.

To estimate the potential risk to human health that may be posed by the presence of COPCs, it is first necessary to estimate the potential exposure dose of each COPC. The exposure dose was estimated for each constituent via each exposure pathway by which the receptor is assumed to be exposed. Exposure dose equations combine the estimates of constituent concentrations in the environmental medium of interest with assumptions regarding the type and magnitude of each receptor potential exposure to provide a numerical estimate of the exposure dose. The exposure dose is defined as the amount of COPC acquired by the receptor and is expressed in units of milligrams of COPC per kilogram of body weight per day (mg/kg-day).

Exposure doses are defined differently for potential carcinogenic and non-carcinogenic effects. The chronic average daily dose is used to estimate a receptor potential intake from exposure to a COPC with non-carcinogenic effects. According to US EPA (1989), the chronic average daily dose should be calculated by averaging the dose over the period of time for which the receptor is assumed to be exposed. Therefore, the averaging period is the same as the exposure duration.

For COPCs with potential carcinogenic effects, however, the lifetime average daily dose is employed to project potential exposures. In accordance with US EPA (1989) guidance, the lifetime average daily dose is calculated by averaging exposure over a receptor assumed lifetime of 70 years. Therefore, the averaging period is the same as the receptor assumed lifetime.

The standardized equations presented by US EPA (1989) were used to estimate a receptor average daily dose, both lifetime and chronic.

2.2.5 *Quantification of Exposure Doses*

The following standard US EPA equation (US EPA, 1989) was used to estimate exposure doses received by the receptor populations for all scenarios:

$$I = \frac{C \times CR \times AF \times EF \times ED}{BW \times AT}$$

Where:

I	=	Chronic daily intake [dose] (mg/kg-day);
C	=	Concentration (mg/kg, mg/l or mg/m^3);
CR	=	Contact rate (kg per day or liters per day);
AF	=	Absorption factor (unitless);
EF	=	Exposure frequency (days per year);
ED	=	Exposure duration (years);
BW	=	Body weight (kg); and
AT	=	Averaging time (days).

Appendix A, Tables A-11 through A-16, provide the intake equations and exposure parameters as defined by receptor population for each exposure medium, route and pathway to quantify hazards and risks.

2.3 *TOXICITY ASSESSMENT AND CHEMICAL-SPECIFIC PARAMETERS*

This section presents toxicity criteria and information that relates COPC exposure (dose) to anticipated health effects (response) for each COPC retained for quantitative evaluation in the HHRA. Toxicity criteria derived from dose-response data were used in this report in the Risk Characterization to estimate the non-carcinogenic hazards and carcinogenic risks (i.e., excess lifetime cancer risk or ELCR) associated with exposure to these COPCs.

Current toxicological criteria (e.g., carcinogenic slope factors (CSFs) and reference doses (RfDs)) were identified for each COPC based on the *Regional Screening Levels for Chemical Contaminants at Superfund Sites* table (US EPA, 2012). As noted in the US EPA *Risk Assessment Users Guide* (US EPA, 2012b), toxicity values from the following sources were used as defaults for the development of RSLs in ***Appendix A, Tables A-17 through A-20***.

- US EPA's Integrated Risk Information System (IRIS);

- The Provisional Peer Reviewed Toxicity Values (PPRTVs) derived by the US EPA's Superfund Health Risk Technical Support Center (STSC) for the US EPA Superfund program;

- The Agency for Toxic Substances and Disease Registry (ATSDR) minimal risk levels (MRLs); and

- The California Environmental Protection Agency Office of Environmental Health Hazard Assessment's (OEHHA) Chronic Reference Exposure Levels (RELs) from December 18, 2008 and the Cancer Potency Values from December 17, 2008.

A slope factor is used to estimate an upper-bound lifetime probability of an individual developing cancer as a result of exposure to a particular level of a potential carcinogen. To derive the carcinogenic slope factors (CSF), data from animal studies (or occasionally from human epidemiological studies) are fit to the linearized multistage model, and the upper 95th percent confidence limit on the slope of the resulting dose-response curve is calculated. This slope factor, therefore, reflects an upper-bound estimate of the probability of carcinogenic response per unit dose of a chemical. The CSF is expressed in units of reciprocal dose (mg/kg-day)-1. CSFs are derived separately for oral and inhalation exposure, as appropriate.

The potential for non-carcinogenic health effects from long duration or chronic exposures (i.e., greater than 7 years) is evaluated by comparing the estimated daily intake with a chronic oral RfD or inhalation RfC. These toxicity values represent average daily exposure levels at which no adverse effects are expected to occur with chronic exposures. Sub-chronic RfDs are applied when exposures are less than 7 years, as is the case with construction workers (i.e., less than 1 year). RfDs reflect the underlying assumption that systemic toxicity occurs as a result of processes that have a threshold (i.e., that a safe level of exposure exists and that toxic effects will not be observed until this level has been exceeded).

Dose-response values are available for oral exposures and these are used to evaluate dermal exposures by applying gastrointestinal absorption factors (GIABS) to the oral RfD. GIABS values used in the adjustment of oral RfDs are presented on the *Regional Screening Levels for Chemical Contaminants at Superfund Sites* table (US EPA, 2010).

For inhalation pathways (carcinogenic and non-carcinogenic COPCs), recommendations presented in *RAGS Part F Guidance* were utilized (US EPA, 2009a). The US EPA (2009) recommends that the inhalation toxicity values no longer be generated using simple route-to-route extrapolation. Rather, reference concentrations (RfCs) in units of mg/m^3 are used for non-carcinogens and inhalation unit risks (IURs) in units of $(ug/m^3)^{-1}$ are used for carcinogens. IURs and RfCs used in the equations are based on continuous exposure (24 hours per day), and are also presented on the *Regional Screening Levels for Chemical Contaminants at Superfund Sites* table (US EPA, 2010).

Appendix A, Table A-17 presents the available oral chronic RfDs used to evaluate non-carcinogenic hazards via the oral exposure route. Dermal RfDs were derived as shown on ***Table A-17*** to evaluate non-carcinogenic hazards via the dermal exposure route. ***Appendix A, Table A-18*** presents the available inhalation chronic RfCs.

Appendix A, Table A-19 presents the available CSFs used to evaluate carcinogenic risks in the HHRA via the oral exposure route. Dermal CSFs were derived as shown on ***Table A-19*** to evaluate carcinogenic risks via the dermal exposure route. ***Appendix A, Table A-20*** presents the available IURs.

2.4 RISK CHARACTERIZATION

The Risk Characterization integrates data developed from the Exposure Assessment and Toxicity Assessment to derive numerical estimates of potential current and future non-carcinogenic hazards and carcinogenic risks attributable to the site COPCs. Hazard and Estimated Lifetime Cancer Risk (ELCR) attributable to site COPCs were assessed for each potential exposure medium (e.g., soil, sediment, surface water, air) under the RME conditions described previously, in accordance with RAGS Part D and US EPA guidance. The US EPA and SCDHEC recognize the acceptable cancer risk range of 1×10^{-6} to 1×10^{-4} and a Hazard Index of 1.0, as defined by the US EPA in the National Oil and Hazardous Substances Pollution Contingency Plan (NCP) (1990). These risks are cumulative of the individual risks posed by each COPC.

Potential non-carcinogenic effects were evaluated based on a comparison of COPC-specific chronic exposure doses with corresponding protective doses derived from health criteria. The result of this comparison is expressed as the hazard quotient (HQ):

$$Hazard\,Quotient = \frac{Dose}{RfD}$$

A HQ that exceeds unity (1) suggests a greater likelihood of developing an adverse sub-chronic or chronic toxic effect. However, the uncertainty factors built into the protective doses result in conservative RfD values. Therefore, the RfD is likely well below the level at which adverse effects may reasonably be anticipated to be observed.

HQs were calculated for each COPC for which health criteria are currently available. The HQs for each COPC were summed to produce a rough estimate of the pathway-specific risk, the Hazard Index (HI). In estimating total non-carcinogenic hazard, potential responses were conservatively assumed to be additive. However, all COPCs do not have the same or similar toxic endpoints and responses may not be additive. Consistent with US EPA (1989) guidance for non-carcinogens, HI values can be calculated for each applicable target organ. The cumulative HI is defined as the sum of the HQs associated with exposure media, COPCs, and pathways of exposure that are applicable for each receptor population. As such, when appropriate, target-organ-specific HIs were used to evaluate potential non-carcinogenic effects. A cumulative target-organ-specific HI greater than 1.0 indicates the potential for adverse health effects.

The ELCR associated with exposure to constituents detected at the site was calculated according to the following equation (US EPA, 1989a):

Incremental Carcinogenic Risk = Cancer Slope Factor x Dose

where the incremental carcinogenic risk represents the probability of developing cancer over a lifetime from exposure to the COPCs associated with the site. Carcinogenic risk (CR) is expressed here in scientific notation. For example, a risk of 1×10^{-6} indicates that an individual has one in 1,000,000 chance of developing cancer as a result of exposure to site COPCs during a lifetime.

The CSF represents the carcinogenic potency of a constituent. The dose, or intake, represents the amount of constituent to which a receptor is exposed. When evaluating ELCRs, the dose is the estimated daily intake of each constituent during the specified period of exposure, and averaged over a lifetime.

The US EPA has not established a specific value that represents a significant incremental cancer risk. However, the US EPA's NCPs acceptable risk range for Superfund sites has been set at approximately 1 x 10^{-6} to 1 x 10^{-4} per environmental medium (NCP, 1990). In other words, the goal of the NCP is to reduce the cancer risk associated with site COPCs in a given medium to within or below a range of one in 1,000,000 to one in 10,000.

The ELCR was calculated for each COPC having a designated CSF/IUR for all applicable exposure pathways. Risk values for all COPCs assessed were summed by exposure pathway to provide total pathway-specific risks. Results for each receptor population are discussed in the following subsections.

2.4.1 Current Land Use

As previously described, the subject site is currently a vacant manufacturing building used for industrial/commercial activities. Under current conditions, only site/maintenance workers could be exposed to COPCs in exposed surface soil. There is no potable use of groundwater in the area. As such, estimated hazard indices and incremental ELCRs for each of these receptor populations under future land use conditions are summarized in ***Table 2*** and detailed below.

Site/Maintenance Workers. ***Table 2*** provides the HQs/HIs and cancer risks calculated for the maintenance worker for the potential direct contact with exposed soil and inhalation exposure occurring from airborne volatiles and particulates originating from soil. The HIs and cancer risks are detailed in ***Appendix A, Tables A-21 and A-24***, respectively.

The total HI across all potential exposure routes for contact with thallium in soil was estimated to be 0.03 for the site/maintenance worker, which is well below the target HI of 1. Thallium is not considered a carcinogen, thus, no incremental ELCRs for the site/maintenance worker was reported.

2.4.2 Future Land Use

Future land use of the Site will be limited to commercial and/or industrial activities. As such, potential exposures are limited to receptors who may participate in building construction activities or receptors that may visit or work in the building(s). Estimated hazard indices and incremental ELCRs for each of these receptor populations under future land use conditions are summarized in ***Table 2*** and detailed below.

Future Facility Workers. ***Table* 2** provides the HQs/HIs and cancer risks calculated for the potential direct contact with exposed soil and inhalation exposure occurring from airborne volatiles and particulates originating from soil. The HIs and cancer risks for these pathways of exposure are the same as reported under future land use and are detailed in Appendix A, Tables A-21 through A-24.

Similar to the site/maintenance worker, described above, potential exposure routes for contact with thallium in soil was estimated to be 0.03 for the site/maintenance worker, which is well below the target HI of 1. Thallium is not considered a carcinogen, thus, no incremental ELCRs for the site/maintenance worker was reported.

The total cancer risk for potential inhalation exposure of VOCs originating from groundwater was estimated to be 1×10^{-4} which is above the US EPA acceptable risk range. The total HI for the potential groundwater to indoor air exposure pathway was estimated to be 61 for the commercial worker which is above the target HI of 1. These elevated risks and hazards are due to elevated concentrations of trichloroethene detected in groundwater (primarily at MW-3, with lower concentrations reported within the contaminant plume). The HIs and cancer risks for these pathways of exposure are the same as reported under future land use and are detailed in ***Appendix A, Tables A-25 and A-26***.

Future Construction/Utility Workers. ***Table* 2** provides the HQs/HIs and cancer risks calculated for the future construction workers conducting subsurface activities. The HIs and cancer risks are detailed in ***Appendix A, Tables A-27 through A-30***.

The total HI for potential exposure with thallium in soil was estimated to be 1.5, with is above the target HI of 1. It is important to note that thallium was detected in only one sample (GP-3) located beneath the building at a depth of 4-8 feet below ground surface. Thallium is not known to have been used at the subject site. Thallium is not considered a carcinogen, thus, no cancer risk for the site/maintenance worker was calculated.

The total cancer risk for potential inhalation of VOCs in trench air was estimated to be 1×10^{-8} and the total HI was estimated at 3×10^{-4}, well below the target HI of 1.0.

2.5 UNCERTAINTY ANALYSIS

The carcinogenic risk and non-carcinogenic hazard estimates presented in this HHRA are not intended to be calculations of absolute risk or hazard to individuals who may use the site currently or in the future. Uncertainties in underlying data prevent exact determination of risk to receptor populations. The goal of the HHRA was to provide reasonable, conservative risk estimates to guide decision-making. Using standardized methodology guidelines, in particular RAGS Part D (US EPA 2001), and standardized default exposure factors provided in US EPA (1997a) risk assessments for Superfund sites, provides a basis for evaluating whether remediation should be considered.

US EPA (1991b) states that, "Where the cumulative carcinogenic site risk to an individual based on reasonable maximum exposure for both current and future land use is less than 10^{-4}, and the non-carcinogenic hazard quotient is less than 1, action generally is not warranted unless there are adverse environmental impacts." Moreover, US EPA guidance (US EPA 1989, 2001) acknowledges that uncertainty in a risk assessment can cause differences in the numerical results of more than an order of magnitude. Therefore, it is important to document and discuss the types of uncertainties that may affect the risk estimates calculated in the previous section.

Risk is broadly a function of exposure and toxicity. Therefore, uncertainties in characterizing either of these cause inaccuracy in risk estimates. Specific sources of uncertainty can be divided into two groups: methodological and site-specific. These types of uncertainties are described in the following subsections. Their effect on final risk estimates is discussed, where possible.

2.5.1 General Methodology Uncertainties

2.5.1.1 Site Characterization

It is sometimes impossible to completely characterize heterogeneous environmental media from a statistical standpoint. Soil constituent concentrations may vary by orders of magnitude over intervals of an inch or less and air constituent concentrations vary greatly over space and time. In some cases, only a few samples are available to evaluate a particular medium or potential source area. Risk estimates based on a limited sample database may not be representative of actual contamination, as is the case for this site. Samples were concentrated in those areas suspected to have come in contact with site-related constituents and, therefore, are considered a conservative representation of the impacts of former site activities.

2.5.1.2 *Toxicological Information*

Toxicity data used in human health risk assessments can be limited. Much of the data used to generate health criteria are derived from animal studies. Uncertainties result, given that:

- both endpoints of toxicity (effect or target organ) and the doses at which effects are observed are extrapolated from animals to humans;

- results of short-term exposure studies are used to predict the effects of long-term exposures;

- results of studies using high doses are used to predict effects from exposures to low doses usually expected at hazardous waste sites; and

- effects exhibited by homogeneous populations of animals (or humans) are used to predict effects in heterogeneous populations with variable sensitivities (e.g., the young, elderly, or infirm).

In addition, thorough toxicity data are not available for all constituents detected at many sites. Often, the toxicity value for the most potent constituent in a group is used as a surrogate for structurally similar compounds. This may result in the overestimation of risk.

US EPA and other regulatory agencies attempt to account for these sources of uncertainty by including uncertainty factors in the determination of health criteria such as RfDs. In addition, the level of confidence in RfDs for non-carcinogenic effects and the weight of evidence for carcinogenic effects are specified for each constituent.

2.5.1.3 *Exposure Assumptions*

Evaluating exposure to environmental constituents requires a number of different inputs and assumptions. These include the types of exposed populations, including their ages and health conditions; average lifespans; activity patterns such as time spent indoors versus outdoors; time spent at different locations; time spent working or residing in the area of the site; contact rates for contaminated media; skin surface area for dermal contact; and absorption rates via the skin and digestive tract. There are significant uncertainties regarding the extent to which a constituent is absorbed from soil through the skin.

Current US EPA guidance for conducting risk assessments at Superfund sites recommends values to be used for many of these parameters. This serves to reduce unwarranted variability in exposure assumptions used to perform baseline risk assessments across different sites. Because values specified in guidance documents are often conservative, upper-bound figures, they would rarely lead to underestimating risks. Site-specific exposure parameters should be used over standard default exposure parameters when they are known to prevent masking of site-specific variations.

Baseline risk assessments also estimate current and future exposure scenarios based on constituent concentrations detected at the site during the site investigation. In general, no attenuation or degradation of constituents over space or time is assumed. This also typically results in a conservative estimate of risk, especially for organic constituents that are typically subjected to natural degradation processes such as biodegradation, volatilization, and oxidation/reduction. In some cases, though, natural degradation processes do result in daughter products more toxic than the parent compound, which could result in greater future human health risk.

2.5.1.4 *Risk Characterization*

Constituent-specific risks are generally assumed to be additive. This oversimplifies the fact that some constituents are thought to act synergistically (1 + 1 > 3) while others act antagonistically (1 + 1 < 3). The overall effect of these mechanisms on multi-constituent, multi-media risk estimates is difficult to determine but the effects are usually assumed to balance.

3.0 *SUMMARY AND CONCLUSIONS*

A risk assessment has been conducted to evaluate potential health impacts for current and future occupants of the former Joslyn Clark facility. Both carcinogenic and non-carcinogenic hazards were evaluated as part of the risk assessment. The results of the risk assessment described in this HHRA indicate that there is limited risk/hazard to human health receptors at the site, with the exception of site/ maintenance workers who may be exposed to organic vapors migrating from groundwater, and to a lesser extent construction workers who may contact impacted subsurface soil during future excavation or trenching activities.

Cumulative risks and hazards for each receptor population are shown in ***Table 2***. Under current and future conditions, the cumulative risks estimated for the facility worker receptor population is above the US EPA's acceptable cancer risk range of 1×10^{-6} to 1×10^{-4} due to the potential for inhalation of organic vapors originating from groundwater. Likewise, the cumulative non-carcinogenic hazards under future conditions are only marginally above the Hazard Index of 1.0 for the future construction worker due to potential exposure with thallium in soil at one location beneath the building at the site. Potential exposure with thallium is limited, if occurring at all.

Potential hazards/risks posed to future facility workers may be managed by adjusting the facility heating, ventilation, and air condition (HVAC) system to increase the air exchange in the building and/or installing a subslab ventilation system to mitigate subsurface vapors into the building.

4.0 REFERENCES

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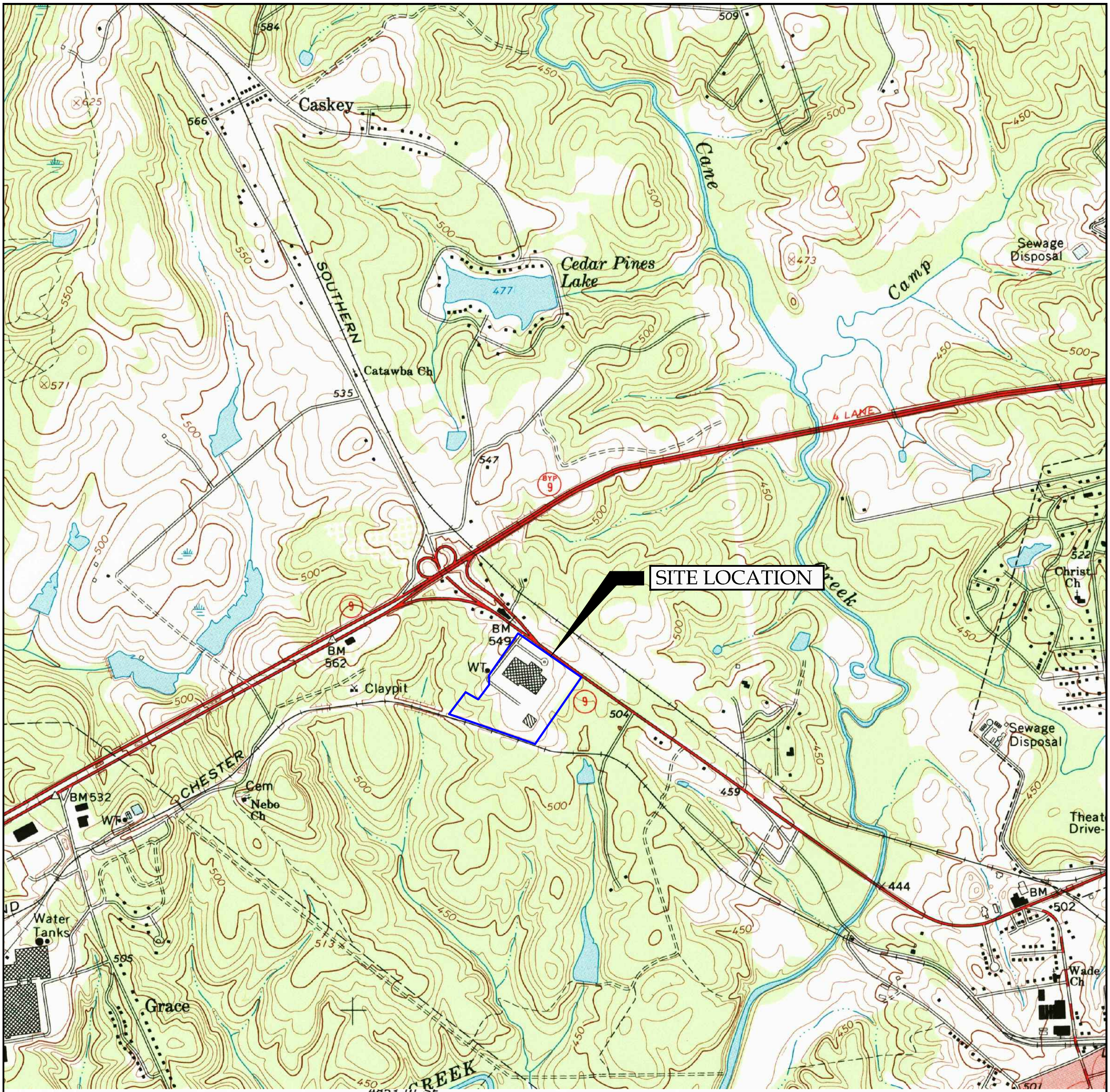
Figures

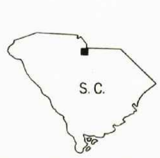


SCALE 1:24 000

1 ½ 0 1 MILE

1000 0 1000 2000 3000 4000 5000 6000 7000 FEET

1 .5 0 1 KILOMETER



QUADRANGLE LOCATION

CONTOUR INTERVAL 10 FEET
DATUM IS MEAN SEA LEVEL

ROAD CLASSIFICATION

Primary highway, all weather, hard surface
Light-duty road, all weather, improved surface
Secondary highway, all weather, hard surface
Unimproved road, fair or dry weather
U. S. Route
State Route

MN GN
2° 36 MILS
0°06′ 2 MILS

UTM GRID AND 1969 MAGNETIC NORTH DECLINATION AT CENTER OF SHEET

LANCASTER, S. C.
N3437.5—W8045/7.5

1969

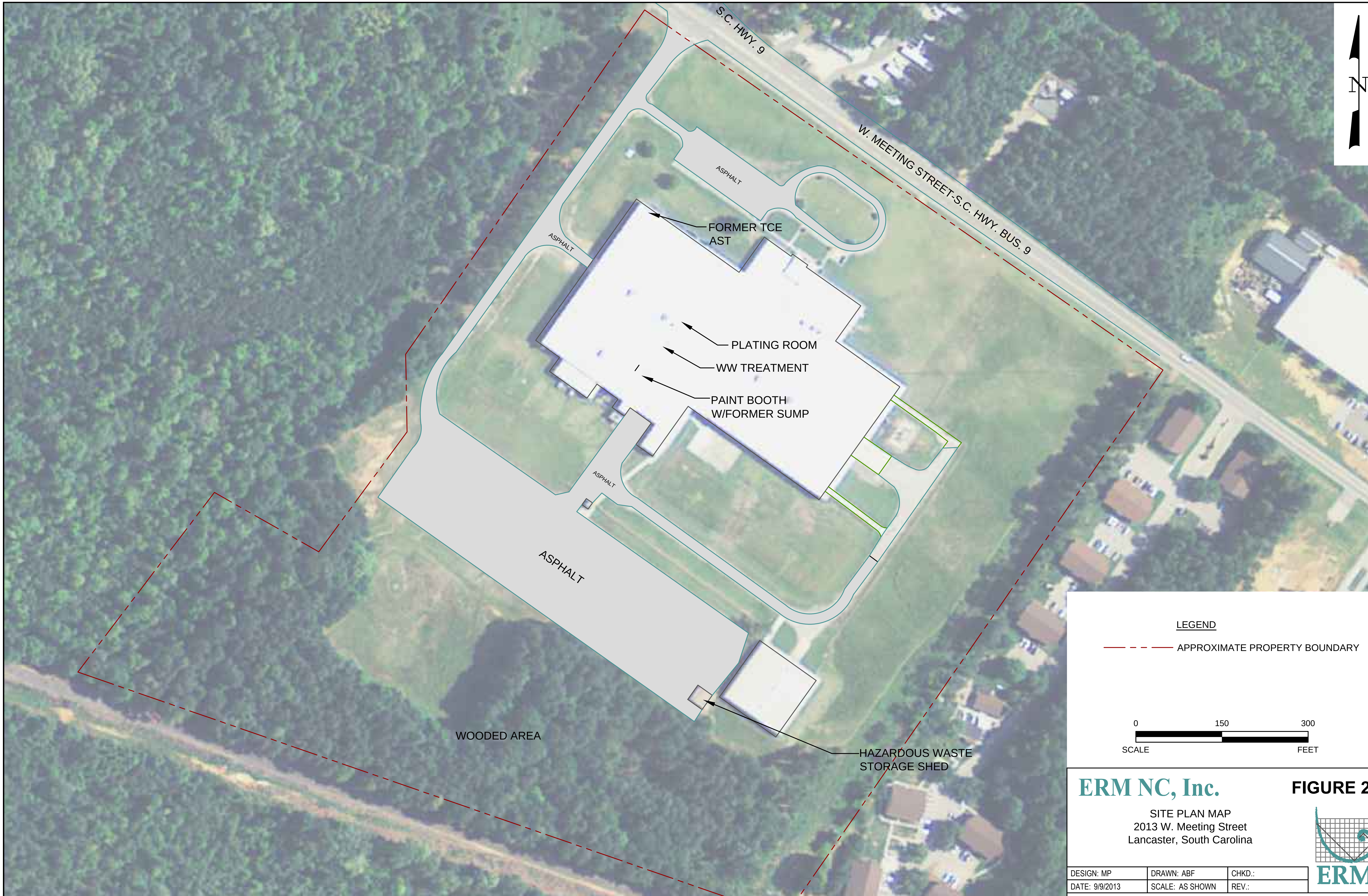
ERM NC, Inc.

FIGURE 1

SITE LOCATION PLAN
2013 W. Meeting Street
Lancaster, South Carolina

DESIGN: MP	DRAWN: ABF	CHKD.:
DATE: 9/9/2013	SCALE: AS SHOWN	REV.:

W.O.NO.: 0172001_HHRA Figs.dwg



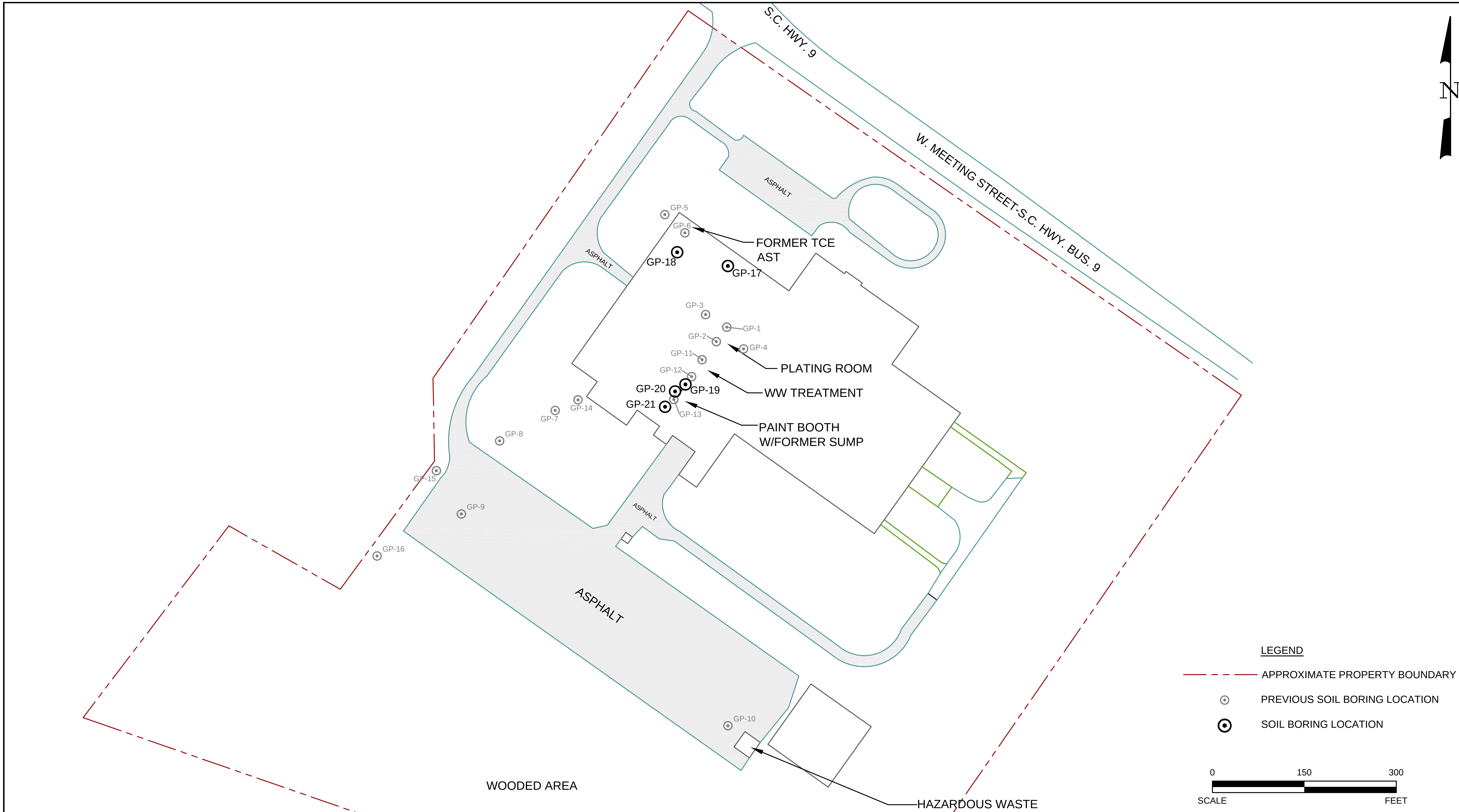
ERM NC, Inc.

FIGURE 2

SITE PLAN MAP
2013 W. Meeting Street
Lancaster, South Carolina

ERM

DESIGN: MP	DRAWN: ABF	CHKD.:
DATE: 9/9/2013	SCALE: AS SHOWN	REV.:
W.O.NO.: 0172001_HHRA Figs.dwg		



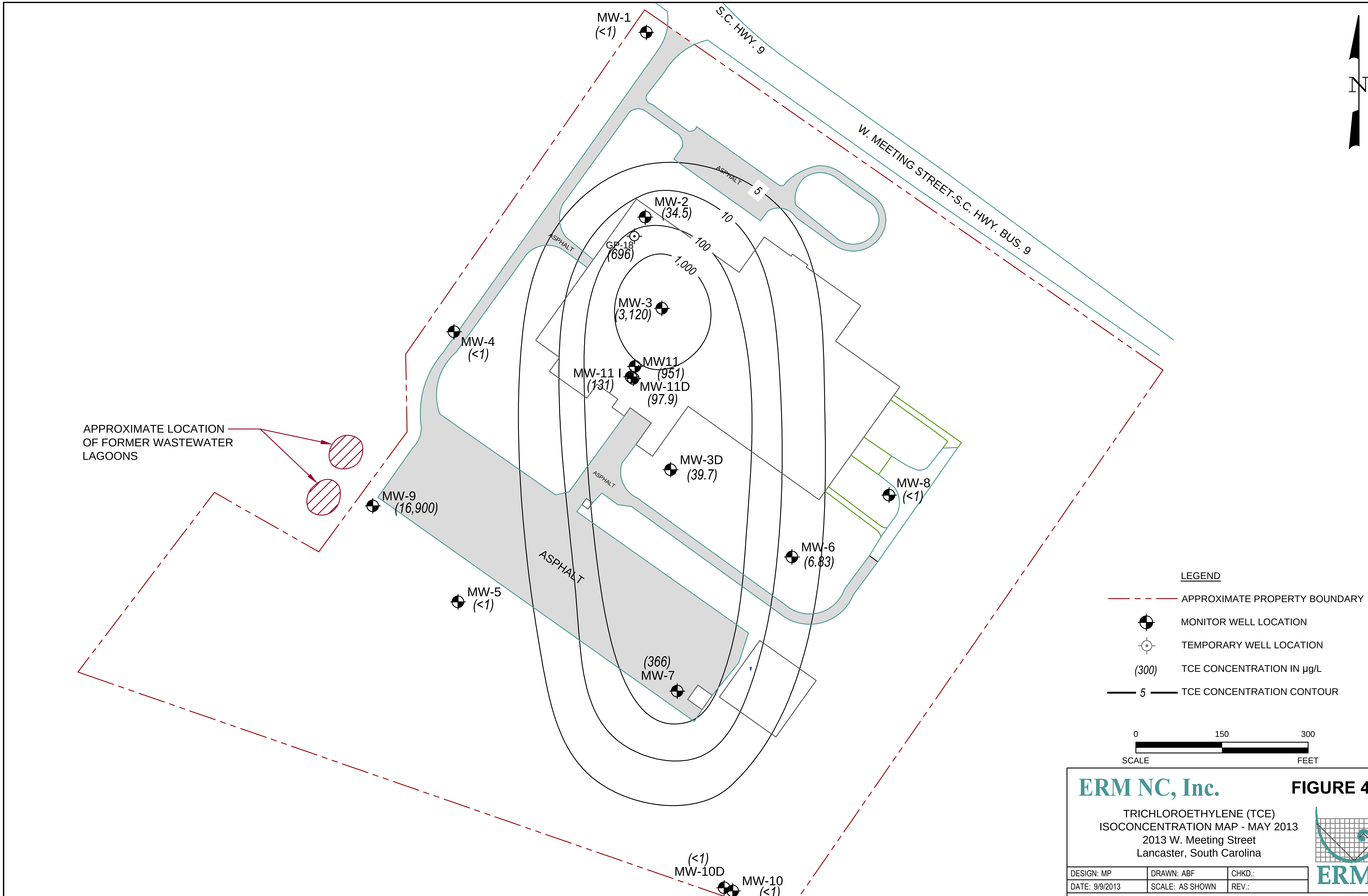
ERM NC, Inc.

FIGURE 3

SOIL BORING LOCATION MAP
2013 W. Meeting Street
Lancaster, South Carolina

ERM

DESIGN: MP	DRAWN: ABF	CHKD.:
DATE: 9/9/2013	SCALE: AS SHOWN	REV.:
W.O.NO.: 0172001_HHRA Figs.dwg		



ERM NC, Inc.

FIGURE 4

TRICHLOROETHYLENE (TCE)
ISOCONCENTRATION MAP - MAY 2013
2013 W. Meeting Street
Lancaster, South Carolina

ERM

DESIGN: MP	DRAWN: ABF	CHKD.:
DATE: 9/9/2013	SCALE: AS SHOWN	REV.:
W.O.NO.: 0172001_HHRA Figs.dwg		

Tables

Table 1
Selection of Exposure Pathways
Joslyn Clark Facility, Lancaster, South Carolina

Medium	Exposure Medium	Receptor Population	Receptor Age	Exposure Route	Rationale for Selection or Exclusion of Exposure Pathway
Groundwater	Groundwater	Construction Worker	Adult	Dermal	**Incomplete Pathway** - Depth to water greater than 20 feet below ground surface
				Ingestion	**Incomplete Pathway** - Depth to water greater than 20 feet below ground surface
	Air			Inhalation	**Potentially Complete Pathway** - Inhalation of vapors may occur during excavation/trenching activities.
	Groundwater	Facility Workers	Adult	Dermal	**Incomplete Pathway** - Site will remain as industrial use; no groundwater use within 1/2 mile downgradient of site; potable water supplied by lancaster Water and Sewer District.
				Ingestion	**Incomplete Pathway** - Site will remain as industrial use; no groundwater use within 1/2 mile downgradient of site; potable water supplied by lancaster Water and Sewer District.
	Building Air	Facility Workers		Inhalation	**Incomplete Pathway** - Vapor mitigation system has been installed to prevent vapor intrusion into the exisitng Site buildings.
Surface Water/Sediment	Surface Water/Sediment	Trespasser/Visitor	Adolescent	Dermal	**Incomplete Pathway** - There are no surface water bodies near the site. As such, there is no potential contact with surface water and/or sediment.
				Ingestion	**Incomplete Pathway** - There are no surface water bodies near the site. As such, there is no potential contact with surface water and/or sediment.
Soil	Soil	Construction Worker	Adult	Dermal	**Potentially Complete Pathway** - Receptors could contact surface and subsurface soil.
				Ingestion	**Potentially Complete Pathway** - Receptors could contact surface and subsurface soil.
	Air			Inhalation	**Potentially Complete Pathway** - Receptors could contact surface and subsurface soil.
	Soil	Site/Maintenance Workers	Adult	Dermal	**Potentially Complete Pathway** - Receptors could contact surface soil while conducting limited maintenance outdoor activities.
				Ingestion	**Potentially Complete Pathway** - Receptors could contact surface soil while conducting limited maintenance outdoor activities.
	Air			Inhalation	**Potentially Complete Pathway** - Receptors could contact surface soil while conducting limited maintenance outdoor activities.

Table 2
Total Carcinogenic and Noncarcinogenic Risk for All Receptors
Joslyn Clark Facility, Lancaster, South Carolina

Potential Receptor Populations and Media of Concern	Current/Future Site/Maintenance Worker		Future Facility Worker		Future Construction Worker	
	Cancer Risk	Noncancer Risk	Cancer Risk	Noncancer Risk	Cancer Risk	Noncancer Risk
Site Soil	0E+00	3.2E-02	0.0E+00	3.2E-02	0E+00	1.5E+00
Vapors in Indoor Air	- -	- -	1.8E-04	6.1E+01	- -	- -
Vapors in trench/excavation	- -	- -	- -	- -	2E-09	2E-05

- - pathway not quantified. See Table 1 for pathway analysis.

Attachment A
Supporting Information for Risk Assessment

APPENDIX A
TABLE A-1
OCCURRENCE, DISTRIBUTION, AND SELECTION OF CHEMICALS OF POTENTIAL CONCERN
Joslyn Clark Facility, Lancaster, South Carolina

Scenario Timeframe:	Current/Future
Medium:	Soil
Exposure Medium:	Soil (0-20')
Exposure Point:	Soil

Chemical Class	CAS Number	Chemical (1)	Minimum Concentration (Qualifier)	Maximum Concentration (Qualifier)	Units	Location of Maximum Concentration	Detection Frequency	Concentration Used for Screening (2)	Background Value (3)	Screening Toxicity Value (N/C) (4)	COPC Flag (Y/N)	Rationale for Selection or Deletion
VOCs	67-64-1	Acetone	0.00131	0.00763	mg/kg	GP-18	4/10	0.00763	--	63000	N	BSL
	156-59-2	cis-1,2-Dichloroethene	10	10	mg/kg	GP-9	1/7	10	--	200	N	BSL
	123-91-1	1,4-Dioxane	0.404	0.992	mg/kg	GP-21	5/10	0.992		17	N	BSL
	79-01-6	Trichloroethene	0.2	0.2	mg/kg	GP-9 (10-12')	1/17	0.2	--	2	N	BSL
Inorganics	7429-90-5	Aluminum	10,000	17,000	mg/kg	GP-15	3/21	17000	--	99000	N	BSL
	7440-36-0	Antimony	0.62	0.62	mg/kg	GP-1 (0-4')	1/21	0.62	--	41	N	BSL
	7440-38-2	Arsenic	0.65 J	1.5	mg/kg	GP-8	7/21	1.5	4.5	2.4	N	BSL
	7440-39-3	Barium	9.5	14	mg/kg	GP-16 (10-12')	3/21	14	--	19000	N	BSL
	7440-41-7	Beryllium	0.3	1.9	mg/kg	GP-9 (10-12)	18/21	1.9	0.54	200	N	BSL
	7440-43-9	Cadmium	0.11	1.1	mg/kg	GP-9 (10-12)	13/21	1.1	0.19	80	N	BSL
	7440-473	Chromium	0.79	160	mg/kg	GP-9 (26-28')	18/21	160	13	150000	N	BSL
	7440-48-4	Cobalt	1.2 J	1.5 J	mg/kg	GP-14	3/21	1.5 J	--	30	N	BSL
	7440-50-8	Copper	1.2	120	mg/kg	GP-1 (0-4')	17/21	120	8.1	4100	N	BSL
	7439-89-6	Iron	22,000	35,000	mg/kg	GP-15	3/21	35000	--	72000	N	BSL
	7439-92-1	Lead	1.1	36	mg/kg	GP-8	15/21	36	13	800	N	BSL
	7439-95-4	Magnesiun	310 J	570	mg/kg	GP-16 (10-12')	3/21	570	--	NE	N	BSL
	7439-96-5	Manganese	39	140	mg/kg	GP-16 (10-12')	3/21	140	--	2300	N	BSL
	7440-02-0	Nickel	1 J	48	mg/kg	GP-9 (10-12)	16/21	48	4.4	2000	N	BSL
	9/7/7440	Potassium	240 J	500	mg/kg	GP-16 (10-12')	3/21	500	--	NE	N	BSL
	7782-49-2	Selenium	4.2 J	4.2 J	mg/kg	GP-16 (26-28'- DUP-1)	3/3	4.2 J	--	510	N	BSL
	7440-22-4	Silver	0.072 J	8.8	mg/kg	GP-1 (0-4')	13/21	8.8	1.2	510	N	BSL
	7440-28-0	Thallium	3.3	3.3	mg/kg	GP-3 (4-8')	1/21	3.3	--	1	Y	ASL
	7440-62-2	Vanadium	9.9	21	mg/kg	GP-15	3/21	21	--	510	N	BSL
	7440-66-6	Zinc	9.9	200	mg/kg	GP-1 (0-4)	9/21	200	--	31000	N	BSL

(1) Constituents with at least one positive detection were included in the screening analysis
(2) Maximum concentration used for screening.
(3) Background concentritIons reported in
(4) EPA Regional Screening Level (RSL) Master Table, May 2013.

J Analyte present, reported value should be considered a quantitative estimate
N/A Screening level not available; Background value not available
ND Non-detect

Rationale codes:
ASL Above Screening Level
BSL Below Screening Level
EN Essential nutrient

APPENDIX A

TABLE A-2

OCCURRENCE, DISTRIBUTION, AND SELECTION OF CHEMICALS OF POTENTIAL CONCERN

Joslyn Clark Facility, Lancaster, South Carolina

Scenario Timeframe:	Current/Future
Medium:	Groundwater
Exposure Medium:	Groundwater
Exposure Point:	Groundwater

Exposure Point	CAS Number	Chemical	Minimum Concentration (Qualifier)	Maximum Concentration (Qualifier)	Units	Location of Maximum Concentration	Detection Frequency	Concentration Used for Screening (2)	Background Value (3)	Screening Toxicity Value (N/C) (TAP) (4)	COPC Flag (Y/N)	Rationale for Selection or Deletion
VOCs	67-64-1	Acetone	3.11	3.11	ug/L	MW-11D	1/37	3.11	NA	1200	N	BSL
	75-15-0	Carbon disulfide	0.12	0.12	ug/L	MW-10D	1/37	0.12	NA	72	N	BSL
	67-66-3	Chloroform	0.36	1.8	ug/L	MW-7	7/37	1.8	NA	0.19	Y	ASL
	74-87-3	Chloromethane	0.37 J	0.52 J	ug/L	MW-6	2/37	0.52 J	NA	19	N	BSL
	75-34-3	1,1-Dichloroethane	0.24 J	30	ug/L	MW-3	4/37	30	NA	2.4	Y	ASL
	75-35-4	1,1-Dichloroethene	0.17	155	ug/L	MW-11	8/37	155	NA	26	Y	ASL
	156-59-2	cis-1,2-Dichloroethene	2.8	64.8	ug/L	MW-11	2/37	64.8	NA	2.8	Y	ASL
	123-91-1	1,4-Dioxane	0.787	0.95	ug/L	GP-18	2/37	0.95	NA	15	N	BSL
	75-09-2	Methylene chloride	1.23	1.73	ug/L	MW-11	2/37	1.73	NA	8.4	N	BSL
	79-34-5	Tetrachloroethene	0.16	55	ug/L	MW-3	14/37	55	NA	3.5	Y	ASL
	108-88-3	Toluene	0.34 J	0.34 J	ug/L	MW-2	1/37	0.34 J	NA	86	N	BSL
	79-00-5	1,1,2-Trichloroethane	4.6 J	6.5	ug/L	MW-3	2/37	6.5	NA	0.24	Y	ASL
	79-02-6	Trichloroethene	0.62 J	3,200	ug/L	MW-3	25/37	3200	NA	0.44	Y	ASL
	96-12-8	1,2-Dibromo-3-chloropropane	0.011 JP	0.011 JP	ug/L	MW-3	1/7	0.011 JP	NA	0.00032	Y	ASL
Metals	7429-90-5	Aluminum	230	6,800	ug/L	MW-7	7 /20	6800	NA	1600	Y	ASL
	7440-36-0	Antimony	0.16 J	2	ug/L	MW-1	6/20	2	NA	0.6	Y	ASL
	7440-38-2	Arsenic	0.29	0.8 J	ug/L	MW-3D	5/20	0.8 J	NA	0.045	Y	ASL
	7440-39-3	Barium	20	190	ug/L	MW-7	22/20	190	NA	290	N	BSL
	7440-41-7	Beryllium	0.029 J	0.83	ug/L	MW-5	3/20	0.83	NA	1.6	N	BSL
	7440-43-9	Cadmium	0.067 J	0.067 J	ug/L	MW-7	1/20	0.067 J		0.69	N	BSL
	7440-70-2	Calcium	890	16,000	ug/L	MW-10D	22/20	16000	NA	EN	N	BSL
	7440-48-4	Cobalt	0.16 J	2.3 J	ug/L	MW-3	17/20	2.3 J	NA	0.47	Y	ASL
	7440-50-8	Copper	0.2 J	7.4	ug/L	MW-3D	19/20	7.4	NA	62	N	BSL
	7439-89-6	Iron	130	8,700	ug/L	MW-7	20/20	8700	NA	1100	Y	ASL
	7439-52-1	Lead	0.21 J	3.3	ug/L	MW-3D	13/20	3.3	NA	15	N	BSL
	7439-95-4	Magnesium	480	5,100	ug/L	MW-8	22/20	5100	NA	EN	N	BSL
	7439-96-5	Manganese	6.7	3,300	ug/L	MW-7	29/33	3300	NA	32	Y	ASL
	7439-97-6	Mercury	0.000054 J	0.000055 J	ug/L	MW-7	2/30	0.000055 J	NA	0.43	N	BSL
	7440-02-0	Nickel	0.34 J	8.3	ug/L	MW-2	17/20	8.3	NA	30	N	BSL
	9/7/7440	Potassium	1,900	4,800	ug/L	MW-7	22/20	4800	NA	EN	N	BSL
	7782-49-2	Selenium	0.32 J	0.32 J	ug/L	MW-5	1/20	0.32 J	NA	7.8	N	BSL
	7440-23-5	Sodium	2,000	15,000	ug/L	MW-8	34/33	15000	NA	EN	N	BSL
	7440-62-2	Vanadium	1.5 J	14	ug/L	MW-7	12/20	14	NA	6.3	Y	ASL
	7440-66-6	Zinc	1.8 J	63	ug/L	MW-7	19/20	63	NA	470	N	BSL

(1) Constituents with at least one positive detection in MW-1, MW-2, MW-3, MW-3D, MW-4, MW-5, MW-6, MW-7, MW-8, MW-10, MW-10D, MW-11, MW-11I, and MW-11D were included in the screening analysis for groundwater. MW-9 is associated with an off-site source and is not included in this analysis.

(2) Maximum concentration used for screening

(3) No background groundwater concentrations available.

(4) EPA Regional Screening Level (RSL) Master Table, May 2013.

Rationale codes:

ASL	Above Screening Level	J	Analyte present, reported value should be considered a quantitative estimate
BSL	Below Screening Level	N/A	Screening level not available; Background value not available
EN	Essential nutrient	ND	Non-detect

APPENDIX A
TABLE A-3
DEVELOPMENT OF SITE-SPECIFIC SCREENING LEVELS FOR VOLATILIZATION FROM GROUNDWATER INTO INDOOR AIR
Joslyn Clark Facility, Lancaster, South Carolina
Hypothetical Future Office Building

Scenario Timeframe:	Future
Medium:	Groundwater
Exposure Medium:	Groundwater
Exposure Point:	Air - Vapor Intrusion into Future Office Building

Calculation taken from USEPA, Vapor Intrusion Screening Level Calculator, June 2013

Constituent	CAS No.	Carciniogenic Target Indoor Air Concentration (ug/m^3)	Non-Carciniogenic Target Indoor Air Concentration (ug/m^3)	Henry's Law Constant (unitless)	Carciniogenic Target Groundwater Concentration (ug/L)	Non-Carciniogenic Target Groundwater Concentration (ug/L)	Selected Target Groundwater Concentration (ug/L)
Acetone	67-64-1	NA	1.40E+05	1.43E-03	NA	9.79E+07	9.79E+07
Chloroform	67-66-3	5.30E-01	4.30E+02	1.50E-01	3.53E+00	2.87E+03	3.53E+00
Chloromethane	74-87-3	NA	3.90E+02	3.61E-01	NA	1.08E+03	1.08E+03
1,1-Dichloroethane	74-34-3	7.70E+00	NA	2.30E-01	3.35E+01	NA	2.30E-01
1,1-Dichloroethene	75-35-4	NA	8.80E+02	1.07E+00	NA	8.25E+02	8.25E+02
cis-1,2-Dichloroethene	156-59-2	NA	NA	1.67E-01	NA	NA	NA
1,4-Dioxane	123-91-1	1.60E+00	4.80E+02	1.96E-04	8.16E+03	2.45E+06	8.16E+03
Methylene chloride	75-09-2	1.20E+03	2.60E+03	1.33E-01	9.04E+03	1.96E+04	9.04E+03
Tetrachloroethene	127-18-4	4.70E+01	1.80E+02	7.24E-01	6.50E+01	2.49E+02	6.50E+01
Toluene	108-88-3	NA	2.20E+05	2.71E-01	NA	8.10E+05	8.10E+05
1,1,2-Trichloroethane	79-00-5	7.70E-01	8.80E-01	3.36E-02	2.29E+01	2.62E+01	2.29E+01
Trichloroethylene	79-01-6	3.00E+00	8.80E+00	4.03E-01	7.45E+00	2.19E+01	7.45E+00

$$\text{Target Groundwater Concentration} = \frac{\text{Cia, target}}{\text{AFgw} \times (1000\ \text{L/m3}) \times \text{HLC}}$$

where:

Cia, target = target indoor air concentration (commercial)
AFgw = generic attentuation factor for groundwater (default value - 0.001)
HLC = Henry's Law Constant

NA = Not applicable.
C = Carcinogenic; NC = Noncarcinogenic
Target indoor air and target groundwater concentrations are set to equal a cancer risk of 1x10-6 and hazard quotient of 1.0.
Average groundwater temperature set at 25 degrees centigrade.

APPENDIX A

TABLE A-4

OCCURRENCE, DISTRIBUTION, AND SELECTION OF CHEMICALS OF POTENTIAL CONCERN

Joslyn Clark Facility, Lancaster, South Carolina

Scenario Timeframe:	Future
Medium:	Groundwater
Exposure Medium:	Groundwater
Exposure Point:	Air - Vapor Intrusion into Future Office Building

Exposure Point	CAS Number	Chemical	Minimum Concentration (Qualifier)	Maximum Concentration (Qualifier)	Units	Location of Maximum Concentration	Detection Frequency	Concentration Used for Screening (2)	Background Value (3)	Screening Toxicity Value (N/C) (TAP) (4)	COPC Flag (Y/N)	Rationale for Selection or Deletion
VOCs	67-64-1	Acetone	3.11	3.11	ug/L	MW-11D	1/38	3.11	NA	97902097.9	N	BSL
	67-66-3	Chloroform	0.36	26	ug/L	MW-9	8/38	26	NA	3.5	Y	ASL
	74-87-3	Chloromethane	0.37 J	0.52 J	ug/L	MW-6	2/38	0.52 J	NA	1081.8	N	BSL
	75-34-3	1,1-Dichloroethane	0.24 J	30	ug/L	MW-3	5/38	30	NA	0.23	Y	ASL
	75-35-4	1,1-Dichloroethene	0.17	320	ug/L	MW-9	10/38	320	NA	824.7	N	BSL
	156-59-2	cis-1,2-Dichloroethene	2.8	250	ug/L	MW-9	4/38	250	NA	NA	N	BSL
	123-91-1	1,4-Dioxane	0.787	6.88	ug/L	MW-9	2/38	6.88	NA	8163.3	N	BSL
	75-09-2	Methylene chloride	1.23	1.73	ug/L	MW-11	2/38	1.73	NA	9036.1	N	BSL
	127-18-4	Tetrachloroethene	0.16	1,360	ug/L	MW-9	16/38	1360	NA	65	Y	ASL
	79-00-5	1,1,2-Trichloroethane	4.6 J	14	ug/L	MW-9	3/38	14	NA	22.9	N	BSL
	79-02-6	Trichloroethene	0.62 J	16,900	ug/L	MW-9	26/38	16900	NA	7.4	Y	ASL

(1) Constituents with at least one positive detection were included in the screening analysis

(2) Maximum concentration used for screening

(3) US Environmental Protection Agency, Vapor Intrusion Screening Level calculator, June 2013.

J	Analyte present, reported value may not be accurate or precise
K	Analyte present, reported value may be biased high, actual value is expected to be lower
L	Analyte present, reported value may be biased low, actual value is expected to be higher
ND	Non-detect

Rationale codes:

ASL	Above Screening Level
BSL	Below Screening Level
NA	Screening Level Not Available

APPENDIX A
TABLE A-5
CALCULATION OF VOLATILIZATION FACTORS
Joslyn Clark Facility, Lancaster, South Carolina

Scenario Timeframe:	Future
Medium:	Groundwater
Exposure Medium:	Groundwater vapors
Exposure Point:	Air

	Cs Medium EPC mg/L	MW g/mole	K_{iL} cm/sec	K_{iG} cm/sec	Ideal Gas Law Constant	Temperature	Henry's Law Constant * atm-m3/mole	Ki cm/sec	Area cm2	Emission Rate mg/sec	RME Air Concentration mg/m3
Acetone	3.11E-03	5.81E+01	4.53E-03	5.63E-01	0.000082	298	3.50E-05	6.84E-04	8.33E-01	1.77E-06	1.6E-07
Chloroform	8.4E-04	1.19E+02	3.16E-03	4.42E-01	0.000082	298	3.67E-03	3.01E-03	8.33E-01	2.11E-06	2.0E-07
Chloromethane	5.2E-04	5.05E+01	4.86E-03	5.90E-01	0.000082	298	8.82E-03	4.75E-03	8.33E-01	2.06E-06	1.9E-07
1,1-Dichloroethane	2.4E-02	9.90E+01	3.47E-03	4.71E-01	0.000082	298	5.62E-03	3.36E-03	8.33E-01	6.61E-05	6.1E-06
1,1-Dichloroethene	2.9E-02	9.69E+01	3.50E-03	4.74E-01	0.000082	298	2.61E-02	3.48E-03	8.33E-01	8.41E-05	7.8E-06
cis-1,2-Dichloroethene	4.4E-02	9.69E+01	3.50E-03	4.74E-01	0.000082	298	4.08E-03	3.36E-03	8.33E-01	1.24E-04	1.1E-05
1,4-Dioxane	8.5E-04	8.81E+01	3.68E-03	4.89E-01	0.000082	298	4.80E-06	9.37E-05	8.33E-01	6.63E-08	6.1E-09
Methylene chloride	1.7E-03	8.49E+01	3.74E-03	4.95E-01	0.000082	298	3.25E-03	3.54E-03	8.33E-01	5.02E-06	4.6E-07
Tetrachloroethene	2.0E-02	1.66E+02	2.68E-03	3.96E-01	0.000082	298	1.77E-02	2.65E-03	8.33E-01	4.45E-05	4.1E-06
Toluene	3.4E-04	9.21E+01	3.59E-03	4.82E-01	0.000082	298	6.64E-03	3.50E-03	8.33E-01	9.91E-07	9.2E-08
1,1,2-Trichloroethane	6.5E-03	1.33E+02	2.99E-03	4.26E-01	0.000082	298	8.24E-04	2.47E-03	8.33E-01	1.34E-05	1.2E-06
Trichloroethene	1.3E+00	1.31E+02	3.01E-03	4.28E-01	0.000082	298	9.85E-03	2.96E-03	8.33E-01	3.30E-03	3.1E-04

* = Regional Screening Level (RSL) chemical-specific parameteres supporting table (USEPA, April 2012).

$C_a = E_i$ / LS x V x MH; where C_a is the Ambient Air Concentration (mg/m^3)
$K_{iG} = (MW_{H2O}/MW_i)$^0.335 x (T/298)^1.005 x (k_{iG}, O_2); where KiG is the Gas Phase Mass Transfer Coefficient (cm/second)
$K_{iL} = (MW_{O2}/MW_i)$^0.5 x (T/298) x (k_L, O_2); where K_{iL} is the Liquid Phase Mass Transfer Coefficient (cm/second)
$K_i^{-1} = K_{iL}^{-1} + ((R \times T)/(H_i \times K_{iG}))$; where K_i is the Overall Mass Transfer Coefficient (cm/second)
$E_i = K_i \times C_s \times A$; where E_i is the Emission Rate (mg/second)

Input Variables:	**Value**	**Units**
Contaminant Liquid Phase Concentration, C_s =	Chem Specific	mg/cm^3
Area, A =	2.23E+04	cm^2
Ideal Gas Law Constant, R =	8.20E-05	atm-m3/mole-degK
Temperature, T =	298	degK
Henry's Law Constant for Compound I, H_i =	Chem Specific	atm-m^3/mole
Molecular Weight of Oxygen , MW_{O2} =	32	g/mole
Molecular Weight of Water, MW_{H2O} =	18	g/mole
Molecular Weight of Compound i, MW_i =	Chem Specific	g/mole
Liquid Phase Mass Transfer Coefficient for Oxygen at 25 degC, k_L, O_2 =	0.0061	cm/second
Gas Phase Mass Transfer Coefficient for Water Vapor at 25 degC, k_{iG}, O_2 =	0.833	cm/second
Length of side perpendicular to the wind, LS =	2.4	meters
Average wind speed, V =	2.25	m/second
Mixing Height before being inhaled, MH =	2	meters
Molecular Weight of Oxygen , MW_{O2} =	32	g/mole
Molecular Weight of Water, MW_{H2O} =	18	g/mole
Molecular Weight of Compound i, MW_i =	Chem Specific	g/mole
Liquid Phase Mass Transfer Coefficient for Oxygen at 25 degC, k_L, O_2 =	0.0061	cm/second
Gas Phase Mass Transfer Coefficient for Water Vapor at 25 degC, k_{iG}, O_2 =	0.833	cm/second
Length of side perpendicular to the wind, LS =	2.4	meters
Average wind speed, V =	2.25	m/second
Mixing Height before being inhaled, MH =	2	meters

APPENDIX A
TABLE A-6
MEDIUM-SPECIFIC EXPOSURE POINT CONCENTRATION SUMMARY
Joslyn Clark Facility, Lancaster, South Carolina

Scenario Timeframe:	Current/Future
Medium:	Soil
Exposure Medium:	Soil
Exposure Point:	Soil (0 - 20 feet)

Chemical of Potential Concern	Units	Arthmetic Mean or Mean of Detected	ProUCL - Recommended [1] UCL on the Mean	Maximum Detected Concentration	Maximum Qualifier	EPC Units	Reasonable Maximum Exposure		
							Medium EPC Value	Medium EPC Statistic	Medium EPC Rationale
Site Soil - (0-20 feet)									
Thallium	mg/kg	--	--	3.3E+00		mg/kg	3.3E+00	maximum	

For duplicate sample results, the average value was used in the calculation.
Statistics: Maximum Detected Value (Maximum); or ProUCL-recommended UCL
[1] Calculated by ProUCL (Version 4.00.02)
NP = Nonparametric
N = Normal
G - Gamma

APPENDIX A

TABLE A-7

MEDIUM-SPECIFIC EXPOSURE POINT CONCENTRATION SUMMARY

Joslyn Clark Facility, Lancaster, South Carolina

Scenario Timeframe:	Current/Future
Medium:	Soil
Exposure Medium:	Soil (0-20 feet)
Exposure Point:	Air

Chemical of Potential Concern	Units	Arthmetic Mean or Mean of Detected	ProUCL - Recommended [1] UCL on the Mean	Maximum Detected Concentration	Maximum Qualifier	EPC Units	Reasonable Maximum Exposure		
							Medium EPC Value	Medium EPC Statistic	Medium EPC Rationale
Site Soil - (0-20 feet)									
Thallium	mg/kg	--	--	3.3E+00		mg/kg	3.3E+00	maximum	

For duplicate sample results, the average value was used in the calculation.

Statistics: Maximum Detected Value (Maximum); or ProUCL-recommended UCL

[1] Calculated by ProUCL (Version 4.00.02)

NP = Nonparametric

N = Normal

G - Gamma

APPENDIX A
TABLE A-8
ROUTE-SPECIFIC CONCENTRATION FOR VAPORS IN AIR BASED UPON TABLE A-6
Joslyn Clark Facility, Lancaster, South Carolina

Scenario Timeframe:	Current/Future
Medium:	Soil
Exposure Medium:	Soil
Exposure Point:	Outdoor Air

Chemical of Potential Concern	Reasonable Maximum Exposure	Calculation of Soil-to-Air Volatilization Factor (VF)						Reasonable Maximum Exposure
	Medium EPC Value (mg/kg)	Apparent Diffusivity (D_A) (cm^2/sec)	Diffusivity in Air (Di)	Diffusivity in Water (Dw)	Henry's Law Constant (H) (dimensionless)	Organic Carbon Partition Coefficient (K_{oc}) (cm^3/g)	Volatilization Factor (VF) (m^3/kg)	Route EPC Value Vapors (mg/m^3)
Site Soil - (0-20 feet)								
No volatiles retained	--	--	--	--	--	--	--	--

Route EPC Value = Medium EPC Value / VF.

$$VF\ (m^3/kg) = \frac{(Q/C \times 3.14 \times D_A \times T)^{1/2)} \times 10^{+4}\ (m^{2/}cm^2)}{(2 \times p_b \times D_A)}$$

$$\text{where } D_A = \frac{[(O_a^{10/3} \times D_i H' \times Ow^{10/3} \times D_w)/n^{2]}}{(p_b \times K_d \times O_w \times O_a \times H)}$$

where:

VF = Volatilization Factor	calculated	m^3/kg
D_A = Apparent diffusivity	calculated	cm^2/s
Q/C = Inverse of the ratio of the geometric mean air concentration to the volatilization flux at center of a square source	site-specific	(g/m^2- s per kg/m^3)
T = Exposure interval	950,000,000	sec
p_b = Air-filled soil porosity	1.5	g/cm^2
O_a = Air-filled soil porosity	n - O_w	L_{air}/L_{soil}
n = Total soil porosity	1 - (p_b/p_s)	L_{pore}/L_{soil}
O_w = Water-filled soil porosity	0.15	L_{water}/L_{soil}
p_s = Soil particle density	2.65	g/cm^2
D_i = Diffusivity in air	chemical-specific	cm^2/s
H' = Henry's Law constant	chemical-specific	dimensionless
K_d = Soil-water partition coefficient	chemical-specific	cm^3/g
K_{oc} = Soil organic carbon partition coefficient	chemical-specific	cm^3/g
f_{oc} = Fraction organic carbon content of soil	0.006	g/g

Parameters obtained from EPA Regional\Screening Level Chemical-specific Parameters Supporting Table, May 2013.

APPENDIX A

TABLE A-9

ROUTE-SPECIFIC CONCENTRATION FOR PARTICULATES AND VAPORS IN AIR BASED UPON TABLES A-7 AND A-8

Joslyn Clark Facility, Lancaster, South Carolina

Scenario Timeframe:	Current/Future
Medium:	Soil
Exposure Medium:	Soil
Exposure Point:	Air

Chemical of Potential Concern	Reasonable Maximum Exposure Route EPC Value Particulates *(Table A-7)* (mg/m^3)	Reasonable Maximum Exposure Route EPC Value Vapors *(Table A-8)* (mg/m^3)	Reasonable Maximum Exposure Route EPC Value (mg/m^3)
Volatile Organics			
Thallium	3.30E+00	--	3.30E+00

N/A = Not applicable; no volatile constituents reported

Route EPC Value = Route EPC Values Particulates + Route EPC Value Vapors

APPENDIX A
TABLE A-10
MEDIUM-SPECIFIC EXPOSURE POINT CONCENTRATION SUMMARY
Joslyn Clark Facility, Lancaster, South Carolina

Scenario Timeframe:	Future
Medium:	Groundwater
Exposure Medium:	Groundwater
Exposure Point:	Groundwater

Chemical of Potential Concern	Units	Arithmetic Mean	ProUCL - Recommended [1] UCL on the Mean	Maximum Detected Concentration	Maximum Qualifier	EPC Units	Reasonable Maximum Exposure		
							Medium EPC Value	Medium EPC Statistic	Medium EPC Rationale
Acetone	mg/L	--	--	0.00311		mg/L	3.11E-03	--	maximum
Chloroform	mg/L	8.30E-04	8.40E-04	1.80E-03		mg/L	8.40E-04	95% UCL - NP	KM (Percentile Bootstrap)
Chloromethane	mg/L	4.50E-04	5.70E-04	5.20E-04		mg/L	5.20E-04	--	maximum
1,1-Dichloroethane	mg/L	1.36E-02	2.36E-02	3.00E-02		mg/L	2.36E-02	95% UCL - NP	KM (Percentile Bootstrap)
1,1-Dichloroethene	mg/L	3.85E-02	2.90E-02	1.55E-01		mg/L	2.90E-02	95% UCL - NP	KM (t)
cis-1,2-Dichloroethene	mg/L	3.38E-02	4.44E-02	6.48E-02		mg/L	4.44E-02	95% UCL - NP	KM (Chebyshev)
1,4-Dioxane	mg/L	8.69E-04	8.50E-04	9.50E-04		mg/L	8.50E-04	95% UCL - NP	KM (t)
Methylene chloride	mg/L	1.48E-03	--	1.70E-03		mg/L	1.70E-03	--	maximum
Tetrachloroethene	mg/L	2.40E-02	2.01E-02	5.50E-02		mg/L	2.01E-02	95% UCL - NP	KM (Percentile Bootstrap)
Toluene	mg/L	--	--	3.40E-04		mg/L	3.40E-04	--	maximum
1,1,2-Trichloroethane	mg/L	5.50E-03	--	6.50E-03		mg/L	6.50E-03	--	maximum
Trichloroethene	mg/L	6.39E-01	1.34E+00	3.20E+00		mg/L	1.34E+00	95% UCL - G	KM (Chebyshev)

For duplicate sample results, the average value was used in the calculation.
Groundwater data from monitoring wells MW-2, MW-3, MW-3D, MW-6, MW-7, MW-11, MW-11I, MW-11D and GP-18 used in the statistical analysis.
Statistics: Maximum Detected Value (Maximum); or ProUCL-recommended UCL
[1] Calculated by ProUCL (Version 4.00.02)
KM = Kaplan Meier
NP = Nonparametric
NC = Not calculated due to insufficiently sized data set

APPENDIX A

TABLE A-11

VALUES USED FOR DAILY INTAKE CALCULATIONS

Joslyn Clark Facility, Lancaster, South Carolina

Scenario Timeframe:	Current/Future
Medium:	Soil
Exposure Medium:	Soil
Exposure Point:	Soil
Receptor Population:	Site Worker
Receptor Age:	Adult

Exposure Route	Parameter Code	Parameter Definition	Units	RME Value	RME Rationale/ Reference	Intake Equation/ Model Name
Ingestion	CSoil	Chemical Concentration in Soil	mg/kg soil			Chronic Daily Intake (CDI) (mg/kg-day) =
	IR_{soil}	Ingestion Rate of Soil	mg soil/day	50	USEPA 2002 -- Recommended value for indoor worker	CSoil x IR_{soil} x CF x FI x EF x ED x 1/BW x 1/AT
	CF	Conversion Factor	kg/mg	0.000001	--	
	FI	Fraction Ingested from Contaminated Source	--	1	Professional Judgment -- assumes 100%	
	EF	Exposure Frequency	days/yr	50	Professional judgment - assumes 1 day/week, 50 weeks/year	
	ED	Exposure Duration	yr	25	USEPA 1991 -- recommended maximum exposure for commercial workers	
	BW	Body Weight	kg	70	USEPA 1989	
	AT_c	Averaging Time for Carcinogens	days	25,550	USEPA 1989	
	AT_{nc}	Averaging Time for Noncarcinogens	days	9,125	USEPA 1989	
Dermal	CSoil	Chemical Concentration in Soil	mg/kg soil			Chronic Daily Intake (CDI) (mg/kg-day) =
	CF	Conversion Factor	kg/mg	0.000001	--	CSoil x CF x SA x SSAF x DABS x EF x
	SA	Skin Surface Area Available for Contact	cm^2/event	3,300	USEPA 2002 -- Recommended value for indoor worker	ED x 1/BW x 1/AT
	SSAF	Soil-to-Skin Adherence Factor	mg/cm^2/event	0.07	USEPA 2004 -- Recommended value for adult worker.	
	DABS	Dermal Absorption Factor	--	Chemical-Specific	USEPA 1995 -- Refer to Supporting Documentation	
	EF	Exposure Frequency	days/yr	50	Professional judgment - assumes 1 day/week, 50 weeks/year	
	ED	Exposure Duration	yr	25	USEPA 1991 -- recommended maximum exposure for commercial workers	
	BW	Body Weight	kg	70	USEPA 1989	
	AT_c	Averaging Time for Carcinogens	days	25,550	USEPA 1989	
	AT_{nc}	Averaging Time for Noncarcinogens	days	9,125	USEPA 1989	

APPENDIX A

TABLE A-12

VALUES USED FOR DAILY INTAKE CALCULATIONS

Joslyn Clark Facility, Lancaster, South Carolina

Scenario Timeframe:	Current/Future
Medium:	Soil
Exposure Medium:	Soil
Exposure Point:	Air - Outdoor
Receptor Population:	Site Worker
Receptor Age:	Adult

Exposure Route	Parameter Code	Parameter Definition	Units	RME Value	RME Rationale/ Reference	Intake Equation/ Model Name
Inhalation	CA	Chemical Concentration in Outdoor Air	mg/m^3		Concentration in Soil /Particulate Emission Factor ($7.8x10^7$ m^3/kg)	Exposure Concentration (EC) (mg/m^3) =
	ET	Exposure Time - Outdoor	hr/day	1	Professional Judgment -- Upper period of time an commercial worker might spend outdoors during the workday	(CA x ET x EF x ED)/AT
	EF	Exposure Frequency - Outdoor	days/yr	50	Professional judgment - assumes 1 day/week, 50 weeks/year	
	ED	Exposure Duration	yr	25	USEPA 1991 -- recommended maximum exposure for commercial workers	
	AT_c	Averaging Time for Carcinogens	hours	613,200	USEPA 2009	
	AT_{nc}	Averaging Time for Noncarcinogens	hours	219,000	USEPA 2009	

APPENDIX A
TABLE A-13
VALUES USED FOR DAILY INTAKE CALCULATIONS
Joslyn Clark Facility, Lancaster, South Carolina

Scenario Timeframe:	Future
Medium:	Soil
Exposure Medium:	Soil
Exposure Point:	Air - Indoor
Receptor Population:	Facility Worker
Receptor Age:	Adult

Exposure Route	Parameter Code	Parameter Definition	Units	RME Value	RME Rationale/ Reference	Intake Equation/ Model Name
Inhalation	CA	Chemical Concentration in Indoor Air	mg/m^3	See Table C-9	See Table C-9	Exposure Concentration (EC) (mg/m^3) = (CA x ET x EF x ED)/AT
	ET	Exposure Time - Indoor	hr/day	8	Professional Judgment -- assumes 8 hr workday	
	EF	Exposure Frequency - Indoor	days/yr	250	Professional Judgment -- assumes 5 days/week, 50 weeks/year	
	ED	Exposure Duration	yr	25	USEPA 1991 -- recommended maximum exposure for commercial workers	
	AT_c	Averaging Time for Carcinogens	hours	613,200	USEPA 2009	
	AT_{nc}	Averaging Time for Noncarcinogens	hours	219,000	USEPA 2009	

APPENDIX A

TABLE A-14

VALUES USED FOR DAILY INTAKE CALCULATIONS

Joslyn Clark Facility, Lancaster, South Carolina

Scenario Timeframe:	Future
Medium:	Soil
Exposure Medium:	Soil
Exposure Point:	Soil
Receptor Population:	Construction Worker
Receptor Age:	Adult

Exposure Route	Parameter Code	Parameter Definition	Units	RME Value	RME Rationale/ Reference	Intake Equation/ Model Name
Ingestion	CSoil	Chemical Concentration in Soil	mg/kg soil			Chronic Daily Intake (CDI) (mg/kg-day) =
	IR_{soil}	Ingestion Rate of Soil	mg soil/day	480	USEPA 1989 -- Recommended value for construction worker.	CSoil x IR_{soil} x CF x FI x EF x ED x 1/BW x 1/AT
	CF	Conversion Factor	kg/mg	0.000001	--	
	FI	Fraction Ingested from Contaminated Source	--	1	Professional Judgment -- assumes 100%	
	EF	Exposure Frequency	days/yr	250	Professional Judgment -- assumes 5 days/week, 50 weeks/year	
	ED	Exposure Duration	yr	1	Professional Judgment -- assumes 1 year construction duration	
	BW	Body Weight	kg	70	USEPA 1989	
	AT_c	Averaging Time for Carcinogens	days	25,550	USEPA 1989	
	AT_{nc}	Averaging Time for Noncarcinogens	days	365	USEPA 1989	
Dermal	CSoil	Chemical Concentration in Soil	mg/kg soil			Chronic Daily Intake (CDI) (mg/kg-day) =
	CF	Conversion Factor	kg/mg	0.000001	--	CSoil x CF x SA x SSAF x DABS x EF x
	SA	Skin Surface Area Available for Contact	cm^2/event	3,280	USEPA 1989 -- Recommended value for construction worker.	ED x 1/BW x 1/AT
	SSAF	Soil-to-Skin Adherence Factor	mg/cm^2/event	0.3	USEPA 2001	
	DABS	Dermal Absorption Factor	--	Chemical-Specific	USEPA 1995 -- Refer to Supporting Documentation	
	EF	Exposure Frequency	days/yr	250	Professional Judgment -- assumes 5 days/week, 50 weeks/year	
	ED	Exposure Duration	yr	1	Professional Judgment -- assumes 1 year construction duration	
	BW	Body Weight	kg	70	USEPA 1989	
	AT_c	Averaging Time for Carcinogens	days	25,550	USEPA 1989	
	AT_{nc}	Averaging Time for Noncarcinogens	days	365	USEPA 1989	

APPENDIX A

TABLE A-15

VALUES USED FOR DAILY INTAKE CALCULATIONS

Joslyn Clark Facility, Lancaster, South Carolina

Scenario Timeframe:	Future
Medium:	Soil
Exposure Medium:	Soil
Exposure Point:	Air
Receptor Population:	Construction Worker
Receptor Age:	Adult

Exposure Route	Parameter Code	Parameter Definition	Units	RME Value	RME Rationale/ Reference	Intake Equation/ Model Name
Inhalation	CA	Chemical Concentration in Outdoor Air	mg/m^3		Concentration in Soil /Particulate Emission Factor (7.8×10^7 m^3/kg)	Exposure Concentration (EC) (mg/m^3) =
	ET	Exposure Time - Outdoor	hr/day	8	Professional Judgment -- assumes 8 hr workday	(CA x ET x EF x ED)/AT
	EF	Exposure Frequency - Outdoor	days/yr	250	Professional Judgment -- assumes 5 days/week, 50 weeks/year	
	ED	Exposure Duration	yr	1	Professional Judgment -- assumes 1 year construction duration	
	AT_c	Averaging Time for Carcinogens	hours	613,200	USEPA 2009	
	AT_{nc}	Averaging Time for Noncarcinogens	hours	8,760	USEPA 2009	

APPENDIX A

TABLE A-16

VALUES USED FOR DAILY INTAKE CALCULATIONS

Joslyn Clark Facility, Lancaster, South Carolina

Scenario Timeframe:	Future
Medium:	Groundwater
Exposure Medium:	Groundwater
Exposure Point:	Vapor in Excavation
Receptor Population:	Construction Worker
Receptor Age:	Adult

Exposure Route	Parameter Code	Parameter Definition	Units	RME Value	RME Rationale/ Reference	Intake Equation/ Model Name
Inhalation	CA	Chemical Concentration in Trench Air	mg/m^3			Exposure Concentration (EC) (mg/m^3) =
	ET	Exposure Time - Outdoor	hr/day	4	Professional Judgment -- assumes 1/2 of the workday may include subsurface activities	(CA x ET x EF x ED)/AT
	EF	Exposure Frequency - Outdoor	days/yr	250	Professional Judgment -- assumes 5 days/week, 50 weeks/year	
	ED	Exposure Duration	yr	1	Professional Judgment -- assumes 1 year construction duration	
	AT_c	Averaging Time for Carcinogens	hours	613,200	USEPA 2009	
	AT_{nc}	Averaging Time for Noncarcinogens	hours	8,760	USEPA 2009	

A box model approach will be used to estimate dispersion of the VOCs within the air in the trench using groundwater concentrations.

APPENDIX A
TABLE A-17
NON-CANCER TOXICITY DATA -- ORAL/DERMAL
Joslyn Clark Facility, Lancaster, South Carolina

Chemical of Potential Concern	Chronic/ Subchronic	Oral RfD Value	Oral RfD	Oral to Dermal Adjustment Factor (1)	Adjusted Dermal RfD (2)	Units	Primary Target Organ	Combined Uncertainty/Modifying Factors	Sources of RfD: Target Organ	Dates of RfD: Target Organ (3)
Volatile Organics										
Acetone	Chronic	9.00E-01	mg/kg-day	100%	9.00E-01	mg/kg-day	Kidney	1000	IRIS	7/31/2003
Chloroform	Chronic	1.00E-02	mg/kg-day	100%	1.00E-02	mg/kg-day	Liver	1000	IRIS	10/19/01
Chloromethane	Chronic	N/A	mg/kg-day	100%	N/A	mg/kg-day	Not Reported	Not Reported	IRIS	07/17/01
1,1-Dichloroethane	Chronic	2.00E-01	mg/kg-day	100%	2.00E-01	mg/kg-day	Not Reported	Not Reported	PPRTV	N/A
1,1-Dichloroethene	Chronic	5.00E-02	mg/kg-day	100%	5.00E-02	mg/kg-day	Liver	100	IRIS	08/13/02
cis-1,2-Dichloroethene	Chronic	2.00E-03	mg/kg-day	100%	2.00E-03	mg/kg-day	Kidney	3000	IRIS	09/30/10
1,4-Dioxane	Chronic	3.00E-02	mg/kg-day	100%	3.00E-02	mg/kg-day	Liver, Kidney	300	IRIS	08/11/10
Methylene chloride	Chronic	6.00E-03	mg/kg-day	100%	6.00E-03	mg/kg-day	Liver	30	IRIS	11/18/11
Tetrachloroethene	Chronic	6.00E-03	mg/kg-day	100%	6.00E-03	mg/kg-day	Liver	1000	IRIS	02/10/12
Toluene	Chronic	8.00E-02	mg/kg-day	100%	8.00E-02	mg/kg-day	Kidney	3000	IRIS	09/23/05
1,1,2-Trichloroethane	Chronic	4.00E-03	mg/kg-day	100%	4.00E-03	mg/kg-day	Liver	1000	IRIS	02/01/95
Trichloroethene	Chronic	5.00E-04	mg/kg-day	100%	5.00E-04	mg/kg-day	Kidney, Heart, Thymus	100	IRIS	09/28/11
Semi-Volatile Organics										
1,2-Dibromo-3-chloropropane	Chronic	2.00E-04	mg/kg-day	100%	2.00E-04	mg/kg-day	Not Reported	Not Reported	PPRTV	N/A
Inorganics										
Aluminum	Chronic	1.00E+00	mg/kg-day	100%	1.00E+00	mg/kg-day	Not Reported	Not Reported	PPRTV	N/A
Antimony	Chronic	4.00E-04	mg/kg-day	15%	6.00E-05	mg/kg-day	Whole Body, Blood	1000	IRIS	01/01/91
Arsenic	Chronic	3.00E-04	mg/kg-day	100%	3.00E-04	mg/kg-day	Skin, vascular system	3	IRIS	02/01/93
Cobalt	Chronic	3.00E-04	mg/kg-day	100%	3.00E-04	mg/kg-day	Not Reported	Not Reported	PPRTV	N/A
Iron	Chronic	7.00E-01	mg/kg-day	100%	7.00E-01	mg/kg-day	Not Reported	Not Reported	PPRTV	N/A
Manganese	Chronic	2.40E-02	mg/kg-day	4%	9.60E-04	mg/kg-day	Nervous system	1	EPA Users Guide	05/01/96
Thallium	Chronic	1.00E-05	mg/kg-day	100%	1.00E-05	mg/kg-day	Nervous system	Not Reported	PPRTV Appendix	09/30/09
Vanadium	Chronic	5.00E-03	mg/kg-day	100%	5.00E-03	mg/kg-day	Not Reported	Not Reported	EPA Users Guide	N/A

(1) Refer to RAGS, Part A
(2) RfD times by the oral to dermal adjustment factor
(3) Toxicity values taken from USEPA Regional Screening Level Table (May 2013).
IRIS = Integrated Risk Information System
N/A = Not Applicable
RfD = Reference Dose

APPENDIX A
TABLE A-18
NON-CANCER TOXICITY DATA -- INHALATION
Joslyn Clark Facility, Lancaster, South Carolina

Chemical of Potential Concern	Chronic/ Subchronic	Value Inhalation RfC	Units	Adjusted Inhalation RfD	Units	Primary Target Organ	Combined Uncertainty/Modifying Factors	Sources of RfC:RfD: Target Organ	Dates (1)
Volatile Organics									
Acetone	Chronic	3.10E+01	mg/m^3	N/A	mg/m^3	Nervous system	100	ATSDR	05/94
Chloroform	Chronic	9.80E-02	mg/m^3	N/A	mg/m^3	Liver	100	ATSDR	09/97
Chloromethane	Chronic	9.00E-02	mg/m^3	N/A	mg/m^3	Brain	1000	IRIS	7/17/2001
1,1-Dichloroethane	Chronic	N/A	mg/m^3	N/A	mg/m^3	N/A	N/A	IRIS	10/01/90
1,1-Dichloroethene	Chronic	2.00E-01	mg/m^3	N/A	mg/m^3	Liver	30	IRIS	08/13/02
cis-1,2-Dichloroethene	Chronic	N/A	mg/m^3	N/A	mg/m^3	N/A	N/A	N/A	09/30/10
1,4-Dioxane	Chronic	1.10E-01	mg/m^3	N/A	mg/m^3	Respiratory System	300	ATSDR	
Methylene chloride	Chronic	6.00E-01	mg/m^3	N/A	mg/m^3	Liver	30	IRIS	11/18/11
Tetrachloroethene	Chronic	4.00E-02	mg/m^3	N/A	mg/m^3	Nervous system	1000	IRIS	02/10/12
Toluene	Chronic	5.00E+00	mg/m^3	N/A	mg/m^3	Nervous system	10	IRIS	09/23/05
1,1,2-Trichloroethane	Chronic	2.00E-04	mg/m^3	N/A	mg/m^3	Not reported	Not reported	PPRTV Appendix	Not reported
Trichloroethene	Chronic	2.00E-03	mg/m^3	N/A	mg/m^3	Thymus/Heart	100	IRIS	09/28/2011
Semi-Volatile Organics									
1,2-Dibromo-3-chloropropane	Chronic	2.00E-04	mg/m^3	N/A	mg/m^3	Testis	1000	IRIS	10/01/91
Inorganics									
Aluminum	Chronic	5.00E-03	mg/m^3	N/A	mg/m^3	Not Reported	Not Reported	PPRTV	N/A
Antimony	Chronic	N/A	mg/m^3	N/A	mg/m^3	N/A	N/A	IRIS	N/A
Arsenic	Chronic	1.50E-05	mg/m^3	N/A	mg/m^3	Cardiovascular, nervous system, development	Not Identified	CalEPA	12/18/08
Cobalt	Chronic	6.00E-06	mg/m^3	N/A	mg/m^3	Not Reported	Not Reported	PPRTV	N/A
Iron	Chronic	N/A	mg/m^3	N/A	mg/m^3	N/A	N/A	N/A	N/A
Manganese	Chronic	5.00E-05	mg/m^3	N/A	mg/m^3	Nervous system	1000	IRIS	12/01/1993
Thallium	Chronic	N/A	mg/m^3	N/A	mg/m^3	N/A	N/A	N/A	09/30/09
Vanadium	Chronic	1.00E-04	mg/m^3	N/A	mg/m^3	Respiratory System	30	ATSDR	

(1) Toxicity values taken from USEPA Regional Screening Level Table (May 2013).
ATSDR = Agency for Toxic Substances and Disease Registry
IRIS = Integrated Risk Information System
N/A = Not Applicable
RfC = Reference Concentration
RfD = Reference Dose

APPENDIX A
TABLE A-19
CANCER TOXICITY DATA -- ORAL/DERMAL
Joslyn Clark Facility, Lancaster, South Carolina

Chemical of Potential Concern	Oral Cancer Slope Factor	Oral to Dermal Adjustment Factor	Adjusted Dermal Cancer Slope Factor (1)	Units	Weight of Evidence/ Cancer Guideline Description	Source	Date (2)
Volatile Organics							
Acetone	N/A	100%	N/A	kg-day/mg	D	IRIS	07/31/03
Chloroform	3.10E-02	100%	3.10E-02	kg-day/mg	B2	CalEPA	12/18/08
Chloromethane	N/A	100%	N/A	kg-day/mg	D	IRIS	7/17/2001
1,1-Dichloroethane	5.70E-03	100%	5.70E-03	kg-day/mg	C	CalEPA	12/18/08
1,1-Dichloroethene	N/A	100%	N/A	kg-day/mg	C	IRIS	08/13/02
cis-1,2-Dichloroethene	N/A	100%	N/A	kg-day/mg	N/A	N/A	09/30/10
1,4-Dioxane	1.00E-01	100%	1.00E-01	kg-day/mg	N/A	IRIS	08/11/10
Methylene chloride	2.00E-03	100%	2.00E-03	kg-day/mg	B2	IRIS	11/18/11
Tetrachloroethene	2.10E-03	100%	2.10E-03	kg-day/mg	B2	IRIS	02/10/12
Toluene	N/A	100%	N/A	kg-day/mg	D	IRIS	09/23/05
1,1,2-Trichloroethane	5.70E-02	100%	5.70E-02	kg-day/mg	C	IRIS	02/01/94
Trichloroethene	4.60E-02	100%	4.60E-02	kg-day/mg	B2	IRIS	09/28/2011
Semi-Volatile Organics							
1,2-Dibromo-3-chloropropane	8.00E-01	100%	8.00E-01	kg-day/mg	N/A	PPRTV	N/A
Inorganics							
Aluminum	N/A	100%	N/A	kg-day/mg	D	N/A	N/A
Antimony	N/A	15%	N/A	kg-day/mg	D	IRIS	N/A
Arsenic	1.50E+00	100%	1.50E+00	kg-day/mg	A	IRIS	04/10/98
Cobalt	N/A	N/A	N/A	kg-day/mg	D	N/A	08/01/91
Iron	N/A	N/A	N/A	kg-day/mg	C	N/A	N/A
Manganese	N/A	4%	N/A	kg-day/mg	D	N/A	12/01/96
Thallium	N/A	N/A	N/A	kg-day/mg	C	N/A	09/30/09
Vanadium	N/A	N/A	N/A	kg-day/mg	D	N/A	05/01/95

(1) Slope factor divided by the oral to dermal adjustment factor
(2) Toxicity values taken from USEPA Regional Screening Level Table (May 2013).

CalEPA = California EPA
IRIS = Integrated Risk Information System
N/A = Not Applicable

EPA Group:
A - Human carcinogen
B1 - Probable human carcinogen - indicates that limited human data are available
B2 - Probable human carcinogen - indicates sufficient evidence in animals and inadequate or no evidence in humans
C - Possible human carcinogen
D - Not classifiable as a human carcinogen
E - Evidence of noncarcinogenicity

APPENDIX A

TABLE A-20

CANCER TOXICITY DATA -- INHALATION

Joslyn Clark Facility, Lancaster, South Carolina

Chemical of Potential Concern	Unit Risk	Units	Adjustment	Inhalation Cancer Slope Factor	Units	Weight of Evidence/ Cancer Guideline Description	Source	Date (1)
Volatile Organics								
Acetone	N/A	m^3/mg	N/A	N/A	m^3/mg	D	IRIS	07/31/03
Chloroform	2.30E-05	m^3/mg	N/A	N/A	m^3/mg	B2	IRIS	12/18/08
Chloromethane	N/A	m^3/mg	N/A	N/A	m^3/mg	D	IRIS	7/17/2001
1,1-Dichloroethane	1.60E-06	m^3/mg	N/A	N/A	m^3/mg	C	CalEPA	12/18/08
1,1-Dichloroethene	N/A	m^3/mg	N/A	N/A	m^3/mg	C	IRIS	08/13/02
cis-1,2-Dichloroethene	N/A	m^3/mg	N/A	N/A	m^3/mg	N/A	N/A	09/30/10
1,4-Dioxane	7.70E-06	m^3/mg	N/A	N/A	m^3/mg	N/A	CalEPA	08/11/10
Methylene chloride	1.00E-08	m^3/mg	N/A	N/A	m^3/mg	B2	IRIS	11/18/11
Tetrachloroethene	2.60E-07	m^3/mg	N/A	N/A	m^3/mg	B2	IRIS	02/10/12
Toluene	N/A	m^3/mg	N/A	N/A	m^3/mg	D	IRIS	09/23/05
1,1,2-Trichloroethane	1.60E-05	m^3/mg	N/A	N/A	m^3/mg	C	IRIS	02/01/94
Trichloroethene	4.10E-06	m^3/mg	N/A	N/A	m^3/mg	B2	IRIS	09/28/2011
Semi-Volatile Organics		m^3/mg						
1,2-Dibromo-3-chloropropane	6.00E-03	m^3/mg	N/A	N/A	m^3/mg	N/A	PPRTV	N/A
Inorganics								
Aluminum	N/A	m^3/mg	N/A	N/A	m^3/mg	D	N/A	N/A
Antimony	N/A	m^3/mg	N/A	N/A	m^3/mg	D	N/A	N/A
Arsenic	4.30E-03	m^3/mg	N/A	N/A	m^3/mg	A	IRIS	04/10/98
Cobalt	9.00E-03	m^3/mg	N/A	N/A	m^3/mg	D	PPRTV	08/01/91
Iron	N/A	m^3/mg	N/A	N/A	m^3/mg	C	N/A	N/A
Manganese	N/A	m^3/mg	N/A	N/A	m^3/mg	D	N/A	12/01/96
Thallium	N/A	m^3/mg	N/A	N/A	m^3/mg	C	N/A	09/30/09
Vanadium	N/A	m^3/mg	N/A	N/A	m^3/mg	D	N/A	05/01/95

(1) Toxicity values taken from USEPA Regional Screening Level Table (May 2013).

CalEPA = California EPA

IRIS = Integrated Risk Information System

N/A = Not Applicable

EPA Group:

- A - Human carcinogen
- B1 - Probable human carcinogen - indicates that limited human data are available
- B2 - Probable human carcinogen - indicates sufficient evidence in animals and inadequate or no evidence in humans
- C - Possible human carcinogen
- D - Not classifiable as a human carcinogen
- E - Evidence of noncarcinogenicity

APPENDIX A
TABLE A-21
CALCULATION OF NON-CANCER HAZARDS
Joslyn Clark Facility, Lancaster, South Carolina

Scenario Timeframe:	Current/Future
Medium:	Soil
Exposure Medium:	Soil - 0-20 feet
Exposure Point:	Soil
Receptor Population:	Site/Maintenance Worker
Receptor Age:	Adult

Exposure Route	Chemical of Potential Concern	Medium EPC Value	Medium EPC Units	Route EPC Value	Route EPC Units	EPC Selected for Hazard Calculation (1)	Intake (Non-Cancer)	Intake (Non-Cancer) Units	Reference Dose	Reference Dose Units	Hazard Quotient
Current/Future Land Use - Site Soil											
Ingestion	Thallium	3.3E+00	mg/kg	3.3E+00	mg/kg	M	3.2E-07	mg/kg-day	1.0E-05	mg/kg-day	3E-02
	(Total)										**3E-02**
Dermal	Thallium	3.3E+00	mg/kg	3.3E+00	mg/kg	M	0.0E+00	mg/kg-day	1.0E-05	mg/kg-day	- -
	(Total)										**0E+00**
				Total Hazard Index for Ingestion and Dermal Contact Exposure Routes/Pathways at Future Site Soil =							**3E-02**

(1) Medium-Specific (M) EPC selected for hazard calculation.
N/A - Not applicable

Dermal Absorption Factors: Reference: *USEPA RAGS Part E, July 2004*

Thallium 0%

APPENDIX A
TABLE A-22
CALCULATION OF CANCER RISKS
Joslyn Clark Facility, Lancaster, South Carolina

Scenario Timeframe:	Current/Future
Medium:	Soil
Exposure Medium:	Soil - 0-20 feet
Exposure Point:	Soil
Receptor Population:	Site/Maintenance Worker
Receptor Age:	Adult

Exposure Route	Chemical of Potential Concern	Medium EPC Value	Medium EPC Units	Route EPC Value	Route EPC Units	EPC Selected for Hazard Calculation (1)	Intake (Cancer)	Intake (Cancer) Units	Cancer Slope Factor	Cancer Slope Factor Units	Cancer Risk
Current/Future Land Use - Site Soil											
Ingestion	Thallium	3.3E+00	mg/kg	3.3E+00	mg/kg	M	1.2E-07	mg/kg-day	N/A	mg/kg-day	- -
	(Total)										**0E+00**
Dermal	Thallium	3.3E+00	mg/kg	3.3E+00	mg/kg	M	0.0E+00	mg/kg-day	N/A	mg/kg-day	- -
	(Total)										**0E+00**
					Total Cancer Risk for Ingestion and Dermal Contact Exposure Routes/Pathways at Future Site Soil =						**0E+00**

(1) Medium-Specific (M) EPC selected for risk calculation.
N/A - Not applicable

Dermal Absorption Factors: Reference: *USEPA RAGS Part E, July 2004*

Thallium 0%

APPENDIX A
TABLE A-23
CALCULATION OF NON-CANCER HAZARDS
Joslyn Clark Facility, Lancaster, South Carolina

Scenario Timeframe:	Current/Future
Medium:	Soil
Exposure Medium:	Soil - 0-20 feet
Exposure Point:	Soil
Receptor Population:	Site/Maintenance Worker
Receptor Age:	Adult

Exposure Route	Chemical of Potential Concern	Medium EPC Value	Medium EPC Units	Route EPC Value	Route EPC Units	EPC Selected for Hazard Calculation (1)	Intake (Non-Cancer)	Intake (Non-Cancer) Units	Reference Concentration	Reference Concentration Units	Hazard Quotient
Current/Future Land Use - Site Soil											
Inhalation	Thallium	3.3E+00	mg/kg	3.3E+00	mg/m^3	R	6.7E-03	mg/m^3	N/A	mg/m^3	--
	(Total)										**0E+00**
			Total Hazard Index for Inhalation Exposure Routes/Pathways at Future Site Soil =								**0E+00**

(1) Route-Specific (R) EPC selected for hazard calculation. See Table A-9 for route-specific EPC.

N/A - Not applicable

APPENDIX A

TABLE A-24

CALCULATION OF CANCER RISKS

Joslyn Clark Facility, Lancaster, South Carolina

Scenario Timeframe:	Current/Future
Medium:	Soil
Exposure Medium:	Soil - 0-20 feet
Exposure Point:	Soil
Receptor Population:	Site/Maintenance Worker
Receptor Age:	Adult

Exposure Route	Chemical of Potential Concern	Medium EPC Value	Medium EPC Units	Route EPC Value	Route EPC Units	EPC Selected for Hazard Calculation (1)	Intake (Cancer)	Intake (Cancer) Units	Inhalation Unit Risk (IUR) Concentration	IUR Concentration Units	Cancer Risk
Current/Future Land Use - Site Soil											
Inhalation	Thallium	3.3E+00	mg/kg	3.3E+00	mg/m^3	R	6.7E-03	mg/m^3	N/A	mg/m^3	- -
	(Total)										**0E+00**
					Total Cancer Risk for Inhalation Exposure Pathways at Future Developed Area =						**0E+00**

(1) Route-Specific (R) EPC selected for risk calculation. See Table A-9 for route-specific EPC.

N/A - Not applicable

APPENDIX A

TABLE A-25

CALCULATION OF NON-CANCER RISK

Joslyn Clark Facility, Lancaster, South Carolina

Scenario Timeframe:	Future
Medium:	Groundwater
Exposure Medium:	Groundwater
Exposure Point:	Air - Indoor
Receptor Population:	Facility Worker
Receptor Age:	Adult

Exposure Route	Chemical of Potential Concern	Groundwater Concentration (GW_{conc})	Medium EPC Units	Non-Carcinogenic Target Groundwater Concentration (1)	Medium EPC Units	Hazard Quotient
Future Office Building						
Inhalation	Chloroform	8.40E-01	ug/L	2.87E+03	ug/L	2.93E-04
	1,1-Dichloroethane	2.36E+01	ug/L	NA	ug/L	N/A
	Tetrachloroethene	2.01E+01	ug/L	2.49E+02	ug/L	8.10E-02
	Trichloroethylene	1.34E+03	ug/L	2.19E+01	ug/L	6.13E+01
Total Risk for Inhalation of Vapors from Groundwater =						**6.14E+01**

(1) Route-Specific (R) EPC selected for risk calculation. See Table A-10 for route-specific EPC.

Target indoor air and target groundwater concentrations are set to equal a cancer risk of 1x10-6 and hazard quotient of 1.0.

Hazard Quotient = GW_{conc} x Target Risk / Carcinogenic Target Groundwater Concentration

APPENDIX A

TABLE A-26

CALCULATION OF CANCER RISK

Joslyn Clark Facility, Lancaster, South Carolina

Scenario Timeframe:	Future
Medium:	Groundwater
Exposure Medium:	Groundwater
Exposure Point:	Air - Indoor
Receptor Population:	Facility Worker
Receptor Age:	Adult

Exposure Route	Chemical of Potential Concern	Groundwater Concentration (GW_{conc})	Medium EPC Units	Carcinogenic Target Groundwater Concentration (1)	Medium EPC Units	Cancer Risk
Future Office Building						
Inhalation	Chloroform	8.40E-01	ug/L	3.53E+00	ug/L	2.38E-07
	1,1-Dichloroethane	2.36E+01	ug/L	3.35E+01	ug/L	7.04E-07
	Tetrachloroethene	2.01E+01	ug/L	6.50E+01	ug/L	3.10E-07
	Trichloroethylene	1.34E+03	ug/L	7.45E+00	ug/L	1.80E-04
Total Risk for Inhalation of Vapors from Groundwater =						**1.8E-04**

(1) Route-Specific (R) EPC selected for risk calculation. See Table A-10 for route-specific EPC.

Target indoor air and target groundwater concentrations are set to equal a cancer risk of 1x10-6 and hazard quotient of 1.0.

Carcinogenic Risk = GW_{conc} x Target Risk / Carcinogenic Target Groundwater Concentration

APPENDIX A

TABLE A-27

CALCULATION OF NON-CANCER HAZARDS

Joslyn Clark Facility, Lancaster, South Carolina

Scenario Timeframe:	Future
Medium:	Soil
Exposure Medium:	Soil - 0-20 feet
Exposure Point:	Soil
Receptor Population:	Construction Worker
Receptor Age:	Adult

Exposure Route	Chemical of Potential Concern	Medium EPC Value	Medium EPC Units	Route EPC Value	Route EPC Units	EPC Selected for Hazard Calculation (1)	Intake (Non-Cancer)	Intake (Non-Cancer) Units	Reference Dose	Reference Dose Units	Hazard Quotient
Future Land Use - Site Soil											
Ingestion	Thallium	3.3E+00	mg/kg	3.3E+00	mg/kg	M	1.5E-05	mg/kg-day	1.0E-05	mg/kg-day	2E+00
	(Total)										**2E+00**
Dermal	Thallium	3.3E+00	mg/kg	3.3E+00	mg/kg	M	0.0E+00	mg/kg-day	1.0E-05	mg/kg-day	- -
	(Total)										**0E+00**
Total Hazard Index for Ingestion and Dermal Contact Exposure Routes/Pathways at Future Site Soil =											**2E+00**

(1) Medium-Specific (M) EPC selected for hazard calculation.

N/A - Not applicable

Dermal Absorption Factors: Reference: *USEPA RAGS Part E, July 2004*

Thallium 0%

APPENDIX A
TABLE A-28
CALCULATION OF CANCER RISKS
Joslyn Clark Facility, Lancaster, South Carolina

Scenario Timeframe:	Future
Medium:	Soil
Exposure Medium:	Soil - 0-20 feet
Exposure Point:	Soil
Receptor Population:	Construction Worker
Receptor Age:	Adult

Exposure Route	Chemical of Potential Concern	Medium EPC Value	Medium EPC Units	Route EPC Value	Route EPC Units	EPC Selected for Hazard Calculation (1)	Intake (Cancer)	Intake (Cancer) Units	Cancer Slope Factor	Cancer Slope Factor Units	Cancer Risk
Future Land Use - Site Soil											
Ingestion	Thallium	3.3E+00	mg/kg	3.3E+00	mg/kg	M	2.2E-07	mg/kg-day	N/A	mg/kg-day	- -
	(Total)										**0E+00**
Dermal	Thallium	3.3E+00	mg/kg	3.3E+00	mg/kg	M	0.0E+00	mg/kg-day	N/A	mg/kg-day	- -
	(Total)										**0E+00**
					Total Cancer Risk for Ingestion and Dermal Contact Exposure Routes/Pathways at Future Site Soil =						**0E+00**

(1) Medium-Specific (M) EPC selected for risk calculation.

N/A - Not applicable

Dermal Absorption Factors: Reference: *USEPA RAGS Part E, July 2004*

Thallium 0%

APPENDIX A

TABLE A-29

CALCULATION OF NON-CANCER HAZARDS

Joslyn Clark Facility, Lancaster, South Carolina

Scenario Timeframe:	Future
Medium:	Soil
Exposure Medium:	Soil - 0-20 feet
Exposure Point:	Air - Outdoor
Receptor Population:	Construction Worker
Receptor Age:	Adult

Exposure Route	Chemical of Potential Concern	Medium EPC Value	Medium EPC Units	Route EPC Value	Route EPC Units	EPC Selected for Hazard Calculation (1)	Intake (Non-Cancer)	Intake (Non-Cancer) Units	Reference Concentration	Reference Concentration Units	Hazard Quotient
Future Land Use - Site Soil											
Inhalation	Thallium	3.3E+00	mg/kg	3.3E+00	mg/m^3	R	7.5E-01	mg/m^3	N/A	mg/m^3	- -
	(Total)										**0E+00**
			Total Hazard Index for Inhalation Exposure Routes/Pathways at Future Site Soil =								**0E+00**

(1) Route-Specific (R) EPC selected for hazard calculation. See Table A-9 for route-specific EPC.

N/A - Not applicable

APPENDIX A

TABLE A-30

CALCULATION OF CANCER RISKS

Joslyn Clark Facility, Lancaster, South Carolina

Scenario Timeframe:	Future
Medium:	Soil
Exposure Medium:	Soil - 0-20 feet
Exposure Point:	Air - Outdoor
Receptor Population:	Construction Worker
Receptor Age:	Adult

Exposure Route	Chemical of Potential Concern	Medium EPC Value	Medium EPC Units	Route EPC Value	Route EPC Units	EPC Selected for Hazard Calculation (1)	Intake (Cancer)	Intake (Cancer) Units	Inhalation Unit Risk (IUR) Concentration	IUR Concentration Units	Cancer Risk
Future Land Use - Site Soil											
Inhalation	Thallium	3.3E+00	mg/kg	3.3E+00	mg/m^3	R	1.1E-02	mg/m^3	N/A	mg/m^3	- -
	(Total)										**0E+00**
Total Cancer Risk for Inhalation Exposure Routes/Pathways at Future Site Soil =											**0E+00**

(1) Route-Specific (R) EPC selected for hazard calculation. See Table A-9 for route-specific EPC.

N/A - Not applicable

APPENDIX A

TABLE A-31

CALCULATION OF NON-CANCER HAZARDS

Joslyn Clark Facility, Lancaster, South Carolina

Scenario Timeframe:	Future
Medium:	Ground Water
Exposure Medium:	Vapor in trench
Exposure Point:	Air-Outdoor
Receptor Population:	Construction Worker
Receptor Age:	Adult

Exposure Route	Chemical of Potential Concern	Medium EPC Value (1)	Medium EPC Units	Route EPC Value	Route EPC Units	EPC Selected for Hazard Calculation (2)	Intake (Non-Cancer)	Intake (Non-Cancer) Units	Reference Concentration	Reference Concentration Units	Hazard Quotient
Inhalation	Acetone	3.11E-03	mg/L	1.64E-07	mg/m^3	R	1.9E-08	mg/m^3	3.1E+01	mg/m^3	6.0E-10
	Chloroform	8.40E-04	mg/L	1.95E-07	mg/m^3	R	2.2E-08	mg/m^3	9.8E-02	mg/m^3	2.3E-07
	Chloromethane	5.20E-04	mg/L	1.90E-07	mg/m^3	R	2.2E-08	mg/m^3	9.0E-02	mg/m^3	2.4E-07
	1,1-Dichloroethane	2.36E-02	mg/L	6.12E-06	mg/m^3	R	7.0E-07	mg/m^3	N/A	mg/m^3	--
	1,1-Dichloroethene	2.90E-02	mg/L	7.78E-06	mg/m^3	R	8.9E-07	mg/m^3	2.0E-01	mg/m^3	4.4E-06
	cis-1,2-Dichloroethene	4.44E-02	mg/L	1.15E-05	mg/m^3	R	1.3E-06	mg/m^3	N/A	mg/m^3	--
	1,4-Dioxane	8.50E-04	mg/L	6.14E-09	mg/m^3	R	7.0E-10	mg/m^3	1.1E-01	mg/m^3	6.4E-09
	Methylene chloride	1.70E-03	mg/L	4.65E-07	mg/m^3	R	5.3E-08	mg/m^3	6.0E-01	mg/m^3	8.8E-08
	Tetrachloroethene	2.01E-02	mg/L	4.12E-06	mg/m^3	R	4.7E-07	mg/m^3	4.0E-02	mg/m^3	1.2E-05
	Toluene	3.40E-04	mg/L	9.18E-08	mg/m^3	R	1.0E-08	mg/m^3	5.0E+00	mg/m^3	2.1E-09
	1,1,2-Trichloroethane	6.50E-03	mg/L	1.24E-06	mg/m^3	R	1.4E-07	mg/m^3	2.0E-04	mg/m^3	7.1E-04
	Trichloroethene	1.34E+00	mg/L	3.06E-04	mg/m^3	R	3.5E-05	mg/m^3	2.0E-03	mg/m^3	1.7E-02
	(Total)										**1.7E-05**
							Total Hazard Index Across All Exposure Routes/Pathways				**1.7E-05**

(1) All detected volatile organic cosntituents retained for evaluation.

(1) Route-Specific (R) EPC selected for hazard calculation.

APPENDIX A

TABLE A-32

CALCULATION OF CANCER RISKS

Joslyn Clark Facility, Lancaster, South Carolina

Scenario Timeframe:	Future
Medium:	Ground Water
Exposure Medium:	Vapor in trench
Exposure Point:	Air-Outdoor
Receptor Population:	Construction Worker
Receptor Age:	Adult

Exposure Route	Chemical of Potential Concern	Medium EPC Value (1)	Medium EPC Units	Route EPC Value	Route EPC Units	EPC Selected for Hazard Calculation (2)	Intake (Cancer)	Intake (Cancer) Units	Inhalation Unit Risk (IUR) Concentration	IUR Concentration Units	Cancer Risk
Inhalation	Acetone	3.11E-03	mg/L	1.64E-07	mg/m^3	R	2.7E-10	mg/m^3	N/A	m^3/mg	--
	Chloroform	8.40E-04	mg/L	1.95E-07	mg/m^3	R	3.2E-10	mg/m^3	2.30E-05	m^3/mg	7.3E-12
	Chloromethane	5.20E-04	mg/L	1.90E-07	mg/m^3	R	3.1E-10	mg/m^3	N/A	m^3/mg	--
	1,1-Dichloroethane	2.36E-02	mg/L	6.12E-06	mg/m^3	R	1.0E-08	mg/m^3	1.60E-06	m^3/mg	1.6E-11
	1,1-Dichloroethene	2.90E-02	mg/L	7.78E-06	mg/m^3	R	1.3E-08	mg/m^3	N/A	m^3/mg	--
	cis-1,2-Dichloroethene	4.44E-02	mg/L	1.15E-05	mg/m^3	R	1.9E-08	mg/m^3	N/A	m^3/mg	--
	1,4-Dioxane	8.50E-04	mg/L	6.14E-09	mg/m^3	R	1.0E-11	mg/m^3	7.70E-06	m^3/mg	7.7E-14
	Methylene chloride	1.70E-03	mg/L	4.65E-07	mg/m^3	R	7.6E-10	mg/m^3	1.00E-08	m^3/mg	7.6E-15
	Tetrachloroethene	2.01E-02	mg/L	4.12E-06	mg/m^3	R	6.7E-09	mg/m^3	2.60E-07	m^3/mg	1.7E-12
	Toluene	3.40E-04	mg/L	9.18E-08	mg/m^3	R	1.5E-10	mg/m^3	N/A	m^3/mg	--
	1,1,2-Trichloroethane	6.50E-03	mg/L	1.24E-06	mg/m^3	R	2.0E-09	mg/m^3	1.60E-05	m^3/mg	3.2E-11
	Trichloroethene	1.34E+00	mg/L	3.06E-04	mg/m^3	R	5.0E-07	mg/m^3	4.10E-06	m^3/mg	2.0E-09
	(Total)										**2.1E-09**
											2.1E-09

(1) All detected volatile organic cosntituents retained for evaluation.

(1) Route-Specific (R) EPC selected for hazard calculation.