# HUMAN HEALTH
# BASELINE RISK ASSESSMENT

## PerkinElmer Missouri Metals Site
## Overland, Missouri

prepared for

## PerkinElmer, Inc.

January 2006

Burns & McDonnell Project No. 26682

prepared by

## Burns & McDonnell Engineering Company, Inc.
## St. Louis, Missouri

FILE

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|---|---|
| bgs | Below Ground Surface |
| COPC | Chemical of Potential Concern |
| DCE | Dichloroethylene |
| HEAST | Health Effects Assessment Summary Tables |
| IRIS | Integrated Risk Information System |
| LOAELs | Lowest Observed Adverse Effect Levels |
| MDNR | Missouri Department of Natural Resources |
| MFs | Modifying Factors |
| MMSC | Missouri Metals Shaping Company |
| MDoH | Missouri Department of Health |
| NCI | National Cancer Institute |
| NOAELs | No Observed Adverse Effect Levels |
| OEHHA | California Office of Environmental Health Hazard Analysis |
| PCE | Tetrachloroethylene |
| PRG | Preliminary Remediation Goal |
| RAE | Remedial Alternatives Evaluation |
| RAGS | Risk Assessment Guidance for Superfund |
| RAP | Remedial Action Plan |
| RASR | Remedial Action Summary Report |
| RfC | Reference Concentration |
| RfD | Reference Dose |
| RI | Remedial Investigation |
| RME | Reasonable Maximum Exposure |
| TCE | Trichloroethylene |
| UCL | Upper Confidence Limit |
| UFs | Uncertainty Factors |
| USEPA | United States Environmental Protection Agency |
| VC | Vinyl Chloride |
| VOCs | Volatile Organic Compounds |

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# 1.0 INTRODUCTION

Burns & McDonnell has prepared this human health baseline risk assessment for PerkinElmer, Inc.'s (PerkinElmer) Missouri Metals Site (Site) located in Overland, Missouri. The scope of the risk assessment was discussed in the Remedial Action Summary Report (RASR) for the Site (Burns & McDonnell, 2005), and in subsequent discussions with Missouri Department of Natural Resources (MDNR) personnel regarding the path forward for the Site.

As required by the Consent Agreement for the Site signed in August 1994, and re-affirmed by MDNR's letter dated June 16, 2005, this risk assessment has been prepared following procedures outlined in the United States Environmental Protection Agency's (USEPA's) *Risk Assessment Guidance for Superfund (RAGS) Volume 1: Human Health Evaluation Manual Part A* (USEPA, 1989) and other USEPA supplemental guidance documents referenced throughout the text.

## 1.1 PURPOSE

The purpose of the evaluation is twofold: to conduct a baseline evaluation of potential human health risks that might be experienced by human exposures to contaminated media associated with the Site, and to determine clean-up levels for on-Site soil and groundwater. The risk assessment was conducted under the assumption that no further remediation beyond that already conducted will take place at the Site. All available on-Site soil and groundwater data will be evaluated to determine if the existing MDNR-established clean-up levels for soil and groundwater listed in the Consent Agreement will be used or if alternate Site-specific preliminary remediation goals (PRGs) will be proposed based on Site-specific data. The clean-up levels determined by this Risk Evaluation will be used to focus any additional on-Site remedial activities.

## 1.2 ORGANIZATION

This human health baseline risk assessment is organized into the following sections:

- Introduction (Section 1.0) - The first section states the purpose of the risk assessment and explains the report organization.
- Site Background (Section 2.0) - This section presents current Site conditions and descriptions, as well as previous investigation results.
- Identification of Chemicals of Potential Concern (COPCs) (Section 3.0) - This section reviews analytical data collected at the Site and identifies media of concern and COPCs.

- Toxicity Assessment (Section 4.0) - General noncancer and cancer toxicities for COPCs are discussed and toxicity values for quantifying risks are presented in this section.

- Exposure Assessment (Section 5.0) - This section considers current and potential future land and water uses to identify possible receptor populations and potentially completed exposure pathways. Exposure point concentrations are estimated from available analytical data and/or the results of contaminant transport modeling. Chemical dose to receptors is then quantified using standard intake calculations.

- Risk Characterization (Section 6.0) - The risk characterization section evaluates the possible nature and magnitude of health risks associated with the Site. Theoretical cancer risks and the likelihood of noncancer adverse health effects are quantified by combining calculated chemical dose with chemical toxicity information. The results are then compared to accepted levels of risk. Uncertainties inherent in the process are also described in this section.

- Section 7.0 discusses the calculation of PRGs.

- Section 8.0 presents conclusions and recommendations based on the baseline risk assessment results.

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# 2.0 SITE BACKGROUND

This section describes background information on the Site collected as part of investigation and remediation activities at the Site.

## 2.1 SITE LOCATION AND DESCRIPTION

The Site is located at 9970 Page Avenue in Overland, Missouri (Figure 2-1), near the center of Section 31, Township 46 North, Range 6 East in St. Louis County, Missouri. The property area is approximately 3.5 acres located in an area that is primarily commercial and/or light industrial. An area of residential development is located southeast of the Site, across Meeks Boulevard. Structures on the property consist of two manufacturing buildings and two metal storage buildings (Figure 2-2).

The Site is located in an area of rolling hills, with the northwest corner of the property approximately 15 feet higher than the southeast corner. The majority of the ground surface, approximately 90 percent, is paved with asphalt or concrete (Figure 2-2) with small areas of grass, gravel and bare soil present in portions of the property.

A public water supply system is available at the Site and the surrounding area. The City of Overland is served by the St. Louis County Water Company which draws water from surface water sources, namely the Meremac and the Missouri Rivers.

Initial industrial activities on the Site began in 1957 and were conducted by Missouri Metals Shaping Company (MMSC). In 1979 the property and business were purchased from MMSC by Alco Standard Corporation – Aerospace Division. In 1988 the property and business were purchased by EG&G KT Aerofab, which was subsequently acquired by PerkinElmer, Inc. In 2001, the business was purchased by Missouri Metals, LLC, with the property retained by PerkinElmer, Inc. and leased to Missouri Metals, LLC. As in the past, the facility currently fabricates aircraft components, with manufacturing activities generally consisting of forming and finishing aircraft components from stock metals.

## 2.2 SITE GEOLOGY AND HYDROGEOLOGY

The geology underlying the Site consists of unconsolidated overburden above sedimentary bedrock from the Pennsylvanian system. The overburden is composed of fill and windblown glacial clays and silt (loess). The fill ranges from 3 to 5 feet in thickness, but is not continuous beneath the Site (Burns & McDonnell, 1992). The loess unit ranges in thickness from approximately 20 to 25 feet below ground surface (bgs) at the Site. Drilling activities during investigation and remediation activities indicate that the loess is dry to approximately 15 feet bgs. Laboratory triaxial permeability tests conducted on representative samples of the loess indicate that the hydraulic conductivity of this native soil is in the range of 1.0 x $10^{-6}$ to 3.0 x $10^{-7}$ cm/sec (Burns & McDonnell, 1992). The laboratory reports are supported by pump test observations at wells screened in different portions of the loess soil layer (Burns & McDonnell, 1992), as well as injection rates during remediation activities (Burns & McDonnell, 2005). The low permeability of the loess suggests that horizontal groundwater flow is limited, and that vertical flow is the dominant flow path for groundwater within this unit.

The upper bedrock consists of siltstone, with minor shale and sandstone layers, that is approximately 20 feet thick. The upper few feet of this unit, at the interface with the loess, is weathered. Results from pumping tests and field permeability tests on monitoring wells screened in the siltstone bedrock indicate that hydraulic conductivity ranges from approximately $10^{-3}$ to $10^{-4}$ cm/sec (Burns & McDonnell, 1992), with the highest conductivity at the loess/siltstone interface. This bedrock unit is separated from the shallow aquifer in the area (Upper Mississippian) by approximately 150 feet of Pennsylvanian age shale and limestone that acts as an aquitard preventing further vertical migration. Groundwater within the loess and upper bedrock in the area of the Site is considered to be perched water, and is not connected to the deeper bedrock aquifer below (Burns & McDonnell, 1992).

Depth to water at the Site ranges from approximately 5 to 15 feet bgs (Table 2-1). The loess unit is semi-confined and the siltstone unit is confined. Groundwater flow is generally to the southeast (Figure 2-3), with some local influence by on-Site utilities (sewer near GMW-5 & 17, and utility corridor near GMW-6. Horizontal groundwater flow beneath the Site occurs primarily in the siltstone bedrock and overlying weathered siltstone interface due to the higher permeability of this unit compared to the overlying loess. This is supported by the results of the pump tests conducted at the Site (Burns & McDonnell, 1992), and injection activities as part of remediation (Burns & McDonnell, 2005).

## 2.3 SUMMARY OF PREVIOUS INVESTIGATIONS

Data obtained from past soil and groundwater investigations suggests that historical releases of solvents, primarily tetrachloroethylene (PCE) and trichloroethylene (TCE), into the soil and groundwater have occurred at the Site. These solvents were previously used at the Site, but are no longer used. Written records on plant chemical usage and waste disposal practices for this facility are limited. No facility spill reports are available concerning historical release information, such as location or date of releases (Burns & McDonnell, 1992).

Based on Site investigations, there are two known source areas of contamination on-Site. These source areas are the former degreasing pit area and the former drum storage area (see Figure 2-2). Elevated levels of PCE, TCE, and their daughter products [dichloroethylene (DCE) and vinyl chloride] have been detected in the soil and groundwater in these areas, and this data was summarized in the Remedial Investigation (RI) report submitted to MDNR in 1992 (Burns & McDonnell, 1992). Soil impacts are limited in extent and difficult to access due to on-going facility operations. However, groundwater impacts are more wide-spread and have resulted in off-Site impacts.

PerkinElmer, Inc. entered into a Consent Agreement with MDNR in 1994 to facilitate the development and implementation of a remedial action plan (RAP) for the Site. As dictated by the Consent Agreement, a five-year groundwater monitoring period of on-Site monitoring wells was conducted from 1994 through 1998. In addition, from 1998 through 2001, various off-Site investigations were conducted by MDNR (MDNR, 2001) and Burns & McDonnell (Burns & McDonnell, 1999, 2000, and 2001b) to determine the off-Site extent (vertical and horizontal) of groundwater contamination from the Site, and any impacts to nearby residents via indoor air or sump water. The off-Site results indicated that significant impacts in the shallow overburden (the unit with potential impact on nearby residents) were limited to areas in close proximity to the Site.

Based on the results of the on-Site monitoring and the off-Site investigations, a revised Remedial Alternatives Evaluation (RAE) was prepared for the Site (Burns & McDonnell, 2001a). The remediation goals were focused on alternatives that were capable of treating the on-Site source areas of groundwater contamination and preventing further off-Site migration of impacted groundwater. Three remedial alternatives for treating on-Site groundwater were evaluated in the RAE, and chemical oxidation was selected as the recommended remedial alternative. Chemical oxidation with permanganate was chosen on the basis of cost, feasibility, and length of time required for remediation (Burns & McDonnell, 2001a).

Burns & McDonnell performed a chemical oxidation treatability study and pilot test at the Site during 2001 to evaluate the effectiveness of the oxidant and delivery methods. The effectiveness of the oxidant was determined by monitoring performance parameters during the pilot test and by comparing pre- and post-pilot test groundwater analytical data. The results of the pilot test indicated that chemical oxidation with permanganate could successfully treat the contaminated groundwater at the Site (Burns & McDonnell, March 2002).

In 2002, a RAP was prepared that included the full-scale design and implementation plan for the Site (Burns & McDonnell, October 2002). The results from the treatability study and pilot test were used to finalize the full-scale design of the chemical oxidation treatment system for the Site.

Burns & McDonnell implemented the RAP during 2003 and 2004. During implementation of the RAP, permanganate was injected via injections wells, fractures, and an injection trench near the former degreasing pit. The results of the RAP implementation were summarized in the Remedial Action Summary Report (RASR) submitted to Missouri Department of Natural Resources (MDNR) in March 2005 (Burns & McDonnell, 2005)

The RASR outlined a series of proposed activities at the Site for 2005. Burns & McDonnell has implemented those proposed activities that have been approved by MDNR. The activities that have been implemented include regenerating the injection trench with additional permanganate, water injection in the former drum storage area to enhance advective movement of permanganate in this area, and preparation of this baseline risk assessment.

## 2.4 SUMMARY OF NATURE AND EXTENT OF CONTAMINATION

As discussed above in Section 2.3, the COPCs at the Site are PCE, TCE, and their daughter products [DCE (total) and vinyl chloride]. Also, there are two known source areas of contamination on-Site, the former degreasing pit area and the former drum storage area (see Figure 2-2).

Surface and subsurface soil samples were collected during the late 1980's and early 1990's to define the extent of on-Site soil contamination. This data was summarized in the RI report (Burns & McDonnell, 1992). Figure 2-4 shows the soil sampling locations, and Table 2-2 summarizes the soil analytical data. In general, wide-spread soil contamination was not detected and significantly impacted soil areas were limited in extent. Because of this, it is believed that any remaining soil source areas are no longer significantly contributing to the impacted groundwater beneath the Site.

Groundwater samples have been collected from on-Site monitoring wells since the late 1980's. Table 2-3 provides a summary of recent groundwater analytical data from on-Site monitoring wells and two off-Site monitoring wells located directly across the street from the Site (see Figure 2-2). Monitoring wells have been completed within the shallow loess, the siltstone, and the loess/siltstone interface to define the vertical and horizontal extent of impact (see Figure 2-2). The data indicates that the most significant impacts are immediately downgradient of the two source areas, with the highest levels within the interface between the loess and siltstone units (GMW-14 & 15). This interface was targeted during permanganate injection activities; especially in the area of the former drum storage area, because it is the most significant pathway for off-Site migration of impacted groundwater. Significant rebound is unlikely within this interface based on the length of time of permanganate persistence and significantly lower contaminant levels above and below this interface at the downgradient area of the Site. Further vertical migration within the siltstone unit is not a concern because the deeper monitoring wells indicate a decrease in COPCs levels, and regionally the groundwater within the siltstone is considered to be perched water that is not connected to the regional aquifer (see Section 2.2)

Monitoring wells completed within the shallow loess at the Site include, GMW-3, 5, 6, 7, 8, 9, 10, and 11. Of these shallow wells, GMW-6, 7, 9, 10, and 11 have shown significant decreases in COPCs levels since the late 1990's either due to remediation activities or natural attenuation. Due to the low permeability of the loess, off-Site migration within this unit has been limited. Off-Site investigations conducted by Burns & McDonnell (Burns & McDonnell, 1999) and MDNR (MDNR, 2001) indicate that significant shallow groundwater contamination is limited to the off-Site area immediately adjacent to the Site. Also, in-door air sampling and sump water sampling conducted as part of the off-Site investigations in downgradient residential homes indicated that there is no apparent public health hazard as a result of shallow off-Site contamination [Missouri Department of Health (MDoH), 2001]. Additional indoor air sampling to further evaluate this conclusion is pending MDNR obtaining access to the three homes specified in the MDNR report (MDNR, 2001).

Detections of COPCs in off-Site groundwater within the upper portion of the deeper siltstone unit have varied over time. The detections in the deeper monitoring wells located closest to the Site (GMW-19 and GMW-20) have remained stable since injection activities began, and are expected to decrease over time since the upgradient on-Site source has been treated with permanganate. The deeper monitoring wells located further downgradient from the Site (GMW-21 through 24) have seen more variation in detections and may indicate another source (Burns & McDonnell, 2005).

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# 3.0 CHEMICALS OF POTENTIAL CONCERN (COPCs)

This section presents an overview of the processes used to identify media of potential concern and COPCs for quantitative evaluation in the risk assessment. In Section 3.1, available Site data are used to identify media of potential concern and associated data sets. Section 3.2 provides an overview of the process used to identify the COPCs associated with each medium of concern and data set.

## 3.1 MEDIA OF POTENTIAL CONCERN

In order to determine COPCs, it is first necessary to establish potential media of concern. Sampling and analysis activities resulted in the detection of Site-related chemicals in soil and groundwater. To evaluate whether a medium should be retained for quantitative evaluation in the risk assessment, both the maximum detected concentration and 95 percent upper confidence limit (UCL) (see Section 5.4.2.2 for further details regarding the calculation of 95 percent UCLs) for each chemical detected in each medium were compared to the clean-up levels established by MDNR in the Consent Agreement for EG&G Missouri Metal Shaping Company, which was signed by both parties in 1994. If a clean-up level for a given compound was not established in the Consent Agreement, the maximum detected concentration and 95 percent UCL values were compared to screening levels for industrial soil obtained from the USEPA Region 9 *PRG* table (USEPA, 2004). If both the maximum concentration and the 95 percent UCL values of any detected constituent in a given medium exceeded the screening level, that medium was considered a medium of potential concern and retained for quantitative evaluation in the risk assessment.

Soil samples were collected from on-Site locations, and the analytical results indicated the presence of Site-related constituents. Chemicals in soil can be directly contacted by workers; therefore, analytical data were further evaluated to determine whether soil should be retained as a medium of concern. As shown on Table 3-1, the maximum detected concentrations of PCE and TCE were above the screening level; however, the 95 percent UCL for each chemical was below the screening level. Based on this comparison, soil was not retained as a medium of potential concern.

Groundwater samples have been collected from both on- and off-Site monitoring wells. As discussed in Section 2.4, the off-Site monitoring wells are screened in the upper portion of the deeper siltstone unit, while the on-Site monitoring wells are screened primarily in the shallow loess or the intermediate loess/siltstone interface. As will be further explained in Section 5.3, there are no completed exposure pathways to intermediate and deep groundwater; therefore, off-Site groundwater was not retained for further quantitative evaluation in this risk assessment. Similarly, data from on-Site monitoring wells that are screened in the intermediate or deep intervals were not considered appropriate for inclusion in this risk assessment. For these reasons, only data from the following monitoring wells were considered relevant for quantitative risk evaluation: GMW-1, GMW-3, GMW-4, GMW-5, GMW-6, GMW-7, GMW-8, GMW-9, GMW-10, and GMW-11. These represent all of the on-Site monitoring wells that are fully or partially screened in the shallow groundwater interval.

Samples collected from the shallow on-Site monitoring wells showed widely varying chemical concentrations in different areas of the Site. To accommodate the range of observed concentrations, two data sets were identified. These two data sets were selected to represent the areas of historically highest concentrations in shallow groundwater. To avoid creating a low bias in the data sets, data from monitoring wells that have been largely nondetect or show only low levels of contamination were not included. Monitoring Wells GMW-3, -7, -8, and -9 were chosen as one of the representative data sets for groundwater. These four monitoring wells are in close proximity to each other and display similar levels of contamination. Monitoring Wells GMW-5 and GMW-6 were identified as the second groundwater data set. These two wells are in close proximity to each other, with GMW-6 historically showing the highest levels of contamination in the shallow monitoring wells (before treatment with permanganate). GMW-10 and GMW-11 are geographically located between the two data sets; however, samples collected from these two monitoring wells have recently shown consistently very low levels of Site-related constituents relative to other nearby monitoring wells. Based on the dissimilar contaminant levels in GMW-10 and GMW-11, data from these two monitoring wells were not included in the risk assessment.

Since groundwater is a dynamic medium, historical data are not representative of current or future Site conditions. To appropriately reflect current and likely future conditions, only groundwater data collected within the past two years are typically included in risk assessments, and this convention was followed for both data sets. It should be noted that Monitoring Wells GMW-5 and GMW-6 are located in close proximity to the potassium permanganate treatment trench, and thus have had permanganate in the wells at some point during the most recent two years' monitoring. Groundwater samples containing permanganate were not analyzed by the laboratory; therefore, the two-year data set for Monitoring Wells GMW-5 and GMW-6 contains fewer observations per well than the data set for GMW-3, GMW-7, GMW-8, and GMW-9.

As shown on Tables 3-2 and 3-3, the maximum detected concentrations and 95 percent UCLs of the volatile organic compounds (VOCs) detected in groundwater samples from both data sets exceeded the clean-up goals established in the Consent Agreement; therefore, groundwater was considered a medium of potential concern.

Air samples were collected from several residences located adjacent to the Site by MDNR in 2001 as part of their evaluation of off-Site impacts. The analytical results were provided to MDoH for evaluation of potential health risks. MDoH concluded in their evaluation that the chemical concentrations measured in indoor air at that time were unlikely to pose unacceptable risks to human health (MDoH, 2001). Since additional air samples have not been collected since that time, the existing air data will not be re-evaluated as part of this risk assessment. However, Burns & McDonnell has proposed to collect additional indoor air samples if access to the residences can be obtained by MDNR. If additional air data are obtained, Burns & McDonnell will evaluate the potential risks associated with exposure to indoor air using the same procedures used by MDoH in the previous evaluation.

## 3.2 IDENTIFICATION OF CHEMICALS OF POTENTIAL CONCERN (COPCs)

COPCs include those Site-related chemicals that have the potential to impact human health. To select COPCs, the maximum detected concentrations and 95 percent UCL values for each positively detected chemical in each data set were compared to the clean-up goals from the Consent Agreement. Those constituents detected at concentrations exceeding the clean-up goal were retained as COPCs. For this risk assessment, the maximum detected concentrations and 95 percent UCLs for all positively detected chemicals in each groundwater data set exceeded the clean-up goals and were retained as COPCs.

As shown on Table 3-2, the following chemicals were identified as COPCs in groundwater from Monitoring Wells GMW-3, -7, -8, and -9: 1,1-DCE; cis-1,2-DCE; trans-1,2-DCE; PCE; TCE; and vinyl chloride

As shown on Table 3-3, the following chemicals were identified as COPCs in groundwater from Monitoring Wells GMW-5 and -6: cis-1,2-DCE; trans-1,2-DCE; PCE; TCE; and vinyl chloride

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# 4.0 TOXICITY ASSESSMENT

The toxicity of COPCs is evaluated for both carcinogenic potential and noncancer adverse health effects. Data regarding health effects are then used by various agencies to derive numerical toxicity values. The USEPA gathers toxicological information from a variety of sources including experimental animal studies, epidemiological investigations, and clinical human studies. Well-conducted epidemiological studies that show a positive correlation between an agent and a disease represent the most convincing evidence about human risk. At present, human data adequate to serve as the sole basis for the development of toxicity values are available for only a few chemicals. In most cases where there is insufficient direct human data, USEPA uses toxicity information developed from experiments conducted on non-human mammals such as rats, mice, dogs, or rabbits.

The primary source of toxicological information for this report was the USEPA sponsored *Integrated Risk Information System* (IRIS) (USEPA, 2005). If toxicity values were not found in IRIS, values were obtained from USEPA's *Provisional Peer-Reviewed Toxicity Values* documentation or from the USEPA Region 9 *PRG* table (USEPA, 2004). As a final source of information, the California Office of Environmental Health Hazard Analysis (OEHHA) was consulted. The following sections detail information regarding both noncancer and cancer toxicity values.

## 4.1 NONCANCER TOXICITY VALUES

The Reference Dose (RfD) and Reference Concentration (RfC) are the toxicity values used in assessing noncancer health effects from oral and inhalation exposures, respectively. For noncancer health effects, the level of exposure below which no adverse health effects develop is termed the threshold level or threshold dose. RfDs and RfCs represent exposure levels that are well below the threshold. Each is an estimate of daily exposure to the general human population (including sensitive subpopulations) that is unlikely to pose an appreciable likelihood of adverse effects during a given term of exposure.

RfDs and/or RfCs are derived from experimental no observed adverse effect levels (NOAELs) or lowest observed adverse effect levels (LOAELs) by application of uncertainty factors (UFs) or modifying factors (MFs). UFs of 10 are used to protect sensitive subpopulations, to account for interspecies variability, and to account for data being obtained from subchronic rather than chronic studies. A UF of 10 is also used when the toxicity value is derived from a LOAEL rather than a NOAEL. MFs, usually a value of 10 or less, are applied for uncertainties not addressed by the UFs just listed.

RfD values are expressed as milligrams of chemical per kilogram body weight per day (mg/kg/day), and RfC values are expressed as a chemical concentration in air in milligrams per cubic meter ($mg/m^3$). For consistency with the inhalation intake dose units, RfC values were converted to inhalation RfD values, which are then expressed as mg/kg/day (USEPA, 1997a).

Chronic RfDs and RfCs pertain to lifetime or other long-term exposures and may be overly protective if used to evaluate the potential for adverse health effects resulting from shorter exposures. For such situations, USEPA has developed toxicity values specifically for subchronic exposure durations. The subchronic RfD is developed using subchronic NOAELs from studies of appropriate exposure duration. In the absence of a subchronic RfD, the chronic RfD is adopted as the subchronic RfD. For short-term exposure durations, such as those used for the construction worker scenario, it is appropriate to use subchronic RfDs rather than chronic RfDs. Where available, subchronic RfDs were obtained from USEPA's *Health Effects Assessment Summary Tables* (HEAST).

Table 4-1 summarizes available RfDs and reference sources. By convention, RfD values, as with all toxicity numbers and risk assessment calculations, are expressed in scientific notation. For example, the oral RfD for benzene, 0.004 mg/kg/day, is expressed as $4 \times 10^{-3}$ mg/kg/day or 4E-03 mg/kg/day, as shown in the table.

## 4.2 CANCER TOXICITY VALUES

The toxicity values used in assessing cancer risk are slope factors. A slope factor represents the 95 percent UCL on the probability that a carcinogen will cause cancer at a dose of one mg/kg/day over a lifetime. Unlike most noncancer health effects, carcinogenesis is not generally believed to conform to the concept of a threshold dose. Mechanistic data indicate that in some instances even the smallest dose of a carcinogen can lead to a clinical state of disease. For this reason, it is not possible to determine a no-response dose, but rather it is necessary to relate a specific dose to the statistical probability of a carcinogenic response.

For carcinogenic effects, the substance is first assigned a weight-of-evidence classification and then a slope factor is calculated. To determine the weight-of-evidence classification, the available evidence is evaluated to determine the likelihood that the agent is a human carcinogen. Table 4-2 shows the USEPA carcinogen weight-of-evidence classification system. In 1996, USEPA proposed revised guidelines for evaluating research evidence for carcinogens, including a more descriptive classification scheme. The IRIS file for vinyl chloride is among the few that have been updated to include both the revised classification and the traditional scheme that is shown in Table 4-2. The revised classification for vinyl chloride is "a known human carcinogen for all routes of exposure based upon convincing human evidence as well as supporting evidence from animal studies."

The slope factor is developed from data on the potency of the agent as a carcinogen in experimental animals and/or humans. Slope factors are available in IRIS for many substances categorized by USEPA as A, B, or C carcinogens. Table 4-3 summarizes the available slope factors, reference sources, and weight-of-evidence classifications for the carcinogenic COPCs.

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# 5.0 EXPOSURE ASSESSMENT

In the exposure assessment, potentially exposed populations and potential pathways of exposure are identified. The assessment considers physical Site features, land use, and zoning in order to identify pathways and populations for exposure. Only completed exposure pathways (i.e., human receptors in contact with contaminated media) may actually pose a human health risk.

Section 5.1 presents a description of the exposure setting and Section 5.2 discusses the likelihood for a human population to have direct contact with contaminated media. Section 5.3 identifies potentially completed exposure pathways and Section 5.4 presents the equations and variables used to quantify chemical intake.

## 5.1 CHARACTERIZATION OF EXPOSURE SETTING

The first step in evaluating exposure is to characterize the Site with respect to its physical features, current and future land uses, and observed and predicted human activities so that potentially exposed populations at and near the Site can be identified.

### 5.1.1 Current and Future Land Use

As discussed in Section 2.1, the Site is located at 9970 Page Avenue in Overland, Missouri, near the center of Section 31, Township 46 North, Range 6 East, in St. Louis County, Missouri. The Site is approximately 3.5 acres located in an area that is primarily commercial and/or light industrial. Structures on the Site consist of two manufacturing buildings and two metal storage buildings (Figure 2-2). An area of residential development is located southeast of the Site, across Meeks Boulevard.

Initial industrial activities on the Site began in 1957 and were conducted by MMSC. Alco Standard Corporation – Aerospace Division purchased the property and business from MMSC in 1979. In 1988 the property and business were purchased by EG&G KT Aerofab, which was subsequently acquired by PerkinElmer. In 2001, the business was purchased by Missouri Metals, LLC, with the property retained by PerkinElmer and leased to Missouri Metals, LLC.

As in the past, the facility currently fabricates aircraft components, with manufacturing activities generally consisting of forming and finishing aircraft components from stock metals. These activities are expected to continue into the foreseeable future. Given the presence of a residential development in the vicinity, it is possible that, in the absence of land use controls, the Site could be developed for residential use in the future. To prevent the possibility of future residential development, PerkinElmer plans to institute appropriate land use controls as needed to maintain commercial/industrial land use of the property. With the institution of appropriate land use controls, use of the Site will remain commercial/industrial in the reasonably foreseeable future.

### 5.1.2 Current and Future Water Use

The Site and surrounding area are currently supplied potable water by a public water supply system. The City of Overland is served by the St. Louis County Water Company, which draws water from surface water sources, namely the Meremac and the Missouri Rivers. Currently shallow groundwater in the vicinity of the Site is not used as a source of potable water, and, with the availability of publicly supplied water, it is not expected to be used as such in the foreseeable future.

As described in Section 2.0 of this report, the monitoring wells installed at the Site have identified the vertical extent of contamination as being in the loess and upper bedrock (siltstone), with the highest levels of contamination occurring in the loess/siltstone interface. Groundwater in these units in the area of the Site is considered to be perched water, and is not hydraulically connected to the deeper bedrock aquifer below (Burns & McDonnell, 1992). The Upper Mississippian aquifer is separated from the shallow water-bearing units at the Site by approximately 150 feet of Pennsylvanian age shale and limestone that acts as an aquitard preventing further vertical migration. Any private potable water wells that may still be in service within four miles of the Site appear to draw water from the Mississippian aquifer (MDNR, 2001); therefore, it is unlikely that groundwater from the Site will impact potable water sources in the future.

## 5.2 POTENTIALLY EXPOSED POPULATIONS

Potentially exposed populations are those persons whose locations and activities create an opportunity for contact with COPCs. The following sections discuss potentially exposed populations, as they are influenced by the land and water uses just described.

### 5.2.1 On-Site Populations

The Site is currently an active industrial facility; therefore, the potentially exposed populations expected to be present on the Site consist of workers. Worker populations are likely to include both full-time and part-time workers, as well as indoor and outdoor workers. Since full-time workers experience longer exposure to the Site than part-time workers, the indoor worker population was evaluated as a full-time population. The outdoor worker population was assumed to be engaged in grounds keeping/landscaping activities at the Site full-time only from mid-April through mid-October. The climate and growing season in Overland, Missouri generally limit year-round outdoor work.

Although the Site is currently developed, it is possible for additional improvements to be completed on the property. Additionally, since underground utilities are present on the Site, future maintenance and occasional repair activities are likely to occur. Both construction and utility installation/repair work involve subsurface excavation of soil; however, the duration of activity is likely to be much longer for construction work than for utility installation/repair work. Therefore, a single population of construction workers was evaluated as conservatively representative for both types of subsurface excavation activities.

Since the Site is currently an active industrial facility, and PerkinElmer intends to implement the necessary institutional controls to restrict future land use to commercial/industrial, residents are not considered potentially exposed on-Site populations.

In summary, the potentially exposed on-Site populations included in this evaluation are indoor commercial/industrial workers, outdoor commercial/industrial workers, and construction workers.

### 5.2.2 Off-Site Populations

An area of residential development is currently located southeast of the Site, across Meeks Boulevard. Investigations at the Site have identified the presence of chlorinated compounds in the shallow groundwater located beneath the residential neighborhood in close proximity to the Site. Given the presence of occupied residential structures, both adult and child residents are considered potentially exposed off-Site populations.

The area surrounding the Site also contains commercial/industrial properties, indicating the worker populations are also likely to be present off-Site. Since the concentrations of Site-related constituents are lower off-Site than they are on-Site, it can reasonably be assumed that off-Site workers would experience a lower level of exposure than on-Site workers. Therefore, off-Site workers will not be evaluated as separate populations in this risk assessment.

In summary, the potentially exposed off-Site populations included in this evaluation are adult and child residents.

## 5.3 POTENTIAL EXPOSURE PATHWAYS

Health risks may occur when there is contact with a chemical by a receptor population. Exposed populations must then either ingest, inhale, or dermally absorb COPCs to complete an exposure pathway and possibly experience a health risk. The following is a discussion of the likelihood of completed pathways.

### 5.3.1 Indoor Commercial/Industrial Workers

VOCs were detected in shallow groundwater on the Site; therefore, indoor inhalation of chemical vapors migrating from shallow groundwater through foundation cracks was considered a potentially completed exposure pathway. Potable water at the Site is currently supplied by a municipal water source, and the potentially impacted water-bearing units at the Site are unlikely to be used as a potable water source in the future, so direct contact with contaminated groundwater is unlikely.

In summary, the potentially completed exposure pathway for the indoor commercial/industrial worker is inhalation of chemical vapors migrating from shallow groundwater through foundation cracks into indoor air.

### 5.3.2 Outdoor Commercial/Industrial Workers

The outdoor commercial/industrial worker population was assumed to consist of groundskeepers engaged in light landscaping and grounds maintenance activities. Chemical vapors could migrate from shallow groundwater and be present in outdoor air. Given the presence of potentially Site-related constituents in outdoor air, inhalation of outdoor air was considered a potentially completed pathway. Potable water at the Site is currently supplied by a municipal water source, and the potentially impacted water-bearing units at the Site are unlikely to be used as a potable water source in the future, so direct contact with contaminated groundwater is unlikely.

In summary, the potentially completed exposure pathway for the outdoor commercial/industrial worker is inhalation of outdoor vapors from shallow groundwater.

### 5.3.3 Construction Workers

Chemical vapors from shallow groundwater are likely to migrate through soils and be present in the breathing zone of a construction/utility worker. Potable water at the Site is currently supplied by a municipal water source, and the potentially impacted water-bearing units at the Site are unlikely to be used as a potable water source in the future. Additionally, during drilling activities groundwater is encountered approximately 15 feet bgs, and is unlikely to be encountered during construction and/or utility repair activities. Because of this, and the presence of publicly-supplied potable water, direct contact with groundwater by construction workers is unlikely to occur.

In summary, the potentially completed exposure pathway for the construction worker is inhalation of outdoor vapors from shallow groundwater.

### 5.3.4 Adult and Child Residents

Off-Site contamination in the residential neighborhood located adjacent to the Site has been identified in shallow groundwater in close proximity to the Site, and in the deeper siltstone unit further downgradient from the Site. Since volatilization can only occur from the top of the water table; it is not possible for chemicals to migrate in the vapor phase upward from deeper within the groundwater to the surface of the water table. For this reason, vapor migration is not considered a potentially completed exposure pathway for contaminants that are located in the deeper siltstone unit. For the deeper groundwater, use of groundwater as a potable water source would be the only likely means of exposure. Currently, potable water is publicly supplied to the neighborhood, and the impacted water-bearing units at the Site are unlikely to be used as a potable water source in the future. Therefore, direct contact with the deeper groundwater is unlikely to occur. Given that volatilization does not occur from deeper groundwater, and groundwater is not likely to be used as a potable water source in the future, there are no potentially completed exposure pathways to off-Site groundwater within the siltstone unit.

The only potentially completed exposure pathway for adult and child residents is indoor inhalation of chemical vapors migrating from shallow groundwater through foundation cracks into basements. This pathway was evaluated by MDoH using all existing data collected from basements in the neighborhood, and they concluded that the chemical concentrations measured in indoor air at that time were unlikely to pose unacceptable risks to human health (MDoH, 2001). Since new indoor air data are not currently available, adult and child residents will not be evaluated further in this document. If additional indoor air samples are collected from these residences in the future, Burns & McDonnell will evaluate the results using the method employed by MDoH in their 2001 evaluation.

## 5.4 ESTIMATION OF INTAKE

This section of the risk assessment presents the calculation of chemical intake through the exposure pathways identified in Section 5.3. Chemical intake is expressed in mg/kg/day. Intakes for all COPCs were quantified using a pathway-specific equation taken from USEPA guidance. This equation is presented in Table 5-1. The exposure and chemical variables used in this equation are discussed in the following sections. The calculated chemical intakes are later used in conjunction with toxicity values to characterize risk, as discussed in Section 6.0, Risk Characterization.

### 5.4.1 Exposure Variables

Recommended exposure variable values from guidance documents were used and referenced, if available. If not, best professional judgment about expected Site conditions was employed to estimate values for the exposure scenarios. The recommended values and estimated values were specifically chosen to result in a reasonable maximum exposure (RME) estimate. An RME represents a high-end exposure situation, but one still within the realm of possible exposures. Values used for all receptors characterized are discussed in the following subsections.

**Indoor Commercial/Industrial Worker Exposure Variables**

Indoor commercial/industrial workers were assumed to weigh 70 kilograms (kg) (USEPA, 1989). It was assumed that an indoor commercial/industrial worker breathes 0.633 cubic meters of air per hour ($m^3$/hr) (USEPA, 1997b). This is a mean value based on a long-term average inhalation rate for adults.

The standard 250 workdays per year for 25 years was used for exposure frequency and duration, respectively (USEPA, 1991). Indoor commercial/industrial workers were assumed to spend 100 percent of their work time indoors. The exposure time for inhalation of chemical vapors was set at the standard 8-hour working day value.

**Outdoor Commercial/Industrial Worker Exposure Variables**

The outdoor commercial/industrial worker was assumed to weigh 70 kg, the recommended default adult body weight (USEPA, 1989). It was assumed that an outdoor commercial/industrial worker breathes 1.3 $m^3$/hr (USEPA, 1997b) based on the hourly average inhalation rate for outdoor workers.

The seasonality of the climate in Overland, Missouri tends to preclude year-round outdoor work. The outdoor commercial/industrial worker was assumed to be engaged in seasonal groundskeeping and landscaping activities, which are likely to take place from mid-April through mid-October. Therefore, the exposure frequency was assumed to equal 125 days per year, representing half of a working year. The outdoor commercial/industrial worker was assumed to be employed at the Site for 25 years, the standard worker exposure duration (USEPA, 1991). Outdoor commercial/industrial workers were assumed to spend 100 percent of their time outdoors. The exposure time for inhalation of outdoor air was set at eight hours per day.

**Construction Worker Exposure Variables**

Construction workers were also assumed to weigh 70 kg, a mean adult weight (USEPA, 1989). Excavation work typically involves some heavy physical labor; therefore, the inhalation rate for the construction worker was assumed to be 2.5 $m^3$/hr (USEPA, 1997b) based on a heavy activity level. To conservatively address the possibility for extensive modification of Site structures, the construction worker was assumed to be exposed for 8 hours per day for 6 months (130 working days).

### 5.4.2 Chemical Variables

Chemical variables used in the risk assessment calculations are summarized in the following sections.

#### 5.4.2.1 Exposure Concentrations

Current USEPA risk assessment guidance specifies that the RME for a receptor population be calculated using the 95 percent UCL of the arithmetic mean of chemical concentrations. However, there are instances where the 95 percent UCL can be greater than the maximum detected value, such as when there are elevated detection limits or small sample sizes. In these situations, USEPA allows the maximum observed concentration to be used as the exposure point concentration rather than the calculated UCL (USEPA, 1992).

UCLs were calculated using USEPA's ProUCL software Version 3.00.02. The program's statistical output for each compound in each data set is provided in Appendix A. The data sets used to calculate the UCLs are provided on Tables 5-2 and 5-3. Tables 5-4 and 5-5 summarize the two sets of exposure concentrations, maximum detected concentrations and 95 percent UCLs, for groundwater.

#### 5.4.2.2 Chemical Vapor Concentrations

On-Site indoor and outdoor air data are not available; therefore, vapor transport modeling was conducted. Vapor transport modeling from groundwater to indoor air was conducted to estimate the exposure concentrations for the indoor commercial/industrial worker scenario. Vapor transport modeling from groundwater to outdoor air was used to estimate the exposure concentrations for the outdoor commercial/industrial worker and construction worker scenarios.

**Vapor Migration to Indoor Air**

Vapor migration from groundwater to indoor air was evaluated using Version 3.0 of USEPA's spreadsheets for the Johnson and Ettinger (1991) *Model for Subsurface Vapor Intrusion into Buildings* spreadsheets. These spreadsheets account for contaminant partitioning into three phases: dissolved phase in soil pore water, sorbed to soil organic carbon, and vapor phase within air-filled pores in soil. The model then accounts for diffusion through the capillary zone (groundwater only), diffusion through the vadose zone (soil and groundwater) and infiltration through foundation cracks into a building. Depth to groundwater was assumed to equal 15 feet bgs. Default values for a clay soil type were used for the remaining parameters. The predicted chemical concentrations in indoor air are summarized on Tables 5-6 and 5-7. The data entry and intermediate calculation pages of the Johnson & Ettinger spreadsheets are provided in Appendix B.

**Vapor Migration to Outdoor Air**

Vapor migration from groundwater to outdoor air was modeled using an equation from *the Standard Guide for Risk-Based Corrective Action at Petroleum Release Sites* (ASTM, 1995). This equation includes a series of effective diffusion coefficient calculations to account for varying subsurface conditions as chemical vapors migrate from groundwater to outdoor air, as well as a traditional box model. The effective diffusion coefficients account for the migration of chemical vapors from groundwater to the soil surface, while the box model estimates chemical dispersion in outdoor air. Chemical partitioning from groundwater to soil gas is accounted for through the application of the Henry's Law constant. Depth to groundwater was assumed to equal 15 feet, and the default values from the Johnson & Ettinger model for a clay soil type were used for the remaining soil properties. Tables 5-8 through 5-11 provide the equations and variables used in modeling vapor migration from groundwater to outdoor air.

The equations used to model vapor migration to outdoor air result in chemical-specific volatilization factors, which were then multiplied by the exposure concentration in groundwater to estimate the chemical concentrations in outdoor air. Tables 5-12 and 5-13 summarize the exposure concentrations in groundwater, the calculated volatilization factors, and the estimated concentration in outdoor air for each data set.

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# 6.0 RISK CHARACTERIZATION

To quantify the potential risk posed by exposure to chemicals through identified pathways, the intake of each chemical is combined mathematically with the appropriate toxicity value to estimate the likelihood of health risks. Sections 6.1 and 6.2 define the general risk characterization process for evaluating noncancer and cancer risks. Section 6.3 summarizes the risk results for each potentially exposed population, and Section 6.4 provides a discussion of uncertainties.

## 6.1 GENERAL NONCANCER RISK DISCUSSION

To characterize the risk of noncancer effects, toxicity values for COPCs are used in conjunction with dose estimates from each exposure scenario to quantitatively estimate the potential for adverse health effects. Chemical-specific doses calculated for each exposure pathway are compared with the reference value, i.e., RfD, for that chemical. If the estimated dose does not exceed the reference value, then adverse noncancer health effects are not expected. The comparison of dose to reference value is expressed mathematically as a hazard quotient, which is the dose divided by the reference value:

$$\text{Hazard Quotient} = \text{Dose (mg/kg/day)} / \text{RfD (mg/kg/day)}$$

Hazard quotients for chemicals within a pathway are summed to give the pathway hazard index. Pathway hazard indices are then summed for a total exposure hazard index. This procedure is followed for each exposure scenario. The summation of chemical and pathway hazard indices is conservative and health-protective as it assumes that the toxic effects of multiple compounds have an additive impact.

## 6.2 GENERAL CANCER RISK DISCUSSION

Cancer risk is expressed as a probability of developing a carcinogenic response as a result of exposure to a given chemical. The estimated dose for each cancer-causing substance is multiplied by the corresponding slope factor to calculate risk. The expression is as follows:

$$\text{Risk} = \text{Dose (mg/kg/day)} \times \text{Slope Factor (mg/kg/day)}^{-1}$$

For simultaneous exposure to several carcinogens, the calculated risks are summed within each pathway and then for all pathways to yield total excess cancer risk posed by a site. This procedure is followed for each exposure scenario. This value represents the probability of developing a carcinogenic response that is solely attributable to exposure from the site and is in excess of the general background risk. Based on National Cancer Institute (NCI) statistics (NCI, 1990), background risk may be considered 0.33 ($3.3 \times 10^{-1}$ or 3.3E-01 in scientific notation), since approximately one in three people in the United States will develop some form of cancer during a lifetime.

Given the current assumption that any exposure to a carcinogen poses some risk, zero risk is not achievable in a practical sense. Therefore, ranges of risk have been developed by USEPA for use as remediation goals. To be protective of human health, USEPA believes that exposure to site-related carcinogens should be limited so as to result in an individual upper bound excess lifetime cancer risk level of one in 10,000 or less (FR, 1990). The risk range of one in 10,000 to one in a million is a commonly accepted remediation goal. In other words, an excess lifetime cancer risk greater than one in 10,000 would generally be considered unacceptably high, while risks within the range would be acceptable depending upon site use. Risks of one in a million or less are generally considered insignificant.

## 6.3 RISK ESTIMATES FOR ON-SITE

Risk estimates for each potentially exposed population are discussed in the following sections.

### 6.3.1 Indoor Commercial/Industrial Workers

**Noncancer Risk**

Tables 6-1 and 6-2 show intake, reference values, and hazard indices for the indoor commercial/industrial worker population. The hazard index for exposure to chemicals through inhalation of indoor air (vapor intrusion) from Monitoring Wells GMW-3, 7, 8, & 9 was 8E-02. This is below the USEPA level of concern for noncancer risk, which is a hazard index greater than one. The hazard index for exposure to chemicals through vapor intrusion from Monitoring Wells GMW-5 & 6 was 4E+00. This is above the USEPA level of concern for noncancer risk, which is a hazard index greater than one.

**Cancer Risk**

Tables 6-3 and 6-4 present intake, slope factors, and the excess lifetime cancer risk associated with chemical exposure for the indoor commercial/industrial worker population. The pathway cancer risk for exposure to chemicals through inhalation of indoor air (vapor intrusion) from Monitoring Wells GMW-3, 7, 8, & 9 was 8E-06. This is within the USEPA 1E-04 to 1E-06 (one in 10,000 to one in a million) acceptable risk range. The pathway cancer risk for exposure to chemicals through vapor intrusion from Monitoring Wells GMW-5 & 6 was 2E-04. This is above the USEPA acceptable risk range.

### 6.3.2 Outdoor Commercial/Industrial Workers

**Noncancer Risk**

Tables 6-5 and 6-6 show intake, reference values, and hazard indices for the outdoor commercial/industrial worker population. Exposure to chemicals through inhalation of outdoor air from Monitoring Wells GMW-3, 7, 8, & 9 resulted in a hazard index of 5E-04. Exposure to chemicals through inhalation of outdoor air from Monitoring Wells GMW-5 & 6 resulted in a hazard index of 3E-01. These are both below the USEPA level of concern for noncancer risk, which is a hazard index greater than one.

**Cancer Risk**

Tables 6-7 and 6-8 present intake, slope factors, and the excess lifetime cancer risk associated with chemical exposure for the outdoor commercial/industrial worker population. The pathway cancer risk for exposure to chemicals through inhalation of outdoor air from Monitoring Wells GMW-3, 7, 8, & 9 was 5E-08. This is below the USEPA 1E-04 to 1E-06 (one in 10,000 to one in a million) acceptable risk range. The pathway cancer risk for exposure to chemicals through inhalation of outdoor air from Monitoring Wells GMW-5 & 6 was 2E-05. This is within the USEPA 1E-04 to 1E-06 (one in 10,000 to one in a million) acceptable risk range.

### 6.3.3 Construction/Utility Workers

**Noncancer Risk**

Tables 6-9 and 6-10 show intake, reference values, and hazard indices for the construction/utility worker population. The hazard index for exposure to chemicals through inhalation of outdoor air from Monitoring Wells GMW-3, 7, 8, & 9 was 2E-03. This is below the USEPA level of concern for noncancer risk, which is a hazard index greater than one. The hazard index for exposure to chemicals through inhalation of outdoor air from Monitoring Wells GMW-5 & 6 was 1E+00. This is equal to the USEPA level of concern for noncancer risk.

**Cancer Risk**

Tables 6-11 and 6-12 present intake, slope factors, and the excess lifetime cancer risk associated with chemical exposure for the construction/utility worker population. The pathway cancer risk for exposure to chemicals through inhalation of outdoor air from Monitoring Wells GMW-3, 7, 8, & 9 was 4E-09. This is below the USEPA 1E-04 to 1E-06 (one in 10,000 to one in a million) acceptable risk range. The pathway cancer risk for exposure to chemicals through inhalation of outdoor air from Monitoring Wells GMW-5 & 6 was 1E-06. This is at the lower end of the USEPA acceptable risk range.

## 6.4 UNCERTAINTIES

Conducting a risk assessment requires making a number of assumptions, which serve to introduce degrees of uncertainty in the final result. The following sections discuss the uncertainties resulting from chemical identification (Section 3.0), toxicity assessment (Section 4.0), and exposure assessment (Section 5.0).

### 6.4.1 Uncertainty Associated with Chemical Identification

At any Site, it is possible that there are more individual chemical substances present than identified in the sampling and analysis effort. The selection of media to be sampled, number of samples, and analyses requested are determined by a review of the history of the Site, information on current conditions, and an evaluation as to which chemicals could potentially be present. The analyses selected during previous investigations were identified based on knowledge of historical Site practices. The use of such knowledge provides confidence that the related constituents present at the Site have been identified.

The application of quality control throughout the sampling, analysis, and data validation phases reduced uncertainty in the results. Therefore, the chemical identification phase of the risk assessment does not appear to have introduced significant uncertainty.

### 6.4.2 Uncertainty from Toxicity Assessment

For some chemical substances there is little or no toxicity information available and for many chemicals, what is available is typically from animal studies. The relative strength of the available toxicological information generates some uncertainty in the evaluation of possible adverse health effects and the exposure level at which they may occur. To provide for a margin of error, USEPA applies conservative adjustments to the toxicity values.

For noncarcinogenic substances, RfD and RfC values are typically established only after uncertainty and/or modifying factors are applied. These factors may result in an RfD/RfC that is as little as a thousandth or less of the "safe" dose level determined through animal studies.

For carcinogens, the slope factor represents the 95 percent UCL of an extrapolated low dose response curve. The actual carcinogenic potency of a substance at low doses is almost certainly less. Additionally, many substances identified as carcinogens in high-dose laboratory testing may not be carcinogenic at low doses and/or may not be carcinogenic to humans.

To quantify risk from chemicals that do not have toxicity numbers posted in IRIS or HEAST, values generated by other states (i.e., California OEHHA) and/or provisional values from Region 9 PRG Table are used when available. Uncertainty is generated by the use of provisional numbers. However, this uncertainty is less than that generated by ignoring or qualitatively assessing risks.

The potential carcinogenicity of TCE is currently under debate within the scientific community. Conflicting evaluations of the potential carcinogenicity of TCE have been presented, resulting from varying interpretations of the toxicological data. The International Agency for Research on Cancer classified TCE as a probable human carcinogen in 1995, based primarily on studies showing carcinogenicity in rodents. Conversely, in 1994 the American Conference of Governmental Industrial Hygienists classified TCE as "not suspected to be a human carcinogen" at accepted occupational levels.

Chronic, high-dose exposure to TCE has been shown to induce pulmonary tumors and hepatocarcinomas in mice and renal tumors in rats. However, epidemiological studies have not demonstrated a causal association between occupational TCE exposure and lung, liver, or kidney cancers in humans. Evaluation of the toxicological data indicates that the disparity in effects is likely due to species-specific differences in TCE metabolism, as it is the metabolites that appear to be responsible for the carcinogenic action in rodents. Although humans and rodents metabolize TCE in similar manners, producing the same general metabolites, different species form these metabolites at different rates and ratios. As a result of these species-specific differences, higher concentrations of the active metabolites are produced in rodents than in humans. Although the mechanisms of action by which TCE causes kidney and liver cancer are not yet fully understood, the available epidemiological evidence suggests that humans who are exposed at environmentally-relevant concentrations are not at increased risk of developing cancer.

When taken together, the mechanistic and epidemiological data fail to support the supposition that TCE is a human carcinogen at environmentally-relevant levels. USEPA has established provisional RfDs and slope factors for TCE; however, the bases for these values are currently undergoing considerable debate within the scientific community. Given the on-going debate regarding the appropriateness of USEPA's current provisional toxicity values for TCE, toxicity values established by the State of California have been used in this evaluation. Use of either set of toxicity values likely carries a level of uncertainty, but given the debate surrounding the scientific validity of the new provisional values, use of the California values is considered the more reliable and appropriate option at this time.

### 6.4.3 Uncertainty from Exposure Assessment

When evaluating exposure, probable scenarios are developed to estimate conditions and duration of human contact with COPCs. Scenarios are based on observations or assumptions about the current or potential activities of human populations that could result in direct exposure. To prevent underestimation of risk, scenarios incorporate exposure levels, frequencies, and durations at or near the top end of the range of probable values. This is sometimes termed a reasonable maximum exposure, one that may be unlikely or at the high end of a range of exposures, but still possible.

Default values, such as respiration rates, are used in the exposure calculations to quantify intakes. Although they are based on USEPA-validated data, there is uncertainty in the applicability of such values to any particular exposed population or individual. To compensate for this uncertainty, the default values are typically set to the upper end (usually the 90th or 95th percentile) of the normal range.

Uncertainty also arises from the treatment of nondetected concentrations in the risk assessment. One-half of the reporting limit was used as a proxy concentration for nondetect samples. The actual concentration of the contaminant could be anywhere between zero and the reporting limit. This may result in either an over- or underestimation of risk.

During the most recent rounds of groundwater sampling, permanganate was present in Monitoring Well GMW-6. Due to the presence of permanganate, samples from this well were not sent to the laboratory for analysis. Since GMW-6 has historically been one of them most impacted monitoring wells, it was not considered appropriate to exclude it from the evaluation. Therefore, exposure concentrations were developed using analytical data from before the permanganate treatment. Current chemical concentrations are likely to be significantly lower; in fact the presence of unoxidized permanganate indicates that chlorinated compounds are not currently present in that monitoring well. Once the remaining permanganate at the Site has been fully oxidized, it is likely that the chemical concentrations in Monitoring Well GMW-6 will be considerably lower than the values used in this risk assessment. Use of analytical data from before permanganate treatment likely results in a significant overestimation of risk.

Models were used for exposure to chemicals through vapor inhalation. Models are simplified representations of reality, which can not effectively account for variations in subsurface conditions or the attenuation processes that will lead to a reduction in source concentrations over time. The use of vapor migration models adds uncertainty to the exposure assessment, and likely results in an overestimation of risk.

The model used to evaluate vapor migration from groundwater to outdoor air does not account for the presence of asphalt or concrete pavement. Pavement generally has a lower permeability than the underlying soil, and this lower permeability layer inhibits the migration of vapors from the subsurface to ambient air. Since the presence of pavement is not addressed in the outdoor vapor model, the use of this model has likely yielded an overestimate of outdoor vapor concentrations for the outdoor commercial/industrial worker population.

All of these factors add uncertainty in the estimates of risk. However, the uncertainty is generally that risk has been overestimated, not underestimated.

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# 7.0 CALCULATION OF PRELIMINARY REMEDIATION GOALS (PRGs)

PRGs are chemical-specific clean-up goals based on specific media and land use exposure scenarios. There are generally two types of PRGs, concentrations based on governing documents and concentrations based on a Site-specific risk assessment. For this Site, the Consent Agreement is the governing document establishing the default clean-up levels. Based on the data evaluation conducted in Section 3.0, the clean-up levels for soil established in the Consent Agreement will be adopted as PRGs for soil. Since the clean-up levels for groundwater in the Consent Agreement are based on use of groundwater as a potable water supply, which has been determined to be inapplicable at this Site, alternate Site-specific PRGs were developed. The remainder of this section addresses the calculation of risk-based PRGs for COPCs in groundwater.

The PRGs were calculated in accordance with the USEPA *RAGS Volume 1: Human Health Evaluation Manual, Part B, Development of Risk-Based Preliminary Remediation Goals* (USEPA, 1991a). The PRGs were developed based upon the exposure scenarios that resulted in a noncancer hazard index greater than or equal to one or an excess cancer risk at or above one in one million (i.e., 1E-06) in this baseline risk assessment. Within each exposure scenario, PRGs were calculated for each chemical having an individual noncancer hazard quotient greater than 0.1 or an individual excess cancer risk greater than 1E-07. A hazard quotient of 0.1 and an individual excess cancer risk of 1E-07 were identified as the decision criteria to allow for the establishment of PRGs for any chemical that could be considered a risk driver at the Site. The risk evaluations for indoor commercial/industrial workers and construction workers resulted in total hazard indices equal to or greater than one; therefore noncancer-based PRGs were calculated for these two populations. The risk evaluations for all three worker scenarios resulted in excess cancer risk levels at or above 1E-06; therefore, cancer-based PRGs were calculated for all three worker populations. Within these exposure scenarios, PRGs were developed for 1,1-DCE, PCE, TCE, and vinyl chloride.

The equations and variables used to calculate the PRGs are provided on Tables 7-1 through 7-5. These equations use previously defined variables, such as body weight, exposure duration, exposure frequency, and others, to calculate an allowable concentration of COPCs in groundwater that would not exceed the target hazard quotient/cancer risk level. To calculate the PRGs for indoor commercial/industrial workers, a volatilization factor to indoor air was calculated using Version 3.0 of USEPA's spreadsheets for the Johnson and Ettinger model. By leaving the initial concentration box blank and selecting to calculate the risk-based groundwater concentration box, a volatilization factor is presented in the intermediate calculations sheet. These spreadsheet inputs and outputs are provided in Appendix C.

The PRGs were calculated using a target hazard quotient of one and a target excess cancer risk level of one in 100,000 (i.e., 1E-05). This target cancer risk level is appropriate given the limited number of chemicals present on the Site. Remediating each individual chemical to a target cancer risk level of 1E-05 will result in a cumulative Site-wide cancer risk level well below the USEPA level of one in 10,000. Additionally, since a target cancer risk of 1E-05 was used by MDNR in the *Missouri Risk-Based Corrective Action Technical Guidance* document (MDNR, 2005), use of this target cancer risk level is consistent with MDNR practices.

Table 7-6 summarizes the calculated PRGs for groundwater for each potentially exposed population. The recommended PRGs are as follows:

- 1,1-DCE = 36.9 mg/L based on the indoor commercial/industrial worker noncancer scenario
- PCE = 1.65 mg/L based on the indoor commercial/industrial worker cancer scenario
- TCE = 7.84 mg/L based on the indoor commercial/industrial worker cancer scenario
- Vinyl Chloride = 0.913 mg/L based on the indoor commercial/industrial worker cancer scenario

The recommended PRG for each chemical represents the most protective concentration of each chemical for the relevant exposure scenarios.

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# 8.0 CONCLUSIONS AND RECOMMENDATIONS

This human health baseline risk assessment evaluated the potential risks that may be associated with exposure to Site-related chemicals. Based on this evaluation, the medium of concern for this Site is groundwater, and the potentially exposed populations consist of on-Site workers. The only potentially completed off-Site exposure pathway is vapor migration from shallow groundwater to indoor air. This potential exposure pathway was not addressed in this evaluation since new indoor air data has not been collected since MDoH performed their risk evaluation in 2001. If new indoor air data are collected from the off-Site residences, the data will be evaluated at that time using the same methodology employed by MDoH.

Information regarding current and potential future land and water use was used to develop the exposure scenarios evaluated. The evaluation was made with the assumption that the Site property will remain commercial/industrial. Indoor commercial/industrial workers were assumed to be potentially exposed to constituents in indoor air from groundwater. Outdoor commercial/industrial workers were assumed to engage in seasonal grounds keeping/landscaping activities that could lead to exposure to constituents in outdoor air through inhalation of vapors from groundwater. Construction workers were assumed to be potentially exposed to constituents in outdoor air through inhalation of vapors from groundwater.

Groundwater analytical data from the last two years were used in this risk assessment; however, non-detects in groundwater due to the presence of permanganate were not used in the evaluation. The risk assessment indicated that the construction worker population had a total hazard index equal to the USEPA level of concern for noncancer risk, and both the outdoor commercial/industrial worker and construction worker populations had excess lifetime cancer risk levels within the USEPA target risk range of one in 10,000 to one in a million (1E-04 to 1E-06). The risk characterization resulted in hazard indices above the USEPA level of concern for noncancer risk for the indoor commercial/industrial worker. The calculated excess lifetime cancer risks were above the USEPA cancer risk threshold of one in 10,000 (1E-04) for the indoor commercial/industrial worker population.

Based on the results of the risk characterization, PRGs were calculated for 1,1-DCE, PCE, TCE, and vinyl chloride. A comparison of the PRGs to analytical data for the Site indicates that current chemical concentrations in all monitoring wells are below the PRGs. Of the shallow Monitoring Wells, GMW-6 currently is non-detect due to the presence of permanganate; however, prior to permanganate treatment levels in GMW-6 were above PRGs. This indicates that the analytical data collected prior to the presence of permanganate are causing the calculated excess risk at the Site.

Based on the results of the baseline risk assessment and comparison to PRGs, further remediation at the Site is not needed at this time to address potential risks. However, the presence of permanganate in GMW-6 will continue to be monitored. Once permanganate is no longer present in GMW-6, groundwater samples will be collected from the well on a semi-annual basis for one year. If the levels rebound above PRGs, PerkinElmer will consider either further additional permanganate treatment in the area of this well or other appropriate mitigation measures (further deed restrictions and/or a venting system for the nearby building) to address the potential vapor intrusion pathway. If the levels remain below PRGs, no further remedial action will be required at the Site.

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# 9.0 REFERENCES

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Tables

# Table 2-1
# Water Level Data
# PerkinElmer
# Missouri Metals Site
# Overland, Missouri

| Monitoring Well | Well Diam. | TD ft, bgs | Screen Length, ft. | Screen Formation | Screen Interval | GS Elev. ft, msl | TOC Elev. ft, msl | 2-Jun-05 DTW ft, btoc | 2-Jun-05 SWL ft, msl |
|---|---|---|---|---|---|---|---|---|---|
| GMW-1 | 2" | 16.5 | 5.0 | loess | shallow | 650.92 | 650.92 | 3.06 | 647.86 |
| GMW-3 | 2" | 16.5 | 5.0 | loess | shallow | 635.87 | 635.83 | 6.69 | 629.14 |
| GMW-4 | 2" | 16.5 | 5.0 | loess | shallow | 641.60 | 641.54 | 6.60 | 634.94 |
| GMW-5 | 2" | 17.5 | 15.0 | loess | shallow | 646.29 | 646.29 | 12.86 | 633.43 |
| [1] GMW-6R | 2" | 15.0 | 10.0 | loess | shallow | 642.61 | 642.35 | 2.95 | 639.40 |
| GMW-7 | 2" | 14.0 | 10.0 | loess | shallow | 638.21 | 638.32 | 5.52 | 632.80 |
| GMW-8 | 2" | 14.0 | 10.0 | loess | shallow | 636.35 | 635.91 | 6.82 | 629.09 |
| GMW-10 | 2" | 15.0 | 10.0 | loess | shallow | 643.06 | 643.06 | 8.75 | 634.31 |
| GMW-11 | 2" | 15.0 | 10.0 | loess | shallow | 643.15 | 643.15 | 7.55 | 635.60 |
| GMW-9 | 2" | 20.0 | 10.0 | loess | shallow/inter. | 637.57 | 637.50 | 7.27 | 630.23 |
| GMW-15 | 4" | 19.9 | 4.5 | loess | intermediate | 642.31 | 642.31 | 9.24 | 633.07 |
| GMW-14 | 4" | 23.0 | 4.5 | loess/siltstone | intermediate | 636.41 | 636.23 | 7.02 | 629.21 |
| GMW-16 | 4" | 34.5 | 5.0 | siltstone | deep | 636.49 | 636.00 | 7.13 | 628.87 |
| GMW-17 | 4" | 48.8 | 10.0 | siltstone (deep) | deep | 646.29 | 646.29 | 14.21 | 632.08 |
| GMW-19 | 2" | 35.7 | 5.0 | siltstone | deep | 633.83 | 633.61 | 7.72 | 625.89 |
| GMW-20 | 2" | 33.3 | 5.0 | siltstone | deep | 634.29 | 634.12 | 7.62 | 626.50 |
| GMW-21 | 2" | 33.8 | 5.0 | siltstone | deep | 627.60 | 627.29 | - | - |
| GMW-22 | 2" | 38.1 | 5.0 | siltstone | deep | 618.03 | 617.60 | - | - |
| GMW-23 | 2" | 34.7 | 5.0 | siltstone | deep | 610.06 | 609.80 | - | - |
| GMW-24 | 2" | 35.5 | 5.0 | siltstone | deep | 618.73 | 618.37 | - | - |

Notes: [1] GMW-6 abandoned and replaced on 3/25/03

# Table 2-2
# Soil Data Summary Table
# PerkinElmer
# Missouri Metals Site
# Overland, Missouri

| Date | Soil Sample Location | Sample Depth (feet) | Compound Concentrations | | | | |
|---|---|---|---|---|---|---|---|
| | | | TCE mg/kg | PCE mg/kg | DCE mg/kg | Vinyl Chloride mg/kg | Methylene Chloride mg/kg |
| 2/1988[1] | OB-1 | 3.5-5.0 | <1.2 | 1.31 | <1.0 | NA | NA |
| | OB-2 | 3.5-5.0 | 12.85 | 21.30 | <1.0 | NA | NA |
| | OB-3 | 2.5-4.0 | <1.2 | 11.03 | 9.34 | NA | NA |
| | OB-4 | 3.0-4.5 | <1.2 | <0.3 | <1.0 | NA | NA |
| | OB-6 | 3.0-4.5 | <1.2 | <0.3 | <1.0 | NA | NA |
| | OB-7 | 2.5-4.0 | <1.2 | 6.73 | <1.0 | NA | NA |
| | OB-9 | 2.5-4.0 | <1.2 | <0.3 | <1.0 | NA | NA |
| | OB-11 | 2.5-4.0 | <1.2 | <0.3 | <1.0 | NA | NA |
| | OB-13 | 3.0-4.5 | <1.2 | 1.35 | <1.0 | NA | NA |
| | OB-15 | 3.5-5.0 | <1.2 | 2.65 | <1.0 | NA | NA |
| | OS-1 | surface | <1.2 | <0.3 | <1.0 | NA | NA |
| | OS-2 | surface | <1.2 | <0.3 | 1.57 | NA | NA |
| | OS-3 | surface | <1.2 | <0.3 | <1.0 | NA | NA |
| | OS-4 | surface | <1.2 | <0.3 | <1.0 | NA | NA |
| | OS-5 | surface | <1.2 | <0.3 | <1.0 | NA | NA |
| 7/1990[2] | SB-1G | 6.0-9.0 | <0.04 | <0.04 | <0.04 | <0.06 | <0.18 |
| | SB-2G | 2.0-3.0 | 0.08 | 0.13 | 0.07 | <0.06 | <0.18 |
| | SB-3G | 1.0-3.0 | 0.33 | 290 | <0.04 | <0.06 | <0.18 |
| | SB-4G | 3.0-6.0 | <0.04 | 0.17 | <0.04 | <0.06 | <0.18 |
| | GMW-5 | 3.0-6.0 | <0.04 | <0.04 | <0.04 | <0.06 | <0.18 |
| | GMW-6 | 6.0-9.0 | 0.56 | 7.30 | 0.23 | <0.06 | <0.18 |
| | GMW-7 | 6.0-9.0 | <0.04 | <0.04 | <0.04 | <0.06 | <0.18 |
| | GMW-8 | 6.0-9.0 | 0.10 | <0.04 | 0.27 | <0.06 | <0.18 |

# Table 2-2
## Soil Data Summary Table
## PerkinElmer
## Missouri Metals Site
## Overland, Missouri

| Date | Soil Sample Location | Sample Depth (feet) | Compound Concentrations TCE mg/kg | PCE mg/kg | DCE mg/kg | Vinyl Chloride mg/kg | Methylene Chloride mg/kg |
|---|---|---|---|---|---|---|---|
| 3/1992[3] | GMW-14 | 1.0-1.5 | 215 | 656 | 426 | <1.000 | <0.500 |
| | SB-1 | 19.0-19.4 | <0.005 | <0.005 | <0.005 | <0.010 | <0.005 |
| | SB-2 | 1.4-1.8 | <0.005 | 0.0143 | <0.005 | <0.010 | <0.005 |
| | | 19.0-19.4 | <0.005 | <0.005 | <0.005 | <0.010 | <0.005 |
| | SB-3 | 6.6-7.0 | <0.005 | <0.005 | <0.005 | <0.010 | <0.005 |
| | SB-6 | 2.0-2.6 | 0.157 | 1.73 | 0.133 | <0.010 | <0.005 |
| | | 7.2-7.8 | <0.005 | <0.005 | <0.005 | <0.010 | <0.005 |
| | | 13-14 | 0.0198 | 0.126 | 0.0744 | <0.010 | <0.005 |
| 4/1992[3] | GMW-15 | 1.2-1.5 | 0.0698 | 2.30 | 0.101 | <0.010 | <0.005 |
| | | 3.8-4.4 | 0.025 | 4.26 | 0.0072 | <0.010 | <0.005 |
| | | 9.0-9.6 | 0.0763 | 1.16 | 0.0822 | <0.010 | <0.005 |
| | GMW-16 | 19.0-19.4 | 0.0156 | <0.005 | 0.0734 | <0.010 | <0.005 |
| | GMW-17 | 0.8-1.3 | 304 | 1900 | 0.490 | <0.500 | <0.250 |
| | SB-4 | 1.1-1.4 | <1.250 | 684 | <1.250 | <2.500 | <1.250 |
| | | 5.5-5.7 | <0.005 | <0.005 | 0.197 | <0.010 | <0.005 |
| | | 10.6-11 | 0.0334 | 0.137 | 1.100 | 0.184 | <0.005 |
| 7/1992[3] | AS-3 | 4.0-4.4 | <0.005 | <0.005 | 0.001 J | <0.010 | 0.013 B |
| | AS-7 | 1.3-1.8 | 0.320 J | 0.200 J | 2.80 | 0.007 J | 0.011 B |
| | AS-8 | 3.3-3.9 | <0.005 | <0.005 | 0.06 | 0.004 J | 0.016 B |
| | AS-9 | 3.0-3.7 | 0.012 | 0.019 | 0.140 | 0.007 J | 0.014 B |

Notes:

[1] Burns & McDonnell Engineering Company, Inc., November 1992. *Remedial Investigation EG&G KT Aerofab Missouri Metals Site.* Appendix B and J. Borings completed by O'Brien and Gere.

[2] Burns & McDonnell Engineering Company, Inc., November 1992. *Remedial Investigation EG&G KT Aerofab Missouri Metals Site.* Appendix B. Borings completed by GTI and Burns & McDonnell.

[3] Burns & McDonnell Engineering Company, Inc., November 1992. *Remedial Investigation EG&G KT Aerofab Missouri Metals Site.* Sections 3 and 4. Borings completed by Burns & McDonnell.

NA = not analyzed

(shaded) = saturated zone

J = estimated value

B = analyte detected in method blank

# Table 2-3
## Groundwater Data Summary Table
## PerkinElmer
## Missouri Metals Site
## Overland, Missouri

| Monitoring Well | Sample Date | PCE (ug/L) MCL - 5 | TCE (ug/L) MCL - 5 | DCE (total) (ug/L) MCL - 70 | Vinyl Chloride (ug/L) MCL - 2 |
|---|---|---|---|---|---|
| GMW-1 | 05/05/97 | ND | ND | ND | ND |
| | 11/17/97 | ND | ND | ND | ND |
| | 06/03/98 | ND | ND | ND | ND |
| | 11/18/98 | ND | ND | ND | ND |
| | 05/27/99 | ND | ND | ND | ND |
| | 03/27/03 | ND | ND | ND | ND |
| | 11/24/03 | ND | ND | ND | ND |
| | 03/10/04 | ND | ND | ND | ND |
| | 07/21/04 | ND | ND | ND | ND |
| | 11/23/04 | ND | ND | ND | ND |
| GMW-3 | 05/05/97 | 12.4 J | 454.0 | 407.0 | 16.4 J |
| | 11/17/97 | ND | 385.0 | 369.0 | 19.7 |
| | 06/03/98 | ND | 370.0 | 280.0 | ND |
| | 11/18/98 | ND | 880.0 | 920.0 | 40 J |
| | 05/27/99 | ND | 860.0 | 970.0 | 34 J |
| pre-pilot | 12/04/01 | 3.1 J | 138.0 | 312.4 | 10.5 |
| post-pilot | 01/10/02 | ND | 65.1 | 478.3 | 19.2 |
| pre-full scale | 03/28/03 | 17 J | 26 J | 835.0 | 22.5 |
| | 11/24/03 | 84 J | 984.0 | 888.0 | 36 J |
| | 03/11/04 | 34.9 | 40.3 | 95.4 | 3.3 |
| | 07/20/04 | 2.5 J | 351.0 | 661.3 | 34.2 |
| | 11/23/04 | ND | 120.0 | 1,010.0 | 47.9 |
| GMW-4 | 12/05/01 | ND | ND | ND | ND |
| pre-full | 03/28/03 | 2.0 U* J | ND | ND | ND |
| | 11/24/03 | 2.6 U* J | ND | ND | ND |
| | 03/11/04 | ND | ND | ND | ND |
| | 07/20/04 | ND | ND | ND | ND |
| | 11/23/04 | ND | ND | ND | ND |
| GMW-5 | 05/06/97 | 10,400.0 | 4,830.0 | 3,800.0 | 713.0 |
| | 11/17/97 | 11,000.0 | 4,630.0 | 3,360.0 | 625 J |
| | 06/03/98 | 7,100.0 | 5,000.0 | 4,200.0 | 740.0 |
| | 11/18/98 | 7,900.0 | 4,800.0 | 4,700.0 | 600.0 |
| | 05/27/99 | 9,100.0 | 5,900.0 | 6,500.0 | 1,100.0 |
| pre-pilot | 12/04/01 | 1,510.0 | 1,120.0 | 2,995.0 | 239.0 |
| post-pilot | 01/11/02 | ND | ND | ND | ND |
| pre-full scale | 03/27/03 | 839.0 | 1,060.0 | 2,880.0 | 254.0 |
| | 11/24/03 | $KMnO_4$ | $KMnO_4$ | $KMnO_4$ | $KMnO_4$ |
| | 03/10/04 | 706.0 | 1,170.0 | 2,900 J | 390.0 |
| | 07/21/04 | 1,250.0 | 1,680.0 | 4,708.0 | 702.0 |
| | 11/23/04 | 1,140.0 | 1,670.0 | 4,820.0 | 657.0 |

# Table 2-3
# Groundwater Data Summary Table
# PerkinElmer
# Missouri Metals Site
# Overland, Missouri

| Monitoring Well | Sample Date | PCE (ug/L) MCL - 5 | TCE (ug/L) MCL - 5 | DCE (total) (ug/L) MCL - 70 | Vinyl Chloride (ug/L) MCL - 2 |
|---|---|---|---|---|---|
| GMW-6 | 05/06/97 | 47,400.0 | 25,200.0 | 25,200.0 | ND |
| | 11/17/97 | 15,800.0 | 12,400.0 | 18,600.0 | ND |
| | 06/03/98 | 67,000.0 | 26,000.0 | 22,000.0 | ND |
| | 11/18/98 | 53,000.0 | 21,000.0 | 21,000.0 | ND |
| | 05/27/99 | 72,000.0 | 26,000.0 | 25,000.0 | ND |
| pre-pilot | 12/04/01 | 64,100.0 | 19,800.0 | 19,517.0 | 797.0 |
| post-pilot | 01/11/02 | 57,000.0 | 17,100.0 | 16,400.0 | ND |
| GMW-6R pre-full | 03/27/03 | 46,400.0 | 19,300.0 | 22,500.0 | ND |
| | 11/24/03 | 36,500.0 | 13,100.0 | 10,600.0 | ND |
| | 03/10/04 | 54,400.0 | 23,100.0 | 23,300.0 | 582.0 |
| | 07/20/04 | $KMnO_4$ | $KMnO_4$ | $KMnO_4$ | $KMnO_4$ |
| | 11/24/04 | $KMnO_4$ | $KMnO_4$ | $KMnO_4$ | $KMnO_4$ |
| GMW-7 | 05/05/97 | ND | 2,180.0 | 401.0 | ND |
| | 11/17/97 | ND | 2,120.0 | 346.0 | ND |
| | 06/03/98 | ND | 2,300.0 | 410.0 | ND |
| | 11/18/98 | ND | 3,200.0 | 460.0 | ND |
| | 05/27/99 | ND | 2,200.0 | 490.0 | ND |
| pre-full scale | 03/28/03 | 25 J | 612.0 | 347.0 | 23.2 |
| | 11/24/03 | 52 J | 487.0 | 282.0 | ND |
| | 03/10/04 | 7.6 | 468.0 | 305.3 J | 14.1 |
| | 07/20/04 | 9.7 | 534.0 | 271.8 | 13.1 |
| | 11/23/04 | 5.7 J | 335.0 | 220.0 | 8.8 J |
| GMW-8 | 05/05/97 | ND | 8,120.0 | 24,500.0 | 2,450.0 |
| | 11/17/97 | 835 J | 8,260.0 | 27,600.0 | 2,770.0 |
| | 06/03/98 | ND | 7,100.0 | 26,000.0 | 1,800.0 |
| | 11/18/98 | ND | 7,900.0 | 32,000.0 | 2,700.0 |
| | 05/27/99 | ND | 5,300.0 | 22,000.0 | 1,400.0 |
| pre-pilot | 12/04/01 | 1,140.0 | 7,110.0 | 25,864.0 | 2,030.0 |
| post-pilot | 01/10/02 | ND | 6,880.0 | 22,400.0 | 1,900.0 |
| pre-full scale | 03/28/03 | 200 J | 3,640.0 | 14,100.0 | 731.0 |
| | 11/25/03 | 920 J | 2,400 J | 15,100.0 | 710 J |
| | 03/11/04 | ND | 1,310.0 | 8,380.0 | 459.0 |
| | 07/20/04 | ND | 2,190.0 | 12,000.0 | 380.0 |
| | 11/23/04 | ND | 3,030.0 | 19,000.0 | 889.0 |
| GMW-9 | 05/05/97 | ND | 8,810.0 | 571.0 | ND |
| | 11/17/97 | ND | 9,220.0 | 577.0 | ND |
| | 06/03/98 | ND | 8,300.0 | 500.0 | ND |
| | 11/18/98 | ND | 8,800.0 | 650.0 | ND |
| | 05/27/99 | ND | 7,300.0 | 570.0 | ND |
| post-pilot | 01/10/02 | ND | ND | ND | ND |
| pre-full scale | 03/28/03 | 8.0 | 148.0 | 97.2 | 3.2 |
| | 11/25/03 | 83 J | 980.0 | 831.0 | ND |
| | 03/11/04 | ND | 592.0 | 1,020.0 | ND |
| | 07/20/04 | ND | 591.0 | 1,150.0 | ND |
| | 11/23/04 | ND | 676.0 | 655.0 | 13 J |

# Table 2-3
# Groundwater Data Summary Table
# PerkinElmer
# Missouri Metals Site
# Overland, Missouri

| Monitoring Well | Sample Date | PCE (ug/L) MCL - 5 | TCE (ug/L) MCL - 5 | DCE (total) (ug/L) MCL - 70 | Vinyl Chloride (ug/L) MCL - 2 |
|---|---|---|---|---|---|
| GMW-10 | 05/22/96 | 187.0 | 543.0 | 533.0 | 30.1 |
| pre-full scale | 03/28/03 | 66.4 | 50.3 | 45.2 | ND |
| | 11/25/03 | 28.8 | 20.1 | 36.1 | ND |
| | 03/11/04 | 5.5 | 5.7 | 39.1 J | 4.0 |
| | 07/21/04 | 5.6 | 4.9 J | 40.6 | 4.7 |
| | 11/24/04 | 4.7 J | 6.9 | 38.6 | 2.6 |
| GMW-11 | 05/05/97 | ND | 258.0 | 1,290.0 | ND |
| | 11/17/97 | ND | 257.0 | 1,780.0 | ND |
| | 06/03/98 | ND | 150.0 | 1,200.0 | ND |
| | 11/18/98 | ND | 460.0 | 1,600.0 | ND |
| | 05/27/99 | ND | 540.0 | 1,800.0 | ND |
| pre-full scale | 03/28/03 | 4.5 U* J | 60.6 | 176.9 J | 3.1 |
| | 11/25/03 | 4.0 U* J | 44.7 | 198.5 J | 4.6 |
| | 03/11/04 | 2.2 J | 49.5 | 174.3 J | 6.4 |
| | 07/21/04 | ND | 12.2 | 77.3 | 11.3 |
| | 11/24/04 | ND | 8.8 | 76.0 | 10.2 |
| GMW-14 | 05/05/97 | 103,000.0 | 123,000.0 | ND | 11,700.0 |
| | 11/17/97 | ND | 43,800.0 | 72,200.0 | 7,040.0 |
| | 06/03/98 | ND | 50,000.0 | 72,000.0 | 5,100.0 |
| | 11/18/98 | ND | 57,000.0 | 84,000.0 | 6,900.0 |
| | 05/27/99 | 2,600 J | 58,000.0 | 85,000.0 | 7,200.0 |
| pre-pilot | 12/04/01 | 3,580.0 | 39,600.0 | 69,768.4 | 6,180.0 |
| post-pilot | 01/10/02 | ND | ND | ND | ND |
| pre-full scale | 03/28/03 | 4,640.0 | 50,700.0 | 64,400.0 | 2,400.0 |
| | 11/24/03 | $KMnO_4$ | $KMnO_4$ | $KMnO_4$ | $KMnO_4$ |
| | 03/11/04 | $KMnO_4$ | $KMnO_4$ | $KMnO_4$ | $KMnO_4$ |
| | 07/20/04 | $KMnO_4$ | $KMnO_4$ | $KMnO_4$ | $KMnO_4$ |
| | 11/23/04 | $KMnO_4$ | $KMnO_4$ | $KMnO_4$ | $KMnO_4$ |

# Table 2-3
# Groundwater Data Summary Table
# PerkinElmer
# Missouri Metals Site
# Overland, Missouri

| Monitoring Well | Sample Date | PCE (ug/L) MCL - 5 | TCE (ug/L) MCL - 5 | DCE (total) (ug/L) MCL - 70 | Vinyl Chloride (ug/L) MCL - 2 |
|---|---|---|---|---|---|
| GMW-15 | 05/06/97 | 39,200.0 | 9,030.0 | 13,500.0 | ND |
| | 06/03/98 | 53,000.0 | 10,000.0 | 17,000.0 | ND |
| | 11/18/98 | 67,000.0 | 18,000.0 | 24,000.0 | ND |
| | 05/27/99 | 74,000.0 | 23,000.0 | 22,000.0 | ND |
| pre-pilot | 12/04/01 | 65,200.0 | 14,500.0 | 23,834.5 | 940 J |
| post-pilot | 01/11/02 | 66,500.0 | 27,200.0 | 19,300.0 | ND |
| pre-full scale | 03/27/03 | 68,100.0 | 17,600.0 | 21,900.0 | ND |
| | 11/24/03 | 64,300.0 | 67,900.0 | 13,700.0 | ND |
| | 03/10/04 | 73,800.0 | 25,500.0 | 27,600.0 | 500 J |
| | 07/20/04 | $KMnO_4$ | $KMnO_4$ | $KMnO_4$ | $KMnO_4$ |
| | 11/23/04 | $KMnO_4$ | $KMnO_4$ | $KMnO_4$ | $KMnO_4$ |
| GMW-16 | 05/05/97 | ND | 48.0 | 32.8 | ND |
| | 11/17/97 | 3.0 | 56.3 | 20.5 | ND |
| | 06/03/98 | ND | 150.0 | 90.0 | ND |
| | 11/19/98 | 3.0 | 36.0 | 20.0 | ND |
| | 05/27/99 | 4.0 J | 60.0 | 38.0 | ND |
| pre-pilot | 12/04/01 | 18.0 J | 158.0 | 178.5 | ND |
| post-pilot | 01/10/02 | 1.6 J | 89.3 | 97.2 | ND |
| pre-full scale | 03/28/03 | 390 J | 5,390.0 | 14,100.0 | 82 J |
| | 04/08/03 | 360 J | 5,750.0 | 13,000.0 | ND |
| | 11/24/03 | $KMnO_4$ | $KMnO_4$ | $KMnO_4$ | $KMnO_4$ |
| | 03/11/04 | $KMnO_4$ | $KMnO_4$ | $KMnO_4$ | $KMnO_4$ |
| | 07/20/04 | $KMnO_4$ | $KMnO_4$ | $KMnO_4$ | $KMnO_4$ |
| | 11/23/04 | $KMnO_4$ | $KMnO_4$ | $KMnO_4$ | $KMnO_4$ |
| GMW-17 | 05/06/97 | ND | 386.0 | ND | ND |
| | 11/17/97 | ND | 513.0 | ND | ND |
| | 06/03/98 | ND | 340.0 | ND | ND |
| | 11/18/98 | ND | 560.0 | ND | ND |
| | 05/27/99 | ND | 460.0 | ND | ND |
| pre-pilot | 12/05/01 | 50.9 | 664.0 | 28.0 J | ND |
| post-pilot | 01/11/02 | 90.3 | 673.0 | 34.0 | ND |
| pre-full scale | 03/27/03 | 339.0 | 772.0 | 132.0 | ND |
| | 11/24/03 | 1,530.0 | 2,620.0 | 450 J | ND |
| | 03/10/04 | 100 J | 2,020.0 | 64 J | ND |
| | 07/21/04 | 119.0 | 1,300.0 | 67 J | ND |
| | 11/23/04 | 100 J | 1,060.0 | 60 J | ND |

# Table 2-3
# Groundwater Data Summary Table
# PerkinElmer
# Missouri Metals Site
# Overland, Missouri

| Monitoring Well | Sample Date | PCE (ug/L) MCL - 5 | TCE (ug/L) MCL - 5 | DCE (total) (ug/L) MCL - 70 | Vinyl Chloride (ug/L) MCL - 2 |
|---|---|---|---|---|---|
| GMW-19 | 08/18/00 | ND | 11,000.0 | 2,900.0 | ND |
| | 03/02/01 | 260 J | 4,300.0 | 1,200.0 | ND |
| pre-pilot | 12/05/01 | 200 B | 7,180.0 | 2,463.1 | 3.3 |
| post-pilot | 01/10/02 | ND | 622.0 | 944.0 | ND |
| pre-full scale | 03/28/03 | 362.0 | 9,060.0 | 3,100.0 | ND |
| | 11/25/03 | 670 J | 11,600.0 | 4,320.0 | ND |
| | 03/11/04 | 280 J | 9,690.0 | 3,720.0 | ND |
| | 07/20/04 | 200 J | 8,070.0 | 3,030.0 | ND |
| | 11/23/04 | 180 J | 7,870.0 | 3,030.0 | ND |
| GMW-20 | 08/18/00 | ND | 2,000.0 | ND | ND |
| | 03/02/01 | ND | 1,700.0 | 400.0 | ND |
| pre-pilot | 12/05/01 | 44.0 | 2,260.0 | 522.3 | ND |
| post-pilot | 01/10/02 | ND | 117.0 | 176.0 | ND |
| pre-full scale | 03/28/03 | 62 J | 1,900.0 | 524.0 | ND |
| | 11/25/03 | 170 J | 1,860.0 | 591.0 | ND |
| | 03/11/04 | 95 J | 2,910.0 | 663.0 | ND |
| | 07/20/04 | 34 J | 2,400.0 | 622.0 | ND |
| | 11/23/04 | 28 J | 2,500.0 | 656.0 | ND |

Notes:
PCE - Tetrachloroethylene
TCE - Trichloroethylene
DCE (total) - Dichloroethylene
ug/L - Micrograms per liter
MCL - Maximum contaminant level for drinking water
ND - Not detected
J - Qualified as estimated
U* - Qualified as undetected
$KMnO_4$ - Potassium permanganate

# Table 3-1
## Data Summary and Identification of COPCs in Soil
## Perkin Elmer
## Missouri Metals Site
## Overland, Missouri

| | Number of Positive Detections | Number of Samples | Percent Positive Detections | Maximum Concentration (mg/kg) | Depth (feet) | Location | 95 Percent UCL (mg/kg) | Screening Level (mg/kg) |
|---|---|---|---|---|---|---|---|---|
| **Volatiles** | | | | | | | | |
| Acetone | 7 | 21 | 33% | 4.64E-01 | 5.5-5.7 | SB-4/CME-2 | 1.46E-01 | 5.40E+04* |
| Benzene | 1 | 5 | 20% | 1.00E-03 | 5.5-5.7 | SB-4/CME-2 | 3.45E-03 | 1.70E+02 |
| 2-Butanone | 3 | 9 | 33% | 1.20E+00 | 1.3-1.8 | AS-7/S-1 | 6.51E-01 | NA |
| 1,1-Dichloroethene | 1 | 19 | 5% | 1.00E-03 | 1.3-1.8 | AS-7/S-1 | 1.13E+00 | 8.30E+00 |
| 1,2-Dichloroethene (total) | 21 | 50 | 42% | 4.26E+02 | 1.0-1.5 | GMW-14/CME-1 | 4.17E+01 | 5.60E+02[1] |
| Ethylbenzene | 2 | 4 | 50% | 1.00E-03 | 1.0-1.5 & 3.3-3.9 | AS-7/S-1 & AS-8/S-2 | 5.57E-03 | 4.00E+02* |
| 2-Hexanone | 1 | 5 | 20% | 2.00E-03 | 5.5-5.7 | SB-4/CME-2 | 6.62E-02 | NA |
| Methylene chloride | 5 | 9 | 56% | 7.50E-02 | 3.8-4.4 | GMW-15/CME-2 | 3.52E-02 | 6.70E+02 |
| Tetrachloroethene | 25 | 50 | 50% | 1.90E+03 | 0.8-1.3 | GMW-17/CME-1 | 2.47E+02 | 3.80E+02 |
| Toluene | 5 | 9 | 56% | 4.00E-03 | 3.3-3.9 | AS-8/S-2 | 3.26E-03 | 1.10E+04 |
| 1,1,1-Trichloroethane | 3 | 15 | 20% | 3.89E+00 | 3.0-4.5 | OB-13 | 3.27E+00 | 2.00E+03 |
| Trichloroethene | 17 | 50 | 34% | 3.04E+02 | 0.8-1.3 | GMW-17/CME-1 | 3.92E+01 | 2.60E+02 |
| 1,1,2-Trichloroethene | 1 | 4 | 25% | 5.00E-03 | 1.3-1.8 | AS-7/S-1 | 4.67E-03 | NA |
| Vinyl chloride | 4 | 9 | 44% | 1.84E-01 | 10.6-11.0 | SB-4/CME-3 | 2.23E-01 | 7.50E-01* |
| Xylenes, total | 5 | 9 | 56% | 6.19E-01 | 19.6-20.0 | SB-4/CME-4 | 7.52E-01 | 4.20E+02* |

Notes:
[1] - Screening level is for cis-1,2-Dichloroethene.
Screening levels represent the cleanup goals established in the consent order unless otherwise noted.
*Screening level obtained from USEPA Region 9 PRG table (USEPA, 2004).
Shaded values indicate exceedance of screening level.
mg/kg - milligrams per kilogram

## Table 3-2
## Data Summary and Identification of COPCs in Groundwater
## Monitoring Wells GMW-3, 7, 8, 9
## Perkin Elmer
## Missouri Metals Site
## Overland, Missouri

| | Number of Positive Detections | Number of Samples | Percent Positive Detections | Maximum Concentration (mg/L) | Location | Date | 95 Percent UCL (mg/L) | Screening Level (mg/L) |
|---|---|---|---|---|---|---|---|---|
| **Volatiles** | | | | | | | | |
| 1,1-Dichloroethene | 3 | 16 | 19% | 1.25E+00 | GMW-8 | 11/24/03 | 4.55E-01 | 7.00E-03 |
| cis-1,2-Dichloroethene | 16 | 16 | 100% | 1.90E+01 | GMW-8 | 11/23/04 | 1.00E+01 | 7.00E-02 |
| trans-1,2-Dichloroethene | 1 | 16 | 6% | 1.25E+00 | GMW-8 | 11/24/03 | 4.54E-01 | 1.00E-01 |
| Tetrachloroethene | 9 | 16 | 56% | 9.20E-01 | GMW-8 | 11/24/03 | 3.51E-01 | 5.00E-03 |
| Trichloroethene | 16 | 16 | 100% | 3.03E+00 | GMW-8 | 11/23/04 | 1.81E+00 | 5.00E-03 |
| Vinyl chloride | 12 | 16 | 75% | 8.89E-01 | GMW-8 | 11/23/04 | 4.53E-01 | 2.00E-03 |

Notes:
Screening levels represent the cleanup goals established in the consent order.
Shaded values indicate exceedance of screening level.
mg/L - milligrams per Liter

# Table 3-3
## Data Summary and Identification of COPCs in Groundwater
## Monitoring Wells GMW-5 6
## Perkin Elmer
## Missouri Metals Site
## Overland, Missouri

| | Number of Positive Detections | Number of Samples | Percent Positive Detections | Maximum Concentration (mg/L) | Location | Date | 95 Percent UCL (mg/L) | Screening Level (mg/L) |
|---|---|---|---|---|---|---|---|---|
| **Volatiles** | | | | | | | | |
| 1,1-Dichloroethene | 0 | 5 | 0% | ND | NA | NA | NA | 7.00E-03 |
| cis-1,2-Dichloroethene | 5 | 5 | 100% | 2.33E+01 | GMW-6 | 3/10/04 | 1.72E+01 | 7.00E-02 |
| trans-1,2-Dichloroethene | 2 | 5 | 40% | 4.00E-02 | GMW-5 | 3/10/04 | 4.51E+00 | 1.00E-01 |
| Tetrachloroethene | 5 | 5 | 100% | 5.44E+01 | GMW-6 | 3/10/04 | 4.28E+01 | 5.00E-03 |
| Trichloroethene | 5 | 5 | 100% | 2.31E+01 | GMW-6 | 3/10/04 | 1.74E+01 | 5.00E-03 |
| Vinyl chloride | 4 | 5 | 80% | 7.02E-01 | GMW-5 | 7/21/04 | 8.77E-01 | 2.00E-03 |

Notes:
Screening levels represent the cleanup goals established in the consent order.
Shaded values indicate exceedance of screening level.
mg/L - milligrams per Liter

# Table 4-1
## Noncancer Toxicity Information for Chemicals of Potential Concern
## Perkin Elmer
## Missouri Metals Site
## Overland, Missouri

| Parameter | Oral RfD[1] (mg/kg/day) | Source | Toxic Effect of Concern | Inhalation RfD[2] (mg/kg/day) | Source | Toxic Effect of Concern |
|---|---|---|---|---|---|---|
| **Volatiles** | | | | | | |
| 1,1-Dichloroethene | 5E-02 | IRIS | Liver toxicity (fatty change) | 6E-02 | IRIS | Liver toxicity (fatty change) |
| cis-1,2-Dichloroethene | 1E-02/1E-01 | PPRTV | | | | |
| trans-1,2-Dichloroethene | 2E-02 | IRIS | Increased serum alkaline phosphatase in male mice | | | |
| Tetrachloroethene | 1E-02/1E-01 | IRIS | Hepatotoxicity in mice, weight gain in rats | 1E-02 | OEHHA | Kidney; alimentary system (liver) |
| Trichloroethene | 3E-04 | Region 9 | | 2E-01 | OEHHA | Nervous system, eyes |
| Vinyl Chloride | 3E-03 | IRIS | Liver cell polymorphism | 3E-02 | IRIS | Liver cell polymorphism |

Notes:
1 - Subchronic reference values, if available in HEAST, are listed following the slash mark.
2 - RfC ($mg/m^3$) values are converted to RfD (mg/kg/day) values using the equation provided in the preface of HEAST.
IRIS - Integrated Risk Information System (USEPA, 2005)
HEAST - Health Effects Assessment Summary Tables (USEPA, 1997a)
OEHHA - California Office of Environmental Health Hazard Assessment, Toxicity Criteria Database (OEHHA, 2005).
PPRTV - Provisional Peer-Reviewed Toxicity Values
Region 9 - USEPA Region 9 Preliminary Remediation Goals (PRGs) (USEPA, 2004)
Blanks indicate that information is not available.
RfD - Reference Dose
RfC - Reference Concentration
mg/kg/day - milligrams per kilogram per day

# Table 4-2
# USEPA Carcinogen Classification*
# Perkin Elmer
# Missouri Metals Site
# Overland, Missouri

**CARCINOGEN CATEGORIES**

A Human carcinogen

B Probable human carcinogen

C Possible human carcinogen

D Not classifiable

E Evidence of noncarcinogenicity

**WEIGHT-OF-EVIDENCE CLASSIFICATION MATRIX**

| | Animal Evidence | | | | |
|---|---|---|---|---|---|
| Human Evidence | Sufficient | Limited | Inadequate | No Data | No Evidence |
| Sufficient | A | A | A | A | A |
| Limited | B1 | B1 | B1 | B1 | B1 |
| Inadequate | B2 | C | D | D | D |
| No Data | B2 | C | D | D | E |
| No Evidence | B2 | D | D | D | E |

Notes: The B category is subdivided into B1 and B2, with the strength of any available human data being the deciding factor.
USEPA = United States Environmental Protection Agency

* FR, 1986

# Table 4-3
# Cancer Toxicity Information
# for Chemicals of Potential Concern
# Perkin Elmer
# Missouri Metals Site
# Overland, Missouri

| Parameter | Weight-of-Evidence Classification[1] | Oral Slope Factor 1/(mg/kg/day) | Source | Inhalation Slope Factor[2] 1/(mg/kg/day) | Source | Site of Tumor |
|---|---|---|---|---|---|---|
| **Volatiles** | | | | | | |
| 1,1-Dichloroethene | C | | | | | |
| cis-1,2-Dichloroethene | D | | | | | |
| trans-1,2-Dichloroethene | | | | | | |
| Tetrachloroethene | | 5E-01 | OEHHA | 2E-02 | OEHHA | Liver |
| Trichloroethene | | 1E-02 | OEHHA | 7E-03 | OEHHA | Nervous system, eyes |
| Vinyl Chloride | A | 8E-01 | IRIS | 2E-02 | IRIS | Liver |

Notes:
[1] - Weight of evidence classifications obtained from IRIS.
[2] - Unit risk [1/(mg/m³)] values are converted to slope factors [1/(mg/kg/day)] values using the equation provided in the preface of HEAST.
IRIS - Integrated Risk Information System (USEPA, 2005)
HEAST - Health Effects Assessment Summary Tables (USEPA, 1997a)
OEHHA - California Office of Environmental Health Hazard Assessment, Toxicity Criteria Database (OEHHA, 2005).
Blanks indicate that information is not available.
$mg/m^3$ - milligrams per cubic meter
mg/kg/day - milligrams per kilogram per day

# Table 5-1
# Formula for Inhalation of Vapor Phase Chemicals*
# Perkin Elmer

Equation:
IN = CA x IR x ET x EF x ED / (BW x AT)

Where:

| | | |
|---|---|---|
| CA | = | Chemical concentrations in air (milligram per cubic meter [$mg/m^3$]) |
| IR | = | Inhalation rate (cubic meter per hour [$m^3/hr$]) |
| ET | = | Exposure time (hours/day) |
| EF | = | Exposure frequency (days/year) |
| ED | = | Exposure duration (years) |
| BW | = | Body weight (kilogram [kg]) |
| AT | = | Averaging time (days) |

Indoor Worker Variable Values:

| | | |
|---|---|---|
| CA | = | Modeled to indoor air from groundwater data (See Table ?) |
| IR | = | 0.633 $m^3/hr$ (mean value for adults) (USEPA, 1997a) |
| ET | = | 8 hours/day (Standard working day) |
| EF | = | 250 days/year (USEPA, 1991) |
| ED | = | 25 years (USEPA, 1991) |
| BW | = | 70 kg (USEPA, 1989) |
| AT | = | 9,125 days for noncancer effects [25 years (ED) x 365 days/year] (USEPA, 1989)<br>25,550 days for cancer effects [70 years (Lifetime) x 365 days/year] (USEPA, 1989) |

Outdoor Worker Variable Values:

| | | |
|---|---|---|
| CA | = | Modeled to outdoor air from groundwater data (See Table ?) |
| IR | = | 1.3 $m^3/hr$ (Hourly average for outdoor workers) (USEPA, 1997a) |
| ET | = | 8 hrs/day (Standard working day) |
| EF | = | 125 days/year (See text) |
| ED | = | 25 years (USEPA, 1991) |
| BW | = | 70 kg (USEPA, 1989) |
| AT | = | 9,125 days for noncancer effects [25 years (ED) x 365 days/year] (USEPA, 1989)<br>25,550 days for cancer effects [70 years (Lifetime) x 365 days/year] (USEPA, 1989) |

Construction Worker Variable Values:

| | | |
|---|---|---|
| CA | = | Modeled to outdoor air from groundwater data (See Table ?) |
| IR | = | 2.5 $m^3/hr$ (mean value for outdoor worker – heavy activity) (USEPA, 1997a) |
| ET | = | 8 hours/day (See text) |
| EF | = | 130 days/year (See text) |
| ED | = | 1 year (See text) |
| BW | = | 70 kg (USEPA, 1989) |
| AT | = | 180 days for noncancer effects<br>25,550 days for cancer effects [70 years (Lifetime) x 365 days/year] (USEPA, 1989) |

* USEPA, 1989

# Table 5-2
## Groundwater Data Set for Monitoring Wells GMW-3, 7, 8, & 9
## Perkin Elmer
## Missouri Metals,Bold"Bold"Site
## Overland, Missouri

| Monitoring Well | Date | DTW (ft) | Tetrachloroethene (mg/L) | | | Trichloroethene (mg/L) | | | cis-1,2-Dichloroethene (mg/L) | | | 1,1-Dichloroethene (mg/L) | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | Calc Value | | | Calc Value | | | Calc Value | | | Calc Value |
| GMW-3 | 11/24/2003 | 4.48 | 0.084 | J | 0.084 | 0.984 | | 0.984 | 0.888 | | 0.888 | 0.250 | U | 0.125 |
| | 3/10/2004 | | 0.035 | | 0.035 | 0.040 | | 0.040 | 0.095 | | 0.095 | 0.005 | U | 0.003 |
| | 7/21/2004 | | 0.003 | J | 0.003 | 0.351 | | 0.351 | 0.652 | | 0.652 | 0.003 | J | 0.003 |
| | 11/23/2004 | 5.17 | 0.025 | U | 0.013 | 0.120 | | 0.120 | 1.010 | | 1.010 | 0.025 | U | 0.013 |
| GMW-7 | 11/24/2003 | 3.07 | 0.052 | J | 0.052 | 0.487 | | 0.487 | 0.282 | | 0.282 | 0.125 | U | 0.063 |
| | 3/10/2004 | | 0.008 | | 0.008 | 0.468 | | 0.468 | 0.302 | | 0.302 | 0.002 | J | 0.002 |
| | 7/21/2004 | | 0.010 | | 0.010 | 0.534 | | 0.534 | 0.270 | | 0.270 | 0.002 | J | 0.002 |
| | 11/23/2004 | 3.47 | 0.006 | J | 0.006 | 0.335 | | 0.335 | 0.220 | | 0.220 | 0.025 | U | 0.025 |
| GMW-8 | 11/24/2003 | 3.71 | 0.920 | J | 0.920 | 2.400 | J | 2.400 | 15.100 | | 15.100 | 2.500 | U | 1.250 |
| | 3/10/2004 | | 0.500 | U | 0.250 | 1.310 | | 1.310 | 8.380 | | 8.380 | 0.500 | U | 0.250 |
| | 7/21/2004 | | 0.250 | U | 0.125 | 2.190 | | 2.190 | 12.000 | | 12.000 | 0.250 | U | 0.125 |
| | 11/23/2004 | 4.78 | 0.500 | U | 0.250 | 3.030 | | 3.030 | 19.000 | | 19.000 | 0.500 | U | 0.250 |
| GMW-9 | 11/24/2003 | 4.03 | 0.083 | J | 0.083 | 0.980 | | 0.980 | 0.831 | | 0.831 | 0.250 | U | 0.125 |
| | 3/10/2004 | | 0.125 | U | 0.063 | 0.592 | | 0.592 | 1.020 | | 1.020 | 0.125 | U | 0.063 |
| | 7/21/2004 | | 0.100 | U | 0.050 | 0.591 | | 0.591 | 1.150 | | 1.150 | 0.100 | U | 0.050 |
| | 11/23/2004 | 5.31 | 0.100 | U | 0.050 | 0.676 | | 0.676 | 0.655 | | 0.655 | 0.100 | U | 0.050 |

**Notes:**

Column labeled "Calc Value" shows the value used in the upper confidence limit calculations.

J - Qualified as estimated

U - Chemical not detected at identified reporting reporting limit

One-half the reporting limit was used as proxy value for undetected compounds.

# Table 5-2
## Groundwater Data Set for Monitoring Wells GMW-3, 7, 8, & 9
## Perkin Elmer
## Missouri Metals,Bold"Bold"Site
## Overland, Missouri

| Monitoring Well | Date | DTW (ft) | trans-1,2-Dichloroethene (mg/L) | | Calc Value | Vinyl Chloride (mg/L) | | Calc Value |
|---|---|---|---|---|---|---|---|---|
| GMW-3 | 11/24/2003 | 4.48 | 0.250 | U | 0.125 | 0.036 | J | 0.036 |
| | 3/10/2004 | | 0.005 | U | 0.003 | 0.003 | | 0.003 |
| | 7/21/2004 | | 0.005 | U | 0.003 | 0.034 | | 0.034 |
| | 11/23/2004 | 5.17 | 0.025 | U | 0.013 | 0.048 | | 0.048 |
| GMW-7 | 11/24/2003 | 3.07 | 0.125 | U | 0.063 | 0.050 | U | 0.025 |
| | 3/10/2004 | | 0.002 | J | 0.002 | 0.014 | | 0.014 |
| | 7/21/2004 | | 0.005 | U | 0.003 | 0.013 | | 0.013 |
| | 11/23/2004 | 3.47 | 0.025 | U | 0.013 | 0.009 | J | 0.009 |
| GMW-8 | 11/24/2003 | 3.71 | 2.500 | U | 1.250 | 0.710 | J | 0.710 |
| | 3/10/2004 | | 0.500 | U | 0.250 | 0.459 | | 0.459 |
| | 7/21/2004 | | 0.250 | U | 0.125 | 0.380 | | 0.380 |
| | 11/23/2004 | 4.78 | 0.500 | U | 0.250 | 0.889 | | 0.889 |
| GMW-9 | 11/24/2003 | 4.03 | 0.250 | U | 0.125 | 0.100 | U | 0.050 |
| | 3/10/2004 | | 0.125 | U | 0.063 | 0.050 | U | 0.025 |
| | 7/21/2004 | | 0.100 | U | 0.050 | 0.040 | U | 0.020 |
| | 11/23/2004 | 5.31 | 0.100 | U | 0.050 | 0.013 | J | 0.013 |

**Notes:**

Column labeled "Calc Value" shows the value used in the upper confidence limit calculations.

J - Qualified as estimated

U - Chemical not detected at identified reporting reporting limit

One-half the reporting limit was used as proxy value for undetected compounds.

# Table 5-3
## Groundwater Data Set for Monitoring Wells GMW-5 & 6
## Perkin Elmer
## Missouri Metals Site
## Overland, Missouri

| Monitoring Well | Date | DTW (ft) | Tetrachloroethene (mg/L) | | Calc Value | Trichloroethene (mg/L) | | Calc Value | cis-1,2-Dichloroethene (mg/L) | | Calc Value | 1,1-Dichloroethene (mg/L) | | Calc Value |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| GMW-5 | 11/24/2003 | 10.87 | $KMnO_4$ | | $KMnO_4$ | $KMnO_4$ | | $KMnO_4$ | $KMnO_4$ | | $KMnO_4$ | $KMnO_4$ | | $KMnO_4$ |
| | 3/10/2004 | | 0.706 | | 0.706 | 1.170 | | 1.170 | 2.860 | | 2.860 | 0.200 | U | 0.100 |
| | 7/21/2004 | | 1.250 | | 1.250 | 1.680 | | 1.680 | 4.670 | | 4.670 | 0.125 | U | 0.063 |
| | 11/23/2004 | 11.78 | 1.140 | | 1.140 | 1.670 | | 1.670 | 4.820 | | 4.820 | 0.250 | U | 0.125 |
| GMW-6 | 11/24/2003 | 0.83 | 36.500 | | 36.500 | 13.100 | | 13.100 | 10.600 | | 10.600 | 5.000 | U | 2.500 |
| | 3/10/2004 | | 54.400 | | 54.400 | 23.100 | | 23.100 | 23.300 | | 23.300 | 1.250 | U | 0.625 |
| | 7/21/2004 | | $KMnO_4$ | | $KMnO_4$ | $KMnO_4$ | | $KMnO_4$ | $KMnO_4$ | | $KMnO_4$ | $KMnO_4$ | | $KMnO_4$ |
| | 11/23/2004 | 5.80 | $KMnO_4$ | | $KMnO_4$ | $KMnO_4$ | | $KMnO_4$ | $KMnO_4$ | | $KMnO_4$ | $KMnO_4$ | | $KMnO_4$ |

**Notes:**

Column labeled "Calc Value" shows the value used in the upper confidence limit calculations.

J - Qualified as estimated

U - Chemical not detected at identified reporting reporting limit

One-half the reporting limit was used as proxy value for undetected compounds.

# Table 5-3
## Groundwater Data Set for Monitoring Wells GMW-5 & 6
## Perkin Elmer
## Missouri Metals Site
## Overland, Missouri

| Monitoring Well | Date | DTW (ft) | trans-1,2-Dichloroethene (mg/L) | | Calc Value | Vinyl Chloride (mg/L) | | Calc Value |
|---|---|---|---|---|---|---|---|---|
| GMW-5 | 11/24/2003 | 10.87 | $KMnO_4$ | | $KMnO_4$ | $KMnO_4$ | | $KMnO_4$ |
| | 3/10/2004 | | 0.040 | J | 0.040 | 0.390 | | 0.390 |
| | 7/21/2004 | | 0.038 | J | 0.038 | 0.702 | | 0.702 |
| | 11/23/2004 | 11.78 | 0.250 | U | 0.125 | 0.657 | | 0.657 |
| GMW-6 | 11/24/2003 | 0.83 | 5.000 | U | 2.500 | 2.000 | U | 1.000 |
| | 3/10/2004 | | 1.250 | U | 0.625 | 0.582 | | 0.582 |
| | 7/21/2004 | | $KMnO_4$ | | $KMnO_4$ | $KMnO_4$ | | $KMnO_4$ |
| | 11/23/2004 | 5.80 | $KMnO_4$ | | $KMnO_4$ | $KMnO_4$ | | $KMnO_4$ |

**Notes:**

Column labeled "Calc Value" shows the value used in the upper confidence limit calculations.

J - Qualified as estimated

U - Chemical not detected at identified reporting reporting limit

One-half the reporting limit was used as proxy value for undetected compounds.

# Table 5-4
## Exposure Concentrations in Groundwater
## Monitoring Wells GMW- 3, 7, 8, & 9
## Perkin Elmer
## Missouri Metals Site
## Overland, Missouri

| Parameter | Maximum Detected Concentration (mg/L) | 95 Percent Upper Confidence Limit (UCL) (mg/L) | Exposure Concentration Used in HHBRA (mg/L) |
|---|---|---|---|
| 1,1-Dichloroethene | 1.25E+00 | 4.55E-01 | 4.55E-01 |
| cis-1,2-Dichloroethene | 1.90E+01 | 1.00E+01 | 1.00E+01 |
| trans-1,2-Dichloroethene | 1.25E+00 | 4.54E-01 | 4.54E-01 |
| Tetrachloroethene | 9.20E-01 | 3.51E-01 | 3.51E-01 |
| Trichloroethene | 3.03E+00 | 1.81E+00 | 1.81E+00 |
| Vinyl Chloride | 8.89E-01 | 4.53E-01 | 4.53E-01 |

Notes:
Concentration used in HHBRA represents the lower of the 95 percent UCL or maximum detected concentration (USEPA, 1992).
95 percent UCL values were calculated using USEPA's ProUCL Software Version 3.00.02.
One-half of the detection limit was used in 95 percent UCL calculations as a proxy concentration for results that were non-detect.
HHBRA - Human Health Baseline Risk Assessment
mg/L - milligrams per Liter

# Table 5-5
## Exposure Concentrations in Groundwater
## Monitoring Wells GMW- 5 & 6
## Perkin Elmer
## Missouri Metals Site
## Overland, Missouri

| Parameter | Maximum Detected Concentration (mg/L) | 95 Percent Upper Confidence Limit (UCL) (mg/L) | Exposure Concentration Used in HHBRA (mg/L) |
|---|---|---|---|
| cis-1,2-Dichloroethene | 2.33E+01 | 1.72E+01 | 1.72E+01 |
| trans-1,2-Dichloroethene* | 4.00E-02 | 4.51E+00 | 4.00E-02 |
| Tetrachloroethene | 5.44E+01 | 4.28E+01 | 4.28E+01 |
| Trichloroethene | 2.31E+01 | 1.74E+01 | 1.74E+01 |
| Vinyl Chloride* | 7.02E-01 | 8.77E-01 | 7.02E-01 |

Notes:
Concentration used in HHBRA represents the lower of the 95 percent UCL or maximum detected concentration (USEPA, 1992).
95 percent UCL values were calculated using USEPA's ProUCL Software Version 3.00.02.
One-half of the detection limit was used in 95 percent UCL calculations as a proxy concentration for results that were non-detect.
HHBRA - Human Health Baseline Risk Assessment
mg/L - milligrams per Liter
* UCL Exceeds Max Detection

## Table 5-6
## USEPA Johnson & Ettinger Vapor Modeling Results
## for Indoor Air from Groundwater
## Monitoring Wells GMW-3, 7, 8, & 9
## Perkin Elmer
## Missouri Metals Site
## Overland, Missouri

| Parameter | Chemical Concentration in Groundwater (mg/L) | Modeled Chemical Concentration in Indoor Air from Groundwater ($mg/m^3$) |
|---|---|---|
| 1,1-Dichloroethene | 4.55E-01 | 1.49E-02 |
| cis-1,2-Dichloroethene | 1.00E+01 | 4.34E-02 |
| trans-1,2-Dichloroethene | 4.54E-01 | 4.67E-03 |
| Tetrachloroethene | 3.51E-01 | 5.71E-03 |
| Trichloroethene | 1.81E+00 | 1.86E-02 |
| Vinyl Chloride | 4.53E-01 | 1.82E-02 |

Notes:
Modeled chemical concentrations in air from groundwater taken from Appendix B.
$mg/m^3$ - milligrams per cubic meter
mg/L - milligrams per liter

# Table 5-7
# USEPA Johnson & Ettinger Vapor Modeling Results for Indoor Air from Groundwater Monitoring Wells GMW-5 & 6 Perkin Elmer Missouri Metals Site Overland, Missouri

| Parameter | Chemical Concentration in Groundwater (mg/L) | Modeled Chemical Concentration in Indoor Air from Groundwater (mg/m$^3$) |
|---|---|---|
| 1,1-Dichloroethene | 3.92E+00 | 1.29E-01 |
| cis-1,2-Dichloroethene | 1.72E+01 | 7.46E-02 |
| trans-1,2-Dichloroethene | 4.00E-02 | 4.11E-04 |
| Tetrachloroethene | 4.28E+01 | 6.97E-01 |
| Trichloroethene | 1.74E+01 | 2.00E-01 |
| Vinyl Chloride | 7.02E-01 | 2.82E-02 |

Notes:

Modeled chemical concentrations in air from groundwater taken from Appendix B.

mg/m$^3$ - milligrams per cubic meter

mg/L - milligrams per liter

# Table 5-8
# Volatilization Factor to Outdoor Air from Groundwater *
# Perkin Elmer
# Missouri Metals Site
# Overland, Missouri

Equation:

$$VF_{wamb}\left[\frac{L}{m^3}\right]=\frac{H'}{1+\left[\frac{U_{air}\times S_{air}\times L_{gw}}{W\times D_{ws}^{eff}}\right]}\times 10^3\ \frac{L}{m^3}$$

Where:

VFwamb = Volatilization factor from groundwater to outdoor air (Liters per cubic meter [L/m³])
H' = Henry's law constant (unitless)
Uair = Wind speed above ground surface in ambient mixing zone (centimeters per second [cm/s])
Sair = Ambient air mixing zone height (centimeters [cm])
Lgw = Depth to groundwater, which = hcap + hv (cm)
W = Width of source area parallel to wind, or groundwater flow direction (cm)
Deffws = Effective diffusion coefficient between groundwater and soil surface (squared centimeters per second [cm²/s])

Variables:

VFwamb = Calculated
H' = Chemical-specific (USEPA, 1996)
Uair = 469 cm/s (MDNR, 2005)
Sair = 200 cm (default breathing zone height, MDNR, 2005)
Lgw = 457 cm (See Text)
W = 4267 cm (Site-specific)
Deffws = Calculated (See Table 5-9)

| Chemical | H' (unitless) | Deffws (cm²/s) | VFwamb (L/m³) |
|---|---|---|---|
| 1,1-Dichloroethene | 1.07E+00 | 1.90E-03 | 2.02E-04 |
| cis-1,2-Dichloroethene | 1.67E-01 | 1.59E-03 | 2.65E-05 |
| trans-1,2-Dichloroethene | 3.85E-01 | 1.51E-03 | 5.78E-05 |
| Tetrachloroethene | 7.54E-01 | 1.52E-03 | 1.14E-04 |
| Trichloroethene | 4.22E-01 | 1.68E-03 | 7.04E-05 |
| Vinyl chloride | 1.11E+00 | 2.23E-03 | 2.46E-04 |

*ASTM, 1995

# Table 5-9
## Effective Diffusion Coefficient Between Groundwater and Soil Surface*
## Perkin Elmer
## Missouri Metals Site
## Overland, Missouri

Equation:

$$D_{ws}^{eff}\left[\frac{cm^2}{s}\right]=\frac{\left(h_{cap}+h_v\right)}{\left[\frac{h_{cap}}{D_{cap}^{eff}}+\frac{h_v}{D_s^{eff}}\right]}$$

Where:

Deffws = Effective diffusion coefficient between groundwater and soil surface (squared centimeters per second [$cm^2/s$])
hcap = Thickness of capillary fringe (centimeters [cm])
hv = Thickness of vadose zone (cm)
Deffcap = Effective diffusion coefficient through capillary fringe ($cm^2/s$)
Deffs = Effective diffusion coefficient in soil based on vapor-phase concentration ($cm^2/s$)

Variables:

Deffws = Calculated
hcap = 30 cm (See Appendix B)
hv = 427.2 cm
Deffcap = Chemical-specific (See Table 5-10)
Deffs = Chemical-specific (See Table 5-11)

| Chemical | Deffcap ($cm^2/s$) | Deffs ($cm^2/s$) | Deffws ($cm^2/s$) |
|---|---|---|---|
| 1,1-Dichloroethene | 2.29E-04 | 3.90E-03 | 1.90E-03 |
| cis-1,2-Dichloroethene | 1.96E-04 | 3.19E-03 | 1.59E-03 |
| trans-1,2-Dichloroethene | 1.84E-04 | 3.06E-03 | 1.51E-03 |
| Tetrachloroethene | 1.84E-04 | 3.12E-03 | 1.52E-03 |
| Trichloroethene | 2.03E-04 | 3.42E-03 | 1.68E-03 |
| Vinyl chloride | 2.68E-04 | 4.59E-03 | 2.23E-03 |

*ASTM, 1995

# Table 5-10
## Effective Diffusion Coefficient Through Capillary Fringe*
## Perkin Elmer
## Missouri Metals Site
## Overland, Missouri

Equation:

$$D_{cap}^{eff}\left[\frac{cm^2}{s}\right] = D^i \frac{\Theta_{acap}^{3.33}}{\Theta_T^2} + \left(D^w \times \frac{1}{H'} \times \frac{\Theta_{wcap}^{3.33}}{\Theta_T^2}\right)$$

Where:

Deffcap = Effective diffusion coefficient through capillary fringe (squared centimeters per second [cm²/s])
Di = Diffusion coefficient in air (cm²/s)
Oacap = Air-filled porosity in capillary fringe soils (liters per liter [L/L])
Dw = Diffusion coefficient in water (cm²/s)
Owcap = Water-filled porosity in capillary fringe soils (L/L)
Ot = Total soil porosity (L/L)
H' = Henry's law constant (unitless)

Variable Values:

Deffcap = Calculated
Di = Chemical-specific (USEPA, 1996)
Oacap = 0.104 L/L (See Appendix B)
Dw = Chemical-specific (USEPA, 1996)
Owcap = 0.355 L/L (See Appendix B)
Ot = 0.459 L/L (See Appendix B)
H' = Chemical-specific (USEPA, 1996)

| Chemical | Di (cm²/s) | Dw (cm²/s) | H' (unitless) | Deffcap (cm²/s) |
|---|---|---|---|---|
| 1,1-Dichloroethene | 9.00E-02 | 1.04E-05 | 1.07E+00 | 2.29E-04 |
| cis-1,2-Dichloroethene | 7.36E-02 | 1.13E-05 | 1.67E-01 | 1.96E-04 |
| trans-1,2-Dichloroethene | 7.07E-02 | 1.19E-05 | 3.85E-01 | 1.84E-04 |
| Tetrachloroethene | 7.20E-02 | 8.20E-06 | 7.54E-01 | 1.84E-04 |
| Trichloroethene | 7.90E-02 | 9.10E-06 | 4.22E-01 | 2.03E-04 |
| Vinyl chloride | 1.06E-01 | 1.23E-06 | 1.11E+00 | 2.68E-04 |

* ASTM, 1995

# Table 5-11
## Effective Diffusion Coefficient Through Soil*
## Perkin Elmer
## Missouri Metals Site
## Overland, Missouri

Equation:

$$D_s^{eff}\left[\frac{cm^2}{s}\right] = D^i \frac{\Theta_{as}^{3.33}}{\Theta_T^2} + \left(D^w \times \frac{1}{H'} \times \frac{\Theta_{ws}^{3.33}}{\Theta_T^2}\right)$$

Where:

Deffs = Effective diffusion coefficient in soil (squared centimeters per second [$cm^2$/s])
Di = Diffusion coefficient in air ($cm^2$/s)
Oas = Air-filled porosity in vadose zone soils (liters per liter [L/L])
Dw = Diffusion coefficient in water ($cm^2$/s)
Ows = Water-filled porosity in vadose zone soils (L/L)
Ot = Total soil porosity (L/L)
H' = Henry's law constant (unitless)

Variable Values:

Deffs = Calculated
Di = Chemical-specific (USEPA, 1996)
Oas = 0.244 L/L (See Appendix B)
Dw = Chemical-specific (USEPA, 1996)
Ows = 0.215 L/L (See Appendix B)
Ot = 0.459 L/L (See Appendix B)
H' = Chemical-specific (USEPA, 1996)

| Chemical | Di ($cm^2$/s) | Dw ($cm^2$/s) | H' (unitless) | Deffs ($cm^2$/s) |
|---|---|---|---|---|
| 1,1-Dichloroethene | 9.00E-02 | 1.04E-05 | 1.07E+00 | 3.90E-03 |
| cis-1,2-Dichloroethene | 7.36E-02 | 1.13E-05 | 1.67E-01 | 3.19E-03 |
| trans-1,2-Dichloroethene | 7.07E-02 | 1.19E-05 | 3.85E-01 | 3.06E-03 |
| Tetrachloroethene | 7.20E-02 | 8.20E-06 | 7.54E-01 | 3.12E-03 |
| Trichloroethene | 7.90E-02 | 9.10E-06 | 4.22E-01 | 3.42E-03 |
| Vinyl chloride | 1.06E-01 | 1.23E-06 | 1.11E+00 | 4.59E-03 |

*ASTM, 1995

# Table 5-12
## MRBCA Vapor Modeling Results for Outdoor Air from Groundwater
## Monitoring Wells GMW-3, 7, 8, & 9
## Perkin Elmer
## Missouri Metals Site
## Overland, Missouri

| Parameter | Chemical Concentration in Groundwater (mg/L) | Volatilization Factor in Groundwater ($L/m^3$) | Modeled Chemical Concentration in Outdoor Air from Groundwater ($mg/m^3$) |
|---|---|---|---|
| 1,1-Dichloroethene | 4.55E-01 | 2.02E-04 | 9.19E-05 |
| cis-1,2-Dichloroethene | 1.00E+01 | 2.65E-05 | 2.65E-04 |
| trans-1,2-Dichloroethene | 4.54E-01 | 5.78E-05 | 2.62E-05 |
| Tetrachloroethene | 3.51E-01 | 1.14E-04 | 4.00E-05 |
| Trichloroethene | 1.81E+00 | 7.04E-05 | 1.27E-04 |
| Vinyl Chloride | 4.53E-01 | 2.46E-04 | 1.11E-04 |

Notes:
Modeled chemical concentration in outdoor air from groundwater calculated by multiplying the chemical concentration in groundwater by the volatilaization factor in groundwater.
$L/m^3$ - liters per cubic meter
mg/L - milligrams per liter
$mg/m^3$ - milligrams per cubic meter

# Table 5-13
# MRBCA Vapor Modeling Results for Outdoor Air from Groundwater
# Monitoring Wells GMW-5 & 6
# Perkin Elmer
# Missouri Metals Site
# Overland, Missouri

| Parameter | Chemical Concentration in Groundwater (mg/L) | Volatilization Factor in Groundwater (L/m$^3$) | Modeled Chemical Concentration in Outdoor Air from Groundwater (mg/m$^3$) |
|---|---|---|---|
| 1,1-Dichloroethene | 3.92E+00 | 1.90E-03 | 7.45E-03 |
| cis-1,2-Dichloroethene | 1.72E+01 | 1.59E-03 | 2.73E-02 |
| trans-1,2-Dichloroethene | 4.00E-02 | 1.51E-03 | 6.04E-05 |
| Tetrachloroethene | 4.28E+01 | 1.52E-03 | 6.51E-02 |
| Trichloroethene | 1.74E+01 | 1.68E-03 | 2.92E-02 |
| Vinyl Chloride | 7.02E-01 | 2.23E-03 | 1.57E-03 |

Notes:
Modeled chemical concentration in outdoor air from groundwater calculated by multiplying the chemical concentration in groundwater by the volatilaization factor in groundwater.
L/m$^3$ - liters per cubic meter
mg/L - milligrams per liter
mg/m$^3$ - milligrams per cubic meter

# Table 6-1
# Hazard Index Estimates for
# Indoor Commercial/Industrial Worker Scenario
# Monitoring Wells GMW-3, 7, 8, & 9
# Perkin Elmer
# Missouri Metals Site
# Overland, Missouri

| Chemical | Daily Intake (mg/kg/day) | RfD (mg/kg/day) | Hazard Quotient | Pathway Hazard Index | Total Hazard Index |
|---|---|---|---|---|---|
| **Exposure Pathway: Inhalation of Indoor Air (Vapor Intrusion) (GMW-3, 7, 8, & 9)** | | | | | |
| **Volatiles** | | | | | |
| 1,1-Dichloroethene | 7.4E-04 | 6E-02 | 1E-02 | | |
| cis-1,2-Dichloroethene | 2.2E-03 | NAv | NAp | | |
| trans-1,2-Dichloroethene | 2.3E-04 | NAv | NAp | | |
| Tetrachloroethene | 2.8E-04 | 1E-02 | 3E-02 | | |
| Trichloroethene | 9.2E-04 | 2E-01 | 5E-03 | | |
| Vinyl Chloride | 9.0E-04 | 3E-02 | 3E-02 | | |
| | | | | 8E-02 | |
| | | | | | 8E-02 |

**Notes:**
NAv - Not available
NAp - Not applicable

## Table 6-2
## Hazard Index Estimates for
## Indoor Commercial/Industrial Worker Scenario
## Monitoring Wells GMW-5 & 6
## Perkin Elmer
## Missouri Metals Site
## Overland, Missouri

| Chemical | Daily Intake (mg/kg/day) | RfD (mg/kg/day) | Hazard Quotient | Pathway Hazard Index | Total Hazard Index |
|---|---|---|---|---|---|
| **Exposure Pathway: Inhalation of Indoor Air (Vapor Intrusion) (GMW-5 & 6)** | | | | | |
| **Volatiles** | | | | | |
| 1,1-Dichloroethene | 6.4E-03 | 6E-02 | 1E-01 | | |
| cis-1,2-Dichloroethene | 3.7E-03 | NAv | NAp | | |
| trans-1,2-Dichloroethene | 2.0E-05 | NAv | NAp | | |
| Tetrachloroethene | 3.5E-02 | 1E-02 | 3E+00 | | |
| Trichloroethene | 9.9E-03 | 2E-01 | 5E-02 | | |
| Vinyl Chloride | 1.4E-03 | 3E-02 | 5E-02 | | |
| | | | | 4E+00 | |
| | | | | | 4E+00 |

**Notes:**
NAv - Not available
NAp - Not applicable

# Table 6-3
# Excess Lifetime Cancer Risk Estimate for Indoor Commercial/Industrial Worker Scenario
# Monitoring Wells GMW-3, 7, 8, & 9
# Perkin Elmer
# Missouri Metals Site
# Overland, Missouri

| Chemical | Daily Intake (mg/kg/day) | Slope Factor (mg/kg/day)-1 | Excess Cancer Risk | Pathway Cancer Risk | Total Cancer Risk |
|---|---|---|---|---|---|
| **Exposure Pathway: Inhalation of Indoor Air (Vapor Intrusion) (GMW-3, 7, 8, & 9)** | | | | | |
| **Volatiles** | | | | | |
| 1,1-Dichloroethene | 2.6E-04 | NAv | NAp | | |
| Tetrachloroethene | 1.0E-04 | 1E-02 | 1E-06 | | |
| Trichloroethene | 3.3E-04 | 7E-03 | 2E-06 | | |
| Vinyl Chloride | 3.2E-04 | 2E-02 | 5E-06 | | |
| | | | | 8E-06 | |
| | | | | | 8E-06 |

**Notes:**
NAv - Not available
NAp - Not applicable

## Table 6-4
## Excess Lifetime Cancer Risk Estimate for Indoor Commercial/Industrial Worker Scenario Monitoring Wells GMW-5 & 6 Perkin Elmer Missouri Metals Site Overland, Missouri

| Chemical | Daily Intake (mg/kg/day) | Slope Factor (mg/kg/day)-1 | Excess Cancer Risk | Pathway Cancer Risk | Total Cancer Risk |
|---|---|---|---|---|---|
| **Exposure Pathway: Inhalation of Indoor Air (Vapor Intrusion) (GMW-5 & 6)** | | | | | |
| **Volatiles** | | | | | |
| 1,1-Dichloroethene | 2.3E-03 | NAv | NAp | | |
| Tetrachloroethene | 1.2E-02 | 1E-02 | 1E-04 | | |
| Trichloroethene | 3.5E-03 | 7E-03 | 2E-05 | | |
| Vinyl Chloride | 5.0E-04 | 2E-02 | 8E-06 | | |
| | | | | 2E-04 | |
| | | | | | 2E-04 |

**Notes:**
NAv - Not available
NAp - Not applicable

# Table 6-5
# Hazard Index Estimates for Outdoor Commercial/Industrial Worker Scenario Monitoring Wells GMW-3, 7, 8, & 9 Perkin Elmer Missouri Metals Site Overland, Missouri

| Chemical | Daily Intake (mg/kg/day) | RfD (mg/kg/day) | Hazard Quotient | Pathway Hazard Index | Total Hazard Index |
|---|---|---|---|---|---|
| **Exposure Pathway: Inhalation of Outdoor Vapors (GMW-3, 7, 8, & 9)** | | | | | |
| **Volatiles** | | | | | |
| 1,1-Dichloroethene | 4.7E-06 | 6E-02 | 8E-05 | | |
| cis-1,2-Dichloroethene | 1.3E-05 | NAv | NAp | | |
| trans-1,2-Dichloroethene | 1.3E-06 | NAv | NAp | | |
| Tetrachloroethene | 2.0E-06 | 1E-02 | 2E-04 | | |
| Trichloroethene | 6.5E-06 | 2E-01 | 3E-05 | | |
| Vinyl Chloride | 5.7E-06 | 3E-02 | 2E-04 | | |
| | | | | 5E-04 | |
| | | | | | 5E-04 |

**Notes:**
NAv - Not available
NAp - Not applicable

# Table 6-6
# Hazard Index Estimates for Outdoor Commercial/Industrial Worker Scenario
# Monitoring Wells GMW-5 & 6
# Perkin Elmer
# Missouri Metals Site
# Overland, Missouri

| Chemical | Daily Intake (mg/kg/day) | RfD (mg/kg/day) | Hazard Quotient | Pathway Hazard Index | Total Hazard Index |
|---|---|---|---|---|---|
| **Exposure Pathway: Inhalation of Outdoor Vapors (GMW-5 & 6)** | | | | | |
| **Volatiles** | | | | | |
| 1,1-Dichloroethene | 3.8E-04 | 6E-02 | 6E-03 | | |
| cis-1,2-Dichloroethene | 1.4E-03 | NAv | NAp | | |
| trans-1,2-Dichloroethene | 3.1E-06 | NAv | NAp | | |
| Tetrachloroethene | 3.3E-03 | 1E-02 | 3E-01 | | |
| Trichloroethene | 1.5E-03 | 2E-01 | 7E-03 | | |
| Vinyl Chloride | 8.0E-05 | 3E-02 | 3E-03 | | |
| | | | | 3E-01 | |
| | | | | | 3E-01 |

Notes:
NAv - Not available
NAp - Not applicable

# Table 6-7
## Excess Lifetime Cancer Risk Estimate for Outdoor Commercial/Industrial Worker Scenario Monitoring Wells GMW-3, 7, 8, & 9 Perkin Elmer Missouri Metals Site Overland, Missouri

| Chemical | Daily Intake (mg/kg/day) | Slope Factor (mg/kg/day)-1 | Excess Cancer Risk | Pathway Cancer Risk | Total Cancer Risk |
|---|---|---|---|---|---|
| Exposure Pathway: Inhalation of Outdoor Vapors (GMW-3, 7, 8, & 9) | | | | | |
| Volatiles | | | | | |
| 1,1-Dichloroethene | 1.7E-06 | NAv | NAp | | |
| Tetrachloroethene | 7.3E-07 | 1E-02 | 7E-09 | | |
| Trichloroethene | 2.3E-06 | 7E-03 | 2E-08 | | |
| Vinyl Chloride | 2.0E-06 | 2E-02 | 3E-08 | | |
| | | | | 5E-08 | |
| | | | | | 5E-08 |

Notes:
NAv - Not available
NAp - Not applicable

# Table 6-8
# Excess Lifetime Cancer Risk Estimate for Outdoor Commercial/Industrial Worker Scenario
# Monitoring Wells GMW-5 & 6
# Perkin Elmer
# Missouri Metals Site
# Overland, Missouri

| Chemical | Daily Intake (mg/kg/day) | Slope Factor (mg/kg/day)-1 | Excess Cancer Risk | Pathway Cancer Risk | Total Cancer Risk |
|---|---|---|---|---|---|
| **Exposure Pathway: Inhalation of Outdoor Vapors (GMW-5 & 6)** | | | | | |
| **Volatiles** | | | | | |
| 1,1-Dichloroethene | 1.4E-04 | NAv | NAp | | |
| Tetrachloroethene | 1.2E-03 | 1E-02 | 1E-05 | | |
| Trichloroethene | 5.3E-04 | 7E-03 | 4E-06 | | |
| Vinyl Chloride | 2.8E-05 | 2E-02 | 4E-07 | | |
| | | | | 2E-05 | |
| | | | | | 2E-05 |

**Notes:**
NAv - Not available
NAp - Not applicable

# Table 6-9
## Hazard Index Estimates for Construction Worker Scenario Monitoring Wells GMW-3, 7, 8, & 9 Perkin Elmer Missouri Metals Site Overland, Missouri

| Chemical | Daily Intake (mg/kg/day) | RfD (mg/kg/day) | Hazard Quotient | Pathway Hazard Index | Total Hazard Index |
|---|---|---|---|---|---|
| **Exposure Pathway: Inhalation of Outdoor Vapors (GMW-3, 7, 8, & 9)** | | | | | |
| **Volatiles** | | | | | |
| 1,1-Dichloroethene | 1.9E-05 | 6E-02 | 3E-04 | | |
| cis-1,2-Dichloroethene | 5.5E-05 | NAv | NAp | | |
| trans-1,2-Dichloroethene | 5.4E-06 | NAv | NAp | | |
| Tetrachloroethene | 8.3E-06 | 1E-02 | 8E-04 | | |
| Trichloroethene | 2.6E-05 | 2E-01 | 1E-04 | | |
| Vinyl chloride | 2.3E-05 | 3E-02 | 8E-04 | | |
| | | | | 2E-03 | |
| | | | | | 2E-03 |

**Notes:**
NAv - Not available
NAp - Not applicable

# Table 6-10
# Hazard Index Estimates for Construction Worker Scenario Monitoring Wells GMW-5 & 6 Perkin Elmer Missouri Metals Site Overland, Missouri

| Chemical | Daily Intake (mg/kg/day) | RfD (mg/kg/day) | Hazard Quotient | Pathway Hazard Index | Total Hazard Index |
|---|---|---|---|---|---|
| **Exposure Pathway: Inhalation of Outdoor Vapors (GMW-5 & 6)** | | | | | |
| **Volatiles** | | | | | |
| 1,1-Dichloroethene | 1.5E-03 | 6E-02 | 3E-02 | | |
| cis-1,2-Dichloroethene | 5.6E-03 | NAv | NAp | | |
| trans-1,2-Dichloroethene | 1.2E-05 | NAv | NAp | | |
| Tetrachloroethene | 1.3E-02 | 1E-02 | 1E+00 | | |
| Trichloroethene | 6.0E-03 | 2E-01 | 3E-02 | | |
| Vinyl chloride | 3.2E-04 | 3E-02 | 1E-02 | | |
| | | | | 1E+00 | |
| | | | | | 1E+00 |

**Notes:**
NAv - Not available
NAp - Not applicable

# Table 6-11
## Excess Lifetime Cancer Risk Estimate for Construction Worker Scenario
## Monitoring Wells GMW-3, 7, 8, & 9
## Perkin Elmer
## Missouri Metals Site
## Overland, Missouri

| Chemical | Daily Intake (mg/kg/day) | Slope Factor (mg/kg/day)-1 | Excess Cancer Risk | Pathway Cancer Risk | Total Cancer Risk |
|---|---|---|---|---|---|
| **Exposure Pathway: Inhalation of Outdoor Vapors (GMW-3, 7, 8, & 9)** | | | | | |
| **Volatiles** | | | | | |
| 1,1-Dichloroethene | 1.3E-07 | NAv | NAp | | |
| Tetrachloroethene | 5.8E-08 | 1E-02 | 6E-10 | | |
| Trichloroethene | 1.9E-07 | 7E-03 | 1E-09 | | |
| Vinyl Chloride | 1.6E-07 | 2E-02 | 2E-09 | | |
| | | | | 4E-09 | |
| | | | | | 4E-09 |

**Notes:**
NAv - Not available
NAp - Not applicable

# Table 6-12
## Excess Lifetime Cancer Risk Estimate for Construction Worker Scenario
## Monitoring Wells GMW-5 & 6
## Perkin Elmer
## Missouri Metals Site
## Overland, Missouri

| Chemical | Daily Intake (mg/kg/day) | Slope Factor (mg/kg/day)-1 | Excess Cancer Risk | Pathway Cancer Risk | Total Cancer Risk |
|---|---|---|---|---|---|
| **Exposure Pathway: Inhalation of Outdoor Vapors (GMW-5 & 6)** | | | | | |
| **Volatiles** | | | | | |
| 1,1-Dichloroethene | 1.1E-05 | NAv | NAp | | |
| Tetrachloroethene | 9.5E-05 | 1E-02 | 9E-07 | | |
| Trichloroethene | 4.2E-05 | 7E-03 | 3E-07 | | |
| Vinyl Chloride | 2.3E-06 | 2E-02 | 4E-08 | | |
| | | | | 1E-06 | |
| | | | | | 1E-06 |

**Notes:**
NAv - Not available
NAp - Not applicable

# Table 7-1
## Allowable Chemical Concentrations in Groundwater for Noncancer Effects
## Indoor Commercial/Industrial Worker Scenario
## Perkin Elmer
## Missouri Metals Site
## Overland, Missouri

Equation:

$$C = \frac{THI \times BW \times AT}{ED \times EF \times ET \times IRa \times VF \times (1/RfDi)}$$

| Variables: | | Indoor Worker |
|---|---|---|
| C = | Allowable concentration in groundwater (mg/L) | Chemical-specific |
| THI = | Target hazard index (unitless) | 1 |
| BW = | Body weight (kg) | 70 |
| AT = | Averaging time (days) | 9,125 |
| ED = | Exposure duration (years) | 25 |
| EF = | Exposure frequency (days/year) | 250 |
| ET = | Exposure time (hours/day) | 8 |
| IRa = | Inhalation rate of air ($m^3$/hr) | 0.633 |
| VF = | Volatilization factor for indoor air (L/$m^3$) | Chemical-specific |
| RfDi = | Inhalation reference dose (mg/kg/day) | Chemical-specific |

| Chemicals with a Hazard Index Over 0.1 | VF (L/$m^3$) | RfDi (mg/kg/day) | Allowable Chemical Concentration in Groundwater (mg/L) |
|---|---|---|---|
| 1,1-Dichloroethene | 3.28E-02 | 6E-02 | 3.69E+01 |
| Tetrachloroethene | 1.63E-02 | 1E-02 | 1.24E+01 |

**Note:**
VF values obtained from USEPA's Johnson & Ettinger Spreadsheets (See Appendix C).

# Table 7-2
# Allowable Chemical Concentrations in Groundwater for Cancer Effects
# Indoor Commercial/Industrial Worker Scenario
# Perkin Elmer
# Missouri Metals Site
# Overland, Missouri

Equation:

$$C = \frac{TR \times BW \times AT}{ED \times EF \times ET \times IRa \times VF \times SFi}$$

| Variables: | | Indoor Worker |
|---|---|---|
| C = | Allowable concentration in groundwater (mg/L) | Chemical-specific |
| TR = | Target risk level (unitless) | 1E-05 |
| BW = | Body weight (kg) | 70 |
| AT = | Averaging time (days) | 25,550 |
| ED = | Exposure duration (years) | 25 |
| EF = | Exposure frequency (days/year) | 250 |
| ET = | Exposure time (hours/day) | 8 |
| IRa = | Inhalation rate of air ($m^3$/hr) | 0.633 |
| VF = | Volatilization factor for indoor air (L/$m^3$) | Chemical-specific |
| SFi = | Inhalation slope factor 1/(mg/kg/day) | Chemical-specific |

| Chemicals with a Cancer Risk of Over 1E-07 | VF (L/$m^3$) | SFi 1/(mg/kg/day) | Allowable Chemical Concentration in Groundwater (mg/L) |
|---|---|---|---|
| Tetrachloroethene | 1.63E-02 | 2E-02 | 1.65E+00 |
| Trichloroethene | 1.03E-02 | 7E-03 | 7.84E+00 |
| Vinyl Chloride | 4.02E-02 | 2E-02 | 9.13E-01 |

**Note:**
VF values obtained from USEPA's Johnson & Ettinger Spreadsheets (See Appendix C).

# Table 7-3
# Allowable Chemical Concentration in Groundwater for Cancer Effects
# Outdoor Commercial/Industrial Worker Scenario
# Perkin Elmer
# Missouri Metals Site
# Overland, Missouri

Equation:

$$C = \frac{TR \times BW \times AT}{ED \times EF \times ET \times IRa \times VF \times SFi}$$

| Variables: | | Outdoor Worker |
|---|---|---|
| C = | Allowable concentration in groundwater (mg/L) | Chemical-specific |
| TR = | Target risk level (unitless) | 1E-05 |
| BW = | Body weight (kg) | 70 |
| AT = | Averaging time (days) | 25,550 |
| ED = | Exposure duration (years) | 25 |
| EF = | Exposure frequency (days/year) | 125 |
| ET = | Exposure time (hours/day) | 8 |
| IRa = | Inhalation rate of air ($m^3$/hr) | 1.3 |
| VF = | Volatilization factor for outdoor air (L/$m^3$) | Chemical-specific |
| SFi = | Inhalation slope factor 1/(mg/kg/day) | Chemical-specific |

| Chemicals with a Cancer Risk of Over 1E-07 | VF (L/$m^3$) | SFi 1/(mg/kg/day) | Allowable Chemical Concentration in Groundwater (mg/L) |
|---|---|---|---|
| Tetrachloroethene | 1.14E-04 | 2E-02 | 2.30E+02 |
| Trichloroethene | 7.04E-05 | 7E-03 | 1.12E+03 |

**Note:**
VF values obtained from Table 5-8.

# Table 7-4
# Allowable Chemical Concentrations in Groundwater for Noncancer Effects
# Construction Worker Scenario
# Perkin Elmer
# Missouri Metals Site
# Overland, Missouri

Equation:

$$C = \frac{THI \times BW \times AT}{ED \times EF \times ET \times IRa \times VF \times (1/RfDi)}$$

| Variables: | | Construction Worker |
|---|---|---|
| C = | Allowable concentration in groundwater (mg/L) | Chemical-specific |
| THI = | Target hazard index (unitless) | 1 |
| BW = | Body weight (kg) | 70 |
| AT = | Averaging time (days) | 180 |
| ED = | Exposure duration (years) | 1 |
| EF = | Exposure frequency (days/year) | 130 |
| ET = | Exposure time (hours/day) | 8 |
| IRa = | Inhalation rate of air ($m^3$/hr) | 2.5 |
| VF = | Volatilization factor for outdoor air (L/$m^3$) | Chemical-specific |
| RfDi = | Inhalation reference dose (mg/kg/day) | Chemical-specific |

| Chemicals with a Hazard Index Over 0.1 | VF (L/$m^3$) | RfDi (mg/kg/day) | Allowable Chemical Concentration in Groundwater (mg/L) |
|---|---|---|---|
| Tetrachloroethene | 1.14E-04 | 6E-02 | 2.55E+03 |

**Note:**
VF value obtained from Table 5-8.

# Table 7-5
# Allowable Chemical Concentrations in Groundwater for Cancer Effects
# Construction Worker Scenario
# Perkin Elmer
# Missouri Metals Site
# Overland, Missouri

Equation:

$$C = \frac{TR \times BW \times AT}{ED \times EF \times ET \times IRa \times VF \times SFi}$$

| Variables: | | Construction Worker |
|---|---|---|
| C = | Allowable concentration in groundwater (mg/L) | Chemical-specific |
| TR = | Target risk level (unitless) | 1E-05 |
| BW = | Body weight (kg) | 70 |
| AT = | Averaging time (days) | 25,550 |
| ED = | Exposure duration (years) | 1 |
| EF = | Exposure frequency (days/year) | 130 |
| ET = | Exposure time (hours/day) | 8 |
| IRa = | Inhalation rate of air ($m^3$/hr) | 2.5 |
| VF = | Volatilization factor for outdoor air (L/$m^3$) | Chemical-specific |
| SFi = | Inhalation slope factor 1/(mg/kg/day) | Chemical-specific |

| Chemicals with a Cancer Risk of Over 1E-07 | VF (L/$m^3$) | SFi 1/(mg/kg/day) | Allowable Chemical Concentration in Groundwater (mg/L) |
|---|---|---|---|
| Tetrachloroethene | 1.14E-04 | 2E-02 | 2.87E+03 |
| Trichloroethene | 7.04E-05 | 7E-03 | 1.40E+04 |

**Note:**
VF values obtained from Table 5-8.

# Table 7-6
## Preliminary Remediation Goals in Groundwater for Commercial/Industrial Land Use Based on Target Cancer Risk Level of 1E-07 and Target Hazard Quotient of 0.1
## Perkin Elmer
## Missouri Metals Site
## Overland, Missouri

| Chemical | Indoor Worker (mg/L) | | Outdoor Worker (mg/L) | Construction Worker (mg/L) | | Recommended Preliminary Remediation Goals (mg/L) |
|---|---|---|---|---|---|---|
| | Noncancer | Cancer | Cancer | Noncancer | Cancer | |
| **Volatile Organic Compounds** | | | | | | |
| 1,1-Dichloroethene | 3.69E+01 | NA | NA | NA | NA | 3.69E+01 |
| Tetrachloroethene | 1.24E+01 | 1.65E+00 | 2.30E+02 | 2.55E+03 | 2.87E+03 | 1.65E+00 |
| Trichloroethene | NA | 7.84E+00 | 1.12E+03 | NA | 1.40E+04 | 7.84E+00 |
| Vinyl Chloride | NA | 9.13E-01 | NA | NA | NA | 9.13E-01 |

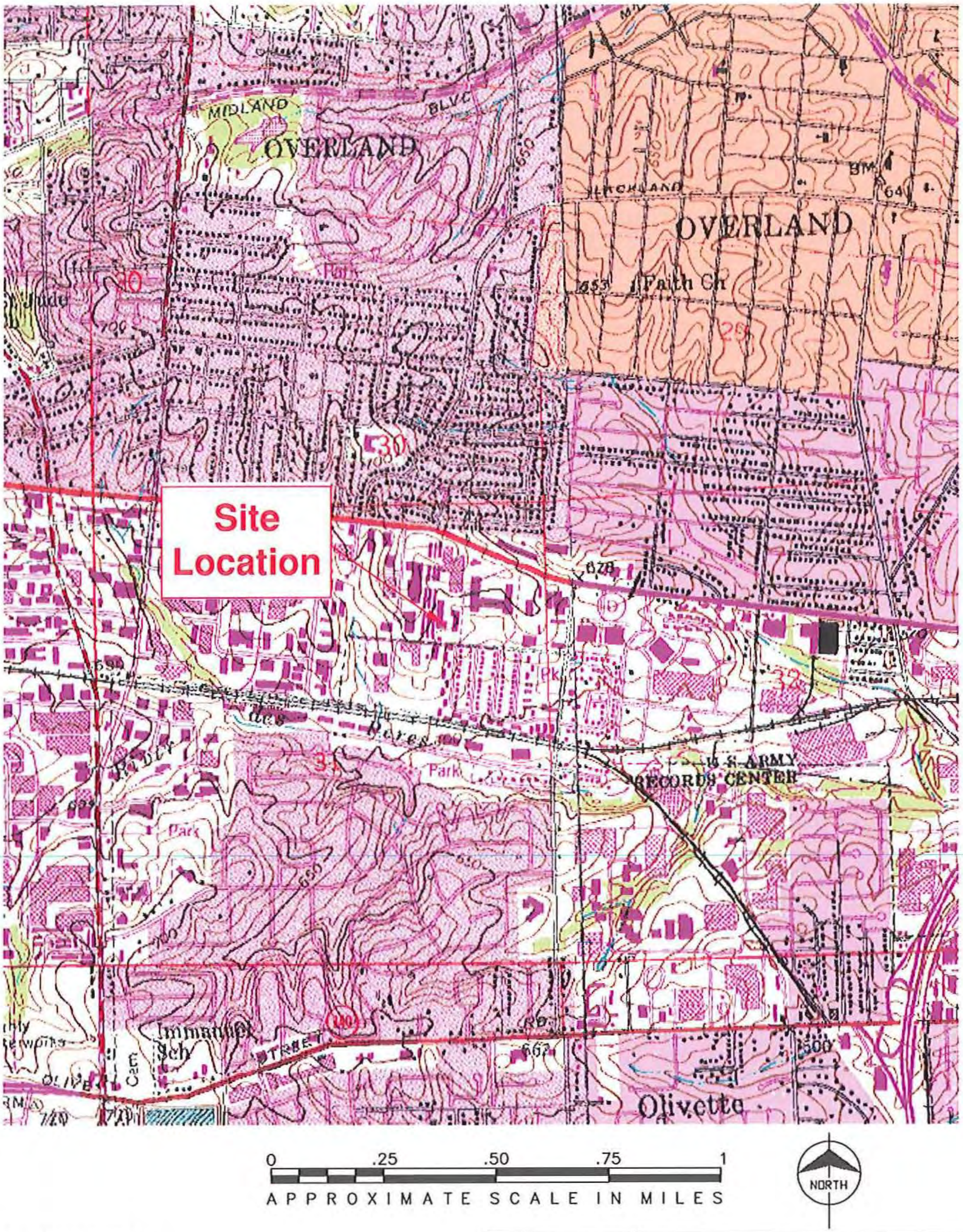
**Notes:**

Preliminary Remediation Goals (PRGs) were calculated only for those scenarios resulting in a noncancer hazard quotient greater than or equal to one or a cancer risk greater than or equal to 1E-06. PRGs were not calculated for noncancer effects to outdoor workers because the total hazard index was less than 1.

Recommended PRG represents the most conservative value calculated for a given chemical.

NA - PRG not calculated because the individual chemical hazard quotient or cancer risk value was below 0.1 or 1E-07, respectively.

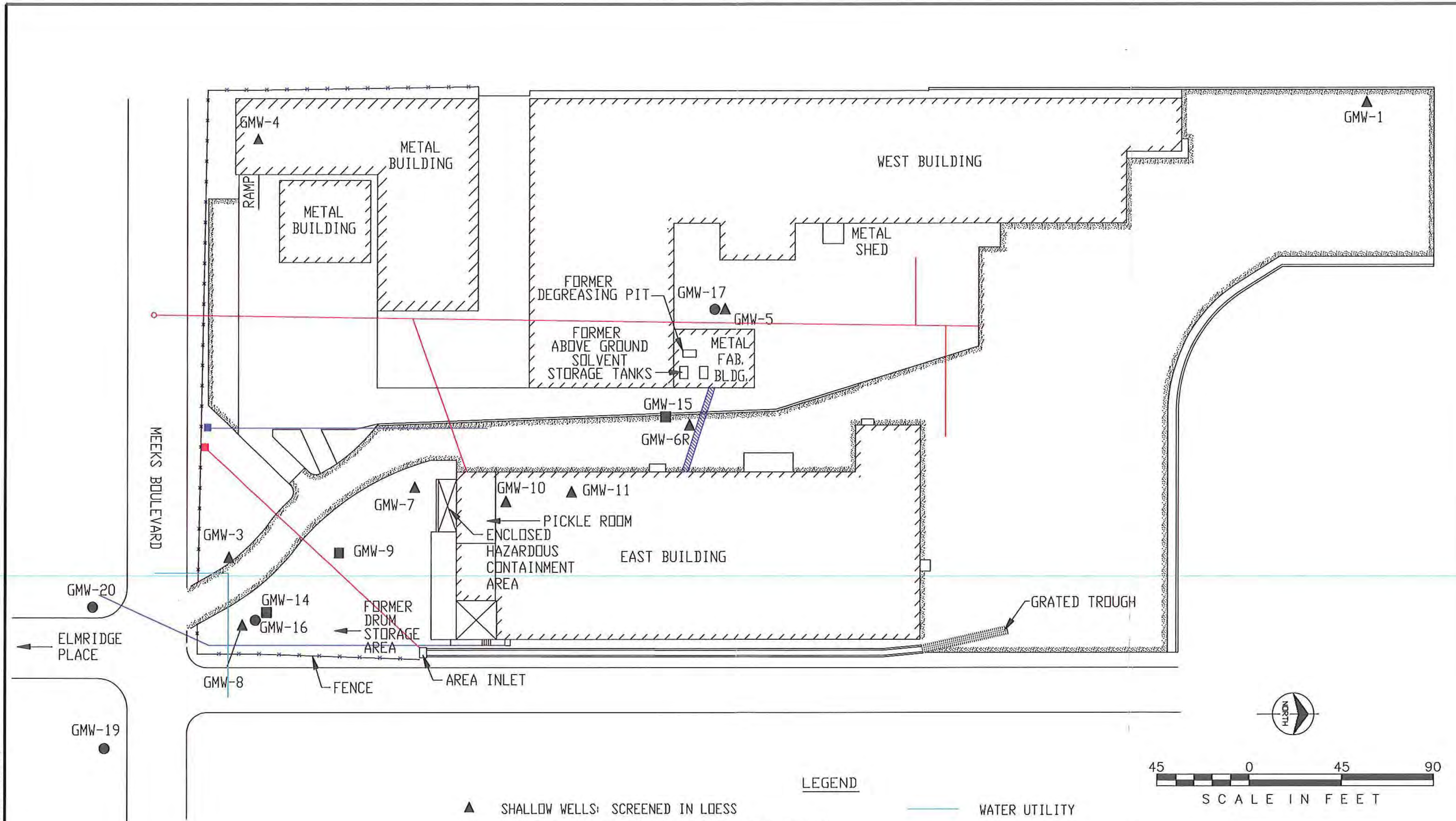
FIGURES




MAP REFERENCE:
This map was prepared from a 1993 photorevised Creve Coeur, MO 7.5 minute series topographic map obtained from the United States Geologic Survey.

Burns & McDonnell
SINCE 1898

Figure 2-1
SITE LOCATION MAP
PerkinElmer
Missouri Metals Site
Overland, Missouri




Burns & McDonnell SINCE 1898

Figure 2-2
SITE MAP
PerkinElmer
Missouri Metals Site
Overland, Missouri

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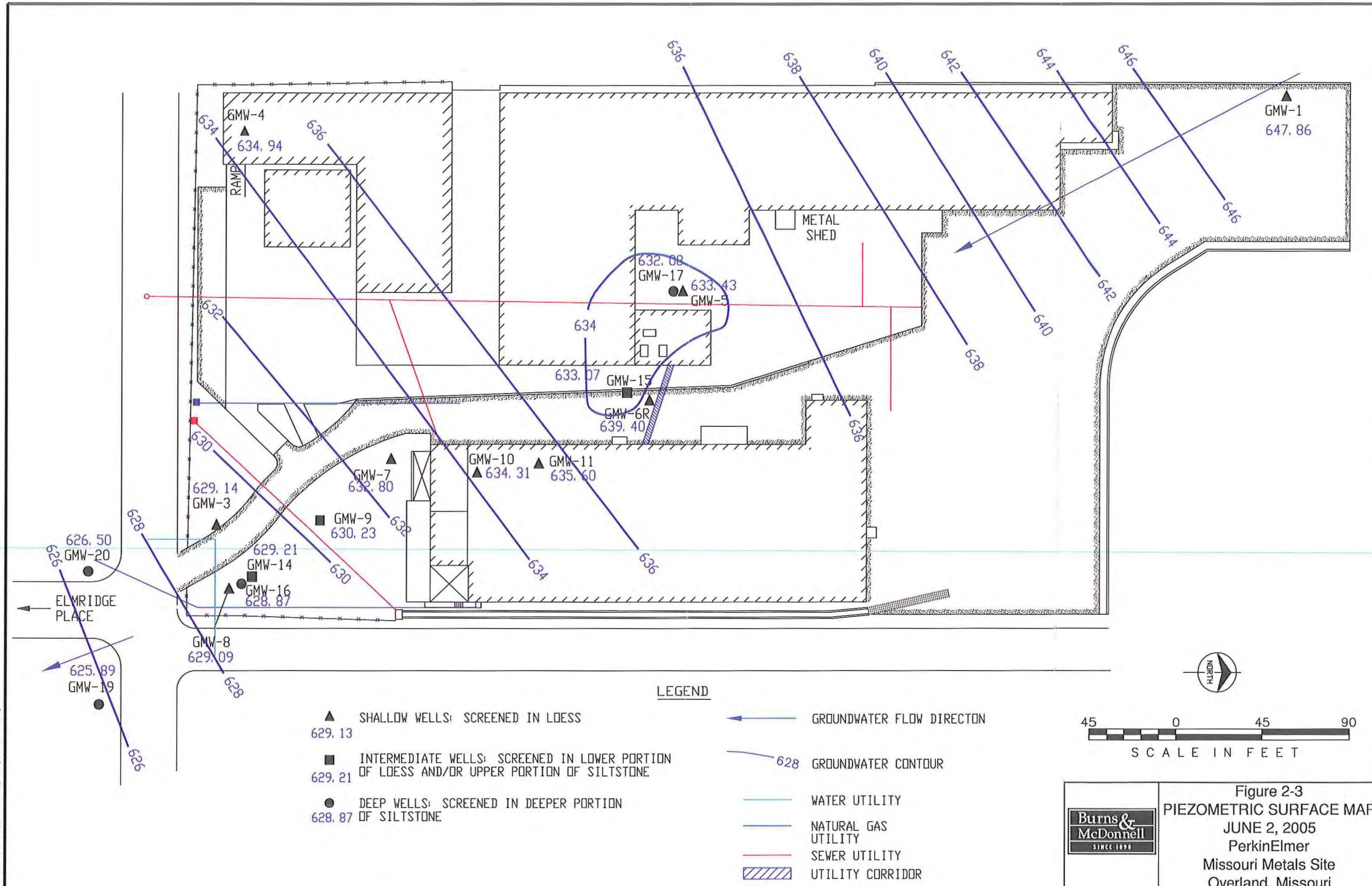
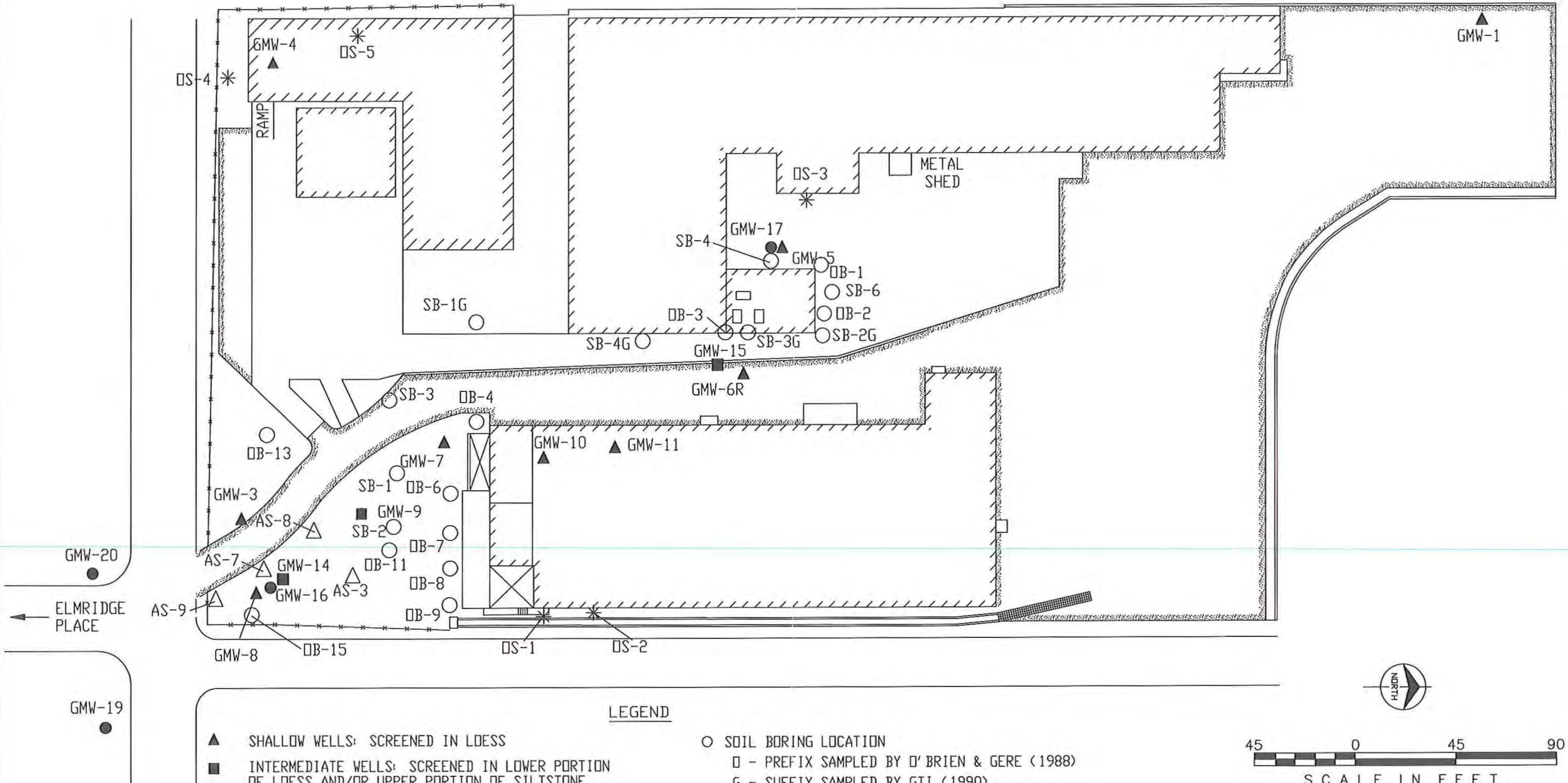



Figure 2-3
PIEZOMETRIC SURFACE MAP
JUNE 2, 2005
PerkinElmer
Missouri Metals Site
Overland, Missouri




LEGEND

▲ SHALLOW WELLS: SCREENED IN LOESS

■ INTERMEDIATE WELLS: SCREENED IN LOWER PORTION OF LOESS AND/OR UPPER PORTION OF SILTSTONE

● DEEP WELLS: SCREENED IN DEEPER PORTION OF SILTSTONE

○ SOIL BORING LOCATION
O - PREFIX SAMPLED BY O'BRIEN & GERE (1988)
G - SUFFIX SAMPLED BY GTI (1990)
ALL OTHERS SAMPLED BY BURNS & McDONNELL (1992)

✳ SURFACE SOIL SAMPLE LOCATION
SAMPLED BY O'BRIEN & GERE (1988)

△ HAND AUGERED SOIL SAMPLE LOCATION
SAMPLED BY BURNS & McDONNELL (1992)

Burns & McDonnell SINCE 1898

Figure 2-4
SOIL SAMPLING LOCATIONS FROM 1992 RI
PerkinElmer
Missouri Metals Site
Overland, Missouri

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Appendix A
USEPA ProUCL Version 3.00.02 Statistical Output Sheets

**Monitoring Wells GMW-3, 7, 8, & 9**

General Statistics

| | | | | |
|---|---|---|---|---|
| Data File | K:\ENV\PERKINELMER INC\site\26682\Deliv | Variable: | 1,1-Dichloroethene | |
| | | | | |
| Raw Statistics | | Normal Distribution Test | | |
| Number of Valid Samples | 17 | Shapiro-Wilk Test Statisitic | | 0.481392 |
| Number of Unique Samples | 12 | Shapiro-Wilk 5% Critical Value | | 0.892 |
| Minimum | 0 | Data not normal at 5% significance level | | |
| Maximum | 1.25 | | | |
| Mean | 0.140959 | 95% UCL (Assuming Normal Distribution) | | |
| Median | 0.05 | Student's-t UCL | | 0.26667 |
| Standard Deviation | 0.296881 | | | |
| Variance | 0.088138 | | | |
| Coefficient of Variation | 2.106151 | | | |
| Skewness | 3.646452 | | | |
| | | | | |
| Gamma Statistics Not Available | | | | |
| | | | | |
| | | | | |
| Lognormal Statistics Not Available | | | | |
| | | | | |
| | | 95% Non-parametric UCLs | | |
| | | CLT UCL | | 0.259395 |
| | | Adj-CLT UCL (Adjusted for skewness) | | 0.327438 |
| | | Mod-t UCL (Adjusted for skewness) | | 0.277283 |
| | | Jackknife UCL | | 0.26667 |
| | | Standard Bootstrap UCL | | 0.258316 |
| | | Bootstrap-t UCL | | 0.55743 |
| RECOMMENDATION | | Hall's Bootstrap UCL | | 0.671616 |
| Data are Non-parametric (0.05) | | Percentile Bootstrap UCL | | 0.275318 |
| | | BCA Bootstrap UCL | | 0.3572 |
| Use 95% Chebyshev (Mean, Sd) UCL | | 95% Chebyshev (Mean, Sd) UCL | | 0.454818 |
| | | 97.5% Chebyshev (Mean, Sd) UCL | | 0.590624 |
| | | 99% Chebyshev (Mean, Sd) UCL | | 0.857391 |

General Statistics

| | | | |
|---|---|---|---|
| Data File | K:\ENV\PERKINELMER INC\site\26682\Deli | Variable: | cis-1,2-Dichloroethene |

| | | | |
|---|---|---|---|
| Raw Statistics | | Normal Distribution Test | |
| Number of Valid Samples | 17 | Shapiro-Wilk Test Statisitic | 0.63109 |
| Number of Unique Samples | 17 | Shapiro-Wilk 5% Critical Value | 0.892 |
| Minimum | 0 | Data not normal at 5% significance level | |
| Maximum | 19 | | |
| Mean | 3.638529 | 95% UCL (Assuming Normal Distribution) | |
| Median | 0.831 | Student's-t UCL | 6.197163 |
| Standard Deviation | 6.042508 | | |
| Variance | 36.5119 | | |
| Coefficient of Variation | 1.660701 | | |
| Skewness | 1.742804 | | |
| | | | |
| Gamma Statistics Not Available | | | |
| | | | |
| Lognormal Statistics Not Available | | | |
| | | | |
| | | 95% Non-parametric UCLs | |
| | | CLT UCL | 6.049101 |
| | | Adj-CLT UCL (Adjusted for skewness) | 6.711008 |
| | | Mod-t UCL (Adjusted for skewness) | 6.300407 |
| | | Jackknife UCL | 6.197163 |
| | | Standard Bootstrap UCL | 5.989062 |
| | | Bootstrap-t UCL | 8.332317 |
| RECOMMENDATION | | Hall's Bootstrap UCL | 6.125192 |
| Data are Non-parametric (0.05) | | Percentile Bootstrap UCL | 6.010412 |
| | | BCA Bootstrap UCL | 6.846882 |
| Use 95% Chebyshev (Mean, Sd) UCL | | 95% Chebyshev (Mean, Sd) UCL | 10.0266 |
| | | 97.5% Chebyshev (Mean, Sd) UCL | 12.79072 |
| | | 99% Chebyshev (Mean, Sd) UCL | 18.2203 |

General Statistics

| | | | |
|---|---|---|---|
| Data File | K:\ENV\PERKINELMER INC\site\26682\Deliv | Variable: | trans-1,2-Dichloroethene |
| Raw Statistics | | Normal Distribution Test | |
| Number of Valid Samples | 17 | Shapiro-Wilk Test Statisitic | 0.481324 |
| Number of Unique Samples | 9 | Shapiro-Wilk 5% Critical Value | 0.892 |
| Minimum | 0 | Data not normal at 5% significance level | |
| Maximum | 1.25 | | |
| Mean | 0.140241 | 95% UCL (Assuming Normal Distribution) | |
| Median | 0.05 | Student's-t UCL | 0.266084 |
| Standard Deviation | 0.297192 | | |
| Variance | 0.088323 | | |
| Coefficient of Variation | 2.119152 | | |
| Skewness | 3.641734 | | |
| Gamma Statistics Not Available | | | |
| Lognormal Statistics Not Available | | | |
| | | 95% Non-parametric UCLs | |
| | | CLT UCL | 0.258802 |
| | | Adj-CLT UCL (Adjusted for skewness) | 0.326828 |
| | | Mod-t UCL (Adjusted for skewness) | 0.276695 |
| | | Jackknife UCL | 0.266084 |
| | | Standard Bootstrap UCL | 0.255768 |
| | | Bootstrap-t UCL | 0.573858 |
| RECOMMENDATION | | Hall's Bootstrap UCL | 0.675885 |
| Data are Non-parametric (0.05) | | Percentile Bootstrap UCL | 0.280135 |
| | | BCA Bootstrap UCL | 0.318771 |
| Use 95% Chebyshev (Mean, Sd) UCL | | 95% Chebyshev (Mean, Sd) UCL | 0.454429 |
| | | 97.5% Chebyshev (Mean, Sd) UCL | 0.590379 |
| | | 99% Chebyshev (Mean, Sd) UCL | 0.857425 |

General Statistics

| | | | | | | |
|---|---|---|---|---|---|---|
| Data File | K:\ENV\PERKINELMER INC\site\26682\Deliv | | Variable: | Tetrachloroethene | | |
| | | | | | | |
| Raw Statistics | | | Normal Distribution Test | | | |
| Number of Valid Samples | 17 | | Shapiro-Wilk Test Statisitic | | | 0.533507 |
| Number of Unique Samples | 15 | | Shapiro-Wilk 5% Critical Value | | | 0.892 |
| Minimum | 0 | | Data not normal at 5% significance level | | | |
| Maximum | 0.92 | | | | | |
| Mean | 0.117612 | | 95% UCL (Assuming Normal Distribution) | | | |
| Median | 0.05 | | Student's-t UCL | | | 0.211044 |
| Standard Deviation | 0.220651 | | | | | |
| Variance | 0.048687 | | | | | |
| Coefficient of Variation | 1.876099 | | | | | |
| Skewness | 3.370769 | | | | | |
| | | | | | | |
| Gamma Statistics Not Available | | | | | | |
| | | | | | | |
| | | | | | | |
| Lognormal Statistics Not Available | | | | | | |
| | | | | | | |
| | | | 95% Non-parametric UCLs | | | |
| | | | CLT UCL | | | 0.205637 |
| | | | Adj-CLT UCL (Adjusted for skewness) | | | 0.252386 |
| | | | Mod-t UCL (Adjusted for skewness) | | | 0.218336 |
| | | | Jackknife UCL | | | 0.211044 |
| | | | Standard Bootstrap UCL | | | 0.202457 |
| | | | Bootstrap-t UCL | | | 0.404301 |
| RECOMMENDATION | | | Hall's Bootstrap UCL | | | 0.494585 |
| Data are Non-parametric (0.05) | | | Percentile Bootstrap UCL | | | 0.214935 |
| | | | BCA Bootstrap UCL | | | 0.274382 |
| Use 95% Chebyshev (Mean, Sd) UCL | | | 95% Chebyshev (Mean, Sd) UCL | | | 0.350882 |
| | | | 97.5% Chebyshev (Mean, Sd) UCL | | | 0.451818 |
| | | | 99% Chebyshev (Mean, Sd) UCL | | | 0.650087 |

General Statistics

| | | | |
|---|---|---|---|
| Data File | K:\ENV\PERKINELMER INC\site\26682\Deliv | Variable: | Trichloroethene |
| | | | |
| Raw Statistics | | Normal Distribution Test | |
| Number of Valid Samples | 17 | Shapiro-Wilk Test Statisitic | 0.825846 |
| Number of Unique Samples | 17 | Shapiro-Wilk 5% Critical Value | 0.892 |
| Minimum | 0 | Data not normal at 5% significance level | |
| Maximum | 3.03 | | |
| Mean | 0.887529 | 95% UCL (Assuming Normal Distribution) | |
| Median | 0.591 | Student's-t UCL | 1.256374 |
| Standard Deviation | 0.87107 | | |
| Variance | 0.758763 | | |
| Coefficient of Variation | 0.981455 | | |
| Skewness | 1.420452 | | |
| | | | |
| Gamma Statistics Not Available | | | |
| | | | |
| Lognormal Statistics Not Available | | | |
| | | | |
| | | 95% Non-parametric UCLs | |
| | | CLT UCL | 1.23503 |
| | | Adj-CLT UCL (Adjusted for skewness) | 1.3128 |
| | | Mod-t UCL (Adjusted for skewness) | 1.268505 |
| | | Jackknife UCL | 1.256374 |
| | | Standard Bootstrap UCL | 1.220867 |
| | | Bootstrap-t UCL | 1.426585 |
| RECOMMENDATION | | Hall's Bootstrap UCL | 1.31036 |
| Data are Non-parametric (0.05) | | Percentile Bootstrap UCL | 1.253294 |
| | | BCA Bootstrap UCL | 1.314118 |
| Use 95% Chebyshev (Mean, Sd) UCL | | 95% Chebyshev (Mean, Sd) UCL | 1.808414 |
| | | 97.5% Chebyshev (Mean, Sd) UCL | 2.206882 |
| | | 99% Chebyshev (Mean, Sd) UCL | 2.989595 |

General Statistics

| | | | | |
|---|---|---|---|---|
| Data File | K:\ENV\PERKINELMER INC\site\26682\Deliv | Variable: | Vinyl Chloride | |
| Raw Statistics | | Normal Distribution Test | | |
| Number of Valid Samples | 17 | Shapiro-Wilk Test Statisitic | | 0.621495 |
| Number of Unique Samples | 16 | Shapiro-Wilk 5% Critical Value | | 0.892 |
| Minimum | 0 | Data not normal at 5% significance level | | |
| Maximum | 0.889 | | | |
| Mean | 0.160465 | 95% UCL (Assuming Normal Distribution) | | |
| Median | 0.025 | Student's-t UCL | | 0.277453 |
| Standard Deviation | 0.27628 | | | |
| Variance | 0.076331 | | | |
| Coefficient of Variation | 1.721751 | | | |
| Skewness | 1.861751 | | | |
| Gamma Statistics Not Available | | | | |
| Lognormal Statistics Not Available | | | | |
| | | 95% Non-parametric UCLs | | |
| | | CLT UCL | | 0.270683 |
| | | Adj-CLT UCL (Adjusted for skewness) | | 0.303013 |
| | | Mod-t UCL (Adjusted for skewness) | | 0.282495 |
| | | Jackknife UCL | | 0.277453 |
| | | Standard Bootstrap UCL | | 0.267715 |
| | | Bootstrap-t UCL | | 0.353269 |
| RECOMMENDATION | | Hall's Bootstrap UCL | | 0.289396 |
| Data are Non-parametric (0.05) | | Percentile Bootstrap UCL | | 0.269529 |
| | | BCA Bootstrap UCL | | 0.314106 |
| Use 95% Chebyshev (Mean, Sd) UCL | | 95% Chebyshev (Mean, Sd) UCL | | 0.452545 |
| | | 97.5% Chebyshev (Mean, Sd) UCL | | 0.578928 |
| | | 99% Chebyshev (Mean, Sd) UCL | | 0.827184 |

## Monitoring Wells GMW-5 & 6

# General Statistics

| | | | |
|---|---|---|---|
| Data File | K:\ENV\PERKINELMER INC\site\26682\Del | Variable: | 1,1-Dichloroethene (GMW-5 & 6) |
| Raw Statistics | | Normal Distribution Test | |
| Number of Valid Samples | 5 | Shapiro-Wilk Test Statisitic | 0.70276 |
| Number of Unique Samples | 5 | Shapiro-Wilk 5% Critical Value | 0.762 |
| Minimum | 0.0625 | Data not normal at 5% significance level | |
| Maximum | 2.5 | | |
| Mean | 0.6825 | 95% UCL (Assuming Normal Distribution) | |
| Median | 0.125 | Student's-t UCL | 1.675712 |
| Standard Deviation | 1.041768 | | |
| Variance | 1.085281 | Gamma Distribution Test | |
| Coefficient of Variation | 1.5264 | A-D Test Statistic | 0.504621 |
| Skewness | 1.98798 | A-D 5% Critical Value | 0.70394 |
| | | K-S Test Statistic | 0.329512 |
| Gamma Statistics | | K-S 5% Critical Value | 0.368886 |
| k hat | 0.63808 | Data follow gamma distribution | |
| k star (bias corrected) | 0.388565 | at 5% significance level | |
| Theta hat | 1.069614 | | |
| Theta star | 1.756461 | 95% UCLs (Assuming Gamma Distribution) | |
| nu hat | 6.380804 | Approx | 3.91857 |
| nu star | 3.885655 | Adjusted Gamma UCL | 9.652081 |
| Approx.Chi Square Value (.05) | 0.676767 | | |
| Adjusted Level of Significance | 0.0086 | Lognormal Distribution Test | |
| Adjusted Chi Square Value | 0.274755 | Shapiro-Wilk Test Statisitic | 0.893408 |
| | | Shapiro-Wilk 5% Critical Value | 0.762 |
| Log-transformed Statistics | | Data are lognormal at 5% significance level | |
| Minimum of log data | -2.77259 | | |
| Maximum of log data | 0.916291 | 95% UCLs (Assuming Lognormal Distribution) | |
| Mean of log data | -1.34167 | 95% H-UCL | 218.2735 |
| Standard Deviation of log data | 1.530799 | 95% Chebyshev (MVUE) UCL | 2.190395 |
| Variance of log data | 2.343345 | 97.5% Chebyshev (MVUE) UCL | 2.880224 |
| | | 99% Chebyshev (MVUE) UCL | 4.235262 |
| | | | |
| | | 95% Non-parametric UCLs | |
| | | CLT UCL | 1.448826 |
| | | Adj-CLT UCL (Adjusted for skewness) | 1.891408 |
| | | Mod-t UCL (Adjusted for skewness) | 1.744746 |
| | | Jackknife UCL | 1.675712 |
| | | Standard Bootstrap UCL | 1.36915 |
| | | Bootstrap-t UCL | 22.5555 |
| RECOMMENDATION | | Hall's Bootstrap UCL | 12.58969 |
| Data follow gamma distribution (0.05) | | Percentile Bootstrap UCL | 1.525 |
| | | BCA Bootstrap UCL | 1.65 |
| Use Approximate Gamma UCL | | 95% Chebyshev (Mean, Sd) UCL | 2.71328 |
| | | 97.5% Chebyshev (Mean, Sd) UCL | 3.592001 |
| | | 99% Chebyshev (Mean, Sd) UCL | 5.318076 |
| Recommended UCL exceeds the maximum observatior | | | |

General Statistics

| | | | | | |
|---|---|---|---|---|---|
| Data File | K:\ENV\PERKINELMER INC\site\26682\Del | Variable: | cis-1,2-Dichloroethene | | |
| | | | (GMW-5 & 6) | | |
| Raw Statistics | | Normal Distribution Test | | | |
| Number of Valid Samples | 5 | Shapiro-Wilk Test Statisitic | | 0.803326 | |
| Number of Unique Samples | 5 | Shapiro-Wilk 5% Critical Value | | 0.762 | |
| Minimum | 2.86 | Data are normal at 5% significance level | | | |
| Maximum | 23.3 | | | | |
| Mean | 9.25 | 95% UCL (Assuming Normal Distribution) | | | |
| Median | 4.82 | Studen | | 17.23601 | |
| Standard Deviation | 8.376431 | | | | |
| Variance | 70.1646 | Gamma Distribution Test | | | |
| Coefficient of Variation | 0.90556 | A-D Test Statistic | | 0.400599 | |
| Skewness | 1.653283 | A-D 5% Critical Value | | 0.684936 | |
| | | K-S Test Statistic | | 0.30848 | |
| Gamma Statistics | | K-S 5% Critical Value | | 0.360771 | |
| k hat | 1.874744 | Data follow gamma distribution | | | |
| k star (bias corrected) | 0.883231 | at 5% significance level | | | |
| Theta hat | 4.934007 | | | | |
| Theta star | 10.47291 | 95% UCLs (Assuming Gamma Distribution) | | | |
| nu hat | 18.74744 | Approximate Gamma UCL | | 25.33111 | |
| nu star | 8.83231 | Adjusted Gamma UCL | | 42.22946 | |
| Approx.Chi Square Value (.05) | 3.225238 | | | | |
| Adjusted Level of Significance | 0.0086 | Lognormal Distribution Test | | | |
| Adjusted Chi Square Value | 1.934642 | Shapiro-Wilk Test Statisitic | | 0.930992 | |
| | | Shapiro-Wilk 5% Critical Value | | 0.762 | |
| Log-transformed Statistics | | Data are lognormal at 5% significance level | | | |
| Minimum of log data | 1.050822 | | | | |
| Maximum of log data | 3.148453 | 95% UCLs (Assuming Lognormal Distribution) | | | |
| Mean of log data | 1.934812 | 95% H-UCL | | 54.19396 | |
| Standard Deviation of log data | 0.824911 | 95% Chebyshev (MVUE) UCL | | 23.04635 | |
| Variance of log data | 0.680478 | 97.5% Chebyshev (MVUE) UCL | | 29.13028 | |
| | | 99% Chebyshev (MVUE) UCL | | 41.08098 | |
| | | | | | |
| | | 95% Non-parametric UCLs | | | |
| | | CLT UCL | | 15.41171 | |
| | | Adj-CLT UCL (Adjusted for skewness) | | 18.3712 | |
| | | Mod-t UCL (Adjusted for skewness) | | 17.69763 | |
| | | Jackknife UCL | | 17.23601 | |
| | | Standard Bootstrap UCL | | 14.76279 | |
| | | Bootstrap-t UCL | | 52.99168 | |
| RECOMMENDATION | | Hall's Bootstrap UCL | | 65.247 | |
| Data are normal (0.05) | | Percentile Bootstrap UCL | | 15.516 | |
| | | BCA Bootstrap UCL | | 13.368 | |
| Use Student's-t UCL | | 95% Chebyshev (Mean, Sd) UCL | | 25.57867 | |
| | | 97.5% Chebyshev (Mean, Sd) UCL | | 32.6441 | |
| | | 99% Chebyshev (Mean, Sd) UCL | | 46.52277 | |

General Statistics

| | | | |
|---|---|---|---|
| Data File | K:\ENV\PERKINELMER INC\site\26682\Deliv | Variable: | trans-1,2-Dichloroethene (GMW 5 & 6) |
| Raw Statistics | | Normal Distribution Test | |
| Number of Valid Samples | 5 | Shapiro-Wilk Test Statisitic | 0.710856 |
| Number of Unique Samples | 5 | Shapiro-Wilk 5% Critical Value | 0.762 |
| Minimum | 0.038 | Data not normal at 5% significance level | |
| Maximum | 2.5 | | |
| Mean | 0.6656 | 95% UCL (Assuming Normal Distribution) | |
| Median | 0.125 | Student's-t UCL | 1.670532 |
| Standard Deviation | 1.054061 | | |
| Variance | 1.111044 | Gamma Distribution Test | |
| Coefficient of Variation | 1.583625 | A-D Test Statistic | 0.431781 |
| Skewness | 1.964911 | A-D 5% Critical Value | 0.710004 |
| | | K-S Test Statistic | 0.274049 |
| Gamma Statistics | | K-S 5% Critical Value | 0.371248 |
| k hat | 0.518798 | Data follow gamma distribution | |
| k star (bias corrected) | 0.340853 | at 5% significance level | |
| Theta hat | 1.282965 | | |
| Theta star | 1.95275 | 95% UCLs (Assuming Gamma Distribution) | |
| nu hat | 5.187983 | Approxi | 4.511654 |
| nu star | 3.408527 | Adjusted Gamma UCL | 11.755 |
| Approx.Chi Square Value (.05) | 0.502857 | | |
| Adjusted Level of Significance | 0.0086 | Lognormal Distribution Test | |
| Adjusted Chi Square Value | 0.193 | Shapiro-Wilk Test Statisitic | 0.896315 |
| | | Shapiro-Wilk 5% Critical Value | 0.762 |
| Log-transformed Statistics | | Data are lognormal at 5% significance level | |
| Minimum of log data | -3.270169 | | |
| Maximum of log data | 0.916291 | 95% UCLs (Assuming Lognormal Distribution) | |
| Mean of log data | -1.62444 | 95% H-UCL | 2503.869 |
| Standard Deviation of log data | 1.819733 | 95% Chebyshev (MVUE) UCL | 2.425933 |
| Variance of log data | 3.311428 | 97.5% Chebyshev (MVUE) UCL | 3.215003 |
| | | 99% Chebyshev (MVUE) UCL | 4.764979 |
| | | | |
| | | 95% Non-parametric UCLs | |
| | | CLT UCL | 1.440968 |
| | | Adj-CLT UCL (Adjusted for skewness) | 1.883576 |
| | | Mod-t UCL (Adjusted for skewness) | 1.739569 |
| | | Jackknife UCL | 1.670532 |
| | | Standard Bootstrap UCL | 1.372943 |
| | | Bootstrap-t UCL | 14.05972 |
| RECOMMENDATION | | Hall's Bootstrap UCL | 10.46514 |
| Data follow gamma distribution (0.05) | | Percentile Bootstrap UCL | 1.516 |
| | | BCA Bootstrap UCL | 1.75 |
| Use Approximate Gamma UCL | | 95% Chebyshev (Mean, Sd) UCL | 2.720343 |
| | | 97.5% Chebyshev (Mean, Sd) UCL | 3.609432 |
| | | 99% Chebyshev (Mean, Sd) UCL | 5.355875 |
| Recommended UCL exceeds the maximum observation | | | |

General Statistics

| | | | |
|---|---|---|---|
| Data File | K:\ENV\PERKINELMER INC\site\26682\Deliv | Variable: | Tetrachloroethene (GMW 5 & 6) |
| Raw Statistics | | Normal Distribution Test | |
| Number of Valid Samples | 5 | Shapiro-Wilk Test Statisitic | 0.773433 |
| Number of Unique Samples | 5 | Shapiro-Wilk 5% Critical Value | 0.762 |
| Minimum | 0.706 | Data are normal at 5% significance level | |
| Maximum | 54.4 | | |
| Mean | 18.7992 | 95% UCL (Assuming Normal Distribution) | |
| Median | 1.25 | Student | 42.76669 |
| Standard Deviation | 25.13922 | | |
| Variance | 631.9802 | Gamma Distribution Test | |
| Coefficient of Variation | 1.337249 | A-D Test Statistic | 0.679445 |
| Skewness | 0.887289 | A-D 5% Critical Value | 0.717191 |
| | | K-S Test Statistic | 0.372737 |
| Gamma Statistics | | K-S 5% Critical Value | 0.373452 |
| k hat | 0.455808 | Data follow gamma distribution | |
| k star (bias corrected) | 0.315657 | at 5% significance level | |
| Theta hat | 41.24366 | | |
| Theta star | 59.55585 | 95% UCLs (Assuming Gamma Distribution) | |
| nu hat | 4.558082 | Approximate Gamma UCL | 141.2611 |
| nu star | 3.156566 | Adjusted Gamma UCL | 375.808 |
| Approx.Chi Square Value (.05) | 0.42008 | | |
| Adjusted Level of Significance | 0.0086 | Lognormal Distribution Test | |
| Adjusted Chi Square Value | 0.157902 | Shapiro-Wilk Test Statisitic | 0.790174 |
| | | Shapiro-Wilk 5% Critical Value | 0.762 |
| Log-transformed Statistics | | Data are lognormal at 5% significance level | |
| Minimum of log data | -0.34814 | | |
| Maximum of log data | 3.996364 | 95% UCLs (Assuming Lognormal Distribution) | |
| Mean of log data | 1.519942 | 95% H-UCL | 1197198 |
| Standard Deviation of log data | 2.094554 | 95% Chebyshev (MVUE) UCL | 81.55031 |
| Variance of log data | 4.387158 | 97.5% Chebyshev (MVUE) UCL | 108.6451 |
| | | 99% Chebyshev (MVUE) UCL | 161.8675 |
| | | | |
| | | 95% Non-parametric UCLs | |
| | | CLT UCL | 37.29163 |
| | | Adj-CLT UCL (Adjusted for skewness) | 42.05843 |
| | | Mod-t UCL (Adjusted for skewness) | 43.51022 |
| | | Jackknife UCL | 42.76669 |
| | | Standard Bootstrap UCL | 35.33118 |
| | | Bootstrap-t UCL | 1729.877 |
| RECOMMENDATION | | Hall's Bootstrap UCL | 1481.357 |
| Data are normal (0.05) | | Percentile Bootstrap UCL | 36.588 |
| | | BCA Bootstrap UCL | 33.0092 |
| Use Student's-t UCL | | 95% Chebyshev (Mean, Sd) UCL | 67.80456 |
| | | 97.5% Chebyshev (Mean, Sd) UCL | 89.00921 |
| | | 99% Chebyshev (Mean, Sd) UCL | 130.6617 |

General Statistics

| | | | |
|---|---|---|---|
| Data File | K:\ENV\PERKINELMER INC\site\26682\Deliv | Variable: Trichloroethene (GMW-5 & 6) | |
| Raw Statistics | | Normal Distribution Test | |
| Number of Valid Samples | 5 | Shapiro-Wilk Test Statisitic | 0.789391 |
| Number of Unique Samples | 5 | Shapiro-Wilk 5% Critical Value | 0.762 |
| Minimum | 1.17 | Data are normal at 5% significance level | |
| Maximum | 23.1 | | |
| Mean | 8.144 | 95% UCL (Assuming Normal Distribution) | |
| Median | 1.68 | Student | 17.44355 |
| Standard Deviation | 9.754185 | | |
| Variance | 95.14413 | Gamma Distribution Test | |
| Coefficient of Variation | 1.197714 | A-D Test Statistic | 0.61213 |
| Skewness | 1.161254 | A-D 5% Critical Value | 0.696193 |
| | | K-S Test Statistic | 0.370577 |
| Gamma Statistics | | K-S 5% Critical Value | 0.365997 |
| k hat | 0.824417 | Data follow approximate gamma distibution | |
| k star (bias corrected) | 0.4631 | at 5% significance level | |
| Theta hat | 9.878501 | | |
| Theta star | 17.58584 | 95% UCLs (Assuming Gamma Distribution) | |
| nu hat | 8.244166 | Approximate Gamma UCL | 38.27653 |
| nu star | 4.631 | Adjusted Gamma UCL | 85.95812 |
| Approx.Chi Square Value (.05) | 0.985326 | | |
| Adjusted Level of Significance | 0.0086 | Lognormal Distribution Test | |
| Adjusted Chi Square Value | 0.438759 | Shapiro-Wilk Test Statisitic | 0.818714 |
| | | Shapiro-Wilk 5% Critical Value | 0.762 |
| Log-transformed Statistics | | Data are lognormal at 5% significance level | |
| Minimum of log data | 0.157004 | | |
| Maximum of log data | 3.139833 | 95% UCLs (Assuming Lognormal Distribution) | |
| Mean of log data | 1.380213 | 95% H-UCL | 894.3526 |
| Standard Deviation of log data | 1.370103 | 95% Chebyshev (MVUE) UCL | 26.9493 |
| Variance of log data | 1.877181 | 97.5% Chebyshev (MVUE) UCL | 35.23127 |
| | | 99% Chebyshev (MVUE) UCL | 51.4996 |
| | | | |
| | | 95% Non-parametric UCLs | |
| | | CLT UCL | 15.31919 |
| | | Adj-CLT UCL (Adjusted for skewness) | 17.73982 |
| | | Mod-t UCL (Adjusted for skewness) | 17.82112 |
| | | Jackknife UCL | 17.44355 |
| | | Standard Bootstrap UCL | 14.66703 |
| | | Bootstrap-t UCL | 246.9364 |
| RECOMMENDATION | | Hall's Bootstrap UCL | 217.4302 |
| Data are normal (0.05) | | Percentile Bootstrap UCL | 14.814 |
| | | BCA Bootstrap UCL | 12.714 |
| Use Student's-t UCL | | 95% Chebyshev (Mean, Sd) UCL | 27.15841 |
| | | 97.5% Chebyshev (Mean, Sd) UCL | 35.38596 |
| | | 99% Chebyshev (Mean, Sd) UCL | 51.54738 |

General Statistics

| | | | |
|---|---|---|---|
| Data File | K:\ENV\PERKINELMER INC\site\26682\Del | Variable: | Vinyl Chloride (GMW-5 & 6) |
| Raw Statistics | | Normal Distribution Test | |
| Number of Valid Samples | 5 | Shapiro-Wilk Test Statisitic | 0.961795 |
| Number of Unique Samples | 5 | Shapiro-Wilk 5% Critical Value | 0.762 |
| Minimum | 0.39 | Data are normal at 5% significance level | |
| Maximum | 1 | | |
| Mean | 0.6662 | 95% UCL (Assuming Normal Distribution) | |
| Median | 0.657 | Studen | 0.877331 |
| Standard Deviation | 0.221452 | | |
| Variance | 0.049041 | Gamma Distribution Test | |
| Coefficient of Variation | 0.332411 | A-D Test Statistic | 0.233618 |
| Skewness | 0.597384 | A-D 5% Critical Value | 0.678857 |
| | | K-S Test Statistic | 0.191203 |
| Gamma Statistics | | K-S 5% Critical Value | 0.357537 |
| k hat | 11.22802 | Data follow gamma distribution | |
| k star (bias corrected) | 4.624541 | at 5% significance level | |
| Theta hat | 0.059334 | | |
| Theta star | 0.144058 | 95% UCLs (Assuming Gamma Distribution) | |
| nu hat | 112.2802 | Approximate Gamma UCL | 0.973739 |
| nu star | 46.24541 | Adjusted Gamma UCL | 1.163916 |
| Approx.Chi Square Value (.05) | 31.63957 | | |
| Adjusted Level of Significance | 0.0086 | Lognormal Distribution Test | |
| Adjusted Chi Square Value | 26.46985 | Shapiro-Wilk Test Statisitic | 0.973262 |
| | | Shapiro-Wilk 5% Critical Value | 0.762 |
| Log-transformed Statistics | | Data are lognormal at 5% significance level | |
| Minimum of log data | -0.94161 | | |
| Maximum of log data | 0 | 95% UCLs (Assuming Lognormal Distribution) | |
| Mean of log data | -0.45136 | 95% H-UCL | 1.031465 |
| Standard Deviation of log data | 0.340091 | 95% Chebyshev (MVUE) UCL | 1.106888 |
| Variance of log data | 0.115662 | 97.5% Chebyshev (MVUE) UCL | 1.297367 |
| | | 99% Chebyshev (MVUE) UCL | 1.671524 |
| | | | |
| | | 95% Non-parametric UCLs | |
| | | CLT UCL | 0.829101 |
| | | Adj-CLT UCL (Adjusted for skewness) | 0.857372 |
| | | Mod-t UCL (Adjusted for skewness) | 0.88174 |
| | | Jackknife UCL | 0.877331 |
| | | Standard Bootstrap UCL | 0.81048 |
| | | Bootstrap-t UCL | 0.905227 |
| RECOMMENDATION | | Hall's Bootstrap UCL | 1.011151 |
| Data are normal (0.05) | | Percentile Bootstrap UCL | 0.8122 |
| | | BCA Bootstrap UCL | 0.8718 |
| Use Student's-t UCL | | 95% Chebyshev (Mean, Sd) UCL | 1.09789 |
| | | 97.5% Chebyshev (Mean, Sd) UCL | 1.284683 |
| | | 99% Chebyshev (Mean, Sd) UCL | 1.651601 |

**Appendix B**
**USEPA Johnson and Ettinger Model Data Entry and Intermediate Calculations Worksheets for Indoor Air Concentrations**

Monitoring Wells GMW-3, 7, 8, & 9

# DATA ENTRY SHEET
## 1,1-Dichloroethene in Groundwater Wells GMW 3, 7, 8, 9
## Perkin Elmer
## Missouri Metals Site
## Overland, Missouri

GW-ADV
Version 3.1; 02/04

Reset to Defaults

CALCULATE RISK-BASED GROUNDWATER CONCENTRATION (enter "X" in "YES" box)

YES [ ]

OR

CALCULATE INCREMENTAL RISKS FROM ACTUAL GROUNDWATER CONCENTRATION (enter "X" in "YES" box and initial groundwater conc. below)

YES [X]

| ENTER Chemical CAS No. (numbers only, no dashes) | ENTER Initial groundwater conc., $C_W$ (µg/L) | Chemical |
|---|---|---|
| 75354 | 4.55E+02 | 1,1-Dichloroethylene |

MORE ↓

| ENTER Average soil/ groundwater temperature, $T_S$ (°C) | ENTER Depth below grade to bottom of enclosed space floor, $L_F$ (cm) | ENTER Depth below grade to water table, $L_{WT}$ (cm) | ENTER Thickness of soil stratum A, $h_A$ (cm) | ENTER Thickness of soil stratum B, (Enter value or 0) $h_B$ (cm) | ENTER Thickness of soil stratum C, (Enter value or 0) $h_C$ (cm) | ENTER Soil stratum directly above water table, (Enter A, B, or C) | ENTER SCS soil type directly above water table | ENTER Soil stratum A SCS soil type (used to estimate soil vapor permeability) | OR | ENTER User-defined stratum A soil vapor permeability, $k_v$ (cm$^2$) |
|---|---|---|---|---|---|---|---|---|---|---|
| 10 | 15 | 457.2 | 457.2 | | | C | SC | C | | |

Totals must add up to value of $L_{WT}$ (cell G28)

MORE ↓

| ENTER Stratum A SCS soil type | ENTER Stratum A soil dry bulk density, $\rho_b^A$ (g/cm$^3$) | ENTER Stratum A soil total porosity, $n^A$ (unitless) | ENTER Stratum A soil water-filled porosity, $\theta_w^A$ (cm$^3$/cm$^3$) | ENTER Stratum B SCS soil type | ENTER Stratum B soil dry bulk density, $\rho_b^B$ (g/cm$^3$) | ENTER Stratum B soil total porosity, $n^B$ (unitless) | ENTER Stratum B soil water-filled porosity, $\theta_w^B$ (cm$^3$/cm$^3$) | ENTER Stratum C SCS soil type | ENTER Stratum C soil dry bulk density, $\rho_b^C$ (g/cm$^3$) | ENTER Stratum C soil total porosity, $n^C$ (unitless) | ENTER Stratum C soil water-filled porosity, $\theta_w^C$ (cm$^3$/cm$^3$) |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Lookup Soil Parameters | | | | Lookup Soil Parameters | | | | Lookup Soil Parameters | | | |
| C | 1.43 | 0.459 | 0.215 | C | 1.43 | 0.459 | 0.215 | C | 1.43 | 0.459 | 0.215 |

MORE ↓

| ENTER Enclosed space floor thickness, $L_{crack}$ (cm) | ENTER Soil-bldg. pressure differential, $\Delta P$ (g/cm-s$^2$) | ENTER Enclosed space floor length, $L_B$ (cm) | ENTER Enclosed space floor width, $W_B$ (cm) | ENTER Enclosed space height, $H_B$ (cm) | ENTER Floor-wall seam crack width, w (cm) | ENTER Indoor air exchange rate, ER (1/h) | ENTER Average vapor flow rate into bldg. OR Leave blank to calculate $Q_{soil}$ (L/m) |
|---|---|---|---|---|---|---|---|
| 10 | 40 | 1000 | 1000 | 366 | 0.1 | 0.25 | |

MORE ↓

| ENTER Averaging time for carcinogens, $AT_C$ (yrs) | ENTER Averaging time for noncarcinogens, $AT_{NC}$ (yrs) | ENTER Exposure duration, ED (yrs) | ENTER Exposure frequency, EF (days/yr) | ENTER Target risk for carcinogens, TR (unitless) | ENTER Target hazard quotient for noncarcinogens, THQ (unitless) |
|---|---|---|---|---|---|
| 70 | 30 | 30 | 350 | 1.0E-06 | 1 |

Used to calculate risk-based groundwater concentration.

END

# INTERMEDIATE CALCULATIONS SHEET
## 1,1-Dichloroethene in Groundwater Wells GMW 3, 7, 8, 9
## Perkin Elmer
## Missouri Metals Site
## Overland, Missouri

| Exposure duration, $\tau$ (sec) | Source-building separation, $L_T$ (cm) | Stratum A soil air-filled porosity, $\theta_a^A$ ($cm^3/cm^3$) | Stratum B soil air-filled porosity, $\theta_a^B$ ($cm^3/cm^3$) | Stratum C soil air-filled porosity, $\theta_a^C$ ($cm^3/cm^3$) | Stratum A effective total fluid saturation, $S_{te}$ ($cm^3/cm^3$) | Stratum A soil intrinsic permeability, $k_i$ ($cm^2$) | Stratum A soil relative air permeability, $k_{rg}$ ($cm^2$) | Stratum A soil effective vapor permeability, $k_v$ ($cm^2$) | Thickness of capillary zone, $L_{cz}$ (cm) | Total porosity in capillary zone, $n_{cz}$ ($cm^3/cm^3$) | Air-filled porosity in capillary zone, $\theta_{a,cz}$ ($cm^3/cm^3$) | Water-filled porosity in capillary zone, $\theta_{w,cz}$ ($cm^3/cm^3$) | Floor-wall seam perimeter, $X_{crack}$ (cm) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 9.46E+08 | 442.2 | 0.244 | 0.244 | 0.244 | 0.324 | 2.26E-09 | 0.821 | 1.86E-09 | 30.00 | 0.459 | 0.104 | 0.355 | 4,000 |

| Bldg. ventilation rate, $Q_{building}$ ($cm^3/s$) | Area of enclosed space below grade, $A_B$ ($cm^2$) | Crack-to-total area ratio, $\eta$ (unitless) | Crack depth below grade, $Z_{crack}$ (cm) | Enthalpy of vaporization at ave. groundwater temperature, $\Delta H_{v,TS}$ (cal/mol) | Henry's law constant at ave. groundwater temperature, $H_{TS}$ ($atm\text{-}m^3/mol$) | Henry's law constant at ave. groundwater temperature, $H'_{TS}$ (unitless) | Vapor viscosity at ave. soil temperature, $\mu_{TS}$ (g/cm-s) | Stratum A effective diffusion coefficient, $D^{eff}_A$ ($cm^2/s$) | Stratum B effective diffusion coefficient, $D^{eff}_B$ ($cm^2/s$) | Stratum C effective diffusion coefficient, $D^{eff}_C$ ($cm^2/s$) | Capillary zone effective diffusion coefficient, $D^{eff}_{cz}$ ($cm^2/s$) | Total overall effective diffusion coefficient, $D^{eff}_T$ ($cm^2/s$) | Diffusion path length, $L_d$ (cm) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 2.54E+04 | 1.06E+06 | 3.77E-04 | 15 | 6,392 | 1.47E-02 | 6.33E-01 | 1.75E-04 | 3.90E-03 | 0.00E+00 | 0.00E+00 | 2.31E-04 | 1.88E-03 | 442.2 |

| Convection path length, $L_p$ (cm) | Source vapor conc., $C_{source}$ ($\mu g/m^3$) | Crack radius, $r_{crack}$ (cm) | Average vapor flow rate into bldg., $Q_{soil}$ ($cm^3/s$) | Crack effective diffusion coefficient, $D^{crack}$ ($cm^2/s$) | Area of crack, $A_{crack}$ ($cm^2$) | Exponent of equivalent foundation Peclet number, $exp(Pe^f)$ (unitless) | Infinite source indoor attenuation coefficient, $\alpha$ (unitless) | Infinite source bldg. conc., $C_{building}$ ($\mu g/m^3$) | Unit risk factor, URF $(\mu g/m^3)^{-1}$ | Reference conc., RfC ($mg/m^3$) |
|---|---|---|---|---|---|---|---|---|---|---|
| 15 | 2.88E+05 | 0.10 | 1.86E+00 | 3.90E-03 | 4.00E+02 | 1.57E+05 | 5.19E-05 | 1.49E+01 | NA | 2.0E-01 |

END

**DATA ENTRY SHEET**
**cis-1,2-Dichloroethene in Groundwater Wells GMW 3, 7, 8, 9**
**Perkin Elmer**
**Missouri Metals Site**
**Overland, Missouri**

GW-ADV
Version 3.1; 02/04

Reset to Defaults

CALCULATE RISK-BASED GROUNDWATER CONCENTRATION (enter "X" in "YES" box)

YES [ ]

**OR**

CALCULATE INCREMENTAL RISKS FROM ACTUAL GROUNDWATER CONCENTRATION (enter "X" in "YES" box and initial groundwater conc. below)

YES [ X ]

| ENTER<br>Chemical CAS No. (numbers only, no dashes) | ENTER<br>Initial groundwater conc., $C_W$ (µg/L) | Chemical |
|---|---|---|
| 156592 | 1.00E+04 | cis-1,2-Dichloroethylene |

MORE ↓

| ENTER<br>Average soil/ groundwater temperature, $T_S$ (°C) | ENTER<br>Depth below grade to bottom of enclosed space floor, $L_F$ (cm) | ENTER<br>Depth below grade to water table, $L_{WT}$ (cm) | ENTER<br>Thickness of soil stratum A, $h_A$ (cm) | ENTER<br>Thickness of soil stratum B, (Enter value or 0) $h_B$ (cm) | ENTER<br>Thickness of soil stratum C, (Enter value or 0) $h_C$ (cm) | ENTER<br>Soil stratum directly above water table, (Enter A, B, or C) | ENTER<br>SCS soil type directly above water table | ENTER<br>Soil stratum A SCS soil type (used to estimate soil vapor permeability) | OR | ENTER<br>User-defined stratum A soil vapor permeability, $k_v$ (cm²) |
|---|---|---|---|---|---|---|---|---|---|---|
| 10 | 15 | 457.2 | 457.2 | | | C | SC | C | | |

Totals must add up to value of $L_{WT}$ (cell G28)

MORE ↓

| ENTER<br>Stratum A SCS soil type<br>Lookup Soil Parameters | ENTER<br>Stratum A soil dry bulk density, $\rho_b^A$ (g/cm³) | ENTER<br>Stratum A soil total porosity, $n^A$ (unitless) | ENTER<br>Stratum A soil water-filled porosity, $\theta_w^A$ (cm³/cm³) | ENTER<br>Stratum B SCS soil type<br>Lookup Soil Parameters | ENTER<br>Stratum B soil dry bulk density, $\rho_b^B$ (g/cm³) | ENTER<br>Stratum B soil total porosity, $n^B$ (unitless) | ENTER<br>Stratum B soil water-filled porosity, $\theta_w^B$ (cm³/cm³) | ENTER<br>Stratum C SCS soil type<br>Lookup Soil Parameters | ENTER<br>Stratum C soil dry bulk density, $\rho_b^C$ (g/cm³) | ENTER<br>Stratum C soil total porosity, $n^C$ (unitless) | ENTER<br>Stratum C soil water-filled porosity, $\theta_w^C$ (cm³/cm³) |
|---|---|---|---|---|---|---|---|---|---|---|---|
| C | 1.43 | 0.459 | 0.215 | C | 1.43 | 0.459 | 0.215 | C | 1.43 | 0.459 | 0.215 |

MORE ↓

| ENTER<br>Enclosed space floor thickness, $L_{crack}$ (cm) | ENTER<br>Soil-bldg. pressure differential, $\Delta P$ (g/cm-s²) | ENTER<br>Enclosed space floor length, $L_B$ (cm) | ENTER<br>Enclosed space floor width, $W_B$ (cm) | ENTER<br>Enclosed space height, $H_B$ (cm) | ENTER<br>Floor-wall seam crack width, w (cm) | ENTER<br>Indoor air exchange rate, ER (1/h) | ENTER<br>Average vapor flow rate into bldg. OR Leave blank to calculate $Q_{soil}$ (L/m) |
|---|---|---|---|---|---|---|---|
| 10 | 40 | 1000 | 1000 | 366 | 0.1 | 0.25 | |

MORE ↓

| ENTER<br>Averaging time for carcinogens, $AT_C$ (yrs) | ENTER<br>Averaging time for noncarcinogens, $AT_{NC}$ (yrs) | ENTER<br>Exposure duration, ED (yrs) | ENTER<br>Exposure frequency, EF (days/yr) | ENTER<br>Target risk for carcinogens, TR (unitless) | ENTER<br>Target hazard quotient for noncarcinogens, THQ (unitless) |
|---|---|---|---|---|---|
| 70 | 30 | 30 | 350 | 1.0E-06 | 1 |

Used to calculate risk-based groundwater concentration.

END

# INTERMEDIATE CALCULATIONS SHEET
## cis-1,2-Dichloroethene in Groundwater Wells GMW 3, 7, 8, 9
## Perkin Elmer
## Missouri Metals Site
## Overland, Missouri

| Exposure duration, $\tau$ (sec) | Source-building separation, $L_T$ (cm) | Stratum A soil air-filled porosity, $\theta_a^A$ ($cm^3/cm^3$) | Stratum B soil air-filled porosity, $\theta_a^B$ ($cm^3/cm^3$) | Stratum C soil air-filled porosity, $\theta_a^C$ ($cm^3/cm^3$) | Stratum A effective total fluid saturation, $S_{te}$ ($cm^3/cm^3$) | Stratum A soil intrinsic permeability, $k_i$ ($cm^2$) | Stratum A soil relative air permeability, $k_{rg}$ ($cm^2$) | Stratum A soil effective vapor permeability, $k_v$ ($cm^2$) | Thickness of capillary zone, $L_{cz}$ (cm) | Total porosity in capillary zone, $n_{cz}$ ($cm^3/cm^3$) | Air-filled porosity in capillary zone, $\theta_{a,cz}$ ($cm^3/cm^3$) | Water-filled porosity in capillary zone, $\theta_{w,cz}$ ($cm^3/cm^3$) | Floor-wall seam perimeter, $X_{crack}$ (cm) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 9.46E+08 | 442.2 | 0.244 | 0.244 | 0.244 | 0.324 | 2.26E-09 | 0.821 | 1.86E-09 | 30.00 | 0.459 | 0.104 | 0.355 | 4,000 |

| Bldg. ventilation rate, $Q_{building}$ ($cm^3/s$) | Area of enclosed space below grade, $A_B$ ($cm^2$) | Crack-to-total area ratio, $\eta$ (unitless) | Crack depth below grade, $Z_{crack}$ (cm) | Enthalpy of vaporization at ave. groundwater temperature, $\Delta H_{v,TS}$ (cal/mol) | Henry's law constant at ave. groundwater temperature, $H_{TS}$ ($atm\text{-}m^3/mol$) | Henry's law constant at ave. groundwater temperature, $H'_{TS}$ (unitless) | Vapor viscosity at ave. soil temperature, $\mu_{TS}$ (g/cm-s) | Stratum A effective diffusion coefficient, $D^{eff}_A$ ($cm^2/s$) | Stratum B effective diffusion coefficient, $D^{eff}_B$ ($cm^2/s$) | Stratum C effective diffusion coefficient, $D^{eff}_C$ ($cm^2/s$) | Capillary zone effective diffusion coefficient, $D^{eff}_{cz}$ ($cm^2/s$) | Total overall effective diffusion coefficient, $D^{eff}_T$ ($cm^2/s$) | Diffusion path length, $L_d$ (cm) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 2.54E+04 | 1.06E+06 | 3.77E-04 | 15 | 7,734 | 2.04E-03 | 8.77E-02 | 1.75E-04 | 3.19E-03 | 0.00E+00 | 0.00E+00 | 2.07E-04 | 1.61E-03 | 442.2 |

| Convection path length, $L_p$ (cm) | Source vapor conc., $C_{source}$ ($\mu g/m^3$) | Crack radius, $r_{crack}$ (cm) | Average vapor flow rate into bldg., $Q_{soil}$ ($cm^3/s$) | Crack effective diffusion coefficient, $D^{crack}$ ($cm^2/s$) | Area of crack, $A_{crack}$ ($cm^2$) | Exponent of equivalent foundation Peclet number, $\exp(Pe^f)$ (unitless) | Infinite source indoor attenuation coefficient, $\alpha$ (unitless) | Infinite source bldg. conc., $C_{building}$ ($\mu g/m^3$) | Unit risk factor, URF $(\mu g/m^3)^{-1}$ | Reference conc., RfC ($mg/m^3$) |
|---|---|---|---|---|---|---|---|---|---|---|
| 15 | 8.77E+05 | 0.10 | 1.86E+00 | 3.19E-03 | 4.00E+02 | 2.22E+06 | 4.95E-05 | 4.34E+01 | NA | 3.5E-02 |

END

# DATA ENTRY SHEET
## trans-1,2-Dichloroethene in Groundwater Wells GMW 3, 7, 8, 9
## Perkin Elmer
## Missouri Metals Site
## Overland, Missouri

GW-ADV
Version 3.1; 02/04

Reset to Defaults

CALCULATE RISK-BASED GROUNDWATER CONCENTRATION (enter "X" in "YES" box)

YES [ ]

OR

CALCULATE INCREMENTAL RISKS FROM ACTUAL GROUNDWATER CONCENTRATION (enter "X" in "YES" box and initial groundwater conc. below)

YES [ X ]

| ENTER Chemical CAS No. (numbers only, no dashes) | ENTER Initial groundwater conc., $C_W$ (μg/L) | Chemical |
|---|---|---|
| 156605 | 4.54E+02 | trans-1,2-Dichloroethylene |

MORE ↓

| ENTER Average soil/ groundwater temperature, $T_S$ (°C) | ENTER Depth below grade to bottom of enclosed space floor, $L_F$ (cm) | ENTER Depth below grade to water table, $L_{WT}$ (cm) | ENTER Thickness of soil stratum A, $h_A$ (cm) | ENTER Thickness of soil stratum B, (Enter value or 0) $h_B$ (cm) | ENTER Thickness of soil stratum C, (Enter value or 0) $h_C$ (cm) | ENTER Soil stratum directly above water table, (Enter A, B, or C) | ENTER SCS soil type directly above water table | ENTER Soil stratum A SCS soil type (used to estimate soil vapor permeability) | OR | ENTER User-defined stratum A soil vapor permeability, $k_v$ (cm²) |
|---|---|---|---|---|---|---|---|---|---|---|
| 10 | 15 | 457.2 | 457.2 | | | C | SC | C | | |

Totals must add up to value of $L_{WT}$ (cell G28)

MORE ↓

| ENTER Stratum A SCS soil type (Lookup Soil Parameters) | ENTER Stratum A soil dry bulk density, $\rho_b^A$ (g/cm³) | ENTER Stratum A soil total porosity, $n^A$ (unitless) | ENTER Stratum A soil water-filled porosity, $\theta_w^A$ (cm³/cm³) | ENTER Stratum B SCS soil type (Lookup Soil Parameters) | ENTER Stratum B soil dry bulk density, $\rho_b^B$ (g/cm³) | ENTER Stratum B soil total porosity, $n^B$ (unitless) | ENTER Stratum B soil water-filled porosity, $\theta_w^B$ (cm³/cm³) | ENTER Stratum C SCS soil type (Lookup Soil Parameters) | ENTER Stratum C soil dry bulk density, $\rho_b^C$ (g/cm³) | ENTER Stratum C soil total porosity, $n^C$ (unitless) | ENTER Stratum C soil water-filled porosity, $\theta_w^C$ (cm³/cm³) |
|---|---|---|---|---|---|---|---|---|---|---|---|
| C | 1.43 | 0.459 | 0.215 | C | 1.43 | 0.459 | 0.215 | C | 1.43 | 0.459 | 0.215 |

MORE ↓

| ENTER Enclosed space floor thickness, $L_{crack}$ (cm) | ENTER Soil-bldg. pressure differential, $\Delta P$ (g/cm-s²) | ENTER Enclosed space floor length, $L_B$ (cm) | ENTER Enclosed space floor width, $W_B$ (cm) | ENTER Enclosed space height, $H_B$ (cm) | ENTER Floor-wall seam crack width, w (cm) | ENTER Indoor air exchange rate, ER (1/h) | ENTER Average vapor flow rate into bldg. OR Leave blank to calculate $Q_{soil}$ (L/m) |
|---|---|---|---|---|---|---|---|
| 10 | 40 | 1000 | 1000 | 366 | 0.1 | 0.25 | |

MORE ↓

| ENTER Averaging time for carcinogens, $AT_C$ (yrs) | ENTER Averaging time for noncarcinogens, $AT_{NC}$ (yrs) | ENTER Exposure duration, ED (yrs) | ENTER Exposure frequency, EF (days/yr) | ENTER Target risk for carcinogens, TR (unitless) | ENTER Target hazard quotient for noncarcinogens, THQ (unitless) |
|---|---|---|---|---|---|
| 70 | 30 | 30 | 350 | 1.0E-06 | 1 |

Used to calculate risk-based groundwater concentration.

END

# INTERMEDIATE CALCULATIONS SHEET
## trans-1,2-Dichloroethene in Groundwater Wells GMW 3, 7, 8, 9
## Perkin Elmer
## Missouri Metals Site
## Overland, Missouri

| Exposure duration, $\tau$ (sec) | Source-building separation, $L_T$ (cm) | Stratum A soil air-filled porosity, $\theta_a^A$ ($cm^3/cm^3$) | Stratum B soil air-filled porosity, $\theta_a^B$ ($cm^3/cm^3$) | Stratum C soil air-filled porosity, $\theta_a^C$ ($cm^3/cm^3$) | Stratum A effective total fluid saturation, $S_{te}$ ($cm^3/cm^3$) | Stratum A soil intrinsic permeability, $k_i$ ($cm^2$) | Stratum A soil relative air permeability, $k_{rg}$ ($cm^2$) | Stratum A soil effective vapor permeability, $k_v$ ($cm^2$) | Thickness of capillary zone, $L_{cz}$ (cm) | Total porosity in capillary zone, $n_{cz}$ ($cm^3/cm^3$) | Air-filled porosity in capillary zone, $\theta_{a,cz}$ ($cm^3/cm^3$) | Water-filled porosity in capillary zone, $\theta_{w,cz}$ ($cm^3/cm^3$) | Floor-wall seam perimeter, $X_{crack}$ (cm) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 9.46E+08 | 442.2 | 0.244 | 0.244 | 0.244 | 0.324 | 2.26E-09 | 0.821 | 1.86E-09 | 30.00 | 0.459 | 0.104 | 0.355 | 4,000 |

| Bldg. ventilation rate, $Q_{building}$ ($cm^3/s$) | Area of enclosed space below grade, $A_B$ ($cm^2$) | Crack-to-total area ratio, $\eta$ (unitless) | Crack depth below grade, $Z_{crack}$ (cm) | Enthalpy of vaporization at ave. groundwater temperature, $\Delta H_{v,TS}$ (cal/mol) | Henry's law constant at ave. groundwater temperature, $H_{TS}$ (atm-$m^3$/mol) | Henry's law constant at ave. groundwater temperature, $H'_{TS}$ (unitless) | Vapor viscosity at ave. soil temperature, $\mu_{TS}$ (g/cm-s) | Stratum A effective diffusion coefficient, $D^{eff}_A$ ($cm^2/s$) | Stratum B effective diffusion coefficient, $D^{eff}_B$ ($cm^2/s$) | Stratum C effective diffusion coefficient, $D^{eff}_C$ ($cm^2/s$) | Capillary zone effective diffusion coefficient, $D^{eff}_{cz}$ ($cm^2/s$) | Total overall effective diffusion coefficient, $D^{eff}_T$ ($cm^2/s$) | Diffusion path length, $L_d$ (cm) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 2.54E+04 | 1.06E+06 | 3.77E-04 | 15 | 7,136 | 4.94E-03 | 2.13E-01 | 1.75E-04 | 3.06E-03 | 0.00E+00 | 0.00E+00 | 1.88E-04 | 1.50E-03 | 442.2 |

| Convection path length, $L_p$ (cm) | Source vapor conc., $C_{source}$ ($\mu g/m^3$) | Crack radius, $r_{crack}$ (cm) | Average vapor flow rate into bldg., $Q_{soil}$ ($cm^3/s$) | Crack effective diffusion coefficient, $D^{crack}$ ($cm^2/s$) | Area of crack, $A_{crack}$ ($cm^2$) | Exponent of equivalent foundation Peclet number, $\exp(Pe^f)$ (unitless) | Infinite source indoor attenuation coefficient, $\alpha$ (unitless) | Infinite source bldg. conc., $C_{building}$ ($\mu g/m^3$) | Unit risk factor, URF $(\mu g/m^3)^{-1}$ | Reference conc., RfC ($mg/m^3$) |
|---|---|---|---|---|---|---|---|---|---|---|
| 15 | 9.66E+04 | 0.10 | 1.86E+00 | 3.06E-03 | 4.00E+02 | 4.08E+06 | 4.84E-05 | 4.67E+00 | NA | 7.0E-02 |

END

# DATA ENTRY SHEET
## Tetrachloroethene in Groundwater Wells GMW 3, 7, 8, 9
## Perkin Elmer
## Missouri Metals Site
## Overland, Missouri

GW-ADV
Version 3.1; 02/04

Reset to Defaults

CALCULATE RISK-BASED GROUNDWATER CONCENTRATION (enter "X" in "YES" box)

YES [ ]

OR

CALCULATE INCREMENTAL RISKS FROM ACTUAL GROUNDWATER CONCENTRATION (enter "X" in "YES" box and initial groundwater conc. below)

YES [ X ]

| ENTER Chemical CAS No. (numbers only, no dashes) | ENTER Initial groundwater conc., $C_W$ (μg/L) | Chemical |
|---|---|---|
| 127184 | 3.51E+02 | Tetrachloroethylene |

MORE ↓

| ENTER Average soil/ groundwater temperature, $T_S$ (°C) | ENTER Depth below grade to bottom of enclosed space floor, $L_F$ (cm) | ENTER Depth below grade to water table, $L_{WT}$ (cm) | ENTER Thickness of soil stratum A, $h_A$ (cm) | ENTER Thickness of soil stratum B, (Enter value or 0) $h_B$ (cm) | ENTER Thickness of soil stratum C, (Enter value or 0) $h_C$ (cm) | ENTER Soil stratum directly above water table, (Enter A, B, or C) | ENTER SCS soil type directly above water table | ENTER Soil stratum A SCS soil type (used to estimate soil vapor permeability) | OR | ENTER User-defined stratum A soil vapor permeability, $k_v$ (cm²) |
|---|---|---|---|---|---|---|---|---|---|---|
| 10 | 15 | 457.2 | 457.2 | | | C | SC | C | | |

Totals must add up to value of $L_{WT}$ (cell G28)

MORE ↓

| ENTER Stratum A SCS soil type (Lookup Soil Parameters) | ENTER Stratum A soil dry bulk density, $\rho_b^A$ (g/cm³) | ENTER Stratum A soil total porosity, $n^A$ (unitless) | ENTER Stratum A soil water-filled porosity, $\theta_w^A$ (cm³/cm³) | ENTER Stratum B SCS soil type (Lookup Soil Parameters) | ENTER Stratum B soil dry bulk density, $\rho_b^B$ (g/cm³) | ENTER Stratum B soil total porosity, $n^B$ (unitless) | ENTER Stratum B soil water-filled porosity, $\theta_w^B$ (cm³/cm³) | ENTER Stratum C SCS soil type (Lookup Soil Parameters) | ENTER Stratum C soil dry bulk density, $\rho_b^C$ (g/cm³) | ENTER Stratum C soil total porosity, $n^C$ (unitless) | ENTER Stratum C soil water-filled porosity, $\theta_w^C$ (cm³/cm³) |
|---|---|---|---|---|---|---|---|---|---|---|---|
| C | 1.43 | 0.459 | 0.215 | C | 1.43 | 0.459 | 0.215 | C | 1.43 | 0.459 | 0.215 |

MORE ↓

| ENTER Enclosed space floor thickness, $L_{crack}$ (cm) | ENTER Soil-bldg. pressure differential, ΔP (g/cm-s²) | ENTER Enclosed space floor length, $L_B$ (cm) | ENTER Enclosed space floor width, $W_B$ (cm) | ENTER Enclosed space height, $H_B$ (cm) | ENTER Floor-wall seam crack width, w (cm) | ENTER Indoor air exchange rate, ER (1/h) | ENTER Average vapor flow rate into bldg. OR Leave blank to calculate $Q_{soil}$ (L/m) |
|---|---|---|---|---|---|---|---|
| 10 | 40 | 1000 | 1000 | 366 | 0.1 | 0.25 | |

MORE ↓

| ENTER Averaging time for carcinogens, $AT_C$ (yrs) | ENTER Averaging time for noncarcinogens, $AT_{NC}$ (yrs) | ENTER Exposure duration, ED (yrs) | ENTER Exposure frequency, EF (days/yr) | ENTER Target risk for carcinogens, TR (unitless) | ENTER Target hazard quotient for noncarcinogens, THQ (unitless) |
|---|---|---|---|---|---|
| 70 | 30 | 30 | 350 | 1.0E-06 | 1 |

Used to calculate risk-based groundwater concentration.

END

# INTERMEDIATE CALCULATIONS SHEET
## Tetrachloroethene in Groundwater Wells GMW 3, 7, 8, 9
## Perkin Elmer
## Misouri Metals Site
## Overland, Missouri

| Exposure duration, $\tau$ (sec) | Source-building separation, $L_T$ (cm) | Stratum A soil air-filled porosity, $\theta_a^A$ (cm³/cm³) | Stratum B soil air-filled porosity, $\theta_a^B$ (cm³/cm³) | Stratum C soil air-filled porosity, $\theta_a^C$ (cm³/cm³) | Stratum A effective total fluid saturation, $S_{te}$ (cm³/cm³) | Stratum A soil intrinsic permeability, $k_i$ (cm²) | Stratum A soil relative air permeability, $k_{rg}$ (cm²) | Stratum A soil effective vapor permeability, $k_v$ (cm²) | Thickness of capillary zone, $L_{cz}$ (cm) | Total porosity in capillary zone, $n_{cz}$ (cm³/cm³) | Air-filled porosity in capillary zone, $\theta_{a,cz}$ (cm³/cm³) | Water-filled porosity in capillary zone, $\theta_{w,cz}$ (cm³/cm³) | Floor-wall seam perimeter, $X_{crack}$ (cm) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 9.46E+08 | 442.2 | 0.244 | 0.244 | 0.244 | 0.324 | 2.26E-09 | 0.821 | 1.86E-09 | 30.00 | 0.459 | 0.104 | 0.355 | 4,000 |

| Bldg. ventilation rate, $Q_{building}$ (cm³/s) | Area of enclosed space below grade, $A_B$ (cm²) | Crack-to-total area ratio, $\eta$ (unitless) | Crack depth below grade, $Z_{crack}$ (cm) | Enthalpy of vaporization at ave. groundwater temperature, $\Delta H_{v,TS}$ (cal/mol) | Henry's law constant at ave. groundwater temperature, $H_{TS}$ (atm-m³/mol) | Henry's law constant at ave. groundwater temperature, $H'_{TS}$ (unitless) | Vapor viscosity at ave. soil temperature, $\mu_{TS}$ (g/cm-s) | Stratum A effective diffusion coefficient, $D^{eff}_A$ (cm²/s) | Stratum B effective diffusion coefficient, $D^{eff}_B$ (cm²/s) | Stratum C effective diffusion coefficient, $D^{eff}_C$ (cm²/s) | Capillary zone effective diffusion coefficient, $D^{eff}_{cz}$ (cm²/s) | Total overall effective diffusion coefficient, $D^{eff}_T$ (cm²/s) | Diffusion path length, $L_d$ (cm) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 2.54E+04 | 1.06E+06 | 3.77E-04 | 15 | 9,553 | 7.81E-03 | 3.36E-01 | 1.75E-04 | 3.12E-03 | 0.00E+00 | 0.00E+00 | 1.87E-04 | 1.51E-03 | 442.2 |

| Convection path length, $L_p$ (cm) | Source vapor conc., $C_{source}$ (µg/m³) | Crack radius, $r_{crack}$ (cm) | Average vapor flow rate into bldg., $Q_{soil}$ (cm³/s) | Crack effective diffusion coefficient, $D^{crack}$ (cm²/s) | Area of crack, $A_{crack}$ (cm²) | Exponent of equivalent foundation Peclet number, $\exp(Pe^f)$ (unitless) | Infinite source indoor attenuation coefficient, $\alpha$ (unitless) | Infinite source bldg. conc., $C_{building}$ (µg/m³) | Unit risk factor, URF (µg/m³)⁻¹ | Reference conc., RfC (mg/m³) |
|---|---|---|---|---|---|---|---|---|---|---|
| 15 | 1.18E+05 | 0.10 | 1.86E+00 | 3.12E-03 | 4.00E+02 | 3.12E+06 | 4.84E-05 | 5.71E+00 | 5.9E-06 | 6.0E-01 |

END

# DATA ENTRY SHEET
## Trichloroethene in Groundwater Wells GMW 3, 7, 8, 9
## Perkin Elmer
## Missouri Metals Site
## Overland, Missouri

GW-ADV
Version 3.1; 02/04

Reset to Defaults

CALCULATE RISK-BASED GROUNDWATER CONCENTRATION (enter "X" in "YES" box)

YES [ ]

**OR**

CALCULATE INCREMENTAL RISKS FROM ACTUAL GROUNDWATER CONCENTRATION (enter "X" in "YES" box and initial groundwater conc. below)

YES [ X ]

| ENTER Chemical CAS No. (numbers only, no dashes) | ENTER Initial groundwater conc., $C_W$ ($\mu$g/L) | Chemical |
|---|---|---|
| 79016 | 1.81E+03 | Trichloroethylene |

MORE ↓

| ENTER Average soil/ groundwater temperature, $T_S$ (°C) | ENTER Depth below grade to bottom of enclosed space floor, $L_F$ (cm) | ENTER Depth below grade to water table, $L_{WT}$ (cm) | ENTER Thickness of soil stratum A, $h_A$ (cm) | ENTER Thickness of soil stratum B, (Enter value or 0) $h_B$ (cm) | ENTER Thickness of soil stratum C, (Enter value or 0) $h_C$ (cm) | ENTER Soil stratum directly above water table, (Enter A, B, or C) | ENTER SCS soil type directly above water table | ENTER Soil stratum A SCS soil type (used to estimate soil vapor permeability) | OR | ENTER User-defined stratum A soil vapor permeability, $k_v$ (cm²) |
|---|---|---|---|---|---|---|---|---|---|---|
| 10 | 15 | 457.2 | 457.2 | | | C | SC | C | | |

Totals must add up to value of $L_{WT}$ (cell G28)

MORE ↓

| ENTER Stratum A SCS soil type (Lookup Soil Parameters) | ENTER Stratum A soil dry bulk density, $\rho_b^A$ (g/cm³) | ENTER Stratum A soil total porosity, $n^A$ (unitless) | ENTER Stratum A soil water-filled porosity, $\theta_w^A$ (cm³/cm³) | ENTER Stratum B SCS soil type (Lookup Soil Parameters) | ENTER Stratum B soil dry bulk density, $\rho_b^B$ (g/cm³) | ENTER Stratum B soil total porosity, $n^B$ (unitless) | ENTER Stratum B soil water-filled porosity, $\theta_w^B$ (cm³/cm³) | ENTER Stratum C SCS soil type (Lookup Soil Parameters) | ENTER Stratum C soil dry bulk density, $\rho_b^C$ (g/cm³) | ENTER Stratum C soil total porosity, $n^C$ (unitless) | ENTER Stratum C soil water-filled porosity, $\theta_w^C$ (cm³/cm³) |
|---|---|---|---|---|---|---|---|---|---|---|---|
| C | 1.43 | 0.459 | 0.215 | C | 1.43 | 0.459 | 0.215 | C | 1.43 | 0.459 | 0.215 |

MORE ↓

| ENTER Enclosed space floor thickness, $L_{crack}$ (cm) | ENTER Soil-bldg. pressure differential, $\Delta P$ (g/cm-s²) | ENTER Enclosed space floor length, $L_B$ (cm) | ENTER Enclosed space floor width, $W_B$ (cm) | ENTER Enclosed space height, $H_B$ (cm) | ENTER Floor-wall seam crack width, w (cm) | ENTER Indoor air exchange rate, ER (1/h) | ENTER Average vapor flow rate into bldg. OR Leave blank to calculate $Q_{soil}$ (L/m) |
|---|---|---|---|---|---|---|---|
| 10 | 40 | 1000 | 1000 | 366 | 0.1 | 0.25 | |

MORE ↓

| ENTER Averaging time for carcinogens, $AT_C$ (yrs) | ENTER Averaging time for noncarcinogens, $AT_{NC}$ (yrs) | ENTER Exposure duration, ED (yrs) | ENTER Exposure frequency, EF (days/yr) | ENTER Target risk for carcinogens, TR (unitless) | ENTER Target hazard quotient for noncarcinogens, THQ (unitless) |
|---|---|---|---|---|---|
| 70 | 30 | 30 | 350 | 1.0E-06 | 1 |

Used to calculate risk-based groundwater concentration.

END

# INTERMEDIATE CALCULATIONS SHEET
## Trichloroethene in Groundwater Wells GMW 3, 7, 8, 9
## Perkin Elmer
## Missouri Metals Site
## Overland, Missouri

| Exposure duration, $\tau$ (sec) | Source-building separation, $L_T$ (cm) | Stratum A soil air-filled porosity, $\theta_a^A$ ($cm^3/cm^3$) | Stratum B soil air-filled porosity, $\theta_a^B$ ($cm^3/cm^3$) | Stratum C soil air-filled porosity, $\theta_a^C$ ($cm^3/cm^3$) | Stratum A effective total fluid saturation, $S_{te}$ ($cm^3/cm^3$) | Stratum A soil intrinsic permeability, $k_i$ ($cm^2$) | Stratum A soil relative air permeability, $k_{rg}$ ($cm^2$) | Stratum A soil effective vapor permeability, $k_v$ ($cm^2$) | Thickness of capillary zone, $L_{cz}$ (cm) | Total porosity in capillary zone, $n_{cz}$ ($cm^3/cm^3$) | Air-filled porosity in capillary zone, $\theta_{a,cz}$ ($cm^3/cm^3$) | Water-filled porosity in capillary zone, $\theta_{w,cz}$ ($cm^3/cm^3$) | Floor-wall seam perimeter, $X_{crack}$ (cm) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 9.46E+08 | 442.2 | 0.244 | 0.244 | 0.244 | 0.324 | 2.26E-09 | 0.821 | 1.86E-09 | 30.00 | 0.459 | 0.104 | 0.355 | 4,000 |

| Bldg. ventilation rate, $Q_{building}$ ($cm^3/s$) | Area of enclosed space below grade, $A_B$ ($cm^2$) | Crack-to-total area ratio, $\eta$ (unitless) | Crack depth below grade, $Z_{crack}$ (cm) | Enthalpy of vaporization at ave. groundwater temperature, $\Delta H_{v,TS}$ (cal/mol) | Henry's law constant at ave. groundwater temperature, $H_{TS}$ ($atm\text{-}m^3/mol$) | Henry's law constant at ave. groundwater temperature, $H'_{TS}$ (unitless) | Vapor viscosity at ave. soil temperature, $\mu_{TS}$ (g/cm-s) | Stratum A effective diffusion coefficient, $D^{eff}_A$ ($cm^2/s$) | Stratum B effective diffusion coefficient, $D^{eff}_B$ ($cm^2/s$) | Stratum C effective diffusion coefficient, $D^{eff}_C$ ($cm^2/s$) | Capillary zone effective diffusion coefficient, $D^{eff}_{cz}$ ($cm^2/s$) | Total overall effective diffusion coefficient, $D^{eff}_T$ ($cm^2/s$) | Diffusion path length, $L_d$ (cm) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 2.54E+04 | 1.06E+06 | 3.77E-04 | 15 | 8,557 | 4.78E-03 | 2.06E-01 | 1.75E-04 | 3.42E-03 | 0.00E+00 | 0.00E+00 | 2.08E-04 | 1.67E-03 | 442.2 |

| Convection path length, $L_p$ (cm) | Source vapor conc., $C_{source}$ ($\mu g/m^3$) | Crack radius, $r_{crack}$ (cm) | Average vapor flow rate into bldg., $Q_{soil}$ ($cm^3/s$) | Crack effective diffusion coefficient, $D^{crack}$ ($cm^2/s$) | Area of crack, $A_{crack}$ ($cm^2$) | Exponent of equivalent foundation Peclet number, $\exp(Pe^f)$ (unitless) | Infinite source indoor attenuation coefficient, $\alpha$ (unitless) | Infinite source bldg. conc., $C_{building}$ ($\mu g/m^3$) | Unit risk factor, URF $(\mu g/m^3)^{-1}$ | Reference conc., RfC ($mg/m^3$) |
|---|---|---|---|---|---|---|---|---|---|---|
| 15 | 3.72E+05 | 0.10 | 1.86E+00 | 3.42E-03 | 4.00E+02 | 8.27E+05 | 5.00E-05 | 1.86E+01 | 1.1E-04 | 4.0E-02 |

END

# DATA ENTRY SHEET
## Vinyl Chloride in Groundwater Wells GMW 3, 7, 8, 9
## Perkin Elmer
## Missouri Metals Site
## Overland, Missouri

GW-ADV
Version 3.1; 02/04

Reset to Defaults

CALCULATE RISK-BASED GROUNDWATER CONCENTRATION (enter "X" in "YES" box)

YES [ ]

OR

CALCULATE INCREMENTAL RISKS FROM ACTUAL GROUNDWATER CONCENTRATION (enter "X" in "YES" box and initial groundwater conc. below)

YES [X]

| ENTER Chemical CAS No. (numbers only, no dashes) | ENTER Initial groundwater conc., $C_W$ (μg/L) | Chemical |
|---|---|---|
| 75014 | 4.53E+02 | Vinyl chloride (chloroethene) |

MORE ↓

| ENTER Average soil/ groundwater temperature, $T_S$ (°C) | ENTER Depth below grade to bottom of enclosed space floor, $L_F$ (cm) | ENTER Depth below grade to water table, $L_{WT}$ (cm) | ENTER Thickness of soil stratum A, $h_A$ (cm) | ENTER Thickness of soil stratum B, (Enter value or 0) $h_B$ (cm) | ENTER Thickness of soil stratum C, (Enter value or 0) $h_C$ (cm) | ENTER Soil stratum directly above water table, (Enter A, B, or C) | ENTER SCS soil type directly above water table | ENTER Soil stratum A SCS soil type (used to estimate soil vapor permeability) | OR | ENTER User-defined stratum A soil vapor permeability, $k_v$ (cm²) |
|---|---|---|---|---|---|---|---|---|---|---|
| 10 | 15 | 457.2 | 457.2 | | | C | SC | C | | |

Totals must add up to value of $L_{WT}$ (cell G28)

MORE ↓

| ENTER Stratum A SCS soil type (Lookup Soil Parameters) | ENTER Stratum A soil dry bulk density, $\rho_b^A$ (g/cm³) | ENTER Stratum A soil total porosity, $n^A$ (unitless) | ENTER Stratum A soil water-filled porosity, $\theta_w^A$ (cm³/cm³) | ENTER Stratum B SCS soil type (Lookup Soil Parameters) | ENTER Stratum B soil dry bulk density, $\rho_b^B$ (g/cm³) | ENTER Stratum B soil total porosity, $n^B$ (unitless) | ENTER Stratum B soil water-filled porosity, $\theta_w^B$ (cm³/cm³) | ENTER Stratum C SCS soil type (Lookup Soil Parameters) | ENTER Stratum C soil dry bulk density, $\rho_b^C$ (g/cm³) | ENTER Stratum C soil total porosity, $n^C$ (unitless) | ENTER Stratum C soil water-filled porosity, $\theta_w^C$ (cm³/cm³) |
|---|---|---|---|---|---|---|---|---|---|---|---|
| C | 1.43 | 0.459 | 0.215 | C | 1.43 | 0.459 | 0.215 | C | 1.43 | 0.459 | 0.215 |

MORE ↓

| ENTER Enclosed space floor thickness, $L_{crack}$ (cm) | ENTER Soil-bldg. pressure differential, $\Delta P$ (g/cm-s²) | ENTER Enclosed space floor length, $L_B$ (cm) | ENTER Enclosed space floor width, $W_B$ (cm) | ENTER Enclosed space height, $H_B$ (cm) | ENTER Floor-wall seam crack width, w (cm) | ENTER Indoor air exchange rate, ER (1/h) | ENTER Average vapor flow rate into bldg. OR Leave blank to calculate $Q_{soil}$ (L/m) |
|---|---|---|---|---|---|---|---|
| 10 | 40 | 1000 | 1000 | 366 | 0.1 | 0.25 | |

MORE ↓

| ENTER Averaging time for carcinogens, $AT_C$ (yrs) | ENTER Averaging time for noncarcinogens, $AT_{NC}$ (yrs) | ENTER Exposure duration, ED (yrs) | ENTER Exposure frequency, EF (days/yr) | ENTER Target risk for carcinogens, TR (unitless) | ENTER Target hazard quotient for noncarcinogens, THQ (unitless) |
|---|---|---|---|---|---|
| 70 | 30 | 30 | 350 | 1.0E-06 | 1 |

Used to calculate risk-based groundwater concentration.

END

# INTERMEDIATE CALCULATIONS SHEET
## Vinyl Chloride in Groundwater Wells GMW 3, 7, 8, 9
## Perkin Elmer
## Missouri Metals Site
## Overland, Missouri

| Exposure duration, $\tau$ (sec) | Source-building separation, $L_T$ (cm) | Stratum A soil air-filled porosity, $\theta_a^A$ ($cm^3/cm^3$) | Stratum B soil air-filled porosity, $\theta_a^B$ ($cm^3/cm^3$) | Stratum C soil air-filled porosity, $\theta_a^C$ ($cm^3/cm^3$) | Stratum A effective total fluid saturation, $S_{te}$ ($cm^3/cm^3$) | Stratum A soil intrinsic permeability, $k_i$ ($cm^2$) | Stratum A soil relative air permeability, $k_{rg}$ ($cm^2$) | Stratum A soil effective vapor permeability, $k_v$ ($cm^2$) | Thickness of capillary zone, $L_{cz}$ (cm) | Total porosity in capillary zone, $n_{cz}$ ($cm^3/cm^3$) | Air-filled porosity in capillary zone, $\theta_{a,cz}$ ($cm^3/cm^3$) | Water-filled porosity in capillary zone, $\theta_{w,cz}$ ($cm^3/cm^3$) | Floor-wall seam perimeter, $X_{crack}$ (cm) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 9.46E+08 | 442.2 | 0.244 | 0.244 | 0.244 | 0.324 | 2.26E-09 | 0.821 | 1.86E-09 | 30.00 | 0.459 | 0.104 | 0.355 | 4,000 |

| Bldg. ventilation rate, $Q_{building}$ ($cm^3/s$) | Area of enclosed space below grade, $A_B$ ($cm^2$) | Crack-to-total area ratio, $\eta$ (unitless) | Crack depth below grade, $Z_{crack}$ (cm) | Enthalpy of vaporization at ave. groundwater temperature, $\Delta H_{v,TS}$ (cal/mol) | Henry's law constant at ave. groundwater temperature, $H_{TS}$ (atm-$m^3$/mol) | Henry's law constant at ave. groundwater temperature, $H'_{TS}$ (unitless) | Vapor viscosity at ave. soil temperature, $\mu_{TS}$ (g/cm-s) | Stratum A effective diffusion coefficient, $D^{eff}_A$ ($cm^2/s$) | Stratum B effective diffusion coefficient, $D^{eff}_B$ ($cm^2/s$) | Stratum C effective diffusion coefficient, $D^{eff}_C$ ($cm^2/s$) | Capillary zone effective diffusion coefficient, $D^{eff}_{cz}$ ($cm^2/s$) | Total overall effective diffusion coefficient, $D^{eff}_T$ ($cm^2/s$) | Diffusion path length, $L_d$ (cm) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 2.54E+04 | 1.06E+06 | 3.77E-04 | 15 | 5,000 | 1.72E-02 | 7.41E-01 | 1.75E-04 | 4.59E-03 | 0.00E+00 | 0.00E+00 | 2.72E-04 | 2.21E-03 | 442.2 |

| Convection path length, $L_p$ (cm) | Source vapor conc., $C_{source}$ ($\mu g/m^3$) | Crack radius, $r_{crack}$ (cm) | Average vapor flow rate into bldg., $Q_{soil}$ ($cm^3/s$) | Crack effective diffusion coefficient, $D^{crack}$ ($cm^2/s$) | Area of crack, $A_{crack}$ ($cm^2$) | Exponent of equivalent foundation Peclet number, $\exp(Pe^f)$ (unitless) | Infinite source indoor attenuation coefficient, $\alpha$ (unitless) | Infinite source bldg. conc., $C_{building}$ ($\mu g/m^3$) | Unit risk factor, URF $(\mu g/m^3)^{-1}$ | Reference conc., RfC ($mg/m^3$) |
|---|---|---|---|---|---|---|---|---|---|---|
| 15 | 3.36E+05 | 0.10 | 1.86E+00 | 4.59E-03 | 4.00E+02 | 2.58E+04 | 5.43E-05 | 1.82E+01 | 8.8E-06 | 1.0E-01 |

END

**Monitoring Wells GMW-5 & 6**

# DATA ENTRY SHEET
## 1,1-Dichloroethene in Groundwater Wells GMW-5 6
## Perkin Elmer
## Missouri Metals Site
## Overland, Missouri

GW-ADV
Version 3.1; 02/04

Reset to Defaults

CALCULATE RISK-BASED GROUNDWATER CONCENTRATION (enter "X" in "YES" box)

YES [ ]

OR

CALCULATE INCREMENTAL RISKS FROM ACTUAL GROUNDWATER CONCENTRATION (enter "X" in "YES" box and initial groundwater conc. below)

YES [ X ]

| ENTER Chemical CAS No. (numbers only, no dashes) | ENTER Initial groundwater conc., $C_W$ (µg/L) | Chemical |
|---|---|---|
| 75354 | 3.92E+03 | 1,1-Dichloroethylene |

MORE ↓

| ENTER Average soil/ groundwater temperature, $T_S$ (°C) | ENTER Depth below grade to bottom of enclosed space floor, $L_F$ (cm) | ENTER Depth below grade to water table, $L_{WT}$ (cm) | ENTER Thickness of soil stratum A, $h_A$ (cm) | ENTER Thickness of soil stratum B, (Enter value or 0) $h_B$ (cm) | ENTER Thickness of soil stratum C, (Enter value or 0) $h_C$ (cm) | ENTER Soil stratum directly above water table, (Enter A, B, or C) | ENTER SCS soil type directly above water table | ENTER Soil stratum A SCS soil type (used to estimate soil vapor permeability) | OR | ENTER User-defined stratum A soil vapor permeability, $k_v$ (cm²) |
|---|---|---|---|---|---|---|---|---|---|---|
| 10 | 15 | 457.2 | 457.2 | | | C | SC | C | | |

Totals must add up to value of $L_{WT}$ (cell G28)

MORE ↓

| ENTER Stratum A SCS soil type (Lookup Soil Parameters) | ENTER Stratum A soil dry bulk density, $\rho_b^A$ (g/cm³) | ENTER Stratum A soil total porosity, $n^A$ (unitless) | ENTER Stratum A soil water-filled porosity, $\theta_w^A$ (cm³/cm³) | ENTER Stratum B SCS soil type (Lookup Soil Parameters) | ENTER Stratum B soil dry bulk density, $\rho_b^B$ (g/cm³) | ENTER Stratum B soil total porosity, $n^B$ (unitless) | ENTER Stratum B soil water-filled porosity, $\theta_w^B$ (cm³/cm³) | ENTER Stratum C SCS soil type (Lookup Soil Parameters) | ENTER Stratum C soil dry bulk density, $\rho_b^C$ (g/cm³) | ENTER Stratum C soil total porosity, $n^C$ (unitless) | ENTER Stratum C soil water-filled porosity, $\theta_w^C$ (cm³/cm³) |
|---|---|---|---|---|---|---|---|---|---|---|---|
| C | 1.43 | 0.459 | 0.215 | C | 1.43 | 0.459 | 0.215 | C | 1.43 | 0.459 | 0.215 |

MORE ↓

| ENTER Enclosed space floor thickness, $L_{crack}$ (cm) | ENTER Soil-bldg. pressure differential, $\Delta P$ (g/cm-s²) | ENTER Enclosed space floor length, $L_B$ (cm) | ENTER Enclosed space floor width, $W_B$ (cm) | ENTER Enclosed space height, $H_B$ (cm) | ENTER Floor-wall seam crack width, w (cm) | ENTER Indoor air exchange rate, ER (1/h) | ENTER Average vapor flow rate into bldg. OR Leave blank to calculate $Q_{soil}$ (L/m) |
|---|---|---|---|---|---|---|---|
| 10 | 40 | 1000 | 1000 | 366 | 0.1 | 0.25 | |

MORE ↓

| ENTER Averaging time for carcinogens, $AT_C$ (yrs) | ENTER Averaging time for noncarcinogens, $AT_{NC}$ (yrs) | ENTER Exposure duration, ED (yrs) | ENTER Exposure frequency, EF (days/yr) | ENTER Target risk for carcinogens, TR (unitless) | ENTER Target hazard quotient for noncarcinogens, THQ (unitless) |
|---|---|---|---|---|---|
| 70 | 30 | 30 | 350 | 1.0E-06 | 1 |

Used to calculate risk-based groundwater concentration.

END

# INTERMEDIATE CALCULATIONS SHEET
## 1,1-Dichloroethene in Groundwater Wells GMW-5 6
## Perkin Elmer
## Missouri Metals Site
## Overland, Missouri

| Exposure duration, $\tau$ (sec) | Source-building separation, $L_T$ (cm) | Stratum A soil air-filled porosity, $\theta_a^A$ ($cm^3/cm^3$) | Stratum B soil air-filled porosity, $\theta_a^B$ ($cm^3/cm^3$) | Stratum C soil air-filled porosity, $\theta_a^C$ ($cm^3/cm^3$) | Stratum A effective total fluid saturation, $S_{te}$ ($cm^3/cm^3$) | Stratum A soil intrinsic permeability, $k_i$ ($cm^2$) | Stratum A soil relative air permeability, $k_{rg}$ ($cm^2$) | Stratum A soil effective vapor permeability, $k_v$ ($cm^2$) | Thickness of capillary zone, $L_{cz}$ (cm) | Total porosity in capillary zone, $n_{cz}$ ($cm^3/cm^3$) | Air-filled porosity in capillary zone, $\theta_{a,cz}$ ($cm^3/cm^3$) | Water-filled porosity in capillary zone, $\theta_{w,cz}$ ($cm^3/cm^3$) | Floor-wall seam perimeter, $X_{crack}$ (cm) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 9.46E+08 | 442.2 | 0.244 | 0.244 | 0.244 | 0.324 | 2.26E-09 | 0.821 | 1.86E-09 | 30.00 | 0.459 | 0.104 | 0.355 | 4,000 |

| Bldg. ventilation rate, $Q_{building}$ ($cm^3/s$) | Area of enclosed space below grade, $A_B$ ($cm^2$) | Crack-to-total area ratio, $\eta$ (unitless) | Crack depth below grade, $Z_{crack}$ (cm) | Enthalpy of vaporization at ave. groundwater temperature, $\Delta H_{v,TS}$ (cal/mol) | Henry's law constant at ave. groundwater temperature, $H_{TS}$ (atm-$m^3$/mol) | Henry's law constant at ave. groundwater temperature, $H'_{TS}$ (unitless) | Vapor viscosity at ave. soil temperature, $\mu_{TS}$ (g/cm-s) | Stratum A effective diffusion coefficient, $D^{eff}_A$ ($cm^2/s$) | Stratum B effective diffusion coefficient, $D^{eff}_B$ ($cm^2/s$) | Stratum C effective diffusion coefficient, $D^{eff}_C$ ($cm^2/s$) | Capillary zone effective diffusion coefficient, $D^{eff}_{cz}$ ($cm^2/s$) | Total overall effective diffusion coefficient, $D^{eff}_T$ ($cm^2/s$) | Diffusion path length, $L_d$ (cm) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 2.54E+04 | 1.06E+06 | 3.77E-04 | 15 | 6,392 | 1.47E-02 | 6.33E-01 | 1.75E-04 | 3.90E-03 | 0.00E+00 | 0.00E+00 | 2.31E-04 | 1.88E-03 | 442.2 |

| Convection path length, $L_p$ (cm) | Source vapor conc., $C_{source}$ ($\mu g/m^3$) | Crack radius, $r_{crack}$ (cm) | Average vapor flow rate into bldg., $Q_{soil}$ ($cm^3/s$) | Crack effective diffusion coefficient, $D^{crack}$ ($cm^2/s$) | Area of crack, $A_{crack}$ ($cm^2$) | Exponent of equivalent foundation Peclet number, exp($Pe^f$) (unitless) | Infinite source indoor attenuation coefficient, $\alpha$ (unitless) | Infinite source bldg. conc., $C_{building}$ ($\mu g/m^3$) | Unit risk factor, URF $(\mu g/m^3)^{-1}$ | Reference conc., RfC ($mg/m^3$) |
|---|---|---|---|---|---|---|---|---|---|---|
| 15 | 2.48E+06 | 0.10 | 1.86E+00 | 3.90E-03 | 4.00E+02 | 1.57E+05 | 5.19E-05 | 1.29E+02 | NA | 2.0E-01 |

END

## DATA ENTRY SHEET
**cis-1,2-Dichloroethene in Groundwater Wells GMW-5 6**
**Perkin Elmer**
**Missouri Metals Site**
**Overland, Missouri**

GW-ADV
Version 3.1; 02/04

Reset to Defaults

CALCULATE RISK-BASED GROUNDWATER CONCENTRATION (enter "X" in "YES" box)

YES [ ]

**OR**

CALCULATE INCREMENTAL RISKS FROM ACTUAL GROUNDWATER CONCENTRATION (enter "X" in "YES" box and initial groundwater conc. below)

YES [ X ]

| ENTER Chemical CAS No. (numbers only, no dashes) | ENTER Initial groundwater conc., $C_W$ (µg/L) | Chemical |
|---|---|---|
| 156592 | 1.72E+04 | cis-1,2-Dichloroethylene |

MORE ↓

ENTER Totals must add up to value of $L_{WT}$ (cell G28)

| ENTER Average soil/ groundwater temperature, $T_S$ (°C) | ENTER Depth below grade to bottom of enclosed space floor, $L_F$ (cm) | ENTER Depth below grade to water table, $L_{WT}$ (cm) | ENTER Thickness of soil stratum A, $h_A$ (cm) | ENTER Thickness of soil stratum B, (Enter value or 0) $h_B$ (cm) | ENTER Thickness of soil stratum C, (Enter value or 0) $h_C$ (cm) | ENTER Soil stratum directly above water table, (Enter A, B, or C) | ENTER SCS soil type directly above water table | ENTER Soil stratum A SCS soil type (used to estimate soil vapor permeability) | OR | ENTER User-defined stratum A soil vapor permeability, $k_v$ (cm²) |
|---|---|---|---|---|---|---|---|---|---|---|
| 10 | 15 | 457.2 | 457.2 | | | C | SC | C | | |

MORE ↓

| ENTER Stratum A SCS soil type (Lookup Soil Parameters) | ENTER Stratum A soil dry bulk density, $\rho_b^A$ (g/cm³) | ENTER Stratum A soil total porosity, $n^A$ (unitless) | ENTER Stratum A soil water-filled porosity, $\theta_w^A$ (cm³/cm³) | ENTER Stratum B SCS soil type (Lookup Soil Parameters) | ENTER Stratum B soil dry bulk density, $\rho_b^B$ (g/cm³) | ENTER Stratum B soil total porosity, $n^B$ (unitless) | ENTER Stratum B soil water-filled porosity, $\theta_w^B$ (cm³/cm³) | ENTER Stratum C SCS soil type (Lookup Soil Parameters) | ENTER Stratum C soil dry bulk density, $\rho_b^C$ (g/cm³) | ENTER Stratum C soil total porosity, $n^C$ (unitless) | ENTER Stratum C soil water-filled porosity, $\theta_w^C$ (cm³/cm³) |
|---|---|---|---|---|---|---|---|---|---|---|---|
| C | 1.43 | 0.459 | 0.215 | C | 1.43 | 0.459 | 0.215 | C | 1.43 | 0.459 | 0.215 |

MORE ↓

| ENTER Enclosed space floor thickness, $L_{crack}$ (cm) | ENTER Soil-bldg. pressure differential, $\Delta P$ (g/cm-s²) | ENTER Enclosed space floor length, $L_B$ (cm) | ENTER Enclosed space floor width, $W_B$ (cm) | ENTER Enclosed space height, $H_B$ (cm) | ENTER Floor-wall seam crack width, w (cm) | ENTER Indoor air exchange rate, ER (1/h) | ENTER Average vapor flow rate into bldg. OR Leave blank to calculate $Q_{soil}$ (L/m) |
|---|---|---|---|---|---|---|---|
| 10 | 40 | 1000 | 1000 | 366 | 0.1 | 0.25 | |

MORE ↓

| ENTER Averaging time for carcinogens, $AT_C$ (yrs) | ENTER Averaging time for noncarcinogens, $AT_{NC}$ (yrs) | ENTER Exposure duration, ED (yrs) | ENTER Exposure frequency, EF (days/yr) | ENTER Target risk for carcinogens, TR (unitless) | ENTER Target hazard quotient for noncarcinogens, THQ (unitless) |
|---|---|---|---|---|---|
| 70 | 30 | 30 | 350 | 1.0E-06 | 1 |

Used to calculate risk-based groundwater concentration.

END

# INTERMEDIATE CALCULATIONS SHEET
## cis-1,2-Dichloroethene in Groundwater Wells GMW-5 6
## Perkin Elmer
## Missouri Metals Site
## Overland, Missouri

| Exposure duration, $\tau$ (sec) | Source-building separation, $L_T$ (cm) | Stratum A soil air-filled porosity, $\theta_a^A$ ($cm^3/cm^3$) | Stratum B soil air-filled porosity, $\theta_a^B$ ($cm^3/cm^3$) | Stratum C soil air-filled porosity, $\theta_a^C$ ($cm^3/cm^3$) | Stratum A effective total fluid saturation, $S_{te}$ ($cm^3/cm^3$) | Stratum A soil intrinsic permeability, $k_i$ ($cm^2$) | Stratum A soil relative air permeability, $k_{rg}$ ($cm^2$) | Stratum A soil effective vapor permeability, $k_v$ ($cm^2$) | Thickness of capillary zone, $L_{cz}$ (cm) | Total porosity in capillary zone, $n_{cz}$ ($cm^3/cm^3$) | Air-filled porosity in capillary zone, $\theta_{a,cz}$ ($cm^3/cm^3$) | Water-filled porosity in capillary zone, $\theta_{w,cz}$ ($cm^3/cm^3$) | Floor-wall seam perimeter, $X_{crack}$ (cm) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 9.46E+08 | 442.2 | 0.244 | 0.244 | 0.244 | 0.324 | 2.26E-09 | 0.821 | 1.86E-09 | 30.00 | 0.459 | 0.104 | 0.355 | 4,000 |

| Bldg. ventilation rate, $Q_{building}$ ($cm^3/s$) | Area of enclosed space below grade, $A_B$ ($cm^2$) | Crack-to-total area ratio, $\eta$ (unitless) | Crack depth below grade, $Z_{crack}$ (cm) | Enthalpy of vaporization at ave. groundwater temperature, $\Delta H_{v,TS}$ (cal/mol) | Henry's law constant at ave. groundwater temperature, $H_{TS}$ ($atm\text{-}m^3/mol$) | Henry's law constant at ave. groundwater temperature, $H'_{TS}$ (unitless) | Vapor viscosity at ave. soil temperature, $\mu_{TS}$ (g/cm-s) | Stratum A effective diffusion coefficient, $D^{eff}_A$ ($cm^2/s$) | Stratum B effective diffusion coefficient, $D^{eff}_B$ ($cm^2/s$) | Stratum C effective diffusion coefficient, $D^{eff}_C$ ($cm^2/s$) | Capillary zone effective diffusion coefficient, $D^{eff}_{cz}$ ($cm^2/s$) | Total overall effective diffusion coefficient, $D^{eff}_T$ ($cm^2/s$) | Diffusion path length, $L_d$ (cm) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 2.54E+04 | 1.06E+06 | 3.77E-04 | 15 | 7,734 | 2.04E-03 | 8.77E-02 | 1.75E-04 | 3.19E-03 | 0.00E+00 | 0.00E+00 | 2.07E-04 | 1.61E-03 | 442.2 |

| Convection path length, $L_p$ (cm) | Source vapor conc., $C_{source}$ ($\mu g/m^3$) | Crack radius, $r_{crack}$ (cm) | Average vapor flow rate into bldg., $Q_{soil}$ ($cm^3/s$) | Crack effective diffusion coefficient, $D^{crack}$ ($cm^2/s$) | Area of crack, $A_{crack}$ ($cm^2$) | Exponent of equivalent foundation Peclet number, $\exp(Pe^f)$ (unitless) | Infinite source indoor attenuation coefficient, $\alpha$ (unitless) | Infinite source bldg. conc., $C_{building}$ ($\mu g/m^3$) | Unit risk factor, URF $(\mu g/m^3)^{-1}$ | Reference conc., RfC ($mg/m^3$) |
|---|---|---|---|---|---|---|---|---|---|---|
| 15 | 1.51E+06 | 0.10 | 1.86E+00 | 3.19E-03 | 4.00E+02 | 2.22E+06 | 4.95E-05 | 7.46E+01 | NA | 3.5E-02 |

END

# DATA ENTRY SHEET
## trans-1,2-Dichloroethene in Groundwater Wells GMW-5 6
## Perkin Elmer
## Missouri Metals Site
## Overland, Missouri

GW-ADV
Version 3.1; 02/04

Reset to Defaults

CALCULATE RISK-BASED GROUNDWATER CONCENTRATION (enter "X" in "YES" box)

YES [ ]

OR

CALCULATE INCREMENTAL RISKS FROM ACTUAL GROUNDWATER CONCENTRATION (enter "X" in "YES" box and initial groundwater conc. below)

YES [ X ]

| ENTER Chemical CAS No. (numbers only, no dashes) | ENTER Initial groundwater conc., $C_W$ (μg/L) | Chemical |
|---|---|---|
| 156605 | 4.00E+01 | trans-1,2-Dichloroethylene |

MORE ↓

| ENTER Average soil/ groundwater temperature, $T_S$ (°C) | ENTER Depth below grade to bottom of enclosed space floor, $L_F$ (cm) | ENTER Depth below grade to water table, $L_{WT}$ (cm) | ENTER Thickness of soil stratum A, $h_A$ (cm) | ENTER Thickness of soil stratum B, (Enter value or 0) $h_B$ (cm) | ENTER Thickness of soil stratum C, (Enter value or 0) $h_C$ (cm) | ENTER Soil stratum directly above water table, (Enter A, B, or C) | ENTER SCS soil type directly above water table | ENTER Soil stratum A SCS soil type (used to estimate soil vapor permeability) | OR | ENTER User-defined stratum A soil vapor permeability, $k_v$ (cm²) |
|---|---|---|---|---|---|---|---|---|---|---|
| 10 | 15 | 457.2 | 457.2 | | | C | SC | C | | |

Totals must add up to value of $L_{WT}$ (cell G28)

MORE ↓

| ENTER Stratum A SCS soil type | ENTER Stratum A soil dry bulk density, $\rho_b^A$ (g/cm³) | ENTER Stratum A soil total porosity, $n^A$ (unitless) | ENTER Stratum A soil water-filled porosity, $\theta_w^A$ (cm³/cm³) | ENTER Stratum B SCS soil type | ENTER Stratum B soil dry bulk density, $\rho_b^B$ (g/cm³) | ENTER Stratum B soil total porosity, $n^B$ (unitless) | ENTER Stratum B soil water-filled porosity, $\theta_w^B$ (cm³/cm³) | ENTER Stratum C SCS soil type | ENTER Stratum C soil dry bulk density, $\rho_b^C$ (g/cm³) | ENTER Stratum C soil total porosity, $n^C$ (unitless) | ENTER Stratum C soil water-filled porosity, $\theta_w^C$ (cm³/cm³) |
|---|---|---|---|---|---|---|---|---|---|---|---|
| C | 1.43 | 0.459 | 0.215 | C | 1.43 | 0.459 | 0.215 | C | 1.43 | 0.459 | 0.215 |

Lookup Soil Parameters | Lookup Soil Parameters | Lookup Soil Parameters

MORE ↓

| ENTER Enclosed space floor thickness, $L_{crack}$ (cm) | ENTER Soil-bldg. pressure differential, $\Delta P$ (g/cm-s²) | ENTER Enclosed space floor length, $L_B$ (cm) | ENTER Enclosed space floor width, $W_B$ (cm) | ENTER Enclosed space height, $H_B$ (cm) | ENTER Floor-wall seam crack width, w (cm) | ENTER Indoor air exchange rate, ER (1/h) | ENTER Average vapor flow rate into bldg. OR Leave blank to calculate $Q_{soil}$ (L/m) |
|---|---|---|---|---|---|---|---|
| 10 | 40 | 1000 | 1000 | 366 | 0.1 | 0.25 | |

MORE ↓

| ENTER Averaging time for carcinogens, $AT_C$ (yrs) | ENTER Averaging time for noncarcinogens, $AT_{NC}$ (yrs) | ENTER Exposure duration, ED (yrs) | ENTER Exposure frequency, EF (days/yr) | ENTER Target risk for carcinogens, TR (unitless) | ENTER Target hazard quotient for noncarcinogens, THQ (unitless) |
|---|---|---|---|---|---|
| 70 | 30 | 30 | 350 | 1.0E-06 | 1 |

Used to calculate risk-based groundwater concentration.

END

# INTERMEDIATE CALCULATIONS SHEET
## trans-1,2-Dichloroethene in Groundwater Wells GMW-5 6
## Perkin Elmer
## Missouri Metals Site
## Overland, Missouri

| Exposure duration, $\tau$ (sec) | Source-building separation, $L_T$ (cm) | Stratum A soil air-filled porosity, $\theta_a^A$ ($cm^3/cm^3$) | Stratum B soil air-filled porosity, $\theta_a^B$ ($cm^3/cm^3$) | Stratum C soil air-filled porosity, $\theta_a^C$ ($cm^3/cm^3$) | Stratum A effective total fluid saturation, $S_{te}$ ($cm^3/cm^3$) | Stratum A soil intrinsic permeability, $k_i$ ($cm^2$) | Stratum A soil relative air permeability, $k_{rg}$ ($cm^2$) | Stratum A soil effective vapor permeability, $k_v$ ($cm^2$) | Thickness of capillary zone, $L_{cz}$ (cm) | Total porosity in capillary zone, $n_{cz}$ ($cm^3/cm^3$) | Air-filled porosity in capillary zone, $\theta_{a,cz}$ ($cm^3/cm^3$) | Water-filled porosity in capillary zone, $\theta_{w,cz}$ ($cm^3/cm^3$) | Floor-wall seam perimeter, $X_{crack}$ (cm) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 9.46E+08 | 442.2 | 0.244 | 0.244 | 0.244 | 0.324 | 2.26E-09 | 0.821 | 1.86E-09 | 30.00 | 0.459 | 0.104 | 0.355 | 4,000 |

| Bldg. ventilation rate, $Q_{building}$ ($cm^3/s$) | Area of enclosed space below grade, $A_B$ ($cm^2$) | Crack-to-total area ratio, $\eta$ (unitless) | Crack depth below grade, $Z_{crack}$ (cm) | Enthalpy of vaporization at ave. groundwater temperature, $\Delta H_{v,TS}$ (cal/mol) | Henry's law constant at ave. groundwater temperature, $H_{TS}$ ($atm\text{-}m^3/mol$) | Henry's law constant at ave. groundwater temperature, $H'_{TS}$ (unitless) | Vapor viscosity at ave. soil temperature, $\mu_{TS}$ (g/cm-s) | Stratum A effective diffusion coefficient, $D^{eff}_A$ ($cm^2/s$) | Stratum B effective diffusion coefficient, $D^{eff}_B$ ($cm^2/s$) | Stratum C effective diffusion coefficient, $D^{eff}_C$ ($cm^2/s$) | Capillary zone effective diffusion coefficient, $D^{eff}_{cz}$ ($cm^2/s$) | Total overall effective diffusion coefficient, $D^{eff}_T$ ($cm^2/s$) | Diffusion path length, $L_d$ (cm) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 2.54E+04 | 1.06E+06 | 3.77E-04 | 15 | 7,136 | 4.94E-03 | 2.13E-01 | 1.75E-04 | 3.06E-03 | 0.00E+00 | 0.00E+00 | 1.88E-04 | 1.50E-03 | 442.2 |

| Convection path length, $L_p$ (cm) | Source vapor conc., $C_{source}$ ($\mu g/m^3$) | Crack radius, $r_{crack}$ (cm) | Average vapor flow rate into bldg., $Q_{soil}$ ($cm^3/s$) | Crack effective diffusion coefficient, $D^{crack}$ ($cm^2/s$) | Area of crack, $A_{crack}$ ($cm^2$) | Exponent of equivalent foundation Peclet number, $\exp(Pe^f)$ (unitless) | Infinite source indoor attenuation coefficient, $\alpha$ (unitless) | Infinite source bldg. conc., $C_{building}$ ($\mu g/m^3$) | Unit risk factor, URF ($(\mu g/m^3)^{-1}$) | Reference conc., RfC ($mg/m^3$) |
|---|---|---|---|---|---|---|---|---|---|---|
| 15 | 8.51E+03 | 0.10 | 1.86E+00 | 3.06E-03 | 4.00E+02 | 4.08E+06 | 4.84E-05 | 4.11E-01 | NA | 7.0E-02 |

END

# DATA ENTRY SHEET
## Tetrachloroethene in Groundwater Wells GMW-5 6
## Perkin Elmer
## Missouri Metals Site
## Overland, Missouri

GW-ADV
Version 3.1; 02/04

Reset to Defaults

CALCULATE RISK-BASED GROUNDWATER CONCENTRATION (enter "X" in "YES" box)

YES [ ]

**OR**

CALCULATE INCREMENTAL RISKS FROM ACTUAL GROUNDWATER CONCENTRATION (enter "X" in "YES" box and initial groundwater conc. below)

YES [ X ]

| ENTER Chemical CAS No. (numbers only, no dashes) | ENTER Initial groundwater conc., $C_W$ (μg/L) | Chemical |
|---|---|---|
| 127184 | 4.28E+04 | Tetrachloroethylene |

MORE ↓

| ENTER Average soil/ groundwater temperature, $T_S$ (°C) | ENTER Depth below grade to bottom of enclosed space floor, $L_F$ (cm) | ENTER Depth below grade to water table, $L_{WT}$ (cm) | ENTER Thickness of soil stratum A, $h_A$ (cm) | ENTER Thickness of soil stratum B, (Enter value or 0) $h_B$ (cm) | ENTER Thickness of soil stratum C, (Enter value or 0) $h_C$ (cm) | ENTER Soil stratum directly above water table, (Enter A, B, or C) | ENTER SCS soil type directly above water table | ENTER Soil stratum A SCS soil type (used to estimate soil vapor permeability) | OR | ENTER User-defined stratum A soil vapor permeability, $k_v$ (cm²) |
|---|---|---|---|---|---|---|---|---|---|---|
| 10 | 15 | 457.2 | 457.2 | | | C | SC | C | | |

Thickness columns: Totals must add up to value of $L_{WT}$ (cell G28)

MORE ↓

| ENTER Stratum A SCS soil type (Lookup Soil Parameters) | ENTER Stratum A soil dry bulk density, $\rho_b^A$ (g/cm³) | ENTER Stratum A soil total porosity, $n^A$ (unitless) | ENTER Stratum A soil water-filled porosity, $\theta_w^A$ (cm³/cm³) | ENTER Stratum B SCS soil type (Lookup Soil Parameters) | ENTER Stratum B soil dry bulk density, $\rho_b^B$ (g/cm³) | ENTER Stratum B soil total porosity, $n^B$ (unitless) | ENTER Stratum B soil water-filled porosity, $\theta_w^B$ (cm³/cm³) | ENTER Stratum C SCS soil type (Lookup Soil Parameters) | ENTER Stratum C soil dry bulk density, $\rho_b^C$ (g/cm³) | ENTER Stratum C soil total porosity, $n^C$ (unitless) | ENTER Stratum C soil water-filled porosity, $\theta_w^C$ (cm³/cm³) |
|---|---|---|---|---|---|---|---|---|---|---|---|
| C | 1.43 | 0.459 | 0.215 | C | 1.43 | 0.459 | 0.215 | C | 1.43 | 0.459 | 0.215 |

MORE ↓

| ENTER Enclosed space floor thickness, $L_{crack}$ (cm) | ENTER Soil-bldg. pressure differential, $\Delta P$ (g/cm-s²) | ENTER Enclosed space floor length, $L_B$ (cm) | ENTER Enclosed space floor width, $W_B$ (cm) | ENTER Enclosed space height, $H_B$ (cm) | ENTER Floor-wall seam crack width, w (cm) | ENTER Indoor air exchange rate, ER (1/h) | ENTER Average vapor flow rate into bldg. OR Leave blank to calculate $Q_{soil}$ (L/m) |
|---|---|---|---|---|---|---|---|
| 10 | 40 | 1000 | 1000 | 366 | 0.1 | 0.25 | |

MORE ↓

| ENTER Averaging time for carcinogens, $AT_C$ (yrs) | ENTER Averaging time for noncarcinogens, $AT_{NC}$ (yrs) | ENTER Exposure duration, ED (yrs) | ENTER Exposure frequency, EF (days/yr) | ENTER Target risk for carcinogens, TR (unitless) | ENTER Target hazard quotient for noncarcinogens, THQ (unitless) |
|---|---|---|---|---|---|
| 70 | 30 | 30 | 350 | 1.0E-06 | 1 |

Used to calculate risk-based groundwater concentration.

END

# INTERMEDIATE CALCULATIONS SHEET
## Tetrachloroethene in Groundwater Wells GMW-5 6
## Perkin Elmer
## Missouri Metals Site
## Overland, Missouri

| Exposure duration, $\tau$ (sec) | Source-building separation, $L_T$ (cm) | Stratum A soil air-filled porosity, $\theta_a^A$ ($cm^3/cm^3$) | Stratum B soil air-filled porosity, $\theta_a^B$ ($cm^3/cm^3$) | Stratum C soil air-filled porosity, $\theta_a^C$ ($cm^3/cm^3$) | Stratum A effective total fluid saturation, $S_{te}$ ($cm^3/cm^3$) | Stratum A soil intrinsic permeability, $k_i$ ($cm^2$) | Stratum A soil relative air permeability, $k_{rg}$ ($cm^2$) | Stratum A soil effective vapor permeability, $k_v$ ($cm^2$) | Thickness of capillary zone, $L_{cz}$ (cm) | Total porosity in capillary zone, $n_{cz}$ ($cm^3/cm^3$) | Air-filled porosity in capillary zone, $\theta_{a,cz}$ ($cm^3/cm^3$) | Water-filled porosity in capillary zone, $\theta_{w,cz}$ ($cm^3/cm^3$) | Floor-wall seam perimeter, $X_{crack}$ (cm) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 9.46E+08 | 442.2 | 0.244 | 0.244 | 0.244 | 0.324 | 2.26E-09 | 0.821 | 1.86E-09 | 30.00 | 0.459 | 0.104 | 0.355 | 4,000 |

| Bldg. ventilation rate, $Q_{building}$ ($cm^3/s$) | Area of enclosed space below grade, $A_B$ ($cm^2$) | Crack-to-total area ratio, $\eta$ (unitless) | Crack depth below grade, $Z_{crack}$ (cm) | Enthalpy of vaporization at ave. groundwater temperature, $\Delta H_{v,TS}$ (cal/mol) | Henry's law constant at ave. groundwater temperature, $H_{TS}$ ($atm\text{-}m^3/mol$) | Henry's law constant at ave. groundwater temperature, $H'_{TS}$ (unitless) | Vapor viscosity at ave. soil temperature, $\mu_{TS}$ (g/cm-s) | Stratum A effective diffusion coefficient, $D^{eff}_A$ ($cm^2/s$) | Stratum B effective diffusion coefficient, $D^{eff}_B$ ($cm^2/s$) | Stratum C effective diffusion coefficient, $D^{eff}_C$ ($cm^2/s$) | Capillary zone effective diffusion coefficient, $D^{eff}_{cz}$ ($cm^2/s$) | Total overall effective diffusion coefficient, $D^{eff}_T$ ($cm^2/s$) | Diffusion path length, $L_d$ (cm) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 2.54E+04 | 1.06E+06 | 3.77E-04 | 15 | 9,553 | 7.81E-03 | 3.36E-01 | 1.75E-04 | 3.12E-03 | 0.00E+00 | 0.00E+00 | 1.87E-04 | 1.51E-03 | 442.2 |

| Convection path length, $L_p$ (cm) | Source vapor conc., $C_{source}$ ($\mu g/m^3$) | Crack radius, $r_{crack}$ (cm) | Average vapor flow rate into bldg., $Q_{soil}$ ($cm^3/s$) | Crack effective diffusion coefficient, $D^{crack}$ ($cm^2/s$) | Area of crack, $A_{crack}$ ($cm^2$) | Exponent of equivalent foundation Peclet number, $\exp(Pe^f)$ (unitless) | Infinite source indoor attenuation coefficient, $\alpha$ (unitless) | Infinite source bldg. conc., $C_{building}$ ($\mu g/m^3$) | Unit risk factor, URF $(\mu g/m^3)^{-1}$ | Reference conc., RfC ($mg/m^3$) |
|---|---|---|---|---|---|---|---|---|---|---|
| 15 | 1.44E+07 | 0.10 | 1.86E+00 | 3.12E-03 | 4.00E+02 | 3.12E+06 | 4.84E-05 | 6.97E+02 | 5.9E-06 | 6.0E-01 |

END

**DATA ENTRY SHEET**
**Trichloroethene in Groundwater Wells GMW-5 6**
**Perkin Elmer**
**Missouri Metals Site**
**Overland, Missouri**

GW-ADV
Version 3.1; 02/04

Reset to Defaults

CALCULATE RISK-BASED GROUNDWATER CONCENTRATION (enter "X" in "YES" box)

YES [ ]

**OR**

CALCULATE INCREMENTAL RISKS FROM ACTUAL GROUNDWATER CONCENTRATION (enter "X" in "YES" box and initial groundwater conc. below)

YES [ X ]

| ENTER Chemical CAS No. (numbers only, no dashes) | ENTER Initial groundwater conc., $C_W$ (µg/L) | Chemical |
|---|---|---|
| 79016 | 1.74E+04 | Trichloroethylene |

MORE ↓

| ENTER Average soil/ groundwater temperature, $T_S$ (°C) | ENTER Depth below grade to bottom of enclosed space floor, $L_F$ (cm) | ENTER Depth below grade to water table, $L_{WT}$ (cm) | ENTER Thickness of soil stratum A, $h_A$ (cm) | ENTER Thickness of soil stratum B, (Enter value or 0) $h_B$ (cm) | ENTER Thickness of soil stratum C, (Enter value or 0) $h_C$ (cm) | ENTER Soil stratum directly above water table, (Enter A, B, or C) | ENTER SCS soil type directly above water table | ENTER Soil stratum A SCS soil type (used to estimate soil vapor permeability) | OR | ENTER User-defined stratum A soil vapor permeability, $k_v$ (cm²) |
|---|---|---|---|---|---|---|---|---|---|---|
| 10 | 200 | 135 | 135 | | | C | SC | C | | |

Totals must add up to value of $L_{WT}$ (cell G28)

MORE ↓

| ENTER Stratum A SCS soil type (Lookup Soil Parameters) | ENTER Stratum A soil dry bulk density, $\rho_b^A$ (g/cm³) | ENTER Stratum A soil total porosity, $n^A$ (unitless) | ENTER Stratum A soil water-filled porosity, $\theta_w^A$ (cm³/cm³) | ENTER Stratum B SCS soil type (Lookup Soil Parameters) | ENTER Stratum B soil dry bulk density, $\rho_b^B$ (g/cm³) | ENTER Stratum B soil total porosity, $n^B$ (unitless) | ENTER Stratum B soil water-filled porosity, $\theta_w^B$ (cm³/cm³) | ENTER Stratum C SCS soil type (Lookup Soil Parameters) | ENTER Stratum C soil dry bulk density, $\rho_b^C$ (g/cm³) | ENTER Stratum C soil total porosity, $n^C$ (unitless) | ENTER Stratum C soil water-filled porosity, $\theta_w^C$ (cm³/cm³) |
|---|---|---|---|---|---|---|---|---|---|---|---|
| C | 1.43 | 0.459 | 0.215 | C | 1.43 | 0.459 | 0.215 | C | 1.43 | 0.459 | 0.215 |

MORE ↓

| ENTER Enclosed space floor thickness, $L_{crack}$ (cm) | ENTER Soil-bldg. pressure differential, $\Delta P$ (g/cm-s²) | ENTER Enclosed space floor length, $L_B$ (cm) | ENTER Enclosed space floor width, $W_B$ (cm) | ENTER Enclosed space height, $H_B$ (cm) | ENTER Floor-wall seam crack width, w (cm) | ENTER Indoor air exchange rate, ER (1/h) | ENTER Average vapor flow rate into bldg. OR Leave blank to calculate $Q_{soil}$ (L/m) |
|---|---|---|---|---|---|---|---|
| 10 | 40 | 1000 | 1000 | 366 | 0.1 | 0.25 | |

MORE ↓

| ENTER Averaging time for carcinogens, $AT_C$ (yrs) | ENTER Averaging time for noncarcinogens, $AT_{NC}$ (yrs) | ENTER Exposure duration, ED (yrs) | ENTER Exposure frequency, EF (days/yr) | ENTER Target risk for carcinogens, TR (unitless) | ENTER Target hazard quotient for noncarcinogens, THQ (unitless) |
|---|---|---|---|---|---|
| 70 | 30 | 30 | 350 | 1.0E-06 | 1 |

Used to calculate risk-based groundwater concentration.

END

# INTERMEDIATE CALCULATIONS SHEET
## Trichloroethene in Groundwater Wells GMW-5 6
## Perkin Elmer
## Missouri Metals Site
## Overland, Missouri

| Exposure duration, $\tau$ (sec) | Source-building separation, $L_T$ (cm) | Stratum A soil air-filled porosity, $\theta_a^A$ (cm$^3$/cm$^3$) | Stratum B soil air-filled porosity, $\theta_a^B$ (cm$^3$/cm$^3$) | Stratum C soil air-filled porosity, $\theta_a^C$ (cm$^3$/cm$^3$) | Stratum A effective total fluid saturation, $S_{te}$ (cm$^3$/cm$^3$) | Stratum A soil intrinsic permeability, $k_i$ (cm$^2$) | Stratum A soil relative air permeability, $k_{rg}$ (cm$^2$) | Stratum A soil effective vapor permeability, $k_v$ (cm$^2$) | Thickness of capillary zone, $L_{cz}$ (cm) | Total porosity in capillary zone, $n_{cz}$ (cm$^3$/cm$^3$) | Air-filled porosity in capillary zone, $\theta_{a,cz}$ (cm$^3$/cm$^3$) | Water-filled porosity in capillary zone, $\theta_{w,cz}$ (cm$^3$/cm$^3$) | Floor-wall seam perimeter, $X_{crack}$ (cm) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 9.46E+08 | 1 | 0.244 | 0.244 | 0.244 | 0.324 | 2.26E-09 | 0.821 | 1.86E-09 | 30.00 | 0.459 | 0.104 | 0.355 | 4,000 |

| Bldg. ventilation rate, $Q_{building}$ (cm$^3$/s) | Area of enclosed space below grade, $A_B$ (cm$^2$) | Crack-to-total area ratio, $\eta$ (unitless) | Crack depth below grade, $Z_{crack}$ (cm) | Enthalpy of vaporization at ave. groundwater temperature, $\Delta H_{v,TS}$ (cal/mol) | Henry's law constant at ave. groundwater temperature, $H_{TS}$ (atm-m$^3$/mol) | Henry's law constant at ave. groundwater temperature, $H'_{TS}$ (unitless) | Vapor viscosity at ave. soil temperature, $\mu_{TS}$ (g/cm-s) | Stratum A effective diffusion coefficient, $D^{eff}_A$ (cm$^2$/s) | Stratum B effective diffusion coefficient, $D^{eff}_B$ (cm$^2$/s) | Stratum C effective diffusion coefficient, $D^{eff}_C$ (cm$^2$/s) | Capillary zone effective diffusion coefficient, $D^{eff}_{cz}$ (cm$^2$/s) | Total overall effective diffusion coefficient, $D^{eff}_T$ (cm$^2$/s) | Diffusion path length, $L_d$ (cm) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 2.54E+04 | 1.80E+06 | 2.22E-04 | 200 | 8,557 | 4.78E-03 | 2.06E-01 | 1.75E-04 | 3.42E-03 | 0.00E+00 | 0.00E+00 | 2.08E-04 | 7.35E-06 | 1 |

| Convection path length, $L_p$ (cm) | Source vapor conc., $C_{source}$ ($\mu$g/m$^3$) | Crack radius, $r_{crack}$ (cm) | Average vapor flow rate into bldg., $Q_{soil}$ (cm$^3$/s) | Crack effective diffusion coefficient, $D^{crack}$ (cm$^2$/s) | Area of crack, $A_{crack}$ (cm$^2$) | Exponent of equivalent foundation Peclet number, exp(Pe$^f$) (unitless) | Infinite source indoor attenuation coefficient, $\alpha$ (unitless) | Infinite source bldg. conc., $C_{building}$ ($\mu$g/m$^3$) | Unit risk factor, URF ($\mu$g/m$^3$)$^{-1}$ | Reference conc., RfC (mg/m$^3$) |
|---|---|---|---|---|---|---|---|---|---|---|
| 200 | 3.58E+06 | 0.10 | 1.28E+00 | 3.42E-03 | 4.00E+02 | 1.17E+04 | 4.60E-05 | 1.65E+02 | 1.1E-04 | 4.0E-02 |

END

**DATA ENTRY SHEET**
**Vinyl Chloride in Groundwater Wells GMW-5 6**
**Perkin Elmer**
**Missouri Metals Site**
**Overland, Missouri**

GW-ADV
Version 3.1; 02/04

Reset to Defaults

CALCULATE RISK-BASED GROUNDWATER CONCENTRATION (enter "X" in "YES" box)

YES [ ]

**OR**

CALCULATE INCREMENTAL RISKS FROM ACTUAL GROUNDWATER CONCENTRATION (enter "X" in "YES" box and initial groundwater conc. below)

YES [ X ]

| ENTER Chemical CAS No. (numbers only, no dashes) | ENTER Initial groundwater conc., $C_W$ (µg/L) | Chemical |
|---|---|---|
| 75014 | 7.02E+02 | Vinyl chloride (chloroethene) |

MORE ↓

| ENTER Average soil/ groundwater temperature, $T_S$ (°C) | ENTER Depth below grade to bottom of enclosed space floor, $L_F$ (cm) | ENTER Depth below grade to water table, $L_{WT}$ (cm) | ENTER Thickness of soil stratum A, $h_A$ (cm) | ENTER Thickness of soil stratum B, (Enter value or 0) $h_B$ (cm) | ENTER Thickness of soil stratum C, (Enter value or 0) $h_C$ (cm) | ENTER Soil stratum directly above water table, (Enter A, B, or C) | ENTER SCS soil type directly above water table | ENTER Soil stratum A SCS soil type (used to estimate soil vapor permeability) | OR | ENTER User-defined stratum A soil vapor permeability, $k_v$ (cm²) |
|---|---|---|---|---|---|---|---|---|---|---|
| 10 | 15 | 457.2 | 457.2 | | | C | SC | C | | |

Totals must add up to value of $L_{WT}$ (cell G28)

MORE ↓

| ENTER Stratum A SCS soil type (Lookup Soil Parameters) | ENTER Stratum A soil dry bulk density, $\rho_b^A$ (g/cm³) | ENTER Stratum A soil total porosity, $n^A$ (unitless) | ENTER Stratum A soil water-filled porosity, $\theta_w^A$ (cm³/cm³) | ENTER Stratum B SCS soil type (Lookup Soil Parameters) | ENTER Stratum B soil dry bulk density, $\rho_b^B$ (g/cm³) | ENTER Stratum B soil total porosity, $n^B$ (unitless) | ENTER Stratum B soil water-filled porosity, $\theta_w^B$ (cm³/cm³) | ENTER Stratum C SCS soil type (Lookup Soil Parameters) | ENTER Stratum C soil dry bulk density, $\rho_b^C$ (g/cm³) | ENTER Stratum C soil total porosity, $n^C$ (unitless) | ENTER Stratum C soil water-filled porosity, $\theta_w^C$ (cm³/cm³) |
|---|---|---|---|---|---|---|---|---|---|---|---|
| C | 1.43 | 0.459 | 0.215 | C | 1.43 | 0.459 | 0.215 | C | 1.43 | 0.459 | 0.215 |

MORE ↓

| ENTER Enclosed space floor thickness, $L_{crack}$ (cm) | ENTER Soil-bldg. pressure differential, $\Delta P$ (g/cm-s²) | ENTER Enclosed space floor length, $L_B$ (cm) | ENTER Enclosed space floor width, $W_B$ (cm) | ENTER Enclosed space height, $H_B$ (cm) | ENTER Floor-wall seam crack width, w (cm) | ENTER Indoor air exchange rate, ER (1/h) | ENTER Average vapor flow rate into bldg. OR Leave blank to calculate $Q_{soil}$ (L/m) |
|---|---|---|---|---|---|---|---|
| 10 | 40 | 1000 | 1000 | 366 | 0.1 | 0.25 | |

MORE ↓

| ENTER Averaging time for carcinogens, $AT_C$ (yrs) | ENTER Averaging time for noncarcinogens, $AT_{NC}$ (yrs) | ENTER Exposure duration, ED (yrs) | ENTER Exposure frequency, EF (days/yr) | ENTER Target risk for carcinogens, TR (unitless) | ENTER Target hazard quotient for noncarcinogens, THQ (unitless) |
|---|---|---|---|---|---|
| 70 | 30 | 30 | 350 | 1.0E-06 | 1 |

Used to calculate risk-based groundwater concentration.

END

**INTERMEDIATE CALCULATIONS SHEET**
**Vinyl Chloride in Groundwater Wells GMW-5 6**
**Perkin Elmer**
**Missouri Metals Site**
**Overland, Missouri**

| Exposure duration, $\tau$ (sec) | Source-building separation, $L_T$ (cm) | Stratum A soil air-filled porosity, $\theta_a^A$ ($cm^3/cm^3$) | Stratum B soil air-filled porosity, $\theta_a^B$ ($cm^3/cm^3$) | Stratum C soil air-filled porosity, $\theta_a^C$ ($cm^3/cm^3$) | Stratum A effective total fluid saturation, $S_{te}$ ($cm^3/cm^3$) | Stratum A soil intrinsic permeability, $k_i$ ($cm^2$) | Stratum A soil relative air permeability, $k_{rg}$ ($cm^2$) | Stratum A soil effective vapor permeability, $k_v$ ($cm^2$) | Thickness of capillary zone, $L_{cz}$ (cm) | Total porosity in capillary zone, $n_{cz}$ ($cm^3/cm^3$) | Air-filled porosity in capillary zone, $\theta_{a,cz}$ ($cm^3/cm^3$) | Water-filled porosity in capillary zone, $\theta_{w,cz}$ ($cm^3/cm^3$) | Floor-wall seam perimeter, $X_{crack}$ (cm) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 9.46E+08 | 442.2 | 0.244 | 0.244 | 0.244 | 0.324 | 2.26E-09 | 0.821 | 1.86E-09 | 30.00 | 0.459 | 0.104 | 0.355 | 4.000 |

| Bldg. ventilation rate, $Q_{building}$ ($cm^3/s$) | Area of enclosed space below grade, $A_B$ ($cm^2$) | Crack-to-total area ratio, $\eta$ (unitless) | Crack depth below grade, $Z_{crack}$ (cm) | Enthalpy of vaporization at ave. groundwater temperature, $\Delta H_{v,TS}$ (cal/mol) | Henry's law constant at ave. groundwater temperature, $H_{TS}$ (atm-$m^3$/mol) | Henry's law constant at ave. groundwater temperature, $H'_{TS}$ (unitless) | Vapor viscosity at ave. soil temperature, $\mu_{TS}$ (g/cm-s) | Stratum A effective diffusion coefficient, $D^{eff}_A$ ($cm^2/s$) | Stratum B effective diffusion coefficient, $D^{eff}_B$ ($cm^2/s$) | Stratum C effective diffusion coefficient, $D^{eff}_C$ ($cm^2/s$) | Capillary zone effective diffusion coefficient, $D^{eff}_{cz}$ ($cm^2/s$) | Total overall effective diffusion coefficient, $D^{eff}_T$ ($cm^2/s$) | Diffusion path length, $L_d$ (cm) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 2.54E+04 | 1.06E+06 | 3.77E-04 | 15 | 5,000 | 1.72E-02 | 7.41E-01 | 1.75E-04 | 4.59E-03 | 0.00E+00 | 0.00E+00 | 2.72E-04 | 2.21E-03 | 442.2 |

| Convection path length, $L_p$ (cm) | Source vapor conc., $C_{source}$ ($\mu g/m^3$) | Crack radius, $r_{crack}$ (cm) | Average vapor flow rate into bldg., $Q_{soil}$ ($cm^3/s$) | Crack effective diffusion coefficient, $D^{crack}$ ($cm^2/s$) | Area of crack, $A_{crack}$ ($cm^2$) | Exponent of equivalent foundation Peclet number, $\exp(Pe^f)$ (unitless) | Infinite source indoor attenuation coefficient, $\alpha$ (unitless) | Infinite source bldg. conc., $C_{building}$ ($\mu g/m^3$) | Unit risk factor, URF $(\mu g/m^3)^{-1}$ | Reference conc., RfC ($mg/m^3$) |
|---|---|---|---|---|---|---|---|---|---|---|
| 15 | 5.20E+05 | 0.10 | 1.86E+00 | 4.59E-03 | 4.00E+02 | 2.58E+04 | 5.43E-05 | 2.82E+01 | 8.8E-06 | 1.0E-01 |

**END**

# Appendix C
# USEPA Johnson and Ettinger Model Data Entry and Intermediate Calculations Worksheets for PRG Volatilization Factors Monitoring Wells GMW-3, 7, 8, & 9 and 5, 6

# DATA ENTRY SHEET
## VF for PRGs
## 1,1-Dichloroethene in Groundwater Wells GMW 3, 7, 8, 9 and 5, 6
## Perkin Elmer
## Missouri Metals Site
## Overland, Missouri

GW-ADV
Version 3.1; 02/04

Reset to Defaults

CALCULATE RISK-BASED GROUNDWATER CONCENTRATION (enter "X" in "YES" box)

YES [ X ]

OR

CALCULATE INCREMENTAL RISKS FROM ACTUAL GROUNDWATER CONCENTRATION (enter "X" in "YES" box and initial groundwater conc. below)

YES [ ]

| ENTER Chemical CAS No. (numbers only, no dashes) | ENTER Initial groundwater conc., $C_W$ (µg/L) | Chemical |
|---|---|---|
| 75354 | | 1,1-Dichloroethylene |

MORE ↓

| ENTER Average soil/ groundwater temperature, $T_S$ (°C) | ENTER Depth below grade to bottom of enclosed space floor, $L_F$ (cm) | ENTER Depth below grade to water table, $L_{WT}$ (cm) | ENTER Thickness of soil stratum A, $h_A$ (cm) | ENTER Thickness of soil stratum B, (Enter value or 0) $h_B$ (cm) | ENTER Thickness of soil stratum C, (Enter value or 0) $h_C$ (cm) | ENTER Soil stratum directly above water table, (Enter A, B, or C) | ENTER SCS soil type directly above water table | ENTER Soil stratum A SCS soil type (used to estimate soil vapor permeability) | OR | ENTER User-defined stratum A soil vapor permeability, $k_v$ (cm²) |
|---|---|---|---|---|---|---|---|---|---|---|
| 10 | 15 | 457.2 | 457.2 | | | C | SC | C | | |

Totals must add up to value of $L_{WT}$ (cell G28)

MORE ↓

| ENTER Stratum A SCS soil type (Lookup Soil Parameters) | ENTER Stratum A soil dry bulk density, $\rho_b^A$ (g/cm³) | ENTER Stratum A soil total porosity, $n^A$ (unitless) | ENTER Stratum A soil water-filled porosity, $\theta_w^A$ (cm³/cm³) | ENTER Stratum B SCS soil type (Lookup Soil Parameters) | ENTER Stratum B soil dry bulk density, $\rho_b^B$ (g/cm³) | ENTER Stratum B soil total porosity, $n^B$ (unitless) | ENTER Stratum B soil water-filled porosity, $\theta_w^B$ (cm³/cm³) | ENTER Stratum C SCS soil type (Lookup Soil Parameters) | ENTER Stratum C soil dry bulk density, $\rho_b^C$ (g/cm³) | ENTER Stratum C soil total porosity, $n^C$ (unitless) | ENTER Stratum C soil water-filled porosity, $\theta_w^C$ (cm³/cm³) |
|---|---|---|---|---|---|---|---|---|---|---|---|
| C | 1.43 | 0.459 | 0.215 | C | 1.43 | 0.459 | 0.215 | C | 1.43 | 0.459 | 0.215 |

MORE ↓

| ENTER Enclosed space floor thickness, $L_{crack}$ (cm) | ENTER Soil-bldg. pressure differential, ΔP (g/cm-s²) | ENTER Enclosed space floor length, $L_B$ (cm) | ENTER Enclosed space floor width, $W_B$ (cm) | ENTER Enclosed space height, $H_B$ (cm) | ENTER Floor-wall seam crack width, w (cm) | ENTER Indoor air exchange rate, ER (1/h) | ENTER Average vapor flow rate into bldg. OR Leave blank to calculate $Q_{soil}$ (L/m) |
|---|---|---|---|---|---|---|---|
| 10 | 40 | 1000 | 1000 | 366 | 0.1 | 0.25 | |

MORE ↓

| ENTER Averaging time for carcinogens, $AT_C$ (yrs) | ENTER Averaging time for noncarcinogens, $AT_{NC}$ (yrs) | ENTER Exposure duration, ED (yrs) | ENTER Exposure frequency, EF (days/yr) | ENTER Target risk for carcinogens, TR (unitless) | ENTER Target hazard quotient for noncarcinogens, THQ (unitless) |
|---|---|---|---|---|---|
| 70 | 30 | 30 | 350 | 1.0E-06 | 1 |

Used to calculate risk-based groundwater concentration.

END

# INTERMEDIATE CALCULATIONS SHEET
## VF for PRGs
## 1,1-Dichloroethene in Groundwater Wells GMW 3, 7, 8, 9 and 5, 6
## Perkin Elmer
## Missouri Metals Site
## Overland, Missouri

| Exposure duration, $\tau$ (sec) | Source-building separation, $L_T$ (cm) | Stratum A soil air-filled porosity, $\theta_a^A$ (cm³/cm³) | Stratum B soil air-filled porosity, $\theta_a^B$ (cm³/cm³) | Stratum C soil air-filled porosity, $\theta_a^C$ (cm³/cm³) | Stratum A effective total fluid saturation, $S_{te}$ (cm³/cm³) | Stratum A soil intrinsic permeability, $k_i$ (cm²) | Stratum A soil relative air permeability, $k_{rg}$ (cm²) | Stratum A soil effective vapor permeability, $k_v$ (cm²) | Thickness of capillary zone, $L_{cz}$ (cm) | Total porosity in capillary zone, $n_{cz}$ (cm³/cm³) | Air-filled porosity in capillary zone, $\theta_{a,cz}$ (cm³/cm³) | Water-filled porosity in capillary zone, $\theta_{w,cz}$ (cm³/cm³) | Floor-wall seam perimeter, $X_{crack}$ (cm) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 9.46E+08 | 442.2 | 0.244 | 0.244 | 0.244 | 0.324 | 2.26E-09 | 0.821 | 1.86E-09 | 30.00 | 0.459 | 0.104 | 0.355 | 4,000 |

| Bldg. ventilation rate, $Q_{building}$ (cm³/s) | Area of enclosed space below grade, $A_B$ (cm²) | Crack-to-total area ratio, $\eta$ (unitless) | Crack depth below grade, $Z_{crack}$ (cm) | Enthalpy of vaporization at ave. groundwater temperature, $\Delta H_{v,TS}$ (cal/mol) | Henry's law constant at ave. groundwater temperature, $H_{TS}$ (atm-m³/mol) | Henry's law constant at ave. groundwater temperature, $H'_{TS}$ (unitless) | Vapor viscosity at ave. soil temperature, $\mu_{TS}$ (g/cm-s) | Stratum A effective diffusion coefficient, $D^{eff}_A$ (cm²/s) | Stratum B effective diffusion coefficient, $D^{eff}_B$ (cm²/s) | Stratum C effective diffusion coefficient, $D^{eff}_C$ (cm²/s) | Capillary zone effective diffusion coefficient, $D^{eff}_{cz}$ (cm²/s) | Total overall effective diffusion coefficient, $D^{eff}_T$ (cm²/s) | Diffusion path length, $L_d$ (cm) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 2.54E+04 | 1.06E+06 | 3.77E-04 | 15 | 6,392 | 1.47E-02 | 6.33E-01 | 1.75E-04 | 3.90E-03 | 0.00E+00 | 0.00E+00 | 2.31E-04 | 1.88E-03 | 442.2 |

| Convection path length, $L_p$ (cm) | Source vapor conc., $C_{source}$ (μg/m³) | Crack radius, $r_{crack}$ (cm) | Average vapor flow rate into bldg., $Q_{soil}$ (cm³/s) | Crack effective diffusion coefficient, $D^{crack}$ (cm²/s) | Area of crack, $A_{crack}$ (cm²) | Exponent of equivalent foundation Peclet number, $\exp(Pe^f)$ (unitless) | Infinite source indoor attenuation coefficient, $\alpha$ (unitless) | Infinite source bldg. conc., $C_{building}$ (μg/m³) | Unit risk factor, URF (μg/m³)⁻¹ | Reference conc., RfC (mg/m³) |
|---|---|---|---|---|---|---|---|---|---|---|
| 15 | 6.33E+02 | 0.10 | 1.86E+00 | 3.90E-03 | 4.00E+02 | 1.57E+05 | 5.19E-05 | 3.28E-02 | NA | 2.0E-01 |

END

**DATA ENTRY SHEET**
**VF for PRGs**
**cis-1,2-Dichloroethene in Groundwater Wells GMW 3, 7, 8, 9 and 5, 6**
**Perkin Elmer**
**Missouri Metals Site**
**Overland, Missouri**

GW-ADV
Version 3.1; 02/04

Reset to Defaults

CALCULATE RISK-BASED GROUNDWATER CONCENTRATION (enter "X" in "YES" box)

YES: X

**OR**

CALCULATE INCREMENTAL RISKS FROM ACTUAL GROUNDWATER CONCENTRATION (enter "X" in "YES" box and initial groundwater conc. below)

YES:

| ENTER Chemical CAS No. (numbers only, no dashes) | ENTER Initial groundwater conc., $C_W$ ($\mu$g/L) | Chemical |
|---|---|---|
| 156592 | | cis-1,2-Dichloroethylene |

MORE ↓

| ENTER Average soil/ groundwater temperature, $T_S$ (°C) | ENTER Depth below grade to bottom of enclosed space floor, $L_F$ (cm) | ENTER Depth below grade to water table, $L_{WT}$ (cm) | ENTER Thickness of soil stratum A, $h_A$ (cm) | ENTER Thickness of soil stratum B, (Enter value or 0) $h_B$ (cm) | ENTER Thickness of soil stratum C, (Enter value or 0) $h_C$ (cm) | ENTER Soil stratum directly above water table, (Enter A, B, or C) | ENTER SCS soil type directly above water table | ENTER Soil stratum A SCS soil type (used to estimate soil vapor permeability) | OR | ENTER User-defined stratum A soil vapor permeability, $k_v$ (cm²) |
|---|---|---|---|---|---|---|---|---|---|---|
| 10 | 15 | 457.2 | 457.2 | | | C | SC | C | | |

Totals must add up to value of $L_{WT}$ (cell G28)

MORE ↓

| ENTER Stratum A SCS soil type (Lookup Soil Parameters) | ENTER Stratum A soil dry bulk density, $\rho_b^A$ (g/cm³) | ENTER Stratum A soil total porosity, $n^A$ (unitless) | ENTER Stratum A soil water-filled porosity, $\theta_w^A$ (cm³/cm³) | ENTER Stratum B SCS soil type (Lookup Soil Parameters) | ENTER Stratum B soil dry bulk density, $\rho_b^B$ (g/cm³) | ENTER Stratum B soil total porosity, $n^B$ (unitless) | ENTER Stratum B soil water-filled porosity, $\theta_w^B$ (cm³/cm³) | ENTER Stratum C SCS soil type (Lookup Soil Parameters) | ENTER Stratum C soil dry bulk density, $\rho_b^C$ (g/cm³) | ENTER Stratum C soil total porosity, $n^C$ (unitless) | ENTER Stratum C soil water-filled porosity, $\theta_w^C$ (cm³/cm³) |
|---|---|---|---|---|---|---|---|---|---|---|---|
| C | 1.43 | 0.459 | 0.215 | C | 1.43 | 0.459 | 0.215 | C | 1.43 | 0.459 | 0.215 |

MORE ↓

| ENTER Enclosed space floor thickness, $L_{crack}$ (cm) | ENTER Soil-bldg. pressure differential, $\Delta P$ (g/cm-s²) | ENTER Enclosed space floor length, $L_B$ (cm) | ENTER Enclosed space floor width, $W_B$ (cm) | ENTER Enclosed space height, $H_B$ (cm) | ENTER Floor-wall seam crack width, w (cm) | ENTER Indoor air exchange rate, ER (1/h) | ENTER Average vapor flow rate into bldg. OR Leave blank to calculate $Q_{soil}$ (L/m) |
|---|---|---|---|---|---|---|---|
| 10 | 40 | 1000 | 1000 | 366 | 0.1 | 0.25 | |

MORE ↓

| ENTER Averaging time for carcinogens, $AT_C$ (yrs) | ENTER Averaging time for noncarcinogens, $AT_{NC}$ (yrs) | ENTER Exposure duration, ED (yrs) | ENTER Exposure frequency, EF (days/yr) | ENTER Target risk for carcinogens, TR (unitless) | ENTER Target hazard quotient for noncarcinogens, THQ (unitless) |
|---|---|---|---|---|---|
| 70 | 30 | 30 | 350 | 1.0E-06 | 1 |

Used to calculate risk-based groundwater concentration.

END

# INTERMEDIATE CALCULATIONS SHEET
## VF for PRGs
## cis-1,2-Dichloroethene in Groundwater Wells GMW 3, 7, 8, 9 and 5, 6
## Perkin Elmer
## Missouri Metals Site
## Overland, Missouri

| Exposure duration, $\tau$ (sec) | Source-building separation, $L_T$ (cm) | Stratum A soil air-filled porosity, $\theta_a^A$ ($cm^3/cm^3$) | Stratum B soil air-filled porosity, $\theta_a^B$ ($cm^3/cm^3$) | Stratum C soil air-filled porosity, $\theta_a^C$ ($cm^3/cm^3$) | Stratum A effective total fluid saturation, $S_{te}$ ($cm^3/cm^3$) | Stratum A soil intrinsic permeability, $k_i$ ($cm^2$) | Stratum A soil relative air permeability, $k_{rg}$ ($cm^2$) | Stratum A soil effective vapor permeability, $k_v$ ($cm^2$) | Thickness of capillary zone, $L_{cz}$ (cm) | Total porosity in capillary zone, $n_{cz}$ ($cm^3/cm^3$) | Air-filled porosity in capillary zone, $\theta_{a,cz}$ ($cm^3/cm^3$) | Water-filled porosity in capillary zone, $\theta_{w,cz}$ ($cm^3/cm^3$) | Floor-wall seam perimeter, $X_{crack}$ (cm) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 9.46E+08 | 442.2 | 0.244 | 0.244 | 0.244 | 0.324 | 2.26E-09 | 0.821 | 1.86E-09 | 30.00 | 0.459 | 0.104 | 0.355 | 4,000 |

| Bldg. ventilation rate, $Q_{building}$ ($cm^3/s$) | Area of enclosed space below grade, $A_B$ ($cm^2$) | Crack-to-total area ratio, $\eta$ (unitless) | Crack depth below grade, $Z_{crack}$ (cm) | Enthalpy of vaporization at ave. groundwater temperature, $\Delta H_{v,TS}$ (cal/mol) | Henry's law constant at ave. groundwater temperature, $H_{TS}$ (atm-$m^3$/mol) | Henry's law constant at ave. groundwater temperature, $H'_{TS}$ (unitless) | Vapor viscosity at ave. soil temperature, $\mu_{TS}$ (g/cm-s) | Stratum A effective diffusion coefficient, $D^{eff}_A$ ($cm^2/s$) | Stratum B effective diffusion coefficient, $D^{eff}_B$ ($cm^2/s$) | Stratum C effective diffusion coefficient, $D^{eff}_C$ ($cm^2/s$) | Capillary zone effective diffusion coefficient, $D^{eff}_{cz}$ ($cm^2/s$) | Total overall effective diffusion coefficient, $D^{eff}_T$ ($cm^2/s$) | Diffusion path length, $L_d$ (cm) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 2.54E+04 | 1.06E+06 | 3.77E-04 | 15 | 7,734 | 2.04E-03 | 8.77E-02 | 1.75E-04 | 3.19E-03 | 0.00E+00 | 0.00E+00 | 2.07E-04 | 1.61E-03 | 442.2 |

| Convection path length, $L_p$ (cm) | Source vapor conc., $C_{source}$ ($\mu g/m^3$) | Crack radius, $r_{crack}$ (cm) | Average vapor flow rate into bldg., $Q_{soil}$ ($cm^3/s$) | Crack effective diffusion coefficient, $D^{crack}$ ($cm^2/s$) | Area of crack, $A_{crack}$ ($cm^2$) | Exponent of equivalent foundation Peclet number, $\exp(Pe^f)$ (unitless) | Infinite source indoor attenuation coefficient, $\alpha$ (unitless) | Infinite source bldg. conc., $C_{building}$ ($\mu g/m^3$) | Unit risk factor, URF $(\mu g/m^3)^{-1}$ | Reference conc., RfC ($mg/m^3$) |
|---|---|---|---|---|---|---|---|---|---|---|
| 15 | 8.77E+01 | 0.10 | 1.86E+00 | 3.19E-03 | 4.00E+02 | 2.22E+06 | 4.95E-05 | 4.34E-03 | NA | 3.5E-02 |

END

**DATA ENTRY SHEET**
**VF for PRGs**
**trans-1,2-Dichloroethene in Groundwater Wells GMW 3, 7, 8, 9 and 5, 6**
**Perkin Elmer**
**Missouri Metals Site**
**Overland, Missouri**

GW-ADV
Version 3.1; 02/04

Reset to Defaults

CALCULATE RISK-BASED GROUNDWATER CONCENTRATION (enter "X" in "YES" box)

YES [ X ]

**OR**

CALCULATE INCREMENTAL RISKS FROM ACTUAL GROUNDWATER CONCENTRATION (enter "X" in "YES" box and initial groundwater conc. below)

YES [ ]

| ENTER Chemical CAS No. (numbers only, no dashes) | ENTER Initial groundwater conc., $C_W$ (µg/L) | Chemical |
|---|---|---|
| 156605 | | trans-1,2-Dichloroethylene |

MORE ↓

| ENTER Average soil/groundwater temperature, $T_S$ (°C) | ENTER Depth below grade to bottom of enclosed space floor, $L_F$ (cm) | ENTER Depth below grade to water table, $L_{WT}$ (cm) | ENTER Thickness of soil stratum A, $h_A$ (cm) | ENTER Thickness of soil stratum B, (Enter value or 0) $h_B$ (cm) | ENTER Thickness of soil stratum C, (Enter value or 0) $h_C$ (cm) | ENTER Soil stratum directly above water table, (Enter A, B, or C) | ENTER SCS soil type directly above water table | ENTER Soil stratum A SCS soil type (used to estimate soil vapor permeability) | OR | ENTER User-defined stratum A soil vapor permeability, $k_v$ (cm²) |
|---|---|---|---|---|---|---|---|---|---|---|
| 10 | 15 | 457.2 | 457.2 | | | C | SC | C | | |

Totals must add up to value of $L_{WT}$ (cell G28)

MORE ↓

| ENTER Stratum A SCS soil type (Lookup Soil Parameters) | ENTER Stratum A soil dry bulk density, $\rho_b^A$ (g/cm³) | ENTER Stratum A soil total porosity, $n^A$ (unitless) | ENTER Stratum A soil water-filled porosity, $\theta_w^A$ (cm³/cm³) | ENTER Stratum B SCS soil type (Lookup Soil Parameters) | ENTER Stratum B soil dry bulk density, $\rho_b^B$ (g/cm³) | ENTER Stratum B soil total porosity, $n^B$ (unitless) | ENTER Stratum B soil water-filled porosity, $\theta_w^B$ (cm³/cm³) | ENTER Stratum C SCS soil type (Lookup Soil Parameters) | ENTER Stratum C soil dry bulk density, $\rho_b^C$ (g/cm³) | ENTER Stratum C soil total porosity, $n^C$ (unitless) | ENTER Stratum C soil water-filled porosity, $\theta_w^C$ (cm³/cm³) |
|---|---|---|---|---|---|---|---|---|---|---|---|
| C | 1.43 | 0.459 | 0.215 | C | 1.43 | 0.459 | 0.215 | C | 1.43 | 0.459 | 0.215 |

MORE ↓

| ENTER Enclosed space floor thickness, $L_{crack}$ (cm) | ENTER Soil-bldg. pressure differential, $\Delta P$ (g/cm-s²) | ENTER Enclosed space floor length, $L_B$ (cm) | ENTER Enclosed space floor width, $W_B$ (cm) | ENTER Enclosed space height, $H_B$ (cm) | ENTER Floor-wall seam crack width, w (cm) | ENTER Indoor air exchange rate, ER (1/h) | ENTER Average vapor flow rate into bldg. OR Leave blank to calculate $Q_{soil}$ (L/m) |
|---|---|---|---|---|---|---|---|
| 10 | 40 | 1000 | 1000 | 366 | 0.1 | 0.25 | |

MORE ↓

| ENTER Averaging time for carcinogens, $AT_C$ (yrs) | ENTER Averaging time for noncarcinogens, $AT_{NC}$ (yrs) | ENTER Exposure duration, ED (yrs) | ENTER Exposure frequency, EF (days/yr) | ENTER Target risk for carcinogens, TR (unitless) | ENTER Target hazard quotient for noncarcinogens, THQ (unitless) |
|---|---|---|---|---|---|
| 70 | 30 | 30 | 350 | 1.0E-06 | 1 |

Used to calculate risk-based groundwater concentration.

END

# INTERMEDIATE CALCULATIONS SHEET

## VF for PRGs

## trans-1,2-Dichloroethene in Groundwater Wells GMW 3, 7, 8, 9 and 5, 6

## Perkin Elmer

## Missouri Metals Site

## Overland, Missouri

| Exposure duration, $\tau$ (sec) | Source-building separation, $L_T$ (cm) | Stratum A soil air-filled porosity, $\theta_a^A$ ($cm^3/cm^3$) | Stratum B soil air-filled porosity, $\theta_a^B$ ($cm^3/cm^3$) | Stratum C soil air-filled porosity, $\theta_a^C$ ($cm^3/cm^3$) | Stratum A effective total fluid saturation, $S_{te}$ ($cm^3/cm^3$) | Stratum A soil intrinsic permeability, $k_i$ ($cm^2$) | Stratum A soil relative air permeability, $k_{rg}$ ($cm^2$) | Stratum A soil effective vapor permeability, $k_v$ ($cm^2$) | Thickness of capillary zone, $L_{cz}$ (cm) | Total porosity in capillary zone, $n_{cz}$ ($cm^3/cm^3$) | Air-filled porosity in capillary zone, $\theta_{a,cz}$ ($cm^3/cm^3$) | Water-filled porosity in capillary zone, $\theta_{w,cz}$ ($cm^3/cm^3$) | Floor-wall seam perimeter, $X_{crack}$ (cm) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 9.46E+08 | 442.2 | 0.244 | 0.244 | 0.244 | 0.324 | 2.26E-09 | 0.821 | 1.86E-09 | 30.00 | 0.459 | 0.104 | 0.355 | 4,000 |

| Bldg. ventilation rate, $Q_{building}$ ($cm^3/s$) | Area of enclosed space below grade, $A_B$ ($cm^2$) | Crack-to-total area ratio, $\eta$ (unitless) | Crack depth below grade, $Z_{crack}$ (cm) | Enthalpy of vaporization at ave. groundwater temperature, $\Delta H_{v,TS}$ (cal/mol) | Henry's law constant at ave. groundwater temperature, $H_{TS}$ ($atm\text{-}m^3/mol$) | Henry's law constant at ave. groundwater temperature, $H'_{TS}$ (unitless) | Vapor viscosity at ave. soil temperature, $\mu_{TS}$ (g/cm-s) | Stratum A effective diffusion coefficient, $D^{eff}_A$ ($cm^2/s$) | Stratum B effective diffusion coefficient, $D^{eff}_B$ ($cm^2/s$) | Stratum C effective diffusion coefficient, $D^{eff}_C$ ($cm^2/s$) | Capillary zone effective diffusion coefficient, $D^{eff}_{cz}$ ($cm^2/s$) | Total overall effective diffusion coefficient, $D^{eff}_T$ ($cm^2/s$) | Diffusion path length, $L_d$ (cm) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 2.54E+04 | 1.06E+06 | 3.77E-04 | 15 | 7,136 | 4.94E-03 | 2.13E-01 | 1.75E-04 | 3.06E-03 | 0.00E+00 | 0.00E+00 | 1.88E-04 | 1.50E-03 | 442.2 |

| Convection path length, $L_p$ (cm) | Source vapor conc., $C_{source}$ ($\mu g/m^3$) | Crack radius, $r_{crack}$ (cm) | Average vapor flow rate into bldg., $Q_{soil}$ ($cm^3/s$) | Crack effective diffusion coefficient, $D^{crack}$ ($cm^2/s$) | Area of crack, $A_{crack}$ ($cm^2$) | Exponent of equivalent foundation Peclet number, $\exp(Pe^f)$ (unitless) | Infinite source indoor attenuation coefficient, $\alpha$ (unitless) | Infinite source bldg. conc., $C_{building}$ ($\mu g/m^3$) | Unit risk factor, URF $(\mu g/m^3)^{-1}$ | Reference conc., RfC ($mg/m^3$) |
|---|---|---|---|---|---|---|---|---|---|---|
| 15 | 2.13E+02 | 0.10 | 1.86E+00 | 3.06E-03 | 4.00E+02 | 4.08E+06 | 4.84E-05 | 1.03E-02 | NA | 7.0E-02 |

END

# DATA ENTRY SHEET
## VF for PRGs
## Tetrachloroethene in Groundwater Wells GMW 3, 7, 8, 9 and 5, 6
## Perkin Elmer
## Missouri Metals Site
## Overland, Missouri

GW-ADV
Version 3.1; 02/04

Reset to Defaults

CALCULATE RISK-BASED GROUNDWATER CONCENTRATION (enter "X" in "YES" box)

YES [X]

**OR**

CALCULATE INCREMENTAL RISKS FROM ACTUAL GROUNDWATER CONCENTRATION (enter "X" in "YES" box and initial groundwater conc. below)

YES [ ]

| ENTER Chemical CAS No. (numbers only, no dashes) | ENTER Initial groundwater conc., $C_W$ (µg/L) | Chemical |
|---|---|---|
| 127184 | | Tetrachloroethylene |

MORE ↓

| ENTER Average soil/ groundwater temperature, $T_S$ (°C) | ENTER Depth below grade to bottom of enclosed space floor, $L_F$ (cm) | ENTER Depth below grade to water table, $L_{WT}$ (cm) | ENTER Thickness of soil stratum A, $h_A$ (cm) | ENTER Thickness of soil stratum B, (Enter value or 0) $h_B$ (cm) | ENTER Thickness of soil stratum C, (Enter value or 0) $h_C$ (cm) | ENTER Soil stratum directly above water table, (Enter A, B, or C) | ENTER SCS soil type directly above water table | ENTER Soil stratum A SCS soil type (used to estimate soil vapor permeability) | OR | ENTER User-defined stratum A soil vapor permeability, $k_v$ (cm²) |
|---|---|---|---|---|---|---|---|---|---|---|
| 10 | 15 | 457.2 | 457.2 | | | C | SC | C | | |

Totals must add up to value of $L_{WT}$ (cell G28)

MORE ↓

| ENTER Stratum A SCS soil type | ENTER Stratum A soil dry bulk density, $\rho_b^A$ (g/cm³) | ENTER Stratum A soil total porosity, $n^A$ (unitless) | ENTER Stratum A soil water-filled porosity, $\theta_w^A$ (cm³/cm³) | ENTER Stratum B SCS soil type | ENTER Stratum B soil dry bulk density, $\rho_b^B$ (g/cm³) | ENTER Stratum B soil total porosity, $n^B$ (unitless) | ENTER Stratum B soil water-filled porosity, $\theta_w^B$ (cm³/cm³) | ENTER Stratum C SCS soil type | ENTER Stratum C soil dry bulk density, $\rho_b^C$ (g/cm³) | ENTER Stratum C soil total porosity, $n^C$ (unitless) | ENTER Stratum C soil water-filled porosity, $\theta_w^C$ (cm³/cm³) |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Lookup Soil Parameters | | | | Lookup Soil Parameters | | | | Lookup Soil Parameters | | | |
| C | 1.43 | 0.459 | 0.215 | C | 1.43 | 0.459 | 0.215 | C | 1.43 | 0.459 | 0.215 |

MORE ↓

| ENTER Enclosed space floor thickness, $L_{crack}$ (cm) | ENTER Soil-bldg. pressure differential, $\Delta P$ (g/cm-s²) | ENTER Enclosed space floor length, $L_B$ (cm) | ENTER Enclosed space floor width, $W_B$ (cm) | ENTER Enclosed space height, $H_B$ (cm) | ENTER Floor-wall seam crack width, w (cm) | ENTER Indoor air exchange rate, ER (1/h) | ENTER Average vapor flow rate into bldg. OR Leave blank to calculate $Q_{soil}$ (L/m) |
|---|---|---|---|---|---|---|---|
| 10 | 40 | 1000 | 1000 | 366 | 0.1 | 0.25 | |

MORE ↓

| ENTER Averaging time for carcinogens, $AT_C$ (yrs) | ENTER Averaging time for noncarcinogens, $AT_{NC}$ (yrs) | ENTER Exposure duration, ED (yrs) | ENTER Exposure frequency, EF (days/yr) | ENTER Target risk for carcinogens, TR (unitless) | ENTER Target hazard quotient for noncarcinogens, THQ (unitless) |
|---|---|---|---|---|---|
| 70 | 30 | 30 | 350 | 1.0E-06 | 1 |

Used to calculate risk-based groundwater concentration.

END

## INTERMEDIATE CALCULATIONS SHEET
## VF for PRGs
## Tetrachloroethene in Groundwater Wells GMW 3, 7, 8, 9 and 5, 6
## Perkin Elmer
## Missouri Metals Site
## Overland, Missouri

| Exposure duration, $\tau$ (sec) | Source-building separation, $L_T$ (cm) | Stratum A soil air-filled porosity, $\theta_a^A$ ($cm^3/cm^3$) | Stratum B soil air-filled porosity, $\theta_a^B$ ($cm^3/cm^3$) | Stratum C soil air-filled porosity, $\theta_a^C$ ($cm^3/cm^3$) | Stratum A effective total fluid saturation, $S_{te}$ ($cm^3/cm^3$) | Stratum A soil intrinsic permeability, $k_i$ ($cm^2$) | Stratum A soil relative air permeability, $k_{rg}$ ($cm^2$) | Stratum A soil effective vapor permeability, $k_v$ ($cm^2$) | Thickness of capillary zone, $L_{cz}$ (cm) | Total porosity in capillary zone, $n_{cz}$ ($cm^3/cm^3$) | Air-filled porosity in capillary zone, $\theta_{a,cz}$ ($cm^3/cm^3$) | Water-filled porosity in capillary zone, $\theta_{w,cz}$ ($cm^3/cm^3$) | Floor-wall seam perimeter, $X_{crack}$ (cm) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 9.46E+08 | 442.2 | 0.244 | 0.244 | 0.244 | 0.324 | 2.26E-09 | 0.821 | 1.86E-09 | 30.00 | 0.459 | 0.104 | 0.355 | 4,000 |

| Bldg. ventilation rate, $Q_{building}$ ($cm^3/s$) | Area of enclosed space below grade, $A_B$ ($cm^2$) | Crack-to-total area ratio, $\eta$ (unitless) | Crack depth below grade, $Z_{crack}$ (cm) | Enthalpy of vaporization at ave. groundwater temperature, $\Delta H_{v,TS}$ (cal/mol) | Henry's law constant at ave. groundwater temperature, $H_{TS}$ ($atm\text{-}m^3/mol$) | Henry's law constant at ave. groundwater temperature, $H'_{TS}$ (unitless) | Vapor viscosity at ave. soil temperature, $\mu_{TS}$ (g/cm-s) | Stratum A effective diffusion coefficient, $D^{eff}_A$ ($cm^2/s$) | Stratum B effective diffusion coefficient, $D^{eff}_B$ ($cm^2/s$) | Stratum C effective diffusion coefficient, $D^{eff}_C$ ($cm^2/s$) | Capillary zone effective diffusion coefficient, $D^{eff}_{cz}$ ($cm^2/s$) | Total overall effective diffusion coefficient, $D^{eff}_T$ ($cm^2/s$) | Diffusion path length, $L_d$ (cm) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 2.54E+04 | 1.06E+06 | 3.77E-04 | 15 | 9,553 | 7.81E-03 | 3.36E-01 | 1.75E-04 | 3.12E-03 | 0.00E+00 | 0.00E+00 | 1.87E-04 | 1.51E-03 | 442.2 |

| Convection path length, $L_p$ (cm) | Source vapor conc., $C_{source}$ ($\mu g/m^3$) | Crack radius, $r_{crack}$ (cm) | Average vapor flow rate into bldg., $Q_{soil}$ ($cm^3/s$) | Crack effective diffusion coefficient, $D^{crack}$ ($cm^2/s$) | Area of crack, $A_{crack}$ ($cm^2$) | Exponent of equivalent foundation Peclet number, $\exp(Pe^f)$ (unitless) | Infinite source indoor attenuation coefficient, $\alpha$ (unitless) | Infinite source bldg. conc., $C_{building}$ ($\mu g/m^3$) | Unit risk factor, URF $(\mu g/m^3)^{-1}$ | Reference conc., RfC ($mg/m^3$) |
|---|---|---|---|---|---|---|---|---|---|---|
| 15 | 3.36E+02 | 0.10 | 1.86E+00 | 3.12E-03 | 4.00E+02 | 3.12E+06 | 4.84E-05 | 1.63E-02 | 5.9E-06 | 6.0E-01 |

END

DATA ENTRY SHEET
VF for PRGs
Trichloroethene in Groundwater Wells GMW 3, 7, 8, 9 and 5, 6
Perkin Elmer
Missouri Metals Site
Overland, Missouri

GW-ADV
Version 3.1; 02/04

Reset to Defaults

CALCULATE RISK-BASED GROUNDWATER CONCENTRATION (enter "X" in "YES" box)

YES X

OR

CALCULATE INCREMENTAL RISKS FROM ACTUAL GROUNDWATER CONCENTRATION (enter "X" in "YES" box and initial groundwater conc. below)

YES

| ENTER Chemical CAS No. (numbers only, no dashes) | ENTER Initial groundwater conc., $C_W$ (µg/L) | Chemical |
|---|---|---|
| 79016 | | Trichloroethylene |

MORE

| ENTER Average soil/ groundwater temperature, $T_S$ (°C) | ENTER Depth below grade to bottom of enclosed space floor, $L_F$ (cm) | ENTER Depth below grade to water table, $L_{WT}$ (cm) | ENTER Thickness of soil stratum A, $h_A$ (cm) | ENTER Thickness of soil stratum B, (Enter value or 0) $h_B$ (cm) | ENTER Thickness of soil stratum C, (Enter value or 0) $h_C$ (cm) | ENTER Soil stratum directly above water table, (Enter A, B, or C) | ENTER SCS soil type directly above water table | ENTER Soil stratum A SCS soil type (used to estimate soil vapor permeability) | OR | ENTER User-defined stratum A soil vapor permeability, $k_v$ ($cm^2$) |
|---|---|---|---|---|---|---|---|---|---|---|
| | | | Totals must add up to value of $L_{WT}$ (cell G28) | | | | | | | |
| 10 | 15 | 457.2 | 457.2 | | | C | SC | C | | |

MORE

| ENTER Stratum A SCS soil type (Lookup Soil Parameters) | ENTER Stratum A soil dry bulk density, $\rho_b^A$ ($g/cm^3$) | ENTER Stratum A soil total porosity, $n^A$ (unitless) | ENTER Stratum A soil water-filled porosity, $\theta_w^A$ ($cm^3/cm^3$) | ENTER Stratum B SCS soil type (Lookup Soil Parameters) | ENTER Stratum B soil dry bulk density, $\rho_b^B$ ($g/cm^3$) | ENTER Stratum B soil total porosity, $n^B$ (unitless) | ENTER Stratum B soil water-filled porosity, $\theta_w^B$ ($cm^3/cm^3$) | ENTER Stratum C SCS soil type (Lookup Soil Parameters) | ENTER Stratum C soil dry bulk density, $\rho_b^C$ ($g/cm^3$) | ENTER Stratum C soil total porosity, $n^C$ (unitless) | ENTER Stratum C soil water-filled porosity, $\theta_w^C$ ($cm^3/cm^3$) |
|---|---|---|---|---|---|---|---|---|---|---|---|
| C | 1.43 | 0.459 | 0.215 | C | 1.43 | 0.459 | 0.215 | C | 1.43 | 0.459 | 0.215 |

MORE

| ENTER Enclosed space floor thickness, $L_{crack}$ (cm) | ENTER Soil-bldg. pressure differential, $\Delta P$ ($g/cm\text{-}s^2$) | ENTER Enclosed space floor length, $L_B$ (cm) | ENTER Enclosed space floor width, $W_B$ (cm) | ENTER Enclosed space height, $H_B$ (cm) | ENTER Floor-wall seam crack width, w (cm) | ENTER Indoor air exchange rate, ER (1/h) | ENTER Average vapor flow rate into bldg. OR Leave blank to calculate $Q_{soil}$ (L/m) |
|---|---|---|---|---|---|---|---|
| 10 | 40 | 1000 | 1000 | 366 | 0.1 | 0.25 | |

MORE

| ENTER Averaging time for carcinogens, $AT_C$ (yrs) | ENTER Averaging time for noncarcinogens, $AT_{NC}$ (yrs) | ENTER Exposure duration, ED (yrs) | ENTER Exposure frequency, EF (days/yr) | ENTER Target risk for carcinogens, TR (unitless) | ENTER Target hazard quotient for noncarcinogens, THQ (unitless) |
|---|---|---|---|---|---|
| 70 | 30 | 30 | 350 | 1.0E-06 | 1 |
| | | | | Used to calculate risk-based groundwater concentration. | |

END

**INTERMEDIATE CALCULATIONS SHEET**
**VF for PRGs**
**Trichloroethene in Groundwater Wells GMW 3, 7, 8, 9 and 5, 6**
**Perkin Elmer**
**Missouri Metals Site**
**Overland, Missouri**

| Exposure duration, $\tau$ (sec) | Source-building separation, $L_T$ (cm) | Stratum A soil air-filled porosity, $\theta_a^A$ ($cm^3/cm^3$) | Stratum B soil air-filled porosity, $\theta_a^B$ ($cm^3/cm^3$) | Stratum C soil air-filled porosity, $\theta_a^C$ ($cm^3/cm^3$) | Stratum A effective total fluid saturation, $S_{te}$ ($cm^3/cm^3$) | Stratum A soil intrinsic permeability, $k_i$ ($cm^2$) | Stratum A soil relative air permeability, $k_{rg}$ ($cm^2$) | Stratum A soil effective vapor permeability, $k_v$ ($cm^2$) | Thickness of capillary zone, $L_{cz}$ (cm) | Total porosity in capillary zone, $n_{cz}$ ($cm^3/cm^3$) | Air-filled porosity in capillary zone, $\theta_{a,cz}$ ($cm^3/cm^3$) | Water-filled porosity in capillary zone, $\theta_{w,cz}$ ($cm^3/cm^3$) | Floor-wall seam perimeter, $X_{crack}$ (cm) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 9.46E+08 | 442.2 | 0.244 | 0.244 | 0.244 | 0.324 | 2.26E-09 | 0.821 | 1.86E-09 | 30.00 | 0.459 | 0.104 | 0.355 | 4,000 |

| Bldg. ventilation rate, $Q_{building}$ ($cm^3/s$) | Area of enclosed space below grade, $A_B$ ($cm^2$) | Crack-to-total area ratio, $\eta$ (unitless) | Crack depth below grade, $Z_{crack}$ (cm) | Enthalpy of vaporization at ave. groundwater temperature, $\Delta H_{v,TS}$ (cal/mol) | Henry's law constant at ave. groundwater temperature, $H_{TS}$ ($atm\text{-}m^3/mol$) | Henry's law constant at ave. groundwater temperature, $H'_{TS}$ (unitless) | Vapor viscosity at ave. soil temperature, $\mu_{TS}$ (g/cm-s) | Stratum A effective diffusion coefficient, $D^{eff}_A$ ($cm^2/s$) | Stratum B effective diffusion coefficient, $D^{eff}_B$ ($cm^2/s$) | Stratum C effective diffusion coefficient, $D^{eff}_C$ ($cm^2/s$) | Capillary zone effective diffusion coefficient, $D^{eff}_{cz}$ ($cm^2/s$) | Total overall effective diffusion coefficient, $D^{eff}_T$ ($cm^2/s$) | Diffusion path length, $L_d$ (cm) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 2.54E+04 | 1.06E+06 | 3.77E-04 | 15 | 8,557 | 4.78E-03 | 2.06E-01 | 1.75E-04 | 3.42E-03 | 0.00E+00 | 0.00E+00 | 2.08E-04 | 1.67E-03 | 442.2 |

| Convection path length, $L_p$ (cm) | Source vapor conc., $C_{source}$ ($\mu g/m^3$) | Crack radius, $r_{crack}$ (cm) | Average vapor flow rate into bldg., $Q_{soil}$ ($cm^3/s$) | Crack effective diffusion coefficient, $D^{crack}$ ($cm^2/s$) | Area of crack, $A_{crack}$ ($cm^2$) | Exponent of equivalent foundation Peclet number, $\exp(Pe^f)$ (unitless) | Infinite source indoor attenuation coefficient, $\alpha$ (unitless) | Infinite source bldg. conc., $C_{building}$ ($\mu g/m^3$) | Unit risk factor, URF $(\mu g/m^3)^{-1}$ | Reference conc., RfC ($mg/m^3$) |
|---|---|---|---|---|---|---|---|---|---|---|
| 15 | 2.06E+02 | 0.10 | 1.86E+00 | 3.42E-03 | 4.00E+02 | 8.27E+05 | 5.00E-05 | 1.03E-02 | 1.1E-04 | 4.0E-02 |

END

# DATA ENTRY SHEET
## VF for PRGs
## Vinyl Chloride in Groundwater Wells GMW 3, 7, 8, 9 and 5, 6
## Perkin Elmer
## Missouri Metals Site
## Overland, Missouri

GW-ADV
Version 3.1; 02/04

Reset to Defaults

CALCULATE RISK-BASED GROUNDWATER CONCENTRATION (enter "X" in "YES" box)

YES [ X ]

**OR**

CALCULATE INCREMENTAL RISKS FROM ACTUAL GROUNDWATER CONCENTRATION (enter "X" in "YES" box and initial groundwater conc. below)

YES [ ]

| ENTER Chemical CAS No. (numbers only, no dashes) | ENTER Initial groundwater conc., $C_W$ (µg/L) | Chemical |
|---|---|---|
| 75014 | | Vinyl chloride (chloroethene) |

MORE ↓

| ENTER Average soil/ groundwater temperature, $T_S$ (°C) | ENTER Depth below grade to bottom of enclosed space floor, $L_F$ (cm) | ENTER Depth below grade to water table, $L_{WT}$ (cm) | ENTER Thickness of soil stratum A, $h_A$ (cm) | ENTER Thickness of soil stratum B, (Enter value or 0) $h_B$ (cm) | ENTER Thickness of soil stratum C, (Enter value or 0) $h_C$ (cm) | ENTER Soil stratum directly above water table, (Enter A, B, or C) | ENTER SCS soil type directly above water table | ENTER Soil stratum A SCS soil type (used to estimate soil vapor permeability) | OR | ENTER User-defined stratum A soil vapor permeability, $k_v$ (cm²) |
|---|---|---|---|---|---|---|---|---|---|---|
| 10 | 15 | 457.2 | 457.2 | | | C | SC | C | | |

Totals must add up to value of $L_{WT}$ (cell G28)

MORE ↓

| ENTER Stratum A SCS soil type (Lookup Soil Parameters) | ENTER Stratum A soil dry bulk density, $\rho_b^A$ (g/cm³) | ENTER Stratum A soil total porosity, $n^A$ (unitless) | ENTER Stratum A soil water-filled porosity, $\theta_w^A$ (cm³/cm³) | ENTER Stratum B SCS soil type (Lookup Soil Parameters) | ENTER Stratum B soil dry bulk density, $\rho_b^B$ (g/cm³) | ENTER Stratum B soil total porosity, $n^B$ (unitless) | ENTER Stratum B soil water-filled porosity, $\theta_w^B$ (cm³/cm³) | ENTER Stratum C SCS soil type (Lookup Soil Parameters) | ENTER Stratum C soil dry bulk density, $\rho_b^C$ (g/cm³) | ENTER Stratum C soil total porosity, $n^C$ (unitless) | ENTER Stratum C soil water-filled porosity, $\theta_w^C$ (cm³/cm³) |
|---|---|---|---|---|---|---|---|---|---|---|---|
| C | 1.43 | 0.459 | 0.215 | C | 1.43 | 0.459 | 0.215 | C | 1.43 | 0.459 | 0.215 |

MORE ↓

| ENTER Enclosed space floor thickness, $L_{crack}$ (cm) | ENTER Soil-bldg. pressure differential, $\Delta P$ (g/cm-s²) | ENTER Enclosed space floor length, $L_B$ (cm) | ENTER Enclosed space floor width, $W_B$ (cm) | ENTER Enclosed space height, $H_B$ (cm) | ENTER Floor-wall seam crack width, w (cm) | ENTER Indoor air exchange rate, ER (1/h) | ENTER Average vapor flow rate into bldg. OR Leave blank to calculate $Q_{soil}$ (L/m) |
|---|---|---|---|---|---|---|---|
| 10 | 40 | 1000 | 1000 | 366 | 0.1 | 0.25 | |

MORE ↓

| ENTER Averaging time for carcinogens, $AT_C$ (yrs) | ENTER Averaging time for noncarcinogens, $AT_{NC}$ (yrs) | ENTER Exposure duration, ED (yrs) | ENTER Exposure frequency, EF (days/yr) | ENTER Target risk for carcinogens, TR (unitless) | ENTER Target hazard quotient for noncarcinogens, THQ (unitless) |
|---|---|---|---|---|---|
| 70 | 30 | 30 | 350 | 1.0E-06 | 1 |

Used to calculate risk-based groundwater concentration.

END

# INTERMEDIATE CALCULATIONS SHEET
## VF for PRGs
## Vinyl Chloride in Groundwater Wells GMW 3, 7, 8, 9 and 5, 6
## Perkin Elmer
## Missouri Metals Site
## Overland, Missouri

| Exposure duration, $\tau$ (sec) | Source-building separation, $L_T$ (cm) | Stratum A soil air-filled porosity, $\theta_a^A$ (cm³/cm³) | Stratum B soil air-filled porosity, $\theta_a^B$ (cm³/cm³) | Stratum C soil air-filled porosity, $\theta_a^C$ (cm³/cm³) | Stratum A effective total fluid saturation, $S_{te}$ (cm³/cm³) | Stratum A soil intrinsic permeability, $k_i$ (cm²) | Stratum A soil relative air permeability, $k_{rg}$ (cm²) | Stratum A soil effective vapor permeability, $k_v$ (cm²) | Thickness of capillary zone, $L_{cz}$ (cm) | Total porosity in capillary zone, $n_{cz}$ (cm³/cm³) | Air-filled porosity in capillary zone, $\theta_{a,cz}$ (cm³/cm³) | Water-filled porosity in capillary zone, $\theta_{w,cz}$ (cm³/cm³) | Floor-wall seam perimeter, $X_{crack}$ (cm) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 9.46E+08 | 442.2 | 0.244 | 0.244 | 0.244 | 0.324 | 2.26E-09 | 0.821 | 1.86E-09 | 30.00 | 0.459 | 0.104 | 0.355 | 4,000 |

| Bldg. ventilation rate, $Q_{building}$ (cm³/s) | Area of enclosed space below grade, $A_B$ (cm²) | Crack-to-total area ratio, $\eta$ (unitless) | Crack depth below grade, $Z_{crack}$ (cm) | Enthalpy of vaporization at ave. groundwater temperature, $\Delta H_{v,TS}$ (cal/mol) | Henry's law constant at ave. groundwater temperature, $H_{TS}$ (atm-m³/mol) | Henry's law constant at ave. groundwater temperature, $H'_{TS}$ (unitless) | Vapor viscosity at ave. soil temperature, $\mu_{TS}$ (g/cm-s) | Stratum A effective diffusion coefficient, $D^{eff}_A$ (cm²/s) | Stratum B effective diffusion coefficient, $D^{eff}_B$ (cm²/s) | Stratum C effective diffusion coefficient, $D^{eff}_C$ (cm²/s) | Capillary zone effective diffusion coefficient, $D^{eff}_{cz}$ (cm²/s) | Total overall effective diffusion coefficient, $D^{eff}_T$ (cm²/s) | Diffusion path length, $L_d$ (cm) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 2.54E+04 | 1.06E+06 | 3.77E-04 | 15 | 5,000 | 1.72E-02 | 7.41E-01 | 1.75E-04 | 4.59E-03 | 0.00E+00 | 0.00E+00 | 2.72E-04 | 2.21E-03 | 442.2 |

| Convection path length, $L_p$ (cm) | Source vapor conc., $C_{source}$ (μg/m³) | Crack radius, $r_{crack}$ (cm) | Average vapor flow rate into bldg., $Q_{soil}$ (cm³/s) | Crack effective diffusion coefficient, $D^{crack}$ (cm²/s) | Area of crack, $A_{crack}$ (cm²) | Exponent of equivalent foundation Peclet number, $\exp(Pe^f)$ (unitless) | Infinite source indoor attenuation coefficient, $\alpha$ (unitless) | Infinite source bldg. conc., $C_{building}$ (μg/m³) | Unit risk factor, URF $(\mu g/m^3)^{-1}$ | Reference conc., RfC (mg/m³) |
|---|---|---|---|---|---|---|---|---|---|---|
| 15 | 7.41E+02 | 0.10 | 1.86E+00 | 4.59E-03 | 4.00E+02 | 2.58E+04 | 5.43E-05 | 4.02E-02 | 8.8E-06 | 1.0E-01 |

END