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FINAL REPORT

RCRA DOCKET NO. I-90-1032

ENVIRITE LANDFILL, THOMASTON, CT

STATISTICAL TREND ANALYSIS OF COPCS IN GROUNDWATER AND CONCEPTUAL MODEL FOR SOURCE IMPACT TO GROUNDWATER

Prepared by

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July 20, 2001

July 20, 2001

Mr. William R. McTigue, Jr.
Envirite Corporation
620 W. Germantown Pk.
Suite 250
Plymouth Meeting PA 19462

Re: RCRA Docket No. I-90-1032

Envirite Landfill, Thomaston, CT: - Statistical Trend Analysis of COPCs in Groundwater and Conceptual Source Model for PEWM

Dear Bill:

The following letter report has been prepared for Envirite Corporation (**Envirite**) by XDD, LLC (XDD) in response to questions raised by the United States Environmental Protection Agency (**EPA**) with regard to the Public Health and Environmental Risk Evaluation (**PHERE**) dated February 28, 2000 developed by Envirite and its consultant for the above referenced site.[1]

INTRODUCTION SIGNIFICANCE

The two subsurface waste piles known as Pre-Envirite Waste Material (**PEWM**) at the above-referenced Thomaston, Connecticut site (**site**) before Envirite purchased the property in 1975. The PEWM contains a variety of chemicals including halogenated volatile organic compounds (**HVOC**), aromatic volatile organic compounds (**AVOC**) and inorganics (i.e, metals). One of the waste piles lies predominantly in the saturated zone under Cell #1 of the landfill (**PEWM-L**). The other waste pile lies in the unsaturated and saturated zones near groundwater monitoring well 31S (MW-31S). This pile straddles the property boundary that separates the site from Old Waterbury Road (**PEWM-R**).

When considered in the context of the proposed Media Protection Standards (MPS),[2] both the location and physiochemical characteristics of the PEWM suggest that the final site remedy could consist of removal of the PEWM-R located on Envirite's property; the PEWM-L could

[1] Envirite first submitted the PHERE on May 30, 1997. In response to EPA's comments, Envirite reissued the PHERE on February 28, 2000.

[2] *See* Public Health and Environmental Risk Evaluation (PHERE), section VI dated February 28, 2000, submitted by Envirite. RCRA Docket No. I-90-1032. Depending upon the environmental medium of concern, the proposed MPS are either risk-based or directly reflect the values published in the State of Connecticut's Remediation Standards Regulations (RSR).

remain in place to naturally attenuate over time. The purpose of this report then is to assess the behavior of the PEWM-L (only) for the natural attenuation component of such a prospective remedy. Because this remedy scenario presumes that a portion of the PEWM-R would remain under Waterbury Road, this remaining (and largely vadose zone) PEWM-R mass is considered to the extent necessary to accurately assess the behavior of the PEWM-L.

The natural attenuation behavior of the PEWM-L could be conceptually described as an aqueous diffusion-limited mass transfer of those organic and inorganic constituents which (a) would tend to characterize the physical/chemical diffusion-limited behavior of the PEWM-L, and (b) pose the most concern from a regulatory standpoint (chemicals of potential concern (**COPC**)). Accordingly, an aqueous diffusion-limited conceptual source model (**CSM**) was developed to demonstrate the expected trends in groundwater concentration resulting from the PEWM-L. A statistical trend analyses (**STA**) of COPCs observed in groundwater at the site was conducted to demonstrate agreement with the CSM and to generally confirm a no-trend to decreasing-trend for COPCs measured in site groundwater for the period January, 1991 through October, 2000.

OBJECTIVES

The objectives of this report are therefore as follows:

- Statistical Trend Analysis (**ST; STA**). Evaluate concentration trends COPCs associated with the PEWM-L in groundwater at and inside the boundary of the site. For this objective, a non-parametric statistical method (Mann-Kendall) will be employed.

- PEWM-L Behavior Analysis (**PB; PBA**). Provide a rationale for the observed COPCs concentration trends by developing a conceptual model (simplified diffusion model) for COPCs migration from the PEWM-L.

SELECTION OF COPCs FOR ANALYSIS

Three criteria were developed for selecting COPCs for ST and PB analyses. These criteria are based to some degree on developed Media Protection Standards (**MPS**) as set out in the PHERE. Even though the MPS's have not been approved by EPA or the State of Connecticut, because the purpose of this evaluation is to understand the natural attenuation behavior of the PEWM-L — not to establish or support the integrity of the proposed MPS— it is assumed the proposed MPS's represent a set of concentration data which, more likely than not, adequately characterizes the PEWM for the assumed remedy scenario as presented. The criteria are

1. As a threshold matter, a COPC was reserved for analysis if it was present in the PEWM-L and had been identified as an MPS constituent in Part VI of the PHERE (as further described in criterion 3 below).

   PHERE Table III- 27, entitled "Summary Statistics for Chemicals Detected in Pre-Envirite Waste Material Samples Located Below the Landfill (PEWM-L)" in

the PHERE was used to identify those MPS constituents present in the PEWM-L. PHERE Table III-28, entitled "Summary Statistics for Chemicals Detected in Pre-Envirite Waste Material Samples Located Near Road (PEWM-R)" was reviewed to compare the concentrations of the COPCs in the PEWM-L with those in the PEWM-R as described;

2. Next, a COPC was reserved for analysis if time-series concentration data was available for the constituent (in the form of quarterly groundwater analytical data for the January, 1991 through October, 2000 period).

   Time series data are not available for a number of the COPCs meeting selection criteria 1. However, the physical/chemical characteristics of many of these constituents are similar to the constituents for which time series data are available. Furthermore, as evinced by their physical/chemical properties, some of these constituents are much less likely to adversely impact groundwater than the COPCs for which times series data are available. Therefore, the trend in behavior of the constituents for which time-series data are available would reasonably be expected to be similar to or more conservative than the constituents for which time series data are unavailable; and

3. Finally, a COPC was included for analysis if the 95% upper confidence limit (UCL) concentrations of the constituent in the PEWM-L equal or exceed the most conservative (i.e., minimum) risk-based MPS value calculated for the constituent's concentration in deep soil, groundwater or surface water, as applicable.[3] These three media and their respective derived MPS's were considered as most appropriately representative for PEWM-L behavioral analysis.

   The universe of constituents eligible for consideration of this criterion is comprised of all COPCs identified in the PHERE, Part VI as follows:
   - Part VI.C: risk-based MPS for on-site deep soil
   - Part VI.E: risk based MPS for groundwater
   - Part VI.F: risk based MPS for surface water
   - Table VI-1 "Summary of Risk-Based MPS Calculations"

In summary, a total of five COPCs were found to satisfy the three selection criteria. The following list represents the COPCs selected for ST and PB analysis;

HVOCs: tetrachloroethylene, trichloroethylene, vinyl chloride.

[3] The PHERE evaluated COPC's, in part, on an environmental media basis according to established EPA risk assessment policy and guidance. These media included on-site surface soil, groundwater, surface water, sediment, soil gas, and the PEWM. PHERE MPS's were based on either
- Connecticut Department of Environmental Protection (CTDEP) Remediation Standard Regulations (RSR-Based MPS; default MPS), or
- Risk-Based MPS based on site-specific risk calculations.

AVOCs:	ethyl benzene; and
Metals:	cadmium.

Table 1 of this report, entitled "Selection of Constituents of Potential Concern (COPCs) for Trend Analysis" summarizes the results of the entire process for selecting COPCs for statistical trend analysis. Table 2 of this report, entitled "Selection of Constituents of Potential Concern (COPCs) Studied and Not Studied for Trend Analysis" summarizes the physical and chemical characteristics of those COPCs contained in the PEWM-L most likely to influence PEWM-L aqueous diffusion-limited mass transfer behavior.

STATISTICAL TREND ANALYSIS OF COPCs IN GROUNDWATER

APPROACH

The quarterly groundwater COPCs concentration data from January 1991 through October 2000 are tabulated, plotted and presented in Attachment A. An initial review of the data plots suggests that the COPCs show a relatively flat (no significant) to downward trend for almost all of the monitoring points. For a number of the monitoring points and monitoring events, evaluation of the data was constrained by the COPCs' concentrations which were at the analytical method quantitation limit.

In order to statistically evaluate the data for the purpose of determining the existence of a trend, the COPCs concentration data were evaluated using a non-parametric statistical method, namely the Mann-Kendall method.[4] The Mann-Kendall procedure is particularly useful in evaluation of environmental data since missing values are allowed and the data need not conform to any particular distribution. Also, data reported as trace or less than the detection limit can be used by assigning them a common value that is smaller than the smallest measured value in the data set. The method is used to test the null hypotheses of no trend against the alternative hypotheses of either a decreasing or increasing trend in a time-series set of data.

The Mann-Kendall procedure was used for all the data sets, since all the data sets contain more than 10 values each. The formulation and sample calculations from EPA QA/G-9 are presented in Attachment B. For the data values below the analytical method quantitation limit, a value less than the quantitation limit (i.e., 0.0001 μg/L) was assigned for the data. The repetition of this value was considered to be a tied value (a "tied value" is two equal values). The Z statistic calculated by this method was compared to Z statistic critical values obtained from Table A-1 of EPA QA/G-9 (Attachment B).

USE OF DATA

According to the site conceptual groundwater model, groundwater generally flows in a southerly to southwesterly direction. Also, during seasons of elevated groundwater levels, groundwater has an easterly flow component in the northern region of the site.[5] Therefore, the concentration

[4] *In* USEPA, "Guidance for Data Quality Assessment, Practical Methods for Data Analysis," EPA QA/G-9, A00 Update, EPA/600/R-96/084 (July 2000) (hereafter, EPA AQ/G-9). http://www.epa.gov/quality1/qa_docs.html.
[5] "*LTR Study Report*," Envirite Corporation, section 5.0, December 21, 1998.

data for the five COPCs for monitoring locations *MW-30, MW-31S, MW-41S, MW-41D, MW-41B, MW-42S, MW-43S, MW-43D, MW-44D* and *MW-44B* were used in the Mann-Kendall analyses (see Attachment A). As shown in Figure 1 (site plan) these monitoring wells are located either at or inside the Envirite site boundary.

As presented above and in Envirite's *LTR Study Report*, a second area of PEWM exists in the vicinity of MW-31S (PEWM-R). This volume of PEWM exists in both the unsaturated and saturated soils (predominantly unsaturated) within and outside of Envirite's eastern property boundary. Analysis of the seasonal site hydrogeology, as presented in the *LTR Study Report*, demonstrates the potential for the PEWM at this location to impact groundwater quality in the vicinity of MW-31S and in the southeastern property boundary (in the vicinity of the MW-41 well cluster).

As shown from the raw data table in Attachment A, the analytical data for the January 2000 sampling event for monitoring wells MW-30, MW-31S, MW-43S and MW-44B show very high concentrations for a number of constituents relative to the time-series data. These high concentrations are considered to be outliers, statistically. Therefore, two sets of statistical analyses were performed as follows:

- Analyses Including Outliers: Mann-Kendall analyses were performed including the outlier values in the data set.

- Analyses Excluding Outliers: Mann-Kendall analyses were performed excluding the outlier values in the data set

RESULTS

1. Analyses Including Outliers

The results of the Mann-Kendall analyses including outliers are summarized in Tables 3 and 3A. Table 3 compares the Z values calculated through the Mann-Kendall analysis with the critical Z value for a 95% confidence limit on the existence of a statistical trend. The summary in Table 3A indicates that, at the 95% confidence level, most monitoring points show either no trend or a decreasing trend. Monitoring well cluster MW 41 (S, D and B) shows an upward trend for TCE and PCE (only at MW-41D). In addition, MW-31S shows an upward trend for ethylbenzene and cadmium. Again, a review of the corresponding figures illustrating these data (Attachment A) indicate that, for these upwards trends, a regression fit curve is relatively flat.

2. Analyses Excluding Outliers:

The results of the Mann-Kendall analyses excluding outliers are summarized in Table 4 and 4A. Two differences were noted when the analyses were performed excluding outliers: the no trend observation for vinyl chloride (VC) at MW-30 indicates a downward trend and the upward trend for ethylbenzene in MW-31S indicates a no trend,

3. General Observations

Two other general, but significant, observations were derived from the Mann-Kendall analyses:

- The monitoring wells that show COPCs having an upward trend are MW-31S and the MW-41 cluster. Based on the hydrogeological analyses performed in the *LTR Study Report*, these wells are in the vicinity of, or hydraulically downgradient of PEWM-R;

- A review of Table 1 demonstrates that for the COPCs that show an upward trend, the concentration of the COPC in the PEWM is orders of magnitude higher in PEWM-R than in PEWM-L. This suggests that PEWM-R is the most probable source for the COPCs' in groundwater.

SUMMARY

A non-parametric statistical analysis of the quarterly analytical groundwater quality data from January 1991 through October 2000 for the five identified COPCs demonstrate that there are either no trends or decreasing statistical trends for each of the five COPCs, except for select COPC upward trends in MW-31S and the MW-41 well cluster. A review of the data plots for MW-31S and the MW-41 well cluster shows a relatively flat regression fit for these data which does not suggest a significant upward trend at these locations. With respect to the objectives of this evaluation the analyses suggest that:

- With the exception of MW-31S and the MW-41 well cluster statistical analyses of the concentration of the five COPCs associated with PEWM-L have, over the last ten years, exhibited no trend or a decreasing trend in groundwater concentrations at the site boundary. This suggests that a low-level PEWM-L state has likely been achieved; that depletion of the remaining PEWM-L source material is occurring; and that over time, COPC levels in groundwater will continue to drop.

- The statistically determined upward trends for PCE, TCE and cadmium are restricted to MW-31S and the MW-41 well. A review of the data plots does not suggest that the trends are significant. In addition, the location of these wells is co-incident with or downgradient of PEWM-R at the site boundary in the vicinity of MW-31S [comment: this sentence doesn't make sense]. Further, Table 1 shows that the COPCs concentrations in PEWM-R are orders of magnitude higher than concentrations in PEWM-L, suggesting PEWM-R is the more probable source of COPCs at MW-31S and the MW-41 well cluster.

  The seasonal hydrogeological analysis presented in the *LTR Study Report* indicates that the MW-41 well cluster is hydraulically downgradient of PEWM-R. Since PEWM-R is predominantly located in the unsaturated zone (whereas the PEWM under Cell#1 is located predominantly in the saturated zone) this condition could be the cause of the determined statistical upward trend at MW-31S and the MW-41 well cluster. Periodic

recharge of PEWM-R constituents into the underlying groundwater could result in inconsistent increases in COPCs that may be incorrectly interpreted as a statistical trend.

CONCEPTUAL SOURCE MODEL – PEWM-L

As previously stated, one of the objectives of this evaluation is to develop a conceptual source model (**CSM; diffusion model**) that would provide a physical/chemical explanation for dissolved-phase COPC concentrations observed at the site boundary that may be associated with PEWM-L. The CSM is based on the following:

- PEWM-L is a low permeability matrix, and is located predominantly in the saturated zone, beneath Cell #1 of the landfill.[6]

- The primary mechanism for PEWM-L constituents to groundwater are desorption of the constituents from the PEWM into the low permeability matrix pore water, and aqueous diffusion of the constituents from the matrix pore water into the groundwater flow field passing the surface of the PEWM.

- COPCs in groundwater then migrate along flow paths to the site boundaries (as described in the *LTR Study Report*).

APPROACH

Based on 1)the measured dissolved COPCs concentrations downgradient of PEWM-L and in the matrix pore water associated with PEWM-L, 2)the effective solubility of the COPCs and 3) the low permeability of PEWM-L, the CSM assumes that groundwater flows across the face of (not through) PEWM-L. Thus, aqueous diffusion of COPCs from the pore water within PEWM-L, into the high permeability sand aquifer is considered to be the rate-limiting transport mechanism and, therefore, the control for the rate of depletion of the COPCs mass present in PEWM-L.

Under conditions of diffusion-limited mass transport, the aqueous diffusion coefficient and the effective solubility are the two most significant physical/chemical properties of any COPC in evaluating its depletion from PEWM-L. As the aqueous diffusion coefficient and effective solubilities of four of the five COPCs are of the same order of magnitude (cadmium is considered relatively insoluble), it is reasonable to expect that the behavior of any one COPC in PEWM-L will be reasonably representative of the behavior of any other of the COPCs. While cadmium may differ most in its physical-chemical properties, reviewing the behavior of any of the other COPCs will tend to be conservative with respect to cadmium's expected impact to groundwater. Therefore, in the following analyses tetrachloroethylene (PCE) and trichloroethylene (TCE) are used to illustrate the expected behavior of any of the five COPCs.

To describe the depletion of PCE and TCE from PEWM-L, a simplified aqueous diffusion model based on Fick's second law for a semi-infinite solid was developed (Attachment C). The historic

[6] *See* EPA letter to Dave Nash of the Connecticut Department of Environmental Protection entitled, Pre-Envirite Waste Materials, dated December 1, 1998 [sic], *In* EPA December 2, 1997 Draft Comments on Final RFI Report.

PEWM-L data, provided in Attachment C, show that PEWM-L varies in thickness from 0.3 to 8 feet. The initial pore water concentrations for PCE and TCE are calculated based on a calibration between the projected partitioning of the COPCs and TCLP concentrations derived from tests on the PEWM. These calculations are present in Attachment C.

To determine the sensitivity of CSM input parameters, several model runs were performed. Variables in the runs were PCE and TCE concentration in PEWM-L pore water, PEWM-L thickness, and the effective diffusion coefficient. Figures 2, 3, 4 and 5 present typical model run outputs which project the expected depletion of the COPCs from PEWM-L and the effect of the diffusion coefficient and percent pore saturation (effective diffusion coefficient) on the process. Additional model outputs and diffusion modeling sample calculations are presented in Attachment C.

RESULTS

A review of Figures 2, 3, 4 and 5 provides a number of observations with respect to CSM results:

Figures 2 and 3

- For the average PEWM-L thickness, the change in concentration of the COPCs in the PEWM-L pore water at any given distance into the PEWM and, therefore, the flux of the COPCs into the groundwater, is not expected to change significantly within the time period for which the groundwater monitoring data at the site were evaluated (i.e., 10 years). In other words, it would be expected that statistical analyses of groundwater quality in wells downgradient of PEWM-L would show a "no- to decreasing" trend. This observation is consistent with the results of the statistical analyses on the boundary wells as presented above, especially for those wells that would be least likely to be impacted by PEWM-R (i.e., all wells except MW-31S and the MW-41 well cluster);

- The rate of depletion of COPCs from PEWM-L significantly changes with the thickness of the PEWM layer (y) (i.e., the lower the thickness of the layer, the higher the depletion rate);

- Depletion of the COPCs from the average thickness of PEWM-L is projected to require a significant time frame.

Figure 4

- While a higher diffusion coefficient will increase the rate of depletion of the source COPC, the depletion will still require a significant timeframe, and the rate of change of COPC flux will be slow. This is consistent with the observed no- to decreasing trend in groundwater COPC concentrations for the 1991 through 2000 time period.

Figure 5

- The variation in percent saturation of PEWM-L impacts the volumetric water content and, therefore, affects the effective diffusion coefficient. If seasonal water table levels expose part of PEWM-L the percent saturation could change. However, even under these conditions the analysis, again, shows the relatively significant period of time for depletion and the slow rate of change expected in the COPC flux to groundwater. Therefore again, a no- to decreasing trend in groundwater COPC concentration is expected over the 1991 through 2000 time period.

With respect to the impact of diffusion from PEWM-L into the surrounding groundwater, the diffusion model was used to predict the COPC concentration profile in groundwater in the vicinity of PEWM-L. Tables 5 and 6 and Figures 6, 7 and 8 present the results of these analyses. The tables and figures present the projected COPC concentrations in groundwater at different distances from the surface of PEWM-L, as the groundwater flows from the upgradient to downgradient edge of PEWM-L (approximately 30 feet).

A review of Table 5 and 6 and Figures 6, 7 and 8 provides the following observations:

- In combination with Figures 2 through 5, this analysis indicates that low concentrations of the COPCs associated with PEWM-L are expected in downgradient monitoring wells and that statistical trends in the COPC levels in the wells would be expected to show a no to decreasing trend over time periods on the order of the ten years for which consistent monitoring data are available.

- The COPC concentration in groundwater is expected to drop exponentially with distance from the PEWM-L surface.

- The COPC concentration in a downgradient monitoring well will be expected to be low compared with the concentration of the COPC in the PEWM-L pore water.

- The COPC concentration in groundwater would increase with increasing effective diffusion coefficient.

CONCLUSIONS

The objectives of this study were to perform statistical analyses of COPC (associated with PEWM-L) groundwater concentrations at select wells along the property boundary of the Envirite site and to provide a rational explanation for the level of COPCs measured in the groundwater and the determined statistical trends.

A simplistic mass-transfer (diffusion) limited conceptual model (CSM) was developed to project the behavior of COPCs in PEWM-L with respect to potential concentrations impacts to groundwater. The results of the CSM indicate that low levels of the COPCs are to be expected in groundwater downgradient of PEWM-L. Further, it is projected that the change in concentrations of the COPCs will occur very slowly, such that a statistical analysis of the COPCs

concentration in groundwater would be expected to show a no- to decreasing trend within the time frame (10 years) used to evaluate the groundwater quality data at the site. In addition, the analysis of the PEWM-L, as a diffusion limited source, indicates that projected groundwater concentrations of COPCs are expected to be in the same range as are measured in the monitoring wells along the property boundary.

The statistical analysis (Mann-Kendall) performed for groundwater data collected for select boundary wells at the site between 1991 to 2000, indicate that, for the majority of the wells analyzed, a no- to decreasing trend was determined for the COPCs. The exceptions to this were for select COPCs in MW-31S and the MW-41 well cluster. However, these two well locations are most likely to be impacted by PEWM-R based on proximity to the source (MW-31S) and that the concentration of the COPCs in PEWM-R is orders of magnitude greater than for PEWM-L, Also, as the *LTR Study Report* indicates that even under high water table conditions, groundwater flows approximately parallel to the eastern property boundary (not into the Naugatuck River). Therefore, the MW-41 well cluster is hydraulically downgradient of PEWM-R. Further, it is speculated that the apparent upward trend at these wells is a result of sporadic recharge events impacting PEWM-R which is located predominantly in the unsaturated zone.

In summary, the COPCs concentrations and change in concentrations with time measured at select boundary wells on the Envirite site can be explained through a conceptual model where the COPCs are being released from a mass transfer-limited source zone (PEWM-L) and that the COPCs' concentrations in groundwater are expected to slowly decline over time to Risk-Based or RSR-Based MPS. Anomalies from this model are likely a result of impact from PEWM-R at and outside of the property boundary. Further, it is not unreasonable to expect that the concentration of the COPCs in groundwater continue to decline downgradient of the property boundary due to natural attenuation mechanisms (e.g. dilution and dispersion).

Please do not hesitate to contact me at 603-778-1100, should the need arise.

Sincerely,

Michael C. Marley
President,
Xpert Design & Diagnostics, LLC

TABLE 1: SELECTION OF CONSTITUENTS OF POTENTIAL CONCERN (COPCS) FOR TREND ANALYSIS (page 1 of 8)

Constituent of Potential Concern (COPC)	CONDITION 1 Present in PEWM-L 95% UCL (mg/ kg, unless otherwise noted))	CONDITION 2 Have Time Series Data	CONDITION 3A 95% UCL Groundwater Concentration (mg/L) ≥ SWPC	SWPC (mg/L)	CONDITION 3B 95% UCL PEWM-L Concentration (mg/kg) ≥ PMC	PMC (mg/kg, unless otherwise noted)	CONDITION 3C 95% UCL Groundwater Concentration (mg/L) ≥ Risk Std.	Most Stringent Risk Std. (mg/L)	Study	Present in PEWM-R 95% UCL: (mg/kg, unless otherwise noted)
Aldrin	0.0036	No	0.00005	—	—	—	Yes 0.00005	0.00000456	No	BQL; DL = 0.024 See Note 7.
Benzene	0.15	Yes	NA	0.017	No	0.2	NA	NA	No	30
Benzo(a)pyrene	Not analyzed	Yes	Not determined	0.0003	Not determined	1	NA	NA	No	BQL; 25< DL > 240 See Note 7.
Benzo(k)fluoranthene	38	No	NA	0.0003	Yes	1	NA	NA	No	j = 0.82 Also, BQL; 89 < DL > 240 See Note 8a.
BHC *(beta)*	0.0036	No	—	—	—	—	Yes 0.00005	0.0000294	No	BQL; 0.0036< DL>0.024 See Note 7
bis(2-ethylhexyl)pthalate	610	No	Yes 0.11	0.059	Yes	11	No 0.11	0.158	No	6,500
Bromodichloromethane	BQL; 0.011<DL>1.3 See Note 9.	No	—	—	—	—	No 0.0009	0.00127	No	BQL; 1.3 < DL >900 See Note 7.

TABLE 1: SELECTION OF CONSTITUENTS OF POTENTIAL CONCERN (COPCS) FOR TREND ANALYSIS (page 2 of 8)

Constituent of Potential Concern (COPC)	CONDITION 1 Present in PEWM-L 95% UCL (mg/ kg, unless otherwise noted))	CONDITION 2 Have Time Series Data	CONDITION 3A 95% UCL Groundwater Concentration (mg/L) ≥ SWPC	SWPC (mg/L)	CONDITION 3B 95% UCL PEWM-L Concentration (mg/kg) ≥ PMC	PMC (mg/kg, unless otherwise noted)	CONDITION 3C 95% UCL Groundwater Concentration (mg/L) ≥ Risk Std.	Most Stringent Risk Std. (mg/L)	Study	Present in PEWM-R 95% UCL; (mg/kg, unless otherwise noted)
2-Butanone	0.01 mg/L	Yes	—	—	80	No	NA	NA	No	2,100
Butylbenzylpthalate	200 See Note 10	No	—	—	Yes	200	NA	NA	No	BQL 25 < DL > 240 See Note 7
Carbon tetrachloride	BQL; 0.011<DL>1.3 See Note 9.	Yes*	NA	0.1320	Yes	1	NA	NA	No*	BQL 1.3< DL > 900 See Note 7
Chloroform	0.24	Yes*	No 0.0089	14.1	No	1.2	Yes 0.0089	0.00113	No*	0.08 < j > 93 Also, BQL DL = 94 See Note 8b.
DDE	0.0071	No	—	—	—	—	Yes 0.0001	0.0000217	No	BQL 0.0071 <DL> 0.047 See Note 7.
DDT	0.0071	No	—	—	—	—	Yes 0.0001	0.00000983	No	BQL 0.0071<DL>0.047 See Note 7.
Dibutylpthalate	200	No	NA	120	Yes	140	NA	NA	No	3,100

TABLE 1: SELECTION OF CONSTITUENTS OF POTENTIAL CONCERN (COPCS) FOR TREND ANALYSIS (page 3 of 8)

Constituent of Potential Concern (COPC)	CONDITION 1 Present in PEWM-L 95% UCL (mg/ kg, unless otherwise noted))	CONDITION 2 Have Time Series Data	CONDITION 3A 95% UCL Groundwater Concentration (mg/L) ≥ SWPC	SWPC (mg/L)	CONDITION 3B 95% UCL PEWM-L Concentration (mg/kg) ≥ PMC	PMC (mg/kg, unless otherwise noted)	CONDITION 3C 95% UCL Groundwater Concentration (mg/L) ≥ Risk Std.	Most Stringent Risk Std. (mg/L)	Study	Present in PEWM-R 95% UCL; (mg/kg, unless otherwise noted)
1,1-Dichloroethene	0.07	Yes	No 0.01	0.096	No	1.4	No 0.01	0.0477	No	j =0.07 Also, BQL 94 < DL > 900 See Note 8c.
1,2-Dichloroethane	BQL; 0.011<DL>1.3 See Note 9.	Yes	No 0.002	2.97	No	0.2	Yes 0.002	0.000496	No	BQL; 1.3 < DL >900 See Note 7.
1,2-Dicholoroethylene *(cis)*	0.002	Yes	NA	—	No	14	NA	NA	No	70
1,2-Dicholoroethylene *(trans)*	0.002	Yes	NA	—	No	20	NA	NA	No	70
Dieldrin	0.007	No	Yes 0.0001	0.0001	Yes	0.007	Yes 0.0001	0.00000254	No	BQL; 0.0071<DL >0.047 See Note 7.
Ethylbenzene	14	Yes	NA	580	Yes	10.1	NA	NA	Yes	3,100
HCH *(gamma)* Lindane	0.0036	No	—	—	No	0.013	No 0.00000950	0.0000414	No	BQL

TABLE 1: SELECTION OF CONSTITUENTS OF POTENTIAL CONCERN (COPCS) FOR TREND ANALYSIS (page 4 of 8)

Constituent of Potential Concern (COPC)	CONDITION 1 Present in PEWM-L 95% UCL (mg/ kg, unless otherwise noted))	CONDITION 2 Have Time Series Data	CONDITION 3A 95% UCL Groundwater Concentration (mg/L) ≥ SWPC	SWPC (mg/L)	CONDITION 3B 95% UCL PEWM-L Concentration (mg/kg) ≥ PMC	PMC (mg/kg, unless otherwise noted)	CONDITION 3C 95% UCL Groundwater Concentration (mg/L) ≥ Risk Std.	Most Stringent Risk Std. (mg/L)	Study	Present in PEWM-R 95% UCL; (mg/kg, unless otherwise noted)
Heptachlor	0.0036	No	Yes 0.00005	0.00005	No	0.013	Yes 0.00005	0.0000111	No	BQL 0.0036<DL>0.024 See Note 7.
Methylchloride (chloromethane)	Not analyzed	Yes	—	—	—	—	NA	NA	No	BQL 1.3 < DL > 900 See Note 7.
Napthalene	18	No	—	—	No	56	NA	NA	No	160
N-nitrosodimethylamine	Not analyzed	No	—	—	—	—	Yes 0.015	0.000561	No	Not analyzed
Pentachlorophenol	180	No	—	—	Yes	1	NA	NA	No	BQL 61 < DL > 570 See Note 7.
Styrene	BQL: 0.011<DL>1.3 See Note 11.	No	—	—	No	20	NA	NA	No	2,300
Tetrachloroethylene	0.01	Yes	No	0.88	No	1	Yes 0.0022	0.000782	Yes	3,100

TABLE 1: SELECTION OF CONSTITUENTS OF POTENTIAL CONCERN (COPCS) FOR TREND ANALYSIS (page 5 of 8)

Constituent of Potential Concern (COPC)	CONDITION 1 Present in PEWM-L 95% UCL (mg/ kg, unless otherwise noted))	CONDITION 2 Have Time Series Data	CONDITION 3A 95% UCL Groundwater Concentration (mg/L) ≥ SWPC	SWPC (mg/L)	CONDITION 3B 95% UCL PEWM-L Concentration (mg/kg) ≥ PMC	PMC (mg/kg, unless otherwise noted)	CONDITION 3C 95% UCL Groundwater Concentration (mg/L) ≥ Risk Std.	Most Stringent Risk Std. (mg/L)	Study	Present in PEWM-R 95% UCL; (mg/kg, unless otherwise noted)
Toluene	0.092	Yes	NA	4,000	No	67	NA	NA	No	15,000
Trichloroethylene	0.2	Yes	No	2.34	No	1	Yes 0.004	0.00185	Yes	3,300
Xylenes	50	Yes	—	—	No	19.5	NA	NA	No	16,000
Vinyl chloride	BQL; 0.011 DL> 1.3 See Note 11.	Yes	No 0.066	15.75	Not determined	0.40	Yes 0.066	0.0151	Yes	BQL; 1.3 <DL >900 See Note 7.
Arsenic	2.3	No	Yes 0.0362	0.004	Yes	0.5 mg/L	Yes 0.0362	0.0191	No	2.8
Beryllium	0.87	No	Yes 0.04	0.004	Not determined	0.04 mg/L	Yes 0.04	0.00665	No	0.430
Cadmium	8.1 Also, 0.11mg/L	Yes	NA	0.006	Yes	0.05 mg/L	NA	NA	Yes	394 Also, 5.7 mg/L

TABLE 1: SELECTION OF CONSTITUENTS OF POTENTIAL CONCERN (COPCS) FOR TREND ANALYSIS (page 6 of 8)

Constituent of Potential Concern (COPC)	CONDITION 1 Present in PEWM-L 95% UCL (mg/ kg, unless otherwise noted))	CONDITION 2 Have Time Series Data	CONDITION 3A 95% UCL Groundwater Concentration (mg/L) ≥ SWPC	SWPC (mg/L)	CONDITION 3B 95% UCL PEWM-L Concentration (mg/kg) ≥ PMC	PMC (mg/kg, unless otherwise noted)	CONDITION 3C 95% UCL Groundwater Concentration (mg/L) ≥ Risk Std.	Most Stringent Risk Std. (mg/L)	Study	Present in PEWM-R 95% UCL; (mg/kg, unless otherwise noted)
Manganese	Not analyzed	Yes	NA	—	Not determined	—	No 0.72	510	No	Not analyzed
Mercury	0.11	No	Yes 2.2	0.0004	Not determined	0.02 mg/L	Yes 2.2	0.00313	No	2.4

Key

— means that no value is shown in the Remediation Standards Regulations (RSRs).	**BQL** means "below quantitation limit, and **DL** means "detection limit.
No means that the condition is not met.	**Yes** means that "the condition is met.
* means that all time series data points indicate the COPC was below the quantitation limit of 0.01 mg/L. Therefore, the COPC was not subject to statistical trend analysis.	
NA means "not applicable. "NA" is reserved for use in the columns labeled" Condition 3A," "Condition 3C" and "Most Stringent Risk Std." It reflects the PHERE's conclusion that the COPC does not pose a cancer risk greater than 10^{-7} and/or does not have a Hazard Index greater than 1.	
Not determined means that the COPC was not subject to analysis, or it was analyzed but the detection limit exceeds the RSR or risk-based standard, or that there is no analytical data measuring its leachability.	

Notes

1. **"Condition 1: Present in PEWM-L"** The value in each cell is the 95% upper confidence limit (UCL) in mg/kg as reported in Table III-27 Envirite's PHERE dated February 28, 2001. Also, for some COPCs a value in mg/L is also reported. This value is referenced in Table III-29 of Envirite's PHERE dated February 28, 2001.

2. **"Condition 2: Have Time Series Data"** A "yes" indicates that the COPC is referenced in all of Envirite's post-closure quarterly groundwater monitoring reports for the period January, 1990 through October,2000: "No" means that the constituent is not referenced in this consecutive series of quarterly groundwater monitoring reports.

3a. **"Condition 3A: SWPC Exceeded"** Although the PMC apparently do not apply, this column is provided only for possible future reference. A "yes" means that the COPC's concentration in the PEWM-L is equal to or exceeds the concentration published in the State of Connecticut's Surface Water Protection Criteria (SWPC), and "no" means that such is not the case. The "SWPC" column specifies the value for the COPC published in the Regulations of Connecticut State Agencies Remediation Standards Regulations at sections 22a-133k-1 through 22a-133k-3.

3b. **"Condition 3B: PMC Exceeded"** A "yes" means that the COPC's concentration in the PEWM-L is equal to or exceeds the concentration published in the State of Connecticut's Pollution Mobility Criteria (PMC), and "no" means that such is not the case. The PMC column specifies the value for the COPC published in the Regulations of Connecticut State Agencies Remediation Standards Regulations at sections 22a-133k-1 through 22a-133k-3.

3c. **"Condition 3C: Exceeds Most Stringent Applicable Risk Standard"** A "yes" means that the COPC's concentration in the PEWM-L is equal to or exceeds the lowest of the two minimum numerical values for "off-site resident" and "off-site worker" groundwater exposure scenarios published in Table VI-1 in Envirite's PHERE dated February 28, 2000.

4. **"Most Stringent Applicable Risk Standard"** is the lower of the risk-based standard for the off-site resident or off-site worker. These are calculated values. These values are referenced in "Table VI-1 Summary of Risk-Based MPS Calculations" in section 6 of Envirite's PHERE dated February 28, 2001.

5. **"Study."** A "yes" means that the COPC is included in the trend analyses described in the attached report. A "no" means that COPC was not subjected to trend analyses.

6. **"Present in PEWM-R."** "PEWM-R" refers the subsurface Pre-Envirite Waste Material at the road. This subsurface pile straddles the property boundary of the site and Old Waterbury Road, which is publicly owned. This column is provided for comparison. The value (if any) reported is the 95% upper confidence limit (UCL) reported in mg/kg (unless otherwise noted) in Table III-28 of Envirite's PHERE dated February 28, 2001. "BQL" means "below quantitation limit, and "DL" means "detection limit.

7. This COPC is not listed in Table III-28 of Envirite's PHERE dated February 28, 2001. However, it is referenced in the table "Pre-Envirite Waste Material Analytical Data Summary (Total)" in *RCRA Facility Investigation Phase I Report*, Volume V, Appendix G, March, 1995. The sample identification numbers referenced [and each sample's depth expressed in feet below ground surface fbgs)] in this table related to the PEWM-R are as follows: W19D 20.5 to 22.5 fbgs); W25C (9 to 11 fbgs); and W30E (13 to 15 fbgs).

8a. This COPC is not listed in Table III-28 of Envirite's PHERE dated February 28, 2001. However, it is referenced in the table "Pre-Envirite Waste Material Analytical Data Summary (Total)" in *RCRA Facility Investigation Phase I Report*, Volume V, Appendix G, March, 1995. The sample identification numbers referenced [and each

sample's depth expressed in feet below ground surface fbgs)] in this table related to the PEWM-R are as follows: W19D 20.5 to 22.5 fbgs); W25C (9 to 11 fbgs); and W30E (13 to 15 fbgs). The "J" value relates to sample W30E.

8b. This COPC is not listed in Table III-28 of Envirite's PHERE dated February 28, 2001. However, it is referenced in the table "Pre-Envirite Waste Material Analytical Data Summary (Total)" in *RCRA Facility Investigation Phase I Report*, Volume V, Appendix G, March, 1995. The sample identification numbers referenced [and each sample's depth expressed in feet below ground surface fbgs)] in this table related to the PEWM-R are as follows: W19D 20.5 to 22.5 fbgs); W25C (9 to 11 fbgs); and W30E (13 to 15 fbgs). The "J" values of 0.08 and 93 apply to samples W19D and W 25C, respectively.

8c. This COPC is not listed in Table III-28 of Envirite's PHERE dated February 28, 2001. However, it is referenced in the table "Pre-Envirite Waste Material Analytical Data Summary (Total)" in *RCRA Facility Investigation Phase I Report*, Volume V, Appendix G, March, 1995. The sample identification numbers referenced [and each sample's depth expressed in feet below ground surface fbgs)] in this table related to the PEWM-R are as follows: W19D 20.5 to 22.5 fbgs); W25C (9 to 11 fbgs); and W30E (13 to 15 fbgs). The "J" value relates to sample W19D.

9. This COPC is not listed in Table III-28 of Envirite's PHERE dated February 28, 2001. However, it is referenced in the table "Pre-Envirite Waste Material Analytical Data Summary (Total)" in *RCRA Facility Investigation Phase I Report*, Volume V, Appendix G, March, 1995. The sample identification numbers referenced [and each sample's depth expressed in feet below ground surface (fbgs)] in this table related to the PEWM-R are as follows: W19D 20.5 to 22.5 fbgs); W25C (9 to 11 fbgs); and W30E (13 to 15 fbgs). Analysis of this constituent in sample W11D was not performed.

10. This COPC is listed in Table III-27 of the PHERE at the referenced concentration. However, the table "Pre-Envirite Waste Material Analytical Data Summary (Total)" in *RCRA Facility Investigation Phase I Report*, Volume V, Appendix G, March, 1995 indicates that analysis for this COPC was not performed.

11. This COPC is not listed in Table III-27 of Envirite's PHERE dated February 28, 2001. However, it is referenced in the table "Pre-Envirite Waste Material Analytical Data Summary (Total)" in *RCRA Facility Investigation Phase I Report*, Volume V, Appendix G, March, 1995. The sample identification numbers referenced [and each sample's depth expressed in feet below ground surface (fbgs)] in this table related to the PEWM-R are as follows: W09G (23.5 to 25.5 fbgs); W11D (26 to 28 fbgs); and W11D (26 to 28 fbgs). Analysis of this constituent in sample W11D was not performed.

TABLE 2
SELECTION OF CONSTITUENTS OF POTENTIAL CONCERN (COPCs)
STUDIED AND NOT STUDIED FOR TREND ANALYSIS
ENVIRITE, THOMASTON, CT

Constituent of Potential Concern (COPC)	Koc cm^3/g	Aqueous Solubility mg/L	Aqueous Diffusivity cm^2/s	Present in PEWM-L [UCL mg/kg]	Present in PEWM-R [UCL mg/kg]
COPCs Studied					
Cadmium	NA	Insoluble	NA	NA	NA
Ethylbenzene	3.63E+02	1.69E+02	7.80E-06	1.40E+01	3.10E+03
Tetrachloroethylene	1.55E+02	2.00E+02	8.20E-06	1.00E-02	3.10E+03
Trichloroethylene	1.66E+02	1.10E+03	9.10E-06	2.00E-01	3.30E+03
Vinyl chloride	1.86E+01	2.76E+03	1.23E-06	BDL	BDL
COPCs Not Studied					
Aldrin	2.45E+06	1.80E-01	4.86E-06	3.60E-03	BDL
Benzo(a)pyrene	1.02E+06	3.00E-03	9.00E-06	NA	BDL
Benzo(k)fluoranthene	1.23E+06	8.00E-04	5.56E-06	3.80E+01	BDL
BHC (beta)	1.26E+03	2.40E-01	7.34E-06	3.60E-03	BDL
HCH (gamma) Lindane	1.07E+03	6.80E+00	7.34E-06	3.60E-03	BDL
bis(2-ethylhexyl)pthalate	1.51E+07	3.40E-01	3.66E-06	6.10E+02	6.50E+03
Butylbenzylpthalate	5.75E+04	2.69E+00	4.83E-06	2.00E+02	BDL
2-Butanone	NA	3.53E+05	NA	0.01 mg/L	2.10E+03
Carbon tetrachloride	1.74E+02	7.93E+02	8.80E-06	BDL	BDL
Chloroform	3.98E+01	7.92E+03	1.00E-05	2.40E-01	BDL
1,1-Dichloroethene	NA	8.69E+03	NA	7.00E-02	BDL
1,2-Dichloroethane	NA	8.69E+03	NA	BDL	BDL
1,2-Dichloroethylene (cis)	3.55E+01	3.50E+03	1.13E-05	2.00E-03	7.00E+01
1,2-Dichloroethylene (trans)	5.25E+01	6.30E+03	1.19E-05	2.00E-03	7.00E+01
DDE	4.47E+06	1.20E-01	5.87E-06	7.10E-03	BDL
DDT	2.45E+05	3.29E-03	4.85E-06	7.10E-03	BDL
Dibutylpthalate	3.39E+04	1.12E+01	7.86E-06	2.00E+02	3.10E+03
Dieldrin	2.14E+04	1.95E-01	4.74E-06	7.00E-03	BDL
Heptachlor	1.41E+06	1.80E-01	5.69E-06	3.60E-03	BDL
Methylchloride (chloromethane)	NA	6.50E+03	NA	NA	BDL
Pentachlorophenol	5.92E+02	1.95E+03	6.10E-06	1.80E+02	BDL
Xylenes[1]	3.63E+02	1.78E+02	1.00E-05	5.00E+01	1.60E+04

Note
1. Based on values for o-xylene
2. Sources include the Johnson and Ettinger 1991 Model for Subsurface Vapor Intrusion into Buildings, Thibodeaux; Environmental Chemodynamics 2nd ed. and Verschueren; Handbook of Environmental Data on Organic Chemicals 3rd ed.
3. NA - Information not available

TABLE 3

RESULTS OF MANN-KENDALL TREND ANALYSES BY NORMAL APPROXIMATION

ANALYTICAL DATA FROM JANUARY 1991 THROUGH OCTOBER 2000

ENVIRITE, THOMASTON, CT

OUTLIERS INCLUDED

Well	PCE ($Z_{calculated}$)	TCE ($Z_{calculated}$)	VC ($Z_{calculated}$)	Ethyl benzene ($Z_{calc.}$)	Cadmium ($Z_{calc.}$)	$Z_{\alpha 0.95}$
MW-30	-4.060	-2.366	-1.647	0.000	0.365	1.6853
MW-31-S	0.277	-0.955	1.156	1.878	3.122	1.6853
MW-41-S	1.093	2.126	0.000	0.000	0.020	1.6853
MW-41--D	3.601	17.120	0.000	0.000	0.000	1.6853
MW-41-B	-0.014	4.146	0.520	0.000	1.213	1.6853
MW-42-S	0.026	-0.264	0.000	0.000	0.017	1.6853
MW-43-S	-0.014	-0.472	-0.347	0.000	0.013	1.6853
MW-43-D	-0.786	-1.062	-1.079	0.000	-6.146	1.6853
MW-44-D	-4.107	-5.622	-3.834	0.000	-4.496	1.6853
MW-44-B	0.016	-1.686	NA	0.000	-0.901	1.6853

NOTES:

- *In order to show a trend the absolute value of $Z_{calculated}$ must be greater than $Z_{critical}$*
- $Z_{critical} = Z_{\alpha}$
- *PCE = tetrachloroethene*
- *TCE = trichloroethene*
- *VC = vinyl chloride*
- *Critical values of Z are taken from Table A-1 of EPA QA/G-9 (Guidance for Data Quality Assessment)*
- *Outliers are not excluded from the data set in this analysis.*
- *NA Not Applicable, Number is a large negative number indicating a downward trend*

TABLE 3A

SUMMARY OF TREND ANALYSES (95% CONFIDENCE LEVEL)

ANALYTICAL DATA FROM JANUARY 1991 THROUGH OCTOBER 2000

ENVIRITE, THOMASTON, CT

OUTLIERS INCLUDED

Well	PCE	TCE	VC	Ethylbenzene	Cadmium
MW-30	Downward Trend	Downward Trend	No Trend	BDL	No Trend
MW-31-S	No Trend	No Trend	No Trend	Upward Trend	Upward Trend
MW-41-S	No Trend	Upward Trend	BDL	BDL	No Trend
MW-41--D	Upward Trend	Upward Trend	BDL	BDL	BDL
MW-41-B	No Trend	Upward Trend	No Trend	BDL	No Trend
MW-42-S	No Trend	No Trend	BDL	BDL	No Trend
MW-43-S	No Trend	No Trend	No Trend	BDL	No Trend
MW-43-D	No Trend	No Trend	No Trend	BDL	Downward Trend
MW-44-D	Downward Trend	Downward Trend	Downward Trend	BDL	Downward Trend
MW-44-B	No Trend	Downward Trend	Downward Trend	BDL	No Trend

NOTES:

- Conclusions for the trends are based on the directions for the Mann-Kendall Procedure (Normal Approximation) of EPA QA/G-9 (Guidance for Data Quality Assessment)
- PCE = tetrachloroethene
- TCE = trichloroethene
- VC = vinyl chloride
- BDL = The conc. values are below detection limit throughout the time frame used for this analyses

TABLE 4

RESULTS OF MANN-KENDALL TREND ANALYSES BY NORMAL APPROXIMATION

ANALYTICAL DATA FROM JANUARY 1991 THROUGH OCTOBER 2000

ENVIRITE, THOMASTON, CT

OUTLIERS EXCLUDED

Well	PCE ($Z_{calculated}$)	TCE ($Z_{calculated}$)	VC ($Z_{calculated}$)	Ethyl benzene ($Z_{calc.}$)	Cadmium ($Z_{calc.}$)	$Z_{\alpha 0.95}$
MW-30	-4.616	-2.856	-2.111	0.000	0.365	1.6866
MW-31-S	0.277	-0.955	0.703	1.548	3.122	1.6866
MW-41-S	1.093	2.126	0.000	0.000	0.020	1.6853
MW-41--D	3.601	17.120	0.000	0.000	0.000	1.6853
MW-41-B	-0.014	4.146	0.520	0.000	1.213	1.6853
MW-42-S	0.026	-0.264	0.000	0.000	0.017	1.6853
MW-43-S	-0.0148	-0.472	-0.347	0.000	0.013	1.6866
MW-43-D	-0.786	-1.062	-1.079	0.000	-6.146	1.6853
MW-44-D	-4.107	-5.622	-3.834	0.000	-4.496	1.6853
MW-44-B	0.015	-2.157	NA	0.000	-0.901	1.6866

NOTES:

- *In order to show a trend the absolute value of $Z_{calculated}$ must be greater than $Z_{critical}$*
- *$Z_{critical} = Z_{\alpha}$*
- *PCE = tetrachloroethene*
- *TCE = trichloroethene*
- *VC = vinyl chloride*
- *Critical values of Z are taken from Table A-1 of EPA QA/G-9 (Guidance for Data Quality Assessment)*
- *Outliers are excluded from the data set in this analysis.*
- *NA Not Applicable, Number is a large negative number indicating a downward trend*

TABLE 4A

SUMMARY OF TREND ANALYSES (95% CONFIDENCE LEVEL)

ANALYTICAL DATA FROM JANUARY 1991 THROUGH OCTOBER 2000

ENVIRITE, THOMASTON, CT

OUTLIERS EXCLUDED

Well	PCE	TCE	VC	Ethylbenzene	Cadmium
MW-30	Downward Trend	Downward Trend	Downward Trend	BDL	No Trend
MW-31-S	No Trend	No Trend	No Trend	No Trend	Upward Trend
MW-41-S	No Trend	Upward Trend	BDL	BDL	No Trend
MW-41--D	Upward Trend	Upward Trend	BDL	BDL	BDL
MW-41-B	No Trend	Upward Trend	No Trend	BDL	No Trend
MW-42-S	No Trend	No Trend	BDL	BDL	No Trend
MW-43-S	No Trend	No Trend	No Trend	BDL	No Trend
MW-43-D	No Trend	No Trend	No Trend	BDL	Downward Trend
MW-44-D	Downward Trend	Downward Trend	Downward Trend	BDL	Downward Trend
MW-44-B	No Trend	Downward Trend	Downward Trend	BDL	No Trend

NOTES: *- Conclusions for the trends are based on the directions for the Mann-Kendall Procedure (Normal Approximation) of EPA QA/G-9 (Guidance for Data Quality Assessment)*

- PCE = tetrachloroethene

- TCE = trichloroethene

- BDL = The conc. values are below detection limit throughout the time frame used for this analyses.

TABLE 5
DIFFUSION MODEL SUMMARY
PCE DIFFUSION INTO SAND LAYER
Average Relative Concentrations
Diffusion Coefficient Sensitivity Analysis
Envirite, Thomaston, CT

C/Co at Distances				
Thickness	**5 ft**	**10 ft**	**20 ft**	**30 ft**
1 cm	44.30%	56.58%	67.56%	72.99%
2 cm	24.27%	34.20%	45.57%	52.47%
5 cm	9.71%	13.83%	19.27%	23.36%
20 cm	2.43%	3.46%	4.82%	5.84%
Thickness	**5 ft**	**10 ft**	**20 ft**	**30 ft**
1 cm	67.47%	76.30%	82.99%	86.04%
2 cm	45.47%	57.17%	67.77%	73.09%
5 cm	19.22%	26.70%	36.81%	43.72%
20 cm	4.80%	6.68%	9.34%	11.39%

NOTE: *Table provides average relative concentration values for different thicknesses of high permeability sand layers at several distances (5, 10, 20 and 30 ft) along the plume.*

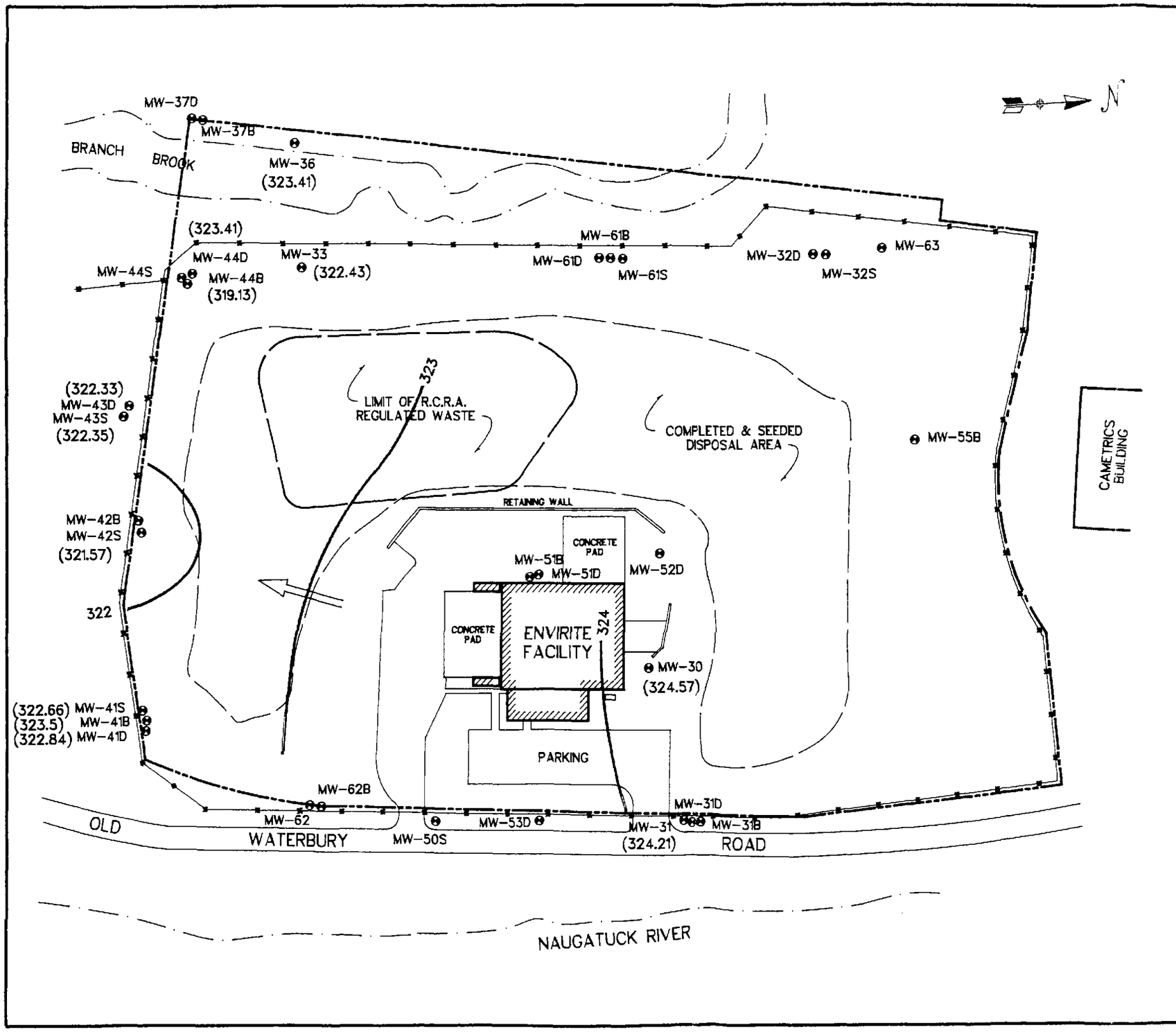
TABLE 6
DIFFUSION MODEL SUMMARY
TCE DIFFUSION INTO SAND LAYER

Average Relative Concentrations
Diffusion Coefficient Sensitivity Analysis

Envirite, Thomaston, CT

C/Co at Distances				
Thickness	**5 ft**	**10 ft**	**20 ft**	**30 ft**
1 cm	46.22%	58.40%	69.07%	74.30%
2 cm	25.68%	35.89%	47.41%	54.28%
5 cm	10.28%	14.57%	20.28%	24.59%
20 cm	2.57%	3.64%	5.07%	6.15%
Thickness	**5 ft**	**10 ft**	**20 ft**	**30 ft**
1 cm	67.47%	76.30%	82.99%	86.04%
2 cm	45.47%	57.17%	67.77%	73.09%
5 cm	19.22%	26.70%	36.81%	43.72%
20 cm	4.80%	6.68%	9.34%	11.39%

NOTE: *Table provides average relative concentration values for different thicknesses of high permeability sand layers at several distances (5, 10, 20 and 30 ft) along the plume.*



ENVIRITE RCRA FACILITY

OLD WATERBURY ROAD
THOMASTON, CONNECTICUT

HORIZONTAL GROUNDWATER FLOW MAP
JULY 17, 1997

LEGEND

- = BUILDING LINE
- = PROPERTY LINE
- = FENCE LINE
- = WALK/STREET
- = RIVER/BROOK
- ⊖ = EXISTING MONITORING WELL
- (322.43) = ELEVATION OF GROUNDWATER IN FEET RELATIVE TO A COMMON DATUM
- 323 = GROUNDWATER ELEVATION CONTOUR
- ⇦ = DIRECTION OF GROUNDWATER FLOW

NOTE:
DATA FROM THE FOLLOWING MONITORING WELLS WERE USED TO CONSTRUCT THIS MAP, MW-31, MW-33, MW-41S, MW-42S AND MW-43S.

MAP INFORMATION

BASED ON "GZA" GEOENVIRONMENTAL, INC. DWG. NO. 2-5, PROJECT NO. 41302.4 TITLED: BEDROCK CONTOUR PLAN, DATED: MARCH 15, 1995 & R.C.R.A. MONITORING (GROUNDWATER CONTOUR PLAN) PROJECT #41391.1, FIG.2.

CHECKED BY:	SCALE: AS SHOWN
REVIEWED BY:	DATED: 02/19/97
DRAWN BY: VSN	REVISED: 5/13/98

FIGURE No. 4
PROJECT No. 1827
DRAWING NAME GW-797

SCALE
0 100'
ALL LOCATIONS ARE APPROXIMATE

AARON ENVIRONMENTAL

FIGURE 2

DEPLETION OF TETRACHLOROETHENE (PCE) IN PRE-ENVIRITE WASTE MATERIAL UNDER CELL 1

DIFFUSION TO THE HIGH PERMEABILITY SAND

Concentration vs. Time

(Assuming: Co = 2 mg/L, C* = 0 mg/L, D* = 1.26 * 10^-6 cm^2/sec)

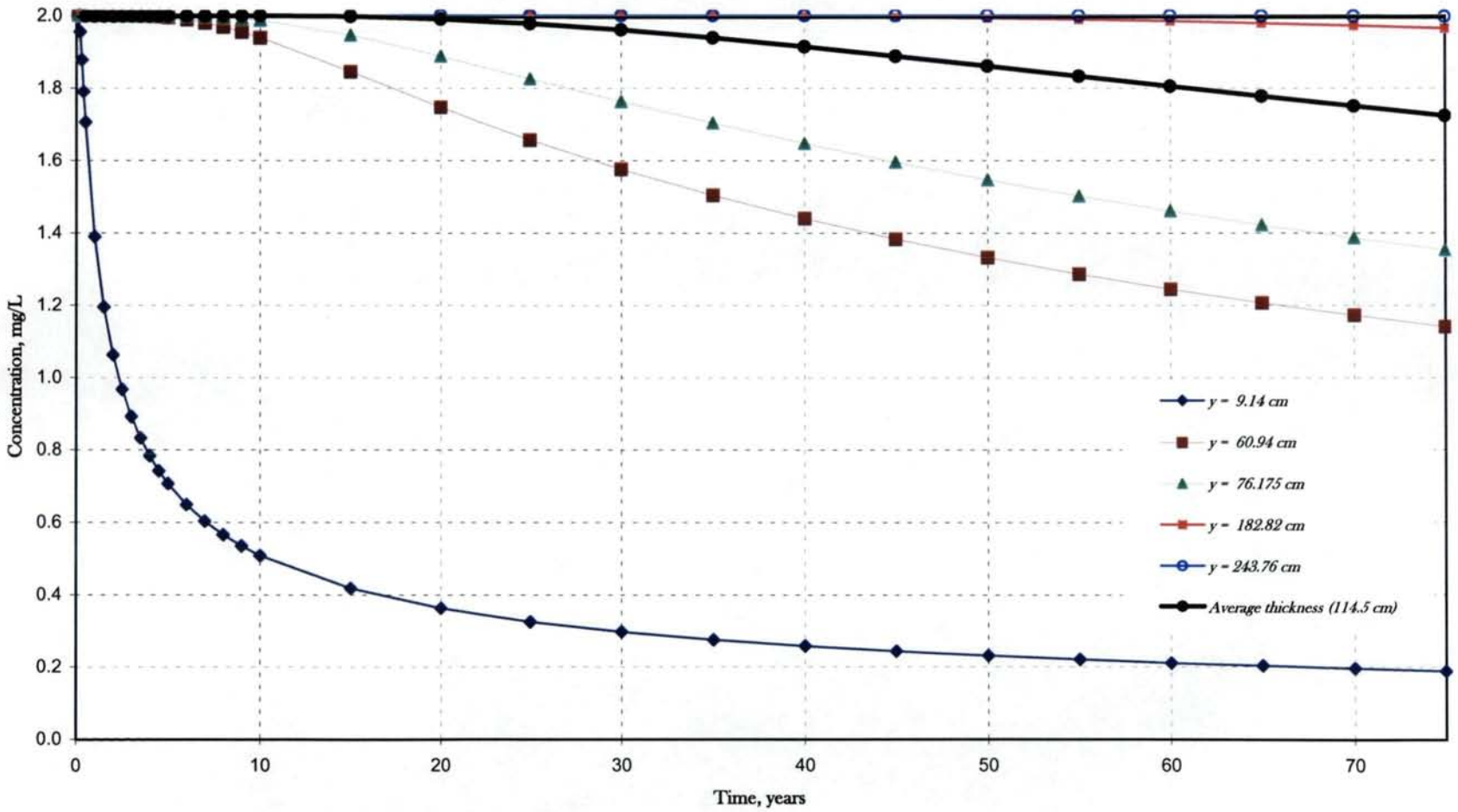


FIGURE 3
DEPLETION OF TRICHLOROETHENE (TCE) IN PRE-ENVIRITE WASTE MATERIAL UNDER CELL 1
DIFFUSION TO THE HIGH PERMEABILITY SAND
Concentration vs. Time
(Assuming: Co = 4 mg/L, C* = 0 mg/L, D* = 1.4 * 10^-6 cm^2/sec)

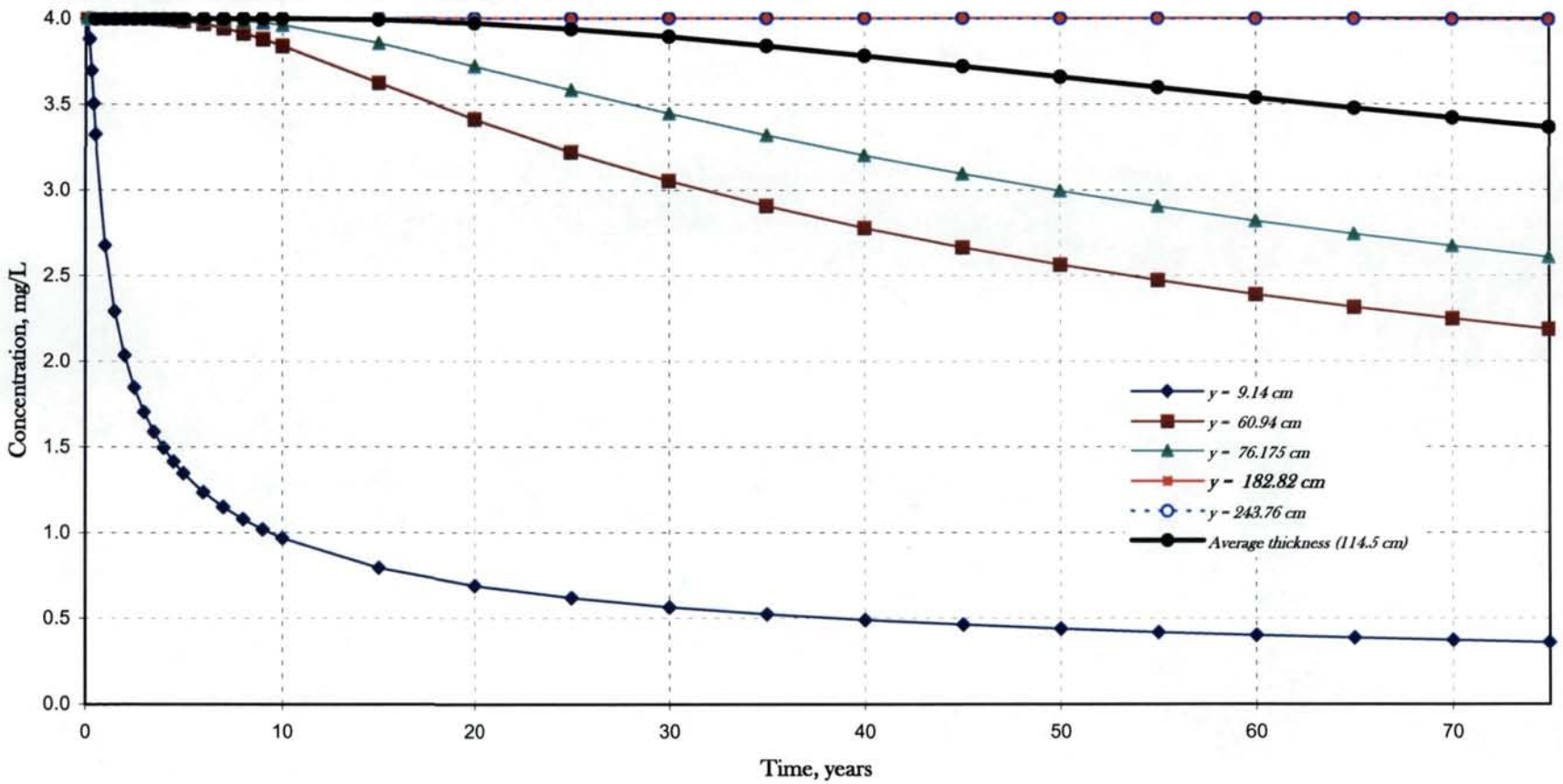


FIGURE 4

DEPLETION OF TETRACHLOROETHENE (PCE) IN PRE-ENVIRITE WASTE MATERIAL UNDER CELL 1

(DIFFUSION COEFFICIENT SENSITIVITY ANALYSES)

Concentration vs. Time

(Assuming: Co = 2 mg/L, C* = 0 mg/L, D* = 5* 10^-6 cm^2/sec)

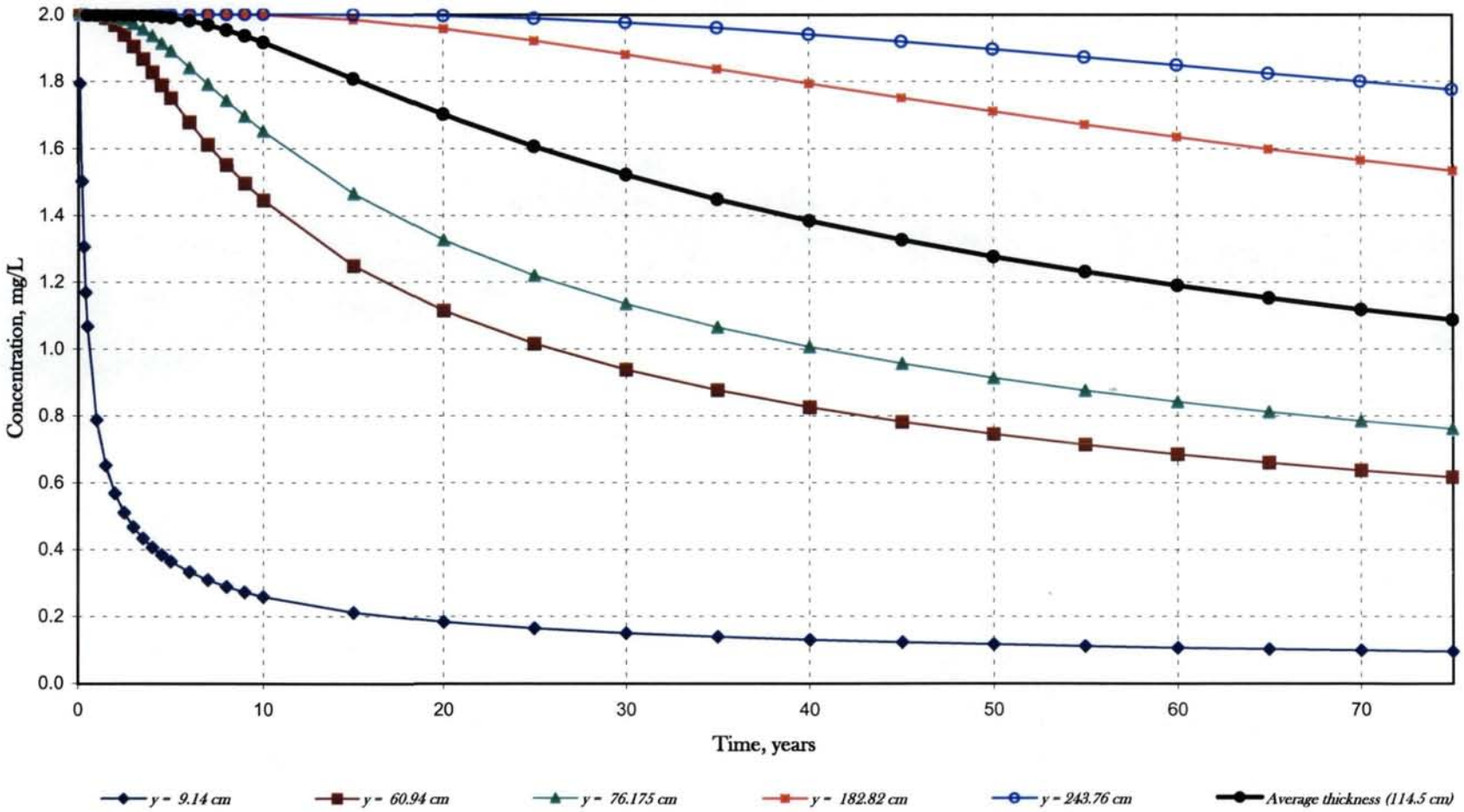


FIGURE 5

DEPLETION OF TETRACHLOROETHENE (PCE) IN PRE-ENVIRITE WASTE MATERIAL UNDER CELL 1

THE EFFECT OF PERCENT SATURATION ON DIFFUSION

Concentration vs. Time

(Assuming: C_o = 2 mg/L, C^* = 0 mg/L, D^* = varies with % sat.)

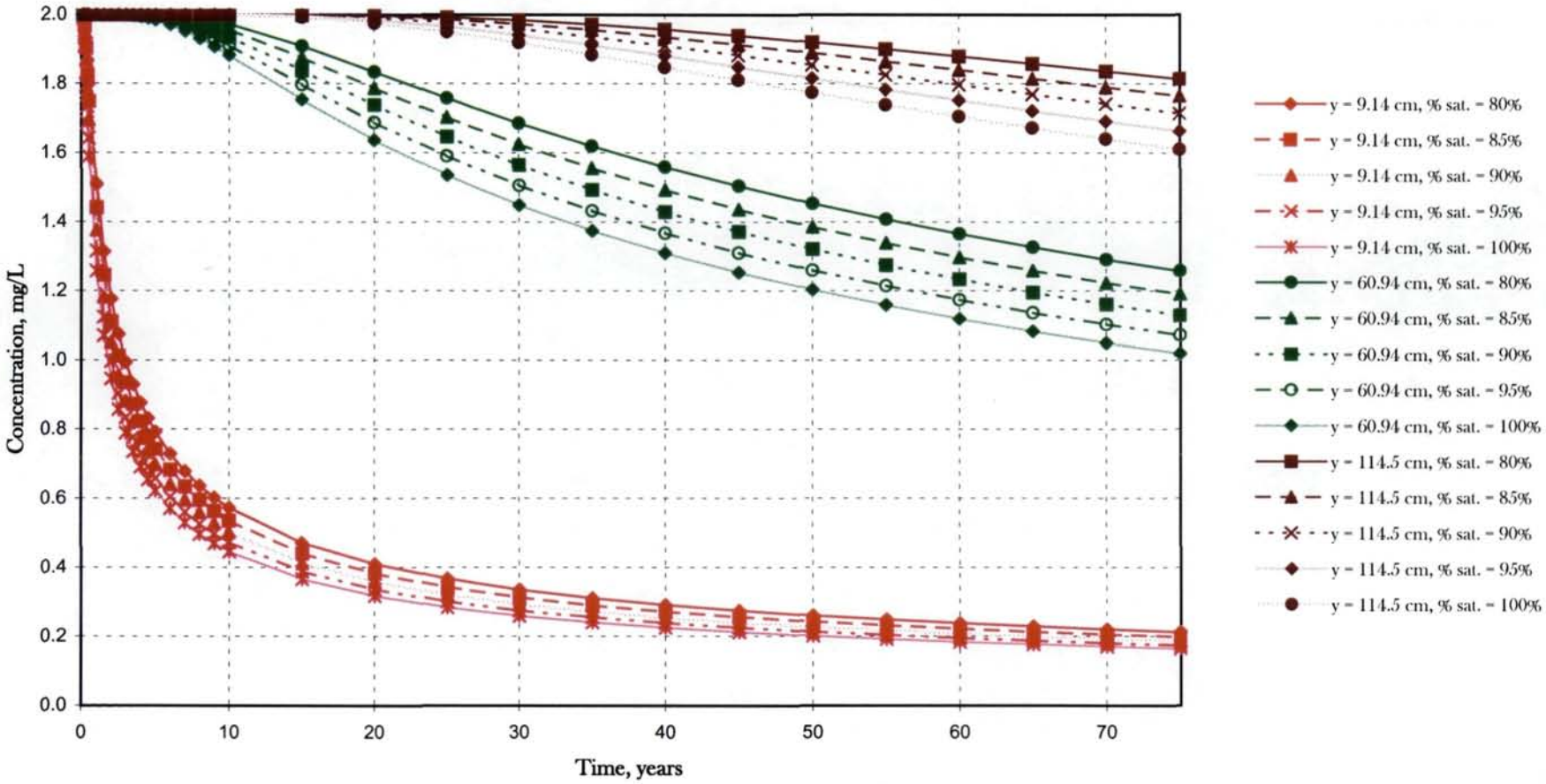


FIGURE 6

PCE Concentration vs. Distance to the Interface

Stagnant Sand Layer, Diffusion Model
D* = 1.26 * 10^-6 cm^2/sec, Co = 2 mg/L
Envirite Landfill Project

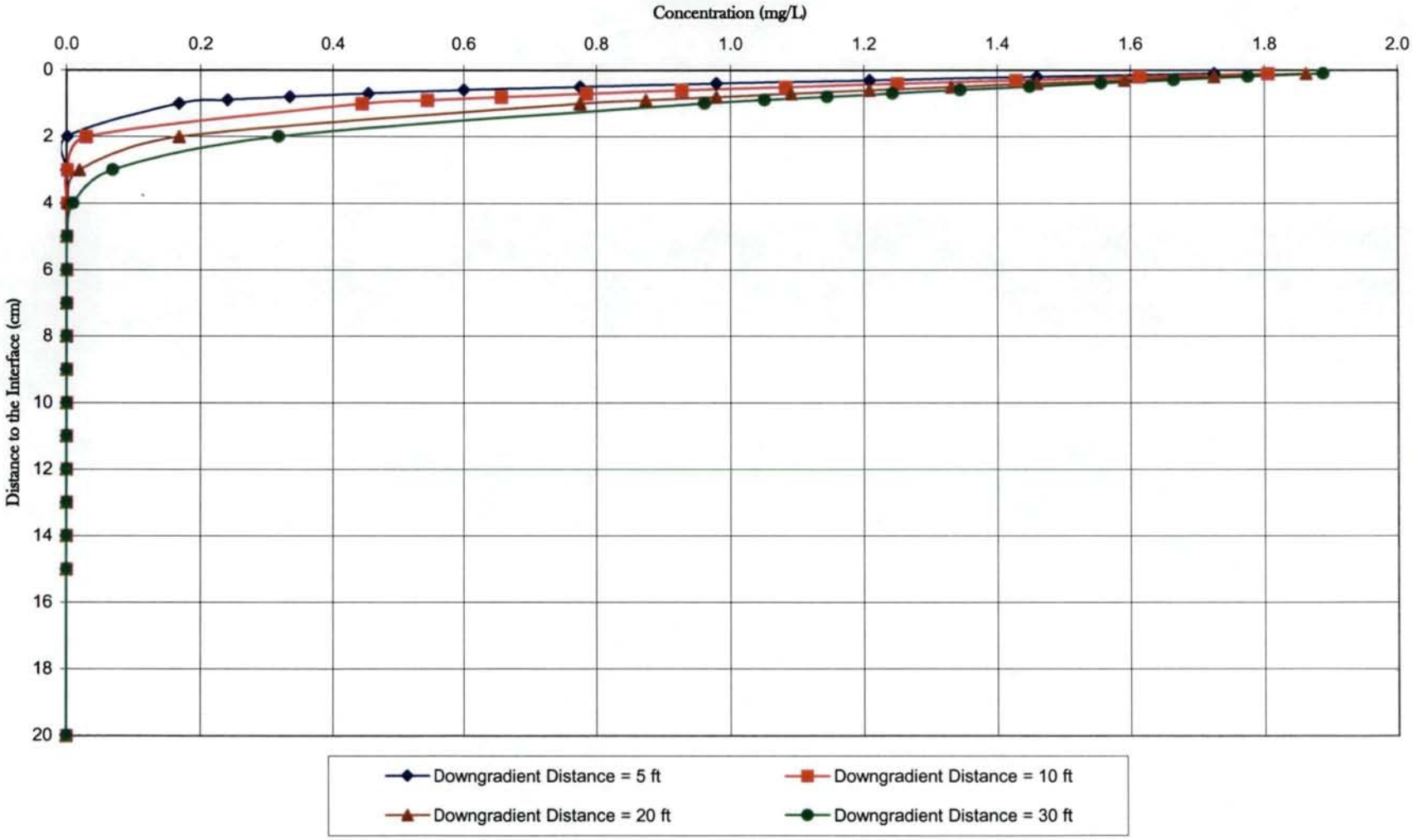


FIGURE 7

TCE Concentration vs. Distance to the Interface

Stagnant Sand Layer, Diffusion Model
D* = 1.4 * 10^-6 cm^2/sec, Co = 4 mg/L
Envirite Landfill Project

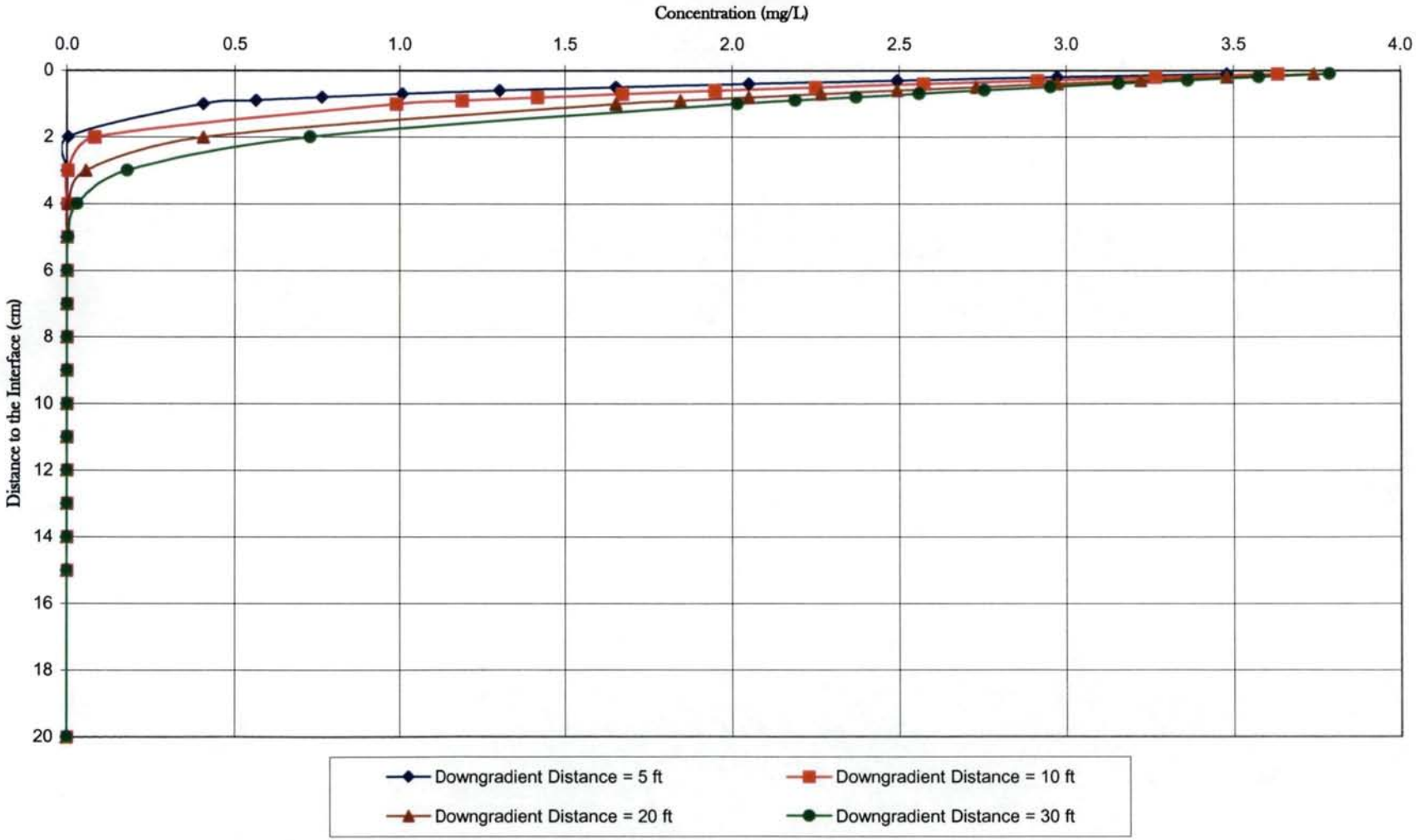
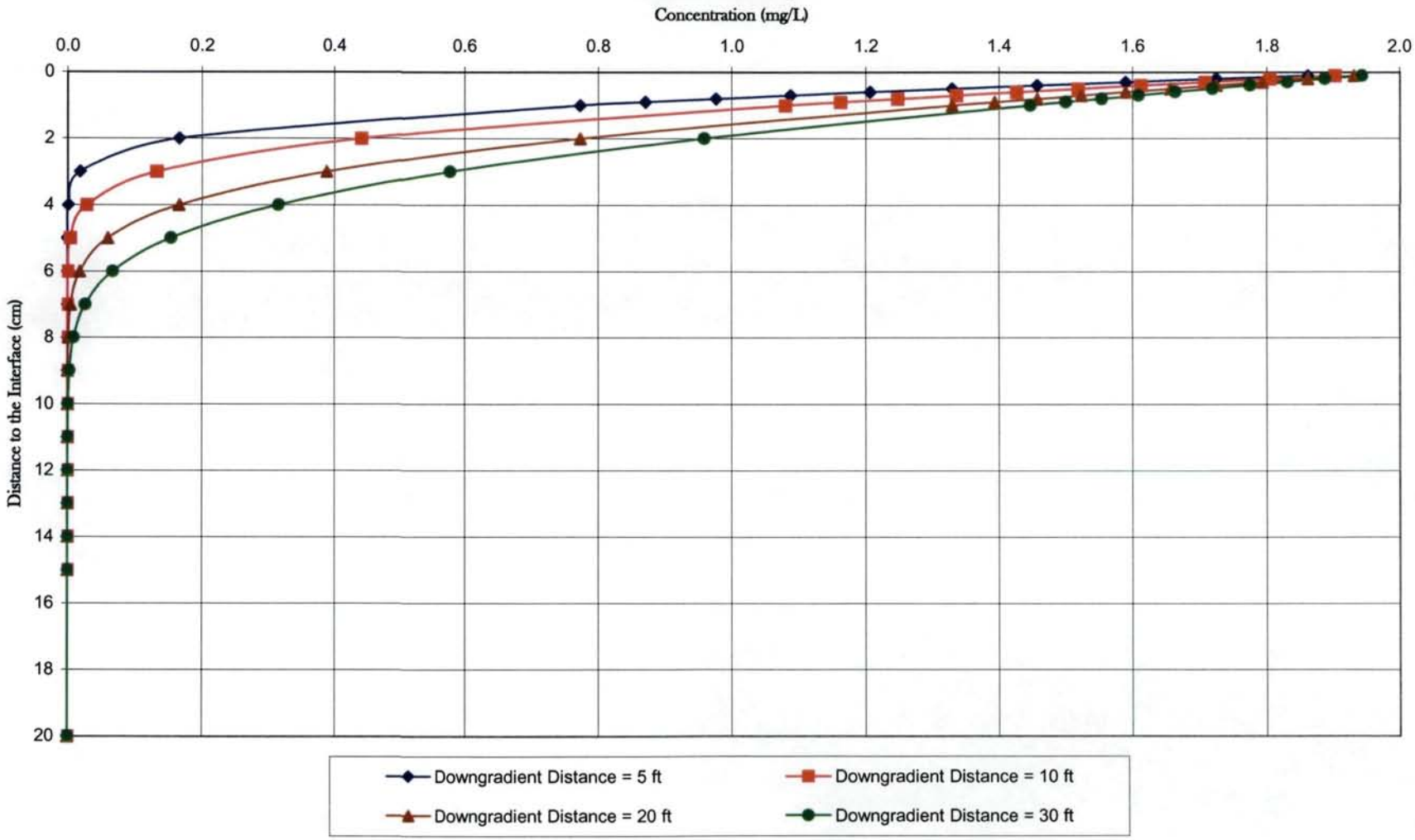


FIGURE 8

PCE Concentration vs. Distance to the Interface

Stagnant Sand Layer, Diffusion Model
D* = 5 * 10^-6 cm^2/sec, Co = 2 mg/L
Envirite Landfill Project



ATTACHMENT A

A1. RAW CONCENTRATION DATA FROM JANUARY 1991 TO OCTOBER 2000

A2. TIME SERIES PLOTS OF CONCENTRATION DATA BY REGRESSION METHOD

ANALYTICAL DATA SUMMARY OF CONCERNED CONSTITUENTS FROM JANUARY 1991 TO OCTOBER 2000 FOR TREND ANALYSES

Well # MW-30

1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36	37	38	39	40	41
Date	Jan-91	Apr-91	Jul-91	Oct-91	Jan-92	Apr-92	Jul-92	Oct-92	Jan-93	Apr-93	Jul-93	Oct-93	Jan-94	Apr-94	Jul-94	Oct-94	Jan-95	Apr-95	Jul-95	Oct-95	Jan-96	Apr-96	Jul-96	Oct-96	Jan-97	Apr-97	Jul-97	Oct-97	Jan-98	Apr-98	Jul-98	Oct-98	Jan-99	Apr-99	Jul-99	Oct-99	Jan-00	Apr-00	Jul-00	Oct-00
PCE (mg/L)	0.49	0.47	0.36	0.56	0.43	0.71	0.63	0.35	0.52	1.7	0.15	0.3	0.47	0.24	0.14	0.18	0.29	0.27	0.26	0.26	0.26	0.24	0.27	0.22	0.079	0.22	0.45	0.24	0.22	0.31	0.25	0.31	0.18	0.2	0.22	0.13	240	0.039	0.12	0.15
TCE (mg/L)	1.3	1.1	0.55	1.2	0.84	1.6	1.4	0.34	0.95	0.49	0.21	0.53	1.2	0.74	0.33	0.63	0.69	0.72	0.63	0.57	0.53	0.76	0.66	0.54	0.27	0.74	1.2	0.6	0.59	0.85	0.7	0.83	0.37	0.5	0.47	0.4	700	0.16	0.43	0.42
VC (mg/L)	0.0001	0.93	0.25	0.56	0.23	0.54	0.48	0.0001	0.23	0.33	0.15	0.14	0.24	0.18	0.063	0.11	0.22	0.28	0.16	0.24	0.12	0.16	0.21	0.16	0.14	0.29	0.69	0.17	0.16	0.27	0.31	0.35	0.097	0.11	0.14	0.11	320	0.068	0.12	0.1
Ethyl benzene (mg/L)	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001
Cadmium (mg/L)	0.001	0.01	0.01	0.001	0.001	0.01	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.0092	0.0085	0.001	0.001	0.01	0.001	0.011	0.001	0.001	0.0059	0.001

Well # MW-43-D

1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36	37	38	39	40	41
Date	Jan-91	Apr-91	Jul-91	Oct-91	Jan-92	Apr-92	Jul-92	Oct-92	Jan-93	Apr-93	Jul-93	Oct-93	Jan-94	Apr-94	Jul-94	Oct-94	Jan-95	Apr-95	Jul-95	Oct-95	Jan-96	Apr-96	Jul-96	Oct-96	09-Jan-97	03-Apr-97	17-Jul-97	01-Oct-97	27-Jan-98	20-Apr-98	20-Jul-98	20-Oct-98	08-Jan-99	23-Apr-99	14-Jul-99	22-Oct-99	28-Jan-00	17-Apr-00	12-Jul-00	12-Oct-00
PCE (mg/L)	0.011	0.0001	0.014	0.01	0.016	0.029	0.019	0.019	0.02	0.027	0.024	0.046	0.065	0.043	0.032	0.019	0.046	0.03	0.07	0.015	0.0001	0.05	0.04	0.066	0.044	0.0001	0.012	0.017	0.018	0.042	0.032	0.033	0.0001	0.02	0.022	0.0001	0.0001	0.0001	0.0001	0.0001
TCE (mg/L)	0.026	0.021	0.024	0.019	0.039	0.072	0.037	0.025	0.037	0.049	0.045	0.13	0.13	0.1	0.073	0.035	0.1	0.073	0.15	0.032	0.0001	0.14	0.06	0.14	0.11	0.0001	0.012	0.031	0.028	0.078	0.06	0.021	0.0001	0.038	0.42	0.01	0.0001	0.0001	0.017	0.017
VC (mg/L)	0.0001	0.0001	0.0001	0.0001	0.015	0.02	0.013	0.0001	0.014	0.011	0.0001	0.046	0.033	0.057	0.015	0.0092	0.037	0.024	0.057	0.011	0.0001	0.05	0.025	0.045	0.052	0.0001	0.033	0.0001	0.0001	0.015	0.014	0.015	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001
Ethyl benzene (mg/L)	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001
Cadmium (mg/L)	0.08	0.07	0.06	0.05	0.05	0.05	0.04	0.03	0.029	0.028	0.027	0.043	0.035	0.033	0.025	0.025	0.022	0.01	0.031	0.001	0.001	0.022	0.017	0.023	0.02	0.014	0.016	0.022	0.011	0.015	0.015	0.001	0.001	0.001	0.02	0.001	0.001	0.001	0.034	0.001

Well # MW-44-D

	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36	37	38	39	40
Date	Jan-91	Apr-91	Jul-91	Oct-91	Jan-92	Apr-92	Jul-92	Oct-92	Jan-93	Apr-93	Jul-93	Oct-93	Jan-94	Apr-94	Jul-94	Oct-94	Jan-95	Apr-95	Jul-95	Oct-95	Jan-96	Apr-96	Jul-96	Oct-96	09-Jan-97	03-Apr-97	17-Jul-97	01-Oct-97	27-Jan-98	20-Apr-98	20-Jul-98	20-Oct-98	08-Jan-99	23-Apr-99	14-Jul-99	22-Oct-99	28-Jan-00	17-Apr-00	12-Jul-00	12-Oct-00
PCE (mg/L)	0.06	0.019	0.0001	0.037	0.074	0.054	0.048	0.056	0.066	0.078	0.074	0.044	0.03	0.063	0.069	0.049	0.013	0.011	0.22	0.0001	0.0001	0.0001	0.0001	0.03	0.032	0.01	0.035	0.031	0.017	0.033	0.018	0.013	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001
TCE (mg/L)	0.21	0.13	0.2	0.11	0.23	0.14	0.13	0.1	0.16	0.22	0.2	0.13	0.06	0.14	0.12	0.12	0.032	0.027	0.052	0.0001	0.0001	0.0001	0.0001	0.065	0.064	0.01	0.035	0.067	0.039	0.064	0.04	0.028	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001
VC (mg/L)	0.0001	0.0001	0.042	0.014	0.048	0.054	0.061	0.055	0.06	0.081	0.069	0.042	0.014	0.066	0.03	0.028	0.0001	0.0001	0.013	0.0001	0.0001	0.0001	0.0001	0.015	0.038	0.0001	0.035	0.011	0.0001	0.014	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001
Ethyl benzene (mg/L)	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001
Cadmium (mg/L)	0.06	0.04	0.04	0.02	0.02	0.02	0.01	0.02	0.013	0.016	0.015	0.001	0.001	0.001	0.012	0.001	0.001	0.001	0.001	0.001	0.017	0.001	0.001	0.001	0.001	0.001	0.016	0.011	0.001	0.001	0.0097	0.001	0.001	0.0056	0.001	0.001	0.001	0.001	0.001	0.001

Well # MW-31-S

	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36	37	38	39	40
Date	Jan-91	Apr-91	Jul-91	Oct-91	Jan-92	Apr-92	Jul-92	Oct-92	Jan-93	Apr-93	Jul-93	Oct-93	Jan-94	Apr-94	Jul-94	Oct-94	Jan-95	Apr-95	Jul-95	Oct-95	Jan-96	Apr-96	Jul-96	Oct-96	09-Jan-97	03-Apr-97	17-Jul-97	01-Oct-97	27-Jan-98	20-Apr-98	20-Jul-98	20-Oct-98	08-Jan-99	23-Apr-99	14-Jul-99	22-Oct-99	28-Jan-00	17-Apr-00	12-Jul-00	12-Oct-00
PCE (mg/L)	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.051	0.0001	0.0001	0.0001	0.094	0.05	0.11	0.093	0.07	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.25	0.0001	0.0001	0.0001	0.092	0.2	0.0001	0.13	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001
TCE (mg/L)	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.065	0.0001	0.0001	0.0001	0.033	0.081	0.63	0.03	0.038	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.03	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001
VC (mg/L)	0.0001	0.0001	0.0001	0.0001	3.2	0.0001	1.9	1.7	0.4	0.4	1.5	0.22	0.74	0.43	0.61	0.11	0.48	0.75	0.43	0.0001	1.2	0.85	1.2	0.58	0.47	1.1	1.2	1.1	0.25	0.59	0.35	0.28	0.41	0.22	1	0.17	360	0.37	0.8	1.1
Ethyl benzene (mg/L)	0.46	2	2.4	0.95	0.0001	0.54	5.1	4.6	1.7	1.7	5.5	2.5	1.1	0.93	4.9	1.9	9.8	3.1	0.0001	0.0001	0.0001	4.1	4.9	0.0001	1.3	5	5.5	6.2	1.2	2.6	1.9	2.5	2	2	5.7	1.3	1800	2.3	3.4	4.7
Cadmium (mg/L)	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.041	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.019	0.032	0.014	0.034	0.026	0.001	0.017	0.028	0.028	0.027	0.001	0.001	0.025	0.001

Well # MW-41-S

	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36	37	38	39	40
Date	Jan-91	Apr-91	Jul-91	Oct-91	Jan-92	Apr-92	Jul-92	Oct-92	Jan-93	Apr-93	Jul-93	Oct-93	Jan-94	Apr-94	Jul-94	Oct-94	Jan-95	Apr-95	Jul-95	Oct-95	Jan-96	Apr-96	Jul-96	Oct-96	09-Jan-97	03-Apr-97	17-Jul-97	01-Oct-97	27-Jan-98	20-Apr-98	20-Jul-98	20-Oct-98	08-Jan-99	23-Apr-99	14-Jul-99	22-Oct-99	28-Jan-00	17-Apr-00	12-Jul-00	12-Oct-00
PCE (mg/L)	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.007	0.0001	0.0016	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.012	0.0001	0.015	0.0001	0.0001	0.0001	0.0001	0.016	0.0001	0.0001	0.011	0.0001	0.0001	0.0001	0.0001	0.0001
TCE (mg/L)	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0012	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.014	0.01	0.01	0.015	0.013	0.0001	0.0001	0.0001	0.0001	0.011	0.0001	0.014	0.0001	0.0001	0.0001	0.0001	0.0001
VC (mg/L)	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001
Ethyl benzene (mg/L)	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001
Cadmium (mg/L)	0.01	0.01	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.01	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.0058	0.0058	0.001	0.001	0.001	0.001

Well # MW-41-D

	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36	37	38	39	40
Date	Jan-91	Apr-91	Jul-91	Oct-91	Jan-92	Apr-92	Jul-92	Oct-92	Jan-93	Apr-93	Jul-93	Oct-93	Jan-94	Apr-94	Jul-94	Oct-94	Jan-95	Apr-95	Jul-95	Oct-95	Jan-96	Apr-96	Jul-96	Oct-96	09-Jan-97	03-Apr-97	17-Jul-97	01-Oct-97	27-Jan-98	20-Apr-98	20-Jul-98	20-Oct-98	08-Jan-99	23-Apr-99	14-Jul-99	22-Oct-99	28-Jan-00	17-Apr-00	12-Jul-00	12-Oct-00
PCE (mg/L)	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0009	0.0001	0.0027	0.0001	0.0001	0.0001	0.0001	0.0001	0.01	0.011	0.011	0.0001	0.15	0.0001	0.01	0.0001	0.014	0.015	0.0001	0.0001	0.011	0.014	0.0001	0.0001	0.014	0.011	0.012
TCE (mg/L)	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0007	0.0001	0.0021	0.0001	0.0001	0.0001	0.0001	0.0001	0.014	0.016	0.016	0.017	0.026	0.0001	0.015	0.0001	0.017	0.02	0.0001	0.0001	0.014	0.02	0.014	0.0001	0.022	0.019	0.018
VC (mg/L)	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001
Ethyl benzene (mg/L)	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001
Cadmium (mg/L)	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001

Well # MW-41-B

	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36	37	38	39	40
Date	Jan-91	Apr-91	Jul-91	Oct-91	Jan-92	Apr-92	Jul-92	Oct-92	Jan-93	Apr-93	Jul-93	Oct-93	Jan-94	Apr-94	Jul-94	Oct-94	Jan-95	Apr-95	Jul-95	Oct-95	Jan-96	Apr-96	Jul-96	Oct-96	09-Jan-97	03-Apr-97	17-Jul-97	01-Oct-97	27-Jan-98	20-Apr-98	20-Jul-98	20-Oct-98	08-Jan-99	23-Apr-99	14-Jul-99	22-Oct-99	28-Jan-00	17-Apr-00	12-Jul-00	12-Oct-00
PCE (mg/L)	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0021	0.0001	0.0036	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.016	0.016	0.0001	0.013	0.013	0.012	0.013	0.012	0.014	0.013	0.018	0.0001	0.012	0.0001	0.0001	0.0001	0.0001	0.0001
TCE (mg/L)	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0044	0.012	0.0049	0.0001	0.0001	0.0001	0.0001	0.01	0.015	0.022	0.031	0.037	0.0001	0.013	0.024	0.023	0.018	0.025	0.023	0.0001	0.011	0.024	0.021	0.0001	0.019	0.013	0.016
VC (mg/L)	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.028	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001
Ethyl benzene (mg/L)	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001
Cadmium (mg/L)	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.0057	0.001	0.001	0.001	0.001	0.001

Well # MW-42-S

	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36	37	38	39	40
Date	Jan-91	Apr-91	Jul-91	Oct-91	Jan-92	Apr-92	Jul-92	Oct-92	Jan-93	Apr-93	Jul-93	Oct-93	Jan-94	Apr-94	Jul-94	Oct-94	Jan-95	Apr-95	Jul-95	Oct-95	Jan-96	Apr-96	Jul-96	Oct-96	09-Jan-97	03-Apr-97	17-Jul-97	01-Oct-97	27-Jan-98	20-Apr-98	20-Jul-98	20-Oct-98	08-Jan-99	23-Apr-99	14-Jul-99	22-Oct-99	28-Jan-00	17-Apr-00	12-Jul-00	12-Oct-00
PCE (mg/L)	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0039	0.012	0.0039	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001
TCE (mg/L)	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0076	0.013	0.0046	0.0001	0.0001	0.0001	0.01	0.0001	0.012	0.0001	0.0001	0.016	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001
VC (mg/L)	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001
Ethyl benzene (mg/L)	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001
Cadmium (mg/L)	0.01	0.01	0.01	0.001	0.001	0.01	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.0077	0.0067	0.001	0.001	0.0069	0.015	0.001	0.001	0.001	0.001	0.001

Well # MW-43-S

	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36	37	38	39	40
Date	Jan-91	Apr-91	Jul-91	Oct-91	Jan-92	Apr-92	Jul-92	Oct-92	Jan-93	Apr-93	Jul-93	Oct-93	Jan-94	Apr-94	Jul-94	Oct-94	Jan-95	Apr-95	Jul-95	Oct-95	Jan-96	Apr-96	Jul-96	Oct-96	09-Jan-97	03-Apr-97	17-Jul-97	01-Oct-97	27-Jan-98	20-Apr-98	20-Jul-98	20-Oct-98	08-Jan-99	23-Apr-99	14-Jul-99	22-Oct-99	28-Jan-00	17-Apr-00	12-Jul-00	12-Oct-00
PCE (mg/L)	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0043	0.02	0.026	0.018	0.0001	0.01	0.021	0.0001	0.0001	0.015	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.015	0.011	0.016	0.017	0.0001	0.0001	0.0001	12	0.0001	0.016	0.0001
TCE (mg/L)	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0047	0.018	0.021	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.014	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001
VC (mg/L)	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0049	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001
Ethyl benzene (mg/L)	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001
Cadmium (mg/L)	0.02	0.02	0.01	0.03	0.001	0.01	0.001	0.01	0.001	0.011	0.016	0.001	0.001	0.001	0.001	0.015	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.014	0.01	0.001	0.016	0.001	0.01	0.0076	0.001	0.001	0.001	0.005	0.001	0.001	0.001	0.069	0.001

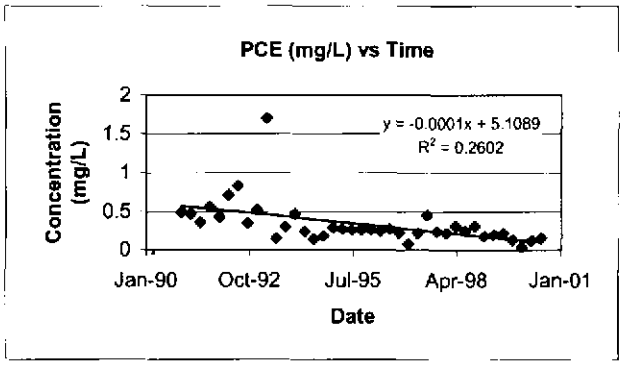
Well # MW-44-B

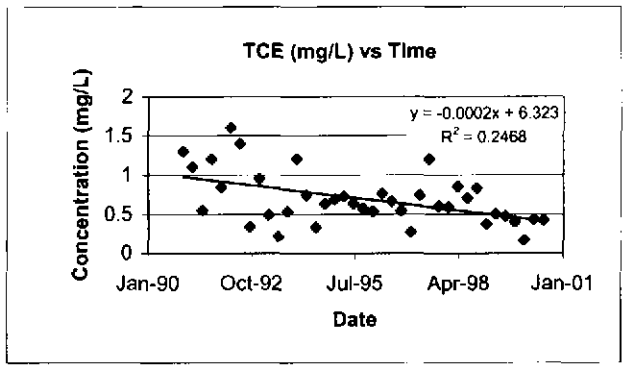
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36	37	38	39	40
Date	Jan-91	Apr-91	Jul-91	Oct-91	Jan-92	Apr-92	Jul-92	Oct-92	Jan-93	Apr-93	Jul-93	Oct-93	Jan-94	Apr-94	Jul-94	Oct-94	Jan-95	Apr-95	Jul-95	Oct-95	Jan-96	Apr-96	Jul-96	Oct-96	09-Jan-97	03-Apr-97	17-Jul-97	01-Oct-97	27-Jan-98	20-Apr-98	20-Jul-98	20-Oct-98	08-Jan-99	23-Apr-99	14-Jul-99	22-Oct-99	28-Jan-00	17-Apr-00	12-Jul-00	12-Oct-00
PCE (mg/L)	0.0001	0.0001	0.0001	0.0001	0.062	0.061	0.071	0.055	0.1	0.12	0.094	0.064	0.05	0.065	0.074	0.049	0.01	0.02	0.04	0.0001	0.0001	0.0001	0.0001	0.0001	0.026	0.016	0.02	0.019	0.014	0.023	0.018	0.026	0.02	0.02	0.013	0.011	0.0001	0.0001	0.0001	0.0001
TCE (mg/L)	0.0001	0.0001	0.0001	0.0001	0.28	0.19	0.27	0.11	0.2	0.32	0.23	0.25	0.12	0.17	0.32	0.13	0.027	0.056	0.1	0.022	0.0001	0.0001	0.023	0.026	0.081	0.016	0.02	0.059	0.042	0.063	0.05	0.073	0.05	0.041	0.026	0.028	26	0.012	0.018	0.013
VC (mg/L)	0.0001	0.0001	0.0001	0.0001	0.042	0.038	0.06	0.095	0.056	0.071	0.072	0.066	0.025	0.03	0.026	0.028	0.0001	0.014	0.019	0.0001	0.0001	0.0001	0.0001	0.0001	0.035	0.016	0.04	0.017	0.01	0.013	0.0001	0.017	0.0001	0.0001	0.0001	0.0001	11	0.0001	0.0001	0.0001
Ethyl benzene (mg/L)	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001
Cadmium (mg/L)	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.022	0.026	0.023	0.023	0.013	0.018	0.019	0.011	0.001	0.001	0.011	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.016	0.001	0.011	0.014	0.0071	0.001	0.001	0.001	0.0055	0.001	0.001	0.001	0.0065	0.001

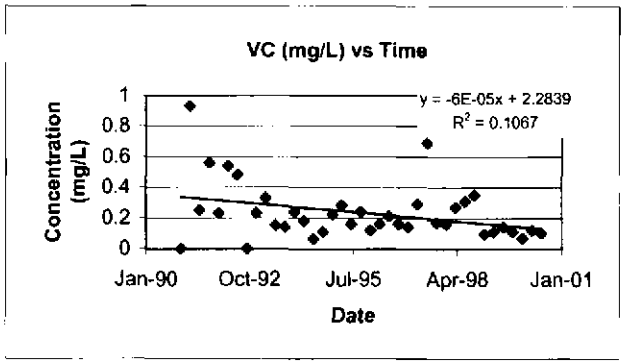
* Constituent values of 0.0001 mg/L are used as the default value in the Mann-Kendall analysis when constituent values are below the detection limit

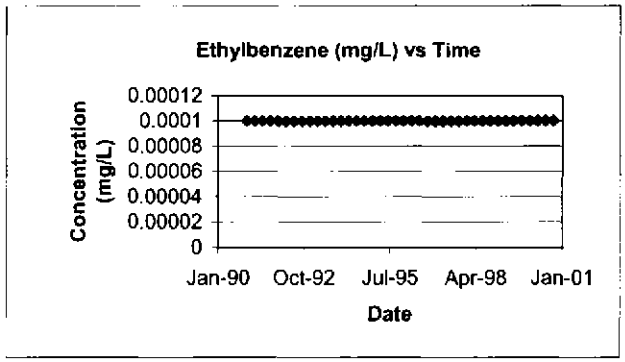
Values shown highlighted were considered "outliers" in the Mann-Kendall statistical analysis. Results from the Mann-Kendall statistical analysis that includes outliers are found in Tables 3 and 3a. Outliers were not included in the historical plots found in Attachment A.

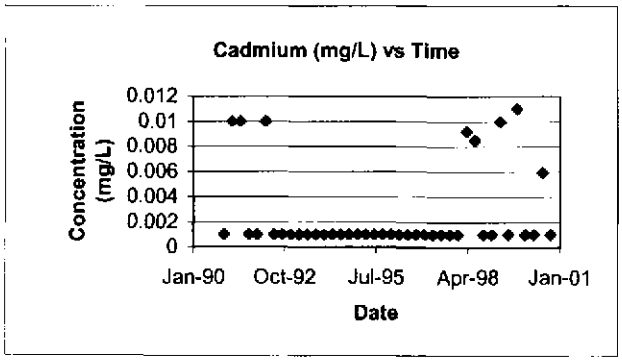
Summary of Historical Analyses-MW-30
Envirite, Thomaston, CT



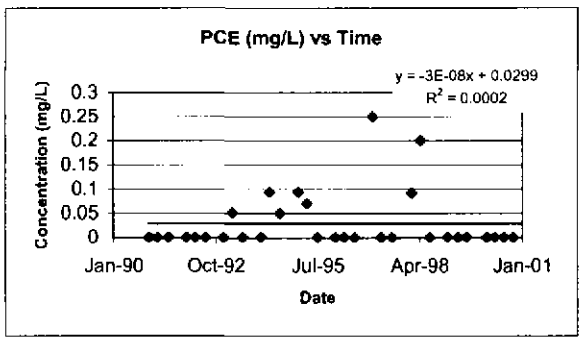


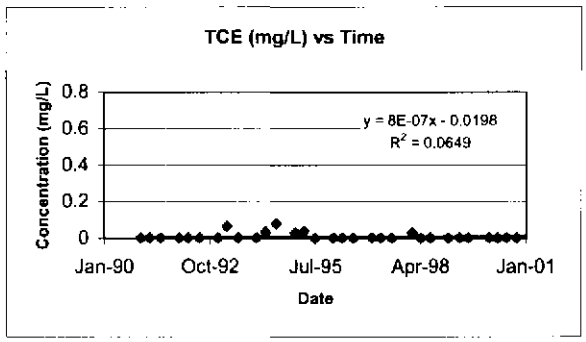


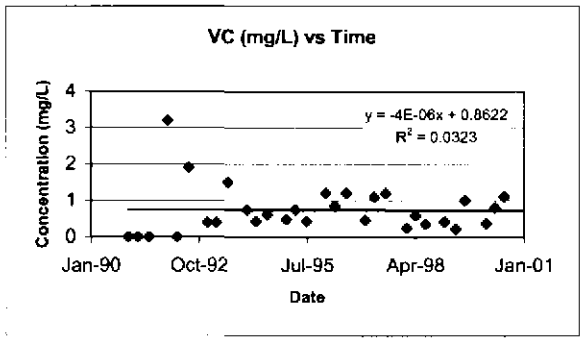


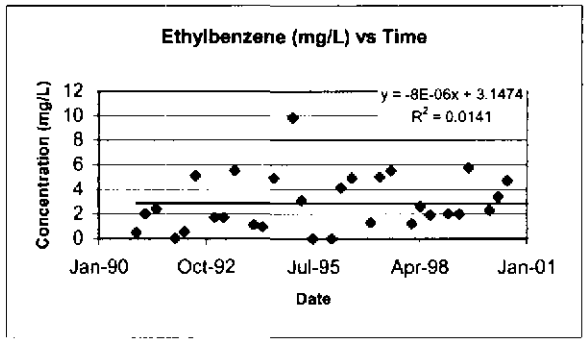


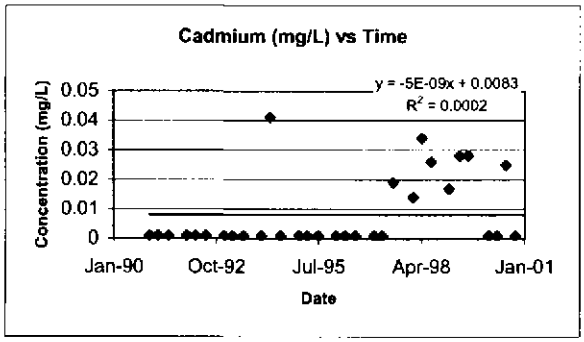
Summary of Historical Analyses-MW-31-S
Envirite, Thomaston, CT



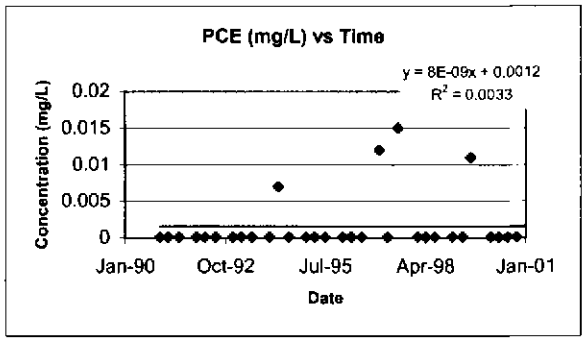


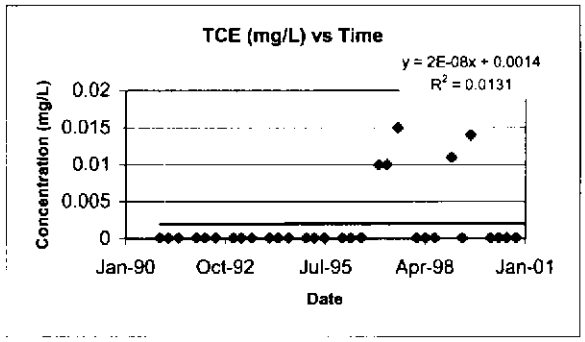


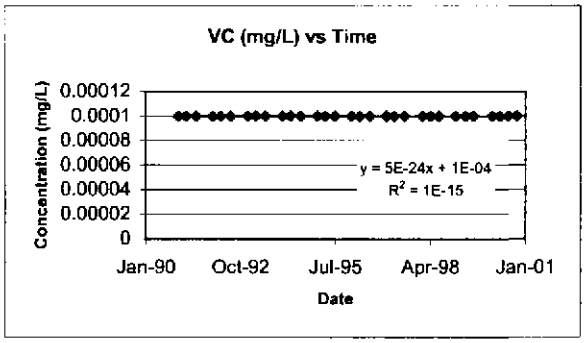


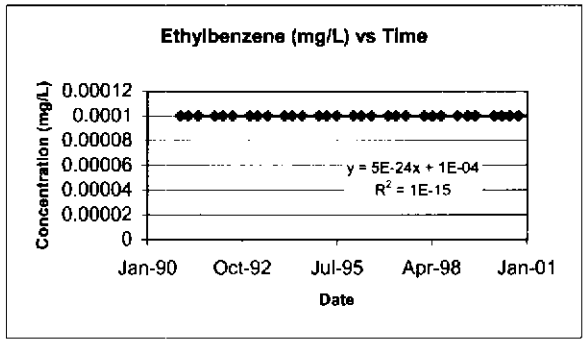


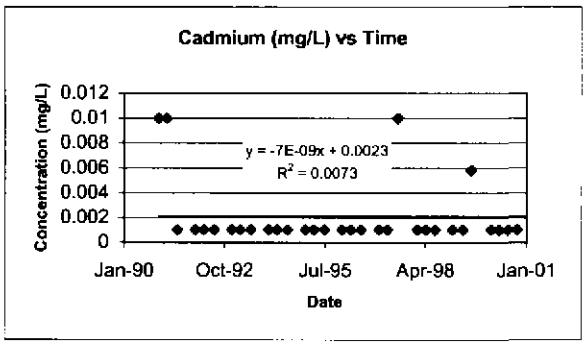
Summary of Historical Analyses-MW-41 S
Envirite, Thomaston, CT





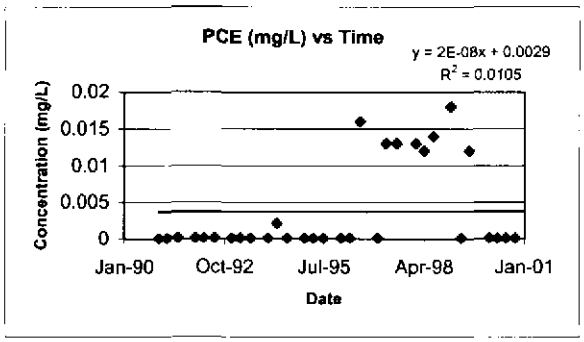


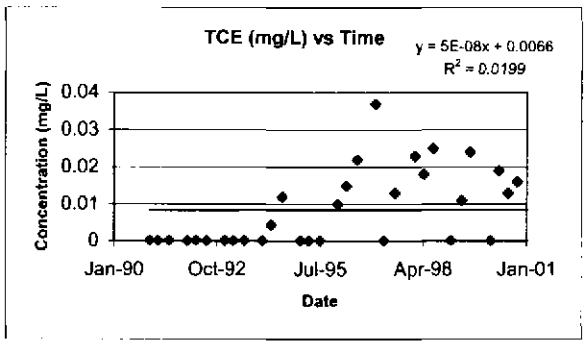


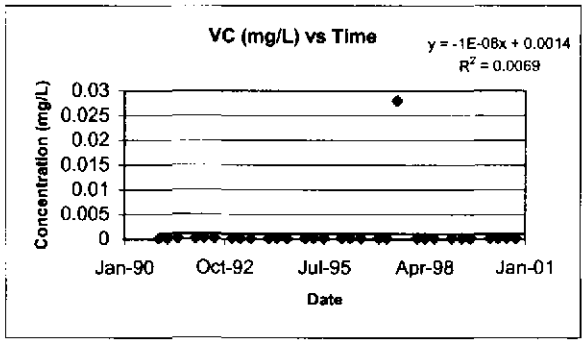


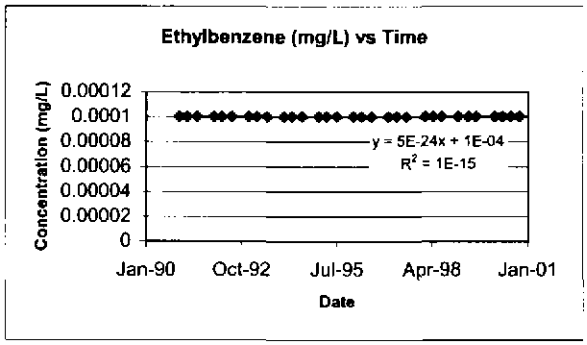
Summary of Historical Analyses-MW-41 B

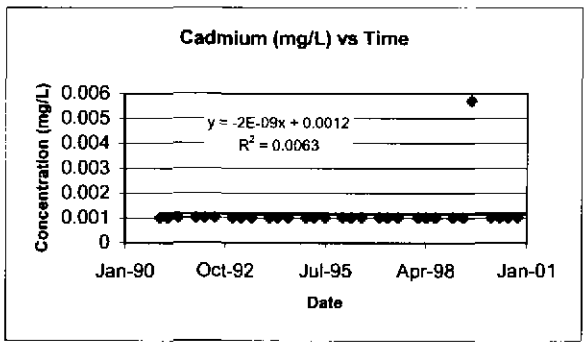
Envirite, Thomaston, CT



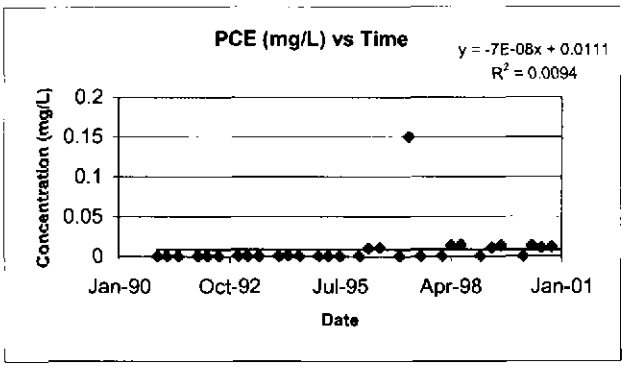


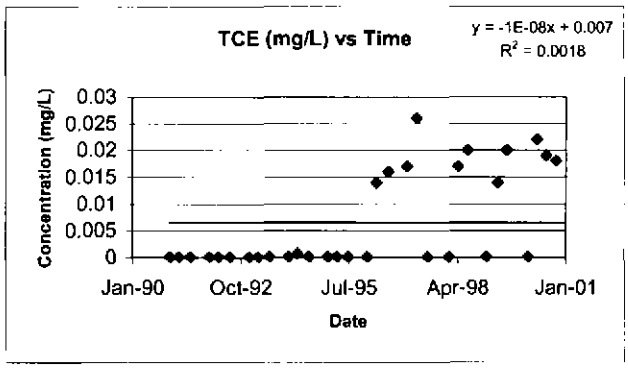


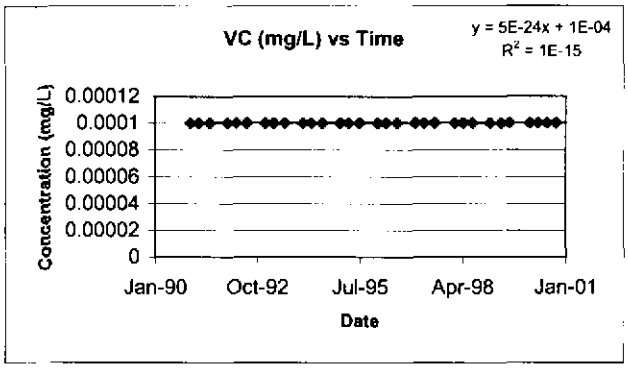


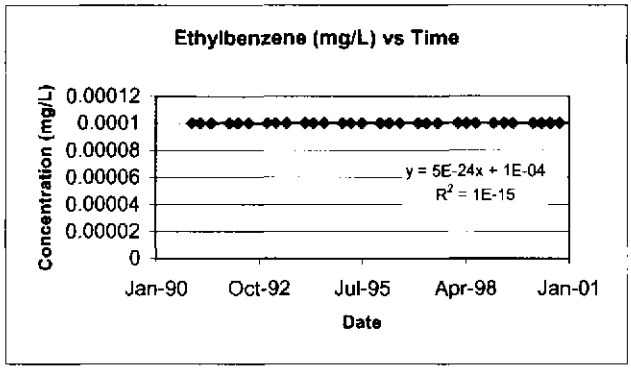


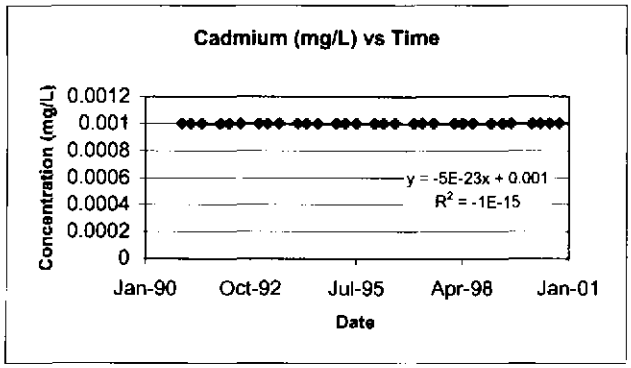
Summary of Historical Analyses-MW-41 D
Envirite, Thomaston, CT



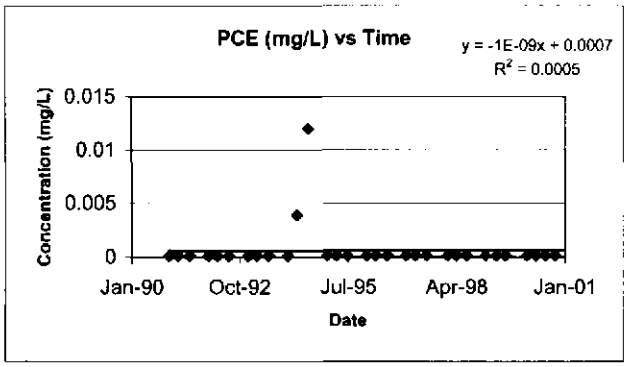


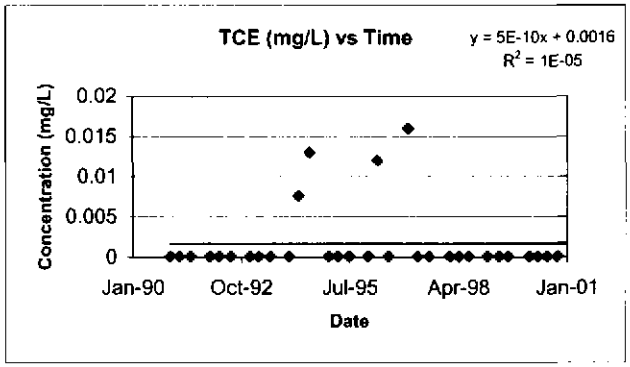


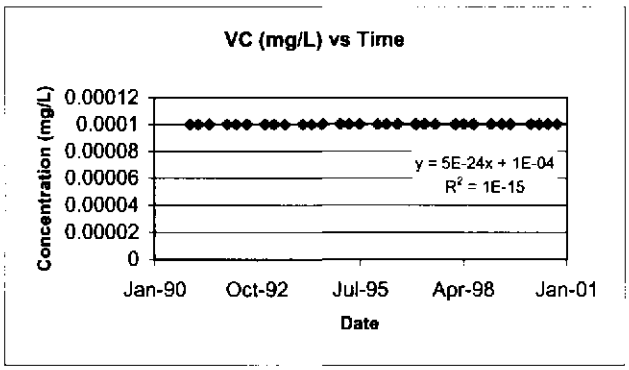


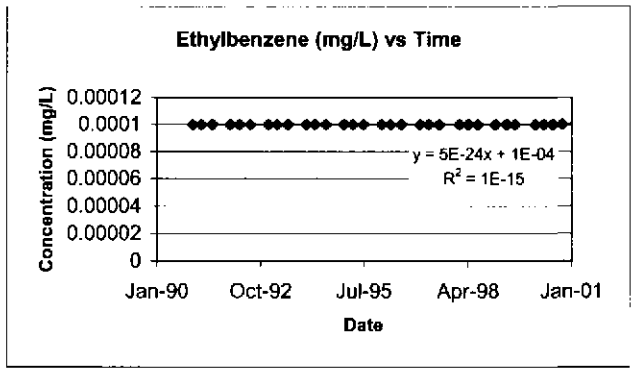


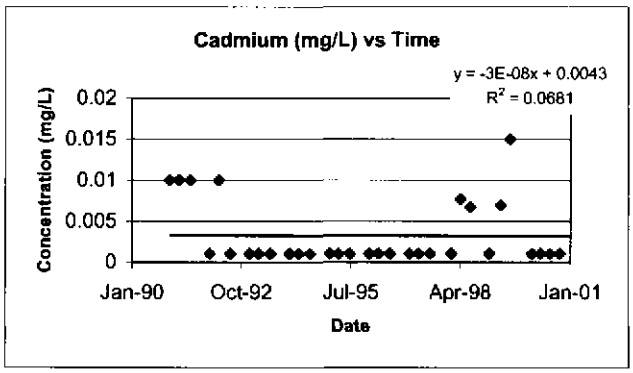
Summary of Historical Analyses-MW-42 S
Envirite, Thomaston, CT











Summary of Historical Analyses-MW-43 S

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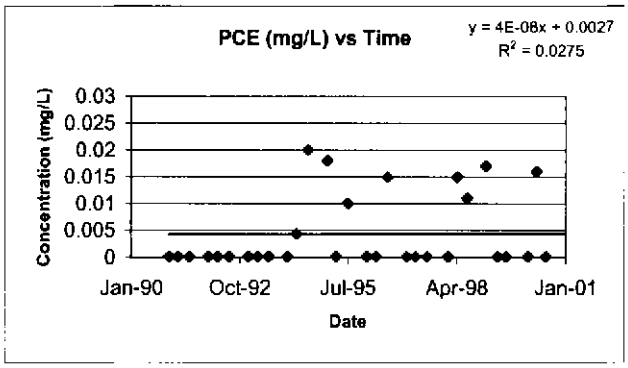
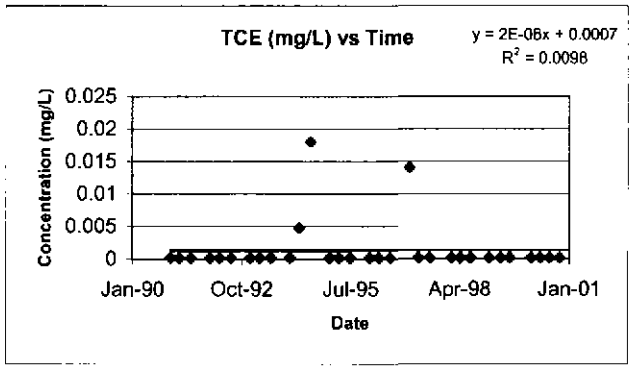
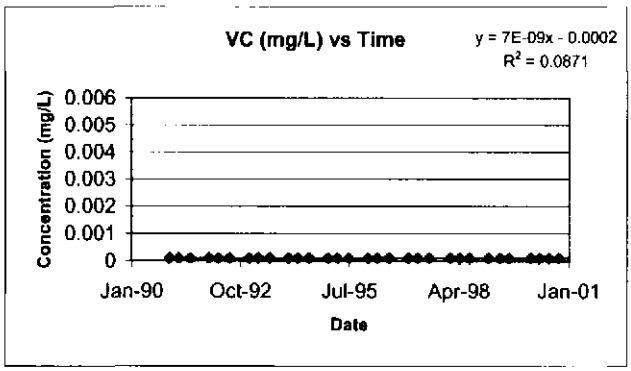
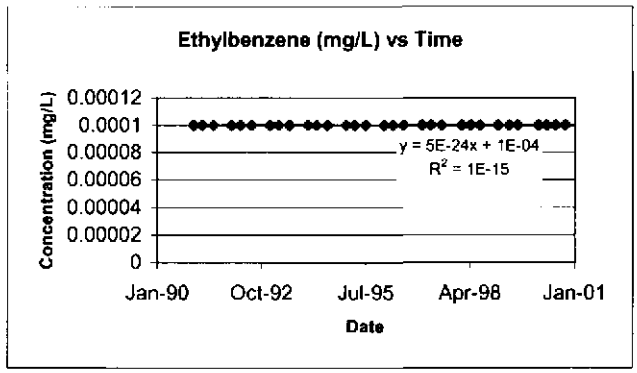
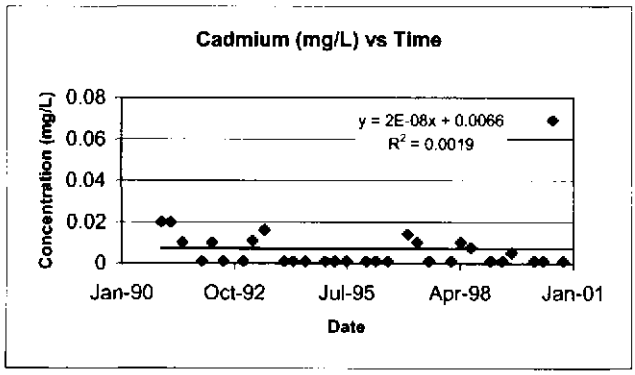


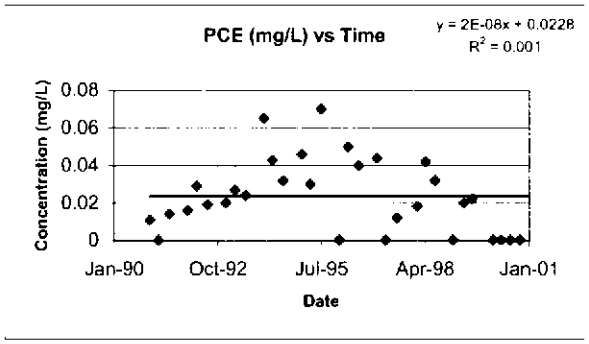


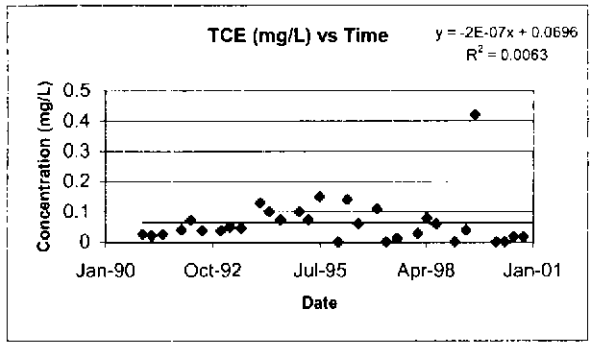


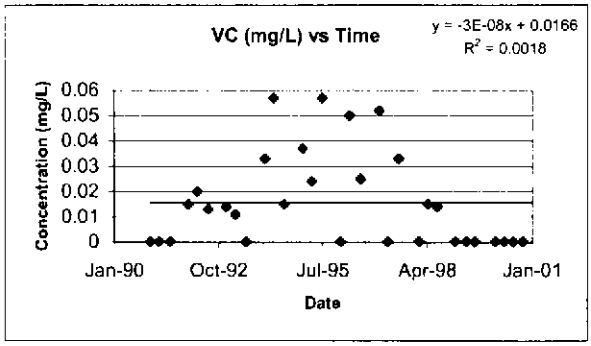


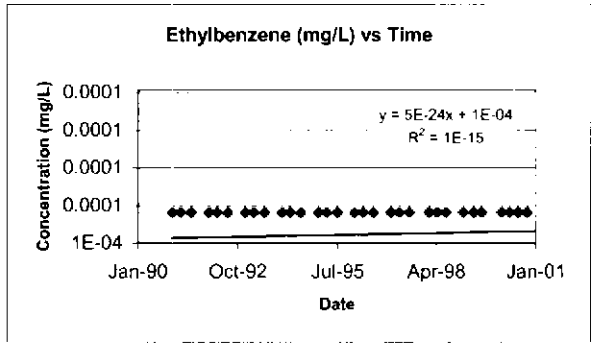


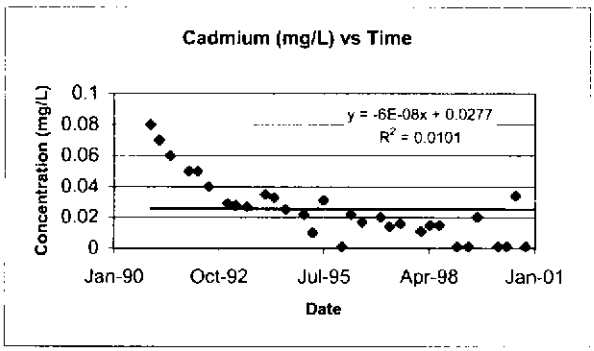
Summary of Historical Analyses-MW-43 D
Envirite, Thomaston, CT





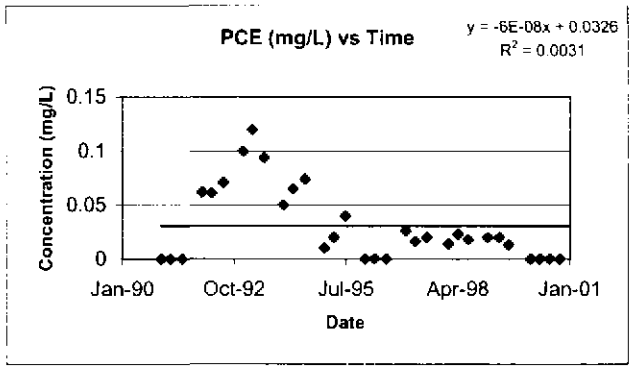


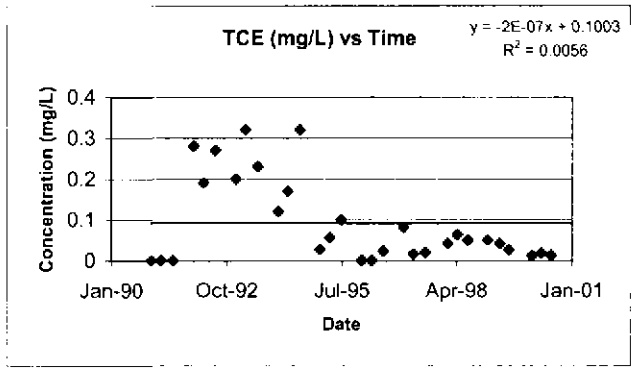


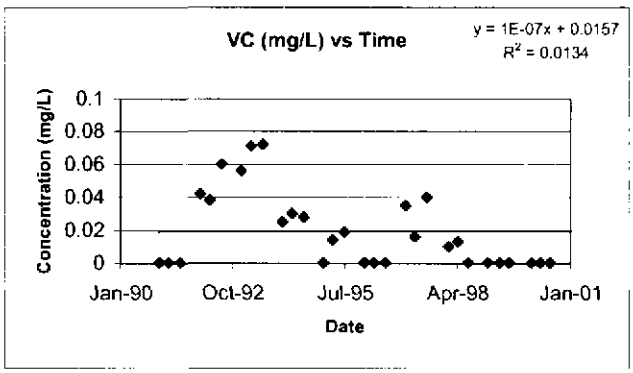


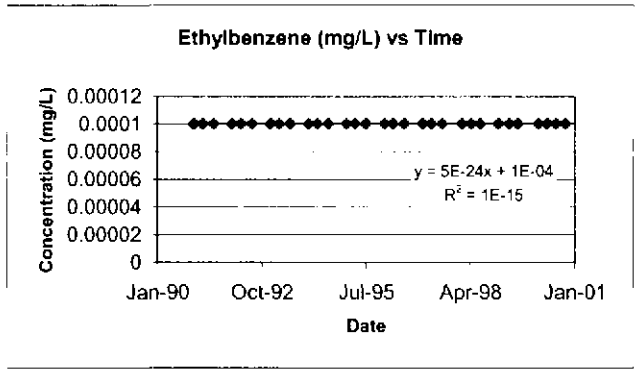
Summary of Historical Analyses-MW-44 B

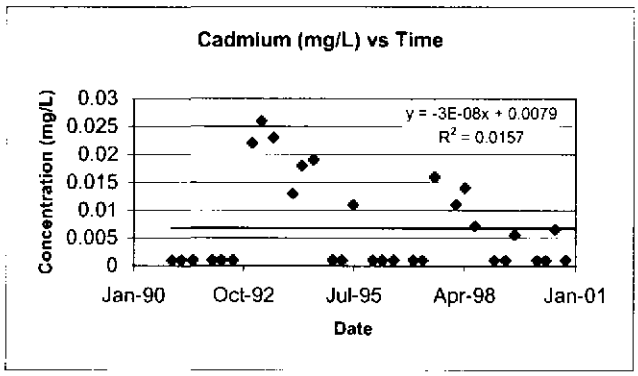
Envirite, Thomaston, CT





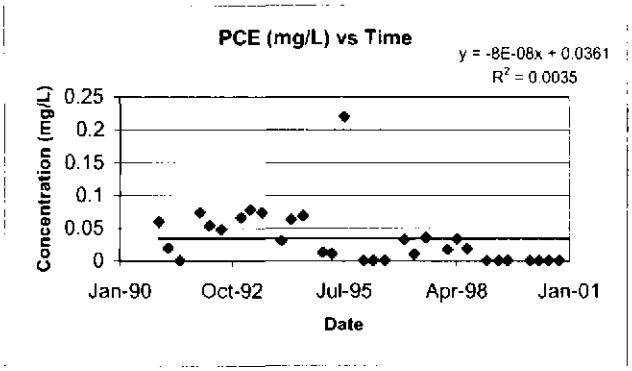


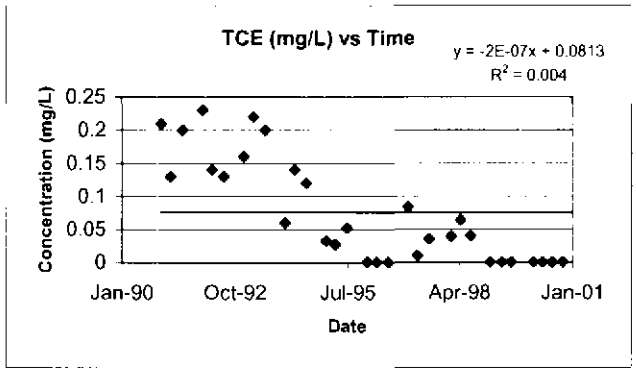


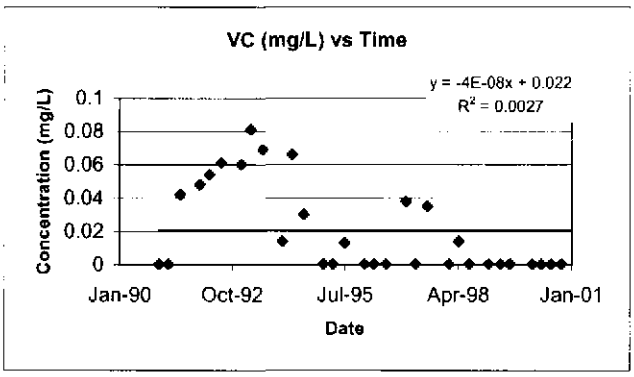


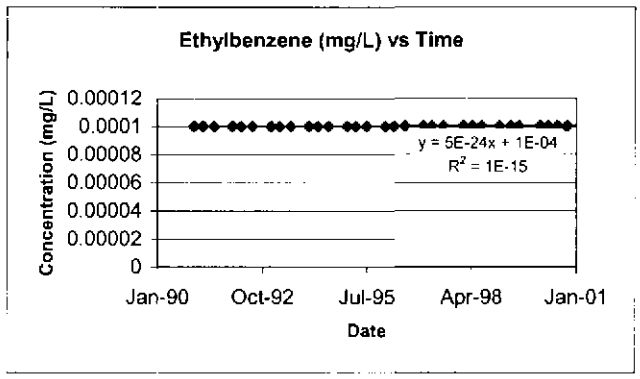
Summary of Historical Analyses-MW-44 D

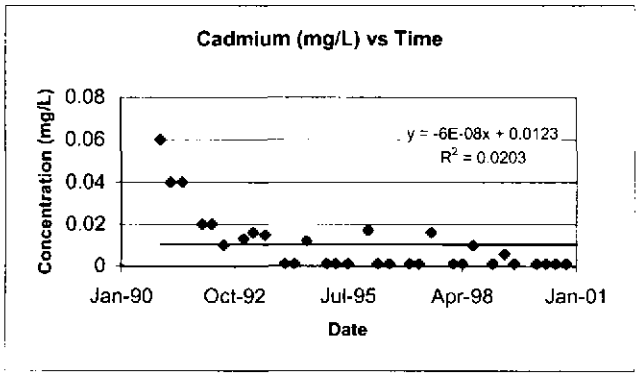
Envirite, Thomaston, CT











ATTACHMENT B

B1. FORMULATION AND SAMPLE CALCULATION FOR MANN-KENDALL ANALYSES FROM EPA QA/G-9

B2. TABLE-A-1 FROM EPA QA/G-9

4.3.3 General Trend Estimation Methods

4.3.3.1 Sen's Slope Estimator

Sen's Slope Estimate is a nonparametric alternative for estimating a slope. This approach involves computing slopes for all the pairs of ordinal time points and then using the median of these slopes as an estimate of the overall slope. As such, it is insensitive to outliers and can handle a moderate number of values below the detection limit and missing values. Assume that there are n time points (or n periods of time), and let X_i denote the data value for the ith time point. If there are no missing data, there will be n(n-1)/2 possible pairs of time points (i, j) in which i > j. The slope for such a pair is called a pairwise slope, b_{ij}, and is computed as $b_{ij} = (X_i - X_j) / (i - j)$. Sen's slope estimator is then the median of the n(n-1)/2 pairwise slopes.

If there is no underlying trend, then a given X_i is as likely to be above another X_j as it is below. Hence, if there is no underlying trend, there would be an approximately equal number of positive and negative slopes, and thus the median would be near zero. Due to the number of calculations required, Sen's estimator is rarely calculated by hand and directions are not given in this document. However, the estimator is contained in the DQA DataQUEST software package (QA/G-9D, 1996).

4.3.3.2 Seasonal Kendall Slope Estimator

If the data exhibit cyclic trends, then Sen's slope estimator can be modified to account for the cycles. For example, if data are available for each month for a number of years, 12 separate sets of slopes would be determined (one for each month of the year); similarly, if daily observations exhibit weekly cycles, seven sets of slopes would be determined, one for each day of the week. In these estimates, the above pairwise slope is calculated for each time period and the median of all of the slopes is an estimator of the slope for a long-term trend. This is known as the seasonal Kendall slope estimator. Because of the number of calculations required, this estimator is rarely calculated by hand so directions are not given in this document. The seasonal Kendall slope estimator is contained in the DataQUEST software package (QA/G-9D, 1996).

4.3.4 Hypothesis Tests for Detecting Trends

Most of the trend tests treated in this section involve the Mann-Kendall test or extensions of it. The Mann-Kendall test does not assume any particular distributional form and accommodates trace values or values below the detection limit by assigning them a common value. The test can also be modified to deal with multiple observations per time period and generalized to deal with multiple sampling locations and seasonality.

4.3.4.1 One Observation per Time Period for One Sampling Location

The Mann-Kendall test involves computing a statistic S, which is the difference between the number of pairwise slopes (as described in 4.3.3.1) that are positive minus the number that are negative. If S is a large positive value, then there is evidence of an increasing trend in the data. If S is a large negative value, then there is evidence of a decreasing trend in the data. The null hypothesis or baseline condition for this test is that there is no temporal trend in the data values, i.e., "H_0: no trend". The alternative condition or hypothesis will usually be either "H_A: upward trend" or "H_A: downward trend."

The basic Mann-Kendall trend test involves listing the observations in temporal order, and computing all differences that may be formed between measurements and earlier measurements, as depicted

in Box 4.3-2. The test statistic is the difference between the number of strictly positive differences and the number of strictly negative differences. If there is an underlying upward trend, then these differences will tend to be positive and a sufficiently large value of the test statistic will suggest the presence of an upward trend. Differences of zero are not included in the test statistic (and should be avoided, if possible, by recording data to sufficient accuracy). The steps for conducting the Mann-Kendall test for small sample sizes (i.e., less than 10) are contained in Box 4.3-3 and an example is contained in Box 4.3-4.

For sample sizes greater than 10, a normal approximation to the Mann-Kendall test is quite accurate. Directions for this approximation are contained in Box 4.3-5 and an example is given in Box 4.3-6. Tied observations (i.e., when two or more measurements are equal) degrade the statistical power and should be avoided, if possible, by recording the data to sufficient accuracy.

Box 4.3-2: "Upper Triangular" Data for Basic Mann-Kendall Trend Test with a Single Measurement at Each Time Point

Data Table

Original Time Measurements	t_1 X_1	t_2 X_2	t_3 X_3	t_4 X_4	... ...	t_{n-1} X_{n-1}	t_n X_n	(time from earliest to latest) (actual values recorded)
X_1		X_2-X_1	X_3-X_1	X_4-X_1	...	$X_{n-1}-X_1$	X_n-X_1	
X_2			X_3-X_2	X_4-X_2	...	$X_{n-1}-X_2$	X_n-X_2	
.						.	.	
.						.	.	
.						.	.	
X_{n-2}						$X_{n-1}-X_{n-2}$	X_n-X_{n-2}	
X_{n-1}							X_n-X_{n-1}	

After performing the subtractions this table converts to:

Original Time Measurements	t_1 X_1	t_2 X_2	t_3 X_3	t_4 X_4	... ...	t_{n-1} X_{n-1}	t_n X_n	# of + Differences (>0)	# of - Differences (<0)
X_1		Y_{21}	Y_{31}	Y_{41}	...	$Y_{(n-1)1}$	Y_{n1}		
X_2			Y_{32}	Y_{42}	...	$Y_{(n-1)2}$	Y_{n2}		
.						.	.		
.						.	.		
.						.	.		
X_{n-2}						$Y_{(n-1)(n-2)}$	$Y_{n(n-2)}$		
X_{n-1}							$Y_{n(n-1)}$		
NOTE: $X_i-Y_k=0$ do not contribute to either total and are discarded.								Total # >0	Total # <0

where Y_{ik} = sign (X_i-X_k) = + if $X_i - X_k > 0$
= 0 if $X_i - X_k = 0$
= - if $X_i - X_k < 0$

Box 4.3-5: Directions for the Mann-Kendall Procedure Using Normal Approximation

If the sample size is 10 or more, a normal approximation to the Mann-Kendall procedure may be used.

STEP 1: Complete steps 1, 2, and 3 of Box 4.3-3.

STEP 2: Calculate the variance of S: $V(S) = \frac{n(n-1)(2n+5)}{18}$.

If ties occur, let g represent the number of tied groups and w_p represent the number of data points in the pth group. The variance of S is: $V(S) = \frac{1}{18}\left[n(n-1)(2n+5) - \sum_{p=1}^{g} w_p(w_p-1)(2w_p+5)\right]$

STEP 4: Calculate $Z = \frac{S-1}{[V(S)]^{1/2}}$ if S > 0, Z = 0 if S = 0, or $Z = \frac{S+1}{[V(S)]^{1/2}}$ if S < 0.

STEP 5: Use Table A-1 of Appendix A to find the critical value $z_{1-\alpha}$ such that 100(1-α)% of the normal distribution is below $z_{1-\alpha}$. For example, if α=0.05 then $z_{1-\alpha}$=1.645.

STEP 6: For testing the hypothesis, H_0 (no trend) against 1) H_1 (an upward trend) – reject H_0 if Z is greater than $z_{1-\alpha}$, or 2) H_2 (a downward trend) – reject H_0 if Z < 0 and the absolute value of Z is greater than $z_{1-\alpha}$.

Box 4.3-6: An Example of Mann-Kendall Trend Test by Normal Approximation

A test for an upward trend with α=.05 will be based on the 11 weekly measurements shown below.

STEP 1: Using Box 4.3-2, a triangular table was used to construct the possible differences. A zero has been used if the difference is zero, a "+" sign if the difference is positive, and a "-" sign if the difference is negative.

Week	1	2	3	4	5	6	7	8	9	10	11	No. of	No. of
Data	10	10	10	5	10	20	18	17	15	24	15	+ Signs	- Signs
10		0	0	-	0	+	+	+	+	+	+	6	1
10			0	-	0	+	+	+	+	+	+	6	1
10				-	0	+	+	+	+	+	+	6	1
5					+	+	+	+	+	+	+	7	0
10						+	+	+	+	+	+	6	0
20							-	-	-	+	-	1	4
18								-	-	+	-	1	3
17									-	+	-	1	2
15										+	0	1	0
24											-	0	1
												35	13

STEP 2: S = (sum of + signs) - (sum of - signs) = 35 - 13 = 22

STEP 3: There are several observations tied at 10 and 15. Thus, the formula for tied values will be used. In this formula, g=2, t_1=4 for tied values of 10, and t_2=2 for tied values of 15.

$$V(S) = \frac{1}{18}\left[11(11-1)(2(11)+5) - [4(4-1)(2(4)+5) + 2(2-1)(2(2)+5)]\right] = 155.33$$

STEP 4: Since S is positive: $Z = \frac{S-1}{[V(S)]^{1/2}} = \frac{22-1}{(155.33)^{1/2}} = \frac{20}{12.46} = 1.605$

STEP 5: From Table A-1 of Appendix A, $z_{1-.05}$=1.645.

STEP 6: H_1 is the alternative of interest. Therefore, since 1.605 is not greater than 1.645, H_0 is not rejected. Therefore, there is not enough evidence to determine that there is an upward trend.

TABLE A-1: CRITICAL VALUES OF STUDENT'S t DISTRIBUTION

$t_{(1-\alpha)}$

Degrees of Freedom	1 - α								
	.70	.75	.80	.85	.90	.95	.975	.99	.995
1	0.727	1.000	1.376	1.963	3.078	6.314	12.706	31.821	63.657
2	0.617	0.816	1.061	1.386	1.886	2.920	4.303	6.965	9.925
3	0.584	0.765	0.978	1.250	1.638	2.353	3.182	4.541	5.841
4	0.569	0.741	0.941	1.190	1.533	2.132	2.776	3.747	4.604
5	0.559	0.727	0.920	1.156	1.476	2.015	2.571	3.365	4.032
6	0.553	0.718	0.906	1.134	1.440	1.943	2.447	3.143	3.707
7	0.549	0.711	0.896	1.119	1.415	1.895	2.365	2.998	3.499
8	0.546	0.706	0.889	1.108	1.397	1.860	2.306	2.896	3.355
9	0.543	0.703	0.883	1.100	1.383	1.833	2.262	2.821	3.250
10	0.542	0.700	0.879	1.093	1.372	1.812	2.228	2.764	3.169
11	0.540	0.697	0.876	1.088	1.363	1.796	2.201	2.718	3.106
12	0.539	0.695	0.873	1.083	1.356	1.782	2.179	2.681	3.055
13	0.538	0.694	0.870	1.079	1.350	1.771	2.160	2.650	3.012
14	0.537	0.692	0.868	1.076	1.345	1.761	2.145	2.624	2.977
15	0.536	0.691	0.866	1.074	1.34	1.753	2.131	2.602	2.947
16	0.535	0.690	0.865	1.071	1.337	1.746	2.120	2.583	2.921
17	0.534	0.689	0.863	1.069	1.333	1.740	2.110	2.567	2.898
18	0.534	0.688	0.862	1.067	1.330	1.734	2.101	2.552	2.878
19	0.533	0.688	0.861	1.066	1.328	1.729	2.093	2.539	2.861
20	0.533	0.687	0.860	1.064	1.325	1.725	2.086	2.528	2.845
21	0.532	0.686	0.859	1.063	1.323	1.721	2.080	2.518	2.831
22	0.532	0.686	0.858	1.061	1.321	1.717	2.074	2.508	2.819
23	0.532	0.685	0.858	1.060	1.319	1.714	2.069	2.500	2.807
24	0.531	0.685	0.857	1.059	1.318	1.711	2.064	2.492	2.797
25	0.531	0.684	0.856	1.058	1.316	1.708	2.060	2.485	2.787
26	0.531	0.684	0.856	1.058	1.315	1.706	2.056	2.479	2.779
27	0.531	0.684	0.855	1.057	1.314	1.703	2.052	2.473	2.771
28	0.530	0.683	0.855	1.056	1.313	1.701	2.048	2.467	2.763
29	0.530	0.683	0.854	1.055	1.311	1.699	2.045	2.462	2.756
30	0.530	0.683	0.854	1.055	1.310	1.697	2.042	2.457	2.750
40	0.529	0.681	0.851	1.050	1.303	1.684	2.021	2.423	2.704
60	0.527	0.679	0.848	1.046	1.296	1.671	2.000	2.390	2.660
120	0.526	0.677	0.845	1.041	1.289	1.658	1.980	2.358	2.617
∞	0.524	0.674	0.842	1.036	1.282	1.645	1.960	2.326	2.576

Note: The last row of the table (∞ degrees of freedom) gives the criticial values for a standard normal distribution (z), e.g., $t_{\infty,0.95} = z_{0.95} = 1.645$.

ATTACHMENT C

C-1 INITIAL PORE WATER CONCENTRATION CALCULATIONS BASED ON SOIL WATER PARTITIONING

C-2 PERCENT SATURATION SENSITIVITY CALCULATIONS

C-3 DIFFUSION MODEL CALCULATIONS BASED ON FICK'S LAW & ADDITIONAL MODEL OUTPUTS

C-1 INITIAL PORE WATER CONCENTRATION CALCULATIONS BASED ON SOIL WATER PARTITIONING

INITIAL PORE WATER CONCENTRATION CALCULATIONS

TABLE A

#	Boring	PCE TCLP (mg/L)	TCE TCLP (mg/L)	PCE soil (mg/Kg)	TCE soil (mg/Kg)	foc PCE (%)	foc TCE(%)
1	SLW12B	0.005	0.005	0.059	0.005	4.49%	0.94%
2	SLW14C	0.082	0.018	12	0.99	55.64%	51.92%
3	SLW15D	0.005	0.005	0.001	0.011	0.08%	2.08%
4	SLW15B	0.005	0.005	0.011	0.011	0.84%	2.08%
5	SLW16C	0.005	0.005	0.023	0.004	1.75%	0.76%
6	SLW17C	0.005	0.002	0.01	0.01	0.76%	4.72%
7	SLW18C	0.017	0.001	0.12	0.011	2.68%	10.38%
8	SLW21D	0.005	0.001	0.004	0.011	0.30%	10.38%
9	SLW20F	0.005	0.005	0.011	0.011	0.84%	2.08%
10	SLW19D	0.005	0.024	0.1	0.2	7.60%	7.87%
Average =		0.0139	0.0071	1.2339	0.1264	7.50%	9.32%
					Average =	8.41%	

Kd_{PCE} - 22.12

Kd_{TCE} - 8.91

TABLE B

	Boring	PCE soil (mg/Kg)	TCE soil (mg/Kg)
1	SLW12B	0.059	0.005
2	SLW14C	12	0.99
3	SLW15D	0.001	0.011
4	SLW15B	0.011	0.011
5	SLW16C	0.023	0.004
6	SLW17C	0.01	0.01
7	SLW18C	0.12	0.011
8	SLW21D	0.004	0.011
9	SLW20F	0.011	0.011
10	SLW19D	0.1	0.2
11	W-03	550	530
12	W-09	1.3	1.3
13	W-11	0.015	0.011
14	W-07	7.1	
15	W-08		0.7
Average Soil Conc. (mg/Kg)=		40.77	38.09
Avarage Pore Water Conc. (mg/L)=		1.84	4.28
Total mass (Kg) =		1.26	1.20

NOTE: The formulation and sample calculations are attached with this summary.

COMPUTATION SHEET

Client _____

Site EMPIRE

Description Soil-water Partitioning

XPERT DESIGN AND DIAGNOSTICS, LLC

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$$K_d = \frac{\left(\frac{\text{Mass of solute sorbed}}{\text{mass of soil}}\right)}{\left(\frac{\text{Mass of solute dissolved}}{\text{Mass of water}}\right)} = (K_{oc})(f_{oc})$$

(K_{oc}: organic carbon water partition coeff; f_{oc}: organic carbon fraction)

f_{oc} = 1.0% assumed here for sample calculations

NOTE: As foc data for PEHM is not available foc (average value) has to be back calculated from soil conc. and TCLP data.

1- Log koc is Available

PCE → $\log k_{oc} = 2.42$ $\log k_{ow} = 2.6$

TCE → $\log k_{oc} = 2.025$ $\log k_{ow} = 2.53$

(kd, kow, koc are dimensionless)

PCE → $K_d = (0.01)(10^{2.42}) = \underline{2.63}$

TCE → $K_d = (0.01)(10^{2.025}) = \underline{1.059}$

2- From Log kow

$$\log K_{oc} = 0.49 + 0.72 \log K_{ow}$$

SEE REFERENCE BELOW

$$K_{oc} = 10^{(0.49 + 0.72 \log k_{ow})}$$

PCE → $K_{oc} = 10^{(0.49 + 0.72(2.6))} = 230.14$

TCE → $K_{oc} = 10^{(0.49 + 0.72(2.53))} = 204.927$

PCE → $K_d = (0.01)(230.14) = \underline{2.3014}$

TCE → $K_d = (0.01)(204.927) = \underline{2.049}$

REFERENCES: SCHWARZENBACH, R.P., AND J. WESTALL. 1981. TRANSPORT OF NONPOLAR ORGANIC COMPOUNDS FROM SURFACE WATER TO GROUNDWATER. LABORATORY STUDIES. ENV. SCI. TECH., VOL. 15, P. 1300-1367.

Initial Pore Water Concentrations Calculations

(Based on Soil-Water Partitioning)

Approach:

Average foc values are back calculated from the soil conc. and TCLP leaching data. The data was available for ten borings (see attached table). The following formulation was used.

$$PCE \rightarrow K_{od} = \frac{C_s \text{ (mass basis)}}{C_w \text{ (mass basis)}} = foc \times (10)^{2.42}$$

$$TCE \rightarrow K_{od} = \frac{C_{sm}}{C_{wm}} = foc \times (10)^{2.025}$$

$\because$ C_{wm} $(\frac{mg}{kg})$ is obtained from TCLP leaching data $(\frac{mg}{L})$, by dividing TCLP conc. by $\rho_w \Rightarrow 1 \frac{kg}{L}$

The values obtained for foc are

PCE_{foc} = 7.5% (obtained by PCE data)

TCE_{foc} = 9.32% (obtained by TCE data)

NOTE: As these organic carbon fraction values obtained from PCE data and TCE data are very close an average foc value is calculated representing PEHM.

$foc_{average}$ = 8.41%

$\therefore$ Kd_{PCE} = 22.12

Kd_{TCE} = 8.91

The soil concentration data was available for 18 borings. This data is used to calculate average pore water concentrations for PCE and TCE using Kod values.

Co_{PCE} = Initial Pore Water conc. for PCE = 1.84 $\frac{mg}{L}$

Co_{TCE} = " " " " TCE = 4.28 $\frac{mg}{L}$

NOTE: The initial pore water conc. values of 2 mg/L for PCE and 4 for TCE are used in model input.

COMPUTATION SHEET

Client

Site ENVIRITE

Description EFFECTIVE SOLUBILITY CALC.

XPERT DESIGN AND DIAGNOSTICS, LLC

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EFFECTIVE SOLUBILITY FORMULATION

x_w^{sat} ⟶ mole fraction solubility of compound in sat. in water

γ_w^{sat} ⟶ Activity of organic liquid compound in water

$$x_w^{sat} = \frac{1}{\gamma_w^{sat}}$$

$$C_w^{sat} = \frac{x_w^{sat}\left(\frac{mol\,x}{mol\,w}\right)}{V_w\left(\frac{mol\,w}{V_w}\right)} = \frac{mol\,x}{V\,water}$$

$$C_w^{sat} = \frac{x_w^{sat}}{0.018}\ (mol/L)$$

$$x_w^{sat} = \frac{\gamma_{org\,mix} \times x_{org\,mix}}{\gamma_w}$$

$$C_w^{sat} = \frac{\overset{1}{\gamma_{org\,mix}} \times x_{org\,mix}}{0.018\ \gamma_w}$$

γ_w ⟶ activity of PCE in H_2O

γ_{org} ⟶ " " PCE in mix

- $\log C_w^{sat}{}_{PCE} = 3.04 \Rightarrow C_w^{sat} = 9.12 \times 10^{-4}\ \frac{mol}{L}$
- $\log C_w^{sat}{}_{TCE} = 2.04 \Rightarrow C_w^{sat} = 9.12 \times 10^{-3}\ \frac{mol}{L}$
- $\log C_w^{sat}{}_{VC} = 1.35 \Rightarrow C_w^{sat} = 0.0446\ \frac{mol}{L}$

$$C_w^{sat} = \frac{x_w^{sat}}{0.018} = \frac{1}{0.018\,\gamma_w^{sat}} \Rightarrow \gamma_w^{sat} = \frac{1}{0.018 \times C_w^{sat}}$$

$$PCE \longrightarrow \gamma_w^{sat} = \frac{1}{0.018 \times 9.12\times10^{-4}} = 6.09\times10^{4}$$

$$TCE \longrightarrow \gamma_w^{sat} = \frac{1}{0.018 \times 9.12\times10^{-3}} = 6.09\times10^{3}$$

PCE

$$x_{org\ mix} = \frac{9.03\times10^{-4}}{0.0339} = 0.0266$$

Based on PCE solubility

$$\because \quad 9.03\times10^{-4}\ \frac{mol}{L} = 150\ \frac{mg}{L} \times \frac{1\ mol}{166\ g} \times \frac{1\ g}{10^3\ mg}$$

and 0.0339 are total # of moles/L based on PCE, TCE, VC, toluene and ethyl benzene

$$\text{Effective sol.} \Rightarrow C_w^{sat} = \frac{1 \times 0.0266}{0.018 \times 6.09\times10^{4}} \times 166\ \frac{g}{mol} \times 10^3 = 4.02\ \frac{mg}{L}$$

TCE

$$x_{org\ mix} = \frac{8.36\times10^{-3}\ \frac{mol}{L}}{0.0339\ \frac{mol}{L}} = 0.2466$$

$$\text{Effective sol.} \Rightarrow C_w^{sat} = \frac{1 \times 0.2466}{0.018 \times 6.09\times10^{3}} \times 131.5\ \frac{g}{mol} \times 10^3 = 295.1\ \frac{mg}{L}$$

COMPUTATION SHEET

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Site ENSUIRITE

Description Effective sol. calc.

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Effective sol. Calc. 2nd Approach

1 - # of moles

PCE = 150 mg/L × mol/166g × 1g/10³ mg = 9.03 × 10⁻⁴ mol/L

TCE = 1100 mg/L × mol/131.5g × " = 8.36 × 10⁻³ mol/L

VC = 1100 mg/L × mol/62.5g × 1g/10³ mg = 0.0176 mol/L

Toulene = 515 mg/L × mol/92.1g × 1g/10³ mg = 5.6 × 10⁻³ mol/L

ethylbenzene = 152 mg/L × mol/106g × 1g/10³ mg = 1.44 × 10⁻³ mol/L

Assumed that pore water consists of these VOC's (based on dotal solubilities)

Total moles = 0.0339 mol/L

PCE_{eff} = (9.03 × 10⁻⁴ mol/L / 0.0339 mol/L) × 150 = 3.99 ≈ 4 mg/L

TCE_{eff} = (8.36 × 10⁻³ mol/L / 0.0339 mol/L) × 1100 = 271 mg/L

C-2 PERCENT SATURATION SENSITIVITY CALCULATIONS

The Effect of Percent Saturation on Diffusion Coefficient

Calculations

Sensitivity Analyses for Porosity and % Saturation

ENVIRITE LANDFILL

Porosity, n = 0.3					
% Saturation	**%Sat * n**	**% Qw**	**Tortuosity**	**D* PCE (cm^2/sec)**	**D* TCE (cm^2/sec)**
50%	0.15	15	1.33E-01	2.23E-07	2.48E-07
75%	0.225	22.5	3.42E-01	5.76E-07	6.39E-07
80%	0.24	24	3.98E-01	6.69E-07	7.43E-07
85%	0.255	25.5	4.58E-01	7.71E-07	8.56E-07
90%	0.27	27	5.24E-01	8.81E-07	9.78E-07
95%	0.285	28.5	5.94E-01	9.99E-07	1.11E-06
100%	0.3	30	6.69E-01	1.13E-06	1.25E-06
Porosity, n = 0.4 *(most likely-because of sand mixed with waste material)*					
Saturation	**%Sat * n**	**% Qw**	**Tortuosity**	**D* PCE (cm^2/sec)**	**D* TCE (cm^2/sec)**
50%	0.2	20	1.46E-01	3.28E-07	3.64E-07
75%	0.3	30	3.77E-01	8.45E-07	9.38E-07
80%	0.32	32	4.38E-01	9.82E-07	1.09E-06
85%	0.34	34	5.04E-01	1.13E-06	1.26E-06
90%	0.36	36	5.76E-01	1.29E-06	1.44E-06
95%	0.38	38	6.54E-01	1.47E-06	1.63E-06
100%	0.4	40	7.37E-01	1.65E-06	1.84E-06
Porosity, n = 0.5					
% Saturation	**%Sat * n**	**% Qw**	**Tortuosity**	**D* PCE (cm^2/sec)**	**D* TCE (cm^2/sec)**
50%	0.25	25	1.57E-01	4.42E-07	4.91E-07
75%	0.375	37.5	4.06E-01	1.14E-06	1.26E-06
80%	0.4	40	4.72E-01	1.32E-06	1.47E-06
85%	0.425	42.5	5.43E-01	1.52E-06	1.69E-06
90%	0.45	45	6.21E-01	1.74E-06	1.93E-06
95%	0.475	47.5	7.04E-01	1.97E-06	2.19E-06
100%	0.5	50	7.94E-01	2.23E-06	2.47E-06
Porosity, n = 0.6					
% Saturation	**%Sat * n**	**% Qw**	**Tortuosity**	**D* PCE (cm^2/sec)**	**D* TCE (cm^2/sec)**
50%	0.3	30	1.67E-01	5.63E-07	6.25E-07
75%	0.45	45	4.31E-01	1.45E-06	1.61E-06
80%	0.48	48	5.01E-01	1.69E-06	1.87E-06
85%	0.51	51	5.77E-01	1.94E-06	2.16E-06
90%	0.54	54	6.60E-01	2.22E-06	2.47E-06
95%	0.57	57	7.48E-01	2.52E-06	2.80E-06
100%	0.6	60	8.43E-01	2.84E-06	3.15E-06

NOTE: *See sample calculations attached.*

COMPUTATION SHEET

Client: ENVIRITE

Site:

Description:

XPERT DESIGN AND DIAGNOSTICS, LLC

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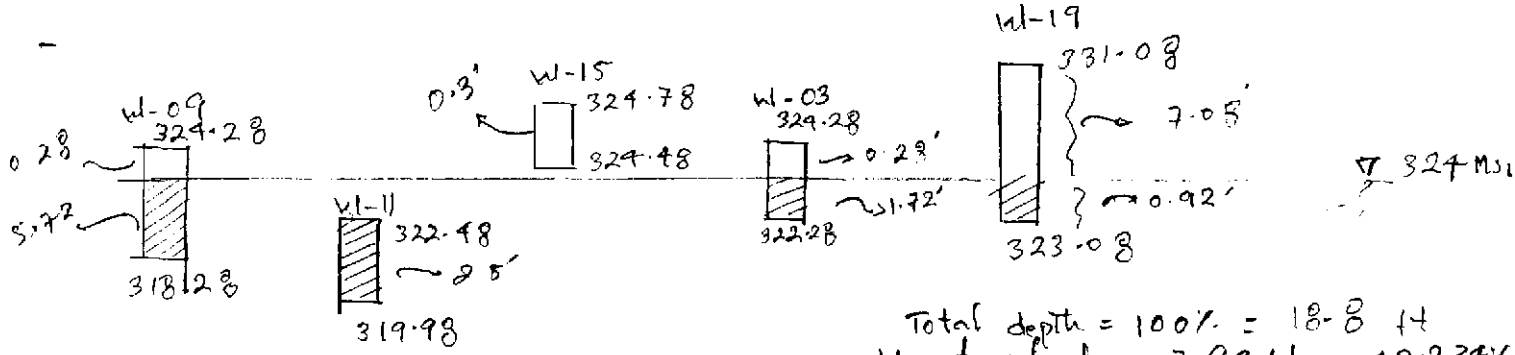
THE EFFECT OF % SATURATION ON DIFFUSION



Total depth = 100% = 18.8 ft

Unsaturated = 7.94 ft = 42.234%

vadose zone sat = 90% saturation.

- Assuming an average groundwater elevation of 324 MSL
- Even with seasonal groundwater elevation fluctuations, not all the PEWM is 100% saturated.
- Following is the analysis showing the impact of % saturation variations on diffusion of VOCs from PEWM pile to the highly permeable sand.

$$\therefore \text{Aqueous diffusion Coefficient} = \frac{13.26 \times 10^{-8}}{\eta_w^{1.4} \times V_B^{0.589}}$$

where η_w = viscosity of water in cp

@ 20°C → 1.002 cp

V_B = LeBas water volume cm^3/mol

PCE_{VB} = 128.00 cm^3/mol

TCE_{VB} = 107.10 cm^3/mol

$D_o(PCE)$ = 5.6084×10^{-6} cm^2/sec

$D_o(TCE)$ = 6.229×10^{-6} cm^2/sec

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Client Envirite

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D^* = soil diffusion Coefficient

$D^* = w D_0$

$D^* = \alpha (Q - b) D_0$

$D^* = \alpha n D_0$

where Q = volumetric water filled porosity in saturation
b = blind or blocked pores or voids
n = porosity.
α = Tortuosity

$$\therefore \boxed{\alpha = (Q_w^{7/3})/(n^2)}$$

SEE REFERENCE BELOW

where Q_w = volumetric water content
n = porosity.

$\therefore Q_w$ is variable with water content

% Saturation	Q_w	α
50		
75	0.239	0.372
80	0.308	0.432
85	0.327	0.497
90	0.346	0.567
95	0.366	0.646
100	0.385	0.727

$\therefore$ % sat * porosity = x * 0.3 = cm^3/cm^3

% Q_w(vol) = $\frac{cm^3 \ H_2O}{cm^3 \ Soil} \times 100$

REFERENCE: MILLINGTON, R. J. AND J. P. QUIRK. 1961. PERMEABILITY OF POROUS SOLIDS. TRANS., FARADAY SOC., VOL. 57, P. 1200-1207.

TABLE 6-3
PRE-ENVIRITE WASTE MATERIAL THICKNESS AND DEPTH[1]
Envirite Facility
Thomaston, Connecticut

Boring	Depth Range (fbg)	Elevation Range (MSL)	Thickness (feet)
W-05	24-26	324.28 - 322.28	2.0
W-09	23.5-29.5	324.28 - 318.28	6.0
W-11	25.5-28	322.48 - 319.98	2.5
W-15	24.6-24.9	324.78 - 324.48	0.3
W-19	15-23	331.08 - 323.08	8.0
W-24	9-17.5	330.58 - 322.08	8.5
W-25	9-12	330.15 - 327.15	3.0
W-27	11-15	328.05 - 324.05	4.0
W-30	11.5-15	327.75 - 324.25	3.5
W-32	11-13	328.55 - 326.55	2.0
R-12	11-13	328.95 - 326.95	2.0

Notes:

fbg = feet below grade
ft = feet
MSL = Mean Sea Level

1. Waste material thickness and depth measurements are based upon split spoon samples collected during the waste pile investigation and field interpretation of drilling conditions.
2. Waste material is assumed to be present in boring W-10 although samples could not be recovered. The drilling augers were observed to be oily when removed from W-10. Waste material was encountered in W-11 drilled adjacent to W-10.

C-3 DIFFUSION MODEL CALCULATIONS BASED ON FICK'S LAW & ADDITIONAL MODEL OUTPUTS

COMPUTATION SHEET

Client

Site ENURITE

Description

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DIFFUSION MODEL

Depletion of PEWM by diffusion.

$C_0 = mg/L$ PEWM-L

$y = 0$

High permeability sand

$C^* = 0\ mg/L$

Fick's Second Law:

$$\frac{C_{ty} - C^*}{C_0 - C^*} = \operatorname{erf}\left(\frac{y}{\sqrt{4D^*t}}\right)$$ SEE REFERENCE BELOW

where C_{ty} = Concentration at time t and y distance ($\frac{mg}{L}$)

C^* = Concentration at the PEWM - sand interface (mg/L)

C_0 = Initial concentration in pore water of PEWM ($\frac{mg}{L}$)

y = distance in the PEWM from the interface (PEWM thickness), cm

D^* = Diffusion Coeff.

t = time (years)

Calculations and Graphs are attached.

REFERENCE: THIBODEAUX, LOUIS J.. ENVIRONMENTAL CHEMODYNAMICS. 2ND ED. SERIES ED. J.L. SCHNOOR AND A. ZEHNDER NEW YORK, 1996. (PAGE 100.)

COMPUTATION SHEET

Client

Site ENVIRITE

Description

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Job#

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Soil Diffusion Coefficient Calculations.

$D_{o\,PCE} = 5.608 \times 10^{-6}$ cm²/sec

$D_{o\,TCE} = 6.229 \times 10^{-6}$ cm²/sec

see attached calculations for percent saturation.

$D^* =$ soil diff Coeff. $= \tau \cdot n \cdot D$

$\tau =$ tortuosity $= 0.75$ assumed

$n =$ porosity $= 0.3$ assumed

$D^*_{PCE} = 1.26 \times 10^{-6}$ cm²/sec

$D^*_{TCE} = 1.4 \times 10^{-6}$ cm²/sec

NOTE: Sensitivity analysis for D^* is required for diffusion modeling.

DEPLETION OF TETRACHLOROEHENE (PCE) IN PRE-ENVIRITE WASTE MATERIAL (PEWM) UNDER CELL 1
DIFFUSION TO THE HIGH PERMEABILITY SAND
ENVIRITE, THOMASTON, CT

Co =	2	mg/L	Initial PCE concentration in PEWM
D* =	1.26E-06	cm^2/sec	PCE diffusion constant
C* =	0	mg/L	PCE concentration at the interface with high permeability sand
y =	variable	cm	Distance in the PEWM layer from the PEWM-sand layer interface

	y = 9.14 cm			y = 60.94 cm			y = 78.175 cm			y = 182.82 cm			y = 243.76 cm			y = 114.56 cm Average thickness		
t years	X = y/(4*D*t)^.5	erf (X)	C mg/L	X = y/(4*D*t)^.5	erf (X)	C mg/L	X = y/(4*D*t)^.5	erf (X)	C mg/L	X = y/(4*D*t)^.5	erf (X)	C mg/L	X = y/(4*D*t)^.5	erf (X)	C mg/L	X = y/(4*D*t)^.5	erf (X)	C mg/L
0.10	2.29	1.00	2.00	15.27	1.00	2.00	19.09	1.00	2.00	45.82			61.10			28.71		
0.20	1.62	0.98	1.96	10.80	1.00	2.00	13.50	1.00	2.00	32.40			43.20			20.30		
0.30	1.32	0.94	1.88	8.82	1.00	2.00	11.02	1.00	2.00	26.46	1.00	2.00	35.27			16.58		
0.40	1.15	0.89	1.79	7.64	1.00	2.00	9.55	1.00	2.00	22.91	1.00	2.00	30.55			14.36		
0.50	1.02	0.85	1.71	6.83	1.00	2.00	8.54	1.00	2.00	20.49	1.00	2.00	27.32	1.00	2.00	12.84	1.00	2.00
1.00	0.72	0.69	1.39	4.83	1.00	2.00	6.04	1.00	2.00	14.49	1.00	2.00	19.32	1.00	2.00	9.08	1.00	2.00
1.50	0.59	0.60	1.19	3.94	1.00	2.00	4.93	1.00	2.00	11.83	1.00	2.00	15.78	1.00	2.00	7.41	1.00	2.00
2.00	0.51	0.53	1.06	3.42	1.00	2.00	4.27	1.00	2.00	10.25	1.00	2.00	13.66	1.00	2.00	6.42	1.00	2.00
2.50	0.46	0.48	0.97	3.05	1.00	2.00	3.82	1.00	2.00	9.16	1.00	2.00	12.22	1.00	2.00	5.74	1.00	2.00
3.00	0.42	0.45	0.89	2.79	1.00	2.00	3.49	1.00	2.00	8.37	1.00	2.00	11.15	1.00	2.00	5.24	1.00	2.00
3.50	0.39	0.42	0.83	2.58	1.00	2.00	3.23	1.00	2.00	7.75	1.00	2.00	10.33	1.00	2.00	4.85	1.00	2.00
4.00	0.36	0.39	0.78	2.42	1.00	2.00	3.02	1.00	2.00	7.25	1.00	2.00	9.66	1.00	2.00	4.54	1.00	2.00
4.50	0.34	0.37	0.74	2.28	1.00	2.00	2.85	1.00	2.00	6.83	1.00	2.00	9.11	1.00	2.00	4.28	1.00	2.00
5.00	0.32	0.35	0.71	2.16	1.00	2.00	2.70	1.00	2.00	6.48	1.00	2.00	8.64	1.00	2.00	4.06	1.00	2.00
6.00	0.30	0.32	0.65	1.97	0.99	1.99	2.46	1.00	2.00	5.92	1.00	2.00	7.89	1.00	2.00	3.71	1.00	2.00
7.00	0.27	0.30	0.60	1.83	0.99	1.98	2.28	1.00	2.00	5.48	1.00	2.00	7.30	1.00	2.00	3.43	1.00	2.00
8.00	0.26	0.28	0.57	1.71	0.98	1.97	2.13	1.00	1.99	5.12	1.00	2.00	6.83	1.00	2.00	3.21	1.00	2.00
9.00	0.24	0.27	0.53	1.61	0.98	1.95	2.01	1.00	1.99	4.83	1.00	2.00	6.44	1.00	2.00	3.03	1.00	2.00
10.00	0.23	0.25	0.51	1.53	0.97	1.94	1.91	0.99	1.99	4.58	1.00	2.00	6.11	1.00	2.00	2.87	1.00	2.00
15.00	0.19	0.21	0.42	1.25	0.92	1.84	1.56	0.97	1.95	3.74	1.00	2.00	4.99	1.00	2.00	2.34	1.00	2.00
20.00	0.16	0.18	0.36	1.08	0.87	1.75	1.35	0.94	1.89	3.24	1.00	2.00	4.32	1.00	2.00	2.03	1.00	1.99
25.00	0.14	0.16	0.32	0.97	0.83	1.66	1.21	0.91	1.82	2.90	1.00	2.00	3.86	1.00	2.00	1.82	0.99	1.98
30.00	0.13	0.15	0.30	0.88	0.79	1.58	1.10	0.88	1.76	2.65	1.00	2.00	3.53	1.00	2.00	1.66	0.98	1.96
35.00	0.12	0.14	0.27	0.82	0.75	1.50	1.02	0.85	1.70	2.45	1.00	2.00	3.27	1.00	2.00	1.53	0.97	1.94
40.00	0.11	0.13	0.26	0.76	0.72	1.44	0.95	0.82	1.65	2.29	1.00	2.00	3.05	1.00	2.00	1.44	0.96	1.92
45.00	0.11	0.12	0.24	0.72	0.69	1.38	0.90	0.80	1.59	2.16	1.00	2.00	2.88	1.00	2.00	1.35	0.94	1.89
50.00	0.10	0.12	0.23	0.68	0.67	1.33	0.85	0.77	1.55	2.05	1.00	1.99	2.73	1.00	2.00	1.28	0.93	1.86
55.00	0.10	0.11	0.22	0.65	0.64	1.29	0.81	0.75	1.50	1.95	0.99	1.99	2.61	1.00	2.00	1.22	0.92	1.83
60.00	0.09	0.11	0.21	0.62	0.62	1.24	0.78	0.73	1.46	1.87	0.99	1.98	2.49	1.00	2.00	1.17	0.90	1.81
65.00	0.09	0.10	0.20	0.60	0.60	1.21	0.75	0.71	1.42	1.80	0.99	1.98	2.40	1.00	2.00	1.13	0.89	1.78
70.00	0.09	0.10	0.19	0.58	0.59	1.17	0.72	0.69	1.39	1.73	0.99	1.97	2.31	1.00	2.00	1.09	0.88	1.75
75.00	0.08	0.09	0.19	0.56	0.57	1.14	0.70	0.68	1.35	1.67	0.98	1.96	2.23	1.00	2.00	1.05	0.86	1.72

DEPLETION OF TETRACHLOROETHENE (PCE) IN PRE-ENVIRITE WASTE MATERIAL (PEWM) UNDER CELL 1
DIFFUSION TO THE HIGH PERMEABILITY SAND
ENVIRITE, THOMASTON, CT

Co =	2	mg/L	Initial PCE concentration in PEWM
D* =	5.00E-06	cm^2/se	PCE diffusion constant
C* =	0	mg/L	PCE concentration at the interface with high permeability sand
y =	variable	cm	Distance in the PEWM layer from the PEWM-sand layer interface

	y = 9.14 cm			y = 60.94 cm			y = 76.175 cm			y = 182.82 cm			y = 243.76 cm			y = 114.56 cm Average thickness		
t years	X = y/(4*D*t)^.5	erf (X)	C mg/L	X = y/(4*D*t)^.5	erf (X)	C mg/L	X = y/(4*D*t)^.5	erf (X)	C mg/L	X = y/(4*D*t)^.5	erf (X)	C mg/L	X = y/(4*D*t)^.5	erf (X)	C mg/L	X = y/(4*D*t)^.5	erf (X)	C mg/L
0.10	1.15	0.90	1.79	7.67	1.00	2.00	9.59	1.00	2.00	23.02			30.69			14.42		
0.20	0.81	0.75	1.50	5.43	1.00	2.00	6.78	1.00	2.00	16.28			21.70			10.20		
0.30	0.66	0.65	1.31	4.43	1.00	2.00	5.54	1.00	2.00	13.29	1.00	2.00	17.72			8.33		
0.40	0.58	0.58	1.17	3.84	1.00	2.00	4.80	1.00	2.00	11.51	1.00	2.00	15.35			7.21		
0.50	0.51	0.53	1.07	3.43	1.00	2.00	4.29	1.00	2.00	10.29	1.00	2.00	13.73	1.00	2.00	6.45	1.00	2.00
1.00	0.36	0.39	0.79	2.43	1.00	2.00	3.03	1.00	2.00	7.28	1.00	2.00	9.71	1.00	2.00	4.56	1.00	2.00
1.50	0.30	0.33	0.65	1.98	0.99	1.99	2.48	1.00	2.00	5.94	1.00	2.00	7.92	1.00	2.00	3.72	1.00	2.00
2.00	0.26	0.28	0.57	1.72	0.98	1.97	2.14	1.00	2.00	5.15	1.00	2.00	6.86	1.00	2.00	3.23	1.00	2.00
2.50	0.23	0.26	0.51	1.53	0.97	1.94	1.92	0.99	1.99	4.60	1.00	2.00	6.14	1.00	2.00	2.88	1.00	2.00
3.00	0.21	0.23	0.47	1.40	0.95	1.90	1.75	0.99	1.97	4.20	1.00	2.00	5.60	1.00	2.00	2.63	1.00	2.00
3.50	0.19	0.22	0.43	1.30	0.93	1.87	1.62	0.98	1.96	3.89	1.00	2.00	5.19	1.00	2.00	2.44	1.00	2.00
4.00	0.18	0.20	0.41	1.21	0.91	1.83	1.52	0.97	1.94	3.64	1.00	2.00	4.85	1.00	2.00	2.28	1.00	2.00
4.50	0.17	0.19	0.38	1.14	0.89	1.79	1.43	0.96	1.91	3.43	1.00	2.00	4.58	1.00	2.00	2.15	1.00	2.00
5.00	0.16	0.18	0.36	1.09	0.88	1.75	1.36	0.94	1.89	3.26	1.00	2.00	4.34	1.00	2.00	2.04	1.00	1.99
6.00	0.15	0.17	0.33	0.99	0.84	1.68	1.24	0.92	1.84	2.97	1.00	2.00	3.96	1.00	2.00	1.86	0.99	1.98
7.00	0.14	0.15	0.31	0.92	0.81	1.61	1.15	0.90	1.79	2.75	1.00	2.00	3.67	1.00	2.00	1.72	0.99	1.97
8.00	0.13	0.14	0.29	0.86	0.77	1.55	1.07	0.87	1.74	2.57	1.00	2.00	3.43	1.00	2.00	1.61	0.98	1.95
9.00	0.12	0.14	0.27	0.81	0.75	1.49	1.01	0.85	1.69	2.43	1.00	2.00	3.24	1.00	2.00	1.52	0.97	1.94
10.00	0.12	0.13	0.26	0.77	0.72	1.44	0.96	0.83	1.65	2.30	1.00	2.00	3.07	1.00	2.00	1.44	0.96	1.92
15.00	0.09	0.11	0.21	0.63	0.62	1.25	0.78	0.73	1.46	1.88	0.99	1.98	2.51	1.00	2.00	1.18	0.90	1.81
20.00	0.08	0.09	0.18	0.54	0.56	1.11	0.68	0.66	1.33	1.63	0.98	1.96	2.17	1.00	2.00	1.02	0.85	1.70
25.00	0.07	0.08	0.16	0.49	0.51	1.01	0.61	0.61	1.22	1.46	0.96	1.92	1.94	0.99	1.99	0.91	0.80	1.61
30.00	0.07	0.07	0.15	0.44	0.47	0.94	0.55	0.57	1.13	1.33	0.94	1.88	1.77	0.99	1.98	0.83	0.76	1.52
35.00	0.06	0.07	0.14	0.41	0.44	0.88	0.51	0.53	1.06	1.23	0.92	1.84	1.64	0.98	1.96	0.77	0.72	1.45
40.00	0.06	0.06	0.13	0.38	0.41	0.83	0.48	0.50	1.00	1.15	0.90	1.79	1.53	0.97	1.94	0.72	0.69	1.38
45.00	0.05	0.06	0.12	0.36	0.39	0.78	0.45	0.48	0.95	1.09	0.88	1.75	1.45	0.96	1.92	0.68	0.66	1.33
50.00	0.05	0.06	0.12	0.34	0.37	0.75	0.43	0.46	0.91	1.03	0.85	1.71	1.37	0.95	1.90	0.65	0.64	1.28
55.00	0.05	0.06	0.11	0.33	0.36	0.71	0.41	0.44	0.87	0.98	0.83	1.67	1.31	0.94	1.87	0.62	0.62	1.23
60.00	0.05	0.05	0.11	0.31	0.34	0.68	0.39	0.42	0.84	0.94	0.82	1.63	1.25	0.92	1.85	0.59	0.60	1.19
65.00	0.05	0.05	0.10	0.30	0.33	0.66	0.38	0.41	0.81	0.90	0.80	1.60	1.20	0.91	1.82	0.57	0.58	1.15
70.00	0.04	0.05	0.10	0.29	0.32	0.64	0.36	0.39	0.78	0.87	0.78	1.56	1.16	0.90	1.80	0.55	0.56	1.12
75.00	0.04	0.05	0.09	0.28	0.31	0.62	0.35	0.38	0.76	0.84	0.77	1.53	1.12	0.89	1.77	0.53	0.54	1.09

DEPLETION OF TRICHLOROETHENE (TCE) IN PRE-ENVIRITE WASTE MATERIAL (PEWM) UNDER CELL 1
DIFFUSION TO THE HIGH PERMEABILITY SAND
ENVIRITE, THOMASTON, CT

Co =	4	mg/L	Initial Tce concentration in PEWM
D* =	1.40E-06	cm^2/sec	TCE diffusion constant
C* =	0	mg/L	TCE concentration at the interface with high permeability sand
y =	variable	cm	Distance in the PEWM layer from the PEWM-sand layer interface

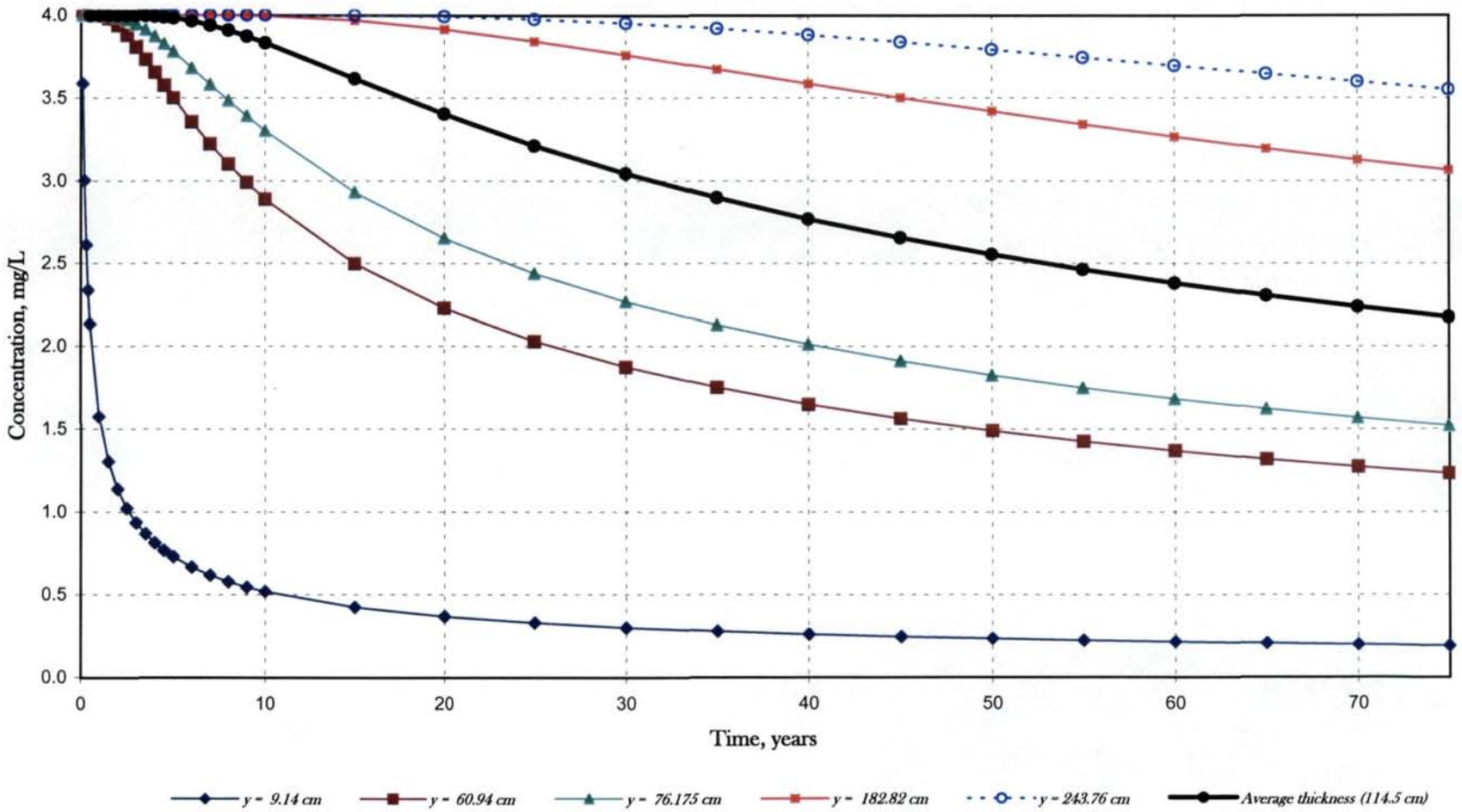
	y = 9.14 cm			y = 60.94 cm			y = 76.175 cm			y = 182.82 cm			y = 243.76 cm			y = 114.56 cm Average thickness		
t years	X = y/(4*D*t)^.5	erf (X)	C mg/L	X = y/(4*D*t)^.5	erf (X)	C mg/L	X = y/(4*D*t)^.5	erf (X)	C mg/L	X = y/(4*D*t)^.5	erf (X)	C mg/L	X = y/(4*D*t)^.5	erf (X)	C mg/L	X = y/(4*D*t)^.5	erf (X)	C mg/L
0.10	2.17	1.00	3.99	14.49	1.00	4.00	18.12	1.00	4.00	43.48			57.97			27.24		
0.20	1.54	0.97	3.88	10.25	1.00	4.00	12.81	1.00	4.00	30.74			40.99			19.27		
0.30	1.25	0.92	3.70	8.37	1.00	4.00	10.46	1.00	4.00	25.10	1.00	4.00	33.47			15.73		
0.40	1.09	0.88	3.50	7.25	1.00	4.00	9.06	1.00	4.00	21.74	1.00	4.00	28.99			13.62		
0.50	0.97	0.83	3.32	6.48	1.00	4.00	8.10	1.00	4.00	19.44	1.00	4.00	25.93	1.00	4.00	12.18	1.00	4.00
1.00	0.69	0.67	2.68	4.58	1.00	4.00	5.73	1.00	4.00	13.75	1.00	4.00	18.33	1.00	4.00	8.62	1.00	4.00
1.50	0.56	0.57	2.29	3.74	1.00	4.00	4.68	1.00	4.00	11.23	1.00	4.00	14.97	1.00	4.00	7.03	1.00	4.00
2.00	0.49	0.51	2.03	3.24	1.00	4.00	4.05	1.00	4.00	9.72	1.00	4.00	12.96	1.00	4.00	6.09	1.00	4.00
2.50	0.43	0.46	1.85	2.90	1.00	4.00	3.62	1.00	4.00	8.70	1.00	4.00	11.59	1.00	4.00	5.45	1.00	4.00
3.00	0.40	0.43	1.70	2.65	1.00	4.00	3.31	1.00	4.00	7.94	1.00	4.00	10.58	1.00	4.00	4.97	1.00	4.00
3.50	0.37	0.40	1.59	2.45	1.00	4.00	3.06	1.00	4.00	7.35	1.00	4.00	9.80	1.00	4.00	4.61	1.00	4.00
4.00	0.34	0.37	1.49	2.29	1.00	4.00	2.86	1.00	4.00	6.87	1.00	4.00	9.17	1.00	4.00	4.31	1.00	4.00
4.50	0.32	0.35	1.41	2.16	1.00	3.99	2.70	1.00	4.00	6.48	1.00	4.00	8.64	1.00	4.00	4.06	1.00	4.00
5.00	0.31	0.34	1.34	2.05	1.00	3.99	2.56	1.00	4.00	6.15	1.00	4.00	8.20	1.00	4.00	3.85	1.00	4.00
6.00	0.28	0.31	1.23	1.87	0.99	3.97	2.34	1.00	4.00	5.61	1.00	4.00	7.48	1.00	4.00	3.52	1.00	4.00
7.00	0.26	0.29	1.15	1.73	0.99	3.94	2.17	1.00	3.99	5.20	1.00	4.00	6.93	1.00	4.00	3.26	1.00	4.00
8.00	0.24	0.27	1.08	1.62	0.98	3.91	2.03	1.00	3.98	4.86	1.00	4.00	6.48	1.00	4.00	3.05	1.00	4.00
9.00	0.23	0.25	1.02	1.53	0.97	3.88	1.91	0.99	3.97	4.58	1.00	4.00	6.11	1.00	4.00	2.87	1.00	4.00
10.00	0.22	0.24	0.97	1.45	0.96	3.84	1.81	0.99	3.96	4.35	1.00	4.00	5.80	1.00	4.00	2.72	1.00	4.00
15.00	0.18	0.20	0.79	1.18	0.91	3.62	1.48	0.96	3.85	3.55	1.00	4.00	4.73	1.00	4.00	2.22	1.00	3.99
20.00	0.15	0.17	0.69	1.02	0.85	3.41	1.28	0.93	3.72	3.07	1.00	4.00	4.10	1.00	4.00	1.93	0.99	3.97
25.00	0.14	0.15	0.62	0.92	0.81	3.22	1.15	0.89	3.58	2.75	1.00	4.00	3.67	1.00	4.00	1.72	0.99	3.94
30.00	0.13	0.14	0.56	0.84	0.76	3.05	1.05	0.86	3.44	2.51	1.00	4.00	3.35	1.00	4.00	1.57	0.97	3.90
35.00	0.12	0.13	0.52	0.77	0.73	2.91	0.97	0.83	3.32	2.32	1.00	4.00	3.10	1.00	4.00	1.46	0.96	3.84
40.00	0.11	0.12	0.49	0.72	0.69	2.78	0.91	0.80	3.20	2.17	1.00	3.99	2.90	1.00	4.00	1.36	0.95	3.78
45.00	0.10	0.12	0.46	0.68	0.67	2.66	0.85	0.77	3.09	2.05	1.00	3.99	2.73	1.00	4.00	1.28	0.93	3.72
50.00	0.10	0.11	0.44	0.65	0.64	2.56	0.81	0.75	2.99	1.94	0.99	3.98	2.59	1.00	4.00	1.22	0.92	3.66
55.00	0.09	0.10	0.42	0.62	0.62	2.47	0.77	0.73	2.90	1.85	0.99	3.97	2.47	1.00	4.00	1.16	0.90	3.60
60.00	0.09	0.10	0.40	0.59	0.60	2.39	0.74	0.70	2.82	1.78	0.99	3.95	2.37	1.00	4.00	1.11	0.88	3.54
65.00	0.09	0.10	0.38	0.57	0.58	2.31	0.71	0.69	2.74	1.71	0.98	3.94	2.27	1.00	3.99	1.07	0.87	3.48
70.00	0.08	0.09	0.37	0.55	0.56	2.25	0.68	0.67	2.67	1.64	0.98	3.92	2.19	1.00	3.99	1.03	0.85	3.42
75.00	0.08	0.09	0.36	0.53	0.55	2.18	0.66	0.65	2.60	1.59	0.98	3.90	2.12	1.00	3.99	0.99	0.84	3.36

DEPLETION OF TRICHLOROETHENE (TCE) IN PRE-ENVIRITE WASTE MATERIAL (PEWM) UNDER CELL 1
DIFFUSION TO THE HIGH PERMEABILITY SAND
ENVIRITE, THOMASTON, CT

Co =	4	mg/L	Initial TCE concentration in PEWM
D* =	5.00E-06	cm^2/se	TCE diffusion constant
C* =	0	mg/L	TCE concentration at the interface with high permeability sand
y =	variable	cm	Distance in the PEWM layer from the PEWM-sand layer interface

	y = 9.14 cm			y = 60.94 cm			y = 76.175 cm			y = 182.82 cm			y = 243.76 cm			y = 114.56 cm Average thickness		
t years	X = y/(4*D*t)^.5	erf (X)	C mg/L	X = y/(4*D*t)^.5	erf (X)	C mg/L	X = y/(4*D*t)^.5	erf (X)	C mg/L	X = y/(4*D*t)^.5	erf (X)	C mg/L	X = y/(4*D*t)^.5	erf (X)	C mg/L	X = y/(4*D*t)^.5	erf (X)	C mg/L
0.10	1.15	0.90	3.59	7.67	1.00	4.00	9.59	1.00	4.00	23.02			30.69			14.42		
0.20	0.81	0.75	3.00	5.43	1.00	4.00	6.78	1.00	4.00	16.28			21.70			10.20		
0.30	0.66	0.65	2.61	4.43	1.00	4.00	5.54	1.00	4.00	13.29	1.00	4.00	17.72			8.33		
0.40	0.58	0.58	2.34	3.84	1.00	4.00	4.80	1.00	4.00	11.51	1.00	4.00	15.35			7.21		
0.50	0.51	0.53	2.13	3.43	1.00	4.00	4.29	1.00	4.00	10.29	1.00	4.00	13.73	1.00	4.00	6.45	1.00	4.00
1.00	0.36	0.39	1.57	2.43	1.00	4.00	3.03	1.00	4.00	7.28	1.00	4.00	9.71	1.00	4.00	4.56	1.00	4.00
1.50	0.30	0.33	1.30	1.98	0.99	3.98	2.48	1.00	4.00	5.94	1.00	4.00	7.92	1.00	4.00	3.72	1.00	4.00
2.00	0.26	0.28	1.14	1.72	0.98	3.94	2.14	1.00	3.99	5.15	1.00	4.00	6.86	1.00	4.00	3.23	1.00	4.00
2.50	0.23	0.26	1.02	1.53	0.97	3.88	1.92	0.99	3.97	4.60	1.00	4.00	6.14	1.00	4.00	2.88	1.00	4.00
3.00	0.21	0.23	0.93	1.40	0.95	3.81	1.75	0.99	3.95	4.20	1.00	4.00	5.60	1.00	4.00	2.63	1.00	4.00
3.50	0.19	0.22	0.87	1.30	0.93	3.73	1.62	0.98	3.91	3.89	1.00	4.00	5.19	1.00	4.00	2.44	1.00	4.00
4.00	0.18	0.20	0.81	1.21	0.91	3.66	1.52	0.97	3.87	3.64	1.00	4.00	4.85	1.00	4.00	2.28	1.00	3.99
4.50	0.17	0.19	0.77	1.14	0.89	3.58	1.43	0.96	3.83	3.43	1.00	4.00	4.58	1.00	4.00	2.15	1.00	3.99
5.00	0.16	0.18	0.73	1.09	0.88	3.50	1.36	0.94	3.78	3.26	1.00	4.00	4.34	1.00	4.00	2.04	1.00	3.98
6.00	0.15	0.17	0.67	0.99	0.84	3.36	1.24	0.92	3.68	2.97	1.00	4.00	3.96	1.00	4.00	1.86	0.99	3.97
7.00	0.14	0.15	0.62	0.92	0.81	3.22	1.15	0.90	3.58	2.75	1.00	4.00	3.67	1.00	4.00	1.72	0.99	3.94
8.00	0.13	0.14	0.58	0.86	0.77	3.10	1.07	0.87	3.48	2.57	1.00	4.00	3.43	1.00	4.00	1.61	0.98	3.91
9.00	0.12	0.14	0.54	0.81	0.75	2.99	1.01	0.85	3.39	2.43	1.00	4.00	3.24	1.00	4.00	1.52	0.97	3.87
10.00	0.12	0.13	0.52	0.77	0.72	2.89	0.96	0.83	3.30	2.30	1.00	4.00	3.07	1.00	4.00	1.44	0.96	3.83
15.00	0.09	0.11	0.42	0.63	0.62	2.50	0.78	0.73	2.93	1.88	0.99	3.97	2.51	1.00	4.00	1.18	0.90	3.62
20.00	0.08	0.09	0.37	0.54	0.56	2.23	0.68	0.66	2.65	1.63	0.98	3.91	2.17	1.00	3.99	1.02	0.85	3.40
25.00	0.07	0.08	0.33	0.49	0.51	2.03	0.61	0.61	2.44	1.46	0.96	3.84	1.94	0.99	3.98	0.91	0.80	3.21
30.00	0.07	0.07	0.30	0.44	0.47	1.88	0.55	0.57	2.27	1.33	0.94	3.76	1.77	0.99	3.95	0.83	0.76	3.04
35.00	0.06	0.07	0.28	0.41	0.44	1.75	0.51	0.53	2.13	1.23	0.92	3.67	1.64	0.98	3.92	0.77	0.72	2.90
40.00	0.06	0.06	0.26	0.38	0.41	1.65	0.48	0.50	2.01	1.15	0.90	3.59	1.53	0.97	3.88	0.72	0.69	2.77
45.00	0.05	0.06	0.24	0.36	0.39	1.56	0.45	0.48	1.91	1.09	0.88	3.50	1.45	0.96	3.84	0.68	0.66	2.66
50.00	0.05	0.06	0.23	0.34	0.37	1.49	0.43	0.46	1.82	1.03	0.85	3.42	1.37	0.95	3.79	0.65	0.64	2.55
55.00	0.05	0.06	0.22	0.33	0.36	1.43	0.41	0.44	1.75	0.98	0.83	3.34	1.31	0.94	3.74	0.62	0.62	2.46
60.00	0.05	0.05	0.21	0.31	0.34	1.37	0.39	0.42	1.68	0.94	0.82	3.26	1.25	0.92	3.69	0.59	0.60	2.38
65.00	0.05	0.05	0.20	0.30	0.33	1.32	0.38	0.41	1.62	0.90	0.80	3.19	1.20	0.91	3.65	0.57	0.58	2.31
70.00	0.04	0.05	0.20	0.29	0.32	1.27	0.36	0.39	1.57	0.87	0.78	3.13	1.16	0.90	3.60	0.55	0.56	2.24
75.00	0.04	0.05	0.19	0.28	0.31	1.23	0.35	0.38	1.52	0.84	0.77	3.06	1.12	0.89	3.55	0.53	0.54	2.17

DEPLETION OF TRICHLOROETHENE (TCE) IN PRE-ENVIRITE WASTE MATERIAL UNDER CELL 1
DIFFUSION TO THE HIGH PERMEABILITY SAND
Concentration vs. Time
(Assuming: Co = 4 mg/L, C* = 0 mg/L, D* = 5* 10^-6 cm^2/sec)



diffusion Calc 12-14-00 senstivity D
TCE sensitivity chart

7/18/01

DEPLETION OF TETRACHLOROEHENE (PCE) IN PRE-ENVIRITE WASTE MATERIAL (PEWM) UNDER CELL 1
DIFFUSION TO THE HIGH PERMEABILITY SAND (PERCENT SATURATION SENSITIVITY ANALYSES)
ENVIRITE, THOMASTON, CT

Co =	2	mg/L	Initial PCE concentration in PEWM
D* =	variable	cm^2/se	PCE diffusion constant
C* =	0	mg/L	PCE concentration at the interface with high permeability sand
y =	variable	cm	Distance in the PEWM layer from the PEWM-sand layer interface

	% Saturation 88	% Qw 22	D* (PCE) 5.62E-07	% Saturation 89	% Qw 24	D* (PCE) 1.12E-06	% Saturation 90	% Qw 26	D* (PCE) 1.79E-06	% Saturation 95	% Qw 28	D* (PCE) 1.47E-06	% Saturation 100	% Qw 40	D* (PCE) 1.60E-06	% Saturation 88	% Qw 32	D* (PCE) 5.62E-07	% Saturation 89	% Qw 34	D* (PCE) 1.12E-06	% Saturation 90	% Qw 36	D* (PCE) 1.79E-06	% Saturation 95	% Qw 38	D* (PCE) 1.47E-06	% Saturation 100	% Qw 40	D* (PCE) 1.60E-06	% Saturation 88	% Qw 32	D* (PCE) 5.62E-07	% Saturation 89	% Qw 34	D* (PCE) 1.12E-06	% Saturation 90	% Qw 36	D* (PCE) 1.79E-06	% Saturation 95	% Qw 38	D* (PCE) 1.47E-06	% Saturation 100	% Qw 40	D* (PCE) 1.60E-06
	y= 9.14 cm			y= 9.14 cm			y= 9.14 cm			y= 9.14 cm			y= 9.14 cm			y= 60.94 cm			y= 60.94 cm			y= 60.94 cm			y= 60.94 cm			y= 60.94 cm			y= 114.5 cm			y= 114.5 cm			y= 114.5 cm			y= 114.5 cm		
t years	X= $y/(4*D*t)^{0.5}$	erf (X)	C mg/L	X= $y/(4*D*t)^{0.5}$	erf (X)	C mg/L	X= $y/(4*D*t)^{0.5}$	erf (X)	C mg/L	X= $y/(4*D*t)^{0.5}$	erf (X)	C mg/L	X= $y/(4*D*t)^{0.5}$	erf (X)	C mg/L	X= $y/(4*D*t)^{0.5}$	erf (X)	C mg/L	X= $y/(4*D*t)^{0.5}$	erf (X)	C mg/L	X= $y/(4*D*t)^{0.5}$	erf (X)	C mg/L	X= $y/(4*D*t)^{0.5}$	erf (X)	C mg/L	X= $y/(4*D*t)^{0.5}$	erf (X)	C mg/L	X= $y/(4*D*t)^{0.5}$	erf (X)	C mg/L	X= $y/(4*D*t)^{0.5}$	erf (X)	C mg/L	X= $y/(4*D*t)^{0.5}$	erf (X)	C mg/L	X= $y/(4*D*t)^{0.5}$	erf (X)	C mg/L	X= $y/(4*D*t)^{0.5}$	erf (X)	C mg/L
0.10	2.60	1.00	2.00	2.42	1.00	2.00	2.28	1.00	2.00	2.13	1.00	1.99	2.00	1.00	1.99	17.31	1.00	2.00	16.13	1.00	2.00	15.09	1.00	2.00	14.17	1.00	2.00	13.35	1.00	2.00	32.53	1.00	2.00	30.31	1.00	2.00	28.36	1.00	2.00	26.62	1.00	2.00	25.08	1.00	2.00
0.20	1.84	0.99	1.98	1.71	0.98	1.97	1.60	0.98	1.95	1.50	0.97	1.93	1.42	0.95	1.91	12.24	1.00	2.00	11.41	1.00	2.00	10.67	1.00	2.00	10.02	1.00	2.00	9.44	1.00	2.00	23.00	1.00	2.00	21.43	1.00	2.00	20.05	1.00	2.00	18.82	1.00	2.00	17.73	1.00	2.00
0.30	1.50	0.97	1.93	1.40	0.95	1.90	1.31	0.94	1.87	1.23	0.92	1.83	1.16	0.90	1.80	10.00	1.00	2.00	9.31	1.00	2.00	8.71	1.00	2.00	8.18	1.00	2.00	7.71	1.00	2.00	18.78	1.00	2.00	17.50	1.00	2.00	16.37	1.00	2.00	15.37	1.00	2.00	14.48	1.00	2.00
0.40	1.30	0.93	1.87	1.21	0.91	1.83	1.13	0.89	1.78	1.06	0.87	1.73	1.00	0.84	1.69	8.66	1.00	2.00	8.07	1.00	2.00	7.55	1.00	2.00	7.08	1.00	2.00	6.67	1.00	2.00	16.27	1.00	2.00	15.16	1.00	2.00	14.18	1.00	2.00	13.31	1.00	2.00	12.54	1.00	2.00
0.50	1.16	0.90	1.80	1.08	0.87	1.75	1.01	0.85	1.70	0.95	0.82	1.64	0.90	0.79	1.59	7.74	1.00	2.00	7.21	1.00	2.00	6.75	1.00	2.00	6.34	1.00	2.00	5.97	1.00	2.00	14.55	1.00	2.00	13.56	1.00	2.00	12.68	1.00	2.00	11.91	1.00	2.00	11.21	1.00	2.00
1.00	0.82	0.75	1.51	0.77	0.72	1.44	0.72	0.69	1.38	0.67	0.66	1.32	0.63	0.63	1.26	5.48	1.00	2.00	5.10	1.00	2.00	4.77	1.00	2.00	4.48	1.00	2.00	4.22	1.00	2.00	10.29	1.00	2.00	9.58	1.00	2.00	8.97	1.00	2.00	8.42	1.00	2.00	7.93	1.00	2.00
1.50	0.67	0.66	1.31	0.62	0.62	1.25	0.58	0.59	1.18	0.55	0.56	1.12	0.52	0.54	1.07	4.47	1.00	2.00	4.17	1.00	2.00	3.90	1.00	2.00	3.66	1.00	2.00	3.45	1.00	2.00	8.40	1.00	2.00	7.83	1.00	2.00	7.32	1.00	2.00	6.87	1.00	2.00	6.47	1.00	2.00
2.00	0.58	0.59	1.18	0.54	0.56	1.11	0.51	0.53	1.05	0.48	0.50	1.00	0.45	0.47	0.95	3.87	1.00	2.00	3.61	1.00	2.00	3.37	1.00	2.00	3.17	1.00	2.00	2.98	1.00	2.00	7.27	1.00	2.00	6.78	1.00	2.00	6.34	1.00	2.00	5.95	1.00	2.00	5.61	1.00	2.00
2.50	0.52	0.54	1.07	0.48	0.51	1.01	0.45	0.48	0.96	0.43	0.45	0.90	0.40	0.43	0.86	3.46	1.00	2.00	3.23	1.00	2.00	3.02	1.00	2.00	2.83	1.00	2.00	2.67	1.00	2.00	6.51	1.00	2.00	6.06	1.00	2.00	5.67	1.00	2.00	5.32	1.00	2.00	5.02	1.00	2.00
3.00	0.47	0.50	0.99	0.44	0.47	0.94	0.41	0.44	0.88	0.39	0.42	0.83	0.37	0.39	0.79	3.16	1.00	2.00	2.95	1.00	2.00	2.76	1.00	2.00	2.59	1.00	2.00	2.44	1.00	2.00	5.94	1.00	2.00	5.53	1.00	2.00	5.18	1.00	2.00	4.86	1.00	2.00	4.58	1.00	2.00
3.50	0.44	0.47	0.93	0.41	0.44	0.87	0.38	0.41	0.82	0.36	0.39	0.78	0.34	0.37	0.74	2.93	1.00	2.00	2.73	1.00	2.00	2.55	1.00	2.00	2.39	1.00	2.00	2.26	1.00	2.00	5.50	1.00	2.00	5.12	1.00	2.00	4.79	1.00	2.00	4.50	1.00	2.00	4.24	1.00	2.00
4.00	0.41	0.44	0.88	0.38	0.41	0.82	0.36	0.39	0.77	0.34	0.37	0.73	0.32	0.35	0.69	2.74	1.00	2.00	2.55	1.00	2.00	2.38	1.00	2.00	2.24	1.00	2.00	2.11	1.00	1.99	5.14	1.00	2.00	4.79	1.00	2.00	4.48	1.00	2.00	4.21	1.00	2.00	3.96	1.00	2.00
4.50	0.39	0.42	0.83	0.36	0.39	0.78	0.34	0.37	0.73	0.32	0.35	0.68	0.30	0.33	0.65	2.58	1.00	2.00	2.40	1.00	2.00	2.25	1.00	2.00	2.11	1.00	1.99	1.99	1.00	1.99	4.85	1.00	2.00	4.52	1.00	2.00	4.23	1.00	2.00	3.97	1.00	2.00	3.74	1.00	2.00
5.00	0.37	0.40	0.79	0.34	0.37	0.74	0.32	0.35	0.70	0.30	0.33	0.66	0.28	0.31	0.62	2.45	1.00	2.00	2.28	1.00	2.00	2.13	1.00	1.99	2.00	1.00	1.99	1.89	0.99	1.98	4.60	1.00	2.00	4.29	1.00	2.00	4.01	1.00	2.00	3.78	1.00	2.00	3.55	1.00	2.00
6.00	0.34	0.36	0.73	0.31	0.34	0.68	0.29	0.32	0.64	0.27	0.30	0.60	0.26	0.29	0.57	2.24	1.00	2.00	2.08	1.00	1.99	1.95	0.99	1.99	1.83	0.99	1.98	1.72	0.99	1.97	4.20	1.00	2.00	3.91	1.00	2.00	3.66	1.00	2.00	3.44	1.00	2.00	3.24	1.00	2.00
7.00	0.31	0.34	0.68	0.29	0.32	0.63	0.27	0.30	0.60	0.25	0.28	0.56	0.24	0.26	0.53	2.07	1.00	1.99	1.93	0.99	1.99	1.80	0.99	1.98	1.69	0.98	1.97	1.60	0.98	1.95	3.89	1.00	2.00	3.62	1.00	2.00	3.39	1.00	2.00	3.18	1.00	2.00	3.00	1.00	2.00
8.00	0.29	0.32	0.64	0.27	0.30	0.60	0.25	0.28	0.56	0.24	0.26	0.53	0.22	0.25	0.50	1.94	0.99	1.99	1.80	0.99	1.98	1.69	0.98	1.97	1.58	0.97	1.95	1.49	0.97	1.93	3.64	1.00	2.00	3.39	1.00	2.00	3.17	1.00	2.00	2.98	1.00	2.00	2.80	1.00	2.00
9.00	0.27	0.30	0.60	0.26	0.28	0.56	0.24	0.26	0.53	0.22	0.25	0.50	0.21	0.23	0.47	1.83	0.99	1.98	1.70	0.98	1.97	1.59	0.98	1.95	1.49	0.97	1.93	1.41	0.95	1.91	3.43	1.00	2.00	3.19	1.00	2.00	2.99	1.00	2.00	2.81	1.00	2.00	2.64	1.00	2.00
10.00	0.26	0.29	0.57	0.24	0.27	0.54	0.23	0.25	0.50	0.21	0.24	0.47	0.20	0.22	0.45	1.73	0.98	1.97	1.61	0.98	1.95	1.51	0.97	1.93	1.42	0.95	1.91	1.33	0.94	1.88	3.25	1.00	2.00	3.03	1.00	2.00	2.84	1.00	2.00	2.66	1.00	2.00	2.51	1.00	2.00
15.00	0.21	0.24	0.47	0.20	0.22	0.44	0.18	0.21	0.41	0.17	0.19	0.39	0.16	0.18	0.37	1.41	0.95	1.91	1.32	0.94	1.88	1.23	0.92	1.84	1.16	0.90	1.80	1.09	0.88	1.75	2.66	1.00	2.00	2.47	1.00	2.00	2.32	1.00	2.00	2.17	1.00	2.00	2.05	1.00	1.99
20.00	0.18	0.20	0.41	0.17	0.19	0.38	0.16	0.18	0.36	0.15	0.17	0.34	0.14	0.16	0.32	1.22	0.92	1.83	1.14	0.89	1.79	1.07	0.87	1.74	1.00	0.84	1.69	0.94	0.82	1.64	2.30	1.00	2.00	2.14	1.00	2.00	2.01	1.00	1.99	1.88	0.99	1.98	1.77	0.99	1.98
25.00	0.16	0.18	0.37	0.15	0.17	0.34	0.14	0.16	0.32	0.13	0.15	0.30	0.13	0.14	0.28	1.10	0.88	1.76	1.02	0.85	1.70	0.95	0.82	1.65	0.90	0.79	1.59	0.84	0.77	1.53	2.06	1.00	1.99	1.92	0.99	1.99	1.79	0.99	1.98	1.68	0.98	1.97	1.58	0.98	1.95
30.00	0.15	0.17	0.34	0.14	0.16	0.31	0.13	0.15	0.29	0.12	0.14	0.28	0.12	0.13	0.26	1.00	0.84	1.69	0.93	0.81	1.62	0.87	0.78	1.56	0.82	0.75	1.51	0.77	0.72	1.45	1.88	0.99	1.98	1.75	0.99	1.97	1.64	0.98	1.96	1.54	0.97	1.94	1.45	0.96	1.92
35.00	0.14	0.16	0.31	0.13	0.15	0.29	0.12	0.14	0.27	0.11	0.13	0.26	0.11	0.12	0.24	0.93	0.81	1.62	0.86	0.78	1.56	0.81	0.75	1.49	0.76	0.72	1.43	0.71	0.69	1.37	1.74	0.99	1.97	1.62	0.98	1.96	1.52	0.97	1.94	1.42	0.96	1.91	1.34	0.94	1.88
40.00	0.13	0.15	0.29	0.12	0.14	0.27	0.11	0.13	0.25	0.11	0.12	0.24	0.10	0.11	0.23	0.87	0.78	1.56	0.81	0.75	1.49	0.75	0.71	1.43	0.71	0.68	1.37	0.67	0.65	1.31	1.63	0.98	1.96	1.52	0.97	1.94	1.42	0.96	1.91	1.33	0.94	1.88	1.25	0.92	1.85
45.00	0.12	0.14	0.27	0.11	0.13	0.26	0.11	0.12	0.24	0.10	0.11	0.23	0.09	0.11	0.21	0.82	0.75	1.50	0.76	0.72	1.44	0.71	0.69	1.37	0.67	0.66	1.31	0.63	0.63	1.25	1.53	0.97	1.94	1.43	0.96	1.91	1.34	0.94	1.88	1.25	0.92	1.85	1.18	0.91	1.81
50.00	0.12	0.13	0.26	0.11	0.12	0.24	0.10	0.11	0.23	0.10	0.11	0.21	0.09	0.10	0.20	0.77	0.73	1.45	0.72	0.69	1.38	0.67	0.66	1.32	0.63	0.63	1.26	0.60	0.60	1.20	1.45	0.96	1.92	1.36	0.94	1.88	1.27	0.93	1.85	1.19	0.91	1.82	1.12	0.89	1.77
55.00	0.11	0.12	0.25	0.10	0.12	0.23	0.10	0.11	0.22	0.09	0.10	0.20	0.09	0.10	0.19	0.74	0.70	1.41	0.69	0.67	1.34	0.64	0.64	1.27	0.60	0.61	1.21	0.57	0.58	1.16	1.39	0.95	1.90	1.29	0.93	1.86	1.21	0.91	1.83	1.14	0.89	1.78	1.07	0.87	1.74
60.00	0.11	0.12	0.24	0.10	0.11	0.22	0.09	0.10	0.21	0.09	0.10	0.20	0.08	0.09	0.18	0.71	0.68	1.37	0.66	0.65	1.30	0.62	0.62	1.23	0.58	0.59	1.17	0.54	0.56	1.12	1.33	0.94	1.88	1.24	0.92	1.84	1.16	0.90	1.80	1.09	0.88	1.75	1.02	0.85	1.70
65.00	0.10	0.11	0.23	0.09	0.11	0.21	0.09	0.10	0.20	0.08	0.09	0.19	0.08	0.09	0.18	0.68	0.66	1.33	0.63	0.63	1.26	0.59	0.60	1.19	0.56	0.57	1.14	0.52	0.54	1.08	1.28	0.93	1.86	1.19	0.91	1.81	1.11	0.88	1.77	1.04	0.86	1.72	0.98	0.84	1.67
70.00	0.10	0.11	0.22	0.09	0.10	0.21	0.09	0.10	0.19	0.08	0.09	0.18	0.08	0.09	0.17	0.65	0.65	1.29	0.61	0.61	1.22	0.57	0.58	1.16	0.54	0.55	1.10	0.50	0.52	1.05	1.23	0.92	1.84	1.15	0.89	1.79	1.07	0.87	1.74	1.01	0.85	1.69	0.95	0.82	1.64
75.00	0.09	0.11	0.21	0.09	0.10	0.20	0.08	0.09	0.19	0.08	0.09	0.17	0.07	0.08	0.16	0.63	0.63	1.26	0.59	0.60	1.19	0.55	0.56	1.13	0.52	0.54	1.07	0.49	0.51	1.02	1.19	0.91	1.81	1.11	0.88	1.76	1.04	0.86	1.71	0.97	0.83	1.66	0.92	0.80	1.61

File Name: diffusion Calc 12-14-00 sensitivity saturation
Tab Name: PCE

7/18/01

DEPLETION OF TRICHLOROEHENE (TCE) IN PRE-ENVIRITE WASTE MATERIAL (PEWM) UNDER CELL 1
DIFFUSION TO THE HIGH PERMEABILITY SAND (PERCENT SATURATION SENSITIVITY ANALYSES)
ENVIRITE, THOMASTON, CT

Co =	4	mg/L	Initial TCE concentration in PEWM
D* =	variable	cm^2/s	TCE diffusion constant
C' =	0	mg/L	TCE concentration at the interface with high permeability sand
y =	variable	cm	Distance in the PEWM layer from the PEWM-sand layer interface

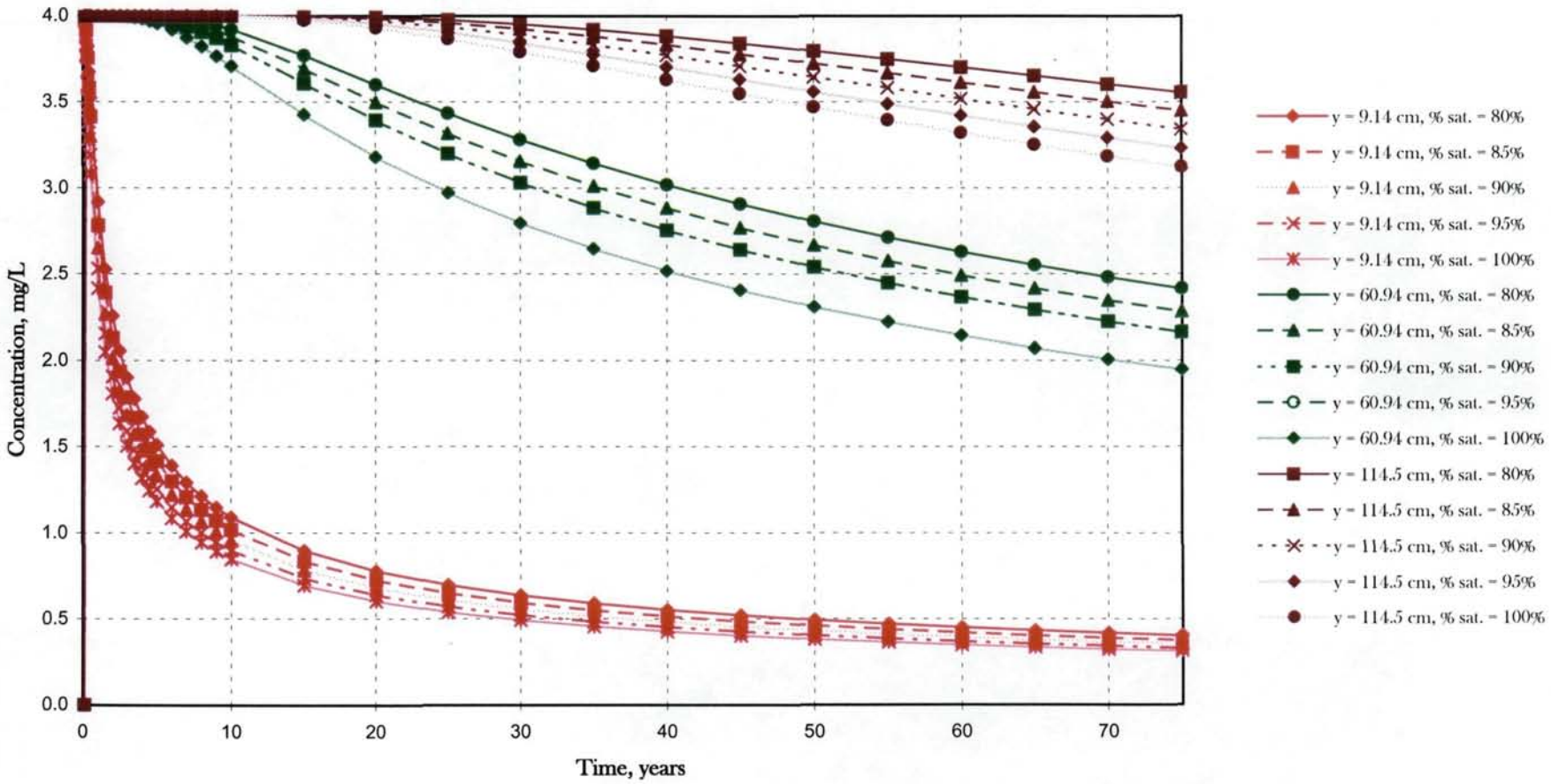
	% Saturation 80	% Qw 32	D* (TCE) 1.09E-06	% Saturation 85	% Qw 34	D* (TCE) 1.25E-06	% Saturation 90	% Qw 36	D* (TCE) 1.44E-06	% Saturation 95	% Qw 38	D* (TCE) 1.63E-06	% Saturation 100	% Qw 40	D* (TCE) 1.84E-06	% Saturation 80	% Qw 32	D* (TCE) 1.09E-06	% Saturation 85	% Qw 34	D* (TCE) 1.25E-06	% Saturation 90	% Qw 36	D* (TCE) 1.44E-06	% Saturation 95	% Qw 38	D* (TCE) 1.44E-06	% Saturation 100	% Qw 40	D* (TCE) 1.84E-06	% Saturation 80	% Qw 32	D* (TCE) 1.09E-06	% Saturation 85	% Qw 34	D* (TCE) 1.25E-06	% Saturation 90	% Qw 36	D* (TCE) 1.44E-06	% Saturation 95	% Qw 38	D* (TCE) 1.63E-06	% Saturation 100	% Qw 40	D* (TCE) 1.84E-06
	y = 9.14 cm			y = 9.14 cm			y = 9.14 cm			y = 9.14 cm			y = 9.14 cm			y = 60.94 cm			y = 60.94 cm			y = 60.94 cm			y = 60.94			y = 60.94 cm			y = 114.5 cm			y = 114.5 cm			y = 114.5 cm			y = 114.5 cm		
t years	X = y/(4*D*t)^.5	erf (X)	C mg/L	X = y/(4*D*t)^.5	erf (X)	C mg/L	X = y/(4*D*t)^.5	erf (X)	C mg/L	X = y/(4*D*t)^.5	erf (X)	C mg/L	X = y/(4*D*t)^.5	erf (X)	C mg/L	X = y/(4*D*t)^.5	erf (X)	C mg/L	X = y/(4*D*t)^.5	erf (X)	C mg/L	X = y/(4*D*t)^.5	erf (X)	C mg/L	X = y/(4*D*t)^.5	erf (X)	C mg/L	X = y/(4*D*t)^.5	erf (X)	C mg/L	X = y/(4*D*t)^.5	erf (X)	C mg/L	X = y/(4*D*t)^.5	erf (X)	C mg/L	X = y/(4*D*t)^.5	erf (X)	C mg/L	X = y/(4*D*t)^.5	erf (X)	C mg/L	X = y/(4*D*t)^.5	erf (X)	C mg/L
0.10	2.46	1.00	4.00	2.30	1.00	4.00	2.15	1.00	3.99	2.02	1.00	3.98	1.90	0.99	3.97	16.43	1.00	4.00	15.31	1.00	4.00	14.32	1.00	4.00	14.32	1.00	4.00	30.87	INUM	INUM	28.76	INUM	INUM	26.91	1.00	4.00	25.26	1.00	4.00	23.79	1.00	4.00
0.20	1.74	0.99	3.95	1.62	0.98	3.91	1.52	0.97	3.87	1.43	0.96	3.82	1.34	0.94	3.77	11.62	1.00	4.00	10.82	1.00	4.00	10.13	1.00	4.00	10.13	1.00	4.00	21.83	1.00	4.00	20.34	1.00	4.00	19.03	1.00	4.00	17.86	1.00	4.00	16.82	1.00	4.00
0.30	1.42	0.96	3.82	1.33	0.94	3.76	1.24	0.92	3.68	1.16	0.90	3.60	1.10	0.88	3.52	9.49	1.00	4.00	8.84	1.00	4.00	8.27	1.00	4.00	8.27	1.00	4.00	17.82	1.00	4.00	16.61	1.00	4.00	15.54	1.00	4.00	14.58	1.00	4.00	13.74	1.00	4.00
0.40	1.23	0.92	3.67	1.15	0.90	3.56	1.07	0.87	3.48	1.01	0.85	3.38	0.95	0.82	3.28	8.21	1.00	4.00	7.65	1.00	4.00	7.16	1.00	4.00	7.16	1.00	4.00	15.43	1.00	4.00	14.38	1.00	4.00	13.46	1.00	4.00	12.63	1.00	4.00	11.90	1.00	4.00
0.50	1.10	0.88	3.52	1.03	0.85	3.41	0.96	0.83	3.30	0.90	0.80	3.19	0.85	0.77	3.08	7.35	1.00	4.00	6.85	1.00	4.00	6.40	1.00	4.00	6.40	1.00	4.00	13.80	1.00	4.00	12.86	1.00	4.00	12.04	1.00	4.00	11.30	1.00	4.00	10.64	1.00	4.00
1.00	0.78	0.73	2.92	0.73	0.70	2.78	0.68	0.66	2.65	0.64	0.63	2.53	0.60	0.60	2.42	5.20	1.00	4.00	4.84	1.00	4.00	4.53	1.00	4.00	4.53	1.00	4.00	9.76	1.00	4.00	9.09	1.00	4.00	8.51	1.00	4.00	7.99	1.00	4.00	7.52	1.00	4.00
1.50	0.64	0.63	2.53	0.59	0.60	2.39	0.55	0.57	2.27	0.52	0.54	2.15	0.49	0.51	2.05	4.24	1.00	4.00	3.95	1.00	4.00	3.70	1.00	4.00	3.70	1.00	4.00	7.97	1.00	4.00	7.43	1.00	4.00	6.95	1.00	4.00	6.52	1.00	4.00	6.14	1.00	4.00
2.00	0.55	0.56	2.26	0.51	0.53	2.13	0.48	0.50	2.01	0.45	0.48	1.91	0.42	0.45	1.81	3.67	1.00	4.00	3.42	1.00	4.00	3.20	1.00	4.00	3.20	1.00	4.00	6.90	1.00	4.00	6.43	1.00	4.00	6.02	1.00	4.00	5.65	1.00	4.00	5.32	1.00	4.00
2.50	0.49	0.51	2.06	0.46	0.48	1.94	0.43	0.46	1.83	0.40	0.43	1.73	0.38	0.41	1.64	3.29	1.00	4.00	3.06	1.00	4.00	2.86	1.00	4.00	2.86	1.00	4.00	6.17	1.00	4.00	5.75	1.00	4.00	5.38	1.00	4.00	5.05	1.00	4.00	4.76	1.00	4.00
3.00	0.45	0.48	1.90	0.42	0.45	1.79	0.39	0.42	1.68	0.37	0.40	1.59	0.35	0.38	1.50	3.00	1.00	4.00	2.79	1.00	4.00	2.61	1.00	4.00	2.61	1.00	4.00	5.64	1.00	4.00	5.25	1.00	4.00	4.91	1.00	4.00	4.61	1.00	4.00	4.34	1.00	4.00
3.50	0.42	0.44	1.78	0.39	0.42	1.67	0.36	0.39	1.57	0.34	0.37	1.48	0.32	0.35	1.40	2.78	1.00	4.00	2.59	1.00	4.00	2.42	1.00	4.00	2.42	1.00	4.00	5.22	1.00	4.00	4.86	1.00	4.00	4.55	1.00	4.00	4.27	1.00	4.00	4.02	1.00	4.00
4.00	0.39	0.42	1.67	0.36	0.39	1.57	0.34	0.37	1.48	0.32	0.35	1.39	0.30	0.33	1.32	2.60	1.00	4.00	2.42	1.00	4.00	2.26	1.00	3.99	2.26	1.00	3.99	4.88	1.00	4.00	4.55	1.00	4.00	4.26	1.00	4.00	3.99	1.00	4.00	3.76	1.00	4.00
4.50	0.37	0.40	1.58	0.34	0.37	1.49	0.32	0.35	1.40	0.30	0.33	1.32	0.28	0.31	1.24	2.45	1.00	4.00	2.28	1.00	3.99	2.13	1.00	3.99	2.13	1.00	3.99	4.60	1.00	4.00	4.29	1.00	4.00	4.01	1.00	4.00	3.77	1.00	4.00	3.55	1.00	4.00
5.00	0.35	0.38	1.51	0.32	0.35	1.42	0.30	0.33	1.33	0.29	0.31	1.25	0.27	0.30	1.18	2.32	1.00	4.00	2.16	1.00	3.99	2.03	1.00	3.98	2.03	1.00	3.98	4.37	1.00	4.00	4.07	1.00	4.00	3.81	1.00	4.00	3.57	1.00	4.00	3.36	1.00	4.00
6.00	0.32	0.35	1.39	0.30	0.32	1.30	0.28	0.31	1.22	0.26	0.29	1.15	0.25	0.27	1.08	2.12	1.00	3.99	1.96	0.99	3.98	1.85	0.99	3.96	1.85	0.99	3.96	1.63	0.98	3.92	3.71	1.00	4.00	3.47	1.00	4.00	3.26	1.00	4.00	3.07	1.00	4.00
7.00	0.29	0.32	1.29	0.27	0.30	1.21	0.26	0.28	1.13	0.24	0.27	1.07	0.23	0.25	1.01	1.96	0.99	3.98	1.83	0.99	3.96	1.71	0.98	3.94	1.71	0.98	3.94	1.51	0.97	3.87	3.69	1.00	4.00	3.44	1.00	4.00	3.02	1.00	4.00	2.84	1.00	4.00
8.00	0.26	0.30	1.21	0.26	0.28	1.13	0.24	0.27	1.06	0.23	0.25	1.00	0.21	0.24	0.94	1.84	0.99	3.96	1.71	0.98	3.94	1.60	0.98	3.91	1.60	0.98	3.91	1.42	0.95	3.82	3.45	1.00	4.00	3.22	1.00	4.00	2.82	1.00	4.00	2.66	1.00	4.00
9.00	0.26	0.29	1.15	0.24	0.27	1.07	0.23	0.25	1.00	0.21	0.24	0.96	0.20	0.22	0.89	1.73	0.99	3.94	1.61	0.98	3.91	1.51	0.97	3.87	1.51	0.97	3.87	1.33	0.94	3.76	3.25	1.00	4.00	3.03	1.00	4.00	2.84	1.00	4.00	2.66	1.00	4.00
10.00	0.25	0.27	1.09	0.23	0.25	1.02	0.21	0.24	0.95	0.20	0.22	0.90	0.19	0.21	0.85	1.64	0.98	3.92	1.53	0.97	3.88	1.43	0.96	3.83	1.43	0.96	3.83	1.27	0.93	3.71	3.09	1.00	4.00	2.88	1.00	4.00	2.69	1.00	4.00	2.53	1.00	4.00
15.00	0.20	0.22	0.90	0.19	0.21	0.84	0.18	0.20	0.78	0.16	0.18	0.74	0.16	0.17	0.69	1.34	0.94	3.77	1.25	0.92	3.69	1.17	0.90	3.61	1.17	0.90	3.61	1.03	0.86	3.43	2.52	1.00	4.00	2.35	1.00	4.00	2.20	1.00	3.99	2.06	1.00	3.99
20.00	0.17	0.19	0.78	0.16	0.18	0.73	0.15	0.17	0.68	0.14	0.16	0.64	0.13	0.15	0.60	1.16	0.90	3.60	1.08	0.87	3.50	1.01	0.85	3.39	1.01	0.85	3.39	0.90	0.79	3.18	2.18	1.00	3.99	2.03	1.00	3.98	1.90	0.99	3.97	1.79	0.99	3.95
25.00	0.16	0.17	0.70	0.15	0.16	0.65	0.14	0.15	0.61	0.13	0.14	0.57	0.12	0.13	0.54	1.04	0.86	3.43	0.97	0.83	3.32	0.91	0.80	3.20	0.91	0.80	3.20	0.80	0.74	2.97	1.95	0.99	3.98	1.82	0.99	3.96	1.70	0.98	3.94	1.60	0.98	3.90
30.00	0.14	0.16	0.64	0.13	0.15	0.59	0.12	0.14	0.56	0.12	0.13	0.52	0.11	0.12	0.49	0.95	0.82	3.28	0.88	0.79	3.15	0.83	0.76	3.03	0.83	0.76	3.03	0.73	0.70	2.80	1.78	0.99	3.95	1.66	0.98	3.92	1.55	0.97	3.89	1.46	0.96	3.84
35.00	0.13	0.15	0.59	0.12	0.14	0.55	0.11	0.13	0.52	0.11	0.12	0.48	0.10	0.11	0.46	0.88	0.79	3.14	0.82	0.75	3.01	0.77	0.72	2.88	0.77	0.72	2.88	0.68	0.66	2.65	1.65	0.98	3.92	1.54	0.97	3.88	1.44	0.96	3.83	1.35	0.94	3.78
40.00	0.12	0.14	0.55	0.11	0.13	0.52	0.11	0.12	0.49	0.10	0.11	0.45	0.09	0.11	0.43	0.82	0.75	3.02	0.77	0.72	2.88	0.72	0.69	2.75	0.72	0.69	2.75	0.63	0.63	2.52	1.54	0.97	3.88	1.44	0.96	3.83	1.35	0.94	3.77	1.26	0.93	3.70
45.00	0.12	0.13	0.52	0.11	0.12	0.49	0.10	0.11	0.46	0.10	0.11	0.43	0.09	0.10	0.40	0.77	0.73	2.91	0.72	0.69	2.77	0.68	0.66	2.64	0.68	0.66	2.64	0.60	0.60	2.41	1.46	0.96	3.84	1.36	0.94	3.78	1.27	0.93	3.71	1.19	0.91	3.63
50.00	0.11	0.12	0.50	0.10	0.12	0.46	0.10	0.11	0.43	0.09	0.10	0.41	0.08	0.10	0.38	0.73	0.70	2.80	0.68	0.67	2.67	0.64	0.63	2.54	0.64	0.63	2.54	0.57	0.58	2.31	1.38	0.95	3.80	1.29	0.93	3.72	1.20	0.91	3.65	1.13	0.89	3.56
55.00	0.11	0.12	0.47	0.10	0.11	0.44	0.09	0.10	0.41	0.09	0.10	0.39	0.08	0.09	0.36	0.70	0.68	2.71	0.65	0.64	2.58	0.61	0.61	2.45	0.61	0.61	2.45	0.54	0.55	2.22	1.32	0.94	3.75	1.23	0.92	3.67	1.15	0.90	3.58	1.08	0.87	3.49
60.00	0.10	0.11	0.45	0.09	0.11	0.42	0.09	0.10	0.39	0.08	0.09	0.37	0.08	0.09	0.35	0.67	0.66	2.63	0.62	0.62	2.49	0.58	0.59	2.37	0.58	0.59	2.37	0.52	0.54	2.14	1.26	0.93	3.70	1.17	0.90	3.61	1.10	0.88	3.52	1.03	0.86	3.42
65.00	0.10	0.11	0.43	0.09	0.10	0.41	0.08	0.09	0.38	0.08	0.09	0.36	0.07	0.08	0.34	0.64	0.64	2.55	0.60	0.60	2.42	0.56	0.57	2.29	0.56	0.57	2.29	0.50	0.52	2.07	1.21	0.91	3.65	1.13	0.89	3.56	1.06	0.86	3.46	0.99	0.84	3.36
70.00	0.09	0.10	0.42	0.09	0.10	0.39	0.08	0.09	0.37	0.08	0.09	0.34	0.07	0.08	0.32	0.62	0.62	2.48	0.58	0.59	2.35	0.54	0.56	2.22	0.54	0.56	2.22	0.48	0.50	2.01	1.17	0.90	3.60	1.09	0.88	3.50	1.02	0.85	3.40	0.95	0.82	3.29
75.00	0.09	0.10	0.41	0.08	0.09	0.38	0.08	0.09	0.35	0.07	0.08	0.33	0.07	0.08	0.31	0.60	0.60	2.42	0.56	0.57	2.28	0.52	0.54	2.16	0.52	0.54	2.16	0.46	0.49	1.95	1.13	0.89	3.56	1.05	0.86	3.45	0.98	0.84	3.34	0.92	0.81	3.23

DEPLETION OF TRICHLOROETHENE (TCE) IN PRE-ENVIRITE WASTE MATERIAL UNDER CELL 1

THE EFFECT OF PERCENT SATURATION ON DIFFUSION

Concentration vs. Time

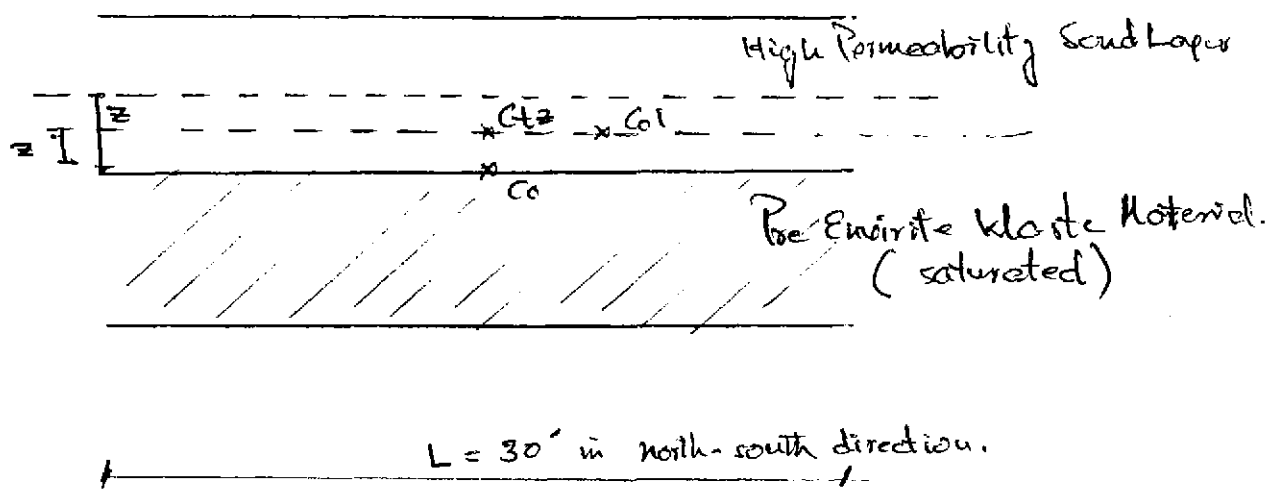
(Assuming: Co = 3 mg/L, C* = 0 mg/L, D* = varies with % sat.)



DIFFUSION MODEL

(Concentration Profile in High Permeability Sand)

Equation used: Fick's Second Law.



SEE REFERENCE NEXT PAGE

Fick's Second Law (Semi Infinite Solution)

$$\frac{C_{tz} - C_o}{C_{oi} - C_o} = \mathrm{erf}\left(\frac{z}{\sqrt{4D^* \cdot t}}\right)$$

$$= \mathrm{erf}(\beta)$$

$$\therefore \beta = \frac{z}{\sqrt{4D^* \cdot t}}$$

where,

C_{tz} = Conc. in sand at depth z and time t ($\frac{mg}{L}$)

C_o = Constant conc. in PEWM

C_{oi} = Initial conc. of sand

z = Depth of penetration. (cm)

D^* = Diffusion Coefficient

COMPUTATION SHEET

Client

Site EMMIRTE

Description

XPERT DESIGN AND DIAGNOSTICS, LLC

Page (2) of (2)

Job#

Computed By OU. Date

Checked By Date

Model Assumptions:

- Groundwater flow is limited to the surface of PEMM. (No flow inside PEMM) This is due to the dense nature of PEMM, effective sol. calc. and observed conc. at downgradient.
- Water packet flows from the north edge to the south edge of PEMM and due to that the conc. at the upper edge are higher.

REFERENCE: THIBODEAUX, LOUIS J.. ENVIRONMENTAL CHEMODYNAMICS 2ND ED. SERIES ED. J.L. SCHNOOR AND A. ZEHNDER NEW YORK, 1996. (PAGES 100-161.)

PCE Concentration vs. Downgradient Distance

Stagnant Sand Layer, Diffusion Model

D* = 1.26 * 10^-6 cm^2/sec, Co = 2 mg/L

Envirite Landfill project

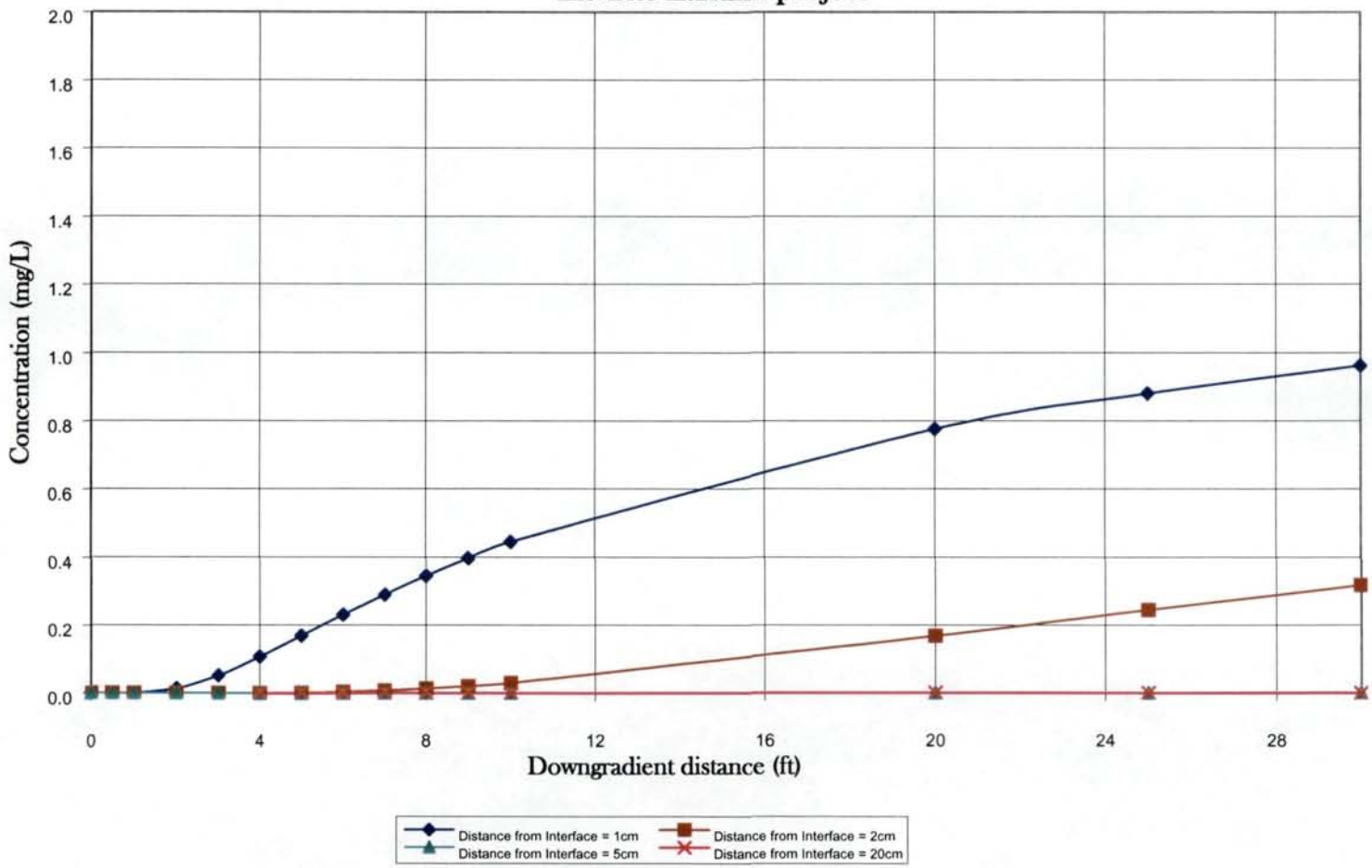
		Distance from interface (Z) = 1 cm			Distance from interface (Z) = 2 cm			Distance from interface (Z) = 5 cm			Distance from interface (Z) = 20 cm		
Distance (ft)	*Distance (cm)*	*B*	*erf(B)*	*C tz (mg/L)*	*B*	*erf(B)*	*C tz (mg/L)*	*B*	*erfB*	*C tz (mg/L)*	*B*	*erfB*	*C tz (mg/L)*
0	0.00	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000		
0.5	15.24	3.862	1.000	0.000	7.723	1.000	0.000	19.309	1.000	0.000	36.003		
1	30.48	2.731	1.000	0.000	5.461	1.000	0.000	13.653	1.000	0.000	54.613		
2	60.96	1.931	0.994	0.013	3.862	1.000	0.000	9.654	1.000	0.000	38.617		
3	91.44	1.577	0.974	0.052	3.153	1.000	0.000	7.883	1.000	0.000	31.531		
4	121.92	1.365	0.946	0.107	2.731	1.000	0.000	6.827	1.000	0.000	27.307	1.000	0.000
5	152.40	1.221	0.916	0.168	2.442	0.999	0.001	6.106	1.000	0.000	24.424	1.000	0.000
6	182.88	1.115	0.885	0.230	2.230	0.998	0.003	5.574	1.000	0.000	22.296	1.000	0.000
7	213.36	1.032	0.856	0.289	2.064	0.996	0.007	5.160	1.000	0.000	20.642	1.000	0.000
8	243.84	0.965	0.828	0.344	1.931	0.994	0.013	4.827	1.000	0.000	19.309	1.000	0.000
9	274.32	0.910	0.802	0.396	1.820	0.990	0.020	4.551	1.000	0.000	18.204	1.000	0.000
10	304.80	0.864	0.778	0.444	1.727	0.985	0.029	4.318	1.000	0.000	17.270	1.000	0.000
20	609.60	0.611	0.612	0.776	1.221	0.916	0.168	3.053	1.000	0.000	12.212	1.000	0.000
25	762.00	0.546	0.560	0.880	1.092	0.878	0.245	2.731	1.000	0.000	10.923	1.000	0.000
30	914.40	0.499	0.519	0.962	0.997	0.841	0.317	2.493	1.000	0.001	9.971	1.000	0.000

PCE Concentration vs. Downgradient Distance Below the PEWM Under Cell 1

Stagnant Sand Layer, Diffusion Model

D* = 1.26 * 10^-6 cm^2/sec, Co = 2 mg/L

Envirite Landfill project



Conc vs Distance diffusion (Co = 1, D = .1) Ctz = .1

TCE Concentration vs. Downgradient Distance

Stagnant Sand Layer, Diffusion Model

D* = 1.4 * 10^-6 cm^2/sec, Co = 4 mg/L

Envirite Landfill project

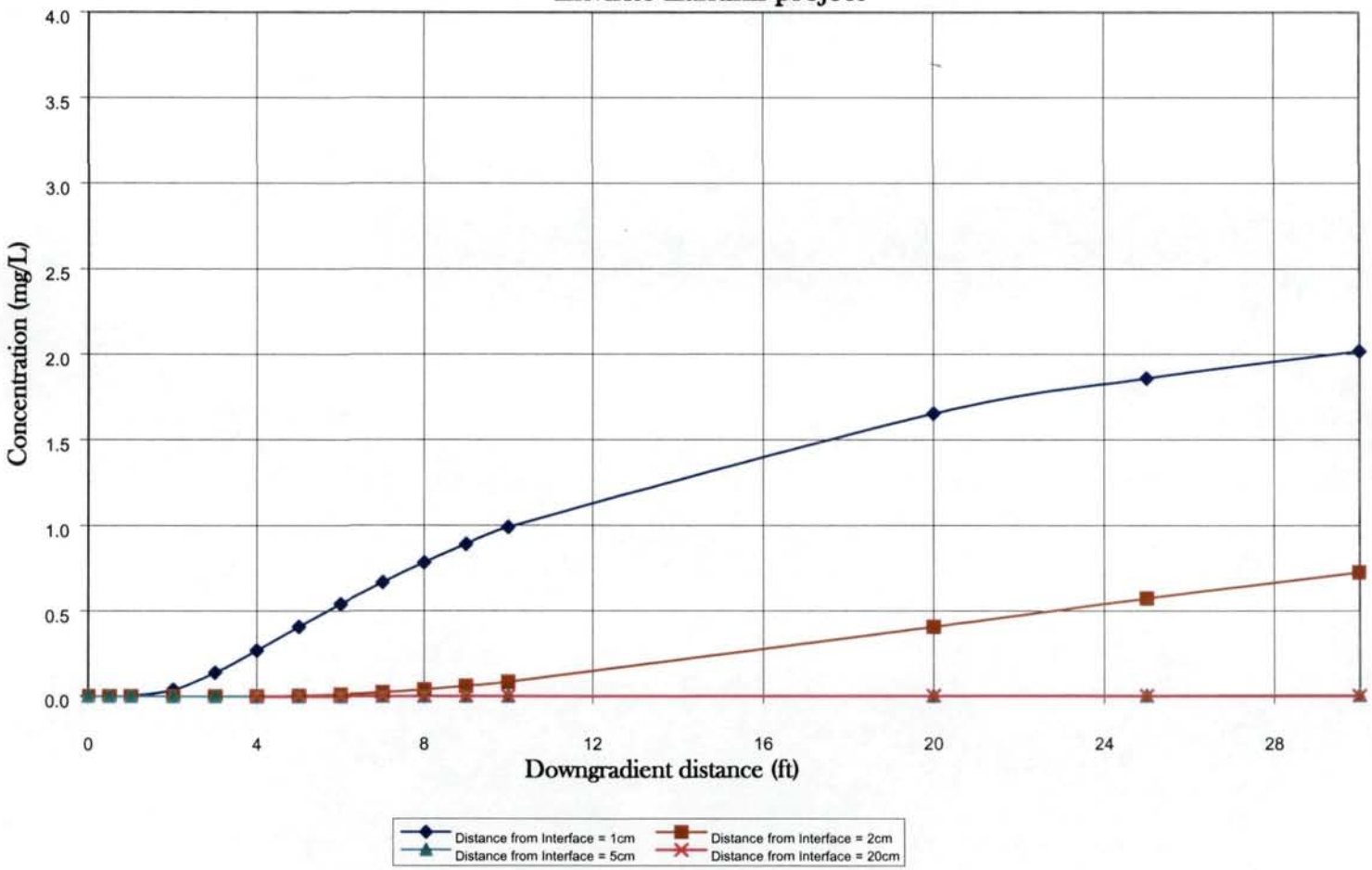
		Distance from interface (Z) = 1 cm			Distance from interface (Z) = 2 cm			Distance from interface (Z) = 5 cm			Distance from interface (Z) = 20 cm		
Distance (ft)	*Distance (cm)*	*B*	*erf(B)*	*C tz (mg/L)*	*B*	*erf(B)*	*C tz (mg/L)*	*B*	*erfB*	*C tz (mg/L)*	*B*	*erfB*	*C tz (mg/L)*
0	0.00	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000		
0.5	15.24	3.659	1.000	0.000	7.319	1.000	0.000	18.297	1.000	0.000	36.003		
1	30.48	2.588	1.000	0.001	5.175	1.000	0.000	12.938	1.000	0.000	51.752		
2	60.96	1.830	0.990	0.039	3.659	1.000	0.000	9.148	1.000	0.000	36.594		
3	91.44	1.494	0.965	0.138	2.988	1.000	0.000	7.470	1.000	0.000	29.879		
4	121.92	1.294	0.933	0.269	2.588	1.000	0.001	6.469	1.000	0.000	25.876	1.000	0.000
5	152.40	1.157	0.898	0.407	2.314	0.999	0.004	5.786	1.000	0.000	23.144	1.000	0.000
6	182.88	1.056	0.865	0.541	2.113	0.997	0.011	5.282	1.000	0.000	21.128	1.000	0.000
7	213.36	0.978	0.833	0.667	1.956	0.994	0.023	4.890	1.000	0.000	19.560	1.000	0.000
8	243.84	0.915	0.804	0.783	1.830	0.990	0.039	4.574	1.000	0.000	18.297	1.000	0.000
9	274.32	0.863	0.777	0.890	1.725	0.985	0.059	4.313	1.000	0.000	17.251	1.000	0.000
10	304.80	0.818	0.753	0.989	1.637	0.979	0.083	4.091	1.000	0.000	16.365	1.000	0.000
20	609.60	0.579	0.587	1.653	1.157	0.898	0.407	2.893	1.000	0.000	11.572	1.000	0.000
25	762.00	0.518	0.536	1.857	1.035	0.857	0.573	2.588	1.000	0.001	10.350	1.000	0.000
30	914.40	0.472	0.496	2.016	0.945	0.819	0.726	2.362	0.999	0.003	9.449	1.000	0.000

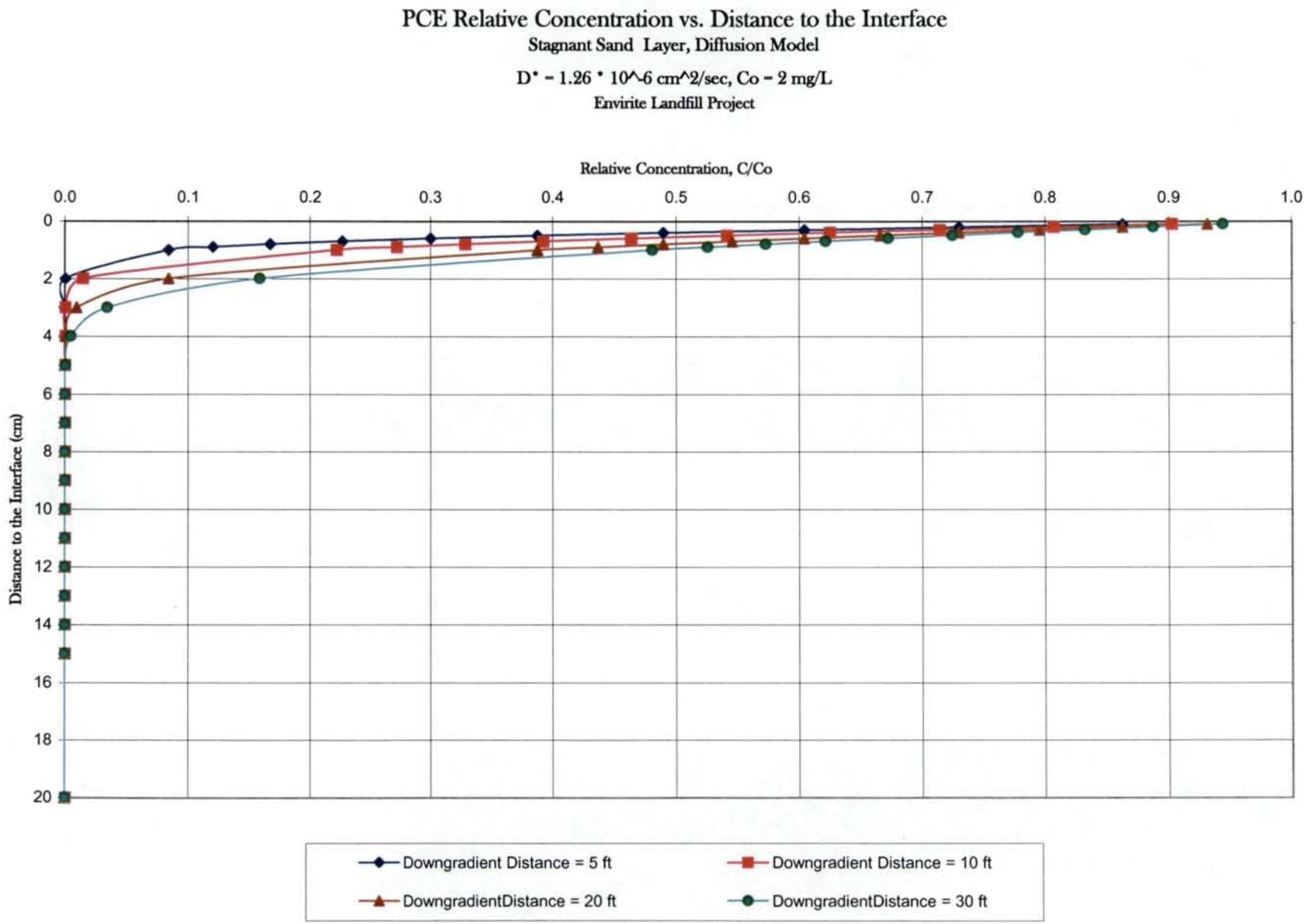
TCE Concentration vs. Downgradient Distance Below the PEWM Under Cell 1

Stagnant Sand Layer, Diffusion Model

D* = 1.4 * 10^-6 cm^2/sec, Co = 4 mg/L

Envirite Landfill project




PCE Relative Concentration vs. Distance to the Interface
Stagnant Sand Layer, Diffusion Model
D* = 1.26 * 10^-6 cm^2/sec, Co = 2 mg/L
Envirite Landfill Project
Relative Concentration, C/Co
0.0
0.1
0.2
0.3
0.4
0.5
0.6
0.7
0.8
0.9
1.0
Distance to the Interface (cm)
0
2
4
6
8
10
12
14
16
18
20
Downgradient Distance = 5 ft
Downgradient Distance = 10 ft
DowngradientDistance = 20 ft
DowngradientDistance = 30 ft

PCE DIFFUSION INTO STAGNANT SAND LAYER
Average Relative Concentrations in High Permeability Sand
(Diffusion Coefficient Sensitivity Analysis)

D* = 1.26 * 10^-6 cm^2/sec, Co = 2mg/L

Envirite Landfill Project

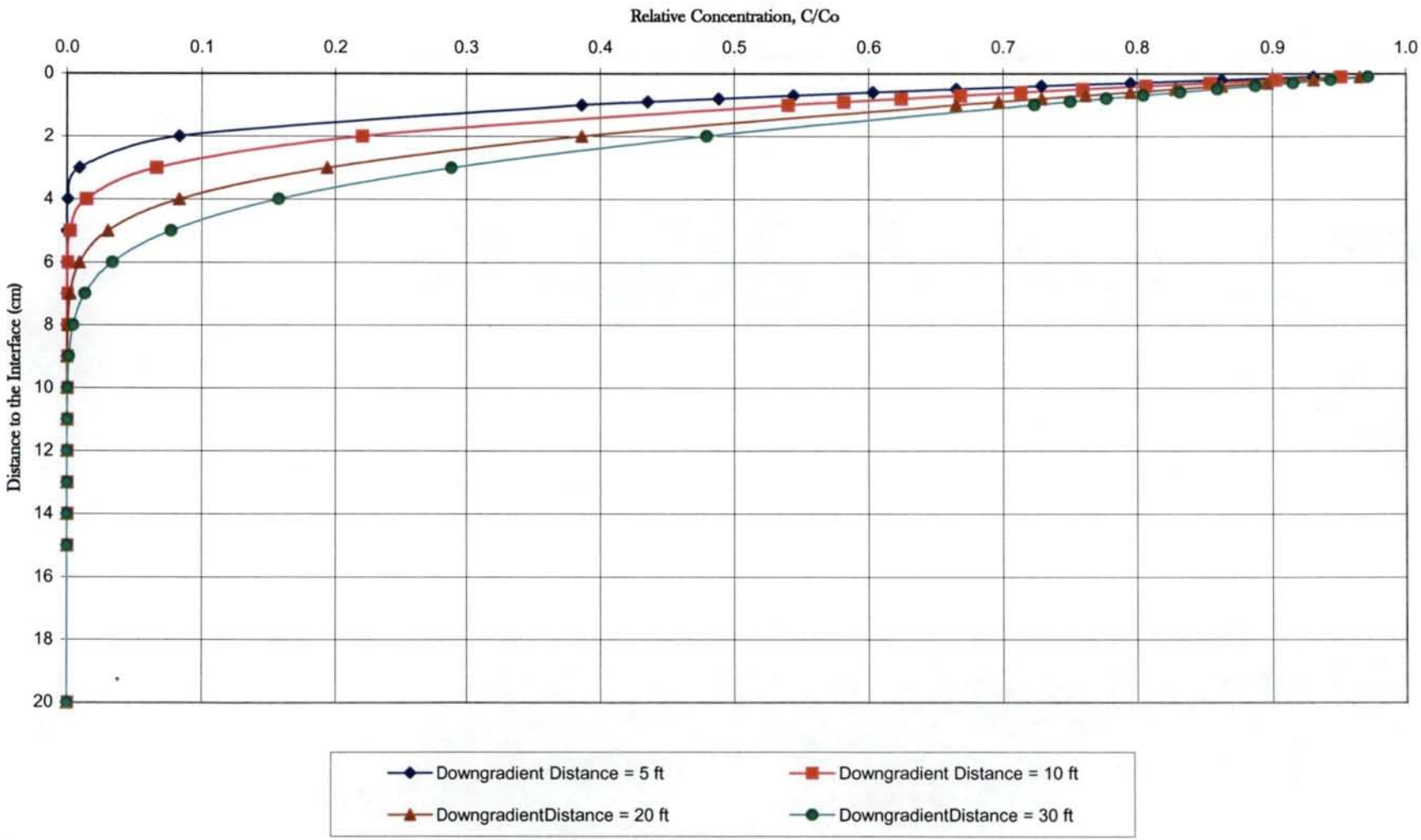
Relative Cumulative Concentration								
Distance to the Interface (cm)	D = 5 ft		D = 10 ft		D = 20 ft		D = 30 ft	
0.1	0.093		0.095		0.097		0.097	
0.2	0.080		0.085		0.090		0.092	
0.3	0.067		0.076		0.083		0.086	
0.4	0.055		0.067		0.076		0.081	
0.5	0.044		0.058		0.070		0.075	
0.6	0.034		0.050		0.064		0.070	
0.7	0.026		0.043		0.057		0.065	
0.8	0.020		0.036		0.052		0.060	
0.9	0.014		0.030		0.046		0.055	
1	0.010	0.443	0.025	0.566	0.041	0.676	0.050	0.730
2	0.042	0.243	0.118	0.342	0.236	0.456	0.320	0.525
3	0.000		0.007		0.047		0.096	
4	0.000	0.121	0.000	0.173	0.005	0.241	0.020	0.291
5	0.000	0.097	0.000	0.138	0.000	0.193	0.003	0.234
6	0.000		0.000		0.000		0.000	
7	0.000		0.000		0.000		0.000	
8	0.000		0.000		0.000		0.000	
9	0.000		0.000		0.000		0.000	
10	0.000	0.049	0.000	0.069	0.000	0.096	0.000	0.117
11	0.000		0.000		0.000		0.000	
12	0.000		0.000		0.000		0.000	
13	0.000		0.000		0.000		0.000	
14	0.000		0.000		0.000		0.000	
15	0.000		0.000		0.000		0.000	
20	0.000	0.024	0.000	0.035	0.000	0.048	0.000	0.058

PCE Relative Concentration vs. Distance to the Interface

Stagnant Sand Layer, Diffusion Model

D* = 5 * 10^-6 cm^2/sec, Co = 2 mg/L

Envirite Landfill Project



PCE DIFFUSION INTO STAGNANT SAND LAYER
Average Relative Concentrations in High Permeability Sand
(Diffusion Coefficient Sensitivity Analysis)
D* = 5 * 10^-6 cm^2/sec, Co = 2mg/L
Envirite Landfill Project

Relative Cumulative Concentration								
Distance to the Interface (cm)	D = 5 ft		D = 10 ft		D = 20 ft		D = 30 ft	
0.1	0.097		0.098		0.098		0.099	
0.2	0.090		0.093		0.095		0.096	
0.3	0.083		0.088		0.091		0.093	
0.4	0.076		0.083		0.088		0.090	
0.5	0.070		0.078		0.085		0.087	
0.6	0.063		0.074		0.081		0.085	
0.7	0.057		0.069		0.078		0.082	
0.8	0.052		0.065		0.075		0.079	
0.9	0.046		0.060		0.071		0.076	
1	0.041	0.675	0.056	0.763	0.068	0.830	0.074	0.860
2	0.235	0.455	0.380	0.572	0.526	0.678	0.601	0.731
3	0.046		0.143		0.290		0.384	
4	0.005	0.240	0.040	0.332	0.138	0.446	0.223	0.517
5	0.000	0.192	0.008	0.267	0.057	0.368	0.117	0.437
6	0.000		0.001		0.020		0.055	
7	0.000		0.000		0.006		0.024	
8	0.000		0.000		0.001		0.009	
9	0.000		0.000		0.000		0.003	
10	0.000	0.096	0.000	0.134	0.000	0.187	0.001	0.228
11	0.000		0.000		0.000		0.000	
12	0.000		0.000		0.000		0.000	
13	0.000		0.000		0.000		0.000	
14	0.000		0.000		0.000		0.000	
15	0.000		0.000		0.000		0.000	
20	0.000	0.048	0.000	0.067	0.000	0.093	0.000	0.114

PCE DIFFUSION INTO STAGNANT SAND LAYER (CALC. FOR FIGURE 6)

Relative Concentration vs. Distance into Stagnant Sand Layer and Travel Distance Along Stagnant Sand Layer Below the PEWM

(Diffusion Coefficient Sensitivity Analysis)

D* = 1.26* 10^-6 cm^2/sec, Co = 2 mg/L

Envirite Landfill Project

	Downgradient-Distance = 5ft = 152.35 cm			Downgradient-Distance = 10ft = 304.7 cm			Downgradient-Distance = 20ft = 609.4 cm			Downgradient Distance = 30 ft = 914.1 cm			Relative Concentration (C/Co)			
Distance(cm)	B	erfB	Ctz (mg/L)	B	erfB	Ctz (mg/L)	B	erfB	Ctz (mg/L)	B	erfB	Ctz (mg/L)	D = 5 ft	D = 10 ft	D = 20 ft	D = 30 ft
0.1	0.122	0.137	1.726	0.086	0.097	1.806	0.061	0.069	1.862	0.050	0.056	1.888	0.863	0.903	0.931	0.944
0.2	0.244	0.270	1.459	0.173	0.193	1.614	0.122	0.137	1.726	0.100	0.112	1.776	0.730	0.807	0.863	0.888
0.3	0.366	0.396	1.209	0.259	0.286	1.428	0.183	0.204	1.591	0.150	0.168	1.665	0.604	0.714	0.796	0.832
0.4	0.489	0.510	0.979	0.345	0.375	1.250	0.244	0.270	1.459	0.199	0.222	1.556	0.490	0.625	0.730	0.778
0.5	0.611	0.612	0.776	0.432	0.459	1.083	0.305	0.334	1.332	0.249	0.276	1.449	0.388	0.541	0.666	0.724
0.6	0.733	0.700	0.600	0.518	0.536	0.927	0.366	0.396	1.209	0.299	0.328	1.344	0.300	0.464	0.604	0.672
0.7	0.855	0.773	0.453	0.605	0.607	0.785	0.427	0.455	1.091	0.349	0.378	1.243	0.227	0.393	0.545	0.622
0.8	0.977	0.833	0.334	0.691	0.671	0.657	0.489	0.510	0.979	0.399	0.427	1.145	0.167	0.329	0.490	0.573
0.9	1.099	0.880	0.240	0.777	0.728	0.543	0.550	0.563	0.874	0.449	0.474	1.051	0.120	0.272	0.437	0.526
1	1.221	0.916	0.168	0.864	0.778	0.444	0.611	0.612	0.776	0.499	0.519	0.961	0.084	0.222	0.388	0.481
2	2.443	0.999	0.001	1.727	0.985	0.029	1.221	0.916	0.168	0.997	0.842	0.317	0.001	0.015	0.084	0.158
3	3.664	1.000	0.000	2.591	1.000	0.000	1.832	0.990	0.019	1.496	0.966	0.069	0.000	0.000	0.010	0.034
4	4.886	1.000	0.000	3.455	1.000	0.000	2.443	0.999	0.001	1.995	0.995	0.010	0.000	0.000	0.001	0.005
5	6.107	1.000	0.000	4.318	1.000	0.000	3.053	1.000	0.000	2.493	1.000	0.001	0.000	0.000	0.000	0.000
6	7.328	1.000	0.000	5.182	1.000	0.000	3.664	1.000	0.000	2.992	1.000	0.000	0.000	0.000	0.000	0.000
7	8.550	1.000	0.000	6.046	1.000	0.000	4.275	1.000	0.000	3.490	1.000	0.000	0.000	0.000	0.000	0.000
8	9.771	1.000	0.000	6.909	1.000	0.000	4.886	1.000	0.000	3.989	1.000	0.000	0.000	0.000	0.000	0.000
9	10.992	1.000	0.000	7.773	1.000	0.000	5.496	1.000	0.000	4.488	1.000	0.000	0.000	0.000	0.000	0.000
10	12.214	1.000	0.000	8.636	1.000	0.000	6.107	1.000	0.000	4.986	1.000	0.000	0.000	0.000	0.000	0.000
11	13.435	1.000	0.000	9.500	1.000	0.000	6.718	1.000	0.000	5.485	1.000	0.000	0.000	0.000	0.000	0.000
12	14.657	1.000	0.000	10.364	1.000	0.000	7.328	1.000	0.000	5.984	1.000	0.000	0.000	0.000	0.000	0.000
13	15.878	1.000	0.000	11.227	1.000	0.000	7.939	1.000	0.000	6.482	1.000	0.000	0.000	0.000	0.000	0.000
14	17.099	1.000	0.000	12.091	1.000	0.000	8.550	1.000	0.000	6.981	1.000	0.000	0.000	0.000	0.000	0.000
15	18.321	1.000	0.000	12.955	1.000	0.000	9.160	1.000	0.000	7.479	1.000	0.000	0.000	0.000	0.000	0.000
20	24.428	1.000	0.000	17.273	1.000	0.000	12.214	1.000	0.000	9.973	1.000	0.000	0.000	0.000	0.000	0.000

NOTE: *D = Downgradient Distance (ft)*

TCE DIFFUSION INTO STAGNANT SAND LAYER (CALC. FOR FIGURE 7)

Relative Concentration vs. Distance into Stagnant Sand Layer and Travel Distance Along Stagnant Sand Layer Below the PEWM

(Diffusion Coefficient Sensitivity Analysis)

D* = 1.4 * 10^-6 cm^2/sec, Co = 4 mg/L

Envirite Landfill Project

	Downgradient-Distance = 5ft = 152.35 cm			Downgradient-Distance = 10ft = 304.7 cm			Downgradient-Distance = 20ft = 609.4 cm			Downgradient Distance = 30 ft = 914.1 cm			Relative Concentration (C/Co)			
Distance(cm)	B	erfB	Ctz (mg/L)	B	erfB	Ctz (mg/L)	B	erfB	Ctz (mg/L)	B	erfB	Ctz (mg/L)	D = 5 ft	D = 10 ft	D = 20 ft	D = 30 ft
0.1	0.116	0.130	3.480	0.082	0.092	3.631	0.058	0.065	3.739	0.047	0.053	3.787	0.870	0.908	0.935	0.947
0.2	0.231	0.257	2.974	0.164	0.183	3.268	0.116	0.130	3.480	0.095	0.106	3.575	0.743	0.817	0.870	0.894
0.3	0.347	0.377	2.494	0.246	0.272	2.914	0.174	0.194	3.224	0.142	0.159	3.364	0.623	0.728	0.806	0.841
0.4	0.463	0.487	2.051	0.327	0.357	2.574	0.231	0.257	2.974	0.189	0.211	3.157	0.513	0.643	0.743	0.789
0.5	0.579	0.587	1.653	0.409	0.437	2.251	0.289	0.318	2.730	0.236	0.262	2.953	0.413	0.563	0.682	0.738
0.6	0.694	0.674	1.304	0.491	0.513	1.950	0.347	0.377	2.494	0.284	0.312	2.754	0.326	0.487	0.623	0.688
0.7	0.810	0.748	1.008	0.573	0.582	1.671	0.405	0.433	2.267	0.331	0.360	2.560	0.252	0.418	0.567	0.640
0.8	0.926	0.810	0.762	0.655	0.646	1.418	0.463	0.487	2.051	0.378	0.407	2.372	0.190	0.354	0.513	0.593
0.9	1.042	0.859	0.563	0.737	0.702	1.190	0.521	0.539	1.846	0.425	0.452	2.190	0.141	0.298	0.461	0.548
1	1.157	0.898	0.407	0.818	0.753	0.988	0.579	0.587	1.653	0.473	0.496	2.016	0.102	0.247	0.413	0.504
2	2.315	0.999	0.004	1.637	0.979	0.082	1.157	0.898	0.407	0.945	0.819	0.726	0.001	0.021	0.102	0.181
3	3.472	1.000	0.000	2.455	0.999	0.002	1.736	0.986	0.056	1.418	0.955	0.180	0.000	0.001	0.014	0.045
4	4.630	1.000	0.000	3.274	1.000	0.000	2.315	0.999	0.004	1.890	0.992	0.030	0.000	0.000	0.001	0.008
5	5.787	1.000	0.000	4.092	1.000	0.000	2.893	1.000	0.000	2.363	0.999	0.003	0.000	0.000	0.000	0.001
6	6.944	1.000	0.000	4.910	1.000	0.000	3.472	1.000	0.000	2.835	1.000	0.000	0.000	0.000	0.000	0.000
7	8.102	1.000	0.000	5.729	1.000	0.000	4.051	1.000	0.000	3.308	1.000	0.000	0.000	0.000	0.000	0.000
8	9.259	1.000	0.000	6.547	1.000	0.000	4.630	1.000	0.000	3.780	1.000	0.000	0.000	0.000	0.000	0.000
9	10.417	1.000	0.000	7.366	1.000	0.000	5.208	1.000	0.000	4.253	1.000	0.000	0.000	0.000	0.000	0.000
10	11.574	1.000	0.000	8.184	1.000	0.000	5.787	1.000	0.000	4.725	1.000	0.000	0.000	0.000	0.000	0.000
11	12.731	1.000	0.000	9.002	1.000	0.000	6.366	1.000	0.000	5.198	1.000	0.000	0.000	0.000	0.000	0.000
12	13.889	1.000	0.000	9.821	1.000	0.000	6.944	1.000	0.000	5.670	1.000	0.000	0.000	0.000	0.000	0.000
13	15.046	1.000	0.000	10.639	1.000	0.000	7.523	1.000	0.000	6.143	1.000	0.000	0.000	0.000	0.000	0.000
14	16.203	1.000	0.000	11.458	1.000	0.000	8.102	1.000	0.000	6.615	1.000	0.000	0.000	0.000	0.000	0.000
15	17.361	1.000	0.000	12.276	1.000	0.000	8.680	1.000	0.000	7.088	1.000	0.000	0.000	0.000	0.000	0.000
20	23.148	1.000	0.000	16.368	1.000	0.000	11.574	1.000	0.000	9.450	1.000	0.000	0.000	0.000	0.000	0.000

NOTE: *D = Downgradient Distance (ft)*

PCE DIFFUSION INTO STAGNANT SAND LAYER (CALC. FOR FIGURE 8)

Relative Concentration vs. Distance into Stagnant Sand Layer and Travel Distance Along Stagnant Sand Layer Below the PEWM

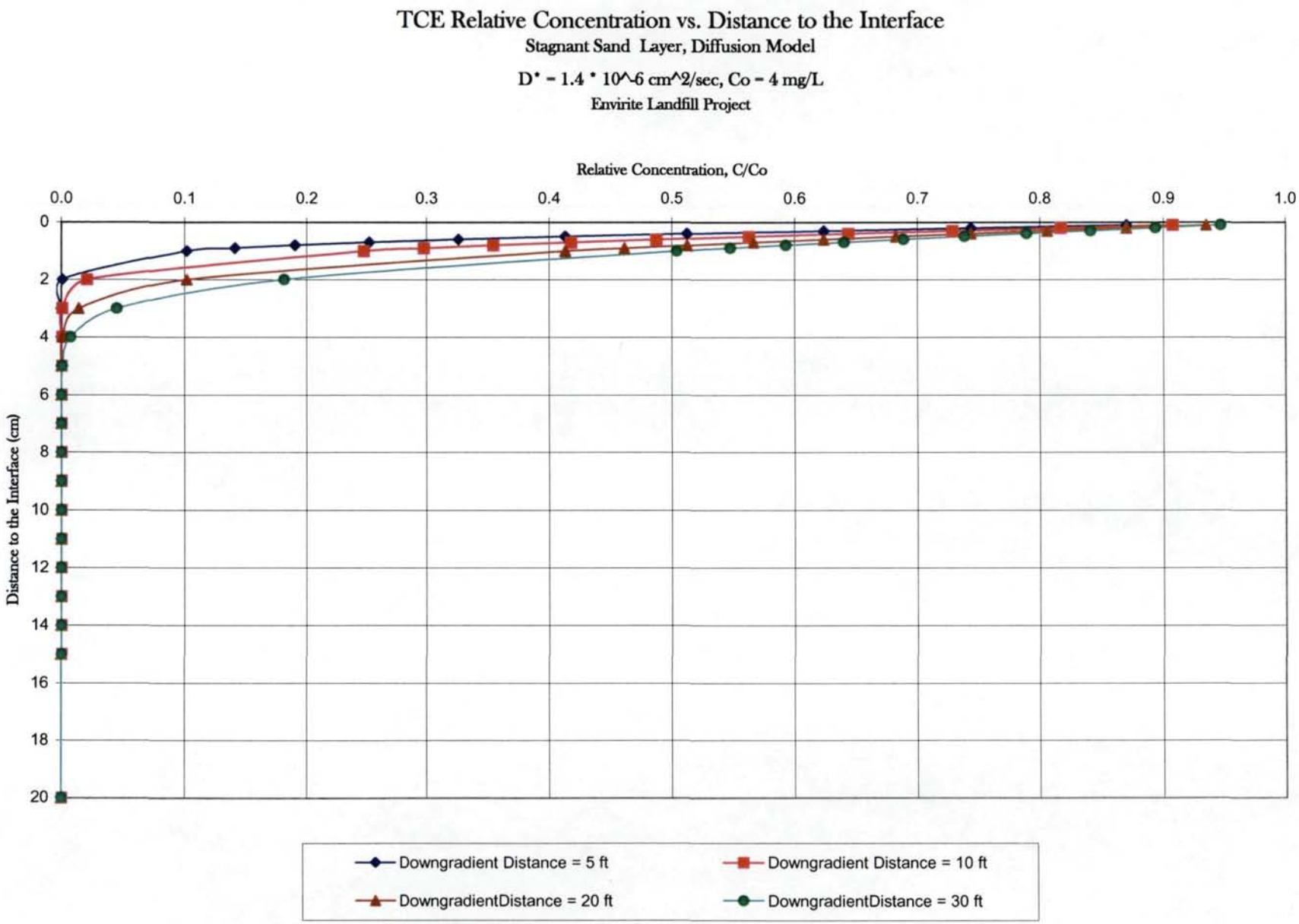
(Diffusion Coefficient Sensitivity Analysis)

D* = 5* 10^-6 cm^2/sec, Co = 2 mg/L

Envirite Landfill Project

	Downgradient-Distance = 5ft = 152.35 cm			Downgradient-Distance = 10ft = 304.7 cm			Downgradient-Distance = 20ft = 609.4 cm			Downgradient Distance = 30 ft = 914.1 cm			Relative Concentration (C/Co)			
Distance(cm)	B	erfB	Ctz (mg/L)	B	erfB	Ctz (mg/L)	B	erfB	Ctz (mg/L)	B	erfB	Ctz (mg/L)	D = 5 ft	D = 10 ft	D = 20 ft	D = 30 ft
0.1	0.061	0.069	1.862	0.043	0.049	1.902	0.031	0.035	1.931	0.025	0.028	1.944	0.931	0.951	0.965	0.972
0.2	0.123	0.138	1.725	0.087	0.098	1.805	0.061	0.069	1.862	0.050	0.056	1.887	0.862	0.902	0.931	0.944
0.3	0.184	0.205	1.590	0.130	0.146	1.708	0.092	0.103	1.793	0.075	0.085	1.831	0.795	0.854	0.897	0.915
0.4	0.245	0.271	1.458	0.173	0.194	1.613	0.123	0.138	1.725	0.100	0.113	1.775	0.729	0.806	0.862	0.887
0.5	0.306	0.335	1.330	0.217	0.241	1.519	0.153	0.171	1.657	0.125	0.140	1.719	0.665	0.759	0.829	0.860
0.6	0.368	0.397	1.206	0.260	0.287	1.426	0.184	0.205	1.590	0.150	0.168	1.664	0.603	0.713	0.795	0.832
0.7	0.429	0.456	1.088	0.303	0.332	1.336	0.214	0.238	1.523	0.175	0.196	1.609	0.544	0.668	0.762	0.804
0.8	0.490	0.512	0.977	0.347	0.376	1.248	0.245	0.271	1.458	0.200	0.223	1.554	0.488	0.624	0.729	0.777
0.9	0.551	0.564	0.871	0.390	0.419	1.163	0.276	0.303	1.393	0.225	0.250	1.500	0.436	0.581	0.697	0.750
1	0.613	0.614	0.773	0.433	0.460	1.080	0.306	0.335	1.330	0.250	0.276	1.447	0.386	0.540	0.665	0.724
2	1.225	0.917	0.166	0.866	0.780	0.441	0.613	0.614	0.773	0.500	0.521	0.959	0.083	0.220	0.386	0.479
3	1.838	0.991	0.019	1.300	0.934	0.132	0.919	0.806	0.388	0.750	0.711	0.577	0.009	0.066	0.194	0.289
4	2.450	0.999	0.001	1.733	0.986	0.029	1.225	0.917	0.166	1.000	0.843	0.314	0.001	0.014	0.083	0.157
5	3.063	1.000	0.000	2.166	0.998	0.004	1.532	0.970	0.061	1.250	0.923	0.154	0.000	0.002	0.030	0.077
6	3.676	1.000	0.000	2.599	1.000	0.000	1.838	0.991	0.019	1.501	0.966	0.068	0.000	0.000	0.009	0.034
7	4.288	1.000	0.000	3.032	1.000	0.000	2.144	0.998	0.005	1.751	0.987	0.027	0.000	0.000	0.002	0.013
8	4.901	1.000	0.000	3.465	1.000	0.000	2.450	0.999	0.001	2.001	0.995	0.009	0.000	0.000	0.001	0.005
9	5.513	1.000	0.000	3.899	1.000	0.000	2.757	1.000	0.000	2.251	0.999	0.003	0.000	0.000	0.000	0.001
10	6.126	1.000	0.000	4.332	1.000	0.000	3.063	1.000	0.000	2.501	1.000	0.001	0.000	0.000	0.000	0.000
11	6.739	1.000	0.000	4.765	1.000	0.000	3.369	1.000	0.000	2.751	1.000	0.000	0.000	0.000	0.000	0.000
12	7.351	1.000	0.000	5.198	1.000	0.000	3.676	1.000	0.000	3.001	1.000	0.000	0.000	0.000	0.000	0.000
13	7.964	1.000	0.000	5.631	1.000	0.000	3.982	1.000	0.000	3.251	1.000	0.000	0.000	0.000	0.000	0.000
14	8.577	1.000	0.000	6.065	1.000	0.000	4.288	1.000	0.000	3.501	1.000	0.000	0.000	0.000	0.000	0.000
15	9.189	1.000	0.000	6.498	1.000	0.000	4.595	1.000	0.000	3.751	1.000	0.000	0.000	0.000	0.000	0.000
20	12.252	1.000	0.000	8.664	1.000	0.000	6.126	1.000	0.000	5.002	1.000	0.000	0.000	0.000	0.000	0.000

NOTE: *D = Downgradient Distance (ft)*


TCE Relative Concentration vs. Distance to the Interface
Stagnant Sand Layer, Diffusion Model
D* = 1.4 * 10^-6 cm^2/sec, Co = 4 mg/L
Envirite Landfill Project
Relative Concentration, C/Co
0.0
0.1
0.2
0.3
0.4
0.5
0.6
0.7
0.8
0.9
1.0
Distance to the Interface (cm)
0
2
4
6
8
10
12
14
16
18
20
Downgradient Distance = 5 ft
Downgradient Distance = 10 ft
DowngradientDistance = 20 ft
DowngradientDistance = 30 ft

TCE DIFFUSION INTO STAGNANT SAND LAYER
Average Relative Concentrations in High Permeability Sand
(Diffusion Coefficient Sensitivity Analysis)
D* = 1.4 * 10^-6 cm^2/sec, Co = 4mg/L
Envirite Landfill Project

Relative Cumulative Concentration								
Distance to the Interface (cm)	D = 5 ft		D = 10 ft		D = 20 ft		D = 30 ft	
0.1	0.093		0.095		0.097		0.097	
0.2	0.081		0.086		0.090		0.092	
0.3	0.068		0.077		0.084		0.087	
0.4	0.057		0.069		0.077		0.082	
0.5	0.046		0.060		0.071		0.076	
0.6	0.037		0.053		0.065		0.071	
0.7	0.029		0.045		0.060		0.066	
0.8	0.022		0.039		0.054		0.062	
0.9	0.017		0.033		0.049		0.057	
1	0.012	0.462	0.027	0.584	0.044	0.691	0.053	0.743
2	0.051	0.257	0.134	0.359	0.257	0.474	0.343	0.543
3	0.001		0.011		0.058		0.113	
4	0.000	0.129	0.000	0.182	0.008	0.253	0.026	0.306
5	0.000	0.103	0.000	0.146	0.001	0.203	0.004	0.246
6	0.000		0.000		0.000		0.000	
7	0.000		0.000		0.000		0.000	
8	0.000		0.000		0.000		0.000	
9	0.000		0.000		0.000		0.000	
10	0.000	0.051	0.000	0.073	0.000	0.101	0.000	0.123
11	0.000		0.000		0.000		0.000	
12	0.000		0.000		0.000		0.000	
13	0.000		0.000		0.000		0.000	
14	0.000		0.000		0.000		0.000	
15	0.000		0.000		0.000		0.000	
20	0.000	0.026	0.000	0.036	0.000	0.051	0.000	0.061

TCE DIFFUSION INTO STAGNANT SAND LAYER

Relative Concentration vs. Distance into Stagnant Sand Layer and Travel Distance Along Stagnant Sand Layer Below the PEWM

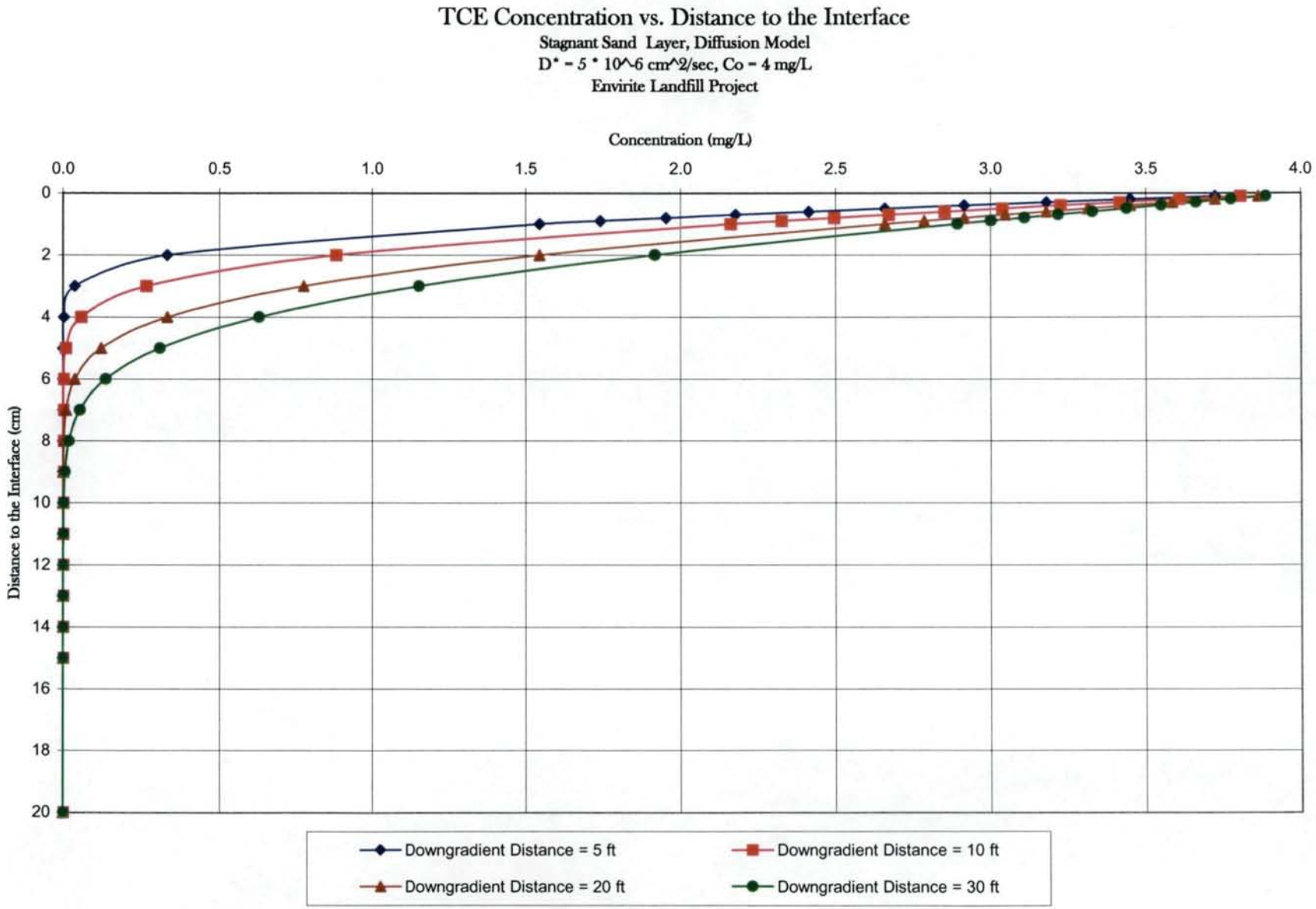
(Diffusion Coefficient Sensitivity Analysis)

D* = 5 * 10^-6 cm^2/sec, Co = 4 mg/L

Envirite Landfill Project

	Downgradient-Distance = 5ft = 152.35 cm			Downgradient-Distance = 10ft = 304.7 cm			Downgradient-Distance = 20ft = 609.4 cm			Downgradient Distance = 30 ft = 914.1 cm			Relative Concentration (C/Co)			
Distance(cm)	B	erfB	Ctz (mg/L)	B	erfB	Ctz (mg/L)	B	erfB	Ctz (mg/L)	B	erfB	Ctz (mg/L)	D = 5 ft	D = 10 ft	D = 20 ft	D = 30 ft
0.1	0.061	0.069	3.724	0.043	0.049	3.805	0.031	0.035	3.862	0.025	0.028	3.887	0.931	0.951	0.965	0.972
0.2	0.123	0.138	3.450	0.087	0.098	3.610	0.061	0.069	3.724	0.050	0.056	3.774	0.862	0.902	0.931	0.944
0.3	0.184	0.205	3.180	0.130	0.146	3.417	0.092	0.103	3.586	0.075	0.085	3.662	0.795	0.854	0.897	0.915
0.4	0.245	0.271	2.916	0.173	0.194	3.226	0.123	0.138	3.450	0.100	0.113	3.550	0.729	0.806	0.862	0.887
0.5	0.306	0.335	2.660	0.217	0.241	3.037	0.153	0.171	3.314	0.125	0.140	3.439	0.665	0.759	0.829	0.860
0.6	0.368	0.397	2.413	0.260	0.287	2.853	0.184	0.205	3.180	0.150	0.168	3.328	0.603	0.713	0.795	0.832
0.7	0.429	0.456	2.177	0.303	0.332	2.672	0.214	0.238	3.047	0.175	0.196	3.218	0.544	0.668	0.762	0.804
0.8	0.490	0.512	1.953	0.347	0.376	2.496	0.245	0.271	2.916	0.200	0.223	3.109	0.488	0.624	0.729	0.777
0.9	0.551	0.564	1.742	0.390	0.419	2.326	0.276	0.303	2.787	0.225	0.250	3.001	0.436	0.581	0.697	0.750
1	0.613	0.614	1.545	0.433	0.460	2.161	0.306	0.335	2.660	0.250	0.276	2.894	0.386	0.540	0.665	0.724
2	1.225	0.917	0.333	0.866	0.780	0.882	0.613	0.614	1.545	0.500	0.521	1.917	0.083	0.220	0.386	0.479
3	1.838	0.991	0.037	1.300	0.934	0.264	0.919	0.806	0.775	0.750	0.711	1.155	0.009	0.066	0.194	0.289
4	2.450	0.999	0.002	1.733	0.986	0.057	1.225	0.917	0.333	1.000	0.843	0.629	0.001	0.014	0.083	0.157
5	3.063	1.000	0.000	2.166	0.998	0.009	1.532	0.970	0.121	1.250	0.923	0.308	0.000	0.002	0.030	0.077
6	3.676	1.000	0.000	2.599	1.000	0.001	1.838	0.991	0.037	1.501	0.966	0.135	0.000	0.000	0.009	0.034
7	4.288	1.000	0.000	3.032	1.000	0.000	2.144	0.998	0.010	1.751	0.987	0.053	0.000	0.000	0.002	0.013
8	4.901	1.000	0.000	3.465	1.000	0.000	2.450	0.999	0.002	2.001	0.995	0.019	0.000	0.000	0.001	0.005
9	5.513	1.000	0.000	3.899	1.000	0.000	2.757	1.000	0.000	2.251	0.999	0.006	0.000	0.000	0.000	0.001
10	6.126	1.000	0.000	4.332	1.000	0.000	3.063	1.000	0.000	2.501	1.000	0.002	0.000	0.000	0.000	0.000
11	6.739	1.000	0.000	4.765	1.000	0.000	3.369	1.000	0.000	2.751	1.000	0.000	0.000	0.000	0.000	0.000
12	7.351	1.000	0.000	5.198	1.000	0.000	3.676	1.000	0.000	3.001	1.000	0.000	0.000	0.000	0.000	0.000
13	7.964	1.000	0.000	5.631	1.000	0.000	3.982	1.000	0.000	3.251	1.000	0.000	0.000	0.000	0.000	0.000
14	8.577	1.000	0.000	6.065	1.000	0.000	4.288	1.000	0.000	3.501	1.000	0.000	0.000	0.000	0.000	0.000
15	9.189	1.000	0.000	6.498	1.000	0.000	4.595	1.000	0.000	3.751	1.000	0.000	0.000	0.000	0.000	0.000
20	12.252	1.000	0.000	8.664	1.000	0.000	6.126	1.000	0.000	5.002	1.000	0.000	0.000	0.000	0.000	0.000

NOTE: *D = Downgradient Distance (ft)*

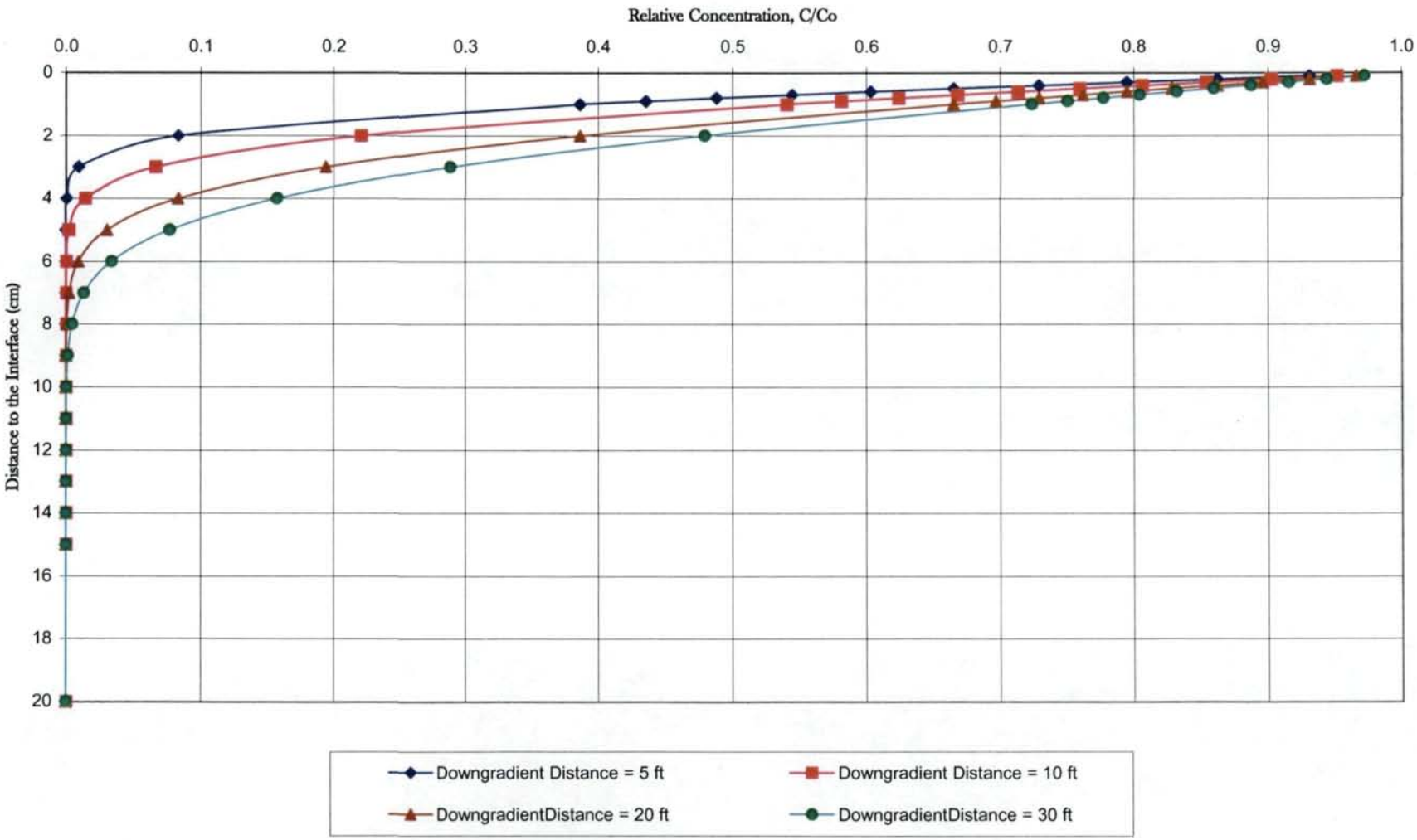

TCE Concentration vs. Distance to the Interface
Stagnant Sand Layer, Diffusion Model
D* = 5 * 10^-6 cm^2/sec, Co = 4 mg/L
Envirite Landfill Project
Concentration (mg/L)
0.0
0.5
1.0
1.5
2.0
2.5
3.0
3.5
4.0
Distance to the Interface (cm)
0
2
4
6
8
10
12
14
16
18
20
Downgradient Distance = 5 ft
Downgradient Distance = 10 ft
Downgradient Distance = 20 ft
Downgradient Distance = 30 ft

TCE Relative Concentration vs. Distance to the Interface

Stagnant Sand Layer, Diffusion Model

D* = 5 * 10^-6 cm^2/sec, Co = 4 mg/L

Envirite Landfill Project



TCE DIFFUSION INTO STAGNANT SAND LAYER
Average Relative Concentrations in High Permeability Sand
(Diffusion Coefficient Sensitivity Analysis)
D* = 1.44 * 10^-6 cm^2/sec, Co = 4mg/L
Envirite Landfill Project

Relative Cumulative Concentration								
Distance to the Interface (cm)	D = 5 ft		D = 10 ft		D = 20 ft		D = 30 ft	
0.1	0.097		0.098		0.098		0.099	
0.2	0.090		0.093		0.095		0.096	
0.3	0.083		0.088		0.091		0.093	
0.4	0.076		0.083		0.088		0.090	
0.5	0.070		0.078		0.085		0.087	
0.6	0.063		0.074		0.081		0.085	
0.7	0.057		0.069		0.078		0.082	
0.8	0.052		0.065		0.075		0.079	
0.9	0.046		0.060		0.071		0.076	
1	0.041	0.675	0.056	0.763	0.068	0.830	0.074	0.860
2	0.235	0.455	0.380	0.572	0.526	0.678	0.601	0.731
3	0.046		0.143		0.290		0.384	
4	0.005	0.240	0.040	0.332	0.138	0.446	0.223	0.517
5	0.000	0.192	0.008	0.267	0.057	0.368	0.117	0.437
6	0.000		0.001		0.020		0.055	
7	0.000		0.000		0.006		0.024	
8	0.000		0.000		0.001		0.009	
9	0.000		0.000		0.000		0.003	
10	0.000	0.096	0.000	0.134	0.000	0.187	0.001	0.228
11	0.000		0.000		0.000		0.000	
12	0.000		0.000		0.000		0.000	
13	0.000		0.000		0.000		0.000	
14	0.000		0.000		0.000		0.000	
15	0.000		0.000		0.000		0.000	
20	0.000	0.048	0.000	0.067	0.000	0.093	0.000	0.114