VOLUNTARY REMEDIATION PLAN APPLICATION ADDENDUM

FORMER AUTOMATIC SPRINKLER SWAINSBORO, EMANUEL COUNTY, GEORGIA HSI SITE NO. 12068

Prepared for:

Tyco Fire Protection

amec

3200 Town Point Drive, N.W.
Suite 100
Kennesaw, Georgia 30144

November 14 2011

AMEC Project # 6125080149

PORTABLE DOCUMENT FORMAT CERTIFICATION

The electronic copy of the Voluntary Remediation Plan Application Addendum HSI Site 10268 located in Swainsboro, Emanuel County, Georgia as provided on this CD is complete and identical to the paper copy and free of viruses to the best of our knowledge.

AMEC E&I, Inc.

Gregory J. Wrenn, P.E.
Project Manager

November 14, 2011

Ms. Alexandra Y. Cleary
Program Manager-Response and Remediation Program
Georgia Department of Natural Resources
Environmental Protection Division
2 Martin Luther King Jr. Drive SE, Suite 1462, East Tower
Atlanta, Georgia 30334

Re: Voluntary Remediation Program Application Addendum
Former Automatic Sprinkler Site, HSI #10268
Swainsboro, Emanuel County, GA Tax Parcel ID S12 005
AMEC Project No. 6125080149

Dear Ms. Cleary:

On behalf of Scott Technologies, Inc. (STI), AMEC Environment & Infrastructure, Inc. (AMEC) is pleased to submit this Voluntary Remediation Program (VRP) Application Addendum for the above-referenced site in Swainsboro, Georgia. The VRP Application was submitted to the Georgia Environmental Protection Division (EPD) on April 29, 2011. EPD issued comments to the Application in correspondence dated September 8, 2011. The EPD comments are listed below in **bold** type, followed by the responses.

<u>Conceptual Site Model (CSM):</u>

1. **The application must include as part of the CSM all potential human health and ecological receptors, and the complete and incomplete exposure pathways that may exist at the site (Section 12-8-108 of the Act). According to Section 6.3.2 of the application, the unnamed tributary of Hughes Prong, approximately 530-feet downgradient of MW-8 and just north of Meadowlake Parkway, serves as the nearest discharge boundary for shallow groundwater. Therefore, the surface water must be evaluated as an ecological receptor/exposure pathway. In-stream water quality standards (ISWQS) for both aquatic toxicity and human health should be utilized for this evaluation. In addition, considering that volatile organic compounds have been detected in the shallow groundwater onsite along with the presence of onsite commercial/industrial structures, the vapor intrusion pathway must be evaluated as a potential exposure pathway.**

   Response: The currently available data, as well as revised groundwater fate and transport model predictions (presented in Appendix A), do not indicate that groundwater contaminants above drinking water standards and/or in-stream water quality criteria (ISWQC) will reach the unnamed, intermittent tributary of Hughes Prong. Therefore, the surface water exposure pathway is likely incomplete. However, to further evaluate potential impacts to the unnamed tributary of Hughes Prong, two surface water monitoring points (SW-5 and SW-6) will be established at the approximate locations shown on the attached Figure 1. SW-5 will be located

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approximately 50 feet upstream and SW-6 will be located approximately 50 feet downstream of the point where the drainage culvert discharge enters the unnamed tributary. If flowing water is present, the unnamed intermittent tributary will be sampled semi-annually for volatile organic compounds (VOCs) in conjunction with the routine groundwater monitoring conducted under the VRP. Table 1 shows the ISWQC and/or ecological endpoint values that will be used to compare against the surface water data to evaluate whether additional actions are needed to protect the unnamed intermittent tributary of Hughes Prong. If surface water impacts are detected, additional evaluation may be necessary to further evaluate the source of the impacts, such as other potential upstream sources.

The Johnson & Ettinger (J&E) model was used to further evaluate impacts to site workers (site usage will be restricted to non-residential) due to VOCs via the indoor air vapor intrusion pathway. The model assumed the building dimensions were equal to that of the smallest building on site and used the mean concentrations of wells with detectable concentrations of VOCs. The model results indicate that vapor intrusion does not pose unacceptable risks. The J&E vapor intrusion modeling is presented in Appendix B.

2. **Please include a list of all constituents that have been identified at the site, including those soil contaminants that have been investigated and removed during previous corrective actions. A table listing the delineation criteria and cleanup values for these soil constituents, along with a figure illustrating where corrective actions have taken place, should also be included as part of the CSM.**

   Response: The attached Table 2 presents a list of constituents of concern that have been identified at the site, and also lists the delineation criteria applied under the VRP and the applicable risk reduction standards (RRS). It should be noted that RRS for metals are from Appendix B of the *Corrective Action Plan For Ground Water, Former Automatic Sprinkler Site (HSI Number 10268), Swainsboro, Georgia, by LAW Engineering and Environmental Services, inc., January 10, 2000.* The RRS for VOCs have been updated for this VRP Application Addendum. The updated RRS calculations are included as Appendix C.

   Figure 2 presents the approximate location of former soil excavations conducted at the site between 1997 and 1999 primarily to address metals impacts. As documented in four EMCON reports and EPD correspondence, the metals impacts were cleaned up to Type 3 RRS.

   Results from previous investigations have been summarized on Figures 2 and 3 to depict the delineation of metals in soil and groundwater, respectively, to the delineation criteria. Figure 4 depicts the delineation of VOCs in groundwater to the delineation criteria. The site groundwater data suggests that the primary origin of VOCs in soil is in the vicinity of MW-8 and the former discharge pipes coming from the building. No VOC data in soil is available in these areas. Therefore, seven shallow (approximately 0.5 to 2 feet below ground surface) soil samples will be collected to evaluate VOC concentrations in soil in comparison to the delineation and cleanup criteria. The locations of the proposed shallow soil samples are shown on Figure 5. It should be noted that the previous Enhanced Fluid Recovery (EFR) events conducted between July and December 2000 using MW-8 as the extraction point reportedly recovered 24.2 pounds of VOCs (*Corrective Action Report, enhanced Fluid Recovery, former Automatic Sprinkler Site, LawGibb Group, February 5, 2001*). These remediation activities, in conjunction with the observed decrease in VOC concentrations in groundwater around MW-8 and the shallow depth to water, suggest that VOCs in soil have been adequately addressed. The results of the additional soil investigation will be presented in the first VRP status report and, if necessary, additional remediation measures for VOC-impacted soil will be considered at that time.

3. **EPD does not concur with the delineation criteria presented in Table 1 of the application, as these values appear to be the Type 3/4 RRS and designated groundwater cleanup values. Therefore, please provide the required "Site Delineation Concentration Criteria" in accordance with Section 12-8-108(1) of the Act.**

   Response: Table 2 shows the "Site Delineation Concentration Criteria" for soil and groundwater.

4. **The application indicates that the point of demonstration well (POD) will be monitored to support the predictions of the contaminant fate-and-transport modeling. However, no POD well was established as part of this application. Please indicate an appropriate POD well(s) to demonstrate that groundwater concentrations are protective of any established downgradient POE.**

   Response: The wells initially proposed as POD wells to collectively demonstrate that groundwater concentrations will not impact potential points of exposure (POE) in the site vicinity and to demonstrate concentration trends are existing wells MW-4, MW-5, MW-6, MW-7, MW-8, MW-9R, MW-11, MW-12, MW-15, MW-18, MW-19, MW-20, and MW-20D and a new monitoring well, MW-21, to be installed along the eastern property boundary (see Figure 4 for proposed location). The number of POD wells may later be reduced depending upon observed concentration trends. Additionally, surface water monitoring points SW-2, SW-4, SW-5, and SW-6 (see Figure 1) will be monitored if surface water is present at the time of sampling to evaluate compliance with ISWQC.

5. **According to Section 7.1, direct groundwater discharge to surface water does not appear to occur, based on impacts above drinking water standards not extending off the property, and therefore the groundwater exposure pathway was determined to be incomplete. However, according to Section 6.3.2, the unnamed tributary of Hughes Prong, approximately 530-feet downgradient of MW-8 and just north of Meadowlake Parkway, serves as the nearest discharge boundary for shallow groundwater. Therefore, please make the necessary revisions to these Sections of the application in order to clarify this discrepancy, and include all necessary information for the evaluation of the surface water pathway as a complete exposure pathway for site contaminants.**

   Response: The unnamed intermittent tributary to Hughes Prong appears to be the nearest discharge boundary for groundwater flowing beneath the site. Because the tributary is intermittent, groundwater may pass beneath it in periods where the water table is low. The current site data, as well as the predictive fate and transport modeling, indicates that contaminant concentrations will be reduced by natural attenuation (combination of biodegradation, dilution, and dispersion) to below drinking water standards and ISWQS before reaching the unnamed intermittent tributary. Therefore, it is likely that there is not a complete unnamed tributary and analyzed for VOCs, assuming there is sufficient water flowing in the tributary for sampling. Surface water samples (SW-2 and SW-4) will also be collected if surface water is present in the drainage feature along the eastern property boundary, although it should be noted that the site data suggests that this feature is a groundwater recharge area rather than discharge boundary.

6. **The application indicates that the hypothetical point of exposure (POE) for the site will be assumed to be at the property line. Please note that while the VOC results from monitoring well MW-9/-9R, at the property boundary, have remained <0.001 mg/L for the past two years, the downgradient monitoring location MW-15 has consistently detected trichloroethane (TCE) degradation products, in the form of vinyl chloride, from 2006 through the most recent monitoring event. Therefore, MW-9 should not be utilized as a POD well and the POE should be revised to an alternate location, or the aforementioned groundwater to surface water discharge point in Comment 5. In addition, should the tributary of Hughes Prong be designated as the POE, please utilize the BIOCHLOR model to indicate what concentration would be necessary at the POD well(s) to impact the potential POE at a level above the applicable ISWQS. This surface water feature and associated potential POE must be illustrated on an applicable site figure.**

   Response: Because of the detection of vinyl chloride above the RRS in MW-15 in December 2006, monitoring well MW-15 will also be used as a POD well at the site. The assumed POE will be the intermittent unnamed tributary of Hughes Prong approximately 250 feet north of the site property line and approximately 530 feet downgradient of the suspected source origin near monitoring well MW-8 (Figure 1). Because the model does not indicate that the intermittent unnamed tributary of Hughes Prong will be impacted and would require stream flow data to evaluate the stream dilution factor, AMEC recommends deferring the request to evaluate what concentrations would be necessary at the POD wells to impact the POE at levels above the ISWQC. This evaluation would be done if subsequent groundwater and surface water monitoring data indicate that it is necessary.

7. **According to Section 7.0, "impacts above drinking water standards do not extend off of the property." Based on the data provided within the application, additional data must be provided east of monitoring locations MW-3, MW-4, and MW-19 in order confirm that the extent impacts above the drinking water standards has not extended beyond the eastern property boundary. Please note that should the facility be admitted into the Voluntary Remediation Program, the responsible party will have 2-years to complete delineation activities offsite.**

   Response: An additional monitoring well, MW-21, will be installed along the eastern property boundary to further evaluate potential contaminant migration east of MW-3 and MW-4. Additionally, existing off-site monitoring well MW-7 will be added to the sampling program to evaluate potential contaminant migration east of MW-19. The approximate location of the proposed MW-21 is presented on Figure 4.

8. **Please provide the calculations and supporting documentation, or the appropriate historical document reference, for the RRS included in Table 1. In addition, please include a Table of the applicable ISWQS, and please provide ecological endpoint values for contaminants of**

concern that do not have ISWQS.

Response: The calculations and supporting documentation for the determination of the RRS included in Table 1 of the VRP are contained Section 2 and Appendix B of the *Corrective Action Plan For Ground Water, Former Automatic Sprinkler Site (HSI Number 10268), Swainsboro, Georgia, by LAW Engineering and Environmental Services, inc., January 10, 2000*. Appendix C of this VRP Application Addendum contains updated RRS calculations for VOCs. Table 1 includes the applicable ISWQC protective of human health and aquatic receptors.

Preliminary Investigation and Remediation Plan:

9. **According to the VRP Application, it is proposed that the site will meet Type 3/4 risk reduction standards for groundwater at the end of the 5-year period. However, Section 8 of the Application indicates that additional monitoring beyond the 5-year period may be possible. Please provide clarification on the remedial action goal(s) for the site by clearly indicating if the site will meet the designated Type 3/4 RRS within the required 5-year timeframe or if the site will meet a designated site specific Type 5 RRS.**

   Response: The observed rate of contaminant degradation in MW-8 and the fate-and-transport modeling indicate that VOC concentrations exceeding traditional HSRA-calculated RRS could persist for approximately 75 years. However, VRP-allowed exposure controls (groundwater use restrictions) will limit the potential for exposure. Therefore, site-specific Type 4 RRS, less than or equal to the highest contaminant concentrations observed at the site to date, are proposed for site groundwater.

   The additional data provided from the proposed 5-year semi-annual groundwater monitoring period, in conjunction with updated fate-and-transport modeling, will help to evaluate whether additional monitoring is necessary after five years or whether the VRP-allowed exposure controls are adequate to protect human health and the environment. Compliance with RRS will be evaluated in the 5-year post-VRP implementation Compliance Status Report (CSR).

10. **The BIOCHLOR model described in Section 7.4 and included in Appendix F of the application is an acceptable model for use with the contaminants of concern identified in the groundwater at the site. However, the model has not been calibrated correctly to existing site conditions, and will need further validation by utilizing the additional data from future monitoring events. Additional comments associated with this model are included as follows:**

    a) **For the initial calibration run, the model inputs should be calibrated to get a biotransformation centerline that closely matches the field data points input into Section 7 of the model.**

    b) **EPD recommends that two (2) validation runs be conducted once the model has been calibrated. The validation runs should use the same input values with the exception of the simulation time. Simulation times should be approximated based on actual groundwater sampling dates and the modeling results should be compared with the actual groundwater data acquired during those dates. If model predictions are not**

consistent with actual groundwater analytical data, the model should be recalibrated and/or the validity of the modeling software used should be re-evaluated.

Response to a) and b): The Biochlor model input parameters have been adjusted slightly to attain a better curve match with the historical site data. Updated model input parameters and calibration runs for the years 2000, 2006, and 2010 are presented in Appendix A.

c) **Once model calibration and validation is complete, please revise the additional runs of the model that used increased simulation times to determine the projected maximum extent of the groundwater contaminant plume and the time projected to reach its maximum extent.**

d) **Please ensure that the modeled area length is defined by the point of shallow groundwater discharge to the unnamed tributary of Hughes Prong.**

Response to c) and d): Updated Biochlor model predictions for years 2016 (20 years), 2026 (30 years), 2046 (50 years), and 2071 (75 years) are included in Appendix A. The location of the down gradient property line, as well as the unnamed intermittent tributary of Hughes Prong, are illustrated on the model runs. The model indicates that future off-site concentrations of TCE and DCE will remain below detection limits and that future off-site vinyl chloride concentrations above the MCL may persist in MW-15 until approximately 2016, although actual recent data from MW-15 indicates that the model predictions are conservative. The data does not indicate that contaminants in groundwater will reach the unnamed intermittent tributary of Hughes Prong.

<u>Miscellaneous:</u>

11. **Please add two additional surface water monitoring locations to the future monitoring events, one upstream and one downstream of the culvert that discharges to Hughes Prong. Please note that for all future surface water sampling events, EPD recommends that samples be collected during low flow periods and analyzed with detection limits set at or below the established in-stream water quality standard, and documented by a table in the semiannual progress reports.**

    Response: As discussed above, two surface water sampling points (SW-5 and SW-6) will be established in the unnamed tributary to Hughes Prong (Figure 1). Because the stream flow conditions at the time of sampling cannot be predicted, the historical low flow conditions of the Canoochee River near Claxton, Georgia (1937 to 2010, USGS gage 02203000) were evaluated to determine the most likely times of year for low flow conditions to occur. The Canoochee River is in the same watershed as Hughes Prong. November had the lowest monthly average flow volume. Based on these data, the semi-annual sampling events will be scheduled for May and November of each year. If possible, surface water sampling will not be conducted within 48 hours of a rainfall event to reduce the potential for stormwater runoff to influence the surface water sampling data.

influence the surface water sampling data.

12. **According to Section 12-8-106 of the Act, "a participant in the voluntary remediation program must not be in violation of any order, judgment, statute, rule, or regulation subject to the enforcement authority of the director." Pursuant to our notice of violation of April 1, 2011, STI is currently in violation of the Corrective Action Plan (CAP) submittal schedule set forth by EPD. The site is therefore in a state of non-compliance. STI must address the compliance issues for this site to meet the criteria of Section 12-8-106 of the Act.**

    Response: The April 1, 2011 Notice of Violation resulted in EPD issuing a proposed Consent Order in correspondence dated September 15, 2011. STI signed and returned the Consent Order to EPD on October 12, 2011, along with a check in the amount of $5,000 to resolve the NOV. Therefore, we believe that the compliance issues have been addressed and the site is eligible to participate in the VRP.

Thank you for your assistance with this project. Please call us at 770-421-3400 if you have any questions regarding the information submitted.

Sincerely,

AMEC E&I, Inc.

GEORGIA REGISTERED No. 025565 PROFESSIONAL 11-14-11 ENGINEER GREGORY J. WRENN

Gregory J. Wrenn, P.E.
Project Manager

Cynthia E. Draper, P.E.
Principal Engineer

Attachments

cc: John Perkins, Tyco Fire Protection

TABLES

Table 1
Summary Table of Instream
Water Quality Criteria for Surface Water
STI Properties, Inc.
Swainsboro, Georgia

Constituent	Georgia EPD ISWQC Protective of Human Health* (µg/L)	ISWQC Protective of Aquatic Receptors (µg/L)
Cis-1,2-Dichloroethylene	None	590 (b)
Trans-1,2-Dichloroethylene	10000	1350 (a)
Trichloroethylene	30	21 (b)
1,2-Dichloroethane	37	2000 (a)
1,1-Dichloroethene	7100	303 (a)
1,1,2,2-Tetrachloroethane	4.0	240 (a)
1,1,1-Trichloroethane	None	528 (a)
1,1,2-Trichloroethane	16	940 (a)
Vinyl chloride	2.4	930 (b)

Notes:
*From GA Rules and Regulations for Water Quality Control Chapter 391-3-6-.03(5)(e)(iii)
(a) - Region 4 Freshwater Chronic Screening Values, 2001
(b) - NOAA Screening Quick Reference Tables, Buckman, M. F., 2008

Prepared By: RPR 10/19/11
Prepared By: GJW 10/19/11

Table 2
Summary of Delineation Criteria and Cleanup Standards
STI Properties, Inc.
Swainsboro, Georgia

Soil COC's	**Delineation Criteria**	**Cleanup Values**	**RRS Data Source**
	mg/kg	mg/kg	
Cadmium	2	39	Type 3, Jan 2000 CAP
Chromium	100	1200	Type 3, Jan 2000 CAP
Copper	100	1500	Type 3, Jan 2000 CAP
Lead	75	300	Type 3, Jan 2000 CAP
Nickel	50	420	Type 3, Jan 2000 CAP
Zinc	100	2800	Type 3, Jan 2000 CAP
Arsenic	20	41	Type 3, Jan 2000 CAP
Barium	1000	1000	Type 3, Jan 2000 CAP
Mercury	0.5	0.5	Type 3, Jan 2000 CAP
Silver	2	10	Type 3, Jan 2000 CAP
Vanadium	100	100	Type 3, Jan 2000 CAP
1,1,1-Trichloroethane	20	20	Type 3, VRP Appl Addendum, Appendix C
1,1,2,2-Tetrachloroethane	0.13	0.13	Type 3, VRP Appl Addendum, Appendix C
1,1,2-Trichloroethane	0.5	0.5	Type 3, VRP Appl Addendum, Appendix C
1,1-Dichloroethene	0.7	0.7	Type 3, VRP Appl Addendum, Appendix C
1,2-Dichloroethane	0.5	0.5	Type 3, VRP Appl Addendum, Appendix C
cis-1,2-Dichloroethene	7	7	Type 3, VRP Appl Addendum, Appendix C
Trichloroethene	0.5	0.5	Type 3, VRP Appl Addendum, Appendix C
Vinyl Chloride	0.2	0.2	Type 3, VRP Appl Addendum, Appendix C
Groundwater COC's	mg/L	mg/L	
Cadmium	0.005	0.005	Type 3, Jan 2000 CAP
Chromium	0.1	0.1	Type 3, Jan 2000 CAP
Copper	1.3	1.3	Type 3, Jan 2000 CAP
Lead	0.015	0.015	Type 3, Jan 2000 CAP
Zinc	2	2	Type 3, Jan 2000 CAP
Mercury	0.002	0.002	Type 3, Jan 2000 CAP
1,1,1-Trichloroethane	0.2	13	Type 4, VRP Appl Addendum, Appendix C
1,1,2,2-Tetrachloroethane	0.001	0.014	Type 4, VRP Appl Addendum, Appendix C
1,1,2-Trichloroethane	0.005	0.005	Type 3, VRP Appl Addendum, Appendix C
1,1-Dichloroethene	0.007	0.52	Type 4, VRP Appl Addendum, Appendix C
1,2-Dichloroethane	0.005	0.005	Type 3, VRP Appl Addendum, Appendix C
cis-1,2-Dichloroethene	0.07	0.2	Type 4, VRP Appl Addendum, Appendix C
Trichloroethene	0.005	0.0052	Type 4, VRP Appl Addendum, Appendix C
Vinyl Chloride	0.002	0.002	Type 3, VRP Appl Addendum, Appendix C

Prepared By: RPR 10/19/11
Prepared By: GJW 10/19/11

FIGURES

LEGEND

- ⊗ SHALLOW MONITORING WELL
- ⊕ DEEP MONITORING WELL
- ABANDONED WELL
- FLOODPLAIN
- ⊕ PROPOSED SURFACE WATER SAMPLE LOCATIONS

SCALE IN FEET

0 200 400

SOURCE: BASE MAP EMCON, 12/98 AND 6/99. GIS, AND ESRI WEBMAP SERVICE.

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FIGURE 1
SITE MAP AND SURFACE WATER SAMPLING LOCATIONS

JOB NO. 6125-08-0149

PREPARED BY/DATE TG 10/24/2011
CHECKED BY/DATE RR 10/24/2011

S-3	0-1' (mg/kg)
Cd	<2
Cr	10
Cu	150
Pb	53
Zn	85

SS-4	Surface (mg/kg)	2.5' (mg/kg)
Cd	<5	6.46
Cr	11.2	<5
Cu	182	<5
Pb	45.1	<5
Zn	75	<10

SS-5	Surface (mg/kg)	2.5' (mg/kg)
Cd	<5	<5
Cr	16.5	7.24
Cu	130	<5
Pb	61.2	6.74
Zn	111	<10

SB-26	0-1' (mg/kg)
Cd	<2
Cr	10
Cu	<5
Pb	14
Zn	<5

S-3	0-1' (mg/kg)
Cd	<2
Cr	10
Cu	150
Pb	53
Zn	85

GP-1	Surface (mg/kg)	2.5' (mg/kg)
Cd	34	<1
Cr	130	<2
Cu	48000	<5
Pb	2890	17
Zn	7060	<5

SB-3	0-1' (mg/kg)
Cd	<2
Cr	7
Cu	8
Pb	12
Zn	9

SB-25	0-1' (mg/kg)
Cd	<2
Cr	<5
Cu	<5
Pb	12
Zn	<5

SB-1	0-1' (mg/kg)
Cd	NA
Cr	<2
Cu	<5
Pb	9
Zn	15
VOCs	22

SB-28	0-1' (mg/kg)
Cd	<2
Cr	<5
Cu	29
Pb	19
Zn	13

SB-27	0-1' (mg/kg)
Cd	<2
Cr	7
Cu	<5
Pb	14
Zn	<5

S-2	0-1' (mg/kg)
Cd	5.7
Cr	37
Cu	1900
Pb	240
Zn	840

GP-2	Surface (mg/kg)	5' (mg/kg)
Cd	28	<1
Cr	67	<2
Cu	13900	<5
Pb	110	18
Zn	1790	8

SS-1	Surface (mg/kg)	2.5' (mg/kg)
Cd	<5	<5
Cr	13.5	13.5
Cu	452	628
Pb	42.1	33.7
Zn	307	55.6

SB-8	0-1' (mg/kg)
Cd	<2
Cr	8
Cu	11
Pb	115
Zn	8

SB-9	0-1' (mg/kg)
Cd	<2
Cr	<5
Cu	11
Pb	16
Zn	110

SB-18	0-1' (mg/kg)
Cd	<2
Cr	<5
Cu	<5
Pb	11
Zn	6

SB-10	0-1' (mg/kg) 7/17/96	3-4' (mg/kg) 7/17/96	0-1' (mg/kg) 8/21/96
Cd	<2	<2	<2
Cr	<5	<5	<2
Cu	<5	<5	<5
Pb	<5	11	7
Zn	110	24	35

SB-19	0-1' (mg/kg)
Cd	<2
Cr	<5
Cu	<5
Pb	9
Zn	<5

SS-2	Surface (mg/kg)	2.5' (mg/kg)
Cd	<5	<5
Cr	35.5	<5
Cu	369	25.6
Pb	192	<5
Zn	565	36.3

GP-5	Surface (mg/kg)	5' (mg/kg)
Cd	12	<1
Cr	210	10
Cu	76000	<5
Pb	2490	16
Zn	9700	<5

S-5	0-1' (mg/kg)
Cd	2.0
Cr	23
Cu	4700
Pb	300
Zn	1700

SB-15	0-1' (mg/kg)
Cd	<2
Cr	<5
Cu	<5
Pb	11
Zn	14

S-6	0-1' (mg/kg)
Cd	<2
Cr	<5
Cu	3
Pb	12
Zn	180

GP-9	Surface (mg/kg)
Cd	<1
Cr	2
Cu	<5
Pb	18
Zn	<5

SB-16	0-1' (mg/kg)
Cd	<2
Cr	<5
Cu	<5
Pb	16
Zn	25

SB-13	0-1' (mg/kg) 7/17/96	0-1' (mg/kg) 7/17/96
Cd	<2	<2
Cr	<10	<5
Cu	22	<5
Pb	11	6
Zn	20	5

SB-21/21A	0.5' (mg/kg)
Cd	<1.0
Cr	<2
Cu	<5
Pb	NA
Zn	16

SB-17	0-1' (mg/kg)
Cd	<2
Cr	<5
Cu	<5
Pb	12
Zn	<5

SB-11	0-1' (mg/kg) 7/17/96	0-1' (mg/kg) 8/21/96
Cd	<2	<2
Cr	6	27
Cu	<5	<5
Pb	11	7
Zn	<5	7

SS-6	Surface (mg/kg)	2.5' (mg/kg)
Cd	<5	<5
Cr	17.1	9.44
Cu	101	7.42
Pb	20.7	<5
Zn	51.4	<10

SB-12	0-1' (mg/kg) 7/17/96	0-1' (mg/kg) 8/21/96
Cd	<2	<2
Cr	<5	<5
Cu	9	<5
Pb	13	<5
Zn	6	120

SS-7	Surface (mg/kg)	2.5' (mg/kg)
Cd	<5	<5
Cr	20.1	<5
Cu	136	<5
Pb	118	<5
Zn	124	<10

SB-18	0-1' (mg/kg)
Cd	<2
Cr	15
Cu	36
Pb	50
Zn	67

GP-8	Surface (mg/kg)	5' (mg/kg)
Cd	1	<1
Cr	11	3
Cu	510	6
Pb	50	18
Zn	140	<5

SB-4	0-1' (mg/kg)
Cd	<2
Cr	<5
Cu	14
Pb	20
Zn	9

SB-2	0-1' (mg/kg)	3-4' (mg/kg)
Cd	2	<2
Cr	14	<5
Cu	12	<5
Pb	91	10
Zn	130	5

SB-24	0-1' (mg/kg)
Cd	<2
Cr	<5
Cu	<5
Pb	12
Zn	<5

SB-6	0-1' (mg/kg)
Cd	<2
Cr	<5
Cu	8
Pb	13
Zn	22

SB-5	0-1' (mg/kg)
Cd	<2
Cr	<5
Cu	8
Pb	19
Zn	52

SB-20	0-1' (mg/kg)
Cd	3
Cr	65
Cu	180
Pb	190
Zn	120

GP-7	Surface (mg/kg)	2.5' (mg/kg)
Cd	9	2
Cr	79	11
Cu	990	9
Pb	1446	50
Zn	580	<5

GP-6	Surface (mg/kg)	5' (mg/kg)
Cd	14	<1
Cr	120	6
Cu	62000	8
Pb	220	32
Zn	24700	<5

S-7	0-1' (mg/kg)
Cd	10
Cr	4100
Cu	240
Pb	7400
Zn	4900

SB-16	0-1' (mg/kg)
Cd	42
Cr	510
Cu	4700
Pb	7500
Zn	5100

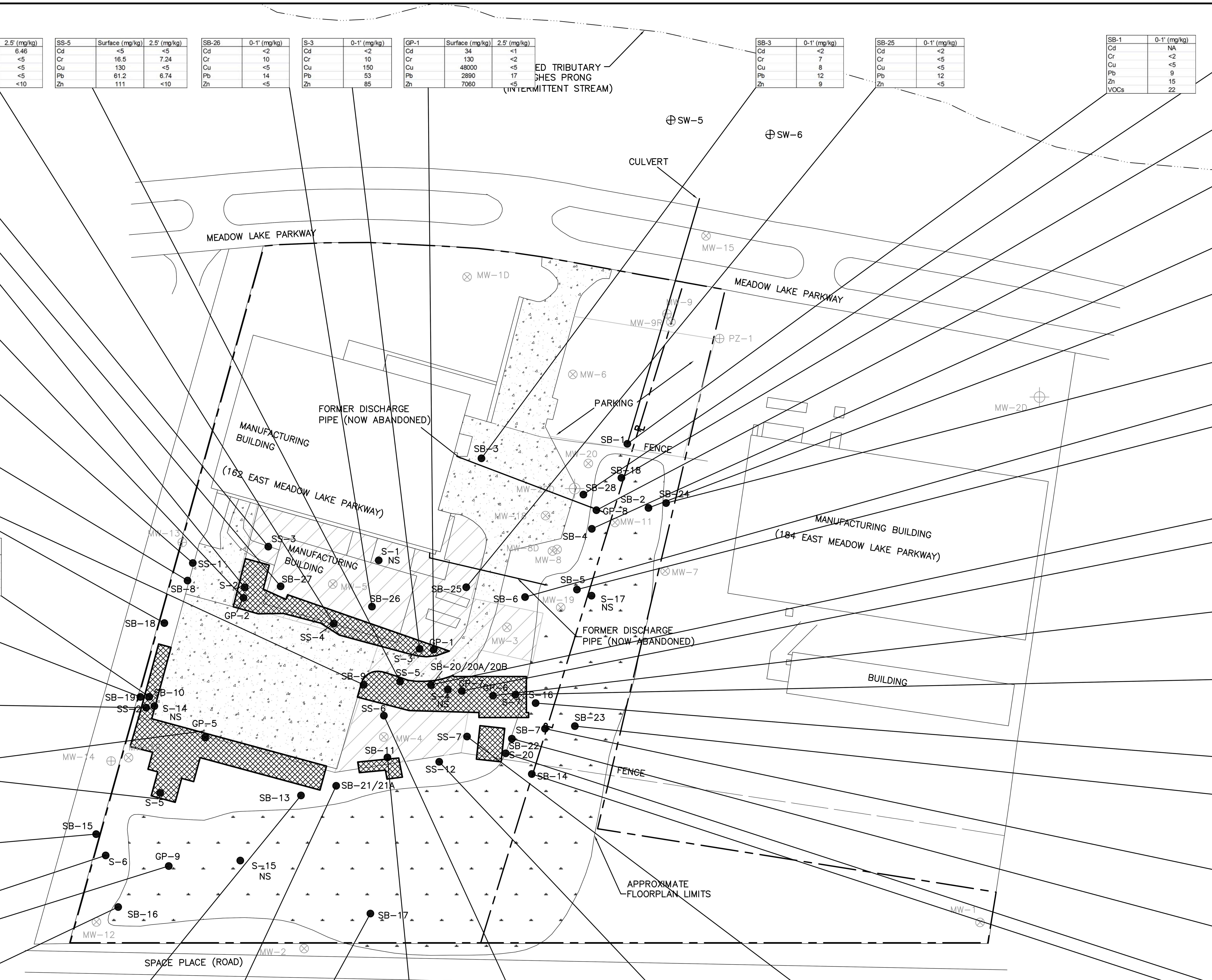
SB-23	0-1' (mg/kg)
Cd	<2
Cr	<5
Cu	12
Pb	18
Zn	22

SB-7	0-1' (mg/kg)	3-4' (mg/kg)
Cd	9	<2
Cr	10	<5
Cu	29	<5
Pb	32	25
Zn	210	12

SB-22	0-1' (mg/kg)
Cd	<2
Cr	<5
Cu	15
Pb	48
Zn	38

S-20	0-1' (mg/kg)
Cd	<2
Cr	36
Cu	140
Pb	63
Zn	93

SB-14	0-1' (mg/kg)
Cd	<2
Cr	8
Cu	7
Pb	13
Zn	13



LEGEND

●	SOIL SAMPLE LOCATION
— —	PROPERTY LINE
NA	NOT ANALYZED
NS	NOT SAMPLED
Cd	CADMIUM
Cr	CHROMIUM
Cu	COPPER
Pb	LEAD
Zn	ZINC

SCALE IN FEET
0 60 120

SOURCE: BASE MAP EMCON, 12/98 AND 6/99. GIS, AND ESRI WEBMAP SERVICE.

REV	DATE	BY	SUB	APP	DESCRIPTION	REV	DATE	BY	SUB	APP	DESCRIPTION

DESIGNED R. ROGERO
DRAWN T. GLADSTONE
CHECKED
IN CHARGE G. WRENN
DATE 11/21/2011

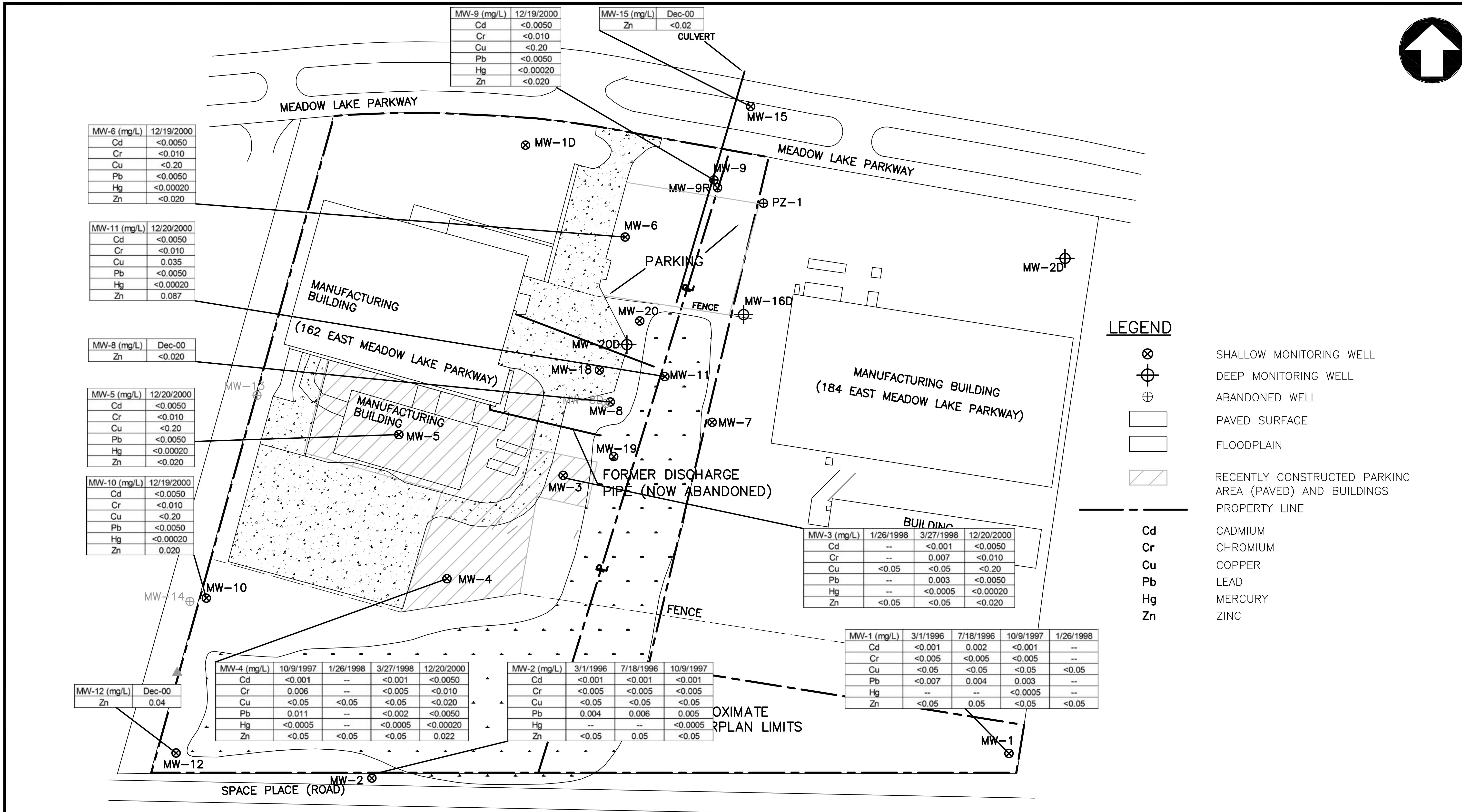
STI PROPERTIES, INC.
SWAINSBORO, GEORGIA

amec
Environment & Infrastructure, Inc.
3200 TOWN POINT DRIVE, SUITE 100
KENNESAW, GEORGIA 30144 (770) 421-3400

FORMER SOIL SAMPLING AND SOIL EXCAVATION LOCATIONS

SCALE AS SHOWN
CONTRACT 6125-08-0149
DWG. NO. | REV | PAGE NO.
2

J:\STI\OCT 2011\SOILS IN GW.dwg -- Layout1 10/27/2011 4:15pm tonya.gladstone



MW-9 (mg/L)	12/19/2000
Cd	<0.0050
Cr	<0.010
Cu	<0.20
Pb	<0.0050
Hg	<0.00020
Zn	<0.020

MW-15 (mg/L)	Dec-00
Zn	<0.02

MW-6 (mg/L)	12/19/2000
Cd	<0.0050
Cr	<0.010
Cu	<0.20
Pb	<0.0050
Hg	<0.00020
Zn	<0.020

MW-11 (mg/L)	12/20/2000
Cd	<0.0050
Cr	<0.010
Cu	0.035
Pb	<0.0050
Hg	<0.00020
Zn	0.087

MW-8 (mg/L)	Dec-00
Zn	<0.020

MW-5 (mg/L)	12/20/2000
Cd	<0.0050
Cr	<0.010
Cu	<0.20
Pb	<0.0050
Hg	<0.00020
Zn	<0.020

MW-10 (mg/L)	12/19/2000
Cd	<0.0050
Cr	<0.010
Cu	<0.20
Pb	<0.0050
Hg	<0.00020
Zn	0.020

MW-3 (mg/L)	1/26/1998	3/27/1998	12/20/2000
Cd	--	<0.001	<0.0050
Cr	--	0.007	<0.010
Cu	<0.05	<0.05	<0.20
Pb	--	0.003	<0.0050
Hg	--	<0.0005	<0.00020
Zn	<0.05	<0.05	<0.020

MW-1 (mg/L)	3/1/1996	7/18/1996	10/9/1997	1/26/1998
Cd	<0.001	0.002	<0.001	--
Cr	<0.005	<0.005	<0.005	--
Cu	<0.05	<0.05	<0.05	<0.05
Pb	<0.007	0.004	0.003	--
Hg	--	--	<0.0005	--
Zn	<0.05	0.05	<0.05	<0.05

MW-12 (mg/L)	Dec-00
Zn	0.04

MW-4 (mg/L)	10/9/1997	1/26/1998	3/27/1998	12/20/2000
Cd	<0.001	--	<0.001	<0.0050
Cr	0.006	--	<0.005	<0.010
Cu	<0.05	<0.05	<0.05	<0.020
Pb	0.011	--	<0.002	<0.0050
Hg	<0.0005	--	<0.0005	<0.00020
Zn	<0.05	<0.05	<0.05	0.022

MW-2 (mg/L)	3/1/1996	7/18/1996	10/9/1997
Cd	<0.001	<0.001	<0.001
Cr	<0.005	<0.005	<0.005
Cu	<0.05	<0.05	<0.05
Pb	0.004	0.006	0.005
Hg	--	--	<0.0005
Zn	<0.05	0.05	<0.05

SOURCE: BASE MAP EMCON, 12/98 AND 6/99. GIS, AND ESRI WEBMAP SERVICE.

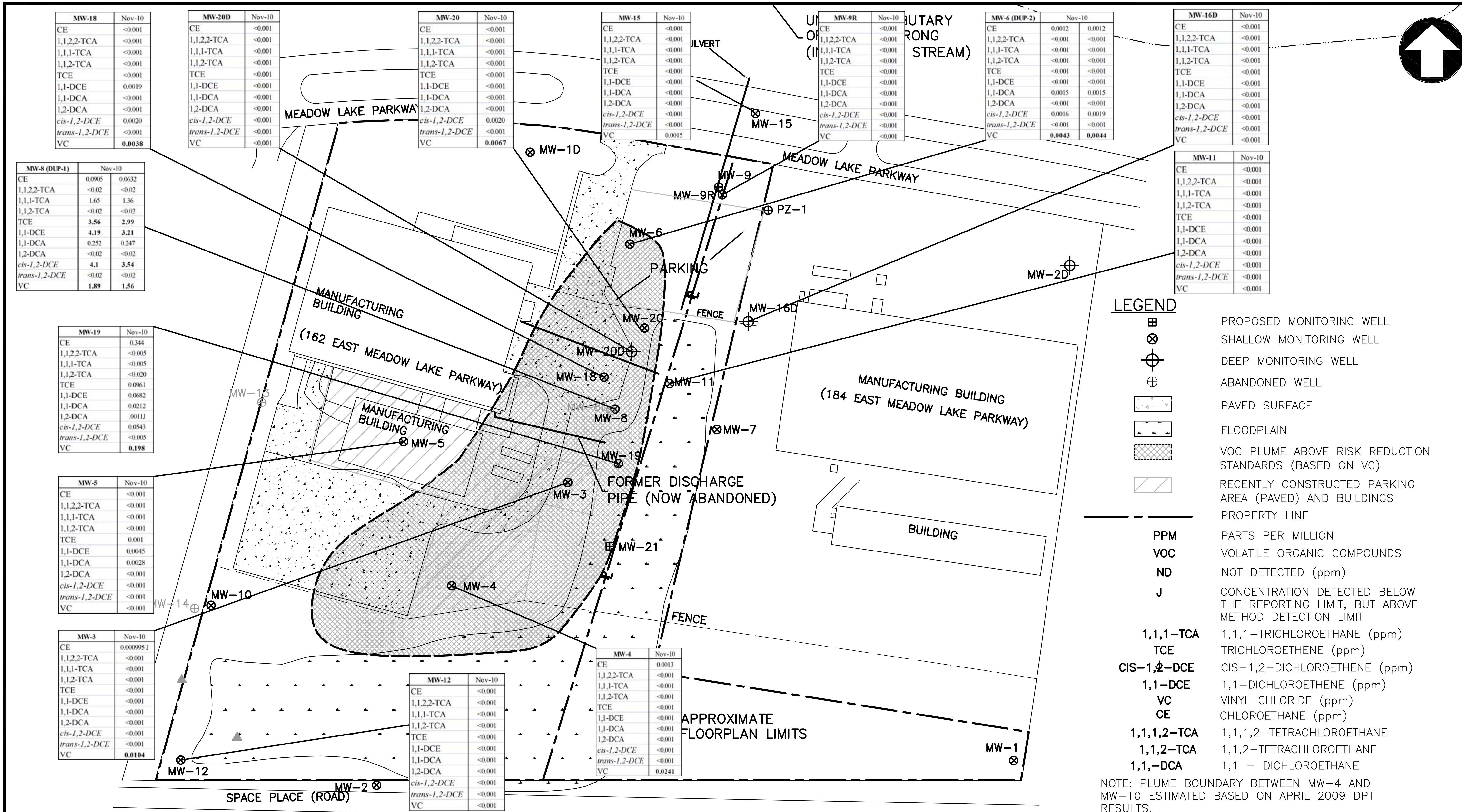
STI PROPERTIES, INC.
162 EAST MEADOWLAKE PKWY
SWAINSBORO, GEORGIA

amec
E&I, INC.
3200 TOWN POINT DRIVE,
SUITE 100
KENNESAW, GEORGIA 30144
(770) 421-3400

FIGURE 3
METALS ANALYTICAL RESULTS IN GROUNDWATER

JOB NO. 6125-08-0149

PREPARED BY/DATE
CHECKED BY/DATE



MW-18	Nov-10
CE	<0.001
1,1,2,2-TCA	<0.001
1,1,1-TCA	<0.001
1,1,2-TCA	<0.001
TCE	<0.001
1,1-DCE	0.0019
1,1-DCA	<0.001
1,2-DCA	<0.001
cis-1,2-DCE	0.0020
trans-1,2-DCE	<0.001
VC	**0.0038**

MW-20D	Nov-10
CE	<0.001
1,1,2,2-TCA	<0.001
1,1,1-TCA	<0.001
1,1,2-TCA	<0.001
TCE	<0.001
1,1-DCE	<0.001
1,1-DCA	<0.001
1,2-DCA	<0.001
cis-1,2-DCE	<0.001
trans-1,2-DCE	<0.001
VC	<0.001

MW-20	Nov-10
CE	<0.001
1,1,2,2-TCA	<0.001
1,1,1-TCA	<0.001
1,1,2-TCA	<0.001
TCE	<0.001
1,1-DCE	<0.001
1,1-DCA	<0.001
1,2-DCA	<0.001
cis-1,2-DCE	0.0020
trans-1,2-DCE	<0.001
VC	**0.0067**

MW-15	Nov-10
CE	<0.001
1,1,2,2-TCA	<0.001
1,1,1-TCA	<0.001
1,1,2-TCA	<0.001
TCE	<0.001
1,1-DCE	<0.001
1,1-DCA	<0.001
1,2-DCA	<0.001
cis-1,2-DCE	<0.001
trans-1,2-DCE	<0.001
VC	0.0015

MW-9R	Nov-10
CE	<0.001
1,1,2,2-TCA	<0.001
1,1,1-TCA	<0.001
1,1,2-TCA	<0.001
TCE	<0.001
1,1-DCE	<0.001
1,1-DCA	<0.001
1,2-DCA	<0.001
cis-1,2-DCE	<0.001
trans-1,2-DCE	<0.001
VC	<0.001

MW-6 (DUP-2)	Nov-10	
CE	0.0012	0.0012
1,1,2,2-TCA	<0.001	<0.001
1,1,1-TCA	<0.001	<0.001
1,1,2-TCA	<0.001	<0.001
TCE	<0.001	<0.001
1,1-DCE	<0.001	<0.001
1,1-DCA	0.0015	0.0015
1,2-DCA	<0.001	<0.001
cis-1,2-DCE	0.0016	0.0019
trans-1,2-DCE	<0.001	<0.001
VC	**0.0043**	**0.0044**

MW-16D	Nov-10
CE	<0.001
1,1,2,2-TCA	<0.001
1,1,1-TCA	<0.001
1,1,2-TCA	<0.001
TCE	<0.001
1,1-DCE	<0.001
1,1-DCA	<0.001
1,2-DCA	<0.001
cis-1,2-DCE	<0.001
trans-1,2-DCE	<0.001
VC	<0.001

MW-8 (DUP-1)	Nov-10	
CE	0.0905	0.0632
1,1,2,2-TCA	<0.02	<0.02
1,1,1-TCA	1.65	1.36
1,1,2-TCA	<0.02	<0.02
TCE	**3.56**	**2.99**
1,1-DCE	**4.19**	**3.21**
1,1-DCA	0.252	0.247
1,2-DCA	<0.02	<0.02
cis-1,2-DCE	**4.1**	**3.54**
trans-1,2-DCE	<0.02	<0.02
VC	**1.89**	**1.56**

MW-11	Nov-10
CE	<0.001
1,1,2,2-TCA	<0.001
1,1,1-TCA	<0.001
1,1,2-TCA	<0.001
TCE	<0.001
1,1-DCE	<0.001
1,1-DCA	<0.001
1,2-DCA	<0.001
cis-1,2-DCE	<0.001
trans-1,2-DCE	<0.001
VC	<0.001

MW-19	Nov-10
CE	0.344
1,1,2,2-TCA	<0.005
1,1,1-TCA	<0.005
1,1,2-TCA	<0.020
TCE	0.0961
1,1-DCE	0.0682
1,1-DCA	0.0212
1,2-DCA	.0011J
cis-1,2-DCE	0.0543
trans-1,2-DCE	<0.005
VC	**0.198**

MW-5	Nov-10
CE	<0.001
1,1,2,2-TCA	<0.001
1,1,1-TCA	<0.001
1,1,2-TCA	<0.001
TCE	0.001
1,1-DCE	0.0045
1,1-DCA	0.0028
1,2-DCA	<0.001
cis-1,2-DCE	<0.001
trans-1,2-DCE	<0.001
VC	<0.001

MW-3	Nov-10
CE	0.000995 J
1,1,2,2-TCA	<0.001
1,1,1-TCA	<0.001
1,1,2-TCA	<0.001
TCE	<0.001
1,1-DCE	<0.001
1,1-DCA	<0.001
1,2-DCA	<0.001
cis-1,2-DCE	<0.001
trans-1,2-DCE	<0.001
VC	**0.0104**

MW-12	Nov-10
CE	<0.001
1,1,2,2-TCA	<0.001
1,1,1-TCA	<0.001
1,1,2-TCA	<0.001
TCE	<0.001
1,1-DCE	<0.001
1,1-DCA	<0.001
1,2-DCA	<0.001
cis-1,2-DCE	<0.001
trans-1,2-DCE	<0.001
VC	<0.001

MW-4	Nov-10
CE	0.0013
1,1,2,2-TCA	<0.001
1,1,1-TCA	<0.001
1,1,2-TCA	<0.001
TCE	<0.001
1,1-DCE	<0.001
1,1-DCA	<0.001
1,2-DCA	<0.001
cis-1,2-DCE	<0.001
trans-1,2-DCE	<0.001
VC	**0.0241**

SOURCE: BASE MAP EMCON, 12/98 AND 6/99. GIS, AND ESRI WEBMAP SERVICE.

STI PROPERTIES, INC.
162 EAST MEADOWLAKE PKWY
SWAINSBORO, GEORGIA

amec
E&I, INC.
3200 TOWN POINT DRIVE,
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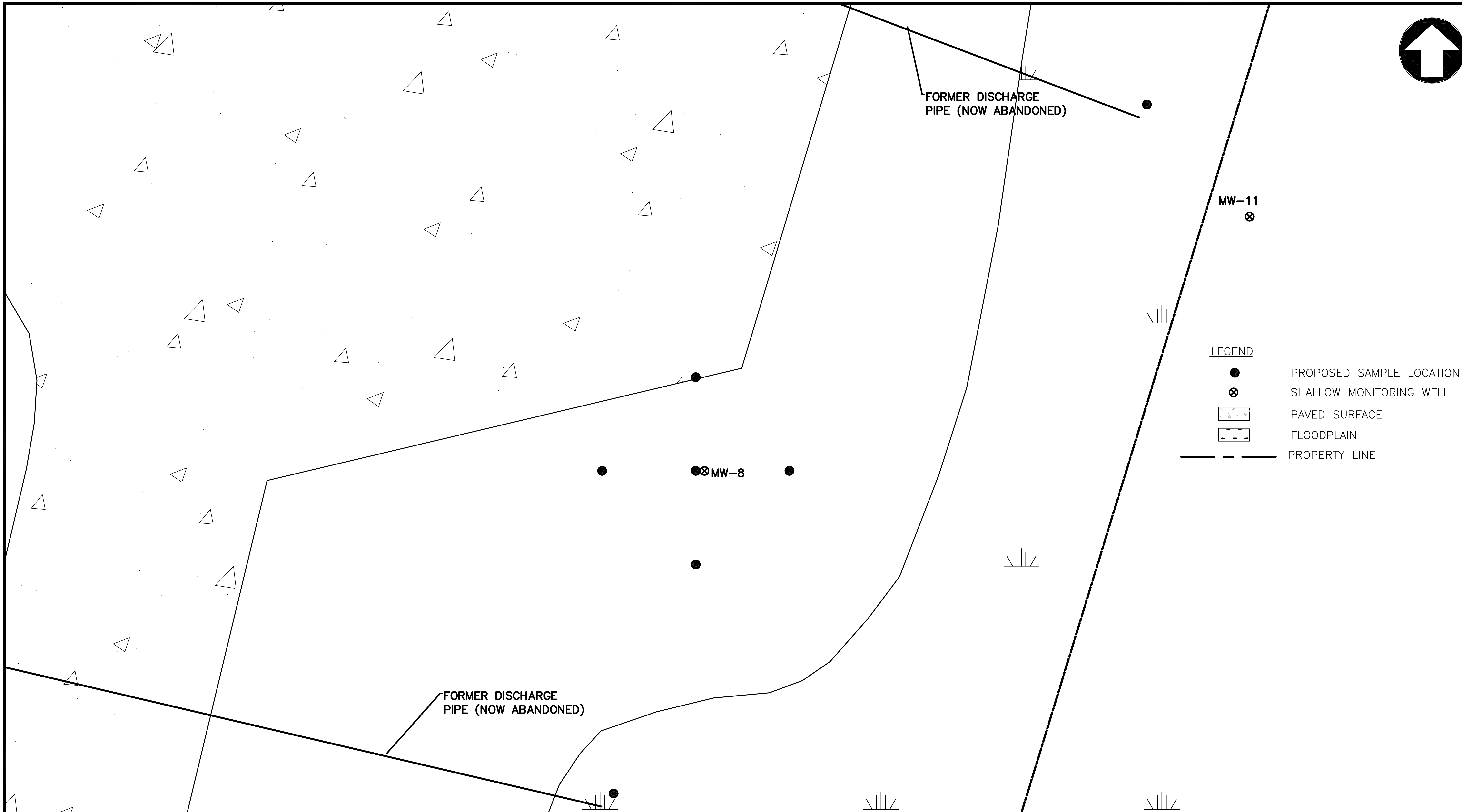
KENNESAW, GEORGIA 30144
(770) 421–3400

FIGURE 4
DELINEATION OF VOCs IN GROUNDWATER NOVEMBER 2010

JOB NO. 6125–08–0149

PREPARED BY/DATE AWE 10/24/2011
CHECKED BY/DATE FKM 10/24/2011

J:\STI\OCT 2011\3.4_MW8-AREA-TCE.dwg - Layout1 10/27/2011 4:09pm tonya.gladstone



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amec

E&I, INC.
3200 TOWN POINT DRIVE,
SUITE 100
KENNESAW, GEORGIA 30144
(770) 421-3400

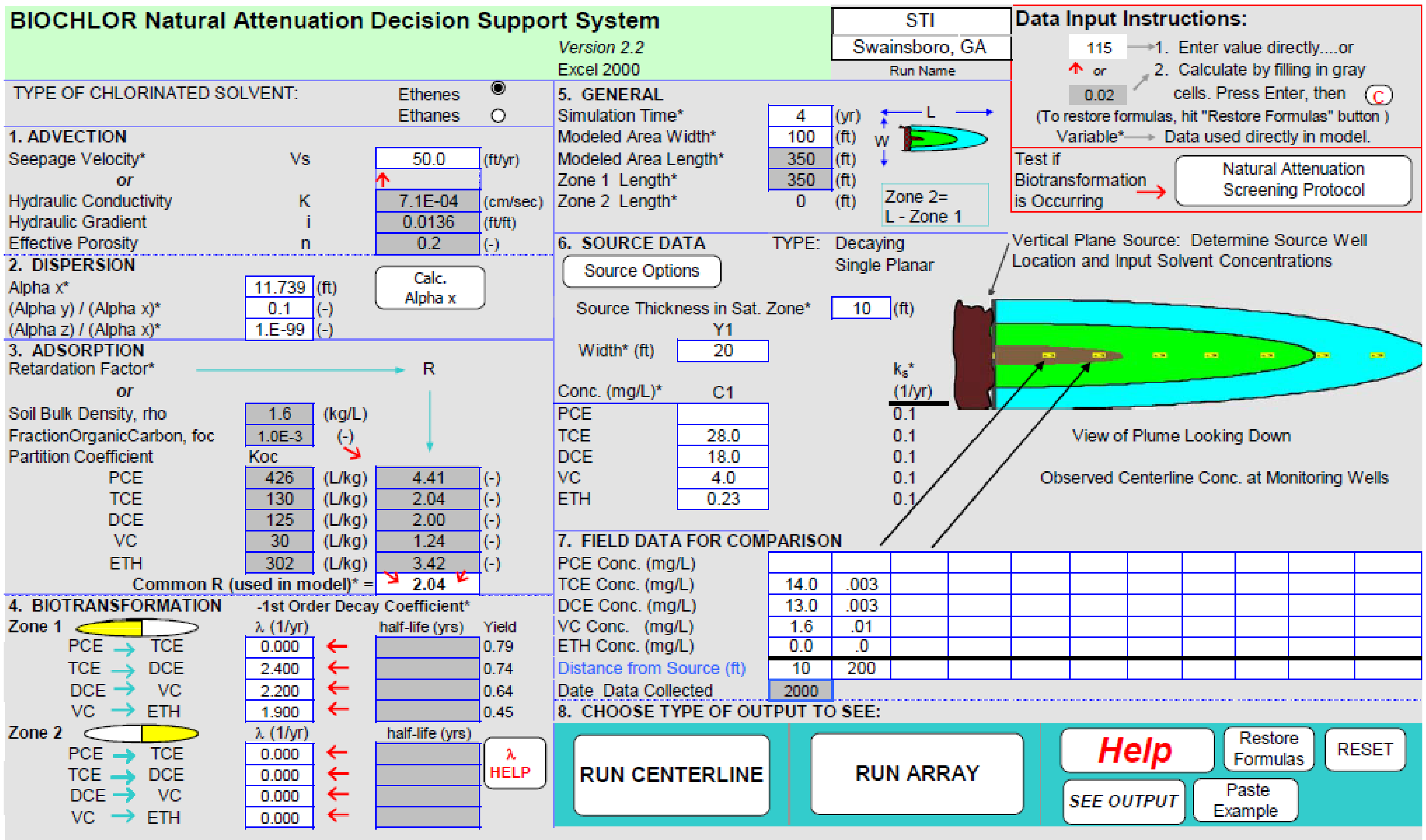
FIGURE 5
PROPOSED SOIL SAMPLE LOCATIONS
FOR VOCs

JOB NO. 6125-08-0149

PREPARED BY/DATE RR 10/24/2011
CHECKED BY/DATE AWE10/24/2011

APPENDIX A
GROUNDWATER FATE AND TRANSPORT MODEL CALIBRATION AND RESULTS

MODEL CALIBRATION – YEAR 2000 (YR 4)
STI SWAINSBORO, GA



BIOCHLOR Natural Attenuation Decision Support System

Version 2.2
Excel 2000

STI
Swainsboro, GA
Run Name

Data Input Instructions:
115 → 1. Enter value directly....or
or 2. Calculate by filling in gray
0.02 cells. Press Enter, then C
(To restore formulas, hit "Restore Formulas" button)
Variable* → Data used directly in model.

Test if Biotransformation is Occurring → Natural Attenuation Screening Protocol

TYPE OF CHLORINATED SOLVENT: Ethenes ◉ / Ethanes ○

1. ADVECTION

Seepage Velocity*	Vs	50.0	(ft/yr)
or			
Hydraulic Conductivity	K	7.1E-04	(cm/sec)
Hydraulic Gradient	i	0.0136	(ft/ft)
Effective Porosity	n	0.2	(-)

2. DISPERSION

Alpha x*	11.739	(ft)
(Alpha y) / (Alpha x)*	0.1	(-)
(Alpha z) / (Alpha x)*	1.E-99	(-)

Calc. Alpha x

3. ADSORPTION

Retardation Factor* → R
or
Soil Bulk Density, rho 1.6 (kg/L)
FractionOrganicCarbon, foc 1.0E-3 (-)

Partition Coefficient	Koc		R	
PCE	426	(L/kg)	4.41	(-)
TCE	130	(L/kg)	2.04	(-)
DCE	125	(L/kg)	2.00	(-)
VC	30	(L/kg)	1.24	(-)
ETH	302	(L/kg)	3.42	(-)

Common R (used in model)* = 2.04

4. BIOTRANSFORMATION -1st Order Decay Coefficient*

Zone 1	λ (1/yr)	half-life (yrs)	Yield
PCE → TCE	0.000		0.79
TCE → DCE	2.400		0.74
DCE → VC	2.200		0.64
VC → ETH	1.900		0.45

Zone 2	λ (1/yr)	half-life (yrs)
PCE → TCE	0.000	
TCE → DCE	0.000	
DCE → VC	0.000	
VC → ETH	0.000	

λ HELP

5. GENERAL

Simulation Time*	4	(yr)
Modeled Area Width*	100	(ft)
Modeled Area Length*	350	(ft)
Zone 1 Length*	350	(ft)
Zone 2 Length*	0	(ft)

L W
Zone 2= L - Zone 1

6. SOURCE DATA TYPE: Decaying Single Planar

Source Options

Vertical Plane Source: Determine Source Well Location and Input Solvent Concentrations

Source Thickness in Sat. Zone* 10 (ft)

Width* (ft) Y1: 20

Conc. (mg/L)*	C1	k_s* (1/yr)
PCE		0.1
TCE	28.0	0.1
DCE	18.0	0.1
VC	4.0	0.1
ETH	0.23	0.1

View of Plume Looking Down

Observed Centerline Conc. at Monitoring Wells

7. FIELD DATA FOR COMPARISON

PCE Conc. (mg/L)											
TCE Conc. (mg/L)	14.0	.003									
DCE Conc. (mg/L)	13.0	.003									
VC Conc. (mg/L)	1.6	.01									
ETH Conc. (mg/L)	0.0	.0									
Distance from Source (ft)	10	200									
Date Data Collected	2000										

8. CHOOSE TYPE OF OUTPUT TO SEE:

RUN CENTERLINE | RUN ARRAY | Help | Restore Formulas | RESET | SEE OUTPUT | Paste Example

MODEL CALIBRATION – TCE IN YEAR 2000 (YR 4)
STI SWAINSBORO, GA

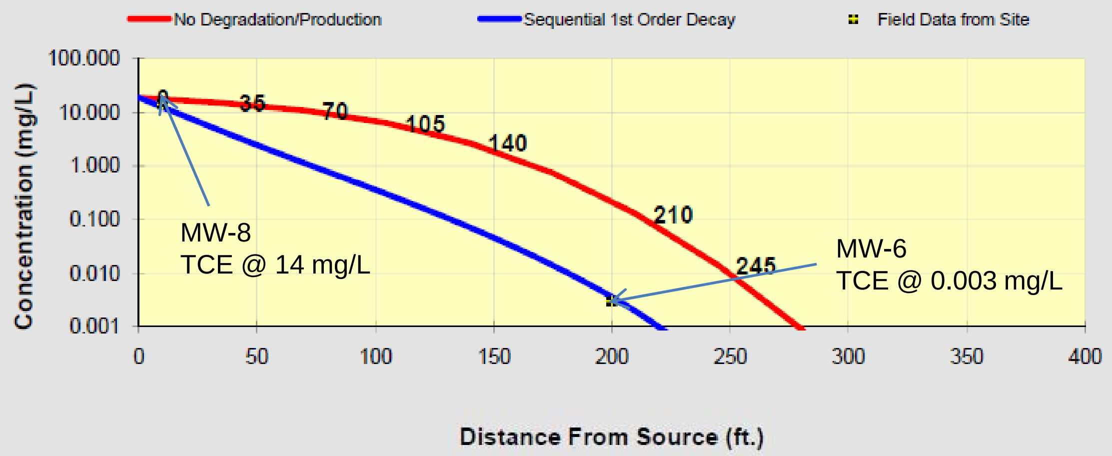
DISSOLVED CHLORINATED SOLVENT CONCENTRATIONS ALONG PLUME CENTERLINE (mg/L) at Z=0

Distance from Source (ft)

TCE	0	35	70	105	140	175	210	245	280	315	350
No Degradation	18.769	14.984	10.757	6.314	2.643	0.731	0.128	0.014	0.001	0.000	0.000
Biotransformation	18.7690	4.473	1.121	0.294	0.071	0.014	0.002	0.000	0.000	0.000	0.000

Monitoring Well Locations (ft)

	10	200									
Field Data from Site	14.000	0.003									



See PCE
See TCE
See DCE
See VC
See ETH

Prepare Animation

Time:
4.0 Years
Log ⟺ Linear

Return to Input

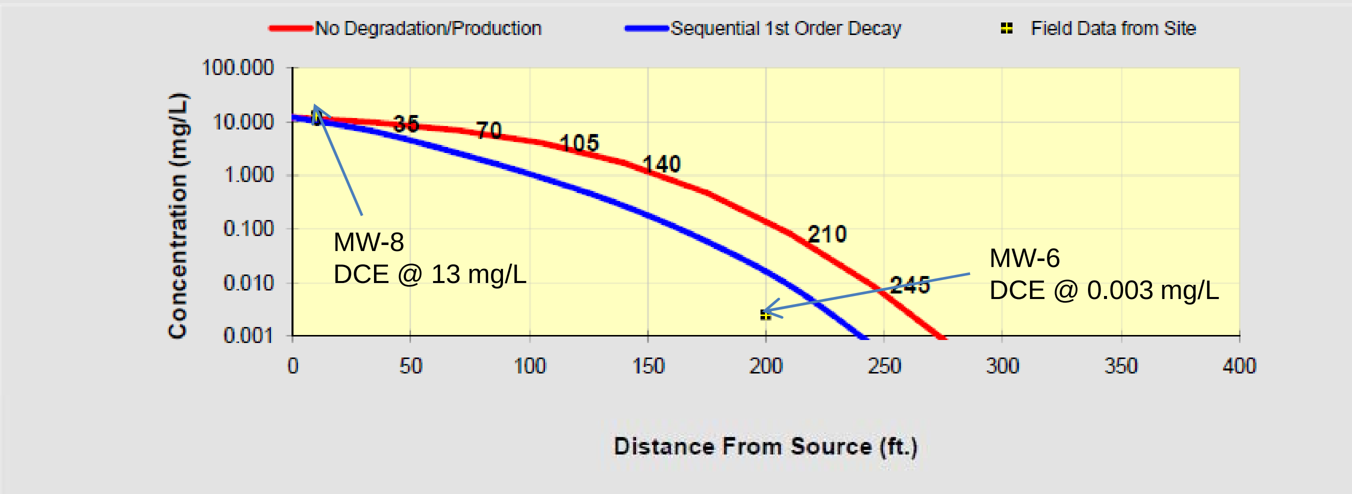
To All

To Array

MODEL CALIBRATION – DCE IN YEAR 2000 (YR 4)
STI SWAINSBORO, GA

DISSOLVED CHLORINATED SOLVENT CONCENTRATIONS ALONG PLUME CENTERLINE (mg/L) at Z=0

	Distance from Source (ft)										
DCE	0	35	70	105	140	175	210	245	280	315	350
No Degradation	12.066	9.633	6.915	4.059	1.699	0.470	0.082	0.009	0.001	0.000	0.000
Biotransformation	12.0658	6.459	2.561	0.907	0.266	0.058	0.009	0.001	0.000	0.000	0.000
	Monitoring Well Locations (ft)										
	10	200									
Field Data from Site	13.000	0.003									



See PCE

See TCE

See DCE

See VC

See ETH

Prepare Animation

Time:
4.0 Years

Log ⟺ Linear

Return to Input

To All

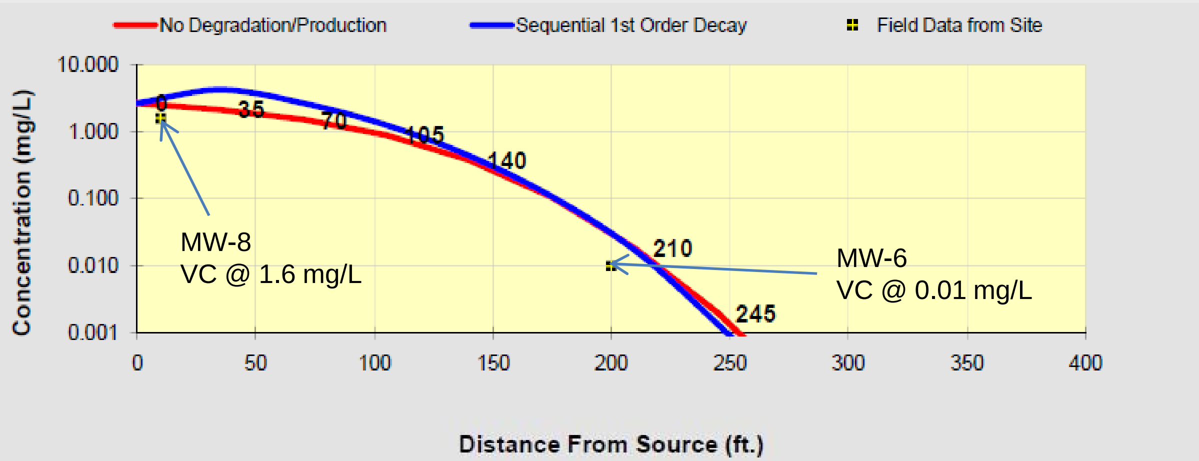
To Array

MODEL CALIBRATION – VC IN YEAR 2000 (YR 4)
STI SWAINSBORO, GA

DISSOLVED CHLORINATED SOLVENT CONCENTRATIONS ALONG PLUME CENTERLINE (mg/L) at Z=0

VC	Distance from Source (ft)										
	0	35	70	105	140	175	210	245	280	315	350
No Degradation	2.681	2.141	1.537	0.902	0.378	0.104	0.018	0.002	0.000	0.000	0.000
Biotransformation	2.6813	4.238	2.681	1.264	0.442	0.108	0.017	0.001	0.000	0.000	0.000

	Monitoring Well Locations (ft)										
	10	200									
Field Data from Site	1.600	0.010									



See PCE
See TCE
See DCE
See VC
See ETH

Prepare Animation

Time:
4.0 Years
Log ⟺ Linear

Return to Input
To All
To Array

MODEL CALIBRATION – YEAR 2006 (YR 10)
STI SWAINSBORO, GA

BIOCHLOR Natural Attenuation Decision Support System
Version 2.2
Excel 2000

STI
Swainsboro, GA
Run Name

Data Input Instructions:
115 → 1. Enter value directly....or
or 2. Calculate by filling in gray
0.02 cells. Press Enter, then (C)
(To restore formulas, hit "Restore Formulas" button)
Variable* → Data used directly in model.

Test if Biotransformation is Occurring → Natural Attenuation Screening Protocol

TYPE OF CHLORINATED SOLVENT: Ethenes (●) / Ethanes (○)

1. ADVECTION

Seepage Velocity*	Vs	50.0	(ft/yr)
or			
Hydraulic Conductivity	K	7.1E-04	(cm/sec)
Hydraulic Gradient	i	0.0136	(ft/ft)
Effective Porosity	n	0.2	(-)

2. DISPERSION (Calc. Alpha x)

Alpha x*	11.739	(ft)
(Alpha y) / (Alpha x)*	0.1	(-)
(Alpha z) / (Alpha x)*	1.E-99	(-)

3. ADSORPTION

Retardation Factor* → R
or

Soil Bulk Density, rho	1.6	(kg/L)	
FractionOrganicCarbon, foc	1.0E-3	(-)	
Partition Coefficient	Koc		
PCE	426	(L/kg)	4.41 (-)
TCE	130	(L/kg)	2.04 (-)
DCE	125	(L/kg)	2.00 (-)
VC	30	(L/kg)	1.24 (-)
ETH	302	(L/kg)	3.42 (-)
Common R (used in model)* =			2.04

4. BIOTRANSFORMATION -1st Order Decay Coefficient*

Zone 1	λ (1/yr)	half-life (yrs)	Yield
PCE → TCE	0.000		0.79
TCE → DCE	2.400		0.74
DCE → VC	2.200		0.64
VC → ETH	1.900		0.45

Zone 2	λ (1/yr)	half-life (yrs)
PCE → TCE	0.000	
TCE → DCE	0.000	
DCE → VC	0.000	
VC → ETH	0.000	

λ HELP

5. GENERAL

Simulation Time*	10	(yr)
Modeled Area Width*	100	(ft)
Modeled Area Length*	350	(ft)
Zone 1 Length*	350	(ft)
Zone 2 Length*	0	(ft)

L, W
Zone 2= L - Zone 1

6. SOURCE DATA TYPE: Decaying Single Planar

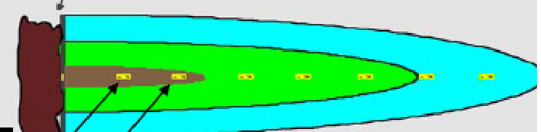
Source Options

Source Thickness in Sat. Zone* 10 (ft)

Y1
Width* (ft) 20

Conc. (mg/L)*	C1	k_s* (1/yr)
PCE		0.1
TCE	28.0	0.1
DCE	18.0	0.1
VC	4.0	0.1
ETH	0.23	0.1

Vertical Plane Source: Determine Source Well Location and Input Solvent Concentrations



View of Plume Looking Down

Observed Centerline Conc. at Monitoring Wells

7. FIELD DATA FOR COMPARISON

PCE Conc. (mg/L)			
TCE Conc. (mg/L)	5.3	.001	.0
DCE Conc. (mg/L)	4.9	.005	.0
VC Conc. (mg/L)	1.4	.006	.002
ETH Conc. (mg/L)	0.1	.0	.0
Distance from Source (ft)	10	200	350
Date Data Collected	2006		

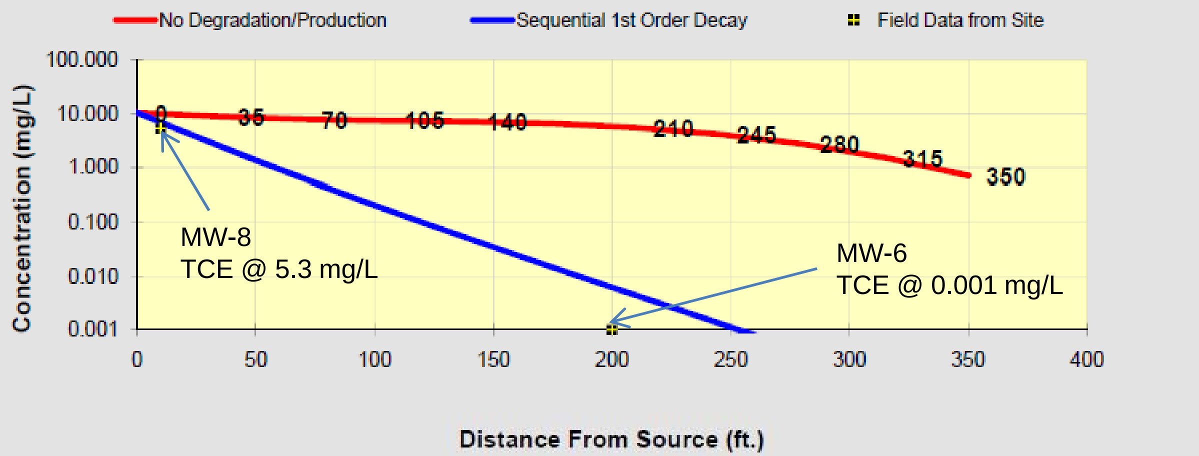
8. CHOOSE TYPE OF OUTPUT TO SEE:

RUN CENTERLINE | RUN ARRAY | Help | Restore Formulas | RESET | SEE OUTPUT | Paste Example

MODEL CALIBRATION – TCE IN YEAR 2006 (YR 10)
STI SWAINSBORO, GA

DISSOLVED CHLORINATED SOLVENT CONCENTRATIONS ALONG PLUME CENTERLINE (mg/L) at Z=0

TCE	Distance from Source (ft)										
	0	35	70	105	140	175	210	245	280	315	350
No Degradation	10.301	8.726	7.781	7.418	7.096	6.502	5.485	4.123	2.692	1.498	0.702
Biotransformation	10.3006	2.456	0.621	0.171	0.049	0.014	0.004	0.001	0.000	0.000	0.000
	Monitoring Well Locations (ft)										
	10	200	350								
Field Data from Site	5.300	0.001	0.000								



See PCE
See TCE
See DCE
See VC
See ETH

Prepare Animation

Time:
10.0 Years
Log ⟺ Linear

Return to Input

To All

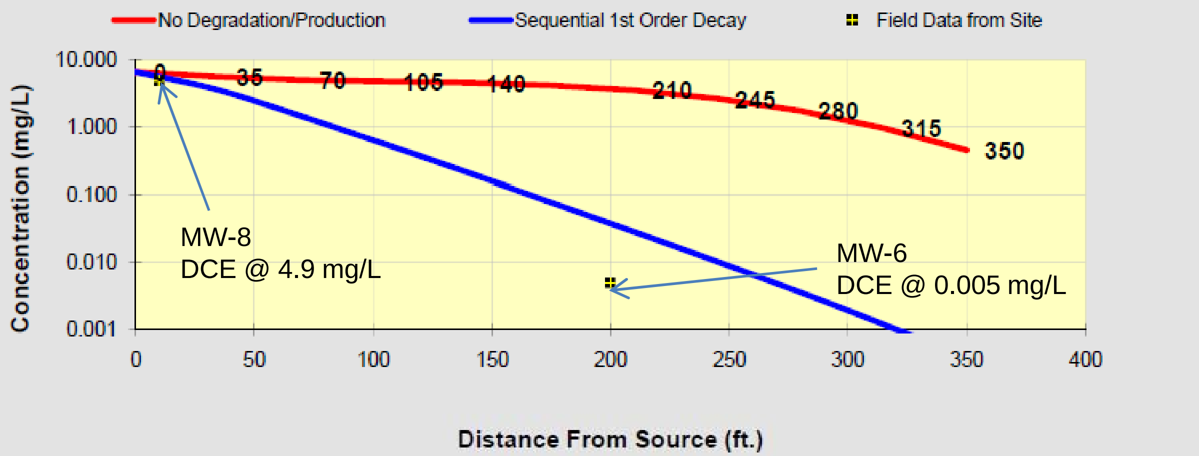
To Array

MODEL CALIBRATION – DCE IN YEAR 2006 (YR 10)
STI SWAINSBORO, GA

DISSOLVED CHLORINATED SOLVENT CONCENTRATIONS ALONG PLUME CENTERLINE (mg/L) at Z=0

DCE	Distance from Source (ft)										
	0	35	70	105	140	175	210	245	280	315	350
No Degradation	6.622	5.610	5.002	4.769	4.562	4.180	3.526	2.650	1.730	0.963	0.451
Biotransformation	6.6218	3.555	1.439	0.558	0.211	0.078	0.029	0.010	0.004	0.001	0.000

	Monitoring Well Locations (ft)										
	10	200	350								
Field Data from Site	4.900	0.005	0.000								



See PCE

See TCE

See DCE

See VC

See ETH

Prepare Animation

Time:

10.0 Years

Log ⟺ Linear

Return to Input

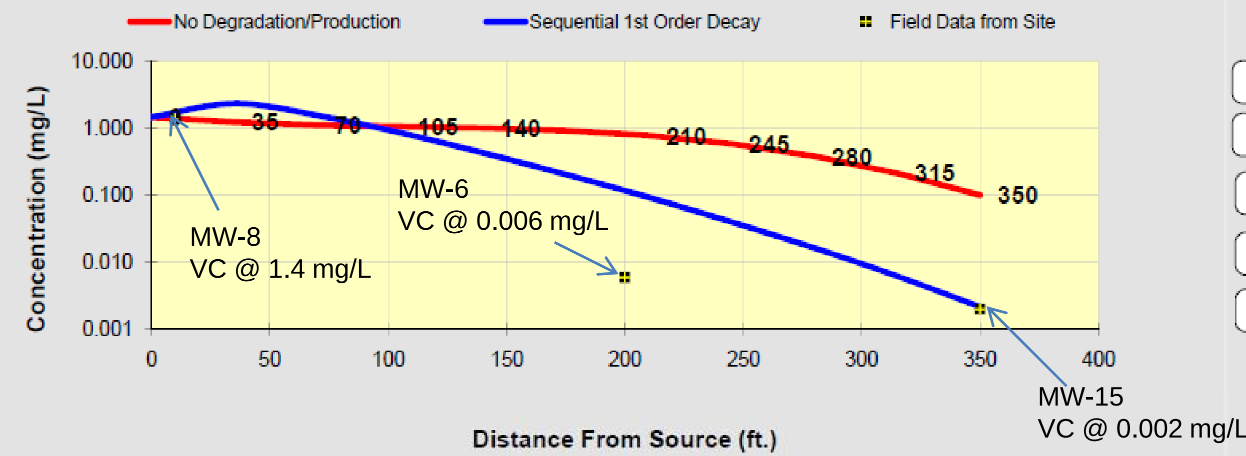
To All

To Array

MODEL CALIBRATION – VC IN YEAR 2006 (YR 10)
STI SWAINSBORO, GA

DISSOLVED CHLORINATED SOLVENT CONCENTRATIONS ALONG PLUME CENTERLINE (mg/L) at Z=0

VC	Distance from Source (ft)										
	0	35	70	105	140	175	210	245	280	315	350
No Degradation	1.472	1.247	1.112	1.060	1.014	0.929	0.784	0.589	0.385	0.214	0.100
Biotransformation	1.4715	2.353	1.564	0.863	0.433	0.205	0.093	0.040	0.016	0.006	0.002
	Monitoring Well Locations (ft)										
	10	200	350								
Field Data from Site	1.400	0.006	0.002								



See PCE
See TCE
See DCE
See VC
See ETH

Prepare Animation

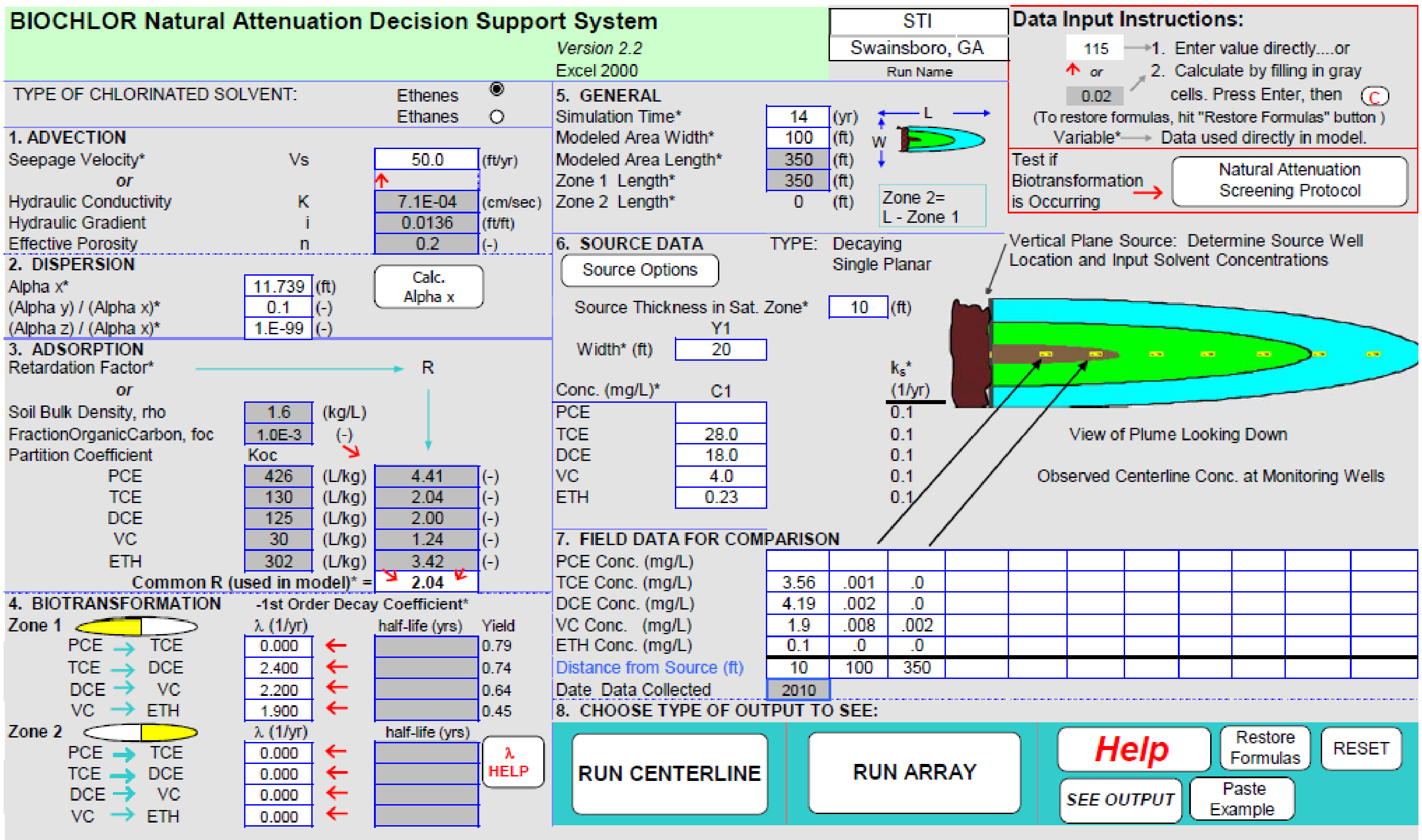
Time:
10.0 Years
Log ⟺ Linear

Return to Input

To All

To Array

MODEL CALIBRATION – YEAR 2010 (YR 14)
STI SWAINSBORO, GA



BIOCHLOR Natural Attenuation Decision Support System
Version 2.2
Excel 2000

STI
Swainsboro, GA
Run Name

Data Input Instructions:
115 → 1. Enter value directly....or
or 2. Calculate by filling in gray
0.02 cells. Press Enter, then C
(To restore formulas, hit "Restore Formulas" button)
Variable* → Data used directly in model.

Test if Biotransformation is Occurring → Natural Attenuation Screening Protocol

TYPE OF CHLORINATED SOLVENT: Ethenes (selected) / Ethanes

1. ADVECTION

Seepage Velocity*	Vs	50.0	(ft/yr)
or			
Hydraulic Conductivity	K	7.1E-04	(cm/sec)
Hydraulic Gradient	i	0.0136	(ft/ft)
Effective Porosity	n	0.2	(-)

2. DISPERSION

Alpha x*	11.739	(ft)
(Alpha y) / (Alpha x)*	0.1	(-)
(Alpha z) / (Alpha x)*	1.E-99	(-)

Calc. Alpha x

3. ADSORPTION

Retardation Factor* → R
or

Soil Bulk Density, rho	1.6	(kg/L)		
FractionOrganicCarbon, foc	1.0E-3	(-)		
Partition Coefficient	Koc			
PCE	426	(L/kg)	4.41	(-)
TCE	130	(L/kg)	2.04	(-)
DCE	125	(L/kg)	2.00	(-)
VC	30	(L/kg)	1.24	(-)
ETH	302	(L/kg)	3.42	(-)
Common R (used in model)* =			2.04	

4. BIOTRANSFORMATION -1st Order Decay Coefficient*

Zone 1	λ (1/yr)	half-life (yrs)	Yield
PCE → TCE	0.000		0.79
TCE → DCE	2.400		0.74
DCE → VC	2.200		0.64
VC → ETH	1.900		0.45

Zone 2	λ (1/yr)	half-life (yrs)
PCE → TCE	0.000	
TCE → DCE	0.000	
DCE → VC	0.000	
VC → ETH	0.000	

λ HELP

5. GENERAL

Simulation Time*	14	(yr)
Modeled Area Width*	100	(ft)
Modeled Area Length*	350	(ft)
Zone 1 Length*	350	(ft)
Zone 2 Length*	0	(ft)

L, W
Zone 2= L - Zone 1

6. SOURCE DATA TYPE: Decaying Single Planar

Source Options

Vertical Plane Source: Determine Source Well Location and Input Solvent Concentrations

Source Thickness in Sat. Zone* 10 (ft)

Y1
Width* (ft) 20

Conc. (mg/L)*	C1	k_s* (1/yr)
PCE		0.1
TCE	28.0	0.1
DCE	18.0	0.1
VC	4.0	0.1
ETH	0.23	0.1

View of Plume Looking Down

Observed Centerline Conc. at Monitoring Wells

7. FIELD DATA FOR COMPARISON

PCE Conc. (mg/L)			
TCE Conc. (mg/L)	3.56	.001	.0
DCE Conc. (mg/L)	4.19	.002	.0
VC Conc. (mg/L)	1.9	.008	.002
ETH Conc. (mg/L)	0.1	.0	.0
Distance from Source (ft)	10	100	350
Date Data Collected	2010		

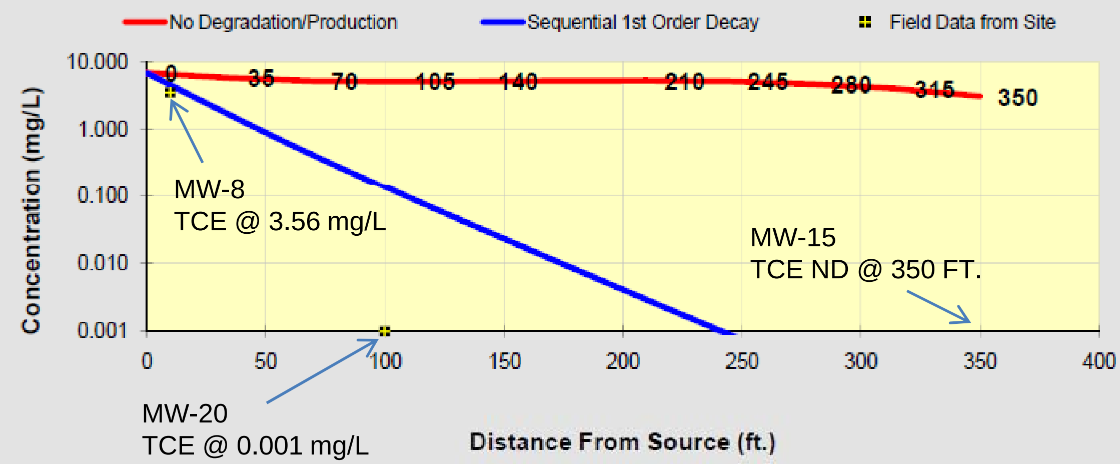
8. CHOOSE TYPE OF OUTPUT TO SEE:

RUN CENTERLINE | RUN ARRAY | Help | Restore Formulas | RESET | SEE OUTPUT | Paste Example

MODEL CALIBRATION – TCE IN YEAR 2010 (YR 14)
STI SWAINSBORO, GA

DISSOLVED CHLORINATED SOLVENT CONCENTRATIONS ALONG PLUME CENTERLINE (mg/L) at Z=0

TCE	Distance from Source (ft)										
	0	35	70	105	140	175	210	245	280	315	350
No Degradation	6.905	5.858	5.261	5.133	5.189	5.294	5.329	5.178	4.751	4.038	3.128
Biotransformation	6.9047	1.647	0.416	0.115	0.033	0.010	0.003	0.001	0.000	0.000	0.000
	Monitoring Well Locations (ft)										
	10	100	350								
Field Data from Site	3.560	0.001	0.000								



See PCE

See TCE

See DCE

See VC

See ETH

Prepare Animation

Time:

14.0 Years

Log ⟺ Linear

Return to Input

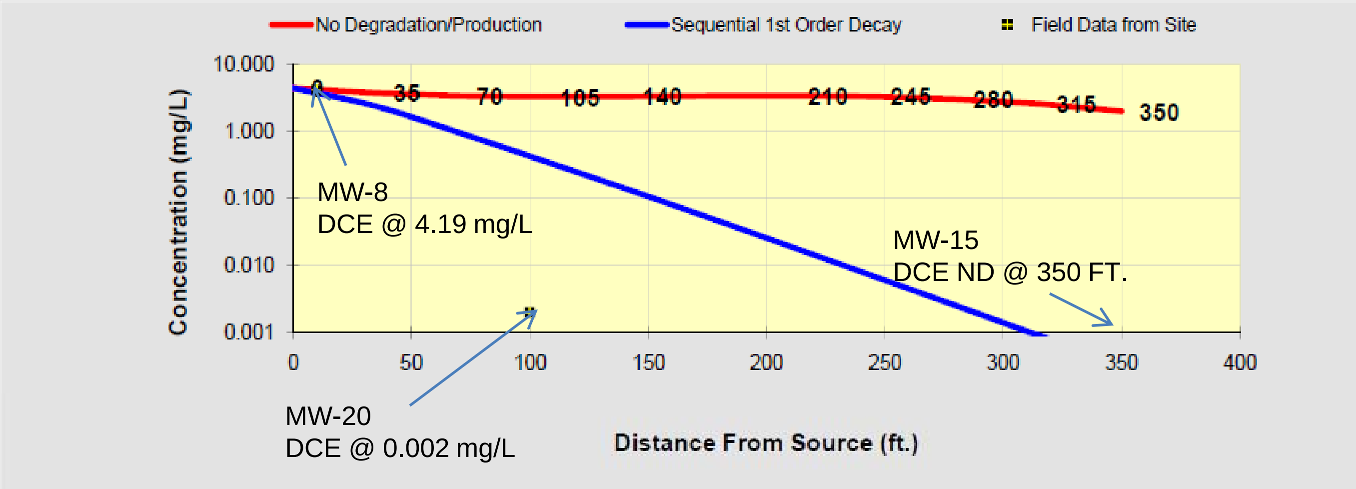
To All

To Array

MODEL CALIBRATION – DCE IN YEAR 2010 (YR 14)
STI SWAINSBORO, GA

DISSOLVED CHLORINATED SOLVENT CONCENTRATIONS ALONG PLUME CENTERLINE (mg/L) at Z=0

DCE	Distance from Source (ft)										
	0	35	70	105	140	175	210	245	280	315	350
No Degradation	4.439	3.766	3.382	3.300	3.336	3.403	3.426	3.328	3.054	2.596	2.011
Biotransformation	4.4387	2.383	0.965	0.374	0.141	0.053	0.019	0.007	0.003	0.001	0.000
	Monitoring Well Locations (ft)										
	10	100	350								
Field Data from Site	4.190	0.002	0.000								



See PCE

See TCE

See DCE

See VC

See ETH

Prepare Animation

Time:

14.0 Years

Log ⟺ Linear

Return to Input

To All

To Array

MODEL CALIBRATION – VC IN YEAR 2010 (YR 14)
STI SWAINSBORO, GA

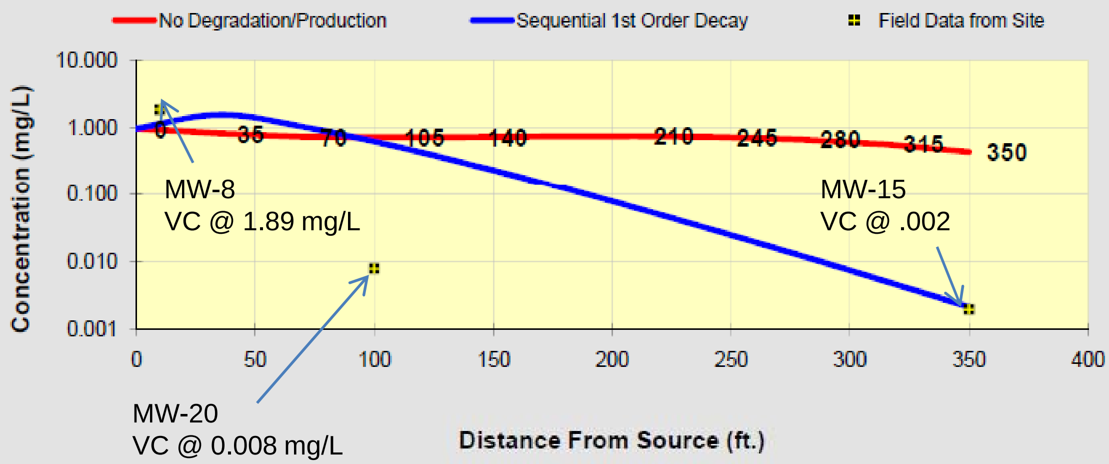
DISSOLVED CHLORINATED SOLVENT CONCENTRATIONS ALONG PLUME CENTERLINE (mg/L) at Z=0

Distance from Source (ft)

VC	0	35	70	105	140	175	210	245	280	315	350
No Degradation	0.986	0.837	0.752	0.733	0.741	0.756	0.761	0.740	0.679	0.577	0.447
Biotransformation	0.9864	1.577	1.049	0.579	0.291	0.138	0.063	0.028	0.012	0.005	0.002

Monitoring Well Locations (ft)

	10	100	350								
Field Data from Site	1.890	0.008	0.002								



See PCE

See TCE

See DCE

See VC

See ETH

Prepare Animation

Time:

14.0 Years

Log ⇔ Linear

Return to Input

To All

To Array

MODEL PREDICTIONS – TCE IN YEAR 2016 (YR 20)
STI SWAINSBORO, GA

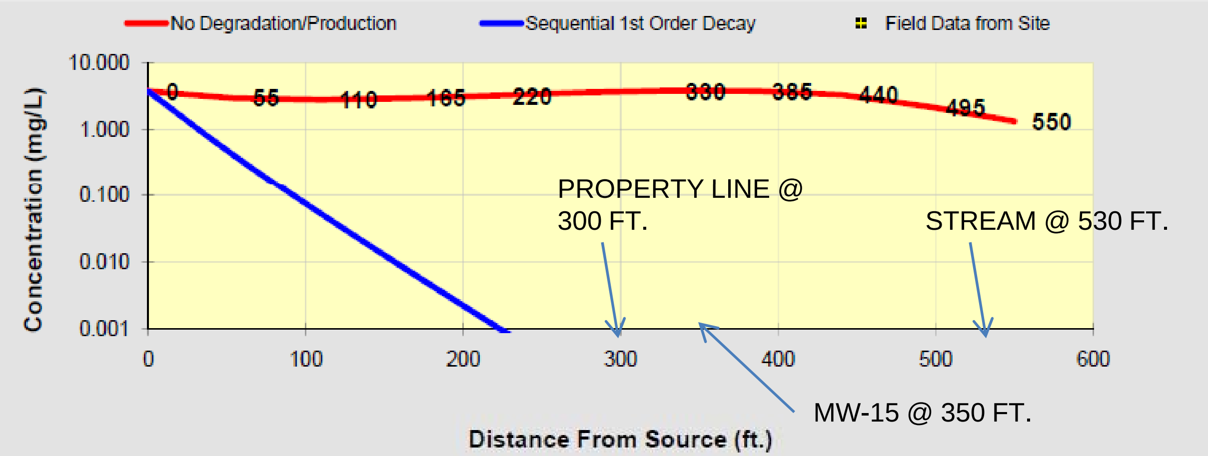
DISSOLVED CHLORINATED SOLVENT CONCENTRATIONS ALONG PLUME CENTERLINE (mg/L) at Z=0

Distance from Source (ft)

TCE	0	55	110	165	220	275	330	385	440	495	550
No Degradation	3.789	2.982	2.834	2.986	3.279	3.620	3.870	3.835	3.372	2.241	1.354
Biotransformation	3.7894	0.406	0.052	0.008	0.001	0.000	0.000	0.000	0.000	0.000	0.000

Monitoring Well Locations (ft)

Field Data from Site											



See PCE

See TCE

See DCE

See VC

See ETH

Prepare Animation

Time:

20.0 Years

Log ⟺ Linear

Return to Input

To All

To Array

MODEL PREDICTIONS – DCE IN YEAR 2016 (YR 20)
STI SWAINSBORO, GA

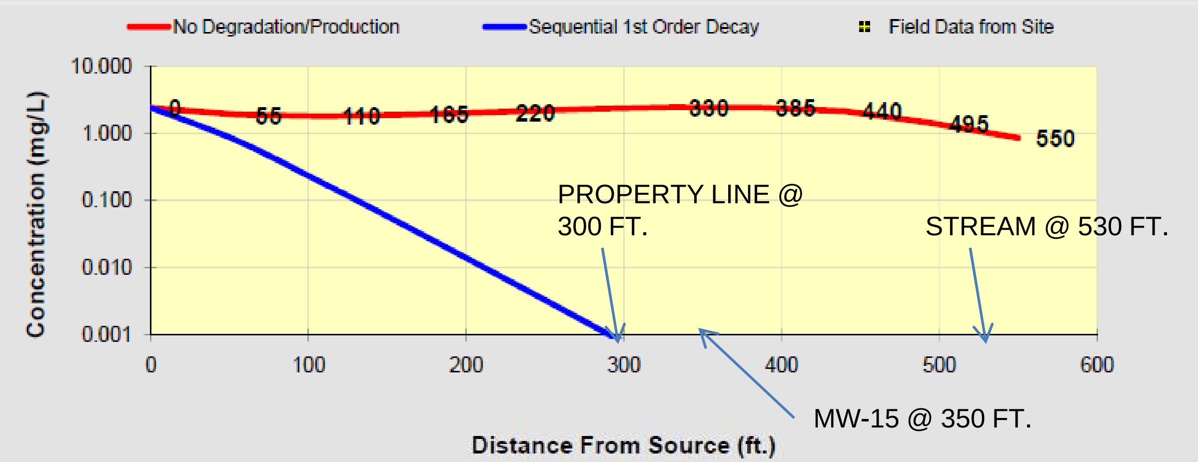
DISSOLVED CHLORINATED SOLVENT CONCENTRATIONS ALONG PLUME CENTERLINE (mg/L) at Z=0

Distance from Source (ft)

DCE	0	55	110	165	220	275	330	385	440	495	550
No Degradation	2.436	1.917	1.822	1.920	2.108	2.327	2.488	2.465	2.167	1.441	0.871
Biotransformation	2.4360	0.786	0.179	0.038	0.008	0.002	0.000	0.000	0.000	0.000	0.000

Monitoring Well Locations (ft)

Field Data from Site											



See PCE
See TCE
See DCE
See VC
See ETH

Prepare Animation

Time: 20.0 Years

Log ⟺ Linear

Return to Input

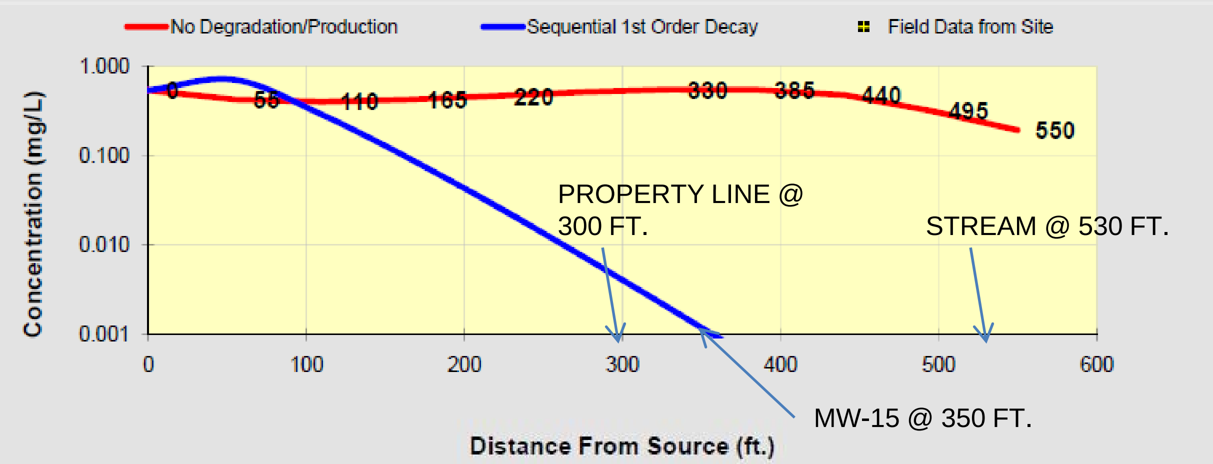
To All

To Array

MODEL PREDICTIONS – VC IN YEAR 2016 (YR 20)
STI SWAINSBORO, GA

DISSOLVED CHLORINATED SOLVENT CONCENTRATIONS ALONG PLUME CENTERLINE (mg/L) at Z=0

VC	Distance from Source (ft)										
	0	55	110	165	220	275	330	385	440	495	550
No Degradation	0.541	0.426	0.405	0.427	0.468	0.517	0.553	0.548	0.482	0.320	0.193
Biotransformation	0.5413	0.708	0.289	0.094	0.027	0.008	0.002	0.001	0.000	0.000	0.000
	Monitoring Well Locations (ft)										
Field Data from Site											



See PCE

See TCE

See DCE

See VC

See ETH

Prepare Animation

Time: 20.0 Years

Log ⇔ Linear

Return to Input

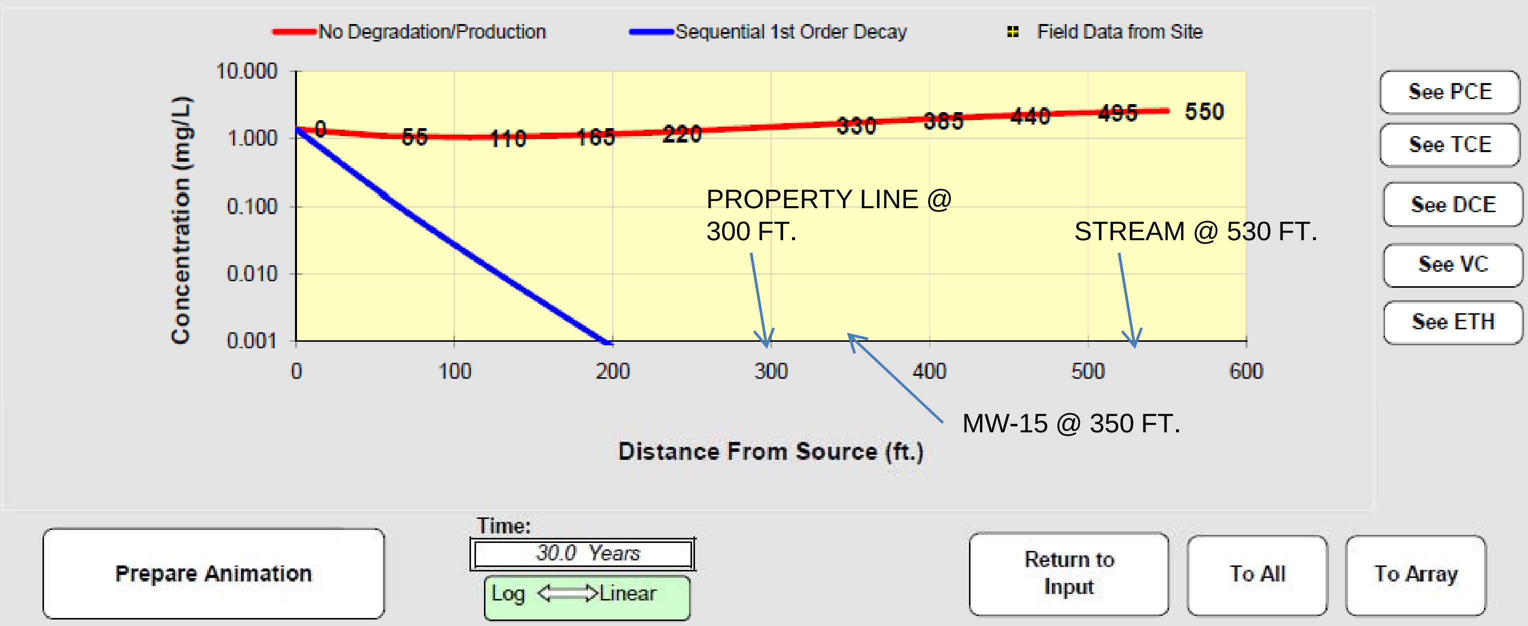
To All

To Array

MODEL PREDICTIONS – TCE IN YEAR 2026 (YR 30)
STI SWAINSBORO, GA

DISSOLVED CHLORINATED SOLVENT CONCENTRATIONS ALONG PLUME CENTERLINE (mg/L) at Z=0

TCE	Distance from Source (ft)										
	0	55	110	165	220	275	330	385	440	495	550
No Degradation	1.394	1.097	1.043	1.101	1.221	1.391	1.611	1.878	2.154	2.423	2.603
Biotransformation	1.3940	0.149	0.019	0.003	0.000	0.000	0.000	0.000	0.000	0.000	0.000
	Monitoring Well Locations (ft)										
Field Data from Site											



MODEL PREDICTIONS – DCE IN YEAR 2026 (YR 30)
STI SWAINSBORO, GA

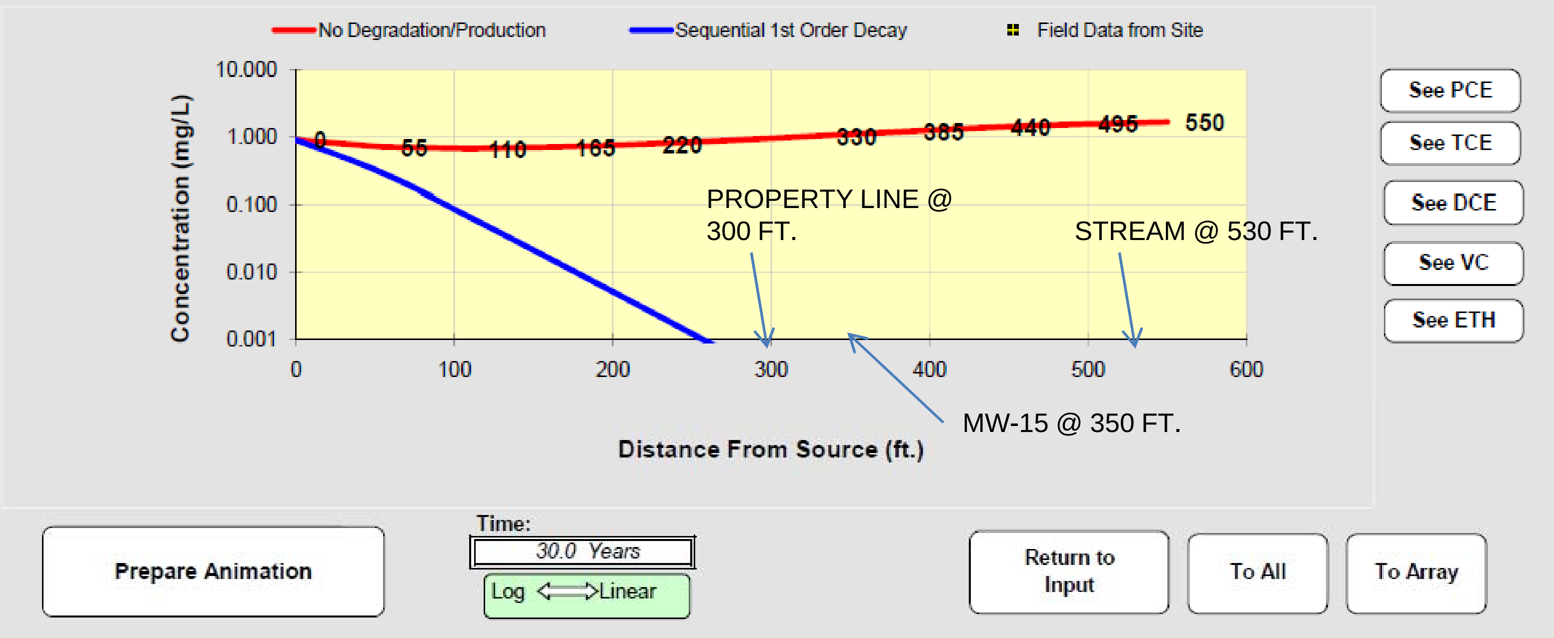
DISSOLVED CHLORINATED SOLVENT CONCENTRATIONS ALONG PLUME CENTERLINE (mg/L) at Z=0

Distance from Source (ft)

DCE	0	55	110	165	220	275	330	385	440	495	550
No Degradation	0.896	0.705	0.671	0.708	0.785	0.894	1.036	1.208	1.385	1.558	1.673
Biotransformation	0.8962	0.289	0.066	0.014	0.003	0.001	0.000	0.000	0.000	0.000	0.000

Monitoring Well Locations (ft)

Field Data from Site											



MODEL PREDICTIONS – VC IN YEAR 2026 (YR 30)
STI SWAINSBORO, GA

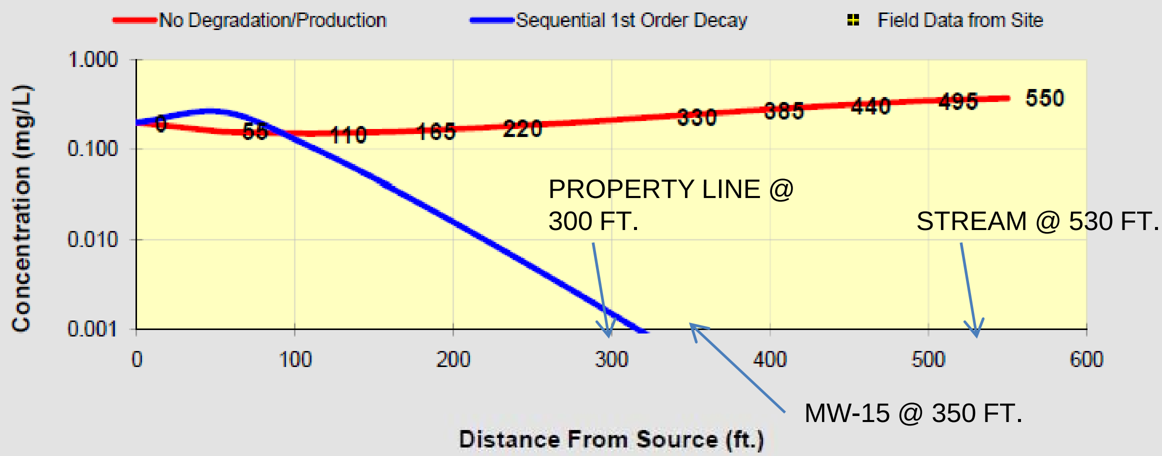
DISSOLVED CHLORINATED SOLVENT CONCENTRATIONS ALONG PLUME CENTERLINE (mg/L) at Z=0

Distance from Source (ft)

VC	0	55	110	165	220	275	330	385	440	495	550
No Degradation	0.199	0.157	0.149	0.157	0.174	0.199	0.230	0.268	0.308	0.346	0.372
Biotransformation	0.1991	0.261	0.106	0.035	0.010	0.003	0.001	0.000	0.000	0.000	0.000

Monitoring Well Locations (ft)

Field Data from Site											



See PCE
See TCE
See DCE
See VC
See ETH

Prepare Animation

Time: 30.0 Years

Log ⇔ Linear

Return to Input

To All

To Array

MODEL PREDICTIONS – TCE IN YEAR 2046 (YR 50)
STI SWAINSBORO, GA

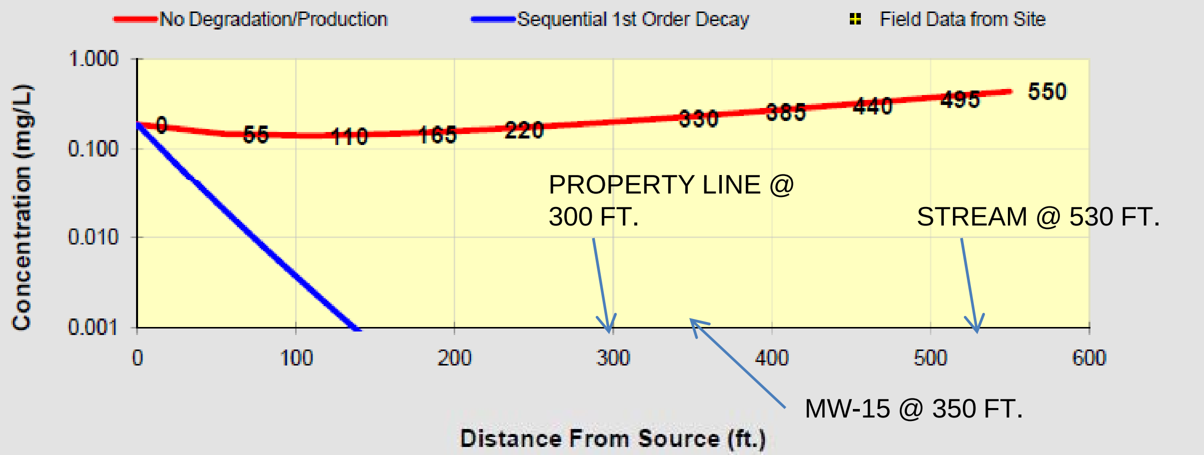
DISSOLVED CHLORINATED SOLVENT CONCENTRATIONS ALONG PLUME CENTERLINE (mg/L) at Z=0

Distance from Source (ft)

TCE	0	55	110	165	220	275	330	385	440	495	550
No Degradation	0.189	0.148	0.141	0.149	0.165	0.188	0.219	0.257	0.306	0.366	0.440
Biotransformation	0.1887	0.020	0.003	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000

Monitoring Well Locations (ft)

Field Data from Site											



See PCE

See TCE

See DCE

See VC

See ETH

Prepare Animation

Time: 50.0 Years

Log ⇔ Linear

Return to Input

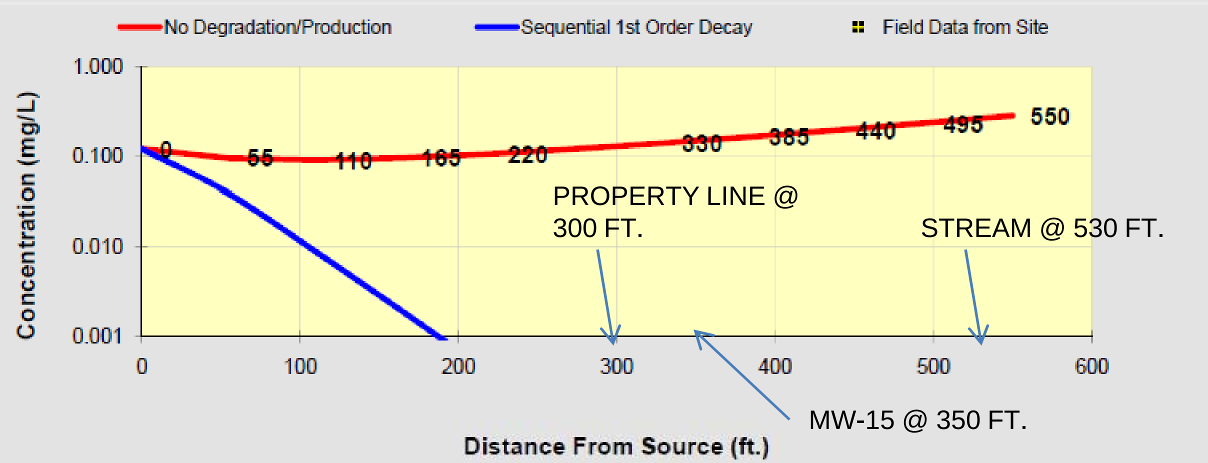
To All

To Array

MODEL PREDICTIONS – DCE IN YEAR 2046 (YR 50)
STI SWAINSBORO, GA

DISSOLVED CHLORINATED SOLVENT CONCENTRATIONS ALONG PLUME CENTERLINE (mg/L) at Z=0

	Distance from Source (ft)										
DCE	0	55	110	165	220	275	330	385	440	495	550
No Degradation	0.121	0.095	0.091	0.096	0.106	0.121	0.141	0.166	0.197	0.235	0.283
Biotransformation	0.1213	0.039	0.009	0.002	0.000	0.000	0.000	0.000	0.000	0.000	0.000
	Monitoring Well Locations (ft)										
Field Data from Site											



See PCE

See TCE

See DCE

See VC

See ETH

Prepare Animation

Time: 50.0 Years

Log ⟺ Linear

Return to Input

To All

To Array

MODEL PREDICTIONS – VC IN YEAR 2046 (YR 50)
STI SWAINSBORO, GA

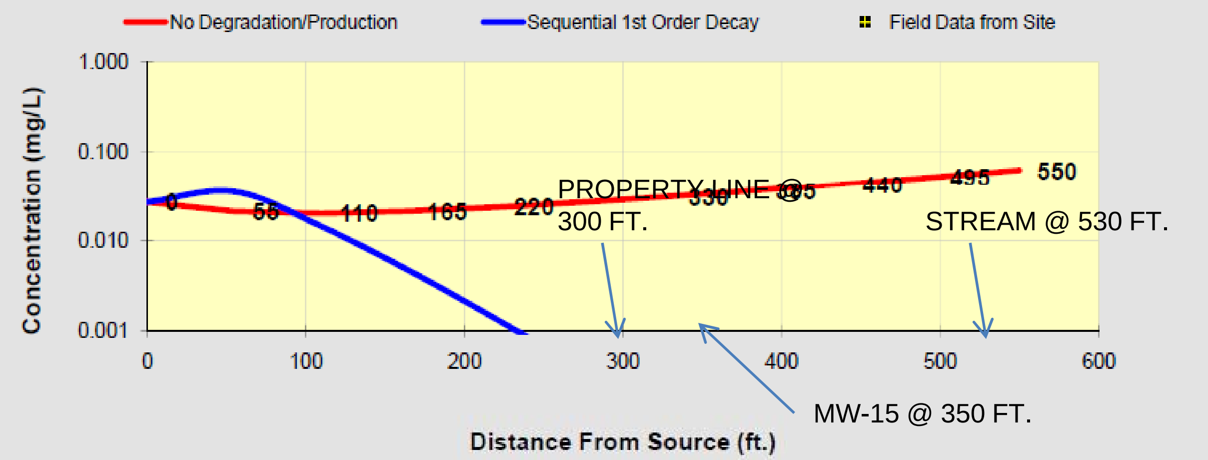
DISSOLVED CHLORINATED SOLVENT CONCENTRATIONS ALONG PLUME CENTERLINE (mg/L) at Z=0

Distance from Source (ft)

VC	0	55	110	165	220	275	330	385	440	495	550
No Degradation	0.027	0.021	0.020	0.021	0.024	0.027	0.031	0.037	0.044	0.052	0.063
Biotransformation	0.0270	0.035	0.014	0.005	0.001	0.000	0.000	0.000	0.000	0.000	0.000

Monitoring Well Locations (ft)

Field Data from Site											



See PCE
See TCE
See DCE
See VC
See ETH

Prepare Animation

Time:
50.0 Years
Log ⟺ Linear

Return to Input

To All

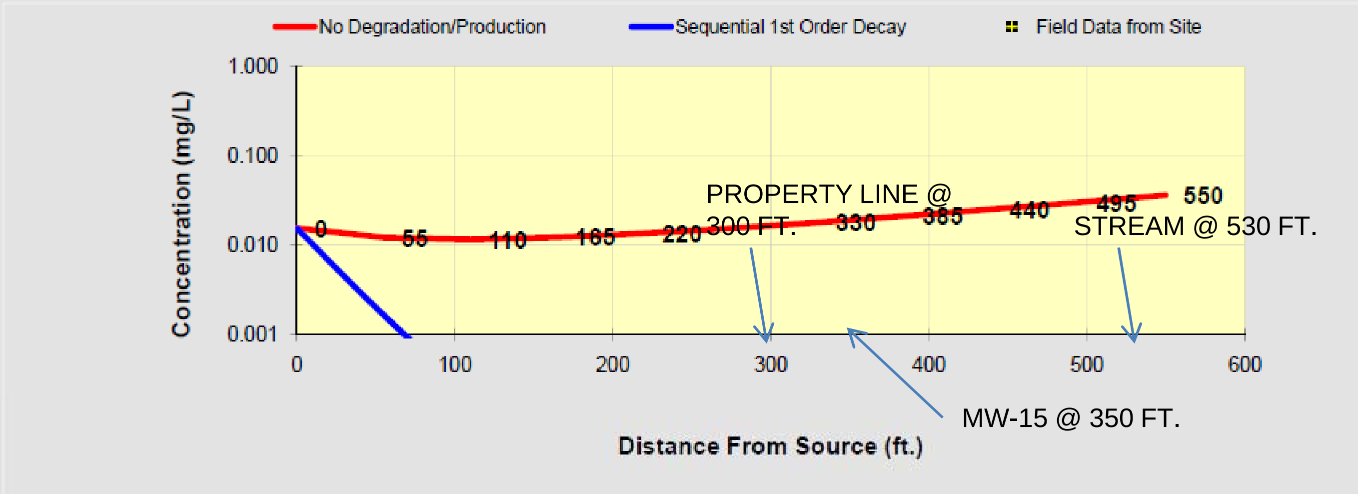
To Array

MODEL PREDICTIONS – TCE IN YEAR 2071 (YR 75)
STI SWAINSBORO, GA

DISSOLVED CHLORINATED SOLVENT CONCENTRATIONS ALONG PLUME CENTERLINE (mg/L) at Z=0

	Distance from Source (ft)										
TCE	0	55	110	165	220	275	330	385	440	495	550
No Degradation	0.015	0.012	0.012	0.012	0.014	0.015	0.018	0.021	0.025	0.030	0.036
Biotransformation	0.0155	0.002	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000

	Monitoring Well Locations (ft)										
Field Data from Site											



See PCE

See TCE

See DCE

See VC

See ETH

Prepare Animation

Time: 75.0 Years

Log ⟺ Linear

Return to Input

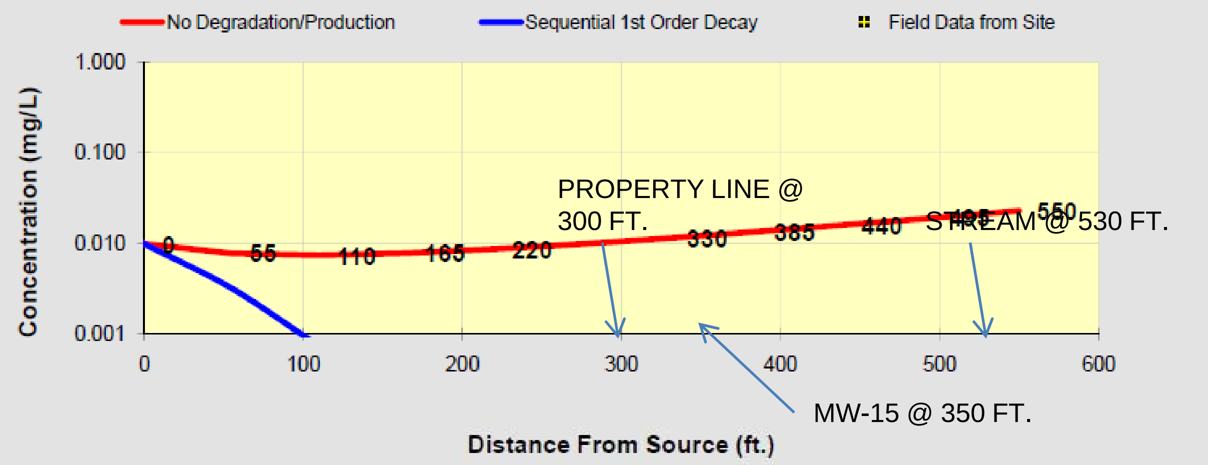
To All

To Array

MODEL PREDICTIONS – DCE IN YEAR 2071 (YR 75)
STI SWAINSBORO, GA

DISSOLVED CHLORINATED SOLVENT CONCENTRATIONS ALONG PLUME CENTERLINE (mg/L) at Z=0

	Distance from Source (ft)										
DCE	0	55	110	165	220	275	330	385	440	495	550
No Degradation	0.010	0.008	0.007	0.008	0.009	0.010	0.012	0.014	0.016	0.019	0.023
Biotransformation	0.0100	0.003	0.001	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
	Monitoring Well Locations (ft)										
Field Data from Site											



See PCE
See TCE
See DCE
See VC
See ETH

Prepare Animation

Time: 75.0 Years

Log ⟺ Linear

Return to Input

To All

To Array

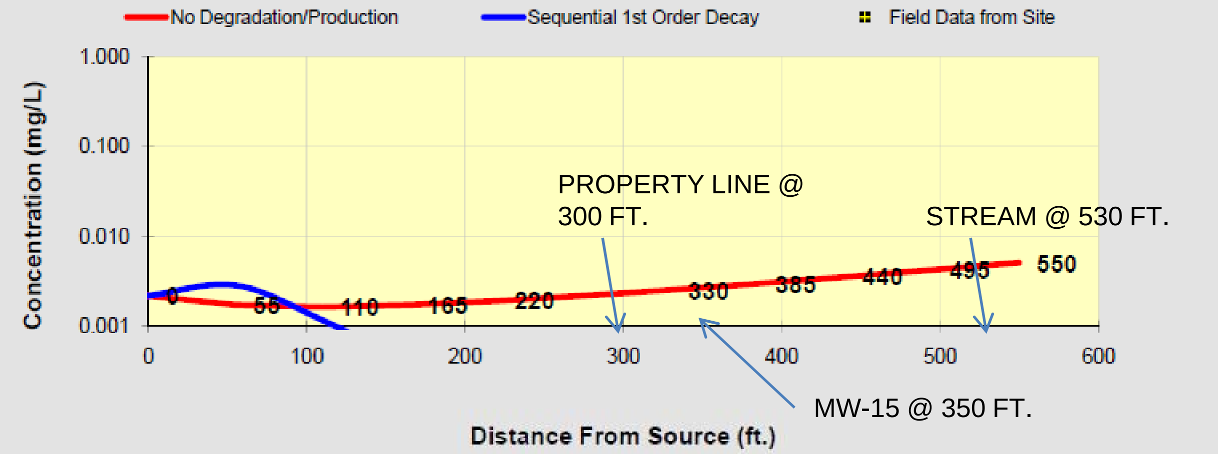
MODEL PREDICTIONS – VC IN YEAR 2071 (YR 75)
STI SWAINSBORO, GA

DISSOLVED CHLORINATED SOLVENT CONCENTRATIONS ALONG PLUME CENTERLINE (mg/L) at Z=0

	Distance from Source (ft)										
VC	0	55	110	165	220	275	330	385	440	495	550
No Degradation	0.002	0.002	0.002	0.002	0.002	0.002	0.003	0.003	0.004	0.004	0.005
Biotransformation	0.0022	0.003	0.001	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000

Monitoring Well Locations (ft)

Field Data from Site											



See PCE

See TCE

See DCE

See VC

See ETH

Prepare Animation

Time: 75.0 Years

Log ⟺ Linear

Return to Input

To All

To Array

APPENDIX B
JOHNSON & ETTINGER VAPOR INTRUSION MODEL

APPENDIX B – INDOOR AIR VAPOR INTRUSION RISK EVALUATION

AMEC evaluated the potential impact of subsurface groundwater contamination on current and future indoor air quality for the STI Swainsboro buildings. As part of the application to enter the site into the Georgia Voluntary Remediation Program, EPD requested information as to whether groundwater contamination crossing the Site might serve as a source of volatile emissions into industrial use buildings located on the property. AMEC utilized the U.S. Environmental Protection Agency (USEPA)'s Draft Guidance for Evaluating the Vapor Intrusion to Indoor Air Pathway from Groundwater and Soils (USEPA, 2002) as a primary guidance document. In accordance with the guidance, AMEC estimated site-specific risks and hazards for current and future indoor air exposures at the site, using USEPA's Johnson and Ettinger Model for Subsurface Vapor Intrusion into Buildings (Version 3.1, February 2004) (the Johnson and Ettinger Model). Using groundwater sampling results from the last two events and site-specific parameters, AMEC used USEPA's Johnson and Ettinger vapor intrusion model (GW-ADV) to estimate potential indoor air concentrations in the smallest on-site building that is currently used for storage. This size building was used as conservatively representative of both current and future buildings. The estimated indoor air concentrations were then used to estimate hazards and risks for industrial site workers. The use of the buildings is expected to remain industrial in the future.

The maximum results of May and November 2011 groundwater sampling events are presented in Table B-1. Seven volatile organic compounds (VOCs) were detected. These detections ranged over ten monitoring wells (MW-3 to MW-6, MW-8, MW-11, MW-15, and MW-18 to MW-20). The maximum detected concentrations were compared to OSWER groundwater screening values for indoor air (USEPA, 2002) in order to identify constituents of potential concern (COPCs). Six constituents had concentrations that exceeded the screening values: 1,1,1-trichloroethane, trichloroethylene, 1,1-dichloroethene, 1,1-dichloroethane, cis-1,2-dichloroethene, and vinyl chloride. These six COPCs were carried forward for indoor air modeling.

Based on previous investigations, the typical soil profile at the Site consists of clayey sands near the ground surface. Soils were classified as SC (Sandy clay) for the purposes of modeling. Based on the measured groundwater elevations, the interpreted groundwater flow direction across the subject Site is in a generally northward direction.

Exposure Assessment

Using the information collected by AMEC during site investigations, AMEC has used a combination of default and site-specific information and assumptions as the inputs for the Johnson and Ettinger Model, reflecting subsurface conditions noted during the site investigations. The assumptions used in the Johnson and Ettinger Model (GW-ADV) are listed on Table B-2. The vapor intrusion risk evaluation is focused on on-site exposures for industrial workers that may be exposed to soil gas vapors emitted to indoor air, and occupational exposure assumptions from risk guidance were used. Workers were assumed present 250 days per year for 25 years (USEPA, 1991).

The warehouse and the manufacturing building are the two buildings closest to the groundwater impacts. These buildings are approximately 70 feet by 140 feet and 160 feet by 225 feet, respectively. To be conservative in the vapor intrusion evaluation, the smallest size building was selected to represent a typical exposure scenario. The ceiling height for the buildings is approximately 20 feet with slab on grade foundations.

An average depth to groundwater of 4.8 feet or 146 centimeters was used in the modeling. The air exchange rate of 1.5 exchanges per hour is based on *Exposure Factors Handbook: 2011 Edition* (USEPA, 2011a), that lists a mean rate for commercial buildings. The mean concentrations for the area of groundwater impact (Table B-1) were used as the exposure point concentrations (USEPA, 2000). The Johnson and Ettinger model was then used to estimate the concentrations in indoor air for the six COPCs (Table B-3).

Toxicity Assessment

Toxicity values [Inhalation Reference Concentrations (RfCs) and Unit Risk Factors (URFs)] used in this evaluation were obtained from the Integrated Risk Information System and the USEPA Regional Screening Level Table (USEPA, 2011b). The toxicity values used in this assessment are listed on the attached modeling output tables and summarized on Table B-3. The RfC is used to estimate non-carcinogenic inhalation hazards. The RfC is an estimate of the daily exposure to the human population (including sensitive subgroups such as children and the elderly) that is likely to be without an appreciable risk of deleterious effects. Cis-1,2-dichloroethene does not currently have an inhalation RfC or IUR; the RfC value for trans-1,2-dichloroethene was used as a surrogate value in order to estimate hazards for cis-1,2-

dichloroethene by the inhalation route. The estimated hazard quotients for each constituent are added together and compared to a target hazard index (HI) of one. Cumulative hazards less than one are not likely to be associated with systemic or non-carcinogenic health risks.

Using chemical-specific URFs, the cumulative carcinogenic risk for the indoor vapor intrusion pathway was calculated and compared to a target risk of 10^{-6}. If the cumulative carcinogenic risk for residents is less than 10^{-6}, risk is considered to be in the acceptable range. The URF is characterized as an upper-bound estimate designed to be protective of the majority of the human population.

Risk Characterization – Vapor Intrusion Modeling

In order to assess potential indoor air exposures, cumulative incremental risks and hazards related to potential vapor intrusion into a representative building, the warehouse building, were calculated. The Johnson and Ettinger Model incorporates both convective and diffusive mechanisms for estimating the transport of contaminant vapors emanating from the subsurface into indoor spaces located directly above the source of contamination. The model is a one-dimensional analytical solution to vapor transport into indoor spaces, relating the vapor concentration in the building to the chemical concentration at the subsurface source area. Inputs to the model include chemical and toxicological properties of the detected constituents, soil properties, and structural properties of the building.

The Johnson and Ettinger Model assumes the structure is located above the subsurface impacts and volatile emissions will enter through the concrete floor slab. This model does not incorporate dispersion, dilution, or bioattenuation. However, in actuality, the concentrations of volatile compounds may naturally attenuate over time. The model also assumes an infinite subsurface contamination source, while the distribution under the buildings is not homogeneous. In general, the assumptions used in the Johnson and Ettinger modeling would tend to overestimate hazards and risks for occupational receptors.

Table B-3 summarizes the results of the risk calculations. The model outputs, with estimated infinite source concentrations for indoor air for the 6 COPCs, are provided in Appendix B. The estimated incremental risk from vapor intrusion in indoor air from the potential carcinogens is 1×10^{-7}. The majority of the risk is associated with vinyl chloride. The estimated hazard index for vapor intrusion to indoor air from the potential systemic toxicants in groundwater is 0.01.

Trichloroethylene is the constituent associated with the majority of systemic hazards. Hazards indices are less than one and the incremental risks are less than $1x10^{-6}$. Based on these results, the vapor intrusion pathway would not pose an unacceptable hazard or risk to occupational receptors, and would not be of concern to human health currently or in the future.

Uncertainty Analysis

This assessment assumes uniform exposure across the site although groundwater concentrations vary by location. The assessment also assumes industrial workers will be exposed over a 25-year period for 250 days per year. These assumptions would tend to overestimate risks because workers do not typically remain in the same job and location for 25 years. In addition, the detected VOCs are biodegradable; thus, attenuation is expected to occur naturally over a period of time.

Summary

Risk calculations were completed using current mean groundwater concentrations in the Johnson and Ettinger Model in order to estimate indoor air concentrations. Risk and hazards associated with potential indoor air exposures were then calculated by estimating exposure concentrations and comparing these concentrations to inhalation toxicity benchmarks. The resulting estimated hazards and risks indicate no unacceptable risk for occupational receptors potentially exposed via indoor air vapor emissions.

References:

USEPA, 1991. Human Health Evaluation Manual, Supplemental Guidance, OSWER Directive 9285.6-03, March 1991.

USEPA, 2000. Supplemental Guidance to RAGS: Region 4 Human Health Risk Assessment Bulletins, Region 4 USEPA.

USEPA, 2002. Draft Guidance for Evaluating the Vapor Intrusion to Indoor Air Pathway from Groundwater and Soils, EPA530-F-02-052, November 2002.

USEPA, 2011a. Exposure Factors Handbook: 2011 Edition, EPA/600/R-090/052F, September 2011.

USEPA, 2011b. Regional Screening Levels Table, June 2011.

TABLES

Table B-1
Summary of Groundwater Concentrations - 2010
STI Swainsboro, Swainsboro, GA

Parameter	**2010 Maximum Detected Groundwater Concentration, mg/L (a)**	**OSWER Screening Value for Indoor Air, mg/L (b)**	**Mean Groundwater Concentration within Site Plume, mg/L (c)**
Volatile Organic Compounds			
Chloroethane (Ethyl chloride)	0.735	2.8 (nc)	NA
1,1,1-Trichloroethane	1.65	0.31 (nc)	0.141
Trichloroethylene	3.56	0.005 (ca)	0.278
1,1-Dichloroethene	4.19	0.019 (nc)	0.320
1,1-Dichloroethane	0.264	0.22 (nc)	0.0340
cis-1,2-Dichloroethene	4.1	0.021 (nc)	0.319
Vinyl Chloride	2.02	0.0025 (ca)	0.256

(a) Maximum detected concentrations for 13 monitoring wells sampled in May and November 2010 (two most recent events).

(b) Table 2b, USEPA, 2002. Draft Guidance for Evaluating the Vapor Intrusion to Indoor Air Pathway from Groundwater and Soils. (nc - noncarcinogenic value divided by 10). (ca- based on carcinogenic risk of 10^{-5}).

(c) Mean of concentrations for wells with positive detections - MW-3, MW-4, MW-5, MW-6,MW -8, MW-11, MW-15, MW-18, MW-19, and MW-20. One-half the reporting limit used as surrogate concentration for non-detections. Used as exposure point concentration in Johnson & Ettinger Modeling.

Bolded compounds - Maximum detected concentration exceeded the OSWER Screening Value.

NA Compound screened out and not carried through to risk characterization.

Prepared/Date: LMS 10/10/2011
Checked/Date: LWC 10/10/2011

Table B-2
Occupational Assumptions Used in Johnson & Ettinger Model (GW-ADV)
STI Swainsboro

Parameter	Value	Justification
Average Water Temp.	21.7 ^{o}C	Soil Temperature for Midville Georgia, Georgia Automated Environmental Monitoring Network, www.griffin.uga.edu.
Depth Below Grade to Enclosed Space Floor	15 cm	Slab on grade foundation - assumption
Depth Below Grade to Groundwater /Thickness of Soil Stratum	146 cm	4.8 feet – Site average within plume
Stratum A Soil Vapor Permeability	SC	Sandy clay – site-specific assumption
SCS Soil Type	SC	Sandy clay
Soil Dry Bulk Density	1.63 g/cm^3	Sandy clay – Model value
Soil Total Porosity	0.385 unitless	Sandy clay – Model value
Soil Water-filled Porosity	0.197 cm^3/cm^3	Sandy clay – Model value
Enclosed Space Floor Thickness	10 cm	Model default
Soil-Building Pressure Differential	40 g/cm-s^2	Model default
Building Footprint Length	4267 cm	Dimension of warehouse
Building Footprint Width	2134 cm	Dimension of warehouse
Building Mixing Height	610 cm	20 foot ceilings
Floor-Wall Seam Crack Width	0.1 cm	Model default
Indoor Air Exchange Rate	1.5/hour	Exposure Factors Handbook:2011 Edition, Mean for Commercial Buildings, Table 19-27.
Average Vapor Flow Rate	Model generated, L/m	Model option
Averaging Time, Carcinogens	70 years	Model default
Averaging Time, Noncarcinogens	25 years	Reasonable Maximum Exposure Time for Occupational Scenario (USEPA, 1991)
Exposure Duration	25 years	Reasonable Maximum Exposure Time for Occupational Scenario (USEPA, 1991)
Exposure Frequency	250 days/year	Default for occupational

Prepared by: LMS 10/10/2011
Checked by: LWC 10/10/11

Table B-3
Calculations of Risk to Indoor Air Concentrations
Site Worker - (Current and Future)
Inhalation of Indoor Air

Parameter	Concentration in Air (ug/m^3)	Exposure Value Type [1]	Exposure Concentration (ug/m^3) [2] Noncarcinogen	Exposure Concentration (ug/m^3) [2] Carcinogen	Toxicity Values: Inhalation RfC (mg/m^3)	Toxicity Values: Inhalation Unit Risk (ug/m^3)$^{-1}$	Source	Hazard Quotient [3] (Unitless)	Excess Cancer Risk [4] (Unitless)
Volatile Organic Compounds									
1,1,1-Trichloroethane	0.0581	Modeled	1.33E-02	4.74E-03	5.0E+00	NA	IRIS	0.000003	NA
1,1-Dichloroethene	0.205	Modeled	4.68E-02	1.67E-02	2.0E-01	NA	IRIS	0.0002	NA
1,1-Dichloroethane	0.00693	Modeled	1.58E-03	5.65E-04	NA	1.6E-06	Cal EPA	NA	9.0E-10
cis-1,2-Dichlorothene	0.0538	Modeled	1.23E-02	4.39E-03	6.0E-02	NA	PPRTV [5]	0.0002	NA
Trichloroethene	0.0803	Modeled	1.83E-02	6.55E-03	2.0E-03	4.0E-06	IRIS	0.009	2.6E-08
Vinyl Chloride	0.192	Modeled	4.38E-02	1.57E-02	1.0E-01	4.4E-06	IRIS	0.0004	6.9E-08
						Total:		0.01	1E-07

NA = Not available or applicable
m^3 = cubic meters
mg = milligram
RfC = Reference Concentration
ug = micrograms
IRIS - Integrated Risk Information System
(1) Infinite source concentration from the Johnson and Ettinger Model (version GW-ADV 3.1, 02/04). Mean groundwater concentration used as the exposure point concentration (Table 1).
(2) Exposure Concentration = See Equations below
(3) Hazard Quotient (Noncarcinogens) = Noncarcinogen Exposure Concentration/RfC x 1000 ug/mg
(4) Excess Cancer Risk (Carcinogens) = Carcinogen Exposure Concentration x Inhalation Unit Risk
(5) PPRTV value from the Regional Screening Level Summary Table June 2011 for trans-1,2-dichloroethene.

Carcinogen Exposure Concentration = CA x ET x EF x ED/ AT_c where:

Noncarcinogen Exposure Concentration = CA x ET x EF x ED/AT_{nc} where:

CA = Constituent Concentration in Air (estimated)	See above
ET = Exposure Time (hours per day)	8
EF = Exposure Frequency (days per year)	250
ED = Exposure Duration (years)	25
AT_{nc} = Averaging Time (Noncarcinogen, hours)	219,000
AT_c = Averaging Time (Carcinogenic, hours)	613,200

Prepared/Date: LMS 10/10/2011
Checked/Date: LWC 10/10/2011

JOHNSON AND ETTINGER MODEL OUTPUTS

Prepared / Date: LMS 10/10/11
Checked/ Date: LWC 10/10/11

GW-ADV
Version 3.1; 02/04

Reset to Defaults

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

YES [ ]

OR

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

YES [x]

ENTER Chemical CAS No. (numbers only, no dashes)	ENTER Initial groundwater conc., C_W (μg/L)	Chemical
75343	3.40E+01	1,1-Dichloroethane

MORE ↓

ENTER Average soil/ groundwater temperature, T_S (°C)	ENTER Depth below grade to bottom of enclosed space floor, L_F (cm)	ENTER Depth below grade to water table, L_{WT} (cm)	ENTER Thickness of soil stratum A, h_A (cm)	ENTER Thickness of soil stratum B, (Enter value or 0) h_B (cm)	ENTER Thickness of soil stratum C, (Enter value or 0) h_C (cm)	ENTER Soil stratum directly above water table, (Enter A, B, or C)	ENTER SCS soil type directly above water table	ENTER Soil stratum A SCS soil type (used to estimate soil vapor permeability)	OR	ENTER User-defined stratum A soil vapor permeability, k_v (cm^2)
21.7	15	146	146			A	SC	SC		

(Totals must add up to value of L_{WT} (cell G28) — applies to thickness of soil strata A, B, C.)

MORE ↓

ENTER Stratum A SCS soil type (Lookup Soil Parameters)	ENTER Stratum A soil dry bulk density, ρ_b^A (g/cm^3)	ENTER Stratum A soil total porosity, n^A (unitless)	ENTER Stratum A soil water-filled porosity, θ_w^A (cm^3/cm^3)	ENTER Stratum B SCS soil type (Lookup Soil Parameters)	ENTER Stratum B soil dry bulk density, ρ_b^B (g/cm^3)	ENTER Stratum B soil total porosity, n^B (unitless)	ENTER Stratum B soil water-filled porosity, θ_w^B (cm^3/cm^3)	ENTER Stratum C SCS soil type (Lookup Soil Parameters)	ENTER Stratum C soil dry bulk density, ρ_b^C (g/cm^3)	ENTER Stratum C soil total porosity, n^C (unitless)	ENTER Stratum C soil water-filled porosity, θ_w^C (cm^3/cm^3)
SC	1.63	0.385	0.197		1.5	0.43			1.5	0.43	

MORE ↓

ENTER Enclosed space floor thickness, L_{crack} (cm)	ENTER Soil-bldg. pressure differential, ΔP (g/cm-s²)	ENTER Enclosed space floor length, L_B (cm)	ENTER Enclosed space floor width, W_B (cm)	ENTER Enclosed space height, H_B (cm)	ENTER Floor-wall seam crack width, w (cm)	ENTER Indoor air exchange rate, ER (1/h)	ENTER Average vapor flow rate into bldg. OR Leave blank to calculate Q_{soil} (L/m)
10	40	4267	2134	610	0.1	1.5	

MORE ↓

ENTER Averaging time for carcinogens, AT_C (yrs)	ENTER Averaging time for noncarcinogens, AT_{NC} (yrs)	ENTER Exposure duration, ED (yrs)	ENTER Exposure frequency, EF (days/yr)	ENTER Target risk for carcinogens, TR (unitless)	ENTER Target hazard quotient for noncarcinogens, THQ (unitless)
70	25	25	250	1.0E-05	1

Used to calculate risk-based groundwater concentration.

END

CHEMICAL PROPERTIES SHEET

Diffusivity in air, D_a (cm^2/s)	Diffusivity in water, D_w (cm^2/s)	Henry's law constant at reference temperature, H (atm-m^3/mol)	Henry's law constant reference temperature, T_R (^oC)	Enthalpy of vaporization at the normal boiling point, $\Delta H_{v,b}$ (cal/mol)	Normal boiling point, T_B (^oK)	Critical temperature, T_C (^oK)	Organic carbon partition coefficient, K_{oc} (cm^3/g)	Pure component water solubility, S (mg/L)	Unit risk factor, URF ($\mu g/m^3)^{-1}$	Reference conc., RfC (mg/m^3)
7.42E-02	1.05E-05	5.61E-03	25	6,895	330.55	523.00	3.16E+01	5.06E+03	1.6E-06	0.0E+00

END

CHEMICAL PROPERTIES SHEET

Exposure duration, τ (sec)	Source-building separation, L_T (cm)	Stratum A soil air-filled porosity, θ_a^A (cm^3/cm^3)	Stratum B soil air-filled porosity, θ_a^B (cm^3/cm^3)	Stratum C soil air-filled porosity, θ_a^C (cm^3/cm^3)	Stratum A effective total fluid saturation, S_{te} (cm^3/cm^3)	Stratum A soil intrinsic permeability, k_i (cm^2)	Stratum A soil relative air permeability, k_{rg} (cm^2)	Stratum A soil effective vapor permeability, k_v (cm^2)	Thickness of capillary zone, L_{cz} (cm)	Total porosity in capillary zone, n_{cz} (cm^3/cm^3)	Air-filled porosity in capillary zone, $\theta_{a,cz}$ (cm^3/cm^3)	Water-filled porosity in capillary zone, $\theta_{w,cz}$ (cm^3/cm^3)	Floor-wall seam perimeter, X_{crack} (cm)
7.88E+08	131	0.188	ERROR	ERROR	0.299	1.78E-09	0.837	1.49E-09	30.00	0.385	0.030	0.355	12,802

Bldg. ventilation rate, $Q_{building}$ (cm^3/s)	Area of enclosed space below grade, A_B (cm^2)	Crack-to-total area ratio, η (unitless)	Crack depth below grade, Z_{crack} (cm)	Enthalpy of vaporization at ave. groundwater temperature, $\Delta H_{v,TS}$ (cal/mol)	Henry's law constant at ave. groundwater temperature, H_{TS} (atm-m^3/mol)	Henry's law constant at ave. groundwater temperature, H'_{TS} (unitless)	Vapor viscosity at ave. soil temperature, μ_{TS} (g/cm-s)	Stratum A effective diffusion coefficient, D^{eff}_A (cm^2/s)	Stratum B effective diffusion coefficient, D^{eff}_B (cm^2/s)	Stratum C effective diffusion coefficient, D^{eff}_C (cm^2/s)	Capillary zone effective diffusion coefficient, D^{eff}_{cz} (cm^2/s)	Total overall effective diffusion coefficient, D^{eff}_T (cm^2/s)	Diffusion path length, L_d (cm)
2.31E+06	9.30E+06	1.38E-04	15	7,320	4.88E-03	2.02E-01	1.79E-04	1.92E-03	0.00E+00	0.00E+00	1.55E-05	6.57E-05	131

Convection path length, L_p (cm)	Source vapor conc., C_{source} ($\mu g/m^3$)	Crack radius, r_{crack} (cm)	Average vapor flow rate into bldg., Q_{soil} (cm^3/s)	Crack effective diffusion coefficient, D^{crack} (cm^2/s)	Area of crack, A_{crack} (cm^2)	Exponent of equivalent foundation Peclet number, $\exp(Pe^f)$ (unitless)	Infinite source indoor attenuation coefficient, α (unitless)	Infinite source bldg. conc., $C_{building}$ ($\mu g/m^3$)	Unit risk factor, URF $(\mu g/m^3)^{-1}$	Reference conc., RfC (mg/m^3)
15	6.86E+03	0.10	4.69E+00	1.92E-03	1.28E+03	1.98E+08	1.01E-06	6.93E-03	1.6E-06	NA

END

RESULTS SHEET

RISK-BASED GROUNDWATER CONCENTRATION CALCULATIONS:

Indoor exposure groundwater conc., carcinogen (µg/L)	Indoor exposure groundwater conc., noncarcinogen (µg/L)	Risk-based indoor exposure groundwater conc., (µg/L)	Pure component water solubility, S (µg/L)	Final indoor exposure groundwater conc., (µg/L)
NA	NA	NA	5.06E+06	NA

INCREMENTAL RISK CALCULATIONS:

Incremental risk from vapor intrusion to indoor air, carcinogen (unitless)	Hazard quotient from vapor intrusion to indoor air, noncarcinogen (unitless)
2.7E-09	NA

MESSAGE AND ERROR SUMMARY BELOW: (DO NOT USE RESULTS IF ERRORS ARE PRESENT)

SCROLL DOWN TO "END"

END

DATA ENTRY SHEET

Prepared / Date: LMS 10/10/11
Checked/ Date: LWC 10/10/11

GW-ADV
Version 3.1; 02/04

Reset to Defaults

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

YES [ ]

OR

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

YES [x]

ENTER Chemical CAS No. (numbers only, no dashes)	ENTER Initial groundwater conc., C_W (μg/L)	Chemical
75354	3.20E+02	1,1-Dichloroethylene

MORE ↓

ENTER Average soil/ groundwater temperature, T_S (^oC)	ENTER Depth below grade to bottom of enclosed space floor, L_F (cm)	ENTER Depth below grade to water table, L_{WT} (cm)	ENTER Thickness of soil stratum A, h_A (cm)	ENTER Thickness of soil stratum B, (Enter value or 0) h_B (cm)	ENTER Thickness of soil stratum C, (Enter value or 0) h_C (cm)	ENTER Soil stratum directly above water table, (Enter A, B, or C)	ENTER SCS soil type directly above water table	ENTER Soil stratum A SCS soil type (used to estimate soil vapor permeability)	OR	ENTER User-defined stratum A soil vapor permeability, k_v (cm^2)
21.7	15	146	146			A	SC	SC		

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

MORE ↓

ENTER Stratum A SCS soil type (Lookup Soil Parameters)	ENTER Stratum A soil dry bulk density, ρ_b^A (g/cm^3)	ENTER Stratum A soil total porosity, n^A (unitless)	ENTER Stratum A soil water-filled porosity, θ_w^A (cm^3/cm^3)	ENTER Stratum B SCS soil type (Lookup Soil Parameters)	ENTER Stratum B soil dry bulk density, ρ_b^B (g/cm^3)	ENTER Stratum B soil total porosity, n^B (unitless)	ENTER Stratum B soil water-filled porosity, θ_w^B (cm^3/cm^3)	ENTER Stratum C SCS soil type (Lookup Soil Parameters)	ENTER Stratum C soil dry bulk density, ρ_b^C (g/cm^3)	ENTER Stratum C soil total porosity, n^C (unitless)	ENTER Stratum C soil water-filled porosity, θ_w^C (cm^3/cm^3)
SC	1.63	0.385	0.197		1.5	0.43			1.5	0.43	

MORE ↓

ENTER Enclosed space floor thickness, L_{crack} (cm)	ENTER Soil-bldg. pressure differential, ΔP ($g/cm\text{-}s^2$)	ENTER Enclosed space floor length, L_B (cm)	ENTER Enclosed space floor width, W_B (cm)	ENTER Enclosed space height, H_B (cm)	ENTER Floor-wall seam crack width, w (cm)	ENTER Indoor air exchange rate, ER (1/h)	ENTER Average vapor flow rate into bldg. OR Leave blank to calculate Q_{soil} (L/m)
10	40	4267	2134	610	0.1	1.5	

MORE ↓

ENTER Averaging time for carcinogens, AT_C (yrs)	ENTER Averaging time for noncarcinogens, AT_{NC} (yrs)	ENTER Exposure duration, ED (yrs)	ENTER Exposure frequency, EF (days/yr)	ENTER Target risk for carcinogens, TR (unitless)	ENTER Target hazard quotient for noncarcinogens, THQ (unitless)
70	25	25	250	1.0E-05	1

Used to calculate risk-based groundwater concentration.

END

CHEMICAL PROPERTIES SHEET

Diffusivity in air, D_a (cm^2/s)	Diffusivity in water, D_w (cm^2/s)	Henry's law constant at reference temperature, H ($atm-m^3/mol$)	Henry's law constant reference temperature, T_R (^oC)	Enthalpy of vaporization at the normal boiling point, $\Delta H_{v,b}$ (cal/mol)	Normal boiling point, T_B (^oK)	Critical temperature, T_C (^oK)	Organic carbon partition coefficient, K_{oc} (cm^3/g)	Pure component water solubility, S (mg/L)	Unit risk factor, URF ($(\mu g/m^3)^{-1}$)	Reference conc., RfC (mg/m^3)
9.00E-02	1.04E-05	2.60E-02	25	6,247	304.75	576.05	5.89E+01	2.25E+03	0.0E+00	2.0E-01

END

INTERMEDIATE CALCULATIONS SHEET

Exposure duration, τ (sec)	Source-building separation, L_T (cm)	Stratum A soil air-filled porosity, θ_a^A (cm^3/cm^3)	Stratum B soil air-filled porosity, θ_a^B (cm^3/cm^3)	Stratum C soil air-filled porosity, θ_a^C (cm^3/cm^3)	Stratum A effective total fluid saturation, S_{te} (cm^3/cm^3)	Stratum A soil intrinsic permeability, k_i (cm^2)	Stratum A soil relative air permeability, k_{rg} (cm^2)	Stratum A soil effective vapor permeability, k_v (cm^2)	Thickness of capillary zone, L_{cz} (cm)	Total porosity in capillary zone, n_{cz} (cm^3/cm^3)	Air-filled porosity in capillary zone, $\theta_{a,cz}$ (cm^3/cm^3)	Water-filled porosity in capillary zone, $\theta_{w,cz}$ (cm^3/cm^3)	Floor-wall seam perimeter, X_{crack} (cm)
7.88E+08	131	0.188	ERROR	ERROR	0.299	1.78E-09	0.837	1.49E-09	30.00	0.385	0.030	0.355	12,802

Bldg. ventilation rate, $Q_{building}$ (cm^3/s)	Area of enclosed space below grade, A_B (cm^2)	Crack-to-total area ratio, η (unitless)	Crack depth below grade, Z_{crack} (cm)	Enthalpy of vaporization at ave. groundwater temperature, $\Delta H_{v,TS}$ (cal/mol)	Henry's law constant at ave. groundwater temperature, H_{TS} (atm-m^3/mol)	Henry's law constant at ave. groundwater temperature, H'_{TS} (unitless)	Vapor viscosity at ave. soil temperature, μ_{TS} (g/cm-s)	Stratum A effective diffusion coefficient, D^{eff}_A (cm^2/s)	Stratum B effective diffusion coefficient, D^{eff}_B (cm^2/s)	Stratum C effective diffusion coefficient, D^{eff}_C (cm^2/s)	Capillary zone effective diffusion coefficient, D^{eff}_{cz} (cm^2/s)	Total overall effective diffusion coefficient, D^{eff}_T (cm^2/s)	Diffusion path length, L_d (cm)
2.31E+06	9.30E+06	1.38E-04	15	6,315	2.31E-02	9.55E-01	1.79E-04	2.32E-03	0.00E+00	0.00E+00	7.57E-06	3.27E-05	131

Convection path length, L_p (cm)	Source vapor conc., C_{source} ($\mu g/m^3$)	Crack radius, r_{crack} (cm)	Average vapor flow rate into bldg., Q_{soil} (cm^3/s)	Crack effective diffusion coefficient, D^{crack} (cm^2/s)	Area of crack, A_{crack} (cm^2)	Exponent of equivalent foundation Peclet number, $\exp(Pe^f)$ (unitless)	Infinite source indoor attenuation coefficient, α (unitless)	Infinite source bldg. conc., $C_{building}$ ($\mu g/m^3$)	Unit risk factor, URF $(\mu g/m^3)^{-1}$	Reference conc., RfC (mg/m^3)
15	3.06E+05	0.10	4.69E+00	2.32E-03	1.28E+03	6.99E+06	6.71E-07	2.05E-01	NA	2.0E-01

END

RESULTS SHEET

RISK-BASED GROUNDWATER CONCENTRATION CALCULATIONS:

Indoor exposure groundwater conc., carcinogen (μg/L)	Indoor exposure groundwater conc., noncarcinogen (μg/L)	Risk-based indoor exposure groundwater conc., (μg/L)	Pure component water solubility, S (μg/L)	Final indoor exposure groundwater conc., (μg/L)
NA	NA	NA	2.25E+06	NA

INCREMENTAL RISK CALCULATIONS:

Incremental risk from vapor intrusion to indoor air, carcinogen (unitless)	Hazard quotient from vapor intrusion to indoor air, noncarcinogen (unitless)
NA	7.0E-04

MESSAGE AND ERROR SUMMARY BELOW: (DO NOT USE RESULTS IF ERRORS ARE PRESENT)

SCROLL DOWN TO "END"

END

Prepared / Date: LMS 10/10/11
Checked/ Date: LWC 10/10/11

GW-ADV
Version 3.1; 02/04

Reset to Defaults

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

YES [ ]

OR

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

YES [x]

ENTER Chemical CAS No. (numbers only, no dashes)	ENTER Initial groundwater conc., C_W (μg/L)	Chemical
71556	1.41E+02	1,1,1-Trichloroethane

MORE ↓

ENTER Average soil/ groundwater temperature, T_S (°C)	ENTER Depth below grade to bottom of enclosed space floor, L_F (cm)	ENTER Depth below grade to water table, L_{WT} (cm)	ENTER Thickness of soil stratum A, h_A (cm)	ENTER Thickness of soil stratum B, (Enter value or 0) h_B (cm)	ENTER Thickness of soil stratum C, (Enter value or 0) h_C (cm)	ENTER Soil stratum directly above water table, (Enter A, B, or C)	ENTER SCS soil type directly above water table	ENTER Soil stratum A SCS soil type (used to estimate soil vapor permeability)	OR	ENTER User-defined stratum A soil vapor permeability, k_v (cm^2)
21.7	15	146	146			A	SC	SC		

Note: ENTER columns for h_A, h_B, h_C: Totals must add up to value of L_{WT} (cell G28)

MORE ↓

ENTER Stratum A SCS soil type (Lookup Soil Parameters)	ENTER Stratum A soil dry bulk density, ρ_b^A (g/cm^3)	ENTER Stratum A soil total porosity, n^A (unitless)	ENTER Stratum A soil water-filled porosity, θ_w^A (cm^3/cm^3)	ENTER Stratum B SCS soil type (Lookup Soil Parameters)	ENTER Stratum B soil dry bulk density, ρ_b^B (g/cm^3)	ENTER Stratum B soil total porosity, n^B (unitless)	ENTER Stratum B soil water-filled porosity, θ_w^B (cm^3/cm^3)	ENTER Stratum C SCS soil type (Lookup Soil Parameters)	ENTER Stratum C soil dry bulk density, ρ_b^C (g/cm^3)	ENTER Stratum C soil total porosity, n^C (unitless)	ENTER Stratum C soil water-filled porosity, θ_w^C (cm^3/cm^3)
SC	1.63	0.385	0.197		1.5	0.43			1.5	0.43	

MORE ↓

ENTER Enclosed space floor thickness, L_{crack} (cm)	ENTER Soil-bldg. pressure differential, ΔP ($g/cm-s^2$)	ENTER Enclosed space floor length, L_B (cm)	ENTER Enclosed space floor width, W_B (cm)	ENTER Enclosed space height, H_B (cm)	ENTER Floor-wall seam crack width, w (cm)	ENTER Indoor air exchange rate, ER (1/h)	ENTER Average vapor flow rate into bldg. OR Leave blank to calculate Q_{soil} (L/m)
10	40	4267	2134	610	0.1	1.5	

MORE ↓

ENTER Averaging time for carcinogens, AT_C (yrs)	ENTER Averaging time for noncarcinogens, AT_{NC} (yrs)	ENTER Exposure duration, ED (yrs)	ENTER Exposure frequency, EF (days/yr)	ENTER Target risk for carcinogens, TR (unitless)	ENTER Target hazard quotient for noncarcinogens, THQ (unitless)
70	25	25	250	1.0E-05	1

Used to calculate risk-based groundwater concentration.

END

CHEMICAL PROPERTIES SHEET

Diffusivity in air, D_a (cm^2/s)	Diffusivity in water, D_w (cm^2/s)	Henry's law constant at reference temperature, H ($atm\text{-}m^3/mol$)	Henry's law constant reference temperature, T_R (^oC)	Enthalpy of vaporization at the normal boiling point, $\Delta H_{v,b}$ (cal/mol)	Normal boiling point, T_B (^oK)	Critical temperature, T_C (^oK)	Organic carbon partition coefficient, K_{oc} (cm^3/g)	Pure component water solubility, S (mg/L)	Unit risk factor, URF ($\mu g/m^3)^{-1}$	Reference conc., RfC (mg/m^3)
7.80E-02	8.80E-06	1.72E-02	25	7,136	347.24	545.00	1.10E+02	1.33E+03	0.0E+00	5.0E+00

END

INTERMEDIATE CALCULATIONS SHEET

Exposure duration, τ (sec)	Source-building separation, L_T (cm)	Stratum A soil air-filled porosity, θ_a^A (cm^3/cm^3)	Stratum B soil air-filled porosity, θ_a^B (cm^3/cm^3)	Stratum C soil air-filled porosity, θ_a^C (cm^3/cm^3)	Stratum A effective total fluid saturation, S_{te} (cm^3/cm^3)	Stratum A soil intrinsic permeability, k_i (cm^2)	Stratum A soil relative air permeability, k_{rg} (cm^2)	Stratum A soil effective vapor permeability, k_v (cm^2)	Thickness of capillary zone, L_{cz} (cm)	Total porosity in capillary zone, n_{cz} (cm^3/cm^3)	Air-filled porosity in capillary zone, $\theta_{a,cz}$ (cm^3/cm^3)	Water-filled porosity in capillary zone, $\theta_{w,cz}$ (cm^3/cm^3)	Floor-wall seam perimeter, X_{crack} (cm)
7.88E+08	131	0.188	ERROR	ERROR	0.299	1.78E-09	0.837	1.49E-09	30.00	0.385	0.030	0.355	12,802

Bldg. ventilation rate, $Q_{building}$ (cm^3/s)	Area of enclosed space below grade, A_B (cm^2)	Crack-to-total area ratio, η (unitless)	Crack depth below grade, Z_{crack} (cm)	Enthalpy of vaporization at ave. groundwater temperature, $\Delta H_{v,TS}$ (cal/mol)	Henry's law constant at ave. groundwater temperature, H_{TS} (atm-m^3/mol)	Henry's law constant at ave. groundwater temperature, H'_{TS} (unitless)	Vapor viscosity at ave. soil temperature, μ_{TS} (g/cm-s)	Stratum A effective diffusion coefficient, D^{eff}_A (cm^2/s)	Stratum B effective diffusion coefficient, D^{eff}_B (cm^2/s)	Stratum C effective diffusion coefficient, D^{eff}_C (cm^2/s)	Capillary zone effective diffusion coefficient, D^{eff}_{cz} (cm^2/s)	Total overall effective diffusion coefficient, D^{eff}_T (cm^2/s)	Diffusion path length, L_d (cm)
2.31E+06	9.30E+06	1.38E-04	15	7,758	1.48E-02	6.12E-01	1.79E-04	2.01E-03	0.00E+00	0.00E+00	7.62E-06	3.29E-05	131

Convection path length, L_p (cm)	Source vapor conc., C_{source} ($\mu g/m^3$)	Crack radius, r_{crack} (cm)	Average vapor flow rate into bldg., Q_{soil} (cm^3/s)	Crack effective diffusion coefficient, D^{crack} (cm^2/s)	Area of crack, A_{crack} (cm^2)	Exponent of equivalent foundation Peclet number, $\exp(Pe^f)$ (unitless)	Infinite source indoor attenuation coefficient, α (unitless)	Infinite source bldg. conc., $C_{building}$ ($\mu g/m^3$)	Unit risk factor, URF $(\mu g/m^3)^{-1}$	Reference conc., RfC (mg/m^3)
15	8.64E+04	0.10	4.69E+00	2.01E-03	1.28E+03	7.88E+07	6.73E-07	5.81E-02	NA	5.0E+00

END

RESULTS SHEET

RISK-BASED GROUNDWATER CONCENTRATION CALCULATIONS:

Indoor exposure groundwater conc., carcinogen (µg/L)	Indoor exposure groundwater conc., noncarcinogen (µg/L)	Risk-based indoor exposure groundwater conc., (µg/L)	Pure component water solubility, S (µg/L)	Final indoor exposure groundwater conc., (µg/L)
NA	NA	NA	1.33E+06	NA

INCREMENTAL RISK CALCULATIONS:

Incremental risk from vapor intrusion to indoor air, carcinogen (unitless)	Hazard quotient from vapor intrusion to indoor air, noncarcinogen (unitless)
NA	8.0E-06

MESSAGE AND ERROR SUMMARY BELOW: (DO NOT USE RESULTS IF ERRORS ARE PRESENT)

SCROLL DOWN TO "END"

END

DATA ENTRY SHEET

Prepared / Date: LMS 10/10/11
Checked/ Date: LWC 10/10/11

GW-ADV
Version 3.1; 02/04

Reset to Defaults

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

YES [ ]

OR

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

YES [x]

ENTER Chemical CAS No. (numbers only, no dashes)	ENTER Initial groundwater conc., C_W (μg/L)	Chemical
156592	3.19E+02	cis-1,2-Dichloroethylene

MORE ↓

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

ENTER Average soil/ groundwater temperature, T_S (°C)	ENTER Depth below grade to bottom of enclosed space floor, L_F (cm)	ENTER Depth below grade to water table, L_{WT} (cm)	ENTER Thickness of soil stratum A, h_A (cm)	ENTER Thickness of soil stratum B, (Enter value or 0) h_B (cm)	ENTER Thickness of soil stratum C, (Enter value or 0) h_C (cm)	ENTER Soil stratum directly above water table, (Enter A, B, or C)	ENTER SCS soil type directly above water table	ENTER Soil stratum A SCS soil type (used to estimate soil vapor permeability)	OR	ENTER User-defined stratum A soil vapor permeability, k_v (cm²)
21.7	15	146	146			A	SC	SC		

MORE ↓

ENTER Stratum A SCS soil type (Lookup Soil Parameters)	ENTER Stratum A soil dry bulk density, ρ_b^A (g/cm³)	ENTER Stratum A soil total porosity, n^A (unitless)	ENTER Stratum A soil water-fillec porosity, θ_w^A (cm³/cm³)	ENTER Stratum B SCS soil type (Lookup Soil Parameters)	ENTER Stratum B soil dry bulk density, ρ_b^B (g/cm³)	ENTER Stratum B soil total porosity, n^B (unitless)	ENTER Stratum B soil water-filled porosity, θ_w^B (cm³/cm³)	ENTER Stratum C SCS soil type (Lookup Soil Parameters)	ENTER Stratum C soil dry bulk density, ρ_b^C (g/cm³)	ENTER Stratum C soil total porosity, n^C (unitless)	ENTER Stratum C soil water-filled porosity, θ_w^C (cm³/cm³)
SC	1.63	0.385	0.197		1.5	0.43			1.5	0.43	

MORE ↓

ENTER Enclosed space floor thickness, L_{crack} (cm)	ENTER Soil-bldg. pressure differential, ΔP (g/cm-s²)	ENTER Enclosed space floor length, L_B (cm)	ENTER Enclosed space floor width, W_B (cm)	ENTER Enclosed space height, H_B (cm)	ENTER Floor-wall seam crack width, w (cm)	ENTER Indoor air exchange rate, ER (1/h)	ENTER Average vapor flow rate into bldg. OR Leave blank to calculate Q_{soil} (L/m)
10	40	4267	2134	610	0.1	1.5	

MORE ↓

ENTER Averaging time for carcinogens, AT_C (yrs)	ENTER Averaging time for noncarcinogens, AT_{NC} (yrs)	ENTER Exposure duration, ED (yrs)	ENTER Exposure frequency, EF (days/yr)	ENTER Target risk for carcinogens, TR (unitless)	ENTER Target hazard quotient for noncarcinogens, THQ (unitless)
70	25	25	250	1.0E-05	1

Used to calculate risk-based groundwater concentration.

END

CHEMICAL PROPERTIES SHEET

Diffusivity in air, D_a (cm^2/s)	Diffusivity in water, D_w (cm^2/s)	Henry's law constant at reference temperature, H (atm-m^3/mol)	Henry's law constant reference temperature, T_R (^oC)	Enthalpy of vaporization at the normal boiling point, $\Delta H_{v,b}$ (cal/mol)	Normal boiling point, T_B (^oK)	Critical temperature, T_C (^oK)	Organic carbon partition coefficient, K_{oc} (cm^3/g)	Pure component water solubility, S (mg/L)	Unit risk factor, URF ($\mu g/m^3)^{-1}$	Reference conc., RfC (mg/m^3)
7.36E-02	1.13E-05	4.07E-03	25	7,192	333.65	544.00	3.55E+01	3.50E+03	0.0E+00	6.0E-02

END

INTERMEDIATE CALCULATIONS SHEET

Exposure duration, τ (sec)	Source-building separation, L_T (cm)	Stratum A soil air-filled porosity, θ_a^A (cm^3/cm^3)	Stratum B soil air-filled porosity, θ_a^B (cm^3/cm^3)	Stratum C soil air-filled porosity, θ_a^C (cm^3/cm^3)	Stratum A effective total fluid saturation, S_{te} (cm^3/cm^3)	Stratum A soil intrinsic permeability, k_i (cm^2)	Stratum A soil relative air permeability, k_{rg} (cm^2)	Stratum A soil effective vapor permeability, k_v (cm^2)	Thickness of capillary zone, L_{cz} (cm)	Total porosity in capillary zone, n_{cz} (cm^3/cm^3)	Air-filled porosity in capillary zone, $\theta_{a,cz}$ (cm^3/cm^3)	Water-filled porosity in capillary zone, $\theta_{w,cz}$ (cm^3/cm^3)	Floor-wall seam perimeter, X_{crack} (cm)
7.88E+08	131	0.188	ERROR	ERROR	0.299	1.78E-09	0.837	1.49E-09	30.00	0.385	0.030	0.355	12,802

Bldg. ventilation rate, $Q_{building}$ (cm^3/s)	Area of enclosed space below grade, A_B (cm^2)	Crack-to-total area ratio, η (unitless)	Crack depth below grade, Z_{crack} (cm)	Enthalpy of vaporization at ave. groundwater temperature, $\Delta H_{v,TS}$ (cal/mol)	Henry's law constant at ave. groundwater temperature, H_{TS} (atm-m^3/mol)	Henry's law constant at ave. groundwater temperature, H'_{TS} (unitless)	Vapor viscosity at ave. soil temperature, μ_{TS} (g/cm-s)	Stratum A effective diffusion coefficient, D^{eff}_A (cm^2/s)	Stratum B effective diffusion coefficient, D^{eff}_B (cm^2/s)	Stratum C effective diffusion coefficient, D^{eff}_C (cm^2/s)	Capillary zone effective diffusion coefficient, D^{eff}_{cz} (cm^2/s)	Total overall effective diffusion coefficient, D^{eff}_T (cm^2/s)	Diffusion path length, L_d (cm)
2.31E+06	9.30E+06	1.38E-04	15	7,615	3.52E-03	1.46E-01	1.79E-04	1.90E-03	0.00E+00	0.00E+00	2.09E-05	8.80E-05	131

Convection path length, L_p (cm)	Source vapor conc., C_{source} ($\mu g/m^3$)	Crack radius, r_{crack} (cm)	Average vapor flow rate into bldg., Q_{soil} (cm^3/s)	Crack effective diffusion coefficient, D^{crack} (cm^2/s)	Area of crack, A_{crack} (cm^2)	Exponent of equivalent foundation Peclet number, $exp(Pe^f)$ (unitless)	Infinite source indoor attenuation coefficient, α (unitless)	Infinite source bldg. conc., $C_{building}$ ($\mu g/m^3$)	Unit risk factor, URF $(\mu g/m^3)^{-1}$	Reference conc., RfC (mg/m^3)
15	4.65E+04	0.10	4.69E+00	1.90E-03	1.28E+03	2.29E+08	1.16E-06	5.38E-02	NA	6.0E-02

END

RESULTS SHEET

RISK-BASED GROUNDWATER CONCENTRATION CALCULATIONS:

Indoor exposure groundwater conc., carcinogen (μg/L)	Indoor exposure groundwater conc., noncarcinogen (μg/L)	Risk-based indoor exposure groundwater conc., (μg/L)	Pure component water solubility, S (μg/L)	Final indoor exposure groundwater conc., (μg/L)
NA	NA	NA	3.50E+06	NA

INCREMENTAL RISK CALCULATIONS:

Incremental risk from vapor intrusion to indoor air, carcinogen (unitless)	Hazard quotient from vapor intrusion to indoor air, noncarcinogen (unitless)
NA	6.1E-04

MESSAGE AND ERROR SUMMARY BELOW: (DO NOT USE RESULTS IF ERRORS ARE PRESENT)

MESSAGE: Risk/HQ or risk-based groundwater concentration is based on a route-to-route extrapolation.

SCROLL DOWN TO "END"

END

DATA ENTRY SHEET

Prepared / Date: LMS 10/10/11
Checked/ Date: LWC 10/10/11

GW-ADV
Version 3.1; 02/04

Reset to Defaults

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

YES [ ]

OR

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

YES [x]

ENTER Chemical CAS No. (numbers only, no dashes)	ENTER Initial groundwater conc., C_W (μg/L)	Chemical
79016	2.78E+02	Trichloroethylene

MORE ↓

ENTER Average soil/ groundwater temperature, T_S (^{o}C)	ENTER Depth below grade to bottom of enclosed space floor, L_F (cm)	ENTER Depth below grade to water table, L_{WT} (cm)	ENTER Totals must add up to value of L_{WT} (cell G28) Thickness of soil stratum A, h_A (cm)	ENTER Thickness of soil stratum B, (Enter value or 0) h_B (cm)	ENTER Thickness of soil stratum C, (Enter value or 0) h_C (cm)	ENTER Soil stratum directly above water table, (Enter A, B, or C)	ENTER SCS soil type directly above water table	ENTER Soil stratum A SCS soil type (used to estimate soil vapor permeability)	OR	ENTER User-defined stratum A soil vapor permeability, k_v (cm^2)
21.7	15	146	146			A	SC	SC		

MORE ↓

ENTER Stratum A SCS soil type Lookup Soil Parameters	ENTER Stratum A soil dry bulk density, ρ_b^A (g/cm^3)	ENTER Stratum A soil total porosity, n^A (unitless)	ENTER Stratum A soil water-fillec porosity, θ_w^A (cm^3/cm^3)	ENTER Stratum B SCS soil type Lookup Soil Parameters	ENTER Stratum B soil dry bulk density, ρ_b^B (g/cm^3)	ENTER Stratum B soil total porosity, n^B (unitless)	ENTER Stratum B soil water-filled porosity, θ_w^B (cm^3/cm^3)	ENTER Stratum C SCS soil type Lookup Soil Parameters	ENTER Stratum C soil dry bulk density, ρ_b^C (g/cm^3)	ENTER Stratum C soil total porosity, n^C (unitless)	ENTER Stratum C soil water-filled porosity, θ_w^C (cm^3/cm^3)
SC	1.63	0.385	0.197		1.5	0.43			1.5	0.43	

MORE ↓

ENTER Enclosed space floor thickness, L_{crack} (cm)	ENTER Soil-bldg. pressure differential, ΔP (g/cm-s^2)	ENTER Enclosed space floor length, L_B (cm)	ENTER Enclosed space floor width, W_B (cm)	ENTER Enclosed space height, H_B (cm)	ENTER Floor-wall seam crack width, w (cm)	ENTER Indoor air exchange rate, ER (1/h)	ENTER Average vapor flow rate into bldg. OR Leave blank to calculate Q_{soil} (L/m)
10	40	4267	2134	610	0.1	1.5	

MORE ↓

ENTER Averaging time for carcinogens, AT_C (yrs)	ENTER Averaging time for noncarcinogens, AT_{NC} (yrs)	ENTER Exposure duration, ED (yrs)	ENTER Exposure frequency, EF (days/yr)	ENTER Target risk for carcinogens, TR (unitless)	ENTER Target hazard quotient for noncarcinogens, THQ (unitless)
70	25	25	250	1.0E-05	1

Used to calculate risk-based groundwater concentration.

END

CHEMICAL PROPERTIES SHEET

Diffusivity in air, D_a (cm^2/s)	Diffusivity in water, D_w (cm^2/s)	Henry's law constant at reference temperature, H (atm-m^3/mol)	Henry's law constant reference temperature, T_R (^oC)	Enthalpy of vaporization at the normal boiling point, $\Delta H_{v,b}$ (cal/mol)	Normal boiling point, T_B (^oK)	Critical temperature, T_C (^oK)	Organic carbon partition coefficient, K_{oc} (cm^3/g)	Pure component water solubility, S (mg/L)	Unit risk factor, URF ($\mu g/m^3)^{-1}$	Reference conc., RfC (mg/m^3)
7.90E-02	9.10E-06	1.03E-02	25	7,505	360.36	544.20	1.66E+02	1.47E+03	4.0E-06	2.0E-03

END

INTERMEDIATE CALCULATIONS SHEET

Exposure duration, τ (sec)	Source-building separation, L_T (cm)	Stratum A soil air-filled porosity, θ_a^A (cm^3/cm^3)	Stratum B soil air-filled porosity, θ_a^B (cm^3/cm^3)	Stratum C soil air-filled porosity, θ_a^C (cm^3/cm^3)	Stratum A effective total fluid saturation, S_{te} (cm^3/cm^3)	Stratum A soil intrinsic permeability, k_i (cm^2)	Stratum A soil relative air permeability, k_{rg} (cm^2)	Stratum A soil effective vapor permeability, k_v (cm^2)	Thickness of capillary zone, L_{cz} (cm)	Total porosity in capillary zone, n_{cz} (cm^3/cm^3)	Air-filled porosity in capillary zone, $\theta_{a,cz}$ (cm^3/cm^3)	Water-filled porosity in capillary zone, $\theta_{w,cz}$ (cm^3/cm^3)	Floor-wall seam perimeter, X_{crack} (cm)
7.88E+08	131	0.188	ERROR	ERROR	0.299	1.78E-09	0.837	1.49E-09	30.00	0.385	0.030	0.355	12,802

Bldg. ventilation rate, $Q_{building}$ (cm^3/s)	Area of enclosed space below grade, A_B (cm^2)	Crack-to-total area ratio, η (unitless)	Crack depth below grade, Z_{crack} (cm)	Enthalpy of vaporization at ave. groundwater temperature, $\Delta H_{v,TS}$ (cal/mol)	Henry's law constant at ave. groundwater temperature, H_{TS} (atm-m^3/mol)	Henry's law constant at ave. groundwater temperature, H'_{TS} (unitless)	Vapor viscosity at ave. soil temperature, μ_{TS} (g/cm-s)	Stratum A effective diffusion coefficient, D^{eff}_A (cm^2/s)	Stratum B effective diffusion coefficient, D^{eff}_B (cm^2/s)	Stratum C effective diffusion coefficient, D^{eff}_C (cm^2/s)	Capillary zone effective diffusion coefficient, D^{eff}_{cz} (cm^2/s)	Total overall effective diffusion coefficient, D^{eff}_T (cm^2/s)	Diffusion path length, L_d (cm)
2.31E+06	9.30E+06	1.38E-04	15	8,411	8.76E-03	3.62E-01	1.79E-04	2.04E-03	0.00E+00	0.00E+00	9.98E-06	4.29E-05	131

Convection path length, L_p (cm)	Source vapor conc., C_{source} (μg/m^3)	Crack radius, r_{crack} (cm)	Average vapor flow rate into bldg., Q_{soil} (cm^3/s)	Crack effective diffusion coefficient, D^{crack} (cm^2/s)	Area of crack, A_{crack} (cm^2)	Exponent of equivalent foundation Peclet number, exp(Pe^f) (unitless)	Infinite source indoor attenuation coefficient, α (unitless)	Infinite source bldg. conc., $C_{building}$ (μg/m^3)	Unit risk factor, URF (μg/m^3)$^{-1}$	Reference conc., RfC (mg/m^3)
15	1.01E+05	0.10	4.69E+00	2.04E-03	1.28E+03	6.25E+07	7.97E-07	8.03E-02	4.0E-06	2.0E-03

END

RESULTS SHEET

RISK-BASED GROUNDWATER CONCENTRATION CALCULATIONS:

Indoor exposure groundwater conc., carcinogen (μg/L)	Indoor exposure groundwater conc., noncarcinogen (μg/L)	Risk-based indoor exposure groundwater conc., (μg/L)	Pure component water solubility, S (μg/L)	Final indoor exposure groundwater conc., (μg/L)
NA	NA	NA	1.47E+06	NA

INCREMENTAL RISK CALCULATIONS:

Incremental risk from vapor intrusion to indoor air, carcinogen (unitless)	Hazard quotient from vapor intrusion to indoor air, noncarcinogen (unitless)
7.9E-08	2.8E-02

MESSAGE AND ERROR SUMMARY BELOW: (DO NOT USE RESULTS IF ERRORS ARE PRESENT)

SCROLL DOWN TO "END"

END

DATA ENTRY SHEET

Prepared / Date: LMS 10/10/11
Checked/ Date: LWC 10/10/11

GW-ADV
Version 3.1; 02/04

Reset to Defaults

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

YES [ ]

OR

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

YES [x]

ENTER Chemical CAS No. (numbers only, no dashes)	ENTER Initial groundwater conc., C_W (µg/L)	Chemical
75014	2.56E+02	Vinyl chloride (chloroethene)

MORE ↓

ENTER Average soil/ groundwater temperature, T_S (°C)	ENTER Depth below grade to bottom of enclosed space floor, L_F (cm)	ENTER Depth below grade to water table, L_{WT} (cm)	ENTER Thickness of soil stratum A, h_A (cm)	ENTER Thickness of soil stratum B, (Enter value or 0) h_B (cm)	ENTER Thickness of soil stratum C, (Enter value or 0) h_C (cm)	ENTER Soil stratum directly above water table, (Enter A, B, or C)	ENTER SCS soil type directly above water table	ENTER Soil stratum A SCS soil type (used to estimate soil vapor permeability)	OR	ENTER User-defined stratum A soil vapor permeability, k_v (cm^2)
			Totals must add up to value of L_{WT} (cell G28)							
21.7	15	146	146			A	SC	SC		

MORE ↓

ENTER Stratum A SCS soil type Lookup Soil Parameters	ENTER Stratum A soil dry bulk density, ρ_b^A (g/cm^3)	ENTER Stratum A soil total porosity, n^A (unitless)	ENTER Stratum A soil water-fillec porosity, θ_w^A (cm^3/cm^3)	ENTER Stratum B SCS soil type Lookup Soil Parameters	ENTER Stratum B soil dry bulk density, ρ_b^B (g/cm^3)	ENTER Stratum B soil total porosity, n^B (unitless)	ENTER Stratum B soil water-filled porosity, θ_w^B (cm^3/cm^3)	ENTER Stratum C SCS soil type Lookup Soil Parameters	ENTER Stratum C soil dry bulk density, ρ_b^C (g/cm^3)	ENTER Stratum C soil total porosity, n^C (unitless)	ENTER Stratum C soil water-filled porosity, θ_w^C (cm^3/cm^3)
SC	1.63	0.385	0.197		1.5	0.43			1.5	0.43	

MORE ↓

ENTER Enclosed space floor thickness, L_{crack} (cm)	ENTER Soil-bldg. pressure differential, ΔP ($g/cm\text{-}s^2$)	ENTER Enclosed space floor length, L_B (cm)	ENTER Enclosed space floor width, W_B (cm)	ENTER Enclosed space height, H_B (cm)	ENTER Floor-wall seam crack width, w (cm)	ENTER Indoor air exchange rate, ER (1/h)	ENTER Average vapor flow rate into bldg. OR Leave blank to calculate Q_{soil} (L/m)
10	40	4267	2134	610	0.1	1.5	

MORE ↓

ENTER Averaging time for carcinogens, AT_C (yrs)	ENTER Averaging time for noncarcinogens, AT_{NC} (yrs)	ENTER Exposure duration, ED (yrs)	ENTER Exposure frequency, EF (days/yr)	ENTER Target risk for carcinogens, TR (unitless)	ENTER Target hazard quotient for noncarcinogens, THQ (unitless)
70	25	25	250	1.0E-05	1
				Used to calculate risk-based groundwater concentration.	

END

CHEMICAL PROPERTIES SHEET

Diffusivity in air, D_a (cm^2/s)	Diffusivity in water, D_w (cm^2/s)	Henry's law constant at reference temperature, H (atm-m^3/mol)	Henry's law constant reference temperature, T_R (°C)	Enthalpy of vaporization at the normal boiling point, $\Delta H_{v,b}$ (cal/mol)	Normal boiling point, T_B (°K)	Critical temperature, T_C (°K)	Organic carbon partition coefficient, K_{oc} (cm^3/g)	Pure component water solubility, S (mg/L)	Unit risk factor, URF ($(\mu g/m^3)^{-1}$)	Reference conc., RfC (mg/m^3)
1.06E-01	1.23E-05	2.69E-02	25	5,250	259.25	432.00	1.86E+01	8.80E+03	4.4E-06	1.0E-01

END

INTERMEDIATE CALCULATIONS SHEET

Exposure duration, τ (sec)	Source-building separation, L_T (cm)	Stratum A soil air-filled porosity, θ_a^A (cm^3/cm^3)	Stratum B soil air-filled porosity, θ_a^B (cm^3/cm^3)	Stratum C soil air-filled porosity, θ_a^C (cm^3/cm^3)	Stratum A effective total fluid saturation, S_{te} (cm^3/cm^3)	Stratum A soil intrinsic permeability, k_i (cm^2)	Stratum A soil relative air permeability, k_{rg} (cm^2)	Stratum A soil effective vapor permeability, k_v (cm^2)	Thickness of capillary zone, L_{cz} (cm)	Total porosity in capillary zone, n_{cz} (cm^3/cm^3)	Air-filled porosity in capillary zone, $\theta_{a,cz}$ (cm^3/cm^3)	Water-filled porosity in capillary zone, $\theta_{w,cz}$ (cm^3/cm^3)	Floor-wall seam perimeter, X_{crack} (cm)
7.88E+08	131	0.188	ERROR	ERROR	0.299	1.78E-09	0.837	1.49E-09	30.00	0.385	0.030	0.355	12,802

Bldg. ventilation rate, $Q_{building}$ (cm^3/s)	Area of enclosed space below grade, A_B (cm^2)	Crack-to-total area ratio, η (unitless)	Crack depth below grade, Z_{crack} (cm)	Enthalpy of vaporization at ave. groundwater temperature, $\Delta H_{v,TS}$ (cal/mol)	Henry's law constant at ave. groundwater temperature, H_{TS} (atm-m^3/mol)	Henry's law constant at ave. groundwater temperature, H'_{TS} (unitless)	Vapor viscosity at ave. soil temperature, μ_{TS} (g/cm-s)	Stratum A effective diffusion coefficient, D^{eff}_A (cm^2/s)	Stratum B effective diffusion coefficient, D^{eff}_B (cm^2/s)	Stratum C effective diffusion coefficient, D^{eff}_C (cm^2/s)	Capillary zone effective diffusion coefficient, D^{eff}_{cz} (cm^2/s)	Total overall effective diffusion coefficient, D^{eff}_T (cm^2/s)	Diffusion path length, L_d (cm)
2.31E+06	9.30E+06	1.38E-04	15	4,867	2.46E-02	1.02E+00	1.79E-04	2.74E-03	0.00E+00	0.00E+00	8.77E-06	3.79E-05	131

Convection path length, L_p (cm)	Source vapor conc., C_{source} ($\mu g/m^3$)	Crack radius, r_{crack} (cm)	Average vapor flow rate into bldg., Q_{soil} (cm^3/s)	Crack effective diffusion coefficient, D^{crack} (cm^2/s)	Area of crack, A_{crack} (cm^2)	Exponent of equivalent foundation Peclet number, $\exp(Pe^f)$ (unitless)	Infinite source indoor attenuation coefficient, α (unitless)	Infinite source bldg. conc., $C_{building}$ ($\mu g/m^3$)	Unit risk factor, URF $(\mu g/m^3)^{-1}$	Reference conc., RfC (mg/m^3)
15	2.60E+05	0.10	4.69E+00	2.74E-03	1.28E+03	6.48E+05	7.38E-07	1.92E-01	4.4E-06	1.0E-01

END

RESULTS SHEET

RISK-BASED GROUNDWATER CONCENTRATION CALCULATIONS:

Indoor exposure groundwater conc., carcinogen (μg/L)	Indoor exposure groundwater conc., noncarcinogen (μg/L)	Risk-based indoor exposure groundwater conc., (μg/L)	Pure component water solubility, S (μg/L)	Final indoor exposure groundwater conc., (μg/L)
NA	NA	NA	8.80E+06	NA

INCREMENTAL RISK CALCULATIONS:

Incremental risk from vapor intrusion to indoor air, carcinogen (unitless)	Hazard quotient from vapor intrusion to indoor air, noncarcinogen (unitless)
2.1E-07	1.3E-03

MESSAGE AND ERROR SUMMARY BELOW: (DO NOT USE RESULTS IF ERRORS ARE PRESENT)

SCROLL DOWN TO "END"

END

APPENDIX C
UPDATED RISK REDUCTION STANDARD CALCULATIONS

Table C-1
Summary of Soil RRS

PARAMETER	Type 1 RRS mg/kg	Type 2 RRS DAF of 1 mg/kg	Type 3 RRS Surface mg/kg	Type 3 RRS Subsurface mg/kg	Type 4 RRS IW DAF of 1 mg/kg
Volatile Organic Compounds (VOCs)					
1,1,1-Trichloroethane	2.0E+01	9.3E-01	2.0E+01	2.0E+01	4.7E+00
1,1,2,2-Tetrachloroethane	1.3E-01	1.7E-03	1.3E-01	1.3E-01	5.6E-03
1,1,2-Trichloroethane	5.0E-01	1.6E-03	5.0E-01	5.0E-01	1.6E-03
1,1-Dichloroethene	7.0E-01	3.7E-02	7.0E-01	7.0E-01	1.9E-01
1,2-Dichloroethane	5.0E-01	1.4E-03	5.0E-01	5.0E-01	1.4E-03
cis-1,2-Dichloroethene	7.0E+00	2.1E-02	7.0E+00	7.0E+00	6.0E-02
Trichloroethene	5.0E-01	1.8E-03	5.0E-01	5.0E-01	1.9E-03
Vinyl chloride (lifetime)	2.0E-01	6.8E-04	2.0E-01	2.0E-01	6.8E-04

UPDATED/DATE: LMS 7/22/11
CHECKED/DATE: LWC 10/14/11

Table C-2
Toxicity Values

PARAMETER	Chronic Reference Dose Oral (RfDo) (mg/kg/day)	Chronic Reference Dose Inhalation (RfDi) (mg/kg/day)	Cancer Slope Factor Oral (SFo) (mg/kg/day)-1	Cancer Slope Factor Inhalation (SFi) (mg/kg/day)-1	Weight of Evidence	Source for Chronic RfDs and SFs
Volatile Organic Compounds (VOCs)						
1,1,1-Trichloroethane	2.0E+00	1.4E+00	ND	ND	D	IRIS
1,1,2,2-Tetrachloroethane	2.0E-02	ND	2.0E-01	2.0E-01	C	IRIS, CALEPA
1,1,2-Trichloroethane	4.0E-03	ND	5.7E-02	5.6E-02	C	IRIS
1,1-Dichloroethene	5.0E-02	5.7E-02	ND	ND	C	IRIS
1,2-Dichloroethane	2.0E-02	6.9E-01	9.1E-02	9.1E-02	B2	IRIS, PPRTV, ATSDR
Cis-1,2-Dichloroethene	2.0E-03	ND	ND	ND	NA	IRIS
Trichloroethene	5.0E-04	5.7E-04	5.0E-02	1.4E-02	A	IRIS
Vinyl chloride (lifetime)	3.0E-03	2.9E-02	1.5E+00	3.1E-02	A	IRIS

SOURCES: IRIS and EPA Regional Screening Level Table, June 2011.
IRIS Integrated Risk Information System
PPRTV Provisional Peer Reviewed Toxicity Values
CALEPA California Environmental Protection Agency
ND No Data
NA Not Available

UPDATED/DATE: LMS 7/22/11
CHECKED/DATE: LWC 10/14/11

Table C-3
Type 1 through Type 4 Ground Water RRS, mg/L

Parameter	Chronic Reference Dose Oral (mg/kg/day)	Chronic Reference Dose Inhalation (mg/kg/day)	Cancer Slope Factor Oral (mg/kg/day)-1	Cancer Slope Factor Inhalation (mg/kg/day)-1	Source for Chronic Rfds and CSFs	Volatile? (a)	Type 1/ Type 3 (mg/L)	Type 2 Standard (mg/L) Adult Noncarcinogenic	Type 2 Standard (mg/L) Adult Carcinogenic	Type 2 Standard (mg/L) Child Noncarcinogenic	Type 2 Standard (mg/L) Child Carcinogenic	Type 2 Overall	Type 4 (mg/L) Industrial Worker Noncarcinogenic	Type 4 (mg/L) Industrial Worker Carcinogenic	Type 4 Overall IW
Volatile Organic Compounds (VOCs)															
1,1,1-Trichloroethane	2.0E+00	1.4E+00	ND	ND	IRIS	v	2.0E-01	9.0E+00	ND	2.7E+00	ND	2.7E+00	1.3E+01	ND	1.3E+01
1,1,2,2-Tetrachloroethane	2.0E-02	ND	2.0E-01	2.0E-01	IRIS, CALEPA	v	1.0E-03 DL	7.3E-01	4.3E-03	3.1E-01	9.1E-03	4.3E-03	2.0E+00	1.4E-02	1.4E-02
1,1,2-Trichloroethane	4.0E-03	ND	5.7E-02	5.6E-02	IRIS	v	5.0E-03	1.5E-01	2.5E-03	6.3E-02	3.8E-03	2.5E-03	4.1E-01	4.6E-03	4.6E-03
1,1-Dichloroethene	5.0E-02	5.7E-02	ND	ND	IRIS	v	7.0E-03	3.4E-01	ND	1.0E-01	ND	1.0E-01	5.2E-01	ND	5.2E-01
1,2-Dichloroethane	2.0E-02	6.9E-01	9.1E-02	9.1E-02	IRIS, PPRTV, ATSDR	v	5.0E-03	6.4E-01	1.6E-03	2.6E-01	2.4E-03	1.6E-03	1.6E+00	2.9E-03	2.9E-03
Cis-1,2-Dichloroethene	2.0E-03	ND	ND	ND	IRIS	v	7.0E-02	7.3E-02	ND	3.1E-02	ND	3.1E-02	2.0E-01	ND	2.0E-01
Trichloroethene	5.0E-04	5.7E-04	5.0E-02	1.4E-02	IRIS	v	5.0E-03	3.4E-03	7.1E-03	1.0E-03	1.2E-02	1.0E-03	5.2E-03	1.5E-02	5.2E-03
Vinyl chloride (lifetime)	3.0E-03	2.9E-02	1.5E+00	3.1E-02	IRIS	v	2.0E-03	7.2E-02	5.1E-04	2.6E-02	1.1E-03	5.1E-04	1.5E-01	1.6E-03	1.6E-03

IRIS Integrated Risk Information System
PPRTV - Provisional Peer Reviewed Toxicity Values, USEPA.
Cal EPA - California Environmental Protection Agency
ND Toxicity values not available
DL Detection limit
v - Potentially volatile

Equation 2 (Noncarcinogens):

$$C = \frac{THI \times BW \times AT \times 365 days/year}{EF \times ED \times [(1/RfDi \times K \times IRa) + (1/RfDo \times IRw)]}$$

Equation 1 (Carcinogens):

$$C = \frac{TR \times BW \times AT \times 365 days/year}{EF \times ED \times [(SFi \times K \times IRa) + (SFo \times IRw)]}$$

Where:	Type 2 Adult	Type 2 Parameters Chil]d	Type 4 Industrial Worker Parameters
THI = Target Hazard Index =	1	1	1
BW = Body Weight =	70 kg	15 kg	70 kg
AT = Averaging Time =	30 years (noncarc.); 70 (carcinogen	6 years (noncarc.); 70 (carcinogens)	25 years for noncarc; 70 years for c
EF = Exposure Frequency =	350 days/year	350 days/year	250 day/year
ED = Exposure Duration =	30 years	6 years	25 year
RfDi = Inhalation Reference Dose =	Chemical Specific	Chemical Specific	Chemical Specific
K = Volatilization Factor = 0.0005 x 1000 L/m3 =	0.5 L/m3	0.5 L/m3	0.5 L/m3
IRa = Inhalation Rate for Air =	20 m3/day	15 m3/day	20 m3/day
RfDo = Oral Reference Dose =	Chemical Specific	Chemical Specific	Chemical Specific
IRw = Ingestion Rate for Water =	2 L/day	1 L/day	1 L/day
TR = Target Risk =	0.00001	0.00001	0.00001
SFo = Oral Cancer Slope Factor =	Chemical Specific	Chemical Specific	Chemical Specific
SFi = Inhalation Cancer Slope Factor =	Chemical Specific	Chemical Specific	Chemical Specific

UPDATED/DATE: LMS 7/22/11
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Table C-4
Type 1 and Type 3 Soil RRS, mg/kg

PARAMETER	**Volatilization Factor (m^3/kg)**	**HSRA Type I Soil Criteria (mg/kg) (a)**	**HSRA Appendix I Value (mg/kg) (b)**	**Type I Groundwater RRS (mg/L) (c)**	**Type 1 GW RRS x 100 (mg/kg)**	**Number 1 (mg/kg) (d)**	**Risk-Based Residential Type 1 Noncarcinogenic (mg/kg) (e)**	**Carcinogenic (mg/kg) (f)**	**Risk-Based Soil Type 1 RRS (mg/kg) (g)**	**Overall Type 1 RRS (mg/kg) (h)**	**Risk-Based Nonresidential Type 3 Noncarcinogenic (mg/kg) (e)**	**Carcinogenic (mg/kg) (f)**	**Risk-Based Soil Type 3 RRS (mg/kg) (g)**	**Subsurface Soil Type 3 RRS (mg/kg) (i)**	**Surface Soil Type 3 RRS (mg/kg) (j)**
Volatile Organic Compounds (VOCs)															
1,1,1-Trichloroethane	1.6E+03	ND	5.4E+00	2.0E-01	2.0E+01	2.0E+01	1.0E+04	ND	1.0E+04	2.0E+01	1.1E+04	ND	1.1E+04	2.0E+01	2.0E+01
1,1,2,2-Tetrachloroethane	1.9E+04	ND	1.3E-01	1.0E-03 RL	1.0E-01	1.3E-01	1.3E+04	7.5E+01	7.5E+01	1.3E-01	4.1E+04	2.9E+03	2.9E+03	1.3E-01	1.3E-01
1,1,2-Trichloroethane	8.8E+03	ND	5.0E-01	5.0E-03	5.0E-01	5.0E-01	2.6E+03	1.7E+02	1.7E+02	5.0E-01	8.2E+03	2.2E+02	2.2E+02	5.0E-01	5.0E-01
1,1-Dichloroethene	8.7E+02	ND	3.6E-01	7.0E-03	7.0E-01	7.0E-01	2.4E+02	ND	2.4E+02	7.0E-01	2.5E+02	ND	2.5E+02	7.0E-01	7.0E-01
1,2-Dichloroethane	5.2E+03	ND	2.0E-02	5.0E-03	5.0E-01	5.0E-01	7.4E+03	6.3E+00	6.3E+00	5.0E-01	1.3E+04	8.1E+00	8.1E+00	5.0E-01	5.0E-01
cis-1,2-Dichloroethene	2.7E+03	ND	5.3E-01	7.0E-02	7.0E+00	7.0E+00	1.3E+03	ND	1.3E+03	7.0E+00	4.1E+03	ND	4.1E+03	7.0E+00	7.0E+00
Trichloroethene	2.4E+03	ND	1.3E-01	5.0E-03	5.0E-01	5.0E-01	6.6E+00	1.9E+01	6.6E+00	5.0E-01	7.1E+00	2.4E+01	7.1E+00	5.0E-01	5.0E-01
Vinyl chloride (lifetime)	5.8E+02	ND	4.0E-02	2.0E-03	2.0E-01	2.0E-01	7.8E+01	1.7E+00	1.7E+00	2.0E-01	8.4E+01	2.5E+00	2.5E+00	2.0E-01	2.0E-01

Notes:

(a) Table 2, Appendix III of HSRA regulations
(b) Appendix I of HSRA regulations. Value is the soil concentration that triggers notification requirements.
(c) Table 1, Appendix III of HSRA regulations. For those substances not listed, reporting limit used as the Type I groundwater RRS.
(d) Value is the highest of the Appendix I value and the groundwater RRS x 100.

(e)
$$\frac{\text{THI x BW x ATn x 365days/year}}{\text{EF x ED x [(1/RfDi x (1/VF + 1/PEF) x InhR) + (1/RfDo x Irs x CF)]}}$$

(f)
$$\frac{\text{TR x BW x ATc x 365days/year}}{\text{EF x ED x [(SFi x (1/VF + 1/PEF) x InhR) + (SFo x Irs x CF)]}}$$

(g) Minimum of noncarcinogenic and carcinogenic concentrations.
(h) Minimum concentration of Number 1 and Type 1 RRS.
(i) Maximum concentration of Number 1 and HSRA Type 1 Soil Criteria.
(j) Minimum concentration of the risk-based soil Type 3 RRS and the subsurface soil Type 3 RRS.
RL Reporting Limit
RRS Risk Reduction Standard
GW Groundwater
ND Not Determined - Can not be calculated

Exposure Parameters	**Residential Type 1**	**Nonresidential Type 3**	**Unit**
Total Hazard Index (THI)	1	1	unitless
Target Risk (TR)	1.E-05	1.E-05	unitless
Target Risk (TR) WOE - C	1.E-04	1.E-04	
Body Weight (BW)	70	70	kg
Averaging Time, Carcinogen (ATc)	70	70	yrs
Averaging Time, Noncarcinogen (ATn)	30	25	yrs
Exposure Duration (ED)	30	25	yrs
Exposure Frequency (EF)	350	250	days/yr
Soil Ingestion Rate (IRs)	114	50	mg/day
Air Inhalation Rate (InhR)	15	20	m^3/day
Particulate Emission Factor (PEF)	4.63E+09	4.63E+09	m^3/kg
Conversion Factor (CF)	1.E-06	1.E-06	kg/mg
Volatilization Factor (VF)	Chemical-specific	:hemical-specific	m^3/kg

UPDATED/DATE: LMS 7/22/11
CHECKED/DATE: LWC 10/14/11

Table C-5
Soil to Ground water Leachability

	K_d (L/kg) (1)	K_{oc} (L/kg) (2)	Source	$Ø_w$	Øa	H' (unitless)	$Øw+Øa*H'/Þ_b$	Groundwater Type 1/3 RRS (C_w, mg/L)	C_w*1	Pathway Type 1/3 C_s (mg/kg)	Groundwater Type 2 RRS (C_w, mg/L)	C_w*1	Pathway Type 2 C_s (mg/kg)	Residential Soil Leaching Criteria (3)	Industrial Worker Groundwater Type 4 RRS (C_w, mg/L)	C_w*1	Pathway Type 4 C_s (mg/kg)	Industrial Worker Soil Leaching Criteria (4)
	foc=0.002																	
Volatile Organic Compounds (VOCs)																		
1,1,1-Trichloroethane	8.8E-02	4.4E+01	RSL	3.0E-01	1.3E-01	7.0E-01	2.6E-01	2.0E-01	2.0E-01	7.0E-02	2.7E+00	2.7E+00	9.3E-01	9.3E-01	1.3E+01	1.3E+01	4.7E+00	4.7E+00
1,1,2,2-Tetrachloroethane	1.9E-01	9.5E+01	RSL	3.0E-01	1.3E-01	1.5E-02	2.0E-01	1.0E-03	1.0E-03	3.9E-04	4.3E-03	4.3E-03	1.7E-03	1.7E-03	1.4E-02	1.4E-02	5.6E-03	5.6E-03
1,1,2-Trichloroethane	1.2E-01	6.1E+01	RSL	3.0E-01	1.3E-01	3.4E-02	2.0E-01	5.0E-03	5.0E-03	1.6E-03	2.5E-03	2.5E-03	8.2E-04	1.6E-03	4.6E-03	4.6E-03	1.5E-03	1.6E-03
1,1-Dichloroethene	6.4E-02	3.2E+01	RSL	3.0E-01	1.3E-01	1.1E+00	3.0E-01	7.0E-03	7.0E-03	2.5E-03	1.0E-01	1.0E-01	3.7E-02	3.7E-02	5.2E-01	5.2E-01	1.9E-01	1.9E-01
1,2-Dichloroethane	7.9E-02	4.0E+01	RSL	3.0E-01	1.3E-01	4.8E-02	2.0E-01	5.0E-03	5.0E-03	1.4E-03	1.6E-03	1.6E-03	4.4E-04	1.4E-03	2.9E-03	2.9E-03	8.1E-04	1.4E-03
Cis-1,2-Dichloroethene	7.9E-02	4.0E+01	RSL	3.0E-01	1.3E-01	1.7E-01	2.1E-01	7.0E-02	7.0E-02	2.1E-02	3.1E-02	3.1E-02	9.2E-03	2.1E-02	2.0E-01	2.0E-01	6.0E-02	6.0E-02
Trichloroethene	1.2E-01	6.1E+01	RSL	3.0E-01	1.3E-01	4.0E-01	2.3E-01	5.0E-03	5.0E-03	1.8E-03	1.0E-03	1.0E-03	3.7E-04	1.8E-03	5.2E-03	5.2E-03	1.9E-03	1.9E-03
Vinyl chloride (lifetime)	4.3E-02	2.2E+01	RSL	3.0E-01	1.3E-01	1.1E+00	3.0E-01	2.0E-03	2.0E-03	6.8E-04	5.1E-04	5.1E-04	1.7E-04	6.8E-04	1.6E-03	1.6E-03	5.4E-04	6.8E-04

NA Not Available
ND No Data Available
RSL EPA Regional Screening Level
HSDB Toxnet Hazardous Substances Data Base
1. Kd values taken from USEPA Regional Screening Table User's Guide.
2. Koc values taken from the EPA RSL Chemical-specific Parameters Supporting Table May 2010 unless otherwise noted. $K_d = K_{oc} * f_{oc}$ where f_{oc} equals 0.00143 {Site Specific}.
3. Residential leaching value is the higher of the values based on the Type 1 and Type 2 groundwater RRS.
4. Non-residential leaching value is the higher of the values based on Type 3 and Type 4 groundwater RRS.

$Ø_w$ Water-filled soil porosity = 0.3 (L/L)
$Ø_a$ Air-filled soil porosity = 0.13 (L/L)
H' Dimensionless Henry Law Constant (HLC x 41) (unitless)
Þb Dry soil bulk density = 1.5 kg/L
RRS Risk Reduction Standard
C_w Target Leachate Concentration (mg/L)
C_s Screening Level in soil (mg/kg)

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Table C-6
Type 2 Soil RRS, mg/kg

PARAMETER	**Volatilization Factor (m^3/kg)**	**Residential Leaching DAF=1 (mg/kg)**	**Risk-Based Residential Child Noncarcinogenic (mg/kg) (a)**	**Risk-Based Residential Child Carcinogenic (mg/kg) (b)**	**Risk-Based Residential Adult Noncarcinogenic (mg/kg) (a)**	**Risk-Based Residential Adult Carcinogenic (mg/kg) (b)**	**Risk-Based Soil Type 2 RRS (mg/kg) (c)**	**Overall Type 2 RRS DAF=1 (mg/kg) (d)**
Volatile Organic Compounds (VOCs)								
1,1,1-Trichloroethane	1.6E+03	9.3E-01	2.2E+03	ND	7.9E+03	ND	2.2E+03	9.3E-01
1,1,2,2-Tetrachloroethane	1.9E+04	1.7E-03	1.6E+03	4.6E+01	1.5E+04	8.5E+01	4.6E+01	1.7E-03
1,1,2-Trichloroethane	8.8E+03	1.6E-03	3.1E+02	1.7E+01	2.9E+03	1.3E+01	1.3E+01	1.6E-03
1,1-Dichloroethene	8.7E+02	3.7E-02	5.1E+01	ND	1.8E+02	ND	5.1E+01	3.7E-02
1,2-Dichloroethane	5.2E+03	1.4E-03	1.1E+03	6.5E+00	6.9E+03	4.8E+00	4.8E+00	1.4E-03
cis-1,2-Dichloroethene	2.7E+03	2.1E-02	1.6E+02	ND	1.5E+03	ND	1.6E+02	2.1E-02
Trichloroethene	2.4E+03	1.8E-03	1.4E+00	1.9E+01	5.0E+00	1.4E+01	1.4E+00	1.8E-03
Vinyl chloride (lifetime)	5.8E+02	6.8E-04	1.6E+01	1.6E+00	5.9E+01	1.4E+00	1.4E+00	6.8E-04

Notes:

RRS Risk Reduction Standard
ND Not Determined - Can not be calculated

(a) $$\frac{\text{THI x BW x ATn x 365days/year}}{\text{EF x ED x [(1/RfDi x (1/VF + 1/PEF) x InhR) + (1/RfDo x Irs x CF)]}}$$

(b) $$\frac{\text{TR x BW x ATc x 365days/year}}{\text{EF x ED x [(SFi x (1/VF + 1/PEF) x InhR) + (SFo x Irs x CF)]}}$$

(c) Minimum of noncarcinogenic and carcinogenic concentrations.
(d) Minimum concentration of Leaching Value and Risk-based Value.

Exposure Parameters	**Residential Child Type 2**	**Residential Adult Type 2**
Total Hazard Index (THI)	1	1
Target Risk (TR)	1.E-05	1.E-05
Body Weight (BW)	15	70
Averaging Time, Carcinogen (ATc)	70	70
Averaging Time, Noncarcinogen (ATn)	6	30
Exposure Duration (ED)	6	30
Exposure Frequency (EF)	350	350
Soil Ingestion Rate (IRs)	200	100
Air Inhalation Rate (InhR)	15	20
Particulate Emission Factor (PEF)	4.63E+09	4.63E+09
Conversion Factor (CF)	1.E-06	1.E-06
Volatilization Factor (VF)	Chemical-specific	Chemical-specific

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Table C-7
Type 4 Soil RRS, mg/kg
Default Industrial Worker

PARAMETER	**Volatilization Factor (m^3/kg)**	**Nonresidential Leaching Leaching DAF=1 (mg/kg)**	**Risk-Based Industrial Worker Noncarcinogenic (mg/kg) (a)**	**Risk-Based Industrial Worker Carcinogenic (mg/kg) (b)**	**Risk-Based Soil IW Type 4 RRS (mg/kg) (c)**	**Overall IW Type 4 RRS DAF=1 (mg/kg) (d)**
Volatile Organic Compounds (VOCs)						
1,1,1-Trichloroethane	1.6E+03	4.7E+00	1.1E+04	ND	1.1E+04	4.7E+00
1,1,2,2-Tetrachloroethane	1.9E+04	5.6E-03	4.1E+04	2.9E+02	2.9E+02	5.6E-03
1,1,2-Trichloroethane	8.8E+03	1.6E-03	8.2E+03	2.2E+01	2.2E+01	1.6E-03
1,1-Dichloroethene	8.7E+02	1.9E-01	2.5E+02	ND	2.5E+02	1.9E-01
1,2-Dichloroethane	5.2E+03	1.4E-03	1.3E+04	8.1E+00	8.1E+00	1.4E-03
cis-1,2-Dichloroethene	2.7E+03	6.0E-02	4.1E+03	ND	4.1E+03	6.0E-02
Trichloroethene	2.4E+03	1.9E-03	7.1E+00	2.4E+01	7.1E+00	1.9E-03
Vinyl chloride (lifetime)	5.8E+02	6.8E-04	8.4E+01	2.5E+00	2.5E+00	6.8E-04

Notes:

RRS Risk Reduction Standard

ND Not Determined - Can not be calculated

(a) $\frac{\text{THI x BW x ATn x 365days/year}}{\text{EF x ED x [(1/RfDi x (1/VF + 1/PEF) x InhR) + (1/RfDo x Irs x CF)]}}$

(b) $\frac{\text{TR x BW x ATc x 365days/year}}{\text{EF x ED x [(SFi x (1/VF + 1/PEF) x InhR) + (SFo x Irs x CF)]}}$

(c) Minimum of noncarcinogenic and carcinogenic concentrations.

(d) Minimum concentration of Leaching Value and Risk-based Value.

Exposure Parameters	**Industrial Worker Type 4**	**Unit**
Total Hazard Index (THI)	1	unitless
Target Risk (TR)	1.E-05	unitless
Body Weight (BW)	70	kg
Averaging Time, Carcinogen (ATc)	70	yrs
Averaging Time, Noncarcinogen (ATn)	25	yrs
Exposure Duration (ED)	25	yrs
Exposure Frequency (EF)	250	days/yr
Soil Ingestion Rate (IRs)	50	mg/day
Air Inhalation Rate (InhR)	20	m3/day
Particulate Emission Factor (PEF)	4.63E+09	m3/kg
Conversion Factor (CF)	1.E-06	kg/mg
Volatilization Factor (VF)	Chemical-specific	m3/kg

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