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June 26, 2015

Mr. Jonathan Callura
Environmental Protection Division – Land Protection Branch
2 Martin Luther King Jr. Dr. Suite 1054
Atlanta, GA 30334

Re: ***BIOCHLOR Model Revisions Based on EPD's April 23, 2015 Comment Letter***
Color Spectrum, HSI Site No. 10831
29 Probasco Street
LaFayette, GA 30728

Dear Mr. Callura:

EPS is submitting this letter on behalf of CSI Realty, LLC for the above-referenced site in response to the Georgia Environmental Protections Division's (EPD's) April 23, 2015 letter, which provided comments on the November 2014 Voluntary Remediation Program Compliance Status Report (CSR). This letter only addresses EPD's comments to the BIOCHLOR Model (Comments 2 through 8 in the April 23, 2014 letter), with the expectation that the model inputs, presentation, and results can be agreed to prior to issuing a Revised CSR. Each of the comments in the April 23, 2014 letter will be addressed with the Revised CSR submittal.

EPD's comments are stated below followed by a response. The comment numbers reflect those from the April 23, 2015 letter.

BIOCHLOR Model Comments and Responses

Comment 2 *The Model Development and Calibration for flow path A discussion states that groundwater concentrations obtained from soil borings SB-22 and SB-23 are considered to be in the zero distance area along with monitoring wells MW-8, MW-10, and MW-11. There is a similar discussion for flow path B. It is not clear from Table A which monitoring wells and concentrations were used for the model for either flow path. Please provide an input table like Table A for each model run. The table should clearly state the monitoring well, the distance of the well from the source, and the concentration being inputted to the model. Justification of the use of model defaults and assumptions should be provided.*

Response: The Model Development and Calibration section has been revised to use only PCE concentrations from permanent monitoring wells. Specifically, the section now states that MW-10 is considered to be the source area (i.e., zero distance). Tables 1 and 2 are included with the BIOCHLOR Model attachment and include the monitoring wells, the distance to the wells from the source, and the input concentrations for the wells for Flow Path A and B, respectively. The source concentration selected was based on model calibration to create a model that best fits the historical groundwater data and does not necessarily reflect groundwater concentrations obtained from any specific wells or soil borings.

Comment 3 *The BIOCHLOR model provides three options for calculating alpha x (the longitudinal distribution of the plume). EPD understands that option 3 was chosen and that an estimated plume length (L) of 85 feet was used in the calculations. Please provide an explanation of how L was determined. Also, state if the plume length is estimated to be the same for both flow paths. Providing figures that depict these parameters would be useful.*

Response: The plume length was determined based on the historical concentrations in down-gradient monitoring wells in each flow path. The plume length is estimated to be 85 feet for both flow paths. Figure A, included in the attachment, shows the location of these monitoring wells and the estimated plume lengths.

Comment 4 *Please correct the modeled plume width and length to more closely reflect conditions at the site, and include a map showing the modeled area. Per the BIOCHLOR User's Manual Version 1.0, the modeled area length is the distance from the source to the receptor, which in this case is the stream. The modeled area width should be larger than the plume width in order to capture all of the mass that could potentially discharge into the stream.*

Response: The plume dimensions along Flow Paths A and B are shown on Figure A. The plume along Flow Path A is 85 feet long and 29 feet wide. The plume along Flow Path B is 85 feet long and 44 feet wide. The modeled area length has been revised to reflect the distances to the stream along each flow path, which is 250 ft for Flow Path A and 154 ft for Flow Path B. The modeled area widths are 700 feet, which are wider than the plume widths.

Comment 5 *The source width area of 0.1 feet is not an accurate representation of site conditions. Per the BIOCHLOR User's Manual, the source area width (Y) the Domenico (1987) model assumes a vertical plane source of constant concentration. The source width is the extent of the source area perpendicular to the ground-water flow. Please provide justification for using a calibrated source width area of 0.1 feet, and submit a sensitivity analysis using varying source area widths.*

Response: The model was initially run with a variety of larger source area widths, but the results did not match actual groundwater concentrations. For example, at a source width of 10 feet, the model over-predicts concentrations at MW-13 and MW-14 are shown below.

	Actual Groundwater Concentration (µg/L)	Model Predicted Concentration with 10ft Source Width (µg /L)
MW-13 in 2013	<5 to 8.6	131
MW-14 in 2014	<0.39	50

The source width was varied to calibrate the model to the empirical data for the site. Based on EPD's comment, EPS revisited this model input and increased the source width slightly to get the best fit for the data. For Flow Path A, a revised source area width of 0.3 ft is used, and for Flow Path B a revised source area width of 0.2 ft is used.

This source area width is justified for the following reasons:

- PCE has not been detected in soil above a Type 1 Risk Reduction Standard.
- The BIOCHLOR model assumes there is a continuous source of PCE feeding the groundwater plume; however, this is not the case at this site. Therefore, the model is overly conservative for this site.

Comment 6 *Input screenshots and input parameter tables should be submitted for all model runs. In addition, output screens should include all data, not just the concentration versus distance from source plot. Source wells and wells along the plume centerline should be clearly indicated.*

Response: Input screenshots are included for all model runs in the attachment. Input parameter tables are not presented for each model run as it would be redundant with the input screenshots. Instead an overall input parameter table is provided for each flow path (Table A for Flow Path A and Table B for Flow Path B). Output screens, including all data, are also included in the attachment. Source area wells and wells along the flow path are indicated as dots on the output plots. The model does not allow for entry of the well names on the input or output screen. This information is provided on Tables A and B for each flow path.

Comment 7 *Please include figures that show reference points including flow paths A and B, point of demonstration monitoring wells, and the adjacent stream, which we consider the theoretical point of exposure.*

Response: Figure A in the attachment shows Flow Paths A and B, the point of demonstration monitoring wells, and the adjacent stream.

Comment 8 *Please correct the units for the source concentration for PCE in the Source Contribution section of Table A Input Parameters for the BIOCHLOR Model from parts per million to parts per billion.*

Response: The units have been revised accordingly.

We anticipate that the revised model and associated information will satisfy EPD's questions. If you have any further questions, please call.

Sincerely,

Justin Vickery
Associate

Attachment: Revised Section 4.3 and Appendix A (Attachments 1-6) from the November 2014 CSR

cc: Tom Watters, CSI Realty
Andrea Rimer, Troutman Sanders

Revised Section 4.3 from the November 2014 CSR

4.3 Groundwater Modeling

4.3.1 Introduction

BIOCHLOR Natural Attenuation Decision Support System (version 2.2) was used to model biodegradation of PCE at the Property. BIOCHLOR is an analytical model approved by the U.S. Environmental Protection Agency that is used to simulate the degradation of chlorinated ethenes and ethanes. It is an Excel-based program based on the Domenico analytical solute transport model. BIOCHLOR simulates advection, 3-D dispersion, linear adsorption and biotransformation via reductive dechlorination.

Under the Georgia Voluntary Remediation Program Act, Code O.C.G.A. § 12-8-100, et seq., the point of exposure is defined as the nearest of the following:

1. The closest existing downgradient drinking water supply well;
2. The likely nearest future location of a downgradient drinking water supply well where public supply water is not currently available and is not likely to be made available within the foreseeable future; or
3. The hypothetical point of drinking water exposure located at a distance of 1,000 feet downgradient from the delineated site contamination under this part.

Under these drinking water scenarios, the groundwater concentrations are compared to Risk Reduction Standards. However, the EPD has requested that the model evaluate the nearby headwater stream of the Chattooga River. In this case, the target concentration for PCE is the Georgia In-Stream Water Quality Standard (ISWQS), which is 3.3 µg/L.

4.3.2 Model Development and Calibration

The groundwater at the Property flows in two different directions (see Figure A in Attachment 1). Accordingly, two different models were developed and calibrated to simulate each of these flow directions. The highest concentrations of PCE in groundwater monitoring wells have occurred at MW-10. Thus, the zero distance area (or "initial concentrations", model variable C_o) was considered to be in the area of MW-10 flowing in two different directions. Flow path A is to the southeast and includes wells MW-10, MW-3, MW-13 and MW-14. Following flow path A, the headwater of the Chattooga River is encountered approximately 250 ft from the zero distance. Flow path B is to the north-east and includes wells MW-10, MW-7 and MW-12. Following flow path B, the headwaters of the Chattooga River is encountered approximately 154 ft from the zero distance.

The input parameters used in the model are presented in Table A for flow path A and Table B for flow path B (tables are included in Attachment 2). The advection parameters (e.g., hydraulic conductivity) were based on site-specific values. The dispersion and adsorption parameters were primarily based on default values available in the model documentation. The biotransformation decay coefficients were not used as biodegradation does not appear to be a primary factor at this Site. The model assumes that there is a continuous source since 1980 when the facility

converted to yarn twisting. The source thickness was based on the approximately thickness of the aquifer (15 ft). The source width was developed during model calibration.

The modeled C_o concentration and source width were developed during model calibration. Historical groundwater data (from 2006 through 2014) were used to adjust the C_o concentrations and source width to develop a model that best represented the conditions at the Site. The C_o concentrations were chosen primarily to model the data from 2006, when the highest concentration of PCE was observed in groundwater (0.35 mg/L). Although the source width (0.3 ft for flow path A and 0.2 ft for flow path B) may or may not accurately represent the actual size of the source, these are the values that result in models that best represent the groundwater data collected at the site.

4.3.3 PCE Results

Attachments 3 and 4 show the input screens and PCE output screens from the BIOCHLOR model for years that data were collected from 2006 through 2014 and for year 2044 (30 years after the last groundwater sampling event) for the two different flow paths (flow path A and flow path B). The squares on these charts represent analytical data collected from groundwater in that year. In year 2013 groundwater was collected quarterly, thus the high and low concentrations observed in 2013 are both shown on the chart to represent the range of concentrations observed.

These charts show that the model, although not perfect, is a good representation of conditions at the Site and can be used to predict future concentrations. The model actually over predicts concentrations especially the further downgradient from the source indicating that the model is conservative. Thus, the model will conservatively estimate the concentrations of PCE into the future.

The projected concentrations for year 2044 show that the modeled PCE concentrations at the Point of Demonstration wells (MW-12 and MW-14) will not exceed the Type 1 RRS (5 µg/L). In addition, the projected concentrations for year 2044 show that the modeled PCE concentrations at the headwaters for the Chattooga River do not exceed the ISWQS (3.3 µg/L). Therefore, in response to Comment #3 in the GA EPD's letter data March 30, 2014, the combination of the two flow paths does not cause PCE concentrations entering the stream at concentrations which exceed the ISWQS (3.3 µg/L).

4.3.4 Sensitivity Analysis

A sensitivity analysis was conducted to evaluate the influence or relative importance of key input variables and assumptions on the predicted concentrations. In the initial CSR submission, the parameters evaluated included the retardation factor, hydraulic conductivity and porosity. This analysis showed that the model was not sensitive to these parameters. A new sensitivity analysis has been conducted for source width and source concentration. This analysis was run for model year 2013. For flow path A the sensitivity analysis was conducted at two distances: 74 feet (MW-13) and 154 feet (MW-14). For flow path B the sensitivity was conducted at 139 ft (MW-12).

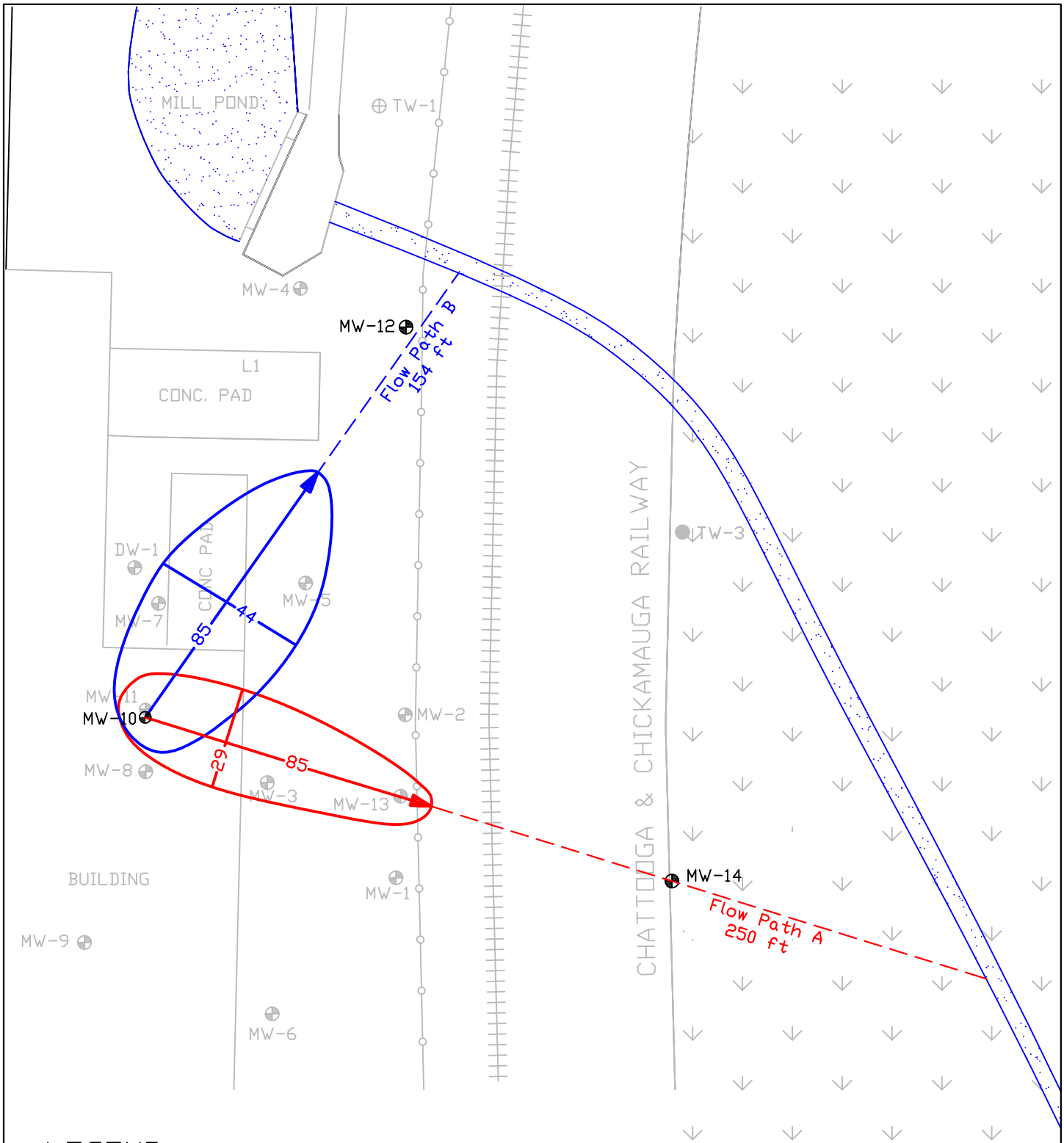
The predicted concentrations (shown in Table C) at each of these distances were determined for three different conditions for each parameter being considered: (1) baseline, (2) a value higher than baseline, and (3) a value lower than baseline. The input and output screens from the BIOCHLOR model sensitivity analysis are shown in Attachments 5 and 6 for flow paths A and B, respectively.

4.3.5 Conclusions

Comparison of the model predictions to actual groundwater results at the Site indicates that the model can be used to conservatively predict future concentrations. According to the model results for the most recent year sampled (2013) and thirty years from then (2044), the PCE concentrations at the Point of Demonstration wells (MW-12 and MW-14) do not exceed the Type 1 RRS, which infers that PCE concentrations do not exceed the Type 1 RRS at the hypothetical points of drinking water exposure located at distances of 1,000 feet along each flow path downgradient from the delineated site contamination. In addition, PCE concentrations at the stream do not exceed the ISWQS.

ATTACHMENT 1

Figure



LEGEND

- Monitoring Well Location
- 85 Plume Dimensions (ft)

0 20 40
Feet

EPS
1050 Crown Pointe Parkway
Suite 350
Atlanta, GA 30338
(404) 315-9113

DRN: JDV | DATE: June 2015

Color Spectrum
29 Probasco Street
LaFayette, GA 30728

Groundwater Plume Dimentions for BIOCHLOR Model

FIGURE
A

ATTACHMENT 2

Tables

Table A. Input Parameters for the BIOCHLOR Model - Flow Path A

Mechanism	Parameter	Value	Units	Basis
Advection	Hydraulic Conductivity	1.10E-04	cm/s	Average hydraulic conductivity presented in the 2009 Revised CSR (EPS, 2009)
	Hydraulic Gradient	0.015	ft/ft	Based on MW-10 to MW-13
	Effective Porosity	0.15	unitless	Typical value for lithological formation (EPA, 2000) and used historically for the Pro
Dispersion	Alpha X	6.2711	ft/ft	Modified Xu Eckstein (L approx 85 ft)
	Alpha Y/Alpha X	0.1	unitless	EPA model default
	Alpha Z/Alpha X	5.00E-02	unitless	EPA model default
Adsorption	Soil Bulk Density	1.7	kg/L	EPA model default
	Fraction Organic Carbon	0.001	unitless	EPA model default
	Organic Carbon Partitioning Coefficients			
	PCE	426	L/kg	EPA model default
	TCE	130	L/kg	EPA model default
	DCE	125	L/kg	EPA model default
	VC	30	L/kg	EPA model default
	Ethenes	302	L/kg	EPA model default
	Retardation Factor	2.47		Calcualted based on above values
Biotransformation	1st Order Decay Coefficients	0	1/yr	
General	Simulation Time	varies	yr	Assuming the source began in 1980
	Modeled Area Width	700	ft	Assumption
	Modeled Area Length	250	ft	Distance to stream
	Zone length	250	ft	Assuming one-zone
Source Contribution	Type	Continuous		Assumes continuous source concentrations throughout time
	Source Thickness in Saturated Zone	15	ft	Approximate thickness of aquifer
	Source Width	0.3	ft	Based on model calibration
	Source Concentrations			
	PCE	0.35	mg/L	Based on model calibration

Well Along Flow Path	Distance Downgradient of Source (ft)	Analytical Results (mg/L)					
		2006	2007	2009	2011	2013	2014
MW-10	0			0.054, 0.042	0.13, 0.12	0.12, 0.12, 0.16, 0.14, 0.15	
MW-3	39	0.0087	0.0076		0.0052		
MW-13	74					<0.005, 0.0073, 0.0086, 0.007	
MW-14	154						<0.00039

EPA,2000: BIOCHLOR Natural Attenuation Decision Support System. User's Manual Version 1.0 USEPA. January 2000
EPA,2002: BIOCHLOR Natural Attenuation Decision Support System. User's Manual Addendum. USEPA. March 2002.

Table B. Input Parameters for the BIOCHLOR Model - Flow Path B

Mechanism	Parameter	Value	Units	Basis
Advection	Hydraulic Conductivity	1.10E-04	cm/s	Average hydraulic conductivity presented in the 2009 Revised CSR (EPS, 2009)
	Hydraulic Gradient	0.02	ft/ft	Based on MW-7 to MW-12
	Effective Porosity	0.15	unitless	Typical value for lithological formation (EPA, 2000) and used historically for the Property
Dispersion	Alpha X	6.2711	ft/ft	Modified Xu Eckstein (L approx 85 ft)
	Alpha Y/Alpha X	0.1	unitless	EPA model default
	Alpha Z/Alpha X	5.00E-02	unitless	EPA model default
Adsorption	Soil Bulk Density	1.7	kg/L	EPA model default
	Fraction Organic Carbon	0.001	unitless	EPA model default
	Organic Carbon Partitioning Coefficients			
	PCE	426	L/kg	EPA model default
	TCE	130	L/kg	EPA model default
	DCE	125	L/kg	EPA model default
	VC	30	L/kg	EPA model default
	Ethenes	302	L/kg	EPA model default
	Retardation Factor	2.47		Calcualted based on above values
Biotransformation	1st Order Decay Coefficients	0	1/yr	
General	Simulation Time	varies	yr	Assuming the source began in 1980
	Modeled Area Width	700	ft	Assumption
	Modeled Area Length	154	ft	Distance to stream
	Zone length	154	ft	Assuming one-zone
Source Contribution	Type	Continuous		Assumes continuous source concentrations throughout time
	Source Thickness in Saturated Zone	15	ft	Approximate thickness of aquifer
	Source Width	0.2	ft	Based on model calibration
	Source Concentrations			
	PCE	0.35	mg/L	Based on model calibration

		Analytical Results (mg/L)			
Well Along Flow Path	Distance Downgradient of Source (ft)	2007	2009	2011	2013
MW-10	0		0.054, 0.042	0.13, 0.12	0.12, 0.12, 0.16, 0.14, 0.15
MW-7	32	<0.005		0.0086	
MW-12	139				<0.00047, <0.00047, <0.00047, <0.00047

EPA,2000: BIOCHLOR Natural Attenuation Decision Support System. User's Manual Version 1.0 USEPA. January 2000
EPA,2002: BIOCHLOR Natural Attenuation Decision Support System. User's Manual Addendum. USEPA. March 2002.

Table C. Sensitivity Analysis (Year 2013)

Source Width

	PCE Concentrations (mg/L)				
	Actual Concentration	**w=0.01**	**w=0.3 (Baseline)**	**w=1**	**w=5**
Flow Path A at MW-13 (74 ft)	<0.005, 0.007, 0.0073, 0.0086	0	0.004	0.014	0.068
Flow Path A at MW-14 (154 ft)	<0.00039	0	0.002	0.005	0.025
Flow Path B at MW-12 (139 ft)	<0.00047, <0.00047, <0.00047, <0.00047	0	0.002	0.0085	0.043

Source Concentration

	PCE Concentration (mg/L)			
	Actual Concentration	**C=0.1**	**C=0.35 (Baseline)**	**C=0.75**
Flow Path A at MW-13 (74 ft)	<0.005, 0.007, 0.0073, 0.0086	0.001	0.004	0.009
Flow Path A at MW-14 (154 ft)	<0.00039	0	0.002	0.0025
Flow Path B at MW-12 (139 ft)	<0.00047, <0.00047, <0.00047, <0.00047	0	0.002	0.004

EPS

ATTACHMENT 3

BIOCHLOR Model

Input/Output Screens

Flow Path A

BIOCHLOR Natural Attenuation Decision Support System

Version 2.2
Excel 2000

Color Spectrum
Flow Path A - 2006
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

TYPE OF CHLORINATED SOLVENT: Ethenes ◉ Ethanes ○

1. ADVECTION

Seepage Velocity*	Vs	11.4	(ft/yr)
or			
Hydraulic Conductivity	K	1.1E-04	(cm/sec)
Hydraulic Gradient	i	0.015	(ft/ft)
Effective Porosity	n	0.15	(-)

2. DISPERSION

Alpha x*	6.2711	(ft)
(Alpha y) / (Alpha x)*	0.1	(-)
(Alpha z) / (Alpha x)*	5.E-02	(-)

Calc.

3. ADSORPTION

Retardation Factor* → R
or

Soil Bulk Density, rho	1.7	(kg/L)		
FractionOrganicCarbon, foc	1.0E-3	(-)		
Partition Coefficient	Koc			
PCE	426	(L/kg)	5.83	(-)
TCE	130	(L/kg)	2.47	(-)
DCE	125	(L/kg)	2.42	(-)
VC	30	(L/kg)	1.34	(-)
ETH	302	(L/kg)	4.42	(-)
Common R (used in model)* =			**2.47**	

4. BIOTRANSFORMATION

-1st Order Decay Coefficient*

	λ (1/yr)		half-life (yrs)	Yield
Zone 1				
PCE → TCE	0.000	←		0.79
TCE → DCE	0.000	←		0.74
DCE → VC	0.000	←		0.64
VC → ETH	0.000	←		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*	26	(yr)
Modeled Area Width*	700	(ft)
Modeled Area Length*	250	(ft)
Zone 1 Length*	250	(ft)
Zone 2 Length*	0	(ft)

L, W

Zone 2=

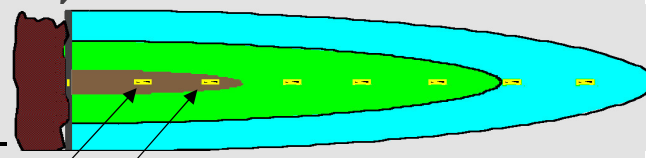
6. SOURCE DATA

TYPE: Continuous / Single Planar

Source Options

Source Thickness in Sat. Zone* 15 (ft)

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



	Y1	k_s* (1/yr)
Width* (ft)	0.3	
Conc. (mg/L)*	C1	
PCE	.35	0
TCE		0
DCE		0
VC		0
ETH		0

View of Plume Looking Down

Observed Centerline Conc. at Monitoring Wells

7. FIELD DATA FOR COMPARISON

PCE Conc. (mg/L)	.009	.008									
TCE Conc. (mg/L)											
DCE Conc. (mg/L)											
VC Conc. (mg/L)											
ETH Conc. (mg/L)											
Distance from Source (ft)	39	39									
Date Data Collected	2006										

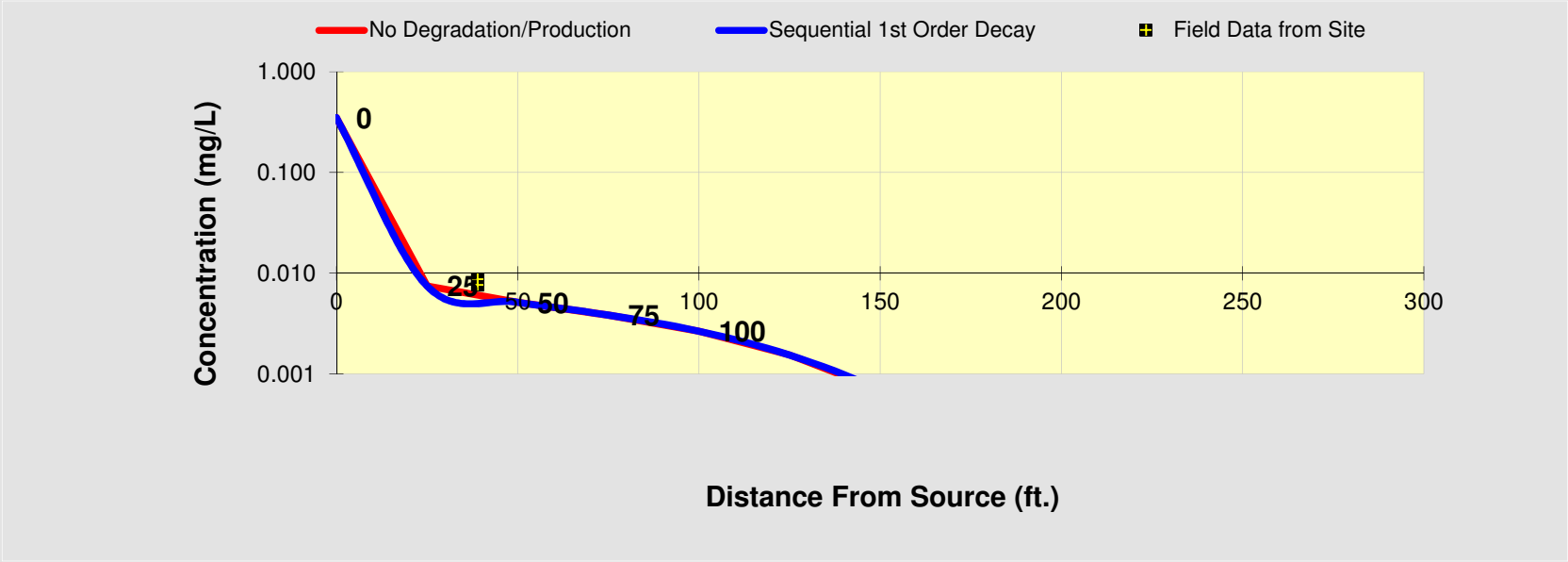
8. CHOOSE TYPE OF OUTPUT TO SEE:

RUN CENTERLINE | **RUN ARRAY**

Help | Restore | RESET
SEE OUTPUT | Paste

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

PCE	Distance from Source (ft)										
	0	25	50	75	100	125	150	175	200	225	250
No Degradation	0.350	0.007	0.005	0.004	0.003	0.002	0.001	0.000	0.000	0.000	0.000
Biotransformation	0.3500	0.007	0.005	0.004	0.003	0.002	0.001	0.000	0.000	0.000	0.000
	Monitoring Well Locations (ft)										
	39	39									
Field Data from Site	0.009	0.008									



See PCE

See TCE

See DCE

See VC

See ETH

Prepare Animation

Time:

26.0 Years

Log ⟺ Linear

Return to Input

To All

To Array

BIOCHLOR Natural Attenuation Decision Support System

Version 2.2
Excel 2000

Color Spectrum
Flow Path A - 2009
Run Name

TYPE OF CHLORINATED SOLVENT: Ethenes ◉ Ethanes ○

1. ADVECTION

Seepage Velocity*	Vs	11.4	(ft/yr)
or			
Hydraulic Conductivity	K	1.1E-04	(cm/sec)
Hydraulic Gradient	i	0.015	(ft/ft)
Effective Porosity	n	0.15	(-)

2. DISPERSION

Alpha x*	6.2711	(ft)
(Alpha y) / (Alpha x)*	0.1	(-)
(Alpha z) / (Alpha x)*	5.E-02	(-)

Calc.

3. ADSORPTION

Retardation Factor* → R

or

Soil Bulk Density, rho		1.7	(kg/L)	
FractionOrganicCarbon, foc		1.0E-3	(-)	
Partition Coefficient	Koc			
PCE	426	(L/kg)	5.83	(-)
TCE	130	(L/kg)	2.47	(-)
DCE	125	(L/kg)	2.42	(-)
VC	30	(L/kg)	1.34	(-)
ETH	302	(L/kg)	4.42	(-)
Common R (used in model)* =			**2.47**	

4. BIOTRANSFORMATION

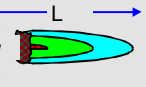
-1st Order Decay Coefficient*

	λ (1/yr)	half-life (yrs)	Yield
Zone 1			
PCE → TCE	0.000		0.79
TCE → DCE	0.000		0.74
DCE → VC	0.000		0.64
VC → ETH	0.000		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*	29	(yr)
Modeled Area Width*	700	(ft)
Modeled Area Length*	250	(ft)
Zone 1 Length*	250	(ft)
Zone 2 Length*	0	(ft)



Zone 2=

6. SOURCE DATA

TYPE: Continuous / Single Planar

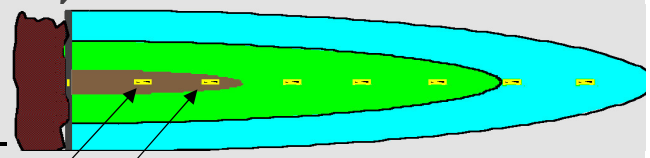
Source Options

Source Thickness in Sat. Zone* 15 (ft)

Width* (ft) Y1 = 0.3

Conc. (mg/L)*	C1	k_s* (1/yr)
PCE	.35	0
TCE		0
DCE		0
VC		0
ETH		0

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)	.005	.004									
TCE Conc. (mg/L)											
DCE Conc. (mg/L)											
VC Conc. (mg/L)											
ETH Conc. (mg/L)											
Distance from Source (ft)	0	0									
Date Data Collected	2009										

8. CHOOSE TYPE OF OUTPUT TO SEE:

RUN CENTERLINE | **RUN ARRAY**

Help | Restore | RESET

SEE OUTPUT | Paste

Data Input Instructions:

115 → 1. Enter value directly....or

↑ *or*

0.02 → 2. Calculate by filling in gray cells. Press Enter, then C

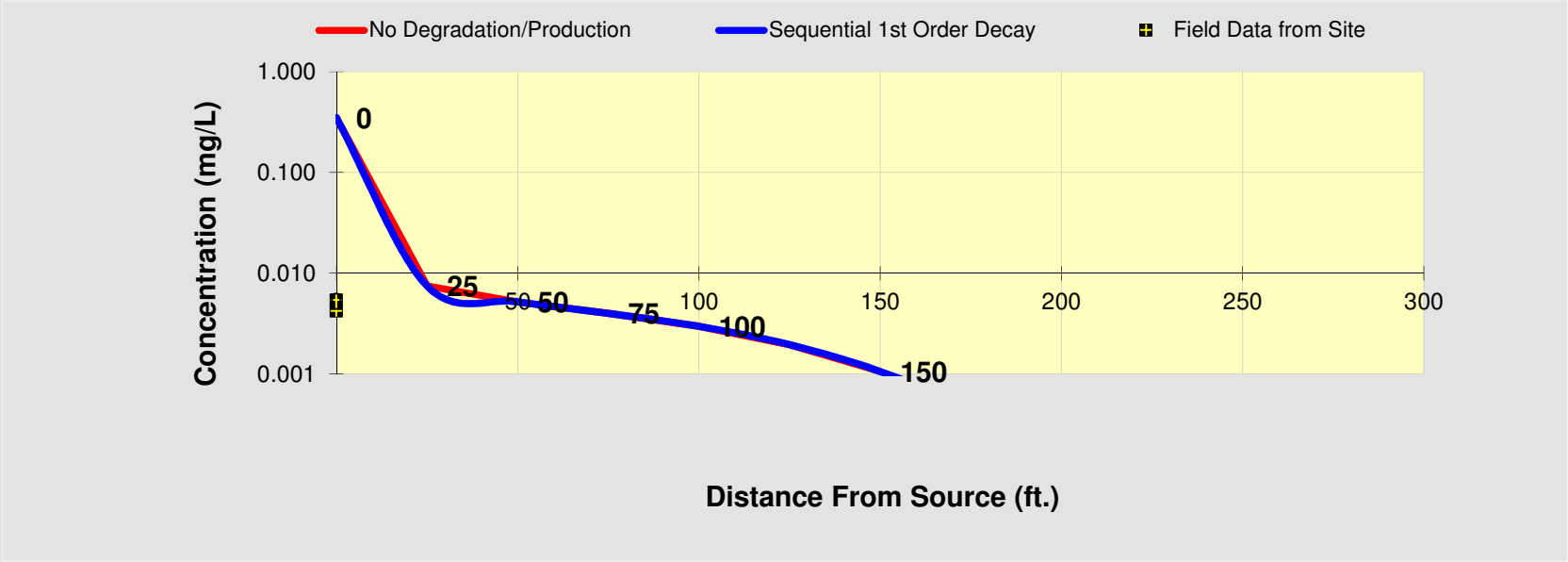
(To restore formulas, hit "Restore Formulas" button)

Variable* → Data used directly in model.

Test if Biotransformation is Occurring → Natural Attenuation

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

PCE	Distance from Source (ft)										
	0	25	50	75	100	125	150	175	200	225	250
No Degradation	0.350	0.007	0.005	0.004	0.003	0.002	0.001	0.000	0.000	0.000	0.000
Biotransformation	0.3500	0.007	0.005	0.004	0.003	0.002	0.001	0.000	0.000	0.000	0.000
	Monitoring Well Locations (ft)										
	0	0									
Field Data from Site	0.005	0.004									



See PCE

See TCE

See DCE

See VC

See ETH

Prepare Animation

Time:

29.0 Years

Log ⟺ Linear

Return to Input

To All

To Array

BIOCHLOR Natural Attenuation Decision Support System

Version 2.2
Excel 2000

Color Spectrum
Flow Path A - 2011
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

TYPE OF CHLORINATED SOLVENT: Ethenes ◉ Ethanes ○

1. ADVECTION

Seepage Velocity*	Vs	11.4	(ft/yr)
or			
Hydraulic Conductivity	K	1.1E-04	(cm/sec)
Hydraulic Gradient	i	0.015	(ft/ft)
Effective Porosity	n	0.15	(-)

2. DISPERSION

Alpha x*	6.2711	(ft)
(Alpha y) / (Alpha x)*	0.1	(-)
(Alpha z) / (Alpha x)*	5.E-02	(-)

Calc.

3. ADSORPTION

Retardation Factor* → R
or

Soil Bulk Density, rho		1.7	(kg/L)	
FractionOrganicCarbon, foc		1.0E-3	(-)	
Partition Coefficient	Koc			
PCE	426	(L/kg)	5.83	(-)
TCE	130	(L/kg)	2.47	(-)
DCE	125	(L/kg)	2.42	(-)
VC	30	(L/kg)	1.34	(-)
ETH	302	(L/kg)	4.42	(-)
Common R (used in model)* =			**2.47**	

4. BIOTRANSFORMATION

-1st Order Decay Coefficient*

	λ (1/yr)	half-life (yrs)	Yield
Zone 1			
PCE → TCE	0.000		0.79
TCE → DCE	0.000		0.74
DCE → VC	0.000		0.64
VC → ETH	0.000		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*	31	(yr)
Modeled Area Width*	700	(ft)
Modeled Area Length*	250	(ft)
Zone 1 Length*	250	(ft)
Zone 2 Length*	0	(ft)

L, W

Zone 2=

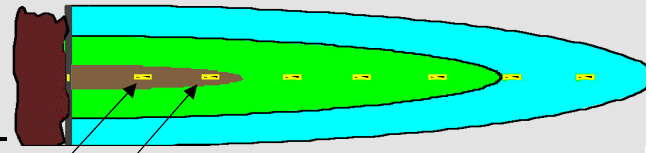
6. SOURCE DATA

TYPE: Continuous / Single Planar

Source Options

Source Thickness in Sat. Zone* 15 (ft)

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



	Y1	k_s* (1/yr)
Width* (ft)	0.3	
Conc. (mg/L)*	C1	
PCE	.35	0
TCE		0
DCE		0
VC		0
ETH		0

View of Plume Looking Down

Observed Centerline Conc. at Monitoring Wells

7. FIELD DATA FOR COMPARISON

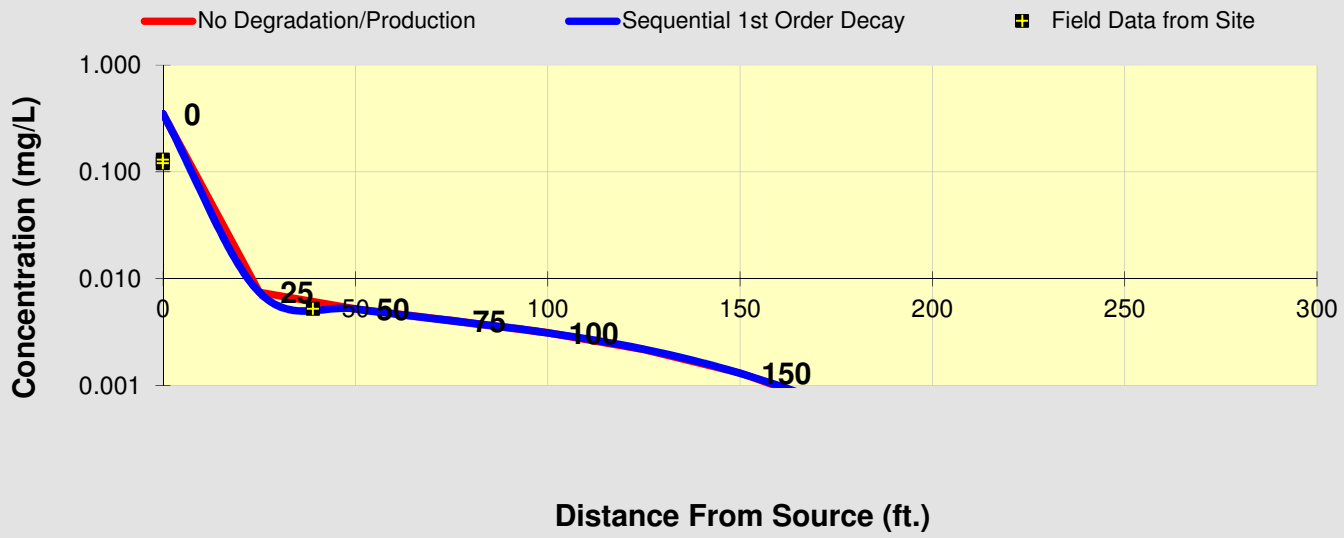
PCE Conc. (mg/L)	.13	.12	.005								
TCE Conc. (mg/L)											
DCE Conc. (mg/L)											
VC Conc. (mg/L)											
ETH Conc. (mg/L)											
Distance from Source (ft)	0	0	39								
Date Data Collected	2011										

8. CHOOSE TYPE OF OUTPUT TO SEE:

RUN CENTERLINE | **RUN ARRAY** | **Help** | Restore | RESET | ***SEE OUTPUT*** | Paste

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

PCE	Distance from Source (ft)										
	0	25	50	75	100	125	150	175	200	225	250
No Degradation	0.350	0.007	0.005	0.004	0.003	0.002	0.001	0.001	0.000	0.000	0.000
Biotransformation	0.3500	0.007	0.005	0.004	0.003	0.002	0.001	0.001	0.000	0.000	0.000
	Monitoring Well Locations (ft)										
	0	0	39								
Field Data from Site	0.130	0.120	0.005								



See PCE

See TCE

See DCE

See VC

See ETH

Prepare Animation

Time:

31.0 Years

Log ⟺ Linear

Return to Input

To All

To Array

BIOCHLOR Natural Attenuation Decision Support System

Version 2.2
Excel 2000

Color Spectrum
Flow Path A - 2013
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

TYPE OF CHLORINATED SOLVENT: Ethenes ◉ Ethanes ○

1. ADVECTION

Seepage Velocity*	Vs	11.4	(ft/yr)
or			
Hydraulic Conductivity	K	1.1E-04	(cm/sec)
Hydraulic Gradient	i	0.015	(ft/ft)
Effective Porosity	n	0.15	(-)

2. DISPERSION

Alpha x*	6.2711	(ft)
(Alpha y) / (Alpha x)*	0.1	(-)
(Alpha z) / (Alpha x)*	5.E-02	(-)

Calc.

3. ADSORPTION

Retardation Factor* → R
or

Soil Bulk Density, rho		1.7	(kg/L)	
FractionOrganicCarbon, foc		1.0E-3	(-)	
Partition Coefficient	Koc			
PCE	426	(L/kg)	5.83	(-)
TCE	130	(L/kg)	2.47	(-)
DCE	125	(L/kg)	2.42	(-)
VC	30	(L/kg)	1.34	(-)
ETH	302	(L/kg)	4.42	(-)
Common R (used in model)* =			**2.47**	

4. BIOTRANSFORMATION

-1st Order Decay Coefficient*

	λ (1/yr)	half-life (yrs)	Yield
Zone 1			
PCE → TCE	0.000		0.79
TCE → DCE	0.000		0.74
DCE → VC	0.000		0.64
VC → ETH	0.000		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*	33	(yr)
Modeled Area Width*	700	(ft)
Modeled Area Length*	250	(ft)
Zone 1 Length*	250	(ft)
Zone 2 Length*	0	(ft)

L, W

Zone 2=

6. SOURCE DATA

TYPE: Continuous / Single Planar

Source Options

Source Thickness in Sat. Zone* 15 (ft)

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

	Y1	k_s* (1/yr)
Width* (ft)	0.3	
Conc. (mg/L)*	C1	
PCE	.35	0
TCE		0
DCE		0
VC		0
ETH		0

View of Plume Looking Down

Observed Centerline Conc. at Monitoring Wells

7. FIELD DATA FOR COMPARISON

PCE Conc. (mg/L)	.12	.16	.14	.15	.005	.007	.009	.007	.001		
TCE Conc. (mg/L)											
DCE Conc. (mg/L)											
VC Conc. (mg/L)											
ETH Conc. (mg/L)											
Distance from Source (ft)	0	0	0	0	74	74	74	74	154		
Date Data Collected	2013										

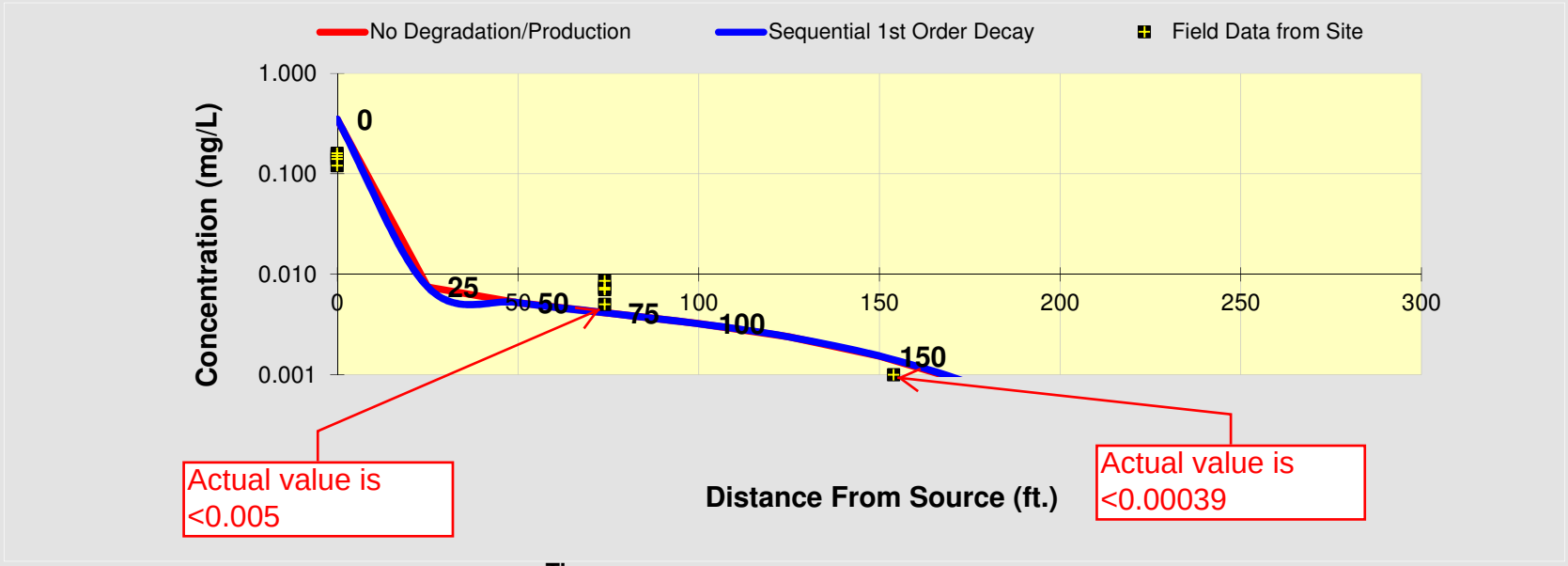
8. CHOOSE TYPE OF OUTPUT TO SEE:

RUN CENTERLINE | **RUN ARRAY**

Help | Restore | RESET
SEE OUTPUT | Paste

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

PCE	Distance from Source (ft)										
	0	25	50	75	100	125	150	175	200	225	250
No Degradation	0.350	0.007	0.005	0.004	0.003	0.002	0.002	0.001	0.000	0.000	0.000
Biotransformation	0.3500	0.007	0.005	0.004	0.003	0.002	0.002	0.001	0.000	0.000	0.000
	Monitoring Well Locations (ft)										
	0	0	0	0	74	74	74	74	154		
Field Data from Site	0.120	0.160	0.140	0.150	0.005	0.007	0.009	0.007	0.001		



See PCE | See TCE | See DCE | See VC | See ETH

Prepare Animation

Time: 33.0 Years

Log ⟺ Linear

Return to Input | To All | To Array

BIOCHLOR Natural Attenuation Decision Support System

Version 2.2
Excel 2000

Color Spectrum
Flow Path A - 2044
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

TYPE OF CHLORINATED SOLVENT: Ethenes ◉ Ethanes ○

1. ADVECTION

Seepage Velocity*	Vs	11.4	(ft/yr)
or			
Hydraulic Conductivity	K	1.1E-04	(cm/sec)
Hydraulic Gradient	i	0.015	(ft/ft)
Effective Porosity	n	0.15	(-)

2. DISPERSION

Alpha x*	6.2711	(ft)
(Alpha y) / (Alpha x)*	0.1	(-)
(Alpha z) / (Alpha x)*	5.E-02	(-)

Calc.

3. ADSORPTION

Retardation Factor* → R
or

Soil Bulk Density, rho	1.7	(kg/L)		
FractionOrganicCarbon, foc	1.0E-3	(-)		
Partition Coefficient	Koc			
PCE	426	(L/kg)	5.83	(-)
TCE	130	(L/kg)	2.47	(-)
DCE	125	(L/kg)	2.42	(-)
VC	30	(L/kg)	1.34	(-)
ETH	302	(L/kg)	4.42	(-)
Common R (used in model)* =			**2.47**	

4. BIOTRANSFORMATION

-1st Order Decay Coefficient*

	λ (1/yr)		half-life (yrs)	Yield
Zone 1				
PCE → TCE	0.000	←		0.79
TCE → DCE	0.000	←		0.74
DCE → VC	0.000	←		0.64
VC → ETH	0.000	←		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*	64	(yr)
Modeled Area Width*	700	(ft)
Modeled Area Length*	250	(ft)
Zone 1 Length*	250	(ft)
Zone 2 Length*	0	(ft)

L, W

Zone 2=

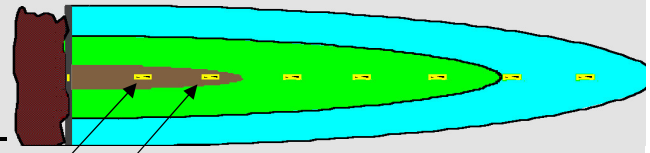
6. SOURCE DATA

TYPE: Continuous / Single Planar

Source Options

Source Thickness in Sat. Zone* 15 (ft)

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



	Y1	k_s* (1/yr)
Width* (ft)	0.3	
Conc. (mg/L)*	C1	
PCE	.35	0
TCE		0
DCE		0
VC		0
ETH		0

View of Plume Looking Down

Observed Centerline Conc. at Monitoring Wells

7. FIELD DATA FOR COMPARISON

PCE Conc. (mg/L)											
TCE Conc. (mg/L)											
DCE Conc. (mg/L)											
VC Conc. (mg/L)											
ETH Conc. (mg/L)											
Distance from Source (ft)											
Date Data Collected	2044										

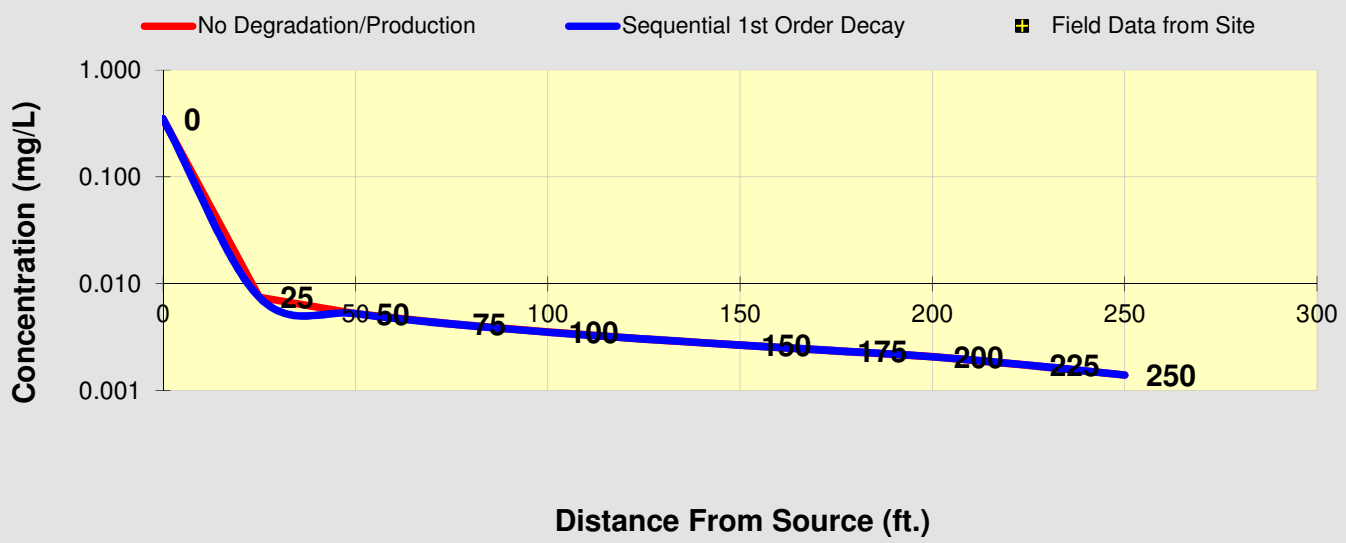
8. CHOOSE TYPE OF OUTPUT TO SEE:

RUN CENTERLINE | **RUN ARRAY**

Help | Restore | RESET
SEE OUTPUT | Paste

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

PCE	Distance from Source (ft)										
	0	25	50	75	100	125	150	175	200	225	250
No Degradation	0.350	0.007	0.005	0.004	0.004	0.003	0.003	0.002	0.002	0.002	0.001
Biotransformation	0.3500	0.007	0.005	0.004	0.004	0.003	0.003	0.002	0.002	0.002	0.001
	Monitoring Well Locations (ft)										
Field Data from Site											



See PCE

See TCE

See DCE

See VC

See ETH

Prepare Animation

Time:

64.0 Years

Log ⟺ Linear

Return to Input

To All

To Array

EPS

ATTACHMENT 4
BIOCHLOR Model
Input/Output Screens
Flow Path B

BIOCHLOR Natural Attenuation Decision Support System

Version 2.2
Excel 2000

Color Spectrum
Flow Path B - 2007
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

TYPE OF CHLORINATED SOLVENT: Ethenes ◉ Ethanes ○

1. ADVECTION

Seepage Velocity*	Vs	15.2	(ft/yr)
or			
Hydraulic Conductivity	K	1.1E-04	(cm/sec)
Hydraulic Gradient	i	0.02	(ft/ft)
Effective Porosity	n	0.15	(-)

2. DISPERSION

Alpha x*	6.2711	(ft)
(Alpha y) / (Alpha x)*	0.1	(-)
(Alpha z) / (Alpha x)*	5.E-02	(-)

Calc.

3. ADSORPTION

Retardation Factor* → R
or

Soil Bulk Density, rho	1.7	(kg/L)		
FractionOrganicCarbon, foc	1.0E-3	(-)		
Partition Coefficient	Koc			
PCE	426	(L/kg)	5.83	(-)
TCE	130	(L/kg)	2.47	(-)
DCE	125	(L/kg)	2.42	(-)
VC	30	(L/kg)	1.34	(-)
ETH	302	(L/kg)	4.42	(-)
Common R (used in model)* =			**2.47**	

4. BIOTRANSFORMATION

-1st Order Decay Coefficient*

	λ (1/yr)		half-life (yrs)	Yield
Zone 1				
PCE → TCE	0.000	←		0.79
TCE → DCE	0.000	←		0.74
DCE → VC	0.000	←		0.64
VC → ETH	0.000	←		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*	29	(yr)	L
Modeled Area Width*	700	(ft)	W
Modeled Area Length*	154	(ft)	
Zone 1 Length*	154	(ft)	
Zone 2 Length*	0	(ft)	Zone 2=

6. SOURCE DATA

TYPE: Continuous / Single Planar

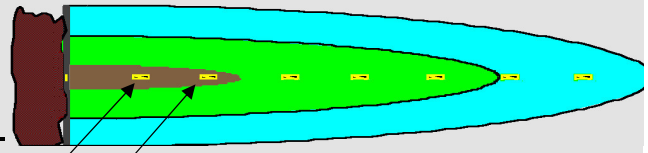
Source Options

Source Thickness in Sat. Zone* 15 (ft)

Width* (ft) Y1 = 0.2

Conc. (mg/L)*	C1	k_s* (1/yr)
PCE	.35	0
TCE		0
DCE		0
VC		0
ETH		0

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

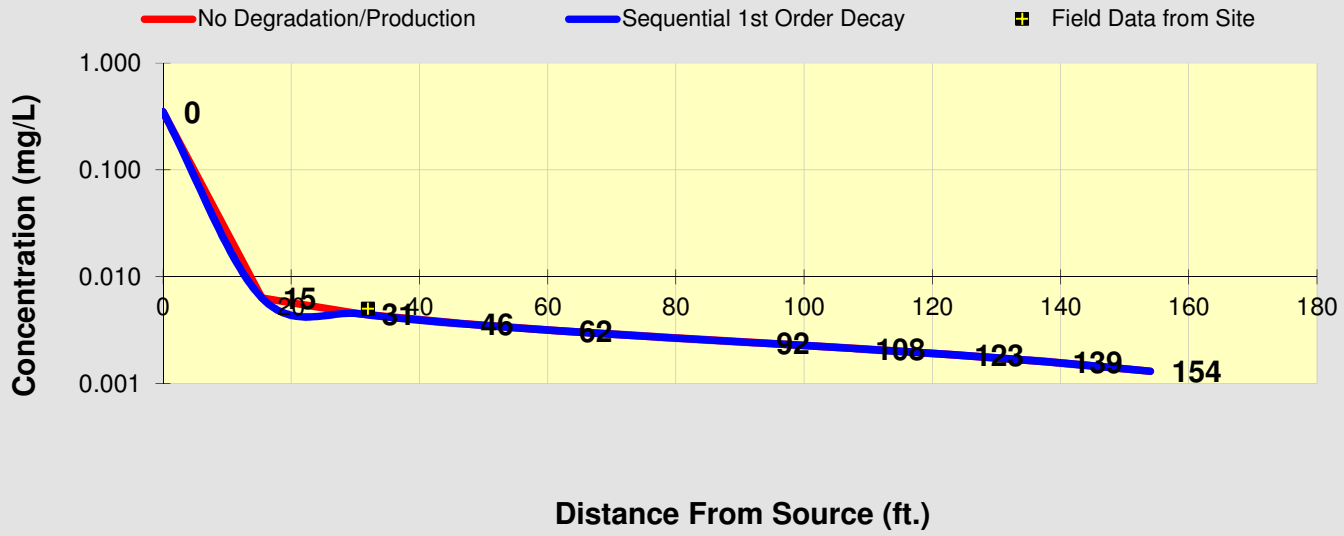
PCE Conc. (mg/L)	.005											
TCE Conc. (mg/L)												
DCE Conc. (mg/L)												
VC Conc. (mg/L)												
ETH Conc. (mg/L)												
Distance from Source (ft)	32											
Date Data Collected	2007											

8. CHOOSE TYPE OF OUTPUT TO SEE:

RUN CENTERLINE | **RUN ARRAY** | ***Help*** | Restore | RESET | ***SEE OUTPUT*** | Paste

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

PCE	Distance from Source (ft)										
	0	15	31	46	62	77	92	108	123	139	154
No Degradation	0.350	0.006	0.004	0.004	0.003	0.003	0.002	0.002	0.002	0.002	0.001
Biotransformation	0.3500	0.006	0.004	0.004	0.003	0.003	0.002	0.002	0.002	0.002	0.001
	Monitoring Well Locations (ft)										
	32										
Field Data from Site	0.005										



See PCE

See TCE

See DCE

See VC

See ETH

Prepare Animation

Time:

29.0 Years

Log ⟺ Linear

Return to Input

To All

To Array

BIOCHLOR Natural Attenuation Decision Support System

Version 2.2
Excel 2000

Color Spectrum
Flow Path B - 2009
Run Name

TYPE OF CHLORINATED SOLVENT: Ethenes ◉ Ethanes ○

1. ADVECTION

Seepage Velocity*	Vs	15.2	(ft/yr)
or			
Hydraulic Conductivity	K	1.1E-04	(cm/sec)
Hydraulic Gradient	i	0.02	(ft/ft)
Effective Porosity	n	0.15	(-)

2. DISPERSION

Alpha x*	6.2711	(ft)
(Alpha y) / (Alpha x)*	0.1	(-)
(Alpha z) / (Alpha x)*	5.E-02	(-)

Calc.

3. ADSORPTION

Retardation Factor* → R

or

Soil Bulk Density, rho		1.7	(kg/L)	
FractionOrganicCarbon, foc		1.0E-3	(-)	
Partition Coefficient	Koc			
PCE	426	(L/kg)	5.83	(-)
TCE	130	(L/kg)	2.47	(-)
DCE	125	(L/kg)	2.42	(-)
VC	30	(L/kg)	1.34	(-)
ETH	302	(L/kg)	4.42	(-)
Common R (used in model)* =			**2.47**	

4. BIOTRANSFORMATION

-1st Order Decay Coefficient*

	Zone 1 λ (1/yr)	half-life (yrs)	Yield
PCE → TCE	0.000		0.79
TCE → DCE	0.000		0.74
DCE → VC	0.000		0.64
VC → ETH	0.000		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*	29	(yr)	L
Modeled Area Width*	700	(ft)	W
Modeled Area Length*	154	(ft)	
Zone 1 Length*	154	(ft)	
Zone 2 Length*	0	(ft)	Zone 2=

6. SOURCE DATA

TYPE: Continuous / Single Planar

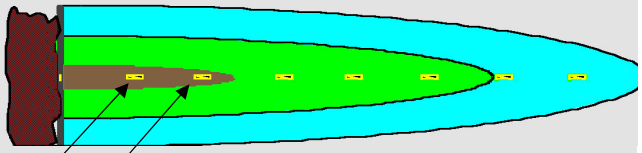
Source Options

Source Thickness in Sat. Zone* 15 (ft)

Width* (ft) Y1 = 0.2

Conc. (mg/L)*	C1	k_s* (1/yr)
PCE	.35	0
TCE		0
DCE		0
VC		0
ETH		0

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)	.054	.042									
TCE Conc. (mg/L)											
DCE Conc. (mg/L)											
VC Conc. (mg/L)											
ETH Conc. (mg/L)											
Distance from Source (ft)	0	0									
Date Data Collected	2009										

8. CHOOSE TYPE OF OUTPUT TO SEE:

RUN CENTERLINE | **RUN ARRAY**

Help | Restore | RESET

SEE OUTPUT | Paste

Data Input Instructions:

115 → 1. Enter value directly....or

or ↑

0.02 ← 2. Calculate by filling in gray cells. Press Enter, then C

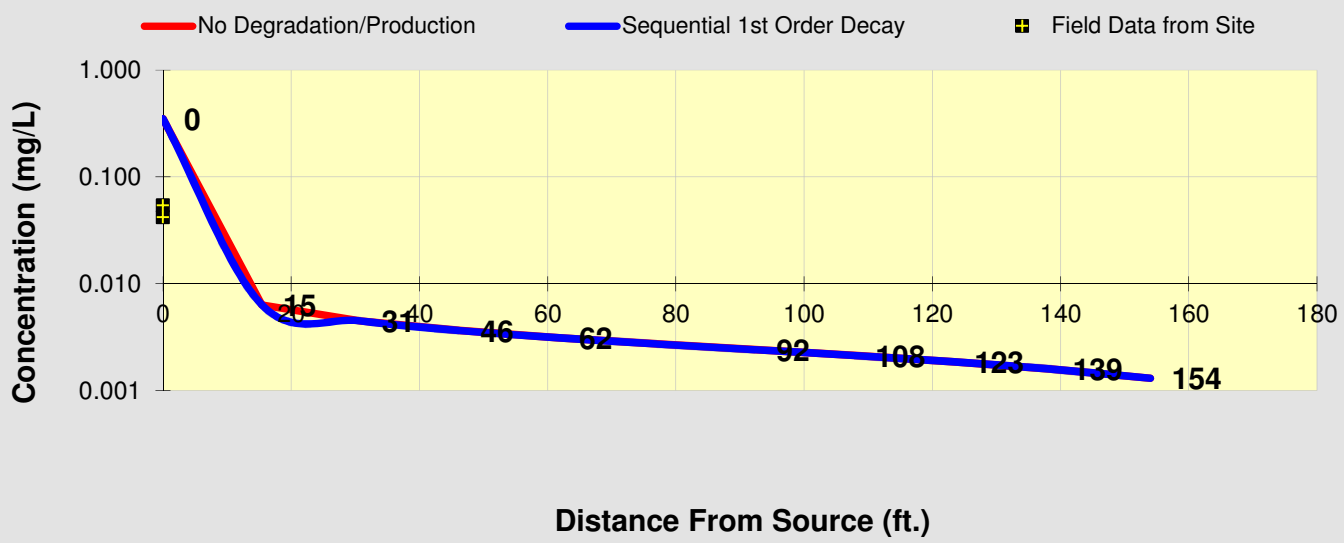
(To restore formulas, hit "Restore Formulas" button)

Variable* → Data used directly in model.

Test if Biotransformation is Occurring → Natural Attenuation

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

PCE	Distance from Source (ft)										
	0	15	31	46	62	77	92	108	123	139	154
No Degradation	0.350	0.006	0.004	0.004	0.003	0.003	0.002	0.002	0.002	0.002	0.001
Biotransformation	0.3500	0.006	0.004	0.004	0.003	0.003	0.002	0.002	0.002	0.002	0.001
	Monitoring Well Locations (ft)										
	0	0									
Field Data from Site	0.054	0.042									



See PCE

See TCE

See DCE

See VC

See ETH

Prepare Animation

Time:

29.0 Years

Log ⟺ Linear

Return to Input

To All

To Array

BIOCHLOR Natural Attenuation Decision Support System

Version 2.2
Excel 2000

Color Spectrum
Flow Path B - 2011
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

TYPE OF CHLORINATED SOLVENT: Ethenes ◉ Ethanes ○

1. ADVECTION

Seepage Velocity*	Vs	15.2	(ft/yr)
or			
Hydraulic Conductivity	K	1.1E-04	(cm/sec)
Hydraulic Gradient	i	0.02	(ft/ft)
Effective Porosity	n	0.15	(-)

2. DISPERSION

Alpha x*	6.2711	(ft)
(Alpha y) / (Alpha x)*	0.1	(-)
(Alpha z) / (Alpha x)*	5.E-02	(-)

Calc.

3. ADSORPTION

Retardation Factor* → R
or

Soil Bulk Density, rho	1.7	(kg/L)		
FractionOrganicCarbon, foc	1.0E-3	(-)		
Partition Coefficient	Koc			
PCE	426	(L/kg)	5.83	(-)
TCE	130	(L/kg)	2.47	(-)
DCE	125	(L/kg)	2.42	(-)
VC	30	(L/kg)	1.34	(-)
ETH	302	(L/kg)	4.42	(-)
Common R (used in model)* =			**2.47**	

4. BIOTRANSFORMATION

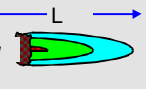
-1st Order Decay Coefficient*

	λ (1/yr)	half-life (yrs)	Yield
Zone 1			
PCE → TCE	0.000		0.79
TCE → DCE	0.000		0.74
DCE → VC	0.000		0.64
VC → ETH	0.000		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*	31	(yr)
Modeled Area Width*	700	(ft)
Modeled Area Length*	154	(ft)
Zone 1 Length*	154	(ft)
Zone 2 Length*	0	(ft)



Zone 2=

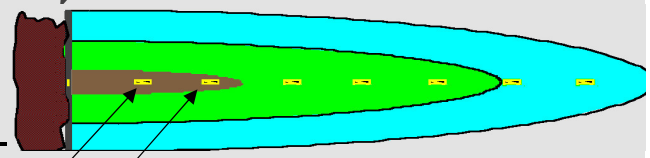
6. SOURCE DATA

TYPE: Continuous Single Planar

Source Options

Source Thickness in Sat. Zone* 15 (ft)

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



	Y1	k_s* (1/yr)
Width* (ft)	0.2	
Conc. (mg/L)*	C1	
PCE	.35	0
TCE		0
DCE		0
VC		0
ETH		0

View of Plume Looking Down

Observed Centerline Conc. at Monitoring Wells

7. FIELD DATA FOR COMPARISON

PCE Conc. (mg/L)	.13	.12	.009									
TCE Conc. (mg/L)												
DCE Conc. (mg/L)												
VC Conc. (mg/L)												
ETH Conc. (mg/L)												
Distance from Source (ft)	0	0	32									
Date Data Collected	2011											

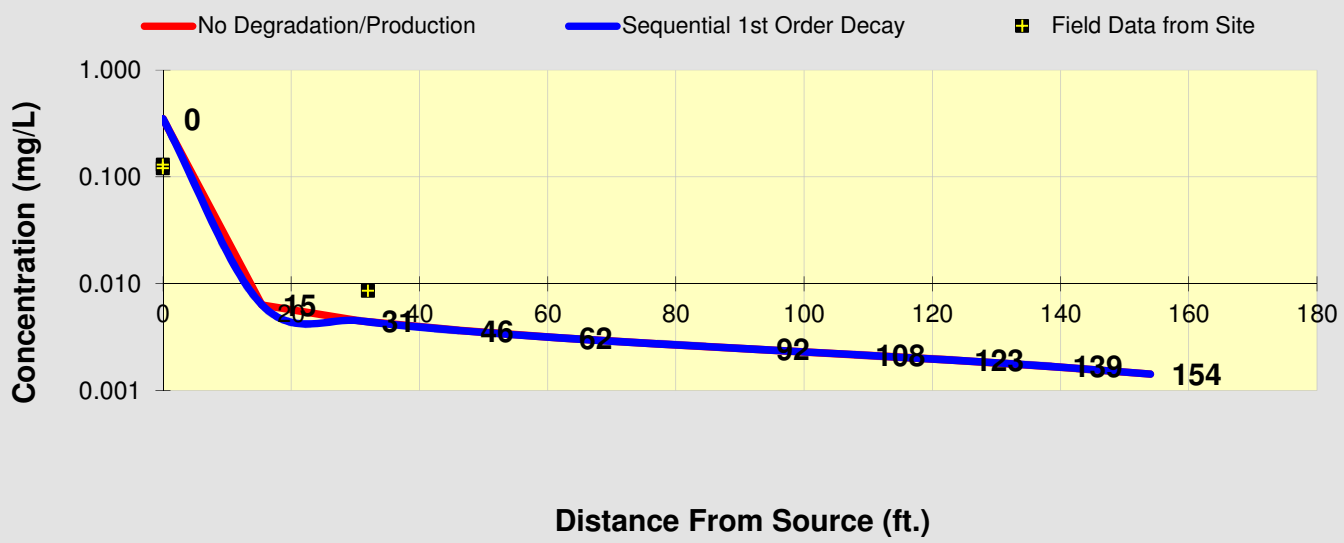
8. CHOOSE TYPE OF OUTPUT TO SEE:

RUN CENTERLINE | **RUN ARRAY**

Help | Restore | RESET
SEE OUTPUT | Paste

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

PCE	Distance from Source (ft)										
	0	15	31	46	62	77	92	108	123	139	154
No Degradation	0.350	0.006	0.004	0.004	0.003	0.003	0.002	0.002	0.002	0.002	0.001
Biotransformation	0.3500	0.006	0.004	0.004	0.003	0.003	0.002	0.002	0.002	0.002	0.001
	Monitoring Well Locations (ft)										
	0	0	32								
Field Data from Site	0.130	0.120	0.009								



See PCE

See TCE

See DCE

See VC

See ETH

Prepare Animation

Time:

31.0 Years

Log ⟺ Linear

Return to Input

To All

To Array

BIOCHLOR Natural Attenuation Decision Support System

Version 2.2
Excel 2000

Color Spectrum
Flow Path B - 2013
Run Name

TYPE OF CHLORINATED SOLVENT: Ethenes ◉ Ethanes ○

1. ADVECTION

Seepage Velocity*	Vs	15.2	(ft/yr)
or			
Hydraulic Conductivity	K	1.1E-04	(cm/sec)
Hydraulic Gradient	i	0.02	(ft/ft)
Effective Porosity	n	0.15	(-)

2. DISPERSION

Alpha x*	6.2711	(ft)
(Alpha y) / (Alpha x)*	0.1	(-)
(Alpha z) / (Alpha x)*	5.E-02	(-)

Calc.

3. ADSORPTION

Retardation Factor* → R

or

Soil Bulk Density, rho		1.7	(kg/L)	
FractionOrganicCarbon, foc		1.0E-3	(-)	
Partition Coefficient	Koc			
PCE	426	(L/kg)	5.83	(-)
TCE	130	(L/kg)	2.47	(-)
DCE	125	(L/kg)	2.42	(-)
VC	30	(L/kg)	1.34	(-)
ETH	302	(L/kg)	4.42	(-)
Common R (used in model)* =			**2.47**	

4. BIOTRANSFORMATION

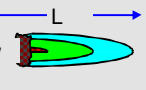
-1st Order Decay Coefficient*

	λ (1/yr)	half-life (yrs)	Yield
Zone 1			
PCE → TCE	0.000		0.79
TCE → DCE	0.000		0.74
DCE → VC	0.000		0.64
VC → ETH	0.000		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*	33	(yr)
Modeled Area Width*	700	(ft)
Modeled Area Length*	154	(ft)
Zone 1 Length*	154	(ft)
Zone 2 Length*	0	(ft)



Zone 2=

6. SOURCE DATA

TYPE: Continuous / Single Planar

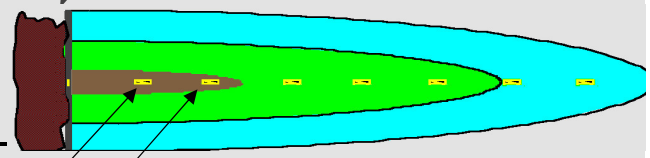
Source Options

Source Thickness in Sat. Zone* 15 (ft)

Width* (ft) Y1 = 0.2

Conc. (mg/L)*	C1	k_s* (1/yr)
PCE	.35	0
TCE		0
DCE		0
VC		0
ETH		0

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)	.12	.16	.14	.15	.001	.001	.001				
TCE Conc. (mg/L)											
DCE Conc. (mg/L)											
VC Conc. (mg/L)											
ETH Conc. (mg/L)											
Distance from Source (ft)	0	0	0	0	139	139	139				
Date Data Collected	2013										

8. CHOOSE TYPE OF OUTPUT TO SEE:

RUN CENTERLINE | **RUN ARRAY**

Help | Restore | RESET

SEE OUTPUT | Paste

Data Input Instructions:

115 → 1. Enter value directly....or

↑ *or*

0.02 → 2. Calculate by filling in gray cells. Press Enter, then C

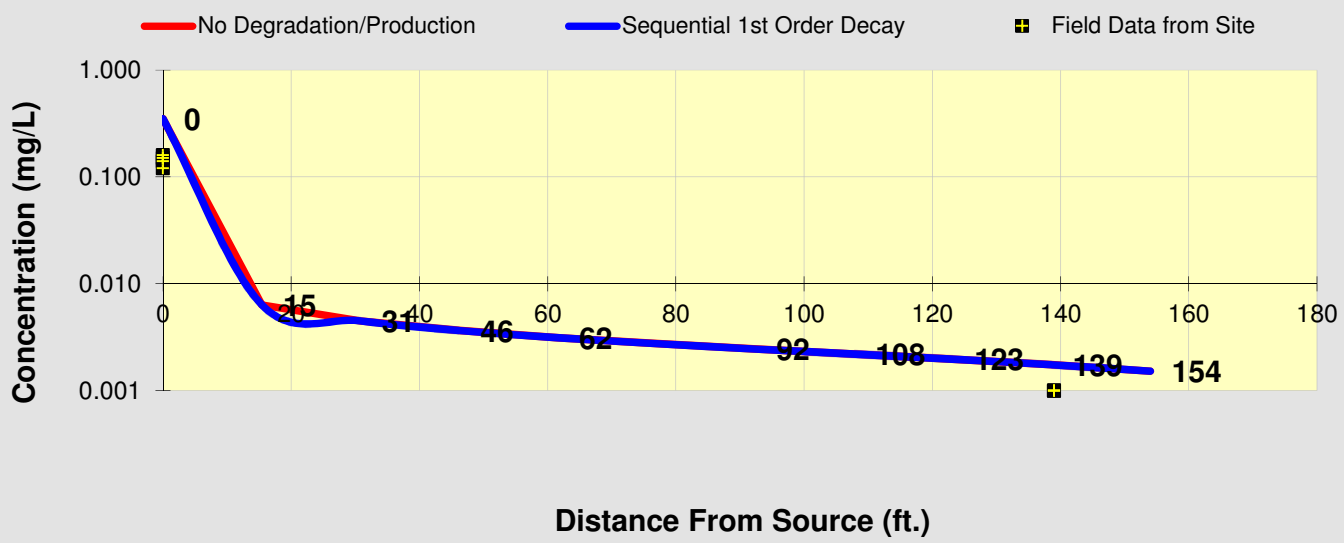
(To restore formulas, hit "Restore Formulas" button)

Variable* → Data used directly in model.

Test if Biotransformation is Occurring → Natural Attenuation

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

PCE	Distance from Source (ft)										
	0	15	31	46	62	77	92	108	123	139	154
No Degradation	0.350	0.006	0.004	0.004	0.003	0.003	0.002	0.002	0.002	0.002	0.002
Biotransformation	0.3500	0.006	0.004	0.004	0.003	0.003	0.002	0.002	0.002	0.002	0.002
	Monitoring Well Locations (ft)										
	0	0	0	0	139	139	139				
Field Data from Site	0.120	0.160	0.140	0.150	0.001	0.001	0.001				



See PCE

See TCE

See DCE

See VC

See ETH

Prepare Animation

Time:

33.0 Years

Log ⟺ Linear

Return to Input

To All

To Array

BIOCHLOR Natural Attenuation Decision Support System

Version 2.2
Excel 2000

Color Spectrum
Flow Path B - 2044
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

TYPE OF CHLORINATED SOLVENT: Ethenes ◉ Ethanes ○

1. ADVECTION

Seepage Velocity*	Vs	15.2	(ft/yr)
or			
Hydraulic Conductivity	K	1.1E-04	(cm/sec)
Hydraulic Gradient	i	0.02	(ft/ft)
Effective Porosity	n	0.15	(-)

2. DISPERSION

Alpha x*	6.2711	(ft)
(Alpha y) / (Alpha x)*	0.1	(-)
(Alpha z) / (Alpha x)*	5.E-02	(-)

Calc.

3. ADSORPTION

Retardation Factor* → R
or

Soil Bulk Density, rho	1.7	(kg/L)		
FractionOrganicCarbon, foc	1.0E-3	(-)		
Partition Coefficient	Koc			
PCE	426	(L/kg)	5.83	(-)
TCE	130	(L/kg)	2.47	(-)
DCE	125	(L/kg)	2.42	(-)
VC	30	(L/kg)	1.34	(-)
ETH	302	(L/kg)	4.42	(-)
Common R (used in model)* =			**2.47**	

4. BIOTRANSFORMATION

-1st Order Decay Coefficient*

	λ (1/yr)	half-life (yrs)	Yield
Zone 1			
PCE → TCE	0.000		0.79
TCE → DCE	0.000		0.74
DCE → VC	0.000		0.64
VC → ETH	0.000		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*	64	(yr)
Modeled Area Width*	700	(ft)
Modeled Area Length*	154	(ft)
Zone 1 Length*	154	(ft)
Zone 2 Length*	0	(ft)

L, W

Zone 2=

6. SOURCE DATA

TYPE: Continuous / Single Planar

Source Options

Source Thickness in Sat. Zone* 15 (ft)

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

	Y1	k_s* (1/yr)
Width* (ft)	0.2	
Conc. (mg/L)*	C1	
PCE	.35	0
TCE		0
DCE		0
VC		0
ETH		0

View of Plume Looking Down

Observed Centerline Conc. at Monitoring Wells

7. FIELD DATA FOR COMPARISON

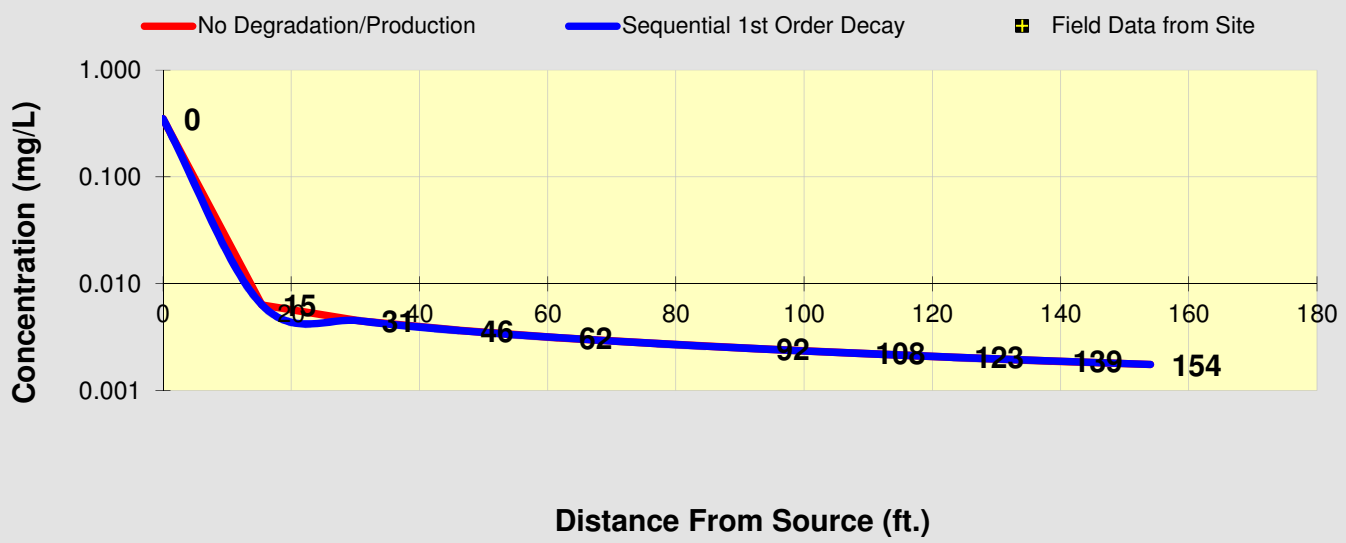
PCE Conc. (mg/L)											
TCE Conc. (mg/L)											
DCE Conc. (mg/L)											
VC Conc. (mg/L)											
ETH Conc. (mg/L)											
Distance from Source (ft)											
Date Data Collected	2044										

8. CHOOSE TYPE OF OUTPUT TO SEE:

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

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

PCE	Distance from Source (ft)										
	0	15	31	46	62	77	92	108	123	139	154
No Degradation	0.350	0.006	0.004	0.004	0.003	0.003	0.002	0.002	0.002	0.002	0.002
Biotransformation	0.3500	0.006	0.004	0.004	0.003	0.003	0.002	0.002	0.002	0.002	0.002
	Monitoring Well Locations (ft)										
Field Data from Site											



See PCE

See TCE

See DCE

See VC

See ETH

Prepare Animation

Time:

64.0 Years

Log ⟺ Linear

Return to Input

To All

To Array

ATTACHMENT 5

Sensitivity Analysis

Input/Output Screens

Flow Path A

BIOCHLOR Natural Attenuation Decision Support System

Version 2.2
Excel 2000

Color Spectrum
Flow Path A - 2013
Run Name

Data Input Instructions:
115 → 1. Enter value directly....or
↑ or
0.02 → 2. Calculate by filling in gray 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

TYPE OF CHLORINATED SOLVENT: Ethenes ◉ Ethanes ○

1. ADVECTION

Seepage Velocity*	Vs	11.4	(ft/yr)
or			
Hydraulic Conductivity	K	1.1E-04	(cm/sec)
Hydraulic Gradient	i	0.015	(ft/ft)
Effective Porosity	n	0.15	(-)

2. DISPERSION

Alpha x*	6.2711	(ft)
(Alpha y) / (Alpha x)*	0.1	(-)
(Alpha z) / (Alpha x)*	5.E-02	(-)

Calc.

3. ADSORPTION

Retardation Factor* → R
or

Soil Bulk Density, rho	1.7	(kg/L)		
FractionOrganicCarbon, foc	1.0E-3	(-)		
Partition Coefficient	Koc			
PCE	426	(L/kg)	5.83	(-)
TCE	130	(L/kg)	2.47	(-)
DCE	125	(L/kg)	2.42	(-)
VC	30	(L/kg)	1.34	(-)
ETH	302	(L/kg)	4.42	(-)
Common R (used in model)* =			**2.47**	

4. BIOTRANSFORMATION

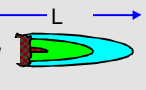
-1st Order Decay Coefficient*

	λ (1/yr)	half-life (yrs)	Yield
Zone 1			
PCE → TCE	0.000		0.79
TCE → DCE	0.000		0.74
DCE → VC	0.000		0.64
VC → ETH	0.000		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*	33	(yr)
Modeled Area Width*	700	(ft)
Modeled Area Length*	250	(ft)
Zone 1 Length*	250	(ft)
Zone 2 Length*	0	(ft)



Zone 2=

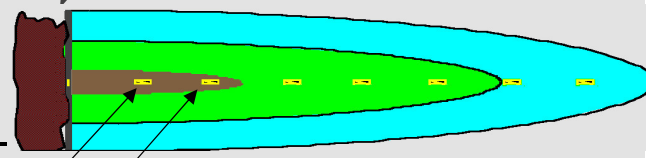
6. SOURCE DATA

TYPE: Continuous Single Planar

Source Options

Source Thickness in Sat. Zone* 15 (ft)

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



	Y1	k_s* (1/yr)
Width* (ft)	0.01	
Conc. (mg/L)*	C1	
PCE	.35	0
TCE		0
DCE		0
VC		0
ETH		0

View of Plume Looking Down

Observed Centerline Conc. at Monitoring Wells

7. FIELD DATA FOR COMPARISON

PCE Conc. (mg/L)	.12	.16	.14	.15	.005	.007	.009	.007	.001		
TCE Conc. (mg/L)											
DCE Conc. (mg/L)											
VC Conc. (mg/L)											
ETH Conc. (mg/L)											
Distance from Source (ft)	0	0	0	0	74	74	74	74	154		
Date Data Collected	2013										

8. CHOOSE TYPE OF OUTPUT TO SEE:

RUN CENTERLINE | **RUN ARRAY**

Help | Restore | RESET
SEE OUTPUT | Paste

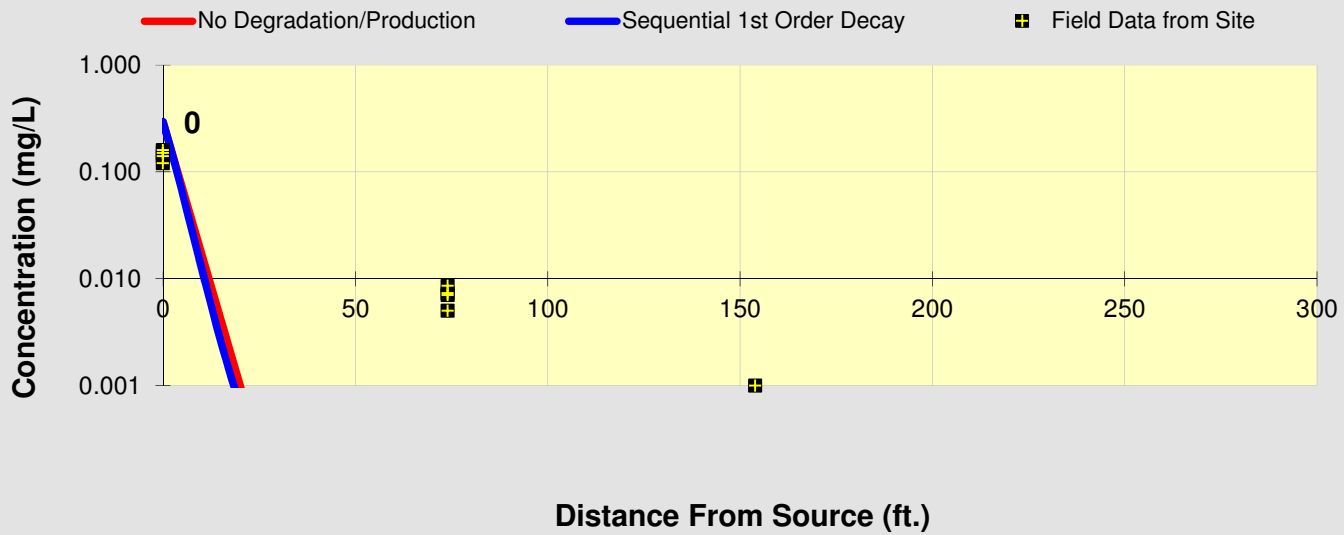
DISSOLVED CHLORINATED SOLVENT CONCENTRATIONS ALONG PLUME CENTERLINE (mg/L) at Z=0

Distance from Source (ft)

PCE	0	25	50	75	100	125	150	175	200	225	250
No Degradation	0.295	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Biotransformation	0.2947	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000

Monitoring Well Locations (ft)

	0	0	0	0	74	74	74	74	154		
Field Data from Site	0.120	0.160	0.140	0.150	0.005	0.007	0.009	0.007	0.001		



See PCE

See TCE

See DCE

See VC

See ETH

Prepare Animation

Time:

33.0 Years

Log ⟺ Linear

Return to Input

To All

To Array

BIOCHLOR Natural Attenuation Decision Support System

Version 2.2
Excel 2000

Color Spectrum
Flow Path A - 2013
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

TYPE OF CHLORINATED SOLVENT: Ethenes ◉ Ethanes ○

1. ADVECTION

Seepage Velocity*	Vs	11.4	(ft/yr)
or			
Hydraulic Conductivity	K	1.1E-04	(cm/sec)
Hydraulic Gradient	i	0.015	(ft/ft)
Effective Porosity	n	0.15	(-)

2. DISPERSION

Alpha x*	6.2711	(ft)
(Alpha y) / (Alpha x)*	0.1	(-)
(Alpha z) / (Alpha x)*	5.E-02	(-)

Calc.

3. ADSORPTION

Retardation Factor* → R
or

Soil Bulk Density, rho		1.7	(kg/L)	
FractionOrganicCarbon, foc		1.0E-3	(-)	
Partition Coefficient	Koc			
PCE	426	(L/kg)	5.83	(-)
TCE	130	(L/kg)	2.47	(-)
DCE	125	(L/kg)	2.42	(-)
VC	30	(L/kg)	1.34	(-)
ETH	302	(L/kg)	4.42	(-)
Common R (used in model)* =			**2.47**	

4. BIOTRANSFORMATION

-1st Order Decay Coefficient*

	λ (1/yr)	half-life (yrs)	Yield
Zone 1			
PCE → TCE	0.000		0.79
TCE → DCE	0.000		0.74
DCE → VC	0.000		0.64
VC → ETH	0.000		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*	33	(yr)
Modeled Area Width*	700	(ft)
Modeled Area Length*	250	(ft)
Zone 1 Length*	250	(ft)
Zone 2 Length*	0	(ft)

L, W

Zone 2=

6. SOURCE DATA

TYPE: Continuous / Single Planar

Source Options

Source Thickness in Sat. Zone* 15 (ft)

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

	Y1	k_s* (1/yr)
Width* (ft)	0.3	
Conc. (mg/L)*	C1	
PCE	.35	0
TCE		0
DCE		0
VC		0
ETH		0

View of Plume Looking Down

Observed Centerline Conc. at Monitoring Wells

7. FIELD DATA FOR COMPARISON

PCE Conc. (mg/L)	.12	.16	.14	.15	.005	.007	.009	.007	.001		
TCE Conc. (mg/L)											
DCE Conc. (mg/L)											
VC Conc. (mg/L)											
ETH Conc. (mg/L)											
Distance from Source (ft)	0	0	0	0	74	74	74	74	154		
Date Data Collected	2013										

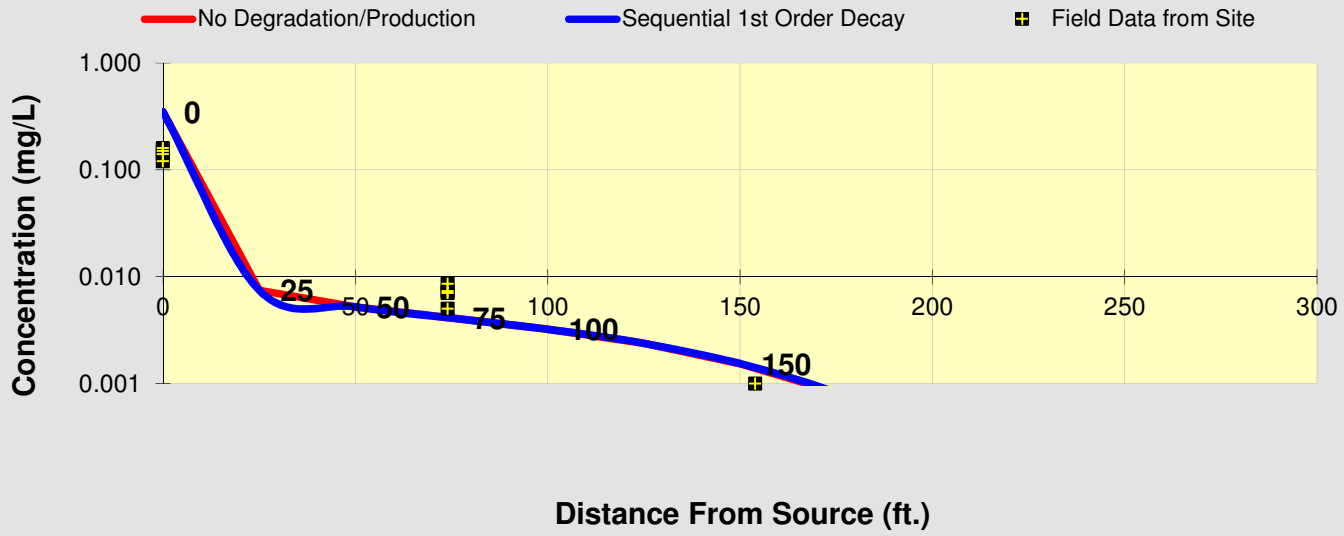
8. CHOOSE TYPE OF OUTPUT TO SEE:

RUN CENTERLINE | **RUN ARRAY**

Help | Restore | RESET
SEE OUTPUT | Paste

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

PCE	Distance from Source (ft)										
	0	25	50	75	100	125	150	175	200	225	250
No Degradation	0.350	0.007	0.005	0.004	0.003	0.002	0.002	0.001	0.000	0.000	0.000
Biotransformation	0.3500	0.007	0.005	0.004	0.003	0.002	0.002	0.001	0.000	0.000	0.000
	Monitoring Well Locations (ft)										
	0	0	0	0	74	74	74	74	154		
Field Data from Site	0.120	0.160	0.140	0.150	0.005	0.007	0.009	0.007	0.001		



See PCE

See TCE

See DCE

See VC

See ETH

Prepare Animation

Time:

33.0 Years

Log ⟺ Linear

Return to Input

To All

To Array

BIOCHLOR Natural Attenuation Decision Support System

Version 2.2
Excel 2000

Color Spectrum
Flow Path A - 2013
Run Name

TYPE OF CHLORINATED SOLVENT: Ethenes ◉ Ethanes ○

1. ADVECTION

Seepage Velocity*	Vs	11.4	(ft/yr)
or			
Hydraulic Conductivity	K	1.1E-04	(cm/sec)
Hydraulic Gradient	i	0.015	(ft/ft)
Effective Porosity	n	0.15	(-)

2. DISPERSION

Alpha x*	6.2711	(ft)
(Alpha y) / (Alpha x)*	0.1	(-)
(Alpha z) / (Alpha x)*	5.E-02	(-)

Calc.

3. ADSORPTION

Retardation Factor* → R

or

Soil Bulk Density, rho		1.7	(kg/L)	
FractionOrganicCarbon, foc		1.0E-3	(-)	
Partition Coefficient	Koc			
PCE	426	(L/kg)	5.83	(-)
TCE	130	(L/kg)	2.47	(-)
DCE	125	(L/kg)	2.42	(-)
VC	30	(L/kg)	1.34	(-)
ETH	302	(L/kg)	4.42	(-)
Common R (used in model)* =			**2.47**	

4. BIOTRANSFORMATION

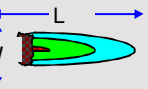
-1st Order Decay Coefficient*

	λ (1/yr)	half-life (yrs)	Yield
Zone 1			
PCE → TCE	0.000		0.79
TCE → DCE	0.000		0.74
DCE → VC	0.000		0.64
VC → ETH	0.000		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*	33	(yr)
Modeled Area Width*	700	(ft)
Modeled Area Length*	250	(ft)
Zone 1 Length*	250	(ft)
Zone 2 Length*	0	(ft)



Zone 2=

6. SOURCE DATA

TYPE: Continuous / Single Planar

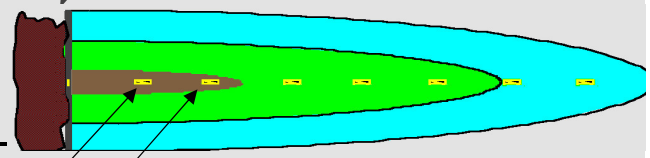
Source Options

Source Thickness in Sat. Zone* 15 (ft)

Width* (ft) Y1: 1

Conc. (mg/L)*	C1	k_s* (1/yr)
PCE	.35	0
TCE		0
DCE		0
VC		0
ETH		0

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)	.12	.16	.14	.15	.005	.007	.009	.007	.001		
TCE Conc. (mg/L)											
DCE Conc. (mg/L)											
VC Conc. (mg/L)											
ETH Conc. (mg/L)											
Distance from Source (ft)	0	0	0	0	74	74	74	74	154		
Date Data Collected	2013										

8. CHOOSE TYPE OF OUTPUT TO SEE:

RUN CENTERLINE | **RUN ARRAY**

Help | Restore | RESET

SEE OUTPUT | Paste

Data Input Instructions:

115 → 1. Enter value directly....or

↑ *or*

0.02 → 2. Calculate by filling in gray cells. Press Enter, then C

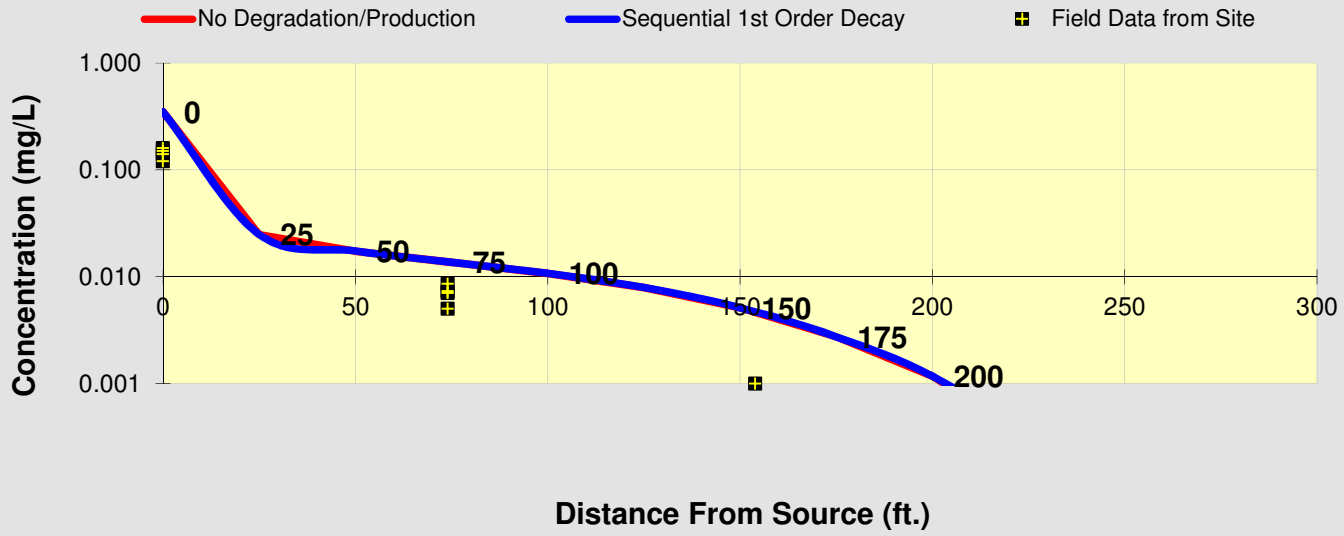
(To restore formulas, hit "Restore Formulas" button)

Variable* → Data used directly in model.

Test if Biotransformation is Occurring → Natural Attenuation

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

PCE	Distance from Source (ft)										
	0	25	50	75	100	125	150	175	200	225	250
No Degradation	0.350	0.025	0.017	0.014	0.011	0.008	0.005	0.003	0.001	0.000	0.000
Biotransformation	0.3500	0.025	0.017	0.014	0.011	0.008	0.005	0.003	0.001	0.000	0.000
	Monitoring Well Locations (ft)										
	0	0	0	0	74	74	74	74	154		
Field Data from Site	0.120	0.160	0.140	0.150	0.005	0.007	0.009	0.007	0.001		



See PCE

See TCE

See DCE

See VC

See ETH

Prepare Animation

Time:

33.0 Years

Log ⟺ Linear

Return to Input

To All

To Array

BIOCHLOR Natural Attenuation Decision Support System

Version 2.2
Excel 2000

Color Spectrum
Flow Path A - 2013
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

TYPE OF CHLORINATED SOLVENT: Ethenes ◉ Ethanes ○

1. ADVECTION

Seepage Velocity*	Vs	11.4	(ft/yr)
or			
Hydraulic Conductivity	K	1.1E-04	(cm/sec)
Hydraulic Gradient	i	0.015	(ft/ft)
Effective Porosity	n	0.15	(-)

2. DISPERSION

Alpha x*	6.2711	(ft)
(Alpha y) / (Alpha x)*	0.1	(-)
(Alpha z) / (Alpha x)*	5.E-02	(-)

Calc.

3. ADSORPTION

Retardation Factor* → R
or

Soil Bulk Density, rho		1.7	(kg/L)	
FractionOrganicCarbon, foc		1.0E-3	(-)	
Partition Coefficient	Koc			
PCE	426	(L/kg)	5.83	(-)
TCE	130	(L/kg)	2.47	(-)
DCE	125	(L/kg)	2.42	(-)
VC	30	(L/kg)	1.34	(-)
ETH	302	(L/kg)	4.42	(-)
Common R (used in model)* =			**2.47**	

4. BIOTRANSFORMATION

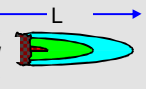
-1st Order Decay Coefficient*

	λ (1/yr)	half-life (yrs)	Yield
Zone 1			
PCE → TCE	0.000		0.79
TCE → DCE	0.000		0.74
DCE → VC	0.000		0.64
VC → ETH	0.000		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*	33	(yr)
Modeled Area Width*	700	(ft)
Modeled Area Length*	250	(ft)
Zone 1 Length*	250	(ft)
Zone 2 Length*	0	(ft)



Zone 2=

6. SOURCE DATA

TYPE: Continuous Single Planar

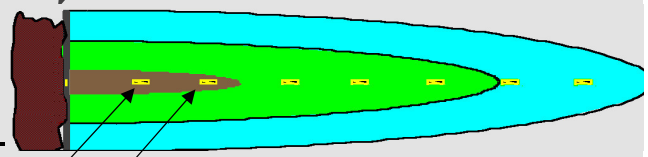
Source Options

Source Thickness in Sat. Zone* 15 (ft)

Width* (ft) Y1 = 5

Conc. (mg/L)*	C1	k_s* (1/yr)
PCE	.35	0
TCE		0
DCE		0
VC		0
ETH		0

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)	.12	.16	.14	.15	.005	.007	.009	.007	.001		
TCE Conc. (mg/L)											
DCE Conc. (mg/L)											
VC Conc. (mg/L)											
ETH Conc. (mg/L)											
Distance from Source (ft)	0	0	0	0	74	74	74	74	154		
Date Data Collected	2013										

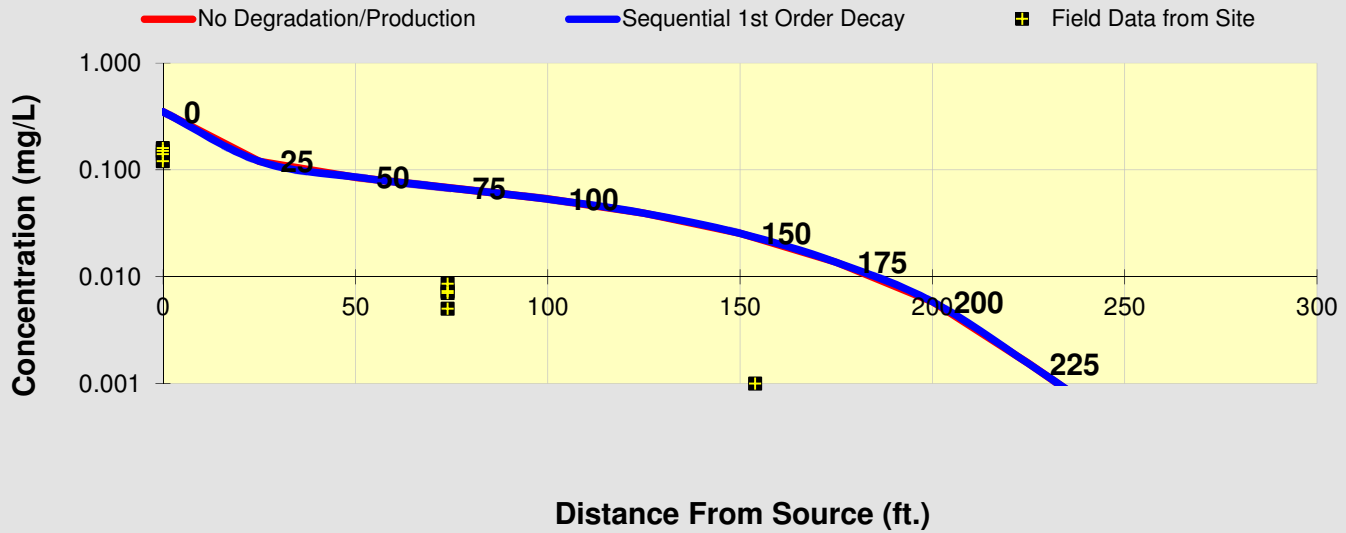
8. CHOOSE TYPE OF OUTPUT TO SEE:

RUN CENTERLINE | **RUN ARRAY**

Help | Restore | RESET
SEE OUTPUT | Paste

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

PCE	Distance from Source (ft)										
	0	25	50	75	100	125	150	175	200	225	250
No Degradation	0.350	0.121	0.086	0.068	0.053	0.039	0.025	0.014	0.006	0.002	0.000
Biotransformation	0.3500	0.121	0.086	0.068	0.053	0.039	0.025	0.014	0.006	0.002	0.000
	Monitoring Well Locations (ft)										
	0	0	0	0	74	74	74	74	154		
Field Data from Site	0.120	0.160	0.140	0.150	0.005	0.007	0.009	0.007	0.001		



See PCE

See TCE

See DCE

See VC

See ETH

Prepare Animation

Time:

33.0 Years

Log ⟺ Linear

Return to Input

To All

To Array

BIOCHLOR Natural Attenuation Decision Support System

Version 2.2
Excel 2000

Color Spectrum
Flow Path A - 2013
Run Name

TYPE OF CHLORINATED SOLVENT: Ethenes ◉ Ethanes ○

1. ADVECTION

Seepage Velocity*	Vs	11.4	(ft/yr)
or			
Hydraulic Conductivity	K	1.1E-04	(cm/sec)
Hydraulic Gradient	i	0.015	(ft/ft)
Effective Porosity	n	0.15	(-)

2. DISPERSION

Alpha x*	6.2711	(ft)
(Alpha y) / (Alpha x)*	0.1	(-)
(Alpha z) / (Alpha x)*	5.E-02	(-)

Calc.

3. ADSORPTION

Retardation Factor* → R

or

Soil Bulk Density, rho		1.7	(kg/L)	
FractionOrganicCarbon, foc		1.0E-3	(-)	
Partition Coefficient	Koc			
PCE	426	(L/kg)	5.83	(-)
TCE	130	(L/kg)	2.47	(-)
DCE	125	(L/kg)	2.42	(-)
VC	30	(L/kg)	1.34	(-)
ETH	302	(L/kg)	4.42	(-)
Common R (used in model)* =			**2.47**	

4. BIOTRANSFORMATION

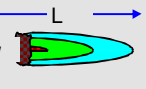
-1st Order Decay Coefficient*

	λ (1/yr)	half-life (yrs)	Yield
Zone 1			
PCE → TCE	0.000		0.79
TCE → DCE	0.000		0.74
DCE → VC	0.000		0.64
VC → ETH	0.000		0.45
Zone 2			
PCE → TCE	0.000		
TCE → DCE	0.000		
DCE → VC	0.000		
VC → ETH	0.000		

λ HELP

5. GENERAL

Simulation Time*	33	(yr)
Modeled Area Width*	700	(ft)
Modeled Area Length*	250	(ft)
Zone 1 Length*	250	(ft)
Zone 2 Length*	0	(ft)



Zone 2=

6. SOURCE DATA

TYPE: Continuous / Single Planar

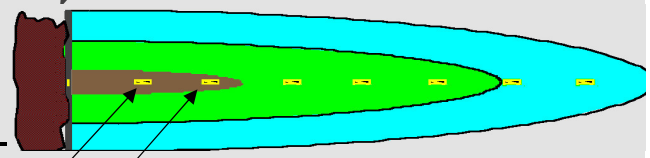
Source Options

Source Thickness in Sat. Zone* 15 (ft)

Width* (ft) Y1 = 0.3

Conc. (mg/L)*	C1	k_s* (1/yr)
PCE	.1	0
TCE		0
DCE		0
VC		0
ETH		0

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)	.12	.16	.14	.15	.005	.007	.009	.007	.001		
TCE Conc. (mg/L)											
DCE Conc. (mg/L)											
VC Conc. (mg/L)											
ETH Conc. (mg/L)											
Distance from Source (ft)	0	0	0	0	74	74	74	74	154		
Date Data Collected	2013										

8. CHOOSE TYPE OF OUTPUT TO SEE:

RUN CENTERLINE | **RUN ARRAY** | ***Help*** | Restore | RESET | ***SEE OUTPUT*** | Paste

Data Input Instructions:

115 → 1. Enter value directly....or
↑ *or*
0.02 → 2. Calculate by filling in gray cells. Press Enter, then C

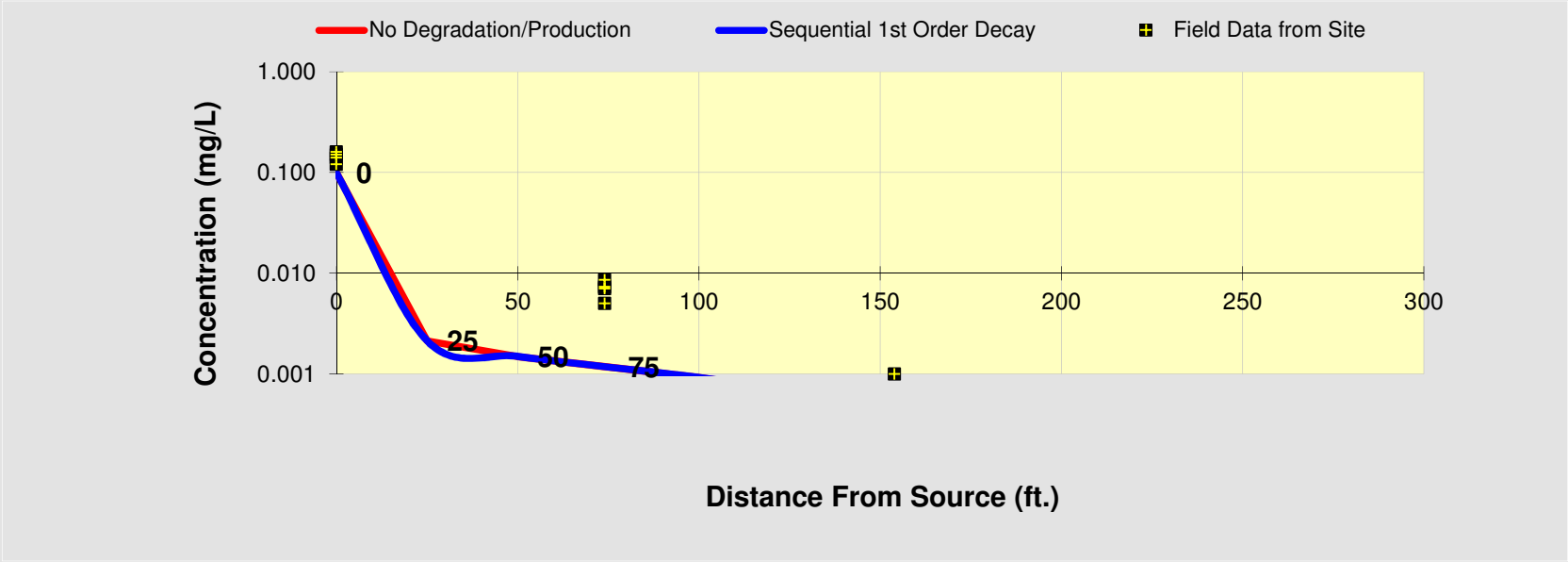
(To restore formulas, hit "Restore Formulas" button)

Variable* → Data used directly in model.

Test if Biotransformation is Occurring → Natural Attenuation

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

PCE	Distance from Source (ft)										
	0	25	50	75	100	125	150	175	200	225	250
No Degradation	0.100	0.002	0.001	0.001	0.001	0.001	0.000	0.000	0.000	0.000	0.000
Biotransformation	0.1000	0.002	0.001	0.001	0.001	0.001	0.000	0.000	0.000	0.000	0.000
	Monitoring Well Locations (ft)										
	0	0	0	0	74	74	74	74	154		
Field Data from Site	0.120	0.160	0.140	0.150	0.005	0.007	0.009	0.007	0.001		



See PCE

See TCE

See DCE

See VC

See ETH

Prepare Animation

Time:

33.0 Years

Log ⟺ Linear

Return to Input

To All

To Array

BIOCHLOR Natural Attenuation Decision Support System

Version 2.2
Excel 2000

Color Spectrum
Flow Path A - 2013
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

TYPE OF CHLORINATED SOLVENT: Ethenes ◉ Ethanes ○

1. ADVECTION

Seepage Velocity*	Vs	11.4	(ft/yr)
or			
Hydraulic Conductivity	K	1.1E-04	(cm/sec)
Hydraulic Gradient	i	0.015	(ft/ft)
Effective Porosity	n	0.15	(-)

2. DISPERSION

Alpha x*	6.2711	(ft)
(Alpha y) / (Alpha x)*	0.1	(-)
(Alpha z) / (Alpha x)*	5.E-02	(-)

Calc.

3. ADSORPTION

Retardation Factor* → R
or

Soil Bulk Density, rho		1.7	(kg/L)	
FractionOrganicCarbon, foc		1.0E-3	(-)	
Partition Coefficient	Koc			
PCE	426	(L/kg)	5.83	(-)
TCE	130	(L/kg)	2.47	(-)
DCE	125	(L/kg)	2.42	(-)
VC	30	(L/kg)	1.34	(-)
ETH	302	(L/kg)	4.42	(-)
Common R (used in model)* =			**2.47**	

4. BIOTRANSFORMATION

-1st Order Decay Coefficient*

	λ (1/yr)	half-life (yrs)	Yield
Zone 1			
PCE → TCE	0.000		0.79
TCE → DCE	0.000		0.74
DCE → VC	0.000		0.64
VC → ETH	0.000		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*	33	(yr)
Modeled Area Width*	700	(ft)
Modeled Area Length*	250	(ft)
Zone 1 Length*	250	(ft)
Zone 2 Length*	0	(ft)

L, W

Zone 2=

6. SOURCE DATA

TYPE: Continuous / Single Planar

Source Options

Source Thickness in Sat. Zone* 15 (ft)

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

	Y1	k_s* (1/yr)
Width* (ft)	0.3	
Conc. (mg/L)*	C1	
PCE	.35	0
TCE		0
DCE		0
VC		0
ETH		0

View of Plume Looking Down

Observed Centerline Conc. at Monitoring Wells

7. FIELD DATA FOR COMPARISON

PCE Conc. (mg/L)	.12	.16	.14	.15	.005	.007	.009	.007	.001		
TCE Conc. (mg/L)											
DCE Conc. (mg/L)											
VC Conc. (mg/L)											
ETH Conc. (mg/L)											
Distance from Source (ft)	0	0	0	0	74	74	74	74	154		
Date Data Collected	2013										

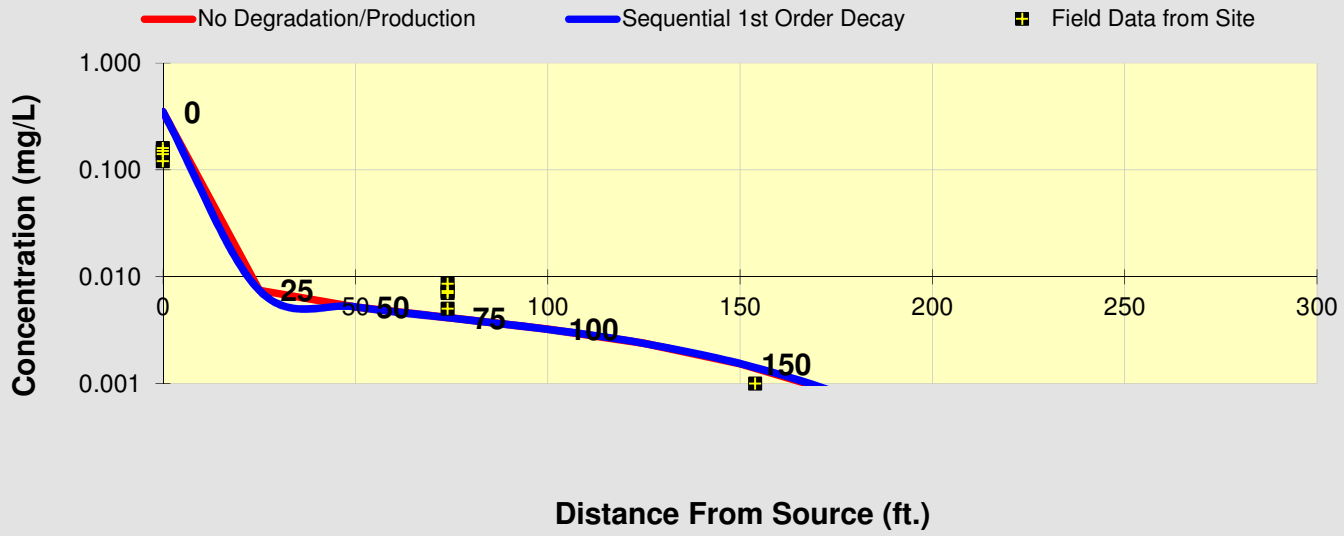
8. CHOOSE TYPE OF OUTPUT TO SEE:

RUN CENTERLINE | **RUN ARRAY**

Help | Restore | RESET
SEE OUTPUT | Paste

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

PCE	Distance from Source (ft)										
	0	25	50	75	100	125	150	175	200	225	250
No Degradation	0.350	0.007	0.005	0.004	0.003	0.002	0.002	0.001	0.000	0.000	0.000
Biotransformation	0.3500	0.007	0.005	0.004	0.003	0.002	0.002	0.001	0.000	0.000	0.000
	Monitoring Well Locations (ft)										
	0	0	0	0	74	74	74	74	154		
Field Data from Site	0.120	0.160	0.140	0.150	0.005	0.007	0.009	0.007	0.001		



See PCE

See TCE

See DCE

See VC

See ETH

Prepare Animation

Time:

33.0 Years

Log ⟺ Linear

Return to Input

To All

To Array

BIOCHLOR Natural Attenuation Decision Support System

Version 2.2
Excel 2000

Color Spectrum
Flow Path A - 2013
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

TYPE OF CHLORINATED SOLVENT: Ethenes ◉ Ethanes ○

1. ADVECTION

Seepage Velocity*	Vs	11.4	(ft/yr)
or			
Hydraulic Conductivity	K	1.1E-04	(cm/sec)
Hydraulic Gradient	i	0.015	(ft/ft)
Effective Porosity	n	0.15	(-)

2. DISPERSION

Alpha x*	6.2711	(ft)
(Alpha y) / (Alpha x)*	0.1	(-)
(Alpha z) / (Alpha x)*	5.E-02	(-)

Calc.

3. ADSORPTION

Retardation Factor* → R
or

Soil Bulk Density, rho	1.7	(kg/L)		
FractionOrganicCarbon, foc	1.0E-3	(-)		
Partition Coefficient	Koc			
PCE	426	(L/kg)	5.83	(-)
TCE	130	(L/kg)	2.47	(-)
DCE	125	(L/kg)	2.42	(-)
VC	30	(L/kg)	1.34	(-)
ETH	302	(L/kg)	4.42	(-)
Common R (used in model)* =			**2.47**	

4. BIOTRANSFORMATION

-1st Order Decay Coefficient*

	λ (1/yr)		half-life (yrs)	Yield
Zone 1				
PCE → TCE	0.000	←		0.79
TCE → DCE	0.000	←		0.74
DCE → VC	0.000	←		0.64
VC → ETH	0.000	←		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*	33	(yr)	
Modeled Area Width*	700	(ft)	
Modeled Area Length*	250	(ft)	
Zone 1 Length*	250	(ft)	
Zone 2 Length*	0	(ft)	Zone 2=

6. SOURCE DATA

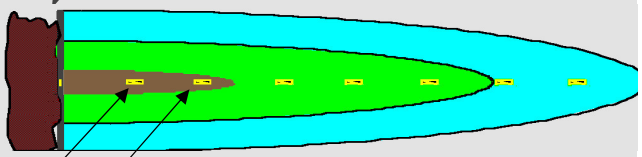
TYPE: Continuous
Single Planar

Source Options

Source Thickness in Sat. Zone* 15 (ft)

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

	Y1	k_s* (1/yr)
Width* (ft)	0.3	
Conc. (mg/L)*	C1	
PCE	.75	0
TCE		0
DCE		0
VC		0
ETH		0



View of Plume Looking Down

Observed Centerline Conc. at Monitoring Wells

7. FIELD DATA FOR COMPARISON

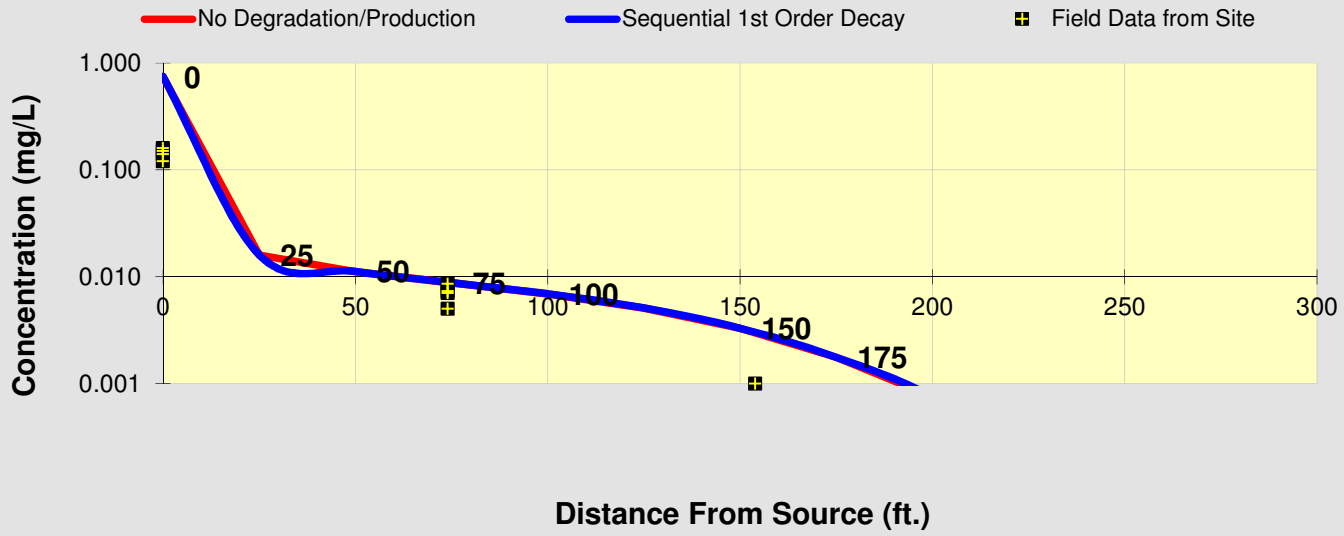
PCE Conc. (mg/L)	.12	.16	.14	.15	.005	.007	.009	.007	.001		
TCE Conc. (mg/L)											
DCE Conc. (mg/L)											
VC Conc. (mg/L)											
ETH Conc. (mg/L)											
Distance from Source (ft)	0	0	0	0	74	74	74	74	154		
Date Data Collected	2013										

8. CHOOSE TYPE OF OUTPUT TO SEE:

RUN CENTERLINE | **RUN ARRAY** | **Help** | Restore | RESET | ***SEE OUTPUT*** | Paste

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

PCE	Distance from Source (ft)										
	0	25	50	75	100	125	150	175	200	225	250
No Degradation	0.750	0.016	0.011	0.009	0.007	0.005	0.003	0.002	0.001	0.000	0.000
Biotransformation	0.7500	0.016	0.011	0.009	0.007	0.005	0.003	0.002	0.001	0.000	0.000
	Monitoring Well Locations (ft)										
	0	0	0	0	74	74	74	74	154		
Field Data from Site	0.120	0.160	0.140	0.150	0.005	0.007	0.009	0.007	0.001		



See PCE

See TCE

See DCE

See VC

See ETH

Prepare Animation

Time:

33.0 Years

Log ⟺ Linear

Return to Input

To All

To Array

ATTACHMENT 6

Sensitivity Analysis

Input/Output Screens

Flow Path B

BIOCHLOR Natural Attenuation Decision Support System

Version 2.2
Excel 2000

Color Spectrum
Flow Path B - 2013
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

TYPE OF CHLORINATED SOLVENT: Ethenes ◉ Ethanes ○

1. ADVECTION

Seepage Velocity*	Vs	15.2	(ft/yr)
or			
Hydraulic Conductivity	K	1.1E-04	(cm/sec)
Hydraulic Gradient	i	0.02	(ft/ft)
Effective Porosity	n	0.15	(-)

2. DISPERSION

Alpha x*	6.2711	(ft)
(Alpha y) / (Alpha x)*	0.1	(-)
(Alpha z) / (Alpha x)*	5.E-02	(-)

Calc.

3. ADSORPTION

Retardation Factor* → R
or

Soil Bulk Density, rho	1.7	(kg/L)		
FractionOrganicCarbon, foc	1.0E-3	(-)		
Partition Coefficient	Koc			
PCE	426	(L/kg)	5.83	(-)
TCE	130	(L/kg)	2.47	(-)
DCE	125	(L/kg)	2.42	(-)
VC	30	(L/kg)	1.34	(-)
ETH	302	(L/kg)	4.42	(-)
Common R (used in model)* =			**2.47**	

4. BIOTRANSFORMATION

-1st Order Decay Coefficient*

	λ (1/yr)		half-life (yrs)	Yield
Zone 1				
PCE → TCE	0.000	←		0.79
TCE → DCE	0.000	←		0.74
DCE → VC	0.000	←		0.64
VC → ETH	0.000	←		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*	33	(yr)
Modeled Area Width*	700	(ft)
Modeled Area Length*	154	(ft)
Zone 1 Length*	154	(ft)
Zone 2 Length*	0	(ft)

L, W

Zone 2=

6. SOURCE DATA

TYPE: Continuous / Single Planar

Source Options

Source Thickness in Sat. Zone* 15 (ft)

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

	Y1	k_s* (1/yr)
Width* (ft)	0.2	
Conc. (mg/L)*	C1	
PCE	.1	0
TCE		0
DCE		0
VC		0
ETH		0

View of Plume Looking Down

Observed Centerline Conc. at Monitoring Wells

7. FIELD DATA FOR COMPARISON

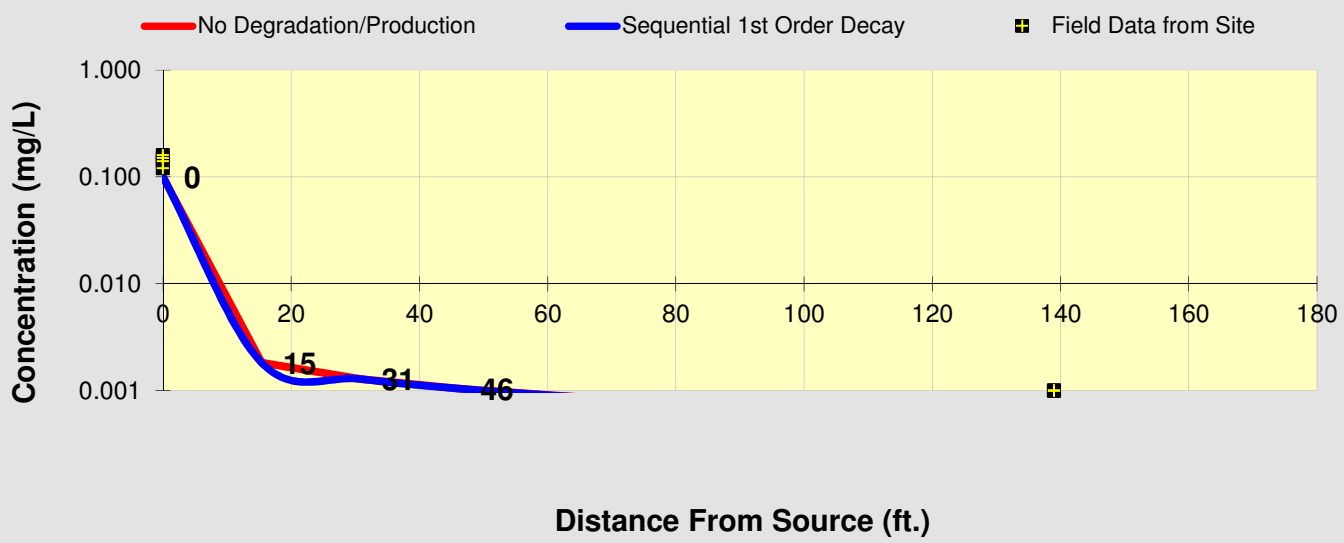
PCE Conc. (mg/L)	.12	.16	.14	.15	.001	.001	.001				
TCE Conc. (mg/L)											
DCE Conc. (mg/L)											
VC Conc. (mg/L)											
ETH Conc. (mg/L)											
Distance from Source (ft)	0	0	0	0	139	139	139				
Date Data Collected	2013										

8. CHOOSE TYPE OF OUTPUT TO SEE:

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

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

PCE	Distance from Source (ft)										
	0	15	31	46	62	77	92	108	123	139	154
No Degradation	0.100	0.002	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.000	0.000
Biotransformation	0.1000	0.002	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.000	0.000
	Monitoring Well Locations (ft)										
	0	0	0	0	139	139	139				
Field Data from Site	0.120	0.160	0.140	0.150	0.001	0.001	0.001				



See PCE

See TCE

See DCE

See VC

See ETH

Prepare Animation

Time:

33.0 Years

Log ⟺ Linear

Return to Input

To All

To Array

BIOCHLOR Natural Attenuation Decision Support System

Version 2.2
Excel 2000

Color Spectrum
Flow Path B - 2013
Run Name

TYPE OF CHLORINATED SOLVENT: Ethenes ◉ Ethanes ○

1. ADVECTION

Seepage Velocity*	Vs	15.2	(ft/yr)
or			
Hydraulic Conductivity	K	1.1E-04	(cm/sec)
Hydraulic Gradient	i	0.02	(ft/ft)
Effective Porosity	n	0.15	(-)

2. DISPERSION

Alpha x*	6.2711	(ft)
(Alpha y) / (Alpha x)*	0.1	(-)
(Alpha z) / (Alpha x)*	5.E-02	(-)

Calc.

3. ADSORPTION

Retardation Factor* → R

or

Soil Bulk Density, rho		1.7	(kg/L)	
FractionOrganicCarbon, foc		1.0E-3	(-)	
Partition Coefficient	Koc			
PCE	426	(L/kg)	5.83	(-)
TCE	130	(L/kg)	2.47	(-)
DCE	125	(L/kg)	2.42	(-)
VC	30	(L/kg)	1.34	(-)
ETH	302	(L/kg)	4.42	(-)
Common R (used in model)* =			**2.47**	

4. BIOTRANSFORMATION

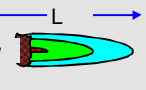
-1st Order Decay Coefficient*

	λ (1/yr)	half-life (yrs)	Yield
Zone 1			
PCE → TCE	0.000		0.79
TCE → DCE	0.000		0.74
DCE → VC	0.000		0.64
VC → ETH	0.000		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*	33	(yr)
Modeled Area Width*	700	(ft)
Modeled Area Length*	154	(ft)
Zone 1 Length*	154	(ft)
Zone 2 Length*	0	(ft)



Zone 2=

6. SOURCE DATA

TYPE: Continuous / Single Planar

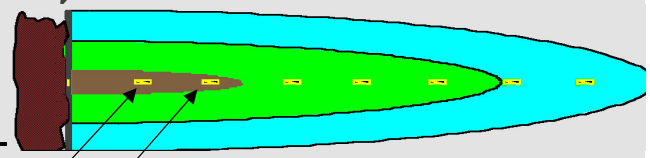
Source Options

Source Thickness in Sat. Zone* 15 (ft)

Width* (ft) Y1 = 0.2

Conc. (mg/L)*	C1	k_s* (1/yr)
PCE	.35	0
TCE		0
DCE		0
VC		0
ETH		0

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)	.12	.16	.14	.15	.001	.001	.001				
TCE Conc. (mg/L)											
DCE Conc. (mg/L)											
VC Conc. (mg/L)											
ETH Conc. (mg/L)											
Distance from Source (ft)	0	0	0	0	139	139	139				
Date Data Collected	2013										

8. CHOOSE TYPE OF OUTPUT TO SEE:

RUN CENTERLINE | **RUN ARRAY**

Help | Restore | RESET

SEE OUTPUT | Paste

Data Input Instructions:

115 → 1. Enter value directly....or

↑ *or*

0.02 → 2. Calculate by filling in gray cells. Press Enter, then C

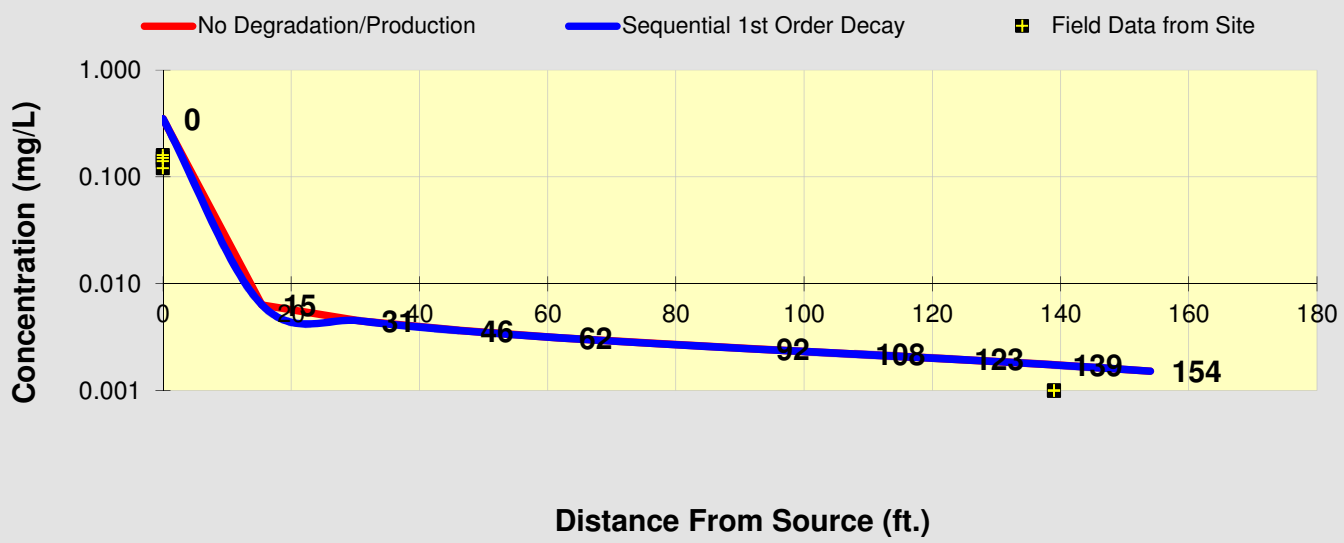
(To restore formulas, hit "Restore Formulas" button)

Variable* → Data used directly in model.

Test if Biotransformation is Occurring → Natural Attenuation

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

PCE	Distance from Source (ft)										
	0	15	31	46	62	77	92	108	123	139	154
No Degradation	0.350	0.006	0.004	0.004	0.003	0.003	0.002	0.002	0.002	0.002	0.002
Biotransformation	0.3500	0.006	0.004	0.004	0.003	0.003	0.002	0.002	0.002	0.002	0.002
	Monitoring Well Locations (ft)										
	0	0	0	0	139	139	139				
Field Data from Site	0.120	0.160	0.140	0.150	0.001	0.001	0.001				



See PCE

See TCE

See DCE

See VC

See ETH

Prepare Animation

Time:

33.0 Years

Log ⟺ Linear

Return to Input

To All

To Array

BIOCHLOR Natural Attenuation Decision Support System

Version 2.2
Excel 2000

Color Spectrum
Flow Path B - 2013
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

TYPE OF CHLORINATED SOLVENT: Ethenes ◉ Ethanes ○

1. ADVECTION

Seepage Velocity*	Vs	15.2	(ft/yr)
or			
Hydraulic Conductivity	K	1.1E-04	(cm/sec)
Hydraulic Gradient	i	0.02	(ft/ft)
Effective Porosity	n	0.15	(-)

2. DISPERSION

Alpha x*	6.2711	(ft)
(Alpha y) / (Alpha x)*	0.1	(-)
(Alpha z) / (Alpha x)*	5.E-02	(-)

Calc.

3. ADSORPTION

Retardation Factor* → R
or

Soil Bulk Density, rho	1.7	(kg/L)		
FractionOrganicCarbon, foc	1.0E-3	(-)		
Partition Coefficient	Koc			
PCE	426	(L/kg)	5.83	(-)
TCE	130	(L/kg)	2.47	(-)
DCE	125	(L/kg)	2.42	(-)
VC	30	(L/kg)	1.34	(-)
ETH	302	(L/kg)	4.42	(-)
Common R (used in model)* =			**2.47**	

4. BIOTRANSFORMATION

-1st Order Decay Coefficient*

	λ (1/yr)		half-life (yrs)	Yield
Zone 1				
PCE → TCE	0.000	←		0.79
TCE → DCE	0.000	←		0.74
DCE → VC	0.000	←		0.64
VC → ETH	0.000	←		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*	33	(yr)
Modeled Area Width*	700	(ft)
Modeled Area Length*	154	(ft)
Zone 1 Length*	154	(ft)
Zone 2 Length*	0	(ft)

L, W

Zone 2=

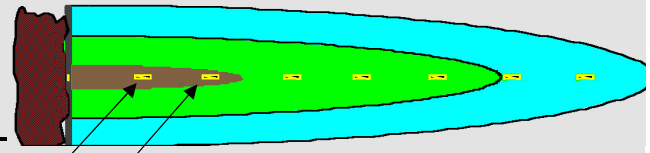
6. SOURCE DATA

TYPE: Continuous / Single Planar

Source Options

Source Thickness in Sat. Zone* 15 (ft)

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



	Y1	k_s* (1/yr)
Width* (ft)	0.2	
Conc. (mg/L)*	C1	
PCE	.75	0
TCE		0
DCE		0
VC		0
ETH		0

View of Plume Looking Down

Observed Centerline Conc. at Monitoring Wells

7. FIELD DATA FOR COMPARISON

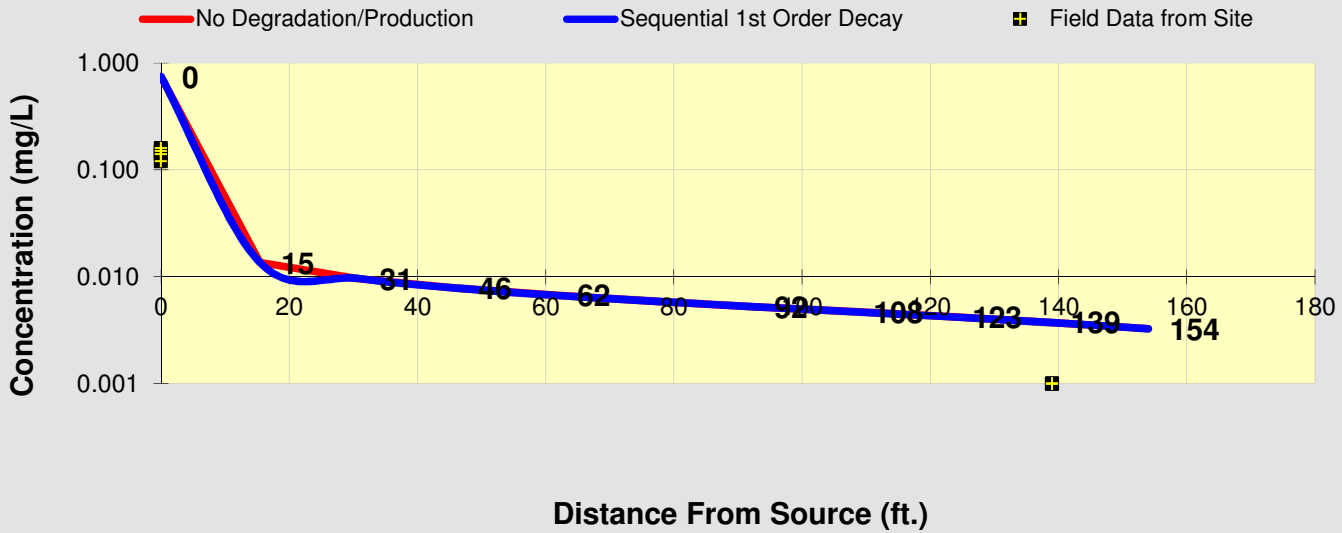
PCE Conc. (mg/L)	.12	.16	.14	.15	.001	.001	.001				
TCE Conc. (mg/L)											
DCE Conc. (mg/L)											
VC Conc. (mg/L)											
ETH Conc. (mg/L)											
Distance from Source (ft)	0	0	0	0	139	139	139				
Date Data Collected	2013										

8. CHOOSE TYPE OF OUTPUT TO SEE:

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

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

PCE	Distance from Source (ft)										
	0	15	31	46	62	77	92	108	123	139	154
No Degradation	0.750	0.014	0.010	0.008	0.007	0.006	0.005	0.005	0.004	0.004	0.003
Biotransformation	0.7500	0.014	0.010	0.008	0.007	0.006	0.005	0.005	0.004	0.004	0.003
	Monitoring Well Locations (ft)										
	0	0	0	0	139	139	139				
Field Data from Site	0.120	0.160	0.140	0.150	0.001	0.001	0.001				



See PCE

See TCE

See DCE

See VC

See ETH

Prepare Animation

Time:

33.0 Years

Log ⟺ Linear

Return to Input

To All

To Array

BIOCHLOR Natural Attenuation Decision Support System

Version 2.2
Excel 2000

Color Spectrum
Flow Path B - 2013
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

TYPE OF CHLORINATED SOLVENT: Ethenes ◉ Ethanes ○

1. ADVECTION

Seepage Velocity*	Vs	15.2	(ft/yr)
or			
Hydraulic Conductivity	K	1.1E-04	(cm/sec)
Hydraulic Gradient	i	0.02	(ft/ft)
Effective Porosity	n	0.15	(-)

2. DISPERSION

Alpha x*	6.2711	(ft)
(Alpha y) / (Alpha x)*	0.1	(-)
(Alpha z) / (Alpha x)*	5.E-02	(-)

Calc.

3. ADSORPTION

Retardation Factor* → R
or

Soil Bulk Density, rho	1.7	(kg/L)		
FractionOrganicCarbon, foc	1.0E-3	(-)		
Partition Coefficient	Koc			
PCE	426	(L/kg)	5.83	(-)
TCE	130	(L/kg)	2.47	(-)
DCE	125	(L/kg)	2.42	(-)
VC	30	(L/kg)	1.34	(-)
ETH	302	(L/kg)	4.42	(-)
Common R (used in model)* =			**2.47**	

4. BIOTRANSFORMATION

-1st Order Decay Coefficient*

	λ (1/yr)	half-life (yrs)	Yield
Zone 1			
PCE → TCE	0.000		0.79
TCE → DCE	0.000		0.74
DCE → VC	0.000		0.64
VC → ETH	0.000		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*	33	(yr)
Modeled Area Width*	700	(ft)
Modeled Area Length*	154	(ft)
Zone 1 Length*	154	(ft)
Zone 2 Length*	0	(ft)

L, W

Zone 2=

6. SOURCE DATA

TYPE: Continuous / Single Planar

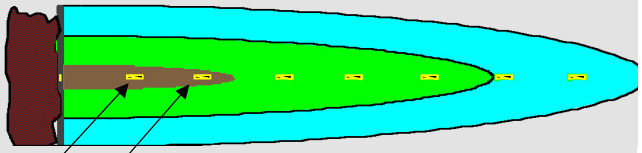
Source Options

Source Thickness in Sat. Zone* 15 (ft)

Width* (ft) Y1: 0.01

Conc. (mg/L)*	C1	k_s* (1/yr)
PCE	.35	0
TCE		0
DCE		0
VC		0
ETH		0

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

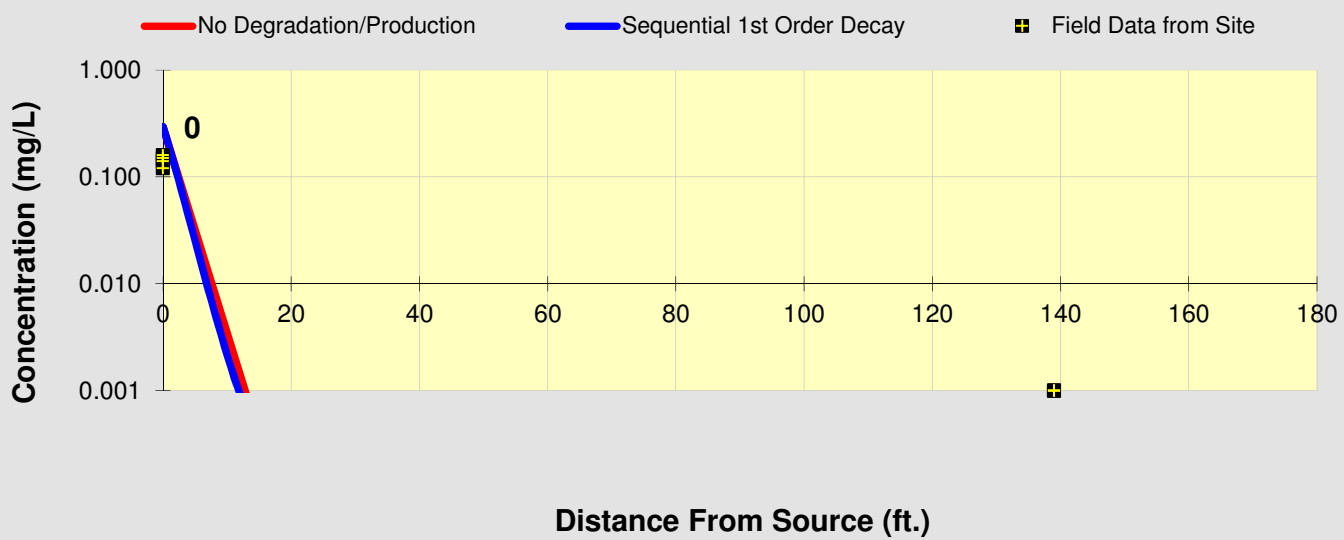
PCE Conc. (mg/L)	.12	.16	.14	.15	.001	.001	.001				
TCE Conc. (mg/L)											
DCE Conc. (mg/L)											
VC Conc. (mg/L)											
ETH Conc. (mg/L)											
Distance from Source (ft)	0	0	0	0	139	139	139				
Date Data Collected	2013										

8. CHOOSE TYPE OF OUTPUT TO SEE:

RUN CENTERLINE | **RUN ARRAY** | **Help** | Restore | RESET | ***SEE OUTPUT*** | Paste

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

PCE	Distance from Source (ft)										
	0	15	31	46	62	77	92	108	123	139	154
No Degradation	0.295	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Biotransformation	0.2947	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
	Monitoring Well Locations (ft)										
	0	0	0	0	139	139	139				
Field Data from Site	0.120	0.160	0.140	0.150	0.001	0.001	0.001				



See PCE

See TCE

See DCE

See VC

See ETH

Prepare Animation

Time:

33.0 Years

Log ⟺ Linear

Return to Input

To All

To Array

BIOCHLOR Natural Attenuation Decision Support System

Version 2.2
Excel 2000

Color Spectrum
Flow Path B - 2013
Run Name

TYPE OF CHLORINATED SOLVENT: Ethenes ◉ Ethanes ○

1. ADVECTION

Seepage Velocity*	Vs	15.2	(ft/yr)
or			
Hydraulic Conductivity	K	1.1E-04	(cm/sec)
Hydraulic Gradient	i	0.02	(ft/ft)
Effective Porosity	n	0.15	(-)

2. DISPERSION

Alpha x*	6.2711	(ft)
(Alpha y) / (Alpha x)*	0.1	(-)
(Alpha z) / (Alpha x)*	5.E-02	(-)

Calc.

3. ADSORPTION

Retardation Factor* → R

or

Soil Bulk Density, rho		1.7	(kg/L)	
FractionOrganicCarbon, foc		1.0E-3	(-)	
Partition Coefficient	Koc			
PCE	426	(L/kg)	5.83	(-)
TCE	130	(L/kg)	2.47	(-)
DCE	125	(L/kg)	2.42	(-)
VC	30	(L/kg)	1.34	(-)
ETH	302	(L/kg)	4.42	(-)
Common R (used in model)* =			**2.47**	

4. BIOTRANSFORMATION

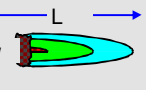
-1st Order Decay Coefficient*

	λ (1/yr)	half-life (yrs)	Yield
Zone 1			
PCE → TCE	0.000		0.79
TCE → DCE	0.000		0.74
DCE → VC	0.000		0.64
VC → ETH	0.000		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*	33	(yr)
Modeled Area Width*	700	(ft)
Modeled Area Length*	154	(ft)
Zone 1 Length*	154	(ft)
Zone 2 Length*	0	(ft)



Zone 2=

6. SOURCE DATA

TYPE: Continuous / Single Planar

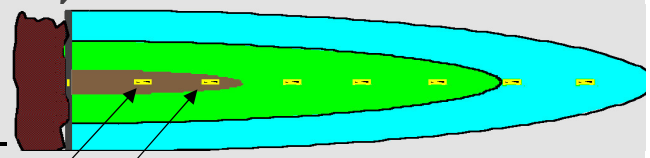
Source Options

Source Thickness in Sat. Zone* 15 (ft)

Width* (ft) Y1 = 0.2

Conc. (mg/L)*	C1	k_s* (1/yr)
PCE	.35	0
TCE		0
DCE		0
VC		0
ETH		0

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)	.12	.16	.14	.15	.001	.001	.001				
TCE Conc. (mg/L)											
DCE Conc. (mg/L)											
VC Conc. (mg/L)											
ETH Conc. (mg/L)											
Distance from Source (ft)	0	0	0	0	139	139	139				
Date Data Collected	2013										

8. CHOOSE TYPE OF OUTPUT TO SEE:

RUN CENTERLINE | **RUN ARRAY**

Help | Restore | RESET

SEE OUTPUT | Paste

Data Input Instructions:

115 → 1. Enter value directly....or

↑ *or*

0.02 → 2. Calculate by filling in gray cells. Press Enter, then C

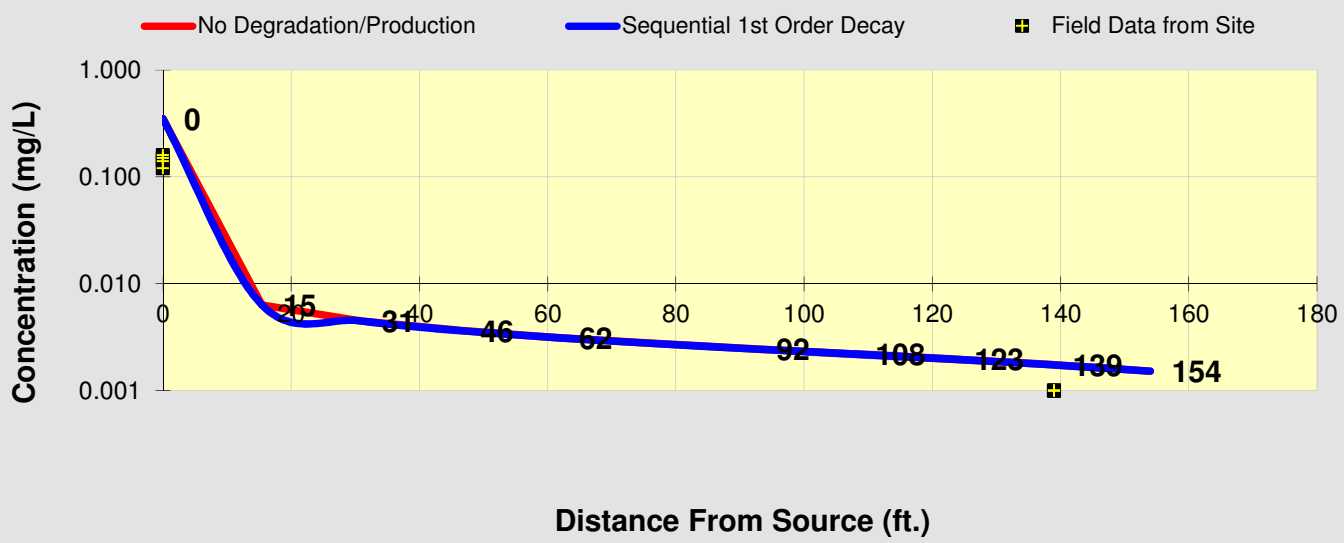
(To restore formulas, hit "Restore Formulas" button)

Variable* → Data used directly in model.

Test if Biotransformation is Occurring → Natural Attenuation

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

PCE	Distance from Source (ft)										
	0	15	31	46	62	77	92	108	123	139	154
No Degradation	0.350	0.006	0.004	0.004	0.003	0.003	0.002	0.002	0.002	0.002	0.002
Biotransformation	0.3500	0.006	0.004	0.004	0.003	0.003	0.002	0.002	0.002	0.002	0.002
	Monitoring Well Locations (ft)										
	0	0	0	0	139	139	139				
Field Data from Site	0.120	0.160	0.140	0.150	0.001	0.001	0.001				



See PCE

See TCE

See DCE

See VC

See ETH

Prepare Animation

Time:

33.0 Years

Log ⟺ Linear

Return to Input

To All

To Array

BIOCHLOR Natural Attenuation Decision Support System

Version 2.2
Excel 2000

Color Spectrum
Flow Path B - 2013
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

TYPE OF CHLORINATED SOLVENT: Ethenes ◉ Ethanes ○

1. ADVECTION

Seepage Velocity*	Vs	15.2	(ft/yr)
or			
Hydraulic Conductivity	K	1.1E-04	(cm/sec)
Hydraulic Gradient	i	0.02	(ft/ft)
Effective Porosity	n	0.15	(-)

2. DISPERSION

Alpha x*	6.2711	(ft)
(Alpha y) / (Alpha x)*	0.1	(-)
(Alpha z) / (Alpha x)*	5.E-02	(-)

Calc.

3. ADSORPTION

Retardation Factor* → R
or

Soil Bulk Density, rho		1.7	(kg/L)	
FractionOrganicCarbon, foc		1.0E-3	(-)	
Partition Coefficient	Koc			
PCE	426	(L/kg)	5.83	(-)
TCE	130	(L/kg)	2.47	(-)
DCE	125	(L/kg)	2.42	(-)
VC	30	(L/kg)	1.34	(-)
ETH	302	(L/kg)	4.42	(-)
Common R (used in model)* =			**2.47**	

4. BIOTRANSFORMATION

-1st Order Decay Coefficient*

Zone 1

	λ (1/yr)	half-life (yrs)	Yield
PCE → TCE	0.000		0.79
TCE → DCE	0.000		0.74
DCE → VC	0.000		0.64
VC → ETH	0.000		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*	33	(yr)	
Modeled Area Width*	700	(ft)	
Modeled Area Length*	154	(ft)	
Zone 1 Length*	154	(ft)	
Zone 2 Length*	0	(ft)	Zone 2=

6. SOURCE DATA

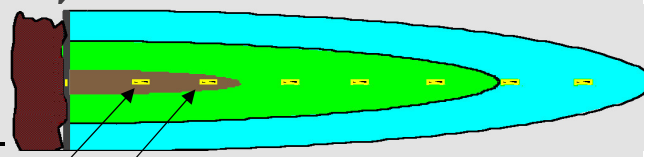
TYPE: Continuous
Single Planar

Source Options

Source Thickness in Sat. Zone* 15 (ft)

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

	Y1	k_s* (1/yr)
Width* (ft)	1	
Conc. (mg/L)*	C1	
PCE	.35	0
TCE		0
DCE		0
VC		0
ETH		0



View of Plume Looking Down

Observed Centerline Conc. at Monitoring Wells

7. FIELD DATA FOR COMPARISON

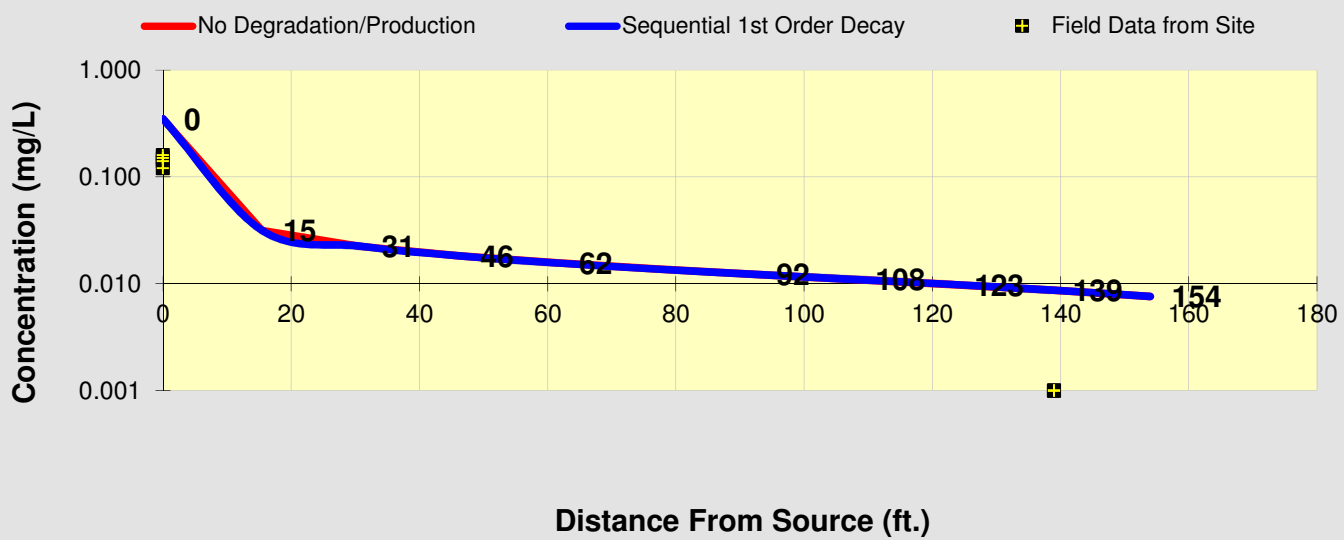
PCE Conc. (mg/L)	.12	.16	.14	.15	.001	.001	.001				
TCE Conc. (mg/L)											
DCE Conc. (mg/L)											
VC Conc. (mg/L)											
ETH Conc. (mg/L)											
Distance from Source (ft)	0	0	0	0	139	139	139				
Date Data Collected	2013										

8. CHOOSE TYPE OF OUTPUT TO SEE:

RUN CENTERLINE | **RUN ARRAY** | **Help** | Restore | RESET | ***SEE OUTPUT*** | Paste

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

PCE	Distance from Source (ft)										
	0	15	31	46	62	77	92	108	123	139	154
No Degradation	0.350	0.032	0.022	0.018	0.016	0.014	0.012	0.011	0.010	0.009	0.008
Biotransformation	0.3500	0.032	0.022	0.018	0.016	0.014	0.012	0.011	0.010	0.009	0.008
	Monitoring Well Locations (ft)										
	0	0	0	0	139	139	139				
Field Data from Site	0.120	0.160	0.140	0.150	0.001	0.001	0.001				



See PCE

See TCE

See DCE

See VC

See ETH

Prepare Animation

Time:

33.0 Years

Log ⟺ Linear

Return to Input

To All

To Array

BIOCHLOR Natural Attenuation Decision Support System

Version 2.2
Excel 2000

Color Spectrum
Flow Path B - 2013
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

TYPE OF CHLORINATED SOLVENT: Ethenes ◉ Ethanes ○

1. ADVECTION

Seepage Velocity*	Vs	15.2	(ft/yr)
or			
Hydraulic Conductivity	K	1.1E-04	(cm/sec)
Hydraulic Gradient	i	0.02	(ft/ft)
Effective Porosity	n	0.15	(-)

2. DISPERSION

Alpha x*	6.2711	(ft)
(Alpha y) / (Alpha x)*	0.1	(-)
(Alpha z) / (Alpha x)*	5.E-02	(-)

Calc.

3. ADSORPTION

Retardation Factor* → R
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Soil Bulk Density, rho	1.7	(kg/L)		
FractionOrganicCarbon, foc	1.0E-3	(-)		
Partition Coefficient	Koc			
PCE	426	(L/kg)	5.83	(-)
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DCE	125	(L/kg)	2.42	(-)
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Common R (used in model)* =			**2.47**	

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	λ (1/yr)	half-life (yrs)	Yield
Zone 1			
PCE → TCE	0.000		0.79
TCE → DCE	0.000		0.74
DCE → VC	0.000		0.64
VC → ETH	0.000		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*	33	(yr)
Modeled Area Width*	700	(ft)
Modeled Area Length*	154	(ft)
Zone 1 Length*	154	(ft)
Zone 2 Length*	0	(ft)

L, W

Zone 2=

6. SOURCE DATA

TYPE: Continuous / Single Planar

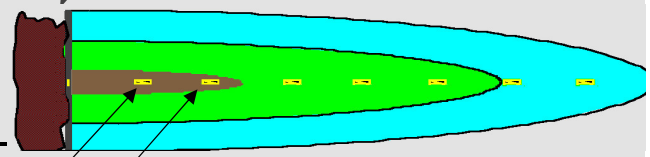
Source Options

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

Source Thickness in Sat. Zone* 15 (ft)

Y1
Width* (ft) 5

Conc. (mg/L)*	C1	k_s* (1/yr)
PCE	.35	0
TCE		0
DCE		0
VC		0
ETH		0



View of Plume Looking Down

Observed Centerline Conc. at Monitoring Wells

7. FIELD DATA FOR COMPARISON

PCE Conc. (mg/L)	.12	.16	.14	.15	.001	.001	.001				
TCE Conc. (mg/L)											
DCE Conc. (mg/L)											
VC Conc. (mg/L)											
ETH Conc. (mg/L)											
Distance from Source (ft)	0	0	0	0	139	139	139				

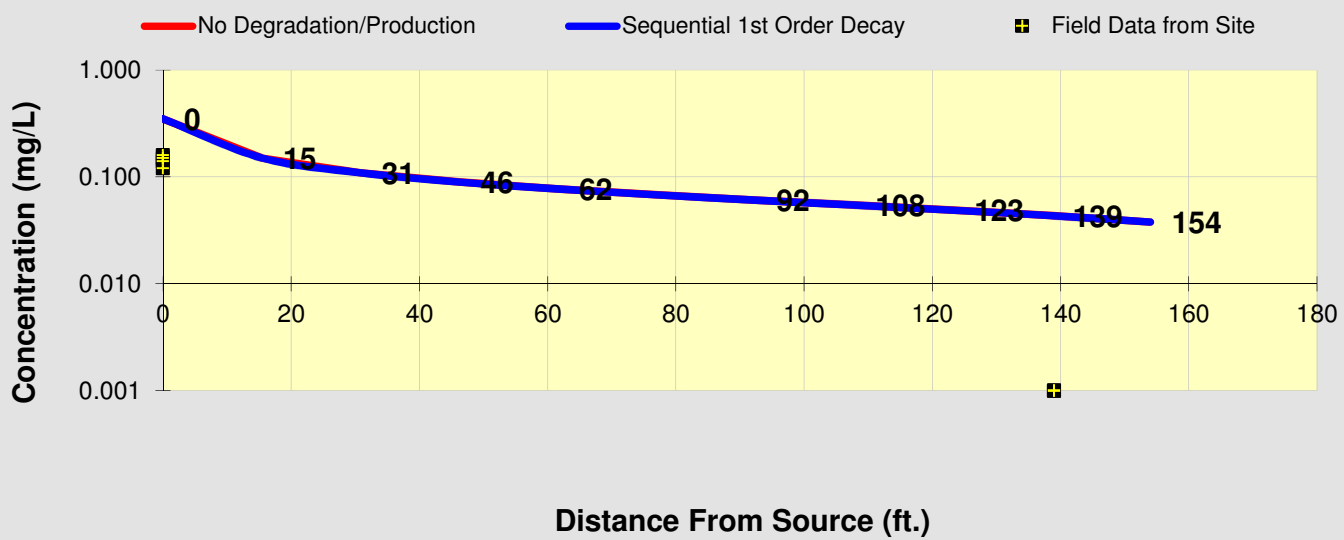
Date Data Collected: 2013

8. CHOOSE TYPE OF OUTPUT TO SEE:

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

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

PCE	Distance from Source (ft)										
	0	15	31	46	62	77	92	108	123	139	154
No Degradation	0.350	0.151	0.109	0.090	0.077	0.068	0.061	0.054	0.049	0.043	0.038
Biotransformation	0.3500	0.151	0.109	0.090	0.077	0.068	0.061	0.054	0.049	0.043	0.038
	Monitoring Well Locations (ft)										
	0	0	0	0	139	139	139				
Field Data from Site	0.120	0.160	0.140	0.150	0.001	0.001	0.001				



See PCE

See TCE

See DCE

See VC

See ETH

Prepare Animation

Time:

33.0 Years

Log ⟺ Linear

Return to Input

To All

To Array