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EMAIL OF TRANSMITTAL FOR DRAFT MASS FLUX MEASUREMENTS REPORT FOR SITE 45 DRY CLEANING FACILITY SPILL AREA WITH ATTACHMENT MCRD PARRIS ISLAND SC
2/20/2007
U S EPA REGION IV

Sladic, Mark -- NUS

From: Cummings.James@epamail.epa.gov
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Subject: Fw: EnviroFlux Parris Island report

Attachments: EnviroFlux Parris Island Report 01.29.07.pdf

EnviroFlux Parris Island Repor...

Per my voice mail message, attached is the draft report from the vendor of the Enviroflux Passive Flux Meter (PFM) tool.

As we have discussed in the past, the primary purpose of this project was to evaluate the PFM tool. A subsidiary objective was to see if we could generate data that might be useful for planning and decision-making at SWMU-45.

We have quite a bit of work to do to prepare a complete report on this project. Not knowing whether the Navy and their consultants might be planning to conduct any additional near-term sampling, I decided to share the draft vendor's report with you now rather than waiting until we complete our analysis. A/The main reason for doing so is the results from two locations - PFM-04 and MW-04-SL. Among the possible interpretations of these data points is a discrete, permeable channel serving as a significant conduit for contaminant transport.

We will be having a conf call w/ the vendor next week to discuss these results and to map out a game plan for completing the larger report on the PFM deployment.

Jim Cummings
Technology Assessment Branch/OSRTI/OSWER USEPA (5102G) 1200 Pennsylvania Ave NW
Washington, DC 20460
703-603-7197

----- Forwarded by James Cummings/DC/USEPA/US on 02/20/2007 04:09 PM -----

"Burhan, Younus -- EMI" <Younus.Burhan@temi.com> 01/30/2007 01:04 PM

To: James Cummings/DC/USEPA/US@EPA
cc:
Subject: FW: EnviroFlux Parris Island report

Hi Jim,

Hope you are enjoying your vacation. Attached is the draft report we received from EnviroFlux. I have asked Robert to review the report and I suggest we have a conference call after we have had a chance to review.

Thanks,

Younus

From: Matt Tilman [mailto:matt.tilman@enviroflux.com]
Sent: Monday, January 29, 2007 5:05 PM
To: Burhan, Younus -- EMI
Subject: EnviroFlux Parris Island report

Younus,

I apologize for the delay in getting this report to you. Please let me know if you have any questions. Thanks!

Matt(See attached file: EnviroFlux Parris Island Report 01.29.07.pdf)

MASS FLUX MEASUREMENTS AT SOLID WASTE MANAGEMENT UNIT (SWMU) 45: MARINE CORPS RECRUIT DEPOT (MCRD), PARRIS ISLAND, SOUTH CAROLINA

Prepared for

Tetra Tech EM Inc.

TETRA TECH, INC.

Prepared by

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January 29, 2007

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1. Executive Summary

Passive Flux Meters (PFMs) were used to measure the ambient groundwater flux and contaminant mass flux at a solid waste management unit (SWMU) 45 located on the Marine Corps Recruit Depot (MCRD), Parris Island, South Carolina. Flux refers to the mass of water and or contaminants flowing per unit area at a measured point in a well screen averaged over a given period of time. Based upon previous site assessments, the expected contaminants at SWMU 45 were tetrachloroethene (PCE), trichloroethene (TCE), and dechlorination products dichloroethene (DCE), vinyl chloride (VC), and ethene.

Plots of flux profiles are provided for the 15 flux wells installed at the site and data are summarized in Appendix A. The maximum local mass flux (115 $mg/m^2/day$) was observed for DCE in the lower portion of well PFM-04. A maximum TCE mass flux of 74.5 $mg/m^2/day$ was observed in MW20-SL. PCE mass flux was observed in MW04-SL and MW20-SU (12.6 and 9.5 $mg/m^2/day$ respectively). The local flux values were integrated to find mass discharges for a control plane defined between wells PFM-03 and PFM-02. At the control plane the primary mass discharge was DCE at 2.84 mg/day.

These results can be used to better understand the nature and extent of contamination and the aquifer flow characteristics for this site.

2. Introduction

Passive Flux Meters (PFMs) were used to measure the ambient groundwater flux and contaminant mass flux at a solid waste management unit (SWMU) 45 located on the Marine Corps Recruit Depot (MCRD), Parris Island, South Carolina. For a description of PFM fundamentals see Hatfield et al. 2004 and for field implementation see Annable et al. 2005. Flux refers to the mass of water and or contaminants flowing per unit area at a measured point in a well screen averaged over a given period of time. Based upon this general definition, the units associated with mass flux are determined as:

$$flux = \frac{mass}{area \cdot time} = \left[\frac{M}{L^2 T}\right]$$

where the terms M, L, and T represent the base units of mass, length, and time respectively. For consistency with common practice, the ambient groundwater flux will be discussed in terms of the specific discharge or Darcy velocity, which is the volumetric water flux (or flowrate) through a specified cross-sectional area. The resulting units are L/T and for this report the Darcy velocity will be represented with the units of cm/day. For this report the contaminant flux will be discussed in terms of mass flux ($M/(L^2T)$) and represented with the units of ($mg/(m^2day)$).

Based upon previous site assessments, the expected contaminants at SWMU 45 were tetrachloroethene (PCE), trichloroethene (TCE), and dechlorination products dichloroethene (DCE), vinyl chloride (VC), and ethene (TtNUS, 2002; 2005). The SWMU 45 site has historically been divided into northern and southern source areas (Figure 1). For the purposes of this project, consistent terminology (identification of the northern and southern source areas) will be implemented.

The intent of this project was to provide assistance with refining the conceptual site model (CSM), which can then be used to provide support for the design of a remedy for the southern source area located within SWMU 45. For this effort, EPA and its teaming partner, the United States Navy, established the following project objectives associated with the deployment of PFMs:

- Refine the current understanding of the nature and extent of the contamination and the aquifer flow characteristics (flux) in the southern source area
- Identify other potential up-gradient sources

To meet these objectives, 29 PFMs were deployed in 15 wells in order to observe and compare relative flux values at the site (26 PFMs in 14 wells for the southern site, and 3 PFMs in 1 well for the northern site). Figure 1 provides a site map indicating monitoring well and PFM installation locations.

3. Methods and Procedures

Southern Site

26 PFMs were deployed in 14, 2-inch diameter wells on November 14, 2006. PFMs in the southern site were deployed along two transects (A-A' and B-B'). Transect A-A' (Figure 1) is oriented perpendicular to the primary direction of groundwater flow and incorporates wells MW19-SL, MW19-SU, PFM-03, PFM-02, MW10-SL, MW10-SU, MW3-SL, and MW3-SU. Transect B-B' (Figure 1) is oriented parallel to the primary direction of groundwater flow and incorporates wells PFM-01, PFM-02, MW04-SL, MW04-SU, MW20-SL, MW20-SU, and PFM-04. (Note: PFM-02 is used as the intersection for the two transects).

The PFMs in the southern site were retrieved on December 5, 2006 (corresponding to a deployment length of 21 days). All 26 PFMs were successfully retrieved, sampled and analyzed to estimate both groundwater and contaminant mass flux. The results are shown in Figures 2 and 3 and the data is summarized in Table 3 (Appendix A).

Northern Site

Three PFM were deployed in a single well (PMW-03) in the northern site on September 29, 2006. The PFMs in the southern site were retrieved on October 10, 2006 (corresponding to a deployment length of 11 days). The results are shown in Figure 3 and the data is summarized in Table 4 (Appendix A).

4. Results

Southern Site

Flux data for the southern site are organized in terms of two transects: A-A' which is oriented perpendicular to the primary direction of groundwater flow, and B-B' which is oriented parallel to the primary direction of groundwater flow. The observed Darcy velocity and flux profiles for transect A-A' and B-B' are shown in Figures 2 and 3 respectively. It should be noted that results for nested wells such as MW03-SL and MW03-SU are combined with the respective upper and lower zones indicated in the figures.

For transect A-A' Darcy velocities are seen to be higher in the upper portion of the surficial aquifer in wells MW19-SU, PFM-03, and PFM-02, with the largest value of 8 cm/day in the upper portion of PFM-02. The greatest DCE and TCE fluxes are also seen in the upper portion of PFM-02. The Darcy velocities in wells MW10 and MW03 are considerably lower as are the mass flux values.

For transect B-B' the Darcy velocities in PFM-01 are relatively low (0.6 cm/day) in the upper portion of the aquifer with increasing velocities in the lower zone (2.9 cm/day). Moving along transect B-B' from PFM-02 to PFM-04 Darcy velocities are consistently in the range of 5 to 8 cm/day in the upper zone. In wells PFM-02, MW04, and MW20 the

velocities are lower in the lower zone. However in PFM-04, the velocities appear to increase with depth. For each well beyond PFM-01, DCE and TCE flux tend to increase with increased velocity (except for well MW04-UL, which shows minimal mass flux). The lower portion of the upper zone well MW20-SU has some apparent PCE flux and the highest TCE flux in the transect. Similarly, the upper portion of lower zone well MW04-SL has both PCE and TCE flux. In well PFM-04 there is a definite trend of increasing Darcy velocity and DCE flux with depth. DCE is the primary contaminant present within this profile.

Northern Site

Flux data for the northern site were collected from three PFMs that were deployed in a single well (PMW-03). The results are shown in Figure 3 and the data is summarized in Table 4 (Appendix A). The observed Darcy velocities in PMW-03 are similar to those of the southern site. However, the chlorinated solvent fluxes (PCE, TCE, DCE, and VC) are considerably higher, with DCE having the greatest flux magnitude (mean and max values of 302 and 633 mg/m^2/day respectively). Three high flux zones at depths of 5, 10 and 13 feet suggest DNAPL pool zones up-gradient with conversion to DCE prior to the flux well.

Integrated Mass Flux

The contaminant mass flux values measured at the local scale (1 foot vertical intervals) can be represented in terms of mass discharge per unit width of aquifer (mg/m/day) and are summarized in Table 1. These values can in turn be used to estimate the mass discharge (mg/day) through a specified aquifer width.

Table 1. Mass discharge per unit width of aquifer for each well.

Well	Ethene (mg/m/day)	VC (mg/m/day)	cis-DCE (mg/m/day)	TCE (mg/m/day)	PCE (mg/m/day)	Total (mmoles/m/d)
MW03-SL	0.0	0.0	4.5	0.4	0.0	0.05
MW03-SU	0.0	0.0	0.0	0.0	0.0	0.00
MW04-SL	0.4	0.0	26.2	27.8	4.0	0.52
MW04-SU	0.0	0.0	0.0	0.0	0.0	0.00
MW10-SL	0.0	0.0	4.3	0.6	0.0	0.05
MW10-SU	0.0	0.0	0.0	0.0	0.0	0.00
MW19-SL	0.0	0.0	0.0	0.0	0.0	0.00
MW19-SU	0.0	0.0	0.0	0.0	0.0	0.00
MW20-SL	0.0	0.0	17.7	0.0	0.0	0.18
MW20-SU	1.4	0.0	29.3	53.3	4.7	0.78
PFM-01	1.4	0.0	67.5	22.8	0.0	0.91
PFM-02	0.9	0.0	61.2	53.5	0.4	1.07
PFM-03	0.1	0.0	36.7	12.7	0.0	0.48
PFM-04	0.0	0.0	235.0	6.8	0.0	2.48
PMW-03*	0.0	45.3	1240.0	98.4	44.4	14.50

**Note: PMW-03 is located in the northern site. All other wells are located in the southern site.*

The mass loads associated with each well provide an integrated measure of contaminant movement at the site. The wells forming the transect B-B' indicate total molar discharges in the range 0.5 to 2.5 mmoles/m/day. Given the gap in data associated with the nested well (MW04 and MW20) the trend of increasing total molar discharge with flow distance may be consistent with a source zone with declining mass flux.

The summation of the product of flux and the cross-sectional flow area represents integration of mass flux and can be used to estimate mass discharge at each well and for a transect of wells. Kübert and Finkel (2006) present a review of the methods and errors associated with mass flux integrations. The following equation is used.

$$W_{cp} = \sum_{n=1}^{n_{well}} \left(\sum_{m}^{m_{ver}} F_{n,m} A_{n,m} \right)$$

For analysis of the SWMU 45 data, wells PFM-03 and PFM-02 can be used to form a control plane perpendicular to the primary direction of groundwater flow. The control plane is assumed to be 190 ft wide based upon a well spacing of 95 ft. Applying the 95 ft width for each well with the mass discharge per unit width from Table 1, the total mass discharge through the control plane for each constituent can be estimated as

Table 2. Estimates of mass discharge at each well and the control plane.

Well	PCE	TCE	cis-DCE	VC	Ethene
	(g/day)	(g/day)	(g/day)	(g/day)	(g/day)
PFM-02	0.03	0	1.77	1.55	0.01
PFM-03	0.00	0	1.06	0.37	0
Control Plane	0.03	0	2.84	1.92	0.01

The results indicate that the primary components passing the control plane are DCE (2.84 g/day) and VC (1.92 g/day). This mass discharge can be compared to other DNAPL contaminated sites for which mass discharges are reported (Einerson and Makay, 2001).

The results of this study, in combination with previous site characterization efforts, can be used to better understand the nature and extent of contamination and the aquifer flow characteristics for this site.

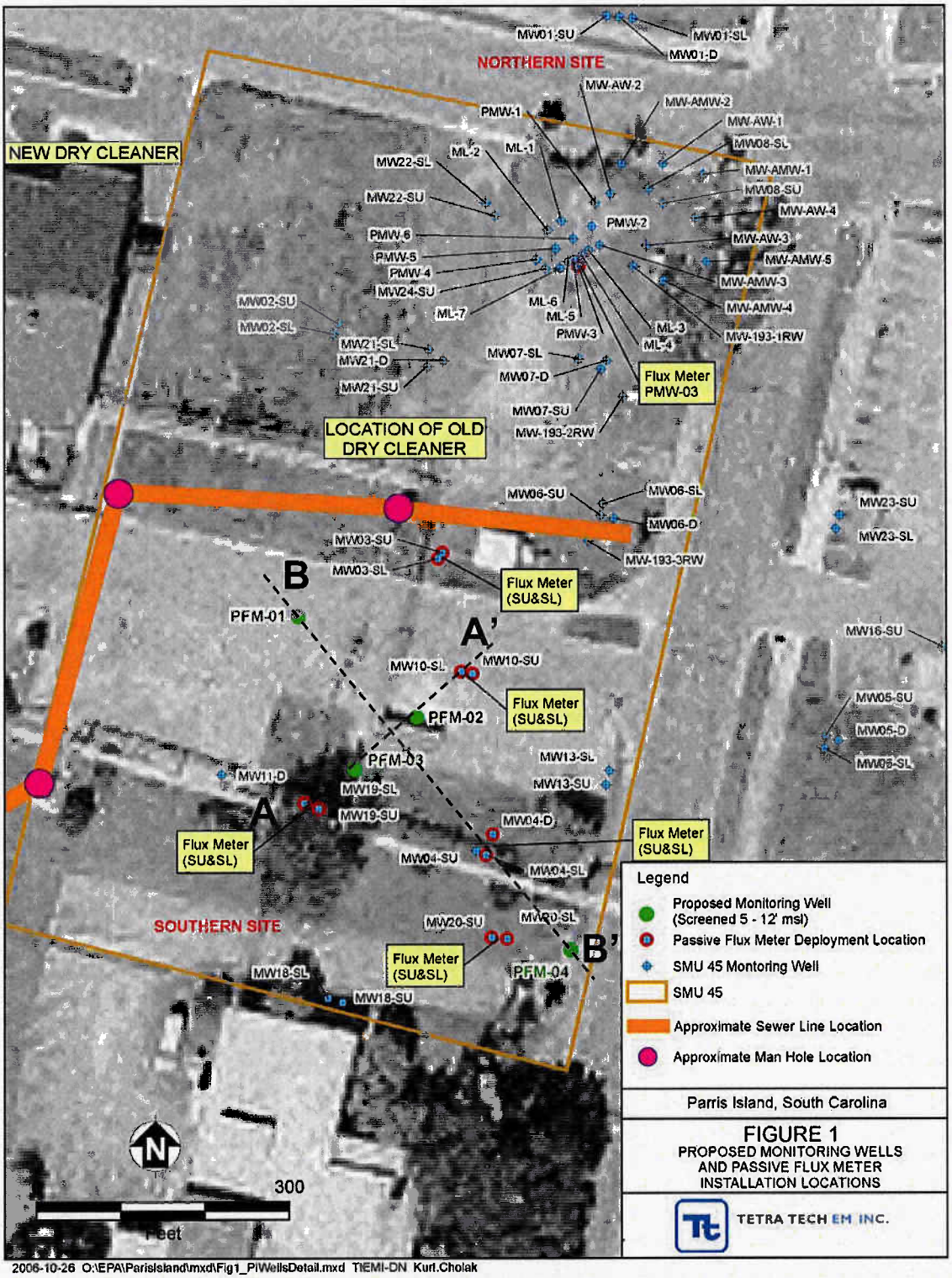

Figure 1. Site map with PFM installation locations (map provided by Tetra Tech).

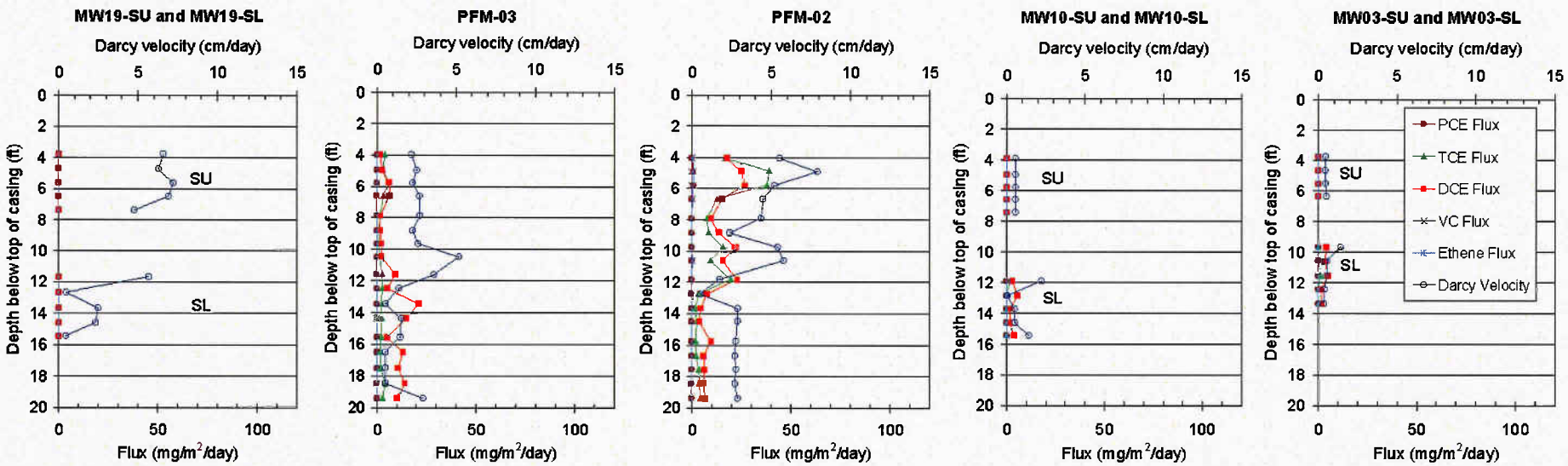

Figure 2. Darcy velocity and flux profiles for wells in transect A-A'.

Note: results for nested wells are combined with the respective upper (SU) and lower (SL) zones indicated in the figures.

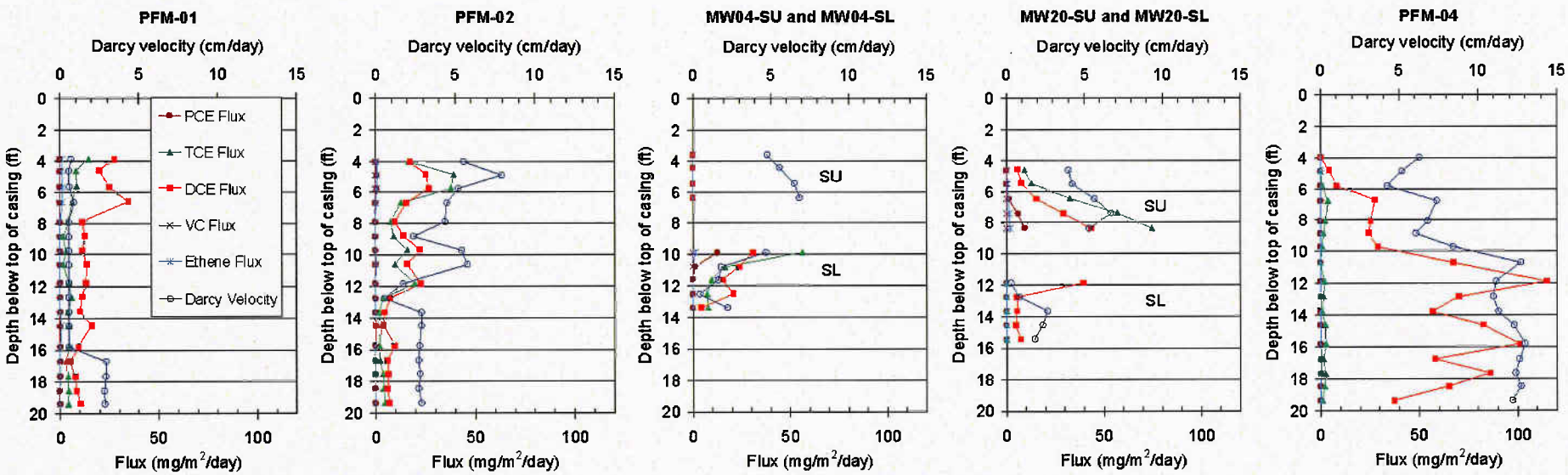

Figure 3: Darcy velocity and flux profiles for wells in transect B-B'.

Note: results for nested wells are combined with the respective upper (SU) and lower (SL) zones indicated in the figures.

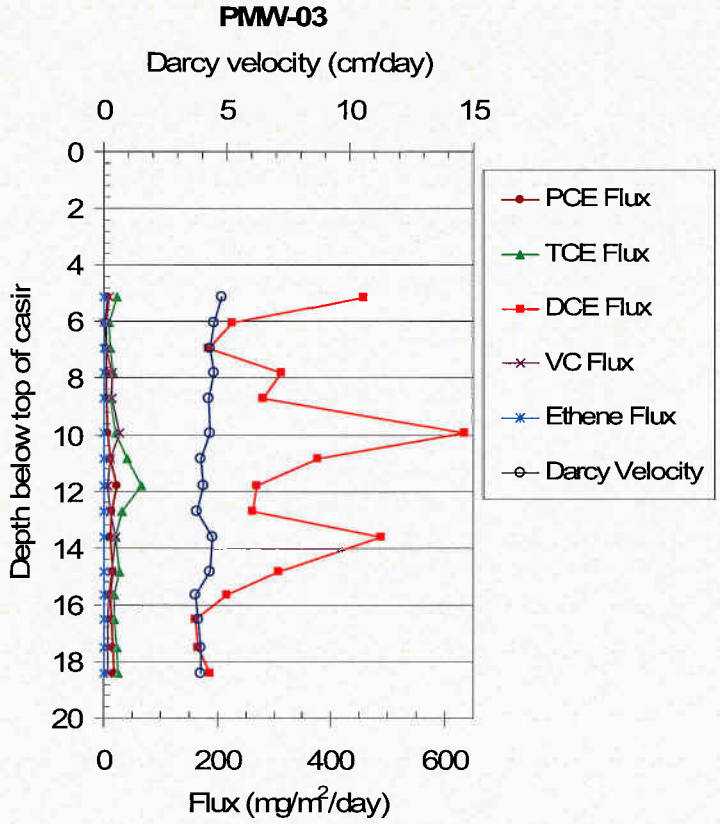

Figure 4. Darcy velocity and flux profiles for well PMW-03 (Northern Site).

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Appendix A: Data from Flux Wells

Table 3. Summary of flux values for southern site.

Well_ID	Distance from bottom of well screen (ft)	Approximate Depth below top of well casing (ft)	Darcy Velocity (cm/day)	Ethene flux (mg/m2/day)	VC flux (mg/m2/day)	DCE flux (mg/m2/day)	TCE flux (mg/m2/day)	PCE flux (mg/m2/day)
MW03-SL	4.33	9.67	1.410	0.000	0.000	4.145	0.000	0.000
MW03-SL	3.40	10.60	0.548	0.000	0.000	3.461	0.000	0.000
MW03-SL	2.44	11.56	0.525	0.000	0.000	5.064	1.413	0.000
MW03-SL	1.55	12.45	0.403	0.000	0.000	1.486	0.000	0.000
MW03-SL	0.64	13.36	0.337	0.000	0.000	2.051	0.000	0.000
MW03-SU	3.28	3.72	0.453	0.000	0.000	0.000	0.000	0.000
MW03-SU	2.35	4.65	0.437	0.000	0.000	0.000	0.000	0.000
MW03-SU	1.51	5.49	0.455	0.000	0.000	0.000	0.000	0.000
MW03-SU	0.64	6.36	0.523	0.000	0.000	0.000	0.000	0.000
MW04-SL	4.10	9.90	4.718	1.400	0.000	31.083	56.465	12.616
MW04-SL	3.21	10.79	1.822	0.000	0.000	24.067	16.635	1.054
MW04-SL	2.38	11.62	1.639	0.000	0.000	15.498	9.725	0.000
MW04-SL	1.50	12.50	0.473	0.000	0.000	20.882	7.491	0.000
MW04-SL	0.61	13.39	2.247	0.000	0.000	4.540	8.022	0.000
MW04-SU	3.42	3.58	4.784	0.000	0.000	0.000	0.000	0.000
MW04-SU	2.62	4.38	5.576	0.000	0.000	0.000	0.000	0.000
MW04-SU	1.57	5.43	6.538	0.000	0.000	0.000	0.000	0.000
MW04-SU	0.62	6.38	6.863	0.000	0.000	0.000	0.000	0.000
MW10-SL	4.08	11.92	2.219	0.000	0.000	2.994	1.845	0.000
MW10-SL	3.14	12.86	0.064	0.000	0.000	5.703	0.000	0.000
MW10-SL	2.29	13.71	0.491	0.000	0.000	1.993	0.000	0.000
MW10-SL	1.39	14.61	0.537	0.000	0.000	1.552	0.000	0.000
MW10-SL	0.56	15.44	1.407	0.000	0.000	4.078	0.000	0.000
MW10-SU	4.11	3.89	0.553	0.000	0.000	0.000	0.000	0.000
MW10-SU	3.06	4.94	0.554	0.000	0.000	0.000	0.000	0.000
MW10-SU	2.21	5.79	0.554	0.000	0.000	0.000	0.000	0.000
MW10-SU	1.43	6.57	0.554	0.000	0.000	0.000	0.000	0.000
MW10-SU	0.61	7.39	0.550	0.000	0.000	0.000	0.000	0.000
MW19-SL	4.33	11.67	5.698	0.000	0.000	0.000	0.000	0.000
MW19-SL	3.34	12.66	0.492	0.000	0.000	0.000	0.000	0.000
MW19-SL	2.34	13.66	2.502	0.000	0.000	0.000	0.000	0.000
MW19-SL	1.41	14.59	2.343	0.000	0.000	0.000	0.000	0.000
MW19-SL	0.57	15.43	0.466	0.000	0.000	0.000	0.000	0.000
MW19-SU	4.25	3.75	6.605	0.000	0.000	0.000	0.000	0.000
MW19-SU	3.30	4.70	6.311	0.000	0.000	0.000	0.000	0.000
MW19-SU	2.38	5.62	7.227	0.000	0.000	0.000	0.000	0.000
MW19-SU	1.50	6.50	6.931	0.000	0.000	0.000	0.000	0.000
MW19-SU	0.62	7.38	4.791	0.000	0.000	0.000	0.000	0.000
MW20-SL	4.15	11.85	0.283	0.000	0.000	39.697	0.000	0.000
MW20-SL	3.25	12.75	0.854	0.000	0.000	5.464	0.000	0.000
MW20-SL	2.36	13.64	2.639	0.000	0.000	5.569	0.000	0.000
MW20-SL	1.44	14.56	2.308	0.000	0.000	4.801	0.000	0.000
MW20-SL	0.57	15.43	1.821	0.000	0.000	7.386	0.000	0.000
MW20-SU	4.40	4.60	3.975	0.000	0.000	5.670	9.057	0.000
MW20-SU	3.51	5.49	4.228	0.576	0.000	7.798	12.647	0.000
MW20-SU	2.54	6.46	5.654	1.001	0.000	15.419	32.497	1.160
MW20-SU	1.57	7.43	6.691	1.460	0.000	29.421	56.805	5.837
MW20-SU	0.62	8.38	5.294	1.854	0.000	43.848	74.470	9.495
PFM-01	16.14	3.86	0.708	1.097	0.000	27.697	14.499	0.000
PFM-01	15.39	4.61	0.553	0.967	0.000	20.085	8.054	0.000
PFM-01	14.35	5.65	0.592	1.228	0.000	25.202	8.647	0.000
PFM-01	13.35	6.65	0.880	1.251	0.000	35.027	6.142	0.000
PFM-01	12.07	7.93	0.553	0.000	0.000	11.570	4.080	0.000
PFM-01	11.15	8.85	0.553	0.000	0.000	12.700	1.655	0.000
PFM-01	10.24	9.76	0.553	0.000	0.000	11.466	2.907	0.000
PFM-01	9.37	10.63	0.553	0.000	0.000	13.575	1.734	0.000
PFM-01	8.23	11.77	0.553	0.000	0.000	13.328	4.391	0.000
PFM-01	7.33	12.67	0.553	0.000	0.000	11.279	5.799	0.000
PFM-01	6.40	13.60	0.553	0.000	0.000	10.233	3.996	0.000
PFM-01	5.51	14.49	0.553	0.587	0.000	16.190	4.498	0.000
PFM-01	4.22	15.78	0.552	0.000	0.000	9.398	4.539	0.000
PFM-01	3.28	16.72	2.931	0.000	0.000	5.552	3.429	0.000
PFM-01	2.35	17.65	2.900	0.000	0.000	7.703	3.948	0.000
PFM-01	1.43	18.57	2.814	0.000	0.000	8.425	4.358	0.000
PFM-01	0.59	19.41	2.837	0.000	0.000	10.419	4.094	0.000
PFM-02	15.98	4.02	5.556	0.604	0.000	17.723	16.960	0.000
PFM-02	15.11	4.89	7.933	0.942	0.000	25.473	39.395	0.704
PFM-02	14.22	5.78	5.220	0.792	0.000	27.014	38.048	0.837
PFM-02	13.30	6.70	4.501	0.480	0.000	15.517	12.959	0.000
PFM-02	12.09	7.91	4.374	0.000	0.000	9.916	7.808	0.000
PFM-02	11.17	8.83	2.400	0.000	0.000	14.297	9.072	0.000
PFM-02	10.25	9.75	5.430	0.000	0.000	22.487	16.787	0.000

Table 3. Summary of flux values for southern site (continued).

Well_ID	Distance from bottom of well screen (ft)	Approximate Depth below top of well casing (ft)	Darcy Velocity (cm/day)	Ethene flux (mg/m2/day)	VC flux (mg/m2/day)	DCE flux (mg/m2/day)	TCE flux (mg/m2/day)	PCE flux (mg/m2/day)
PFM-02	9.38	10.62	5.788	0.437	0.000	16.184	9.966	0.000
PFM-02	8.19	11.81	1.758	0.000	0.000	22.978	19.920	0.000
PFM-02	7.25	12.75	0.553	0.000	0.000	7.676	4.010	0.000
PFM-02	6.35	13.65	2.894	0.000	0.000	4.729	1.980	0.000
PFM-02	5.51	14.49	2.894	0.000	0.000	3.986	2.771	0.000
PFM-02	4.25	15.75	2.788	0.000	0.000	9.801	2.138	0.000
PFM-02	3.33	16.67	2.731	0.000	0.000	6.102	2.497	0.000
PFM-02	2.48	17.52	2.803	0.000	0.000	6.558	3.756	0.000
PFM-02	1.56	18.44	2.728	0.000	0.000	6.108	4.126	0.000
PFM-02	0.62	19.38	2.891	0.000	0.000	6.968	4.763	0.000
PFM-03	16.01	3.99	2.194	0.000	0.000	1.732	4.013	0.000
PFM-03	15.06	4.94	2.510	0.000	0.000	2.586	3.119	0.000
PFM-03	14.23	5.77	2.271	0.222	0.000	6.100	6.314	0.000
PFM-03	13.39	6.61	2.687	0.000	0.000	6.717	3.574	0.000
PFM-03	12.16	7.84	2.725	0.000	0.000	1.607	1.743	0.000
PFM-03	11.20	8.80	2.276	0.000	0.000	1.693	0.894	0.000
PFM-03	10.37	9.63	2.609	0.000	0.000	2.362	1.022	0.000
PFM-03	9.53	10.47	5.199	0.000	0.000	2.236	1.355	0.000
PFM-03	8.38	11.62	3.600	0.000	0.000	9.812	3.029	0.000
PFM-03	7.51	12.49	1.414	0.000	0.000	5.315	2.757	0.000
PFM-03	6.55	13.45	0.553	0.000	0.000	21.825	2.496	0.000
PFM-03	5.63	14.37	1.552	0.000	0.000	14.946	2.445	0.000
PFM-03	4.45	15.55	1.486	0.000	0.000	5.185	2.287	0.000
PFM-03	3.53	16.47	0.552	0.000	0.000	13.278	1.643	0.000
PFM-03	2.53	17.47	0.552	0.000	0.000	10.772	2.191	0.000
PFM-03	1.54	18.46	0.549	0.000	0.000	14.243	4.169	0.000
PFM-03	0.59	19.41	2.917	0.000	0.000	10.756	2.969	0.000
PFM-04	16.02	3.98	6.299	0.000	0.000	0.000	0.000	0.000
PFM-04	15.17	4.83	5.166	0.000	0.000	4.512	0.000	0.000
PFM-04	14.21	5.79	4.255	0.000	0.000	8.385	0.891	0.000
PFM-04	13.25	6.75	7.389	0.000	0.000	27.682	3.790	0.000
PFM-04	11.95	8.05	6.827	0.000	0.000	25.549	2.440	0.000
PFM-04	11.17	8.83	6.077	0.000	0.000	24.521	1.523	0.000
PFM-04	10.31	9.69	8.431	0.000	0.000	29.297	0.702	0.000
PFM-04	9.32	10.68	12.712	0.000	0.000	67.813	0.000	0.000
PFM-04	8.14	11.86	11.141	0.000	0.000	115.172	2.015	0.000
PFM-04	7.19	12.81	10.968	0.000	0.000	70.330	1.353	0.000
PFM-04	6.24	13.76	11.311	0.000	0.000	57.155	0.814	0.000
PFM-04	5.40	14.60	12.306	0.000	0.000	82.980	2.379	0.000
PFM-04	4.20	15.80	12.987	0.000	0.000	101.447	2.565	0.000
PFM-04	3.25	16.75	12.662	0.000	0.000	58.274	1.176	0.000
PFM-04	2.38	17.62	12.393	0.000	0.000	86.294	2.160	0.000
PFM-04	1.54	18.46	12.746	0.000	0.000	65.515	2.146	0.000
PFM-04	0.62	19.38	12.210	0.000	0.000	37.610	0.933	0.000
		Min	0.064	0.000	0.000	0.000	0.000	0.000
		Max	12.987	1.854	0.000	115.172	74.470	12.616
		Mean	3.520	0.128	0.000	15.179	5.527	0.273

Table 4. Summary of flux values for northern site (well PMW-03).

Well_ID	Distance from bottom of well screen (ft)	Approximate Depth below top of well casing (ft)	Darcy Velocity (cm/day)	Ethene flux (mg/m2/day)	VC flux (mg/m2/day)	DCE flux (mg/m2/day)	TCE flux (mg/m2/day)	PCE flux (mg/m2/day)
Well_ID	Distance from bottom of well screen (ft)	Approximate Depth below top of well casing (ft)	Darcy Velocity (cm/day)	Ethene flux (mg/m2/day)	VC flux (mg/m2/day)	DCE flux (mg/m2/day)	TCE flux (mg/m2/day)	PCE flux (mg/m2/day)
PMW-03	13.88	5.12	4.808	0.000	9.383	457.367	22.103	6.546
PMW-03	12.97	6.03	4.478	0.000	5.007	226.815	8.393	2.274
PMW-03	12.07	6.93	4.302	0.000	4.822	185.736	10.392	3.628
PMW-03	11.20	7.80	4.475	0.000	12.551	312.824	15.271	5.233
PMW-03	10.29	8.71	4.279	0.000	13.945	279.524	12.239	3.894
PMW-03	9.07	9.93	4.298	0.000	27.799	633.336	19.616	7.430
PMW-03	8.16	10.84	3.968	0.000	11.342	376.522	39.938	11.701
PMW-03	7.19	11.81	4.056	0.000	6.128	268.212	65.584	23.020
PMW-03	6.31	12.69	3.813	0.000	10.963	263.256	31.161	13.690
PMW-03	5.41	13.59	4.442	0.000	21.022	488.931	19.933	10.543
PMW-03	4.17	14.83	4.337	0.000	13.996	308.452	26.879	16.579
PMW-03	3.38	15.62	3.750	0.000	8.512	216.060	19.079	10.330
PMW-03	2.50	16.50	3.851	0.000	6.518	161.099	18.646	13.280
PMW-03	1.50	17.50	3.924	0.000	6.969	166.184	21.891	15.315
PMW-03	0.58	18.42	3.937	0.000	6.931	186.380	23.511	17.955
		Min	3.750	0.000	4.822	161.099	8.393	2.274
		Max	4.808	0.000	27.799	633.336	65.584	23.020
		Mean	4.181	0.000	11.059	302.046	23.776	10.761