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FOSTER WHEELER ENVIRONMENTAL CORPORATION

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UPDATED DRAFT ARSENIC MASS BALANCE FOR THE BLACKWATER BRANCH, MAURICE RIVER AND UNION LAKE VINELAND, NEW JERSEY

MARCH 1996

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ARSENIC MASS BALANCE FOR THE BLACKWATER BRANCH, MAURICE RIVER AND UNION LAKE VINELAND, NEW JERSEY

MARCH 1996

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ARSENIC MASS BALANCE
FOR THE BLACK BRANCH, MAURICE
RIVER AND UNION LAKE
VINELAND, NEW JERSEY

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1.0 INTRODUCTION

Foster Wheeler Environmental Corporation (Foster Wheeler Environmental), under Work Assignment Number 081-2NB8 with the U.S. Environmental Protection Agency (EPA), has conducted surface water, sediment and pore water sampling and analysis to support an evaluation of the influx of arsenic (As) from the Vineland Chemical Company site in Vineland, New Jersey to the adjacent Blackwater Branch watershed and the subsequent transfer of As through the Blackwater Branch, Maurice River and Union Lake fluvial–lacustrine system. The investigation has been conducted to comply with the Record of Decision (ROD) for the Vineland Chemical Company, which was signed September 28, 1989.

The ROD specified that certain "Additional Activities" be performed in support of remedial design, future monitoring and implementation of selected remedial alternatives. The work described in this report has been performed in response to the ROD directive that "The mass balance of arsenic coming in and out of the [Maurice River] basin will be determined to aid in the assessment of the river's natural flushing mechanisms." The investigation was also designed to support other activities mandated in the ROD, especially the following:

- providing a baseline of data prior to implementation of remedial action against which the effectiveness of source control and natural flushing can be evaluated;

- providing data from the basin for input into the sediment distribution modeling effort and against which model results can be validated.

- providing data in support of the environmental assessment of the effects of dredging on the Blackwater Branch, Maurice River and northern portion of Union Lake.

The arsenic mass balance investigation and related studies have been mandated to support decisions regarding the extent of remediation necessary in the Maurice River. The arsenic mass balance investigation has been divided into four major categories:

1) The gross mass balance of the fluvial–lacustrine system is evaluated by combining surface-water arsenic concentration data with measurements of stream discharge to allow calculation of the mass of As passing each of four locations in the stream. When combined with an estimate of the flux of As from the Vineland Chemical Company site into the Blackwater Branch, these measurements document the existing

flux of arsenic from its point of entry into the Blackwater Branch, through the Maurice River–Union Lake system and over the Union Lake Dam. This report does not address the fate of As in the Maurice River downstream of the Union Lake Dam.

2) An experimental study has been conducted to determine desorption rates of As from contaminated sediments in a quiescent system. The purpose of these experiments is to allow prediction of the rate of decrease of As concentrations as a result of desorption in contaminated sediments within Union Lake once the influx of As has been stopped.

3) The effect of speciation on the partitioning of As between contaminated sediments and interstitial pore water is determined by direct measurement of As^{+3} and As^{+5} concentrations in sediment cores and coexisting interstitial water.

4) Finally, a series of As concentration profiles were measured during a period of stratification and overturn of Union Lake to determine the effects of this event, which may occur annually, on As transport through the lake.

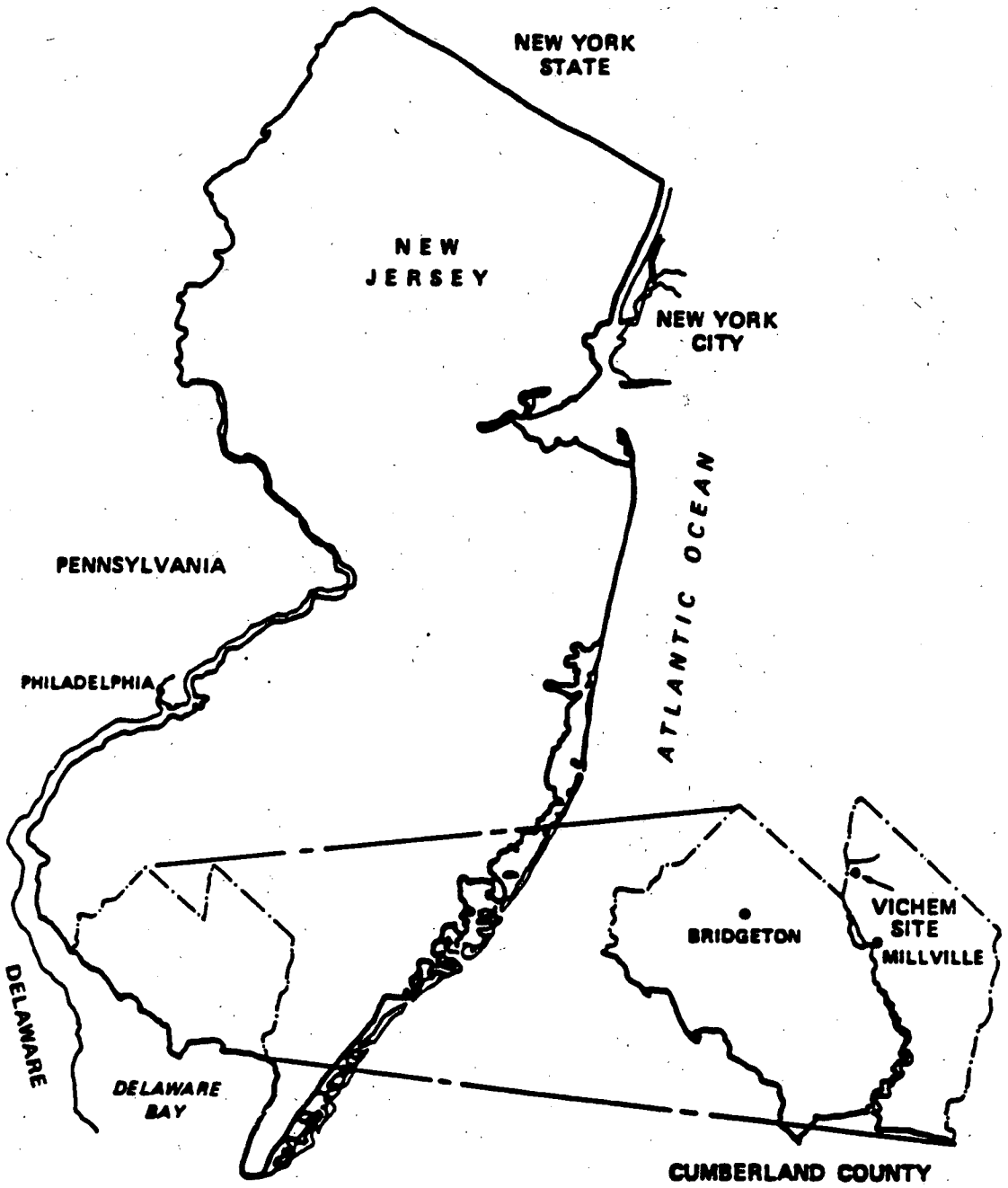
This report presents results based on currently available data collected during the first year of the As mass balance investigation. When practicable, these results are then used to support preliminary interpretations that may be used to guide decisions affecting remediation of the Blackwater Branch, Maurice River and Union Lake.

This document will also serve as an outline for future revisions as additional data become available. Some sections of the report are thus included for the purpose of organization even though data are not yet available. For example, recommendations concerning remediation of sediments in the Maurice River (Section 14.2) and Union Lake (Section 14.3) must await the three-year naural flushing period as mandated in the ROD.

2.0 SITE BACKGROUND

The Vineland Chemical Company site is located in the city of Vineland in Cumberland County, New Jersey. Vineland Chemical manufactured organic arsenic-based herbicides at this facility between approximately 1949 and the late 1980's. Previous investigations have shown that arsenic contamination, attributable to the Vineland Chemical Company, is found within the Blackwater Branch adjacent to the site and within the Maurice River drainage as far as 36 miles downstream from the company's manufacturing plant.

Figure 2-1 shows the general location of the site within the state of New Jersey. The study area is shown in more detail in Figure 2-2 and consists of several sub-areas of contamination. The plant site itself occupies 54 acres in a mixed residential and industrial area at the north end of the city of Vineland. The Blackwater Branch flows to the southwest along the northern edge of the plant site and continues approximately 1.5 miles to its confluence with the Maurice River. The Maurice River flows approximately 7 miles south from this confluence to Union Lake. Sediment contamination within the Blackwater Branch and Maurice River are generally confined within the 100-year flood plain limits. Union Lake is an artificial impoundment on the Maurice River, comprising approximately 870 surface acres (mean water level), and is approximately 2 miles long and 1.5 miles wide. The Maurice River then flows under tidal influence approximately 25 miles from the Union Lake Dam into the Delaware Bay.



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VINELAND CHEMICAL COMPANY SITE

FIGURE 2-1
VINELAND CHEMICAL COMPANY
REGIONAL LOCATION MAP

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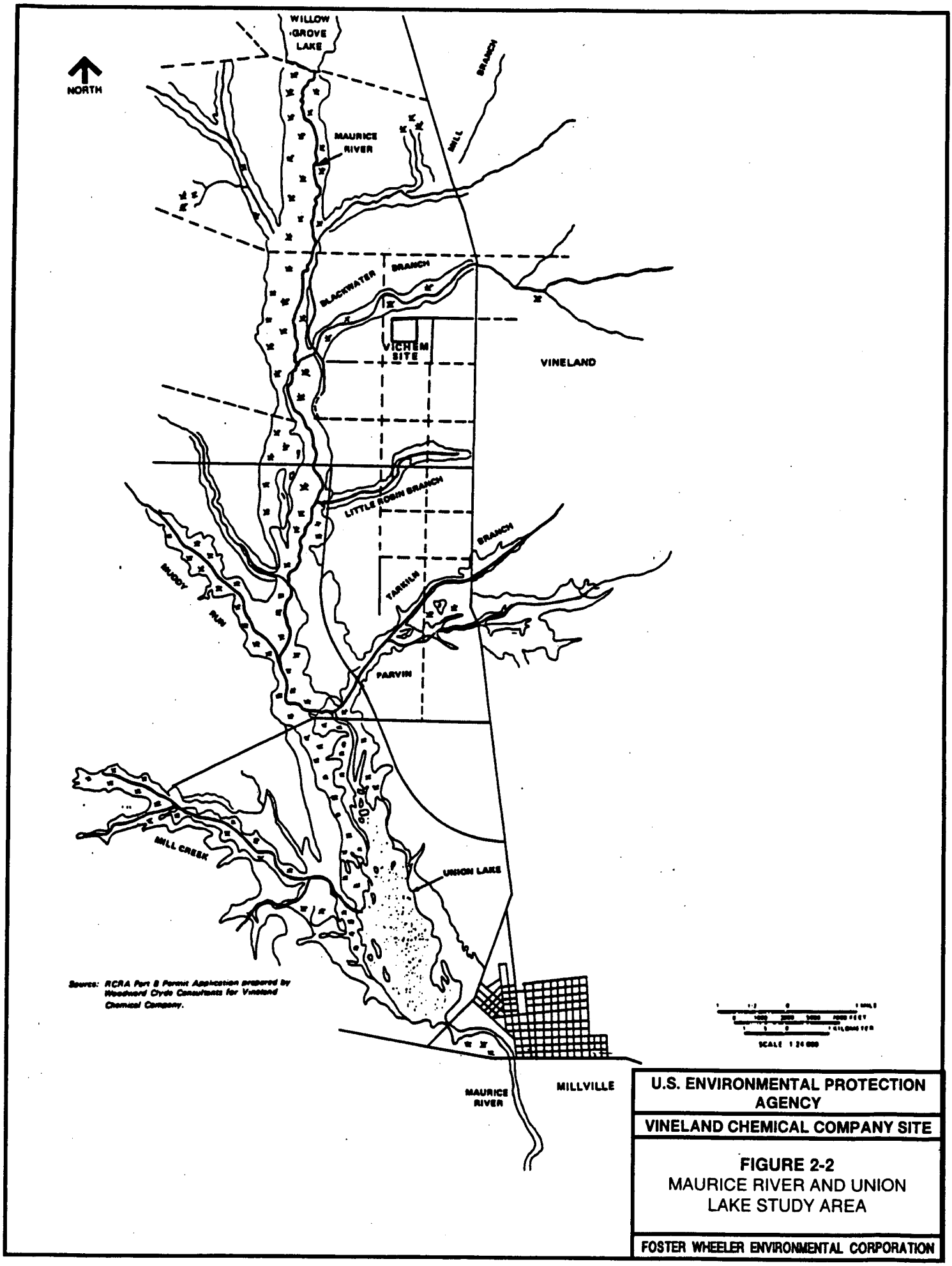

Source: RCRA Part B Permit Application prepared by Woodward Clyde Consultants for Vineland Chemical Company.

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VINELAND CHEMICAL COMPANY SITE

FIGURE 2-2
MAURICE RIVER AND UNION LAKE STUDY AREA

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3.0 PREVIOUS RESEARCH

Ebasco Services Incorporated previously prepared Remedial Investigation (RI) and Feasibility Study (FS) reports for the Vineland Chemical Company site in response to Work Assignment Number 37-2LB8 under REM III Contract Number 68-01-7250. A total of three RI and three FS reports were submitted to the EPA in June of 1989: (1) Plant Site RI and FS, (2) River Areas RI and FS and (3) Union Lake RI and FS. Ebasco Services Incorporated also prepared an Optional Design Investigations Report (DI Report; December, 1993) and a Design Investigations Groundwater Modeling Report (GW Report; December, 1993) for the Vineland Chemical Plant site under Contract Number DACW41-90-C-0057 with the Department of the Army, Kansas City District, Corps of Engineers (USACE).

Other previous research directed specifically toward the Maurice River and Union Lake system includes: Hughes-Calcagno and Ashley (1981), Winka (1985) and Faust et al. (1987*a*, 1987*b*, 1987*c*).

4.0 ARSENIC IN SURFACE WATERS DURING NORMAL FLOW CONDITIONS

As described in the Final Field Operations Plan (FOP; April, 1992), surface water samples were collected on a periodic basis at six sampling locations (MRU, BBU, GS-1, GS-2, GS-3 and ULD; see Figure 4-1) to support the As mass balance investigation. During year 1 (July, 1992 through July, 1993), samples were collected monthly from GS-1, GS-2, GS-3 and ULD and quarterly from MRU and BBU. Stream gauging stations operated by the United States Geological Survey (USGS) at MRU (Station #01411485), GS-1 (Station #01411495), GS-2 (Station #01411500), GS-3 (Station #01411800) and ULD (Station #01411878) also provided stream discharge information for the period over which most samples were collected. The flux of As is then calculated as the product of the concentration of As and the stream discharge rate, with the concentration in unfiltered samples giving the total flux of As in the water column, (including both dissolved and sorbed As) and the concentration in filtered samples giving the flux of As in solution.

4.1 TOTAL ARSENIC FLUX

This section presents the results of analyses of unfiltered surface water samples collected on a periodic basis from MRU, BBU, GS-1, GS-2, GS-3 and ULD. Complete analytical results are given in Appendix A.

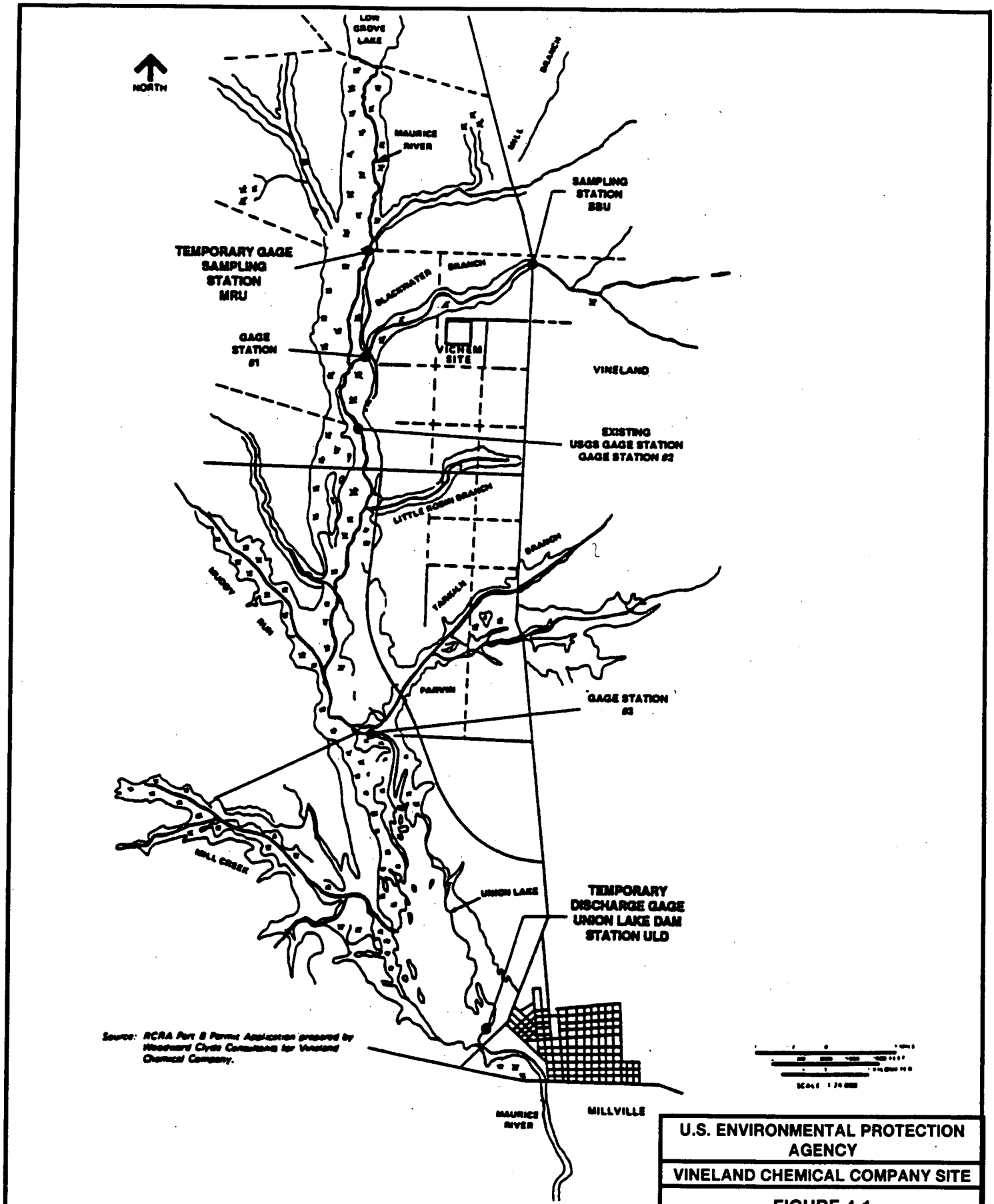
4.1.1 *Methods*

In the Blackwater Branch (sampling locations BBU and GS-1), where the stream depth was less than 3 feet, samples were collected near the center of the primary channel from the mid-depth point in the water column. Water samples were collected according to the Standard Operating Procedure #1 (SOP #1) presented in the FOP (April, 1992). Analytical methods and sample preservation techniques are detailed in Table 3-1 of the FOP (April, 1992). Measurements of pH, Eh, D.O., conductivity and temperature were conducted in the field.

In the Maurice River, where depths typically exceed four feet within the channel, samples were composites of equal volumes of discrete samples taken from one foot below the surface and one foot above the bottom. All other sampling and analytical procedures were identical to those described above for the Blackwater Branch.

4.1.2 *Data Set for Total As Flux*

For convenience, data that are referenced in the following discussion of the total flux of As in the Blackwater Branch, Maurice River and Union Lake system are presented in Table 4-1. Data qualifiers utilized in Table 4-1, and in subsequent tables presented within this document, are



Source: RCRA Part B Permit Application prepared by Woodward Clyde Consultants for Vineland Chemical Company.

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VINELAND CHEMICAL COMPANY SITE

FIGURE 4-1
LOCATIONS OF GAGE AND SAMPLING STATIONS FOR MONTHLY AND STORM SAMPLING

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TABLE 4-1

Arsenic Concentrations in Unfiltered Surface Water

"Normal Flow"

EPA Sample I.D	Sampling Date	Ebasco Sample I.D.	Location	Stream Discharge (cfs)	As Flux (g/s)	As µg/l	
MBJT23	7/15/92	VC-SW-CH-GS1-2001	Gauging Station 1		No Flow Data	325.00	J
7383B-01-005	7/15/92	VC-SW-CH-GS1-2001	Gauging Station 1		No Flow Data	279.00	
MBJT25	8/17/92	VC-SW-CH-GS1-2002	Gauging Station 1	17	0.291	605.00	
104751	8/17/92	VC-SW-CH-GS1-2002	Gauging Station 1	17	0.433	900.00	
104771	9/16/92	VC-SW-CH-GS1-2003	Gauging Station 1	8.3	0.032	138.00	
104759	9/16/92	VC-SW-CH-GS1-2003	Gauging Station 1	8.3	0.035	149.00	
MBJT80	10/22/92	VC-SW-CH-GS1-2004	Gauging Station 1	8.6	0.031	127.00	J
7576B-01-002	10/22/92	VC-SW-CH-GS1-2004	Gauging Station 1	8.6	0.029	120.00	J
103429	11/18/92	VC-SW-CH-GS1-2005	Gauging Station 1	9.7	0.037	134.00	
7576B-02-013	11/18/92	VC-SW-CH-GS1-2005	Gauging Station 1	9.7	0.034	122.00	S
MBMK32	12/10/92	VC-ST-SC-GS1-1002-01	Gauging Station 1	10	0.064	225.00	
103959	1/19/93	VC-SW-CH-GS1-2006	Gauging Station 1	14	0.053	134.00	
MBMK63	3/1/93	VC-SW-CH-GS1-2007	Gauging Station 1	12	0.038	111.00	J
MBML25	3/30/93	VC-SW/CH-GS1-2008 (T)	Gauging Station 1	38	0.056	51.60	JB
MBML27	3/30/93	VC-SW/CH-GS1-2008 (T)	Gauging Station 1	38	0.063	58.80	B
101505	4/14/93	VC-SW-CH-GS1-2009	Gauging Station 1	23	0.071	109.00	
MBML89	5/20/93	VC-SW-CH-GS1-2010 (T)	Gauging Station 1	32	0.154	170.00	
101549	6/30/93	VL-SW-CH-GS1-2011 (T)	Gauging Station 1	9.2	0.045	172.00	
MBMF02	7/16/93	VC-ST-CH-GS1-1003-06 (T)	Gauging Station 1	8.4	0.049	205.00	
MBNB61	10/26/93	VC-SW-CH-GS1-3002 (T)	Gauging Station 1	12	0.031	91.40	
			min	**8.30**	**0.029**	**51.60**	
			max	**38.00**	**0.433**	**900.00**	
			avg	**15.55**	**0.079**	**186.162**	
MBJT24	7/15/92	VC-SW-CH-GS2-2001	Gauging Station 2	66	0.067	35.90	J
7383B-01-006	7/15/92	VC-SW-CH-GS2-2001	Gauging Station 2	66	0.074	39.70	
MBJT26	8/17/92	VC-SW-CH-GS2-2002	Gauging Station 2	135	0.089	23.20	S
104752	8/17/92	VC-SW-CH-GS2-2002	Gauging Station 2	135	0.125	32.70	
104772	9/16/92	VC-SW-CH-GS2-2003	Gauging Station 2	65	0.035	19.00	
104773	9/16/92	VC-SW-CH-GS2-2003D	Gauging Station 2	65	0.026	14.10	
104761	9/16/92	VC-SW-CH-GS2-2003	Gauging Station 2	65	0.039	21.20	
104763	9/16/92	VC-SW-CH-GS2-2003	Gauging Station 2	65	0.066	36.10	
MBJT81	10/22/92	VC-SW-CH-GS2-2004	Gauging Station 2	65	0.032	17.60	J
7576B-01-004	10/22/92	VC-SW-CH-GS2-2004	Gauging Station 2	65	0.028	15.00	J

TABLE 4-1

Arsenic Concentrations in Unfiltered Surface Water

"Normal Flow"

EPA Sample I.D	Sampling Date	Ebasco Sample I.D.	Location	Stream Discharge (cfs)	As Flux (g/s)	As µg/l	
103428	11/18/92	VC-SW-CH-GS2-2005	Gauging Station 2	98	0.035	12.50	
7576B-02-011	11/18/92	VC-SW-CH-GS2-2005	Gauging Station 2	98	0.033	12.00	
MBMK33	12/10/92	VC-ST-SC-GS2-1002-01	Gauging Station 2	97	0.076	27.70	J
103960	1/19/93	VC-SW-CH-GS2-2006	Gauging Station 2	148	0.063	15.00	
MBMK65	3/1/93	VC-SW-CH-GS2-2007	Gauging Station 2	155	0.046	10.40	J
MBML21	3/30/93	VC-SW/CH-GS2-2008 (T)	Gauging Station 2	325	0.083	9.00	B
101504	4/14/93	VC-SW-CH-GS2-2009	Gauging Station 2	240	0.086	12.70	
MBML91	5/20/93	VC-SW-CH-GS2-2010 (T)	Gauging Station 2	193	0.169	31.00	
MBML93	5/20/93	VC-SW-CH-GS2-2010 (T)	Gauging Station 2	193	0.169	31.00	
101547	6/30/93	VL-SW-CH-GS2-2011 (T)	Gauging Station 2	95	0.057	21.20	
MBMF04	7/16/93	VC-ST-CH-GS2-1003-06 (T)	Gauging Station 2	74	0.044	20.90	
MBNB63	10/26/93	VC-SW-CH-GS2-3002 (T)	Gauging Station 2	83	0.025	10.50	
			min	**65.00**	**0.025**	**9.00**	
			max	**325.00**	**0.169**	**39.70**	
			avg	**131.36**	**0.065**	**20.200**	
7383B-01-007	7/15/92	VC-SW-CH-GS3-2001	Gauging Station 3		No Flow Data	15.50	
MBJT27	8/17/92	VC-SW-CH-GS3-2002	Gauging Station 3		No Flow Data	16.50	J
104753	8/17/92	VC-SW-CH-GS3-2002	Gauging Station 3		No Flow Data	14.40	
104774	9/16/92	VC-SW-CH-GS3-2003	Gauging Station 3	98	0.031	11.10	J
104765	9/16/92	VC-SW-CH-GS3-2003	Gauging Station 3	98	0.024	8.60	
MBJT82	10/22/92	VC-SW-CH-GS3-2004	Gauging Station 3	110	0.029	9.40	JB
7576B-01-001	10/22/92	VC-SW-CH-GS3-2004	Gauging Station 3	110	0.026	8.30	BJ
103427	11/18/92	VC-SW-CH-GS3-2005	Gauging Station 3	164	ND	10.00	U
7576B-02-009	11/18/92	VC-SW-CH-GS3-2005	Gauging Station 3	164	0.033	7.10	B
MBMK34	12/10/92	VC-ST-SC-GS3-1002-01	Gauging Station 3	157	0.132	29.70	
103961	1/19/93	VC-SW-CH-GS3-2006	Gauging Station 3	230	ND	10.00	U
MBMK67	3/1/93	VC-SW-CH-GS3-2007	Gauging Station 3	233	0.044	6.70	JB
MBML31	3/30/93	VC-SW/CH-GS3-2008 (T)	Gauging Station 3	501	0.065	4.60	B
101502	4/14/93	VC-SW-CH-GS3-2009	Gauging Station 3	448	ND	10.00	U
MBML95	5/20/93	VC-SW-CH-GS3-2010 (T)	Gauging Station 3	393	0.283	25.40	
101545	6/30/93	VL-SW-CH-GS3-2011 (T)	Gauging Station 3	145	0.058	14.10	
MBMF06	7/16/93	VC-ST-CH-GS3-1003-06 (T)	Gauging Station 3	122	0.068	19.70	B
MBML35	10/26/93	VC-SW-CH-GS3-3002 (T)	Gauging Station 3	130	0.032	8.60	B

TABLE 4-1

Arsenic Concentrations in Unfiltered Surface Water

"Normal Flow"

EPA Sample I.D	Sampling Date	Ebasco Sample I.D.	Location	Stream Discharge (cfs)	As Flux (g/s)	As µg/l	
			min	**98.00**	**0.024**	**4.60**	
			max	**501.00**	**0.283**	**29.70**	
			avg	**227.58**	**0.077**	**13.357**	
MBJT20	7/14/92	VC-SW-CH-MRU-2001	Maurice River - Garden Rd.	43	ND	2.40	U
7383B-01-001	7/14/92	VC-SW-CH-MRU-2001	Maurice River - Garden Rd.	43	ND	2.00	U
MBJT85	10/22/92	VC-SW-CH-MRU-2004	Maurice River - Garden Rd.	46	ND	4.00	U
7576B-01-006	10/22/92	VC-SW-CH-MRU-2004	Maurice River - Garden Rd.	46	0.002	1.20	BJ
103424	11/18/92	VC-SW-CH-MRU-2003	Maurice River - Garden Rd.	75	ND	10.00	U
103425	11/18/92	VC-SW-CH-MRU-2003D	Maurice River - Garden Rd.	75	ND	10.00	U
7576B-02-003	11/18/92	VC-SW-CH-MRU-2003	Maurice River - Garden Rd.	75	ND	1.00	U
7576B-02-005	11/18/92	VC-SW-CH-MRU-2003D	Maurice River - Garden Rd.	75	ND	1.00	U
MBMK31	12/10/92	VC-ST-SC-MRU-1002-01	Maurice River - Garden Rd.	74	ND	3.70	U
103957	1/19/93	VC-SW-CH-MRU-2004	Maurice River - Garden Rd.	120	ND	10.00	U
MBMK61	3/1/93	VC-SW-CH-MRU-2007	Maurice River - Garden Rd.	124	ND	3.90	U
MBML29	3/30/93	VC-SW/CH-MRU-2008 (T)	Maurice River - Garden Rd.	328	ND	1.60	U
MBMF10	7/16/93	VC-ST-CH-MRU-1003-06 (T)	Maurice River - Garden Rd.	51	0.003	2.20	UJ
101508	4/14/93	VC-SW-CH-MRU-2009	Maurice River - Garden Rd.	230	ND	10.00	U
MBNB65	10/26/93	VC-SW-CH-MRU-3002 (T)	Maurice River - Garden Rd.	70	0.002	1.00	B
			min	**43.00**	**0.002**	**1.00**	
			max	**328.00**	**0.003**	**10.00**	
			avg	**116.10**	**0.002**	**4.27**	
7383B-01-004	7/15/92	VC-SW-CH-ULD-2001	Union Lake Dam		No Flow Data	19.30	
104754	8/19/92	VC-SW-CH-ULD-2002	Union Lake Dam		No Flow Data	17.80	
MBJT55	8/20/92	VC-SW-CH-ULD-2002	Union Lake Dam		No Flow Data	18.60	
104775	9/16/92	VC-SW-CH-ULD-2003	Union Lake Dam		No Flow Data	14.90	
104767	9/16/92	VC-SW-CH-ULD-2003	Union Lake Dam		No Flow Data	15.30	
MBJT83	10/22/92	VC-SW-CH-ULD-2004	Union Lake Dam		No Flow Data	16.80	J
7576B-01-005	10/22/92	VC-SW-CH-ULD-2004	Union Lake Dam		No Flow Data	17.40	J
103426	11/18/92	VC-SW-CH-ULD-2005	Union Lake Dam		No Flow Data	10.00	U
7576B-02-007	11/18/92	VC-SW-CH-ULD-2005	Union Lake Dam		No Flow Data	11.50	
MBMK30	12/10/92	VC-ST-SC-ULD-1002-01	Union Lake Dam		No Flow Data	9.70	BJ
103962	1/19/93	VC-SW-CH-ULD-2006	Union Lake Dam		No Flow Data	10.00	U
MBMK69	3/1/93	VC-SW-CH-ULD-2007	Union Lake Dam		No Flow Data	4.90	JB

TABLE 4-1

Arsenic Concentrations in Unfiltered Surface Water

"Normal Flow"

EPA Sample I.D	Sampling Date	Ebasco Sample I.D.	Location	Stream Discharge (cfs)	As Flux (g/s)	As µg/l	
MBML17	3/30/93	VC-SW/CH-ULD-2008 (T)	Union Lake Dam		No Flow Data	4.30	B
101511	4/15/93	VC-SW-CH-ULD-2009	Union Lake Dam		No Flow Data	10.00	U
MBML97	5/20/93	VC-SW-CH-ULD-2010 (T)	Union Lake Dam	372	0.260	24.70	
101543	6/30/93	VL-SW-CH-ULD-2011 (T)	Union Lake Dam	170	0.091	18.80	
MBMF08	7/16/93	VC-ST-CH-ULD-1003-06 (T)	Union Lake Dam	141	0.087	21.80	
MBML36	10/26/93	VC-SW-CH-ULD-3002 (T)	Union Lake Dam	141	0.079	19.70	
MBML38	10/26/93	VC-SW-CH-ULD-3002D (T)	Union Lake Dam	141	0.080	20.10	
			min	**141.00**	**0.079**	**4.30**	
			max	**372.00**	**0.260**	**24.70**	
			avg	**206.00**	**0.119**	**15.03**	

defined in Appendix F. These data represent a subset of the complete analytical results presented in Appendix A, and include the As concentrations (in units of micrograms per liter, µg/l), for samples collected during a period for which stream discharge information is available, the discharge rate (in units of cubic feet per second, cfs) and the total As flux (in units of grams per second, g/s).

4.1.3 *Results*

To constrain the mass of As entering the Blackwater Branch and Maurice River from sources other than the Vineland Chemical Company site, water samples were collected from upstream of the Vineland Chemical Company site, at station BBU on the Blackwater Branch, and upstream of the confluence of the Blackwater Branch and the Maurice River, at station MRU on the Maurice River. All unfiltered water samples from BBU had As concentrations below the analytical detection limit. Only one of 14 unfiltered samples from MRU had measurable As, with 1.2 µg/l in sample 7576B-01-006. The daily average stream discharge on October 22, 1992, when this sample was collected was 46 cfs. This yields a total As flux of 0.002 g/s. This represents the maximum flux of As past MRU during periods of "normal" stream flow.

Unfiltered surface water samples collected from the Blackwater Branch at gauging station GS-1 had As concentrations ranging from 51.6 µg/l to 900 µg/l, with an average As concentration of 186 µg/l. Daily average stream discharge ranged from 8.3 cfs to 38 cfs on days when samples were collected, with an average discharge of 16 cfs. The total As flux, calculated as the product of the individual As concentration measurements and daily average stream discharge, ranged from 0.029 g/s to 0.433 g/s. The average of these instantaneous As fluxes was 0.079 g/s, which is equivalent to 2.5 metric tons of As per year.

This flux includes all arsenic transported within the water column, either in solution or sorbed to suspended materials. Only the As contained within sediments transported as bedload are excluded from this calculated flux. Bedload As transport will be addressed by the sediment transport modeling that will be performed by Dr. Earl Hayter (Clemson University Department of Civil Engineering). These modeling results will be included in the total flux calculations as they become available.

Based on the direction of groundwater flow within the Vineland Chemical Plant site, which is west or slightly north of west (GW Report, December, 1993), all groundwater flowing through the plant site will enter the Blackwater Branch upstream of GS-1 (see Figure 4-1). Thus the flux measured at GS-1 represents the total flux of As derived from the Vineland Chemical Company site into the Blackwater Branch, Maurice River and Union Lake system.

Gauging station GS-2 is located on the Maurice River approximately one mile downstream of the confluence of the Maurice River and the Blackwater Branch. Therefore the flux of As past this location over the same period of record will demonstrate whether this reach of the fluvial system constitutes an additional source of As, acts as a simple conduit for As transport, or stores some fraction of the As that passes GS-1 during periods of normal stream flow.

Unfiltered surface water samples collected from GS-2 had As concentrations ranging from 9.00 µg/l to 39.7 µg/l, with an average As concentration of 20.2 µg/l. Daily average stream discharge ranged from 65 cfs to 325 cfs on days when samples were collected, with an average discharge of 131 cfs. The total As flux, calculated as the product of the individual As concentration measurements and daily average stream discharge, ranged from 0.025 g/s to 0.169 g/s. The average of these instantaneous As fluxes was 0.065 g/s, which is equivalent to 2.1 metric tons of As per year. This is slightly lower than the average flux at GS-1 (0.079 g/s), which could indicate that a small fraction of the total As flux was stored within the sediments. However, this small difference may be within the uncertainty associated with these measurements, which includes both analytical uncertainty in the As concentrations and uncertainty in the stream discharge measurements. Furthermore, exclusion of non-detects potentially yields a slight overestimation of the average flux.

Gauging station GS-3 is located approximately four miles downstream of GS-2, where Sherman Avenue crosses the Maurice River. The flux of As past this location can be used to demonstrate whether the Maurice River between GS-2 and GS-3 constitutes an additional source of As, acts as a simple conduit for As transport, or stores some fraction of the As that passes GS-2 during periods of "normal" stream flow.

Unfiltered surface water samples collected from GS-3 had As concentrations ranging from below the analytical detection limit to a maximum of 29.7 µg/l. The lowest measured As concentration was 4.60 µg/l and the average was 13.4 µg/l. Daily average stream discharge ranged from 98 cfs to 501 cfs on days when samples were collected, with an average discharge of 228 cfs. The total As flux, calculated as the product of the individual As concentration measurements (excluding non-detects) and daily average stream discharge, ranged from 0.024 g/s to 0.283 g/s. The average of these instantaneous As fluxes was 0.077 g/s, which is equivalent to 2.4 metric tons of As per year. This is slightly higher than the average flux past GS-2 (0.065 g/s) and nearly identical to the average flux past GS-1 (0.079 g/s). Although this could be taken to indicate that Maurice River sediments between GS-2 and GS-3 constitute a minor source of As, the identical fluxes past GS-1 and GS-3 suggest that the Blackwater Branch and Maurice River have acted as a simple conduit for As transport during year one of the study. The slightly lower flux at GS-2 probably reflects uncertainty in the measurements. Furthermore, exclusion of non-detects potentially yields a slight overestimation of the average flux.

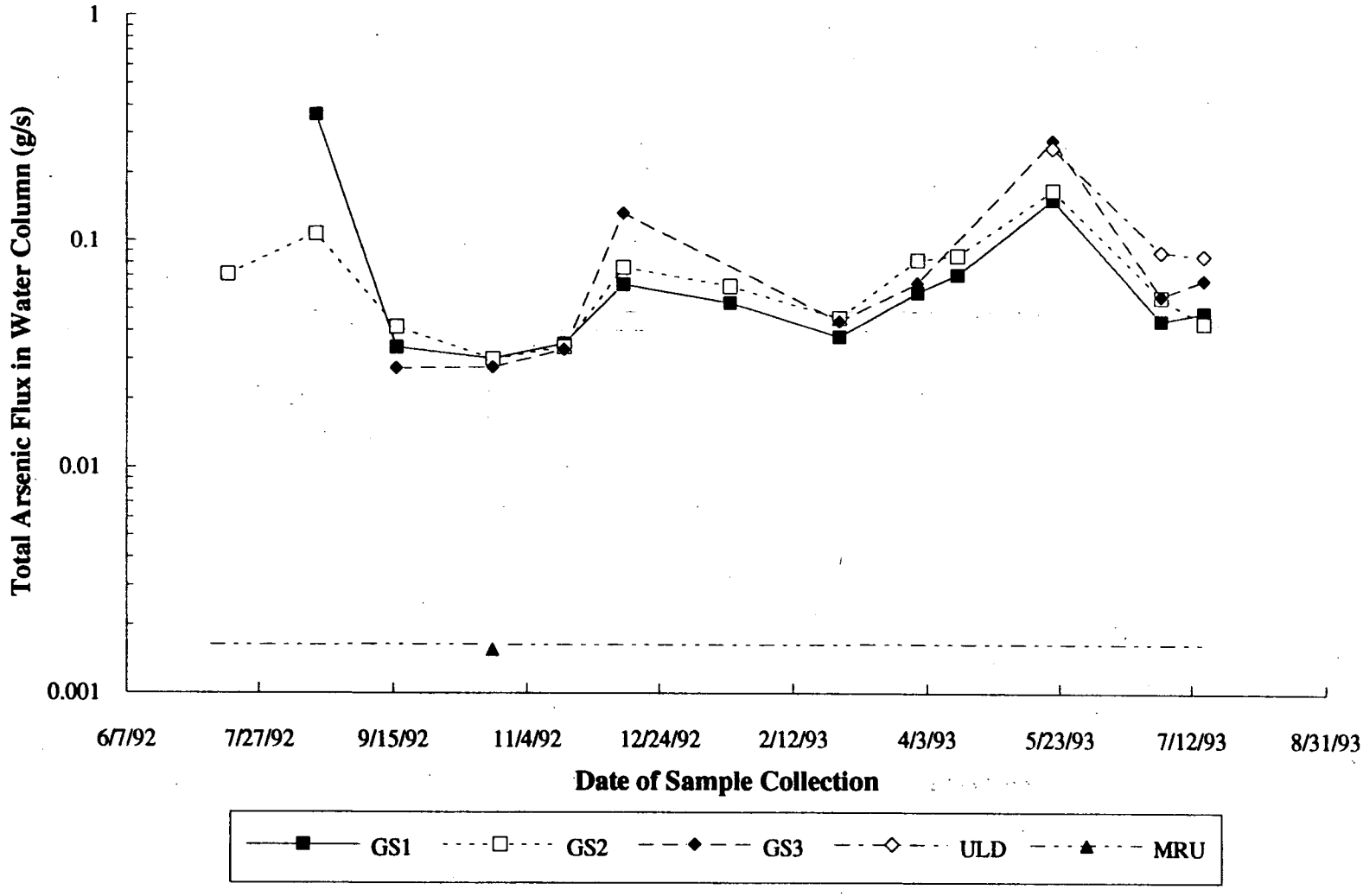
The final control point for As flux in this study is the Union Lake Dam, gauging station ULD. The flux of As out of Union Lake via water discharged from the Union Lake Dam, in water either overflowing the spillway or discharged through the gates, represents permanent removal of As from the system under consideration. This study does not consider the fate of As in the Maurice River downstream of the Union Lake Dam. The balance of As fluxes past GS-3 and ULD can thus be used to determine whether Union Lake constitutes a source of additional As, acts as a simple conduit for As transport, or stores some fraction of the As that passes GS-3 during periods of "normal" stream flow. Discharge data are not available for ULD for samples collected prior to May of 1993, when the USGS installed a gauging station at the spillway.

Unfiltered surface water samples collected from ULD had As concentrations ranging from below analytical detection limits to a maximum of 24.7 µg/l. The lowest measured As concentration was 4.3 µg/l and the average was 15.0 µg/l. Daily average dam overflow ranged from 141 cfs to 372 cfs on days when samples were collected, with an average discharge of 206 cfs (May 20, 1993 through October 26, 1993 only). The total As flux, calculated as the product of the individual As concentration measurements (excluding non-detects) and daily average dam overflow, ranged from 0.079 g/s to 0.260 g/s. The average of these instantaneous As fluxes was 0.119 g/s. If this flux is assumed to be an average for the year, it would represent 3.8 metric tons of As per year, nearly twice the average flux past GS-3. However, this apparent difference in fluxes results from comparison of flux measurements over different periods of record. The average flux past GS-3 for the same period (May 20, 1993 through October 26, 1993) was 0.11 g/s, which would represent 3.5 metric tons per year, very similar to the ULD average.

4.1.4 *Summary of Total Arsenic Fluxes*

Periodic measurement of total As fluxes within the Blackwater Branch, Maurice River and Union Lake fluvial–lacustrine system over a one year period (July, 1992 through July, 1993) indicate no significant sources or sinks of As between gauging station GS-1 on the Blackwater Branch and station ULD at the spillway of the Union Lake Dam. Figure 4-2 shows the variations in total As flux measured at GS-1, GS-2, GS-3 and ULD over this period. Although there is significant scatter, variations in the fluxes at the four measurement locations are correlated. Thus, these stretches of the stream system have generally acted as simple conduits for the transport of As derived from the Blackwater Branch upstream of GS-1.

For comparison, Figure 4-2 also shows the maximum total flux of As in the Maurice River upstream of its confluence with the Blackwater Branch at station MRU. This maximum flux, which represents one sample with a detectable As concentration among 14 samples that were analyzed, is more than an order of magnitude lower than the fluxes of As within contaminated portions of the stream. None of the samples collected from the Blackwater Branch upstream of the Vineland Chemical Company site had As concentrations above the analytical detection limit,



Flux = (As concentration in unfiltered water) x (daily average stream discharge)

U.S. ENVIRONMENTAL PROTECTION AGENCY

VINELAND CHEMICAL COMPANY SITE

FIGURE 4-2
TOTAL ARSENIC FLUX
BLACKWATER BRANCH, MAURICE RIVER AND UNION LAKE

FOSTER WHEELER ENVIRONMENTAL CORPORATION

so measurement location BBU is not represented on Figure 4-2. It is clear from these analyses that neither the Maurice River upstream of the Blackwater Branch, nor the Blackwater Branch upstream of the Vineland Chemical Company site constitute a significant source of As into downstream reaches of the stream system.

4.2 DISSOLVED ARSENIC FLUX

This section presents the results of analyses of filtered surface water samples collected on a periodic basis from MRU, BBU, GS-1, GS-2, GS-3 and ULD. These measurements allow a determination of the percentage of the total arsenic flux that results from arsenic carried in solution. Following EPA convention, we refer to the As contained in a sample that passes through a 0.45 µm filter as "dissolved," however it should be noted that such a sample may also contain As that is sorbed to colloidal particles ranging in size from 0.1–0.45 µm. Distinction between As that is truly in solution and As that is sorbed to suspended colloids is largely unimportant for consideration of transport in surface waters, since the colloids would remain suspended indefinitely. Complete analytical results are given in Appendix A.

4.2.1 *Methods*

Sample collection procedures were identical to those used for unfiltered samples (Section 4.1.1) except that samples were filtered through a cellulose-based membrane filter with a nominal pore size of 0.45µm according to SOP # 2 presented in the FOP (April, 1992). Analytical methods and sample preservation techniques are detailed in Table 3-1 of the FOP (April, 1992). Measurements of pH, Eh, D.O., conductivity and temperature were conducted in the field.

4.2.2 *Data Set for Dissolved As Flux*

For convenience, data that are referenced in the following discussion of the dissolved flux of As in the Blackwater Branch, Maurice River and Union Lake system are presented in Table 4-2. These data represent a subset of the complete analytical results presented in Appendix A, and include the As concentrations (in units of micrograms per liter, µg/l), and for samples collected during a period for which stream discharge information is available, the discharge rate (in units of cubic feet per second, cfs) and the dissolved As flux (in units of grams per second, g/s).

TABLE 4-2

Arsenic Concentrations in Filtered Surface Water

"NormalFlow"

EPA Sample I.D	Sampling Date	Ebasco Sample I.D.	Location	Stream Discharge (cfs)	As Flux (g/s)	As µg/l	
7384B-01-005	7/15/92	VC-SW-CH-GS1-2001	Gauging Station 1		No Flow Data	166.00	
104755	8/17/92	VC-SW-CH-GS1-2002	Gauging Station 1	17	0.088	183.00	
104760	9/16/92	VC-SW-CH-GS1-2003	Gauging Station 1	8.3	0.028	119.00	
7576B-01-009	10/22/92	VC-SW-CH-GS1-2004	Gauging Station 1	8.6	0.026	105.00	J
7576B-02-014	11/18/92	VC-SW-CH-GS1-2005	Gauging Station 1	9.7	0.031	114.00	
103490	12/10/92	VC-ST-SC-GS1-1002-01	Gauging Station 1	10	0.024	85.70	
103966	1/19/93	VC-SW-CH-GS1-2006	Gauging Station 1	14	0.048	121.00	
MBMK64	3/1/93	VC-SW-CH-GS1-2007	Gauging Station 1	12	0.038	112.00	J
MBML26	3/30/93	VC-SW/CH-GS1-2008 (D)	Gauging Station 1	38	0.066	60.90	J
MBML28	3/30/93	VC-SW/CH-GS1-2008 (D)	Gauging Station 1	38	0.040	37.20	JB
101506	4/14/93	VC-SW-CH-GS1-2009	Gauging Station 1	23	No As Data		R
MBML90	5/20/93	VC-SW-CH-GS1-2010 (D)	Gauging Station 1	32	0.118	130.00	
101550	6/30/93	VL-SW-CH-GS1-2011 (D)	Gauging Station 1	9.2	0.027	104.00	
MBMF01	7/16/93	VC-ST-CH-GS1-1003-06 (D)	Gauging Station 1	8.4	0.022	94.30	B
MBNB60	10/26/93	VC-SW-CH-GS1-3002 (D)	Gauging Station 1	12	0.025	74.10	
			minimum	**8.3**	**0.022**	**37.20**	
			maximum	**38**	**0.118**	**183.00**	
			average	**15.6**	**0.044**	**107.596**	
7384B-01-006	7/15/92	VC-SW-CH-GS2-2001	Gauging Station 2	66	0.038	20.20	
104756	8/17/92	VC-SW-CH-GS2-2002	Gauging Station 2	135	0.079	20.70	
104762	9/16/92	VC-SW-CH-GS2-2003	Gauging Station 2	65	0.028	15.40	
104764	9/16/92	VC-SW-CH-GS2-2003	Gauging Station 2	65	0.038	20.70	
7576B-01-011	10/22/92	VC-SW-CH-GS2-2004	Gauging Station 2	65	0.024	12.90	J
7576B-02-012	11/18/92	VC-SW-CH-GS2-2005	Gauging Station 2	98	0.029	10.30	
103491	12/10/92	VC-ST-SC-GS2-1002-01	Gauging Station 2	97	0.032	11.60	
103967	1/19/93	VC-SW-CH-GS2-2006	Gauging Station 2	148	0.047	11.30	
MBMK66	3/1/93	VC-SW-CH-GS2-2007	Gauging Station 2	155	0.046	10.50	J
MBML22	3/30/93	VC-SW/CH-GS2-2008 (D)	Gauging Station 2	325	0.073	7.90	JB
101503	4/14/93	VC-SW-CH-GS2-2009	Gauging Station 2	240	0.100	14.70	
MBML92	5/20/93	VC-SW-CH-GS2-2010 (D)	Gauging Station 2	193	0.131	24.00	J
MBML94	5/20/93	VC-SW-CH-GS2-2010 (D)	Gauging Station 2	193	0.061	11.20	J
101548	6/30/93	VL-SW-CH-GS2-2011 (D)	Gauging Station 2	95	0.039	14.60	
MBMF03	7/16/93	VC-ST-CH-GS2-1003-06 (D)	Gauging Station 2	74	0.045	21.70	

TABLE 4-2

Arsenic Concentrations in Filtered Surface Water

"NormalFlow"

EPA Sample I.D	Sampling Date	Ebasco Sample I.D.	Location	Stream Discharge (cfs)	As Flux (g/s)	As µg/l	
MBNB62	10/26/93	VC-SW-CH-GS2-3002 (D)	Gauging Station 2	83	0.018	7.60	B
			min	**65.00**	**0.018**	**7.60**	
			max	**325.00**	**0.131**	**24.00**	
			avg	**131.36**	**0.050**	**14.261**	
7384B-01-007	7/15/92	VC-SW-CH-GS3-2001	Gauging Station 3		No Flow Data	6.00	JB
104757	8/17/92	VC-SW-CH-GS3-2002	Gauging Station 3		No Flow Data	5.20	
104766	9/16/92	VC-SW-CH-GS3-2003	Gauging Station 3	98	ND	5.00	U
7576B-01-008	10/22/92	VC-SW-CH-GS3-2004	Gauging Station 3	110	0.020	6.30	BJ
7576B-02-010	11/18/92	VC-SW-CH-GS3-2005	Gauging Station 3	164	0.019	4.00	B
103492	12/10/92	VC-ST-SC-GS3-1002-01	Gauging Station 3	157	ND	10.00	U
103968	1/19/93	VC-SW-CH-GS3-2006	Gauging Station 3	230	ND	10.00	U
MBMK68	3/1/93	VC-SW-CH-GS3-2007	Gauging Station 3	233	0.044	6.60	JB
MBML32	3/30/93	VC-SW/CH-GS3-2008 (D)	Gauging Station 3	501	0.060	4.20	JB
101501	4/14/93	VC-SW-CH-GS3-2009	Gauging Station 3	448	ND	10.00	U
MBML96	5/20/93	VC-SW-CH-GS3-2010 (D)	Gauging Station 3	393	0.169	15.20	
101546	6/30/93	VL-SW-CH-GS3-2011 (D)	Gauging Station 3	145	0.038	9.30	
MBMF17	7/16/93	VC-ST-CH-GS3-1003-05 (D)	Gauging Station 3	122	0.018	5.20	BJ
MBNB66	10/26/93	VC-SW-CH-GS3-3002 (D)	Gauging Station 3	130	0.012	3.30	B
			min	**98.00**	**0.012**	**3.30**	
			max	**501.00**	**0.169**	**15.20**	
			avg	**227.58**	**0.047**	**7.164**	
7384B-01-001	7/14/92	VC-SW-CH-MRU-2001	Maurice River - Garden Rd.	43	0.005	4.30	B
7576B-01-013	10/22/92	VC-SW-CH-MRU-2004	Maurice River - Garden Rd.	46	0.002	1.30	BJ
7576B-02-004	11/18/92	VC-SW-CH-MRU-2003	Maurice River - Garden Rd.	75	ND	1.00	U
7576B-02-006	11/18/92	VC-SW-CH-MRU-2003D	Maurice River - Garden Rd.	75	ND	1.00	U
103489	12/10/92	VC-ST-SC-MRU-1002-01	Maurice River - Garden Rd.	74	ND	10.00	U
103964	1/19/93	VC-SW-CH-MRU-2004	Maurice River - Garden Rd.	120	ND	10.00	U
MBMK62	3/1/93	VC-SW-CH-MRU-2007	Maurice River - Garden Rd.	124	ND	3.70	U
MBML30	3/30/93	VC-SW/CH-MRU-2008 (D)	Maurice River - Garden Rd.	328	0.015	1.60	UJ
101507	4/14/93	VC-SW-CH-MRU-2009	Maurice River - Garden Rd.	230	ND	10.00	U
MBMF09	7/16/93	VC-ST-CH-MRU-1003-06 (D)	Maurice River - Garden Rd.	51	0.003	2.20	UJ
MBNB64	10/26/93	VC-SW-CH-MRU-3002 (D)	Maurice River - Garden Rd.	70	0.002	0.90	B

TABLE 4-2

Arsenic Concentrations in Filtered Surface Water

"NormalFlow"

EPA Sample I.D	Sampling Date	Ebasco Sample I.D.	Location	Stream Discharge (cfs)	As Flux (g/s)	As µg/l	
			min	**43.00**	**0.002**	**0.90**	
			max	**328.00**	**0.015**	**10.00**	
			avg	**116.10**	**0.005**	**4.182**	
7384B-01-004	7/15/92	VC-SW-CH-ULD-2001	Union Lake Dam		No Flow Data	12.40	
104758	8/19/92	VC-SW-CH-ULD-2002	Union Lake Dam		No Flow Data	16.00	
104768	9/16/92	VC-SW-CH-ULD-2003	Union Lake Dam		No Flow Data	8.90	
7576B-01-012	10/22/92	VC-SW-CH-ULD-2004	Union Lake Dam		No Flow Data	9.10	BJ
7576B-02-008	11/18/92	VC-SW-CH-ULD-2005	Union Lake Dam		No Flow Data	4.90	B
103493	12/10/92	VC-ST-SC-ULD-1002-01	Union Lake Dam		No Flow Data	10.00	
103969	1/19/93	VC-SW-CH-ULD-2006	Union Lake Dam		No Flow Data	10.00	U
MBMK70	3/1/93	VC-SW-CH-ULD-2007	Union Lake Dam		No Flow Data	3.70	U
MBML18	3/30/93	VC-SW/CH-ULD-2008 (D)	Union Lake Dam		No Flow Data	2.00	JB
101512	4/15/93	VC-SW-CH-ULD-2009	Union Lake Dam		No Flow Data	10.00	U
MBML98	5/20/93	VC-SW-CH-ULD-2010 (D)	Union Lake Dam	372	0.112	10.60	
101544	6/30/93	VL-SW-CH-ULD-2011 (D)	Union Lake Dam	170	0.072	14.90	
MBMF07	7/16/93	VC-ST-CH-ULD-1003-06 (D)	Union Lake Dam	141	0.092	23.10	
MBML37	10/26/93	VC-SW-CH-ULD-3002 (D)	Union Lake Dam	141	0.028	7.10	B
MBML39	10/26/93	VC-SW-CH-ULD-3002D (D)	Union Lake Dam	141	0.034	8.60	B
			min	**141.00**	**0.028**	**2.00**	
			max	**372.00**	**0.112**	**23.10**	
			avg	**206.00**	**0.068**	**10.09**	

4.2.3 *Results*

To constrain the mass of As entering the Blackwater Branch and Maurice River from sources other than the Vineland Chemical Company site, water samples were collected from upstream of the Vineland Chemical Company site, at station BBU on the Blackwater Branch, and upstream of the confluence of the Blackwater Branch and the Maurice River, at station MRU on the Maurice River. All filtered water samples from BBU had As concentrations below the analytical detection limit. Only two of ten filtered samples from MRU had measurable As, with 4.3 µg/l in sample 7384B-01-001 and 1.3 µg/l in sample 7576B-01-013. The daily average stream discharge at MRU when these samples were collected was 43 cfs and 46 cfs, respectively. This yields a dissolved As flux of 0.005 g/s and 0.002 g/s, respectively.

Filtered surface water samples collected from the Blackwater Branch at gauging station GS-1 had As concentrations ranging from 37.2 µg/l to 183 µg/l, with an average As concentration of 108 µg/l. The dissolved As flux, calculated as the product of the individual As concentration measurements and daily average stream discharge, ranged from 0.022 g/s to 0.118 g/s. The average of these instantaneous As fluxes was 0.044 g/s, which is equivalent to 1.4 metric tons of As per year, approximately 56% of the average total As flux past GS-1 (2.5 metric tons per year).

Filtered surface water samples collected from GS-2 had As concentrations ranging from 7.60 µg/l to 24.0 µg/l, with an average As concentration of 14.3 µg/l. The dissolved As flux, calculated as the product of the individual As concentration measurements and daily average stream discharge, ranged from 0.018 g/s to 0.131 g/s. The average of these instantaneous As fluxes was 0.050 g/s, which is equivalent to 1.6 metric tons of As per year, approximately 75% of the average total As flux past GS-2 (2.1 metric tons per year).

Filtered surface water samples collected from GS-3 had As concentrations ranging from below the analytical detection limit to a maximum of 15.2 µg/l. The lowest measured As concentration was 3.30 µg/l and the average was 7.16 µg/l. The dissolved As flux, calculated as the product of the individual As concentration measurements (excluding non-detects) and daily average stream discharge, ranged from 0.012 g/s to 0.169 g/s. The average of these instantaneous As fluxes was 0.047 g/s, which is equivalent to 1.5 metric tons of As per year, approximately 62% of the average total flux past GS-3 (2.4 metric tons per year).

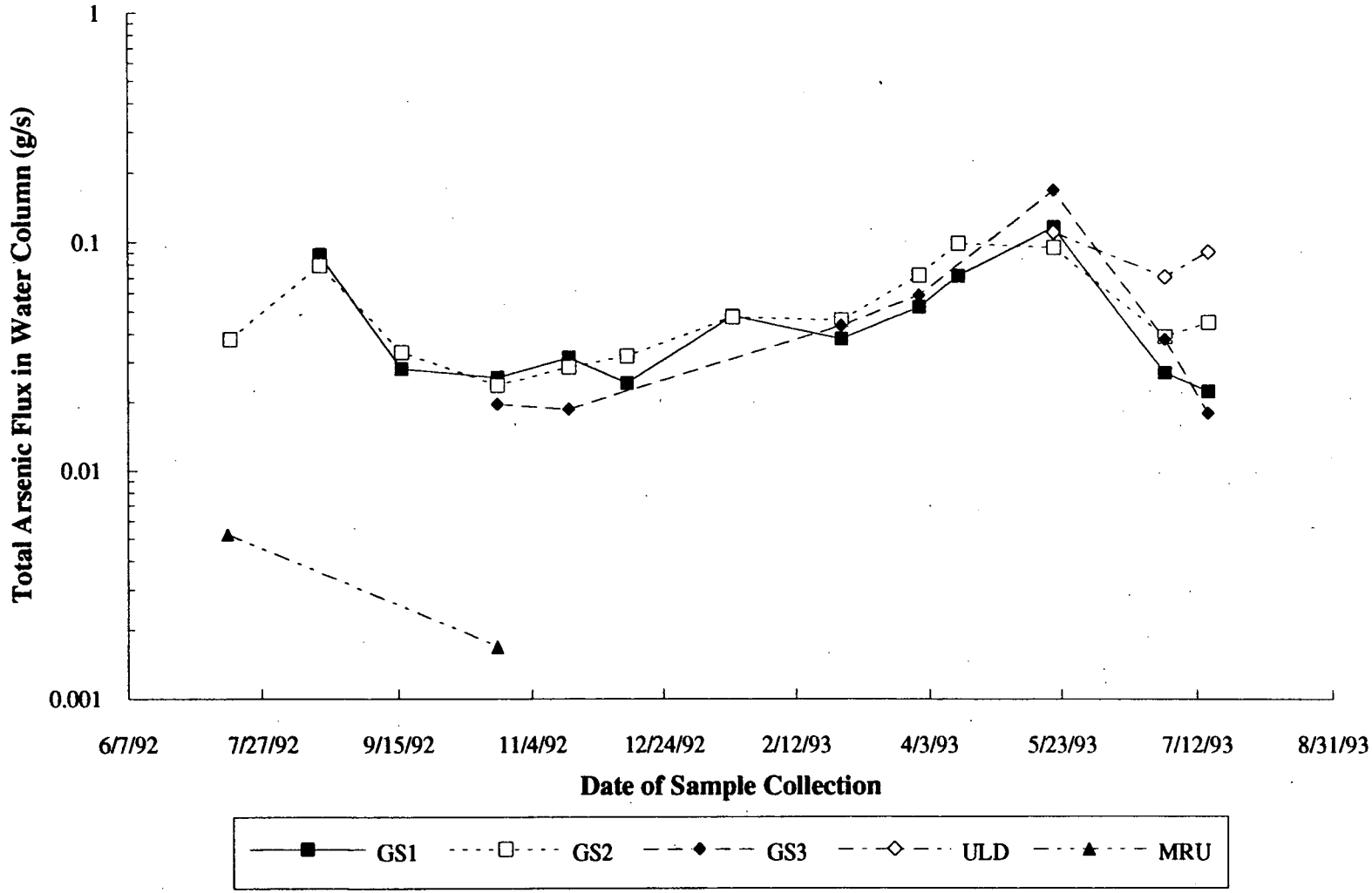
Filtered surface water samples collected from ULD had As concentrations ranging from below analytical detection limits to a maximum of 23.1 µg/l. The lowest measured As concentration was 2.00 µg/l and the average was 10.1 µg/l. The dissolved As flux, calculated as the product of the individual As concentration measurements and daily average dam overflow (May 20, 1993

through October 26, 1993 only), ranged from 0.028 g/s to 0.112 g/s. The average of these instantaneous As fluxes was 0.068 g/s, approximately 63% of the average total As flux for the same period. As with the total As flux measured during this period, if this dissolved flux is assumed to be an average for the year, it would represent 2.1 metric tons of As per year, much higher than the average flux past GS-3. The average dissolved flux past GS-3 for the same period (May 20, 1993 through October 26, 1993) was 0.059 g/s, much closer to the ULD average.

4.2.4 *Summary of Dissolved Arsenic Fluxes*

Periodic measurements of dissolved arsenic fluxes within the Blackwater Branch, Maurice River and Union Lake show that during periods of "normal" stream flow, between approximately 56% and 75% of the total flux of As carried within the water column is comprised of As in solution (i.e., either dissolved or adsorbed to particles <0.45 μm).

Figure 4-3 shows the variations in dissolved As flux measured at GS-1, GS-2, GS-3 and ULD over this period. As was observed for total arsenic fluxes, there is significant scatter, but variations at the four measurement locations are correlated. The dissolved fluxes measured at MRU are shown for comparison. These fluxes at MRU represent maximums, since only two of ten samples had As concentrations above detection limits.



Flux = (As concentration in filtered water) x (daily average stream discharge)

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FIGURE 4-3
DISSOLVED ARSENIC FLUX
BLACKWATER BRANCH, MAURICE RIVER
AND UNION LAKE

FOSTER WHEELER ENVIRONMENTAL CORPORATION

5.0 ARSENIC IN SURFACE WATERS DURING STORM EVENTS

As described in the Final Field Operations Plan (FOP; April, 1992), surface water samples were collected during seasonal storm events from five sampling locations (MRU, GS-1, GS-2, GS-3 and ULD; see Figure 4-1) to determine the effects of storm-induced runoff and the subsequent increased stream flow on the flux of As. Storm event sampling was also designed to provide data for development and validation of the sediment transport model.

Samples were collected from each location six times during a given storm event, corresponding as closely as possible to the following schedule: two samples during the early stages of runoff, two samples during the peak runoff period, and two samples during the gradual subsidence of storm runoff. Stream gauging stations operated by the USGS provided stream discharge information during the storm events. The flux of As was calculated as the product of the concentration of As and the stream discharge rate, with the concentration in unfiltered samples giving the total flux of As in the water column, and the concentration in filtered samples giving the flux of As in solution (i.e., dissolved or adsorbed on particles <0.45 μm).

5.1 TOTAL ARSENIC FLUX

This section presents the results of analyses of unfiltered surface water samples collected from MRU, GS-1, GS-2, GS-3 and ULD during three storm events: one each in the fall and winter of 1992 and one in the summer of 1993. Complete analytical results are given in Appendix A.

5.1.1 *Methods*

In the Blackwater Branch (sampling location GS-1), where the stream depth was less than 3 feet, samples were collected near the center of the primary channel from the mid-depth point in the water column. Water samples were collected according to the Standard Operating Procedure #1 (SOP #1) presented in the FOP (April, 1992). Analytical methods and sample preservation techniques are detailed in Table 3-1 of the FOP (April, 1992). Measurements of pH, Eh, D.O., conductivity and temperature were conducted in the field.

In the Maurice River, where depths typically exceed four feet within the channel, samples were composites of equal volumes of discrete samples taken from one foot below the surface and one foot above the bottom. All other sampling and analytical procedures were identical to those described above for the Blackwater Branch.

5.1.2 *Data Set for Total As Flux*

For convenience, data that are referenced in the following discussion of the total flux of As in the Blackwater Branch, Maurice River and Union Lake system during storm events are presented in Table 5-1. These data represent a subset of the complete analytical results presented in

TABLE 5-1

Arsenic Concentrations Unfiltered Surface Water

"Storm Flow"

EPA Sample I.D	Sampling Date	Ebasco Sample I.D.	Location	Stream Discharge (cfs)	As Flux (g/s)	As µg/l	
104844	9/25/92	VC-ST-SC-GS1-1001	Gauging Station 1	8.7	0.080	323.00	
104840	9/26/92	VC-ST-SC-GS1-1003	Gauging Station 1	23	0.158	242.00	
104843	9/26/92	VC-ST-SC-GS1-1002	Gauging Station 1	23	0.126	194.00	
104838	9/27/92	VC-ST-SC-GS1-1004	Gauging Station 1	12	0.060	178.00	
104815	9/28/92	VC-ST-SC-GS1-1005	Gauging Station 1	10	0.048	170.00	
104825	9/29/92	VC-ST-SC-GS1-1006	Gauging Station 1	9.8	0.044	159.00	
MBMK32	12/10/92	VC-ST-SC-GS1-1002-01	Gauging Station 1	10	0.064	225.00	
MBMK37	12/11/92	VC-ST-SC-GS1-1002-02	Gauging Station 1	34	0.282	293.00	J
MBMK42	12/11/92	VC-ST-SC-GS1-1002-03	Gauging Station 1	34	0.163	169.00	J
MBMK47	12/12/92	VC-ST-SC-GS1-1002-04	Gauging Station 1	35	0.109	110.00	J
MBMK51	12/14/92	VC-ST-SC-GS1-1002-05	Gauging Station 1	19	No As Data		R
MBMK60	12/23/92	VC-ST-SC-GS1-1002-06	Gauging Station 1	15	No As Data		R
103515	12/23/92	VC-ST-SC-GS1-1002-06	Gauging Station 1	15	0.045	106.00	
MBMF61	7/15/93	VC-ST-GS1-1003-01 (T)	Gauging Station 1	10	0.096	340.00	
MBMF67	7/15/93	VC-ST-GS1-1003-02 (T)	Gauging Station 1	10	0.077	272.00	
MBMF63	7/15/93	VC-ST-GS1-1003-03 (T)	Gauging Station 1	10	0.077	272.00	
MBMF26	7/16/93	VC-ST-CH-GS1-1003-04 (T)	Gauging Station 1	8.4	0.045	189.00	
MBMF14	7/16/93	VC-ST-CH-GS1-1003-05 (T)	Gauging Station 1	8.4	0.043	181.00	B
MBMF02	7/16/93	VC-ST-CH-GS1-1003-06 (T)	Gauging Station 1	8.4	0.049	205.00	
			min	**8.40**	**0.043**	**106.00**	
			max	**35.00**	**0.282**	**340.00**	
			avg	**16.24**	**0.092**	**213.41**	
104839	9/25/92	VC-ST-SC-GS2-1001	Gauging Station 2	64	0.045	25.00	
104828	9/26/92	VC-ST-SC-GS2-1002	Gauging Station 2	143	0.174	42.90	
104841	9/26/92	VC-ST-SC-GS2-1003	Gauging Station 2	143	0.155	38.30	
104817	9/27/92	VC-ST-SC-GS2-1004	Gauging Station 2	145	0.077	18.70	
104820	9/28/92	VC-ST-SC-GS2-1005	Gauging Station 2	143	0.049	12.20	
104826	9/29/92	VC-ST-SC-GS2-1006	Gauging Station 2	136	0.050	13.00	
MBMK33	12/10/92	VC-ST-SC-GS2-1002-01	Gauging Station 2	97	0.076	27.70	J
MBMK38	12/11/92	VC-ST-SC-GS2-1002-02	Gauging Station 2	179	0.219	43.30	
MBMK43	12/11/92	VC-ST-SC-GS2-1002-03	Gauging Station 2	179	0.184	36.30	
MBMK48	12/12/92	VC-ST-SC-GS2-1002-04	Gauging Station 2	238	0.151	22.40	
MBMK52	12/14/92	VC-ST-SC-GS3-1002-05	Gauging Station 2	290	No As Data		R

TABLE 5-1
Arsenic Concentrations Unfiltered Surface Water
"Storm Flow"

EPA Sample I.D	Sampling Date	Ebasco Sample I.D.	Location	Stream Discharge (cfs)	As Flux (g/s)	As µg/l	
MBMK58	12/23/92	VC-ST-SC-GS2-1002-06	Gauging Station 2	176	No As Data		R
MBMF72	7/15/93	VC-ST-GS2-1003-01 (T)	Gauging Station 2	74	0.043	20.40	
MBMF75	7/15/93	VC-ST-GS2-1003-02 (T)	Gauging Station 2	74	0.043	20.60	
MBMF74	7/15/93	VC-ST-GS2-1003-03 (T)	Gauging Station 2	74	0.066	31.60	
MBMF30	7/15/93	VC-ST-CH-GS2-1003-04 (T)	Gauging Station 2	74	0.065	30.90	
MBMF16	7/16/93	VC-ST-CH-GS2-1003-05 (T)	Gauging Station 2	74	0.049	23.50	
MBMF04	7/16/93	VC-ST-CH-GS2-1003-06 (T)	Gauging Station 2	74	0.044	20.90	
			min	**64.00**	**0.043**	**12.20**	
			max	**290.00**	**0.219**	**43.30**	
			avg	**146.58**	**0.093**	**26.731**	
104833	9/25/92	VC-ST-SC-GS3-1001	Gauging Station 3	98	ND	10.00	U
104831	9/26/92	VC-ST-SC-GS3-1003	Gauging Station 3	299	0.091	10.70	
104846	9/26/92	VC-ST-SC-GS3-1002	Gauging Station 3	299	0.100	11.80	
104827	9/27/92	VC-ST-SC-GS3-1004	Gauging Station 3	271	0.103	13.40	
104824	9/28/92	VC-ST-SC-GS3-1005	Gauging Station 3	249	ND	10.00	U
104819	9/29/92	VC-ST-SC-GS3-1006	Gauging Station 3	204	0.064	11.00	
MBMK34	12/10/92	VC-ST-SC-GS3-1002-01	Gauging Station 3	157	0.132	29.70	
MBMK39	12/11/92	VC-ST-SC-GS3-1002-02	Gauging Station 3	414	0.116	9.90	JB
MBMK44	12/11/92	VC-ST-SC-GS3-1002-03	Gauging Station 3	414	0.260	22.20	J
MBMK49	12/12/92	VC-ST-SC-GS3-1002-04	Gauging Station 3	602	0.206	12.10	
MBMK53	12/14/92	VC-ST-SC-GS2-1002-05	Gauging Station 3	513	No As Data		R
MBMK57	12/23/92	VC-ST-SC-GS3-1002-06	Gauging Station 3	280	No As Data		R
MBMF56	7/14/93	VC-ST-GS3-1003-01 (T)	Gauging Station 3	117	0.035	10.70	
MBMF46	7/15/93	VC-ST-GS3-1003-02 (T)	Gauging Station 3	121	No As Data		R
MBMF40	7/15/93	VC-ST-GS3-1003-03 (T)	Gauging Station 3	121	0.048	13.90	
MBMF32	7/15/93	VC-ST-CH-GS3-1003-04 (T)	Gauging Station 3	121	0.044	12.80	
MBMF18	7/16/93	VC-ST-CH-GS3-1003-05 (T)	Gauging Station 3	122	0.039	11.40	
MBMF06	7/16/93	VC-ST-CH-GS3-1003-06 (T)	Gauging Station 3	122	0.068	19.70	B
			min	**98.00**	**0.035**	**9.90**	
			max	**602.00**	**0.260**	**29.70**	
			avg	**265.15**	**0.100**	**13.953**	
104836	9/25/92	VC-ST-SC-MRU-1001	Maurice River - Garden Rd.	48	ND	10.00	U

TABLE 5-1

Arsenic Concentrations Unfiltered Surface Water

"Storm Flow"

EPA Sample I.D	Sampling Date	Ebasco Sample I.D.	Location	Stream Discharge (cfs)	As Flux (g/s)	As µg/l	
104818	9/26/92	VC-ST-SC-MRU-1003	Maurice River - Garden Rd.	105	ND	10.00	U
104829	9/26/92	VC-ST-SC-MRU-1002	Maurice River - Garden Rd.	105	ND	10.00	U
104835	9/27/92	VC-ST-SC-MRU-1004	Maurice River - Garden Rd.	111	ND	10.00	U
104842	9/28/92	VC-ST-SC-MRU-1005	Maurice River - Garden Rd.	113	ND	10.00	U
104814	9/29/92	VC-ST-SC-MRU-1006	Maurice River - Garden Rd.	105	ND	10.00	U
104822	9/29/92	VC-ST-SC-MRU-1006D	Maurice River - Garden Rd.	105	ND	10.00	U
MBMK31	12/10/92	VC-ST-SC-MRU-1002-01	Maurice River - Garden Rd.	74	ND	3.70	U
MBMK36	12/11/92	VC-ST-SC-MRU-1002-02	Maurice River - Garden Rd.	141	ND	3.70	U
MBMK40	12/11/92	VC-ST-SC-MRU-1002-03	Maurice River - Garden Rd.	141	ND	3.70	U
MBMK45	12/12/92	VC-ST-SC-MRU-1002-04	Maurice River - Garden Rd.	263	ND	3.70	U
MBMK54	12/14/92	VC-ST-SC-MRU-1002-05	Maurice River - Garden Rd.	348	No As Data		R
MBMK59	12/23/92	VC-ST-SC-MRU-1002-06	Maurice River - Garden Rd.	145	No As Data		R
MBMF52	7/14/93	VC-ST-MRU-1003-01 (T)	Maurice River - Garden Rd.	45	ND	2.20	U
MBMF50	7/15/93	VC-ST-MRU-1003-02 (T)	Maurice River - Garden Rd.	49	ND	2.20	U
MBMF44	7/15/93	VC-ST-MRU-1003-03 (T)	Maurice River - Garden Rd.	49	0.008	5.60	B
MBMF36	7/15/93	VC-ST-CH-MRU-1003-04 (T)	Maurice River - Garden Rd.	49	ND	1.30	U
MBMF22	7/16/93	VC-ST-CH-MRU-1003-05 (T)	Maurice River - Garden Rd.	51	0.005	3.20	B
MBMF10	7/16/93	VC-ST-CH-MRU-1003-06 (T)	Maurice River - Garden Rd.	51	0.003	2.20	UJ
			min	**45.00**	**0.003**	**1.30**	
			max	**348.00**	**0.008**	**10.00**	
			avg	**122.92**	**0.005**	**5.97**	
104834	9/26/92	VC-ST-SC-ULD-1002	Union Lake Dam		No Flow Data	19.50	
104845	9/26/92	VC-ST-SC-ULD-1001	Union Lake Dam		No Flow Data	25.00	
104830	9/27/92	VC-ST-SC-ULD-1003	Union Lake Dam		No Flow Data	20.20	
104837	9/27/92	VC-ST-SC-ULD-1003D	Union Lake Dam		No Flow Data	19.30	
104816	9/28/92	VC-ST-SC-ULD-1004	Union Lake Dam		No Flow Data	17.00	
104823	9/29/92	VC-ST-SC-ULD-1005	Union Lake Dam		No Flow Data	16.70	
MBMK30	12/10/92	VC-ST-SC-ULD-1002-01	Union Lake Dam		No Flow Data	9.70	BJ
MBMK35	12/11/92	VC-ST-SC-ULD-1002-02	Union Lake Dam		No Flow Data	13.20	
MBMK41	12/11/92	VC-ST-SC-ULD-1002-03	Union Lake Dam		No Flow Data	10.70	J
MBMK46	12/12/92	VC-ST-SC-ULD-1002-04	Union Lake Dam		No Flow Data	9.70	B
MBMK50	12/14/92	VC-ST-SC-ULD-1002-05	Union Lake Dam		No As Data		R
MBMK56	12/23/92	VC-ST-SC-ULD-1002-06	Union Lake Dam		No As Data		R
MBMF54	7/14/93	VC-ST-ULD-1003-01 (T)	Union Lake Dam	136	0.057	14.80	

TABLE 5-1
Arsenic Concentrations Unfiltered Surface Water
"Storm Flow"

EPA Sample I.D	Sampling Date	Ebasco Sample I.D.	Location	Stream Discharge (cfs)	As Flux (g/s)	As µg/l	
MBMF48	7/15/93	VC-ST-ULD-1003-02 (T)	Union Lake Dam	173	0.081	16.50	J
MBMF42	7/15/93	VC-ST-ULD-1003-03 (T)	Union Lake Dam	173	0.101	20.60	
MBMF34	7/15/93	VC-ST-CH-ULD-1003-04 (T)	Union Lake Dam	173	0.077	15.80	
MBMF20	7/16/93	VC-ST-CH-ULD-1003-05 (T)	Union Lake Dam	141	0.079	19.70	
MBMF08	7/16/93	VC-ST-CH-ULD-1003-06 (T)	Union Lake Dam	141	0.087	21.80	
			min	**136.00**	**0.057**	**9.70**	
			max	**173.00**	**0.101**	**25.00**	
			avg	**150.00**	**0.080**	**16.89**	

Appendix A, and include the As concentrations (in units of micrograms per liter, µg/l), and for samples collected during a period for which stream discharge information is available, the discharge rate (in units of cubic feet per second, cfs) and the total As flux (in units of grams per second, g/s).

5.1.3 *Results*

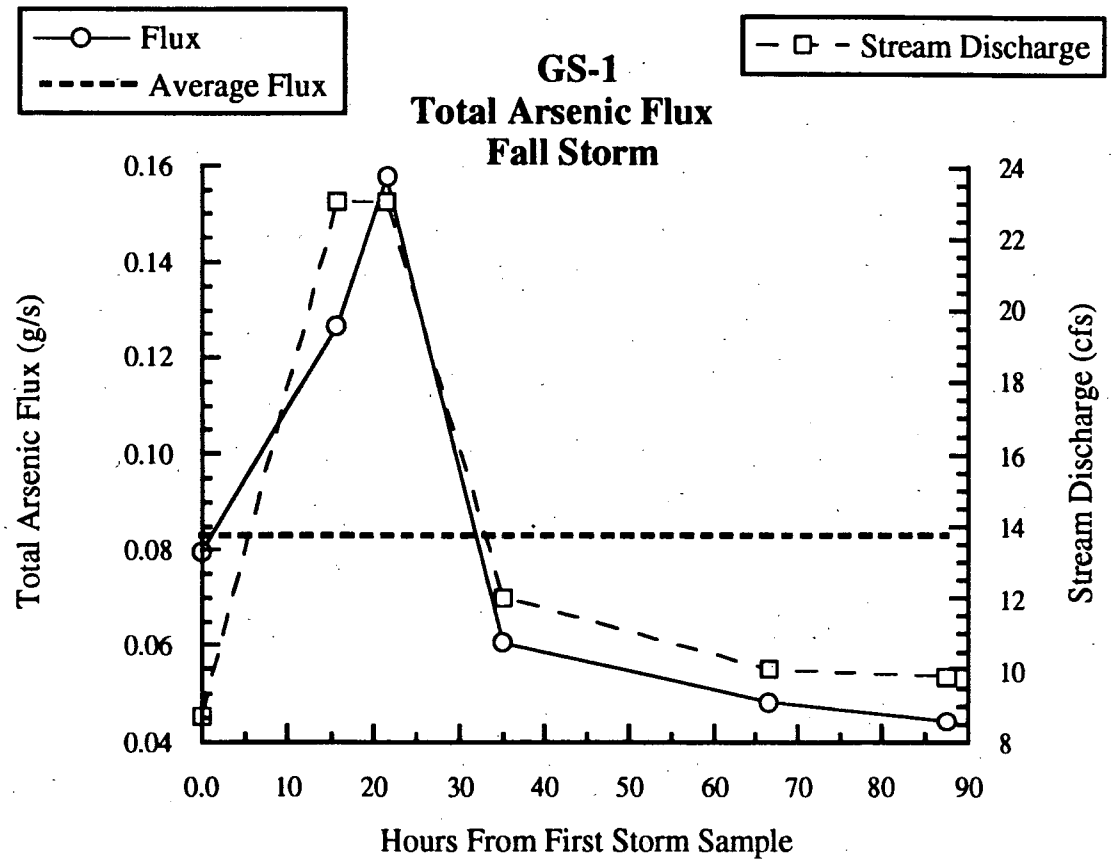
5.1.3.1 *Fall Storm Event*

The variation in total arsenic flux at GS-1 through GS-3 during the "fall" storm event, which occurred between September 25, 1992 and September 29,1992, is shown in Figures 5-1 through 5-3. These figures show the flux as a function of the number of hours from the time sampling was initiated. For comparison, each figure also shows the variation in stream discharge (daily averages) during the same period and the average total arsenic flux measured during periodic sampling events (see Section 4.1).

Variations in the flux at GS-1 closely followed variations in the stream discharge, with both reaching their maximum values 15 to 25 hours from the beginning of the storm. The peak discharge was 23 cfs, compared to an average of 16 cfs during periodic sampling events. The peak arsenic flux was 0.158 g/s, compared to an average of 0.083 g/s during periodic normal flow sampling events. After reaching its peak value, the flux of As fell below the average to a low of 0.044 g/s (Figure 5-1).

The flux at GS-2 reached its maximum value of 0.174 g/s approximately 15 hours from the beginning of the storm, similar to the flux at GS-1. The stream discharge also approached its maximum value (145 cfs) approximately 15 hours from the beginning of the storm, but maintained high values for the duration of the sampling (87 hours), while the flux of As dropped below the average flux to a minimum of 0.049 g/s (Figure 5-2).

The stream discharge reached its peak value at GS-3 approximately 15 to 20 hours from the beginning of the storm, just as it did at GS-1 and GS-2. The peak in the arsenic flux, however, was delayed at GS-3, reaching its maximum value (0.103 g/s) approximately 32 hours from the start of the storm. The arsenic flux decreased more rapidly than the stream discharge, dropping below the average flux to a minimum of 0.064 g/s (Figure 5-3).



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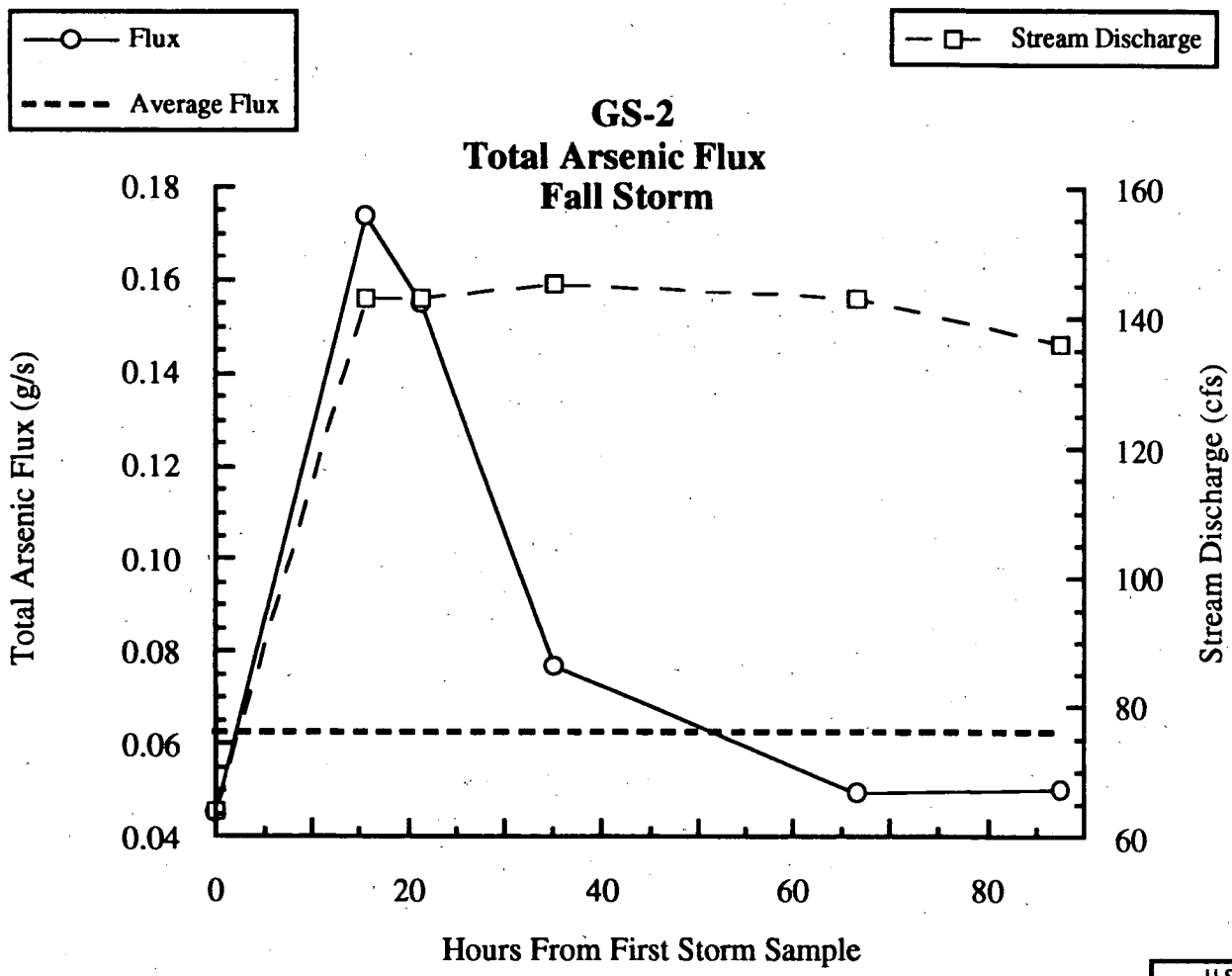
VINELAND CHEMICAL COMPANY SITE
FIGURE 5-1 GS-1 TOTAL ARSENIC FLUX FALL STORM
FOSTER WHEELER ENVIRONMENTAL CORPORATION

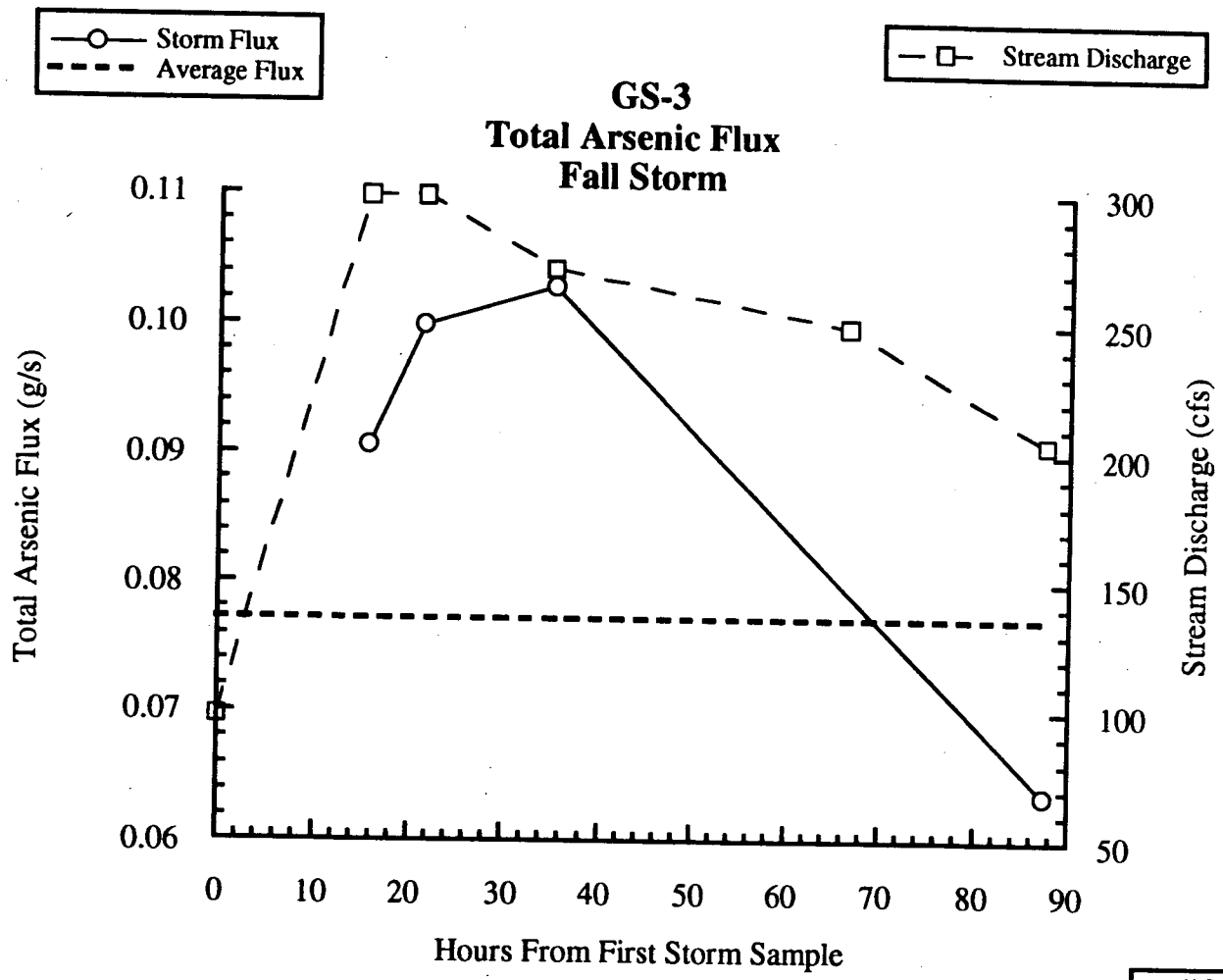


U.S. ENVIRONMENTAL PROTECTION AGENCY

VINELAND CHEMICAL COMPANY SITE

FIGURE 5-2
GS-2
TOTAL ARSENIC FLUX
FALL STORM

FOSTER WHEELER ENVIRONMENTAL CORPORATION



U.S. ENVIRONMENTAL PROTECTION AGENCY

VINELAND CHEMICAL COMPANY SITE

FIGURE 5-3
GS-3
TOTAL ARSENIC FLUX
FALL STORM

FOSTER WHEELER ENVIRONMENTAL CORPORATION

There are no dam overflow data available for the period of the fall storm event.

5.1.3.2 *Winter Storm Event*

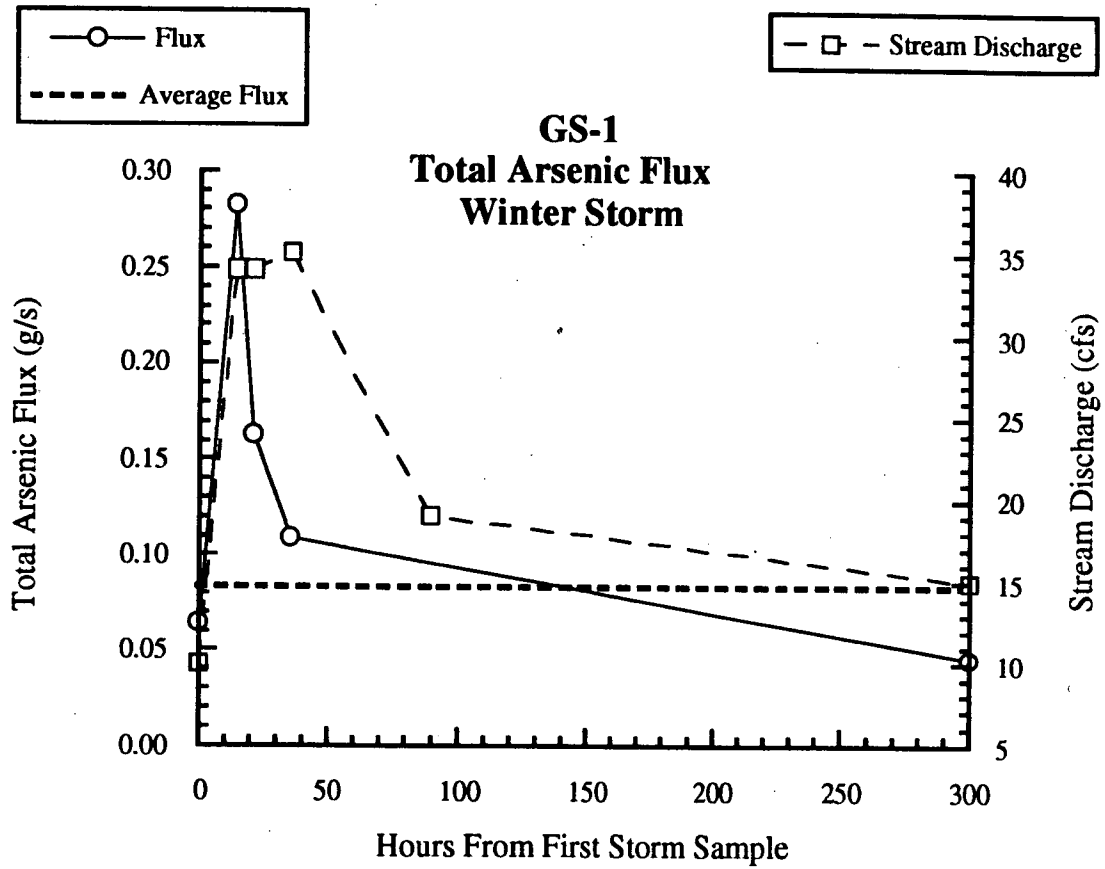
The variation in total arsenic flux at GS-1 through GS-3 during the "winter" storm event, which occurred between December 10, 1992 and December 23,1992, is shown in Figures 5-4 through 5-6. These figures show the flux as a function of the number of hours from the time sampling was initiated. For comparison, each figure also shows the variation in stream discharge (daily averages) during the same period and the average total arsenic flux measured during periodic sampling events (see Section 4.1). The peak discharge was nearly twice that of the fall storm and discharge remained well above average for over 300 hours.

The total As flux at GS-1 reaches its peak value of 0.282 g/s approximately 20 hours after the beginning of the storm, well before the peak stream discharge of 35 cfs, which occurred approximately 40 hours after the beginning of the storm. In fact, the As flux had dropped nearly to its average value of 0.083 g/s by the time the discharge reached its peak. After approximately 90 hours, variations in the As flux and stream discharge were similar, with the flux dropping to a minimum of 0.045 g/s after 300 hours (Figure 5-4).

The As flux at GS-2 reached its maximum value of 0.219 g/s approximately 20 hours from the beginning of the storm, similar to the flux at GS-1, then dropped very rapidly to 0.151 g/s after approximately 35 hours (Figure 5-5). Although it can be inferred that the As flux continued to decrease, the last two samples, taken approximately 90 and 300 hours after the beginning of the storm, had rejected As analyses. The stream discharge increased more slowly, reaching its maximum value of 290 cfs approximately 90 hours after the beginning of the storm. The stream discharge also subsided much more slowly and was still well above the average value of 131 cfs when the last sample was collected 300 hours after the beginning of the storm.

The As flux at GS-3 reached its maximum value of 0.260 g/s approximately 20 hours after the beginning of the storm, then dropped rapidly (Figure 5-6). The stream discharge reached its peak value of 602 cfs after approximately 35 hours, then subsided slowly as it did at GS-2. The stream discharge remained well above the average value of 228 cfs when the last sample was collected 300 hours after the beginning of the storm.

There are no dam overflow data available for the period of the fall storm event.

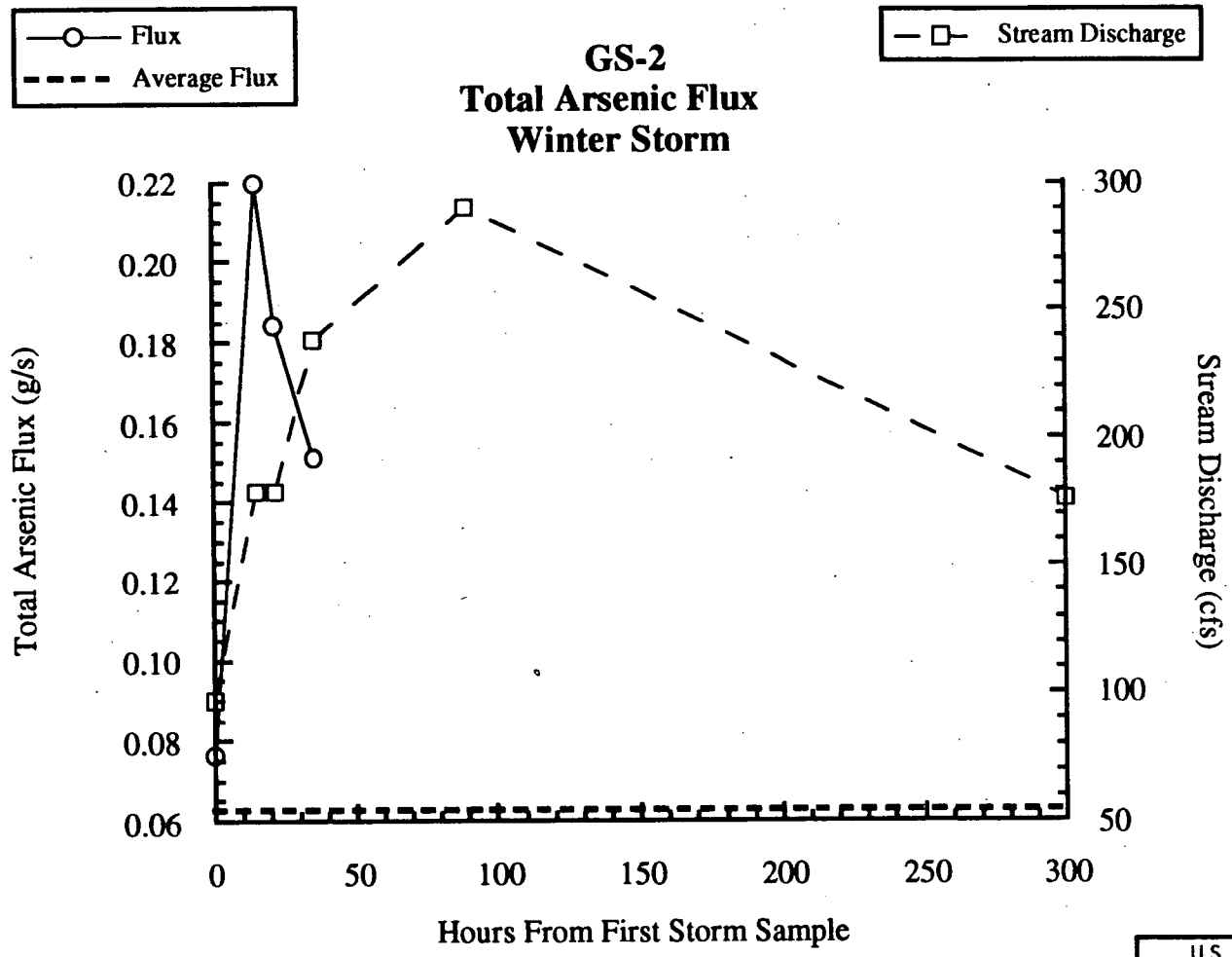


U.S. ENVIRONMENTAL PROTECTION AGENCY

VINELAND CHEMICAL COMPANY SITE

FIGURE 5-4
GS-1
TOTAL ARSENIC FLUX
WINTER STORM

FOSTER WHEELER ENVIRONMENTAL CORPORATION

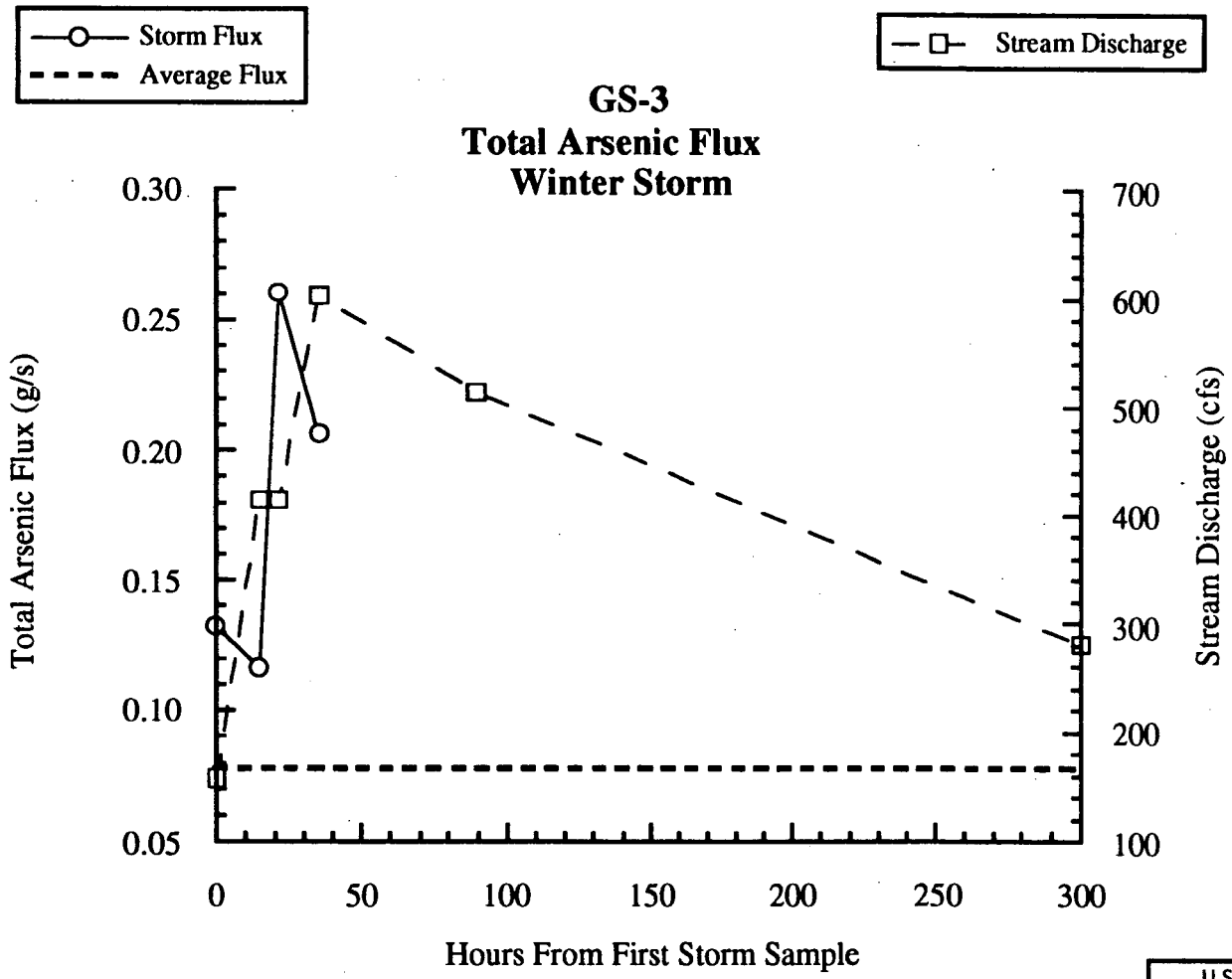


U.S. ENVIRONMENTAL PROTECTION AGENCY

VINELAND CHEMICAL COMPANY SITE

FIGURE 5-5
GS-2
TOTAL ARSENIC FLUX
WINTER STORM

FOSTER WHEELER ENVIRONMENTAL CORPORATION



U.S. ENVIRONMENTAL PROTECTION AGENCY

VINELAND CHEMICAL COMPANY SITE

FIGURE 5-6
GS-3
TOTAL ARSENIC FLUX
WINTER STORM

FOSTER WHEELER ENVIRONMENTAL CORPORATION

5.1.3.3 *Summer Storm Event*

The variation in total arsenic flux at GS-1, GS-2, GS-3 and ULD during the "summer" storm event, which occurred between July 14, 1993 and July 16, 1993, is shown in Figures 5-7 through 5-10. These figures show the flux as a function of the number of hours from the time sampling was initiated. For comparison, each figure also shows the variation in stream discharge (daily averages) during the same period and the average total arsenic flux measured during periodic sampling events (see Section 4.1).

Due to the extremely rapid approach, high intensity and short duration that is typical of summer storms, both the As flux and the stream discharge had reached their maximum values at GS-1 by the time sampling was initiated (Figure 5-7). The maximum As flux was 0.096 g/s, only slightly higher than the average total As flux measured during the periodic sampling events (0.083 g/s). The peak stream discharge (15 cfs) was slightly lower than the average discharge measured during the periodic sampling events (15.6 cfs). Both the As flux and the stream discharge then dropped gradually to their minimum values of 0.043 g/s, and 8.4 cfs, respectively, after approximately 40 hours from the beginning of the storm.

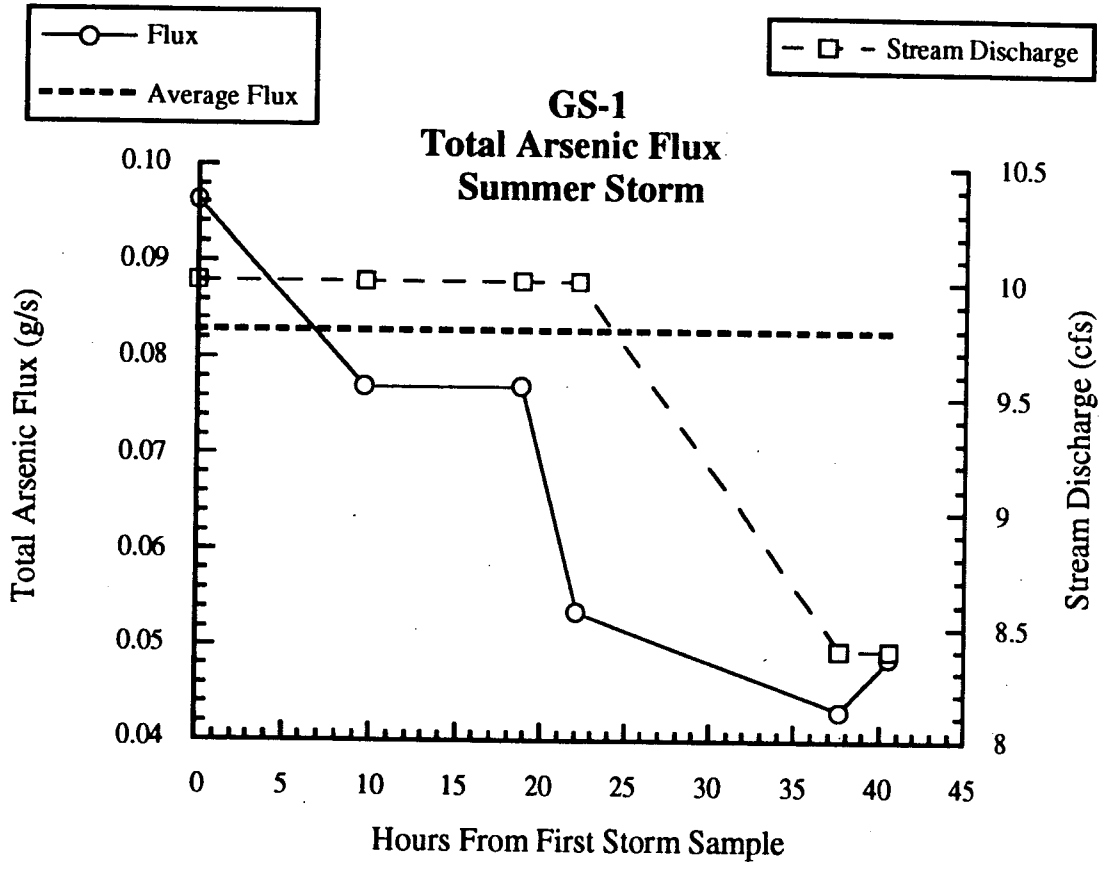
The As flux at GS-2 reached its maximum value of 0.066 g/s approximately 20 hours from the beginning of the storm, then dropped to 0.044 g/s by the time the last sample was collected approximately 40 hours after sampling began (Figure 5-8). The daily average stream discharge at GS-2 was 74 cfs for both days of sampling, compared to an average discharge of 131 cfs for the periodic sampling events.

Both the stream discharge and the As flux increased at GS-3 throughout the 41 hours of sampling (Figure 5-9). The maximum total As flux was 0.068 g/s, lower than the average flux measured during the periodic sampling events. The maximum stream discharge was 122 cfs, also well below the average value of 228 cfs measured during the periodic sampling.

The total arsenic flux over Union Lake Dam during the summer storm event reached a maximum value of 0.101 g/s approximately 19 hours after the beginning of the storm (Figure 5-10). Discharge from the dam also peaked during approximately the same time period, with a maximum value of 173 cfs.

5.1.3.4 *Summary of Total Arsenic Flux During Storm Events*

The total flux of As generally reached its maximum value early during a storm event, then dropped rapidly, usually to values lower than the initial flux at the beginning of the storm. The

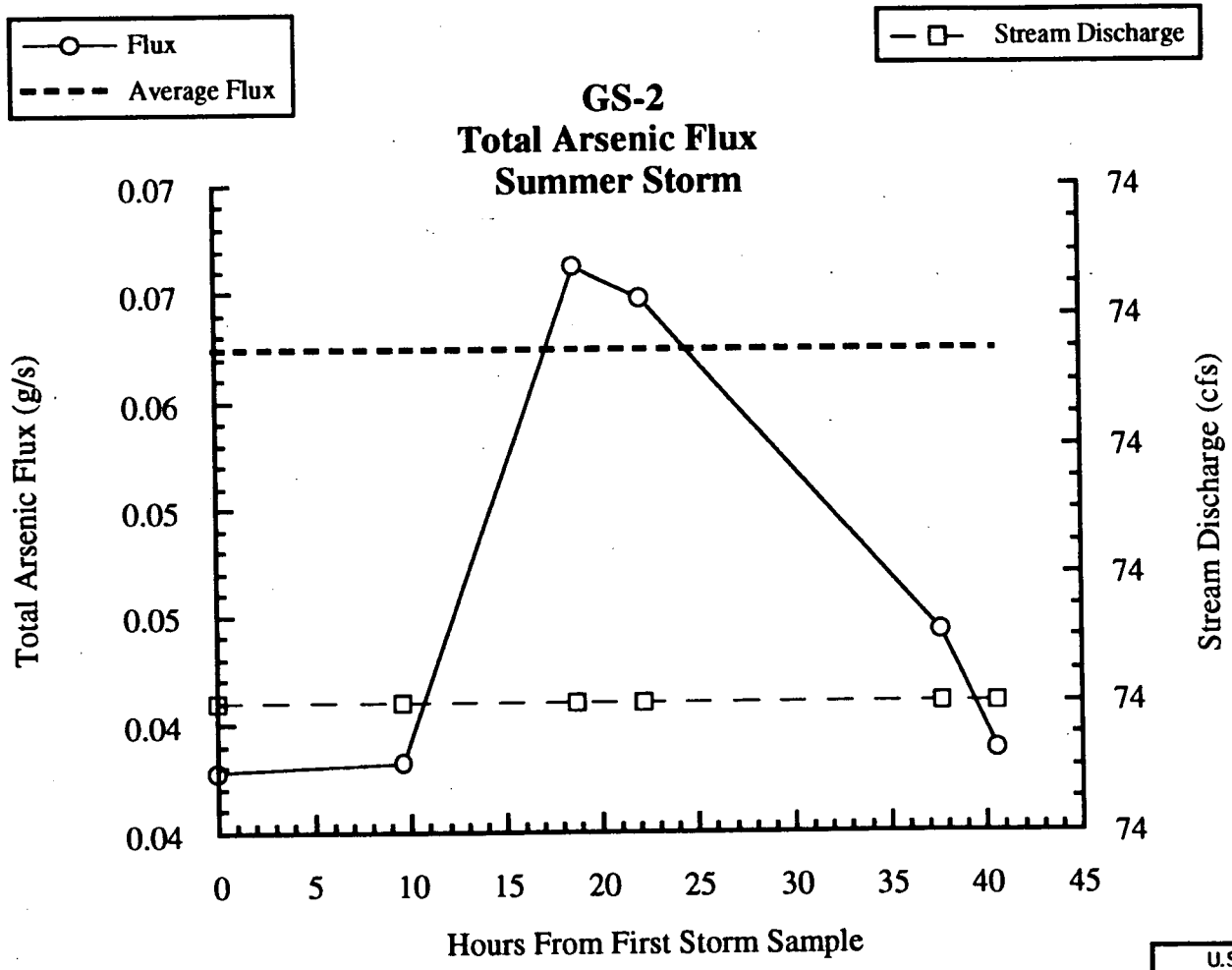


U.S. ENVIRONMENTAL PROTECTION AGENCY

VINELAND CHEMICAL COMPANY SITE

FIGURE 5-7
GS-1
TOTAL ARSENIC FLUX
SUMMER STORM

FOSTER WHEELER ENVIRONMENTAL CORPORATION

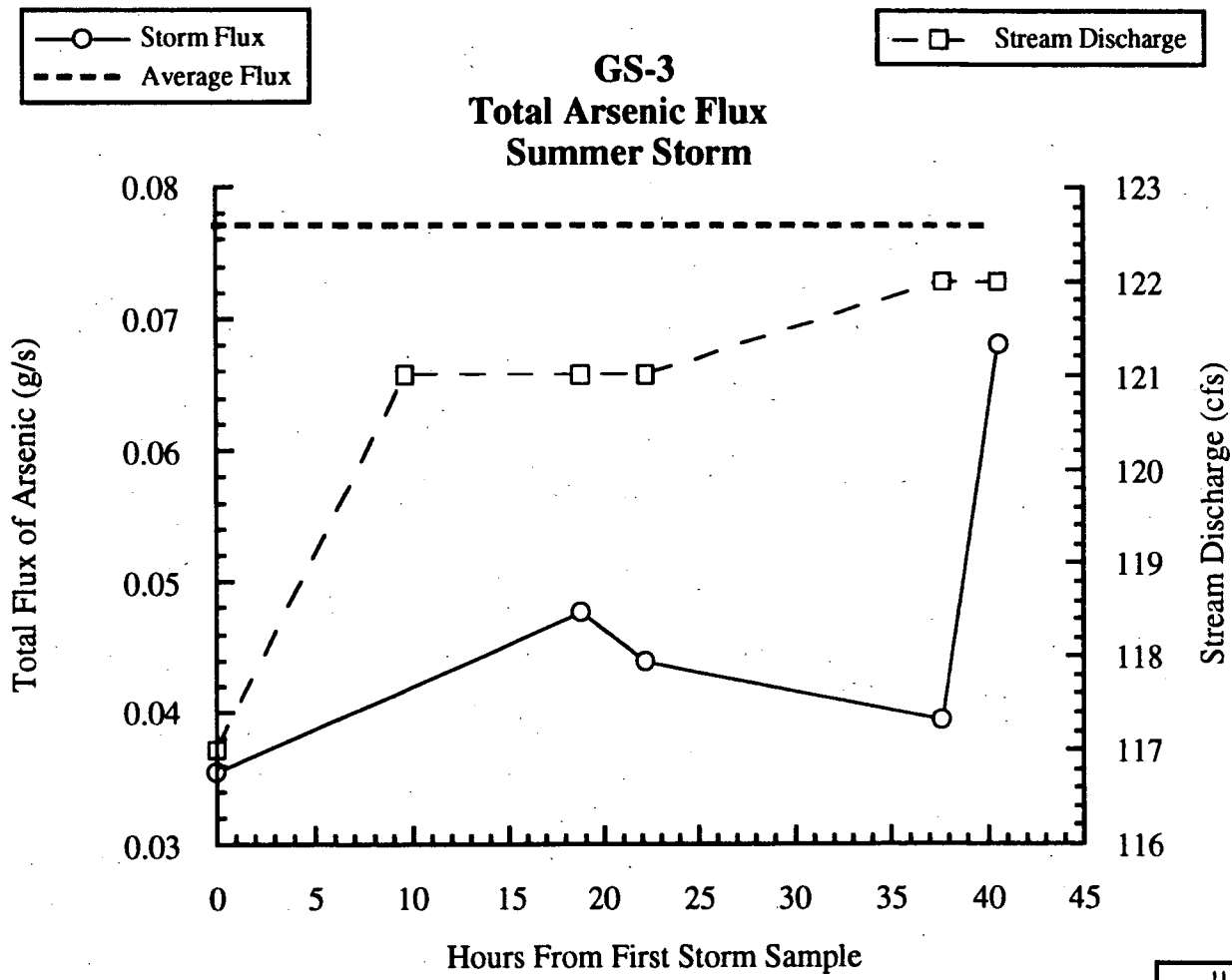


U.S. ENVIRONMENTAL PROTECTION AGENCY

VINELAND CHEMICAL COMPANY SITE

FIGURE 5-8
GS-2
TOTAL ARSENIC FLUX
SUMMER STORM

FOSTER WHEELER ENVIRONMENTAL CORPORATION

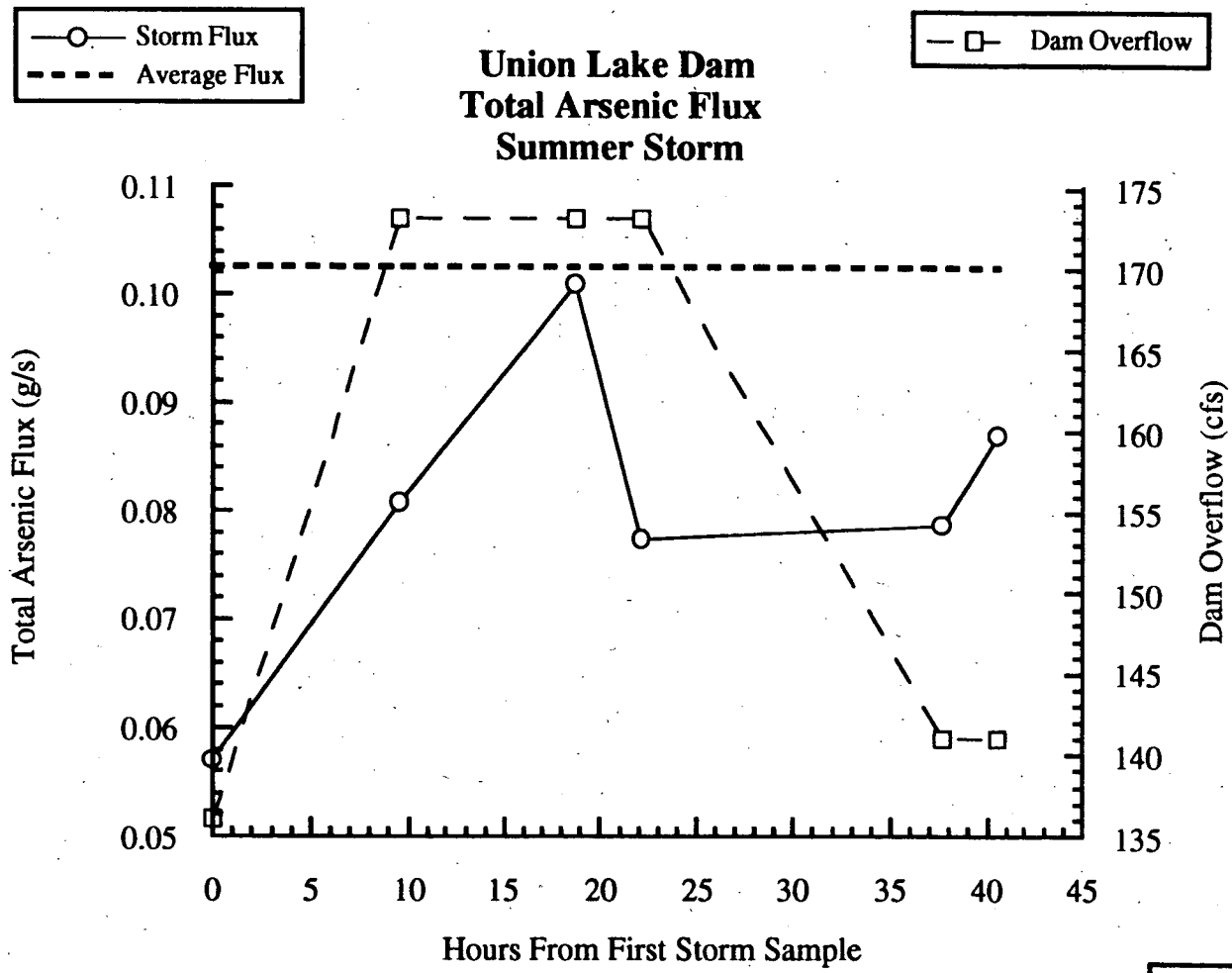


U.S. ENVIRONMENTAL PROTECTION AGENCY

VINELAND CHEMICAL COMPANY SITE

FIGURE 5-9
GS-3
TOTAL ARSENIC FLUX
SUMMER STORM

FOSTER WHEELER ENVIRONMENTAL CORPORATION



U.S. ENVIRONMENTAL PROTECTION AGENCY

VINELAND CHEMICAL COMPANY SITE

FIGURE 5-10
ULD
TOTAL ARSENIC FLUX
SUMMER STORM

FOSTER WHEELER ENVIRONMENTAL CORPORATION

maximum stream discharge generally took longer to develop, especially during a very large storm event such as the winter storm (Section 5.1.3.2), and then decreased more slowly after reaching its maximum value.

The initial rapid increase in the flux of As during storm runoff could result from (1) the increased rate of discharge of As-contaminated water already in the stream prior to the storm event and (2) re-suspension of fine sediments that may have collected on the stream bottom prior to the storm event by the initial "pulse" of faster flowing water. Once the As-contaminated water in the stream has been replaced by relatively clean storm runoff, and the fine sediments have been transported downstream, the flux of As would decrease, even though the stream discharge may remain elevated above normal values. This scenario may also explain the decrease in total As flux to values lower than the flux prior to the storm, since the stream system would be "cleansed" of both As-contaminated water and As-contaminated surficial sediments by the initial large pulse of storm runoff.

5.2 DISSOLVED ARSENIC FLUX

This section presents the results of analyses of filtered surface water samples collected from MRU, GS-1, GS-2, GS-3 and ULD during three storm events: one each in the fall and winter of 1992 and one in the summer of 1993. These measurements allow a determination of the percentage of the total arsenic flux that results from arsenic carried in solution. Following EPA convention, we refer to the As contained in a sample that passes through a 0.45 µm filter as "dissolved," however it should be noted that such a sample may also contain As that is sorbed to colloidal particles ranging in size from 0.1–0.45 µm. Distinction between As that is truly in solution and As that is sorbed to suspended colloids is largely unimportant for consideration of transport in surface waters, since the colloids would remain suspended indefinitely. Complete analytical results are given in Appendix A.

5.2.1 Methods

Sample collection procedures were identical to those used for unfiltered storm event samples (Section 5.1.1) except that samples were filtered through a cellulose-based membrane filter with a nominal pore size of 0.45µm according to SOP # 2 presented in the FOP (April, 1992). Analytical methods and sample preservation techniques are detailed in Table 3-1 of the FOP (April, 1992). Measurements of pH, Eh, D.O., conductivity and temperature were conducted in the field.

TABLE 5-2
Arsenic Concentrations in Filtered Surface Water
"Storm Flow"

EPA Sample I.D	Sampling Date	Ebasco Sample I.D.	Location	Stream Discharge (cfs)	As Flux (g/s)	As µg/l	
104778	9/25/92	VC-ST-SC-GS1-1001	Gauging Station 1	8.7	0.030	122.00	
104783	9/26/92	VC-ST-SC-GS1-1002	Gauging Station 1	23	0.079	122.00	
104788	9/26/92	VC-ST-SC-GS1-1003	Gauging Station 1	23	0.076	117.00	
104794	9/27/92	VC-ST-SC-GS1-1004	Gauging Station 1	12	0.040	117.00	
104801	9/28/92	VC-ST-SC-GS1-1005	Gauging Station 1	10	0.033	117.00	
104804	9/29/92	VC-ST-SC-GS1-1006	Gauging Station 1	9.8	0.032	116.00	
103490	12/10/92	VC-ST-SC-GS1-1002-01	Gauging Station 1	10	0.024	85.70	
	12/11/92	VC-ST-SC-GS1-1002-02		34			
	12/11/92	VC-ST-SC-GS1-1002-03		34			
	12/12/92	VC-ST-SC-GS1-1002-04		35			
103507	12/14/92	VC-ST-SC-GS1-1002-05	Gauging Station 1	19	0.046	85.50	
103512	12/23/92	VC-ST-SC-GS1-1002-06	Gauging Station 1	15	0.050	117.00	
MBMF62	7/15/93	VC-ST-GS1-1003-01 (D)	Gauging Station 1	10	0.033	117.00	J
MBMF68	7/15/93	VC-ST-GS1-1003-02 (D)	Gauging Station 1	10	0.029	104.00	J
MBMF64	7/15/93	VC-ST-GS1-1003-03 (D)	Gauging Station 1	10	No As Data		
MBMF25	7/16/93	VC-ST-CH-GS1-1003-04 (D)	Gauging Station 1	8.4	0.028	118.00	
MBMF23	7/16/93	VC-ST-CH-GS1-1003-05 (D)	Gauging Station 1	8.4	0.020	82.00	B
MBMF01	7/16/93	VC-ST-CH-GS1-1003-06 (D)	Gauging Station 1	8.4	0.022	94.30	B
			min	**8.40**	**0.020**	**82.00**	
			max	**35.00**	**0.079**	**122.00**	
			avg	**16.24**	**0.039**	**108.18**	
104779	9/25/92	VC-ST-SC-GS2-1001	Gauging Station 2	64	0.035	19.40	
104784	9/26/92	VC-ST-SC-GS2-1002	Gauging Station 2	143	ND	5.00	U
104789	9/26/92	VC-ST-SC-GS2-1003	Gauging Station 2	143	0.098	24.10	
104795	9/27/92	VC-ST-SC-GS2-1004	Gauging Station 2	145	0.058	14.20	
104802	9/28/92	VC-ST-SC-GS2-1005	Gauging Station 2	143	0.038	9.30	
104805	9/29/92	VC-ST-SC-GS2-1006	Gauging Station 2	136	0.039	10.20	
103491	12/10/92	VC-ST-SC-GS2-1002-01	Gauging Station 2	97	0.032	11.60	
103495	12/11/92	VC-ST-SC-GS2-1002-02	Gauging Station 2	179	0.076	14.90	
103499	12/11/92	VC-ST-SC-GS2-1002-03	Gauging Station 2	179	0.075	14.80	
	12/12/92	VC-ST-SC-GS2-1002-04	Gauging Station 2	238			
103506	12/14/92	VC-ST-SC-GS2-1002-05	Gauging Station 2	290	ND	10.00	U
103511	12/23/92	VC-ST-SC-GS2-1002-06	Gauging Station 2	176	ND	10.00	U

TABLE 5-2
Arsenic Concentrations in Filtered Surface Water
"Storm Flow"

EPA Sample I.D	Sampling Date	Ebasco Sample I.D.	Location	Stream Discharge (cfs)	As Flux (g/s)	As µg/l	
MBMF71	7/15/93	VC-ST-GS2-1003-01 (D)	Gauging Station 2	74	0.041	19.70	J
MBMF76	7/15/93	VC-ST-GS2-1003-02 (D)	Gauging Station 2	74	0.031	15.00	
MBMF73	7/15/93	VC-ST-GS2-1003-03 (D)	Gauging Station 2	74	0.034	16.00	
MBMF29	7/15/93	VC-ST-CH-GS2-1003-04 (D)	Gauging Station 2	74	0.068	32.40	
MBMF15	7/16/93	VC-ST-CH-GS2-1003-05 (D)	Gauging Station 2	74	0.037	17.50	B
MBMF03	7/16/93	VC-ST-CH-GS2-1003-06 (D)	Gauging Station 2	74	0.045	21.70	
			min	**64.00**	**0.031**	**5.00**	
			max	**290.00**	**0.098**	**32.40**	
			avg	**146.58**	**0.050**	**15.635**	
104780	9/25/92	VC-ST-SC-GS3-1001	Gauging Station 3	98	ND	5.00	U
104785	9/26/92	VC-ST-SC-GS3-1002	Gauging Station 3	299	0.175	20.70	
104790	9/26/92	VC-ST-SC-GS3-1003	Gauging Station 3	299	0.052	6.10	
104796	9/27/92	VC-ST-SC-GS3-1004	Gauging Station 3	271	0.054	7.00	
104803	9/28/92	VC-ST-SC-GS3-1005	Gauging Station 3	249	0.037	5.20	
104806	9/29/92	VC-ST-SC-GS3-1006	Gauging Station 3	204	0.038	6.60	
103492	12/10/92	VC-ST-SC-GS3-1002-01	Gauging Station 3	157	ND	10.00	U
103496	12/11/92	VC-ST-SC-GS3-1002-02	Gauging Station 3	414	0.117	10.00	
103500	12/11/92	VC-ST-SC-GS3-1002-03	Gauging Station 3	414	ND	10.00	U
		VC-ST-SC-GS3-1002-04	Gauging Station 3	602			
103508	12/14/92	VC-ST-SC-GS3-1002-05	Gauging Station 3	513	ND	10.00	U
103510	12/23/92	VC-ST-SC-GS3-1002-06	Gauging Station 3	280	ND	10.00	U
MBMF55	7/14/93	VC-ST-GS3-1003-01 (D)	Gauging Station 3	117	0.007	2.20	B
MBMF45	7/15/93	VC-ST-GS3-1003-02 (D)	Gauging Station 3	121	No As Data		R
MBMF39	7/15/93	VC-ST-GS3-1003-03 (D)	Gauging Station 3	121	0.018	5.20	B
MBMF31	7/15/93	VC-ST-CH-GS3-1003-04 (D)	Gauging Station 3	121	0.019	5.50	B
MBMF05	7/16/93	VC-ST-CH-GS3-1003-06 (D)	Gauging Station 3	122	0.022	6.30	BJ
MBMF17	7/16/93	VC-ST-CH-GS3-1003-05 (D)	Gauging Station 3	122	0.018	5.20	BJ
			min	**98.00**	**0.007**	**2.20**	
			max	**602.00**	**0.175**	**20.70**	
			avg	**265.15**	**0.051**	**7.81**	
104777	9/25/92	VC-ST-SC-MRU-1001	Maurice River - Garden Rd.	48	ND	5.00	U
104781	9/26/92	VC-ST-SC-MRU-1002	Maurice River - Garden Rd.	105	ND	5.00	U

TABLE 5-2

Arsenic Concentrations in Filtered Surface Water

"Storm Flow"

EPA Sample I.D	Sampling Date	Ebasco Sample I.D.	Location	Stream Discharge (cfs)	As Flux (g/s)	As µg/l	
104786	9/26/92	VC-ST-SC-MRU-1003	Maurice River - Garden Rd.	105	ND	5.00	U
104791	9/27/92	VC-ST-SC-MRU-1004	Maurice River - Garden Rd.	111	ND	5.00	U
104800	9/28/92	VC-ST-SC-MRU-1005	Maurice River - Garden Rd.	113	ND	5.00	U
104807	9/29/92	VC-ST-SC-MRU-1006	Maurice River - Garden Rd.	105	ND	5.00	U
104810	9/29/92	VC-ST-SC-MRU-1006D	Maurice River - Garden Rd.	105	ND	5.00	U
103489	12/10/92	VC-ST-SC-MRU-1002-01	Maurice River - Garden Rd.	74	ND	10.00	U
103494	12/11/92	VC-ST-SC-MRU-1002-02	Maurice River - Garden Rd.	141	ND	10.00	U
103498	12/11/92	VC-ST-SC-MRU-1002-03	Maurice River - Garden Rd.	141	ND	10.00	U
103502	12/12/92	VC-ST-SC-MRU-1002-04	Maurice River - Garden Rd.	263	ND	10.00	U
103504	12/14/92	VC-ST-SC-MRU-1002-05	Maurice River - Garden Rd.	348	ND	10.00	U
103513	12/23/92	VC-ST-SC-MRU-1002-06	Maurice River - Garden Rd.	145	ND	10.00	U
MBMF51	7/14/93	VC-ST-MRU-1003-01 (D)	Maurice River - Garden Rd.	45	0.007	5.50	B
MBMF49	7/15/93	VC-ST-MRU-1003-02 (D)	Maurice River - Garden Rd.	49	ND	2.20	U
MBMF43	7/15/93	VC-ST-MRU-1003-03 (D)	Maurice River - Garden Rd.	49	ND	2.20	U
MBMF35	7/15/93	VC-ST-CH-MRU-1003-04 (D)	Maurice River - Garden Rd.	49	0.002	1.70	B
MBMF21	7/16/93	VC-ST-CH-MRU-1003-05 (D)	Maurice River - Garden Rd.	51	ND	1.30	U
MBMF09	7/16/93	VC-ST-CH-MRU-1003-06 (D)	Maurice River - Garden Rd.	51	0.003	2.20	UJ
			min	**45.00**	**0.002**	**1.30**	
			max	**348.00**	**0.007**	**10.00**	
			avg	**122.92**	**0.004**	**5.79**	
104782	9/26/92	VC-ST-SC-ULD-1001	Union Lake Dam		No Flow Data	9.10	
104787	9/26/92	VC-ST-SC-ULD-1002	Union Lake Dam		No Flow Data	10.40	
104792	9/27/92	VC-ST-SC-ULD-1003	Union Lake Dam		No Flow Data	7.40	
104793	9/27/92	VC-ST-SC-ULD-1003D	Union Lake Dam		No Flow Data	7.50	
104799	9/28/92	VC-ST-SC-ULD-1004	Union Lake Dam		No Flow Data	10.20	
104808	9/29/92	VC-ST-SC-ULD-1006	Union Lake Dam		No Flow Data	8.90	
103493	12/10/92	VC-ST-SC-ULD-1002-01	Union Lake Dam		No Flow Data	10.00	
103497	12/11/92	VC-ST-SC-ULD-1002-02	Union Lake Dam		No Flow Data	10.00	
103501	12/11/92	VC-ST-SC-ULD-1002-03	Union Lake Dam		No Flow Data	10.00	U
103503	12/12/92	VC-ST-SC-ULD-1002-04	Union Lake Dam		No Flow Data	10.00	U
103505	12/14/92	VC-ST-SC-ULD-1002-05	Union Lake Dam		No Flow Data	10.00	U
103509	12/23/92	VC-ST-SC-ULD-1002-06	Union Lake Dam		No Flow Data	10.00	U
MBMF53	7/14/93	VC-ST-ULD-1003-01 (D)	Union Lake Dam	136	0.046	12.00	
MBMF47	7/15/93	VC-ST-ULD-1003-02 (D)	Union Lake Dam	173	0.095	19.30	J

TABLE 5-2

Arsenic Concentrations in Filtered Surface Water

"Storm Flow"

EPA Sample I.D	Sampling Date	Ebasco Sample I.D.	Location	Stream Discharge (cfs)	As Flux (g/s)	As µg/l	
MBMF41	7/15/93	VC-ST-ULD-1003-03 (D)	Union Lake Dam	173	0.082	16.70	J
MBMF33	7/15/93	VC-ST-CH-ULD-1003-04 (D)	Union Lake Dam	173	0.055	11.20	
MBMF19	7/16/93	VC-ST-CH-ULD-1003-05 (D)	Union Lake Dam	141	0.047	11.80	
MBMF07	7/16/93	VC-ST-CH-ULD-1003-06 (D)	Union Lake Dam	141	0.092	23.10	
			min	**136.00**	**0.046**	**7.40**	
			max	**173.00**	**0.095**	**23.10**	
			avg	**150.00**	**0.069**	**11.53**	

5.2.2 *Data Set for Dissolved As Flux*

For convenience, data that are referenced in the following discussion of the dissolved As flux in the Blackwater Branch Maurice River and Union Lake system during storm events are presented in Table 5-2. These data represent a subset of the complete analytical results presented in Appendix A, and include the As concentrations (in units of micrograms per liter, µg/l), and for samples collected during a period for which stream discharge information is available, the discharge rate (in units of cubic feet per second, cfs) and the total As flux (in units of grams per second, g/s).

5.2.3 *Results*

5.2.3.1 *Fall Storm Event*

Variation in the flux of dissolved arsenic at GS-1 through GS-3 during the fall storm event, which occurred between September 25, 1992 and September 29,1992, is shown in Figures 5-11 through 5-13. These figures show the flux as a function of the number of hours from the time sampling was initiated. For comparison, each figure also shows the variation in stream discharge (daily averages) during the same period and the average dissolved arsenic flux measured during the periodic sampling events (see Section 4.2).

Variations in the dissolved flux at GS-1 closely followed variations in the stream discharge, both reaching their maximum values approximately 20 hours after the beginning of the storm. The peak discharge was 23 cfs, compared to an average of 16 cfs during periodic sampling events. The peak dissolved arsenic flux was 0.079 g/s, 50% of the peak total arsenic flux of 0.158 g/s during the same storm. After reaching its peak value, the flux fell below the average dissolved As flux of 0.048 g/s measured during the periodic sampling events to a low of 0.032 g/s (Figure 5-11).

The dissolved As flux at GS-2 reached its maximum value approximately 20 hours after the beginning of the storm (Figure 5-12), similar to the flux at GS-1. The peak dissolved As flux (0.098 g/s) is approximately 56% of the peak total As flux during the same storm. The stream discharge approached its maximum value (145 cfs) approximately 15 hours from the beginning of the storm, but maintained high values for the duration of the sampling (87 hours), while the flux of As dropped below the average flux to a minimum of 0.038 g/s.

The stream discharge reached its peak value of 299 cfs at GS-3 approximately 15 to 20 hours from the beginning of the storm, then decreased gradually to 204 cfs after 89 hours. The

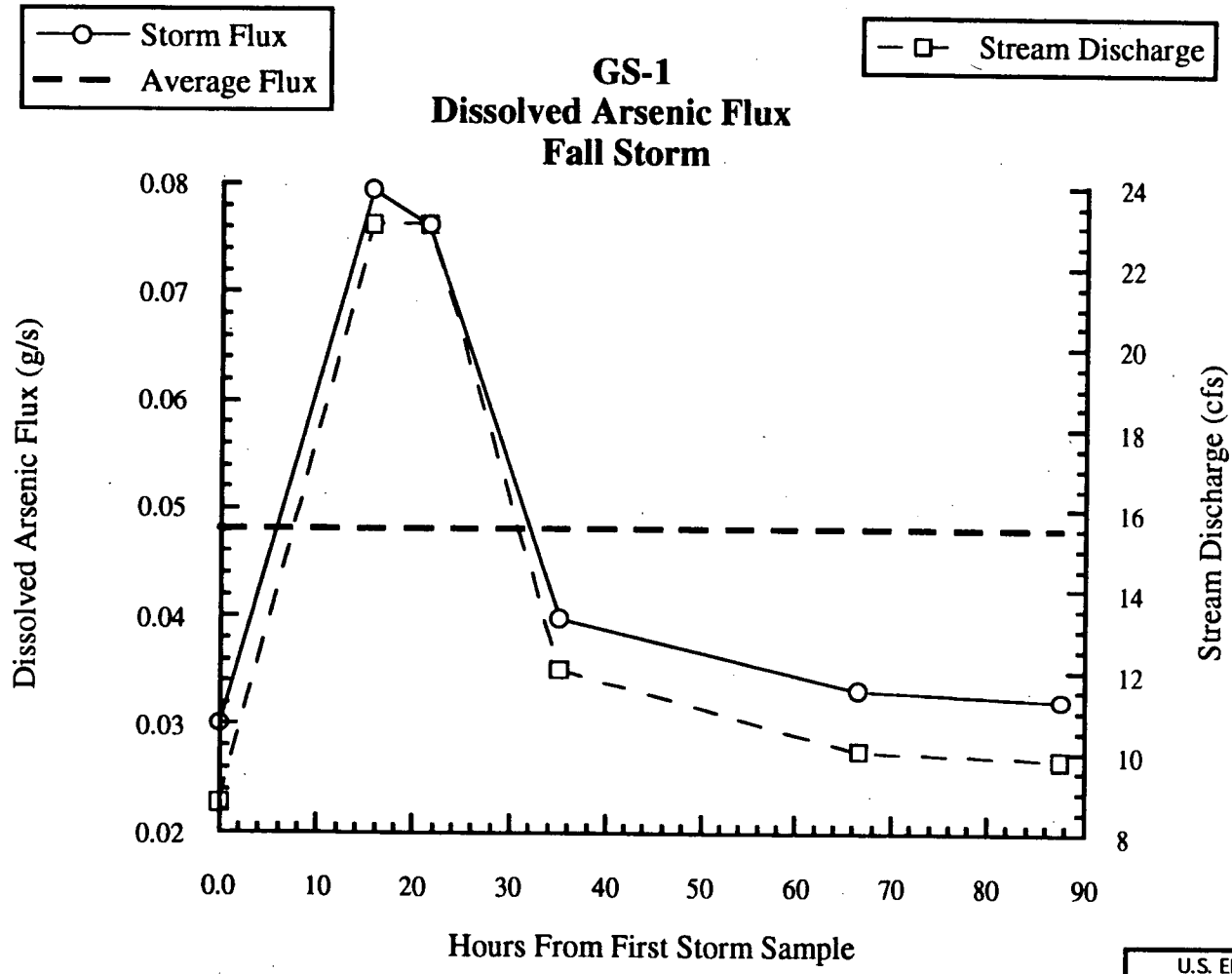


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FIGURE 5-11
GS-1
DISSOLVED ARSENIC FLUX
FALL STORM

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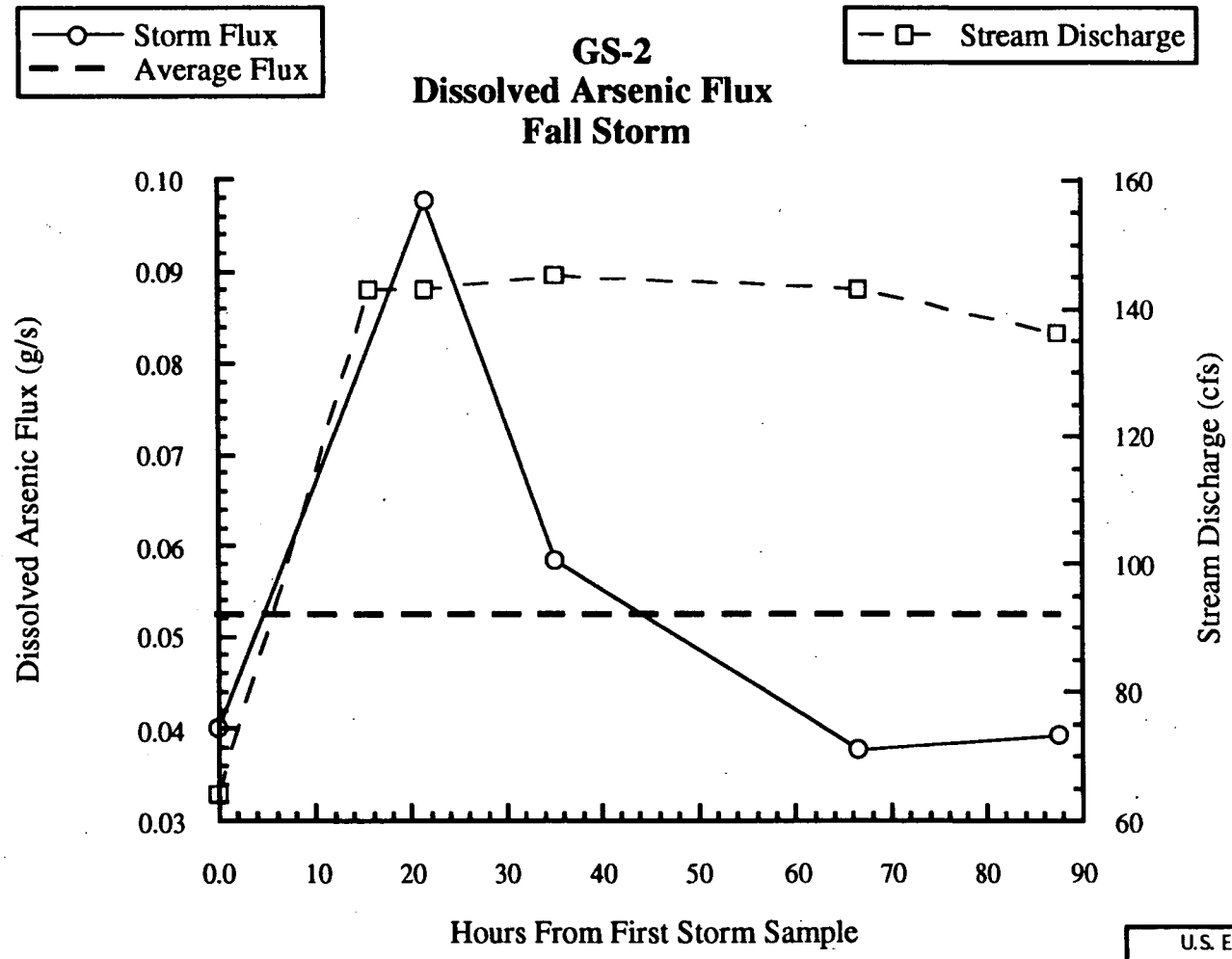

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FIGURE 5-12
GS-2
DISSOLVED ARSENIC FLUX
FALL STORM

FOSTER WHEELER ENVIRONMENTAL CORPORATION

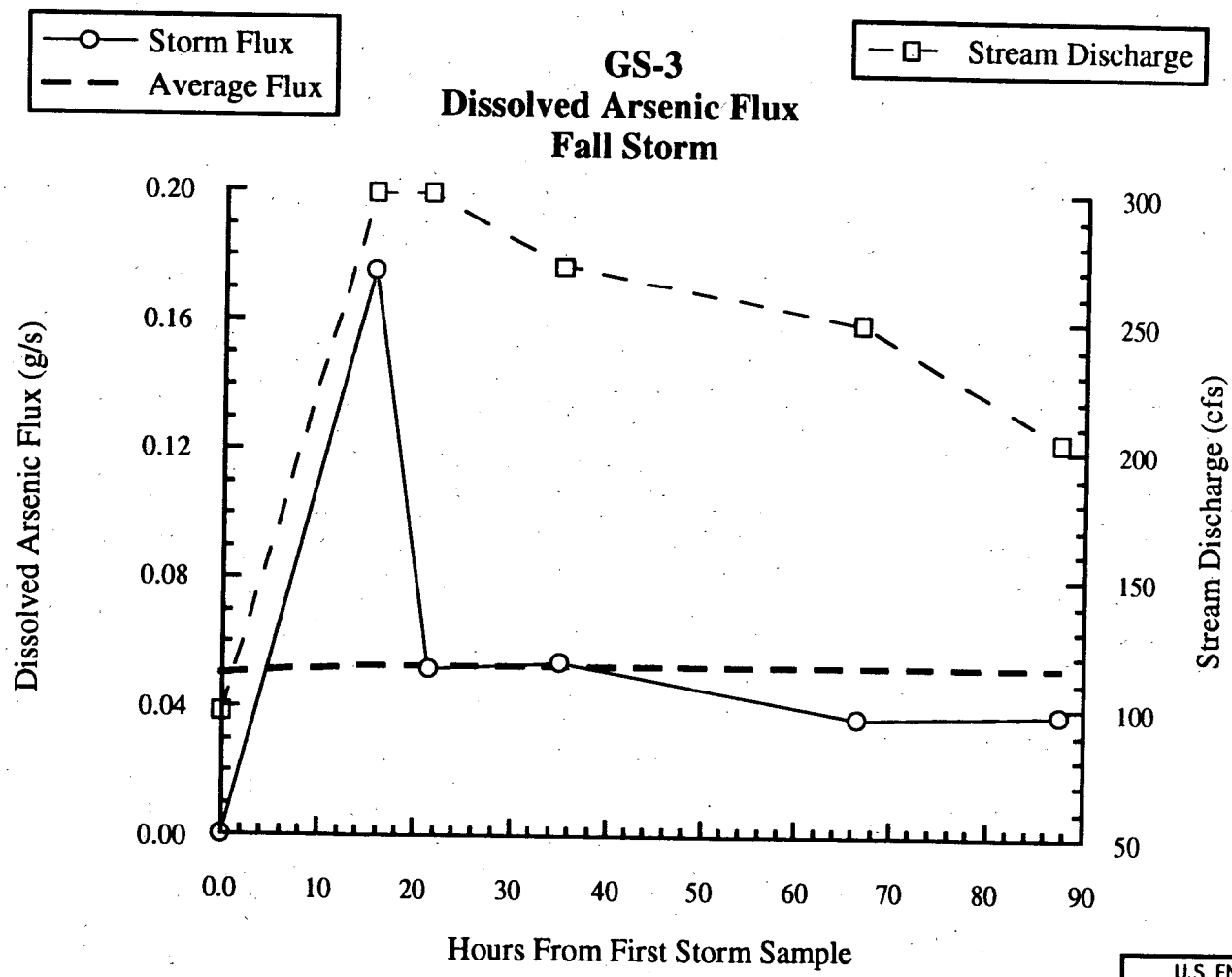

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FIGURE 5-13
GS-3
DISSOLVED ARSENIC FLUX
FALL STORM

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dissolved arsenic flux also reached its maximum value of 0.175 g/s 15 hours after the beginning of the storm, then dropped rapidly to 0.052 g/s after 22 hours, reaching a minimum of 0.038 g/s after 89 hours (Figure 5-13). The peak dissolved flux is unusually high, 170% of the total As flux for the same storm. This anomalously high flux may represent an error during sampling, for example an undetected failure of the filter membrane, or an error during the laboratory analysis of the filtered water sample.

There are no dam overflow data available for the period of the fall storm event.

5.2.3.2 *Winter Storm Event*

The variation in dissolved arsenic flux at GS-2 and GS-3 during the winter storm event, which occurred between December 10, 1992 and December 23,1992, is shown in Figures 5-14 and 5-15. These figures show the flux as a function of the number of hours from the time sampling was initiated. For comparison, each figure also shows the variation in stream discharge (daily averages) during the same period and the average dissolved arsenic flux measured during periodic sampling events (see Section 4.2). Insufficient data are available to illustrate trends in the variation at GS-1.

The dissolved As flux at GS-1 was 0.024 g/s when the first sample was collected on December 10, 1992. No data are available for the second, third and fourth filtered water samples from GS-1, which were taken at approximately 15 hours, 22 hours and 36 hours, respectively, after the beginning of the storm. The flux was 0.046 g/s when the fifth sample was collected, 90 hours after the storm began, and 0.05 g/s when the final sample was collected, 300 hours after the storm began.

The As flux at GS-2 reached its maximum value of 0.076 g/s approximately 15 hours from the beginning of the storm, then dropped very rapidly (Figure 5-14). Filtered samples collected at 90 hours and 300 hours after the beginning of the storm had As concentrations below the analytical detection limit. The peak dissolved As flux of 0.076 g/s is approximately 35% of the peak total As flux approximately 90 hours after the beginning of the storm. The stream discharge also subsided much more slowly and was still well above the average value of 131 cfs when the last sample was collected 300 hours after the beginning of the storm.

The variation in dissolved As flux at GS-3 was similar to its variation at GS-2, reaching its maximum value approximately 15 hours after the beginning of the storm, then dropping rapidly (Figure 5-15), with subsequent samples having As concentrations below the analytical detection limit. The peak dissolved As flux of 0.117 g/s was approximately 45% of the peak total As flux during the same storm event. The stream discharge reached its peak value of 602 cfs after

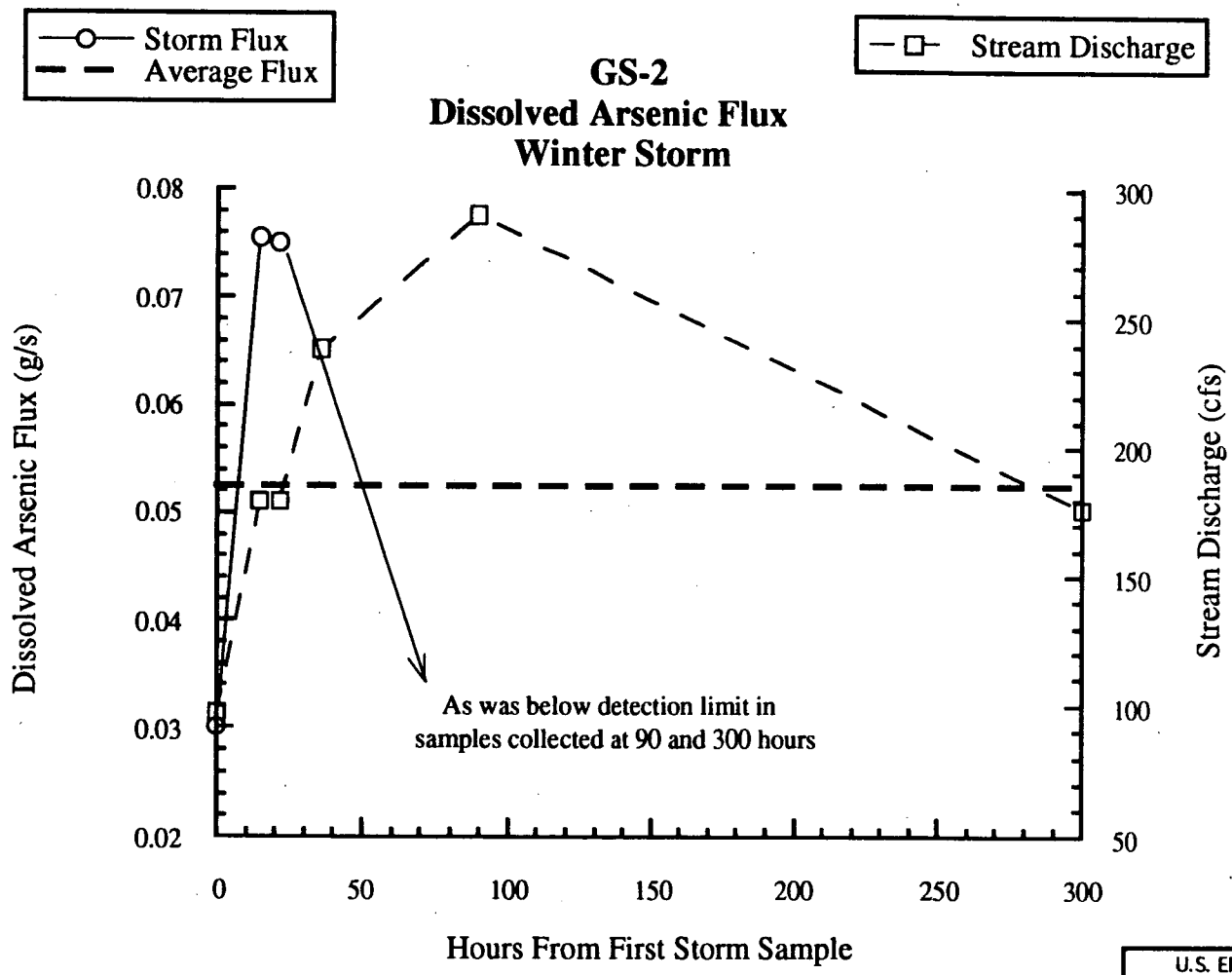

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FIGURE 5-14
GS-2
DISSOLVED ARSENIC FLUX
WINTER STORM

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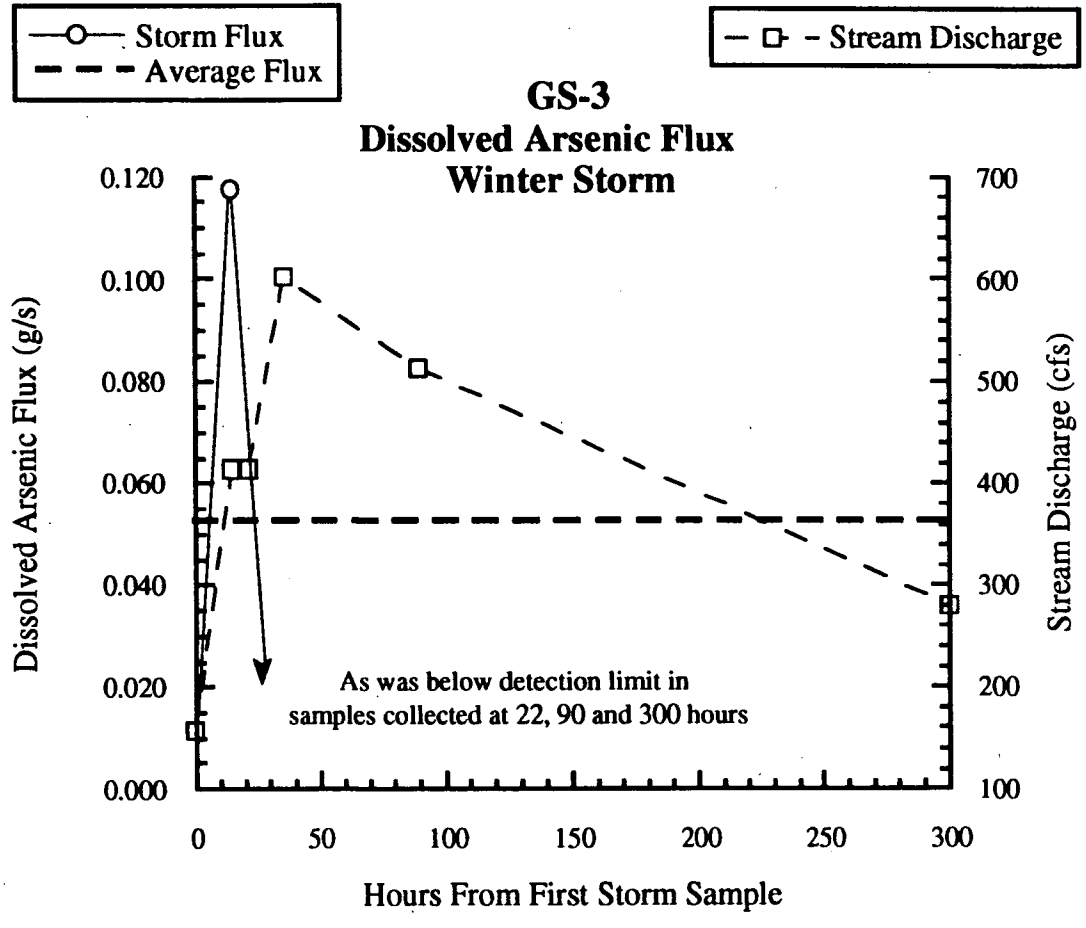

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FIGURE 5-15
GS-3
DISSOLVED ARSENIC FLUX
WINTER STORM

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approximately 35 hours, then subsided slowly as it did at GS-2. The stream discharge remained well above the average value of 228 cfs when the last sample was collected 300 hours after the beginning of the storm.

There are no dam overflow data available for the period of the fall storm event.

5.2.3.3 *Summer Storm Event*

The variation in total arsenic flux at GS-1, GS-2, GS-3 and ULD during the summer storm event, which occurred between July 14, 1993 and July 16, 1993, is shown in Figures 5-16 through 5-19. These figures show the flux as a function of the number of hours from the time sampling was initiated. For comparison, each figure also shows the variation in stream discharge (daily averages) during the same period and the average dissolved arsenic flux measured during periodic sampling events (see Section 4.2).

Due to the extremely rapid approach and short duration of the summer storm, both the As flux and the stream discharge had reached their maximum values at GS-1 by the time sampling was initiated (Figure 5-16). The maximum dissolved As flux was 0.033 g/s, only 34% of the maximum total As flux measured at GS-1 during the same storm (0.096 g/s). The peak stream discharge (15 cfs) was slightly lower than the average discharge measured during the periodic sampling events (15.6 cfs). Both the As flux and the stream discharge then dropped gradually to their minimum values of 0.020 g/s, and 8.4 cfs, respectively, after approximately 40 hours from the beginning of the storm.

The As flux at GS-2 reached its maximum value of 0.068 g/s approximately 22 hours from the beginning of the storm, then dropped rapidly to 0.037 g/s after 38 hours (Figure 5-17). The daily average stream discharge at GS-2 was 74 cfs for both days of sampling, compared to an average discharge of 131 cfs for the periodic sampling events. The maximum dissolved flux of 0.068 g/s is slightly higher than the maximum total As flux measured during the same storm event. This anomalously high flux reflects an As concentration of 32.4 µg/l, and may represent an error during sampling, for example an undetected failure of the filter membrane, or an error during the laboratory analysis of the filtered water sample.

The As flux increased at GS-3 throughout most of the 41 hours of sampling (Figure 5-18), reaching a maximum value of 0.022 g/s after 38 hours, then dropping slightly to 0.018 g/s when the final sample was collected 41 hours after the beginning of the storm. The maximum dissolved As flux was only 32% of the maximum total As flux during the same storm.

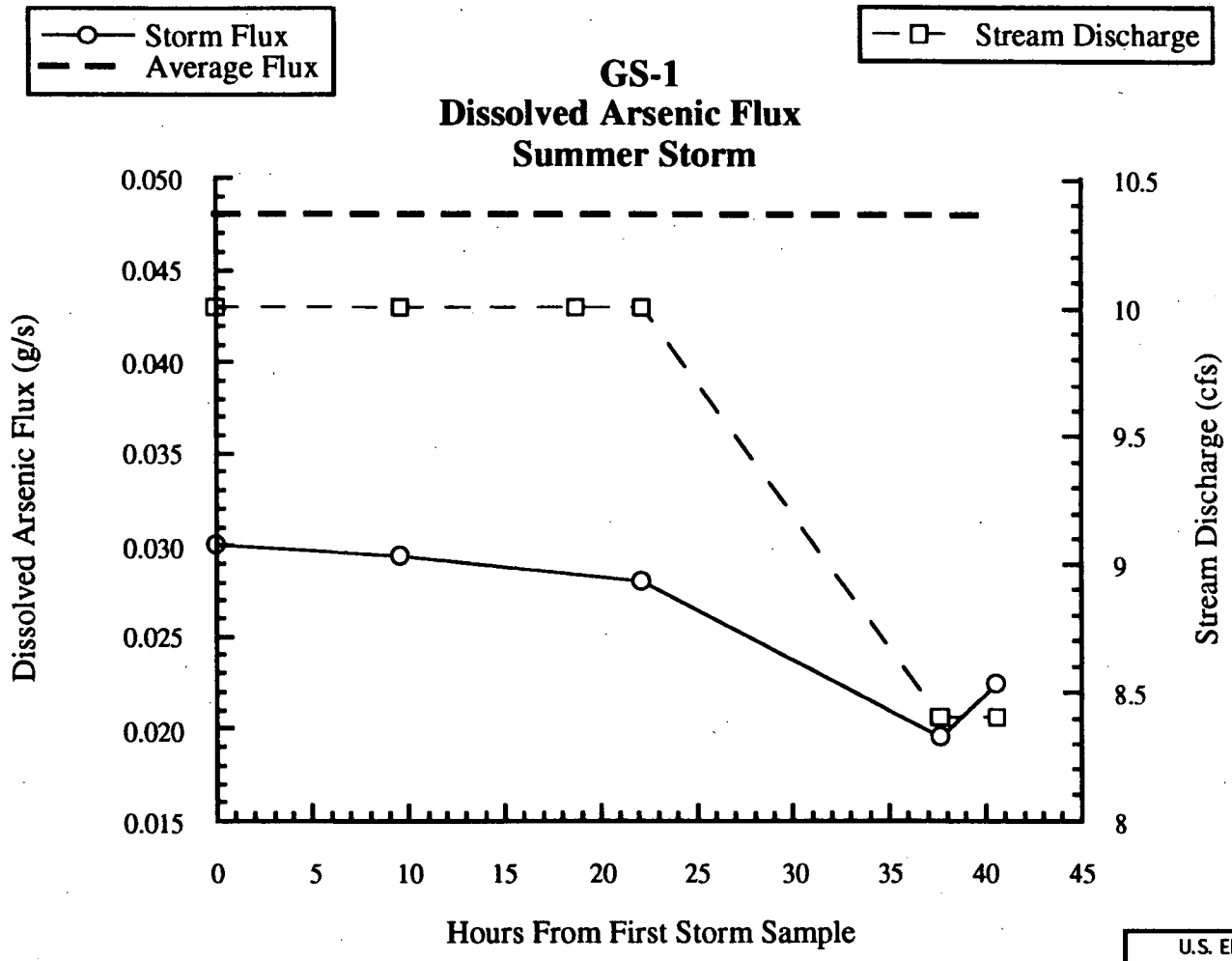

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FIGURE 5-16
GS-1
DISSOLVED ARSENIC FLUX
SUMMER STORM

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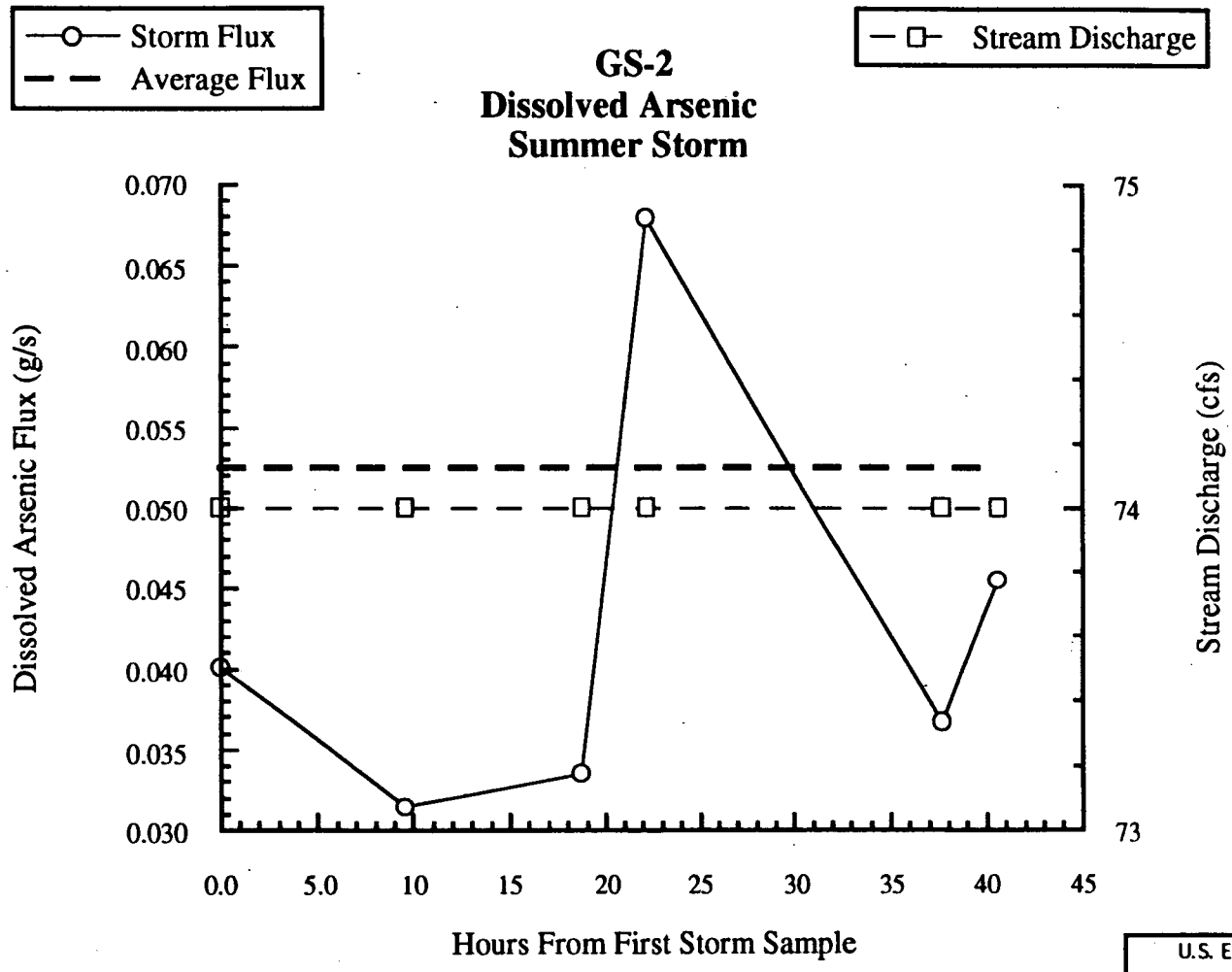

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FIGURE 5-17
GS-2
DISSOLVED ARSENIC FLUX
SUMMER STORM

FOSTER WHEELER ENVIRONMENTAL CORPORATION

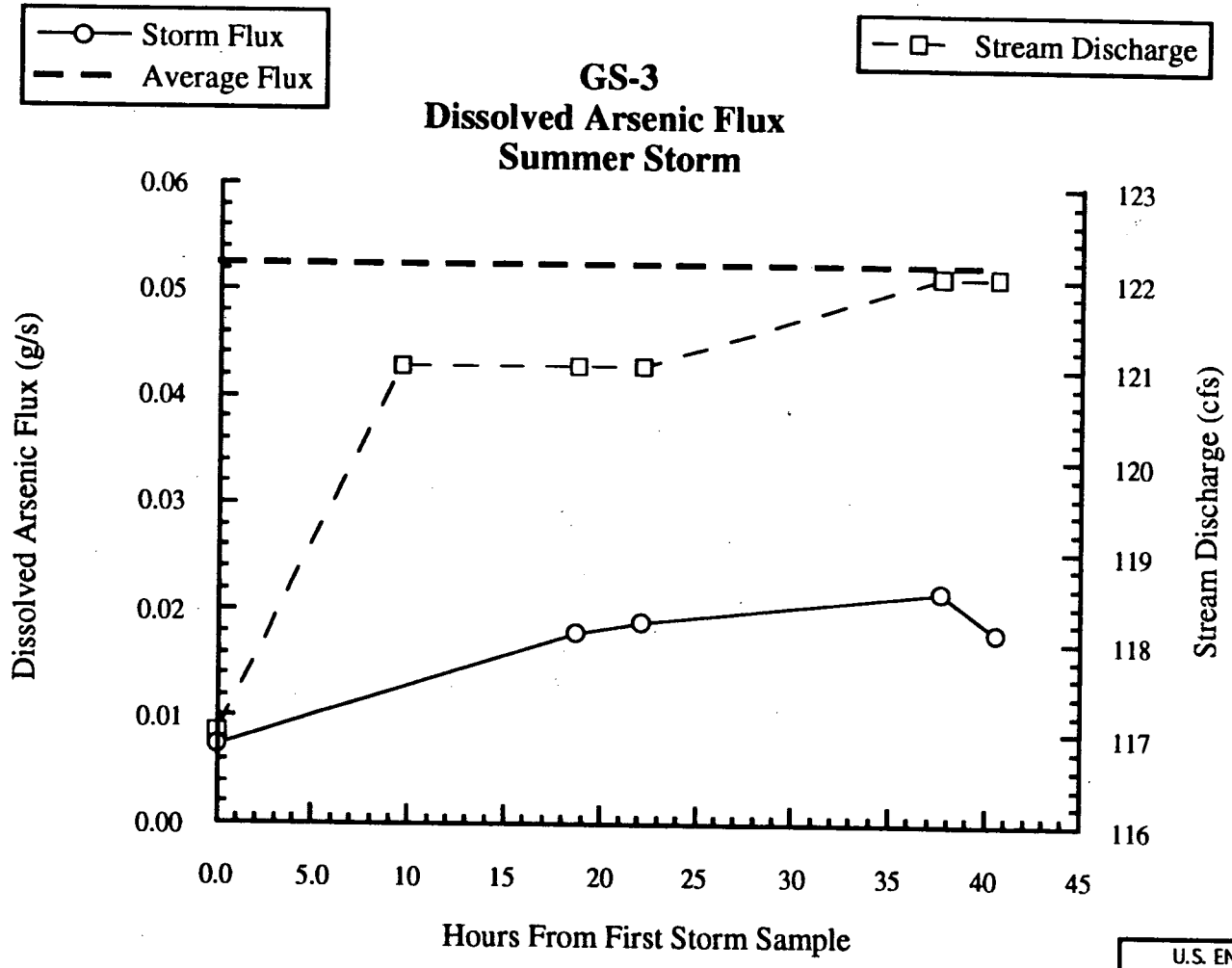

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FIGURE 5-18
GS-3
DISSOLVED ARSENIC FLUX
SUMMER STORM

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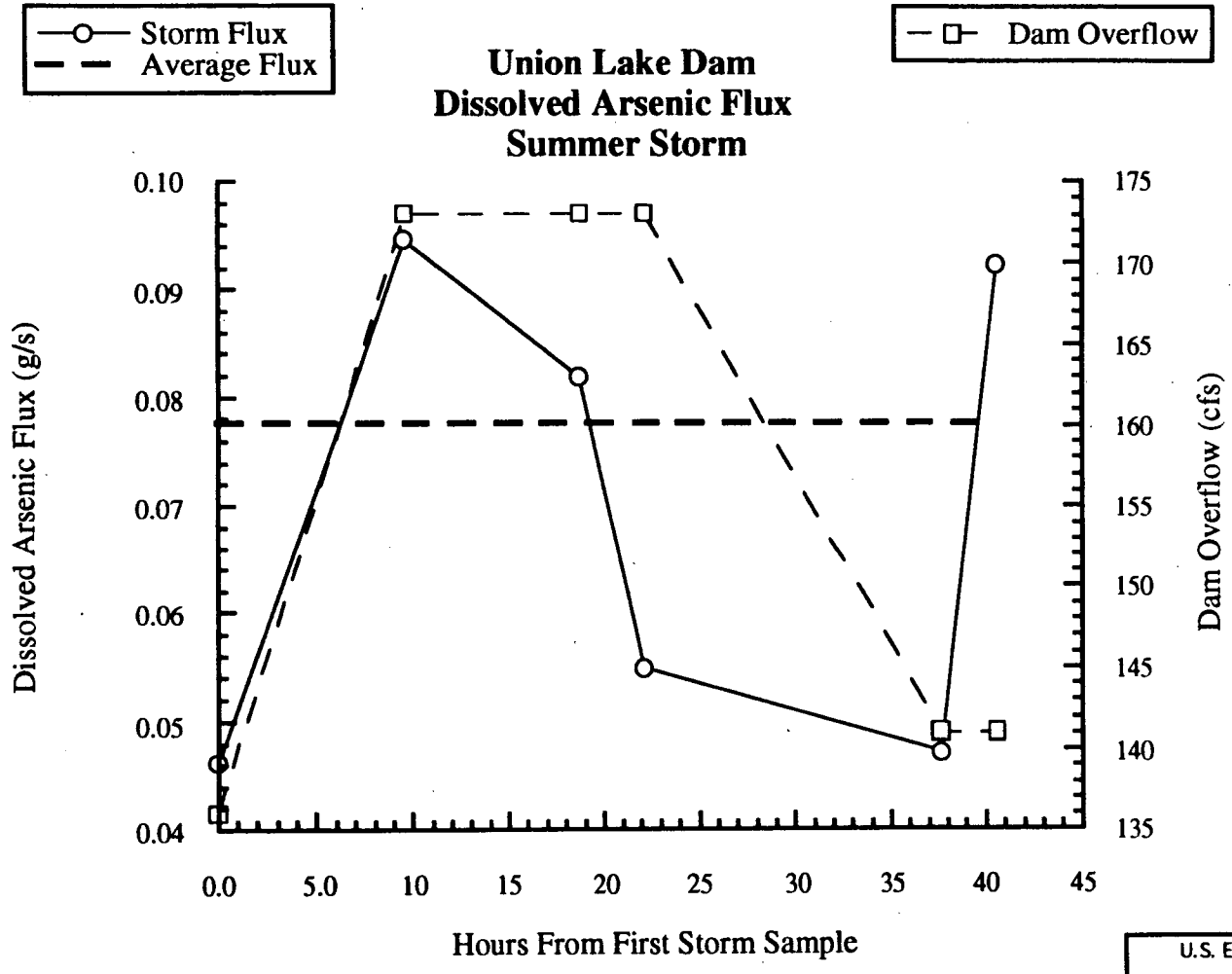

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FIGURE 5-19
ULD
DISSOLVED ARSENIC FLUX
SUMMER STORM

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The dissolved arsenic flux over Union Lake Dam during the summer storm event reached a maximum value of 0.095 g/s approximately 10 hours after the beginning of the storm (Figure 5-19), then decreased rapidly to 0.047 g/s after 38 hours. The final sample collected indicates a sharp increase in the dissolved As flux to 0.092 g/s after 41 hours. Discharge from the dam reached its maximum value of 173 cfs approximately 10 hours after the beginning of the storm.

5.2.3.4 *Summary of Dissolved Arsenic Flux During Storm Events*

Variations in the dissolved As flux over the course of a storm event were similar to variations in the total As flux. The flux generally reached its maximum value early during a storm event, then dropped rapidly, usually to values lower than the initial flux at the beginning of the storm, while the maximum stream discharge occurred later during the storm event and took longer to subside. With two exceptions that may represent either sampling or laboratory errors (GS-3 fall storm and GS-2 summer storm), peak dissolved As fluxes ranged from 32% (GS-3, summer storm) to 94% (ULD, summer storm) of the corresponding total As flux.

6.0 RATES OF ARSENIC DESORPTION FROM SEDIMENTS

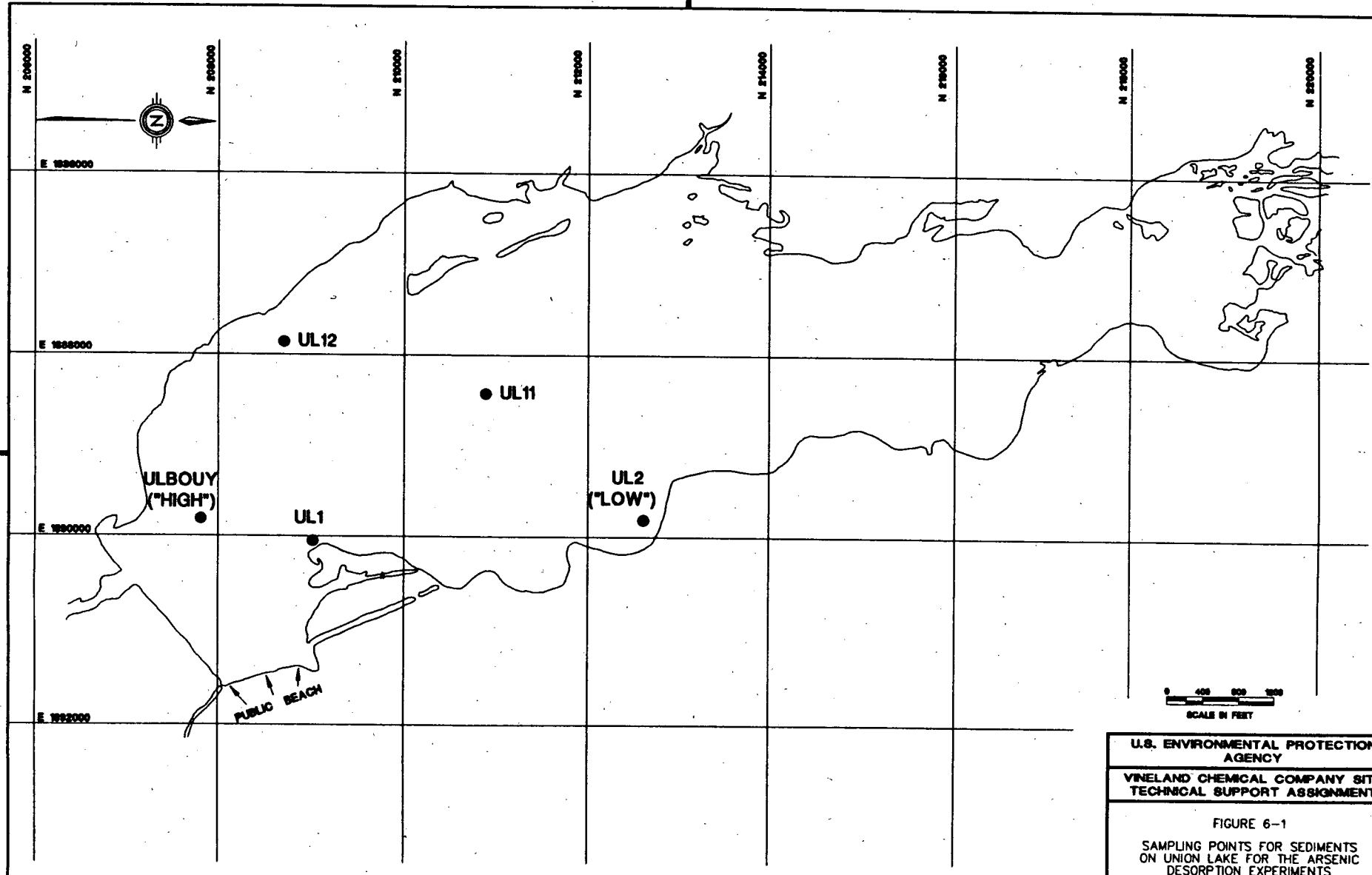
As described in the Final Work Plan (WP; March, 1991), the Final Field Operations Plan (FOP; April, 1992) and the Draft Work Plan Addendum (October, 1994), laboratory experiments were performed to determine the rate at which arsenic was removed from contaminated sediments by chemical desorption into uncontaminated river water in a quiescent flow regime, i.e., with little or no resuspension of particulates. The purpose of these experiments was to assess the rate at which contaminated sediments in the Maurice River Basin may "lose" arsenic naturally by chemical desorption into the overflowing uncontaminated river water once the influx of arsenic from the Vineland Chemical Company Plant site to river system is eliminated. These results are ultimately to be used in conjunction with estimates of arsenic mobility resulting from bedload and suspended sediment transport to predict natural cleanup rates for the Maurice River once the source of arsenic to the river basin has been removed. The requisite sediment transport modeling for the Maurice River Basin is being conducted by Dr. Earl Hayter of Clemson University. The following sections describe the experimental methods used to evaluate arsenic desorption rates, present the analytical data for both the starting materials and for the experimental run products, and present a summary and interpretation of the experimental results.

6.1 METHODS

6.1.1 *Starting Materials*

6.1.1.1 *Sediments*

Four independent experiments were performed, one each representing "low" and "medium" initial arsenic concentrations in the sediment, and two representing "high" initial arsenic concentrations in the sediment. Large volume (5 gallons ≈ 20 liters) surficial sediment samples were collected from 10 locations within the Maurice River Basin (see Figures 6-1 and 6-2), homogenized and analyzed for Target Analyte List (TAL) metals content. Duplicate volumes of sediment were collected from the three sampling locations that, on the basis of previous analytical results, were expected to represent sediments with "high" concentrations of arsenic. Depending on the depth of the overlying water, sediment samples were collected using either a decontaminated stainless-steel ponar dredge (deep water) or a decontaminated stainless-steel scoop or trowel (shallow water). In situations where sampling personnel were required to enter the water, the sample location was approached from the downstream side to avoid disturbance or contamination of sediments to be sampled. Sampling personnel wore new "surgical" sampling gloves for each sample collected to avoid cross-contamination of samples. Sediment was transferred directly from the sampling implement into 5-gallon polyethylene plastic buckets.



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VINELAND CHEMICAL COMPANY SITE
TECHNICAL SUPPORT ASSIGNMENT

FIGURE 6-1

SAMPLING POINTS FOR SEDIMENTS ON UNION LAKE FOR THE ARSENIC DESORPTION EXPERIMENTS

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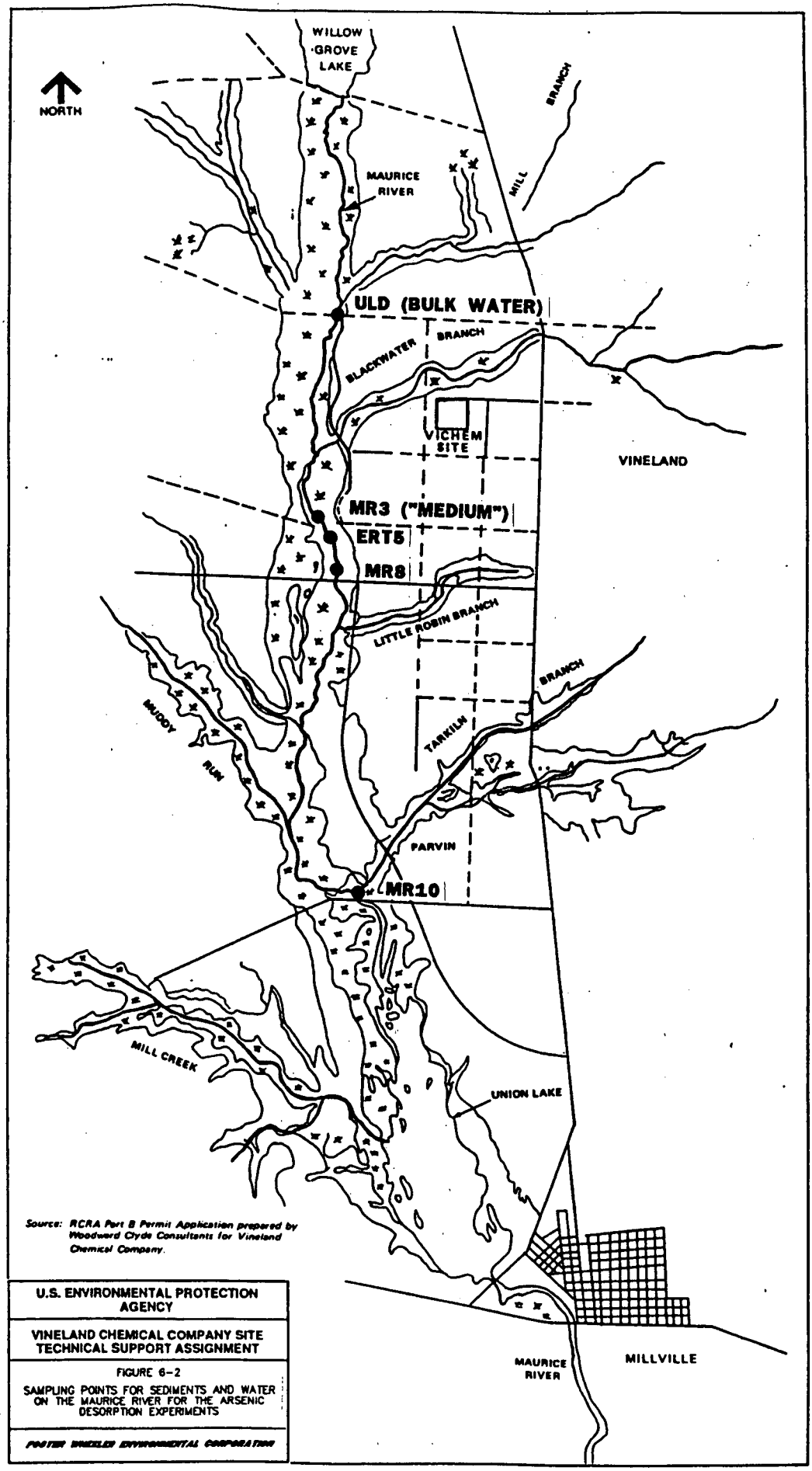

Source: RCRA Part B Permit Application prepared by Woodward Clyde Consultants for Vineland Chemical Company.

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VINELAND CHEMICAL COMPANY SITE
TECHNICAL SUPPORT ASSIGNMENT

FIGURE 6-2

SAMPLING POINTS FOR SEDIMENTS AND WATER ON THE MAURICE RIVER FOR THE ARSENIC DESORPTION EXPERIMENTS

FOSTER WHEELER ENVIRONMENTAL CORPORATION

SCALE 1:74 000

When the buckets were approximately 90% full, the sediments were allowed to settle and the overlying water was decanted. The sediment remaining in the bucket was then covered with plastic wrap (e.g. Saran Wrap) to help prevent moisture loss, and the lid was securely attached to the bucket. The sample buckets were then clearly labeled and stored in coolers packed with water ice to maintain their temperature at less than or equal to 4 degrees Celsius until they were delivered to the experimental laboratory, Cosper Environmental Services, Inc. (CEI). After homogenization of each sediment sample, CEI submitted three aliquots of each of the 13 samples (including three duplicates) for analysis of TAL metals content following the analytical method described in the EPA Contract Laboratory Program (CLP) Statement of Work (SOW) ILM03.0.

Four of the 13 sediment samples were chosen on the basis of their arsenic content for use in the experiments. Sample VC-SD-DE-UL2-09, with an average arsenic concentration of 86 mg/kg, was chosen for the "Low" experiment. This sample was collected from a cove along the eastern residential shoreline of Union Lake (see Figure 6-1). Sample VC-SD-DE-MR3-01, with an average arsenic concentration of 550 mg/kg, was chosen for the "Medium" experiment. This sample was collected from the Maurice River near transect MR3, approximately 100 meters upstream of the Almond Road Overpass (see Figure 6-2). Samples VC-SD-ULBUOY-06 and VC-SD-ULBUOY-06Dup, with average arsenic concentrations of 738 mg/kg and 1063 mg/kg, respectively, were chosen for the two "High" experiments. These are duplicate samples from the deepest portion of Union Lake, near the location of the thermal monitoring buoy (see Figure 6-1). Complete analytical results for the potential sediment starting materials are given in Table 6-1.

6.1.1.2 *Flush Water*

The uncontaminated river water used for all four experiments was collected from the Maurice River, upstream of its confluence with the Blackwater Branch, at the Garden Road overpass (see (Figure 6-2). The water was collected from a depth of approximately 15 centimeters (cm) using a Grunfos Redi Flo2 submersible pump through 1/2-inch interior diameter polyvinyl chloride tubing. The water was first passed through a high-volume 5.0 micron (µm) pleated polypropylene filter cartridge (Osmonics, Inc. Model #FPN051AAE) to remove coarse particulates and organic material, then through a high-volume 0.45 µm pleated polypropylene filter cartridge (Osmonics, Inc. Model #FPN941AAE). Analytical samples and the large volume bulk water sample for the experiments were collected using the same sampling apparatus.

The entire pump and filter system was first flushed with a volume of deionized water greater than three times the total capacity of the pump, tubing and filter cartridges. One filtered field blank comprised of deionized water was then collected through the sampling apparatus, including the filter cartridges. One unfiltered field blank was also collected through the sampling apparatus,

TABLE 6-1
ANALYTICAL RESULTS FROM SEDIMENT SAMPLING
POTENTIAL EXPERIMENTAL STARTING MATERIALS
VINELAND CHEMICAL COMPANY SITE

Ebasco Sample I.D.	Sampling Date	Sampling Time	Location	Units	As		Al		Sb		Ba		Be	
VC-SD-DE-UL2-09-01	9/25/95	1700	Cove area by Union Lake Dam (UL12)	mg/kg	98.50		3160.00		7.80	U	568.00		1.60	B
VC-SD-DE-UL2-09-02	9/25/95	1700	Cove area by Union Lake Dam (UL12)	mg/kg	89.40		1720.00		6.90	U	364.00		0.99	B
VC-SD-DE-UL2-09-03	9/25/95	1700	Cove area by Union Lake Dam (UL12)	mg/kg	70.90		2190.00		6.70	U	358.00		1.10	B
			AVERAGE ("LOW")		**86.27**		**2356.67**		**7.13**		**430.00**		**1.23**	
VC-SD-DE-MR3-01-01	9/19/95	0900	MR3 above Almond Road	mg/kg	505.00		3670.00		3.10	U	77.60	B	0.63	B
VC-SD-DE-MR3-01-02	9/19/95	0900	MR3 above Almond Road	mg/kg	556.00		4720.00		3.30	U	85.30	B	0.68	B
VC-SD-DE-MR3-01-03	9/19/95	0900	MR3 above Almond Road	mg/kg	588.00		4970.00		3.40	U	99.00	B	0.78	B
			AVERAGE ("MEDIUM")		**549.67**		**4453.33**		**3.27**		**87.30**		**0.70**	
VC-SD-DE-ULBUOY-06-01	9/25/95	1330	Buoy by Union Lake Dam	mg/kg	760.00		15500.00		9.40	U	292.00	B	2.30	B
VC-SD-DE-ULBUOY-06-02	9/25/95	1330	Buoy by Union Lake Dam	mg/kg	751.00		17800.00		9.70	U	281.00	B	2.20	B
VC-SD-DE-ULBUOY-06-03	9/25/95	1330	Buoy by Union Lake Dam	mg/kg	702.00		14800.00		9.50	U	264.00	B	2.20	B
			AVERAGE ("HIGH1")		**737.67**		**16033.33**		**9.53**		**279.00**		**2.23**	
VC-SD-DE-ULBUOY-06-01D	9/25/95	1330	Buoy by Union Lake Dam	mg/kg	1130.00		19400.00		11.60	u	376.00	B	3.20	B
VC-SD-DE-ULBUOY-06-02D	9/25/95	1330	Buoy by Union Lake Dam	mg/kg	998.00		24100.00		11.10	U	369.00	B	3.50	B
VC-SD-DE-ULBUOY-06-03D	9/25/95	1330	Buoy by Union Lake Dam	mg/kg	1060.00		22300.00		12.10	U	368.00	B	3.30	B
			AVERAGE ("HIGH2")		**1062.67**		**21933.33**		**11.60**		**371.00**		**3.33**	
VC-SD-DE-ER5-04-01	9/20/95	0945	ER-5 Below Almond Road	mg/kg	1.30	B	111.00		1.10	U	0.78	B	0.08	U
VC-SD-DE-ER5-04-02	9/20/95	0945	ER-5 Below Almond Road	mg/kg	1.60	B	187.00		1.10	U	1.30	B	0.07	U
VC-SD-DE-ER5-04-03	9/20/95	0945	ER-5 Below Almond Road	mg/kg	2.00	B	143.00		1.00	U	1.00	B	0.07	U
			AVERAGE		**1.63**		**147.00**		**1.07**		**1.03**		**0.07**	

TABLE 6-1
ANALYTICAL RESULTS FROM SEDIMENT SAMPLING
POTENTIAL EXPERIMENTAL STARTING MATERIALS
VINELAND CHEMICAL COMPANY SITE

Ebasco Sample I.D.	Sampling Date	Sampling Time	Location	Units	As		Al	Sb		Ba		Be	
VC-SD-DE-MR8-05-01	9/20/95	1400	MR8 Transect	mg/kg	1.20	B	267.00	1.00	U	1.60	B	0.07	U
VC-SD-DE-MR8-05-02	9/20/95	1400	MR8 Transect	mg/kg	1.80	B	214.00	1.10	U	1.60	B	0.07	U
VC-SD-DE-MR8-05-03	9/20/95	1400	MR8 Transect	mg/kg	2.90		1120.00	1.00	U	27.00	B	0.07	U
			AVERAGE		**1.97**		**533.67**	**1.03**		**10.07**		**0.07**	
VC-SD-DE-UL1-08-01	9/25/95	1630	Sand Spit UL1	mg/kg	1.40	B	827.00	1.10	U	7.60	B	0.07	U
VC-SD-DE-UL1-08-02	9/25/95	1630	Sand Spit UL1	mg/kg	1.80	B	854.00	1.10	U	7.60	B	0.07	U
VC-SD-DE-UL1-08-03	9/25/95	1630	Sand Spit UL1	mg/kg	1.80	B	1020.00	1.10	U	7.60	B	0.07	U
			AVERAGE		**1.67**		**900.33**	**1.10**		**7.60**		**0.07**	
VC-SD-DE-MR10-03-01	9/19/95	1450	MR10 Transect/Sherman Road	mg/kg	4.40		212.00	1.00	U	2.40	B	0.11	B
VC-SD-DE-MR10-03-02	9/19/95	1450	MR10 Transect/Sherman Road	mg/kg	2.50		189.00	1.10	U	2.20	B	0.17	B
VC-SD-DE-MR10-03-03	9/19/95	1450	MR10 Transect/Sherman Road	mg/kg	2.20	B	240.00	1.10	U	2.70	B	0.13	B
			AVERAGE		**3.03**		**213.67**	**1.07**		**2.43**		**0.14**	
VC-SD-DE-MR3-02-01	9/19/95	1025	MR3 in Center of Channel	mg/kg	154.00		1520.00	2.20	U	50.80	B	0.40	B
VC-SD-DE-MR3-02-02	9/19/95	1025	MR3 in Center of Channel	mg/kg	136.00		1480.00	2.00	U	47.40	B	0.32	B
VC-SD-DE-MR3-02-03	9/19/95	1025	MR3 in Center of Channel	mg/kg	156.00		1900.00	2.70	U	46.10	B	0.43	B
			AVERAGE		**148.67**		**1633.33**	**2.30**		**48.10**		**0.38**	
VS-SD-DE-UL12-10-01	9/25/95	1730	Cove area by eroded bluff (UL12)	mg/kg	343.00		16700.00	7.70	U	220.00	B	2.10	B
VS-SD-DE-UL12-10-02	9/25/95	1730	Cove area by eroded bluff (UL12)	mg/kg	317.00		17000.00	7.40	U	219.00	B	2.00	B
VS-SD-DE-UL12-10-03	9/25/95	1730	Cove area by eroded bluff (UL12)	mg/kg	763.00		16200.00	7.40	U	243.00	B	2.00	B
			AVERAGE		**474.33**		**16633.33**	**7.50**		**227.33**		**2.03**	

TABLE 6-1
ANALYTICAL RESULTS FROM SEDIMENT SAMPLING
POTENTIAL EXPERIMENTAL STARTING MATERIALS
VINELAND CHEMICAL COMPANY SITE

Ebasco Sample I.D.	Sampling Date	Sampling Time	Location	Units	As		Al		Sb		Ba		Be	
VC-SD-DE-MR3-01-01D	9/19/95	0900	MR3 above Almond Road	mg/kg	1170.00		9790.00		7.80	U	206.00	B	1.40	B
VC-SD-DE-MR3-01-02D	9/19/95	0900	MR3 above Almond Road	mg/kg	980.00		9190.00		6.00	U	181.00	B	1.20	B
VC-SD-DE-MR3-01-03D	9/19/95	0900	MR3 above Almond Road	mg/kg	910.00		8190.00		6.20	U	194.00	B	1.60	B
			AVERAGE		**1020.00**		**9056.67**		**6.67**		**193.67**		**1.40**	
VC-SD-DE-UL11-07-01D	9/25/95	1515	Midlake location (UL11)	mg/kg	443.00		14000.00		9.80	U	251.00	B	2.00	B
VC-SD-DE-UL11-07-02D	9/25/95	1515	Midlake location (UL11)	mg/kg	426.00		12300.00		9.40	U	241.00	B	1.90	B
VC-SD-DE-UL11-07-03D	9/25/95	1515	Midlake location (UL11)	mg/kg	417.00		12800.00		9.20	U	41.00	B	1.90	B
			AVERAGE		**428.67**		**13033.33**		**9.47**		**177.67**		**1.93**	
VC-SD-DE-UL11-07-01	9/25/95	1515	Midlake location (UL11)	mg/kg	475.00		11800.00		9.60	U	255.00	B	2.00	B
VC-SD-DE-UL11-07-02	9/25/95	1515	Midlake location (UL11)	mg/kg	497.00		11500.00		8.90	U	259.00	B	2.00	B
VC-SD-DE-UL11-07-03	9/25/95	1515	Midlake location (UL11)	mg/kg	544.00		16200.00		9.70	U	292.00	B	2.20	B
			AVERAGE		**505.33**		**13166.67**		**9.40**		**268.67**		**2.07**	

TABLE 6-1
ANALYTICAL RESULTS FROM SEDIMENT SAMPLING
POTENTIAL EXPERIMENTAL STARTING MATERIALS
VINELAND CHEMICAL COMPANY SITE

Ebasco Sample I.D.	Cd		Ca		Cr		Co		Cu		Fe	Pb	Mg		Mn	Hg		Ni	
VC-SD-DE-UL2-09-01	0.88	B	8830.00	B	10.40	B	12.30	B	3.80	B	11600.00	44.40	1970.00	B	391.00	0.32	U	12.30	B
VC-SD-DE-UL2-09-02	0.52	B	6880.00	B	6.20	B	8.90	B	3.20	B	9250.00	18.80	1540.00	B	312.00	0.35	B	8.20	B
VC-SD-DE-UL2-09-03	0.46	U	6690.00	B	7.70	B	8.70	B	2.60	U	9130.00	19.10	1490.00	B	298.00	0.35	U	8.50	B
	0.62		**7466.67**		**8.10**		**9.97**		**3.20**		**9993.33**	**27.43**	**1666.67**		**333.67**	**0.34**		**9.67**	
VC-SD-DE-MR3-01-01	0.72	B	812.00	B	37.20		9.80	B	7.40	B	4180.00	39.50	189.00	B	57.50	1.10		8.50	B
VC-SD-DE-MR3-01-02	0.75	B	928.00	B	43.90		10.70	B	7.70	B	4540.00	43.60	232.00	B	63.60	0.96		10.40	B
VC-SD-DE-MR3-01-03	0.90	B	1040.00	B	53.20		10.90	B	9.20	B	5140.00	50.30	250.00	B	71.30	0.99		11.30	B
	0.79		**926.67**		**44.77**		**10.47**		**8.10**		**4620.00**	**44.47**	**223.67**		**64.13**	**1.02**		**10.07**	
VC-SD-DE-ULBUOY-06-01	1.80	B	4500.00	B	82.80		28.70	B	68.70		30100.00	158.00	1170.00	B	282.00	1.00		27.50	B
VC-SD-DE-ULBUOY-06-02	1.80	B	3430.00	B	77.20		27.80		34.10	B	29000.00	152.00	1120.00	B	270.00	1.20		17.30	B
VC-SD-DE-ULBUOY-06-03	1.60	B	2970.00	B	72.00		23.50	B	32.80	B	28300.00	140.00	940.00	B	255.00	1.20		15.10	B
	1.73		**3633.33**		**77.33**		**26.67**		**45.20**		**29133.33**	**150.00**	**1076.67**		**269.00**	**1.13**		**19.97**	
VC-SD-DE-ULBUOY-06-01D	2.70	B	4100.00	B	145.00		36.30	B	39.60	B	51100.00	206.00	1220.00	B	425.00	1.90		38.20	B
VC-SD-DE-ULBUOY-06-02D	3.10	B	6480.00	B	154.00		38.80	B	43.40	B	47000.00	208.00	1410.00	B	406.00	1.70		38.30	B
VC-SD-DE-ULBUOY-06-03D	2.60	B	4360.00	B	149.00		37.90	B	41.60	B	48400.00	205.00	1330.00	B	410.00	2.00		32.10	B
	2.80		**4980.00**		**149.33**		**37.67**		**41.53**		**48833.33**	**206.33**	**1320.00**		**413.67**	**1.87**		**36.20**	
VC-SD-DE-ER5-04-01	0.08	U	54.70	B	0.77	B	0.71	U	1.10	B	180.00	1.70	29.40	B	0.99	B	0.05	U	0.91	U
VC-SD-DE-ER5-04-02	0.07	U	37.20	B	0.95	B	0.67	U	0.41	U	326.00	2.00	14.60	B	3.20	B	0.06	U	0.87	U
VC-SD-DE-ER5-04-03	0.07	U	23.70	B	0.87	B	0.65	U	0.39	U	236.00	1.80	9.50	B	3.20	B	0.06	U	0.84	U
	0.07		**38.53**		**0.86**		**0.68**		**0.63**		**247.33**	**1.83**	**17.83**		**2.46**	**0.06**		**0.87**	

TABLE 6-1
ANALYTICAL RESULTS FROM SEDIMENT SAMPLING
POTENTIAL EXPERIMENTAL STARTING MATERIALS
VINELAND CHEMICAL COMPANY SITE

Ebasco Sample I.D.	Cd		Ca		Cr		Co		Cu		Fe		Pb		Mg		Mn		Hg		Ni	
VC-SD-DE-MR8-05-01	0.07	U	32.20	B	2.10	B	0.65	U	0.40	U	482.00		2.70		11.40	B	2.10	B	0.05	U	0.84	U
VC-SD-DE-MR8-05-02	0.07	U	28.40	B	2.20	B	0.68	U	0.42	U	588.00		2.30		11.20	B	1.70	B	0.06	U	0.88	U
VC-SD-DE-MR8-05-03	0.08	B	124.00	B	3.60		0.83	B	0.84	B	1220.00		5.10		47.20	B	12.30		0.05	U	0.86	B
	0.07		**61.53**		**2.63**		**0.72**		**0.55**		**763.33**		**3.37**		**23.27**		**5.37**		**0.05**		**0.86**	
VC-SD-DE-UL1-08-01	0.07	U	99.20	B	1.30	B	0.70	B	0.42	U	721.00		2.20		29.00	B	9.20		0.05	U	0.89	U
VC-SD-DE-UL1-08-02	0.07	U	106.00	B	1.30	B	0.72	B	0.41	U	775.00		2.30		29.10	B	10.30		0.05	B	0.88	U
VC-SD-DE-UL1-08-03	1.30		124.00	B	1.60	B	0.82	B	0.42	U	970.00		2.20		31.70	B	10.40		0.05	U	1.00	B
	0.48		**109.73**		**1.40**		**0.75**		**0.42**		**822.00**		**2.23**		**29.93**		**9.97**		**0.05**		**0.92**	
VC-SD-DE-MR10-03-01	0.07	U	25.70	B	1.30	B	0.67	U	0.41	U	882.00		3.90		10.00	B	6.20		0.05	B	0.86	U
VC-SD-DE-MR10-03-02	0.07	U	39.70	B	1.40	B	0.69	U	0.59	B	894.00		3.90		18.90	B	9.10		0.04	U	0.88	U
VC-SD-DE-MR10-03-03	0.07	U	21.30	B	1.80	B	0.71	B	0.42	U	1380.00		4.90		11.50	B	18.90		0.05	U	0.89	U
	0.07		**28.90**		**1.50**		**0.69**		**0.47**		**1052.00**		**4.23**		**13.47**		**11.40**		**0.05**		**0.88**	
VC-SD-DE-MR3-02-01	0.33	B	598.00	B	9.40		10.90	B	5.90	B	2860.00		18.60		144.00	B	70.60		0.46		4.20	B
VC-SD-DE-MR3-02-02	0.23	B	490.00	B	9.10		5.60	B	2.10	B	2280.00		14.70		83.40	B	61.70		0.31		2.50	B
VC-SD-DE-MR3-02-03	0.31	B	490.00	B	22.20		7.90	B	3.30	B	2770.00		19.70		102.00	B	78.50		0.54		28.70	
	0.29		**526.00**		**13.57**		**8.13**		**3.77**		**2636.67**		**17.67**		**109.80**		**70.27**		**0.44**		**11.80**	
VS-SD-DE-UL12-10-01	1.30	B	2340.00	B	54.40		16.00	B	23.50	B	21400.00		120.00		954.00	B	110.00		1.00		19.10	B
VS-SD-DE-UL12-10-02	10.40		2370.00	B	50.10		15.00	B	24.80	B	20900.00		117.00		970.00	B	108.00		1.00		18.20	B
VS-SD-DE-UL12-10-03	0.90	B	2380.00	B	49.30		15.50	B	23.60	B	29400.00		114.00		940.00	B	126.00		1.00		17.60	B
	4.20		**2363.33**		**51.27**		**15.50**		**23.97**		**23900.00**		**117.00**		**954.67**		**114.67**		**1.00**		**18.30**	

TABLE 6-1
ANALYTICAL RESULTS FROM SEDIMENT SAMPLING
POTENTIAL EXPERIMENTAL STARTING MATERIALS
VINELAND CHEMICAL COMPANY SITE

Ebasco Sample I.D.	Cd		Ca		Cr	Co		Cu		Fe	Pb	Mg		Mn	Hg	Ni	
VC-SD-DE-MR3-01-01D	2.00	B	2220.00	B	86.10	43.20	B	20.00	B	9640.00	93.80	516.00	B	104.00	2.20	27.80	B
VC-SD-DE-MR3-01-02D	1.70	B	1880.00	B	71.20	17.00	B	14.80	B	8150.00	81.40	458.00	B	90.40	2.00	19.20	B
VC-SD-DE-MR3-01-03D	1.70	B	1970.00	B	67.00	18.60	B	14.10	B	8110.00	76.40	438.00	B	93.30	2.10	18.00	B
	1.80		**2023.33**		**74.77**	**26.27**		**16.30**		**8633.33**	**83.87**	**470.67**		**95.90**	**2.10**	**21.67**	
VC-SD-DE-UL11-07-01D	1.80	B	3230.00	B	51.90	16.90	B	28.70	B	22100.00	98.10	982.00	B	163.00	1.10	14.90	B
VC-SD-DE-UL11-07-02D	1.60	B	2980.00	B	51.20	15.80	B	22.60	B	20500.00	94.00	860.00	B	153.00	1.20	14.30	B
VC-SD-DE-UL11-07-03D	1.50	B	2940.00	B	50.40	16.10	B	22.60	B	20000.00	95.50	867.00	B	151.00	1.20	14.40	B
	1.63		**3050.00**		**51.17**	**16.27**		**24.63**		**20866.67**	**95.87**	**903.00**		**155.67**	**1.17**	**14.53**	
VC-SD-DE-UL11-07-01	1.90	B	3260.00	B	56.40	18.30	B	21.90	B	24800.00	96.00	842.00	B	172.00	1.10	14.40	B
VC-SD-DE-UL11-07-02	1.90	B	3210.00	B	58.00	16.80	B	22.40	B	25700.00	99.80	822.00	B	177.00	1.00	15.00	B
VC-SD-DE-UL11-07-03	2.10	B	3320.00	B	69.20	18.30	B	27.00	B	29300.00	111.00	1050.00	B	200.00	1.10	17.80	B
	1.97		**3263.33**		**61.20**	**17.80**		**23.77**		**26600.00**	**102.27**	**904.67**		**183.00**	**1.07**	**15.73**	

TABLE 6-1
ANALYTICAL RESULTS FROM SEDIMENT SAMPLING
POTENTIAL EXPERIMENTAL STARTING MATERIALS
VINELAND CHEMICAL COMPANY SITE

Ebasco Sample I.D.	K		Se		Ag		Na		Tl		V		Zn	
VC-SD-DE-UL2-09-01	33.50	U	2.50	U	1.10	U	649.00	B	3.40	U	14.40	B	60.60	
VC-SD-DE-UL2-09-02	29.50	U	2.80	B	0.94	U	620.00	B	3.00	U	8.00	B	52.60	
VC-SD-DE-UL2-09-03	28.90	U	2.10	U	0.92	U	599.00	B	2.90	U	9.70	B	63.20	
	30.63		**2.47**		**0.99**		**622.67**		**3.10**		**10.70**		**58.80**	
VC-SD-DE-MR3-01-01	21.60	B	1.70	B	0.42	U	299.00	B	1.30	U	28.00	B	45.00	
VC-SD-DE-MR3-01-02	35.00	B	2.80	B	0.45	U	355.00	B	1.40	U	32.10	B	53.10	
VC-SD-DE-MR3-01-03	33.20	B	1.80	B	0.47	U	324.00	B	1.50	U	36.60	B	64.30	
	29.93		**2.10**		**0.45**		**326.00**		**1.40**		**32.23**		**54.13**	
VC-SD-DE-ULBUOY-06-01	370.00	B	3.00	U	1.30	U	272.00	B	4.00	U	68.20	B	242.00	
VC-SD-DE-ULBUOY-06-02	453.00	B	4.90	B	1.30	U	265.00	U	4.20	U	67.20	B	260.00	
VC-SD-DE-ULBUOY-06-03	346.00	B	3.90	B	1.30	U	259.00	U	4.10	U	61.70	B	237.00	
	389.67		**3.93**		**1.30**		**265.33**		**4.10**		**65.70**		**246.33**	
VC-SD-DE-ULBUOY-06-01D	392.00	B	3.70	U	1.60	U	317.00	U	5.00	U	110.00	B	368.00	
VC-SD-DE-ULBUOY-06-02D	602.00	B	3.50	U	1.50	U	548.00	B	4.80	U	111.00	B	358.00	
VC-SD-DE-ULBUOY-06-03D	509.00	B	3.80	U	1.60	U	339.00	B	5.20	U	111.00	B	364.00	
	501.00		**3.67**		**1.57**		**401.33**		**5.00**		**110.67**		**363.33**	
VC-SD-DE-ER5-04-01	4.80	U	0.35	U	0.15	U	105.00	B	0.48	U	0.68	U	2.40	B
VC-SD-DE-ER5-04-02	4.50	U	0.34	U	0.14	U	79.20	B	0.46	U	0.96	B	2.00	B
VC-SD-DE-ER5-04-03	4.40	U	0.32	U	0.14	U	84.10	B	0.44	U	0.63	B	1.70	B
	4.57		**0.34**		**0.14**		**89.43**		**0.46**		**0.76**		**2.03**	

TABLE 6-1
ANALYTICAL RESULTS FROM SEDIMENT SAMPLING
POTENTIAL EXPERIMENTAL STARTING MATERIALS
VINELAND CHEMICAL COMPANY SITE

Ebasco Sample I.D.	K		Se		Ag		Na		Tl		V		Zn	
VC-SD-DE-MR8-05-01	4.40	U	0.33	U	0.14	U	87.00	B	0.44	U	1.30	B	2.90	B
VC-SD-DE-MR8-05-02	4.60	U	0.34	U	0.15	U	95.90	B	0.46	U	1.30	B	3.20	B
VC-SD-DE-MR8-05-03	7.50	B	0.33	U	0.14	U	97.30	B	0.45	U	3.20	B	9.00	
	5.50		**0.33**		**0.14**		**93.40**		**0.45**		**1.93**		**5.03**	
VC-SD-DE-UL1-08-01	4.70	U	0.35	U	0.15	U	91.40	B	0.47	U	2.00	B	5.90	
VC-SD-DE-UL1-08-02	4.60	U	0.46	B	0.15	U	86.70	B	0.46	U	2.10	B	6.70	
VC-SD-DE-UL1-08-03	4.70	U	0.36	B	0.15	U	97.90	B	0.47	U	2.50	B	8.50	
	4.67		**0.39**		**0.15**		**92.00**		**0.47**		**2.20**		**7.03**	
VC-SD-DE-MR10-03-01	4.50	U	0.33	U	0.14	U	56.80	B	0.45	U	1.60	B	3.70	B
VC-SD-DE-MR10-03-02	4.60	U	0.34	U	0.15	U	62.80	B	0.47	U	1.70	B	53.00	
VC-SD-DE-MR10-03-03	4.70	U	0.35	U	0.15	U	47.60	B	0.47	U	2.40	B	4.30	B
	4.60		**0.34**		**0.15**		**55.73**		**0.46**		**1.90**		**20.33**	
VC-SD-DE-MR3-02-01	9.30	U	0.69	U	0.30	U	176.00	B	0.94	U	10.40	B	34.51	
VC-SD-DE-MR3-02-02	8.60	U	0.64	U	0.27	U	102.00	B	0.87	U	12.60	B	22.50	
VC-SD-DE-MR3-02-03	13.60	B	0.86	U	0.37	U	85.40	B	1.20	U	11.40	B	29.80	
	10.50		**0.73**		**0.31**		**121.13**		**1.00**		**11.47**		**28.94**	
VS-SD-DE-UL12-10-01	237.00	B	3.90	B	1.00	U	706.00	B	3.30	U	45.30		193.00	
VS-SD-DE-UL12-10-02	250.00	B	3.60	B	1.00	U	758.00	B	3.20	U	43.30	B	193.00	
VS-SD-DE-UL12-10-03	229.00	B	2.40	U	1.00	U	623.00		3.20	U	44.90	B	188.00	
	238.67		**3.30**		**1.00**		**695.67**		**3.23**		**44.50**		**191.33**	

TABLE 6-1
ANALYTICAL RESULTS FROM SEDIMENT SAMPLING
POTENTIAL EXPERIMENTAL STARTING MATERIALS
VINELAND CHEMICAL COMPANY SITE

Ebasco Sample I.D.	K		Se		Ag		Na		Tl		V		Zn	
VC-SD-DE-MR3-01-01D	71.70	B	5.50	B	1.10	U	830.00	B	3.40	U	86.50	B	119.00	
VC-SD-DE-MR3-01-02D	77.90	B	2.40	B	0.82	U	510.00	B	2.60	U	78.10		106.00	
VC-SD-DE-MR3-01-03D	64.10	B	3.30	B	0.84	U	584.00	B	2.70	U	73.70		92.20	
	71.23		**3.73**		**0.92**		**641.33**		**2.90**		**79.43**		**105.73**	
VC-SD-DE-UL11-07-01D	315.00	B	4.70	B	1.30	U	465.00	B	4.20	U	46.90	B	231.00	
VC-SD-DE-UL11-07-02D	244.00	B	3.00	U	1.30	U	256.00	U	4.00	U	45.20	B	223.00	
VC-SD-DE-UL11-07-03D	269.00	B	4.80	B	1.20	U	251.00	U	4.00	U	44.20	B	209.00	
	276.00		**4.17**		**1.27**		**324.00**		**4.07**		**45.43**		**221.00**	
VC-SD-DE-UL11-07-01	234.00	B	3.00	U	1.30	U	262.00	U	4.10	U	49.30	B	222.00	
VC-SD-DE-UL11-07-02	217.00	B	2.80	U	1.20	U	243.00	U	3.80	U	49.60	B	223.00	
VC-SD-DE-UL11-07-03	385.00	B	3.10	B	1.30	U	265.00	U	4.20	U	59.00	B	240.00	
	278.67		**2.97**		**1.27**		**256.67**		**4.03**		**52.63**		**228.33**	

bypassing the filter cartridges. Representative samples, one filtered and one unfiltered, were then collected from the Maurice River for TAL metals analysis. The filtered and unfiltered field blanks and surface water samples were analyzed through the EPA contract laboratory program (CLP) for TAL metals content. An additional sample, with filtration of specific aliquots as appropriate for the analytical method, was analyzed by the EPA Environmental Services Division (ESD) for total suspended solids (TSS), total dissolved solids (TDS), total organic carbon (TOC), dissolved organic carbon (DOC), acidity, alkalinity, chloride, sulfate, nitrogen (nitrate + nitrite) and phosphorous.

Field measurements recorded during the sampling event include temperature, dissolved oxygen content, specific conductivity, pH, redox potential and sulfide content. Temperature, dissolved oxygen content, specific conductivity and pH were measured *in situ* at all sampling locations using an ICM multiple parameter water analyzer (Industrial Chemical Management, Hillsboro, OR). Redox potential and sulfide content were measured in an aliquot of each surface water sample using a redox potential meter (Hanna Instruments, Woonscoket, RI) and a LaMotte colorimetric sulfide test kit (LaMotte Corporation, Chestertown, MD), respectively. Complete analytical results for the surface water and field blanks are given in Table 6-2.

Approximately 700 liters of surface water were then collected through the sampling apparatus described above and dispensed directly into 15-gallon polyethylene containers. These containers were transported to CEI immediately following collection. Duplicate aliquots of the large-volume filtered water sample were analyzed by CEI for TAL metals, TSS, TDS, TOC, DOC, acidity, alkalinity, chloride, sulfate, nitrogen (nitrate + nitrite), phosphorous and bicarbonate. Results of these analyses are also included in Table 6-2.

6.1.2 *Experimental Design*

Each of the four experiments (Low, Medium, High1, High2) employed a continuous flow of the uncontaminated river water (see Section 6.1.1.2) over the contaminated sediments, with the flow rate chosen to simulate the average two-week residence time of water within Union Lake. Each experimental apparatus consisted of a 30 cm wide by 60 cm long by 25 cm deep Plexiglas tank, with an inlet port 13 cm from the base of the tank on one 30 cm side and an outlet port 20 cm from the base of the tank on the opposing side. The tanks and all associated equipment were decontaminated prior to their use for the experiments. Each tank was then filled to a depth of 10 cm with the appropriate sediment (see Section 6.1.1.1). Thus the outlet port was situated to maintain a water depth of approximately 10 cm above the sediment-water surface. The inlet port was situated 7 cm lower in the tank to promote mixing of the water within the tank. A peristaltic pump was used to supply uncontaminated river water to the inlet port at a rate of 53.6 ml/hr

TABLE 6-2
ANALYTICAL RESULTS FROM SURFACE WATER SAMPLING
BULK SAMPLE FOR EXPERIMENTAL FEED WATER
VINELAND CHEMICAL COMPANY SITE

EPA Sample I.D.	Sampling Date	Sampling Time	Filtered/ Unfiltered	Ebasco Sample I.D.	Location	Units	As		Al		Sb		Ba		Be		Cd	
MBNS07	9/21/95	1200	UF	VC-SW-DE-MRU-01	Maurice River - Garden Rd.	ug/L	2.10	U	57.80	B	2.20	U	72.60	B	0.20	U	0.30	U
MBNS08	9/21/95	1200	F	VC-SW-DE-MRU-02	Maurice River - Garden Rd.	ug/L	2.10	U	39.90	B	2.20	U	71.00	B	0.20	U	0.30	U
MBNS08	9/20/91	1200	UF	VC-SW-DE-FB-01	Field Blank	ug/L	2.10	U	9.9	U	2.20	U	3.40	U	0.20	U	0.30	U
MBNS09	9/20/91	1215	F	VC-SW-DE-FB-02	Field Blank	ug/L	2.10	U	9.9	U	2.20	U	3.40	U	0.20	U	0.30	U
	9/27/95	1427	bulk sample previously filtered	MRU-BW-1-15-01	Bulk Water from Maurice River - Garden Road (Aliquot #1)	ug/l	1.70	U	29.40	U	4.40	U	74.60	B	0.60	B	1.50	B
	9/27/95	1430	bulk sample previously filtered	MRU-BW-1-15-02	Bulk Water from Maurice River - Garden Road (Aliquot #2)	ug/l	1.70	U	29.40	U	4.40	U	73.10	B	0.30	U	0.30	U

TABLE 6-2
ANALYTICAL RESULTS FROM SURFACE WATER SAMPLING
BULK SAMPLE FOR EXPERIMENTAL FEED WATER
VINELAND CHEMICAL COMPANY SITE

Ebasco Sample I.D.	Ca		Cr		Co		Cu		Fe		Pb		Mg		Mn		Hg		Ni		K		Se		Ag		Na		Tl	
VC-SW-DE-MRU-01	3820.00	B	0.50	U	1.00	U	0.70	U	426.00		1.50	U	2380.00	B	35.60		0.02	U	2.00	B	2130.00	B	3.70	U	0.80	U	5230.00	J	3.00	U
VC-SW-DE-MRU-02	3770.00	B	0.50	U	1.00	U	0.81	B	325.00	J	1.50	U	2360.00	B	30.70		0.02	U	3.00	B	2120.00	B	3.70	U	0.80	U	5120.00	J	3.70	B
VC-SW-DE-FB-01	87.00	U	0.50	U	1.00	U	1.50	B	18.50	U	1.50	U	92.50	U	0.40	U	0.02	U	5.50	B	105.00	U	3.70	U	0.80	U	200.00	U	4.00	B
VC-SW-DE-FB-02	87.00	U	0.50	U	1.00	U	0.70	U	18.50	U	1.50	U	92.50	U	0.40	U	0.02	U	1.30	B	105.00	U	3.70	U	0.80	U	200.00	U	5.00	B
MRU-BW-1-15-01	3780.00	B	3.00	U	2.80	U	1.70	U	328.00		1.00	U	2510.00	B	29.20		0.10	U	3.60	U	1330.00	B	1.40	U	0.60	U	5960.00		2.90	B
MRU-BW-1-15-02	3690.00	B	3.00	U	2.80	U	1.70	U	309.00		1.00	U	2480.00	B	28.30		0.10	U	3.60	U	1310.00	B	1.40	U	0.60	U	5930.00		1.90	U

TABLE 6-2
ANALYTICAL RESULTS FROM SURFACE WATER SAMPLING
BULK SAMPLE FOR EXPERIMENTAL FEED WATER
VINELAND CHEMICAL COMPANY SITE

Ebasco Sample I.D.	V		Zn		Total Dissolved Solids		Total Organic Carbon		Dissolved Organic Carbon		Acidity		Alkalinity (Bicarbonate)		Alkalinity (Total)		Chloride		Sulfate		Total Suspended Solids	
VC-SW-DE-MRU-01	1.10	U	3.50	B	108.00		5.00	U	5.00	U	10.00	U	6.20		6.20		8.70		7.90			
VC-SW-DE-MRU-02	1.10	U	5.00	B																		
VC-SW-DE-FB-01	1.20	B	2.10	B																		
VC-SW-DE-FB-02	1.10	U	7.00	B																		
MRU-BW-1-15-01	2.70	U	21.50		38.00		5.50		5.30		<10		6.00		6.00		8.00		7.90		<5	
MRU-BW-1-15-02	2.70	U	10.30	B	41.00		5.40		5.50		<10		5.00		5.00		8.00		8.00		<5	

TABLE 6-2
ANALYTICAL RESULTS FROM SURFACE WATER SAMPLING
BULK SAMPLE FOR EXPERIMENTAL FEED WATER
VINELAND CHEMICAL COMPANY SITE

Ebasco Sample I.D.	Nitrogen NO_3, NO_4		Total Phosphorus		Field Parameters Temperature (°C)	Conductivity (uS)	pH	D.O. (ppm)	eH	Sulfide (ppm)
VC-SW-DE-MRU-01	0.56		0.05	U	15.40	54.10	6.01	11.90	112.00	<0.2
VC-SW-DE-MRU-02					~~15.40~~	~~54.10~~	~~6.01~~	~~11.90~~	~~112.00~~	~~<0.2~~
VC-SW-DE-FB-01										
VC-SW-DE-FB-02										
MRU-BW-1-15-01	0.70		<0.05							
MRU-BW-1-15-02	0.70		<0.05							

throughout the duration of the experiments, including the period during which the tanks were initially filled with water. This slow initial fill rate was chosen to avoid agitation and resuspension of the sediments.

The dissolved oxygen content (DO), pH and temperature of the water in the tank were measured daily throughout the duration of the experiments. Water temperature was controlled at a "room" temperature of approximately 20°C.

Outflow samples were collected at discrete time intervals, with the collection frequency decreasing over time. To prevent suspended particulates from exiting the tank, the outflow was filtered through 0.45 μm filters. Used filter membranes were then placed into a plastic basket within the tank, such that they were exposed to the flowing water. Thus only filtered outflow water was permanently removed from the experiment system. Eight samples were collected during the first three days of the experiment, followed by one sample per day thereafter. The following collection schedule was used for each experiment (note that all four experiments were conducted concurrently):

Day 1:

- First 4 hours outflow, approximately 214 ml, Sample #1
- Second 4 hours outflow, approximately 214 ml, Sample #2
- Next two 8 hours outflow, approximately 429 ml each, Samples #3 and #4

Days 2 - 3:

- Next four 12 hours outflow, approximately 643 ml each, Samples #5 through #8

Days 4 - 63:

- Subsequent 24 hours outflow, approximately 1286 ml each, samples #9 through #68

The pH, eH and DO of each sample was measured at the time of collection, then each sample was acidified to pH <2 by addition of concentrated nitric acid. The samples were stored in polyethylene bottles for potential analysis of arsenic content by method 200.7 CLP-M. Of the 68 samples collected, the following 24 were initially selected for analysis: Samples #1, #3, #5, #7, #9 (first four days), and samples collected every three days thereafter (Samples #12, #15, ..., #66). Analytical results for the outflow samples are presented in Tables 6-3*a* through 6-3*d*.

The experiments were originally designed to run for a total of 60 days, at which time an evaluation was to be made to determine whether a steady-state rate of arsenic desorption had been reached. The contract allowed continuation of the experiments for as much as an additional 30 days in an attempt to achieve steady state. On the basis of the analytical data available on the

TABLE 6-3*a*
AQUEOUS EXPERIMENTAL RUN DATA
"LOW" EXPERIMENT
VINELAND CHEMICAL COMPANY SITE

			Measurements in Outflow Samples					In Situ Measurements		
Sample	Date	Time (hours)	pH	DO (mg/l)	Eh (mV)	T (deg.C)	As (ppb)	pH in tank	DO in tank (mg/l)	T in tank (deg.C)
1	10/31/95	4	5.82	6.0	238.2	21.6	12	5.78	7.2	20.5
2	10/31/95	8	6.63	5.2	268.8	20.5		5.78	7.2	20.5
3	11/1/95	16	6.38	5.2	285.2	20.3	14.7	5.86	6.4	20
4	11/1/95	24	6.26	5.9	323.4	20.9		5.86	6.4	20
5	11/2/95	36	6.60	6.8	280.7	21.1	14.9	5.76	6.6	20.1
6	11/2/95	48	6.42	6.0	265.4	21.5		5.76	6.6	20.1
7	11/3/95	60	6.22	6.4	213.6	21.9	14.6	5.62	6.2	20
8	11/3/95	72	6.43	5.9	205.4	21.5		5.62	6.2	20
9	11/4/95	96	6.22	6.0	198.4	21.1	16.4	5.72	6.5	20.1
10	11/5/95	120	6.20	6.0	203.6	20.2		5.75	6.4	20
11	11/6/95	144	6.46	6.0	226.2	20.3		5.7	6.5	19.8
12	11/7/95	168	6.64	6.0	259.4	20.3	17.6	5.73	6.4	19.5
13	11/8/95	192	5.90	5.8	222.2	21.4		5.93	6.7	20.4
14	11/9/95	216	6.42	5.7	260.9	21.4		5.75	6.6	20.5
15	11/10/95	240	6.44	5.2	244.9	20.9	18.9	5.67	6.6	20.1
16	11/11/95	264	6.38	4.9	238.1	21.8		5.66	6.4	20.8
17	11/12/95	288	6.54	6.9	265.3	20.9		5.78	6.6	20.7
18	11/13/95	312	6.21	5.6	267.5	20.2	16.7	5.88	6.6	19.9
19	11/14/95	336	6.46	5.5	263.3	20.1		6.13	6.8	20.1
20	11/15/95	360	6.58	5.6	260.6	19.9		6.44	6.7	19.4
21	11/16/95	384	6.60	5.3	245.8	20.7	16.8	6.26	6.4	20
22	11/17/95	408	6.62	5.8	292.5	21.0		6.18	6.6	20.2
23	11/18/95	432	6.37	6.3	230.3	20.3		5.72	6.4	20.3
24	11/19/95	456	6.34	5.8	290.9	20.7	16.7	5.8	6.3	20.6
25	11/20/95	480	6.40	5.8	243.2	20.2		6.16	6.2	20.2
26	11/21/95	504	6.52	5.8	296.1	20.4		6.2	6	20
27	11/22/95	528	6.70	6.1	330.2	20.0	15.95	6.22	6.8	20.1
28	11/23/95	552	6.65	5.7	301.9	20.8		6.15	6.6	20
29	11/24/95	576	6.50	6.3	280.6	20.3		6.24	6.2	19.7
30	11/25/95	600	6.53	7.0	271.7	19.6	15.2	5.89	6.9	19.3
31	11/26/95	624	6.39	7.0	271.4	21.2		5.93	7.3	21
32	11/27/95	648	6.48	6.3	263.8	20.4		6.02	6.6	20.2
33	11/28/95	672	6.54	6.7	278.2	22.0	12.9	5.98	6.2	20.3
34	11/29/95	696	6.58	6.2	288.2	21.1		6.1	6	20.5
35	11/30/95	720	6.41	6.0	279.6	20.6		6.08	6.4	19.8
36	12/1/95	744	6.44	6.3	277.3	20.2	11.3	5.98	6.3	19.7
37	12/2/95	768	6.84	5.6	275.9	21.6		6.13	6.2	19.4
38	12/3/95	792	6.52	6.0	222.9	19.9		5.95	6.6	20.1
39	12/4/95	816	6.48	6.0	238.1	20.3	11.2	6.02	6.1	20
40	12/5/95	840	6.50	5.8	280.4	20.9		5.9	6	20.8
41	12/6/95	864	6.57	6.2	307.3	20.8		5.98	6.1	20
42	12/7/95	888	6.64	6.5	336.5	21.1	12	6.02	6.4	20.2

TABLE 6-3*a*
AQUEOUS EXPERIMENTAL RUN DATA
"LOW" EXPERIMENT
VINELAND CHEMICAL COMPANY SITE

			Measurements in Outflow Samples					In Situ Measurements		
Sample	Date	Time (hours)	pH	DO (mg/l)	Eh (mV)	T (deg.C)	As (ppb)	pH in tank	DO in tank (mg/l)	T in tank (deg.C)
43	12/8/95	912	6.60	6.2	310.3	20.8		5.88	5.9	20.5
44	12/9/95	936	6.30	5.6	298.6	25.0		5.93	6.4	20.2
45	12/10/95	960	6.36	5.7	268.4	25.0	11	5.94	6.4	19.2
46	12/11/95	984	6.67	5.7	319.5	25.0		6.36	6.7	18.1
47	12/12/95	1008	6.33	6.4	310.2	20.2		6.05	6.8	19.8
48	12/13/95	1032	6.38	6.8	342.1	19.8	13.5	6.02	6.6	20.4
49	12/14/95	1056	6.42	6.6	357.4	19.3		5.95	6.6	19.2
50	12/15/95	1080	6.40	6.3	336.4	20.1		5.9	6.2	20.4
51	12/16/95	1104	6.44	6.2	321.4	19.5	8.7	5.94	6.2	19.5
52	12/17/95	1128	6.70	5.6	343.5	25.0		6.25	5.3	19.2
53	12/18/95	1152	6.70	4.7	294.5	25.0		6.33	4.7	21.3
54	12/19/95	1176	6.52	6.4	303.8	20.4	7.7	5.93	7	21
55	12/20/95	1200	6.91	7.1	306.7	18.9		6.13	7.1	20.2
56	12/21/95	1224	6.76	5.8	265.1	19.3		6.41	6.4	20
57	12/22/95	1248	6.87	6.2	333.4	21.4	7.3	6.35	6.9	21.3
58	12/23/95	1272	6.74	6.2	317.3	20.3		6.61	7.1	21.8
59	12/24/95	1296	6.75	6.5	301.9	19.3		6.41	6.7	21.5
60	12/25/95	1320	6.53	6.5	327.3	20.7	7.9	6.97	7	21
61	12/26/95	1344	7.13	6.8	322.5	19.0		6.58	7.3	20.5
62	12/27/95	1368	6.55	6.0	284.2	20.8		6.22	7.2	20.2
63	12/28/95	1392	6.53	6.1	280.7	18.4	7	6.25	7	19.6
64	12/29/95	1416	6.32	6.0	298.9	20.6		6.13	6.8	19.9
65	12/30/95	1440	6.53	6.0	296.8	19.9		6.41	6.7	19.3
66	12/31/95	1464	6.57	5.7	255.5	20.0	6.7	6.25	7.1	19.4
67	1/1/96	1488	6.44	5.6	286.3	19.8		6.3	6.8	20.1
68	1/2/96	1512	6.33	5.3	267.1	19.6		6.33	6.6	20
Max			7.13	7.10	357.40	25.00	18.90	6.97	7.30	21.80
Min			5.82	4.70	198.40	18.40	6.70	5.62	4.70	18.10
Average			6.49	6.02	280.05	20.81	12.82	6.04	6.53	20.13
Stdev			0.21	0.50	36.67	1.40	3.76	0.27	0.43	0.60

TABLE 6-3*b*
AQUEOUS EXPERIMENTAL RUN DATA
"MEDIUM" EXPERIMENT
VINELAND CHEMICAL COMPANY SITE

			Measurements in Outflow Samples					In Situ Measurements		
Sample	Date	Time (hours)	pH	DO (mg/l)	Eh (mV)	T (deg.C)	As (ppb)	pH in tank	DO in tank (mg/l)	T in tank (deg.C)
1	10/31/95	4	5.86	5.1	225.6	21.3	27.7	5.66	5.1	20.5
2	10/31/95	8	6.66	6.8	250.7	21.1		5.66	5.1	20.5
3	11/1/95	16	6.65	6.0	266.5	20.3	31.1	5.98	5.2	20
4	11/1/95	24	6.83	6.1	289.9	21.1		5.98	5.2	20
5	11/2/95	36	6.88	6.4	245.5	21.1	41	5.85	5.4	20.1
6	11/2/95	48	6.52	5.2	253.5	21.5		5.85	5.4	20.1
7	11/3/95	60	6.17	5.7	196.3	21.8	34	5.71	5.1	20
8	11/3/95	72	6.37	5.8	197.2	21.5		5.71	5.1	20
9	11/4/95	96	6.42	4.8	180.6	21.0	29.1	5.79	5.4	20.1
10	11/5/95	120	6.32	5.2	200.1	20.5		5.76	5.2	20
11	11/6/95	144	6.53	5.3	215.0	20.2		5.77	5.2	19.8
12	11/7/95	168	6.73	5.2	240.6	20.2	31	5.79	5.3	19.5
13	11/8/95	192	6.10	5.6	210.6	21.2		5.95	5.2	20.4
14	11/9/95	216	6.50	5.7	240.8	21.1		5.68	5.1	20.5
15	11/10/95	240	6.45	5.1	232.8	20.6	27.5	5.73	5	20.1
16	11/11/95	264	6.35	5.2	231.9	21.7		5.36	4.8	20.8
17	11/12/95	288	6.43	7.7	256.0	21.4		5.36	4.5	20.7
18	11/13/95	312	6.13	5.2	250.8	20.1	22.2	5.45	5	19.9
19	11/14/95	336	6.49	5.3	248.6	20.1		5.78	5.1	20.1
20	11/15/95	360	6.50	5.4	255.8	19.8		6.06	5.4	19.4
21	11/16/95	384	6.49	5.0	230.7	20.6	22.2	5.96	5.2	20
22	11/17/95	408	6.53	5.3	286.0	20.7		5.8	5.7	20.2
23	11/18/95	432	6.19	4.8	225.2	20.2		5.41	5.7	20.3
24	11/19/95	456	6.12	5.4	265.0	20.6	22.2	5.4	5.3	20.6
25	11/20/95	480	6.25	5.6	206.8	20.2		5.71	5.4	20.2
26	11/21/95	504	6.38	5.4	251.8	20.3		5.91	5.8	20
27	11/22/95	528	6.59	5.2	307.3	20.1	23.85	5.83	6	20.1
28	11/23/95	552	6.25	5.6	300.6	20.8		5.92	6.3	20
29	11/24/95	576	6.40	5.9	250.1	20.4		5.8	5.8	19.7
30	11/25/95	600	6.48	7.0	284.6	19.4	25.5	5.83	6.9	19.3
31	11/26/95	624	6.40	6.1	280.2	21.1		5.39	5.8	21
32	11/27/95	648	6.35	5.6	278.9	20.4		5.48	5.7	20.2
33	11/28/95	672	6.58	5.3	286.6	21.8	27.7	5.4	6	20.3
34	11/29/95	696	6.42	5.8	291.3	21.1		5.65	6.3	20.5
35	11/30/95	720	6.50	5.5	288.7	20.7		5.43	5.9	19.8
36	12/1/95	744	6.60	5.9	283.3	20.2	27.7	5.51	5.8	19.7
37	12/2/95	768	6.59	5.4	287.1	21.6		5.51	5.8	19.4
38	12/3/95	792	6.28	6.1	279.0	19.9		5.4	5.2	20.1
39	12/4/95	816	6.30	6.0	281.9	20.3	27.4	5.5	5	20
40	12/5/95	840	6.52	5.7	299.6	20.9		5.88	5.8	20.8
41	12/6/95	864	6.45	5.8	300.7	20.9		5.86	6.1	20
42	12/7/95	888	6.49	5.7	327.7	21.0	26.1	6.05	6	20.2

TABLE 6-3*b*
AQUEOUS EXPERIMENTAL RUN DATA
"MEDIUM" EXPERIMENT
VINELAND CHEMICAL COMPANY SITE

			Measurements in Outflow Samples					In Situ Measurements		
Sample	Date	Time (hours)	pH	DO (mg/l)	Eh (mV)	T (deg.C)	As (ppb)	pH in tank	DO in tank (mg/l)	T in tank (deg.C)
43	12/8/95	912	6.50	6.0	309.1	20.8		5.89	5.9	20.5
44	12/9/95	936	6.53	4.6	307.5	25.0		5.48	4.8	20.2
45	12/10/95	960	6.56	5.4	287.8	20.0	20.5	5.36	4.7	19.2
46	12/11/95	984	6.57	4.8	323.3	19.7		6.56	5	18.1
47	12/12/95	1008	6.40	5.3	312.8	20.1		5.72	4.7	19.8
48	12/13/95	1032	6.49	5.2	339.3	19.7	21.9	5.58	4.9	20.4
49	12/14/95	1056	6.45	5.4	354.3	19.2		5.45	4.8	19.2
50	12/15/95	1080	6.46	5.1	340.2	20.1		5.51	4.5	20.4
51	12/16/95	1104	6.45	5.0	329.3	19.6	26.5	5.43	3.8	19.5
52	12/17/95	1128	6.54	5.3	305.7	25.0		5.88	3.1	19.2
53	12/18/95	1152	6.71	4.4	283.3	25.0		5.93	3	21.3
54	12/19/95	1176	6.50	5.0	310.1	20.4	24	5.9	4.4	21
55	12/20/95	1200	6.83	5.4	296.1	18.8		5.72	4.8	20.2
56	12/21/95	1224	6.79	6.0	278.4	19.3		6.06	4.1	20
57	12/22/95	1248	6.84	6.5	330.4	21.4	24.3	6.24	4.6	21.3
58	12/23/95	1272	6.85	5.3	320.4	20.4		6.33	4.6	21.8
59	12/24/95	1296	6.70	5.0	288.7	19.3		6.04	4.2	21.5
60	12/25/95	1320	6.56	6.0	328.1	20.7	23.4	6.91	4.1	21
61	12/26/95	1344	6.97	5.8	321.8	18.7		6.3	4.5	20.5
62	12/27/95	1368	6.52	6.0	285.7	20.9		5.78	4.6	20.2
63	12/28/95	1392	6.53	6.2	271.5	18.4	22.7	5.6	4	19.6
64	12/29/95	1416	6.40	5.8	312.0	20.6		5.86	3.8	19.9
65	12/30/95	1440	6.52	5.2	282.0	19.9		5.97	3.7	19.3
66	12/31/95	1464	6.28	5.0	263.0	20.0	23.3	5.7	3.6	19.4
67	1/1/96	1488	6.21	5.0	290.5	19.8		5.76	3.4	20.1
68	1/2/96	1512	6.28	4.8	270.8	19.8		5.71	3.7	20
Max			6.97	7.70	354.30	25.00	41.00	6.91	6.90	21.80
Min			5.86	4.40	180.60	18.40	20.50	5.36	3.00	18.10
Average			6.48	5.54	275.35	20.64	26.37	5.77	5.02	20.13
Stdev			0.20	0.57	39.23	1.20	4.60	0.29	0.80	0.60

TABLE 6-3*c*
AQUEOUS EXPERIMENTAL DATA
"HIGH1" EXPERIMENT
VINELAND CHEMICAL COMPANY SITE

			Measurements in Outflow Samples					In Situ Measurements		
Sample	Date	Time (hours)	pH	DO (mg/l)	Eh (mV)	T (deg.C)	As (ppb)	pH in tank	DO in tank (mg/l)	T in tank (deg.C)
1	10/31/95	4	5.72	5.2	250.2	21.3	9	5.64	7.2	20.5
2	10/31/95	8	6.34	6.8	263.8	21.1		5.64	7.2	20.5
3	11/1/95	16	6.24	6.2	262.9	20.3	8.4	5.91	6.6	20
4	11/1/95	24	6.54	6.1	335.2	21.3		5.91	6.6	20
5	11/2/95	36	6.45	6.3	266.5	21.1	10.6	5.8	6.6	20.1
6	11/2/95	48	6.41	5.2	255.1	21.5		5.8	6.6	20.1
7	11/3/95	60	6.05	5.2	214.3	21.9	12.6	5.61	6.4	20
8	11/3/95	72	6.35	5.1	208.7	21.5		5.61	6.4	20
9	11/4/95	96	6.24	5.5	212.3	20.8	18.3	5.76	6.5	20.1
10	11/5/95	120	6.22	5.8	217.8	20.5		5.8	6.4	20
11	11/6/95	144	6.55	5.7	231.5	20.2		5.74	6.4	19.8
12	11/7/95	168	6.57	5.8	252.3	20.2	19.7	5.79	6.4	19.5
13	11/8/95	192	5.95	5.8	230.0	21.1		5.91	6.6	20.4
14	11/9/95	216	6.43	5.8	240.4	21.0		5.73	6.7	20.5
15	11/10/95	240	6.36	5.4	240.5	20.7	23	5.91	6.8	20.1
16	11/11/95	264	6.27	5.0	228.5	21.5		5.71	6.6	20.8
17	11/12/95	288	6.43	6.5	258.0	21.2		5.78	6.8	20.7
18	11/13/95	312	6.23	6.0	242.0	20.0	21.6	5.9	6.8	19.9
19	11/14/95	336	6.33	6.1	256.1	20.2		5.99	6.9	20.1
20	11/15/95	360	6.54	6.0	236.4	19.7		6.16	6.9	19.4
21	11/16/95	384	6.56	5.6	230.2	20.5	20.5	6.22	6.5	20
22	11/17/95	408	6.50	5.5	287.3	20.9		6.07	6.2	20.2
23	11/18/95	432	6.11	5.3	231.7	20.2		5.68	6.9	20.3
24	11/19/95	456	6.17	6.0	282.2	20.6	19.5	5.79	6.7	20.6
25	11/20/95	480	6.20	6.0	219.9	20.3		6.12	6.4	20.2
26	11/21/95	504	6.33	5.4	260.6	20.3		6.08	6.6	20
27	11/22/95	528	6.62	5.4	290.8	20.2		6.14	7	20.1
28	11/23/95	552	6.30	6.0	260.2	20.6		6.2	6.8	20
29	11/24/95	576	6.43	6.2	281.3	20.5		6.24	6.6	19.7
30	11/25/95	600	6.49	7.1	304.9	19.4	17.1	6.11	6.3	19.3
31	11/26/95	624	6.43	7.0	287.6	21.0		5.97	7.2	21
32	11/27/95	648	6.26	6.0	288.1	20.4		6	6.6	20.2
33	11/28/95	672	6.54	6.4	293.9	21.8	14.9	5.88	6.4	20.3
34	11/29/95	696	6.51	6.3	290.1	21.0		5.93	6.2	20.5
35	11/30/95	720	6.39	5.8	280.2	20.7		5.97	6.3	19.8
36	12/1/95	744	6.58	6.0	290.1	20.2	16.8	5.86	6.2	19.7
37	12/2/95	768	6.64	5.8	294.4	21.6		6.11	6.4	19.4
38	12/3/95	792	6.20	6.6	307.3	19.8		6.07	6.7	20.1
39	12/4/95	816	6.52	6.1	300.5	20.3	15.2	6.09	6.2	20
40	12/5/95	840	6.62	5.9	286.1	20.9		5.96	6	20.8
41	12/6/95	864	6.48	6.0	298.4	20.9		6.01	6.6	20
42	12/7/95	888	6.56	6.0	319.2	21.0	17.4	5.9	6.8	20.2

TABLE 6-3*d*
AQUEOUS EXPERIMENTAL RUN DATA
"HIGH2" EXPERIMENT
VINELAND CHEMICAL COMPANY SITE

			Measurements in Outflow Samples					In Situ Measurements		
Sample	Date	Time (hours)	pH	DO (mg/l)	Eh (mV)	T (deg.C)	As (ppb)	pH in tank	DO in tank (mg/l)	T in tank (deg.C)
43	12/8/95	912	6.60	6.1	288.6	20.6		5.95	5.9	20.5
44	12/9/95	936	6.49	4.3	298.1	25.0		5.82	6.6	20.2
45	12/10/95	960	6.81	5.1	309.4	19.7	18	6.11	6.5	19.2
46	12/11/95	984	6.63	5.6	331.9	19.5		6.81	6.9	18.1
47	12/12/95	1008	6.54	6.6	262.1	20.2		6.13	6.8	19.8
48	12/13/95	1032	6.65	6.6	278.9	19.6	17.3	6.06	6.8	20.4
49	12/14/95	1056	6.59	6.6	318.3	19.4		6.04	6.7	19.2
50	12/15/95	1080	6.66	6.4	300.2	20.0		5.98	6.2	20.4
51	12/16/95	1104	6.58	6.3	311.6	19.7	15.2	5.9	6.3	19.5
52	12/17/95	1128	6.74	5.4	314.5	25.0		6.43	5.1	19.2
53	12/18/95	1152	6.98	4.2	325.0	25.0		6.5	4.8	21.3
54	12/19/95	1176	6.62	6.4	309.3	20.4	13.8	6.11	6.9	21
55	12/20/95	1200	6.83	6.4	304.3	18.8		6.42	7.4	20.2
56	12/21/95	1224	6.85	6.0	290.7	19.2		6.58	6.6	20
57	12/22/95	1248	6.73	6.7	321.5	21.5	13.6	6.28	7	21.3
58	12/23/95	1272	6.98	6.0	334.6	20.3		6.56	7.2	21.8
59	12/24/95	1296	6.85	6.4	283.0	19.3		6.52	7	21.5
60	12/25/95	1320	6.54	6.6	312.6	20.8	14.7	6.83	7.1	21
61	12/26/95	1344	7.05	6.3	310.8	18.8		6.81	7.4	20.5
62	12/27/95	1368	6.49	7.2	280.8	20.8		6.15	7.4	20.2
63	12/28/95	1392	6.30	6.1	295.0	18.4	16.1	6.32	7.1	19.6
64	12/29/95	1416	6.51	5.8	280.6	20.6		6.68	6.8	19.9
65	12/30/95	1440	6.98	5.6	277.3	19.9		6.23	6.9	19.3
66	12/31/95	1464	6.66	5.9	269.0	20.0	14.7	6.71	7.1	19.4
67	1/1/96	1488	6.49	5.7	288.4	19.8		6.53	6.9	20.1
68	1/2/96	1512	6.37	5.2	277.3	20.1		6.44	6.8	20
Max			7.05	7.20	348.00	25.00	22.70	6.83	7.40	21.80
Min			5.97	4.20	195.80	18.40	9.70	5.70	4.80	18.10
Average			6.56	5.87	273.64	20.62	16.94	6.12	6.67	20.13
Stdev			0.21	0.60	36.51	1.19	3.08	0.28	0.47	0.60

60th day, the experiments did not appear to have reached a steady-state rate of arsenic desorption. Therefore the decision was made to continue the experiments. The experiments were terminated on their 63rd day, however, as a result of a Stop Work Order Issued by the EPA on January 2, 1996. At this time Foster Wheeler Environmental instructed CEI to terminate the experiments according to the original design, which entailed slowly draining the tanks to avoid disturbance of the sediments. CEI drained most of the water from the tanks, leaving only an amount sufficient to prevent desiccation of the sediments. The Stop Work Order was rescinded on January 10, 1996. Following consultation with the EPA on January 11, 1996, Foster Wheeler instructed CEI to drain the remainder of the water from the tanks and sample the sediments as per the original design. The sediments were sampled at four discrete 2.5 cm depth intervals (0-2.5 cm, 2.5-5 cm; 5-7.5 cm, 7.5-10 cm), with each depth interval sampled in triplicate. Each of the resulting 48 samples (4 experiments, 12 samples per experiment) was analyzed for arsenic content by EPA Method 200.7 CLP-M. Analytical results for these sediment samples are presented in Table 6-4.

6.2 DATA SET

For convenience, data that are referenced in the following discussion of experimental results are presented in Tables 6-1 through 6-4.

6.3 RESULTS

6.3.1 *Flush Water*

Tables 6-3*a* through 6-3*d* present both the results of outflow sample analyses and those of the daily in situ measurements of pH, DO and temperature in the experimental tanks. As discussed in Section 6.1.2, the water samples collected for analysis of arsenic content were filtered through 0.45 µm filters. No suspended particulates greater than 0.45 µm in size were removed from the experimental tanks. Therefore the arsenic concentrations presented in Tables 6-3*a* through 6-3*d* represent only the dissolved fraction (and possibly a portion of the colloidal fraction) of arsenic released from the sediments into the flush water. These arsenic concentrations are shown as a function of the time after initiation of the experiments in Figure 6-3. Three of the four experiments exhibited similar desorption characteristics, with the concentration of arsenic in the outflow water increasing gradually over the first 240 hours, then gradually decreasing during the remainder of the experiment. The results of the "Medium" experiment were unique, with the concentration of arsenic in the outflow water peaking after only 36 hours, then gradually decreasing in a more episodic (or erratic) nature than in the other experiments. The "Medium" experiment also had the highest concentrations of arsenic in the outflow water and, as can be seen in Figures 6-4 and 6-5, was characterized by lower pH, and dissolved oxygen content. Eh remained relatively high in all the experiments, as can be seen in Figure 6-6.

TABLE 6-4
EXPERIMENTAL RUN DATA FOR SEDIMENTS
VINELAND CHEMICAL COMPANY SITE

DEPTH INTERVAL (cm)	"LOW"	"MEDIUM"	"HIGH1"	"HIGH2"
0 to 2.5A	142	1400	971	1180
0 to 2.5B	97.7	409	937	1110
0 to 2.5C	56.5	1430	1070	1380
Average 0 to 2.5	98.7	1079.7	992.7	1223.3
2.5 to 5.0A	84.3	450	833	1770
2.5 to 5.0B	77.1	454	888	999
2.5 to 5.0C	64.7	469	789	1140
Average 2.5 to 5.	75.4	457.7	836.7	1303.0
5.0 to 7.5A	75.2	527	763	942
5.0 to 7.5B	79.9	502	796	1020
5.0 to 7.5C	81.7	513	830	1080
Average 5.0 to 7.	78.9	514.0	796.3	1014.0
7.5 to 10.0A	59.9	463	810	997
7.5 to 10.0B	87.1	479	762	957
7.5 to 10.0C	75.3	408	792	1020
verage 7.5 to 10.	74.1	450.0	788.0	991.3
AVERAGE BULK	**81.8**	**625.3**	**853.4**	**1132.9**

FIGURE 6-3
ARSENIC CONCENTRATION IN FLUSH WATER

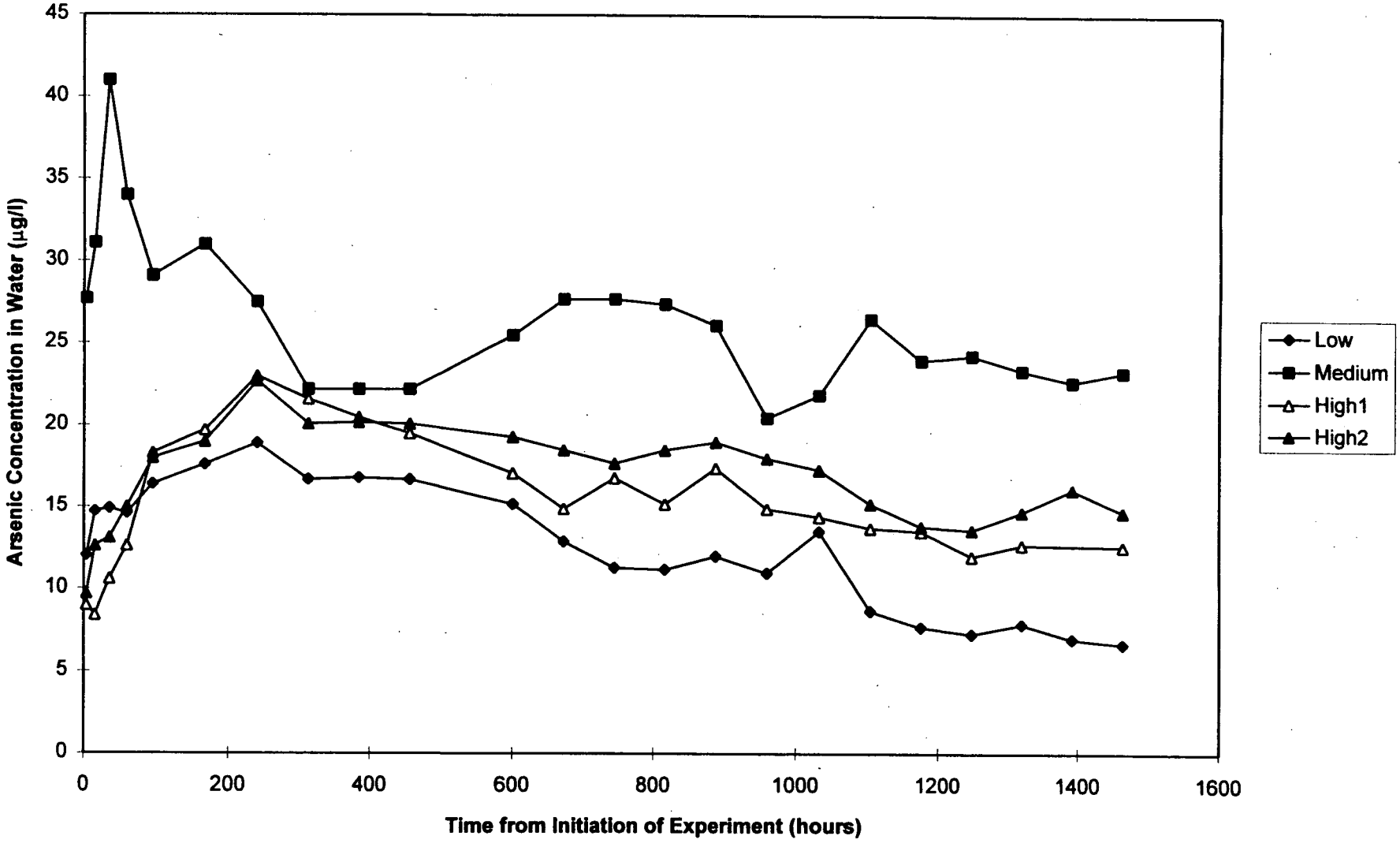


Fig 6-3

FIGURE 6-4
DISSOLVED OXYGEN CONCENTRATION IN FLUSH WATER
Measured *In Situ*

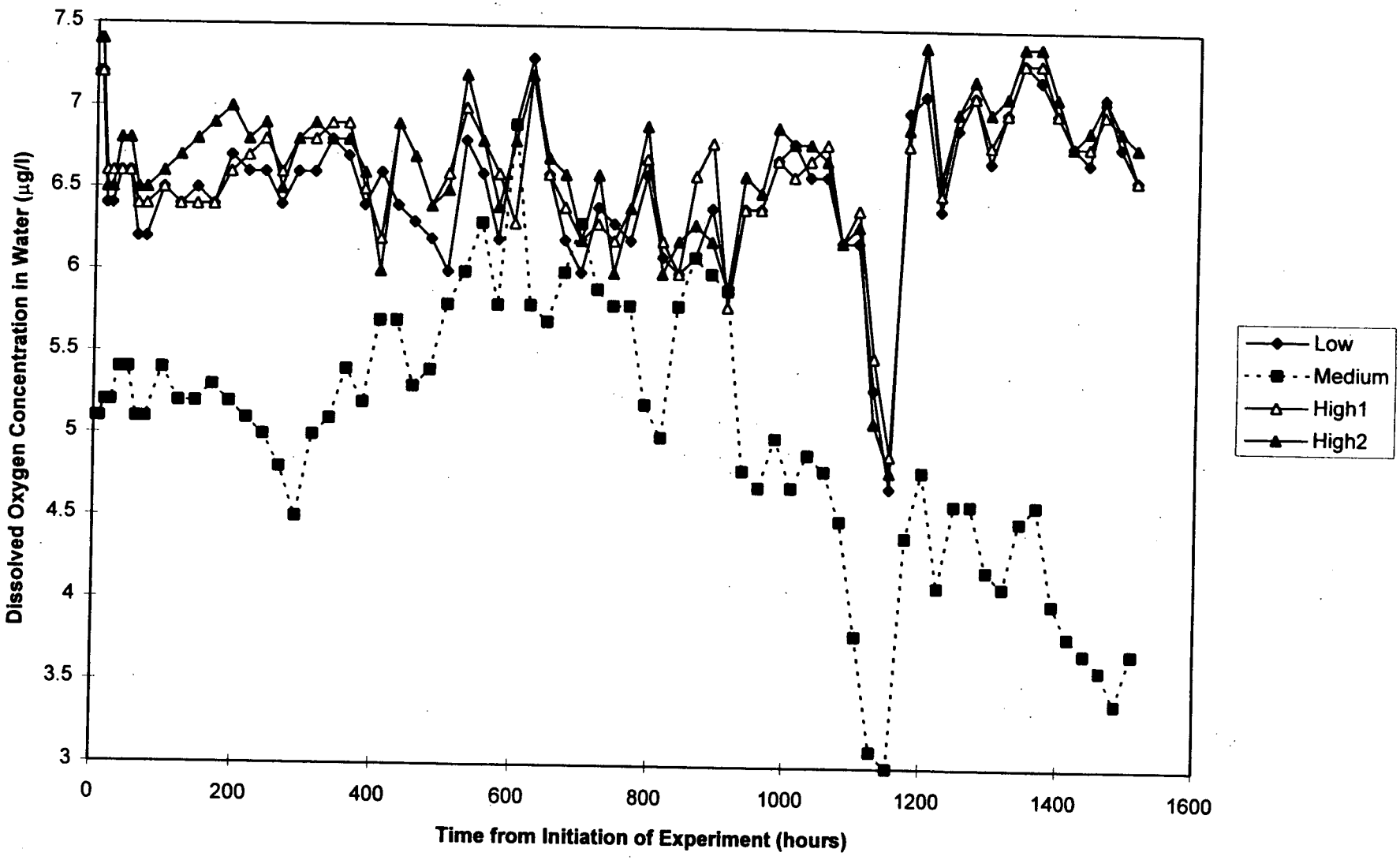


FIGURE 6-5
pH OF FLUSH WATER
Measured *In Situ*

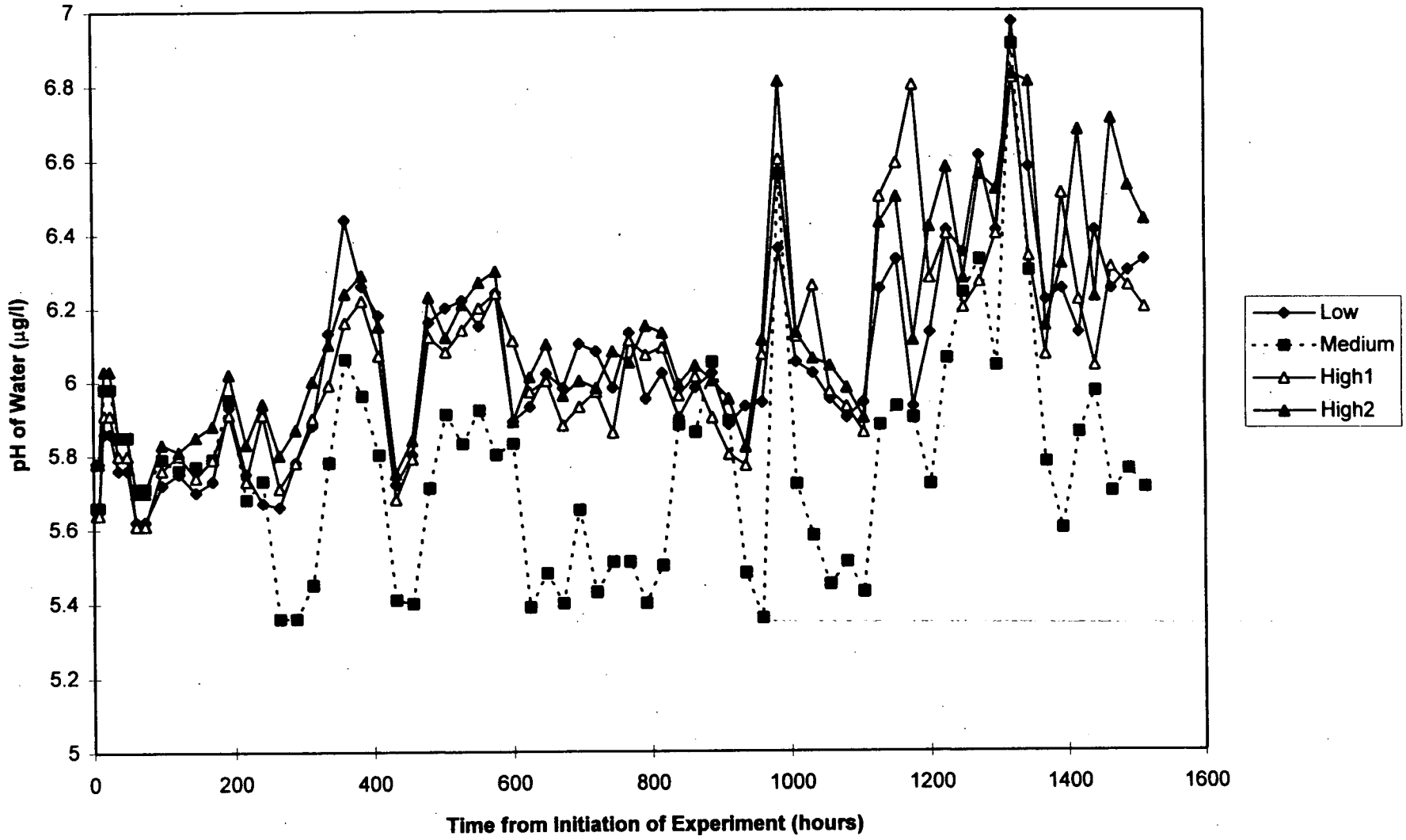


Fig 6-5

FIGURE 6-6
Eh OF FLUSH WATER
Measured in Collected Samples

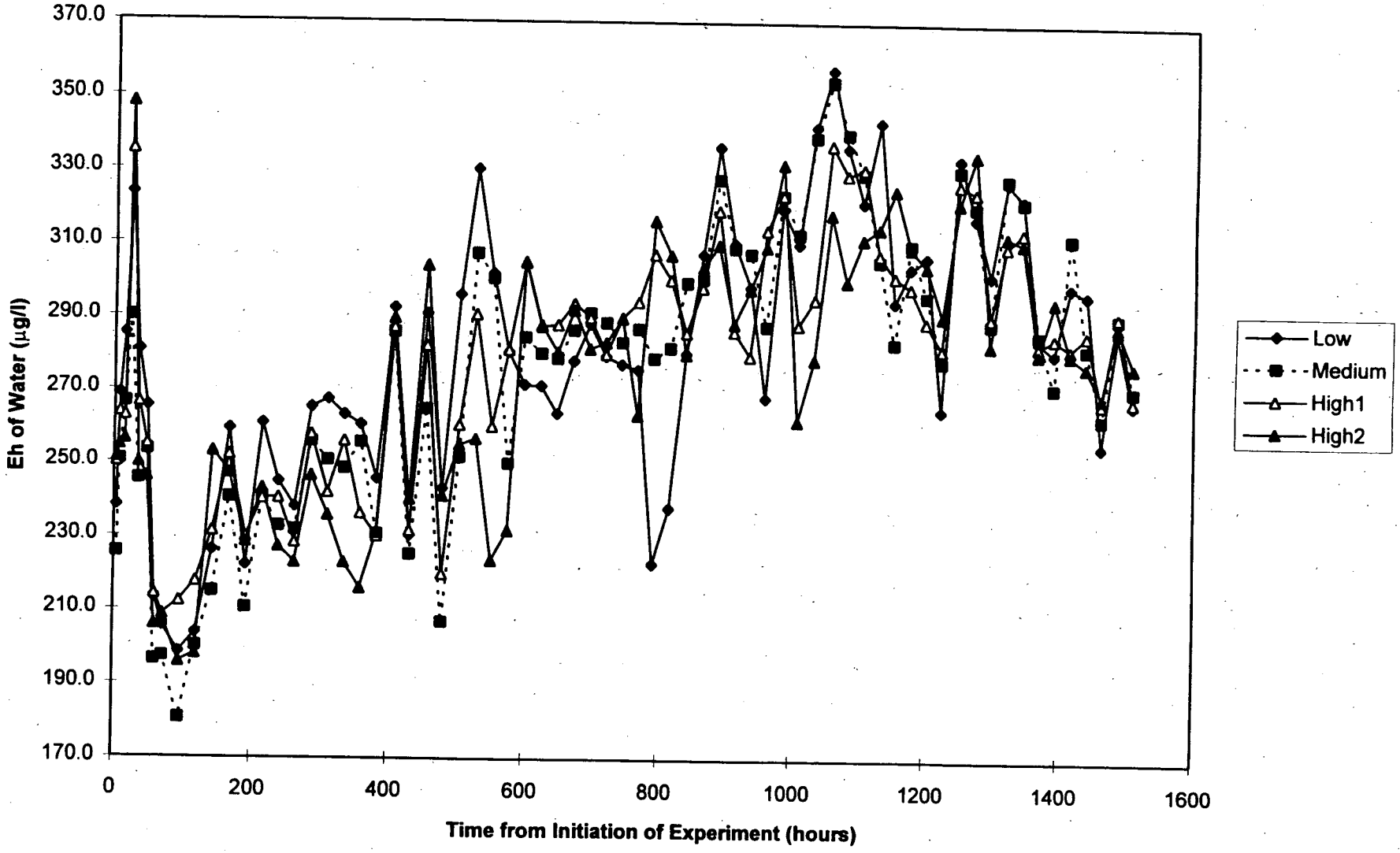


Fig 6-6

Because the experiments began with a non-detectable concentration of arsenic in the flush water, the gradual increase in arsenic concentrations observed in three of the four experiments likely results from kinetic limitations on the desorption reaction. The higher initial concentrations of arsenic in the "Medium" experiment may reflect a larger fraction of arsenic on colloidal particles. The initial flush water in the "Medium" experiment contained more suspended material (before filtration) than in the other three experiments. Although particulates greater than 0.45 μm in size were filtered out of the overflow samples, these samples may have contained more colloidal material (approximately 0.10 to 0.45 μm) than did samples from the other experiments.

Another unique aspect of the "Medium" experiment was the early appearance of aquatic worms in the sediment bed. Although worms were eventually observed in the "High1" and "High2" experiments, they were first noticed and were most abundant in the "Medium" experiment. The respiratory and metabolic processes of the worms likely contributed to the lower pH and dissolved oxygen levels and possibly to the higher rate of arsenic release in the medium experiment. This is consistent with the potential effects of invertebrates on partitioning of metals in contaminated sediments observed by Hattum et al. (1991).

6.3.2 *Arsenic Mass Balance Within the Experiments*

Because the incoming flush water for the experiments contained no arsenic, mass balance requires that the mass of arsenic contained in the outflow water is equal to the mass of arsenic removed from the sediments by desorption into the overflowing water. Therefore, the mass of arsenic removed from the sediments, $M_{a,i}^{As}$, during the interval of time, t_i, represented by any given outflow sample, i, can be estimated by

$$M_{a,i}^{As} = V_{a,i} C_{a,i}^{As}, \qquad 6.1$$

where: $V_{a,i}$ = the volume of outflow water represented by a given sample, i, (depends on flow rate and sample frequency).

$C_{a,i}^{As}$ = the concentration of arsenic in a given outflow sample, i.

The rate of arsenic desorption over that time interval is then given by

$$\nabla_{desorp}^{As} = \frac{M_{a,i}^{As}}{t_i}. \qquad 6.2$$

The cumulative mass of arsenic removed from the sediments from the initiation of the experiment through the time interval represented by outflow sample n can be calculated by summation of the mass removed during each time interval

$$-M_{s,n}^{As} = \sum_{i=1}^{n} M_{a,i}^{As} \qquad 6.3$$

The total mass of arsenic initially in the sediments can be estimated as the product of the initial arsenic concentration (dry weight basis) of the sediments, $C_{s,0}^{As}$, and the total mass of sediments in the tank, M^{sed},

$$M_{s,0}^{As} = C_{s,0}^{As} V_s \rho_s f_{sol}, \qquad 6.4$$

where: V_s = the volume of water saturated sediment in the tank,
ρ_s = the particle density of the solid fraction of the sediment,
f_{sol} = the fraction of solid material in the sediment,

The concentration of arsenic remaining in the sediment following the time interval represented by outflow sample n can then be calculated as

$$C_{s,n}^{As} = \frac{M_{s,0}^{As} - M_{s,n}^{As}}{V_s \rho_s f_{sol}}. \qquad 6.5$$

This allows calculation of a bulk arsenic distribution coefficient, K^{As}, between the sediments and the overflowing water,

$$K_n^{As} = \frac{C_{s,n}^{As}}{C_{a,n}^{As}}. \qquad 6.6$$

The results of the mass balance calculations described in Equations 6.1 through 6.6 are presented for each experiment in Appendix E, along with plots of both K^{As} and desorption rate as a function of time after initiation of the experiments.

A general result of all four experiments is that a very small percentage (0.03% to 0.2%) of the total mass of arsenic contained in the sediments was removed by desorption into the overflowing

water. This corresponds to very low rates of arsenic desorption, with final steady-state desorption rates ranging from 0.0004 mg/hr for the "Low" experiment to 0.0012 mg/hr for the "Medium" experiment. The "High1" and "High2" experiments had steady-state desorption rates of 0.0007 mg/hr and 0.0008 mg/hr, respectively. Figure 6-7 presents a comparison of the desorption rates for all four experiments as a function of time, and shows the steady-state desorption rate for each as calculated in Appendix E.

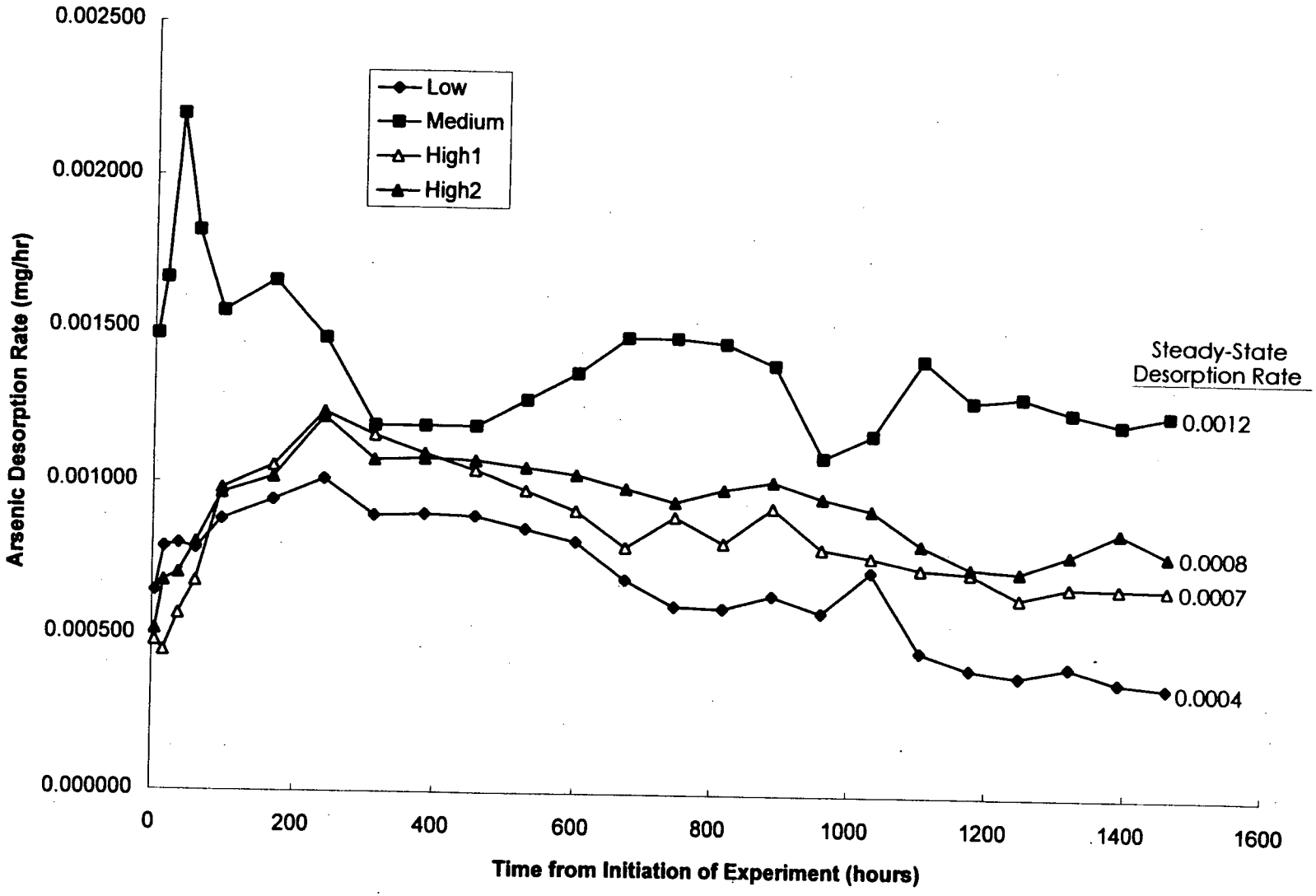
The low rates of arsenic desorption also correspond to low concentrations of arsenic in the water, and to high distribution coefficients, as defined by Equation 6.6, with steady-state K^{As} values ranging from a minimum of 12,856 for the "Low" experiment to a maximum of 72,586 for the "High2" experiment. It is important to note that these K^{As} values do not necessarily represent equilibrium distribution coefficients, but rather describe the bulk partitioning of arsenic between bedded sediments and overflowing water as a result of desorption in a quiescent flow regime. Figure 6-8 presents a comparison of the calculated K^{As} values for all four experiments as a function of time, and shows the steady-state K^{As} for each as calculated in Appendix E.

6.3.3 *Residual Sediments*

As discussed in Section 6.3.2, the mass of arsenic contained in the sediment beds of these experiments was reduced by a maximum of 0.2% ("Low" experiment). This corresponds to a change from 86.3 mg/kg arsenic (measured, see Table 6-1) in the starting material for the "Low" experiment to a final bulk arsenic content of 86.1 mg/kg (calculated by Equation 6.5, see Appendix E). Similarly, the concentrations of arsenic in sediments used for the "Medium," "High1," and "High2" experiments dropped from 549.7 mg/kg to 549.6 mg/kg, 737.7 mg/kg to 737.4 mg/kg, and 1062.7 mg/kg to 1062.3 mg/kg, respectively.

The analytical results of sediment samples collected following termination of the experiments are presented in Table 6-4. Although the average reported concentrations of arsenic in these samples are slightly higher for three of the four experiments than the average concentrations reported for the starting materials, the differences are not statistically significant ($\alpha = 0.05$; student's t-tests performed using Microsoft Excel). Therefore, to facilitate comparison of the initial distribution of arsenic in the homogenized starting material to the final distribution after termination of the experiments, the post-experiment analytical results were normalized to the same bulk concentration of arsenic reported for the starting material for each experiment. Figures 6-9 through 6-12 show the distribution of arsenic concentrations with depth in the sediment both before and after the experiments.

FIGURE 6-7
ARSENIC DESORPTION RATE



MASSBAL.XLS

FIGURE 6-8
DISTRIBUTION COEFFICIENT OF ARSENIC
BETWEEN SEDIMENT AND OVERFLOWING WATER

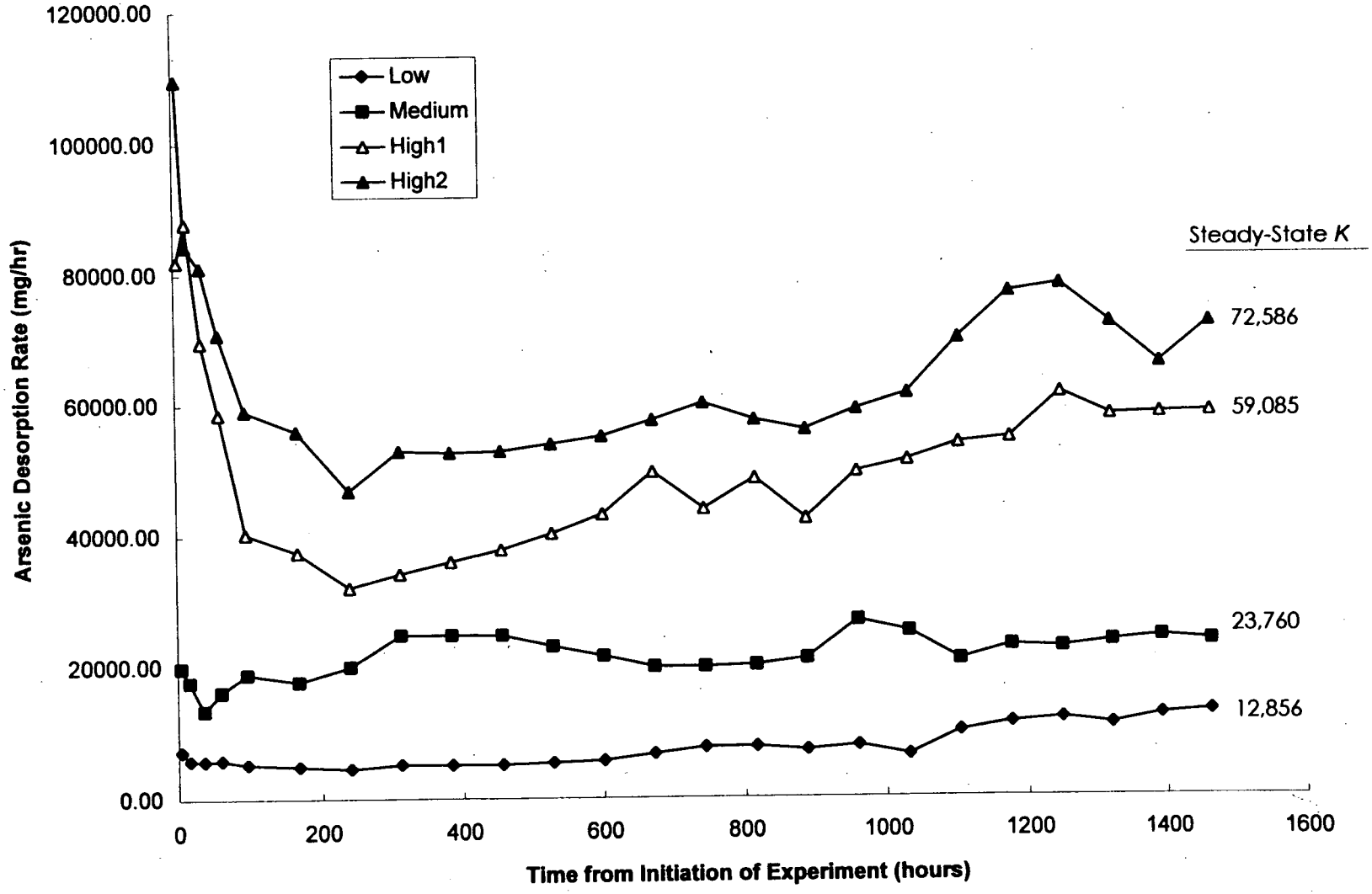


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FIGURE 6-9
ARSENIC CONCENTRATION PROFILES
"LOW" EXPERIMENT

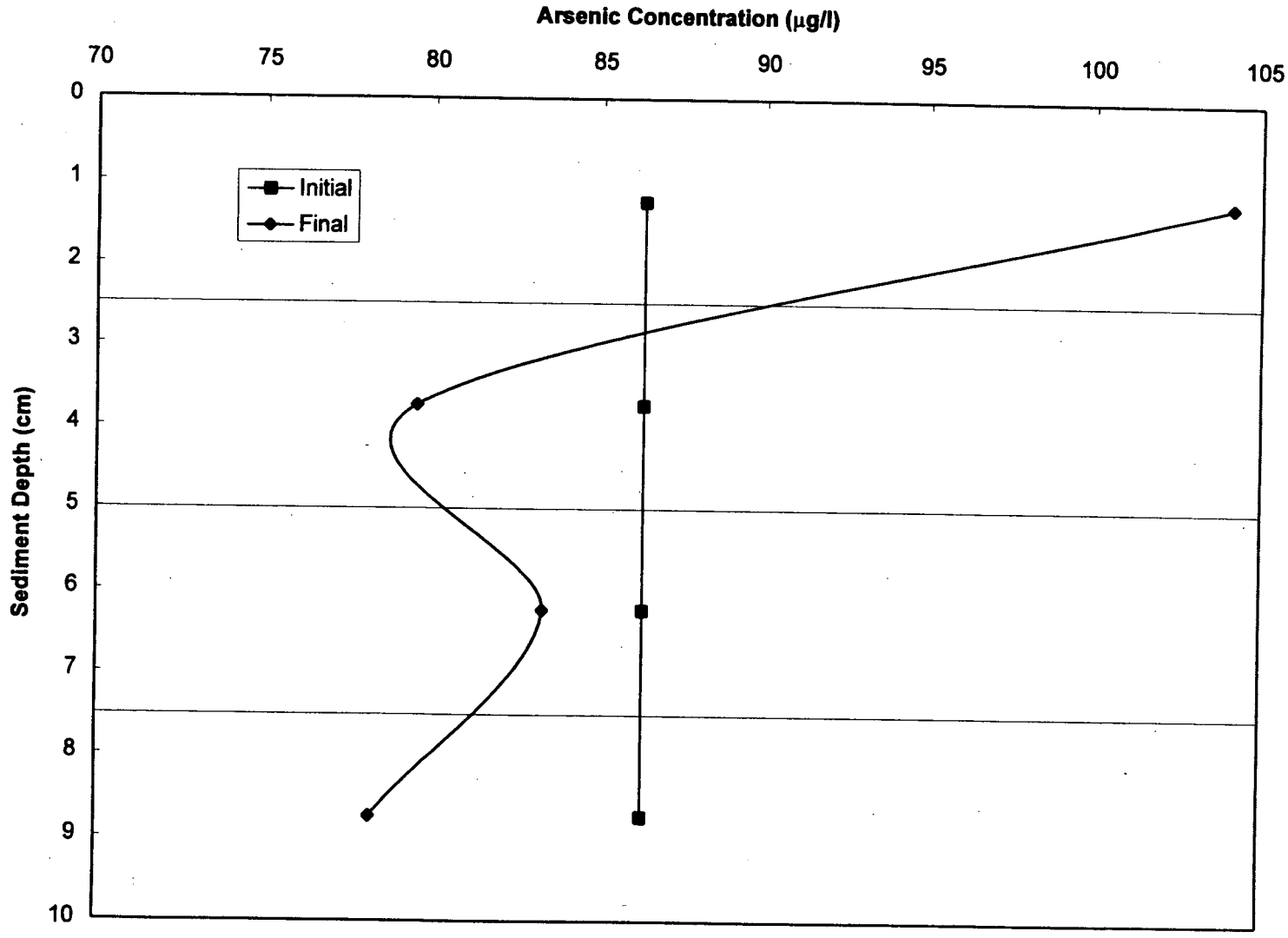

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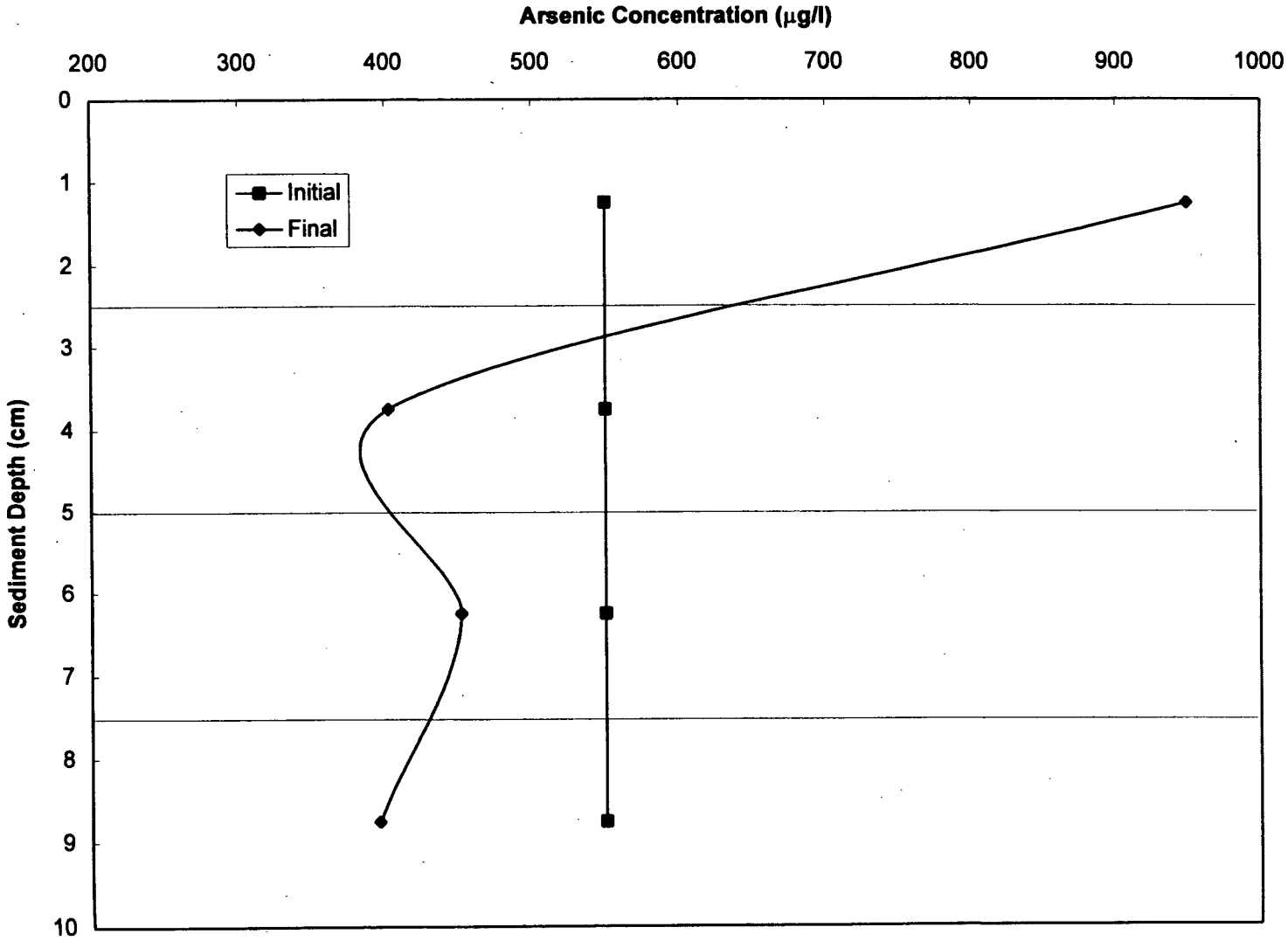
FIGURE 6-10
ARSENIC CONCENTRATION PROFILES
"MEDIUM" EXPERIMENT



VLAND.XLS

FIGURE 6-11
ARSENIC CONCENTRATION PROFILES
"HIGH1" EXPERIMENT

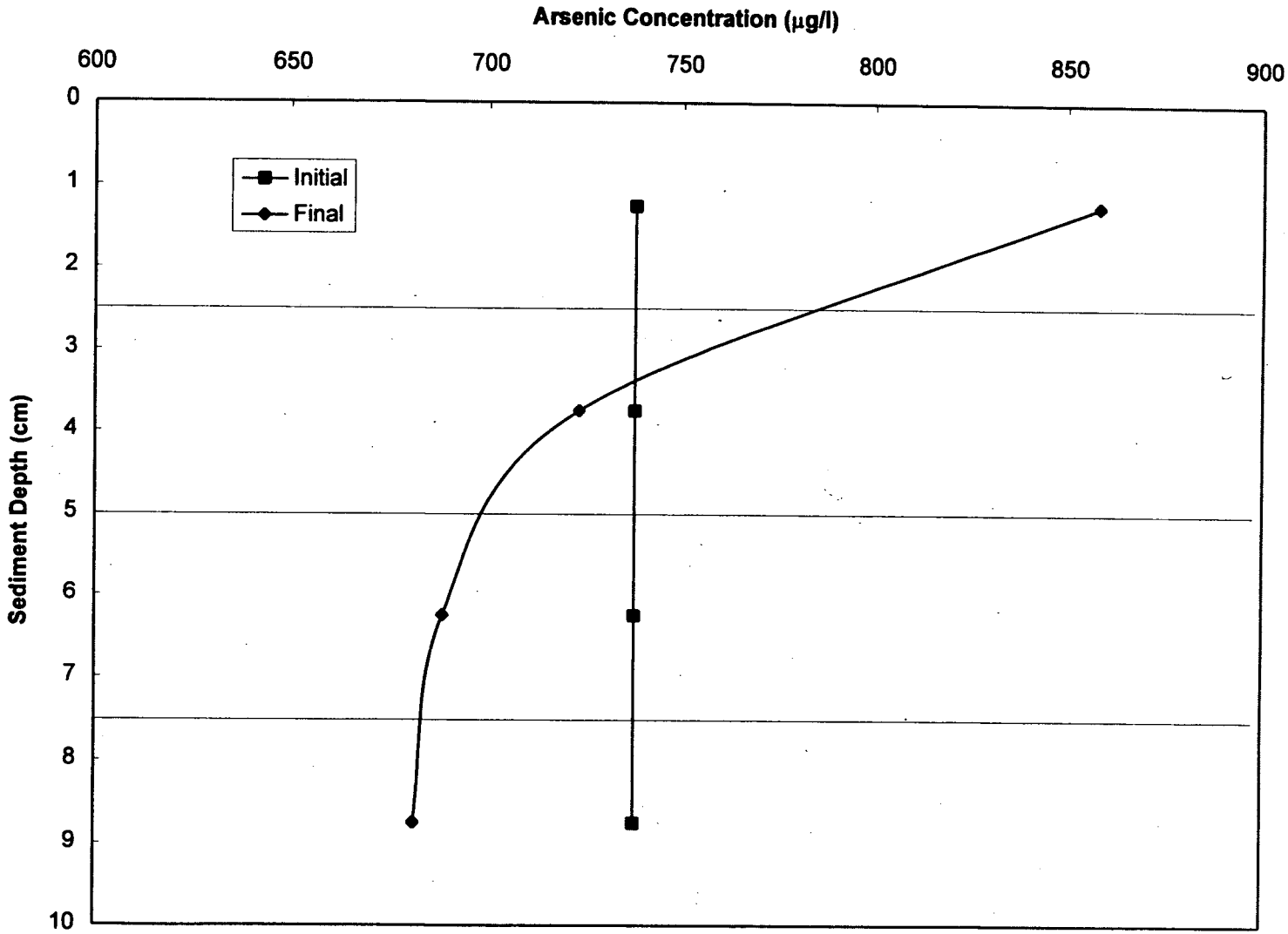


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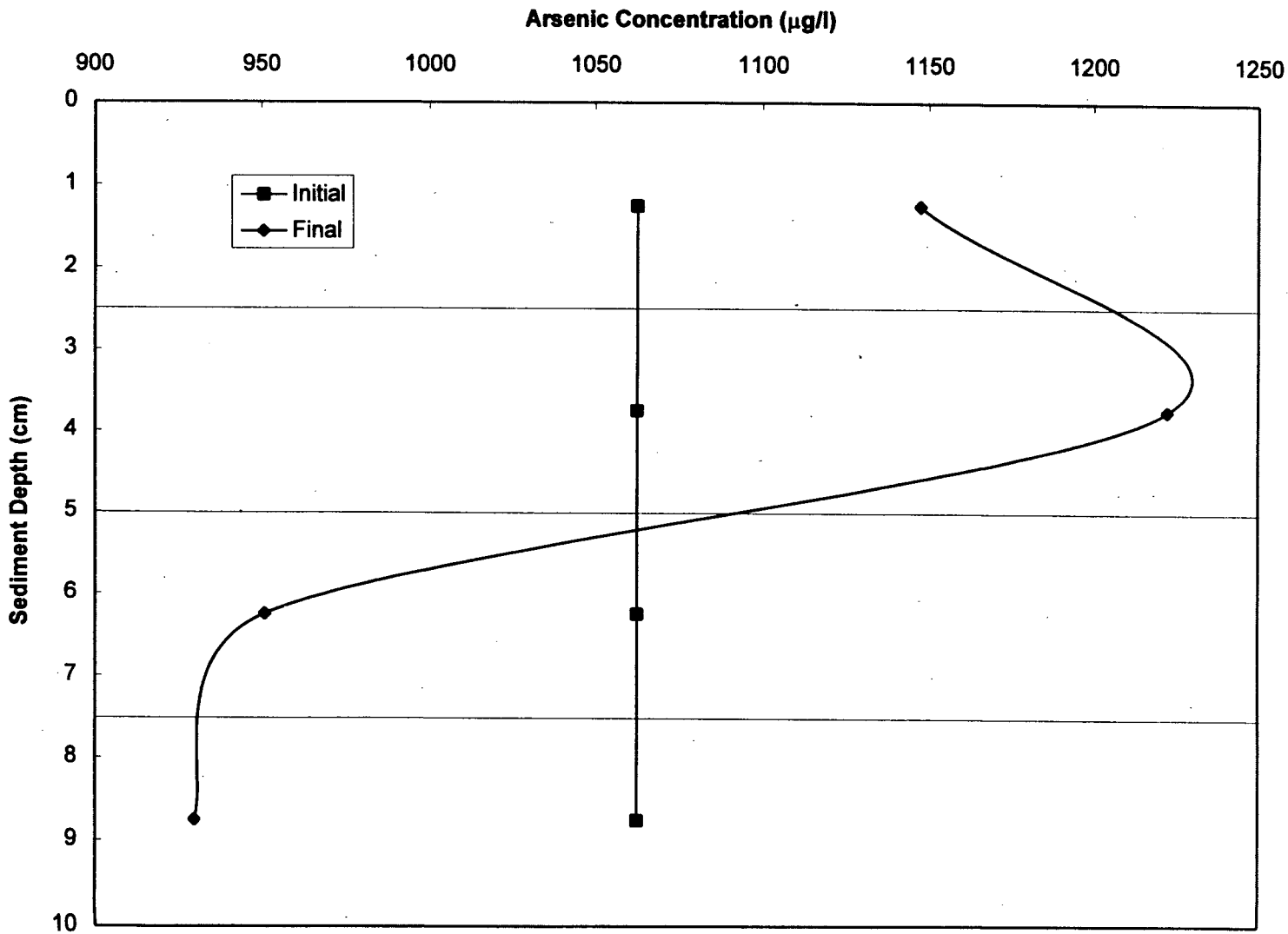
FIGURE 6-12
ARSENIC CONCENTRATION PROFILES
"HIGH2" EXPERIMENT



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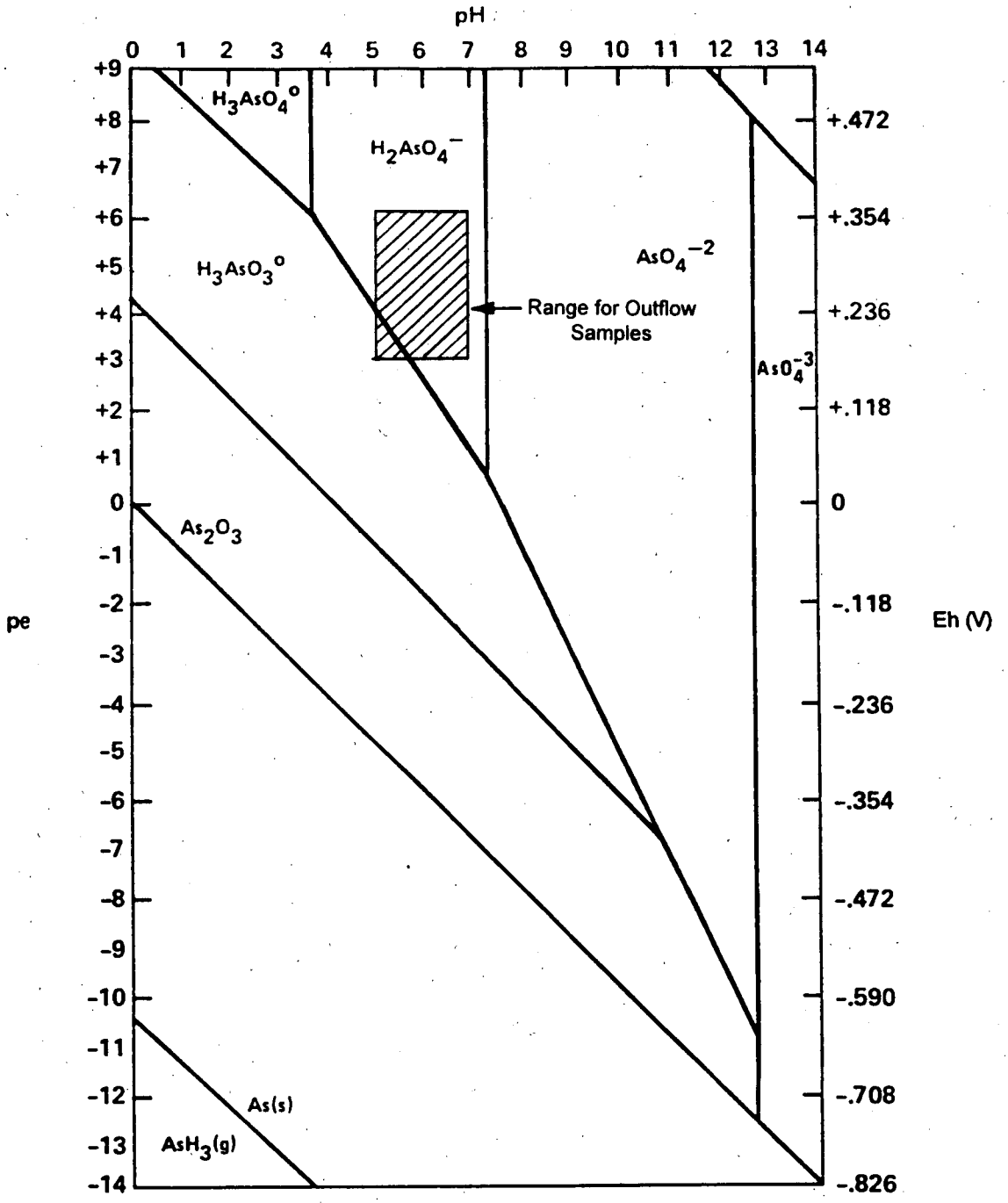
The arsenic concentration profiles observed within sediments in the experiments, with higher concentrations of arsenic near the sediment-water interface, are similar to those observed in nature. Studies in Lake Washington (Peterson and Carpenter, 1986), Loch Lomond (Farmer and Lovell, 1986) and Lake Ohakuri (Agett and O'Brien, 1985) have shown that the trivalent form of arsenic, As^{+3}, in reduced sediment pore waters diffuses upward toward the sediment-water interface. At or near the sediment-water interface, As^{+3} is either oxidized to less-soluble As^{+5} and reprecipitated or re-adsorbed when the overlying waters are oxic, as in Lake Washington and Loch Lomond, or released into the water column when the overlying waters are anoxic, as in Lake Ohakuri. The overflowing water in all four experiments retained relatively high dissolved oxygen content (3.0 to 7.4 ppm; measured in situ), and redox potential (+181 to +357 mV; measured in samples, see Tables 6-3a through d). These conditions are well within the stability range of As^{+5}, either as $H_3AsO_3^0$ at the lowest measured Eh and pH, or as $H_2AsO_4^-$ at higher Eh and pH (see Figure 6-13). These redox conditions are consistent with measurements of arsenic speciation performed on samples of pore waters and overlying waters from sediment cores collected from Union Lake (see Section 7.0). Both the uppermost pore waters and the water immediately overlying the sediment water interface in these cores were dominated by As^{+5}. Thus the higher concentrations of arsenic near the sediment-water interface are consistent with upward diffusion of reduced arsenic in the deeper pore waters followed by oxidation and reprecipitation or re-adsorption near the sediment-water interface.

6.4 DISCUSSION AND CONCLUSIONS

The most important result of these experiments is that very little arsenic is removed from the sediments by desorption into the overflowing water in a quiescent flow regime. Thus desorption of arsenic from the sediments will not likely result in a rapid decline in the arsenic concentrations of contaminated sediments in the Maurice River Basin following removal of the source of arsenic. For example, using the "High2" experiment as an analog for the deep sediments of Union Lake, reduction of the concentration of arsenic from 1063 mg/kg (3886 mg arsenic, see Equation 6.4 and Appendix E) to the cleanup criterion of 20 mg/kg (73 mg arsenic) at the rate of 0.0008 mg/hr would require 544 years. Similarly, using the "Low" experiment to represent shallow, near-shore sediments in Union Lake, reduction of the concentration of arsenic from 86.3 mg/kg (510 mg arsenic) to 20 mg/kg (118 mg arsenic) at the rate of 0.0004 mg/hr would require 112 years.

The experimental results can also be used to predict the flux of arsenic resulting from desorption from the Union Lake sediments. If it is assumed that the rates of arsenic desorption measured in the experiments were not limited by the depth of either the sediment bed or the overlying water, the desorption rate per unit area can be applied to the entire surface area of sediments within



BASED ON CLEMENT & FAUST, 1973 AND FERGUSON & GAVIS, 1972.

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FIGURE 6-13

Eh-pH OXIDATION-REDUCTION STABILITY DIAGRAM FOR ARSENIC COMPOUNDS

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Union Lake. As discussed above, the sediments used for both the "High" and "Low" experiments were collected from Union Lake. Therefore an average of the desorption rates for these experiments, 0.0006 mg/hr, was divided by the surface area of sediment in each of the experiments, 1800 cm^2, to obtain a desorption rate per unit area of 3.3×10^{-7} $mg \cdot hr^{-1} \cdot cm^{-2}$. This rate was then multiplied by the 870-acre (3.52×10^{10} cm^2) area of Union Lake to obtain an arsenic flux estimate of 1.17×10^4 mg/hr or 0.103 metric tons per year.

Two important conclusions can be drawn from this analysis: (1) Desorption of arsenic from sediments into the overflowing water will not likely result in a rapid decline in the arsenic concentrations of contaminated sediments in the Maurice River Basin following removal of the source of arsenic, and (2) The flux of arsenic likely to result from desorption of arsenic from contaminated sediments in Union Lake is more than an order of magnitude lower than the current total flux (dissolved + suspended) of approximately three metric tons of arsenic per year entering the lake via the Maurice River flow passing GS-3 (see Section 4).

It is important to note that the results of these experiments constrain only the rate of arsenic lost from sediments by desorption. Mobilization of arsenic by bedload sediment transport and by resuspension of contaminated sediments may also be important transport mechanisms. These sediment-bound arsenic transport mechanisms will be addressed by the sediment transport modeling being performed by Clemson University.

7.0 ARSENIC IN PORE WATERS

Literature investigations have previously demonstrated that As is commonly enriched in sediments at the sediment–water interface. Studies in Lake Washington (Peterson and Carpenter, 1986), Loch Lomond (Farmer and Lovell, 1986) and Lake Ohakuri (Agett and O'Brien, 1985) have shown that the reduced, trivalent form of arsenic, As^{+3}, in reduced sediment pore water diffuses upward toward the sediment–water interface. At the interface, As^{+3} is either oxidized to less soluble As^{+5} and reprecipitated or re-adsorbed when the overlying water is oxidizing (Lake Washington and Lake Lomond) or released into the water column when the overlying water is anoxic (Lake Ohakuri).

Five sediment cores were collected between July 22, 1992 and July 24, 1992. Two cores were collected from the Maurice River, one near the confluence of the Blackwater Branch and the Maurice River and one in the vicinity of the Almond Road overpass. The remaining three cores were collected from Union Lake. Two were collected slightly upstream of a submerged dam near the northern end of the lake and one was collected near the southern end in the deepest portion of Union Lake (≈ 7 meters water depth).

The sediment cores were collected by divers using a Jahnke coring device (Jahnke, 1988) that allows subsequent extraction of discrete depth intervals of pore water without exposure to the atmosphere. The sediments were then analyzed for As^{+3}, As^{+5} and "residual" As by graphite furnace atomic absorption (Ficklin, 1990), sulfur species by unpublished USGS methods, and bulk As, Fe, Mn and other metals by inductively coupled plasma emission spectrometry (Briggs, 1990). Pore waters were extracted through 0.45 µm filters and analyzed for As^{+3}, As^{+5}, and total As by methods presented by Ficklin (1983) and Fe^{+2}, total Fe, sulfide, pH, Cl, SO_4, NO_3, Mg, Ca, K, Na, dissolved organic carbon (DOC), NO_2+NH_4, Si and PO_4 by methods detailed in Ficklin et al. (1993), which is duplicated in Appendix B for convenience. Complete analytical results are also presented in Appendix B (Ficklin et al., 1993).

Nitrate (NO_3) reduction in the Union Lake pore waters is evidenced by decreases in the nitrate concentration and increases in combined nitrite and ammonia (NO_2+NH_4) with depth in the upper portions of each of the cores. Reduction of Fe and Mn is also indicated in the bottom waters and sediments of Union Lake, however no measurable concentrations of sulfide were present in either the overlying waters or the pore waters. A significant portion of the dissolved As in the pore waters and overlying waters was also present as As^{+3}. The relatively large change in the concentrations of As, Mn and Fe across the sediment–water interface indicates the potential for these elements to diffuse out of the sediment and into the overlying water. However, based on the concentration ratios of As in the sediments to As in coexisting pore water, it is evident that As partitions very strongly into the organic-rich lake bottom sediments. K_d, defined as the total

concentration of As in the sediment divided by the concentration of As dissolved in coexisting pore water,

$$K_d^{As} = \frac{C_s^{As}}{C_a^{As}}$$

ranges from 198 to 8667 in the Union Lake cores, with an average value of 2231. These partition coefficients may closely approach thermodynamic equilibrium, since the flow of pore water through the sediments is likely to be very slow. The extremely high values suggest that a very small percentage of the As contained in the lake sediment will be released to the overlying water. These results are consistent with the extremely low rates of arsenic desorption (0.0004 to 0.0012 mg/hr) and correspondingly high bulk partition coefficients (K^{As} = 12,856 to 72,586) determined for a quiescent flow regime by the arsenic desorption experiments described in Section 6.0. A very small percentage (0.03% to 0.2%) of the total mass of arsenic contained in the sediments used for these experiments was removed by desorption into the overflowing water.

These sediments have obviously acted as a sink for As during previous years when the total flux of As into Union Lake was larger. However, the limited data that are currently available suggests that the present flux of As into the lake is roughly balanced by the flux of As over the Union Lake Dam. This suggests that the concentrations of As in the sediments are close to equilibrium with the present concentrations in the overlying water. If the flux of As into Union Lake is further reduced, it is possible that the sediments will constitute a source of As into the water column and over the dam. However, as discussed above, the extremely high Kd's suggest that As would be released very slowly. It is unlikely that As desorbed from the sediments would result in significant increases in concentrations of As in the water column.

8.0 ARSENIC CONCENTRATIONS IN UNION LAKE DURING ANOXIC EVENTS

Union Lake is a large impoundment of the Maurice River located in Millville, New Jersey. The lake is located approximately five miles downstream from the confluence of Maurice River with the Blackwater Branch. Arsenic contamination linked to the Vineland Chemical site on the Blackwater Branch has been detected in the surface waters and sediments of Union Lake. Historical studies have identified elevated arsenic concentrations in both the surface waters and sediments in Union Lake (Hughes et al. 1981, Faust et al. 1983, 1987a, 1987b, Ebasco 1989). Previous investigations have indicated that the lower waters of Union Lake become anoxic during summer stratification (Hughes et al. 1981). In the absence of oxygen, chemically reduced compounds may be liberated into the anoxic water column from the sediments. This potential contribution may act as an internal source of arsenic loading to the Maurice River system below Union Lake. This potential mass contribution of arsenic may elevate surface water concentrations during Fall turnover of Union Lake and create a potential pulse of arsenic to the lower tidal Maurice River.

8.1 METHODS

In July 1993, a remotely monitored thermocouple array was deployed in Union Lake to allow continuous monitoring of the temperature profile of the lake to identify the early stages of summer stratification. The thermocouple array was positioned in the deepest portion of the lake outside of the spillway safety area of the Union Lake Dam. The maximum depth at this point (6.6 m) was determined to be within the upper boundary of the anoxic waters during summer stratification in Union Lake (Hughes et al. 1981). Thermocouples were installed along the array from surface (0 m) to bottom (6.6 m) at approximate 1.0 m intervals. In a cooperative effort with USGS personnel, temperature profiles were monitored on a daily basis and data were retrieved via telephone modem from the USGS gauging station located on the Union Lake Dam. These data were used to develop temperature profiles of the water column which were used to identify the early stages of summer stratification and to monitor the onset of Fall turnover. When the temperature between the near bottom and near surface waters was > 3 °C for three successive days and the bottom waters indicated anoxic conditions (chemical stratification), sampling of the water column for arsenic concentrations began (Aug. 3, 1993). For purposes of this study, anoxic conditions were defined as dissolved oxygen concentrations of less than or equal to 0.1 mg/l (i.e. the limit of resolution of the monitoring instrument used).

Monitoring via thermocouple array and manual measurements of temperature and dissolved oxygen indicated that thermal stratification was present and bottom waters were anoxic on August 3, 1993. Chemical monitoring of the water column was initiated on this date and continued until September 9, 1993. During the chemical monitoring effort, samples from the water column were collected on August 3, 4, 5, 7, 11, 16 23, 30, September 2, 7 and 9. Samples for TAL metals analysis were collected on August 3, 4, 5, 7, 11, 16, 23, 30 and September 7. Samples for arsenic speciation were collected on August 3, 4, 5, 7, 11, 16, 23, 30, September 7 and 9. Water samples were collected from the near surface (0 m) to near bottom (6.5 m) at 0.8 m intervals. Collection of samples at depth was conducted using a variable flow peristaltic pump (GeoPump II, Geotech Environmental, Denver, CO) with 1/4" polyethylene tubing. Tubing lengths cut to the sampling depth were dedicated to each sampling point in the water column, thus eliminating the potential for cross contamination during each sampling event. The pump tubing was weighted with a stainless-steel sampling intake port. After lowering the intake to the appropriate depth, a volume of water at least two times the capacity of the pump tubing was drawn through the system prior to collecting a sample to ensure that only water from the desired depth was sampled. When filtered samples were required, an in-line filter was attached directly to the ouput tubing and the filtered sample discharged directly into the sample bottle. Filtered samples were collected after unfiltered samples so that only water from the desired depth interval passed through the filter. Filtered and unfiltered samples (1.0 liter) collected for TAL metals analyses were preserved to pH < 2 using concentrated nitric acid. Filtered samples (125 ml) collected for speciation analyses by the USGS were preserved using 1 ml of concentrated, trace-metal grade hydrochloric acid as specified by Walter Ficklin of the USGS (pers. com.). Compared to the Van Dorn sampler originally proposed for collection of these samples, the peristaltic pump allowed collection of samples that better reflect the *in situ* conditions within the discrete depth intervals. Samples were collected with minimal exposure to the atmosphere (important for determinations of As speciation) and because the flow rate could be accurately controlled, sampling near the sediment–water interface was possible with minimal disturbance of the sediment.

During each sampling event, field measurements of water column profiles (0.30 m intervals) of temperature, dissolved oxygen, specific conductivity and pH were collected using an ICM water analyzer (Industrial Chemical Management, Hillsboro, OR). Redox potential was measured using a redox meter (Redox Potential Value Tester, Hanna Instruments, Woonscoket, RI) or was calculated empirically from dissolved oxygen. Sulfide was measured using a sulfide test kit (LaMotte Sulfide Test Kit, Chestertown, MD). Sulfide data were collected only on September 7 and 9. Collection of redox potential and sulfide data were limited to sampling depths where chemical sampling occurred (0.8 m intervals).

A two foot contour interval bathymetric map of Union Lake was used to determine depth interval volume and the total volume of Union Lake as the sum of individual strata. Interval volume was calculated using the formula given in Wetzel and Likens (1991):

$$V = (h/3)(A_1 + A_2 + \sqrt{A_1 A_2}) \quad (1)$$

Where V is the volume (m^3) in A_2, h is the contour interval (m), A_1 is the area (m^2) of the upper stratum and A_2 is the area (m^2) of the lower stratum. Contour areas were determined using an area calculating program in ArcInfo. A depth-volume curve was developed from the individual strata volumes for use in calculating volume of anoxic and oxygen depleted waters. Concentrations of filtered and unfiltered arsenic were compared between anoxic waters and oxygenated waters within the water column. Total mass of arsenic present in anoxic strata was calculated as the product of the volume of anoxic water and the mean concentration of arsenic measured within the anoxic stratum. To consider a worst-case scenario, the highest concentration found (typically at a depth of 6.5 m) was used to calculate the total mass of arsenic present in the anoxic layer. The mean total mass of arsenic for each date was used as the mass of arsenic potentially mixed in the water column during turnover. This mass estimate includes the assumption that no sedimentation processes of arsenic removal occurred. Since the volume of anoxic strata represented less than or equal to 2.5% of the total lake volume, the mean concentration of arsenic from the depths collected within the anoxic layer was assumed to be uniform throughout.

8.2 DATA SET: ARSENIC CONCENTRATION IN UNION LAKE DURING ANOXIC EVENTS

For convenience, data that are referenced in the following discussion of arsenic concentration in Union Lake during anoxic events are presented in the results section. These data represent the complete analytical results and are also presented in Appendix A.

8.3 RESULTS

8.3.1 *Thermal and Chemical Stratification*

Remote monitoring via the thermocouple array indicated that Union Lake was stratified by the end of July 1993 (Figure 8-1). Union Lake appeared to remain weakly stratified throughout the surface water monitoring field effort. Historical studies also classified Union Lake as a weakly stratified lake (Hughes et al. 1981). Classical thermal stratification during the summer stagnation period is categorized as the division of three thermally distinct layers within the water column. These layers are defined as the epilimnion, a thermocline or a gradient of decreasing temperature

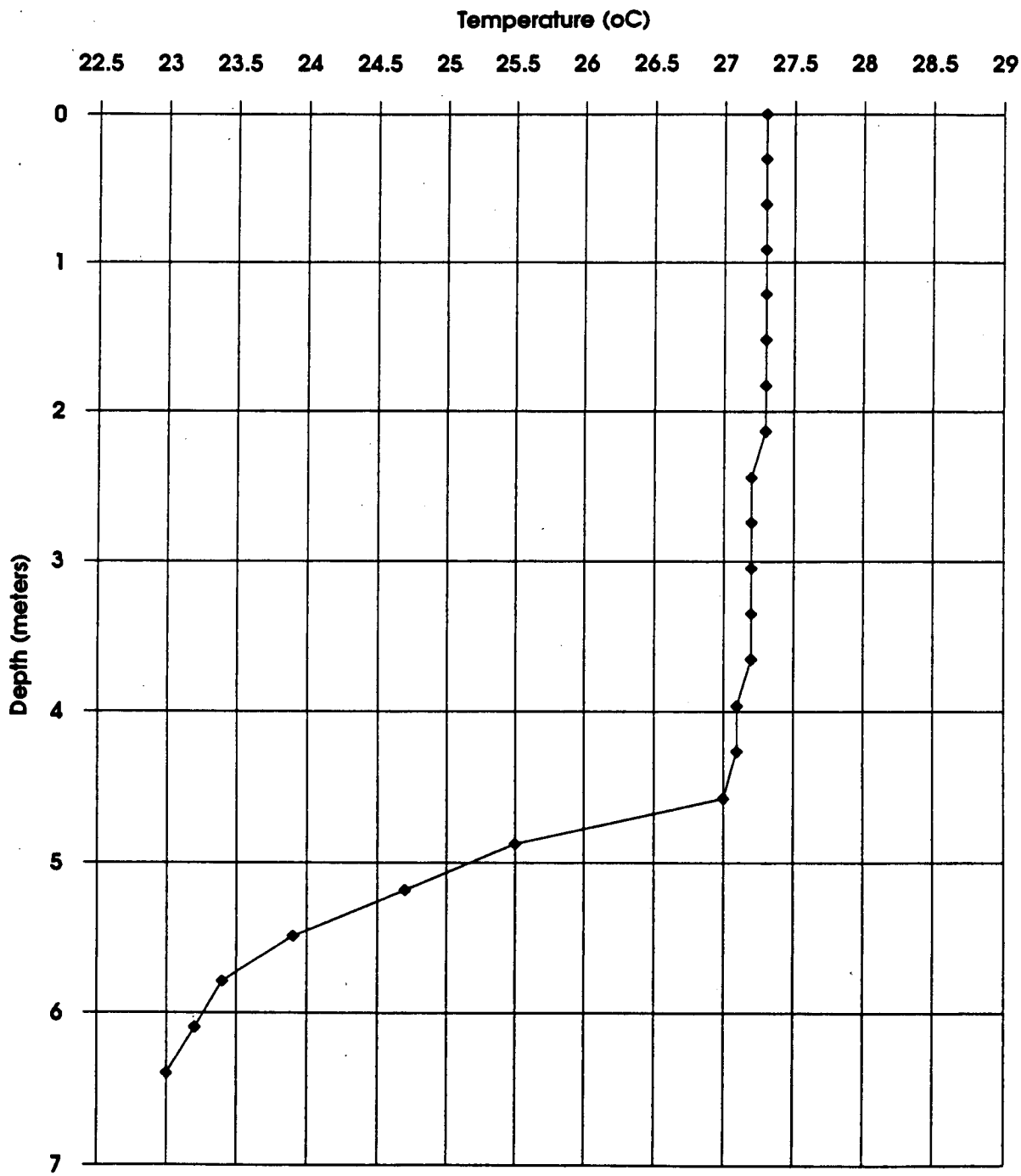

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FIGURE 8-1
UNION LAKE
THERMAL GRADIENT
7/30/93

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and the hypolimnion (Wetzel 1975). Because Union Lake is relatively shallow (maximum depth 7.7 m; 6.6 m at the monitoring and sampling location), a poorly developed hypolimnion was largely restricted to only the deepest portions of the lake. In the absence of elevated wind conditions and storm events these layers were defined as 0-0.62 m (epilimnion), 0.62-6.5 m (thermocline) and depths > 6.5 (hypolimnion). However, as shown on Figure 8-1, the depth of the lower boundary of the epilimnion varied with meteorological conditions, and reached depths of up to approximately 4.5 m. Because the lake was weakly stratified, the epilimnion and the upper waters of the thermocline underwent partial mixing during storm events or high wind conditions. During the sampling dates of August 4, 5 and 7, 4-6 knot winds from a northerly direction extended the lower boundary of epilimnion to 4.0-5.5 m from the surface (Figures 8-2 through 8-5).

Although the upper waters were subject to partial mixing during these conditions, the lake remained thermally stratified throughout the sampling period. Mixing of the epilimnion and the upper waters of the thermocline are common in temperate, shallow lakes during summer stratification when wind speed and direction generate such an event. Although these upper waters may partially mix, thermal stratification typically remains intact (Wetzel 1975).

Manual monitoring on July 30, 1993 indicated that although thermal stratification was in place, dissolved oxygen concentrations in the bottom waters of the lake were above 0.1 mg/l (Figure 8-6). Monitoring on August 3, 1993 indicated that the bottom waters turned anoxic during the first week in August 1993 (Figure 8-7) and remained anoxic until the onset of Fall turnover in early September 1993. The anoxic strata during summer stratification appeared to be restricted to depths > 6.15 m (20 ft.) throughout the sampling period. Chemical stratification of the lake was much more defined relative to depth than thermal stratification. Dissolved oxygen concentrations in the water column displayed a defined chemocline extending from approximately 3 - 6 meters in the lake. The chemocline represented the gradient of decrease in dissolved oxygen concentration separating the well oxygenated (> 6.5 mg/l O_2) upper waters (0 -3 meters) from the lower (6.15 -7.7 m) anoxic waters. Meteorological conditions directly affect the extent of the chemocline in Union Lake via partial mixing of the upper strata of the water column. Dissolved oxygen profiles during periods of 4-6 knot winds from the north or storm events correlated well with the temperature profiles observed. During the August 11 sampling period, sporadic thunderstorms reduced the anoxic layer to the interval of 6.5-7.7 m. Although the upper waters did periodically mix, the lower anoxic profile remained essentially intact. Dissolved oxygen concentrations in the anoxic layer remained less than or equal to 0.1 mg/l.

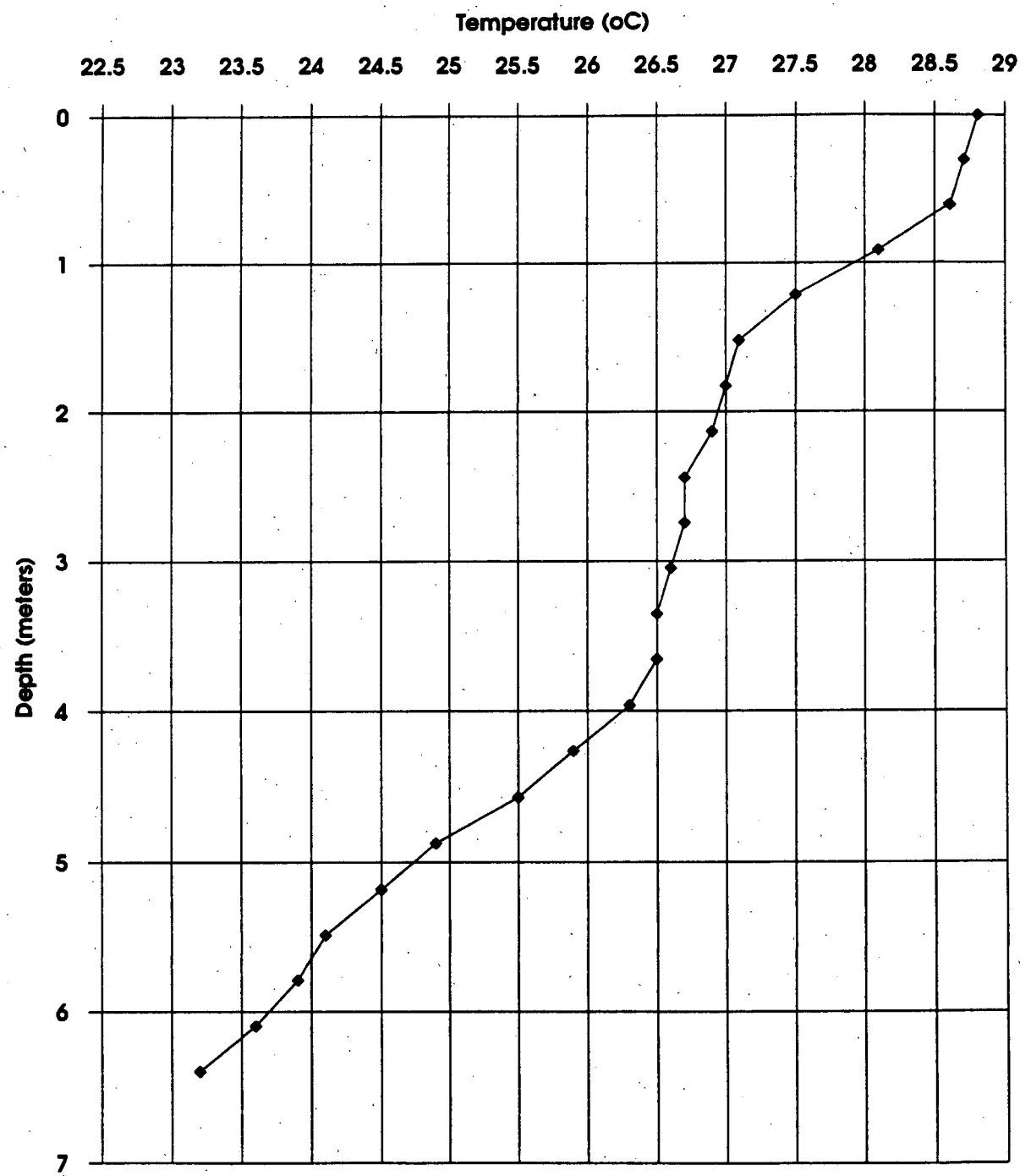

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FIGURE 8-2 UNION LAKE THERMAL GRADIENT 8/3/93
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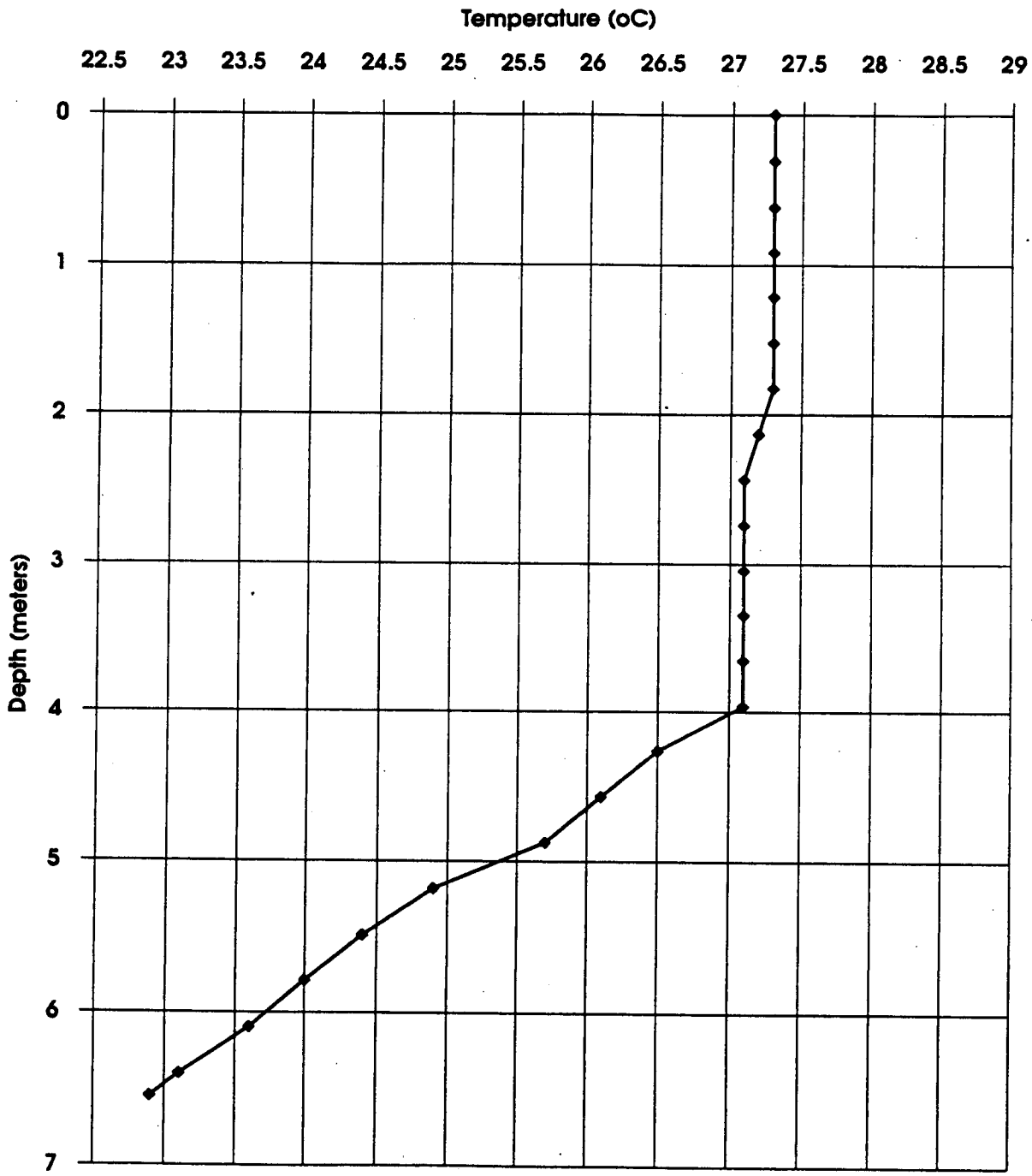

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FIGURE 8-3
UNION LAKE
THERMAL GRADIENT
8/4/93

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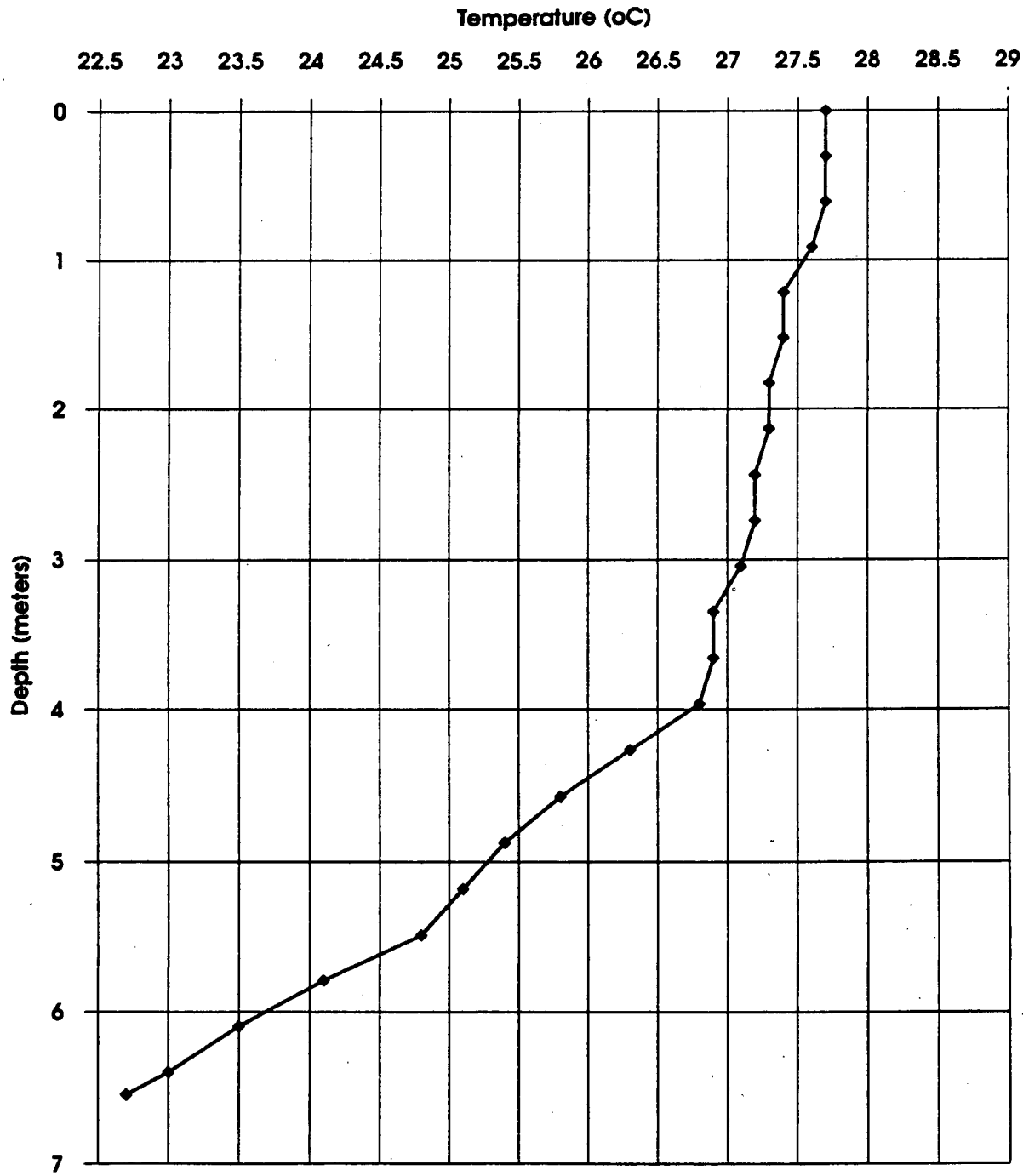

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FIGURE 8-4 UNION LAKE THERMAL GRADIENT 8/5/93
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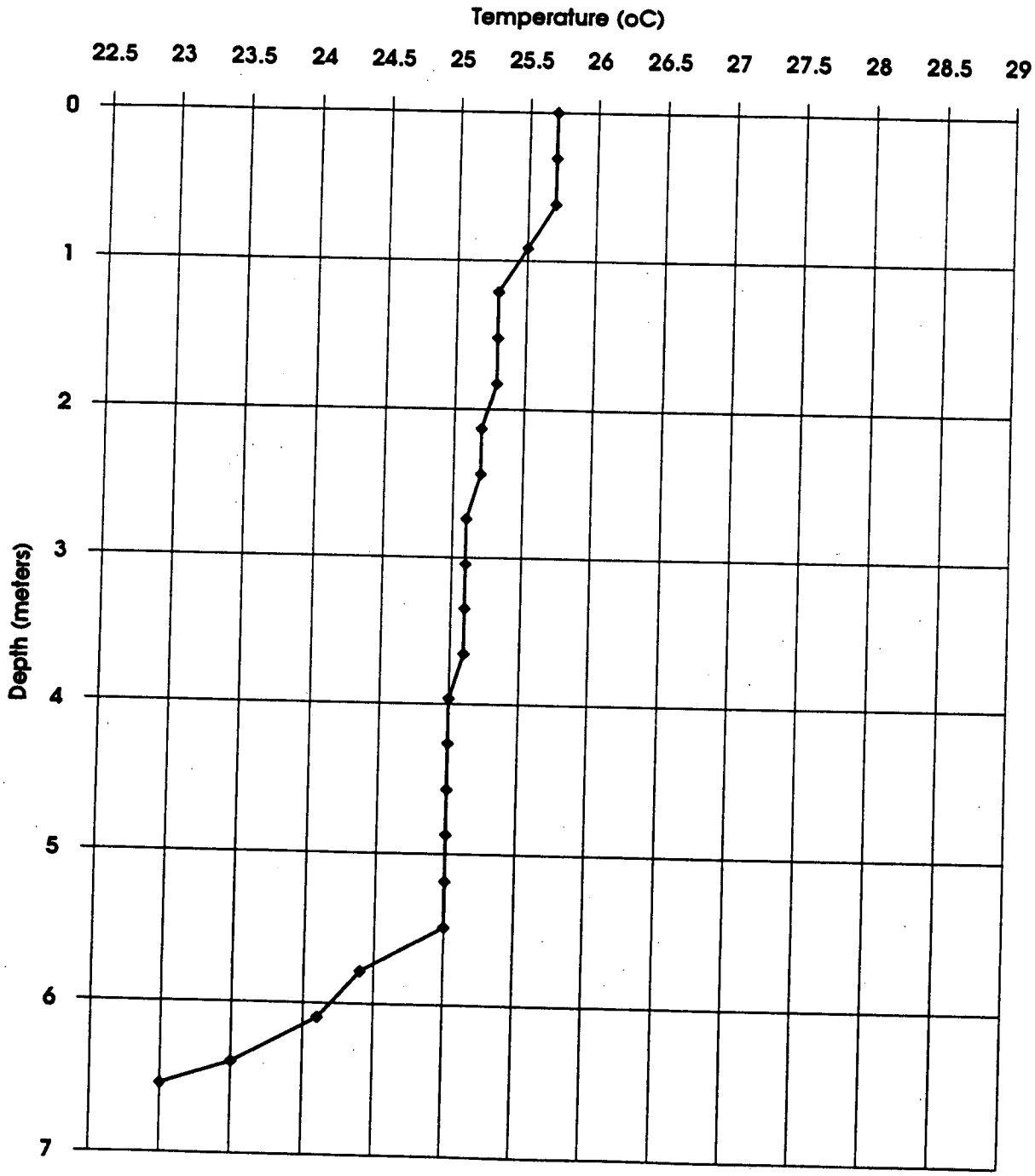

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VINELAND CHEMICAL COMPANY SITE
FIGURE 8-5 UNION LAKE THERMAL GRADIENT 8/7/93
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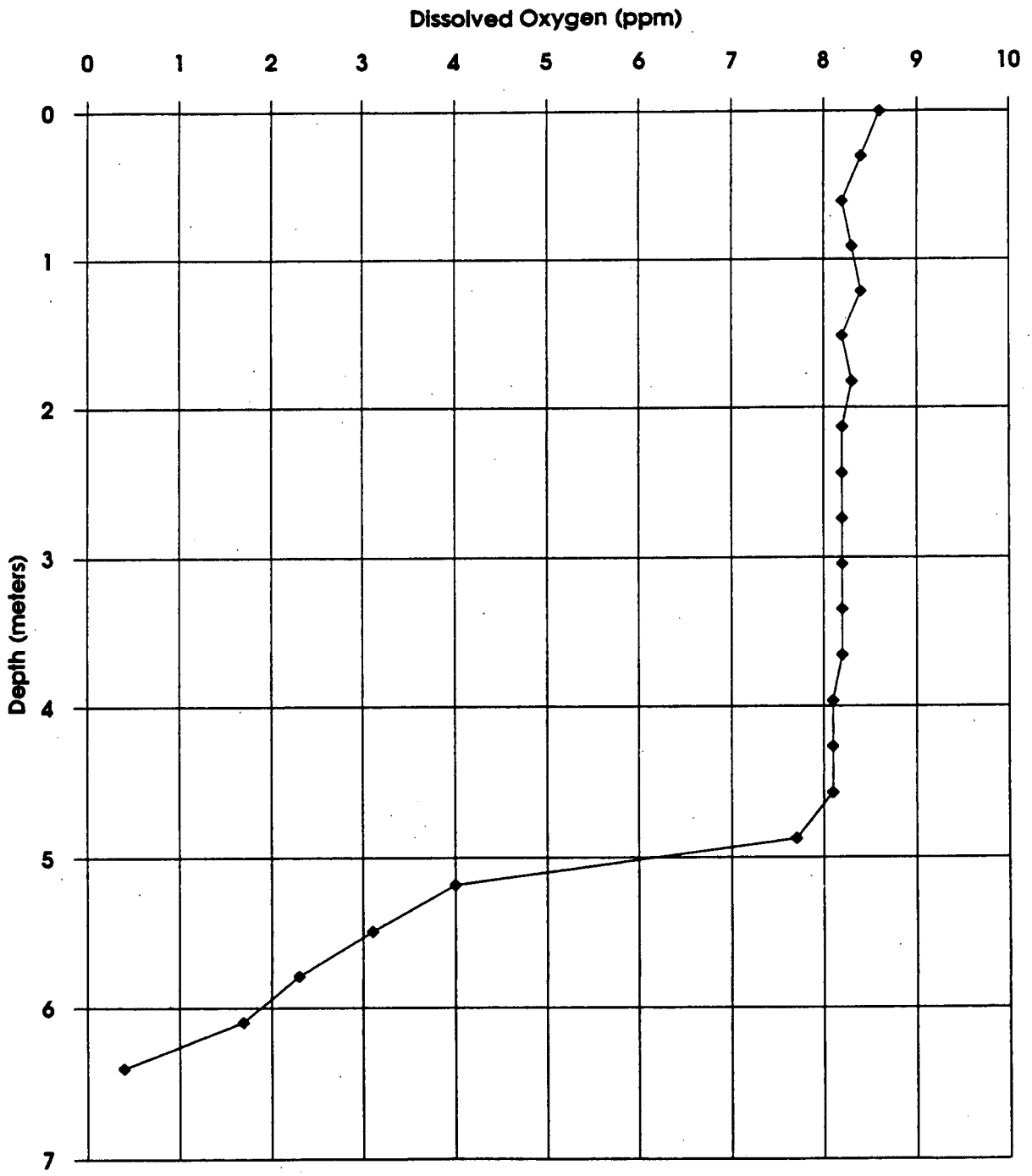

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FIGURE 8-6 UNION LAKE DISSOLVED OXYGEN GRADIENT 7/30/93
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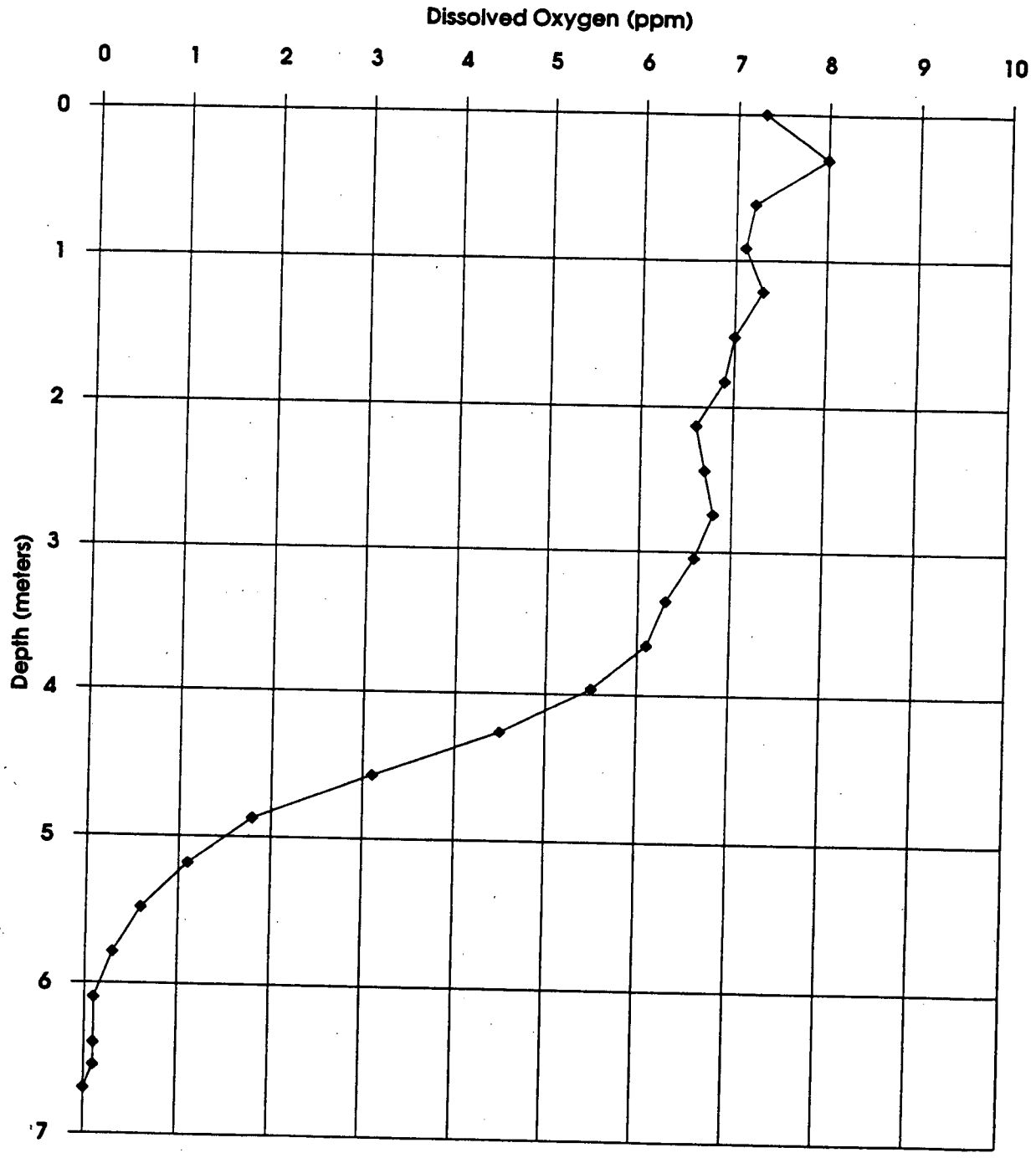

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FIGURE 8-7
UNION LAKE
DISSOLVED OXYGEN GRADIENT
8/3/93

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8.3.2 *Unfiltered and Filtered Arsenic Concentrations and Arsenic (III) and Arsenic (V) Speciation in the Stratified Water Column*

Concentration of unfiltered arsenic from sampling points in the water column are presented in Table 8-1. Similar to dissolved oxygen, unfiltered arsenic concentrations were stratified, with a layer of fairly uniform concentration giving way to a chemocline of increasing concentration (Table 8-1). Highest concentrations were associated with the near bottom waters (>6.15m). In comparing depth profile data for all sampling dates, a layer of essentially uniform concentration extended from the surface to the 4.0-5.7 m sampling depth. Uniformity of concentrations within this layer suggests that mixing within this interval was constant. The depth interval in which uniformity in concentration was detected varied with sampling date. For the sampling period August 3-7, the uniform depth interval extended from the surface to 4.0 m (Table 8-1). Mean concentration of unfiltered arsenic within this mixed layer was 14.1 ug/l on August 3, 17.5 ug/l on August 4 and 16.3 ug/l on August 5. When subjected to windy conditions on August 7, this mixed layer increased in depth to 5.7 m (Table 8-1). Mean concentration of unfiltered arsenic within the mixed layer on August 7 was 18.3 ug/l. By August 11, the lake had returned to pre-event conditions and the mixed layer was reduced to a depth of 2.4 m. The mean arsenic concentration within this layer was 16.0 ug/l. For the period of August 16-30, the mixed layer extended to 3.2 m. Mean unfiltered arsenic concentrations increased in this layer during each of the sampling events. On August 16, the mean unfiltered arsenic concentration was 19.4 ug/l and 21.4 ug/l on August 23. On August 30, the mean unfiltered arsenic concentration declined to 15.7 ug/l. This concentration was similar to that found prior to August 7 (Table 8-1). Uniformity in unfiltered arsenic concentration remained consistent to a depth of 3.2 m on the September 7 sampling date. The mean unfiltered arsenic concentration in this layer on September 7 was 20.0 ug/l.

In general, the concentration of unfiltered arsenic in deeper waters increased with depth. The highest concentrations of unfiltered arsenic were associated with bottom waters (6.5 m) (Table 8-1). Concentrations of unfiltered arsenic at 6.5 m sampling depth range from 36.0-66.3 ug/l, respectively. Table 8-2 contains concentrations of filtered arsenic monitored in the water column. Filtered arsenic generally followed trends similar to unfiltered arsenic during the sampling period. The relative concentrations of arsenic in filtered and unfiltered samples were variable, with the dissolved fraction exceeding the total fraction on certain dates. These minor differences (1-2 ug/l) are attributed to different laboratories and/or standard curves used in analysis. The close correlation between dissolved and total fractions of arsenic in the samples indicates that these differences were not significant.

Table 8-1. Unfiltered (total) arsenic concentrations (ug/l) versus depth in the water column during summer stratification in Union Lake, Millville, NJ for the year 1993.

Sample Depth (m)	Aug.[1] 3	Aug. 4	Aug. 5	Aug. 7	Aug. 11	Aug. 16	Aug. 23	Aug. 30	Sept.[2] 7
0	14.4	18.4	17.8	17.6	15.5	19.4	21.5	15.6	19.8
0.8	14.0	17.7	14.5	19.0	16.2	19.0	20.7	14.7	19.5
1.6	14.2	18.0	17.4	18.0	16.0	16.7	20.9	14.3	19.8
2.4	14.4	16.4	17.0	17.0	16.6	21.0	22.6	15.6	20.1
3.2	13.9	17.1	15.0	20.0	32.6	20.7	21.1	18.3	21.0
4.0	16.4	19.4	17.6	18.7[3]	29.0	26.2	24.0	22.5	27.7
4.9	22.6	25.6	34.1	19.4	22.2	20.7	25.0	31.2[3]	35.7
5.7	28.2	37.6	35.8	17.0	35.8	39.5	48.2	36.0	35.8
6.5	42.0	63.9[3]	66.3	59.2	36.0	50.2[3]	64.5	63.8	56.1

[1] Early stage of lake stratification in Union Lake.
[2] Late stage of lake stratification prior to beginning of Fall turnover (Sept. 11, 1993).
[3] Datum represents the mean concentration of sample and duplicate.

Table 8-2. Filtered (dissolved) arsenic concentrations (ug/l) versus depth in the water column during summer stratification in Union Lake, Millville, NJ for the year 1993.

Sample Depth (m)	Aug.[1] 3	Aug. 4	Aug. 5	Aug. 7	Aug. 11	Aug. 16	Aug. 23	Aug. 30	Sept.[2] 7
0	17.0	14.6	20.0	19.0	17.2	16.8	18.1	14.4	20.1
0.8	17.2	14.4	18.8	20.0	16.0	19.5	20.5	13.9	16.8
1.6	15.4	14.8	15.6	18.1	17.9	17.6	20.2	12.6	19.2
2.4	17.5	15.6	16.2	18.0	17.6	19.6	19.0	14.1	15.5
3.2	16.6	14.4	16.4	18.0	16.4	19.7	20.8	13.6	18.5
4.0	16.6	13.0	16.6	16.5[3]	16.7	20.1	20.6	13.6	22.6
4.9	23.0	20.1	25.6	17.4	21.4	21.2	21.0	26.4[3]	27.5
5.7	29.6	31.4	30.0	17.8	27.2	34.8	46.2	31.2	24.7
6.5	42.6	59.5[3]	48.2	61.6	46.2	45.1[3]	59.8	69.8	35.2

[1] Early stage of lake stratification in Union Lake.

[2] Late stage of lake stratification prior to beginning of Fall turnover (Sept. 11, 1993).

[3] Datum represents the mean concentration of sample and duplicate.

Table 8-3. USGS arsenic speciation data for filtered (dissolved) As III/As V concentrations (ug/l) versus depth in the water column during summer stratification in Union Lake, Millville, NJ for the year 1993.

Sample Depth (m)	Aug.[1] 3	Aug. 4	Aug. 5	Aug. 7	Aug. 11	Aug. 16	Aug. 23	Aug. 30	Sept. 7	Sept.[2] 9
0	<1/15.0	<1/17.0	<1/18.0	<1/21.0	<1/18.0	<1/18.0	<1/15.0	<1/15.0	<1/15.0	<1/14.0
0.8	<1/15.0	<1/18.0	<1/18.0	<1/21.0	<1/18.0	<1/16.0	<1/17.0	<1/16.0	<1/14.0	<1/14.0
1.6	<1/18.0	<1/18.0	<1/16.0	<1/19.0	<1/19.0	<1/19.0	<1/18.0	2.0/13.0	<1/18.0	<1/15.0
2.4	<1/17.0	<1/16.0	<1/16.0	<1/20.0	<1/19.0	<1/21.0	<1/18.0	<1/15.0	<1/11.0	<1/14.0
3.2	<1/16.0	<1/18.0	<1/16.0	<1/18.0	<1/16.0	<1/22.0	<1/18.0	<1/15.0	<1/16.0	<1/14.0
4.0	<1/17.0	<1/17.0	<1/16.0	<1/19.0	<1/17.0	<1/19.0	<1/19.0	<1/16.0	<1/21.0	<1/21.0
4.9	<1/25.0	<1/25.0	<1/32.0	<1/20.0	<1/21.0	<1/26.0	<1/21.0	<1/32.0[3]	<1/24.0	ND
5.7	<1/34.0	<1/39.0	<1/35.0	<1/20.0	<1/27.0	<1/37.0	<1/63.0	<1/37.0	<1/27.0	<1/35.0
6.5	<1/47.0	<1/66.5[3]	<1/58.0	<1/47.5[3]	<1/40.0	<1/50.0[3]	<1/66.0	<1/75.0	<1/30.0	<1/53.0

[1] Early stage of lake stratification in Union Lake.
[2] Late stage of lake stratification prior to beginning of Fall turnover (Sept. 11, 1993).
[3] Datum represents the mean concentration of sample and duplicate.
ND-Sample container damaged in transport and not analyzed.

Table 8-4. Filtered (dissolved) arsenic concentrations (ug/l) from USGS arsenic speciation monitoring versus depth in the water column during summer stratification in Union Lake, Millville, NJ for the year 1993.

Sample Depth (m)	Aug.[1] 3	Aug. 4	Aug. 5	Aug. 7	Aug. 11	Aug. 16	Aug. 23	Aug. 30	Sept. 7	Sept.[2] 9
0	17.0	17.0	19.0	22.0	19.0	20.0	17.0	16.0	17.0	15.0
0.8	16.0	17.0	19.0	23.0	19.0	18.0	18.0	18.0	17.0	16.0
1.6	18.0	19.0	16.0	22.0	20.0	21.0	18.0	15.0	18.0	17.0
2.4	17.0	17.0	18.0	21.0	20.0	18.0	19.0	16.0	12.0	16.0
3.2	16.0	17.0	18.0	20.0	17.0	20.0	20.0	17.0	18.0	16.0
4.0	19.0	19.0	14.0	21.0[3]	18.0	19.0	19.0	17.0	23.0	23.0
4.9	26.0	28.0	34.0	24.0	22.0	21.0	20.0	30.0[3]	25.0	ND
5.7	34.0	39.0	38.0	22.0	29.0	35.0	50.0	38.0	28.0	35.0
6.5	48.0	67.5[3]	60.0	48.0	42.0	46.5[3]	64.0	70.0	30.0	54.0

[1] Early stage of lake stratification in Union Lake.

[2] Late stage of lake stratification prior to beginning of Fall turnover (Sept. 11, 1993).

[3] Datum represents the mean concentration of sample and duplicate.

ND-Sample container damaged in transport and not analyzed.

Arsenic speciation for all sampling dates and depths was dominated by arsenic (V); with arsenic (III) concentrations at or below detection limits (<1.0 ug/l) (Table 8-3). Like filtered and unfiltered concentrations in the CLP dataset, arsenic (V) generally increased in concentration with greater sampling depth. Highest concentrations were associated with the 6.5 m sampling depth. The close agreement between the concentration of arsenic (V) and total filtered arsenic suggests that arsenic (V) is the dominant chemical form of arsenic present in the Union Lake water column (Tables 8-3 and 8-4).

8.3.3 *Calculation of Total Mass of Arsenic within Anoxic Waters*

The two-foot contour bathymetric map for Union Lake was used to determine contour interval volumes of the lake (Appendix D). Table 8-5 presents the calculated interval volume and total volume for Union Lake. Depth-interval volume data were used to develop a depth versus cumulative volume curve (Figure 8-8). From this curve the volume of the anoxic layer was determined on the basis of the upper boundary of the anoxic layer from dissolved oxygen profiles collected during stratification monitoring. For purposes in estimating the volume of anoxic waters, it was assumed that anoxic conditions extended from the upper boundary down to the deepest point of the lake (7.78 m). Depth intervals and corresponding volumes of anoxic water for each sampling date are given in Table 8-6. Anoxic waters in Union Lake were generally restricted to depths > 6.15 m. The volume of anoxic waters monitored during stratification represented < 2.5% of the total volume of the lake.

Total mass of arsenic was calculated by multiplying the volume of anoxic water by the mean concentration of unfiltered arsenic sampled in the anoxic layer for each date. Total mass of arsenic as calculated for each sampling date are given in Table 8-7. The mean total mass of arsenic in anoxic waters of the lake fluctuated between 0.4-6.5 kg As (Table 8-7). This fluctuation was attributed to variation in the volume of water considered anoxic. Wind and storm events affected the boundary of the upper layer of anoxic water via mixing in the upper waters of the thermocline. Compared to the mass loading of arsenic from the Maurice River, the contribution of internal mass loading appears to be minimum. If the sediment-water (1 cm above sediment) interface is considered to be near anoxic throughout the entire lake basin, the total contribution may be greater. Hughes et al. (1981) found that shallow areas of Union Lake (< 4.0 m) had dissolved oxygen concentrations approaching anoxic conditions. Assuming a one centimeter height of anoxia above the sediments and the highest As concentration observed (66.3 ug/l), the mass of arsenic potentially released basin wide would be < 0.001 kg, respectively. An alternative worst-case scenario would be the cumulative maximum mass of unfiltered arsenic present in the anoxic waters of the hypolimnion from each sampling period being introduced into the upper waters of Union Lake. Using the maximum concentration observed during each event, the cumulative mass would approximate 41.0 kg of unfiltered As. Even this maximal value for internal loading represents only 1.2% of the mass contributed by the Maurice River. Thus, on the basis of the available data, it appears that potential internal mass loading from anoxic submerged sediments may not represent a significant source of arsenic to Union Lake.

Table 8-5. Interval volume for two foot contours as determined from the Union Lake bathymetric map.

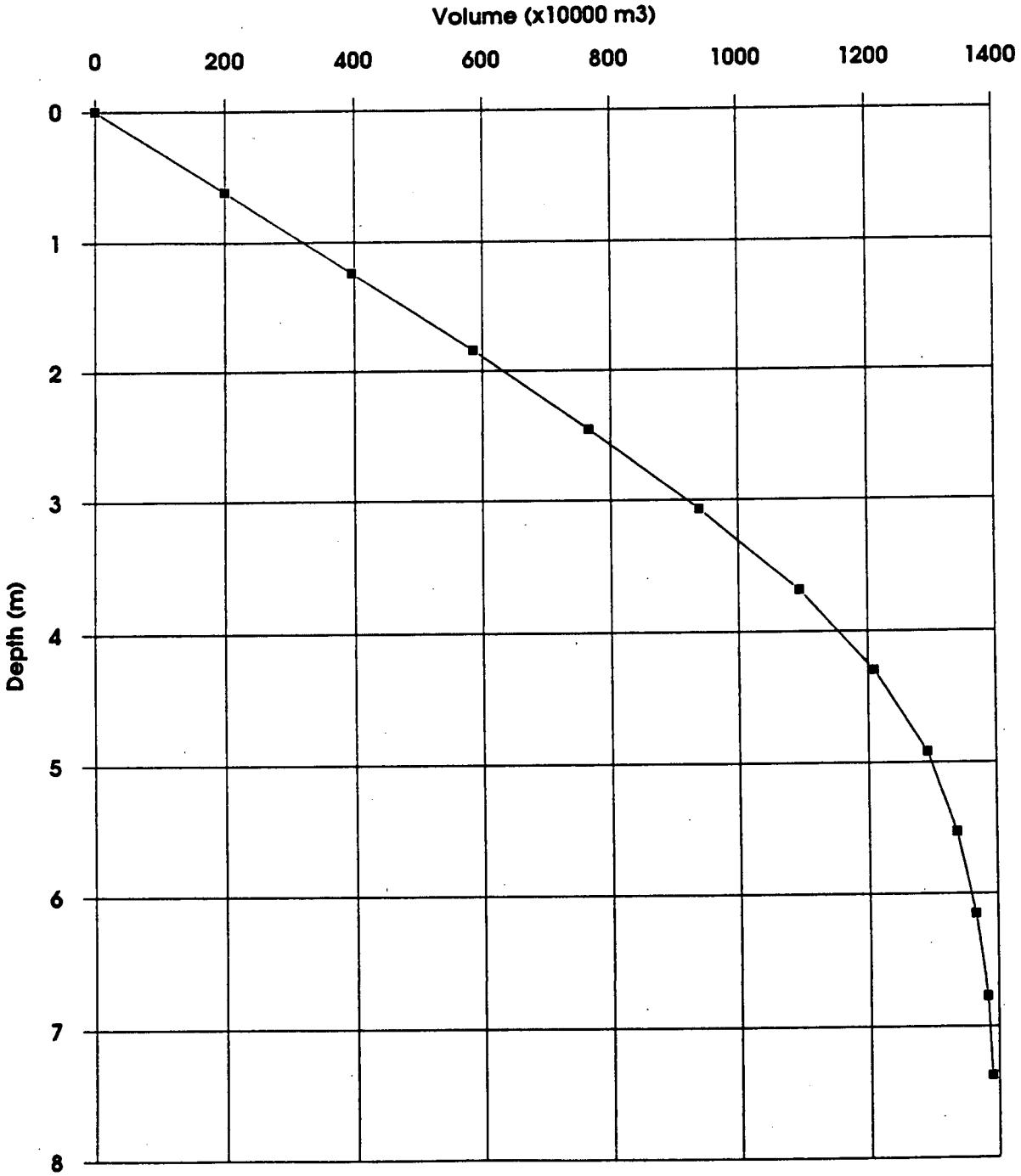
Depth Interval (m)	Contour Volume ($x10^4$ m^3)	Cumulative Volume ($x10^4$ m^3)
0-0.62	198.05	198.05
0.62-1.24	189.41	387.46
1.24-1.84	176.81	564.27
1.84-2.46	161.75	726.02
2.46-3.07	127.98	598.04
3.07-3.69	87.66	685.70
3.69-4.30	54.17	739.87
4.30-4.92	31.08	770.95
4.92-5.53	20.79	791.74
5.53-6.15	12.89	804.63
6.15-6.77	5.79	810.42
6.77-7.38	1.49	811.91
7.38-Bottom	0.1823	812.09
Total	$812.09x10^4$ m^3	$812.09x10^4$ m^3

Table 8-6. Depth interval and volume of anoxic waters in Union Lake during summer stratification sampling.

Date	Depth Interval (m)	Volume ($x10^4$ m^3)	Percent of Total Lake Volume
August 3	6.15-7.69	7.46	0.9%
August 4	5.80-7.69	12.7	1.5%
August 5	6.15-7.69	7.46	0.9%
August 7	6.50-7.69	3.40	0.4%
August 11	6.90-7.69	1.10	0.1%
August 16	6.61-7.69	2.64	0.3%
August 23	6.15-7.69	7.46	0.9%
August 30	6.15-7.69	7.46	0.9%
September 7	4.92-7.69	20.4	2.5%

Table 8-7. Calculated mass of arsenic (unfiltered) in anoxic waters during summer stratification monitoring.

Date	Minimum As ug/l	Maximum As ug/l	Mean As ug/l	Anoxic Volume ($x10^4 m^3$)	Mean Mass of Arsenic (kg)	Maximum Mass of Arsenic (Kg)
August 3	28.2	42.0	35.1	7.46	2.6	3.1
August 4	37.6	63.9	50.8	12.74	6.5	8.1
August 5	35.8	66.3	51.1	7.46	3.8	4.9
August 7	59.2	59.2	59.2	3.40	2.0	2.0
August 11	36.0	36.0	36.0	1.10	0.4	0.4
August 16	50.2	50.2	50.2	2.64	1.3	1.3
August 23	48.2	64.5	56.4	7.46	4.2	4.8
August 30	30.6	63.8	47.2	7.46	3.5	4.8
Sept. 7	35.7	56.1	42.5	20.4	8.6	11.4



U.S. ENVIRONMENTAL PROTECTION AGENCY

VINELAND CHEMICAL COMPANY SITE

FIGURE 8-8

UNION LAKE
DEPTH VERSUS VOLUME

FOSTER WHEELER ENVIRONMENTAL CORPORATION

9.0 ARSENIC CONCENTRATIONS IN UNION LAKE OUTFLOW DURING LAKE TURNOVER

Under anoxic conditions, bottom waters may receive a substantial internal mass loading of chemically reduced anions or metals from bottom sediments (Chapra and Reckhow 1983, Cooke et al. 1986). Union Lake has been identified as developing anoxic bottom waters in deeper areas of the lake basin near the dam (McHuges et al. 1981). The presence of anoxic conditions in these lower waters may facilitate the desorption of arsenic bound in the lake sediments and contribute to the mass balance of arsenic in Union Lake. This contribution of arsenic to the surface waters of Union Lake may occur as an elevation in arsenic concentrations lake wide during Fall turnover. This condition may result in a short term pulse of surface water containing elevated arsenic concentrations during Fall turnover. The receiving waters of this potential source would be the Maurice River estuary below the spillway of Union Lake. To determine if such a pulse in arsenic concentration occurs following destratification, the Union Lake outflow was monitored immediately following destratification of the lake and the subsequent Fall turnover during 1993.

9.1 METHODS

Temperature profiles of Union Lake were monitored remotely via the *in situ* thermocouple array and manually during stratification sampling. Outflow from Union Lake was monitored for seven consecutive days following the initiation of Fall turnover on September 11, 1993. Because of the rapid destratification of the lake in early September, sampling of the water column in terms of depth of the mixing zone was not feasible. Therefore, sampling was initiated when turnover was observed in the temperature profile monitoring data. Sampling was conducted at the Union Lake spillway on the Union Lake Dam. Water samples were collected using a peristaltic pump (GeoPump II, Geotech Environmental, Denver, CO) and polyethylene tubing. Samples were collected within the 0-0.1 m depth interval at the spillway overflow. A dedicated length of tubing was used to eliminate potential cross contamination during other sampling field efforts. The pump tubing was weighted with a stainless steel sampling intake port. After lowering the intake to the appropriate depth, a volume of water at least two times the capacity of the pump tubing was drawn through the system prior to collecting a sample to ensure that only water from the desired depth was sampled. When filtered samples were required, an in-line filter was attached directly to the output tubing and the filtered sample discharged directly into the sample bottle. Filtered samples were collected after unfiltered samples so that only water from the desired depth interval passed through the filter. Filtered and unfiltered samples (1.0 liter) collected for CLP analyses were preserved to pH < 2 using concentrated nitric acid. Filtered samples (125 ml) collected for speciation analyses by the USGS were preserved using 1 ml of concentrated, trace-metal grade hydrochloric acid as specified by Walter Ficklin of the USGS

(pers. com.). Compared to the Van Dorn sampler originally proposed for collection of these samples, the peristaltic pump allowed collection of samples that better reflect the *in situ* conditions within the discrete depth intervals. Samples were collected with minimal exposure to the atmosphere, which is important for determinations of As speciation.

Field measurements recorded during each sampling event included temperature, dissolved oxygen, specific conductivity, pH, redox potential and sulfide. Temperature, dissolved oxygen, specific conductivity and pH were measured using an ICM water analyzer (Industrial Chemical Management, Hillsboro, OR). Redox potential was measured using a redox potential meter (Hanna Instruments, Woonscoket, RI). Sulfide was measured using a LaMotte sulfide test kit (LaMotte Corporation, Chestertown, MD). Flow data for the Union Lake spillway were recorded from the USGS gaging station located on Union Lake Dam.

Arsenic flux (As g/sec) over the spillway dam was calculated as the product of the concentration of unfiltered arsenic multiplied by the flow rate over the center spillway. During Fall overturn monitoring, flood gates on Union Lake Dam were open and gaging station data were incomplete since this release was not measured. Therefore, arsenic flux could not be calculated under these conditions.

9.2 DATA SET

The data set for monitoring of the Union Lake outflow during Fall turnover consists of field parameters and chemical data from five days of sampling following the August 9-11 storm event. These data represented the closest pre-turnover data for the Union Lake spillway available for comparison to post-turnover conditions. These results are discussed in the following section.

9.3 RESULTS

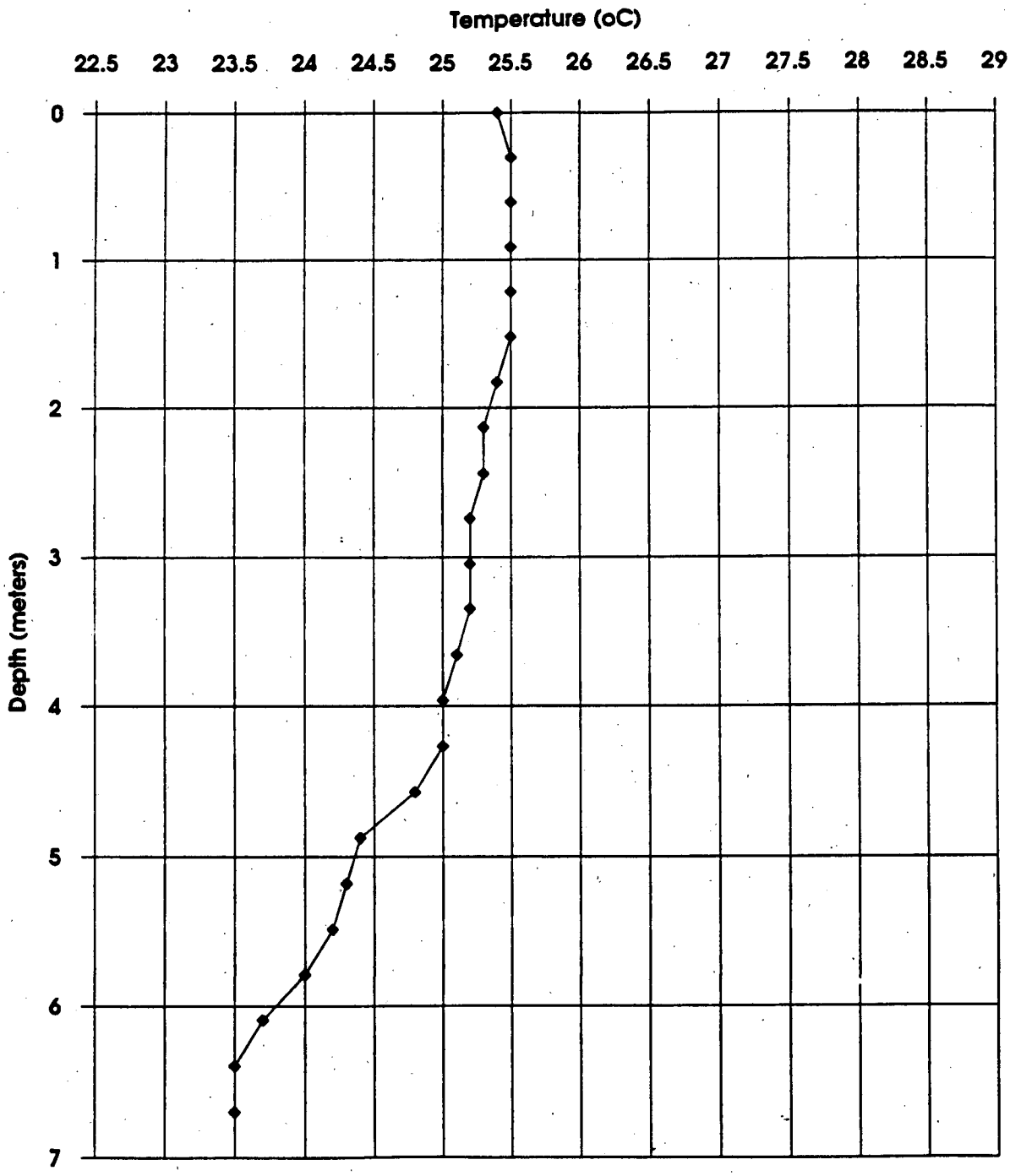
During the period August 9-11,1993, the Union Lake-Millville area experienced severe lightning and thunderstorms. Stratification monitoring during this period revealed that the epilimnion and a portion of the thermocline were mixed. Because Union Lake was a weakly stratified system, severe weather conditions were considered to be potential causative factors in initiating complete turnover of the lake. Because of the extent of mixing observed in the upper waters of the lake, sampling of the outflow was initiated as a precautionary measure in the event that the meteorological conditions caused complete mixing throughout the entire water column. Outflow sampling was started on August 11 and continued until August 20. Temperature profiles of the lake during this period revealed that the lake restratified and mixing had a limited impact on bottom anoxia.

Temperature profiles of Union Lake indicated that destratification began during the first week in September 1993 (Figure 9-1). Subsequent sampling revealed that the lake began to turn over on September 11, 1993 (Figure 9-2). As a consequence, outflow monitoring was started on September 11, 1993.

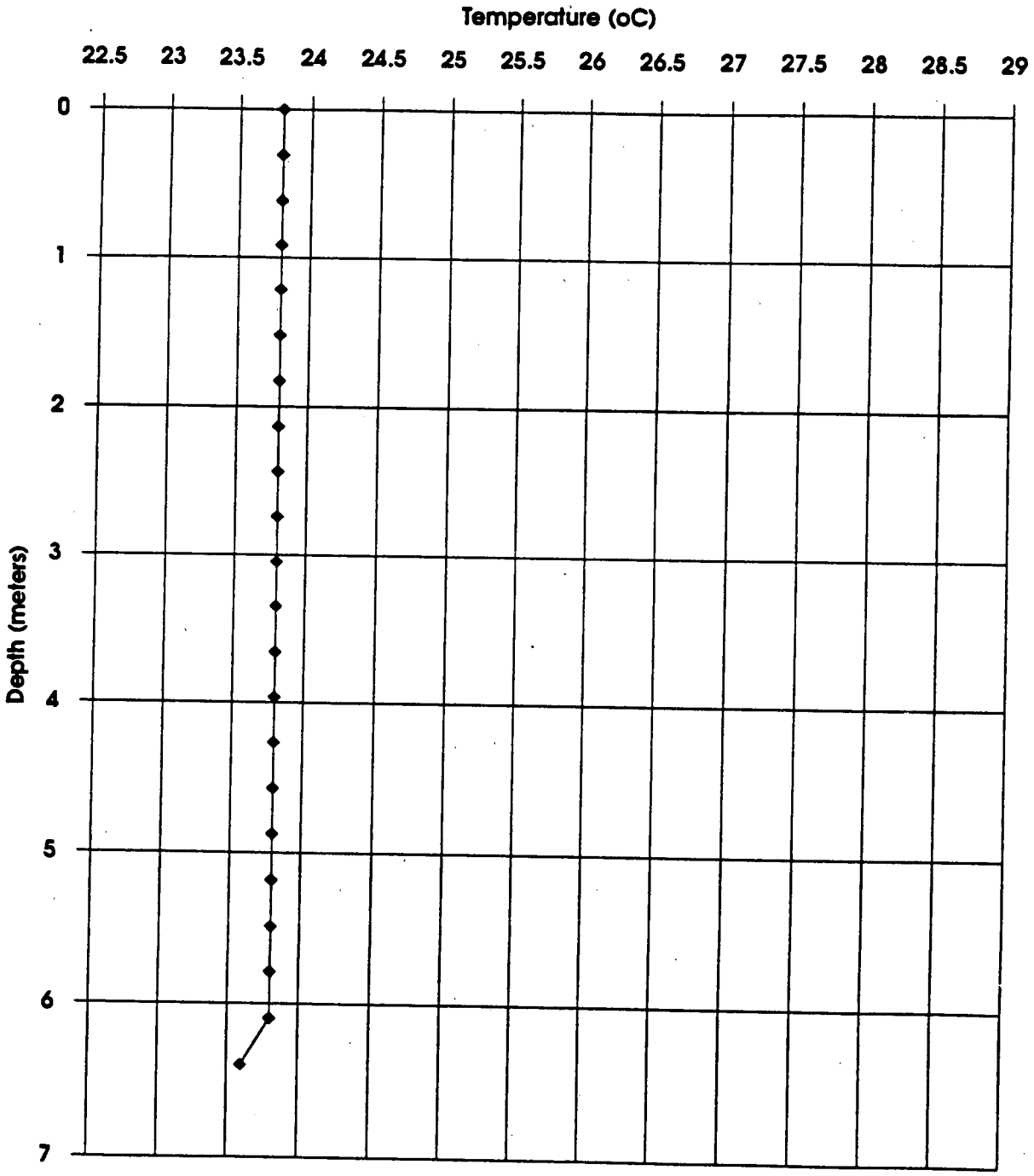
Unfiltered and filtered arsenic concentrations measured during the August 11-20 period were comparable to those measured in the upper waters of the lake during summer stratification. Both unfiltered and filtered fractions were found at similar concentrations (Table 9-1). Mean concentration of unfiltered arsenic was 18.3 ug/l and mean concentration of filtered arsenic was 20.2 ug/l. Additionally, arsenic flux of both unfiltered and filtered fractions were comparable during this event (Table 9-2). Mean flux of unfiltered arsenic over the spillway during this period was 0.076 g/sec. Mean flux of filtered arsenic was 0.069 g/sec. Relative fluxes of both fractions were comparable to that observed at other monitoring stations on the Maurice River. Arsenic speciation was dominated by As (V) during each sampling event, with As (III) concentrations occurring below detection limits (<1.0 ug/l). During monitoring following the start of turnover, arsenic (III) was at or below detection limits (<1.0 ug/l) and arsenic (V) was the dominant species present (Table 9-3). Mean concentration of arsenic (V) during this period was 13.2 ug/l.

Following the start of destratification/turnover conditions on September 11, arsenic concentrations in the lake discharge were monitored daily for seven consecutive days (September 11-17). Results of this monitoring effort are summarized in Table 9-3. Total unfiltered arsenic ranged from 19.8 to 23.4 ug/l with a mean of 22.2 ug/l. Filtered arsenic ranged from 13.3 to 18.8 ug/l with a mean concentration of 16.3 ug/l. Calculated arsenic flux over the spillway during this period could only be estimated for two of the seven days. Ungaged flood gates on the Union Lake dam remained open during the first five days of monitoring. Thus an accurate estimate of flux could not be calculated given the absence of total outflow data over the spillway. The flood gates were closed during the last two monitoring days. Therefore, arsenic flux (gAs/sec) over the Union Lake spillway could only be estimated for these two days. Arsenic flux of both unfiltered and filtered fractions remained comparable to preturnover fluxes over the spillway.

Unfiltered arsenic flux over the spillway remained comparable for both days ranging from 0.055-0.056 g/sec. (Table 9-4). The filtered fraction displayed a little more variability in flux ranging from 0.032-0.046 g/sec. Based upon these limited data, arsenic flux did not appear to increase as a result of a pulsed flux of arsenic from anoxic bottom waters. Arsenic speciation data also showed no deviation from pre-turnover conditions. Arsenic (V) dominated, with arsenic (III) remaining below detection limits (<1.0 ugAs/l). The results of the turnover monitoring revealed no appreciable difference in arsenic concentrations or speciation compared to pre-turnover conditions. Therefore, no "pulsed" loading of arsenic as the result of Fall turnover appears to be occurring to the lower Maurice River.



U.S. ENVIRONMENTAL PROTECTION AGENCY
VINELAND CHEMICAL COMPANY SITE
FIGURE 9-1 THERMAL GRADIENT UNION LAKE DAM 9/9/93
FOSTER WHEELER ENVIRONMENTAL CORPORATION



U.S. ENVIRONMENTAL PROTECTION AGENCY

VINELAND CHEMICAL COMPANY SITE

FIGURE 9-2
THERMAL GRADIENT
UNION LAKE DAM
9/11/93

FOSTER WHEELER ENVIRONMENTAL CORPORATION

Table 9-1. Summary of unfiltered, filtered and USGS filtered speciation data for preturnover storm event conditions as monitored from the Union Lake spillway.

Pre-Fall Overturn

Sample Date	Total Unfiltered As(ug/l)	Total Filtered As(ug/l)	Filtered As (III) (ug/l)	Filtered As (V) (ug/l)
August 11	15.6	17.8	<1.0	18.0
August 13	16.4	17.6	<1.0	20.0
August 16	21.2	15.5	<1.0	17.0
August 18	17.8	13.1	ND	ND
August 20	20.5	19.1	<1.0	15.0

ND-No data collected.

Table 9-2. Calculated arsenic flux (g/sec) over Union Lake spillway during pre-turnover storm event.

Date	Total Unfiltered As(ug/l)	Total Filtered As(ug/l)	Spillway Flow (m^3/sec)	Unfiltered As Flux (g As/sec)	Filtered As Flux (g As/sec)
August 11	15.6	17.8	4.50	0.070	0.080
August 13	16.4	17.6	4.30	0.070	0.075
August 16	21.2	15.5	3.80	0.080	0.058
August 18	17.8	13.1	5.20	0.092	0.068
August 20	20.5	19.1	3.40	0.070	0.065

Table 9-3. Summary of unfiltered, filtered and USGS filtered speciation data for Fall turnover monitored from the Union Lake spillway.

Fall Overturn

Sample Date	Total Unfiltered As(ug/l)	Total Filtered As(ug/l)	Filtered As (III) (ug/l)	Filtered As (V) (ug/l)
Sept. 11	22.2	16.8	<1.0	15.0
Sept. 12	22.1	15.3	<1.0	15.0
Sept. 13	23.4	15.3	<1.0	11.0
Sept. 14	22.5	18.7	<1.0	15.0
Sept. 15	22.9	18.8	<1.0	11.0
Sept. 16	22.4	13.3	<1.0	12.0
Sept. 17	19.8	16.1[1]	<1.0	14.0

[1]Mean value of sample and duplicate

Table 9-4. Calculated arsenic flux (g/sec) over Union Lake spillway at the beginning of Fall turnover.

Date	Total Unfiltered As(ug/l)	Total Filtered As(ug/l)	Spillway Flow (m^3/sec)	Unfiltered As Flux (g As/sec)	Filtered As Flux (g As/sec)
September 11	22.2	16.8	ND	-	-
September 12	22.1	15.3	ND	-	-
September 13	23.4	15.3	ND	-	-
September 14	22.5	18.7	ND	-	-
September 15	22.9	18.8	ND	-	-
September 16	22.4	13.3	2.4	0.055	0.032
September 17	19.8	16.1	2.8	0.056	0.046

ND - Flood gates on the Union Lake Dam remained open, estimate of total flow unavailable.
- Flux values not available

10.0 SOURCE AND FATES OF ARSENIC IN THE BLACKWATER BRANCH

One of the specific issues addressed by the As mass balance study was to determine whether the sediments within the floodplain adjacent to the plant site currently represent a significant source of As to the Blackwater Branch. The following sections address this question with a comparison of known inputs of As to the Blackwater Branch and the total flux past gauging station GS-1. Determination of the potential these sediments have to act as a source of As after input from the Vineland Chemical Plant site is controlled (Operable Units One and Two; ROD) depends largely on the sediment transport modeling, the results of which are not yet available.

10.1 METHODS

The question of whether the floodplain sediments constitute a significant source of As can be addressed by considering the balance between other known sources of As into the Blackwater Branch, e.g., the flux of contaminated groundwater and surface runoff from the Vineland Chemical Company site, and the total flux of As in the Blackwater Branch downstream of the plant site at gauging station GS-1. Based on the direction of groundwater flow within the Vineland Chemical Company site, which is west or slightly north of west (GW Report, December, 1992), all groundwater flowing through the plant site will enter the Blackwater Branch upstream of GS-1 (see Figure 4-1). Therefore if the flux of As resulting from influx of plant-site groundwater is insufficient to explain the total flux of As past GS-1, an additional source of As would be required. Because of their proximity to the Blackwater Branch, the floodplain sediments, which are known to have high concentrations of As (Plant Site RI, 1989; DI Report, 1993), would represent the most likely source of additional As. Conversely, if the the flux of As in plant-site groundwater is larger than the flux past GS-1, the floodplain sediments represent the most probable "sink" for storage of the excess As.

10.2 DATA SET

Surface water samples were collected from the Blackwater Branch at locations BBU (at the Delsea Drive overpass) and GS-1 (at the Maurice River Parkway overpass) on a periodic basis to support the As mass balance study (Figure 4-1). Complete analytical results are presented in Appendix A.

The results of samples collected from BBU show that the Blackwater Branch upstream of the Vineland Chemical Company site does not constitute a significant source of As into downstream reaches of the stream. The total flux of As past GS-1 during the first year of the mass balance study ranged from 0.029 g/s to 0.433 g/s. The average flux for the first year was 0.083 g/s, which is equivalent to 2.6 metric tons of As per year (see Section 4.1.3).

The total flux of As into the Blackwater Branch from the Vineland Chemical Plant site was previously estimated in the Plant Site RI report (June, 1989) to be between 1.2 to 11 metric tons per year (0.04 to 0.35 gs^{-1}), based on geometric mean and arithmetic mean arsenic concentrations, respectively, in the plant site groundwater. Nearly all of this flux results from As contained in the plant site groundwater, which discharges into the Blackwater Branch. The total estimated flux of As resulting from runoff (3.1×10^{-3} gs^{-1}), which includes both As dissolved in the runoff water (3.1×10^{-3} gs^{-1}) and As contained in suspended sediment (4.4×10^{-8} gs^{-1}), was insignificant when compared to the flux of As in groundwater.

These estimated fluxes of As derived from the Vineland Chemical Company site can now be refined using the results of subsequent investigations. The flux of As in groundwater flowing from the Vineland Chemical Company site into the Blackwater Branch can be calculated as the product of the flux of groundwater through the site and the average concentration of As in the groundwater. Based on calibrated "MODFLOW" models (McDonald and Harbaugh, 1988; GW Report, December 1993), the natural flux of groundwater through the Vineland Chemical company site is approximately 307 gallons per minute. The area-weighted average As concentration in the site groundwater, based on the As isoconcentration contours presented in the GW Report (December,1993) is 5484 µg/l (see Figure 10-1). This yields a total calculated As flux of 0.106 g/s (3.3 metric tons per year) into the Blackwater Branch via influx of groundwater from the Vineland Chemical Company site.

The flux of As into the Blackwater Branch resulting from surface runoff, which may transport As in both dissolved and particulate form, can also be estimated. Using the total area of the plant site which was characterized by soil borings during the DI Report (815,000 ft^2; December, 1993), a mean arsenic concentration of 126 mg/kg in soil samples from the 0' to 2' depth interval, and a net sediment transport rate for this drainage area of 0.056 g/ft^2 (194 tons/yr per 113 mi^2; Lennon and Johnston, 1982) yields a sediment-bound As transport of 1.8×10^{-6} g/s. If equilibrium between runoff water and the surface soils is assumed, then with a distribution coefficient of 408 l/kg (median value from column leaching study, DI Report, 1993) and 22% of the annual precipitation of 44 inches appearing as runoff, the dissolved arsenic transport is 1.8×10^{-4} g/s. The total As transported by surface runoff (1.8×10^{-3} g/s or 0.006 metric tons per year) is thus insignificant when compared to the mass of As transported via groundwater.

10.3 RESULTS

The estimated flux of As into the Blackwater Branch derived from the Vineland Chemical Company site (0.106 g/s or 3.3 metric tons per year) is larger than the average flux of As past GS-1 (0.083 g/s or 2.6 metric tons per year). Therefore, on an annual average basis the floodplain sediments are not a significant source of As into the Blackwater Branch, but are likely

to represent a sink for the excess As. However, this does not preclude the sediments acting as a source of As at some times during the year. If the flux of As in the groundwater is assumed to be relatively constant, then the upper range of the As flux past GS-1 (0.433 g/s) exceeds the groundwater flux by more than a factor of four, suggesting that As derived from the floodplain sediments is included. Thus, the floodplain may act as a reservoir for temporary storage of As derived from the Vineland Chemical Company site. During periods of increased stream discharge, additional As may then be flushed from the sediments or the fine-grained floodplain sediments containing adsorbed As may be re-suspended and transported downstream.

Furthermore, if the plant-site groundwater is eliminated as a source of As, these sediments will likely constitute a minor residual source of As into the Blackwater Branch. However, because of the extremely high distribution coefficients measured between As in fine-grained, organic-rich sediments and their coexisting porewaters (Section 7.0), desorption of As from the floodplain sediments is not likely to yield a large flux of As into the Blackwater Branch. Re-suspension during periods of high stream flow represents the most likely mode of As transport from the floodplain sediments. This transport mechanism will be evaluated further by the sediment transport modeling being conducted by Dr. Earl Hayter of Clemson University.

11.0 SOURCES AND FATES OF ARSENIC IN THE MAURICE RIVER

11.1 METHODS

See Sections 4.1.1 and 4.2.1.

11.2 DATA SET

See Sections 4.1.3 and 4.2.3.

11.3 RESULTS

Periodic measurement of total As fluxes within the Blackwater Branch, Maurice River and Union Lake fluvial–lacustrine system over a one year period (July, 1992 through July, 1993) indicate no significant sources or sinks of As between gauging station GS-1 on the Blackwater Branch and station ULD at the spillway of the Union Lake Dam (see Section 4.0). Figure 4-2 shows the variations in total As flux measured at GS-1, GS-2, GS-3 and ULD over this period. Although there is significant scatter, variations in the fluxes at the four measurement locations are correlated. Thus, these stretches of the stream system have generally acted as simple conduits for the transport of As derived from the Blackwater Branch upstream of GS-1.

For comparison, Figure 4-2 also shows the maximum total flux of As in the Maurice River upstream of its confluence with the Blackwater Branch at station MRU. This maximum flux, which represents one sample with a detectable As concentration among 14 samples that were analyzed, is more than an order of magnitude lower than the fluxes of As within contaminated portions of the stream. None of the samples collected from the Blackwater Branch upstream of the Vineland Chemical Company site had As concentrations above the analytical detection limit, so measurement location BBU is not represented on Figure 4-2. It is clear from these analyses that neither the Maurice River upstream of the Blackwater Branch, nor the Blackwater Branch upstream of the Vineland Chemical Company site constitute a significant source of As into downstream reaches of the stream system.

12.0 SOURCES AND FATES OF ARSENIC IN UNION LAKE

12.1 METHODS

See Sections 4.1.1 and 4.2.1.

12.2 DATA SET

See Sections 4.1.3 and 4.2.3.

12.3 RESULTS

Although measurements of the flux of As in the water overflowing the Union Lake Dam are limited, the existing data suggests that fluxes are similar to those measured at GS-1, GS-2 and GS-3 (Figure 4-2), thus Union Lake, Blackwater Branch and upper Maurice River appear to be acting primarily as simple conduits for the transport of As. For this to be the case, especially for Union Lake, the sediments must be in a state of dynamic equilibrium with the overlying water column. This may result partially from limited exchange between the lake water and the sediments, since the retention time of water is only 12 to 24 days (0.03 to 0.06 years; USEPA, 1976; Hughes et al., 1981) for Union Lake.

13.0 OVERALL ARSENIC MASS BALANCE FOR THE VINELAND CHEMICAL COMPANY SURFACE WATERS

13.1 METHODS

See previous methods sections.

13.2 SUMMARY

Periodic measurement of total As fluxes within the Blackwater Branch, Maurice River and Union Lake fluvial–lacustrine system over a one year period (July, 1992 through July, 1993) indicate no significant sources or sinks of As between gauging station GS-1 on the Blackwater Branch and station ULD at the spillway of the Union Lake Dam. Figure 4-2 shows the variations in total As flux measured at GS-1, GS-2, GS-3 and ULD over this period. Although there is significant scatter, variations in the fluxes at the four measurement locations are correlated. Thus, these stretches of the stream system have generally acted as simple conduits for the transport of As derived from the Blackwater Branch upstream of GS-1. Arsenic-contaminated groundwater migrating from the Vineland Chemical Company site is the primary source of As to the Blackwater Branch, providing an estimated flux of 3.3 metric tons of As per year. Fine-grained sediments in the floodplain adjacent to the Vineland Chemical Company site may act as a temporary storage reservoir for As transported from the plant site. Thus, their role in the overall As mass balance may alternate between source and sink on an episodic basis. The potential these sediments have to act as a residual source of As following remediation of the plant site soils, sediments and groundwater (Operable Units One and Two of the ROD) requires further evaluation by modeling of sediment transport properties.

Figure 4-2 also shows the maximum total flux of As in the Maurice River upstream of its confluence with the Blackwater Branch at station MRU. This maximum flux, which represents one sample with a detectable As concentration among 14 samples that were analyzed, is more than an order of magnitude lower than the fluxes of As within contaminated portions of the stream. None of the samples collected from the Blackwater Branch upstream of the Vineland Chemical Company site had As concentrations above the analytical detection limit, so measurement location BBU is not represented on Figure 4-2. It is clear from these analyses that neither the Maurice River upstream of the Blackwater Branch, nor the Blackwater Branch upstream of the Vineland Chemical Company site constitute a significant source of As into downstream reaches of the stream system.

Storm events can mobilize and transport a significant mass of As. The total flux of As generally reaches its maximum value early during a storm event, then drops rapidly, usually to values lower than the initial flux at the beginning of the storm. The maximum stream discharge may take longer to develop, especially during a very large storm event such as the winter storm (Section 5.1.3.2), and then generally decreases more slowly after reaching its maximum value. The initial rapid increase in the flux of As during storm runoff could result from (1) the increased rate of discharge of As-contaminated water already in the stream prior to the storm event and (2) re-suspension of fine sediments that may have collected on the stream bottom prior to the storm event by the initial "pulse" of faster flowing water. Once the As-contaminated water in the stream has been replaced by relatively clean storm runoff, and the fine sediments have been transported downstream, the flux of As would decrease, even though the stream discharge may remain elevated above normal values. This scenario may also explain the decrease in total As flux to values lower than the flux prior to the storm, since the stream system would be "cleansed" of both As-contaminated water and As-contaminated sediments by the initial large pulse of storm runoff.

Based on their high concentrations of As, Union Lake sediments have obviously acted as a sink for As during previous years when the total flux of As into Union Lake was larger. However, the limited data that are currently available suggest that the present flux of As into the lake is roughly balanced by the flux of As over the Union Lake Dam. This suggests that the concentrations of As in the sediments are close to equilibrium with the present concentrations in the overlying water. If the flux of As into Union Lake is further reduced, it is possible that the sediments will constitute a source of As into the water column. However, the extremely high partition coefficients for As between sediments and porewaters (Section 7.0) suggest that As would be released very slowly. Because of the low retention time of water within Union Lake (12 to 24 days; USEPA, 1976; Hughes et al., 1981) it is unlikely that internal loading from As desorbed from the sediments would result in significant increases in the average concentration of As in Union Lake. This thesis is supported by measurements of As concentrations at discrete depth intervals within Union Lake during a period of stratification (Section 8.0). Although As concentrations are significantly higher in the anoxic bottom waters, they represent a very small proportion of the total volume of Union Lake. Thus, the total mass of As contained in the bottom waters is insufficient to cause a significant increase in the average concentration of As in Union Lake upon mixing with the overlying water column.

Available data indicate that the Blackwater Branch, upper Maurice River and Union Lake presently function as conduits for the transport of approximately 3 metric tons of As per year, derived primarily from groundwater migrating from the Vineland Chemical Company site, into the Maurice River downstream of the Union Lake Dam. This result must, however, be regarded as preliminary since current mass balance calculations do not include the flux of As transported

as bedload. These fluxes will be estimated by the sediment transport modeling being conducted by Dr. Earl Hayter of Clemson University.

This study does not address the fate of As in the lower Maurice River.

14.0 RECOMMENDATIONS

The primary source of As into the Blackwater Branch, Maurice River and Union Lake fluvial–lacustrine system is the flow of contaminated groundwater from the Vineland Chemical Company site. Therefore, remediation of Operable Units One and Two (Plant Site Soils and Groundwater, respectively; Record of Decision, September, 1989) must occur before the flux of As through the fluvial–lacustrine system will be significantly reduced.

14.1 BLACKWATER BRANCH FLOODPLAIN SEDIMENTS

The fine-grained sediments within the Blackwater Branch floodplain adjacent to the Vineland Chemical Company site may presently act as a temporary storage reservoir for As transported from the plant site. Their role in the overall As mass balance may alternate between source and sink on an episodic basis. If the plant-site groundwater is eliminated as a source of As, these sediments will likely constitute a minor residual source of As into the Blackwater Branch.

Because of the extremely high distribution coefficients measured between As in fine-grained, organic-rich sediments and their coexisting porewaters (Section 7.0), desorption of As from the floodplain sediments is not likely to yield a large flux of As into the Blackwater Branch. Re-suspension during periods of high stream flow represents the most likely mode of As transport from the floodplain sediments. This transport mechanism will be evaluated further by the sediment transport modeling being performed by Dr. Earl Hayter of Clemson University.

Since these sediments will most likely represent only a minor residual source of As once the groundwater source is eliminated, both the environmental damage and the cost of their removal should also be considered. Monitoring of the flux of As past GS-1 once the groundwater source is eliminated may be warranted prior to initiation of any planned future excavation or dredging of the Blackwater Branch sediments.

14.2 MAURICE RIVER SEDIMENTS

Recommendations must await a three-year natural flushing period following the remediation of Operable Units One and Two (Record of Decision, September, 1989).

14.3 UNION LAKE SEDIMENTS

Recommendations must await a three-year natural flushing period following the remediation of Operable Units One and Two (Record of Decision, September, 1989).

14.4 LONG-TERM POST-REMEDIAL MONITORING

The present study has provided sufficient documentation that neither the Blackwater Branch upstream of the Vineland Chemical Company site or the Maurice River upstream of the Blackwater Branch constitute a significant source of As into the stream system. Thus, further monitoring or sampling may not be warranted at these locations.

14.5 LIMITATIONS OF THE PRESENT STUDY

All conclusions or recommendations based on the currently available data must be regarded as preliminary. Some portions of the mass balance investigation, e.g., the sediment transport modeling and years two and three of the As mass balance study, have not been completed. Furthermore, the results of additional field investigations by the remedial design contractor were not available for inclusion in this report. The following identifies key limitations of the present study:

1. The results of the sediment transport modeling to be performed by Clemson University are needed to assess the importance of bedload sediment transport to the total flux of As in the Blackwater Branch and Maurice River Basins and to further quantify the mobilization and transport of arsenic by resuspension of contaminated sediments. Also included within the scope of the sediment transport modeling was calculation of the inventory of sediment-bound arsenic within each segment of the Blackwater Branch and Maurice River Basin.

2. USGS gauging station #01411878 (ULD) was not operable until May of 1993, thus the current data include only three months of flux measurements at ULD. Additional As flux measurements for the Union Lake Dam are not available because years two and three of the As mass balance investigation have been suspended.

3. The results of further investigations by the remedial design contractor concerning the presence of groundwater contamination to the north of the Blackwater Branch in the vicinity of the Vineland Chemical Company Plant site were not available for inclusion in this report. Thus, it is possible that present calculations of the flux of As into the Blackwater Branch via contaminated groundwater do not represent all potential source components or that some contaminated groundwater flows beneath rather than into the Blackwater Branch in the vicinity of the plant site.

4. Although all available chemical and stratigraphic data indicate the presence of a contiguous clay layer acting as an aquitard separating the shallow and middle aquifers, it is possible that this aquitard is not contiguous to the west of the Vineland Chemical Company Plant site,

beyond the range of the investigation. If the aquitard is not contiguous, the assumption that all groundwater from the shallow aquifer flows into the Blackwater Branch upstream of gauging station GS-1 may not be completely accurate.

5. The lake stratification monitoring and sampling station was located in the deepest portion of the lake outside the spillway safety zone of the Union Lake Dam. The water depth at this location was 6.6m. To avoid collection of suspended sediment, water samples for chemical analysis were collected from a maximum depth of 6.5m. Since the maximum depth of Union Lake is approximately 7.7m, it is possible that during the period of stratification anoxic water at depths greater than 6.5m may have contained higher concentrations of arsenic than did the samples collected from a depth of 6.5m. This could potentially result in a slight underestimate of the total mass of As in the reduced waters of the hypolimnion. However, the small percentage of the lake volume (<1%) represented by depths greater than 6.5m limits the significance of this potential error.

6. There may a small error associated with the use of daily average stream discharge rates, which were collected as required by the FOP, along with "instantaneous" measurements of arsenic concentrations in samples to calculate arsenic fluxes.

7. Final decisions regarding the potential remediation of sediments within the Maurice River and Union Lake require evaluation of the results of a three-year natural flushing period following remediation of the Vineland Chemical Company Plant site soil, sediment and groundwater (Operable Units One and Two of the ROD). The remedial action has not yet been initiated.

8. This study does not address the fate of arsenic in the lower Maurice River, i.e., below the Union Lake Dam.

16.0 REFERENCES

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APPENDIX A

ANALYTICAL RESULTS

APPENDIX A
ANALYTICAL RESULTS FROM SURFACE WATER SAMPLING
Vineland Chemical Company Site

EPA Sample I.D.	Sampling Date	Sampling Time	Filtered/ Unfiltered	Storm/ Normal	Ebasco Sample I.D.	Location	Stream Discharge (cfs)	As Flux (g/s)
MBJT23	7/15/92	1540	U	N	VC-SW-CH-GS1-2001	Gauging Station 1		No Flow Data
7383B-01-005	7/15/92	1540	U	N	VC-SW-CH-GS1-2001	Gauging Station 1		No Flow Data
MBJT25	8/17/92	1345	U	N	VC-SW-CH-GS1-2002	Gauging Station 1	17	0.291
104751	8/17/92	1345	U	N	VC-SW-CH-GS1-2002	Gauging Station 1	17	0.433
104771	9/16/92	1530	U	N	VC-SW-CH-GS1-2003	Gauging Station 1	8.3	0.032
104759	9/16/92	1530	U	N	VC-SW-CH-GS1-2003	Gauging Station 1	8.3	0.035
MBJT80	10/22/92	1050	U	N	VC-SW-CH-GS1-2004	Gauging Station 1	8.6	0.031
7576B-01-002	10/22/92	1050	U	N	VC-SW-CH-GS1-2004	Gauging Station 1	8.6	0.029
103429	11/18/92	1145	U	N	VC-SW-CH-GS1-2005	Gauging Station 1	9.7	0.037
7576B-02-013	11/18/92	1145	U	N	VC-SW-CH-GS1-2005	Gauging Station 1	9.7	0.034
MBMK32	12/10/92	2300	U	S	VC-ST-SC-GS1-1002-01	Gauging Station 1	10	0.064
103959	1/19/93	1305	U	N	VC-SW-CH-GS1-2006	Gauging Station 1	14	0.053
MBMK63	3/1/93	1500	U	N	VC-SW-CH-GS1-2007	Gauging Station 1	12	0.038
MBML25	3/30/93	1600	U	N	VC-SW/CH-GS1-2008 (T)	Gauging Station 1	38	0.056
MBML27	3/30/93	1116	U	N	VC-SW/CH-GS1-2008 (T)	Gauging Station 1	38	0.063
101505	4/14/93	1335	U	N	VC-SW-CH-GS1-2009	Gauging Station 1	23	0.071
MBML89	5/20/93	0830	U	N	VC-SW-CH-GS1-2010 (T)	Gauging Station 1	32	0.154
101549	6/30/93	1320	U	N	VL-SW-CH-GS1-2011 (T)	Gauging Station 1	9.2	0.045
MBMF02	7/16/93	1715	U	S	VC-ST-CH-GS1-1003-06 (T)	Gauging Station 1	8.4	0.049
MBNB61	10/26/93	1930	U	N	VC-SW-CH-GS1-3002 (T)	Gauging Station 1	12	0.031
MBJT24	7/15/92	1515	U	N	VC-SW-CH-GS2-2001	Gauging Station 2	66	0.067
7383B-01-006	7/15/92	1515	U	N	VC-SW-CH-GS2-2001	Gauging Station 2	66	0.074
MBJT26	8/17/92	1500	U	N	VC-SW-CH-GS2-2002	Gauging Station 2	135	0.089
104752	8/17/92	1500	U	N	VC-SW-CH-GS2-2002	Gauging Station 2	135	0.125
104772	9/16/92	1430	U	N	VC-SW-CH-GS2-2003	Gauging Station 2	65	0.035
104773	9/16/92	1430	U	N	VC-SW-CH-GS2-2003D	Gauging Station 2	65	0.026
104761	9/16/92	1430	U	N	VC-SW-CH-GS2-2003	Gauging Station 2	65	0.039
104763	9/16/92	1430	U	N	VC-SW-CH-GS2-2003	Gauging Station 2	65	0.066
MBJT81	10/22/92	1115	U	N	VC-SW-CH-GS2-2004	Gauging Station 2	65	0.032
7576B-01-004	10/22/92	1115	U	N	VC-SW-CH-GS2-2004	Gauging Station 2	65	0.028
103428	11/18/92	1100	U	N	VC-SW-CH-GS2-2005	Gauging Station 2	98	0.035

Qualifiers: U - Not Detected at Contract Required Detection Limit (CRDL); J - Estimated Concentration;
R - Rejected; B - Detected between CRDL and Instrument Detection Limit (IDL).

APPENDIX A
ANALYTICAL RESULTS FROM SURFACE WATER SAMPLING
Vineland Chemical Company Site

EPA Sample I.D.	Sampling Date	Sampling Time	Filtered/ Unfiltered	Storm/ Normal	Ebasco Sample I.D.	Location	Stream Discharge (cfs)	As Flux (g/s)
7576B-02-011	11/18/92	1100	U	N	VC-SW-CH-GS2-2005	Gauging Station 2	98	0.033
MBMK33	12/10/92	2330	U	S	VC-ST-SC-GS2-1002-01	Gauging Station 2	97	0.076
103960	1/19/93	1245	U	N	VC-SW-CH-GS2-2006	Gauging Station 2	148	0.063
MBMK65	3/1/93	1600	U	N	VC-SW-CH-GS2-2007	Gauging Station 2	155	0.046
MBML21	3/30/93	1310	U	N	VC-SW/CH-GS2-2008 (T)	Gauging Station 2	325	0.083
101504	4/14/93	1250	U	N	VC-SW-CH-GS2-2009	Gauging Station 2	240	0.086
MBML91	5/20/93	0930	U	N	VC-SW-CH-GS2-2010 (T)	Gauging Station 2	193	0.169
MBML93	5/20/93	0930	U	N	VC-SW-CH-GS2-2010 (T)	Gauging Station 2	193	0.169
101547	6/30/93	1230	U	N	VL-SW-CH-GS2-2011 (T)	Gauging Station 2	95	0.057
MBMF04	7/16/93	1700	U	S	VC-ST-CH-GS2-1003-06 (T)	Gauging Station 2	74	0.044
MBNB63	10/26/93	1945	U	N	VC-SW-CH-GS2-3002 (T)	Gauging Station 2	83	0.025
7383B-01-007	7/15/92	1140	U	N	VC-SW-CH-GS3-2001	Gauging Station 3		No Flow Data
MBJT27	8/17/92	1600	U	N	VC-SW-CH-GS3-2002	Gauging Station 3		No Flow Data
104753	8/17/92	1600	U	N	VC-SW-CH-GS3-2002	Gauging Station 3		No Flow Data
104774	9/16/92	1100	U	N	VC-SW-CH-GS3-2003	Gauging Station 3	98	0.031
104765	9/16/92	1100	U	N	VC-SW-CH-GS3-2003	Gauging Station 3	98	0.024
MBJT82	10/22/92	0815	U	N	VC-SW-CH-GS3-2004	Gauging Station 3	110	0.029
7576B-01-001	10/22/92	0815	U	N	VC-SW-CH-GS3-2004	Gauging Station 3	110	0.026
103427	11/18/92	0900	U	N	VC-SW-CH-GS3-2005	Gauging Station 3	164	ND
7576B-02-009	11/18/92	0900	U	N	VC-SW-CH-GS3-2005	Gauging Station 3	164	0.033
MBMK34	12/10/92	24:00	U	S	VC-ST-SC-GS3-1002-01	Gauging Station 3	157	0.132
103961	1/19/93	1220	U	N	VC-SW-CH-GS3-2006	Gauging Station 3	230	ND
MBMK67	3/1/93	1630	U	N	VC-SW-CH-GS3-2007	Gauging Station 3	233	0.044
MBML31	3/30/93	1347	U	N	VC-SW/CH-GS3-2008 (T)	Gauging Station 3	501	0.065
101502	4/14/93	1110	U	N	VC-SW-CH-GS3-2009	Gauging Station 3	448	ND
MBML95	5/20/93	1000	U	N	VC-SW-CH-GS3-2010 (T)	Gauging Station 3	393	0.283
101545	6/30/93	1110	U	N	VL-SW-CH-GS3-2011 (T)	Gauging Station 3	145	0.058
MBMF06	7/16/93	1645	U	S	VC-ST-CH-GS3-1003-06 (T)	Gauging Station 3	122	0.068
MBML35	10/26/93	1800	U	N	VC-SW-CH-GS3-3002 (T)	Gauging Station 3	130	0.032
MBJT20	7/14/92	0930	U	N	VC-SW-CH-MRU-2001	Maurice River - Garden Rd.	43	ND

Qualifiers: U - Not Detected at Contract Required Detection Limit (CRDL); J - Estimated Concentration;
R - Rejected; B - Detected between CRDL and Instrument Detection Limit (IDL).

APPENDIX A
ANALYTICAL RESULTS FROM SURFACE WATER SAMPLING
Vineland Chemical Company Site

EPA Sample I.D.	Sampling Date	Sampling Time	Filtered/ Unfiltered	Storm/ Normal	Ebasco Sample I.D.	Location	Stream Discharge (cfs)	As Flux (g/s)
7383B-01-001	7/14/92	0930	U	N	VC-SW-CH-MRU-2001	Maurice River - Garden Rd.	43	ND
MBJT85	10/22/92	1025	U	N	VC-SW-CH-MRU-2004	Maurice River - Garden Rd.	46	ND
7576B-01-006	10/22/92	1025	U	N	VC-SW-CH-MRU-2004	Maurice River - Garden Rd.	46	0.002
103424	11/18/92	1500	U	N	VC-SW-CH-MRU-2003	Maurice River - Garden Rd.	75	ND
103425	11/18/92	1500	U	N	VC-SW-CH-MRU-2003D	Maurice River - Garden Rd.	75	ND
7576B-02-003	11/18/92	1500	U	N	VC-SW-CH-MRU-2003	Maurice River - Garden Rd.	75	ND
7576B-02-005	11/18/92	1500	U	N	VC-SW-CH-MRU-2003D	Maurice River - Garden Rd.	75	ND
MBMK31	12/10/92	0100	U	S	VC-ST-SC-MRU-1002-01	Maurice River - Garden Rd.	74	ND
103957	1/19/93	1320	U	N	VC-SW-CH-MRU-2004	Maurice River - Garden Rd.	120	ND
MBMK61	3/1/93	1400	U	N	VC-SW-CH-MRU-2007	Maurice River - Garden Rd.	124	ND
MBML29	3/30/93	1035	U	N	VC-SW/CH-MRU-2008 (T)	Maurice River - Garden Rd.	328	ND
MBMF10	7/16/93	1745	U	S	VC-ST-CH-MRU-1003-06 (T)	Maurice River - Garden Rd.	51	0.003
101508	4/14/93	1455	U	N	VC-SW-CH-MRU-2009	Maurice River - Garden Rd.	230	ND
MBNB65	10/26/93	1900	U	N	VC-SW-CH-MRU-3002 (T)	Maurice River - Garden Rd.	70	0.002
7383B-01-004	7/15/92	1030	U	N	VC-SW-CH-ULD-2001	Union Lake Dam		No Flow Data
104754	8/19/92	1430	U	N	VC-SW-CH-ULD-2002	Union Lake Dam		No Flow Data
MBJT55	8/20/92	1545	U	N	VC-SW-CH-ULD-2002	Union Lake Dam		No Flow Data
104775	9/16/92	1000	U	N	VC-SW-CH-ULD-2003	Union Lake Dam		No Flow Data
104767	9/16/92	1100	U	N	VC-SW-CH-ULD-2003	Union Lake Dam		No Flow Data
MBJT83	10/22/92	0900	U	N	VC-SW-CH-ULD-2004	Union Lake Dam		No Flow Data
7576B-01-005	10/22/92	0900	U	N	VC-SW-CH-ULD-2004	Union Lake Dam		No Flow Data
103426	11/18/92	0950	U	N	VC-SW-CH-ULD-2005	Union Lake Dam		No Flow Data
7576B-02-007	11/18/92	0950	U	N	VC-SW-CH-ULD-2005	Union Lake Dam		No Flow Data
MBMK30	12/10/92	2230	U	S	VC-ST-SC-ULD-1002-01	Union Lake Dam		No Flow Data
103962	1/19/93	1120	U	N	VC-SW-CH-ULD-2006	Union Lake Dam		No Flow Data
MBMK69	3/1/93	1800	U	N	VC-SW-CH-ULD-2007	Union Lake Dam		No Flow Data
MBML17	3/30/93	1420	U	N	VC-SW/CH-ULD-2008 (T)	Union Lake Dam		No Flow Data
101511	4/15/93	1000	U	N	VC-SW-CH-ULD-2009	Union Lake Dam		No Flow Data
MBML97	5/20/93	1030	U	N	VC-SW-CH-ULD-2010 (T)	Union Lake Dam	372	0.260
101543	6/30/93	1000	U	N	VL-SW-CH-ULD-2011 (T)	Union Lake Dam	170	0.091
MBMF08	7/16/93	1620	U	S	VC-ST-CH-ULD-1003-06 (T)	Union Lake Dam	141	0.087

Qualifiers: U - Not Detected at Contract Required Detection Limit (CRDL); J - Estimated Concentration;
R - Rejected; B - Detected between CRDL and Instrument Detection Limit (IDL).

APPENDIX A
ANALYTICAL RESULTS FROM SURFACE WATER SAMPLING
Vineland Chemical Company Site

EPA Sample I.D.	Sampling Date	Sampling Time	Filtered/ Unfiltered	Storm/ Normal	Ebasco Sample I.D.	Location	Stream Discharge (cfs)	As Flux (g/s)
MBML36	10/26/93	1600	U	N	VC-SW-CH-ULD-3002 (T)	Union Lake Dam	141	0.079
MBML38	10/26/93	1600	U	N	VC-SW-CH-ULD-3002D (T)	Union Lake Dam	141	0.080
7384B-01-005	7/15/92	1540	F	N	VC-SW-CH-GS1-2001	Gauging Station 1		No Flow Data
104755	8/17/92	1345	F	N	VC-SW-CH-GS1-2002	Gauging Station 1	17	0.088
104760	9/16/92	1530	F	N	VC-SW-CH-GS1-2003	Gauging Station 1	8.3	0.028
7576B-01-009	10/22/92	1050	F	N	VC-SW-CH-GS1-2004	Gauging Station 1	8.6	0.026
7576B-02-014	11/18/92	1145	F	N	VC-SW-CH-GS1-2005	Gauging Station 1	9.7	0.031
103966	1/19/93	1305	F	N	VC-SW-CH-GS1-2006	Gauging Station 1	14	0.048
MBMK64	3/1/93	1500	F	N	VC-SW-CH-GS1-2007	Gauging Station 1	12	0.038
MBML26	3/30/93	1600	F	N	VC-SW/CH-GS1-2008 (D)	Gauging Station 1	38	0.066
MBML28	3/30/93	1116	F	N	VC-SW/CH-GS1-2008 (D)	Gauging Station 1	38	0.040
101506	4/14/93	1335	F	N	VC-SW-CH-GS1-2009	Gauging Station 1	23	No As Data
MBML90	5/20/93	0830	F	N	VC-SW-CH-GS1-2010 (D)	Gauging Station 1	32	0.118
101550	6/30/93	1320	F	N	VL-SW-CH-GS1-2011 (D)	Gauging Station 1	9.2	0.027
MBMF01	7/16/93	1715	F	S	VC-ST-CH-GS1-1003-06 (D)	Gauging Station 1	8.4	0.022
MBNB60	10/26/93	1930	F	N	VC-SW-CH-GS1-3002 (D)	Gauging Station 1	12	0.025
7384B-01-006	7/15/92	1515	F	N	VC-SW-CH-GS2-2001	Gauging Station 2	66	0.038
104756	8/17/92	1500	F	N	VC-SW-CH-GS2-2002	Gauging Station 2	135	0.079
104762	9/16/92	1430	F	N	VC-SW-CH-GS2-2003	Gauging Station 2	65	0.028
104764	9/16/92	1430	F	N	VC-SW-CH-GS2-2003	Gauging Station 2	65	0.038
7576B-01-011	10/22/92	1115	F	N	VC-SW-CH-GS2-2004	Gauging Station 2	65	0.024
7576B-02-012	11/18/92	1100	F	N	VC-SW-CH-GS2-2005	Gauging Station 2	98	0.029
103491	12/10/92	2330	F	S	VC-ST-SC-GS2-1002-01	Gauging Station 2	97	0.032
103967	1/19/93	1245	F	N	VC-SW-CH-GS2-2006	Gauging Station 2	148	0.047
MBMK66	3/1/93	1600	F	N	VC-SW-CH-GS2-2007	Gauging Station 2	155	0.046
MBML22	3/30/93	1310	F	N	VC-SW/CH-GS2-2008 (D)	Gauging Station 2	325	0.073
101503	4/14/93	1250	F	N	VC-SW-CH-GS2-2009	Gauging Station 2	240	0.100
MBML92	5/20/93	0930	F	N	VC-SW-CH-GS2-2010 (D)	Gauging Station 2	193	0.131
MBML94	5/20/93	0930	F	N	VC-SW-CH-GS2-2010 (D)	Gauging Station 2	193	0.061
101548	6/30/93	1230	F	N	VL-SW-CH-GS2-2011 (D)	Gauging Station 2	95	0.039

Qualifiers: U - Not Detected at Contract Required Detection Limit (CRDL); J - Estimated Concentration;
R - Rejected; B - Detected between CRDL and Instrument Detection Limit (IDL).

APPENDIX A
ANALYTICAL RESULTS FROM SURFACE WATER SAMPLING
Vineland Chemical Company Site

EPA Sample I.D.	Sampling Date	Sampling Time	Filtered/ Unfiltered	Storm/ Normal	Ebasco Sample I.D.	Location	Stream Discharge (cfs)	As Flux (g/s)
MBMF03	7/16/93	1700	F	S	VC-ST-CH-GS2-1003-06 (D)	Gauging Station 2	74	0.045
MBNB62	10/26/93	1945	F	N	VC-SW-CH-GS2-3002 (D)	Gauging Station 2	83	0.018
7384B-01-007	7/15/92	1140	F	N	VC-SW-CH-GS3-2001	Gauging Station 3		No Flow Data
104757	8/17/92	1600	F	N	VC-SW-CH-GS3-2002	Gauging Station 3		No Flow Data
104766	9/16/92	1100	F	N	VC-SW-CH-GS3-2003	Gauging Station 3	98	ND
7576B-01-008	10/22/92	0815	F	N	VC-SW-CH-GS3-2004	Gauging Station 3	110	0.020
7576B-02-010	11/18/92	0900	F	N	VC-SW-CH-GS3-2005	Gauging Station 3	164	0.019
103492	12/10/92	2300	F	S	VC-ST-SC-GS3-1002-01	Gauging Station 3	157	ND
103968	1/19/93	1220	F	N	VC-SW-CH-GS3-2006	Gauging Station 3	230	ND
MBMK68	3/1/93	1630	F	N	VC-SW-CH-GS3-2007	Gauging Station 3	233	0.044
MBML32	3/30/93	1347	F	N	VC-SW/CH-GS3-2008 (D)	Gauging Station 3	501	0.060
101501	4/14/93	1110	F	N	VC-SW-CH-GS3-2009	Gauging Station 3	448	ND
MBML96	5/20/93	1000	F	N	VC-SW-CH-GS3-2010 (D)	Gauging Station 3	393	0.169
101546	6/30/93	1110	F	N	VL-SW-CH-GS3-2011 (D)	Gauging Station 3	145	0.038
MBMF17	7/16/93	1345	F	S	VC-ST-CH-GS3-1003-05 (D)	Gauging Station 3	122	0.018
MBNB66	10/26/93	1800	F	N	VC-SW-CH-GS3-3002 (D)	Gauging Station 3	130	0.012
7384B-01-001	7/14/92	0930	F	N	VC-SW-CH-MRU-2001	Maurice River - Garden Rd.	43	0.005
7576B-01-013	10/22/92	1025	F	N	VC-SW-CH-MRU-2004	Maurice River - Garden Rd.	46	0.002
7576B-02-004	11/18/92	1500	F	N	VC-SW-CH-MRU-2003	Maurice River - Garden Rd.	75	ND
7576B-02-006	11/18/92	1500	F	N	VC-SW-CH-MRU-2003D	Maurice River - Garden Rd.	75	ND
103489	12/10/92	0100	F	S	VC-ST-SC-MRU-1002-01	Maurice River - Garden Rd.	74	ND
103964	1/19/93	1320	F	N	VC-SW-CH-MRU-2004	Maurice River - Garden Rd.	120	ND
MBMK62	3/1/93	1400	F	N	VC-SW-CH-MRU-2007	Maurice River - Garden Rd.	124	ND
MBML30	3/30/93	1035	F	N	VC-SW/CH-MRU-2008 (D)	Maurice River - Garden Rd.	328	0.015
101507	4/14/93	1445	F	N	VC-SW-CH-MRU-2009	Maurice River - Garden Rd.	230	ND
MBMF09	7/16/93	1745	F	S	VC-ST-CH-MRU-1003-06 (D)	Maurice River - Garden Rd.	51	0.003
MBNB64	10/26/93	1900	F	N	VC-SW-CH-MRU-3002 (D)	Maurice River - Garden Rd.	70	0.002
7384B-01-004	7/15/92	1030	F	N	VC-SW-CH-ULD-2001	Union Lake Dam		No Flow Data
104758	8/19/92	1430	F	N	VC-SW-CH-ULD-2002	Union Lake Dam		No Flow Data

Qualifiers: U - Not Detected at Contract Required Detection Limit (CRDL); J - Estimated Concentration;
R - Rejected; B - Detected between CRDL and Instrument Detection Limit (IDL).

APPENDIX A
ANALYTICAL RESULTS FROM SURFACE WATER SAMPLING
Vineland Chemical Company Site

EPA Sample I.D.	Sampling Date	Sampling Time	Filtered/ Unfiltered	Storm/ Normal	Ebasco Sample I.D.	Location	Stream Discharge (cfs)	As Flux (g/s)
104768	9/16/92	1100	F	N	VC-SW-CH-ULD-2003	Union Lake Dam		No Flow Data
7576B-01-012	10/22/92	0900	F	N	VC-SW-CH-ULD-2004	Union Lake Dam		No Flow Data
7576B-02-008	11/18/92	0950	F	N	VC-SW-CH-ULD-2005	Union Lake Dam		No Flow Data
103493	12/10/92	2230	F	S	VC-ST-SC-ULD-1002-01	Union Lake Dam		No Flow Data
103969	1/19/93	1120	F	N	VC-SW-CH-ULD-2006	Union Lake Dam		No Flow Data
MBMK70	3/1/93	1800	F	N	VC-SW-CH-ULD-2007	Union Lake Dam		No Flow Data
MBML18	3/30/93	1420	F	N	VC-SW/CH-ULD-2008 (D)	Union Lake Dam		No Flow Data
101512	4/15/93	1000	F	N	VC-SW-CH-ULD-2009	Union Lake Dam		No Flow Data
MBML98	5/20/93	1030	F	N	VC-SW-CH-ULD-2010 (D)	Union Lake Dam	372	0.112
101544	6/30/93	1000	F	N	VL-SW-CH-ULD-2011 (D)	Union Lake Dam	170	0.072
MBMF07	7/16/93	1620	F	S	VC-ST-CH-ULD-1003-06 (D)	Union Lake Dam	141	0.092
MBML37	10/26/93	1600	F	N	VC-SW-CH-ULD-3002 (D)	Union Lake Dam	141	0.028
MBML39	10/26/93	1600	F	N	VC-SW-CH-ULD-3002D (D)	Union Lake Dam	141	0.034
104844	9/25/92	1950	U	S	VC-ST-SC-GS1-1001	Gauging Station 1	8.7	0.080
104840	9/26/92	1720	U	S	VC-ST-SC-GS1-1003	Gauging Station 1	23	0.158
104843	9/26/92	1230	U	S	VC-ST-SC-GS1-1002	Gauging Station 1	23	0.126
104838	9/27/92	0700	U	S	VC-ST-SC-GS1-1004	Gauging Station 1	12	0.060
104815	9/28/92	1430	U	S	VC-ST-SC-GS1-1005	Gauging Station 1	10	0.048
104825	9/29/92	1125	U	S	VC-ST-SC-GS1-1006	Gauging Station 1	9.8	0.044
MBMK32	12/10/92	2300	U	S	VC-ST-SC-GS1-1002-01	Gauging Station 1	10	0.064
MBMK37	12/11/92	1345	U	S	VC-ST-SC-GS1-1002-02	Gauging Station 1	34	0.282
MBMK42	12/11/92	2030	U	S	VC-ST-SC-GS1-1002-03	Gauging Station 1	34	0.163
MBMK47	12/12/92	1030	U	S	VC-ST-SC-GS1-1002-04	Gauging Station 1	35	0.109
MBMK51	12/14/92	1630	U	S	VC-ST-SC-GS1-1002-05	Gauging Station 1	19	No As Data
MBMK60	12/23/92	1100	U	S	VC-ST-SC-GS1-1002-06	Gauging Station 1	15	No As Data
103515	12/23/92	1100	U	S	VC-ST-SC-GS1-1002-06	Gauging Station 1	15	0.045
MBMF61	7/15/93	0040	U	S	VC-ST-GS1-1003-01 (T)	Gauging Station 1	10	0.096
MBMF67	7/15/93	1020	U	S	VC-ST-GS1-1003-02 (T)	Gauging Station 1	10	0.077
MBMF63	7/15/93	1925	U	S	VC-ST-GS1-1003-03 (T)	Gauging Station 1	10	0.077
MBMF26	7/16/93	2250	U	S	VC-ST-CH-GS1-1003-04 (T)	Gauging Station 1	8.4	0.045
MBMF14	7/16/93	1420	U	S	VC-ST-CH-GS1-1003-05 (T)	Gauging Station 1	8.4	0.043

Qualifiers: U - Not Detected at Contract Required Detection Limit (CRDL); J - Estimated Concentration;
R - Rejected; B - Detected between CRDL and Instrument Detection Limit (IDL).

APPENDIX A
ANALYTICAL RESULTS FROM SURFACE WATER SAMPLING
Vineland Chemical Company Site

EPA Sample I.D.	Sampling Date	Sampling Time	Filtered/ Unfiltered	Storm/ Normal	Ebasco Sample I.D.	Location	Stream Discharge (cfs)	As Flux (g/s)
MBMF02	7/16/93	1715	U	S	VC-ST-CH-GS1-1003-06 (T)	Gauging Station 1	8.4	0.049
104839	9/25/92	1915	U	S	VC-ST-SC-GS2-1001	Gauging Station 2	64	0.045
104828	9/26/92	1200	U	S	VC-ST-SC-GS2-1002	Gauging Station 2	143	0.174
104841	9/26/92	1710	U	S	VC-ST-SC-GS2-1003	Gauging Station 2	143	0.155
104817	9/27/92	0730	U	S	VC-ST-SC-GS2-1004	Gauging Station 2	145	0.077
104820	9/28/92	1400	U	S	VC-ST-SC-GS2-1005	Gauging Station 2	143	0.049
104826	9/29/92	1115	U	S	VC-ST-SC-GS2-1006	Gauging Station 2	136	0.050
MBMK33	12/10/92	2330	U	S	VC-ST-SC-GS2-1002-01	Gauging Station 2	97	0.076
MBMK38	12/11/92	1315	U	S	VC-ST-SC-GS2-1002-02	Gauging Station 2	179	0.219
MBMK43	12/11/92	1930	U	S	VC-ST-SC-GS2-1002-03	Gauging Station 2	179	0.184
MBMK48	12/12/92	0900	U	S	VC-ST-SC-GS2-1002-04	Gauging Station 2	238	0.151
MBMK52	12/14/92	1830	U	S	VC-ST-SC-GS3-1002-05	Gauging Station 2	290	No As Data
MBMK58	12/23/92	1030	U	S	VC-ST-SC-GS2-1002-06	Gauging Station 2	176	No As Data
MBMF72	7/15/93	0015	U	S	VC-ST-GS2-1003-01 (T)	Gauging Station 2	74	0.043
MBMF75	7/15/93	0945	U	S	VC-ST-GS2-1003-02 (T)	Gauging Station 2	74	0.043
MBMF74	7/15/93	1910	U	S	VC-ST-GS2-1003-03 (T)	Gauging Station 2	74	0.066
MBMF30	7/15/93	2225	U	S	VC-ST-CH-GS2-1003-04 (T)	Gauging Station 2	74	0.065
MBMF16	7/16/93	1405	U	S	VC-ST-CH-GS2-1003-05 (T)	Gauging Station 2	74	0.049
MBMF04	7/16/93	1700	U	S	VC-ST-CH-GS2-1003-06 (T)	Gauging Station 2	74	0.044
104833	9/25/92	1830	U	S	VC-ST-SC-GS3-1001	Gauging Station 3	98	ND
104831	9/26/92	1630	U	S	VC-ST-SC-GS3-1003	Gauging Station 3	299	0.091
104846	9/26/92	1030	U	S	VC-ST-SC-GS3-1002	Gauging Station 3	299	0.100
104827	9/27/92	0815	U	S	VC-ST-SC-GS3-1004	Gauging Station 3	271	0.103
104824	9/28/92	1250	U	S	VC-ST-SC-GS3-1005	Gauging Station 3	249	ND
104819	9/29/92	1000	U	S	VC-ST-SC-GS3-1006	Gauging Station 3	204	0.064
MBMK34	12/10/92	24:00	U	S	VC-ST-SC-GS3-1002-01	Gauging Station 3	157	0.132
MBMK39	12/11/92	1300	U	S	VC-ST-SC-GS3-1002-02	Gauging Station 3	414	0.116
MBMK44	12/11/92	2000	U	S	VC-ST-SC-GS3-1002-03	Gauging Station 3	414	0.260
MBMK49	12/12/92	0800	U	S	VC-ST-SC-GS3-1002-04	Gauging Station 3	602	0.206
MBMK53	12/14/92	1930	U	S	VC-ST-SC-GS3-1002-05	Gauging Station 3	513	No As Data

Qualifiers: U - Not Detected at Contract Required Detection Limit (CRDL); J - Estimated Concentration;
R - Rejected; B - Detected between CRDL and Instrument Detection Limit (IDL).

APPENDIX A
ANALYTICAL RESULTS FROM SURFACE WATER SAMPLING
Vineland Chemical Company Site

EPA Sample I.D.	Sampling Date	Sampling Time	Filtered/ Unfiltered	Storm/ Normal	Ebasco Sample I.D.	Location	Stream Discharge (cfs)	As Flux (g/s)
MBMK57	12/23/92	1000	U	S	VC-ST-SC-GS3-1002-06	Gauging Station 3	280	No As Data
MBMF56	7/14/93	2330	U	S	VC-ST-GS3-1003-01 (T)	Gauging Station 3	117	0.035
MBMF46	7/15/93	0915	U	S	VC-ST-GS3-1003-02 (T)	Gauging Station 3	121	No As Data
MBMF40	7/15/93	1840	U	S	VC-ST-GS3-1003-03 (T)	Gauging Station 3	121	0.048
MBMF32	7/15/93	2145	U	S	VC-ST-CH-GS3-1003-04 (T)	Gauging Station 3	121	0.044
MBMF18	7/16/93	1345	U	S	VC-ST-CH-GS3-1003-05 (T)	Gauging Station 3	122	0.039
MBMF06	7/16/93	1645	U	S	VC-ST-CH-GS3-1003-06 (T)	Gauging Station 3	122	0.068
104836	9/25/92	2030	U	S	VC-ST-SC-MRU-1001	Maurice River - Garden Rd.	48	ND
104818	9/26/92	0750	U	S	VC-ST-SC-MRU-1003	Maurice River - Garden Rd.	105	ND
104829	9/26/92	1300	U	S	VC-ST-SC-MRU-1002	Maurice River - Garden Rd.	105	ND
104835	9/27/92	0640	U	S	VC-ST-SC-MRU-1004	Maurice River - Garden Rd.	111	ND
104842	9/28/92	1455	U	S	VC-ST-SC-MRU-1005	Maurice River - Garden Rd.	113	ND
104814	9/29/92	1145	U	S	VC-ST-SC-MRU-1006	Maurice River - Garden Rd.	105	ND
104822	9/29/92	1145	U	S	VC-ST-SC-MRU-1006D	Maurice River - Garden Rd.	105	ND
MBMK31	12/10/92	0100	U	S	VC-ST-SC-MRU-1002-01	Maurice River - Garden Rd.	74	ND
MBMK36	12/11/92	1445	U	S	VC-ST-SC-MRU-1002-02	Maurice River - Garden Rd.	141	ND
MBMK40	12/11/92	2200	U	S	VC-ST-SC-MRU-1002-03	Maurice River - Garden Rd.	141	ND
MBMK45	12/12/92	0830	U	S	VC-ST-SC-MRU-1002-04	Maurice River - Garden Rd.	263	ND
MBMK54	12/14/92	2000	U	S	VC-ST-SC-MRU-1002-05	Maurice River - Garden Rd.	348	No As Data
MBMK59	12/23/92	1150	U	S	VC-ST-SC-MRU-1002-06	Maurice River - Garden Rd.	145	No As Data
MBMF52	7/14/93	0115	U	S	VC-ST-MRU-1003-01 (T)	Maurice River - Garden Rd.	45	ND
MBMF50	7/15/93	1100	U	S	VC-ST-MRU-1003-02 (T)	Maurice River - Garden Rd.	49	ND
MBMF44	7/15/93	1950	U	S	VC-ST-MRU-1003-03 (T)	Maurice River - Garden Rd.	49	0.008
MBMF36	7/15/93	2330	U	S	VC-ST-CH-MRU-1003-04 (T)	Maurice River - Garden Rd.	49	ND
MBMF22	7/16/93	1530	U	S	VC-ST-CH-MRU-1003-05 (T)	Maurice River - Garden Rd.	51	0.005
MBMF10	7/16/93	1745	U	S	VC-ST-CH-MRU-1003-06 (T)	Maurice River - Garden Rd.	51	0.003
104834	9/26/92	1515	U	S	VC-ST-SC-ULD-1002	Union Lake Dam		No Flow Data
104845	9/26/92	0930	U	S	VC-ST-SC-ULD-1001	Union Lake Dam		No Flow Data
104830	9/27/92	0915	U	S	VC-ST-SC-ULD-1003	Union Lake Dam		No Flow Data
104837	9/27/92	0930	U	S	VC-ST-SC-ULD-1003D	Union Lake Dam		No Flow Data

Qualifiers: U - Not Detected at Contract Required Detection Limit (CRDL); J - Estimated Concentration;
R - Rejected; B - Detected between CRDL and Instrument Detection Limit (IDL).

APPENDIX A
ANALYTICAL RESULTS FROM SURFACE WATER SAMPLING
Vineland Chemical Company Site

EPA Sample I.D.	Sampling Date	Sampling Time	Filtered/ Unfiltered	Storm/ Normal	Ebasco Sample I.D.	Location	Stream Discharge (cfs)	As Flux (g/s)
104816	9/28/92	1200	U	S	VC-ST-SC-ULD-1004	Union Lake Dam		No Flow Data
104823	9/29/92	0900	U	S	VC-ST-SC-ULD-1005	Union Lake Dam		No Flow Data
MBMK30	12/10/92	2230	U	S	VC-ST-SC-ULD-1002-01	Union Lake Dam		No Flow Data
MBMK35	12/11/92	1230	U	S	VC-ST-SC-ULD-1002-02	Union Lake Dam		No Flow Data
MBMK41	12/11/92	1900	U	S	VC-ST-SC-ULD-1002-03	Union Lake Dam		No Flow Data
MBMK46	12/12/92	1100	U	S	VC-ST-SC-ULD-1002-04	Union Lake Dam		No Flow Data
MBMK50	12/14/92	1700	U	S	VC-ST-SC-ULD-1002-05	Union Lake Dam		No As Data
MBMK56	12/23/92	0930	U	S	VC-ST-SC-ULD-1002-06	Union Lake Dam		No As Data
MBMF54	7/14/93	2045	U	S	VC-ST-ULD-1003-01 (T)	Union Lake Dam	136	0.057
MBMF48	7/15/93	0845	U	S	VC-ST-ULD-1003-02 (T)	Union Lake Dam	173	0.081
MBMF42	7/15/93	1800	U	S	VC-ST-ULD-1003-03 (T)	Union Lake Dam	173	0.101
MBMF34	7/15/93	2045	U	S	VC-ST-CH-ULD-1003-04 (T)	Union Lake Dam	173	0.077
MBMF20	7/16/93	1315	U	S	VC-ST-CH-ULD-1003-05 (T)	Union Lake Dam	141	0.079
MBMF08	7/16/93	1620	U	S	VC-ST-CH-ULD-1003-06 (T)	Union Lake Dam	141	0.087
104778	9/25/92	1950	F	S	VC-ST-SC-GS1-1001	Gauging Station 1	8.7	0.030
104783	9/26/92	1230	F	S	VC-ST-SC-GS1-1002	Gauging Station 1	23	0.079
104788	9/26/92	1700	F	S	VC-ST-SC-GS1-1003	Gauging Station 1	23	0.076
104794	9/27/92	0700	F	S	VC-ST-SC-GS1-1004	Gauging Station 1	12	0.040
104801	9/28/92	1430	F	S	VC-ST-SC-GS1-1005	Gauging Station 1	10	0.033
104804	9/29/92	1125	F	S	VC-ST-SC-GS1-1006	Gauging Station 1	9.8	0.032
103490	12/10/92	1500	F	S	VC-ST-SC-GS1-1002-01	Gauging Station 1	10	0.024
	12/11/92				VC-ST-SC-GS1-1002-02		34	
	12/11/92				VC-ST-SC-GS1-1002-03		34	
	12/12/92				VC-ST-SC-GS1-1002-04		35	
103507	12/14/92	1630	F	S	VC-ST-SC-GS1-1002-05	Gauging Station 1	19	0.046
103512	12/23/92	1100	F	S	VC-ST-SC-GS1-1002-06	Gauging Station 1	15	0.050
MBMF62	7/15/93	0040	F	S	VC-ST-GS1-1003-01 (D)	Gauging Station 1	10	0.033
MBMF68	7/15/93	1020	F	S	VC-ST-GS1-1003-02 (D)	Gauging Station 1	10	0.029
MBMF64	7/15/93	1925	F	S	VC-ST-GS1-1003-03 (D)	Gauging Station 1	10	No As Data
MBMF25	7/16/93	2250	F	S	VC-ST-CH-GS1-1003-04 (D)	Gauging Station 1	8.4	0.028
MBMF23	7/16/93	1420	F	S	VC-ST-CH-GS1-1003-05 (D)	Gauging Station 1	8.4	0.020

Qualifiers: U - Not Detected at Contract Required Detection Limit (CRDL); J - Estimated Concentration;
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APPENDIX A
ANALYTICAL RESULTS FROM SURFACE WATER SAMPLING
Vineland Chemical Company Site

EPA Sample I.D.	Sampling Date	Sampling Time	Filtered/ Unfiltered	Storm/ Normal	Ebasco Sample I.D.	Location	Stream Discharge (cfs)	As Flux (g/s)
MBMF01	7/16/93	1715	F	S	VC-ST-CH-GS1-1003-06 (D)	Gauging Station 1	8.4	0.022
104779	9/25/92	1900	F	S	VC-ST-SC-GS2-1001	Gauging Station 2	64	0.035
104784	9/26/92	1200	F	S	VC-ST-SC-GS2-1002	Gauging Station 2	143	ND
104789	9/26/92	1710	F	S	VC-ST-SC-GS2-1003	Gauging Station 2	143	0.098
104795	9/27/92	0730	F	S	VC-ST-SC-GS2-1004	Gauging Station 2	145	0.058
104802	9/28/92	1400	F	S	VC-ST-SC-GS2-1005	Gauging Station 2	143	0.038
104805	9/29/92	1115	F	S	VC-ST-SC-GS2-1006	Gauging Station 2	136	0.039
103491	12/10/92	2330	F	S	VC-ST-SC-GS2-1002-01	Gauging Station 2	97	0.032
103495	12/11/92	1315	F	S	VC-ST-SC-GS2-1002-02	Gauging Station 2	179	0.076
103499	12/11/92	1930	F	S	VC-ST-SC-GS2-1002-03	Gauging Station 2	179	0.075
	12/12/92				VC-ST-SC-GS2-1002-04	Gauging Station 2	238	
103506	12/14/92	1930	F	S	VC-ST-SC-GS2-1002-05	Gauging Station 2	290	ND
103511	12/23/92	1030	F	S	VC-ST-SC-GS2-1002-06	Gauging Station 2	176	ND
MBMF71	7/15/93	0015	F	S	VC-ST-GS2-1003-01 (D)	Gauging Station 2	74	0.041
MBMF76	7/15/93	0945	F	S	VC-ST-GS2-1003-02 (D)	Gauging Station 2	74	0.031
MBMF73	7/15/93	1910	F	S	VC-ST-GS2-1003-03 (D)	Gauging Station 2	74	0.034
MBMF29	7/15/93	2225	F	S	VC-ST-CH-GS2-1003-04 (D)	Gauging Station 2	74	0.068
MBMF15	7/16/93	1405	F	S	VC-ST-CH-GS2-1003-05 (D)	Gauging Station 2	74	0.037
MBMF03	7/16/93	1700	F	S	VC-ST-CH-GS2-1003-06 (D)	Gauging Station 2	74	0.045
104780	9/25/92	1830	F	S	VC-ST-SC-GS3-1001	Gauging Station 3	98	ND
104785	9/26/92	1030	F	S	VC-ST-SC-GS3-1002	Gauging Station 3	299	0.175
104790	9/26/92	1630	F	S	VC-ST-SC-GS3-1003	Gauging Station 3	299	0.052
104796	9/27/92	0800	F	S	VC-ST-SC-GS3-1004	Gauging Station 3	271	0.054
104803	9/28/92	1250	F	S	VC-ST-SC-GS3-1005	Gauging Station 3	249	0.037
104806	9/29/92	1000	F	S	VC-ST-SC-GS3-1006	Gauging Station 3	204	0.038
103492	12/10/92	2300	F	S	VC-ST-SC-GS3-1002-01	Gauging Station 3	157	ND
103496	12/11/92	1300	F	S	VC-ST-SC-GS3-1002-02	Gauging Station 3	414	0.117
103500	12/11/92	2000	F	S	VC-ST-SC-GS3-1002-03	Gauging Station 3	414	ND
					VC-ST-SC-GS3-1002-04	Gauging Station 3	602	
103508	12/14/92	1830	F	S	VC-ST-SC-GS3-1002-05	Gauging Station 3	513	ND

Qualifiers: U - Not Detected at Contract Required Detection Limit (CRDL); J - Estimated Concentration;
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APPENDIX A
ANALYTICAL RESULTS FROM SURFACE WATER SAMPLING
Vineland Chemical Company Site

EPA Sample I.D.	Sampling Date	Sampling Time	Filtered/ Unfiltered	Storm/ Normal	Ebasco Sample I.D.	Location	Stream Discharge (cfs)	As Flux (g/s)
103510	12/23/92	1000	F	S	VC-ST-SC-GS3-1002-06	Gauging Station 3	280	ND
MBMF55	7/14/93	2330	F	S	VC-ST-GS3-1003-01 (D)	Gauging Station 3	117	0.007
MBMF45	7/15/93		F	S	VC-ST-GS3-1003-02 (D)	Gauging Station 3	121	No As Data
MBMF39	7/15/93	1840	F	S	VC-ST-GS3-1003-03 (D)	Gauging Station 3	121	0.018
MBMF31	7/15/93	2145	F	S	VC-ST-CH-GS3-1003-04 (D)	Gauging Station 3	121	0.019
MBMF05	7/16/93	1645	F	S	VC-ST-CH-GS3-1003-06 (D)	Gauging Station 3	122	0.022
MBMF17	7/16/93	1345	F	S	VC-ST-CH-GS3-1003-05 (D)	Gauging Station 3	122	0.018
104777	9/25/92	2030	F	S	VC-ST-SC-MRU-1001	Maurice River - Garden Rd.	48	ND
104781	9/26/92	1300	F	S	VC-ST-SC-MRU-1002	Maurice River - Garden Rd.	105	ND
104786	9/26/92	1750	F	S	VC-ST-SC-MRU-1003	Maurice River - Garden Rd.	105	ND
104791	9/27/92	0640	F	S	VC-ST-SC-MRU-1004	Maurice River - Garden Rd.	111	ND
104800	9/28/92	1455	F	S	VC-ST-SC-MRU-1005	Maurice River - Garden Rd.	113	ND
104807	9/29/92	1145	F	S	VC-ST-SC-MRU-1006	Maurice River - Garden Rd.	105	ND
104810	9/29/92	1145	F	S	VC-ST-SC-MRU-1006D	Maurice River - Garden Rd.	105	ND
103489	12/10/92	0100	F	S	VC-ST-SC-MRU-1002-01	Maurice River - Garden Rd.	74	ND
103494	12/11/92	1415	F	S	VC-ST-SC-MRU-1002-02	Maurice River - Garden Rd.	141	ND
103498	12/11/92	2030	F	S	VC-ST-SC-MRU-1002-03	Maurice River - Garden Rd.	141	ND
103502	12/12/92	1030	F	S	VC-ST-SC-MRU-1002-04	Maurice River - Garden Rd.	263	ND
103504	12/14/92	1700	F	S	VC-ST-SC-MRU-1002-05	Maurice River - Garden Rd.	348	ND
103513	12/23/92	1200	F	S	VC-ST-SC-MRU-1002-06	Maurice River - Garden Rd.	145	ND
MBMF51	7/14/93	0115	F	S	VC-ST-MRU-1003-01 (D)	Maurice River - Garden Rd.	45	0.007
MBMF49	7/15/93	1100	F	S	VC-ST-MRU-1003-02 (D)	Maurice River - Garden Rd.	49	ND
MBMF43	7/15/93	1950	F	S	VC-ST-MRU-1003-03 (D)	Maurice River - Garden Rd.	49	ND
MBMF35	7/15/93	2300	F	S	VC-ST-CH-MRU-1003-04 (D)	Maurice River - Garden Rd.	49	0.002
MBMF21	7/16/93	1530	F	S	VC-ST-CH-MRU-1003-05 (D)	Maurice River - Garden Rd.	51	ND
MBMF09	7/16/93	1745	F	S	VC-ST-CH-MRU-1003-06 (D)	Maurice River - Garden Rd.	51	0.003
104782	9/26/92	0930	F	S	VC-ST-SC-ULD-1001	Union Lake Dam		No Flow Data
104787	9/26/92	1515	F	S	VC-ST-SC-ULD-1002	Union Lake Dam		No Flow Data
104792	9/27/92	0915	F	S	VC-ST-SC-ULD-1003	Union Lake Dam		No Flow Data
104793	9/27/92	0930	F	S	VC-ST-SC-ULD-1003D	Union Lake Dam		No Flow Data

Qualifiers: U - Not Detected at Contract Required Detection Limit (CRDL); J - Estimated Concentration;
R - Rejected; B - Detected between CRDL and Instrument Detection Limit (IDL).

APPENDIX A
ANALYTICAL RESULTS FROM SURFACE WATER SAMPLING
Vineland Chemical Company Site

EPA Sample I.D.	Sampling Date	Sampling Time	Filtered/ Unfiltered	Storm/ Normal	Ebasco Sample I.D.	Location	Stream Discharge (cfs)	As Flux (g/s)
104799	9/28/92	1200	F	S	VC-ST-SC-ULD-1004	Union Lake Dam		No Flow Data
104808	9/29/92	0900	F	S	VC-ST-SC-ULD-1006	Union Lake Dam		No Flow Data
103493	12/10/92	2230	F	S	VC-ST-SC-ULD-1002-01	Union Lake Dam		No Flow Data
103497	12/11/92	1230	F	S	VC-ST-SC-ULD-1002-02	Union Lake Dam		No Flow Data
103501	12/11/92	1800	F	S	VC-ST-SC-ULD-1002-03	Union Lake Dam		No Flow Data
103503	12/12/92	0800	F	S	VC-ST-SC-ULD-1002-04	Union Lake Dam		No Flow Data
103505	12/14/92	2030	F	S	VC-ST-SC-ULD-1002-05	Union Lake Dam		No Flow Data
103509	12/23/92	0930	F	S	VC-ST-SC-ULD-1002-06	Union Lake Dam		No Flow Data
MBMF53	7/14/93	2045	F	S	VC-ST-ULD-1003-01 (D)	Union Lake Dam	136	0.046
MBMF47	7/15/93	0845	F	S	VC-ST-ULD-1003-02 (D)	Union Lake Dam	173	0.095
MBMF41	7/15/93	1800	F	S	VC-ST-ULD-1003-03 (D)	Union Lake Dam	173	0.082
MBMF33	7/15/93	2045	F	S	VC-ST-CH-ULD-1003-04 (D)	Union Lake Dam	173	0.055
MBMF19	7/16/93	1315	F	S	VC-ST-CH-ULD-1003-05 (D)	Union Lake Dam	141	0.047
MBMF07	7/16/93	1620	F	S	VC-ST-CH-ULD-1003-06 (D)	Union Lake Dam	141	0.092
MBNC83	8/11/93	1505	U		VC-OF-01 (UF)	Overflow	158	0.070
MBZ443	8/13/93	-	U		VC-OF-02 (UF)	Overflow	151	0.070
MBGZ41	8/16/93	1320	U		VC-OF-03 (UF)	Overflow	133	0.080
MBJT96	8/18/93	1300	U		VC-OF-04 (UF)	Overflow	183	0.092
MBEN17	8/20/93	1320	U		VC-OF-O5 (UF)	Overflow	120	0.070
102175	9/11/93	1740	U		VC-OF-07 (T)	Overflow	gates open	No Flow Data
102363	9/12/93	0910	U		VC-OF-08 (T)	Overflow	gates open	No Flow Data
102367	9/13/93	1140	U		VC-OF-09 (T)	Overflow	gates open	No Flow Data
102371	9/14/93	1100	U		VC-OF-10 (T)	Overflow	gates open	No Flow Data
102375	9/15/93	1305	U		VC-OF-11 (T)	Overflow	gates open	No Flow Data
101566	9/16/93	1130	U		VC-OF-12 (T)	Overflow	86	0.055
101570	9/17/93	1230	U		VC-OF-13 (T)	Overflow	100	0.054
101572	9/17/93	1230	U		VC-OF-13D (T)	Overflow	100	0.059
MBNC84	8/11/93	1505	F		VC-OF-01 (F)	Overflow	158	0.080
MBZ444	8/13/93	-	F		VC-OF-02 (F)	Overflow	151	0.075
MBGZ31	8/16/93	1320	F		VC-OF-03 (F)	Overflow	133	0.058

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APPENDIX A
ANALYTICAL RESULTS FROM SURFACE WATER SAMPLING
Vineland Chemical Company Site

EPA Sample I.D.	Sampling Date	Sampling Time	Filtered/ Unfiltered	Storm/ Normal	Ebasco Sample I.D.	Location	Stream Discharge (cfs)	As Flux (g/s)
MBJT95	8/18/93	1300	F		VC-OF-04 (F)	Overflow	183	0.068
MBEN18	8/20/93	1320	F		VC-OF-O5 (F)	Overflow	120	0.065
102360	9/11/93	1740	F		VC-OF-07 (D)	Overflow	gates open	No Flow Data
102364	9/12/93	0910	F		VC-OF-08 (D)	Overflow	gates open	No Flow Data
102368	9/13/93	1140	F		VC-OF-09 (D)	Overflow	gates open	No Flow Data
102372	9/14/93	1100	F		VC-OF-10 (D)	Overflow	gates open	No Flow Data
101561	9/15/93	1305	F		VC-OF-11 (D)	Overflow	gates open	No Flow Data
101567	9/16/93	1130	F		VC-OF-12 (D)	Overflow	86	0.032
101571	9/17/93	1230	F		VC-OF-13 (D)	Overflow	100	0.047
101573	9/17/93	1230	F		VC-OF-13D (D)	Overflow	100	0.044
MBMD99	8/3/93	1230	F		VC-LS01-01 (F)	Union Lake		
MBML77	8/3/93	1230	U		VC-LS01-01 (UF)	Union Lake		
MBNC11	8/4/93	1123	F		VC-LS01-02 (F)	Union Lake		
MBNC00	8/4/93	1123	U		VC-LS01-02 (UF)	Union Lake		
MBNC12	8/4/93	1123	F		VC-LS01-02D (F)	Union Lake		
MBNC01	8/4/93	1123	U		VC-LS01-02D (UF)	Union Lake		
MBNC23	8/5/93	1130	F		VC-LS01-03 (F)	Union Lake		
MBNC22	8/5/93	1130	U		VC-LS01-03 (UF)	Union Lake		
MBNC43	8/7/93	0930	F		VC-LS01-04 (F)	Union Lake		
MBNC42	8/7/93	0930	U		VC-LS01-04 (UF)	Union Lake		
MBNC74	8/11/93	1105	F		VC-LS01-05 (F)	Union Lake		
MBNC64	8/11/93	1105	U		VC-LS01-05 (UF)	Union Lake		
MBGZ22	8/16/93	1045	F		VC-LS01-06 (F)	Union Lake		
MBGZ32	8/16/93	1045	U		VC-LS01-06 (UF)	Union Lake		
MBGZ43	8/16/93	1045	F		VC-LS01-06D (F)	Union Lake		
MBGZ42	8/16/93	1045	U		VC-LS01-06D (UF)	Union Lake		
MBEN20	8/23/93	1300	F		VC-LS01-07 (F)	Union Lake		
MBEN30	8/23/93	1300	U		VC-LS01-07 (UF)	Union Lake		
MBGZ45	8/30/93	1106	F		VC-LS01-08 (F)	Union Lake		
MBGZ44	8/30/93	1106	U		VC-LS01-08 (UF)	Union Lake		
MBME00	8/3/93	1349	F		VC-LS02-01 (F)	Union Lake		

Qualifiers: U - Not Detected at Contract Required Detection Limit (CRDL); J - Estimated Concentration;
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APPENDIX A
ANALYTICAL RESULTS FROM SURFACE WATER SAMPLING
Vineland Chemical Company Site

EPA Sample I.D.	Sampling Date	Sampling Time	Filtered/ Unfiltered	Storm/ Normal	Ebasco Sample I.D.	Location	Stream Discharge (cfs)	As Flux (g/s)
MBML78	8/3/93	1349	U		VC-LS02-01 (UF)	Union Lake		
MBNC13	8/4/93	1145	F		VC-LS02-02 (F)	Union Lake		
MBNC02	8/4/93	1145	U		VC-LS02-02 (UF)	Union Lake		
MBNC25	8/5/93	1140	F		VC-LS02-03 (F)	Union Lake		
MBNC24	8/5/93	1140	U		VC-LS02-03 (UF)	Union Lake		
MBNC45	8/7/93	0940	F		VC-LS02-04 (F)	Union Lake		
MBNC44	8/7/93	0940	U		VC-LS02-04 (UF)	Union Lake		
MBNC75	8/11/93	1116	F		VC-LS02-05 (F)	Union Lake		
MBNC65	8/11/93	1116	U		VC-LS02-05 (UF)	Union Lake		
MBGZ23	8/16/93	1050	F		VC-LS02-06 (F)	Union Lake		
MBGZ33	8/16/93	1050	U		VC-LS02-06 (UF)	Union Lake		
MBEN21	8/23/93	1311	F		VC-LS02-07 (F)	Union Lake		
MBEN31	8/23/93	1311	U		VC-LS02-07 (UF)	Union Lake		
MBGZ47	8/30/93	1117	F		VC-LS02-08 (F)	Union Lake		
MBGZ46	8/30/93	1117	U		VC-LS02-08 (UF)	Union Lake		
MBME01	8/3/93	1409	F		VC-LS03-01 (F)	Union Lake		
MBML79	8/3/93	1409	U		VC-LS03-01 (UF)	Union Lake		
MBNC14	8/4/93	1220	F		VC-LS03-02 (F)	Union Lake		
MBNC03	8/4/93	1220	U		VC-LS03-02 (UF)	Union Lake		
MBNC27	8/5/93	1210	F		VC-LS03-03 (F)	Union Lake		
MBNC26	8/5/93	1210	U		VC-LS03-03 (UF)	Union Lake		
MBNC47	8/7/93	0955	F		VC-LS03-04 (F)	Union Lake		
MBNC46	8/7/93	0955	U		VC-LS03-04 (UF)	Union Lake		
MBNC76	8/11/93	1135	F		VC-LS03-05 (F)	Union Lake		
MBNC66	8/11/93	1135	U		VC-LS03-05 (UF)	Union Lake		
MBGZ24	8/16/93	1105	F		VC-LS03-06 (F)	Union Lake		
MBGZ34	8/16/93	1105	U		VC-LS03-06 (UF)	Union Lake		
MBEN22	8/23/93	1318	F		VC-LS03-07 (F)	Union Lake		
MBEN32	8/23/93	1318	U		VC-LS03-07 (UF)	Union Lake		
MBGZ51	8/30/93	1129	F		VC-LS03-08 (F)	Union Lake		
MBGZ50	8/30/93	1129	U		VC-LS03-08 (UF)	Union Lake		
MBGZ49	8/30/93	1129	F		VC-LS03-08D (F)	Union Lake		

Qualifiers: U - Not Detected at Contract Required Detection Limit (CRDL); J - Estimated Concentration;
R - Rejected; B - Detected between CRDL and Instrument Detection Limit (IDL).

APPENDIX A
ANALYTICAL RESULTS FROM SURFACE WATER SAMPLING
Vineland Chemical Company Site

EPA Sample I.D.	Sampling Date	Sampling Time	Filtered/ Unfiltered	Storm/ Normal	Ebasco Sample I.D.	Location	Stream Discharge (cfs)	As Flux (g/s)
MBGZ48	8/30/93	1129	U		VC-LS03-08D (UF)	Union Lake		
MBMF82	8/3/93	1424	F		VC-LS04-01 (F)	Union Lake		
MBML80	8/3/93	1424	U		VC-LS04-01 (UF)	Union Lake		
MBNC15	8/4/93	1235	F		VC-LS04-02 (F)	Union Lake		
MBNC04	8/4/93	1235	U		VC-LS04-02 (UF)	Union Lake		
MBNC29	8/5/93	1225	F		VC-LS04-03 (F)	Union Lake		
MBNC28	8/5/93	1225	U		VC-LS04-03 (UF)	Union Lake		
MBNC49	8/7/93	1005	F		VC-LS04-04 (F)	Union Lake		
MBNC48	8/7/93	1005	U		VC-LS04-04 (UF)	Union Lake		
MBNC55	8/7/93	1005	F		VC-LS04-04D (F)	Union Lake		
MBNC54	8/7/93	1005	U		VC-LS04-04D (UF)	Union Lake		
MBNC77	8/11/93	1143	F		VC-LS04-05 (F)	Union Lake		
MBNC67	8/11/93	1143	U		VC-LS04-05 (UF)	Union Lake		
MBGZ25	8/16/93	1115	F		VC-LS04-06 (F)	Union Lake		
MBGZ35	8/16/93	1115	U		VC-LS04-06 (UF)	Union Lake		
MBEN23	8/23/93	1328	F		VC-LS04-07 (F)	Union Lake		
MBEN33	8/23/93	1328	U		VC-LS04-07 (UF)	Union Lake		
MBGZ53	8/30/93	1148	F		VC-LS04-08 (F)	Union Lake		
MBGZ52	8/30/93	1148	U		VC-LS04-08 (UF)	Union Lake		
MBMF83	8/3/93	1455	F		VC-LS05-01 (F)	Union Lake		
MBML81	8/3/93	1455	U		VC-LS05-01 (UF)	Union Lake		
MBNC16	8/4/93	1247	F		VC-LS05-02 (F)	Union Lake		
MBNC05	8/4/93	1247	U		VC-LS05-02 (UF)	Union Lake		
MBNC32	8/5/93	1250	F		VC-LS05-03 (F)	Union Lake		
MBNC31	8/5/93	1250	U		VC-LS05-03 (UF)	Union Lake		
MBNC51	8/7/93	1020	F		VC-LS05-04 (F)	Union Lake		
MBNC50	8/7/93	1020	U		VC-LS05-04 (UF)	Union Lake		
MBNC78	8/11/93	1155	F		VC-LS05-05 (F)	Union Lake		
MBNC68	8/11/93	1155	U		VC-LS05-05 (UF)	Union Lake		
MBGZ26	8/16/93	1125	F		VC-LS05-06 (F)	Union Lake		
MBGZ36	8/16/93	1125	U		VC-LS05-06 (UF)	Union Lake		
MBEN24	8/23/93	1343	F		VC-LS05-07 (F)	Union Lake		

Qualifiers: U - Not Detected at Contract Required Detection Limit (CRDL); J - Estimated Concentration;
R - Rejected; B - Detected between CRDL and Instrument Detection Limit (IDL).

APPENDIX A
ANALYTICAL RESULTS FROM SURFACE WATER SAMPLING
Vineland Chemical Company Site

EPA Sample I.D.	Sampling Date	Sampling Time	Filtered/ Unfiltered	Storm/ Normal	Ebasco Sample I.D.	Location	Stream Discharge (cfs)	As Flux (g/s)
MBEN34	8/23/93	1343	U		VC-LS05-07 (UF)	Union Lake		
MBGZ55	8/30/93	1156	F		VC-LS05-08 (F)	Union Lake		
MBGZ54	8/30/93	1156	U		VC-LS05-08 (UF)	Union Lake		
MBMF84	8/3/93	1510	F		VC-LS06-01 (F)	Union Lake		
MBML82	8/3/93	1510	U		VC-LS06-01 (UF)	Union Lake		
MBNC17	8/4/93	1258	F		VC-LS06-02 (F)	Union Lake		
MBNC06	8/4/93	1258	U		VC-LS06-02 (UF)	Union Lake		
MBNC34	8/5/93	1300	F		VC-LS06-03 (F)	Union Lake		
MBNC33	8/5/93	1300	U		VC-LS06-03 (UF)	Union Lake		
MBNC53	8/7/93	1040	F		VC-LS06-04 (F)	Union Lake		
MBNC52	8/7/93	1040	U		VC-LS06-04 (UF)	Union Lake		
MBNC79	8/11/93	1205	F		VC-LS06-05 (F)	Union Lake		
MBNC69	8/11/93	1205	U		VC-LS06-05 (UF)	Union Lake		
MBGZ27	8/16/93	1130	F		VC-LS06-06 (F)	Union Lake		
MBGZ37	8/16/93	1130	U		VC-LS06-06 (UF)	Union Lake		
MBEN25	8/23/93	1349	F		VC-LS06-07 (F)	Union Lake		
MBEN35	8/23/93	1349	U		VC-LS06-07 (UF)	Union Lake		
MBGZ57	8/30/93	1205	F		VC-LS06-08 (F)	Union Lake		
MBGZ56	8/30/93	1205	U		VC-LS06-08 (UF)	Union Lake		
MBNB97	8/3/93	1520	F		VC-LS07-01 (F)	Union Lake		
MBML83	8/3/93	1520	U		VC-LS07-01 (UF)	Union Lake		
MBNC18	8/4/93	1308	F		VC-LS07-02 (F)	Union Lake		
MBNC07	8/4/93	1308	U		VC-LS07-02 (UF)	Union Lake		
MBNC36	8/5/93	1310	F		VC-LS07-03 (F)	Union Lake		
MBNC35	8/5/93	1310	U		VC-LS07-03 (UF)	Union Lake		
MBNC57	8/7/93	1050	F		VC-LS07-04 (F)	Union Lake		
MBNC56	8/7/93	1050	U		VC-LS07-04 (UF)	Union Lake		
MBNC80	8/11/93	1215	F		VC-LS07-05 (F)	Union Lake		
MBNC70	8/11/93	1215	U		VC-LS07-05 (UF)	Union Lake		
MBGZ28	8/16/93	1140	F		VC-LS07-06 (F)	Union Lake		
MBGZ38	8/16/93	1140	U		VC-LS07-06 (UF)	Union Lake		
MBEN26	8/23/93	1358	F		VC-LS07-07 (F)	Union Lake		

Qualifiers: U - Not Detected at Contract Required Detection Limit (CRDL); J - Estimated Concentration;
R - Rejected; B - Detected between CRDL and Instrument Detection Limit (IDL).

APPENDIX A
ANALYTICAL RESULTS FROM SURFACE WATER SAMPLING
Vineland Chemical Company Site

EPA Sample I.D.	Sampling Date	Sampling Time	Filtered/ Unfiltered	Storm/ Normal	Ebasco Sample I.D.	Location	Stream Discharge (cfs)	As Flux (g/s)
MBEN36	8/23/93	1358	U		VC-LS07-07 (UF)	Union Lake		
MBGZ59	8/30/93	1215	F		VC-LS07-08 (F)	Union Lake		
MBGZ58	8/30/93	1215	U		VC-LS07-08 (UF)	Union Lake		
MBNB98	8/3/93	1533	F		VC-LS08-01 (F)	Union Lake		
MBML84	8/3/93	1533	U		VC-LS08-01 (UF)	Union Lake		
MBNC19	8/4/93	1318	F		VC-LS08-02 (F)	Union Lake		
MBNC08	8/4/93	1318	U		VC-LS08-02 (UF)	Union Lake		
MBNC38	8/5/93	1325	F		VC-LS08-03 (F)	Union Lake		
MBNC37	8/5/93	1325	U		VC-LS08-03 (UF)	Union Lake		
MBNC59	8/7/93	1058	F		VC-LS08-04 (F)	Union Lake		
MBNC58	8/7/93	1058	U		VC-LS08-04 (UF)	Union Lake		
MBNC81	8/11/93	1225	F		VC-LS08-05 (F)	Union Lake		
MBNC71	8/11/93	1225	U		VC-LS08-05 (UF)	Union Lake		
MBGZ29	8/16/93	1150	F		VC-L08-06 (F)	Union Lake		
MBGZ39	8/16/93	1150	U		VC-L08-06 (UF)	Union Lake		
MBEN27	8/23/93	1404	F		VC-LS08-07 (F)	Union Lake		
MBEN37	8/23/93	1404	U		VC-LS08-07 (UF)	Union Lake		
MBGZ61	8/30/93	1225	F		VC-LS08-08 (F)	Union Lake		
MBGZ60	8/30/93	1225	U		VC-LS08-08 (UF)	Union Lake		
MBNB99	8/3/93	1542	F		VC-LS09-01 (F)	Union Lake		
MBML85	8/3/93	1542	U		VC-LS09-01 (UF)	Union Lake		
MBNC20	8/4/93	1328	F		VC-LS09-02 (F)	Union Lake		
MBNC09	8/4/93	1328	U		VC-LS09-02 (UF)	Union Lake		
MBNC40	8/5/93	1335	F		VC-LS09-03 (F)	Union Lake		
MBNC39	8/5/93	1335	U		VC-LS09-03 (UF)	Union Lake		
MBNC61	8/7/93	1105	F		VC-LS09-04 (F)	Union Lake		
MBNC60	8/7/93	1105	U		VC-LS09-04 (UF)	Union Lake		
MBNC82	8/11/93	1235	F		VC-LS09-05 (F)	Union Lake		
MBNC72	8/11/93	1235	U		VC-LS09-05 (UF)	Union Lake		
MBGZ30	8/16/93	1220	F		VC-LS09-06 (F)	Union Lake		
MBGZ40	8/16/93	1220	U		VC-LS09-06 (UF)	Union Lake		
MBEN28	8/23/93	1414	F		VC-LS09-07 (F)	Union Lake		

Qualifiers: U - Not Detected at Contract Required Detection Limit (CRDL); J - Estimated Concentration;
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APPENDIX A
ANALYTICAL RESULTS FROM SURFACE WATER SAMPLING
Vineland Chemical Company Site

EPA Sample I.D.	Sampling Date	Sampling Time	Filtered/ Unfiltered	Storm/ Normal	Ebasco Sample I.D.	Location	Stream Discharge (cfs)	As Flux (g/s)
MBEN38	8/23/93	1414	U		VC-LS09-07 (UF)	Union Lake		
MBGZ63	8/30/93	1235	F		VC-LS09-08 (F)	Union Lake		
MBGZ62	8/30/93	1235	U		VC-LS09-08 (UF)	Union Lake		

Qualifiers: U - Not Detected at Contract Required Detection Limit (CRDL); J - Estimated Concentration;
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APPENDIX A
ANALYTICAL RESULTS FROM SURFACE WATER SAMPLING
Vineland Chemical Company Site

EPA Sample I.D.	Units	As		Al		Sb		Ba		Be		Cd		Ca		Cr		Co		Cu		Fe	
MBJT23	µg/l	325.00	J	116.0	JB	16.50	U	87.70	JB	0.40	U	1.40	U	3100.00	B	3.70	U	2.80	JB	4.50	JB	592.00	J
7383B-01-005	µg/l	279.00																				599.00	
MBJT25	µg/l	605.00		834.0	J	16.50	U	91.80	B	0.43	B	1.40	U	3930.00	B	3.70	U	4.10	B	5.80	B	3490.00	
104751	µg/l	900.00																				991.00	
104771	µg/l	138.00		200.0	U	60.00	U	200.00	U	5.00	U	5.00	U	5000.00	U	10.00	U	50.00	U	25.00	U	308.00	
104759	µg/l	149.00																				315.00	
MBJT80	µg/l	127.00	J	157.0	B	60.00	U	90.30	B	1.00	U	5.00	U	3430.00	B	6.00	U	9.00	U	5.00	U	202.00	
7576B-01-002	µg/l	120.00	J																			471.00	J
103429	µg/l	134.00		200.0	U	60.00	U	200.00	U	5.00	U	5.00	U	5000.00	U	10.00	U	50.00	U	25.00	U	198.00	J
7576B-02-013	µg/l	122.00																				185.00	J
MBMK32	µg/l	225.00		138.0	B	18.40	U	80.50	B	0.50	U	1.60	U	3520.00	B	2.70	U	2.50	U	4.30	JB	640.00	
103959	µg/l	134.00		200.0	U	60.00	U	200.00	U	5.00	U	5.00	U	5000.00	U	10.00	U	50.00	U	25.00	U	279.00	
MBMK63	µg/l	111.00	J	109.0	JB	18.40	U	83.80	JB	0.50	U	1.60	U	4280.00	JB	2.70	U	2.50	U	2.90	U	182.00	J
MBML25	µg/l	51.60	JB	316.0		28.70	U	77.50	B	1.80	U	2.00	U	5540.00	J	5.00	U	10.40	U	3.10	B	431.00	
MBML27	µg/l	58.80	B	254.0		28.70	U	78.40	B	1.80	U	2.00	U	5630.00	J	5.00	U	10.40	U	7.40	B	401.00	
101505	µg/l	109.00		258.00		60.00	U	200.00	U	5.00	U	5.00	U	5000.00	U	32.00		50.00	U	25.00	U	481.00	
MBML89	µg/l	170.00		315.0	J	16.00	U	74.70	B	0.30	U	3.70	U	4550.00	B	2.80	UJ	3.20	U	3.20	B	1310.00	
101549	µg/l	172.00		200.0	U	60.00	U	200.00	U	5.00	U	5.00	U	5000.00	U	10.00	U	50.00	U	25.00	U	851.00	
MBMF02	µg/l	205.00		99.0	B	50.60	U	75.10	B	2.10	U	2.90	U	3560.00	B	4.40	U	11.30	U	2.70	U	566.00	
MBNB61	µg/l	91.40		48.80	B	15.30	U	91.50	B	0.40	U	2.70	U	3280.00	B	2.50	U	2.90	U	1.50	U	303.00	
MBJT24	µg/l	35.90	J	96.3	JB	16.50	U	42.60	JB	0.40	U	1.40	U	3790.00	B	3.70	U	2.30	U	3.80	JB	490.00	J
7383B-01-006	µg/l	39.70																				498.00	
MBJT26	µg/l	23.20		255.0	J	16.50	U	48.70	B	0.40	U	1.40	U	3670.00	B	3.70	U	2.30	U	2.40	U	1060.00	
104752	µg/l	32.70																				974.00	
104772	µg/l	19.00		200.0	U	60.00	U	200.00	U	5.00	U	5.00	U	5000.00	U	10.00	U	50.00	U	25.00	U	286.00	
104773	µg/l	14.10		200.0	U	60.00	U	200.00	U	5.00	U	5.00	U	5000.00	U	10.00	U	50.00	U	25.00	U	100.00	U
104761	µg/l	21.20																				292.00	
104763	µg/l	36.10																				529.00	
MBJT81	µg/l	17.60	J	171.0	B	60.00	U	49.30	B	1.00	U	5.00	U	4020.00	B	6.00	U	9.00	U	5.00	U	195.00	
7576B-01-004	µg/l	15.00	J																			330.00	J
103428	µg/l	12.50		200.0	U	60.00	U	200.00	U	5.00	U	5.00	U	5000.00	U	20.00	U	50.00	U	25.00	U	340.00	J

Qualifiers: U - Not Detected at Contract Required Detection Limit (CRDL); J - Estimated Concentration;
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APPENDIX A
ANALYTICAL RESULTS FROM SURFACE WATER SAMPLING
Vineland Chemical Company Site

EPA Sample I.D.	Units	As		Al		Sb		Ba		Be		Cd		Ca		Cr		Co		Cu		Fe	
7576B-02-011	µg/l	12.00																				310.00	J
MBMK33	µg/l	27.70	J	251.0	J	18.40	U	63.20	JB	0.50	U	1.60	U	3960.00	JB	2.70	U	2.60	JB	4.70	JB	745.00	J
103960	µg/l	15.00		200.0	U	60.00	U	200.00	U	5.00	U	5.00	U	5000.00	U	10.00	U	50.00	U	25.00	U	274.00	
MBMK65	µg/l	10.40	J	122.0	JB	18.40	U	66.30	JB	0.50	U	1.60	U	4530.00	JB	2.70	U	2.50	U		R	152.00	J
MBML21	ug/L	9.00	B	215.0		28.70	U	60.40	B	1.80	U	2.00	U	4550.00	B	5.00	U	10.40	U	2.50	B	397.00	
101504	µg/l	12.70		263.00		60.00	U	200.00	U	5.00	U	5.00	U	5000.00	U	13.00		50.00	U	25.00	U	422.00	
MBML91	ug/L	31.00		270.0	J	16.00	U	68.80	B	0.30	U	3.70	U	4540.00	B	2.80	UJ	3.20	U	3.20	B	1400.00	
MBML93	ug/L	31.00		258.0	J	16.00	U	66.80	B	0.30	U	3.70	U	4360.00	B	2.80	UJ	3.20	U	2.70	U	1350.00	
101547	ug/L	21.20		200.0	U	60.00	U	200.00	U	5.00	U	5.00	U	5000.00	U	10.00	U	50.00	U	25.00	U	745.00	
MBMF04	ug/L	20.90		41.4	U	50.60	U	55.90	B	2.10	U	2.90	U	4140.00	B	4.40	U	11.30	U	2.70	U		R
MBNB63	ug/L	10.50		59.5	B	15.30	U	75.60	B	0.40	U	2.70	U	4030.00	B	2.50	U	2.90	U	1.50	U	285.00	
7383B-01-007	µg/l	15.50																				979.00	
MBJT27	µg/l	16.50	J	321.0	J	16.50	U	47.50	JB	0.40	U	1.40	U	3950.00	JB	3.70	U	2.30	U	4.30	JB	3170.00	J
104753	µg/l	14.40																				2720.00	
104774	µg/l	11.10	J	200.0	U	60.00	U	200.00	U	5.00	U	5.00	U	5000.00	U	10.00	U	50.00	U	25.00	U	905.00	
104765	µg/l	8.60																				1390.00	
MBJT82	µg/l	9.40	JB	220.0		60.00	U	60.30	B	1.00	U	5.00	U	4770.00	B	6.00	U	9.00	U	5.00	U	1210.00	
7576B-01-001	µg/l	8.30	BJ																			1350.00	J
103427	µg/l	10.00	U	247.0		60.00	U	200.00	U	5.00	U	5.00	U	5000.00		10.00	U	50.00	U	25.00	U	827.00	J
7576B-02-009	µg/l	7.10	B																			784.00	J
MBMK34	µg/l	29.70		499.0		18.40	U	79.20	B	0.50	U	1.60	U	5440.00		2.70	U	4.20	B	5.10	JB	21400.00	
103961	µg/l	10.00	U	200.0	U	60.00	U	200.00	U	5.00	U	5.00	U	6000.00		10.00	U	50.00	U	25.00	U	771.00	
MBMK67	µg/l	6.70	JB	134.0	JB	18.40	U	67.30	JB	0.50	U	1.60	U	5500.00	J	2.70	U	2.50	U	2.90	U	580.00	J
MBML31	ug/L	4.60	B	207.0		28.70	U	58.90	B	1.80	U	2.00	U	5060.00	J	5.00	U	10.40	U	3.20	B	517.00	
101502	µg/l	10.00	U	229.00		60.00	U	200.00	U	5.00	U	5.00	U	5000.00		10.00	U	50.00	U	25.00	U	586.00	
MBML95	ug/L	25.40		241.0	J	16.00	U	64.70	B	0.30	U	3.70	U	5440.00		2.80	UJ	3.20	U	4.00	B	2020.00	
101545	ug/L	14.10		200.0	U	60.00	U	200.00	U	5.00	U	5.00	U	5000.00	U	10.00	U	50.00	U	25.00	U	1310.00	
MBMF06	ug/L	19.70	B	71.9	B	50.60	U	65.70	B	2.10	U	2.90	U	4850.00	B	4.40	U	11.30	U	2.70	U	1320.00	
MBML35	ug/L	8.60	B	69.2	B	15.30	U	79.60	B	0.40	U	2.70	U	5360.00		2.50	U	3.00	B	1.50	U	1800.00	
MBJT20	µg/l	2.40	U	205.0	J	16.50	U	38.70	JB	0.40	U	1.40	U	4050.00	B	4.00	JB	2.40	JB	5.20	JB	642.00	J

Qualifiers: U - Not Detected at Contract Required Detection Limit (CRDL); J - Estimated Concentration;
R - Rejected; B - Detected between CRDL and Instrument Detection Limit (IDL).

APPENDIX A
ANALYTICAL RESULTS FROM SURFACE WATER SAMPLING
Vineland Chemical Company Site

EPA Sample I.D.	Units	As		Al		Sb		Ba		Be		Cd		Ca		Cr		Co		Cu		Fe	
7383B-01-001	µg/l	2.00	U																			602.00	
MBJT85	µg/l	4.00	U	162.0	B	60.00	U	36.10	B	1.00	U	5.00	U	4220.00	B	6.00	U	9.00	U	5.00	U	247.00	
7576B-01-006	µg/l	1.20	BJ																			274.00	J
103424	µg/l	10.00	U	200.0	U	60.00	U	200.00	U	5.00	U	5.00	U	5000.00	U	10.00	U	50.00	U	25.00	U	349.00	J
103425	µg/l	10.00	U	200.0	U	60.00	U	200.00	U	5.00	U	5.00	U	5000.00	U	20.00	U	50.00	U	25.00	U	447.00	J
7576B-02-003	µg/l	1.00	U																			354.00	J
7576B-02-005	µg/l	1.00	U																			362.00	J
MBMK31	µg/l	3.70	U	195.0	B	20.70	B	59.20	B	0.50	U	1.60	U	4090.00	B	2.80	B	2.50	U	9.80	JB	504.00	
103957	µg/l	10.00	U	200.0	U	60.00	U	200.00	U	5.00	U	5.00	U	5000.00	U	10.00	U	50.00	U	25.00	U	278.00	
MBMK61	µg/l	3.90	U	146.0	B	18.40	U	65.10	B	0.50	U	1.60	U	4790.00	B	2.70	U	2.50	U	2.90	U	203.00	
MBML29	µg/l	1.60	U	217.0		28.70	U	56.80	B	1.80	U	2.00	U	4030.00	B	5.00	U	10.40	U	3.70	B		R
MBMF10	µg/l	2.20	UJ	41.4	U	50.60	U	47.10	B	2.10	U	2.90	U	4420.00	B	4.40	U	11.30	U	2.70	U	833.00	
101508	µg/l	10.00	U	242.00		60.00	U	200.00	U	5.00	U	5.00	U	5000.00	U	29.00		50.00	U	25.00	U	493.00	
MBNB65	µg/l	1.00	B	49.8	B	15.30	U	66.40	B	0.40	U	2.70	U	3970.00	B	2.50	U	2.90	U	1.50	U	265.00	
7383B-01-004	µg/l	19.30																				782.00	
104754	µg/l	17.80																				498.00	
MBJT55	µg/l	18.60		33.9	B	16.50	U	54.40	B	0.40	U	1.40	U	3760.00	B	3.70	U	2.30	U	2.40	U	471.00	
104775	µg/l	14.90		200.0	U	60.00	U	200.00	U	5.00	U	5.00	U	5000.00	U	10.00	U	50.00	U	25.00	U	474.00	
104767	µg/l	15.30																				673.00	
MBJT83	µg/l	16.80	J	494.0		60.00	U	58.10	B	1.00	U	5.00	U	4180.00	B	6.00	U	9.00	U	5.00	U	716.00	
7576B-01-005	µg/l	17.40	J																			819.00	J
103426	µg/l	10.00	U	200.0	U	60.00	U	200.00	U	5.00	U	5.00	U	5000.00	U	27.00		50.00	U	25.00	U	729.00	J
7576B-02-007	µg/l	11.50																				540.00	J
MBMK30	µg/l	9.70	BJ	78.6	BJ	18.40	U	55.70	BJ	0.52	BJ	1.60	U	4610.00	BJ	2.70	U	2.50	U	7.20	BJ	584.00	J
103962	µg/l	10.00	U	200.0	U	60.00	U	200.00	U	5.00	U	5.00	U	5000.00		10.00	U	50.00	U	25.00	U	594.00	
MBMK69	µg/l	4.90	JB	125.0	B	18.40	U	62.00	B	0.50	U	1.60	U	5080.00	J	2.70	U	2.50	U	2.90	U	361.00	
MBML17	µg/l	4.30	B	219.0		28.70	U	56.20	B	1.80	U	2.00	U	4880.00	B	5.00	U	10.40	U	2.70	B	570.00	
101511	µg/l	10.00	U	311.00		60.00	U	200.00	U	5.00	U	5.00	U	5000.00	U	10.00	U	50.00	U	25.00	U	729.00	
MBML97	µg/l	24.70		203.0		16.00	U	66.00	B	0.30	U	3.70	U	5010.00		2.80	UJ	3.20	U	2.70	U	1430.00	
101543	µg/l	18.80		200.0	U	60.00	U	200.00	U	5.00	U	5.00	U	5000.00	U	10.00	U	50.00	U	25.00	U	987.00	
MBMF08	µg/l	21.80		42.5	B	50.60	U	61.70	B	2.10	U	2.90	U	4670.00	B	4.40	U	11.30	U	2.70	U	783.00	

Qualifiers: U - Not Detected at Contract Required Detection Limit (CRDL); J - Estimated Concentration;
R - Rejected; B - Detected between CRDL and Instrument Detection Limit (IDL).

APPENDIX A
ANALYTICAL RESULTS FROM SURFACE WATER SAMPLING
Vineland Chemical Company Site

EPA Sample I.D.	Units	As		Al		Sb		Ba		Be		Cd		Ca		Cr		Co		Cu		Fe	
MBML36	µg/l	19.70		137.0	B	15.30	U	63.60	B	0.40	U	2.70	U	4060.00	B	2.50	U	2.90	U	1.50	U	758.00	
MBML38	µg/l	20.10		121.0	B	15.30	U	61.40	B	0.40	U	2.70	U	4070.00	B	2.50	U	2.90	U	1.90	B	744.00	
7384B-01-005	µg/l	166.00																					
104755	µg/l	183.00																				42.10	B
104760	µg/l	119.00																				258.00	
7576B-01-009	µg/l	105.00	J																			100.00	U
7576B-02-014	µg/l	114.00																				59.00	BJ
103966	µg/l	121.00		200.0	U	60.00	U	200.00	U	5.00	U	5.00	U	5000.00	U	10.00	U	50.00	U	25.00	U	29.10	B
MBMK64	µg/l	112.00	J	73.5	JB	19.00	U	81.10	JB	0.90	U	1.40	U	4050.00	JB	6.80	JB	3.20	U	4.90	U	100.00	U
MBML26	µg/l	60.90	J	247.0		28.70	U	74.50	B	1.80	U	2.00	U	5740.00	J	5.00	U	10.40	U	4.10	B	101.00	J
MBML28	µg/l	37.20	JB	232.0		28.70	U	74.90	B	1.80	U	2.00	U	5740.00	J	5.00	U	10.40	U	3.80	B	296.00	J
101506	µg/l		R	200.00	U	60.00	U	200.00	U	5.00	U	5.00	U	5000.00	U	10.00	U	50.00	U	25.00	U	221.00	J
MBML90	µg/l	130.00		211.0	J	21.10	B	69.90	B	0.30	U	3.70	U	4540.00	B	2.80	UJ	3.20	U	3.20	B	171.00	
101550	µg/l	104.00		200.0	U	60.00	U	200.00	U	5.00	U	5.00	U	5000.00	U	10.00	U	50.00	U	25.00	U	628.00	EJ
MBMF01	µg/l	94.30	B	41.4	U	50.60	U	76.30	B	2.10	U	2.90	U	3560.00	B	4.40	U	11.30	U	2.70	U	159.00	
MBNB60	µg/l	74.10		20.9	U	15.30	U	88.70	B	0.40	U	2.70	U	3260.00	B	2.50	U	2.90	U	1.50	U	147.00	
																						92.20	B
7384B-01-006	µg/l	20.20																					
104756	µg/l	20.70																				156.00	
104762	µg/l	15.40																				222.00	
104764	µg/l	20.70																				100.00	U
7576B-01-011	µg/l	12.90	J																			100.00	U
7576B-02-012	µg/l	10.30																				52.70	BJ
103491	µg/l	11.60																				108.00	J
103967	µg/l	11.30		200.0	U	60.00	U	200.00	U	5.00	U	5.00	U	5000.00	U	10.00	U	50.00	U	25.00	U	153.00	
MBMK66	µg/l	10.50	J	117.0	JB	19.00	U	71.40	JB	0.90	U	1.40	U	4470.00	JB	4.20	U	3.20	U		R	104.00	
MBML22	µg/l	7.90	JB	213.0		28.70	U	59.70	B	1.80	U	2.00	U	4710.00	B	5.00	U	10.40	U	5.10	B	102.00	J
101503	µg/l	14.70		200.00	U	60.00	U	200.00	U	5.00	U	5.00	U	5000.00	U	10.00	U	50.00	U	25.00	U	199.00	J
MBML92	µg/l	24.00	J	212.0	J	16.00	U	64.70	B	0.30	U	3.70	U	4390.00	B	2.80	U	3.20	U	2.70	U	173.00	
MBML94	µg/l	11.20	J	206.0	J	16.00	U	64.00	B	0.30	U	3.70	U	4350.00	B	2.80	U	3.20	U	3.20	B	905.00	EJ
101548	µg/l	14.60		200.0	U	60.00	U	200.00	U	5.00	U	5.00	U	5000.00	U	10.00	U	50.00	U	25.00	U	895.00	EJ
																						374.00	

Qualifiers: U - Not Detected at Contract Required Detection Limit (CRDL); J - Estimated Concentration;
R - Rejected; B - Detected between CRDL and Instrument Detection Limit (IDL).

APPENDIX A
ANALYTICAL RESULTS FROM SURFACE WATER SAMPLING
Vineland Chemical Company Site

EPA Sample I.D.	Units	As		Al		Sb		Ba		Be		Cd		Ca		Cr		Co		Cu		Fe	
MBMF03	µg/l	21.70		71.6	B	50.60	U	55.60	B	2.10	U	2.90	U	4010.00	B	4.40	U	11.30	U	2.70	U		R
MBNB62	µg/l	7.60	B	29.0	B	15.30	U	74.50	B	0.40	U	2.70	U	4040.00	B	2.00	U	2.90	U	1.50	U	114.00	
7384B-01-007	µg/l	6.00	JB																			157.00	
104757	µg/l	5.20																				100.00	U
104766	µg/l	5.00	U																			208.00	
7576B-01-008	µg/l	6.30	BJ																			754.00	J
7576B-02-010	µg/l	4.00	B																			415.00	J
103492	µg/l	10.00	U																			1280.00	
103968	µg/l	10.00	U	200.0	U	60.00	U	200.00	U	5.00	U	5.00	U	6000.00		10.00	U	50.00	U	25.00	U	444.00	
MBMK68	µg/l	6.60	JB	75.3	JB	19.00	U	71.40	JB	0.90	U	1.40	U	5320.00	J	4.20	U	3.20	U	4.90	U	313.00	J
MBML32	µg/l	4.20	JB	196.0	B	28.70	U	56.60	B	1.80	U	2.00	U	4800.00	B	5.00	U	10.40	U	2.60	B	334.00	J
101501	µg/l	10.00	U	200.00	U	60.00	U	200.00	U	5.00	U	5.00	U	5000.00		10.00	U	50.00	U	525.00	U	254.00	
MBML96	µg/l	15.20		132.0	B	16.00	U	61.00	B	0.30	U	3.70	U	5400.00		2.80	U	3.20	U	3.20	B	1100.00	EJ
101546	µg/l	9.30		200.0	U	60.00	U	200.00	U	5.00	U	5.00	U	5000.00		10.00	U	50.00	U	25.00	U	609.00	
MBMF17	µg/l	5.20	BJ	41.4	U	50.60	U	65.70	B	2.10	U	2.90	U	4960.00	B	4.40	U	11.30	U	2.70	U	637.00	
MBNB66	µg/l	3.30	B	28.4	B	15.30	U	76.30	B	0.40	U	2.70	U	5290.00		2.50	U	2.90	U	1.50	U	711.00	
7384B-01-001	µg/l	4.30	B																			62.40	B
7576B-01-013	µg/l	1.30	BJ																			93.50	BJ
7576B-02-004	µg/l	1.00	U																			263.00	J
7576B-02-006	µg/l	1.00	U																			268.00	J
103489	µg/l	10.00	U																			100.00	U
103964	µg/l	10.00	U	200.0	U	60.00	U	200.00	U	5.00	U	5.00	U	5000.00	U	10.00	U	50.00	U	25.00	U	119.00	
MBMK62	µg/l	3.70	U	121.0	JB	19.00	U	61.70	JB	0.90	U	1.40	U	4460.00	JB	4.20	U	3.20	U	4.90	U	120.00	J
MBML30	ug/L	1.60	UJ	195.0	B	28.70	U	54.90	B	1.80	U	2.00	U	3950.00	B	5.00	U	10.40	U	1.70	U		R
101507	µg/l	10.00	U	200.00	U	60.00	U	200.00	U	5.00	U	5.00	U	5000.00	U	10.00	U	50.00	U	25.00	U	173.00	
MBMF09	µg/l	2.20	UJ	49.5	B	50.60	U	48.00	B	2.10	U	2.90	U	4540.00	B	4.40	U	11.30	U	2.70	U	769.00	
MBNB64	µg/l	0.90	B	30.00	B	15.30	U	67.20	B	0.40	U	2.70	U	3960.00	B	2.50	U	2.90	U	1.50	U	130.00	
7384B-01-004	µg/l	12.40																				380.00	
104758	µg/l	16.00																				506.00	

Qualifiers: U - Not Detected at Contract Required Detection Limit (CRDL); J - Estimated Concentration;
R - Rejected; B - Detected between CRDL and Instrument Detection Limit (IDL).

APPENDIX A
ANALYTICAL RESULTS FROM SURFACE WATER SAMPLING
Vineland Chemical Company Site

EPA Sample I.D.	Units	As		Al		Sb		Ba		Be		Cd		Ca		Cr		Co		Cu		Fe	
104768	µg/l	8.90																				209.00	
7576B-01-012	µg/l	9.10	BJ																			248.00	J
7576B-02-008	µg/l	4.90	B																			159.00	J
103493	µg/l	10.00																				116.00	
103969	µg/l	10.00	U	200.0	U	60.00	U	200.00	U	5.00	U	5.00	U	5000.00		10.00	U	50.00	U	25.00	U	165.00	
MBMK70	µg/l	3.70	U	63.8	JB	19.00	U	58.10	JB	0.90	U	1.40	U	4780.00	JB	4.20	U	3.20	U	4.90	U	106.00	J
MBML18	ug/L	2.00	JB	169.0	B	28.70	U	54.60	B	1.80	U	2.00	U	4870.00	B	5.00	U	10.40	U	1.70	U	168.00	J
101512	µg/l	10.00	U	200.00	U	60.00	U	200.00	U	5.00	U	5.00	U	5000.00	U	10.00	U	50.00	U	25.00	U	163.00	
MBML98	µg/l	10.60		105.0	B	16.00	U	62.30	B	0.30	U	3.70	U	4820.00	B	2.80	U	3.20	U	9.70	B	454.00	EJ
101544	µg/l	14.90		200.0	U	60.00	U	200.00	U	5.00	U	5.00	U	5000.00	U	10.00	U	50.00	U	25.00	U	675.00	
MBMF07	µg/l	23.10		41.4	U	50.60	U	61.00	B	2.10	U	2.90	U	4440.00	B		R	11.30	U	2.70	U	662.00	
MBML37	µg/l	7.10	B	20.9	U	15.30	U	60.10	B	0.40	U	2.70	U	4100.00	B	2.50	U	3.00	B	4.70	B	114.00	J
MBML39	µg/l	8.60	B	20.9	U	15.30	U	61.10	B	0.40	U	2.70	U	4110.00	B	2.50	U	2.90	U	1.50	U	218.00	J
104844	µg/l	323.00		200.0	U	60.00	U	200.00	U	5.00	U	5.00	U	5000.00	U	10.00	U	50.00	U	25.00	U	1050.00	
104840	µg/l	242.00		304.0		60.00	U	200.00	U	5.00	U	5.00	U	5000.00	U	10.00	U	50.00	U	25.00	U	861.00	
104843	µg/l	194.00		200.0	U	60.00	U	200.00	U	5.00	U	5.00	U	5000.00	U	10.00	U	50.00	U	25.00	U	807.00	
104838	µg/l	178.00		200.0	U	60.00	U	200.00	U	5.00	U	5.00	U	5000.00	U	10.00	U	50.00	U	25.00	U	647.00	
104815	µg/l	170.00		200.0	U	60.00	U	200.00	U	5.00	U	5.00	U	5000.00	U	10.00	U	50.00	U	25.00	U	371.00	
104825	µg/l	159.00		200.0	U	60.00	U	200.00	U	5.00	U	5.00	U	5000.00	U	10.00	U	50.00	U	25.00	U	380.00	
MBMK32	µg/l	225.00		138.0	B	18.40	U	80.50	B	0.50	U	1.60	U	3520.00	B	2.70	U	2.50	U	4.30	JB	640.00	
MBMK37	µg/l	293.00	J	525.0	J	18.40	U	52.10	JB	0.50	U	1.60	U	2670.00	JB	2.70	U	2.60	JB	6.00	JB	1870.00	J
MBMK42	µg/l	169.00	J	414.0	J	19.30	JB	51.70	JB	0.50	U	1.60	U	2940.00	JB	2.70	U	2.50	U	2.90	U	1050.00	J
MBMK47	µg/l	110.00	J	360.0		18.40	U	60.60	B	0.50	U	1.60	U	3750.00	B	2.70	U	2.50	U	2.90	U	546.00	
MBMK51	µg/l		R	189.0	J	18.40	U	103.00	B	0.50	U	4.40	JB	5480.00		2.70	U	2.50	U	2.90	U	303.00	
MBMK60	µg/l		R	127.0		18.40	U	92.40	B	0.50	U	1.60	U	4620.00	B	2.70	U	2.50	U	2.90	U	283.00	
103515	µg/l	106.00		200.0	U	60.00	U	200.00	U	5.00	U	5.00	U	5000.00	U	10.00	U	50.00	U	25.00	U	124.00	
MBMF61	ug/L	340.00		175.0	B	50.60	U	87.30	B	2.10	U	2.90	U	4050.00	B	4.40	U	11.30	U	5.00	B	1480.00	J
MBMF67	ug/L	272.00		214.0		50.60	U	90.00	B	2.10	U	2.90	U	4100.00	B	4.40	U	11.30	U	5.00	B	1060.00	J
MBMF63	ug/L	272.00		126.0	B	50.60	U	87.60	B	2.10	U	2.90	U	4650.00	B	4.40	U	11.30	U	4.00	B	904.00	J
MBMF26	ug/L	189.00		138.0	B	50.60	U	85.40	B	2.10	U	3.40	B	4510.00	B	4.40	U	11.30	U	4.40	B		R
MBMF14	ug/L	181.00	B	98.6	B	50.60	U	72.10	B	2.10	U	2.90	U	3550.00	B	4.40	U	11.30	U	2.70	U	637.00	

Qualifiers: U - Not Detected at Contract Required Detection Limit (CRDL); J - Estimated Concentration;
R - Rejected; B - Detected between CRDL and Instrument Detection Limit (IDL).

APPENDIX A
ANALYTICAL RESULTS FROM SURFACE WATER SAMPLING
Vineland Chemical Company Site

EPA Sample I.D.	Units	As		Al		Sb		Ba		Be		Cd		Ca		Cr		Co		Cu		Fe	
MBMF02	ug/L	205.00		99.0	B	50.60	U	75.10	B	2.10	U	2.90	U	3560.00	B	4.40	U	11.30	U	2.70	U	566.00	
104839	µg/l	25.00		200.0	U	60.00	U	200.00	U	5.00	U	5.00	U	5000.00	U	10.00	U	50.00	U	25.00	U	327.00	
104828	µg/l	42.90		200.0	U	60.00	U	200.00	U	5.00	U	5.00	U	5000.00	U	10.00	U	50.00	U	25.00	U	530.00	
104841	µg/l	38.30		200.0	U	60.00	U	200.00	U	5.00	U	5.00	U	5000.00	U	10.00	U	50.00	U	25.00	U	365.00	
104817	µg/l	18.70		200.0	U	60.00	U	200.00	U	5.00	U	5.00	U	5000.00	U	10.00	U	50.00	U	25.00	U	327.00	
104820	µg/l	12.20		200.0	U	60.00	U	200.00	U	5.00	U	5.00	U	5000.00	U	10.00	U	50.00	U	25.00	U	331.00	
104826	µg/l	13.00		200.0	U	60.00	U	200.00	U	5.00	U	5.00	U	5000.00	U	10.00	U	50.00	U	25.00	U	312.00	
MBMK33	µg/l	27.70	J	251.0	J	18.40	U	63.20	JB	0.50	U	1.60	U	3960.00	JB	2.70	U	2.60	JB	4.70	JB	745.00	J
MBMK38	µg/l	43.30		306.0		18.40	U	59.20	B	0.50	U	1.60	U	3630.00	B	2.70	U	2.60	B	2.90	U	725.00	
MBMK43	µg/l	36.30		326.0		18.40	U	56.70	B	0.50	U	1.60	U	3780.00	B	2.70	U	2.50	U	2.90	U	719.00	
MBMK48	µg/l	22.40		331.0		18.40	U	52.50	B	0.52	B	1.60	U	3610.00	B	2.70	U	2.50	U	2.90	U	786.00	
MBMK52	µg/l		R	692.0	J	18.40	U	49.90	JB	0.50	U	3.60	JB	4400.00	JB	2.80	JB	2.50	U	2.90	U	1130.00	J
MBMK58	µg/l		R	220.0		18.40	U	65.20	B	0.50	U	2.40	JB	4430.00	B	2.70	U	2.50	U	2.90	U	334.00	
MBMF72	µg/l	20.40		70.4	B	50.60	U	58.50	B	2.10	U	2.90	U	4170.00	B	4.40	U	11.30	U	2.70	U	633.00	J
MBMF75	µg/l	20.60		135.0	B	50.60	U	64.30	B	2.10	U	2.90	U	4460.00	B	4.40	U	11.30	U	4.40	B	684.00	J
MBMF74	µg/l	31.60		159.0	B	50.60	U	77.60	B	2.10	U	2.90	U	4470.00	B	4.40	U	11.30	U	6.00	B	813.00	J
MBMF30	µg/l	30.90		91.4	B	50.60	U	65.60	B	2.10	U	2.90	U	4650.00	B	4.40	U	11.30	U	2.70	U		R
MBMF16	µg/l	23.50		110.0	B	50.60	U	57.50	U	2.10	U	2.90	U	4200.00	B	4.40	U	11.30	U	11.20	B	669.00	
MBMF04	µg/l	20.90		41.4	U	50.60	U	55.90	B	2.10	U	2.90	U	4140.00	B	4.40	U	11.30	U	2.70	U		R
104833	µg/l	10.00	U	200.0	U	60.00	U	200.00	U	5.00	U	5.00	U	5000.00	U	10.00	U	50.00	U	25.00	U	1040.00	
104831	µg/l	10.70		200.0	U	60.00	U	200.00	U	5.00	U	5.00	U	5000.00	U	10.00	U	50.00	U	25.00	U	929.00	
104846	µg/l	11.80		200.0	U	60.00	U	200.00	U	5.00	U	5.00	U	5000.00	U	10.00	U	50.00	U	25.00	U	1390.00	
104827	µg/l	13.40		200.0	U	60.00	U	200.00	U	5.00	U	5.00	U	5000.00	U	10.00	U	50.00	U	25.00	U	1040.00	
104824	µg/l	10.00	U	200.0	U	60.00	U	200.00	U	5.00	U	5.00	U	5000.00	U	10.00	U	50.00	U	25.00	U	784.00	
104819	µg/l	11.00		200.0	U	60.00	U	200.00	U	5.00	U	5.00	U	5000.00	U	10.00	U	50.00	U	25.00	U	864.00	
MBMK34	µg/l	29.70		499.0		18.40	U	79.20	B	0.50	U	1.60	U	5440.00		2.70	U	4.20	B	5.10	JB	21400.00	
MBMK39	µg/l	9.90	JB	408.0	J	18.40	U	40.50	JB	0.50	U	1.60	U	3710.00	JB	2.70	U	2.60	JB	2.90	U	2370.00	J
MBMK44	µg/l	22.20	J	632.0	J	18.40	U	45.60	JB	0.50	U	1.60	U	4070.00	JB	3.50	JB	2.50	U	2.90	U	4170.00	J
MBMK49	µg/l	12.10		377.0		18.40	U	49.00	B	0.50	U	1.60	U	4790.00	B	2.70	U	2.50	U	2.90	U	1360.00	
MBMK53	µg/l		R	247.0		18.40	U	48.30	B	0.50	U	2.70	JB	3540.00	B	2.70	U	2.50	U	2.90	U	438.00	

Qualifiers: U - Not Detected at Contract Required Detection Limit (CRDL); J - Estimated Concentration;
R - Rejected; B - Detected between CRDL and Instrument Detection Limit (IDL).

APPENDIX A
ANALYTICAL RESULTS FROM SURFACE WATER SAMPLING
Vineland Chemical Company Site

EPA Sample I.D.	Units	As		Al		Sb		Ba		Be		Cd		Ca		Cr		Co		Cu		Fe	
MBMK57	µg/l		R	225.0		18.40	U	62.00	B	0.50	U	2.10	JB	5060.00		2.70	U	2.50	U	2.90	U	780.00	
MBMF56	µg/l	10.70		290.0		50.60	U	66.70	B	2.10	U	2.90	U	5070.00		4.40	U	11.30	U	2.70	U	10400.00	
MBMF46	µg/l		R	136.0	B	50.60	U	71.10	B	2.10	U	2.90	U	5480.00	J	4.40	U	11.30	U	4.40	U	3610.00	J
MBMF40	µg/l	13.90		99.8	B	50.60	U	68.90	B	2.10	U	2.90	U	5160.00		4.40	U	11.30	U	2.70	U		R
MBMF32	µg/l	12.80		80.2	B	50.60	U	66.00	B	2.10	U	2.90	U	5100.00		4.40	U	11.30	U	2.70	U		R
MBMF18	µg/l	11.40		65.2	B	50.60	U	66.80	B	2.10	U	2.90	U	4860.00	B	4.40	U	11.30	U	2.70	U	1310.00	
MBMF06	µg/l	19.70	B	71.9	B	50.60	U	65.70	B	2.10	U	2.90	U	4850.00	B	4.40	U	11.30	U	2.70	U	1320.00	
104836	µg/l	10.00	U	246.0		60.00	U	200.00	U	5.00	U	5.00	U	5000.00	U	10.00	U	50.00	U	25.00	U	585.00	
104818	µg/l	10.00	U	200.0	U	60.00	U	200.00	U	5.00	U	5.00	U	5000.00	U	10.00	U	50.00	U	25.00	U	378.00	
104829	µg/l	10.00	U	200.0	U	60.00	U	200.00	U	5.00	U	5.00	U	5000.00	U	10.00	U	50.00	U	25.00	U	380.00	
104835	µg/l	10.00	U	200.0	U	60.00	U	200.00	U	5.00	U	5.00	U	5000.00	U	10.00	U	50.00	U	25.00	U	352.00	
104842	µg/l	10.00	U	200.0	U	60.00	U	200.00	U	5.00	U	5.00	U	5000.00	U	10.00	U	50.00	U	25.00	U	318.00	
104814	µg/l	10.00	U	200.0	U	60.00	U	200.00	U	5.00	U	5.00	U	5000.00	U	10.00	U	50.00	U	25.00	U	338.00	
104822	µg/l	10.00	U	200.0	U	60.00	U	200.00	U	5.00	U	5.00	U	5000.00	U	10.00	U	50.00	U	25.00	U	366.00	
MBMK31	µg/l	3.70	U	195.0	B	20.70	B	59.20	B	0.50	U	1.60	U	4090.00	B	2.80	B	2.50	U	9.80	JB	504.00	
MBMK36	µg/l	3.70	U	249.0	J	18.40	U	61.60	JB	0.50	U	1.60	U	4260.00	JB	2.70	U	2.50	U	2.90	U	582.00	J
MBMK40	µg/l	3.70	U	277.0		18.40	U	61.80	B	0.50	U	1.60	U	4020.00	B	2.70	U	2.50	U	2.90	U	740.00	
MBMK45	µg/l	3.70	U	264.0	J	18.40	U	47.40	JB	0.50	U	1.60	U	3570.00	JB	2.70	U	2.50	U	4.20	JB	497.00	J
MBMK54	µg/l		R	264.0		18.40	U	47.40	B	0.50	U	2.50	JB	3640.00	B	2.70	U	2.50	U	2.90	U	510.00	
MBMK59	µg/l		R	210.0		18.40	U	61.80	B	0.50	U	2.70	JB	4360.00	B	2.70	U	2.50	U	2.90	U	336.00	
MBMF52	µg/l	2.20	U	41.4	U	50.60	U	46.60	B	2.10	U	2.90	U	4340.00	B	4.40	U	11.30	U	2.70	U	689.00	J
MBMF50	µg/l	2.20	U	67.0	B	50.60	U	46.60	B	2.10	U	2.90	U	4440.00	B	4.40	U	11.30	U	3.10	B	2240.00	J
MBMF44	µg/l	5.60	B	48.8	B	50.60	U	47.20	B	2.10	U	2.90	U	4590.00	B	4.40	U	11.30	U	3.40	B	755.00	J
MBMF36	µg/l	1.30	U	64.4	B	50.60	U	51.50	B	2.10	U	2.90	U	4820.00	B	4.40	U	11.30	U	2.70	U		R
MBMF22	µg/l	3.20	B	69.3	B	50.60	U	48.00	B	2.10	U	2.90	U	4430.00	B	4.40	U	11.30	U	2.70	B		R
MBMF10	µg/l	2.20	UJ	41.4	U	50.60	U	47.10	B	2.10	U	2.90	U	4420.00	B	4.40	U	11.30	U	2.70	U	833.00	
104834	µg/l	19.50		200.0	U	60.00	U	200.00	U	5.00	U	5.00	U	5000.00	U	10.00	U	50.00	U	25.00	U	533.00	
104845	µg/l	25.00		200.0	U	60.00	U	200.00	U	5.00	U	5.00	U	5000.00	U	10.00	U	50.00	U	25.00	U	712.00	
104830	µg/l	20.20		200.0	U	60.00	U	200.00	U	5.00	U	5.00	U	5000.00	U	10.00	U	50.00	U	25.00	U	622.00	
104837	µg/l	19.30		200.0	U	60.00	U	200.00	U	5.00	U	5.00	U	5000.00	U	10.00	U	50.00	U	25.00	U	608.00	

Qualifiers: U - Not Detected at Contract Required Detection Limit (CRDL); J - Estimated Concentration;
R - Rejected; B - Detected between CRDL and Instrument Detection Limit (IDL).

APPENDIX A
ANALYTICAL RESULTS FROM SURFACE WATER SAMPLING
Vineland Chemical Company Site

EPA Sample I.D.	Units	As		Al		Sb		Ba		Be		Cd		Ca		Cr		Co		Cu		Fe	
104816	µg/l	17.00		200.0	U	60.00	U	200.00	U	5.00	U	5.00	U	5000.00	U	10.00	U	50.00	U	25.00	U	606.00	
104823	µg/l	16.70		200.0	U	60.00	U	200.00	U	5.00	U	5.00	U	5000.00	U	10.00	U	50.00	U	25.00	U	464.00	
MBMK30	µg/l	9.70	BJ	78.6	BJ	18.40	U	55.70	BJ	0.52	BJ	1.60	U	4610.00	BJ	2.70	U	2.50	U	7.20	BJ	584.00	J
MBMK35	µg/l	13.20		93.6	B	18.40	U	56.30	B	0.50	U	1.60	U	4570.00	B	2.70	U	2.50	U	2.90	U	672.00	
MBMK41	µg/l	10.70	J	91.4	JB	18.40	U	57.60	JB	0.50	U	1.60	U	4600.00	JB	2.70	U	2.50	U	2.90	U	667.00	J
MBMK46	µg/l	9.70	B	98.7	B	18.40	U	57.20	B	0.50	U	1.60	U	4600.00	B	2.70	U	2.60	B	2.90	U	677.00	
MBMK50	µg/l		R	592.0	J	18.40	U	56.60	JB	0.50	U	3.20	JB	4430.00	JB	2.70	U	2.50	U	2.90	U	1180.00	J
MBMK56	µg/l		R	483.0		18.40	U	52.20	B	0.50	U	1.90	JB	4210.00	B	2.70	U	2.50	U	2.90	U	879.00	
MBMF54	µg/l	14.80		151.0	B	50.60	U	68.50	B	2.10	U	2.90	U	4810.00	B	4.40	U	11.30	U	4.80	B	1000.00	J
MBMF48	µg/l	16.50	J	41.4	U	50.60	U	60.40	B	2.10	U	2.90	U	4530.00	B	4.40	U	11.30	U	2.70	U	649.00	J
MBMF42	µg/l	20.60		58.9	B	50.60	U	61.60	B	2.10	U	2.90	U	4620.00	B	4.40	U	11.30	U	3.60	B	886.00	J
MBMF34	µg/l	15.80		89.8	B	50.60	U	60.10	B	2.10	U	2.90	U	4360.00	B	4.40	U	11.30	U	2.70	U		R
MBMF20	µg/l	19.70		66.4	B	50.60	U	62.40	B	2.10	U	2.90	U	4480.00	B	4.40	U	11.30	U	3.90	B		R
MBMF08	µg/l	21.80		42.5	B	50.60	U	61.70	B	2.10	U	2.90	U	4670.00	B	4.40	U	11.30	U	2.70	U	783.00	
104778	µg/l	122.00																				150.00	
104783	µg/l	122.00																				140.00	
104788	µg/l	117.00																				100.00	U
104794	µg/l	117.00																				100.00	U
104801	µg/l	117.00																				100.00	U
104804	µg/l	116.00																				100.00	U
103490	µg/l	85.70																				100.00	U
103507	µg/l	85.50																				100.00	U
103512	µg/l	117.00																				117.00	
MBMF62	µg/l	117.00	J	41.4	U	50.60	U	79.10	B	2.10	U	2.90	U	3690.00		4.40	U	11.30	U	2.80	B	153.00	J
MBMF68	µg/l	104.00	J	63.6	B	50.60	U	86.90	B	2.10	U	2.90	U	4050.00	B	4.40	U	11.30	U	4.00	B	177.00	J
MBMF64	µg/l																						
MBMF25	µg/l	118.00		83.2	B	50.60	U	78.60	B	2.10	U	2.90	U	4260.00	B	4.40	U	11.30	U	4.40	B	274.00	J
MBMF23	µg/l	82.00	B	41.4	U	50.60	U	71.60	B	2.10	U	2.90	U	3900.00	B	4.40	U	11.30	U	2.70	U	182.00	

Qualifiers: U - Not Detected at Contract Required Detection Limit (CRDL); J - Estimated Concentration;
R - Rejected; B - Detected between CRDL and Instrument Detection Limit (IDL).

APPENDIX A
ANALYTICAL RESULTS FROM SURFACE WATER SAMPLING
Vineland Chemical Company Site

EPA Sample I.D.	Units	As		Al		Sb		Ba		Be		Cd		Ca		Cr		Co		Cu		Fe	
MBMF01	µg/l	94.30	B	41.4	U	50.60	U	76.30	B	2.10	U	2.90	U	3560.00	B	4.40	U	11.30	U	2.70	U	147.00	
104779	µg/l	19.40																				100.00	U
104784	µg/l	5.00	U																			147.00	
104789	µg/l	24.10																				125.00	
104795	µg/l	14.20																				123.00	
104802	µg/l	9.30																				104.00	
104805	µg/l	10.20																				143.00	
103491	µg/l	11.60																				153.00	
103495	µg/l	14.90																				283.00	
103499	µg/l	14.80																				207.00	
103506	µg/l	10.00	U																			183.00	
103511	µg/l	10.00	U																			195.00	
MBMF71	µg/l	19.70	J	41.4	U	50.60	U	57.70	B	2.10	U	2.90	U	4250.00	B	4.40	U	11.30	U	2.70	U	340.00	J
MBMF76	µg/l	15.00		77.4	B	50.60	U	63.10	B	2.10	U	2.90	U	4330.00	B	4.40	U	11.30	U	3.30	B	359.00	J
MBMF73	µg/l	16.00		92.8	B	50.60	U	57.90	B	2.10	U	2.90	U	4150.00	B	4.40	U	11.30	U	7.50	B	410.00	J
MBMF29	µg/l	32.40		65.6	B	50.60	U	60.00	B	2.10	U	2.90	U	4330.00	B	4.40	U	11.30	U	2.90	B	446.00	J
MBMF15	µg/l	17.50	B	41.4	U	50.60	U	57.70	B	2.10	U	2.90	U	4400.00	B	4.40	U	11.30	U	2.70	U	401.00	
MBMF03	µg/l	21.70		71.6	B	50.60	U	55.60	B	2.10	U	2.90	U	4010.00	B	4.40	U	11.30	U	2.70	U		R
104780	µg/l	5.00	U																			162.00	
104785	µg/l	20.70																				116.00	
104790	µg/l	6.10																				100.00	U
104796	µg/l	7.00																				100.00	U
104803	µg/l	5.20																				100.00	U
104806	µg/l	6.60																				220.00	
103492	µg/l	10.00	U																			1280.00	
103496	µg/l	10.00																				173.00	
103500	µg/l	10.00	U																			192.00	
103508	µg/l	10.00	U																			237.00	

Qualifiers: U - Not Detected at Contract Required Detection Limit (CRDL); J - Estimated Concentration;
R - Rejected; B - Detected between CRDL and Instrument Detection Limit (IDL).

APPENDIX A
ANALYTICAL RESULTS FROM SURFACE WATER SAMPLING
Vineland Chemical Company Site

EPA Sample I.D.	Units	As		Al		Sb		Ba		Be		Cd		Ca		Cr		Co		Cu		Fe	
103510	µg/l	10.00	U																			440.00	
MBMF55	µg/l	2.20	B	41.4	U	50.60	U	53.10	B	2.10	U	2.90	U	5110.00		4.40	U	11.30	U	2.70	U	403.00	
MBMF45	µg/l		R	41.4	U	50.60	U	62.60	B	2.10	U	2.90	U	5130.00		4.40	U	11.30	U	2.70	U	580.00	J
MBMF39	µg/l	5.20	B	52.1	B	50.60	U	66.00	B	2.10	U	2.90	U	5240.00		4.40	U	11.30	U	2.70	U	641.00	J
MBMF31	µg/l	5.50	B	42.0	B	50.60	U	64.40	B	2.10	U	2.90	U	4860.00	B	4.40	U	11.30	U	2.70	U	630.00	J
MBMF05	µg/l	6.30	BJ	41.4	U	50.60	U	62.20	B	2.10	U	2.90	U	4700.00	B	4.40	U	11.30	U	2.70	U	568.00	
MBMF17	µg/l	5.20	BJ	41.4	U	50.60	U	65.70	B	2.10	U	2.90	U	4960.00	B	4.40	U	11.30	U	2.70	U	637.00	
104777	µg/l	5.00	U																			100.00	U
104781	µg/l	5.00	U																			154.00	
104786	µg/l	5.00	U																			100.00	U
104791	µg/l	5.00	U																			275.00	
104800	µg/l	5.00	U																			100.00	U
104807	µg/l	5.00	U																			100.00	U
104810	µg/l	5.00	U																			100.00	U
103489	µg/l	10.00	U																			100.00	U
103494	µg/l	10.00	U																			189.00	
103498	µg/l	10.00	U																			126.00	
103502	µg/l	10.00	U																			170.00	
103504	µg/l	10.00	U																			261.00	
103513	µg/l	10.00	U																			213.00	
MBMF51	µg/l	5.50	B	41.4	U	50.60	U	46.10	B	2.10	U	2.90	U	4510.00	B	4.40	U	11.30	U	2.70	U	359.00	J
MBMF49	µg/l	2.20	U	64.7	B	50.60	U	48.20	B	2.10	U	2.90	U	4470.00	B	4.40	U	11.30	U	2.70	U	729.00	J
MBMF43	µg/l	2.20	U	41.4	U	50.60	U	45.70	B	2.10	U	2.90	U	4480.00	B	4.40	U	11.30	U	3.20	B	558.00	J
MBMF35	µg/l	1.70	B	62.6	B	50.60	U	48.60	B	2.10	U	2.90	U	4610.00	B	4.40	U	11.30	U	9.40	B	575.00	J
MBMF21	µg/l	1.30	U	54.9	B	50.60	U	47.00	B	2.10	U	2.90	U	4390.00	B	4.40	U	11.30	U	2.70	U	679.00	J
MBMF09	µg/l	2.20	UJ	49.5	B	50.60	U	48.00	B	2.10	U	2.90	U	4540.00	B	4.40	U	11.30	U	2.70	U	769.00	
104782	µg/l	9.10																				100.00	U
104787	µg/l	10.40																				110.00	
104792	µg/l	7.40																				100.00	U
104793	µg/l	7.50																				100.00	U

Qualifiers: U - Not Detected at Contract Required Detection Limit (CRDL); J - Estimated Concentration;
R - Rejected; B - Detected between CRDL and Instrument Detection Limit (IDL).

APPENDIX A
ANALYTICAL RESULTS FROM SURFACE WATER SAMPLING
Vineland Chemical Company Site

EPA Sample I.D.	Units	As		Al		Sb		Ba		Be		Cd		Ca		Cr		Co		Cu		Fe	
104799	µg/l	10.20																				145.00	
104808	µg/l	8.90																				100.00	U
103493	µg/l	10.00																				116.00	
103497	µg/l	10.00																				106.00	
103501	µg/l	10.00	U																			169.00	
103503	µg/l	10.00	U																			100.00	U
103505	µg/l	10.00	U																			134.00	
103509	µg/l	10.00	U																			244.00	
MBMF53	µg/l	12.00		104.0	B	50.60	U	66.50	B	2.10	U	2.90	U	4960.00	B	4.40	U	11.30	U	4.60	B	703.00	J
MBMF47	µg/l	19.30	J	56.2	B	50.60	U	59.80	B	2.10	U	2.90	U	4430.00	B	4.40	U	11.30	U	2.70	U	851.00	J
MBMF41	µg/l	16.70	J	51.0	B	50.60	U	60.80	B	2.10	U	2.90	U	4320.00	B	4.40	U	11.30	U	3.10	B	664.00	J
MBMF33	µg/l	11.20		58.3	B	50.60	U	60.90	B	2.10	U	2.90	U	4540.00	B	4.40	U	11.30	U	3.10	B	691.00	J
MBMF19	µg/l	11.80		63.8	B	50.60	U	62.40	B	2.10	U	2.90	U	4400.00	B	4.40	U	11.30	U	5.30	B	732.00	J
MBMF07	µg/l	23.10		41.4	U	50.60	U	61.00	B	2.10	U	2.90	U	4440.00	B		R	11.30	U	2.70	U	662.00	
MBNC83	µg/l	15.60	J	56.0	U	36.00	U	53.50	B	2.00	U	3.00	U	3620.00	B	6.00	U	8.00	U	11.00	U	686.00	
MBZ443	µg/l	16.40	J	84.9	B	36.00	U	61.70	B	2.00	U	3.00	U	3780.00	B	6.00	U	8.00	U	11.00	U	743.00	
MBGZ41	µg/l	21.20	J	54.8	B	17.90	U	62.30	B	0.40	U	1.50	U	4200.00	B	1.80	U	1.50	U	2.20	U	839.00	
MBJT96	µg/l	17.80	J	47.6	B	17.90	U	58.40	B	0.40	U	1.50	U	3860.00	B	1.80	U	1.50	U	2.20	U	710.00	
MBEN17	µg/l	20.50	J	68.4	BJ	15.70	UJ	57.80	BJ	1.20	UJ	1.50	UJ	3710.00	BJ	5.10	UJ	2.50	UJ	4.00	UJ	783.00	J
102175	µg/l	22.2		200	U	60	U	200	U	5	U	5	U	5000	U	10	U	50	U	25	U	764	
102363	µg/l	22.1		200	U	60	U	200	U	5	U	5	U	5000	U	10	U	50	U	25	U	982	
102367	µg/l	23.4		200	U	60	U	200	U	5	U	5	U	5000	U	10	U	50	U	25	U	766	
102371	µg/l	22.5		200	U	60	U	200	U	5	U	5	U	5000	U	10	U	50	U	25	U	738	
102375	µg/l	22.9		200	U	60	U	200	U	5	U	5	U	5000	U	10	U	50	U	25	U	682	
101566	µg/l	22.4		200	U	60	U	200	U	5	U	5	U	5000	U	10	U	50	U	25	U	632	
101570	µg/l	18.9		200	U	60	U	200	U	5	U	5	U	5000	U	20	U	50	U	25	U	746	
101572	µg/l	20.7		200	U	60	U	200	U	5	U	5	U	5000	U	20	U	50	U	25	U	742	
MBNC84	µg/l	17.80	J	31.0	U	48.00	U	58.50	B	1.00	U	5.00	UJ	3590.00	B	10.00	UJ	10.00	U	5.00	U	635.00	
MBZ444	µg/l	17.60		31.0	U	48.00	U	57.00	B	1.00	U	5.00	UJ	3570.00	B	10.00	UJ	10.00	U	5.00	U	644.00	
MBGZ31	µg/l	15.50	J	161.0	BJ	17.90	UJ	60.60	BJ	0.40	UJ	1.50	UJ	4190.00	BJ	3.20	BJ	1.50	UJ	2.20	UJ	743.00	J

Qualifiers: U - Not Detected at Contract Required Detection Limit (CRDL); J - Estimated Concentration;
R - Rejected; B - Detected between CRDL and Instrument Detection Limit (IDL).

APPENDIX A
ANALYTICAL RESULTS FROM SURFACE WATER SAMPLING
Vineland Chemical Company Site

EPA Sample I.D.	Units	As		Al		Sb		Ba		Be		Cd		Ca		Cr		Co		Cu		Fe	
MBJT95	µg/l	13.10	J	43.8	B	17.90	U	59.00	B	0.40	U	1.50	U	3800.00	B	1.80	U	1.50	U	2.20	U	566.00	
MBEN18	µg/l	19.10	J	35.1	B	17.90	U	61.80	B	0.40	U	1.50	U	3730.00	B	1.80	U	1.50	U		R	622.00	
102360	µg/l	16.8		200	U	60	U	200	U	5	U	5	U	5000	U	10	U	50	U	25	U	527	
102364	µg/l	15.3		200	U	60	U	200	U	5	U	5	U	5000	U	10	U	50	U	25	U	654	
102368	µg/l	15.3		200	U	60	U	200	U	5	U	5	U	5000	U	10	U	50	U	25	U	441	
102372	µg/l	18.7		200	U	60	U	200	U	5	U	5	U	5000	U	10	U	50	U	25	U	621	
101561	µg/l	18.8		200	U	60	U	200	U	5	U	5	U	5000	U	10	U	50	U	25	U	595	
101567	µg/l	13.3		200	U	60	U	200	U	5	U	5	U	5000	U	10	U	50	U	25	U	356	
101571	µg/l	16.5		200	U	60	U	200	U	5	U	5	U	5000	U	10	U	50	U	25	U	475	
101573	µg/l	15.7		200	U	60	U	200	U	5	U	5	U	5000	U	10	U	50	U	25	U	454	
MBMD99	µg/L	42.60		68.7	B	48.00	U	81.00	B	1.00	U	5.00	U	4630.00	B	10.00	U	10.00	U	5.00	U	2450.00	
MBML77	µg/L	42.00		134.0	B	36.00	U	81.90	B	3.40	B	3.00	U	4760.00	B	6.00	U	8.00	U	11.00	U	2920.00	
MBNC11	µg/L	60.00		59.6	B	48.00	U	83.60	B	1.00	U	5.00	U	4830.00	B	10.00	U	10.00	U	5.00	U	3590.00	
MBNC00	µg/L	64.80		63.1	B	36.00	U	84.90	B	2.00	U	3.00	U	4840.00	B	6.00	U	8.00	U	11.00	U	4040.00	
MBNC12	µg/L	59.00		49.2	B	48.00	U	82.80	B	1.00	U	5.00	U	4710.00	B	10.00	U	10.00	U	5.00	U	3660.00	
MBNC01	µg/L	63.00		64.4	B	36.00	U	86.60	B	2.00	U	3.00	U	4920.00	B	6.00	U	8.00	U	11.00	U	3980.00	
MBNC23	µg/L	48.20		35.5	B	48.00	U	78.40	B	1.00	U	5.00	U	4630.00	B	10.00	U	10.00	U	5.00	U	3040.00	
MBNC22	µg/L	66.30		146.0	B	36.00	U	82.30	B	2.00	U	3.00	U	4960.00	B	6.00	U	8.00	U	11.00	U	3970.00	
MBNC43	µg/L	61.60		105.0	B	48.00	U	81.80	B	1.00	U	5.00	U	5020.00		10.00	U	10.00	U	5.00	U	3800.00	
MBNC42	µg/L	59.20		156.0	B	36.00	U	83.20	B	3.70	JB	3.00	U	4980.00	B	6.00	U	18.70	B	11.00	U	4220.00	
MBNC74	µg/L	46.20	J	38.2	B	48.00	U	83.00	B	1.00	U	5.00	UJ	4490.00	B	10.00	UJ	10.00	U	5.00	U	2040.00	
MBNC64	µg/L	36.00	J	87.7	B	36.00	U	78.80	B	2.00	UJ	3.00	U	4540.00	B	6.00	U	8.00	U	11.00	U	2080.00	
MBGZ22	µg/L	45.80	J	60.9	JB	17.90	UJ	87.00	JB	0.40	UJ	1.50	UJ	4240.00	JB	1.80	UJ	1.90	JB	2.20	UJ	1810.00	J
MBGZ32	µg/L	59.00		244.0		15.70	U	91.30	B	1.20	U	1.50	B	4310.00	B	5.10	U	3.30	B	4.00	U	2540.00	
MBGZ43	µg/L	44.40	J	72.7	JB	17.90	UJ	86.20	JB	0.40	UJ	1.50	UJ	4830.00	JB	1.80	UJ	1.80	JB	2.20	UJ	1870.00	J
MBGZ42	µg/L	41.40	J	122.0	JB	17.90	UJ	86.30	JB	0.40	UJ	1.50	UJ	4630.00	JB	1.80	UJ	2.80	JB	2.20	UJ	2170.00	J
MBEN20	µg/L	59.80	J	75.4	B	17.90	U	82.20	B	0.40	U	1.50	U	4360.00	B	1.80	U	2.20	B	2.20	U	2910.00	
MBEN30	µg/L	64.50		114.0	B	15.70	U	82.30	B	1.20	U	1.50	U	4100.00	B	5.10	U	3.80	B	4.00	U	3140.00	
MBGZ45	µg/L	69.80	J		R	17.90	UJ	85.10	JB	0.40	UJ	1.50	UJ	4020.00	JB	1.80	UJ	2.40	JB		R	3200.00	J
MBGZ44	µg/L	63.80	J		R	17.90	UJ	90.10	JB	0.40	UJ	1.70	JB	4160.00	JB	1.80	UJ	1.60	JB	2.20	UJ	2670.00	J
MBME00	µg/L	29.60		31.0	U	48.00	U	67.60	B	1.00	U	5.00	U	4300.00	B	10.00	U	10.00	U	5.00	U	1340.00	

Qualifiers: U - Not Detected at Contract Required Detection Limit (CRDL); J - Estimated Concentration;
R - Rejected; B - Detected between CRDL and Instrument Detection Limit (IDL).

APPENDIX A
ANALYTICAL RESULTS FROM SURFACE WATER SAMPLING
Vineland Chemical Company Site

EPA Sample I.D.	Units	As		Al		Sb		Ba		Be		Cd		Ca		Cr		Co		Cu		Fe	
MBML78	µg/L	28.20		77.3	B	36.00	U	69.00	B	3.40	JB	3.00	U	4560.00	B	6.00	U	8.00	U	11.00	U	1600.00	
MBNC13	µg/L	31.40		46.7	B	48.00	UJ	73.20	B	1.00	U	5.00	U	4490.00	B	10.00	U	10.00	U	5.00	U	1520.00	
MBNC02	µg/L	37.60		58.9	B	36.00	U	75.40	B	2.00	U	3.00	U	4650.00	B	6.00	U	8.00	U	11.00	U	1900.00	
MBNC25	µg/L	30.00	B	31.0	U	48.00	U	67.90	B	1.00	U	5.00	U	4280.00	B	10.00	U	10.00	U	5.00	U	1420.00	
MBNC24	µg/L	35.80		59.0	B	36.00	U	69.30	B	3.70	JB	3.00	U	4500.00	B	6.00	U	8.00	U	11.00	U	1650.00	
MBNC45	µg/L	17.80		38.3	B	48.00	U	61.90	B	1.00	U	5.00	U	3970.00	B	10.00	U	10.00	U	5.00	U	759.00	
MBNC44	µg/L	17.00		84.3	B	36.00	U	62.40	B	3.40	JB	3.00	U	4120.00	B	6.00	U	8.00	U	11.00	U	890.00	
MBNC75	µg/L	27.20		46.1	B	48.00	U	63.50	B	1.00	U	5.00	UJ	4090.00	B	10.00	UJ	10.00	U	5.00	U	1180.00	
MBNC65	µg/L	35.80		97.2	B	36.00	U	62.90	B	2.00	UJ	3.00	UJ	4100.00	B	6.00	U	8.00	U	11.00	U	1330.00	
MBGZ23	µg/L	34.80	J	48.0	JB	17.90	UJ	69.20	JB	0.40	UJ	1.50	UJ	4080.00	JB	1.80	UJ	1.50	UJ	2.20	UJ	1230.00	J
MBGZ33	µg/L	39.50	J	57.4	JB	15.70	UJ	66.80	JB	1.20	UJ	1.50	UJ	4210.00	JB	5.10	UJ	2.50	UJ	4.00	UJ	1370.00	J
MBEN21	µg/L	46.20	J	71.6	JB	17.90	UJ	67.60	JB	0.40	UJ	1.50	UJ	3880.00	JB	1.80	UJ	1.90	JB	2.20	UJ	1640.00	J
MBEN31	µg/L	48.20	J	101.0	JB	15.70	UJ	61.70	JB	1.20	UJ	1.50	UJ	3840.00	JB	5.10	UJ	2.50	UJ	5.40	JB	1780.00	J
MBGZ47	µg/L	31.20		65.2	B	17.90	U	64.50	B	0.40	U	1.50	U	4000.00	B	1.80	U	1.50	U	2.20	U	1160.00	
MBGZ46	µg/L	36.00	J	50.5	JB	17.90	UJ	66.40	JB	0.40	UJ	1.90	JB	3800.00	JB	1.80	UJ	1.50	UJ	2.20	UJ	1330.00	J
MBME01	µg/L	23.00		31.0	U	48.00	U	62.00	B	1.00	U	5.00	U	3870.00	B	10.00	U	10.00	U	5.00	U	880.00	
MBML79	µg/L	22.60		80.2	B	36.00	U	65.50	B	3.40	JB	3.00	U	4330.00	B	6.00	U	8.00	U	11.00	U	1090.00	
MBNC14	µg/L	20.10		64.9	B	48.00	UJ	64.70	B	1.00	U	5.00	U	4190.00	B	10.00	U	10.00	U	5.00	U	898.00	
MBNC03	µg/L	25.60		71.8	B	36.00	U	65.80	B	2.00	U	3.00	U	4200.00	B	6.00	U	8.00	U	11.00	U	1030.00	
MBNC27	µg/L	25.60		31.0	U	48.00	U	63.30	B	1.00	U	5.00	U	4050.00	B	10.00	U	10.00	U	5.00	U	1100.00	
MBNC26	µg/L	34.10		63.2	B	36.00	U	67.60	B	2.00	U	3.00	U	4350.00	B	6.00	U	8.00	U	11.00	U	1290.00	
MBNC47	µg/L	17.40		37.7	B	48.00	U	60.40	B	1.00	U	5.00	U	3920.00	B	10.00	U	10.00	U	5.30	B	711.00	
MBNC46	µg/L	19.40		80.1	B	36.00	U	62.40	B	3.70	JB	3.00	U	4080.00	B	6.00	U	8.00	U	11.00	U	874.00	
MBNC76	µg/L	21.40		31.2	B	48.00	U	62.00	B	1.00	U	5.00	UJ	3810.00	B	10.00	UJ	10.00	U	5.00	U	857.00	
MBNC66	µg/L	22.20		67.8	B	36.00	U	61.50	B	2.00	UJ	3.00	U	3960.00	B	6.00	U	8.00	U	11.00	U	972.00	
MBGZ24	µg/L	21.20	J	35.4	JB	17.90	UJ	63.20	JB	0.40	UJ	1.50	UJ	3730.00	JB	1.80	UJ	1.50	UJ	2.20	UJ	765.00	J
MBGZ34	µg/L	20.70	J	63.5	JB	15.70	UJ	59.10	JB	1.20	UJ	1.50	UJ	3920.00	JB	5.10	UJ	2.50	UJ	4.00	UJ	852.00	J
MBEN22	µg/L	21.00	J	49.0	B	17.90	U	61.20	B	0.40	U	1.50	U	3590.00	B	1.80	U	1.50	U	2.20	U	728.00	
MBEN32	µg/L	25.00		69.4	B	15.70	U	59.10	B	1.20	U	1.50	U	3530.00	B	5.10	U	2.50	U	4.00	U	887.00	
MBGZ51	µg/L	27.50		50.4	B	17.90	U	62.90	B	0.40	U	1.50	U	3840.00	B	1.80	U	1.50	U	2.20	U	962.00	
MBGZ50	µg/L	31.70	J	60.0	JB	17.90	UJ	64.50	JB	0.40	UJ	1.50	UJ	3770.00	JB	1.80	UJ	1.50	UJ	2.20	UJ	1100.00	J
MBGZ49	µg/L	25.30		45.9	B	17.90	U	63.70	B	0.40	U	1.50	U	3860.00	B	1.80	U	1.50	U	2.20	U	906.00	

Qualifiers: U - Not Detected at Contract Required Detection Limit (CRDL); J - Estimated Concentration;
R - Rejected; B - Detected between CRDL and Instrument Detection Limit (IDL).

APPENDIX A
ANALYTICAL RESULTS FROM SURFACE WATER SAMPLING
Vineland Chemical Company Site

EPA Sample I.D.	Units	As		Al		Sb		Ba		Be		Cd		Ca		Cr		Co		Cu		Fe	
MBGZ48	µg/L	30.60		36.1	B	17.90	U	61.00	B	0.40	U	1.50	U	3620.00	B	1.80	U	1.50	U	2.20	U	1060.00	
MBMF82	µg/L	16.60		31.0	U	48.00	U	58.20	B	1.00	U	5.00	U	3720.00	B	10.00	U	10.00	U	5.00	U	654.00	
MBML80	µg/L	16.40		74.4	B	36.00	U	64.60	B	3.40	JB	3.00	U	4140.00	B	6.00	U	8.00	U	11.00	U	824.00	
MBNC15	µg/L	13.00		41.0	B	48.00	UJ	55.30	B	1.00	U	5.00	U	3660.00	B	10.00	U	10.00	U	5.00	U	541.00	
MBNC04	µg/L	19.40		61.7	B	36.00	U	62.40	B	2.00	U	3.00	U	4080.00	B	6.00	U	8.00	U	11.00	U	726.00	
MBNC29	µg/L	16.60		31.0	U	48.00	U	59.30	B	1.00	U	5.00	U	3680.00	B	10.00	U	10.00	U	5.00	U	628.00	
MBNC28	µg/L	17.60		61.6	B	36.00	U	62.40	B	2.00	U	3.00	U	4070.00	B	6.00	U	8.00	U	11.00	U	757.00	
MBNC49	µg/L	16.80		31.0	U	48.00	U	59.60	B	1.00	U	5.00	U	3760.00	B	10.00	U	10.00	U	5.00	U	595.00	
MBNC48	µg/L	19.00		66.1	B	36.00	U	61.00	B	3.40	JB	3.00	U	3940.00	B	6.00	U	8.00	U	11.00	U	824.00	
MBNC55	µg/L	16.10		42.8	B	48.00	U	61.80	B	1.00	U	5.00	U	4030.00	B	10.00	U	10.00	U	5.00	U	663.00	
MBNC54	µg/L	18.40		71.8	B	36.00	U	67.40	B	4.20	JB	3.00	U	4440.00	B	6.00	U	8.00	U	11.00	U	899.00	
MBNC77	µg/L	16.70		31.0	U	48.00	U	61.40	B	1.00	U	5.00	UJ	3850.00	B	10.00	UJ	10.00	U	5.00	U	638.00	
MBNC67	µg/L	29.00		63.2	B	36.00	U	60.00	B	2.00	UJ	3.00	U	3910.00	B	6.00	U	8.00	U	11.00	U	820.00	
MBGZ25	µg/L	20.10		32.2	B	17.90	U	62.70	B	0.40	U	1.50	U	3710.00	B	1.80	U	1.50	U	2.20	U	1010.00	
MBGZ35	µg/L	26.20		65.1	B	15.70	U	64.30	B	1.20	U	1.50	U	3890.00	B	5.10	U	2.50	U	4.00	U	1000.00	
MBEN23	µg/L	20.60	J	46.6	B	17.90	U	60.20	B	0.40	U	1.50	U	3660.00	B	1.80	U	1.50	U	2.20	U	711.00	
MBEN33	µg/L	24.00		53.8	B	15.70	U	57.80	B	1.20	U	1.50	U	3640.00	B	5.10	U	2.50	U	4.00	U	840.00	
MBGZ53	µg/L	13.60		47.4	B	17.90	U	60.10	B	0.40	U	1.50	U		R	1.80	U	1.50	U	2.20	U	493.00	
MBGZ52	µg/L	22.50	J	39.5	JB	17.90	UJ	60.00	JB	0.40	UJ	1.50	UJ		R	1.80	UJ	1.50	UJ	2.20	UJ	805.00	J
MBMF83	µg/L	16.60		31.0	U	48.00	U	58.80	B	1.00	U	5.00	U	3830.00	B	10.00	U	10.00	U	5.00	U	623.00	
MBML81	µg/L	13.90	J	56.0	U	36.00	U	62.00	B	2.00	U	3.00	U	3630.00	B	6.00	U	8.00	U	11.00		652.00	
MBNC16	µg/L	14.40		34.2	B	48.00	UJ	57.30	B	1.00	U	5.00	U	3820.00	B	10.00	U	10.00	U	5	U	581.00	
MBNC05	µg/L	17.10		66.0	B	36.00	U	60.60	B	3.10	JB	3.00	U	4030.00	B	6.00	U	8.00	U	11.00	U	715.00	
MBNC32	µg/L	16.40		31.0	U	48.00	U	59.90	B	1.00	U	5.00	U	3890.00	B	10.00	U	10.00	U	5.00	U	638.00	
MBNC31	µg/L	15.00		74.4	B	36.00	U	62.40	B	3.70	JB	3.00	U	4130.00	B	6.00	U	12.50	B	11.00	U	723.00	
MBNC51	µg/L	18.00		44.5	B	48.00	U	62.10	B	1.00	U	5.00	U	3990.00	B	10.00	U	10.00	U	5.00	U	730.00	
MBNC50	µg/L	20.00		84.5	B	36.00	U	61.00	B	3.40	JB	3.00	U	3990.00	B	6.00	U	8.00	U	11.00	U	854.00	
MBNC78	µg/L	16.40		31.9	B	48.00	U	60.10	B	1.00	U	5.00	UJ	3890.00	B	10.00	UJ	10.00	U	5.00	U	649.00	
MBNC68	µg/L	32.60		69.0	B	36.00	U	62.20	B	2.00	U	3.00	U	3870.00	B	6.00	U	8.00	U	11.00	U	799.00	
MBGZ26	µg/L	19.70		42.2	B	17.90	U	61.80	B	0.40	U	1.50	U	3690.00	B	1.80	U	1.50	U	2.20	U	713.00	
MBGZ36	µg/L	20.70		52.2	B	15.70	U	60.40	B	1.20	U	1.50	U	3770.00	B	5.10	U	2.50	U	4.00	U	791.00	
MBEN24	µg/L	20.80	J	45.6	B	17.90	U	62.00	B	0.40	U	1.50	U	3700.00	B	1.80	U	1.50	U	2.20	U	727.00	

Qualifiers: U - Not Detected at Contract Required Detection Limit (CRDL); J - Estimated Concentration;
R - Rejected; B - Detected between CRDL and Instrument Detection Limit (IDL).

APPENDIX A
ANALYTICAL RESULTS FROM SURFACE WATER SAMPLING
Vineland Chemical Company Site

EPA Sample I.D.	Units	As		Al		Sb		Ba		Be		Cd		Ca		Cr		Co		Cu		Fe	
MBEN34	µg/L	21.10	J	51.1	JB	15.70	UJ	56.60	JB	1.20	UJ	1.50	UJ	3700.00	JB	5.10	UJ	2.50	UJ	4.00	UJ	798.00	J
MBGZ55	µg/L	13.60		34.9	B	17.90	U	59.80	B	0.40	U	1.50	U	3710.00	B	1.80	U	1.50	U	2.20	U	532.00	
MBGZ54	µg/L	18.30	J	38.6	JB	17.90	UJ	61.70	JB	0.40	UJ	1.50	UJ	3680.00	JB	1.80	UJ	1.54	UJ	2.20	UJ	730.00	J
MBMF84	µg/L	17.50	J	31.0	U	48.00	U	55.80	B	1.00	U	5.00	U	3770.00	B	10.00	U	10.00	U	5.00	U	594.00	
MBML82	µg/L	14.40	J	56.0	U	36.00	U	62.00	B	2.00	U	3.00	U	3670.00	B	6.00	U	8.00	U	11.00	U	657.00	
MBNC17	µg/L	15.60		37.0	B	48.00	UJ	62.30	B	1.00	U	5.00	U	4240.00	B	10.00	U	10.00	U	5.00	U	644.00	
MBNC06	µg/L	16.40		56.0	U	36.00	U	62.40	B	3.70	JB	3.00	U	4060.00	B	6.00	U	8.00	U	1.00	U	720.00	
MBNC34	µg/L	16.20		31.0	U	48.00	U	58.60	B	1.00	U	5.00	U	3730.00	B	10.00	U	10.00	U	5.00	U	616.00	
MBNC33	µg/L	17.00		56.0	U	36.00	U	62.40	B	3.70	JB	3.00	U	4090.00	B	6.00	U	8.00	U	11.00	U	720.00	
MBNC53	µg/L	18.00		31.5	B	48.00	U	58.60	B	1.00	U	5.00	U	3760.00	B	10.00	U	10.00	U	5.00	U	666.00	
MBNC52	µg/L	17.00		56.0	U	36.00	U	63.90	B	3.90	JB	3.00	U	4330.00	B	6.00	U	8.00	U	11.00	U	893.00	
MBNC79	µg/L	17.60		31.0	U	48.00	U	58.10	B	1.00	U	5.00	UJ	3760.00	B	10.00	UJ	10.00	U	5.00	U	6898.00	
MBNC69	µg/L	16.60	J	70.2	B	36.00	U	62.90	B	2.00	UJ	3.00	UJ	3860.00	B	6.00	U	8.00	U	11.00	U	791.00	
MBGZ27	µg/L	19.60	J	28.0	JB	17.90	UJ	62.30	JB	0.40	UJ	1.50	UJ	3810.00	JB	1.80	UJ	1.50	UJ	2.50	JB	653.00	J
MBGZ37	µg/L	21.00	J	52.7	JB	15.70	UJ	60.40	JB	1.20	UJ	1.60	JB	3730.00	JB	5.10	UJ	2.50	UJ	`4.00	UJ	759.00	J
MBEN25	µg/L	19.00	J	38.5	B	17.90	U	59.30	B	0.40	U	1.50	U	3510.00	B	1.80	U	1.50	U	2.20	U	694.00	
MBEN35	µg/L	22.60		50.6	B	15.70	U	59.10	B	1.20	U	1.50	U	3660.00	B	5.10	U	2.50	U	4.00	U	814.00	
MBGZ57	µg/L	14.10		41.4	B	17.90	U	58.20	B	0.40	U	1.50	U	3670.00	B	1.80	U	1.50	U	2.20	U	480.00	
MBGZ56	µg/L	15.60	J	34.4	JB	17.90	UJ	61.00	JB	0.40	UJ	1.50	UJ	3650.00	JB	1.80	UJ	1.50	UJ	2.20	UJ	596.00	J
MBNB97	µg/L	15.40		31.0	U	48.00	U	61.80	B	1.00	U	5.00	U	4080.00	B	10.00	U	10.00	U	5.00	U	655.00	
MBML83	µg/L	14.20		56.0	U	36.00	U	60.30	B	2.00	U	3.00	U	3700.00	B	6.00	U	8.00	U	11.00	U	679.00	
MBNC18	µg/L	14.80		44.4	B	48.00	UJ	58.70	B	1.00	U	5.00	U	3880.00	B	10.00	U	10.00	U	5.00	U	554.00	
MBNC07	µg/L	18.00		64.6	B	36.00	U	61.50	B	2.00	U	3.00	U	4040.00	B	6.00	U	8.00	U	11.00	U	708.00	
MBNC36	µg/L	15.60		31.0	U	48.00	U	60.40	B	1.00	U	5.00	U	3810.00	B	10.00	U	10.00	U	5.00	U	649.00	
MBNC35	µg/L	17.40		101.0	B	36.00	U	62.40	B	3.70	JB	3.00	U	4150.00	B	6.00	U	8.00	U	11.00	U	725.00	
MBNC57	µg/L	18.10		38.7	B	48.00	U	61.50	B	1.00	U	5.00	U	4130.00	B	10.00	U	10.00	U	5.00	U	721.00	
MBNC56	µg/L	18.00		56.0	U	36.00	U	63.90	B	4.20	JB	3.00	U	4390.00	B	6.00	U	8.00	U	11.00	U	896.00	
MBNC80	µg/L	17.90	J	31.0	U	48.00	U	60.70	B	1.00	U	5.00	UJ	3800.00	B	10.00	UJ	5.00	U	682.00		1.00	UJ
MBNC70	µg/L	16.00	UJ	56.0	U	36.00	U	61.50	B	2.00	UJ	3.00	U	3880.00	B	6.00	U	8.00	U	11.00	U	757.00	
MBGZ28	µg/L	17.60	J	50.0	B	17.90	U	63.20	B	0.40	U	1.50	B	4160.00	B	1.80	U	1.50	B	2.20	U	725.00	
MBGZ38	µg/L	16.70	J	44.3	JB	17.90	UJ	59.60	JB	0.40	UJ	1.50	UJ	3980.00	JB	1.80	UJ	1.50	UJ	2.20	UJ	793.00	J
MBEN26	µg/L	20.20	J	39.4	JB	17.90	UJ	60.20	JB	0.40	J	1.50	UJ	3640.00	JB	1.80	UJ	1.50	UJ		R	710.00	J

Qualifiers: U - Not Detected at Contract Required Detection Limit (CRDL); J - Estimated Concentration;
R - Rejected; B - Detected between CRDL and Instrument Detection Limit (IDL).

APPENDIX A
ANALYTICAL RESULTS FROM SURFACE WATER SAMPLING
Vineland Chemical Company Site

EPA Sample I.D.	Units	As		Al		Sb		Ba		Be		Cd		Ca		Cr		Co		Cu		Fe	
MBEN36	µg/L	20.90		63.0	B	15.70	U	55.30	B	1.20	U	1.50	U	3370.00	B	5.10	U	2.50	U	4.00	U	782.00	
MBGZ59	µg/L	12.60		32.5	B	17.90	U	59.60	B	0.40	U	1.50	U	3710.00	B	1.80	U	1.50	U	2.20	U	481.00	
MBGZ58	µg/L	14.30		22.8	U	17.90	U	62.00	B	0.40	U	1.50	U	3740.00	B	1.80	U	1.50	U	2.20	U	611.00	
MBNB98	µg/L	17.20	J	31.0	U	48.00	U	59.80	B	1.00	U	5.00	U	3920.00	B	10.00	U	10.00	U	5.00	U	639.00	
MBML84	µg/L	14.00	J	85.7	B	36.00	U	62.00	B	2.00	U	3.00	U	3720.00	B	6.00	U	8.00	U	12.60	B	655.00	
MBNC19	µg/L	14.40		31.0	U	748.00	UJ	60.50	B	1.00	U	5.00	U	4060.00	B	10.00	U	10.00	U	5.00	U	608.00	
MBNC08	µg/L	17.70		56.0	U	36.00	U	62.40	B	3.70	JB	3.00	U	4090.00	B	6.00	U	8.00	U	11.00	U	707.00	
MBNC38	µg/L	18.80		31.0	U	48.00	U	59.00	B	1.00	U	5.00	U	3780.00	B	10.00	U	10.00	U	5.00	U	624.00	
MBNC37	µg/L	14.50	J	56.0	U	36.00	U	61.50	B	3.70	JB	3.00	U	4040.00	B	6.00	U	8.00	U	11.00	U	710.00	
MBNC59	µg/L	20.00		45.2	B	48.00	U	62.10	B	1.00	U	5.00	U	3930.00	B	10.00	U	10.00	U	5.00	U	717.00	
MBNC58	µg/L	19.00		79.2	B	36.00	U	63.90	B	4.20	JB	3.00	U	4370.00	B	6.00	U	8.00	U	11.00	U	901.00	
MBNC81	µg/L	16.00		31.0	U	48.00	U	57.80	B	1.00	U	5.00	UJ	3550.00	B	10.00	UJ	10.00	U	5.00	U	613.00	
MBNC71	µg/L	16.20	J	73.6	B	36.00	U	61.50	B	2.00	U	3.00	U	3950.00	B	6.00	U	8.00	U	11.00	U	768.00	
MBGZ29	µg/L	19.00	J	53.8	JB	15.70	UJ	60.40	JB	1.20	UJ	1.50	UJ	3800.00	JB	5.10	UJ	2.50	UJ	4.00	UJ	676.00	J
MBGZ39	µg/L	42.60		68.7	B	48.00	U	81.00	B	1.00	U	5.00	U	4630.00	B	10.00	U	10.00	U	5.00	U	2450.00	
MBEN27	µg/L	20.50	J	55.9	B	17.90	U	62.30	B	0.40	U	1.50	U	3720.00	B	1.80	U	1.60	B	2.20	U	741.00	
MBEN37	µg/L	20.70	J	63.0	JB	15.70	UJ	56.60	JB	1.20	J	1.50	UJ	3800.00	JB	5.10	UJ	2.50	UJ	4.00	UJ	785.00	J
MBGZ61	µg/L	13.90	J	39.8	JB	17.90	UJ	60.70	JB	0.40	UJ	1.50	UJ	3780.00	JB	1.80	UJ	1.80	JB	2.20	UJ	490.00	J
MBGZ60	µg/L	14.70		37.7	B	17.90	U	62.70	B	0.40	U	1.50	U	3660.00	B	1.80	U	1.50	U	2.20	U	595.00	
MBNB99	µg/L	17.00	J	31.0	U	48.00	U	60.90	B	1.00	U	5.00	U	3930.00	B	10.00	U	10.00	U	5.00	U	634.00	
MBML85	µg/L	14.40	J	56.0	U	36.00	U	61.20	B	2.00	U	3.00	U	3740.00	B	6.00	U	8.00	U	11.00	U	644.00	
MBNC20	µg/L	14.60		37.3	B	48.00	UJ	60.40	B	1.00	U	5.00	U	4050.00	B	10.00	U	10.00	U	5.00	U	617.00	
MBNC09	µg/L	18.40		59.0	B	36.00	U	62.40	B	3.70	JB	3.00	U	4050.00	B	6.00	U	8.00	U	11.00	U	692.00	
MBNC40	µg/L	20.00		31.0	U	48.00	U	60.30	B	1.00	U	5.00	U	3840.00	B	10.00	U	10.00	U	5.00	U	627.00	
MBNC39	µg/L	17.80	J	56.0	U	36.00	U	61.50	B	3.70	JB	3.00	U	4170.00	B	6.00	U	8.00	U	11.00	U	718.00	
MBNC61	µg/L	19.00		55.5	B	48.00	U	59.90	B	1.00	U	5.00	U	23920.00	B	10.00	U	10.00	U	5.00	U	701.00	
MBNC60	µg/L	17.60		56.0	U	36.00	U	63.90	B	4.20	JB	3.00	U	4380.00	B	6.00	U	8.00	U	11.00	U	939.00	
MBNC82	µg/L	17.20	J	50.8	B	48.00	U	58.20	B	1.00	U	5.00	UJ	3690.00	B	10.00	UJ	10.00	U	5.00	U	724.00	
MBNC72	µg/L	15.50	J	58.5	B	36.00	U	58.60	B	2.00	UJ	3.00	UJ	3820.00	B	6.00	U	8.00	U	11.00	U	728.00	
MBGZ30	µg/L	16.80	J	28.2	JB	17.90	UJ	60.30	JB	0.40	UJ	1.50	UJ	3580.00	JB	1.80	UJ	1.50	UJ	2.20	UJ	596.00	J
MBGZ40	µg/L	19.40		43.1	B	15.70	U	60.40	B	1.20	U	1.70	B	3830.00	B	5.10	U	2.50	U	4.00	U	686.00	
MBEN28	µg/L	18.10	J	47.2	JB	17.90	UJ	61.50	JB	0.40	UJ	1.50	UJ	3600.00	JB	1.80	UJ	1.50	UJ	2.20	UJ	635.00	J

Qualifiers: U - Not Detected at Contract Required Detection Limit (CRDL); J - Estimated Concentration;
R - Rejected; B - Detected between CRDL and Instrument Detection Limit (IDL).

APPENDIX A
ANALYTICAL RESULTS FROM SURFACE WATER SAMPLING
Vineland Chemical Company Site

EPA Sample I.D.	Units	As		Al		Sb		Ba		Be		Cd		Ca		Cr		Co		Cu		Fe	
MBEN38	µg/L	21.50		62.4	B	15.70	U	59.10	B	1.20	U	1.50	U	3680.00	B	7.60	B	2.50	U	4.00	U	711.00	
MBGZ63	µg/L	14.40		48.9	B	17.90	U	58.30	B	0.40	U	1.50	U	3770.00	B	1.80	U	1.50	U	2.20	U	558.00	
MBGZ62	µg/L	15.60	J	38.0	JB	17.90	UJ	62.20	JB	0.40	UJ	1.50	UJ	3720.00	JB	1.80	UJ	1.50	UJ	2.20	UJ	583.00	J

Qualifiers: U - Not Detected at Contract Required Detection Limit (CRDL); J - Estimated Concentration;
R - Rejected; B - Detected between CRDL and Instrument Detection Limit (IDL).

APPENDIX A
ANALYTICAL RESULTS FROM SURFACE WATER SAMPLING
Vineland Chemical Company Site

EPA Sample I.D.	Pb		Mg		Mn		Hg		Ni		K		Se		Ag		Na		Tl		V	
MBJT23	15.90	J	2000.00	B	25.10	J	0.26	J	6.00	U	2260.00	B	3.60	U	2.30	U	7090.00	J	4.30	U	3.30	U
7383B-01-005																						
MBJT25	12.00	J	1860.00	B	63.90	J	0.24		6.00	U	2040.00	B		R	2.30	U	5810.00		1.60	U	3.30	U
104751																						
104771	3.00	U	5000.00	U	17.00		0.30	U	40.00	U	5000.00	U	5.00	U	10.00	U			10.00	U	50.00	U
104759																						
MBJT80	2.00	U	2210.00	B	21.00		0.20	U	11.00	U	1960.00	B	4.00	U	6.00	U	6610.00	J	2.00	U	5.00	U
7576B-01-002																						
103429	3.00	U	5000.00	U	24.00		0.20	U	40.00	U	5000.00	U	5.00	U	10.00	U	6000.00		10.00	U	50.00	U
7576B-02-013																						
MBMK32	3.50		1940.00	B	43.00		0.16	JB	3.00	U	1760.00	B		R	3.90	U	5680.00		2.60	U	2.50	U
103959	3.00	U	5000.00	U	37.00		0.20	U	40.00	U	5000.00	U	5.00	U	10.00	U	6000.00		10.00	U	50.00	U
MBMK63	1.20	JB	2530.00	JB	35.50	J	0.36	J	3.00	U	1820.00	JB	3.10	U	3.90	U	6710.00	J	1.50	U	2.50	U
MBML25	1.10	JB	2930.00	B	30.40	J		R	15.30	U	2240.00	B	1.60	UJ	1.60	U	8170.00	J	2.00	UJ	4.70	U
MBML27	1.00	UJ	2910.00	B	31.00	J		R	15.30	U	2240.00	B	1.60	UJ	1.60	U	5530.00	J	2.00	UJ	5.30	B
101505	3.00	U	5000.00	U	28.00		0.20	U	40.00	U	5000.00	U	5.00	U	10.00	U	6000.00		10.00	U	50.00	U
MBML89	4.60		2550.00	B	29.60		0.14	B	19.80	U	1800.00	B	1.80	B	2.90	U	5120.00		1.40	UJ	2.70	U
101549	3.00	U	5000.00	U	31.00		0.20	U	40.00	U	5000.00	U	5.00	U	10.00	U	6000.00		10.00	U	50.00	U
MBMF02	1.10	UJ	2060.00	B	17.80			R	28.50	U	1080.00	B	1.50	UJ	3.40	U	5990.00	J	1.60	UJ	8.50	U
MBNB61	1.10	B	2170.00	B	12.40	B	0.20	U	7.40	U	1920.00	B	1.00	U	2.10	U	5460.00		1.00	U	2.00	U
MBJT24	5.20	J	2150.00	B	21.90	J	0.26	J	6.00	U	1810.00	B	3.60	U	2.30	U	4720.00	B	4.30	U	3.30	U
7383B-01-006																						
MBJT26	3.60		1920.00	B	27.10	J	0.20	U	6.00	U	1720.00	B	3.70	U	2.30	U	4340.00	B	1.60	U	3.30	U
104752																						
104772	3.00	U	5000.00	U	15.00	U	0.30	U	40.00	U	5000.00	U	5.00	U	10.00	U			10.00	U	50.00	U
104773	3.00	U	5000.00	U	15.00	U	0.30	U	40.00	U	5000.00	U	5.00	U	10.00	U			10.00	U	50.00	U
104761																						
104763																						
MBJT81	2.00	U	2230.00	B	17.30		0.20	U	11.00	U	1790.00	B	4.00	U	6.00	U	5240.00	J	2.00	U	5.00	U
7576B-01-004																						
103428	3.00	U	5000.00	U	18.00		0.20	U	40.00	U	5000.00	U	5.00	U	10.00	U	5000.00	U	10.00	U	50.00	U

Qualifiers: U - Not Detected at Contract Required Detection Limit (CRDL); J - Estimated Concentration;
R - Rejected; B - Detected between CRDL and Instrument Detection Limit (IDL).

APPENDIX A
ANALYTICAL RESULTS FROM SURFACE WATER SAMPLING
Vineland Chemical Company Site

EPA Sample I.D.	Pb		Mg		Mn		Hg		Ni		K		Se		Ag		Na		Tl		V	
7576B-02-011																						
MBMK33	2.80	JB	2170.00	JB	49.20		0.10	U	3.00	U	1710.00	JB	3.30	U	3.90	U	4670.00	JB	2.60	U	2.50	U
103960	3.00	U	5000.00	U	27.00		0.20	U	40.00	U	5000.00	U	5.00	U	10.00	U	5000.00		10.00	U	50.00	U
MBMK65	1.20	U	2430.00	JB	28.10	J	0.10	J	3.00	U	1700.00	JB	3.10	U	3.90	U	6340.00	J	1.50	U	2.50	U
MBML21	1.00	UJ	2220.00	B	33.40			R	15.30	U	1800.00	B	1.60	UJ	1.60	U	5380.00	J	2.00	UJ	5.40	B
101504	3.00	U	5000.00	U	18.00		0.20	U	40.00	U	5000.00	U	5.00	U	10.00	U	6000.00		10.00	U	50.00	U
MBML91		R	2390.00	B	42.20		0.10	U	19.80	U	2120.00	B	1.70	U	2.90	U	5390.00		1.40	UJ	5.00	B
MBML93	1.70	U	2310.00	B	39.70		0.10	U	19.80	U	1350.00	B	2.20	JB	2.90	U	5360.00		1.40	UJ	2.90	B
101547	3.00	U	5000.00	U	21.00		0.20	U	40.00	U	5000.00	U	5.00	U	10.00	U	5000.00		10.00	U	50.00	U
MBMF04	1.10	UJ	2220.00	B	13.50	BJ		R	28.50	U	920.00	B	1.50	UJ	3.40	U	5280.00	J	1.60	UJ	8.50	U
MBNB63	0.60	B	2390.00	B	18.50		0.20	U	7.40	U	2040.00	B	1.00	U	2.10	U	5140.00		1.00	UW	2.00	U
7383B-01-007																						
MBJT27	7.90	JW	2010.00	JB	42.20	J	0.20	U	6.00	U	2310.00	JB	3.70	U	2.30	U	9340.00	J	1.60	U	3.30	U
104753																						
104774	3.00	U	5000.00	U	33.00		0.30	U	40.00	U	5000.00	U	5.00	U	10.00	U			10.00	U	50.00	U
104765																						
MBJT82	2.00	U	2690.00	B	33.80		0.20	U	11.00	U	2520.00	B	4.00	U	6.00	U	9190.00	J	2.00	U	5.00	U
7576B-01-001																						
103427	3.00	U	5000.00	U	30.00		0.20	U	40.00	U	5000.00	U	5.00	U	10.00	U	8000.00		10.00	U	50.00	U
7576B-02-009																						
MBMK34	8.30		2720.00	B	124.00		0.10	U	3.00	U	3210.00	B	3.30	U	3.90	U	13600.00		2.60	U	3.50	B
103961	3.00	U	5000.00	U	37.00		0.20	U	40.00	U	5000.00	U	5.00	U	10.00	U	8000.00		10.00	U	50.00	U
MBMK67	1.20	U	2840.00	JB	34.90	J	0.10	U	3.00	U	2310.00	JB	3.10	U	3.90	U	9600.00	J	1.50	U	2.50	U
MBML31	1.40	JB	2530.00	B	30.40	J		R	15.30	U	1930.00	B	1.60	UJ	1.60	U	6910.00	J	2.00	UJ	5.40	B
101502	3.00	U	5000.00	U	17.00		0.20	U	40.00	U	5000.00	U	5.00	U	10.00	U	8000.00		10.00	U	50.00	U
MBML95	1.70	U	2880.00	B	58.20		0.10	U	19.80	U	2340.00	B	1.70	U	2.90	U	7260.00		1.40	UJ	4.90	B
101545	3.00	U	5000.00	U	41.00		0.20	U	40.00	U	5000.00	U	5.00	U	10.00	U	9000.00		10.00	U	50.00	U
MBMF06	1.30	BJ	2650.00	B	37.00			R	28.50	U	1280.00	B	1.50	UJ	3.40	U	9430.00	J	1.60	UJ	8.50	U
MBML35	1.30	B	2880.00	B	41.20		0.20	U	7.40	U	2670.00	B	1.00	U	2.10	U	10400.00		1.00	U	2.00	U
MBJT20		R	2410.00	B	31.00	J	0.20	U	6.00	U	2150.00	B	3.60	U	2.30	U	4520.00	B	4.30	U	3.30	U

Qualifiers: U - Not Detected at Contract Required Detection Limit (CRDL); J - Estimated Concentration;
R - Rejected; B - Detected between CRDL and Instrument Detection Limit (IDL).

APPENDIX A
ANALYTICAL RESULTS FROM SURFACE WATER SAMPLING
Vineland Chemical Company Site

EPA Sample I.D.	Pb		Mg		Mn		Hg		Ni		K		Se		Ag		Na		Tl		V	
7383B-01-001																						
MBJT85	2.00	U	2260.00	B	15.10		0.20	U	11.00	U	1960.00	B	4.00	U	6.00	U	5330.00	J	2.00	U	5.00	U
7576B-01-006																						
103424	3.00	U	5000.00	U	17.00		0.20	U	40.00	U	5000.00	U	5.00	U	10.00	U	5000.00	U	10.00	U	50.00	U
103425	3.00	U	5000.00	U	18.00		0.20	U	40.00	U	5000.00	U	5.00	U	10.00	U	5000.00	U	10.00	U	50.00	U
7576B-02-003																						
7576B-02-005																						
MBMK31	2.70	B	2230.00	B	31.40		0.10	U	3.70	B	1630.00	B	3.30	U	3.90	U	4790.00	B	2.60	U	4.10	B
103957	3.00	U	5000.00	U	25.00		0.20	U	40.00	U	5000.00	U	5.00	U	10.00	U	5000.00		10.00	U	50.00	U
MBMK61	2.00	JB	2500.00	B	28.30		0.12		3.00	U	1710.00	B	3.10	U	3.90	U	6640.00		1.50	U	2.50	U
MBML29	1.00	UJ	2130.00	B	33.10	J		R	15.30	U	1160.00	B	1.60	UJ	1.60	U	5310.00	J	2.00	UJ	4.70	U
MBMF10	1.10	UJ	2240.00	B	14.00	B		R	28.50	U	942.00	B	1.50	UJ	3.40	U	5560.00	J	1.60	UJ	8.50	U
101508	3.00	U	5000.00	U	22.00		0.20	U	40.00	U	5000.00	U	5.00	U	10.00	U	6000.00		10.00	U	50.00	U
MBNB65	0.60	B	2270.00	B	16.60		0.20	U	7.40	U	1780.00	B	1.00	U	2.10	U	4760.00	B	1.00	U	2.00	U
7383B-01-004																						
104754																						
MBJT55		R	2200.00	B	27.20	J	0.20	U	6.00	U	1990.00	B		R	2.30	U	7710.00		4.30	U	3.30	U
104775	3.00	U	5000.00	U	25.00		0.30	U	40.00	U	5000.00	U	5.00	U	10.00	U			5.00	U	50.00	U
104767																						
MBJT83	2.00	U	2400.00	B	28.10		0.20	U	11.00	U	2340.00	B	4.00	U	6.00	U	9120.00	J	2.00	U	5.00	U
7576B-01-005																						
103426	3.00	U	5000.00	U	29.00		0.20	U	40.00	U	5000.00	U	5.00	U	10.00	U	8000.00		10.00	U	50.00	U
7576B-02-007																						
MBMK30	4.60	J	2460.00	BJ	24.80	J	0.10	U	3.00	U	2220.00	BJ	3.30	U	3.90	U	7690.00	J	2.60	U	2.50	U
103962	3.00	U	5000.00	U	35.00		0.20	U	40.00	U	5000.00	U	5.00	U	10.00	U	7000.00		10.00	U	50.00	U
MBMK69	1.20	U	2720.00	B	27.40		0.10	U	3.00	U	2020.00	B	3.10	U	3.90	U	8070.00		1.50	U	2.50	U
MBML17	1.00	UJ	2480.00	B	31.70			R	15.30	U	1930.00	B	1.60	UJ	1.60	U	6500.00	J	2.00	UJ	4.70	U
101511	3.00	U	5000.00	U	28.00		0.20	U	40.00	U	5000.00	U	5.00	U	10.00	U	7000.00		10.00	U	50.00	U
MBML97	1.70	U	2700.00	B	64.30		0.10	U	19.80	U	3060.00	B	2.00	JB	2.90	U	7010.00	J	1.40	UJ	2.90	B
101543	3.00	U	5000.00	U	36.00		0.20	U	40.00	U	5000.00	U	5.00	U	10.00	U	8000.00		10.00	U	50.00	U
MBMF08	1.10	UJ	2570.00	B	34.80			R	28.50	U	1240.00	B	1.50	UJ	3.40	U	8140.00	J	1.60	UJ	8.50	U

Qualifiers: U - Not Detected at Contract Required Detection Limit (CRDL); J - Estimated Concentration;
R - Rejected; B - Detected between CRDL and Instrument Detection Limit (IDL).

APPENDIX A
ANALYTICAL RESULTS FROM SURFACE WATER SAMPLING
Vineland Chemical Company Site

EPA Sample I.D.	Pb		Mg		Mn		Hg		Ni		K		Se		Ag		Na		Tl		V	
MBML36	1.00	B	2420.00	B	33.40		0.20	U	7.40	U	2140.00	B	1.00	U	2.10	U	9200.00		1.00	U	2.00	U
MBML38	1.40	B	2360.00	B	32.70		0.20	U	7.40	U	2360.00	B	1.00	U	2.10	U	9290.00		1.00	U	2.00	U
7384B-01-005																						
104755																						
104760																						
7576B-01-009																						
7576B-02-014																						
103966	3.00	U	5000.00	U	35.00		0.20	U	40.00	U	5000.00	U	5.00	U	10.00	U	6000.00		10.00	U	50.00	U
MBMK64	1.90	JB	2470.00	JB	35.80	J	0.10	U	7.20	JB	1610.00	JB	3.30	U	4.60	U	6570.00	J	1.50	U	4.00	U
MBML26	1.00	UJ	2950.00	B	30.40	J		R	15.30	U	2360.00	B	1.60	UJ	1.60	U	5850.00	J	2.00	UJ	5.30	B
MBML28	1.00	UJ	2950.00	B	31.70	J		R	15.30	U	2300.00	B	1.60	UJ	1.60	U	5910.00	J	20.00	UJ	5.40	B
101506	3.00	U	5000.00	U	24.00		0.20	U	40.00	U	5000.00	U	5.00	U	10.00	U	5000.00		10.00	U	50.00	U
MBML90	2.50	B	2510.00	B	24.40	J	0.10	U	19.80	U	2200.00	B	1.70	U	2.90	U	5070.00		1.40	UJ	2.70	U
101550	3.00	U	5000.00	U	24.00		0.20	U	40.00	U	5000.00	U	5.00	U	10.00	U	6000.00		10.00	U	50.00	U
MBMF01	1.20	BJ	2120.00	B	13.50	B	0.20	U	28.50	U	910.00	B	1.50	UJ	3.40	U	6070.00		1.60	UJ	8.50	U
MBNB60	0.70	B	2140.00	B	8.40	B	0.20	U	7.40	U	1910.00	B	1.00	U	2.10	U	5420.00		1.00	U	2.00	U
7384B-01-006																						
104756																						
104762																						
104764																						
7576B-01-011																						
7576B-02-012																						
103491																						
103967	3.00	U	5000.00	U	25.00		0.20	U	40.00	U	5000.00	U	5.00	U	10.00	U	9000.00		10.00	U	50.00	U
MBMK66	1.20	U	2420.00	JB	28.20	J	0.10	U	5.40	U	1700.00	JB	3.30	U	4.60	U	6350.00	J	1.50	U	4.00	U
MBML22	1.00	UJ	2240.00	B	33.10			R	15.30	U	1960.00	B	1.60	UJ	1.60	U	5830.00	J	2.00	UJ	5.50	B
101503	3.00	U	5000.00	U	15.00	U	0.20	U	40.00	U	5000.00	U	5.00	U	10.00	U	5000.00	U	10.00	UQR	50.00	U
MBML92	1.70	U	2290.00	B		R	0.10	U	19.80	U	1670.00	B	1.70	U	2.90	U	5260.00		1.40	UJ	4.50	B
MBML94	1.70	U	2270.00	B		R	0.10	U	19.80	U	1730.00	B	1.70	U	2.90	U	5250.00		1.40	UJ	2.70	U
101548	3.00	U	5000.00	U	19.00		0.20	U	40.00	U	5000.00	U	5.00	U	10.00	U	6000.00		10.00	U	50.00	U

Qualifiers: U - Not Detected at Contract Required Detection Limit (CRDL); J - Estimated Concentration;
R - Rejected; B - Detected between CRDL and Instrument Detection Limit (IDL).

APPENDIX A
ANALYTICAL RESULTS FROM SURFACE WATER SAMPLING
Vineland Chemical Company Site

EPA Sample I.D.	Pb		Mg		Mn		Hg		Ni		K		Se		Ag		Na		Tl		V	
MBMF03	1.10	UJ	2210.00	B	17.80	J	0.20	U	28.50	U	994.00	B	2.80	BJ	3.40	U	5420.00		1.60	UJ	8.50	U
MBNB62	2.00	B	2400.00	B	14.60	B	0.20	U	7.40	U	2010.00	B	1.00	U	2.10	U	5030.00		1.00	U	2.00	U
7384B-01-007																						
104757																						
104766																						
7576B-01-008																						
7576B-02-010																						
103492																						
103968	3.00	U	5000.00	U	36.00		0.20	U	40.00	U	5000.00	U	5.00	U	10.00	U	9000.00		10.00	U	50.00	U
MBMK68	1.20	U	2820.00	JB	32.80	J	0.10	U	5.40	U	2220.00	JB	3.30	U	4.60	U	9280.00	J	1.50	U	4.00	U
MBML32	1.00	UJ	2580.00	B	27.70	J		R	15.30	U	1720.00	B	1.60	UJ	1.60	U	6790.00	J	2.00	UJ	4.70	U
101501	3.00	U	5000.00	U	15.00	U	0.20	U	40.00	U	5000.00	U	5.00	U	10.00	U	8000.00		10.00	UQR	50.00	U
MBML96	1.90	B	2850.00	B		R	0.10	U	19.80	U	2320.00	B	1.70	U	2.90	U	7220.00		1.40	UJ	2.70	U
101546	3.00	U	5000.00	U	36.00		0.20	U	40.00	U	5000.00	U	5.00	U	10.00	U	10000.00		10.00	U	50.00	U
MBMF17	1.10	UJ	2670.00	B	38.80		0.20	U	28.50	U	1580.00	B	1.50	UJ	3.40	U	10100.00		1.60	UJ	8.50	U
MBNB66	0.50	U	2870.00	B	37.50	J	0.20	U	7.40	U	2690.00	B	1.00	U	2.10	U	10400.00		1.00	U	2.00	U
7384B-01-001																						
7576B-01-013																						
7576B-02-004																						
7576B-02-006																						
103489																						
103964	3.00	U	5000.00	U	24.00		0.20	U	40.00	U	5000.00	U	5.00	U	10.00	U	5000.00		10.00	U	50.00	U
MBMK62	2.60	JB	2400.00	JB	27.40	J	0.10	U	5.40	U	1640.00	JB	3.30	U	4.60	U	6640.00	J	1.50	U	4.00	U
MBML30	1.00	UJ	2070.00	B	35.70	J		R	15.30	U	1120.00	B	1.60	UJ	1.60	U	5140.00	J	2.00	UJ	5.40	B
101507	3.00	U	5000.00	U	15.00	U	0.20	U	40.00	U	5000.00	U	5.00	U	10.00	U	5000.00		10.00	U	50.00	U
MBMF09	1.10	UJ	2290.00	B	10.20	B	0.20	U	28.50	U	1050.00	B	1.50	UJ	3.40	U	5670.00		1.60	UJ	8.50	U
MBNB64	0.80	B	2290.00	B	13.90	B	0.20	U	7.40	U	2000.00	B	1.00	U	2.10	U	4850.00	B	1.00	U	2.00	U
7384B-01-004																						
104758																						

Qualifiers: U - Not Detected at Contract Required Detection Limit (CRDL); J - Estimated Concentration;
R - Rejected; B - Detected between CRDL and Instrument Detection Limit (IDL).

APPENDIX A
ANALYTICAL RESULTS FROM SURFACE WATER SAMPLING
Vineland Chemical Company Site

EPA Sample I.D.	Pb		Mg		Mn		Hg		Ni		K		Se		Ag		Na		Tl		V	
104768																						
7576B-01-012																						
7576B-02-008																						
103493																						
103969	3.00	U	5000.00	U	33.00		0.20	U	40.00	U	5000.00	U	5.00	U	10.00	U	7000.00		10.00	U	50.00	U
MBMK70	1.20	U	2630.00	JB	25.80	J	0.10	U	5.40	U	1810.00	JB	16.50	U	4.60	U	7850.00	J	1.50	U	4.00	U
MBML18	1.00	UJ	2470.00	B	29.70			R	15.30	U	1900.00	B	1.60	UJ	1.60	U	6420.00	J	2.00	UJ	4.70	U
101512	3.00	U	5000.00	U	24.00		0.20	U	40.00	U	5000.00	U	5.00	U	10.00	U	7000.00		10.00	U	50.00	U
MBML98	1.70	U	2620.00	B		R	0.10	U	19.80	U	2660.00	B	1.70	U	2.90	U	7790.00	J	1.40	UJ	2.70	U
101544	3.00	U	5000.00	U	24.00		0.20	U	40.00	U	5000.00	U	5.00	U	10.00	U	8000.00		10.00	U	50.00	U
MBMF07	1.10	UJ	2530.00	B	18.50		0.20	U	28.50	U	1060.00	B	1.50	UJ	3.40	U	7650.00		1.60	UJ	8.50	U
MBML37	0.50	U	2420.00	B	20.90	J	0.20	U	7.40	U	2220.00	B	1.00	U	2.10	U	9320.00		1.00	U	2.00	U
MBML39	0.70	B	2420.00	B	21.60	J	0.20	U	7.40	U	2250.00	B	1.00	U	2.10	U	9260.00		1.00	U	2.00	U
104844	3.50		5000.00	U	46.00		0.20	U	40.00	U	5000.00	U	5.00	U	10.00	U	7000.00		10.00	U	50.00	U
104840	4.50		5000.00	U	44.00		0.20	U	40.00	U	5000.00	U	5.00	U	10.00	U	6000.00		10.00	U	50.00	U
104843	3.40		5000.00	U	30.00		0.20	U	40.00	U	5000.00	U	5.00	U	10.00	U	5000.00	U	10.00	U	50.00	U
104838	3.10		5000.00	U	27.00		0.20	U	40.00	U	5000.00	U	5.00	U	10.00	U	5000.00		10.00	U	50.00	U
104815	3.00	U	5000.00	U	25.00		0.20	U	40.00	U	5000.00	U	5.00	U	10.00	U	5000.00		10.00	U	50.00	U
104825	3.00	U	5000.00	U	25.00		0.20	U	40.00	U	5000.00	U	5.00	U	10.00	U	6000.00		10.00	U	50.00	U
MBMK32	3.50		1940.00	B	43.00		0.16	JB	3.00	U	1760.00	B		R	3.90	U	5680.00		2.60	U	2.50	U
MBMK37	8.00	J	1430.00	JB	53.80	J	0.33	J	3.00	U	1870.00	JB	3.30	U	3.90	U	4730.00	JB	2.60	U	2.50	U
MBMK42	6.20	J	1540.00	JB	42.50	J	0.10	U	3.00	U	1960.00	JB	16.50	U	3.90	U	5670.00	J	2.60	U	2.50	U
MBMK47	5.20	J	1920.00	B	35.60		0.10	U	3.00	U	1920.00	B	3.30	U	3.90	U	5830.00		2.60	U	2.50	U
MBMK51	2.80	B	3040.00	B	42.80		0.10	U	3.00	U	1850.00	B	3.80	U	3.90	U	5970.00		1.90	U	2.50	U
MBMK60	3.20	J	2650.00	B	41.50		0.11	B	3.00	U	1890.00	B	19.00	U	3.90	U	6010.00		1.90	U	2.50	U
103515			5000.00	U	44.00				40.00	U	5000.00	U			10.00	U	6000.00				50.00	U
MBMF61	1.20	BJ	2110.00	B	51.00		0.20	J	28.50	U	1860.00	B	1.50	UJ	3.40	U	5500.00	J	1.60	UJ	8.50	U
MBMF67	1.90	BJ	2010.00	B	40.50		0.20	J	28.50	U	1980.00	B	1.50	UJ	3.40	U	5920.00	J	1.60	UJ	8.50	U
MBMF63	1.60	BJ	2260.00	B	32.50		0.20	J	28.50	U	2370.00	B	1.50	UJ	3.40	U	6980.00	J	1.60	UJ	8.50	U
MBMF26	4.40	J	2190.00	B	41.00		0.20		28.50	U	2400.00	B	0.80	U	3.40	U	6780.00	J	1.00	UJ	8.50	U
MBMF14	1.10	UJ	2030.00	B	20.40			R	28.50	U	1030.00	B	1.50	UJ	3.40	U	5880.00	J	1.60	UJ	8.50	U

Qualifiers: U - Not Detected at Contract Required Detection Limit (CRDL); J - Estimated Concentration;
R - Rejected; B - Detected between CRDL and Instrument Detection Limit (IDL).

APPENDIX A
ANALYTICAL RESULTS FROM SURFACE WATER SAMPLING
Vineland Chemical Company Site

EPA Sample I.D.	Pb		Mg		Mn		Hg		Ni		K		Se		Ag		Na		Tl		V	
MBMF02	1.10	UJ	2060.00	B	17.80			R	28.50	U	1080.00	B	1.50	UJ	3.40	U	5990.00	J	1.60	UJ	8.50	U
104839	3.00	U	5000.00	U	21.00		0.20	U	40.00	U	5000.00	U	5.00	U	10.00	U	6000.00		10.00	U	50.00	U
104828	3.00	U	5000.00	U	36.00		0.20	U	40.00	U	5000.00	U	5.00	U	10.00	U	5000.00	U	10.00	U	50.00	U
104841	3.00	U	5000.00	U	25.00		0.20	U	40.00	U	5000.00	U	5.00	U	10.00	U	5000.00	U	10.00	U	50.00	U
104817	3.00	U	5000.00	U	16.00		0.20	U	40.00	U	5000.00	U	5.00	U	10.00	U	5000.00	U	10.00	U	50.00	U
104820	3.00	U	5000.00	U	18.00		0.20	U	40.00	U	5000.00	U	5.00	U	10.00	U	5000.00	U	10.00	U	50.00	U
104826	3.00	U	5000.00	U	16.00		0.20	U	40.00	U	5000.00	U	5.00	U	10.00	U	5000.00	U	10.00	U	50.00	U
MBMK33	2.80	JB	2170.00	JB	49.20		0.10	U	3.00	U	1710.00	JB	3.30	U	3.90	U	4670.00	JB	2.60	U	2.50	U
MBMK38	4.40		1960.00	B	53.70		0.10	U	3.00	U	1740.00	B	3.30	U	3.90	U	4260.00	B	2.60	U	2.50	U
MBMK43	3.60		2080.00	B	64.20		0.10	U	3.00	U	1790.00	B		R	3.90	U	4700.00	B	2.60	U	2.50	U
MBMK48	3.20		2050.00	B	58.30		0.10	U	3.00	U	1680.00	B	3.30	U	3.90	U	4750.00	B	2.60	U	4.70	B
MBMK52	10.90	J	2420.00	JB	53.70	J	0.10	U	3.40	JB	2290.00	JB	3.80	U	3.90	U	6600.00	J	1.90	U	2.90	JB
MBMK58	3.90		2440.00	B	42.10		0.10	U	4.90	B	1670.00	B	3.80	U	3.90	U	4660.00	B	1.90	U	2.50	U
MBMF72	1.10	UJ	2170.00	B	25.40			R	28.50	U	1450.00	B	1.50	U	3.40	U	4930.00	B	1.60	UJ	8.50	U
MBMF75	6.60		2340.00	B	28.50		0.20	U	28.50	U	2040.00	B	0.80	U	3.40	U	5270.00		1.00	UJ	8.50	U
MBMF74	6.50	J	2340.00	B	36.60		0.20	U	28.50	U	1900.00	B	0.80	U		R	5580.00		1.00	UJ	8.50	U
MBMF30		R	2330.00	B	27.80		0.20	U	28.50	U	2320.00	B	0.80	U	3.40	U	5670.00	J	1.00	UJ	8.50	U
MBMF16	1.10	UJ	2230.00	B	20.70			R	28.50	U	1170.00	B	1.50	UJ	3.40	U	6460.00	J	1.60	UJ	8.50	U
MBMF04	1.10	UJ	2220.00	B	13.50	BJ		R	28.50	U	920.00	B	1.50	UJ	3.40	U	5280.00	J	1.60	UJ	8.50	U
104833	3.00	U	5000.00	U	30.00		0.20	U	40.00	U	5000.00	U	5.00	U	10.00	U	7000.00		10.00	U	50.00	U
104831	3.00	U	5000.00	U	36.00		0.20	U	40.00	U	5000.00	U	5.00	U	10.00	U	7000.00		10.00	U	50.00	U
104846	3.00	U	5000.00	U	40.00		0.20	U	40.00	U	5000.00	U	5.00	U	10.00	U	6000.00		10.00	U	50.00	U
104827	3.00	U	5000.00	U	30.00		0.20	U	40.00	U	5000.00	U	5.00	U	10.00	U	7000.00		10.00	U	50.00	U
104824	3.00	U	5000.00	U	23.00		0.20	U	40.00	U	5000.00	U	5.00	U	10.00	U	8000.00		10.00	U	50.00	U
104819	3.00	U	5000.00	U	30.00		0.20	U	40.00	U	5000.00	U	5.00	U	10.00	U	8000.00		10.00	U	50.00	U
MBMK34	8.30		2720.00	B	124.00		0.10	U	3.00	U	3210.00	B	3.30	U	3.90	U	13600.00		2.60	U	3.50	B
MBMK39	5.40	J	1890.00	JB	46.30	J	0.10	U	3.00	U	2260.00	JB	3.30	U	3.90	U	7970.00	J	2.60	U	2.90	JB
MBMK44	6.00	J	2080.00	JB	77.90	J	0.10	U	3.00	U	2130.00	JB	3.30	U	3.90	U	7080.00	J	2.60	U	3.90	JB
MBMK49	3.20		2700.00	B	59.00		0.10	U	3.00	U	2430.00	B	3.30	U	3.90	U	7300.00		2.60	U	2.50	U
MBMK53	3.30		2060.00	B	49.00		0.10	U	3.40	B	1480.00	B	3.80	U	3.90	U	4190.00	B	1.90	U	2.50	U

Qualifiers: U - Not Detected at Contract Required Detection Limit (CRDL); J - Estimated Concentration;
R - Rejected; B - Detected between CRDL and Instrument Detection Limit (IDL).

APPENDIX A
ANALYTICAL RESULTS FROM SURFACE WATER SAMPLING
Vineland Chemical Company Site

EPA Sample I.D.	Pb		Mg		Mn		Hg		Ni		K		Se		Ag		Na		Tl		V	
MBMK57	2.90	B	2610.00	B	46.20		0.10	U	3.00	U	2200.00	B	3.80	U	3.90	U	7390.00		1.90	U	2.50	U
MBMF56	1.10	UJ	2380.00	B	84.40			R	28.50	U	2400.00	B	1.50	UJ	3.40	U	12500.00	J	1.60	UJ	8.50	U
MBMF46	1.40	BJ	2700.00	B	68.30			R	28.50	U	2050.00	B	1.50	UJ	3.40	U	10500.00	J	1.60	UJ	8.50	U
MBMF40	2.50	BJ	2640.00	B	51.60		0.20	U	28.50	U	2580.00	B	0.80	U	3.40	U	9770.00	J	1.00	UJ	8.50	U
MBMF32	5.30	J	2560.00	B	49.20		0.20	U	28.50	U	2440.00	B	0.80	U	3.40	U	9440.00	J	1.00	UJ	8.50	U
MBMF18	1.10	UJ	2690.00	B	40.60			R	28.50	U	1740.00	B	1.50	UJ	3.40	U	10300.00	J	1.60	UJ	8.50	U
MBMF06	1.30	BJ	2650.00	B	37.00			R	28.50	U	1280.00	B	1.50	UJ	3.40	U	9430.00	J	1.60	UJ	8.50	U
104836	7.30		5000.00	U	36.00		0.20	U	40.00	U	5000.00	U	5.00	U	10.00	U	5000.00	U	10.00	U	50.00	U
104818	3.00	U	5000.00	U	23.00		0.20	U	40.00	U	5000.00	U	5.00	U	10.00	U	5000.00	U	10.00	U	50.00	U
104829	3.00	U	5000.00	U	21.00		0.20	U	40.00	U	5000.00	U	5.00	U	10.00	U	5000.00	U	10.00	U	50.00	U
104835	3.00	U	5000.00	U	17.00		0.20	U	40.00	U	5000.00	U	5.00	U	10.00	U	5000.00	U	10.00	U	50.00	U
104842	3.00	U	5000.00	U	16.00		0.20	U	40.00	U	5000.00	U	5.00	U	10.00	U	5000.00	U	10.00	U	50.00	U
104814	3.00	U	5000.00	U	16.00		0.20	U	40.00	U	5000.00	U	5.00	U	10.00	U	5000.00	U	10.00	U	50.00	U
104822	3.00	U	5000.00	U	18.00		0.20	U	40.00	U	5000.00	U	5.00	U	10.00	U	5000.00	U	10.00	U	50.00	U
MBMK31	2.70	B	2230.00	B	31.40		0.10	U	3.70	B	1630.00	B	3.30	U	3.90	U	4790.00	B	2.60	U	4.10	B
MBMK36	2.90	JB	2150.00	JB	42.50	J	0.10	U	3.00	U	1770.00	JB	3.30	U	3.90	U	4550.00	JB	2.60	U	4.70	JB
MBMK40	3.00		2310.00	B	49.80		0.10	U	3.00	U	1740.00	B	3.30	U	3.90	U	4900.00	B	2.60	U	4.40	B
MBMK45	4.20	J	1960.00	JB	37.80	J	0.10	U	3.00	U	1610.00	JB	3.30	U	3.90	U	4180.00	JB	2.60	U	3.40	JB
MBMK54	2.80	B	2060.00	B	42.20		0.10	U	5.70	B	1540.00	B	3.80	U	3.90	U	4010.00	B	1.90	U	2.50	U
MBMK59	2.40	B	2360.00	B	39.20		0.10	U	3.40	B	1580.00	B	3.80	U	3.90	U	4410.00	B	1.90	U	2.50	U
MBMF52	1.10	UJ	2170.00	B	20.60			R	28.50	U	1640.00	B	1.50	UJ	3.40	U	5170.00	J	1.60	UJ	8.50	U
MBMF50	1.10	UJ	2250.00	BJ	17.40	J		R	28.50	U	1600.00	B	1.50	UJ	3.40	U	5440.00	J	1.60	UJ	8.50	U
MBMF44	1.10	UJ	2270.00	B	17.20			R	28.50	U	1490.00	B	1.50	UJ	3.40	U	5260.00	J	1.60	UJ	8.50	U
MBMF36	2.90	BJ	2250.00	B	21.10		0.20	U	28.50	U	1890.00	B	0.80	U	3.40	U	5420.00	J	1.00	UJ	8.50	U
MBMF22	3.20	J	2220.00	B	17.40		0.20	U	28.50	U	1750.00	B	0.80	U	3.40	U	5490.00	J	1.00	UJ	8.50	U
MBMF10	1.10	UJ	2240.00	B	14.00	B		R	28.50	U	942.00	B	1.50	UJ	3.40	U	5560.00	J	1.60	UJ	8.50	U
104834	3.00	U	5000.00	U	30.00		0.20	U	40.00	U	5000.00	U	5.00	U	10.00	U	8000.00		10.00	U	50.00	U
104845	3.00	U	5000.00	U	43.00		0.20	U	40.00	U	5000.00	U	5.00	U	10.00	U	11000.00		10.00	U	50.00	U
104830	3.00	U	5000.00	U	32.00		0.20	U	40.00	U	5000.00	U	5.00	U	10.00	U	9000.00		10.00	U	50.00	U
104837	3.00	U	5000.00	U	30.00		0.20	U	40.00	U	5000.00	U	5.00	U	10.00	U	9000.00		10.00	U	50.00	U

Qualifiers: U - Not Detected at Contract Required Detection Limit (CRDL); J - Estimated Concentration;
R - Rejected; B - Detected between CRDL and Instrument Detection Limit (IDL).

APPENDIX A
ANALYTICAL RESULTS FROM SURFACE WATER SAMPLING
Vineland Chemical Company Site

EPA Sample I.D.	Pb		Mg		Mn		Hg		Ni		K		Se		Ag		Na		Tl		V	
104816	3.00	U	5000.00	U	33.00		0.20	U	40.00	U	5000.00	U	5.00	U	10.00	U	9000.00		10.00	U	50.00	U
104823	3.00	U	5000.00	U	26.00		0.20	U	40.00	U	5000.00	U	5.00	U	10.00	U	8000.00		10.00	U	50.00	U
MBMK30	4.60	J	2460.00	BJ	24.80	J	0.10	U	3.00	U	2220.00	BJ	3.30	U	3.90	U	7690.00	J	2.60	U	2.50	U
MBMK35	2.20	B	2490.00	B	26.80		0.10	U	3.00	U	2150.00	B	3.30	U	3.90	U	7730.00		2.60	U	2.50	U
MBMK41	2.00	JB	2520.00	JB	27.70	J	0.10	U	3.00	U	2180.00	JB	3.30	U	3.90	U	7770.00	J	2.60	U	2.50	JB
MBMK46	2.30	B	2510.00	B	27.20		0.10	U	3.00	U	2180.00	B	3.30	U	3.90	U	7700.00		2.60	U	2.50	U
MBMK50	3.70	J	2550.00	JB	49.90	J	0.10	U	3.00	U	2310.00	JB	3.80	U	3.90	U	6610.00	J	1.90	U	2.90	JB
MBMK56	4.00		2330.00	B	45.80		0.10	U	3.00	U	2050.00	B	3.80	U	3.90	U	6070.00		1.90	U	2.50	U
MBMF54	2.90	BJ	2720.00	B	52.00		0.20	U	28.50	U	2100.00	B	0.80	U	3.40	U	8420.00		1.00	UJ	8.50	U
MBMF48	1.10	UJ	2510.00	B		R		R	28.50	U	1790.00	B	1.50	UJ	3.40	U	7540.00	J	1.60	UJ	8.50	U
MBMF42	2.00	BJ	2570.00	B	34.50			R	28.50	U	1600.00	B	1.50	UJ	3.40	U	7770.00	J	1.60	UJ	8.50	U
MBMF34	2.20	BJ	2470.00	B	38.00		0.20	U	28.50	U	1930.00	B	1.70	B	3.40	U	7580.00	J	1.00	UJ	8.50	U
MBMF20	5.90	J	2520.00	B	38.40		0.20	U	28.50	U	1890.00	B	0.80	U	3.40	U	7660.00	J	1.00	UJ	8.50	U
MBMF08	1.10	UJ	2570.00	B	34.80			R	28.50	U	1240.00	B	1.50	UJ	3.40	U	8140.00	J	1.60	UJ	8.50	U
104778																						
104783																						
104788																						
104794																						
104801																						
104804																						
103490																						
103507																						
103512																						
MBMF62	1.10	UJ	2030.00	B	23.40			R	28.50	U	1870.00	B	1.50	UJ	3.40	U	5500.00	J	1.60	UJ	8.50	U
MBMF68	1.10	UJ	2020.00	B	33.70			R	28.50	U	1830.00	B	1.50	UJ	3.40	U	5930.00	J	1.60	UJ	8.50	U
MBMF64																						
MBMF25	5.90	J	2080.00	B	22.80		0.20	U	28.50	U	2260.00	B	0.80	U	3.40	U	6720.00	J	1.00	UJ	8.50	U
MBMF23	1.10	UJ	2060.00	B	16.40		0.20	U	28.50	U	1040.00	B	1.50	UJ	3.40	U	5890.00		1.60	UJ	8.50	U

Qualifiers: U - Not Detected at Contract Required Detection Limit (CRDL); J - Estimated Concentration;
R - Rejected; B - Detected between CRDL and Instrument Detection Limit (IDL).

APPENDIX A
ANALYTICAL RESULTS FROM SURFACE WATER SAMPLING
Vineland Chemical Company Site

EPA Sample I.D.	Pb		Mg		Mn		Hg		Ni		K		Se		Ag		Na		Tl		V	
MBMF01	1.20	BJ	2120.00	B	13.50	B	0.20	U	28.50	U	910.00	B	1.50	UJ	3.40	U	6070.00		1.60	UJ	8.50	U
104779																						
104784																						
104789																						
104795																						
104802																						
104805																						
103491																						
103495																						
103499																						
103506																						
103511																						
MBMF71	1.10	UJ	2190.00	B	23.80			R	28.50	U	1640.00	B	1.50	UJ	3.40	U	4820.00	B	1.60	UJ	8.50	U
MBMF76	6.80	J	2250.00	B	26.80		0.20	U	28.50	U	1850.00	B	0.80	U	3.40	U	5220.00		1.00	UJ	8.50	U
MBMF73	7.60	J	2200.00	B	13.20	B	0.20	U	28.50	U	1620.00	B	0.80	U		R	5190.00		1.00	UJ	8.50	U
MBMF29		R	2150.00	B	21.10		0.20	U	28.50	U	2020.00	B	0.80	U	3.40	U	5410.00	J	1.00	UJ	8.50	U
MBMF15	1.10	UJ	2290.00	B	16.40		0.20	U	28.50	U	1290.00	B	1.50	UJ	3.40	U	5420.00		1.60	UJ	8.50	U
MBMF03	1.10	UJ	2210.00	B	17.80	J	0.20	U	28.50	U	994.00	B	2.80	BJ	3.40	U	5420.00		1.60	UJ	8.50	U
104780																						
104785																						
104790																						
104796																						
104803																						
104806																						
103492																						
103496																						
103500																						
103508																						

Qualifiers: U - Not Detected at Contract Required Detection Limit (CRDL); J - Estimated Concentration;
R - Rejected; B - Detected between CRDL and Instrument Detection Limit (IDL).

APPENDIX A
ANALYTICAL RESULTS FROM SURFACE WATER SAMPLING
Vineland Chemical Company Site

EPA Sample I.D.	Pb		Mg		Mn		Hg		Ni		K		Se		Ag		Na		Tl		V	
103510																						
MBMF55	1.10	UJ	2380.00	B	65.20			R	28.50	U	2360.00	B	1.50	UJ	3.40	U	12500.00		16.00	UJ	8.50	U
MBMF45	1.10	UJ	2570.00	B	56.00			R	28.50	U	2220.00	B	1.50	U	3.40	U	10200.00	J	1.60	UJ	8.50	U
MBMF39	3.30	J	2560.00	B	44.40		0.20	U	28.50	U	2610.00	B	0.80	U	3.40	U	9440.00	J	1.00	UJ	8.50	U
MBMF31	4.80	J	2530.00	B	43.90		0.20	U	28.50	U	2380.00	B	0.80	U	3.40	U	9500.00	J	1.00	UJ	8.50	U
MBMF05	1.10	UJ	2600.00	B	32.30		0.20	U	28.50	U	1370.00	B	1.50	UJ	3.40	U	9390.00		1.60	UJ	8.50	U
MBMF17	1.10	UJ	2670.00	B	38.80		0.20	U	28.50	U	1580.00	B	1.50	UJ	3.40	U	10100.00		1.60	UJ	8.50	U
104777																						
104781																						
104786																						
104791																						
104800																						
104807																						
104810																						
103489																						
103494																						
103498																						
103502																						
103504																						
103513																						
MBMF51	1.10	UJ	2170.00	B	17.40			R	28.50	U	1490.00	B	1.50	UJ	3.40	U	5120.00	J	1.60	J	8.50	U
MBMF49	1.10	UJ	2250.00	B	22.20	J		R	28.50	U	1490.00	B	1.50	UJ	3.40	U	5400.00	J	1.60	UJ	8.50	U
MBMF43	1.10	UJ	2210.00	B	5.50	B		R	28.50	U	1450.00	B	1.50	U	3.40	U	5170.00	J	1.60	UJ	8.50	U
MBMF35	2.20	B	2260.00	B	13.40	B	0.20	U	28.50	U	1990.00	B	0.80	U	3.40	U	5620.00	J	1.00	UJ	8.50	U
MBMF21	3.10		2200.00	B	14.30	B	0.20	U	28.50	U	1860.00	B	0.80	U	3.40	U	5430.00	J	1.00	UJ	8.50	U
MBMF09	1.10	UJ	2290.00	B	10.20	B	0.20	U	28.50	U	1050.00	B	1.50	UJ	3.40	U	5670.00		1.60	UJ	8.50	U
104782																						
104787																						
104792																						
104793																						

Qualifiers: U - Not Detected at Contract Required Detection Limit (CRDL); J - Estimated Concentration;
R - Rejected; B - Detected between CRDL and Instrument Detection Limit (IDL).

APPENDIX A
ANALYTICAL RESULTS FROM SURFACE WATER SAMPLING
Vineland Chemical Company Site

EPA Sample I.D.	Pb		Mg		Mn		Hg		Ni		K		Se		Ag		Na		Tl		V	
104799																						
104808																						
103493																						
103497																						
103501																						
103503																						
103505																						
103509																						
MBMF53	2.50	B	2680.00	B	35.40		0.20	U	28.50	U	2120.00	B	0.80	U	3.40	U	8110.00		1.00	UJ	8.50	U
MBMF47	1.10	UJ	2540.00	B		R		R	28.50	U	1770.00	B	1.50	UJ	3.40	U	7740.00	J	1.60	UJ	8.50	U
MBMF41	1.10	UJ	2550.00	B	20.80			R	28.50	U	1550.00	B	1.50	UJ	3.40	U	7840.00	J	1.60	UJ	8.50	U
MBMF33	1.10	U	2480.00	B	21.00		0.20	U	28.50	U	1920.00	B	3.20	J	3.40	U	7570.00	J	1.00	UJ	8.50	U
MBMF19	5.60		2550.00	B	26.30		0.20	U	28.50	U	2040.00	B	0.80	U	3.40	U	7880.00	J	1.00	UJ	8.50	U
MBMF07	1.10	UJ	2530.00	B	18.50		0.20	U	28.50	U	1060.00	B	1.50	UJ	3.40	U	7650.00		1.60	UJ	8.50	U
MBNC83	1.00	UJ	2420.00	B	23.50		0.20	U	12.00	U	2150.00	B	2.00	U	6.00	U	8120.00		3.00	UWJ	12.00	U
MBZ443	1.00	UJ	2540.00	B	32.50		0.20	U	12.00	U	2140.00	B	2.00	UW	6.00	U	8630.00		3.00	UWJ	12.00	U
MBGZ41	2.80	B	2720.00	B	27.90			R	3.70	U	2290.00	B	2.30	U	3.40	U	8850.00		2.20	U	2.30	U
MBJT96	3.30		2560.00	B	21.20		0.20	U	3.70	U	2090.00	B	2.30	U	3.40	U	8440.00		2.20	U	2.30	U
MBEN17		R	2400.00	BJ	32.40	J	0.20	UJ	4.70	UJ	2310.00	BJ	2.30	UJ	5.00	UJ	8530.00	J	2.20	UJ	2.60	UJ
102175	3	U	5000	U	352		0.2	U	40	U	5000	U	5	U	10	U	9000		10	U	50	U
102363	3	U	5000	U	36		0.2	U	40	U	5000	U	100	U	10	U	9000		10	U	50	U
102367	3	U	5000	U	35		0.2	U	40	U	5000	U	5	U	10	U	9000		10	U	50	U
102371	3	U	5000	U	28		0.2	U	40	U	5000	U	5	U	10	U	10000		10	U	50	U
102375	3	U	5000	U	27		0.2	U	40	U	5000	U	5	U	10	U	9000		10	U	50	U
101566	3	U	5000	U	22		0.2	U	40	U	5000	U	5	U	10	U	9000		10	U	50	U
101570	3	U	5000	U	26		0.2	U	40	U	5000	U	5	U	10	U	9000		10	U	50	U
101572	3	U	5000	U	27		0.2	U	40	U	5000	U	5	U	10	U	9000		10	U	50	U
MBNC84	1.00	UJ	2420.00	B	15.50		0.20	U	16.00	U	2520.00	B	2.00	U	4.00	U	8460.00		2.00	U	7.00	U
MBZ444	2.30	BJ	2430.00	B	15.70		0.20	U	16.00	U	2400.00	B	2.10	B	4.00	U	8550.00		2.00	UJ	7.00	U
MBGZ31	2.00	BJ	2660.00	BJ	23.00	J	0.20	UJ	3.70	UJ	2200.00	BJ	2.30	UJ	3.40	UJ	8540.00	J	2.20	UJ	2.30	UJ

Qualifiers: U - Not Detected at Contract Required Detection Limit (CRDL); J - Estimated Concentration;
R - Rejected; B - Detected between CRDL and Instrument Detection Limit (IDL).

APPENDIX A
ANALYTICAL RESULTS FROM SURFACE WATER SAMPLING
Vineland Chemical Company Site

EPA Sample I.D.	Pb		Mg		Mn		Hg		Ni		K		Se		Ag		Na		Tl		V	
MBJT95	1.80	BJ	2590.00	B	12.40	B	0.20	U	3.70	U	2170.00	B	2.30	U	3.40	U	8590.00		2.20	U	2.30	U
MBEN18		R	2560.00	B	15.50		0.20	U	3.70	U	2180.00	B	2.30	U	3.40	U	8600.00		2.20	U	2.30	U
102360	3	U	5000	U	18		0.2	U	40	U	5000	U	5	U	10	U	9000		10	U	50	U
102364	3	U	5000	U	16		0.2	U	40	U	5000	U	20	U	10	U	10000		10	U	50	U
102368	3	U	5000	U	15	U	0.2	U	40	U	5000	U	5	U	10	U	10000		10	U	50	U
102372	3	U	5000	U	21		0.2	U	40	U	5000	U	5	U	10	U	10000		10	U	50	U
101561	3	U	5000	U	21		0.2	U	40		5000	U	5	U	10	U	10000		10	U	50	U
101567	3	U	5000	U	15	U	0.2	U	40	U	5000	U	5	U	10	U	10000		10	U	50	U
101571	3	U	5000	U	15	U	0.2	U	40	U	5000	U	5	U	10	U	10000		10	U	50	U
101573	3	U	5000	U	15	U	0.2	U	40	U	5000	U	5	U	10	U	10000		10	U	50	U
MBMD99	1.00	U	2510.00	B	335.00		0.20	U	16.00	U	1610.00	B	2.00	U	4.00	U	7800.00	J	1.00	U	7.00	U
MBML77		R	2680.00	B	339.00		0.20	U	12.00	U	1800.00	B	3.00	UJ	6.00	U	7570.00	J	3.00	U	12.00	U
MBNC11	1.30	JB	2570.00	B	402.00		0.20	U	16.00	U	2080.00	B	2.00	U	4.00	U	8060.00	J	1.00	U	7.00	U
MBNC00	2.40	B	2810.00	B	404.00		0.20	U	12.00	U	2200.00	B	3.00	U	6.00	U	7530.00		3.00	UJ	12.00	U
MBNC12	1.80	JB	2570.00	B	396.00		0.20	U	16.00	U	1700.00	B	2.00	U	4.00	U	7930.00	J	1.00	U	7.00	U
MBNC01	3.30		2760.00	B	407.00		0.20	U	12.00	U	2200.00	B	3.00	U	6.00	U	7690.00		3.00	U	12.00	U
MBNC23	2.30	JB	2570.00	B	355.00		0.20	U	16.00	U	1830.00	B	2.00	U	4.00	U	7680.00	J	1.00	U	7.00	U
MBNC22	2.20	B	2780.00	B	376.00		0.20	U	12.00	U	1600.00	B	3.00	U	6.00	U	7690.00		3.00	U	12.00	U
MBNC43	1.20	B	2800.00	B	366.00		0.20	U	16.00	U	2070.00	B	1.00	U	4.00	U	8240.00		2.00	U	7.00	U
MBNC42		R	2770.00	B	376.00		0.20	U	12.00	U	1500.00	B	3.00	U	6.00	U	7690.00	J	3.00	U	12.00	U
MBNC74	1.40	JB	2700.00	B	202.00		0.20	U	16.00	U	2830.00	B	2.00	U	4.00	U	8770.00		2.00	U	7.00	U
MBNC64	1.00	UJ	2700.00	B	188.00		0.20	U	12.00	U	2140.00	B	2.00	UJ	6.00	U	9020.00		3.00	UJ	12.00	U
MBGZ22	2.20	JB	2620.00	JB	250.00	J	0.20	UJ	3.70	UJ	2160.00	JB	2.30	UJ	3.40	UJ	8650.00	J	2.20	UJ	2.30	UJ
MBGZ32	7.10		2610.00	B	249.00		0.20	U	4.70	U	2230.00	B	2.30	U	5.00	U	8900.00		2.20	U	3.60	B
MBGZ43	3.80	J	2700.00	JB	241.00	J	0.20	UJ	3.70	UJ	2260.00	JB	2.30	UJ	3.40	UJ	8810.00	J	2.20	UJ	2.30	UJ
MBGZ42	4.10	J	2710.00	JB	243.00	J		R	3.70	UJ	2230.00	JB	2.30	UJ	3.40	UJ	8890.00	J	2.20	UJ	2.30	UJ
MBEN20	3.80		2680.00	B	348.00		0.20	U	3.87	U	2260.00	B	2.30	U	5.60	B	8790.00		2.20	U	2.30	U
MBEN30	4.60		2520.00	B	324.00		0.20	U	4.70	U	2370.00	B	2.30	U	5.00	U	8620.00		2.20	U	2.60	U
MBGZ45		R	2510.00	JB	229.00	J	0.20	UJ	3.70	UJ	2160.00	JB	2.30	UJ	3.40	UJ	8330.00	J	2.20	UJ	3.20	JB
MBGZ44		R	2750.00	JB	242.00	J	0.20	UJ	3.70	UJ	2400.00	JB	2.30	UJ	3.40	UJ	9050.00	J	2.20	UJ	2.30	UJ
MBME00	1.00	U	2420.00	B	184.00		0.20	U	16.00	U	1970.00	B	2.00	U	4.00	U	7930.00	J	1.00	U	7.00	U

Qualifiers: U - Not Detected at Contract Required Detection Limit (CRDL); J - Estimated Concentration;
R - Rejected; B - Detected between CRDL and Instrument Detection Limit (IDL).

APPENDIX A
ANALYTICAL RESULTS FROM SURFACE WATER SAMPLING
Vineland Chemical Company Site

EPA Sample I.D.	Pb		Mg		Mn		Hg		Ni		K		Se		Ag		Na		Tl		V	
MBML78		R	2670.00	B	195.00		0.20	U	12.00	U	1800.00	B	3.00	U	6.00	U	7830.00	J	3.00	U	12.00	U
MBNC13	1.30	B	2560.00	B	219.00		0.20	U	16.00	U	1900.00	B	1.50	B	4.00	U	7690.00		2.00	U	7.00	U
MBNC02	2.00	U	2700.00	B	250.00		0.20	U	12.00	U	1700.00	B	3.00	UJ	6.00	U	7750.00		3.00	UJ	12.00	U
MBNC25	1.40	JB	2530.00	B	170.00		0.20	U	16.00	U	2090.00	B	2.00	U	4.00	U	7880.00	J	1.00	U	7.00	U
MBNC24	8.60		2660.00	B	176.00		0.20	U	12.00	U	1900.00	B	3.00	U	6.00	U	7740.00		3.00	UJ	12.00	U
MBNC45	1.00	U	2520.00	B	42.80		0.20	U	16.00	U	1960.00	B	1.00	U	4.00	U	8120.00		2.00	U	7.00	U
MBNC44		R	2590.00	B	49.50	J	0.20	U	12.00	U	1700.00	B	3.00	U	6.00	U	7950.00	J	3.00	U	12.00	U
MBNC75	1.00	UJ	2520.00	B	80.80		0.20	U	16.00	U	2200.00	B	2.00	U	4.00	U	9010.00		2.00	U	7.00	U
MBNC65	1.00	UJ	2560.00	B	78.20		0.20	U	12.00	U	2140.00	B	2.00	U	6.00	U	9100.00		3.00	UJ	12.00	U
MBGZ23	3.20	J	2570.00	JB	163.00	J	0.20	UJ	3.70	UJ	2180.00	JB	2.30	UJ	3.40	UJ	8670.00	J	2.20	UJ	2.30	UJ
MBGZ33	4.20	J	2570.00	JB	153.00	J	0.20	UJ	4.70	UJ	2430.00	JB	2.30	UJ	5.00	UJ	9000.00	J	2.20	UJ	2.60	UJ
MBEN21	3.10	J	2540.00	JB	143.00	J	0.20	UJ	3.70	UJ	2170.00	JB	2.30	UJ	3.40	UJ	8450.00	J	2.20	UJ	2.30	UJ
MBEN31	3.80	J	2400.00	JB	142.00	J	0.20	UJ	4.70	UJ	2260.00	JB	2.30	UJ	5.00	UJ	8460.00	J	2.20	UJ	2.60	UJ
MBGZ47	3.50		2560.00	B	119.00		0.20	U	3.70	U	2210.00	B	2.30	U	3.40	U	8590.00		2.20	U	2.30	U
MBGZ46	14.30	J	2610.00	JB	130.00	J	0.20	UJ	3.70	UJ	2360.00	JB	2.30	UJ	3.40	UJ	8630.00	J	2.20	UJ	2.30	UJ
MBME01	1.00	U	2260.00	B	89.90		0.20	U	16.00	U	1850.00	B	2.00	UJ	4.00	U	7610.00	J	1.00	UJ	7.00	U
MBML79		R	2620.00	B	115.00		0.20	U	12.00	U	1800.00	B	3.00	UJ	6.00	U	7830.00	J	3.00	U	12.00	U
MBNC14	1.00	U	2540.00	B	87.50		0.20	U	16.00	U	1530.00	B	1.00	U	4.00	U	7920.00		2.00	U	7.00	U
MBNC03	2.00	U	2610.00	B	87.90		0.20	U	12.00	U	1800.00	B	3.00	U	6.00	U	7670.00		3.00	U	12.00	U
MBNC27	1.00	U	2360.00	B	108.00		0.20	U	16.00	U	2110.00	B	2.00	U	4.00	U	7760.00	J	1.00	U	7.00	U
MBNC26	2.00	U	2650.00	B	121.00		0.20	U	12.00	U	1700.00	B	3.00	U	6.00	U	7840.00		3.00	U	12.00	U
MBNC47	1.00	U	2530.00	B	35.50		0.20	U	16.00	U	1990.00	B	1.00	U	4.00	U	8100.00		2.00	U	7.00	U
MBNC46	6.40		2580.00	B	46.70	J	0.20	U	12.00	U	1800.00	B	3.00	UJ	6.00	U	7880.00	J	3.00	U	12.00	U
MBNC76	1.00	UJ	2510.00	B	51.40		0.20	U	16.00	U	2250.00	B	2.00	U	4.00	U	8500.00		2.00	U	7.00	U
MBNC66	1.00	UJ	2560.00	B	60.60		0.20	U	12.00	U	2140.00	B	2.00	U	6.00	U	8820.00		3.00	UJ	12.00	U
MBGZ24	4.20	J	2550.00	JB	32.10	J	0.20	UJ	3.70	UJ	2150.00	JB	2.30	UJ	3.40	UJ	8640.00	J	2.20	UJ	2.30	UJ
MBGZ34	6.40	J	2550.00	JB	36.80	J	0.20	UJ	4.70	UJ	2070.00	JB	2.30	J	5.00	UJ	8670.00	J	2.20	UJ	2.60	UJ
MBEN22	2.00	B	2510.00	B	28.00		0.20	U	6.90	B	2120.00	B	2.30	U	3.40	U	8400.00		2.20	U	2.30	U
MBEN32	3.80		2400.00	B	38.60		0.20	U	4.70	U	2460.00	B	2.30	U	5.00	U	8520.00		2.20	U	2.60	U
MBGZ51	2.60	B	2530.00	B	78.80		0.20	U	3.70	U	2230.00	B	2.30	U	3.40	U	8490.00		2.20	U	2.30	U
MBGZ50	2.70	JB	2660.00	JB	86.40	J	0.20	UJ	3.70	UJ	2340.00	JB	2.30	UJ	3.40	UJ	8730.00	J	2.20	UJ	2.30	UJ
MBGZ49	1.90	B	2560.00	B	74.80		0.20	U	3.70	U	2210.00	B	2.30	U	3.40	U	8570.00		2.20	U	2.30	U

Qualifiers: U - Not Detected at Contract Required Detection Limit (CRDL); J - Estimated Concentration;
R - Rejected; B - Detected between CRDL and Instrument Detection Limit (IDL).

APPENDIX A
ANALYTICAL RESULTS FROM SURFACE WATER SAMPLING
Vineland Chemical Company Site

EPA Sample I.D.	Pb		Mg		Mn		Hg		Ni		K		Se		Ag		Na		Tl		V	
MBGZ48	1.90	B	2490.00	B	81.30		0.20	U	3.70	U	2180.00	B	2.30	U	5.00	B	8360.00		2.20	U	2.30	U
MBMF82	1.40	JB	2240.00	B	26.70		0.20	U	16.00	U	1410.00	B	2.00	U	4.00	U	7710.00	J	1.00	U	7.00	U
MBML80		R	2590.00	B	48.80	J	0.20	U	12.00	U	1800.00	B	3.00	UJ	6.00	U	8010.00	J	3.00	U	12.00	U
MBNC15	1.00	U	2370.00	B	10.90	B	0.20	U	16.00	U	1870.00	B	1.40	B	4.00	U	7650.00		2.00	U	7.00	U
MBNC04	2.00	U	2590.00	B	24.70	J	0.20	U	12.00	U	1900.00	B	3.00	U	6.00	U	7590.00		3.00	U	12.00	U
MBNC29	1.00	U	2340.00	B	18.40		0.20	U	16.00	U	1740.00	B	2.00	U	4.00	U	7860.00	J	1.00	U	7.00	U
MBNC28	2.00	U	2580.00	B	33.00	J	0.20	U	12.00	U	1900.00	B	3.00	U	6.00	U	8060.00		3.00	U	12.00	U
MBNC49	1.00	U	2500.00	B	26.20		0.20	U	16.00	U	1860.00	B	1.00	U	4.00	U	8050.00		2.00	U	7.00	U
MBNC48		R	2550.00	B	35.90	J	0.20	U	12.00	U	1700.00	B	3.00	UJ	6.00	UJ	7750.00	J	3.00	U	12.00	U
MBNC55	1.00	U	2580.00	B	30.10		0.20	U	16.00	U	2140.00	B	1.00	U	4.00	U	8280.00		2.00	U	7.00	U
MBNC54		R	2880.00	B	58.30	J	0.20	U	12.00	U	1900.00	B	3.00	UJ	6.00	U	9480.00	J	3.00	U	12.00	U
MBNC77	1.00	UJ	2590.00	B	14.20	B	0.20	U	16.00	U	2730.00	B	2.00	U	4.00	U	8680.00		2.00	U	7.00	U
MBNC67	1.00	UJ	2570.00	B	39.10		0.20	U	12.00	U	2200.00	B	2.00	U	6.00	U	8710.00		3.00	UJ	12.00	U
MBGZ25	1.90	B	2500.00	B	34.10		0.20	U	3.70	U	2150.00	B	2.30	U	3.40	U	8440.00		2.20	U	2.30	U
MBGZ35	3.80		2550.00	B	56.20		0.20	U	4.70	U	2230.00	B	2.30	U	5.00	U	8710.00		2.20	U	2.60	U
MBEN23	3.50		2510.00	B	23.60		0.20	U	3.70	U	2180.00	B	2.30	U	3.40	U	8420.00		2.20	U	2.30	U
MBEN33	6.30		2460.00	B	33.90		0.20	U	4.70	U	2430.00	B	2.30	U	5.00	U	8690.00		2.20	U	2.60	U
MBGZ53	1.40	B	2550.00	B	24.10		0.20	U	3.70	U	2210.00	B	2.30	U	3.40	U	8410.00		2.20	U	2.30	U
MBGZ52	1.90	JB	2490.00	JB	45.40	J	0.20	UJ	3.70	UJ	2200.00	JB	2.30	UJ	3.40	UJ	8450.00	J	2.20	UJ	2.30	UJ
MBMF83	1.50	JB	2310.00	B	13.10	B	0.20	U	16.00	U	1950.00	B	2.00	U	4.00	U	8060.00	J	1.00	U	7.00	U
MBML81		R	2650.00	B	23.00	J	0.20	U	12.00	U	1800.00	B	3.00	U	6.00	U	8080.00	J	3.00	UJ	12.00	U
MBNC16	1.00	U	2430.00	B	11.80	B	0.20	U	16.00	U	2040.00	B	1.20	B	4.00	U	7700.00		2.00	U	7.00	U
MBNC05	2.00	U	2560.00	B	27.50	J	0.20	U	12.00	U	2000.00	B	3.00	U	6.00	U	7840.00		3.00	U	12.00	U
MBNC32	1.00	U	2420.00	B	14.40	B	0.20	U	16.00	U	1370.00	B	2.00	U	4.00	U	8070.00	J	1.00	U	7.00	U
MBNC31	2.00	U	2640.00	B	30.20	J	0.20	U	12.00	U	1800.00	B	3.00	U	6.00	U	8050.00		3.00	U	12.00	U
MBNC51	1.00	U	2570.00	B	41.00		0.20	U	16.00	U	1880.00	B	1.00	U	4.00	U	8020.00		2.00	U	7.00	U
MBNC50		R	2540.00	B	44.20	J	0.20	U	12.00	U	1600.00	B	3.00	UJ	6.00	U	7780.00	J	3.00	U	12.00	U
MBNC78	1.00	UJ	2670.00	B	9.50	B	0.20	U	16.00	U	2210.00	B	2.00	U	4.00	U	8750.00		2.00	U	7.00	U
MBNC68	1.00	UJ	2580.00	B	31.30		0.20	U	12.00	U	2200.00	B	2.00	U	6.00	U	8760.00		3.00	UJ	12.00	U
MBGZ26	3.50		2530.00	B	19.30		0.20	U	3.70	U	2160.00	B	2.30	U	3.40	U	8490.00		2.20	U	2.30	U
MBGZ36	3.40		2570.00	B	28.20		0.20	U	4.70	U	2240.00	B	2.30	U	5.00	U	8640.00		2.20	U	2.60	U
MBEN24	2.60	B	2540.00	B	23.20		0.20	U	3.70	U	2160.00	B	2.30	U	3.40	U	8560.00		2.20	U	2.30	U

Qualifiers: U - Not Detected at Contract Required Detection Limit (CRDL); J - Estimated Concentration;
R - Rejected; B - Detected between CRDL and Instrument Detection Limit (IDL).

APPENDIX A
ANALYTICAL RESULTS FROM SURFACE WATER SAMPLING
Vineland Chemical Company Site

EPA Sample I.D.	Pb		Mg		Mn		Hg		Ni		K		Se		Ag		Na		Tl		V	
MBEN34	3.40	J	2460.00	JB	30.20	J	0.20	UJ	4.70	UJ	2210.00	JB	2.30	UJ	5.00	J	8570.00	J	2.20	UJ	2.60	UJ
MBGZ55	2.00	B	2540.00	B	13.80	B	0.20	U	3.70	U	2270.00	B	2.30	U	3.40	U	8580.00		2.20	U	2.30	U
MBGZ54	2.20	JB	2580.00	JB	25.20	J	0.20	UJ	3.70	UJ	2300.00	JB	2.30	UJ	3.40	UJ	8820.00	J	2.20	UJ	2.30	UJ
MBMF84	1.90	JB	2270.00	B	13.10	B	0.20	U	16.00	U	2130.00	B	2.00	U	4.00	U	7610.00	J	1.00	U	7.00	U
MBML82		R	2670.00	B	23.00	J	0.20	U	12.00	U	1800.00	B	3.00	U	6.00	U	8120.00	J	3.00	UJ	12.00	U
MBNC17	1.00	U	2640.00	B	14.90	B	0.20	U	16.00	U	2070.00	B	5.00	UJ	4.00	U	8220.00		2.00	UJ	7.00	U
MBNC06	2.00	U	2560.00	B	19.20	J	0.20	U	12.00	U	1800.00	B	3.00	U	6.00	U	7880.00		3.00	UJ	12.00	U
MBNC34	1.00	U	2320.00	B	16.50		0.20	U	16.00	U	1710.00	B	2.00	U	4.00	U	7990.00	J	1.00	U	7.00	U
MBNC33	2.00	U	2580.00	B	33.00	J	0.20	U	12.00	U	1800.00	B	3.00	UJ	6.00	U	8050.00		3.00	U	12.00	U
MBNC53	1.00	U	2470.00	B	37.60		0.20	U	16.00	U	1740.00	B	1.00	U	4.00	U	7950.00		2.00	U	7.00	U
MBNC52		R	2800.00	B	58.30	J	0.20	U	12.00	U	1800.00	B	3.00	UJ	6.00	U	9160.00	J	4.20	B	12.00	U
MBNC79	1.70	JB	2570.00	B	16.30		0.20	U	16.00	U	2580.00	B	2.00	U	4.00	U	8560.00		2.00	U	7.00	U
MBNC69	1.00	UJ	2620.00	B	25.40		0.20	U	12.00	U	2200.00	B	2.00	U	6.00	U	8730.00		3.00	UJ	12.00	U
MBGZ27	3.30	J	2560.00	JB	12.30	JB	0.20	UJ	3.70	UJ	2140.00	JB	2.30	UJ	3.40	UJ	8630.00	J	2.20	UJ	2.30	UJ
MBGZ37	3.90	J	2520.00	JB	22.00	J	0.20	UJ	4.70	UJ	2270.00	JB	2.30	UJ	5.00	UJ	8580.00	J	2.20	UJ	2.60	UJ
MBEN25	3.70		2440.00	B	22.60		0.20	U	3.70	U	2110.00	B	2.30	U	3.40	U	8300.00		2.20	U	2.60	B
MBEN35	2.80	B	2450.00	B	31.10		0.20	U	4.70	U	2200.00	B	2.30	U	5.00	U	8660.00		2.20	U	2.60	U
MBGZ57	1.70	B	2480.00	B	10.70	B	0.20	U	3.70	U	2170.00	B	2.30	U	3.40	U	8320.00		2.20	U	2.30	U
MBGZ56	1.60	JB	2600.00	JB	18.20	J	0.20	UJ	3.70	UJ	2300.00	JB	2.30	UJ	3.40	UJ	8660.00	J	2.20	UJ	2.30	UJ
MBNB97	1.00	U	2520.00	B	13.70	B	0.20	U	16.00	U	1940.00	B	2.00	U	4.00	U	8360.00	J	1.00	U	7.00	U
MBML83		R	2660.00	B	23.00	J	0.20	U	12.00	U	1800.00	B	3.00	U	6.00	U	8160.00	J	3.00	UJ	12.00	U
MBNC18	1.00	U	2410.00	B	8.50	B	0.20	U	16.00	U	1770.00	B	1.00	U	4.00	U	7990.00		2.00	U	7.00	U
MBNC07	2.00	U	2600.00	B	22.00	J	0.20	U	12.00	U	1900.00	B	3.00	UJ	6.00	U	7930.00		3.00	U	12.00	U
MBNC36	1.00	U	2370.00	B	18.10		0.20	U	16.00	U	1750.00	B	2.00	U	4.00	U	8090.00	J	1.00	U	7.00	U
MBNC35	2.00	U	2620.00	B	33.00	J	0.20	U	12.00	U	2000.00	B	3.00	UJ	6.00	U	8070.00		3.00	U	12.00	U
MBNC57	1.00	U	2540.00	B	41.40		0.20	U	16.00	U	1740.00	B	1.00	U	4.00	U	8030.00		2.00	U	7.00	U
MBNC56		R	2810.00	B	54.90	J	0.20	U	12.00	U	1600.00	B	3.00	UJ	6.00	U	9170.00	J	3.00	U	12.00	U
MBNC80	2570.00	B	15.30		0.20	U	16.00	U	2330.00	B	2.00	U	4.00	U	8650.00		2.00	U	7.00	U	11.20	B
MBNC70	1.00	UJ	2610.00	B	27.40		0.20	U	12.00	U	2090.00	B	2.00	U	6.00	U	8820.00		3.00	UJ	12.00	U
MBGZ28	3.40	J	2720.00	B	27.60		0.20	U	3.70	U	2260.00	B	2.30	U	3.40	U	8840.00		2.20	U	2.30	U
MBGZ38	4.70	J	2540.00	JB	33.10	J		R	3.70	UJ	2120.00	JB	2.30	UJ	3.40	UJ	8430.00	J	2.20	UJ	2.30	UJ
MBEN26	3.10	J	2470.00	JB	23.80	J	0.20	UJ	3.70	UJ	2100.00	JB	2.30	UJ	3.40	UJ	8370.00	J	2.20	UJ	2.30	UJ

Qualifiers: U - Not Detected at Contract Required Detection Limit (CRDL); J - Estimated Concentration;
R - Rejected; B - Detected between CRDL and Instrument Detection Limit (IDL).

APPENDIX A
ANALYTICAL RESULTS FROM SURFACE WATER SAMPLING
Vineland Chemical Company Site

EPA Sample I.D.	Pb		Mg		Mn		Hg		Ni		K		Se		Ag		Na		Tl		V	
MBEN36	3.80		2330.00	B	268.60		0.20	U	4.70	U	2030.00	B	2.30	U	5.00	U	8170.00		2.20	U	2.60	U
MBGZ59	1.80	B	2580.00	B	10.80	B	0.20	U	3.70	U	2200.00	B	2.30	U	3.40	U	8660.00		2.20	U	2.30	U
MBGZ58	2.90	B	2620.00	B	19.30		0.20	U	3.70	U	2390.00	B	2.30	U	3.40	U	8910.00		3.40	B	2.30	U
MBNB98	1.50	JB	2380.00	B	15.30		0.20	U	16.00	U	1040.00	B	2.00	U	4.00	U	8140.00	J	1.00	U	7.00	U
MBML84		R	2650.00	B	20.10	J	0.20	U	12.00	U	1800.00	B	3.00	UJ	6.00	U	8080.00	J	3.00	U	12.00	U
MBNC19	1.00	U	2600.00	B	12.20	B	0.20	U	16.00	U	1670.00	B	1.00	U	4.00	U	8140.00		2.00	U	7.00	U
MBNC08	2.00	U	2580.00	B	24.70	J	0.20	U	12.00	U	2000.00	B	3.00	UJ	6.00	U	7930.00		3.00	U	12.00	U
MBNC38	1.00	U	2320.00	B	16.70		0.20	U	16.00	U	1430.00	B	2.00	U	4.00	U	7930.00	J	1.00	U	7.00	U
MBNC37	2.00	U	2580.00	B	30.20	J	0.20	U	12.00	U	1800.00	B	3.00	UJ	6.00	U	7980.00		3.00	U	12.00	U
MBNC59	1.00	U	2600.00	B	44.00		0.20	U	16.00	U	2020.00	B	1.00	U	4.00	U	8030.00		2.00	U	7.00	U
MBNC58		R	2840.00	B	61.70		0.20	U	12.00	U	1800.00	B	3.00	UJ	6.00	U	9130.00	J	3.00	U	12.00	U
MBNC81	1.00	UJ	2420.00	B	13.40	B	0.20	U	16.00	U	2170.00	B	2.00	U	4.00	U	8270.00		2.00	U	7.00	U
MBNC71	1.00	U	2620.00	B	25.40		0.20	U	12.00	U	2270.00	B	2.00	U	6.00	U	8990.00		3.00	UJ	12.00	U
MBGZ29	3.60	J	2570.00	JB	16.50	J	0.20	UJ	4.70	UJ	2020.00	JB	2.30	UJ	5.00	UJ	8670.00	J	2.20	UJ	2.60	UJ
MBGZ39	1.00	U	2510.00	B	335.00		0.20	U	16.00	U	1610.00	B	2.00	U	4.00	U	7800.00	J	1.00	U	7.00	U
MBEN27	3.30		2560.00	B	21.20		0.20	U	3.70	U	2180.00	B	2.30	U	3.40	U	8710.00		2.20	U	2.30	U
MBEN37	4.10	J	2350.00	JB	27.10	J	0.20	UJ	4.70	UJ	2210.00	JB	2.30	UJ	5.00	UJ	8450.00	J	2.20	UJ	2.60	UJ
MBGZ61	2.10	JB	2600.00	JB	11.20	JB	0.20	UJ	3.70	UJ	2260.00	JB	2.30	UJ	3.40	UJ	8750.00	J	2.20	UJ	2.30	UJ
MBGZ60	1.40	B	2650.00	B	18.20		0.20	U	3.70	U	2350.00	B	2.30	U	3.40	U	8870.00		2.20	B	2.30	U
MBNB99	1.30	JB	2450.00	B	15.30		0.20	U	16.00	U	1970.00	B	2.00	U	4.00	U	8250.00	J	1.00	U	7.00	U
MBML85		R	2690.00	B	17.20	J	0.20	U	12.00	U	1700.00	B	3.00	UJ	6.00	U	8210.00	J	3.00	U	12.00	U
MBNC20	1.00	U	2590.00	B	13.10	B	0.20	U	16.00	U	2080.00	B	1.00	U	4.00	U	8210.00		2.00	U	7.00	U
MBNC09	2.00	U	2550.00	B	22.00	J	0.20	U	12.00	U	1900.00	B	3.00	U	6.00	U	7860.00		3.00	UJ	12.00	U
MBNC40	1.00	U	2440.00	B	17.20		0.20	U	16.00	U	1740.00	B	2.00	U	4.00	U	8170.00	J	1.00	U	7.00	U
MBNC39	2.00	U	2640.00	B	30.20	J	0.20	U	12.00	U	1900.00	B	3.00	U	6.00	U	8250.00		3.00	U	12.00	U
MBNC61	1.00	U	2500.00	B	43.00		0.20	U	16.00	UJ	1700.00	B	1.00	U	4.00	U	7950.00		2.00	U	7.00	U
MBNC60		R	2810.00	B	61.70		0.20	U	12.00	U	1800.00	B	3.00	UJ	6.00	U	9100.00	J	3.00	U	12.00	U
MBNC82	1.00	UJ	2510.00	B	19.20		0.20	U	16.00	U	2820.00	B	2.00	U	4.00	U	8420.00		2.00	U	7.00	U
MBNC72	1.00	UJ	2530.00	B	19.60		0.20	U	12.00	U	2280.00	B	2.00	U	6.00	U	8640.00		3.00	UJ	12.00	U
MBGZ30	1.70	JB	2480.00	JB	12.50	JB	0.20	UJ	3.70	UJ	2130.00	JB	2.30	UJ	3.40	UJ	8400.00	J	2.20	UJ	2.30	UJ
MBGZ40	4.00		2580.00	B	18.10		0.20	U	4.70	U	2140.00	B	2.30	U	5.00	U	8730.00		2.20	U	2.60	U
MBEN28	2.70	JB	2540.00	JB	20.60	J	0.20	UJ	3.70	UJ	2140.00	JB	2.30	UJ	3.40	UJ	8500.00	J	2.20	UJ	2.30	UJ

Qualifiers: U - Not Detected at Contract Required Detection Limit (CRDL); J - Estimated Concentration;
R - Rejected; B - Detected between CRDL and Instrument Detection Limit (IDL).

APPENDIX A
ANALYTICAL RESULTS FROM SURFACE WATER SAMPLING
Vineland Chemical Company Site

EPA Sample I.D.	Pb		Mg		Mn		Hg		Ni		K		Se		Ag		Na		Tl		V	
MBEN38	5.00		2490.00	B	24.70		0.20	U	4.70	U	2050.00	B	2.30	U	5.00	U	8770.00		2.20	U	2.60	U
MBGZ63	2.20	B	2500.00	B	14.90	B	0.20	U	3.70	U	2150.00	B	2.30	U	3.40	U	8450.00		2.20	U	2.30	U
MBGZ62	1.20	JB	2630.00	JB	16.50	J	0.20	U	3.70	UJ	2370.00	JB	2.30	UJ	3.40	UJ	8910.00	J	2.20	UJ	2.30	UJ

Qualifiers: U - Not Detected at Contract Required Detection Limit (CRDL); J - Estimated Concentration;
R - Rejected; B - Detected between CRDL and Instrument Detection Limit (IDL).

APPENDIX A
ANALYTICAL RESULTS FROM SURFACE WATER SAMPLING
Vineland Chemical Company Site

			Field Parameters		Field Parameters					
EPA Sample I.D.	Zn		Temperature (°C)	Conductivity (uS)	pH	D.O. (ppm)	eH	Salinity (as % NaCl)	Staff Gauge (ft)	Sulfide (ppm)
MBJT23	21.10	J	27.00	80.00	7.40	5.40	233.00	0.00		
7383B-01-005			27.00	80.00	7.40	5.40	233.00	0.00		
MBJT25	41.80									
104751										
104771	20.00	U	24.50	70.00	7.25	6.20	150.00	0.00		
104759			24.50	70.00	7.25	6.20	150.00	0.00		
MBJT80	15.30	B	11.00	97.50	6.37	2.40	ND	ND		
7576B-01-002			11.00	97.50	6.37	2.40	ND	ND		
103429	20.00	U	11.00	142.00	5.47	9.40	264.00	0.16		
7576B-02-013			11.00	142.00	5.47	9.40	264.00	0.16		
MBMK32	9.10	B	8.70	84.50	6.82	9.60	333.00	0.63	3.80	
103959	20.00	U	13.10	111.00	6.75	7.00	215.00	0.00		
MBMK63	21.20	J	9.00	105.00	10.12	ND	241.00	0.00	3.80	
MBML25	20.70	J	13.20	177.00	7.51	ND	212.00	0.00	4.48	
MBML27	62.70	J	13.20	177.00	7.51	ND	212.00	0.00	4.48	
101505	20.00	U	20.50	84.70	6.55	ND	224.00	0.00	4.19	
MBML89		R	15.90	121.00	13.13	ND	0.30	0.00	4.36	
101549	25.00		22.00	80.00	6.09	ND	226.00	0.01	3.80	
MBMF02	18.30	U	23.90	64.60	6.81	6.70	209.00	0.00	3.75	
MBNB61	16.90	B	13.60	78.00	ND	8.50	145.00		3.66	
MBJT24	12.70	JB	25.00	90.00	6.90	7.70	231.00	0.00		
7383B-01-006			25.00	90.00	6.90	7.70	231.00	0.00		
MBJT26	10.50	B								
104752										
104772	20.00	U	27.50	5.10	7.35	5.10	130.00	0.00		
104773	20.00	U	27.50	5.10	7.35	5.10	130.00	0.00		
104761			27.50	5.10	7.35	5.10	130.00	0.00		
104763			27.50	5.10	7.35	5.10	130.00	0.00		
MBJT81	6.70	B	11.60	96.10	6.34	2.00	ND	ND		
7576B-01-004			11.60	96.10	6.34	2.00	ND	ND		
103428	20.00	U	10.10	86.60	5.84	9.30	237.00	0.01		

Qualifiers: U - Not Detected at Contract Required Detection Limit (CRDL); J - Estimated Concentration;
R - Rejected; B - Detected between CRDL and Instrument Detection Limit (IDL).

APPENDIX A
ANALYTICAL RESULTS FROM SURFACE WATER SAMPLING
Vineland Chemical Company Site

			Field Parameters		Field Parameters					
EPA Sample I.D.	Zn		Temperature (°C)	Conductivity (uS)	pH	D.O. (ppm)	eH	Salinity (as % NaCl)	Staff Gauge (ft)	Sulfide (ppm)
7576B-02-011			10.10	86.60	5.84	9.30	237.00	0.01		
MBMK33	10.30	JB	8.40	80.90	6.77	9.90	180.00	0.06	2.98	
103960	20.00	U	10.80	108.00	7.13	7.30	198.00	0.00		
MBMK65		R	6.00	111.00	8.78	ND	308.00	0.00	2.84	
MBML21	13.80	B	12.30	96.90	7.05	ND	237.00	0.00	3.39	
101504	20.00	U	18.00	89.10	7.40	ND	236.00	0.00	3.10	
MBML91	13.50	B	15.90	95.50	9.50	ND	0.94	0.00	3.38	
MBML93	13.30	B	15.90	95.50	9.50	ND	0.94	0.00	3.38	
101547	20.00	U	24.00	135.00	6.38	ND	214.00	0.01	2.60	
MBMF04	18.30	U	26.40	70.10	6.86	7.60	183.00	0.00	2.50	
MBNB63	11.50	B	13.50	81.00	ND	8.80	160.00		2.50	
7383B-01-007			24.00	140.00	6.90	4.80	86.00	0.00		
MBJT27	13.80	JB								
104753										
104774	20.00	U	24.00	122.00	7.74	4.90	60.00	0.00		
104765			24.00	122.00	7.74	4.90	60.00	0.00		
MBJT82	14.60	B	8.90	164.00	8.23	6.40	ND	ND		
7576B-01-001			8.90	164.00	8.23	6.40	ND	ND		
103427	39.00		9.20	235.00	5.17	8.30	87.00	0.47		
7576B-02-009			9.20	235.00	5.17	8.30	87.00	0.47		
MBMK34	17.00	B	9.00	111.00	7.03	8.10	144.00	0.10	6.88	
103961	20.00	U	9.30	145.00	7.38	7.20	132.00	0.00		
MBMK67	9.30	JB	5.60	148.00	7.92	ND	193.00	0.00	6.08	
MBML31	16.10	JB	12.60	111.00	6.53	ND	254.00	0.00	7.00	
101502	20.00	U	16.60	156.00	7.24	0.00	136.00	0.00	6.86	
MBML95	10.20	B	16.00	116.00	8.81	ND	81.00	0.00	6.78	
101545	20.00	U	24.00	80.00	6.43	ND	85.00	0.02	5.59	
MBMF06	18.30	U	24.50	108.00	6.86	6.60	168.00	0.00	5.46	
MBML35	15.20	B	13.70	124.00	ND	8.40	-9.00		5.45	
MBJT20	23.80	J	26.00	80.00	7.00	9.90	200.00	0.50		

Qualifiers: U - Not Detected at Contract Required Detection Limit (CRDL); J - Estimated Concentration;
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APPENDIX A
ANALYTICAL RESULTS FROM SURFACE WATER SAMPLING
Vineland Chemical Company Site

			Field Parameters		Field Parameters					
EPA Sample I.D.	Zn		Temperature (°C)	Conductivity (uS)	pH	D.O. (ppm)	eH	Salinity (as % NaCl)	Staff Gauge (ft)	Sulfide (ppm)
7383B-01-001			26.00	80.00	7.00	9.90	200.00	0.50		
MBJT85	7.40	B	12.00	90.80	6.65	3.50	ND	ND		
7576B-01-006			12.00	90.80	6.65	3.50	ND	ND		
103424	20.00	U	10.10	273.00	5.47	6.90	288.00	0.01		
103425	20.00	U	10.10	273.00	5.47	6.90	288.00	0.01		
7576B-02-003			10.10	273.00	5.47	6.90	288.00	0.01		
7576B-02-005			10.10	273.00	5.47	6.90	288.00	0.01		
MBMK31	10.00	B	7.50	80.20	6.85	10.40	169.00	0.29	5.28	
103957	20.00	U	12.00	90.80	6.65	3.50	ND	ND		
MBMK61	44.10	J	5.90	156.00	10.65	ND	202.00	0.00	5.76	
MBML29	15.70	JB	13.00	57.90	7.82	ND	163.00	0.00	7.08	
MBMF10	18.30	U	26.20	67.80	6.96	6.50	208.00	0.00	4.50	
101508	20.00	U	19.20	92.10	7.06	ND	263.00	0.00	6.69	
MBNB65	19.20	B	13.80	74.20	ND	8.70	126.00		4.76	
7383B-01-004			32.00	100.00	7.90	5.00	-286.00	0.00		
104754										
MBJT55	10.10	U								
104775	20.00	U	24.50	99.20	8.47	4.60	182.00	0.00		
104767			24.50	99.20	8.47	4.60	182.00	0.00		
MBJT83	7.20	B	12.70	20.40	7.05	7.50	ND	ND		
7576B-01-005			12.70	20.40	7.05	7.50	ND	ND		
103426	20.00	U	10.50	152.00	5.72	9.30	157.00	0.00		
7576B-02-007			10.50	152.00	5.72	9.30	157.00	0.00		
MBMK30	10.00	BJ	6.80	124.00	7.22	11.90	207.00	0.32	27.15	
103962	20.00	U	10.60	186.00	7.47	9.20	99.00	0.00		
MBMK69	12.00	B	3.20	121.00	7.64	ND	324.00	0.00	27.00	
MBML17	13.70	B	13.00	97.70	6.44	ND	273.00	0.00	26.90	
101511	20.00	U	14.20	135.00	6.73	ND	180.00	0.00	27.20	
MBML97	10.20	B	17.20	108.00	8.09	ND	126.00	0.00	27.20	
101543	20.00	U	26.00	100.00	7.07	ND	177.00	0.01	26.80	
MBMF08	18.30	U	28.10	92.00	6.98	5.80	224.00	0.00		

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APPENDIX A
ANALYTICAL RESULTS FROM SURFACE WATER SAMPLING
Vineland Chemical Company Site

			Field Parameters		Field Parameters					
EPA Sample I.D.	Zn		Temperature (°C)	Conductivity (uS)	pH	D.O. (ppm)	eH	Salinity (as % NaCl)	Staff Gauge (ft)	Sulfide (ppm)
MBML36	9.80	B	15.00	106.00	ND	8.00	20.00		26.80	
MBML38	-	-	15.00	106.00	ND	8.00	20.00		26.80	
7384B-01-005			27.00	80.00	7.40	5.40	233.00	0.00		
104755										
104760			24.50	70.00	7.25	6.20	150.00	0.00		
7576B-01-009			11.00	97.50	6.37	2.40	ND	ND		
7576B-02-014			11.00	142.00	5.47	9.40	264.00	0.16		
103966	20.00	U	13.10	111.00	6.75	7.00	215.00	0.00		
MBMK64	12.00	JB	9.00	105.00	10.12	ND	241.00	0.00	3.80	
MBML26		R	13.20	177.00	7.51	ND	212.00	0.00	4.48	
MBML28	25.90	J	13.20	177.00	7.51	ND	212.00	0.00	4.48	
101506	20.00	U	20.50	84.70	6.55	ND	224.00	0.00	4.19	
MBML90		R	15.90	121.00	13.13	ND	0.30	0.00	4.36	
101550	20.00	U	22.00	80.00	6.09	ND	226.00	0.01	3.80	
MBMF01	18.30	U	23.90	64.60	6.81	6.70	209.00	0.00	3.75	
MBNB60	18.00	B	13.60	78.00	ND	8.50	145.00		3.66	
7384B-01-006			25.00	90.00	6.90	7.70	231.00	0.00		
104756										
104762			27.50	5.10	7.35	5.10	130.00	0.00		
104764			27.50	5.10	7.35	5.10	130.00	0.00		
7576B-01-011			11.60	96.10	6.34	2.00	ND	ND		
7576B-02-012			10.10	86.60	5.84	9.30	237.00	0.01		
103491			8.40	80.90	6.77	9.90	180.00	0.06	2.98	
103967	20.00	U	10.80	108.00	7.13	7.30	198.00	0.00		
MBMK66		R	6.00	111.00	8.78	ND	308.00	0.00	2.84	
MBML22	17.10	B	12.30	96.90	7.05	ND	237.00	0.00	3.39	
101503	20.00	U	18.00	89.10	7.40	ND	236.00	0.00	3.10	
MBML92	15.20	B	15.90	95.50	9.50	ND	0.94	0.00	3.38	
MBML94	18.80	B	15.90	95.50	9.50	ND	0.94	0.00	3.38	
101548	20.00	U	24.00	135.00	6.38	ND	214.00	0.01	2.60	

Qualifiers: U - Not Detected at Contract Required Detection Limit (CRDL); J - Estimated Concentration;
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APPENDIX A
ANALYTICAL RESULTS FROM SURFACE WATER SAMPLING
Vineland Chemical Company Site

			Field Parameters		Field Parameters					
EPA Sample I.D.	Zn		Temperature (°C)	Conductivity (uS)	pH	D.O. (ppm)	eH	Salinity (as % NaCl)	Staff Gauge (ft)	Sulfide (ppm)
MBMF03	18.30	U	26.40	70.10	6.86	7.60	183.00	0.00	2.50	
MBNB62	13.70	B	13.50	81.00	ND	8.80	160.00		2.50	
7384B-01-007			24.00	140.00	6.90	4.80	86.00	0.00		
104757										
104766			24.00	122.00	7.74	4.90	60.00	0.00		
7576B-01-008			8.90	164.00	8.23	6.40	ND	ND		
7576B-02-010			9.20	235.00	5.17	8.30	87.00	0.47		
103492			9.00	111.00	7.03	8.10	144.00	0.10	6.88	
103968	20.00	U	9.30	145.00	7.38	7.20	132.00	0.00		
MBMK68	6.60	JB	5.60	148.00	7.92	ND	193.00	0.00	6.08	
MBML32	13.80	JB	12.60	111.00	6.53	ND	254.00	0.00	7.00	
101501	20.00	U	16.60	156.00	7.24	0.00	136.00	0.00	6.86	
MBML96	11.70	B	16.00	116.00	8.81	ND	81.00	0.00	6.78	
101546	20.00	U	24.00	80.00	6.43	ND	85.00	0.02	5.59	
MBMF17	18.30	U	24.50	108.00	6.86	6.60	168.00	0.00	5.46	
MBNB66	15.00	B	13.70	124.00	ND	8.40	-9.00		5.45	
7384B-01-001			26.00	80.00	7.00	9.90	200.00	0.50		
7576B-01-013			12.00	90.80	6.65	3.50	ND	ND		
7576B-02-004			10.10	273.00	5.47	6.90	288.00	0.01		
7576B-02-006			10.10	273.00	5.47	6.90	288.00	0.01		
103489			7.50	80.20	6.85	10.40	169.00	0.29	5.28	
103964	20.00	U	12.20	108.00	6.61	7.10	224.00	0.00		
MBMK62	18.00	JB	5.90	156.00	10.65	ND	202.00	0.00	5.76	
MBML30	19.40	JB	13.00	57.90	7.82	ND	163.00	0.00	7.08	
101507	20.00	U	19.20	92.10	7.06	ND	263.00	0.00	6.69	
MBMF09	18.30	U	26.20	67.80	6.96	6.50	208.00	0.00	4.50	
MBNB64	12.20	B	13.80	74.20	ND	8.70	126.00		4.76	
7384B-01-004			32.00	100.00	7.90	5.00	-286.00	0.00		
104758										

Qualifiers: U - Not Detected at Contract Required Detection Limit (CRDL); J - Estimated Concentration;
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APPENDIX A
ANALYTICAL RESULTS FROM SURFACE WATER SAMPLING
Vineland Chemical Company Site

			Field Parameters		Field Parameters					
EPA Sample I.D.	Zn		Temperature (°C)	Conductivity (uS)	pH	D.O. (ppm)	eH	Salinity (as % NaCl)	Staff Gauge (ft)	Sulfide (ppm)
104768			24.50	99.20	8.47	4.60	182.00	0.00		
7576B-01-012			12.70	20.40	7.05	7.50	ND	ND		
7576B-02-008			10.50	152.00	5.72	9.30	157.00	0.00		
103493			7.10	2.68	6.20	9.20	148.00	0.31	26.90	
103969	20.00	U	10.60	186.00	7.47	9.20	99.00	0.00		
MBMK70	11.40	JB	3.20	121.00	7.64	ND	324.00	0.00	27.00	
MBML18	13.80	B	13.00	97.70	6.44	ND	273.00	0.00	26.90	
101512	20.00	U	14.20	135.00	6.73	ND	180.00	0.00	27.20	
MBML98	10.60	B	17.20	108.00	8.09	ND	126.00	0.00	27.20	
101544	20.00	U	26.00	100.00	7.07	ND	177.00	0.01	26.80	
MBMF07	18.30	U	28.10	92.00	6.98	5.80	224.00	0.00		
MBML37	13.70	J	15.00	106.00	ND	8.00	20.00		26.80	
MBML39			15.00	106.00	ND	8.00	20.00		26.80	
104844	20.00	U	21.30	80.20	7.12	5.10	177.00	0.00		
104840	21.00		25.60	78.50	5.97	3.60	215.00			
104843	20.00	U	ND	91.70	6.53	4.10	29.00			
104838	20.00	U	19.90	99.00	6.38	5.50	223.00			
104815	20.00	U	23.30	97.90	6.65	5.80	196.00		3.52	
104825	20.00	U	25.30	109.00	6.30	4.10	225.00		3.54	
MBMK32	9.10	B	8.70	84.50	6.82	9.60	333.00	0.63	3.80	
MBMK37	17.80	JB	9.00	75.50	6.16	10.10	189.00	0.07	4.50	
MBMK42	18.00	JB	8.80	78.10	5.82	6.40	209.00	0.06	4.62	
MBMK47	16.80	B	7.90	90.40	5.98	8.60	194.00	0.06	4.40	
MBMK51	29.10	J	11.00	113.00	7.12	9.40	194.00	0.06	3.88	
MBMK60	14.90	B	9.00	94.30	6.52	12.10	ND	0.00	3.72	
103515	20.00	U	9.00	94.30	6.52	12.10	ND	0.00	3.72	
MBMF61	18.30	UJ	22.00	79.00	6.14	ND	110.00	0.00		
MBMF67	18.30	UJ	25.00	75.00	6.12	ND	200.00	0.00	3.96	
MBMF63	18.30	UJ	24.00	95.00	6.02	ND	236.00	0.00	3.98	
MBMF26		R	22.00	10.00	6.11	ND	243.00	0.00	3.86	
MBMF14	18.30	U	22.20	72.00	6.75	7.40	199.00	0.00	3.74	

Qualifiers: U - Not Detected at Contract Required Detection Limit (CRDL); J - Estimated Concentration;
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APPENDIX A
ANALYTICAL RESULTS FROM SURFACE WATER SAMPLING
Vineland Chemical Company Site

			Field Parameters		Field Parameters					
EPA Sample I.D.	Zn		Temperature (°C)	Conductivity (uS)	pH	D.O. (ppm)	eH	Salinity (as % NaCl)	Staff Gauge (ft)	Sulfide (ppm)
MBMF02	18.30	U	23.90	64.60	6.81	6.70	209.00	0.00	3.75	
104839	20.00	U	22.20	82.60	7.11	4.80	160.00	0.00		
104828	20.00	U	24.10	87.50	6.96	4.10	225.00			
104841	20.00	U	25.80	90.20	6.44	4.40	208.00			
104817	20.00	U	21.40	81.10	6.56	4.40	225.00			
104820	20.00	U	25.00	86.30	7.12	4.40	129.00		2.82	
104826	20.00	U	26.90	86.70	6.97	4.10	238.00		2.80	
MBMK33	10.30	JB	7.40	83.00	7.35	8.30	143.00	0.01	2.72	
MBMK38	11.20	B	8.40	9.90	6.77	9.90	180.00	0.06	2.98	
MBMK43	13.50	B	8.00	89.20	6.10	6.90	198.00	0.06	3.02	
MBMK48	16.50	B	7.30	87.60	6.42	10.40	179.00	0.06	3.14	
MBMK52	18.30	JB	10.50	84.10	5.97	9.10	222.00	0.00	3.28	
MBMK58	13.90	B	6.70	91.90	6.70	10.90	ND	0.00	2.92	
MBMF72	18.30	UJ	24.00	120.00	6.34	ND	116.00	0.00	2.50	
MBMF75	18.30	U	26.50	85.00	6.38	ND	193.00	0.00	2.50	
MBMF74	18.30	U	25.00	80.00	6.34	ND	205.00	0.00	2.56	
MBMF30	18.30	U	23.00	50.00	6.31	ND	211.00	0.00	2.50	
MBMF16	18.30	U	26.10	70.00	6.80	7.60	164.00	0.00	2.50	
MBMF04	18.30	U	26.40	70.10	6.86	7.60	183.00	0.00	2.50	
104833	20.00	U	21.30	120.00	7.21	5.60	173.00	0.00		
104831	20.00	U	27.20	116.00	6.48	4.00	199.00			
104846	20.00	U	21.90	109.00	7.10	4.50	193.00			
104827	20.00	U	27.40	149.00	6.66	3.30	198.00			
104824	20.00	U	24.40	118.00	7.06	4.70	163.00		6.12	
104819	20.00	U	24.80	120.00	6.51	4.00	236.00		5.86	
MBMK34	17.00	B	7.10	177.00	7.00	9.00	98.00	0.09		
MBMK39	16.90	JB	9.00	111.00	7.03	8.10	144.00	0.10	6.88	
MBMK44	21.40	J	8.50	100.00	7.01	7.80	174.00	0.08	6.90	
MBMK49	17.30	B	7.40	119.00	6.96	10.40	162.00	0.08	7.12	
MBMK53	16.50	B	10.60	109.00	6.85	8.80	172.00	0.01	6.96	

Qualifiers: U - Not Detected at Contract Required Detection Limit (CRDL); J - Estimated Concentration;
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APPENDIX A
ANALYTICAL RESULTS FROM SURFACE WATER SAMPLING
Vineland Chemical Company Site

			Field Parameters		Field Parameters					
EPA Sample I.D.	Zn		Temperature (°C)	Conductivity (uS)	pH	D.O. (ppm)	eH	Salinity (as % NaCl)	Staff Gauge (ft)	Sulfide (ppm)
MBMK57	12.90	B	6.90	114.00	6.95	10.50	125.00	0.00	6.29	
MBMF56		R	23.50	120.00	6.37	ND	127.00	0.00	5.47	
MBMF46	18.30	UJ	24.00	12.00	6.50	ND	134.00	0.00	5.47	
MBMF40	18.30	U	25.00	120.00	6.41	ND	133.00	0.00	5.39	
MBMF32	18.30	U	23.00	110.00	6.36	ND	174.00	0.00	5.35	
MBMF18		R	27.00	103.00	6.80	6.10	75.00	0.00	5.35	
MBMF06	18.30	U	24.50	108.00	6.86	6.60	168.00	0.00	5.46	
104836	20.00	U	21.60	75.80	7.38	4.50	180.00	0.00		
104818	20.00	U	24.50	95.20	6.40	4.40	221.00			
104829	20.00	U	ND	91.70	6.53	4.10	29.00			
104835	20.00	U	20.80	92.80	6.92	4.60	207.00			
104842	20.00	U	24.40	88.50	6.81	4.60	181.00		5.68	
104814	20.00	U	25.80	97.30	6.61	4.50	222.00		5.54	
104822	20.00	U	25.80	97.30	6.61	4.50	222.00		5.54	
MBMK31	10.00	B	7.50	80.20	6.85	10.40	169.00	0.29	5.28	
MBMK36	11.20	JB	7.50	87.20	6.16	10.60	584.00	0.05	6.26	
MBMK40	11.80	B	7.20	87.50	6.05	6.30	223.00	0.05	6.45	
MBMK45	14.50	JB	7.20	78.70	6.15	9.60	195.00	0.03	7.66	
MBMK54	18.70	B	9.80	ND	ND	ND	241.00	0.00	7.02	
MBMK59	14.20	B	6.90	84.10	6.90	10.70	ND	0.00	6.12	
MBMF52	18.30	UJ	25.00	145.00	6.34	ND	0.98	0.00		
MBMF50	18.30	UJ	27.00	85.00	6.58	ND	2.20	0.00	4.48	
MBMF44	18.30	UJ	25.00	70.00	6.47	ND	238.00	0.00	4.48	
MBMF36	18.30	UJ	23.00	80.00	6.36	ND	236.00	0.00	4.49	
MBMF22		R	26.10	80.00	6.91	6.90	212.00	0.00	4.50	
MBMF10	18.30	U	26.20	67.80	6.96	6.50	208.00	0.00	4.50	
104834	20.00	U	28.30	119.00	6.61	4.10	192.00			
104845	20.00	U	21.70	105.00	7.60	4.50	188.00	0.00	12.92	
104830	20.00	U	22.70	134.00	6.69	4.10	263.00			
104837	20.00	U	22.70	134.00	6.69	4.10	263.00			

Qualifiers: U - Not Detected at Contract Required Detection Limit (CRDL); J - Estimated Concentration;
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APPENDIX A
ANALYTICAL RESULTS FROM SURFACE WATER SAMPLING
Vineland Chemical Company Site

			Field Parameters		Field Parameters					
EPA Sample I.D.	Zn		Temperature (°C)	Conductivity (uS)	pH	D.O. (ppm)	eH	Salinity (as % NaCl)	Staff Gauge (ft)	Sulfide (ppm)
104816	20.00	U	22.90	106.00	7.57	5.00	189.00			
104823	20.00	U	25.80	133.00	6.52	4.40	206.00			
MBMK30	10.00	BJ	7.10	2.68	6.20	9.20	148.00	0.31	26.90	
MBMK35	5.30	B	6.80	124.00	7.22	11.90	207.00	0.32	27.15	
MBMK41	6.10	JB	6.90	101.00	6.90	15.50	215.00	0.09	27.30	
MBMK46	6.70	B	6.10	121.00	6.83	9.60	232.00	0.08	27.40	
MBMK50	25.20	J	9.10	10.00	6.83	8.90	191.00	0.01	27.30	
MBMK56	12.90	B	6.40	110.00	7.56	11.90	215.00	0.00	27.00	
MBMF54	18.30	U	26.00	100.00	6.24	ND	137.00	0.00	26.80	
MBMF48	18.30	UJ	27.50	119.00	6.47	ND	144.00	0.00	26.90	
MBMF42	18.30	UJ	30.00	110.00	6.54	ND	182.00	0.00	27.00	
MBMF34	18.30	U	27.00	108.00	6.53	ND	256.00	0.00	26.90	
MBMF20	18.30	U	28.20	92.00	6.85	5.10	200.00	0.00	26.70	
MBMF08	18.30	U	28.10	92.00	6.98	5.80	224.00	0.00		
104778			21.30	80.20	7.12	5.10	177.00	0.00		
104783			24.40	75.50	6.07	4.30	252.00			
104788			25.60	78.50	5.97	3.60	215.00			
104794			19.90	99.00	6.38	5.50	223.00			
104801			23.30	97.90	6.65	5.80	196.00		3.52	
104804			25.30	109.00	6.30	4.10	225.00		3.54	
103490			8.70	84.50	6.82	9.60	333.00	0.63	3.80	
			9.00	75.50	6.16	10.10	189.00	0.07	4.50	
			8.80	78.10	5.82	6.40	209.00	0.06	4.62	
			7.90	90.40	5.98	8.60	194.00	0.06	4.40	
103507			11.00	113.00	7.12	9.40	194.00	0.06	3.88	
103512			9.00	94.30	6.52	12.10	ND	0.00	3.72	
MBMF62	18.30	U	22.00	79.00	6.14	ND	110.00	0.00		
MBMF68		R	25.00	75.00	6.12	ND	200.00	0.00	3.96	
MBMF64			24.00	95.00	6.02	ND	236.00	0.00	3.98	
MBMF25		R	22.00	10.00	6.11	ND	243.00	0.00	3.86	
MBMF23	18.30	U	22.20	72.00	6.75	7.40	199.00	0.00	3.74	

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APPENDIX A
ANALYTICAL RESULTS FROM SURFACE WATER SAMPLING
Vineland Chemical Company Site

			Field Parameters		Field Parameters					
EPA Sample I.D.	Zn		Temperature (°C)	Conductivity (uS)	pH	D.O. (ppm)	eH	Salinity (as % NaCl)	Staff Gauge (ft)	Sulfide (ppm)
MBMF01	18.30	U	23.90	64.60	6.81	6.70	209.00	0.00	3.75	
104779			22.20	82.60	7.11	4.80	160.00	0.00		
104784			24.10	87.50	6.96	4.10	225.00			
104789			25.80	90.20	6.44	4.40	208.00			
104795			21.40	81.10	6.56	4.40	225.00			
104802			25.00	86.30	7.12	4.40	129.00		2.82	
104805			26.90	86.70	6.97	4.10	238.00		2.80	
103491			7.40	83.00	7.35	8.30	143.00	0.01	2.72	
103495			8.40	9.90	6.77	9.90	180.00	0.06	2.98	
103499			8.00	89.20	6.10	6.90	198.00	0.06	3.02	
			7.30	87.60	6.42	10.40	179.00	0.06	3.14	
103506			10.50	84.10	5.97	9.10	222.00	0.00	3.28	
103511			6.70	91.90	6.70	10.90	ND	0.00	2.92	
MBMF71	18.30	U	24.00	120.00	6.34	ND	116.00	0.00	2.50	
MBMF76	18.30	U	26.50	85.00	6.38	ND	193.00	0.00	2.50	
MBMF73	18.30	U	25.00	80.00	6.34	ND	205.00	0.00	2.56	
MBMF29	18.30	U	23.00	50.00	6.31	ND	211.00	0.00	2.50	
MBMF15	18.30	U	26.10	70.00	6.80	7.60	164.00	0.00	2.50	
MBMF03	18.30	U	26.40	70.10	6.86	7.60	183.00	0.00	2.50	
104780			21.30	120.00	7.21	5.60	173.00	0.00		
104785			21.90	109.00	7.10	4.50	193.00			
104790			27.20	116.00	6.48	4.00	199.00			
104796			27.40	149.00	6.66	3.30	198.00			
104803			24.40	118.00	7.06	4.70	163.00		6.12	
104806			24.80	120.00	6.51	4.00	236.00		5.86	
103492			7.10	177.00	7.00	9.00	98.00	0.09		
103496			9.00	111.00	7.03	8.10	144.00	0.10	6.88	
103500			8.50	100.00	7.01	7.80	174.00	0.08	6.90	
			7.40	119.00	6.96	10.40	162.00	0.08	7.12	
103508			10.60	109.00	6.85	8.80	172.00	0.01	6.96	

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APPENDIX A
ANALYTICAL RESULTS FROM SURFACE WATER SAMPLING
Vineland Chemical Company Site

			Field Parameters		Field Parameters					
EPA Sample I.D.	Zn		Temperature (°C)	Conductivity (uS)	pH	D.O. (ppm)	eH	Salinity (as % NaCl)	Staff Gauge (ft)	Sulfide (ppm)
103510			6.90	114.00	6.95	10.50	125.00	0.00	6.29	
MBMF55	18.30	U	23.50	120.00	6.37	0.00	127.00	0.00	5.47	
MBMF45	18.30	U	24.00	12.00	6.50	ND	134.00	0.00	5.47	
MBMF39	18.30	U	25.00	120.00	6.41	ND	133.00	0.00	5.39	
MBMF31	18.30	U	23.00	110.00	6.36	ND	174.00	0.00	5.35	
MBMF05	18.30	U	24.50	108.00	6.86	6.60	168.00	0.00	5.46	
MBMF17	18.30	U	27.00	103.00	6.80	6.10	75.00	0.00	5.35	
104777			21.60	75.80	7.38	4.50	180.00	0.00		
104781			ND	91.70	6.53	4.10	29.00			
104786			24.50	95.20	6.40	4.40	221.00			
104791			20.80	92.80	6.92	4.60	207.00			
104800			24.40	88.50	6.81	4.60	181.00		5.68	
104807			25.80	97.30	6.61	4.50	222.00		5.54	
104810			25.80	97.30	6.61	4.50	222.00		5.54	
103489			7.50	80.20	6.85	10.40	169.00	0.29	5.28	
103494			7.50	87.20	6.16	10.60	584.00	0.05	6.26	
103498			7.20	87.50	6.05	6.30	223.00	0.05	6.45	
103502			7.20	78.70	6.15	9.60	195.00	0.03	7.66	
103504			9.80	ND	ND	ND	241.00	0.00	7.02	
103513			6.90	84.10	6.90	10.70	ND	0.00	6.12	
MBMF51	18.30	U	25.00	145.00	6.34	ND	0.98	0.00		
MBMF49	18.30	U	24.00	12.00	6.50	ND	134.00	0.00	5.47	
MBMF43	18.30	U	25.00	120.00	6.41	ND	133.00	0.00	5.39	
MBMF35		R	23.00	80.00	6.36	ND	236.00	0.00	4.49	
MBMF21	18.30	U	26.10	80.00	6.91	6.90	212.00	0.00	4.50	
MBMF09	18.30	U	26.20	67.80	6.96	6.50	208.00	0.00	4.50	
104782			21.70	105.00	7.60	4.50	188.00	0.00	12.92	
104787			28.30	119.00	6.61	4.10	192.00			
104792			22.70	134.00	6.69	4.10	263.00			
104793			22.70	134.00	6.69	4.10	263.00			

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APPENDIX A
ANALYTICAL RESULTS FROM SURFACE WATER SAMPLING
Vineland Chemical Company Site

			Field Parameters		Field Parameters					
EPA Sample I.D.	Zn		Temperature (°C)	Conductivity (uS)	pH	D.O. (ppm)	eH	Salinity (as % NaCl)	Staff Gauge (ft)	Sulfide (ppm)
104799			22.90	106.00	7.57	5.00	189.00			
104808			25.80	133.00	6.52	4.40	206.00			
103493			7.10	2.68	6.20	9.20	148.00	0.31	26.90	
103497			6.80	124.00	7.22	11.90	207.00	0.32	27.15	
103501			6.90	101.00	6.90	15.50	215.00	0.09	27.30	
103503			6.10	121.00	6.83	9.60	232.00	0.08	27.40	
103505			9.10	10.00	6.83	8.90	191.00	0.01	27.30	
103509			6.40	110.00	7.56	11.90	215.00	0.00	27.00	
MBMF53	18.30	U	26.00	100.00	6.24	ND	137.00	0.00	26.80	
MBMF47	18.30	U	27.50	119.00	6.47	ND	144.00	0.00	26.90	
MBMF41	18.30	U	30.00	110.00	6.54	ND	182.00	0.00	27.00	
MBMF33	18.30	U	27.00	108.00	6.53	ND	256.00	0.00	26.90	
MBMF19	18.30	U	28.20	92.00	6.85	5.10	200.00	0.00	26.70	
MBMF07	18.30	U	28.10	92.00	6.98	5.80	224.00	0.00		
MBNC83	4.00	U	25.00	98.80	6.67	8.90	ND		ND	ND
MBZ443	5.50	B	25.30	98.30	6.60	8.30	ND		ND	ND
MBGZ41	8.40	B	25.70	101.00	6.60	7.30	ND		ND	ND
MBJT96	4.10	U	26.30	102.00	5.84	7.90	ND		ND	ND
MBEN17	19.00	BJ	25.80	99.90	6.66	6.90	ND		ND	ND
102175	20	U	24.20	99.10	7.11	9.00	189.00		ND	0.20
102363	20	U	23.00	97.90	7.15	7.00	195.00		ND	0.20
102367	20	U	22.70	98.50	6.08	7.50	159.00		ND	0.20
102371	20	U	23.40	102.00	6.93	7.00	162.00		ND	0.20
102375	20	U	24.30	97.50	6.75	7.50	151.00		ND	0.20
101566	20	U	23.50	98.40	6.99	8.50	108.00		ND	0.20
101570	20	U	22.80	98.40	6.13	7.60	162.00		ND	2.00
101572	20	U	22.80	98.40	6.13	7.60	162.00		ND	2.00
MBNC84	9.00	U	25.00	98.80	6.67	8.90	ND		ND	ND
MBZ444	9.00	U	25.30	98.30	6.60	8.30	ND		ND	ND
MBGZ31	9.60	BJ	25.70	101.00	6.60	7.30	ND		ND	ND

Qualifiers: U - Not Detected at Contract Required Detection Limit (CRDL); J - Estimated Concentration;
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APPENDIX A
ANALYTICAL RESULTS FROM SURFACE WATER SAMPLING
Vineland Chemical Company Site

			Field Parameters		Field Parameters					
EPA Sample I.D.	Zn		Temperature (°C)	Conductivity (uS)	pH	D.O. (ppm)	eH	Salinity (as % NaCl)	Staff Gauge (ft)	Sulfide (ppm)
MBJT95	4.10	U	26.30	102.00	5.84	7.90	ND		ND	ND
MBEN18		R	25.80	99.90	6.66	6.90	ND		ND	ND
102360	20	U	24.20	99.10	7.11	9.00	189.00		ND	0.20
102364	20	U	23.00	97.90	7.15	7.00	195.00		ND	0.20
102368	20	U	22.70	98.50	6.08	7.50	159.00		ND	0.20
102372	20	U	23.40	102.00	6.93	7.00	162.00		ND	0.20
101561	20	U	24.30	97.50	6.75	7.50	151.00		ND	0.20
101567	20	U	23.50	98.40	6.99	8.50	108.00		ND	0.20
101571	20	U	22.80	98.40	6.13	7.60	162.00		ND	2.00
101573	20	U	22.80	98.40	6.13	7.60	162.00		ND	2.00
MBMD99	9.00	U	23.20	106.00	5.14	0.10				
MBML77	4.00	U	23.20	106.00	5.14	0.10				
MBNC11	9.00	U	23.10	108.00	5.76	0.00				
MBNC00	4.00	U	23.10	108.00	5.76	0.00				
MBNC12	9.00	U	23.10	108.00	5.76	0.00				
MBNC01	4.00	U	23.10	108.00	5.76	0.00				
MBNC23	9.00	U	23.30	112.00	5.92	0.10				
MBNC22	4.00	U	23.30	112.00	5.92	0.10				
MBNC43	9.00	U	23.00	102.00	5.69	0.00				
MBNC42	4.00	U	23.00	102.00	5.69	0.00				
MBNC74	9.00	U	22.60	114.00	5.56	1.60				
MBNC64	4.00	U	22.60	114.00	5.56	1.60				
MBGZ22	10.00	JB	23.00	155.00	6.80	0.00				
MBGZ32	6.10	B	23.00	155.00	6.80	0.00				
MBGZ43	7.40	JB	23.00	155.00	6.80	0.00				
MBGZ42	15.40	JB	23.00	155.00	6.80	0.00				
MBEN20	16.60	B	23.00	227.00	6.92	0.30				
MBEN30	6.60	B	23.00	227.00	6.92	0.30				
MBGZ45		R	23.80	179.00	6.59	0.00				
MBGZ44		R	23.80	179.00	6.59	0.00				
MBME00	9.00	U	23.90	102.00	5.17	0.40				

Qualifiers: U - Not Detected at Contract Required Detection Limit (CRDL); J - Estimated Concentration;
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APPENDIX A
ANALYTICAL RESULTS FROM SURFACE WATER SAMPLING
Vineland Chemical Company Site

			Field Parameters		Field Parameters					
EPA Sample I.D.	Zn		Temperature (°C)	Conductivity (uS)	pH	D.O. (ppm)	eH	Salinity (as % NaCl)	Staff Gauge (ft)	Sulfide (ppm)
MBML78	4.00	U	23.90	102.00	5.17	0.40				
MBNC13	9.00	U	24.00	100.00	5.72	0.00				
MBNC02	4.00	U	24.00	100.00	5.72	0.00				
MBNC25	9.00	U	24.20	99.50	5.79	1.20				
MBNC24	4.00	U	24.20	99.50	5.79	1.20				
MBNC45	9.00	U	24.90	95.70	6.24	6.00				
MBNC44	4.00	U	24.90	95.70	6.24	6.00				
MBNC75	9.00	U	23.10	96.40	5.92	3.80				
MBNC65	4.00	U	23.10	96.40	5.92	3.80				
MBGZ23	13.80	JB	23.10	95.50	5.60	1.30				
MBGZ33	6.70	JB	23.10	95.50	5.60	1.30				
MBEN21	8.40	JB	23.90	93.20	5.56	2.20				
MBEN31	6.70	JB	23.90	93.20	5.56	2.20				
MBGZ47	11.40	JB	23.90	91.80	5.65	1.70				
MBGZ46	4.10	UJ	23.90	91.80	5.65	1.70				
MBME01	9.00	U	25.30	103.00	5.43	2.70				
MBML79	4.00	U	25.30	103.00	5.43	2.70				
MBNC14	9.00	U	24.90	98.30	5.82	2.50				
MBNC03	4.00	U	24.90	98.30	5.82	2.50				
MBNC27	9.00	U	25.00	101.00	5.96	3.00				
MBNC26	4.00	U	25.00	101.00	5.96	3.00				
MBNC47	9.00	U	25.00	95.70	6.31	6.50				
MBNC46	4.00	U	25.00	95.70	6.31	6.50				
MBNC76	9.20	B	23.80	92.40	6.17	5.70				
MBNC66	4.00	U	23.80	92.40	6.17	5.70				
MBGZ24		R	23.30	96.10	5.80	2.40				
MBGZ34		R	23.30	96.10	5.80	2.40				
MBEN22	6.70	J	24.40	92.70	5.75	4.90				
MBEN32	7.00	B	24.40	92.70	5.75	4.90				
MBGZ51	15.00	JB	24.30	92.40	5.56	2.90				
MBGZ50	4.10	UJ	24.30	92.40	5.56	2.90				
MBGZ49	7.60	JB	24.30	92.40	5.56	2.90				

Qualifiers: U - Not Detected at Contract Required Detection Limit (CRDL); J - Estimated Concentration;
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APPENDIX A
ANALYTICAL RESULTS FROM SURFACE WATER SAMPLING
Vineland Chemical Company Site

			Field Parameters		Field Parameters					
EPA Sample I.D.	Zn		Temperature (°C)	Conductivity (uS)	pH	D.O. (ppm)	eH	Salinity (as % NaCl)	Staff Gauge (ft)	Sulfide (ppm)
MBGZ48	4.10	U	24.30	92.40	5.56	2.90				
MBMF82	9.00	U	26.30	105.00	6.03	5.50				
MBML80	4.00	U	26.30	105.00	6.03	5.50				
MBNC15	9.00	U	26.80	102.00	6.57	7.50				
MBNC04	4.00	U	26.80	102.00	6.57	7.50				
MBNC29	9.00	U	26.60	104.00	6.50	8.10				
MBNC28	4.00	U	26.60	104.00	6.50	8.10				
MBNC49	9.00	U	25.00	97.10	6.36	6.60				
MBNC48	4.00	U	25.00	97.10	6.36	6.60				
MBNC55	9.00	U	25.00	97.10	6.36	6.60				
MBNC54	4.00	U	25.00	97.10	6.36	6.60				
MBNC77	19.40	B	23.90	92.40	6.36	6.80				
MBNC67	4.00	U	23.90	92.40	6.36	6.80				
MBGZ25	7.00	B	23.80	93.50	6.00	4.40				
MBGZ35	17.20	B	23.80	93.50	6.00	4.40				
MBEN23	17.70	J	24.70	94.10	6.20	5.60				
MBEN33	17.20	B	24.70	94.10	6.20	5.60				
MBGZ53		R	24.80	92.40	6.00	3.90				
MBGZ52		R	24.80	92.40	6.00	3.90				
MBMF83	9.00	U	26.50	107.00	6.10	6.50				
MBML81	4.00	U	26.50	107.00	6.10	6.50				
MBNC16	11.30	B	27.00	105.00	6.67	7.60				
MBNC05	4.00	U	27.00	105.00	6.67	7.60				
MBNC32	9.00	U	27.10	107.00	6.74	8.20				
MBNC31	4.00	U	27.10	107.00	6.74	8.20				
MBNC51	9.00	U	25.00	100.00	6.33	6.30				
MBNC50	4.00	U	25.00	100.00	6.33	6.30				
MBNC78	9.00	U	23.90	93.20	6.49	6.70				
MBNC68	4.00	U	23.90	93.20	6.49	6.70				
MBGZ26	8.60	B	24.20	92.70	6.30	6.20				
MBGZ36	3.90	B	24.20	92.70	6.30	6.20				
MBEN24	11.80	J	24.90	94.10	6.40	6.50				

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			Field Parameters		Field Parameters					
EPA Sample I.D.	Zn		Temperature (°C)	Conductivity (uS)	pH	D.O. (ppm)	eH	Salinity (as % NaCl)	Staff Gauge (ft)	Sulfide (ppm)
MBEN34	21.70	J	24.90	94.10	6.40	6.50				
MBGZ55	6.50	JB	26.40	95.00	6.50	6.40				
MBGZ54	4.10	UJ	26.40	95.00	6.50	6.40				
MBMF84	9.00	U	26.80	108.00	5.80	6.30				
MBML82	4.00	U	26.80	108.00	5.80	6.30				
MBNC17	13.70	B	27.00	106.00	6.74	8.20				
MBNC06	4.00	U	27.00	106.00	6.74	8.20				
MBNC34	9.00	U	27.10	105.00	6.76	8.90				
MBNC33	4.00	U	27.10	105.00	6.76	8.90				
MBNC53	9.00	U	25.10	101.00	6.39	6.20				
MBNC52	4.00	U	25.10	101.00	6.39	6.20				
MBNC79	9.00	U	24.30	95.00	6.57	7.40				
MBNC69	4.00	U	24.30	95.00	6.57	7.40				
MBGZ27	19.00	JB	24.60	94.10	7.00	6.40				
MBGZ37	29.00	J	24.60	94.10	7.00	6.40				
MBEN25	7.70	B	25.00	95.70	6.59	7.30				
MBEN35	18.80	B	25.00	95.70	6.59	7.30				
MBGZ57	6.00	JB	26.70	96.80	6.95	6.60				
MBGZ56	4.10	UJ	26.70	96.80	6.95	6.60				
MBNB97	9.00	U	27.10	112.00	5.89	7.00				
MBML83	4.00	U	27.10	112.00	5.89	7.00				
MBNC18	9.00	U	27.10	107.00	6.76	8.40				
MBNC07	4.00	U	27.10	107.00	6.76	8.40				
MBNC36	9.00	U	27.20	108.00	6.81	8.90				
MBNC35	4.00	U	27.20	108.00	6.81	8.90				
MBNC57	9.00	U	25.20	103.00	6.44	6.40				
MBNC56	4.00	U	25.20	103.00	6.44	6.40				
MBNC80			24.50	101.00	6.71	8.10				
MBNC70	4.00	U	24.50	101.00	6.71	8.10				
MBGZ28	10.40	B	25.50	99.90	6.40	6.30				
MBGZ38	11.20	JB	25.50	99.90	6.40	6.30				
MBEN26	13.00	JB	25.30	97.70	6.63	7.30				

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Vineland Chemical Company Site

			Field Parameters		Field Parameters					
EPA Sample I.D.	Zn		Temperature (°C)	Conductivity (uS)	pH	D.O. (ppm)	eH	Salinity (as % NaCl)	Staff Gauge (ft)	Sulfide (ppm)
MBEN36	7.00	B	25.30	97.70	6.63	7.30				
MBGZ59	8.80	JB	27.00	99.50	7.07	6.60				
MBGZ58	5.70	B	27.00	99.50	7.07	6.60				
MBNB98	9.00	U	28.40	117.00	6.65	7.10				
MBML84	6.90	B	28.40	117.00	6.65	7.10				
MBNC19	9.00	U	27.10	108.00	6.80	8.20				
MBNC08	4.00	U	27.10	108.00	6.80	8.20				
MBNC38	9.00	U	27.30	109.00	6.95	9.20				
MBNC37	4.00	U	27.30	109.00	6.95	9.20				
MBNC59	9.00	U	25.40	105.00	6.45	6.20				
MBNC58	4.00	U	25.40	105.00	6.45	6.20				
MBNC81	9.00	U	24.70	96.40	6.76	7.80				
MBNC71	4.00	U	24.70	96.40	6.76	7.80				
MBGZ29	3.90	JB	26.30	99.30	7.00	8.40				
MBGZ39	9.00	U	26.30	99.30	7.00	8.40				
MBEN27	32.10	J	25.90	102.00	6.66	8.40				
MBEN37	19.60	JB	25.90	102.00	6.66	8.40				
MBGZ61	5.70	JB	27.90	100.00	7.35	6.80				
MBGZ60	4.10	U	27.90	100.00	7.35	6.80				
MBNB99	9.00	U	28.80	118.00	6.74	7.30				
MBML85	4.00	U	28.80	118.00	6.74	7.30				
MBNC20	17.70		27.20	111.00	6.80	8.60				
MBNC09	4.00	U	27.20	111.00	6.80	8.60				
MBNC40	9.00	U	27.90	109.00	6.92	9.70				
MBNC39	4.00	U	27.90	109.00	6.92	9.70				
MBNC61	9.00	U	25.50	108.00	6.51	6.20				
MBNC60	4.50	B	25.50	108.00	6.51	6.20				
MBNC82	9.00	U	26.40	100.00	6.92	7.90				
MBNC72	4.00	U	26.40	100.00	6.92	7.90				
MBGZ30	13.40	JB	27.10	101.00	6.90	8.40				
MBGZ40	13.80	B	27.10	101.00	6.90	8.40				
MBEN28	10.80	JB	26.50	104.00	6.72	8.40				

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			Field Parameters		Field Parameters					
EPA Sample I.D.	Zn		Temperature (°C)	Conductivity (uS)	pH	D.O. (ppm)	eH	Salinity (as % NaCl)	Staff Gauge (ft)	Sulfide (ppm)
MBEN38	6.20	B	26.50	104.00	6.72	8.40				
MBGZ63	6.80	B	28.20	103.00	7.34	6.60				
MBGZ62	4.10	UJ	28.20	103.00	7.34	6.60				

Qualifiers: U - Not Detected at Contract Required Detection Limit (CRDL); J - Estimated Concentration;
R - Rejected; B - Detected between CRDL and Instrument Detection Limit (IDL).

APPENDIX B

ANALYTICAL RESULTS FOR AS SPECIES AND RELATED ELEMENTS IN INTERSTITIAL POREWATER AND SEDIMENT FROM THE MAURICE RIVER AND UNION LAKE IN VINELAND, NEW JERSEY

U. S. DEPARTMENT OF THE INTERIOR
GEOLOGICAL SURVEY

Analytical results for As species and related elements in interstitial porewater and sediment from the Maurice River and Union Lake in Vineland, New Jersey

By
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David L. Fey* and Matthew Westgate ***

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This report is preliminary and has not been reviewed for conformity with U.S. Geological Survey editorial standards or with the North American stratigraphic code. Any use of trade names is for descriptive purposes only and does not imply endorsement by the U.S. Geological Survey.

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1993

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INTRODUCTION

Union Lake, the Maurice River, and the Blackwater Branch , a tributary of the Maurice River, all parts of a small watershed near Vineland, New Jersey, are contaminated by arsenic (As) from a local chemical factory (fig. 1)(Faust and others, 1987). An in-depth study to be used for the design of the remedial action at the Vineland Chemical Co. Superfund site was initiated by the U.S. Environmental Protection Agency to determine the extent and severity of the contamination. The Vineland Chemical Co. site is located in Cumberland County, New Jersey. Organic As herbicides were manufactured there from approximately 1949 to the late 1980's. As part of the effort, core samples were collected in the Maurice River close to the chemical factory and from Union Lake, a reservoir approximately seven miles from the factory. This report summarizes the analytical results for As speciation and various constituents in the interstitial porewater and associated sediment from these cores. Because the U.S. Geological Survey has the analytical expertise and necessary equipment, the samples were analyzed in USGS laboratories in Denver, Colorado and Seattle, Washington.

SAMPLE COLLECTION

Five cores were collected between July 22 and July 24, 1992. Two of these cores were taken from the Maurice River, one near the confluence of the Blackwater Branch and Maurice River, and the other where Almond Road crosses the river (fig. 1). Samples from these sites are identified as BW and AR, respectively, in the tables containing the analytical results. Two of the cores were collected at a site behind a submerged dam near the north end of Union Lake (1UL and 2UL), and the final core was obtained near the existing dam at the south end of the lake (3UL). The reservoir cores were collected at depths of 20 to 25 ft. by divers using a Jahnke coring device (Jahnke, 1988). The river cores were collected in about three ft. of water using the same type of corer. Plugs were placed in both ends of the core liners while the cores were still underwater. Approximately 30 centimeters of sediment plus overlying water were collected in the core liner from each site.

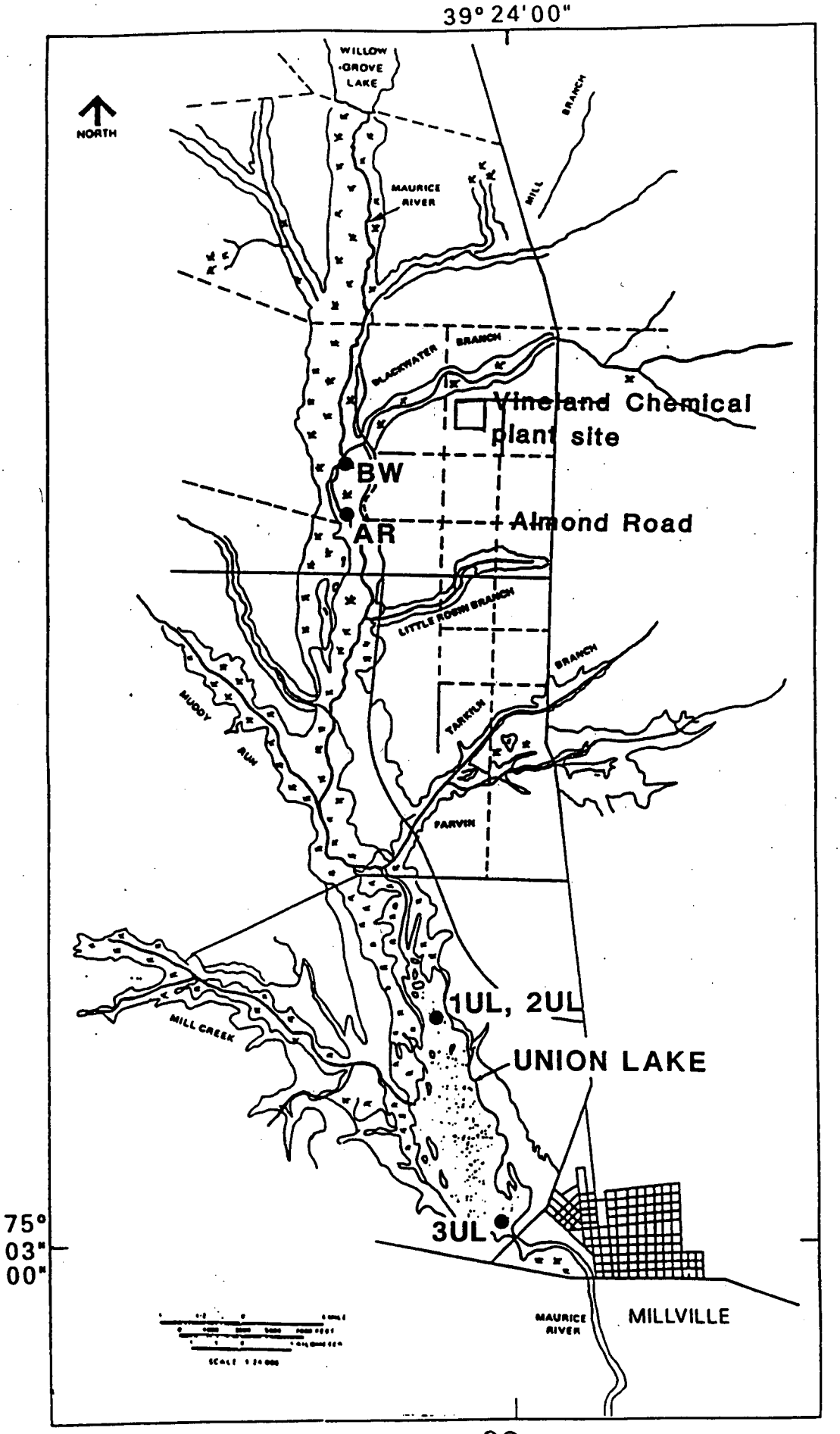
Cores were returned to a field laboratory located in Vineland within hours of collection and stored at 5^0C until porewater and sediment were extracted. The core liner had pre-tapped holes at various depths into which syringes were attached by Luer Lok fittings (fig. 2). The interstitial water was extracted into the syringes by applying pressure (60 psi) to the whole core. This system ensured that anoxic water samples were not contaminated by atmospheric oxygen. The material in the core was compressed and, hence, the level from which a given sample was taken changed during the extraction of the water. These depths are summarized in the tables containing the analytical information. The associated sediment was extruded in discrete intervals from the cores, packed in plastic bags, and frozen. Extraction of porewater and subsectioning of the cores occurred at the field laboratory within 12 hours of core collection.

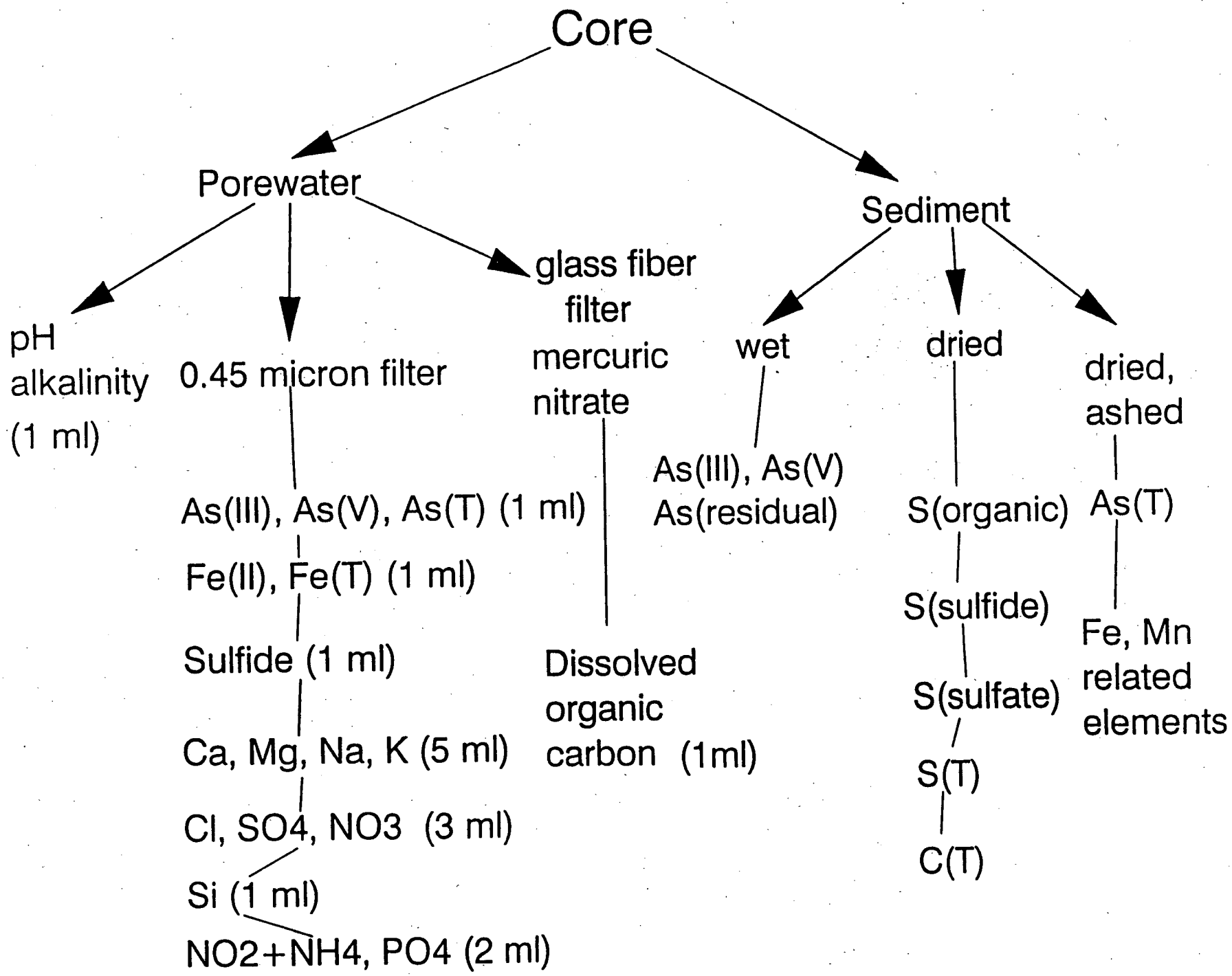
Captions for figures.

Figure 1--Map of the study area near Vineland, New Jersey. Adapted from Final Field Operations Plan, Vineland Chemical Co. site, by Ebasco Environmental.

Figure 2--The Jahnke corer in use during extraction of interstitial porewater.

Figure 3--Diagram showing the distribution of water sample during subsectioning of each core.


39° 24'00"
NORTH
WILLOW GROVE LAKE
MAURICE RIVER
MILL BRANCH
BLACKWATER BRANCH
Vineland Chemical plant site
BW
AR
Almond Road
LITTLE ROBIN BRANCH
BRANCH
TARKILN
MUDDY RUN
PARVIN
1UL, 2UL
UNION LAKE
MILL CREEK
3UL
75° 03" 00"
MAURICE RIVER
MILLVILLE


Core
Porewater
Sediment
pH
alkalinity
(1 ml)
0.45 micron filter
glass fiber
filter
mercuric
nitrate
wet
dried
dried,
ashed
As(III), As(V), As(T) (1 ml)
Fe(II), Fe(T) (1 ml)
Sulfide (1 ml)
Ca, Mg, Na, K (5 ml)
Cl, SO4, NO3 (3 ml)
Si (1 ml)
NO2+NH4, PO4 (2 ml)
Dissolved
organic
carbon (1ml)
As(III), As(V)
As(residual)
S(organic)
S(sulfide)
S(sulfate)
S(T)
C(T)
As(T)
Fe, Mn
related
elements

CHEMICAL ANALYSIS

The sectioning of the cores resulted in a total of 42 water samples and 37 sediment samples. All water samples, except those subsamples for pH, alkalinity, and dissolved organic carbon (DOC), were filtered through 0.45 µm disposable filters prior to any subsequent treatment. The flow diagram presented in fig. 3 indicates the subsectioning of each sample and the volume of water required for a particular analysis. In general, there was insufficient porewater available to do each of the chemical analyses more than once. The methods for the water and sediment determinations are summarized in Table 1. A description of the visual appearance of the cores is presented in Table 2.

Each water sample was analyzed for ferrous and total iron, hydrogen sulfide, and pH immediately following extraction from the core. A subsample of water was preserved for arsenic speciation by adding 10 µl of concentrated HCl to one ml of water. Subsamples of water for chloride, sulfate, and nitrate determinations were frozen and sent to Denver for analyses. Dissolved organic carbon samples were filtered through precombusted glass fiber filters, transferred to precombusted glass vials, preserved with mercuric nitrate solution, and refrigerated for shipment to Denver. Subsamples for alkalinity determinations were refrigerated before analysis, whereas samples for phosphorus, nitrite, and ammonia analyses were frozen for shipment to Seattle. The analytical results for the water immediately overlying the sediment and the interstitial pore water are summarized in Table 3. Hydrogen sulfide was not detected in any of the water samples and the results are not included in Table 3.

For some of the pore-water samples, the sum of the concentration of As(III) and As(V) do not add up to the concentration of total arsenic determined independently of the speciation. Because of the limited quantity of water available for the speciation, the speciation analysis could not be repeated in order to achieve better agreement. In these cases the results do reflect the presence or absence of one or both species.

Subsections of sediment were immediately frozen in order to preserve the speciation of arsenic in its original form and shipped to Denver for analysis. The samples were thawed just before analysis of the sediment. Arsenic was extracted from wet sediment samples using 4.0N HCl and separated into As(III) and As(V) according to the method of Ficklin (1990). The arsenic remaining in the sediment following extraction with 4.0N HCl was partially dissolved by adding potassium chlorate and concentrated HCl. This treatment dissolves sulfides and probably other forms of arsenic (Ficklin, 1990). Analyses of these leachates are identified as residual As (table 4). A subsample of the wet sediment was dried at 100°C to determine wet to dry weights and used for the determination of sulfur species and total carbon. Subsamples of the dried sediment were also ashed and then used for the determination of bulk sediment concentrations of arsenic, iron, and manganese by inductively couple plasma-atomic emission spectrometry (ICP-AES) (Briggs and others, 1990). Results for arsenic species and other constituents in the sediment are summarized in Table 4. Some elements are part of the ICP-AES scan but they were below the detection limit of the analytical procedure. These are listed below with the detection limit in parentheses following the element: gold (8 ppm), silver (2 ppm), bismuth (10 ppm), europium (2 ppm), holmium (4 ppm), tin (5 ppm), tantalum (40 ppm), and uranium (100 ppm).

The extraction of arsenic from the solid phase material also resulted in some concentrations of the three species that did not add up to the total concentration obtained by ICP-AES. There are several explanations for this: (1) The samples used for the ICP-AES analysis were dried and ashed before a sample was weighed, whereas the samples for the speciation were wet. (2) The samples used for the speciation may not have been homogeneous, and the small amount used for the analysis may not have been as representative as desired. (3) Some organic arsenic compounds may occur in the sediment and may not react with the reagents employed in the analysis of arsenic species.

DISCUSSION AND CONCLUSIONS

The oxidation of organic matter in recently deposited sediments occurs via a series of thermodynamically predictable reactions (Berner, 1980). These reaction are mediated by bacteria. Entrained oxygen is used first, followed by denitrification (i.e. the reduction of nitrate via nitrite and ammonia to nitrogen). When readily available oxygen is gone, the bacteria then obtain oxygen from manganese oxide, iron oxide, and sulfate. The final step is the dissociation of organic matter into carbon dioxide and methane. These reactions result in the sequential disappearance of oxygen, nitrate, and sulfate, and the appearance of dissolved Mn(II), Fe(II), sulfide, and methane in the interstitial pore waters of sediment.

Evidence for nitrate reduction in Union Lake pore waters is shown by decreases in nitrate concentration and increases in concentrations of combined nitrite and ammonia with depth in the upper portions of each of the cores (Table 3). The presence of dissolved Mn and Fe(II) in the overlying water and increases in these species in the upper portions of the cores indicate that reduction of Mn and Fe oxides is also occurring in the bottom waters and sediments of Union Lake (Table 3). No measurable concentrations of sulfide were observed in the interstitial pore waters of Union Lake.

Arsenic is also a redox sensitive element. The redox potential for the As(V)/As(III) couple is between the potential for Fe(III)/Fe(II) and SO_4^{2-}/S^{2-} in freshwater systems at pH 6 (Turner and others, 1981). However, the transformation of elements between their oxidation states may be sluggish so predictions of natural water concentrations and speciation based on thermodynamic principles may only indicate the direction the system is heading. Based on the Fe(II) data for the overlying water and pore water of Union Lake, we might expect As in the pore waters to be in its reduced state, and indeed, the As speciation data indicate that a significant portion of the total dissolved As occurs as As(III) (Table 3).

The mobility of As(III) and As (V0 in aquatic environments is also controlled by adsorption onto hydrous ferric oxyhydroxides (Ferguson and Gavis, 1972; Aggett and O'Brien, 1985). When oxygen is present Fe will primarily exist as insoluble oxyhydroxides capable of adsorbing dissolved arsenic species. However, for anoxic conditions, Fe oxyhydroxides may be reduced and any associated elements (e.g. As species) can be released. This process may be occurring in Union Lake as there is a positive correlation between Fe(II) and total As in the porewater (r^2=0.69). The large change in concentrations of dissolved Fe(II), As(III), As(V), and Mn across the sediment-water interface in the river and lake cores indicates that these species are diffusing out of the sediment and into the overlying water.

Despite the absence of sulfide in the pore water, sulfate reduction may be occurring in the sediments. Sulfide produced during the reduction of sulfate may be consumed in the precipitation reactions involving heavy metals and sulfide (e.g. CuS, PbS, and ZnS). Sulfate reduction in Union Lake may be occurring because decreases in sulfate concentration in the pore waters with depth are observed (Table 3) and a significant proportion of the solid sulfur exists as sulfide (Table 4). The large amount of arsenic in the sediments that was not dissolved by 4.0N HCL but dissolved by potassium chlorate and concentrated hydrochloric acid (Table 4) may be indicative of arsenopyrite, a mineral composed of As(III), Fe(II), and sulfide.

The cores from the river had a dark brown layer that occurred above a tan, sandy layer and the lake cores were all dark brown (Table 2). The dark brown layers were high in organic matter (7 to 23% total carbon), whereas the sandy layers had less than 2% total carbon (Table 4). The highest concentration of arsenic in the sediments occurred in the organic rich layers of the cores (Table 4). In fact, there is an excellent correlation between total carbon and total arsenic in the river sediments (r^2=0.71).

Summary

The widespread distribution of As in the area around and downstream of the Vineland Chemical Co. Superfund site is demonstrated by the data contained in Tables 3 and 4. The As occurs mostly as As(III) and As(V) in the interstitial pore water of cores collected from Union Lake and from the Maurice River. Bacterial mediated reactions occurring in the sediment are responsible for maintaining the speciation of As. As is relatively soluble in the interstitial water and it occurs in the overlying water, consequently As is diffusing from the sediment into the lake water. The organic rich parts of the sediment contain more arsenic than the sandy sediment.

ACKNOWLEDGMENTS

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Table 1--Analytical methods for analyses of interstitial pore water and sediment samples in the Maurice River-Union Lake arsenic study

Specie	Method	Reference
WATER SAMPLES		
As(III), As(V)	Ion exchange/GFAAS[a]	Ficklin (1983)
As(T)	GFAAS	Ficklin (1983)
Fe(II), Fe(T)	Colorimetric	Gibbs (1976)
Sulfide	Colorimetric	Cline (1969)
pH	Ross electrode	
Cl, SO_4, NO_3	Ion chromatography	Pfaff et al. (1989)
Mg, Ca, K, Na	AAS[b]	Fishman and Friedman (1989)
DOC	UV/persulfate oxidation	Standard Methods (1981)
NO_2+NH_4, Si, PO_4[c]	Colorimetric	Strickland and Parsons (1972)
SEDIMENT SAMPLES		
As(III), As(V), As(res)	Acid extraction/ ion exchange/GFAAS	Ficklin (1990)
Sulfur species		Unpublished method, USGS
Bulk As, Fe, Mn, and others	ICP-AES[d]	Briggs (1990)

[a] graphite furnace atomic absorption spectrometry
[b] flame atomic absorption spectrometry
[c] arsenic interferes with PO_4; results for PO_4 questionable
[d] inductively coupled plasma-atomic emission spectrometry

Core	depth	
AR1		Overlying water
AR2	1.9-3.8 cm	organic, sand mixture with stems and roots, brown
AR3	7.6-8.6 cm	organic, sand mixture with stems and roots, brown
AR4	10.2-11.4 cm	organic sand mixture with stems and roots, brown
AR5	14.6-15.2 cm	mostly sand , some clasts, roots, tan color
AR6	26-26.7 cm	mostly sand, gas pockets, clasts, tan color
BW1		Overlying water
BW2	.6-1.9 cm	organic rich, very little sand, fine grains, dark brown
BW3	3.8-5.1 cm	mix of organic and sand, fine grains, very dark brown
BW4	8.9-9.8 cm	sand with minor organic, few gas bubbles, tan
BW5	13.3-14.9 cm	sand with mnior organic, few gas bubbles, tan
BW6	23.5-24.1 cm	mostly sand, fine grains, light tan
1UL1		overlying water
1UL2	.6-1.9 cm	very fine organic, no visible sand, no roots, dark brown
1UL3	1.3-2.5 cm	very fine organic, no visible sand, no roots, dark brown
1UL4	4.5-5.7 cm	similar to above but with gas pockets
1UL5	5.1-6.7 cm	similar to above but with gas pockets
1UL6	8.3-9.5 cm	similar to above but with gas pockets
1UL7	9.5-10.8 cm	similar to above but with gas pockets
1UL8	14-15.2 cm	similar to above but with gas pockets
1UL9	16.5-17.1 cm	similar to above but with gas pockets
1UL10	23.5-24.8 cm	similar to above but with gas pockets
2UL1		overlying water
2UL2	.6 cm	very fine organic, no visible sand, no roots, dark brown
2UL3	1.3-1.9 cm	very fine organic, no visible sand, no roots, dark brown
2UL4	3.2-4.5 cm	similar to above but with gas pockets
2UL5	5.1-5.7 cm	similar to above but with gas pockets
2UL6	9.5 cm	similar to above but with gas pockets
2UL7	11.4-11.8 cm	similar to above but with gas pockets
2UL8	13.3-14 cm	similar to above but with gas pockets
2UL9	18.4-18.7 cm	similar to above but with gas pockets
2UL10	21.3-21.5 cm	similar to above but with gas pockets
3UL1		overlying water
3UL2	1.3-4.5 cm	organic very fine grains, dark brown
3UL3	1.9-5.1 cm	organic very fine grains, dark brown
3UL4	5.1-8.2 cm	organic very fine grains, dark brown
3UL5	8.3-11.4 cm	organic very fine grains, dark brown
3UL6	11.4-14 cm	organic very fine grains, dark brown
3UL7	16.5-19.4 cm	organic very fine grains, dark brown
3UL8	18.4-21.6 cm	organic very fine grains, dark brown
3UL9	24.1-27.3 cm	organic very fine grains, dark brown
3UL10	27.3-29.2 cm	organic very fine grains, dark brown

Table 2--Core descriptions for the two river cores and the three lake cores collected in the Maurice River-Union Lake study.

Explanation of chemical symbols used in Table 3.

As(III)=arsenic(III)
As(V)= arsenic(V)
Sum(III)(V)= the sum of As(III) and As(V)
As(total)= total arsenic (determined independently of the speciation
Fe(2)= ferrous iron , The field determination was in uM. the second column labelled Fe(2) is the conversion from uM to milligrams per liter
Fe(t)= total iron in uM.
Fe(T)= total iron in milligrams/L converterd from uM.
Mn= manganese
Cl= chloride
NO3= nitrate
SO4= sulfate
DOC= dissolved organic carbon
Alk= alkalinity
Ca=calcium
Mg= magnesium
Na= sodium
K= potassium
Si= silicon
P= phosphorus
NH4+NO2= nitrogen occurring as ammonium ion or nitrite ion
ug/L= micrograms per liter
uM= micromoles per liter
mg/L= milligrams per liter

Table 3--Analytical results for overlying water and interstitial porewater samples from five cores collected in the Maurice River and Union Lake. Sample descriptors are discussed in the text. The depths before and after squeezing of the core are listed in the column labeled depth. At levels where insufficient sample was available for all of the determinations the result is listed as "ins".

SAMPLE	depth	As(III) ug/L	As(V) ug/L	Sum(III)(V) ug/L	As(total) ug/L
AR1	overlying	24	73	97	110
AR2	1.9-3.8cm	15	190	205	330
AR3	7.6-8.6 cm	<5	170	170	210
AR4	10.2-11.4 cm	<5	350	350	410
AR5	14.6-15.2 cm	<5	130	130	110
AR6	26-26.7 cm	<5	32	32	50
BW1	overlying	930	360	1290	1090
BW2	0.6-1.9 cm	1000	2030	3030	3100
BW3	3.8-5.1 cm	3900	2170	6070	5900
BW4	8.9-9.8 cm	130	160	290	270
BW5	13.3-14.9 cm	80	70	150	180
BW6	23.5-24.1 cm	10	9	19	18
1UL1	overlying	30	100	130	170
1UL2	0.6-1.9 cm	110	210	320	330
1UL3	1.3-2.5 cm	90	100	190	250
1UL4	4.5-5.7 cm	590	1250	1840	1910
1UL5	5.1-6.7 cm	500	1330	1830	2110
1UL6	8.3-9.5 cm	1100	1610	2710	2910
1UL7	9.5-10.8 cm	1670	1200	2870	3100
1UL8	13.9-15.2 cm	680	1600	2280	2400
1UL9	16.5-17.1 cm	870	1130	2000	2110
1UL10	23.5-24.8 cm	390	390	780	720
2UL1	overlying	25	130	155	140
2UL2	0.6 cm	60	170	230	250
2UL3	1.3-1.9 cm	60	290	350	340
2UL4	3.2-4.4 cm	760	930	1690	1680
2UL5	5.1-5.7 cm	800	1270	2070	1960
2UL6	9.5 cm	510	1700	2210	2150
2UL7	11.4-11.7 cm	790	1100	1890	1750
2UL8	13.3-13.9 cm	1400	1190	2590	2480
2UL9	18.4-18.7 cm	480	930	1410	1450
2UL10	21.3-21.6 cm	120	330	450	560
3UL1	overlying	15	120	135	130
3UL2	1.27 cm	160	640	800	760
3UL3	1.91 cm	10	130	140	150
3UL4	5.1-8.3 cm	400	1200	1600	1660
3UL5	8.3-11.4 cm	230	850	1080	1040
3UL6	11.4-13.9 cm	670	860	1530	2200
3UL7	16.5-19.4 cm	50	900	950	920
3UL8	18.4-21.6 cm	310	790	1100	1260
3UL9	24.1-27.3 cm	160	610	770	900
3UL10	27.3-29.2 cm	150	330	480	500

Table 3--continued

SAMPLE	Fe(2) uM	Fe(2) mg/L	Fe(t) uM	Fe(T) mg/L	Mn ug/L	Cl mg/L
AR1	17.3	0.97	22.1	1.23	440	6.1
AR2	137	7.64	104	5.80	1260	6.3
AR3	177	9.90	242	13.4	ins	7.2
AR4	266	14.9	266	14.8	1680	7.0
AR5	177	9.90	148	8.28	370	7.3
AR6	156	8.72	293	16.3	360	6.8
BW1	86.2	4.82	77.5	4.33	360	8.6
BW2	220	12.3	233	13.0	ins	10
BW3	323	18.0	343	19.2	240	22
BW4	31.1	1.73	31.3	1.75	210	24
BW5	17.5	0.98	18.5	1.03	190	24
BW6	4.63	0.26	2.46	0.14	190	23
1UL1	11.9	0.66	16.8	0.94	90	11
1UL2	178	9.95	135	7.56	190	11
1UL3	95.7	5.35	77.6	4.34	140	11
1UL4	326	18.2	472	26.4	410	24
1UL5	337	18.8	472	26.4	350	11
1UL6	484	27.0	632	35.3	420	7.2
1UL7	418	23.3	632	35.3	ins	14
1UL8	257	14.3	499	27.9	ins	4.8
1UL9	359	20.0	436	24.3	290	3.8
1UL10	285	15.9	366	20.5	240	3.3
2UL1	19.0	1.06	27.4	1.53	90	11
2UL2	95.8	5.35	120	6.71	150	11
2UL3	115	6.45	156	8.71	190	11
2UL4	517	28.9	609	34.1	380	9.7
2UL5	382	21.3	519	29.0	380	11
2UL6	340	19.0	492	27.5	370	7.7
2UL7	504	28.1	627	35.0	350	7.3
2UL8	451	25.2	549	30.6	360	5.3
2UL9	371	20.7	479	26.8	300	5.2
2UL10	320	17.9	416	23.3	250	5.1
3UL1	13.9	0.78	21.7	1.21	460	7.9
3UL2	176	9.83	224	12.5	1110	8.2
3UL3	9.16	0.51	12.6	0.70	440	7.1
3UL4	223	12.5	321	17.9	1370	8.5
3UL5	192	10.7	270	15.19	1230	7.5
3UL6	335	18.7	474	26.4	1210	8.7
3UL7	192	10.7	260	14.5	900	9.2
3UL8	240	13.4	280	15.7	1000	8.9
3UL9	192	10.7	241	13.5	760	7.1
3UL10	184	10.3	207	11.5	510	7.4

Table 3--continued

SAMPLE	NO3 mg/L	SO4 mg/L	DOC mg/L	Alk meq/l	pH	Ca mg/L
AR1	4.9	8.6	5.6	0.247	6.03	4.9
AR2	1	5.9	7.6	0.474	5.53	2.6
AR3	<.1	5.1	14.3	1.518	5.59	12
AR4	<.1	5	12.1	0.502	5.62	17
AR5	<.1	5.1	0	0.907	5.49	4
AR6	<.1	5.2	ins	0.768	5.4	7.3
BW1	7.3	10	4.3	0.191		1.9
BW2	6.1	11	5.8	0.072	6.34	4
BW3		7.1	10	0.302	6.17	6.6
BW4	3.3	23	5.6	0.116	5.47	6.2
BW5	5	24	6.3	0.061	5.34	4.8
BW6	6.7	27	3.8	0.088	5.14	7.4
1UL1	6.2	8.4	6.8	0.257	6.37	4
1UL2	3.8	11	9.5	0.209	7.03	3.7
1UL3	5	12	6.6	0.121	6.55	3.3
1UL4	0.4	6	16	1.20	6.52	13
1UL5	1	5.7	13	0.722	6.67	9.2
1UL6	<.1	5.7	7.1	1.16	6.63	15
1UL7	<.1	5.7	ins	0.143	6.97	
1UL8	<.1	5.6	ins	0.272	6.82	7.9
1UL9	<.1	5.8	8.5	0.406	7.72	8
1UL10	<.1	5.7	7.5	0.597	6.59	6.7
2UL1	5.7	10	6	0.409	6.54	2.1
2UL2	5.4	11	8.4	0.170	6.71	3.2
2UL3	1.9	8.1	12	0.097	6.43	5
2UL4	<.1	5.1	9.5	0.111	7.03	8.5
2UL5	<.1	5	18	1.01	6.56	10
2UL6	<.1	5	14	0.274	6.54	7.2
2UL7	<.1	5	15	0.617	6.58	8.7
2UL8	<.1	5.1	13	0.556	6.58	12
2UL9	<.1	5	8.3	0.9458	6.54	8.1
2UL10	<.1	4.8	9.5	0.788	6.52	7.1
3UL1	1.3	6.7	7.4	0.432	6.92	5.1
3UL2	<.1	5.6	17	0.139	7.08	8.5
3UL3	0.9	9.2	7.7	0.174	6.75	5
3UL4	<.1	5.6	20	0.991	7.71	12
3UL5	<.1	5.5	15	0.890	6.73	11
3UL6	<.1	5.4	ins	ins	ins	11
3UL7	<.1	5.4	29	0.247	6.8	11
3UL8	<.1	5.5	47	0.660	6.75	12
3UL9	<.1	5.5	15	1.13	6.8	10
3UL10	<.1	5.5	31	1.01	6.75	11

Table 3--continued

SAMPLE	Mg mg/L	Na mg/L	K mg/L	Si uM	P uM	NH4+NO2 uM
AR1	2.5	5	2.2	63.8	0.00	32
AR2	0.7	1.1	0.8	164	0.00	56
AR3	4.2	7.6	7.9	420	0.00	84
AR4	5.6	7.1	5.4	128	0.00	71
AR5	1.3	2.5	1.3	638	4.0	77
AR6	2.9	6.5	3.3	658	0.50	59
BW1	0.6	1.9	0.6	114.9	0.00	35
BW2	2	9.8	2	112.9	0.50	38
BW3	2.9	15	1.2	89.1	9.3	36
BW4	2.5	15	1.4	80.3	0.00	33
BW5	1.8	12	1.4	75.7	0.00	33
BW6	2.6	16	1.9	81.3	0.00	34
1UL1	2.1	9.2	2.5	76.2	0.00	34
1UL2	1.8	8.4	2.4	106	6.0	41
1UL3	1.5	7.8	2.2	95.8	0.00	35
1UL4	4.4	12	3.3	202	6.0	60
1UL5	3.6	6.9	2.5	240	3.5	51
1UL6	7.6	8.5	3.7	237	1.3	57
1UL7				280	9.0	71
1UL8	3.9	6.8	3.4	286	0.2	66
1UL9	4.1	7.6	3.9	371	6.1	60
1UL10	3	6.4	3.6	442	5.5	50
2UL1	1.1	3.9	1	77.7	0.00	42
2UL2	1.7	8.9	2.3	1.25	0.00	39
2UL3	2.7	11	2.7	18.3	0.00	41
2UL4	3.9	10	3.1	218	0.00	53
2UL5	4.4	9.8	3.1	224	2.7	51
2UL6	3.2	5.4	1.9	305	6.8	54
2UL7	3.8	6.2	2.8	340	0.00	62
2UL8	5.8	8.9	3.8	290	0.00	64
2UL9	3.7	8.3	4.1	397	0.00	58
2UL10	3.4	5.8	4.8	57.6	1.2	57
3UL1	2.5	6.8	2.2	108	0.00	39
3UL2	3.8	7.2	2.6	27.1	11	50
3UL3	2.5	6.9	2.3	6.42	0.00	42
3UL4	5.7	7.2	2.8	183	5.5	53
3UL5	5.3	6.1	2.5	196	0.00	51
3UL6	4.8	7.6	3.2	243	17	58
3UL7	4.4	5.9	2.5	215	3.5	47
3UL8	5.5	11	4.4	28.6	0.00	43
3UL9	5.2	8.4	3.1	247	4.2	48
3UL10	5.5	9.1	3.3	256	0.00	43

Explanation of chemical symbols used in Table 4.

As(III)s= arsenic(III) from acid extraction of a sample of sediment
As(V)s=arsenic(V) from acid extraction of a sample of sediment
As(S)res= arsenic that was dissolved by hydrochloric acid and potassium chlorate following extraction of acid soluble arsenic
Sum As= sum of As(III)s+As(V)s+As(res)
As(total)= total arsenic determined by ICPAES
C(total)= total carbon
OrgS= sulfur that was chemically bound with organic material
SulfateS= sulfur that was chemically bound as sulfate
SulfideS= sulfur that was chemically bound as sulfide
S(total)= total sulfur regardless of chemical form
Fe(total)= total iron
Mn= manganese
Al=aluminum
Ca= calcium
K= potassium
Mg= magnesium
Na= sodium
P=phosphorus
Ti= titanium
Ba= barium
Cd= cadmium
Ce=cerium
Co= cobalt
Cr= chromium
Cu= copper
Ga=gasllium
La= lantnanum
Li=lithium
Mo=molybdenum
Nb=niobium
Nd=neodymium
Ni= nickel
Pb= lead
Sc=scandium
Sr= strontium
V= vanadium
Y= yttrium
Yb= ytterbium
Zn= zinc
%= concentration in per cent
ppm= concentration in parts per million

Table 4--Analytical results for sediment samples from five cores collected in the Maurice River and Union Lake. See text for sample descriptors. Blank spaces for sulfur species indicate that the sample was not run for that species because the total sulfur concentration was insufficient.

SAMPLE	As(III)s mg/kg	As(V)s mg/kg	As(S)res mg/kg	Sum As mg.kg	As(total) s mg/kg (ICPAES)	C(total) %
AR2	460	6	430	896	640	15.6
AR3	50	<.5	320	370	290	7.54
AR4	31	2.2	200	233.2	310	10.3
AR5	13	3.4	34	50.4	58	0.79
AR6	14	<.5	50	64	29	0.85
BW2	3000	550	860	4410	4100	23.3
BW3	120	59	48	227	100	0.80
BW4	1.5	11	5	17.5	24	0.16
BW5	3.5	42	15	60.5	43	2.06
BW6	<.5	7.3	<1	7.3	<10	0.05
1UL2	1600	70	200	1870	1600	21.9
1UL3	920	44	300	1264	1700	21.4
1UL4	990	1.2	240	1230	1500	22.8
1UL5	680	22	320	1022	970	17.6
1UL6	880	13	350	1243	1700	22.2
1UL7	650	24	430	1104	1300	20.7
1UL8	400	11	150	561	800	22.2
1UL9	190	<.5	330	520	680	20.6
1UL10	90	11	160	261	320	24.6
2UL2	960	95	360	1415	1600	21.1
2UL3	1000	32	330	1362	1700	22.3
2UL4	820	19	260	1099	1400	21.7
2UL5	660	10	410	1080	1300	22.1
2UL6	410	12	330	752	1000	20.9
2UL7	140	10	280	430	600	20.1
2UL8	140	12	200	352	490	21.0
2UL9	70	<.5	240	310	460	21.7
2UL10	40	16	360	416	500	23.0
3UL2	900	450	200	1550	1600	18.5
3UL3	940	150	260	1350	1300	17.7
3UL4	660	160	390	1210	1300	19.4
3UL5	440	11	250	701	1500	22.3
3UL6	430	30	160	620	530	17.6
3UL7	210	8.8	270	490	540	17.6
3UL8	300	38	ins	ins	550	16.3
3UL9	220	52	690	962	1100	17.2
3UL10	95	<.5	720	815	1300	17.2

Table 4--continued

SAMPLE	OrgS %	SulfateS %	SulfideS %	S(total) %	Fe(total) %	Mn mg/kg
AR2	0.12	0.01	0.21	0.34	1.7	510
AR3	0.09	0.03	0.11	0.23	0.78	190
AR4	0.06	0.01	0.12	0.19	0.81	210
AR5				0.04	0.19	63
AR6				0.03	0.17	59
BW2	0.16	0.03	0.24	0.43	5	460
BW3				0.02	0.21	36
BW4				0.01	0.10	23
BW5				0.04	0.13	26
BW6				<0.01	0.24	66
1UL2	0.18	0.05	0.23	0.46	9.4	340
1UL3	0.16	0.04	0.22	0.42	9.8	360
1UL4	0.14	0.04	0.28	0.46	9.4	360
1UL5	0.14	0.03	0.18	0.35	7.2	620
1UL6	0.29	0.05	0.19	0.53	9.4	300
1UL7	0.25	0.05	0.26	0.56	8.7	260
1UL8	0.22	0.08	0.34	0.64	7.0	230
1UL9	0.24	0.03	0.35	0.62	6.4	230
1UL10	0.20	0.04	0.35	0.59	3.3	160
2UL2	0.24	<0.01	0.21	0.43	9.6	340
2UL3	0.17	0.05	0.23	0.45	9.6	330
2UL4	0.14	0.04	0.24	0.42	9.2	320
2UL5	0.19	0.03	0.22	0.44	9.2	310
2UL6	0.25	0.05	0.22	0.52	8.5	260
2UL7	0.29	0.05	0.29	0.63	6.3	230
2UL8	0.32	0.05	0.25	0.62	5.5	200
2UL9	0.15	0.04	0.44	0.63	4.4	190
2UL10	0.18	0.05	0.42	0.65	3.7	160
3UL2	0.12	0.02	0.19	0.33	8.4	840
3UL3	0.12	0.02	0.19	0.33	8.1	820
3UL4	0.1	0.02	0.22	0.34	7.8	700
3UL5	0.13	0.05	0.36	0.54	9.1	310
3UL6	0.07	0.05	0.3	0.42	5.6	500
3UL7	0.1	0.03	0.34	0.47	5.3	460
3UL8	0.12	0.06	0.29	0.47	6.1	490
3UL9	0.12	0.05	0.33	0.5	4.0	370
3UL10	0.14	0.02	0.38	0.54	4.0	350

Table 4--Continued

	Al	Ca	K	Mg	Na	P
	%	%	%	%	%	%
AR2	1.2	.21	.16	.06	.04	.08
AR3	.60	.12	.10	.03	.02	.04
AR$	.61	.16	.11	.03	.02	.04
AR5	.14	.01	.05	.006	.005	.006
AR6	.16	.01	.10	.006	.01	<.005
BW2	2.8	.20	.30	.12	.12	.19
BW3	.16	.01	.04	.007	.008	.009
BW4	.09	<.005	.03	<.005	<.005	<.005
BW5	.11	<.005	.03	<.005	.006	<.005
BW6	.08	<.005	.04	<.005	<.005	<.005
1UL2	2.9	.43	.29	.17	.08	.32
1UL3	2.8	.43	.28	.16	.07	.32
1UL4	3.0	.40	.29	.16	.08	.32
1UL5	3.9	.43	.33	.20	.07	.28
1UL6	3.0	.39	.29	.16	.07	.34
1UL7	3.3	.37	.32	.17	.08	.34
1UL8	3.8	.36	.37	.19	.09	.31
1UL9	3.6	.36	.35	.18	.09	.30
1UL10	3.3	.38	.30	.16	.08	.25
2UL2	2.9	.44	.28	.17	.08	.33
2UL3	2.6	.40	.25	.15	.07	.31
2UL4	3.1	.37	.29	.16	.08	.34
2UL5	3.2	.36	.29	.16	.08	.34
2UL6	3.6	.36	.33	.18	.08	.35
2UL7	4.0	.38	.38	.21	.10	.29
2UL8	3.7	.38	.35	.19	.09	.28
2UL9	3.5	.37	.32	.18	.08	.27
2UL10	3.3	.37	.28	.16	.22	.27
3UL2	4.0	.44	.30	.19	.07	.27
3UL3	4.4	.42	.33	.20	.08	.25
3UL4	4.0	.47	.30	.20	.07	.26
3UL5	2.8	.39	.26	.15	.08	.32
3UL6	4.2	.43	.31	.21	.07	.26
3UL7	4.1	.44	.30	.21	.07	.25
3UL8	4.2	.41	.30	.21	.07	.27
3UL9	3.8	.44	.29	.20	.07	.22
3UL10	3.7	.43	.27	.19	.07	.22

Table 4--continued

	Ti %	Ba ppm	Cd ppm	Ce ppm	Co ppm	Cr ppm
AR2	.33	240	<2	31	35	74
AR3	.22	130	<2	17	21	57
AR4	.26	170	<2	19	17	58
AR5	.21	38	<2	12	2	13
AR6	.23	57	<2	<4	1	22
BW2	.15	440	3	78	48	52
BW3	.13	34	<2	4	1	22
BW4	.12	22	<2	<4	<1	7
BW5	.13	22	<2	<4	<1	5
BW6	.36	27	<2	6	<1	18
1UL2	.18	470	3	62	31	160
1UL3	.16	470	3	59	28	150
1UL4	.18	460	3	58	28	140
1UL5	.17	450	2	69	42	200
1UL6	.17	460	3	63	29	160
1UL7	.19	450	3	67	29	190
1UL8	.22	490	3	65	29	250
1UL9	.23	470	3	64	28	260
1UL10	.21	460	4	70	20	310
2UL2	.20	470	3	61	26	160
2UL3	.18	450	3	55	26	140
2UL4	.19	440	3	61	27	150
2UL5	.21	420	3	61	29	150
2UL6	.17	420	3	69	29	190
2UL7	.20	470	3	69	29	290
2UL8	.22	460	4	69	26	320
2UL9	.22	470	3	66	26	450
2UL10	.19	450	4	71	22	330
3UL2	.18	460	<2	67	45	180
3UL3	.16	450	<2	68	45	170
3UL4	.14	460	<2	68	39	190
3UL5	.16	430	3	56	30	140
3UL6	.15	450	3	72	51	270
3UL7	.15	450	3	71	47	270
3UL8	.15	430	2	73	39	240
3UL9	.15	430	3	67	40	240
3UL10	.16	420	2	67	38	220

Table 4--contiinued

	Cu ppm	Ga ppm	La ppm	Li ppm	Mo ppm	Nb ppm
AR2	16	<4	23	5	<2	5
AR3	9	<4	12	3	2	<4
AR4	9	<4	13	3	<2	5
AR5	<1	<4	6	<2	<2	<4
AR6	2	<4	3	<2	2	<4
BW2	66	5	10	10	3	4
BW3	3	<4	<2	<2	<2	<4
BW4	<1	<4	<2	<2	<2	<4
BW5	<1	<4	<2	<2	<2	<4
BW6	<1	<4	2	2	<2	5
1UL2	39	4	40	13	4	6
1UL3	38	<4	40	12	3	5
1UL4	38	<4	39	13	3	5
1UL5	40	7	43	17	3	5
1UL6	40	4	42	13	3	5
1UL7	44	5	43	15	3	6
1UL8	50	6	41	18	2	5
1UL9	50	6	41	16	3	7
1UL10	45	7	41	14	2	4
2UL2	39	4	41	13	4	5
2UL3	35	<4	37	11	3	6
2UL4	39	4	39	14	3	6
2UL5	39	4	40	14	3	6
2UL6	44	6	44	16	4	6
2UL7	53	7	43	18	5	6
2UL8	51	8	42	16	3	6
2UL9	43	7	40	15	3	6
2UL10	45	7	42	14	3	5
3UL2	36	6	41	16	4	6
3UL3	36	8	42	17	4	5
3UL4	37	7	42	16	4	5
3UL5	35	4	38	18	4	6
3UL6	42	9	43	18	3	5
3UL7	43	8	43	18	3	5
3UL8	43	7	43	18	3	5
3UL9	42	8	40	16	3	5
3UL10	40	8	39	16	4	5

Table 4—continued

	Nd ppm	Ni ppm	Pb ppm	Sc ppm	Sr ppm	V ppm
AR2	28	28	69	<2	25	65
AR3	14	25	38	<2	15	41
AR4	15	21	41	<2	19	43
AR5	6	5	8	<2	6	10
AR6	6	8	6	<2	7	6
BW2	61	48	250	4	32	49
BW3	<4	12	12	<2	5	5
BW4	<4	4	5	<2	3	3
BW5	<4	2	6	<2	3	3
BW6	<4	7	<4	<2	4	7
1UL2	41	59	180	5	50	180
1UL3	42	51	170	5	50	160
1UL4	37	51	160	5	48	150
1UL5	43	61	180	6	50	210
1UL6	43	57	180	5	47	220
1UL7	44	54	230	5	49	210
1UL8	42	53	270	6	54	190
1UL9	41	54	290	6	53	210
1UL10	41	43	200	5	54	99
2UL2	43	49	180	5	49	160
2UL3	38	46	160	4	46	150
2UL4	41	51	180	5	46	170
2UL5	42	51	180	5	45	170
2UL6	48	60	230	6	49	190
2UL7	43	64	300	6	57	190
2UL8	43	60	300	6	55	180
2UL9	38	51	240	5	53	130
2UL10	42	45	200	5	54	100
3UL2	41	60	140	6	51	130
3UL3	41	61	140	7	51	150
3UL4	41	60	150	6	52	140
3UL5	40	54	160	5	46	150
3UL6	44	66	220	6	52	190
3UL7	42	62	220	6	54	160
3UL8	42	60	210	6	51	190
3UL9	41	60	190	6	56	110
3UL10	39	50	190	6	55	110

Table 4--continued

	Y ppm	Yb ppm	Zn ppm
AR2	28	3	92
AR3	14	1	50
AR4	14	1	44
AR5	<2	<1	8
AR6	<2	<1	6
BW2	56	4	220
BW3	<2	<1	6
BW4	<2	<1	<2
BW5	<2	<1	2
BW6	<2	<1	3
1UL2	46	4	310
1UL3	46	4	300
1UL4	46	4	290
1UL5	44	4	320
1UL6	47	4	320
1UL7	46	4	310
1UL8	43	4	290
1UL9	43	4	310
1UL10	41	3	370
2UL2	47	4	290
2UL3	43	4	280
2UL4	47	4	300
2UL5	47	4	300
2UL6	48	4	310
2UL7	43	3	310
2UL8	44	3	330
2UL9	39	3	300
2UL10	40	3	340
3UL2	42	4	290
3UL3	41	4	290
3UL4	42	4	300
3UL5	43	4	290
3UL6	43	4	360
3UL7	42	4	360
3UL8	45	4	320
3UL9	36	3	330
3UL10	34	3	300

APPENDIX C - REMOTE THERMAL MONITORING SYSTEM

Buoy-Mounted Components (Figure C-1)

- Nine Ronan Series X54-210 two-wire, type T thermocouple transmitters with linearized 4-20 mA output.

- Stainless steel NEMA Type 4 enclosure to house the thermocouple transmitters (see Figure C-2).

- Nine Type T thermocouples, Teflon insulation with Teflon-Neoflon shrink tubing over juctions.

- Waterproof signal cable with twenty 16-gauge copper conductors for thermocouple transmitter circuits to control building on dam.

Components Housed in Dam Control Building

- 16 channel Odessa® DSM-3200 data logger, with modem communication capabilities. Input ranges are ± 100 mV, ± 1.0 V, or ± 5.0 V.

- Ronan model 115-24-125 power supply ; 115V AC input, 24V DC output (Figure C-3).

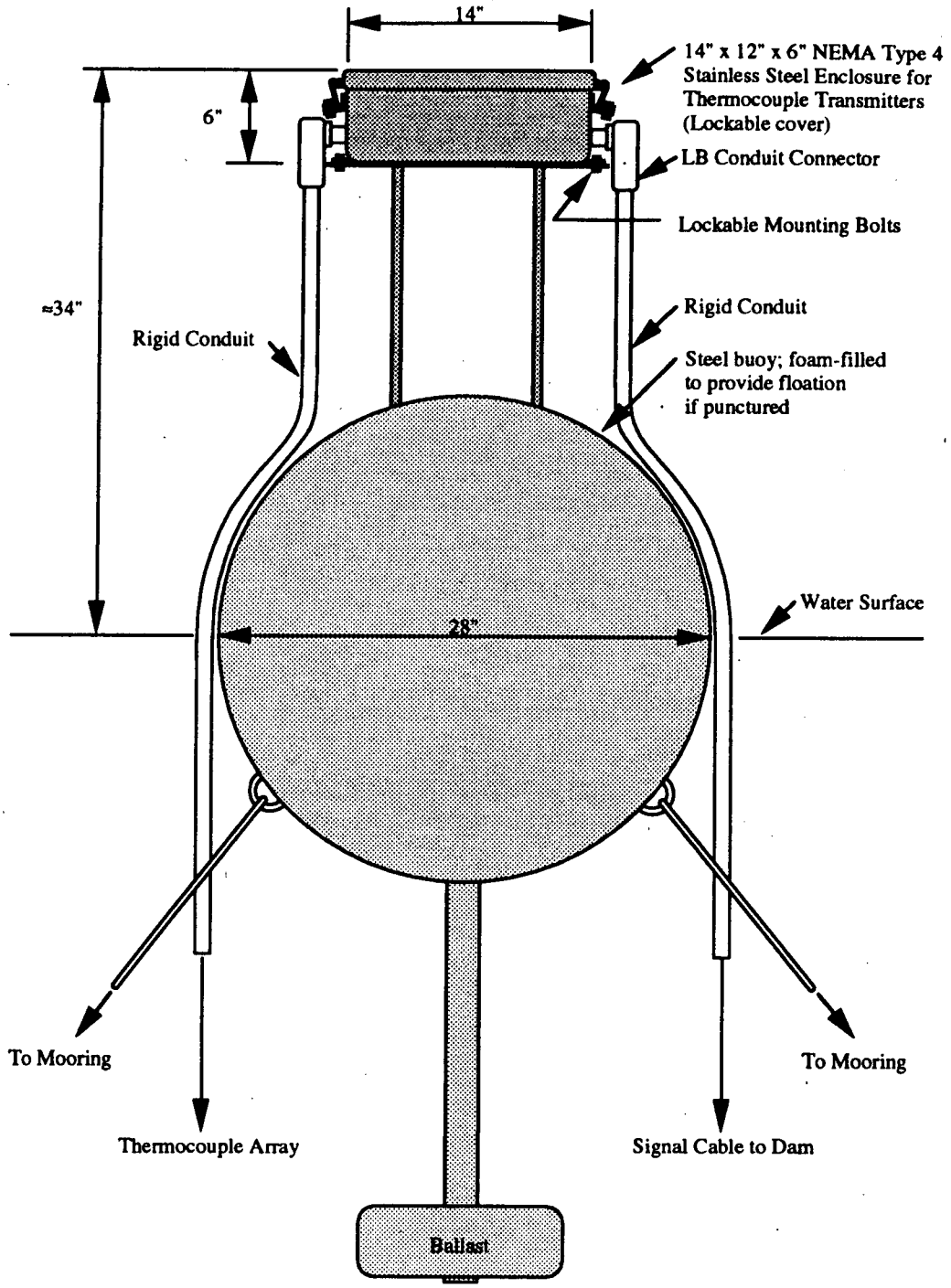
- Current–voltage signal converter; accepts 4-20 mA signal from thermocouple transmitters and returns a 0.2-1.0 V signal to data logger (Figure C-4).

- Hayes 2400 baud modem.

Components located at Ebasco's Lyndhurst Office

- MS-DOS compatible computer running Envicom *Plus* communications software.

- Hayes 2400 baud modem



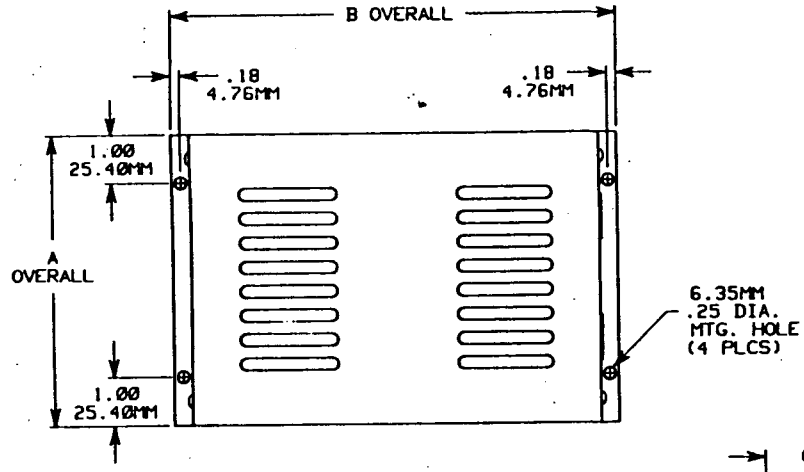
Total buoyancy = 294 pounds (i.e. floats half-submerged with 147 pounds added weight)

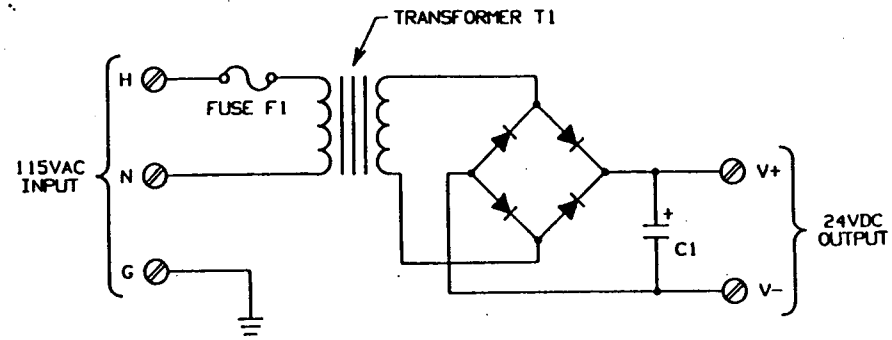
The instrument package plus mounting hardware weighs roughly 30 pounds, therefore a ballast of approximately 100 pounds was used.

A double mooring was used to prevent the buoy from rotating on its own axis, which would foul the thermocouple array.

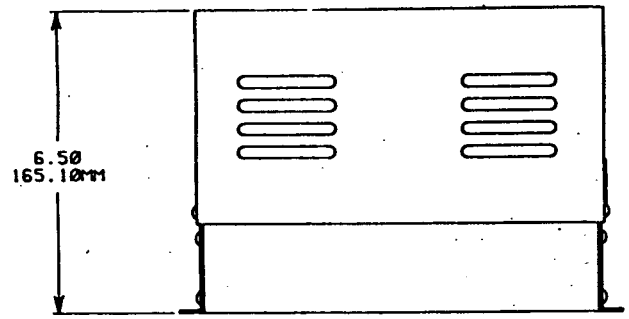
U.S. ENVIRONMENTAL PROTECTION AGENCY
VINELAND CHEMICAL COMPANY SITE
FIGURE C-1 BUOY DESIGN UNION LAKE THERMAL MONITOR
EBASCO SERVICES INCORPORATED

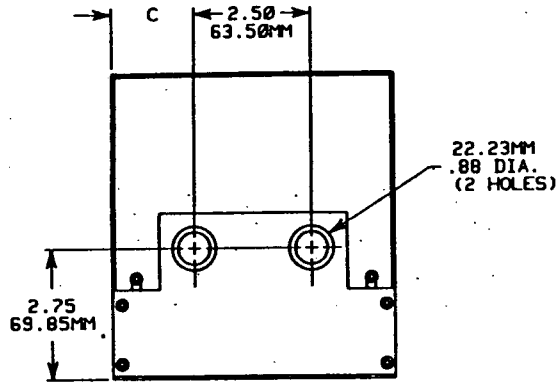
	DESCRIPTION	DATE	DR	CHKD	APPD	CHG
5	CHANGED FUSE AMPS, -375 WAS 5 AMPS	12/1/86	NDF	RP	CK	AG
6	CHANGED FUSE AMPS; -500 WAS 7 AMPS, -750 WAS 10 AMPS	12/3/89	MM	MRO	CM	AG





SCHEMATIC





MODEL	A DIM. IN.	A DIM. MM	B DIM. IN.	B DIM. MM	C DIM. IN.	C DIM. MM	INPUT VOLTS(V)	INPUT AMPS(I)	OUTPUT VOLTS(V)	OUTPUT AMPS(I)	FUSE (AMPS)
115-24-125	6.00	152.40	9.25	234.95	1.75	44.45	115	1.2	24	5	3
115-24-250	6.00	152.40	9.25	234.95	1.75	44.45	115	3	24	10	5
115-24-375	6.00	152.40	9.25	234.95	1.75	44.45	115	3	24	14	7
115-24-500	8.00	203.20	10.12	234.95	2.75	69.85	115	4	24	19	10
115-24-750	8.00	203.20	10.12	234.95	2.75	69.85	115	6	24	28	15

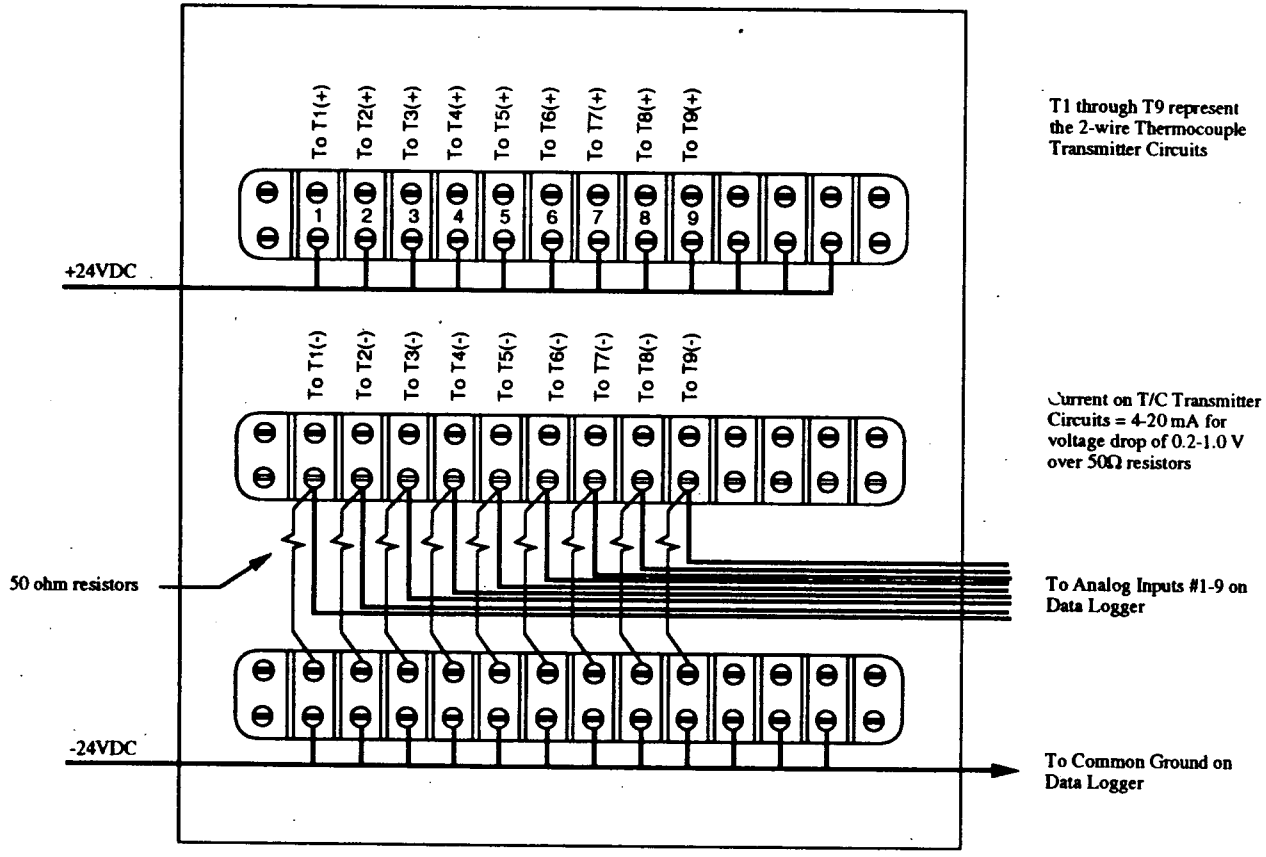
FIGURE C-3

NOTES:

1. SPECIFY OPERATING RANGE IF OTHER THAN SHOWN.
2. CHASSIS MAY BE MOUNTED IN ANY POSITION.

CUSTOMER: EBASCO SERVICES INC.	SERIAL NUMBER: 18-6073
P.O. NUMBER: 8310-925-3116	TAG NUMBER:
TITLE: ACCESSORIES POWER SUPPLIES SCHEMATIC AND DIMENSIONAL INFORMATION	DRAWN: T. TRAN 1/14/85; CHECKED: R. PONS 1/14/85; ENGINEER: T. CROSBY 1/14/85; APPROVED: C. KELLER 1/14/85; QUALITY ASSURANCE: B. GARINO 1/14/85
RONAN, WOODLAND HILLS, CALIFORNIA	DRAWING NUMBER: SS2052 REV 6

IG.0SS2052 R6 12-05-89



U.S. ENVIRONMENTAL PROTECTION AGENCY

VINELAND CHEMICAL COMPANY SITE

FIGURE C-4
SCHEMATIC DIAGRAM
CURRENT-VOLTAGE
SIGNAL CONVERTER

EBASCO SERVICES INCORPORATED

APPENDIX E

MASS BALANCE CALCULATION FOR ARSENIC DESORPTION EXPERIMENTS

Table E-1
Mass Balance Calculations for "Low" Experiment

86.3	Initial Concentration (mg/kg)			Notes: Concentrations in italics are			
2.65	Soil Partical Density (kg/l)			estimated by interpolation. Final steady-			
18	Soil Bed Volume (liters)			state K and desorption rate are averages			
0.124	% Solids in sediment			of values in bold.			
	(average of 3 replicates)						
Sample #	Aqueous As Concentration (ug/l)	Aqueous Volume Represented (ml)	Mass As in water (mg)	Mass As in sediment (mg)	Conc As in sediment (mg/kg)	K	
			(aqueous volume) * (aqueous conc.)	(conc) *(particle density)* (% solids) * (bed vol.)	(mass As) / (mass sediment)	(conc soil) / (aq conc)	
				510.45	86.30		
1LOW	12	214	0.002568	510.44	86.30	7191.63	
3LOW	14.7	643	0.0094521	510.44	86.30	5870.61	
5LOW	14.9	1072	0.0159728	510.42	86.30	5791.63	
7LOW	14.6	1286	0.0187756	510.40	86.29	5910.42	
9LOW	16.4	1929	0.0316356	510.37	86.29	5261.39	
12LOW	17.6	3858	0.0679008	510.30	86.28	4902.00	
15LOW	18.9	3858	0.0729162	510.23	86.26	4564.18	
18LOW	16.7	3858	0.0644286	510.16	86.25	5164.79	
21LOW	16.8	3858	0.0648144	510.10	86.24	5133.40	
24LOW	16.7	3858	0.0644286	510.03	86.23	5163.48	
27LOW	*15.95*	3858	0.0615351	509.97	86.22	5405.63	
30LOW	15.2	3858	0.0586416	509.91	86.21	5671.70	
33LOW	12.9	3858	0.0497682	509.86	86.20	6682.28	
36LOW	11.3	3858	0.0435954	509.82	86.19	7627.80	
39LOW	11.2	3858	0.0432096	509.78	86.19	7695.25	
42LOW	12	3858	0.046296	509.73	86.18	7181.58	
45LOW	11	3858	0.042438	509.69	86.17	7833.80	
48LOW	13.5	3858	0.052083	509.64	86.16	6382.44	
51LOW	8.7	3858	0.0335646	509.60	86.16	9903.14	
54LOW	7.7	3858	0.0297066	509.57	86.15	11188.61	
57LOW	7.3	3858	0.0281634	509.55	86.15	11801.03	
60LOW	7.9	3858	0.0304782	509.51	86.14	10904.10	
63LOW	7	3858	0.027006	509.49	86.14	12305.40	
66LOW	6.7	3858	0.0258486	509.46	86.13	**12855.74**	
Total mass of arsenic in elutriate =			**0.99**	Final Steady-State K =		**12856**	

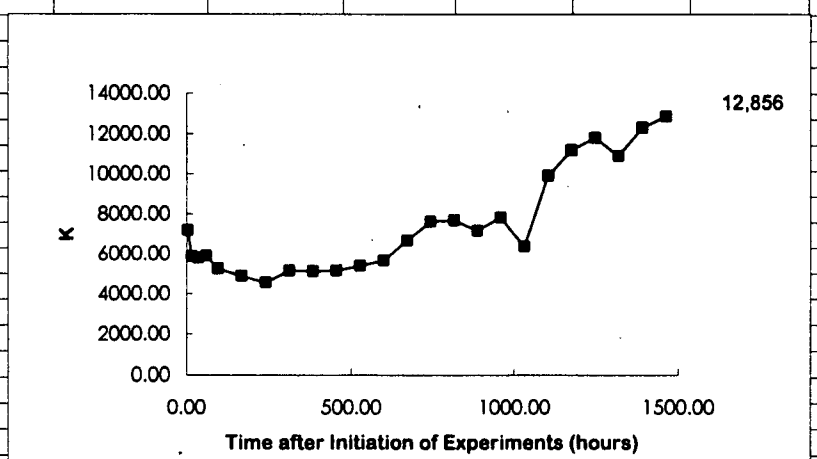


Table E-1
Mass Balance Calculations for "Low" Experiment

Time After Initiation of Experiment (hrs)	Cum Mass As in Water (mg)	Mass As Desorbed into Water per Hour (mg/hr)
0	0.00	
4	0.00	0.000642
16	0.01	0.000788
36	0.03	0.000799
60	0.05	0.000782
96	0.08	0.000879
168	0.15	0.000943
240	0.22	0.001013
312	0.28	0.000895
384	0.35	0.000900
456	0.41	0.000895
528	0.47	0.000855
600	0.53	0.000814
672	0.58	0.000691
744	0.63	0.000605
816	0.67	0.000600
888	0.72	0.000643
960	0.76	0.000589
1032	0.81	0.000723
1104	0.84	0.000466
1176	0.87	0.000413
1248	0.90	0.000391
1320	0.93	0.000423
1392	0.96	0.000375
1464	0.99	**0.000359**
Final Steady-State Desorption Rate =		**0.0004**

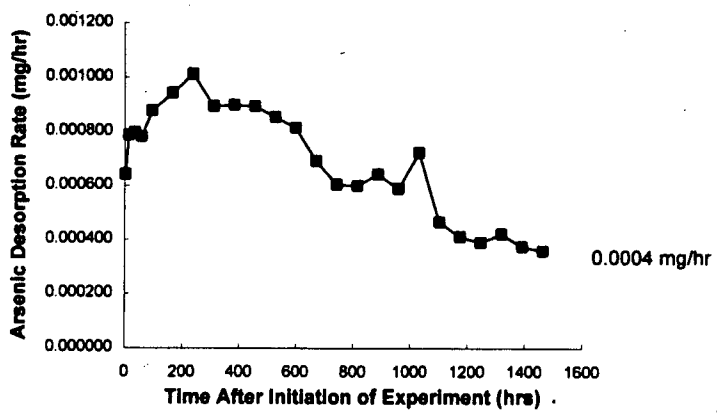


Table E-2
Mass Balance Calculations for "Medium" Experiment

549.7	Initial Concentration (mg/kg)			Notes: Concentrations in italics are			
2.65	Soil Partical Density (kg/l)			estimated by interpolation. Final steady-			
18	Soil Bed Volume (liters)			state K and desorption rate are averages			
0.270	% Solids in sediment			of values in bold.			
	(average of 3 replicates)						
Sample #	Aqueous As Concentration (ug/l)	Aqueous Volume Represented (ml)	Mass As in water (mg)	Mass As in sediment (mg)	Conc As in sediment (mg/kg)	K	
			(aqueous volume) * (aqueous conc.)	*(particle density)* (% solids) * (bed vol.)	(mass As) / (mass sediment)	(conc soil) / (aq conc)	
				7088.33	549.70		
1MED	27.7	214	0.005928	7088.32	549.70	19844.75	
3MED	31.1	643	0.019997	7088.30	549.70	17675.18	
5MED	41	1072	0.043952	7088.26	549.69	13407.18	
7MED	34	1286	0.043724	7088.21	549.69	16167.39	
9MED	29.1	1929	0.056134	7088.16	549.69	18889.58	
12MED	31	3858	0.119598	7088.04	549.68	17731.53	
15MED	27.5	3858	0.106095	7087.93	549.67	19987.98	
18MED	22.2	3858	0.085648	7087.85	549.66	24759.58	
21MED	22.2	3858	0.085648	7087.76	549.66	24759.28	
24MED	22.2	3858	0.085648	7087.67	549.65	24758.98	
27MED	*23.85*	3858	0.092013	7087.58	549.64	23045.80	
30MED	25.5	3858	0.098379	7087.48	549.63	21554.30	
33MED	27.7	3858	0.106867	7087.38	549.63	19842.11	
36MED	27.7	3858	0.106867	7087.27	549.62	19841.81	
39MED	27.4	3858	0.105709	7087.16	549.61	20058.75	
42MED	26.1	3858	0.100694	7087.06	549.60	21057.55	
45MED	20.5	3858	0.079089	7086.98	549.60	26809.56	
48MED	21.9	3858	0.08449	7086.90	549.59	25095.41	
51MED	26.5	3858	0.102237	7086.80	549.58	20738.92	
54MED	24	3858	0.092592	7086.71	549.57	22898.93	
57MED	24.3	3858	0.093749	7086.61	549.57	22615.93	
60MED	23.4	3858	0.090277	7086.52	549.56	**23485.47**	
63MED	22.7	3858	0.087577	7086.43	549.55	**24209.39**	
66MED	23.3	3858	0.089891	7086.34	549.55	**23585.68**	
	Total mass of arsenic in elutriate =		**1.98**	Final Steady-State K =		**23760**	

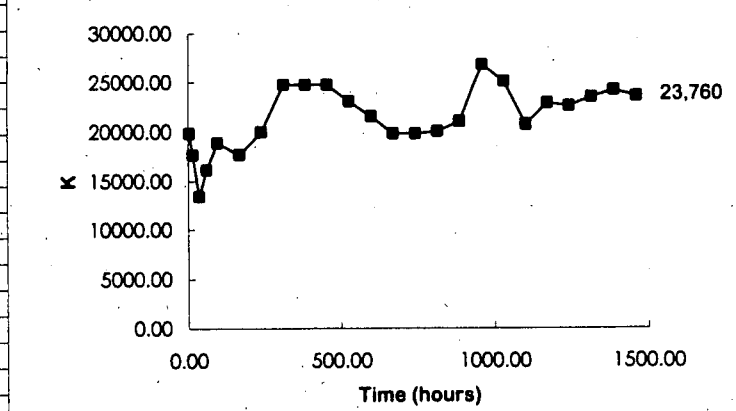


Table E-2
Mass Balance Calculations for "Medium" Experiment

Time	Cum Mass As in Water (mg)	Mass As in Water per Hour
0	0.00	
4	0.01	0.001482
16	0.03	0.001666
36	0.07	0.002198
60	0.11	0.001822
96	0.17	0.001559
168	0.29	0.001661
240	0.40	0.001474
312	0.48	0.001190
384	0.57	0.001190
456	0.65	0.001190
528	0.74	0.001278
600	0.84	0.001366
672	0.95	0.001484
744	1.06	0.001484
816	1.16	0.001468
888	1.26	0.001399
960	1.34	0.001098
1032	1.43	0.001173
1104	1.53	0.001420
1176	1.62	0.001286
1248	1.72	0.001302
1320	1.81	**0.001254**
1392	1.89	**0.001216**
1464	1.98	**0.001248**
Final Steady-State Desorption Rate =		**0.0012**

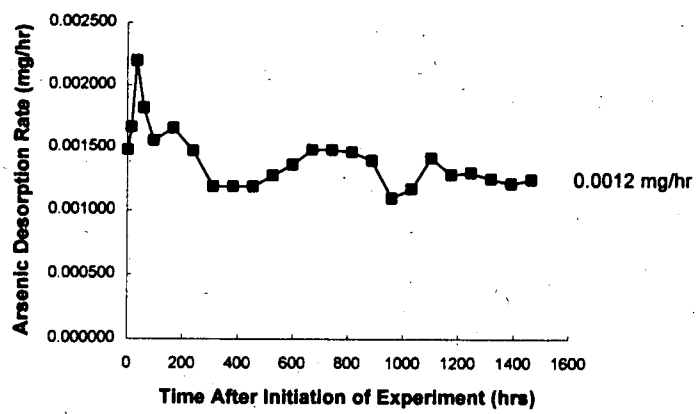


Table E-3
Mass Balance Calculations for "High1" Experiment

737.7	Initial Concentration (mg/kg)			Notes: Concentrations in italics are			
2.65	Soil Partical Density (kg/l)			estimated by interpolation. Final steady-			
18	Soil Bed Volume (liters)			state K and desorption rate are averages			
0.093	% Solids in sediment			of values in bold.			
	(average of 3 replicates)						
Sample #	Aqueous As Concentration (ug/l)	Aqueous Volume Represented (ml)	Mass As in water (mg)	Mass As in sediment (mg)	Conc As in sediment (mg/kg)	K	
		(delta bed volume no.) * (bed volume)	(aqueous volume) * (aqueous conc.)	*(particle density)* (% solids) * (bed vol.)	(mass As) / (mass sediment)	(conc soil) / (aq conc)	
				3260.78	737.70		
1HIGH1	9	214	0.001926	3260.78	737.70	81966.62	
3HIGH1	8.4	643	0.005401	3260.77	737.70	87821.23	
5HIGH1	10.6	1072	0.011363	3260.76	737.70	69593.94	
7HIGH1	12.6	1286	0.016204	3260.75	737.69	58546.99	
9HIGH1	18.3	1929	0.035301	3260.71	737.68	40310.61	
12HIGH1	19.7	3858	0.076003	3260.64	737.67	37445.02	
15HIGH1	23	3858	0.088734	3260.55	737.65	32071.60	
18HIGH1	21.6	3858	0.083333	3260.46	737.63	34149.44	
21HIGH1	20.5	3858	0.079089	3260.38	737.61	35980.98	
24HIGH1	19.5	3858	0.075231	3260.31	737.59	37825.29	
27HIGH1	*18.3*	3858	0.070601	3260.24	737.58	40304.76	
30HIGH1	17.1	3858	0.065972	3260.17	737.56	43132.29	
33HIGH1	14.9	3858	0.057484	3260.11	737.55	49499.95	
36HIGH1	16.8	3858	0.064814	3260.05	737.53	43900.86	
39HIGH1	15.2	3858	0.058642	3259.99	737.52	48521.14	
42HIGH1	17.4	3858	0.067129	3259.92	737.51	42385.41	
45HIGH1	14.9	3858	0.057484	3259.87	737.49	49496.18	
48HIGH1	14.4	3858	0.055555	3259.81	737.48	51213.92	
51HIGH1	13.7	3858	0.052855	3259.76	737.47	53829.82	
54HIGH1	13.5	3858	0.052083	3259.71	737.46	54626.43	
57HIGH1	12	3858	0.046296	3259.66	737.45	**61453.86**	
60HIGH1	12.7	3858	0.048997	3259.61	737.44	**58065.76**	
63HIGH1	*12.7*	3858	0.048804	3259.56	737.42	**58294.40**	
66HIGH1	12.6	3858	0.048611	3259.51	737.41	**58524.85**	
Total mass of arsenic in elutriate =			**1.27**	Final Steady-State K =		**59085**	

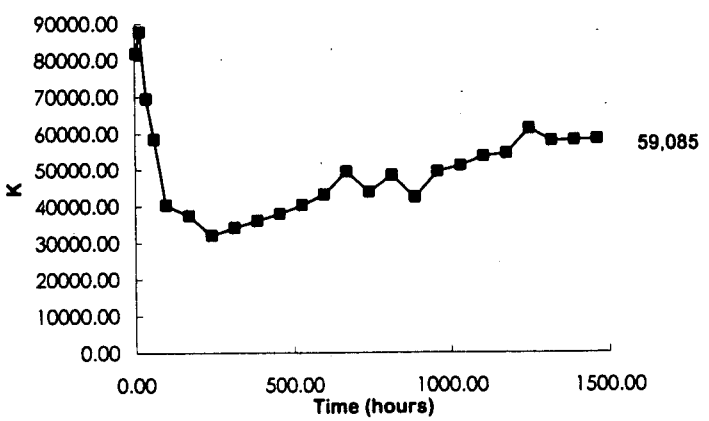


Table E-3
Mass Balance Calculations for "High1" Experiment

Time	Cum Mass As in Water (mg)	Mass As in Water per Hour
0	0.00	
4	0.00	0.000482
16	0.01	0.000450
36	0.02	0.000568
60	0.03	0.000675
96	0.07	0.000981
168	0.15	0.001056
240	0.23	0.001232
312	0.32	0.001157
384	0.40	0.001098
456	0.47	0.001045
528	0.54	0.000981
600	0.61	0.000916
672	0.67	0.000798
744	0.73	0.000900
816	0.79	0.000814
888	0.86	0.000932
960	0.91	0.000798
1032	0.97	0.000772
1104	1.02	0.000734
1176	1.08	0.000723
1248	1.12	**0.000643**
1320	1.17	**0.000681**
1392	1.22	**0.000678**
1464	1.27	**0.000675**
Final Steady-State Desorption Rate =		**0.0007**

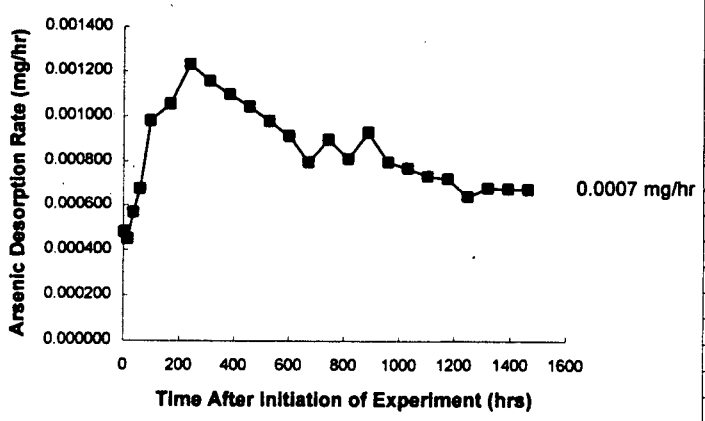


Table E-4
Mass Balance Calculations for "High2" Experiment

1062.7	Initial Concentration (mg/kg)			Notes: Concentrations in italics are		
2.65	Soil Partical Density (kg/l)			estimated by interpolation. Final steady-		
18	Soil Bed Volume (liters)			state K and desorption rate are averages		
0.077	% Solids in sediment			of values in bold.		
	(average of 3 replicates)					
Sample #	Aqueous As Concentration (ug/l)	Aqueous Volume Represented (ml)	Mass As in water (mg)	Mass As in sediment (mg)	Conc As in sediment (mg/kg)	K
		(delta bed volume no.) * (bed volume)	(aqueous volume) * (aqueous conc.)	*(particle density)* (% solids) * (bed vol.)	(mass As) / (mass sediment)	(conc soil) / (aq conc)
				3886.29	1062.70	
1HIGH2	9.7	214	0.002076	3886.29	1062.70	109556.64
3HIGH2	12.6	643	0.008102	3886.28	1062.70	84341.05
5HIGH2	13.1	1072	0.014043	3886.27	1062.69	81121.63
7HIGH2	15	1286	0.01929	3886.25	1062.69	70845.87
9HIGH2	18	1929	0.034722	3886.22	1062.68	59037.70
12HIGH2	19	3858	0.073302	3886.14	1062.66	55929.40
15HIGH2	22.7	3858	0.087577	3886.05	1062.63	46812.10
18HIGH2	20.1	3858	0.077546	3885.98	1062.61	52866.34
21HIGH2	20.2	3858	0.077932	3885.90	1062.59	52603.57
24HIGH2	20.1	3858	0.077546	3885.82	1062.57	52864.22
27HIGH2	19.7	3858	0.076003	3885.75	1062.55	53936.55
30HIGH2	19.3	3858	0.074459	3885.67	1062.53	55053.36
33HIGH2	18.5	3858	0.071373	3885.60	1062.51	57432.99
36HIGH2	17.7	3858	0.068287	3885.53	1062.49	60027.77
39HIGH2	18.5	3858	0.071373	3885.46	1062.47	57430.92
42HIGH2	19	3858	0.073302	3885.39	1062.45	55918.53
45HIGH2	18	3858	0.069444	3885.32	1062.43	59024.06
48HIGH2	17.3	3858	0.066743	3885.25	1062.41	61411.26
51HIGH2	15.2	3858	0.058642	3885.19	1062.40	**69894.65**
54HIGH2	13.8	3858	0.05324	3885.14	1062.38	**76984.36**
57HIGH2	13.6	3858	0.052469	3885.09	1062.37	**78115.43**
60HIGH2	14.7	3858	0.056713	3885.03	1062.35	**72269.00**
63HIGH2	16.1	3858	0.062114	3884.97	1062.34	**65983.68**
66HIGH2	14.7	3858	0.056713	3884.91	1062.32	**72266.79**
	Total mass of arsenic in elutriate =		**1.38**	Final Steady-State K =		**72586**

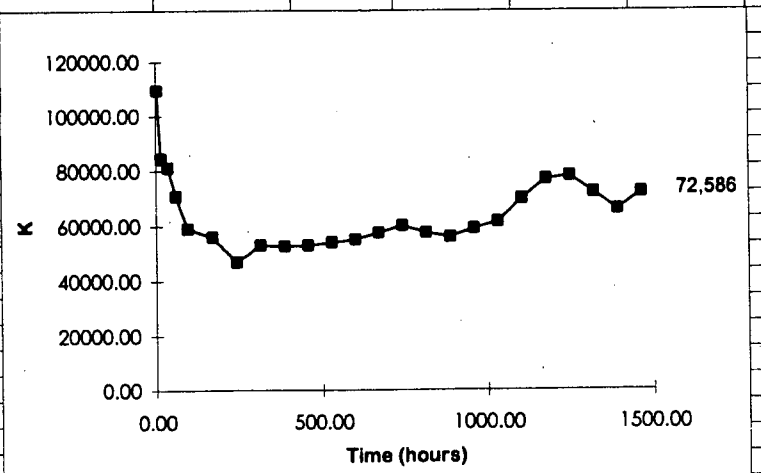
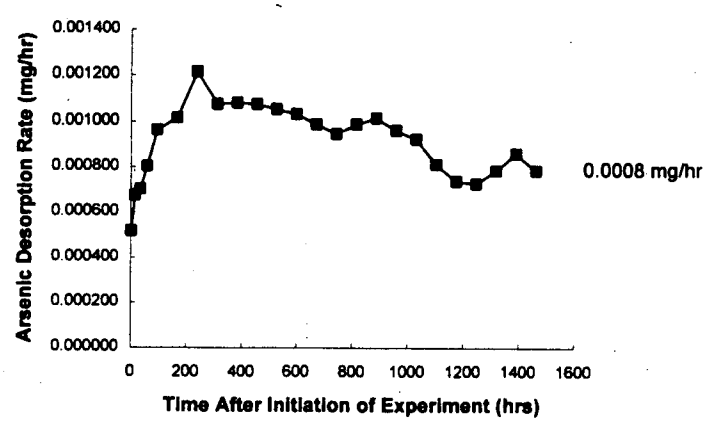


Table E-4
Mass Balance Calculations for "High2" Experiment

Time	Cum Mass As in Water (mg)	Mass As in Water per Hour
0	0.00	
4	0.00	0.000519
16	0.01	0.000675
36	0.02	0.000702
60	0.04	0.000804
96	0.08	0.000965
168	0.15	0.001018
240	0.24	0.001216
312	0.32	0.001077
384	0.39	0.001082
456	0.47	0.001077
528	0.55	0.001056
600	0.62	0.001034
672	0.69	0.000991
744	0.76	0.000948
816	0.83	0.000991
888	0.91	0.001018
960	0.98	0.000965
1032	1.04	0.000927
1104	1.10	**0.000814**
1176	1.16	**0.000739**
1248	1.21	**0.000729**
1320	1.26	**0.000788**
1392	1.33	**0.000863**
1464	1.38	**0.000788**
Final Steady-State Desorption Rate =		**0.0008**



APPENDIX F

CLP DATA QUALIFIERS

Appendix F - CLP Data Qualifiers

B	-	The reported value was obtained from a reading that was less than the Contract Required Quantitation Limit (CRQL), but greater than or equal to the Instrument Detection Limit (IDL).
U	-	Analyte was analyzed for but not detected, i.e., concentration was below the IDL.
J	-	The reported value is estimated.
R	-	Data rejected due to exceeding one or more data validation criteria limits.
E	-	The reported value is estimated because of the presence of an interference.
M	-	Duplicate injection precision was not met.
N	-	Spiked sample recovery is not within control limits.
S	-	The reported value was determined by the Method of Standard Additions (MSA).
W	-	The post-digestion spike for Furnace AA analysis is out of control limits (85-115%), while absorbance is less than 50% of spike absorbance.
*	-	Duplicate analysis is not within control limits.
+	-	Correlation coefficient for MSA is less than 0.995.