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Exponent™

Ward Cove Sediment Remediation Project

Detailed Technical Studies Report

Volume II
Appendices

Prepared for

Ketchikan Pulp Company
Ketchikan, Alaska

Exponent

Ward Cove Sediment Remediation Project

Detailed Technical Studies Report Volume II, Appendices

Prepared for

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Appendix A

Appendix A

Data Tables for Chemical Analyses, Sediment Toxicity Tests, Specialized Toxicity Tests, and Engineering Properties Tests Conducted for Ward Cove in 1996 and/or 1997

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NOTE:

All data qualifiers assigned by the laboratory and during data validation are included in the following tables. For those data also presented in tables with the main text, *J* qualifiers (estimated) have been omitted because the assignment of this qualifier does not affect the usability of the data. The *J* qualifier indicates that there is a greater degree of uncertainty around the reported value than around an unqualified value and does not indicate low confidence in the analysis (U.S. EPA 1989).

U.S. EPA. 1989. J-qualified CLP data and recommendations for its use. Memorandum from Howard M. Fribush, Technical Project Officer, Analytical Operations Branch, to Suzanne Wells, Chief, NPL Criteria Section, Site Assessment Branch. U.S. Environmental Protection Agency, Office of Solid Waste and Emergency Response, Washington, DC.

Appendix A1

Data Tables for Chemical Analyses

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TABLE A1-1. CONVENTIONAL ANALYTES IN SURFACE SEDIMENTS COLLECTED IN 1996 AND 1997

Station	Field Rep.	Date	Sample Number	Ammonia-nitrogen (mg/kg)	Acid-Volatile Sulfide (mg/kg)	Sulfides (mg/kg)	Total Organic Carbon (percent)	Biochemical Oxygen Demand-5-Day Test (mg/kg)	Chemical Oxygen Demand (mg/kg)	Extractable Organic Halides (mg/kg)	Particles Greater Than 2 mm (percent)	Particles 2.0 mm to 1.0 mm (percent)
1996												
Ward Cove-Subtidal												
W01		06/01/96	KW001	310		1,700	31.6	16,000	480,000		1.70	4.9
W02	1	06/01/96	KW002	220	2,200	1,200	14.0	9,900	330,000	44 *U*	31.9	12.2
W02	2	06/01/96	KW032	280	2,100	380	41.2	9,900	180,000	48 *U*	26.9	13.6
W03		06/02/96	KW003	14	2,800	5,300	21.9	7,300	250,000	34 *U*	53.0	11.4
W04		06/02/96	KW004	97	2,400	6,500	25.9	12,000	470,000	52 *U*	0.22	0.62
W05		06/01/96	KW005	67	2,000	5,400	36.2	10,000	590,000	49 *U*	44.0	10.1
W06		06/04/96	KW006	360		2,200	33.2	13,000	540,000		3.97	4.82
W07		06/02/96	KW007	74		1,800	26.0	8,700	620,000		0.04	0.31
W08		06/02/96	KW008	100		2,700	23.5	12,000	2,400,000		0.20	1.77
W09		06/02/96	KW009	82		4,500	26.5	19,000	550,000		14.7	1.83
W010R		06/03/96	KW010	99		5,500	26.5	9,800	340,000		1.20	2.56
W011		05/30/96	KW011	50	1,500	1,500	14.4	6,400	190,000	33 *U*	17.6	9.01
W012		06/04/96	KW012	260		2,700	23.8	10,000	520,000		9.60	5.44
W013		06/04/96	KW013	150	320	4,300	22.2	8,300	440,000	62 *U*	0.12	0.63
W014		06/04/96	KW014	130		2,200	25.0	16,000	190,000		2.34	0.94
W015		06/02/96	KW015	83		2,700	25.2	6,000	490,000		1.02	2.44
W016		06/03/96	KW016	81	13,000	16,000	30.7	18,000	620,000	68 *U*	2.42	1.95
W017R		06/03/96	KW017	11		27,000	30.8	7,600	150,000		58.4	10.1
W018		05/29/96	KW018	13	240	150	1.1	1,400	17,000	14 *U*	47.2	19.8
W019		06/01/96	KW019	44		800	18.2	9,600	270,000		0.19	0.43
W020		05/31/96	KW020	84		420	17.4	11,000	120,000		1.16	1.52
W021		06/03/96	KW021	88		3,500	20.7	6,200	420,000		2.60	2.86
W022		05/28/96	KW022	21	540	380	4.6	3,500	98,000	24 *U*	7.89	10.8
W023		05/29/96	KW023	14	2,100	1,200	13.1	7,900	200,000	40 *U*	2.07	2.25
W024	1	06/01/96	KW024	34		670	12.7	7,000	190,000		0.18	1.26
W024	2	06/01/96	KW031	40		1,800	13.6	9,100	230,000		1.64	3.27
W025		05/30/96	KW025	160	4,200	1,000	10.5	9,200	160,000	34 *U*	1.14	1.48
W026		05/30/96	KW026	66		2,200	29.9	8,500	550,000		1.15	2.14
W027		05/29/96	KW027	43	3,200	4,300	21.1	10,000	330,000	52 *U*	2.96	3.43
W028		05/29/96	KW028	34		2,400	20.2	10,000	330,000		6.11	4.51
Moser Bay-Subtidal												
W029		06/05/96	KW029	12		590	4.3	2,100	71,000		3.56	0.27
W030		06/05/96	KW035	11		570	5.2	4,500	130,000		0.08	0.39
1997												
Ward Cove-Subtidal												
SD-2		7/24/97	SD0011	85	1,600	4,500 *J*	33.2	44,700	12,000	20	17.3	11.5
SD-3		7/24/97	SD0012	80	2,500	500 *J*	29.6	45,800	10,000	23	9.44	7.9

TABLE A1-1. (cont.)

Station	Field Rep.	Date	Sample Number	Ammonia-nitrogen (mg/kg)	Acid-Volatile Sulfide (mg/kg)	Sulfides (mg/kg)	Total Organic Carbon (percent)	Biochemical Oxygen Demand-5-Day Test (mg/kg)	Chemical Oxygen Demand (mg/kg)	Extractable Organic Halides (mg/kg)	Particles Greater Than 2 mm (percent)	Particles 2.0 mm to 1.0 mm (percent)
SD-4		7/24/97	SD0013	150	4,500	3,700 *J*	24.8	64,400	13,000	10 *U*	0.12	0.85
SD-5		8/1/97	SD0014R	57	3,700	2,300	38.2	9,200	5,600	10 *U*	1.0	2.5
SD-7		7/29/97	SD0030	120		1,900	25.7	8,030	9,600		0.10	0.8
SD-11		7/24/97	SD0008	34	3,000	2,300	19.3	14,100	16,000	27	31.4	9.36
SD-12		8/1/97	SD0039	240		1,900	20.9	6,440	7,800		13.2	6.7
SD-13		8/1/97	SD0037	320	4,300	2,700	22.4	12,400	7,000	10 *U*	1.2	3
SD-13	A	8/1/97	SD0038	240	4,400	2,500	22.6	6,410	5,100	10 *U*	0.5	1.3
SD-16		7/29/97	SD0029	40	17,000	12,000	27.8	13,100	16,000	10 *U*	1.4	2.7
SD-17		7/30/97	SD0031	99		50	27.8	10,400	9,800		0.3	1.6
SD-18		7/23/97	SD0007	13	580	310	4.04	1,580	2,200	10 *U*	32.5	17.9
SD-19		7/28/97	SD0024	110		5,500 *J*	17.3	8,510	11,000		1.1	1.8
SD-22		7/22/97	SD0001	19	680	560	4	3,510	6,500	10 *U*	22.8	10.6
SD-23		7/23/97	SD0002	86	3,900	3,900	9	37,400	26,000	10 *U*	2.95	1.4
SD-25		7/24/97	SD0009	120	5,800	3,800 *J*	12.9	33,900	30,000	10 *U*	2.24	2.76
SD-27		7/23/97	SD0005	47	5,300	4,500	20	33,900	12,000	79	5.18	3.04
SD-28		7/23/97	SD0006	34		4,400	19.2	32,200	5,600		18.5	5.71
SD-31		7/25/97	SD0015	510		11,000 *J*	21	11,100	13,000		1.3	1.6
SD-32		7/25/97	SD0016	82		13,000 *J*	22.6	9,100	7,100		5.5	4.9
SD-33		7/25/97	SD0017	23		1,600	5.12	1,690	4,500		11.5	14.2
SD-34		7/31/97	SD0033	120		2,300	28.8	10,400	12,000		3.7	4.9
SD-35		7/31/97	SD0034	120		3,300	29.5	13,700	10,000		0.4	1.3
SD-37		7/25/97	SD0018	54		2,700	30.6	7,070	8,700		1.7	3
SD-37	A	7/25/97	SD0019	58		4,200 *J*	31.6	5,500	12,000		1.6	3.3
SD-38		7/24/97	SD0010	260		6,700 *J*	33.7	65,300	15,000		23.6	11.3
SD-39		7/25/97	SD0020	110		2,700 *J*	23.3	7,700	8,300		0.9	2.4
SD-40		7/25/97	SD0021	80		3,800 *J*	22.8	7,840	11,000		2	2.6
SD-41		7/30/97	SD0032	58		48	22.2	6,350	52,000		0.1	0.9
SD-42		7/29/97	SD0028	82		2,000	24	6,850	11,000		0.1	0.87
SD-43		7/28/97	SD0027	110		9,700 *J*	18.3	7,380	9,800		0 *U*	1
SD-44		7/31/97	SD0035	690		2,300	25.8	12,600	15,000		0 *U*	0.3
SD-44	A	7/31/97	SD0036	540		2,800	28.4	10,400	15,000		0.2	0.6
SD-45		7/28/97	SD0025	170		4,800 *J*	20.9	9,050	12,000		0.5	1.7
SD-47		8/1/97	SD0040	120		3,000	26.4	7,110	7,900		20.4	8.2
SD-48		7/28/97	SD0026	300		3,900 *J*	25	9,200	19,000		4.5	5.6
Moser Bay-Subtidal												
SD-29		7/27/97	SD0022	16	240	240	3.57	1,670	3,500	10 *U*	0.1	0.57
SD-30		7/27/97	SD0023	18	260	530	5.25	2,970	4,500		0.1	0.8

TABLE A1-1. (cont.)

Station	Field Rep.	Date	Sample Number	Ammonia-nitrogen (mg/kg)	Acid-Volatile Sulfide (mg/kg)	Sulfides (mg/kg)	Total Organic Carbon (percent)	Biochemical Oxygen Demand-5-Day Test (mg/kg)	Chemical Oxygen Demand (mg/kg)	Extractable Organic Halides (mg/kg)	Particles Greater Than 2 mm (percent)	Particles 2.0 mm to 1.0 mm (percent)
Ward Cove-Intertidal												
SD-50		7/23/97	SD0003	3.2			1.32	716	1,300	10 *U*	61.1	12.5
SD-50		8/1/97	SD0003R			20 *U*						
SD-51		7/23/97	SD0004	11		1,000	5.06	8,700	6,200	10 *U*	16.7	5.6

TABLE A1-1. (cont.)

Station	Field Rep.	Date	Sample Number	Particles 1.0 mm to 0.5 mm (percent)	Particles 0.5 mm to 0.25 mm (percent)	Particles 0.25 mm to 0.125 mm (percent)	Particles 0.125 mm to 0.062 mm (percent)	Particles 0.062 mm to 0.004 mm (percent)	Particles less than 0.004 mm (percent)	Percent Fines (Particles less than 0.062 mm) (percent)	Total Solids (percent)
1996											
Ward Cove-Subtidal											
W01		06/01/96	KW001	15.0	15.5	9.68	5.88	27.9	25.5	53.4	14.5
W02	1	06/01/96	KW002	11.4	8.04	4.58	1.97	15.2	14.3	29.5	22.7
W02	2	06/01/96	KW032	14.2	9.51	0.79	9.02	17.5	14.8	32.3	20.8
W03		06/02/96	KW003	15.7	10.1	3.98	3.49	13.9	10.1	24	29.6
W04		06/02/96	KW004	2.08	6.8	15.3	13.1	42.9	20.8	63.7	19.2
W05		06/01/96	KW005	10.1	10.9	6.92	4.44	16.3	14.7	31	20.4
W06		06/04/96	KW006	11.5	16.7	13.0	7.31	18.9	31.1	50	12.1
W07		06/02/96	KW007	2.01	9.31	13.8	9.72	44.1	25.0	69.1	16.7
W08		06/02/96	KW008	5.36	9.11	10.2	7.96	42.8	23.4	66.2	18.0
W09		06/02/96	KW009	3.7	10.6	15.4	10.7	35.6	20.4	56	18.3
W010R		06/03/96	KW010	4.61	10.1	15.1	14.4	39.3	18.7	58	18.5
W011		05/30/96	KW011	11.2	14.1	15.2	7.31	15.0	10.6	25.6	29.9
W012		06/04/96	KW012	11.4	13.4	12.5	7.18	31.1	22.0	53.1	16.2
W013		06/04/96	KW013	3.08	8.47	8.52	7.16	48.3	28.3	76.6	16.2
W014		06/04/96	KW014	5.35	11.2	10.4	7.93	42.9	27.0	69.9	14.6
W015		06/02/96	KW015	5.51	9.11	10.5	9.47	39.4	21.9	61.3	20.0
W016		06/03/96	KW016	3.84	9.19	16.4	9.47	40.5	24.1	64.6	14.7
W017R		06/03/96	KW017	7.89	6.35	3.36	1.94	11.4	7.06	18.46	30.3
W018		05/29/96	KW018	14.1	8.96	4.26	2.18	4.49	1.61	6.1	71.6
W019		06/01/96	KW019	1.69	4.87	5.14	7.14	50.9	23.4	74.3	18.8
W020		05/31/96	KW020	4.84	6.68	5.44	5.55	53.4	24.0	77.4	19.7
W021		06/03/96	KW021	4.79	8.37	9.51	17.2	44.0	22.2	66.2	19.3
W022		05/28/96	KW022	8.41	8.1	10.7	15.8	27.3	11.3	38.6	42.2
W023		05/29/96	KW023	3.78	6.67	7.57	13.8	45.8	21.6	67.4	24.9
W024	1	06/01/96	KW024	2.54	4.97	12.2	18.2	43.2	16.5	59.7	26.6
W024	2	06/01/96	KW031	5.25	14.2	15.8	17.6	14.6	16.0	30.6	24.7
W025		05/30/96	KW025	2.67	3.96	15.9	33.8	33.4	12.6	46.0	29.0
W026		05/30/96	KW026	4.37	10.6	15.5	9.8	42.4	21.6	64.0	18.5
W027		05/29/96	KW027	6.82	10.8	8.73	7.12	42.3	23.7	66.0	19.1
W028		05/29/96	KW028	5.38	8.23	12.0	13.9	40.6	15.6	56.2	23.6
Moser Bay-Subtidal											
W029		06/05/96	KW029	0.53	1.24	7.62	32.0	50.7	6.6	57.3	40.2
W030		06/05/96	KW035	0.61	0.84	2.12	12.0	69.3	11.3	80.6	32.8
1997											
Ward Cove-Subtidal											
SD-2		7/24/97	SD0011	8.35	7.06	5.14	3.29	22.8	22.5	45.3	16.8
SD-3		7/24/97	SD0012	7.91	9.99	9.88	7.87	32.5	20.8	53.3	19.8

TABLE A1-1. (cont.)

Station	Field Rep.	Date	Sample Number	Particles 1.0 mm to 0.5 mm (percent)	Particles 0.5 mm to 0.25 mm (percent)	Particles 0.25 mm to 0.125 mm (percent)	Particles 0.125 mm to 0.062 mm (percent)	Particles 0.062 mm to 0.004 mm (percent)	Particles less than 0.004 mm (percent)	Percent Fines (Particles less than 0.062 mm) (percent)	Total Solids (percent)
SD-4		7/24/97	SD0013	2.2	7.94	13.5	12.1	43	22.9	65.9	19.2
SD-5		8/1/97	SD0014R	4.9	9.5	15.4	13	32.9	22.3	55.2	17.9
SD-7		7/29/97	SD0030	3.5	11.8	14.3	15.3	32.2	25.4	57.6	15.5
SD-11		7/24/97	SD0008	9.8	12.7	11	4.85	16.8	10.5	27.3	25.9
SD-12		8/1/97	SD0039	9.4	11.2	11.9	6.8	18.2	16.5	34.7	20.7
SD-13		8/1/97	SD0037	7.2	7.5	7.9	6.1	42.9	28.7	71.6	16.0
SD-13	A	8/1/97	SD0038	3.9	8.4	8	7.6	36.8	27.7	64.5	16.4
SD-16		7/29/97	SD0029	6.4	11.6	13.9	9.7	36.6	21.9	58.5	17.2
SD-17		7/30/97	SD0031	4.6	13.8	14	10.3	35.5	23.2	58.7	16.2
SD-18		7/23/97	SD0007	17.3	12.3	5.5	2.55	5.26	2.21	7.47	64.7
SD-19		7/28/97	SD0024	2.9	5.4	5.8	6.9	57.5	26.8	84.3	16.3
SD-22		7/22/97	SD0001	6.44	7.21	9.4	14.5	24.6	8.93	33.5	47.2
SD-23		7/23/97	SD0002	2.24	3.02	4.13	6.61	59.4	21	80.4	19.8
SD-25		7/24/97	SD0009	3.17	5.38	12.4	19	35.3	14.8	50.1	24.4
SD-27		7/23/97	SD0005	3.8	7.84	8.28	6.95	46.7	18.5	65.2	19.7
SD-28		7/23/97	SD0006	5.71	6.98	8.06	9.52	42.2	13.8	56	22.2
SD-31		7/25/97	SD0015	2.3	11.9	14.8	17.6	51.6	28.7	80.3	13.2
SD-32		7/25/97	SD0016	4.4	9.9	14.8	13	31.2	16	47.2	21.0
SD-33		7/25/97	SD0017	20.2	17	9.8	6.7	12.6	5.8	18.4	45.2
SD-34		7/31/97	SD0033	6.7	10	14.8	13.3	34.7	20.2	54.9	18.0
SD-35		7/31/97	SD0034	3.9	10.4	10.2	11.1	34.1	25.3	59.4	14.9
SD-37		7/25/97	SD0018	3.7	5.7	7.7	9.7	35.2	23.6	58.8	18.4
SD-37	A	7/25/97	SD0019	4.5	6.1	8.8	8.6	38.2	30.5	68.7	15.5
SD-38		7/24/97	SD0010	7.27	7.92	4.96	3.25	21.8	24.4	46.2	14.0
SD-39		7/25/97	SD0020	3.3	7	9.1	9.8	38.9	24.3	63.2	18.5
SD-40		7/25/97	SD0021	3.6	7.5	13.7	10.7	41.7	20.8	62.5	18.9
SD-41		7/30/97	SD0032	3	11.1	14.9	13.3	37.1	21	58.1	19.4
SD-42		7/29/97	SD0028	4.7	11.4	11.3	11.7	46.1	19	65.1	16.2
SD-43		7/28/97	SD0027	5	7.6	7.9	8.1	56.2	25.2	81.4	17.0
SD-44		7/31/97	SD0035	3.1	11.6	12.1	9.1	35.9	33.5	69.4	12.5
SD-44	A	7/31/97	SD0036	4	12.3	11.2	11.8	25.7	30	55.7	12.8
SD-45		7/28/97	SD0025	5.8	8.7	8.2	7.1	56.7	31	87.7	14.2
SD-47		8/1/97	SD0040	8.6	10.7	10.1	6.6	18.3	19.4	37.7	18.0
SD-48		7/28/97	SD0026	8.9	12.7	11.9	9.6	40.1	29.6	69.7	13.9
Moser Bay-Subtidal											
SD-29		7/27/97	SD0022	0.77	1.6	12.4	35.1	46.1	7.0	53.1	45.5
SD-30		7/27/97	SD0023	0.7	0.8	1.8	11	77.8	13.2	91	32.1

TABLE A1-1. (cont.)

Station	Field Rep.	Date	Sample Number	Particles 1.0 mm to 0.5 mm (percent)	Particles 0.5 mm to 0.25 mm (percent)	Particles 0.25 mm to 0.125 mm (percent)	Particles 0.125 mm to 0.062 mm (percent)	Particles 0.062 mm to 0.004 mm (percent)	Particles less than 0.004 mm (percent)	Percent Fines (Particles less than 0.062 mm) (percent)	Total Solids (percent)
Ward Cove-Intertidal											
SD-50		7/23/97	SD0003	7.22	8.44	7.97	5.26	4.7	1.53	6.23	79.6
SD-50		8/1/97	SD0003R								75.0
SD-51		7/23/97	SD0004	5.2	6.29	13.9	26	26.3	4.58	30.9	56.0

Note: All laboratory replicates are averaged.

J - estimated

U - undetected

[a] Composites of surface (top 5 cm) sediment from five stations along a transect.

TABLE A1-2. METALS IN SURFACE SEDIMENTS COLLECTED IN 1996 AND 1997

Station	Field Rep.	Date	Sample Number	Arsenic (mg/kg)	Cadmium (mg/kg)	Methyl-mercury (µg/kg)	Total Mercury (mg/kg)	Zinc (mg/kg)
1996								
Ward Cove-Subtidal								
W01		06/01/96	KW001		4.6		0.1	205
W02	1	06/01/96	KW002	17.6	2.3	0.57	0.1 *U*	135
W02	2	06/01/96	KW032	20.5	2.3	0.70	0.1 *U*	341
W03		06/02/96	KW003	15.6	1.3	0.76	0.7	214
W04		06/02/96	KW004	29.0	4.3	10.4	0.2	277
W05		06/01/96	KW005	8.5	1.3	0.58	0.1 *U*	117
W06		06/04/96	KW006		4.8		0.1	165
W07		06/02/96	KW007	38.9	7.3		0.25	197
W08		06/02/96	KW008		6.1		0.2	203
W09		06/02/96	KW009		5		0.1	226
W010R		06/03/96	KW010		2.8		0.1 *U*	270
W011		05/30/96	KW011	17.0	2.4	3.5	0.1 *U*	115
W012		06/04/96	KW012	37.9	5.5		0.1	200
W013		06/04/96	KW013	33.4	5.2	6.9	0.1	142
W014		06/04/96	KW014		6.7		0.1	188
W015		06/02/96	KW015		4.8		0.1	121
W016		06/03/96	KW016	18.8	3.7	1.0	0.1 *U*	190
W017R		06/03/96	KW017		0.99		0.1 *U*	192
W018		05/29/96	KW018	2.7	0.16	0.8	0.1 *U*	42.6
W019		06/01/96	KW019		3.7		0.1	110
W020		05/31/96	KW020	31.4	5.3		0.2	147
W021		06/03/96	KW021		5.2		0.1	135
W022		05/28/96	KW022	11.1	1	5.4	0.1 *U*	68.7
W023		05/29/96	KW023	29.2	2.5	9.5	0.2	159
W024	1	06/01/96	KW024		3.5		0.2	242
W024	2	06/01/96	KW031		3.7		0.5	451
W025		05/30/96	KW025	23.5	3.7	0.51	0.1	340
W026		05/30/96	KW026		4		0.1	144
W027		05/29/96	KW027	26.3	4.7	3.1	0.1	133
W028		05/29/96	KW028		2.6		0.1 *U*	171
Moser Bay-Subtidal								
W029		06/05/96	KW029		0.33		0.1 *U*	77.8
W030		06/05/96	KW035		1.4		0.1 *U*	70.3
1997								
Ward Cove-Subtidal								
SD-2		7/24/97	SD0011	22.9	3.0	0.43	0.2 *U*	195
SD-3		7/24/97	SD0012	24.5	3.6	1.16	0.2 *U*	219
SD-4		7/24/97	SD0013	31.4	4.8	1.33	0.2 *U*	396
SD-5		8/1/97	SD0014R	8.7	1.5	0.55	0.2 *U*	167
SD-11		7/24/97	SD0008	17.4	2.6	0.65	0.2 *U*	103
SD-13		8/1/97	SD0037	29.1	4.4	3.61	0.2 *U*	142
SD-13	A	8/1/97	SD0038	25.4	3.8	2.65	0.2 *U*	121
SD-16		7/29/97	SD0029	18.2	2.5	0.54	0.2 *U*	180
SD-18		7/23/97	SD0007	3.6	0.26	0.28	0.2 *U*	38.8
SD-22		7/22/97	SD0001	10.7	0.78	3.43	0.2 *U*	61.7
SD-23		7/23/97	SD0002	18.7	2.3	14.3	0.2 *U*	132
SD-25		7/24/97	SD0009	24.0	5.1	0.22	0.2 *U*	530
SD-27		7/23/97	SD0005	34.1	5.0	3.59	0.2 *U*	172
Moser Bay-Subtidal								
SD-29		7/27/97	SD0022	5.2	0.29	0.36	0.2 *U*	74.4
SD-30		7/27/97	SD0023	12.0	1.5	0.53	0.2 *U*	90.3
Ward Cove-Intertidal[a]								
SD-50		7/23/97	SD0003		0.14		0.2 *U*	64.2
SD-51		7/23/97	SD0004		0.48		0.2 *U*	71.6

Note: All results are reported on a dry weight basis.
All laboratory replicates are averaged following Rule Set 2.
U - undetected

[a] Composites of surface (top 5 cm) sediment from five stations along a transect.

TABLE A1-3. SEMIVOLATILE ORGANIC COMPOUNDS IN SURFACE SEDIMENTS COLLECTED IN 1996 AND 1997

				LPAHs							
Station	Field Rep.	Date	Sample Number	Naphthalene (µg/kg)	2-Methyl-naphthalene (µg/kg)	Acenaphthylene (µg/kg)	Acenaphthene (µg/kg)	Fluorene (µg/kg)	Phenanthrene (µg/kg)	Anthracene (µg/kg)	Total[a] (µg/kg)
Toxic Equivalent Factor[b]											
1996											
Ward Cove-Subtidal											
W01		06/01/96	KW001								
W02		06/01/96	KW002	86 *J*	87 *J*	100 *U*	68 *J*	64 *J*	350	62 *J*	680
W02	A	06/01/96	KW032	73 *J*	87 *J*	100 *U*	47 *J*	52 *J*	230	42 *J*	490
W03		06/02/96	KW003	440	280	100 *U*	500	470	1,100	260	2,800
W04		06/02/96	KW004	200	140	34 *J*	170	170	670	190	1,400
W05		06/01/96	KW005	49 *J*	74 *J*	100 *U*	60 *J*	67 *J*	270	62 *J*	560
W06		06/04/96	KW006								
W07		06/02/96	KW007								
W08		06/02/96	KW008								
W09		06/02/96	KW009								
W010R		06/03/96	KW010								
W011		05/30/96	KW011	24 *J*	22 *J*	100 *U*	100 *U*	20 *J*	150	41 *J*	340
W012		06/04/96	KW012								
W013		06/04/96	KW013	54 *J*	25 *J*	100 *UJ*	100 *UJ*	20 *J*	130 *J*	34 *J*	340
W014		06/04/96	KW014								
W015		06/02/96	KW015								
W016		06/03/96	KW016	12 *J*	15 *J*	50 *UJ*	32 *J*	34 *J*	97 *J*	49 *J*	250
W017R		06/03/96	KW017								
W018		05/29/96	KW018	1 *J*	10 *U*	10 *U*	10 *U*	10 *U*	6 *J*	3 *J*	25
W019		06/01/96	KW019								
W020		05/31/96	KW020								
W021		06/03/96	KW021								
W022		05/28/96	KW022	100 *U*	100 *U*	12 *J*	100 *U*	12 *J*	110	33 *J*	270
W023		05/29/96	KW023	20 *J*	20 *J*	110	34 *J*	99 *J*	850	360	1,500
W024		06/01/96	KW024								
W024	A	06/01/96	KW031								
W025		05/30/96	KW025	24 *J*	22 *J*	100	37 *J*	110	900	380	1,600
W026		05/30/96	KW026								
W027		05/29/96	KW027	17 *J*	18 *J*	100 *U*	100 *U*	21 *J*	120	40 *J*	300
W028		05/29/96	KW028								
Moser Bay-Subtidal											
W029		06/05/96	KW029								
W030		06/05/96	KW035								
1997											
Ward Cove-Subtidal											
SD-2		7/24/97	SD0011	140 *J*	151 *J*	20 *UJ*	95 *J*	111 *J*	479 *J*	103 *J*	938 *J*
SD-3		7/24/97	SD0012	245 *J*	167 *J*	20 *UJ*	234 *J*	257 *J*	899 *J*	234 *J*	1,879 *J*
SD-4		7/24/97	SD0013	313 *J*	275 *J*	20 *UJ*	261 *J*	300 *J*	920 *J*	247 *J*	2,051 *J*
SD-5		8/1/97	SD0014R	193	196	20 *U*	140	135	387	70	935
SD-7		7/29/97	SD0030								

TABLE A1-3. (cont.)

				LPAHs							
Station	Field Rep.	Date	Sample Number	Naphthalene (μg/kg)	2-Methyl-naphthalene (μg/kg)	Acenaphthylene (μg/kg)	Acenaphthene (μg/kg)	Fluorene (μg/kg)	Phenanthrene (μg/kg)	Anthracene (μg/kg)	Total[a] (μg/kg)
SD-11		7/24/97	SD0008	37 *J*	46 *J*	20 *UJ*	20 *UJ*	20 *UJ*	101 *J*	36 *J*	204 *J*
SD-12		8/1/97	SD0039								
SD-13		8/1/97	SD0037	142	63	20 *U*	24	38	218	53	485
SD-13	A	8/1/97	SD0038	141	71	20 *U*	29	47	269	70	566
SD-16		7/29/97	SD0029	54	79	20 *U*	82	109	307	86	648
SD-17		7/30/97	SD0031								
SD-18		7/23/97	SD0007	10 *UJ*	10 *UJ*	10 *UJ*	10 *UJ*	10 *UJ*	16 *J*	10 *UJ*	41 *J*
SD-19		7/28/97	SD0024								
SD-22		7/22/97	SD0001	11 *J*	10 *J*	11 *J*	10 *UJ*	14 *J*	97 *J*	32 *J*	170 *J*
SD-23		7/23/97	SD0002	21 *J*	26 *J*	20 *J*	20 *UJ*	31 *J*	233 *J*	61 *J*	376 *J*
SD-25		7/24/97	SD0009	52 *J*	60 *J*	35 *J*	42 *J*	92 *J*	551 *J*	325 *J*	1,097 *J*
SD-27		7/23/97	SD0005	51 *J*	69 *J*	20 *UJ*	31 *J*	52 *J*	223 *J*	84 *J*	451 *J*
SD-28		7/23/97	SD0006	31 *J*	38 *J*	10 *UJ*	33 *J*	45 *J*	122 *J*	46 *J*	282 *J*
SD-31		7/25/97	SD0015								
SD-32		7/25/97	SD0016								
SD-33		7/25/97	SD0017								
SD-34		7/31/97	SD0033								
SD-35		7/31/97	SD0034								
SD-37		7/25/97	SD0018								
SD-37	A	7/25/97	SD0019								
SD-38		7/24/97	SD0010								
SD-39		7/25/97	SD0020								
SD-40		7/25/97	SD0021								
SD-41		7/30/97	SD0032								
SD-42		7/29/97	SD0028								
SD-43		7/28/97	SD0027								
SD-44		7/31/97	SD0035								
SD-44	A	7/31/97	SD0036								
SD-45		7/28/97	SD0025								
SD-47		8/1/97	SD0040	200 *U*	200 *U*	200 *U*	200 *U*	200 *U*	310	200 *U*	810
SD-48		7/28/97	SD0026								
Moser Bay-Subtidal											
SD-29		7/27/97	SD0022	10 *UJ*	10 *UJ*	10 *UJ*	10 *UJ*	10 *UJ*	10 *UJ*	10 *UJ*	30 *UJ*
SD-30		7/27/97	SD0023	15 *UJ*	15 *UJ*	15 *UJ*	15 *UJ*	15 *UJ*	15 *UJ*	15 *UJ*	45 *UJ*
Ward Cove-Intertidal[e]											
SD-50		7/23/97	SD0003	10 *UJ*	10 *UJ*	10 *UJ*	10 *UJ*	10 *UJ*	42 *J*	10 *UJ*	67 *J*
SD-50		8/1/97	SD0003R								
SD-51		7/23/97	SD0004	14 *J*	13 *J*	10 *UJ*	14 *J*	18 *J*	86 *J*	33 *J*	170 *J*

TABLE A1-3. (cont.)

Station	Field Rep.	Date	Sample Number	HPAHs Fluoranthene (µg/kg)	Pyrene (µg/kg)	Benz[a]-anthracene[c] (µg/kg)	Chrysene[c] (µg/kg)	Benzo[b]-fluoranthene[c] (µg/kg)	Benzo[k]-fluoranthene[c] (µg/kg)	Benzo[a]-pyrene[c] (µg/kg)	Indeno [1,2,3-cd]-pyrene[c] (µg/kg)	Dibenz[a,h]-anthracene[c] (µg/kg)	Benzo[ghi]-perylene (µg/kg)	Total[a] (µg/kg)
Toxic Equivalent Factor[b]						0.1	0.01	0.1	0.1	1.0	0.1	1.0		
1996														
Ward Cove-Subtidal														
W01		06/01/96	KW001											
W02		06/01/96	KW002	630	320	110	130	79 *J*	52 *J*	56 *J*	40 *J*	100 *U*	19 *J*	1,400
W02	A	06/01/96	KW032	550	210	71 *J*	99 *J*	56 *J*	37 *J*	34 *J*	35 *J*	100 *U*	15 *J*	1,100
W03		06/02/96	KW003	1,900	1,400	480	450	220 *J*	150 *J*	220 *J*	110 *J*	22 *J*	79 *J*	5,000
W04		06/02/96	KW004	1,300	830	350	410	240 *J*	170 *J*	170 *J*	140 *J*	39 *J*	90 *J*	3,700
W05		06/01/96	KW005	690	230	160	130	95 *J*	61 *J*	65 *J*	36 *J*	100 *U*	19 *J*	1,500
W06		06/04/96	KW006											
W07		06/02/96	KW007											
W08		06/02/96	KW008											
W09		06/02/96	KW009											
W010R		06/03/96	KW010											
W011		05/30/96	KW011	340	230	160	100	69 *J*	51 *J*	67 *J*	51 *J*	100 *U*	31 *J*	1,100
W012		06/04/96	KW012											
W013		06/04/96	KW013	270 *J*	170 *J*	77 *J*	100 *J*	62 *J*	48 *J*	46 *J*	33 *J*	100 *UJ*	30 *J*	890 *J*
W014		06/04/96	KW014											
W015		06/02/96	KW015											
W016		06/03/96	KW016	330 *J*	190 *J*	94 *J*	96 *J*	50 *J*	36 *J*	40 *J*	25 *J*	6 *J*	16 *J*	900 *J*
W017R		06/03/96	KW017											
W018		05/29/96	KW018	15	8 *J*	3 *J*	4 *J*	3 *J*	10 *U*	10 *U*	1 *J*	10 *U*	1 *J*	50
W019		06/01/96	KW019											
W020		05/31/96	KW020											
W021		06/03/96	KW021											
W022		05/28/96	KW022	220	200	100	110	58 *J*	72 *J*	63 *J*	37 *J*	100 *U*	32 *J*	890
W023		05/29/96	KW023	1,000	1,200	790	950	510	440	620	350	49 *J*	250	6,100
W024		06/01/96	KW024											
W024	A	06/01/96	KW031											
W025		05/30/96	KW025	1,500	1,500	990	1,300	690	530	750	520	73 *J*	290	8,100
W026		05/30/96	KW026											
W027		05/29/96	KW027	300	220	110	140	82 *J*	54 *J*	60 *J*	46 *J*	100 *U*	30 *J*	1,000
W028		05/29/96	KW028											
Moser Bay-Subtidal														
W029		06/05/96	KW029											
W030		06/05/96	KW035											
1997														
Ward Cove-Subtidal														
SD-2		7/24/97	SD0011	550 *J*	422 *J*	162 *J*	135 *J*	186 *J*	68 *J*	80 *J*	40 *J*	20 *UJ*	91 *J*	1,744 *J*
SD-3		7/24/97	SD0012	1,400 *J*	1,200 *J*	507 *J*	538 *J*	671 *J*	252 *J*	242 *J*	116 *J*	20 *UJ*	61 *J*	4,997 *J*
SD-4		7/24/97	SD0013	2,200 *J*	1,760 *J*	659 *J*	483 *J*	525 *J*	176 *J*	191 *J*	20 *UJ*	20 *UJ*	64 *J*	6,078 *J*
SD-5		8/1/97	SD0014F	558	438	92	93	20 *U*	20 *U*	32	20 *U*	20 *U*	41	1,294
SD-7		7/29/97	SD0030											

TABLE A1-3. (cont.)

				HPAHs										
Station	Field Rep.	Date	Sample Number	Fluoranthene (µg/kg)	Pyrene (µg/kg)	Benz[a]-anthracene[c] (µg/kg)	Chrysene[c] (µg/kg)	Benzo[b]-fluoranthene[c] (µg/kg)	Benzo[k]-fluoranthene[c] (µg/kg)	Benzo[a]-pyrene[c] (µg/kg)	Indeno [1,2,3-cd]-pyrene[c] (µg/kg)	Dibenz[a,h]-anthracene[c] (µg/kg)	Benzo[ghi]-perylene (µg/kg)	Total[a] (µg/kg)
SD-11		7/24/97	SD0008	195 *J*	148 *J*	58 *J*	49 *J*	77 *J*	26 *J*	45 *J*	24 *J*	20 *UJ*	20 *UJ*	642 *J*
SD-12		8/1/97	SD0039											
SD-13		8/1/97	SD0037	330	257	97	126	152	49	63	34	20 *U*	50	1,168
SD-13	A	8/1/97	SD0038	374	291	135	179	202	65	81	39	20 *U*	54	1,430
SD-16		7/29/97	SD0029	424	372	124	158	81	31	42	23	20 *U*	20 *U*	1,275
SD-17		7/30/97	SD0031											
SD-18		7/23/97	SD0007	30 *J*	23 *J*	10 *UJ*	12 *J*	13 *J*	10 *UJ*	10 *UJ*	10 *UJ*	10 *UJ*	10 *UJ*	108 *J*
SD-19		7/28/97	SD0024											
SD-22		7/22/97	SD0001	228 *J*	240 *J*	122 *J*	148 *J*	148 *J*	49 *J*	103 *J*	75 *J*	14 *J*	63 *J*	1,190 *J*
SD-23		7/23/97	SD0002	462 *J*	429 *J*	211 *J*	268 *J*	267 *J*	87 *J*	167 *J*	115 *J*	22 *J*	85 *J*	2,113 *J*
SD-25		7/24/97	SD0009	961 *J*	830 *J*	669 *J*	592 *J*	737 *J*	254 *J*	388 *J*	226 *J*	20 *UJ*	161 *J*	4,828 *J*
SD-27		7/23/97	SD0005	394 *J*	363 *J*	168 *J*	191 *J*	264 *J*	86 *J*	136 *J*	72 *J*	20 *UJ*	64 *J*	1,748 *J*
SD-28		7/23/97	SD0006	387 *J*	313 *J*	108 *J*	104 *J*	130 *J*	44 *J*	54 *J*	10 *UJ*	10 *UJ*	10 *UJ*	1,155 *J*
SD-31		7/25/97	SD0015											
SD-32		7/25/97	SD0016											
SD-33		7/25/97	SD0017											
SD-34		7/31/97	SD0033											
SD-35		7/31/97	SD0034											
SD-37		7/25/97	SD0018											
SD-37	A	7/25/97	SD0019											
SD-38		7/24/97	SD0010											
SD-39		7/25/97	SD0020											
SD-40		7/25/97	SD0021											
SD-41		7/30/97	SD0032											
SD-42		7/29/97	SD0028											
SD-43		7/28/97	SD0027											
SD-44		7/31/97	SD0035											
SD-44	A	7/31/97	SD0036											
SD-45		7/28/97	SD0025											
SD-47		8/1/97	SD0040	470	460	460	210	200 *U*	200 *U*	200 *U*	200 *U*	200 *U*	200 *U*	2,200
SD-48		7/28/97	SD0026											
Moser Bay-Subtidal														
SD-29		7/27/97	SD0022	10 *UJ*	10 *UJ*	10 *UJ*	10 *UJ*	10 *UJ*	10 *UJ*	10 *UJ*	10 *UJ*	10 *UJ*	10 *UJ*	50 *UJ*
SD-30		7/27/97	SD0023	15 *UJ*	15 *UJ*	15 *UJ*	15 *UJ*	15 *UJ*	15 *UJ*	15 *UJ*	15 *UJ*	15 *UJ*	15 *UJ*	75 *UJ*
Ward Cove-Intertidal[e]														
SD-50		7/23/97	SD0003	150 *J*	120 *J*	28 *J*	47 *J*	48 *J*	18 *J*	23 *J*	11 *J*	10 *UJ*	10 *UJ*	455 *J*
SD-50		8/1/97	SD0003R											
SD-51		7/23/97	SD0004	258 *J*	200 *J*	81 *J*	94 *J*	107 *J*	39 *J*	46 *J*	25 *J*	10 *UJ*	19 *J*	874 *J*

TABLE A1-3. (cont.)

Station	Field Rep.	Date	Sample Number	Carcinogenic PAH Relative Potency Concentration[a] (µg/kg)	Carcinogenic PAH Relative Potency Concentration[d] (µg/kg)	Phenols: Phenol (µg/kg)	Phenols: 4-Methyl-phenol[f] (µg/kg)	Miscellaneous Oxygenated Compound: Benzoic Acid (µg/kg)	Dibenzofuran (µg/kg)
Toxic Equivalent Factor[b]				NA	NA				
1996									
Ward Cove-Subtidal									
W01		06/01/96	KW001			240 *J*	6,000 *J*		
W02		06/01/96	KW002	135 *J*	85 *J*	510 *J*	11,000 *J*	990 *J*	
W02	A	06/01/96	KW032	105 *J*	55 *J*	700 *J*	12,000 *J*	500 *UJ*	
W03		06/02/96	KW003	340 *J*	340 *J*	110 *J*	5,600 *J*	500 *UJ*	
W04		06/02/96	KW004	300 *J*	300 *J*	170 *J*	2,900 *J*	1,600 *J*	
W05		06/01/96	KW005	152 *J*	102 *J*	150 *J*	860 *J*	500 *UJ*	
W06		06/04/96	KW006			97 *J*	8,300 *J*		
W07		06/02/96	KW007			200 *UJ*	1,700 *J*		
W08		06/02/96	KW008			250 *UJ*	1,400 *J*		
W09		06/02/96	KW009			250 *UJ*	1,400 *J*		
W010R		06/03/96	KW010			250 *UJ*	250 *UJ*		
W011		05/30/96	KW011	151 *J*	101 *J*	200 *UJ*	200 *UJ*	500 *UJ*	
W012		06/04/96	KW012			200 *UJ*	620 *J*		
W013		06/04/96	KW013	119 *J*	69 *J*	200 *UJ*	390 *J*	500 *UJ*	
W014		06/04/96	KW014			200 *UJ*	1,000 *J*		
W015		06/02/96	KW015			200 *UJ*	220 *J*		
W016		06/03/96	KW016	67 *J*	67 *J*	360 *J*	250 *UJ*	500 *UJ*	
W017R		06/03/96	KW017			250 *UJ*	250 *UJ*		
W018		05/29/96	KW018	11.2 *J*	0.74 *J*	15 *J*	20 *UJ*	100 *UJ*	
W019		06/01/96	KW019			250 *UJ*	250 *UJ*		
W020		05/31/96	KW020			200 *UJ*	470 *J*		
W021		06/03/96	KW021			250 *UJ*	250 *UJ*		
W022		05/28/96	KW022	141 *J*	91 *J*	200 *UJ*	200 *UJ*	500 *UJ*	
W023		05/29/96	KW023	890	890	46 *J*	49 *J*	500 *UJ*	
W024		06/01/96	KW024			250 *UJ*	250 *UJ*		
W024	A	06/01/96	KW031			200 *UJ*	380 *J*		
W025		05/30/96	KW025	1,100	1,100	130 *J*	1,700 *J*	500 *UJ*	
W026		05/30/96	KW026			200 *UJ*	200 *UJ*		
W027		05/29/96	KW027	141 *J*	91 *J*	200 *UJ*	200 *UJ*	500 *UJ*	
W028		05/29/96	KW028			200 *UJ*	200 *UJ*		
Moser Bay-Subtidal									
W029		06/05/96	KW029			20 *UJ*	20 *UJ*		
W030		06/05/96	KW035			20 *UJ*	20 *UJ*		
1997									
Ward Cove-Subtidal									
SD-2		7/24/97	SD0011	137 *J*	127 *J*	908 *J*	15,000 *J*	100 *UJ*	20 *UJ*
SD-3		7/24/97	SD0012	412 *J*	402 *J*	200 *J*	6,200 *J*	100 *UJ*	144 *J*
SD-4		7/24/97	SD0013	343 *J*	332 *J*	217 *J*	4,500 *J*	868 *J*	183 *J*
SD-5		8/1/97	SD0014R	55	42	909	16,000	100 *U*	80
SD-7		7/29/97	SD0030				7,500 *J*		

TABLE A1-3. (cont.)

Station	Field Rep.	Date	Sample Number	Carcinogenic PAH Relative Potency Concentration[a] (µg/kg)	Carcinogenic PAH Relative Potency Concentration[d] (µg/kg)	Phenols: Phenol (µg/kg)	Phenols: 4-Methyl-phenol[f] (µg/kg)	Miscellaneous Oxygenated Compound: Benzoic Acid (µg/kg)	Miscellaneous Oxygenated Compound: Dibenzofuran (µg/kg)
SD-11		7/24/97	SD0008	74 *J*	64 *J*	53 *J*	380 *J*	344 *J*	20 *UJ*
SD-12		8/1/97	SD0039				8,300 *J*		
SD-13		8/1/97	SD0037	107	97	150	1,700	542	33
SD-13	A	8/1/97	SD0038	137	127	174	1,700	590	38
SD-16		7/29/97	SD0029	79	69	102	1,240	401	62
SD-17		7/30/97	SD0031				570 *J*		
SD-18		7/23/97	SD0007	13 *J*	1.4 *J*	12 *J*	26 *J*	151 *J*	10 *UJ*
SD-19		7/28/97	SD0024				730 *J*		
SD-22		7/22/97	SD0001	158 *J*	158 *J*	17 *J*	24 *J*	63 *J*	10 *UJ*
SD-23		7/23/97	SD0002	260 *J*	260 *J*	48 *J*	168 *J*	272 *J*	20 *UJ*
SD-25		7/24/97	SD0009	593 *J*	583 *J*	993 *J*	6,600 *J*	100 *UJ*	38 *J*
SD-27		7/23/97	SD0005	207 *J*	197 *J*	57 *J*	472 *J*	595 *J*	20 *UJ*
SD-28		7/23/97	SD0006	89 *J*	83 *J*	90 *J*	802 *J*	265 *J*	10 *UJ*
SD-31		7/25/97	SD0015				17,000 *J*		
SD-32		7/25/97	SD0016				2,700 *J*		
SD-33		7/25/97	SD0017				980 *J*		
SD-34		7/31/97	SD0033				5,100 *J*		
SD-35		7/31/97	SD0034				460 *J*		
SD-37		7/25/97	SD0018				4,400 *J*		
SD-37	A	7/25/97	SD0019				5,300 *J*		
SD-38		7/24/97	SD0010				8,300 *J*		
SD-39		7/25/97	SD0020				1,300 *J*		
SD-40		7/25/97	SD0021				1,000 *J*		
SD-41		7/30/97	SD0032				640 *J*		
SD-42		7/29/97	SD0028				5,700 *J*		
SD-43		7/28/97	SD0027				1,000 *J*		
SD-44		7/31/97	SD0035				9,000 *J*		
SD-44	A	7/31/97	SD0036				9,200 *J*		
SD-45		7/28/97	SD0025				2,400 *J*		
SD-47		8/1/97	SD0040	278	48	210	1,800 *J*	1,000 *U*	200 *U*
SD-48		7/28/97	SD0026				1,100 *J*		
Moser Bay-Subtidal									
SD-29		7/27/97	SD0022	12 *UJ*	0 *UJ*	12 *J*	10 *UJ*	140 *J*	10 *UJ*
SD-30		7/27/97	SD0023	18 *UJ*	0 *UJ*	15 *UJ*	15 *UJ*	116 *J*	15 *UJ*
Ward Cove-Intertidal[e]									
SD-50		7/23/97	SD0003	39 *J*	34 *J*	10 *UJ*	10 *UJ*	62 *J*	10 *UJ*
SD-50		8/1/97	SD0003R						
SD-51		7/23/97	SD0004	77 *J*	72 *J*	37 *J*	231 *J*	115 *J*	10 *J*

Note: All results are reported on a dry weight basis.

All laboratory replicates are averaged.

J - estimated
U - undetected

TABLE A1-3. (cont.)

[a] Detection limits are included in the sum at half their value.

[b] Toxic equivalent factors for PAHs currently considered carcinogenic are based on U.S. EPA 1989.

[c] The carcinogenic PAHs include benz[a]anthracene, chrysene, benzo[b]fluoranthene, benzo[k]fluoranthene, benzo[a]pyrene, indeno[1,2,3-cd]pyrene, and dibenz[a,h]anthracene.

[d] Detection limits are excluded from the sum.

[e] Composites of surface (top 5 cm) sediment from five stations along a transect.

[f] 3- and 4-methylphenol results were quantified as 4-methylphenol.

TABLE A1-4. DIOXINS AND FURANS IN SURFACE SEDIMENTS COLLECTED IN 1996 AND 1997

Station	Field Rep.	Date	Sample Number	Dioxin and Furan Toxic Equivalent Concentration[a] (ng/kg)	Dioxin and Furan Toxic Equivalent Concentration[b] (ng/kg)	2,3,7,8-TCDD (ng/kg)	1,2,3,7,8-PeCDD (ng/kg)	1,2,3,4,7,8-HxCDD (ng/kg)	1,2,3,6,7,8-HxCDD (ng/kg)	1,2,3,7,8,9-HxCDD (ng/kg)	1,2,3,4,6,7,8-HpCDD (ng/kg)	1,2,3,4,6,7,8,9-OCDD (ng/kg)	2,3,7,8-TCDF (ng/kg)
Toxic Equivalent Factors[c]				NA	NA	1.0	0.5	0.1	0.1	0.1	0.01	0.001	0.1
1996													
Ward Cove-Subtidal													
W02	1	06/01/96	KW002	23.0	20.9	1.3 *U*	4.8	4.8	19	11	360	2,600	17
W02	2	06/01/96	KW032	22.6	20.5	1.2 *U*	4.5	3.7	19	10	340	2,600	17
W03		06/02/96	KW003	22.8	21.3	1.0 *U*	3.6	3.8	21	11	540	3,700	12
W04		06/02/96	KW004	45.7	42.7	2.6	10	11	41	26	920	6,100	30 *U*
W05		06/01/96	KW005	13.9	11.9	1.9 *U*	3.5	3.2 *U*	12	6.9	240	1,600	8.8
W07		06/02/96	KW007	46.2	44.7	2.3 *U*	6.0	5.4	23	14	400	2,600	36
W09		06/02/96	KW009	12.0	10.4	1.2 *U*	3.1	2.8	10	6.8	230	1,500	9.9 *U*
W011		05/30/96	KW011	5.7	4.4	0.82 *U*	1.8 *U*	1.4 *U*	5.6	3.3	110	610	6.6
W013		06/04/96	KW013	7.8	6.2	1.3 *U*	2.8	1.3 *U*	5.8	5.1	120	1,100	6.3 *U*
W016		06/03/96	KW016	6.7	5.4	1.4 *U*	2.3	2.3 *U*	4.9	4.0	87	610	4.3
W018		05/29/96	KW018	1.1	0.085	0.66 *U*	0.78 *U*	0.85 *U*	0.86 *U*	0.86 *U*	4.5	26	0.59 *U*
W022		05/28/96	KW022	4.4	2.5	1.1 *U*	1.5 *U*	1.9 *U*	3.8	2.0 *U*	90	620	2.6
W023		05/29/96	KW023	5.8	2.3	2.3 *U*	2.4 *U*	3.3 *U*	4.7	3.3 *U*	100	680	2.1 *U*
W025		05/30/96	KW025	21.1	18.9	2.2 *U*	3.4	3.3 *U*	19	9.7	550	3,900	7.7
W027		05/29/96	KW027	5.1	0.88	3.0 *U*	2.0 *U*	2.8 *U*	2.9 *U*	2.8 *U*	47	320	3.3 *U*
1996 Archived													
Ward Cove-Subtidal													
KW-01		6/4/96	KW001	24.3	22.0	1.5	6.7 *J*	22 *U*	19	12	400	3100	21 *U*
KW-06		6/7/96	KW006	15.3	12.7	1.3 *U*	4.8 *J*	15 *U*	14	6.9 *J*	230	2000	20 *U*
KW-12		6/7/96	KW012	16.6	14.6	1.3	5.2 *J*	15 *U*	13	8.5 *J*	240	1800	19 *U*
KW-14		6/7/96	KW014	26.5	24.2	2	8.9 *J*	22 *U*	23	17	400	2700	21 *U*
KW-15		6/4/96	KW015	14.5	12.2	1 *U*	4.1 *J*	13 *U*	13	8.9 *J*	290	2100	12 *U*
KW-17		6/7/96	KW017	2.6	0.9	1 *U*	1.6 *U*	2 *U*	1.9	1.5 *U*	35	240	4.1 *U*
KW-19		6/4/96	KW019	10.9	7.5	1.2 *U*	3.3 *U*	10 *U*	12	5.4 *J*	290	2100	7 *U*
KW-20		6/4/96	KW020	17.9	15.2	0.95 *U*	4.5 *J*	16 *U*	20	7.3 *J*	430	3000	18 *U*
KW-21		6/7/96	KW021	16.5	14.3	0.97 *U*	4.2 *J*	12 *U*	16	9.3	360	2600	12 *U*
KW-24		6/4/96	KW024	21.8	18.6	1.6 *U*	4 *J*	15 *U*	16	9.1	430	3000	30 *U*
KW-26		6/4/96	KW026	14.0	11.9	1.1 *U*	4 *J*	11 *U*	12	8.9 *J*	280	2100	9.6 *U*
Moser Bay-Subtidal													
KW-30		6/7/96	KW030	1.7	0 *U*	1.2 *U*	1 *U*	1.2 *U*	1.4 *U*	1.3 *U*	3.4 *U*	20 *U*	1.2 *U*
1997													
Ward Cove-Subtidal													
SD-2		07/24/97	SD0011	21.8	15.3	1.5	6.2 *U*	6.6 *U*	23 *J*	17 *J*	450	3,700	7.6 *U*
SD-3		07/24/97	SD0012	31.5	27.3	1.2	8.2	7	28	20	740	5,800	19 *U*
SD-4		07/24/97	SD0013	45.2	42.1	1.7	12	11	44	30	880	6,300	22 *U*

TABLE A1-4. (cont.)

Station	Field Rep.	Date	Sample Number	Dioxin and Furan Toxic Equivalent Concentration[a] (ng/kg)	Dioxin and Furan Toxic Equivalent Concentration[b] (ng/kg)	2,3,7,8-TCDD (ng/kg)	1,2,3,7,8-PeCDD (ng/kg)	1,2,3,4,7,8-HxCDD (ng/kg)	1,2,3,6,7,8-HxCDD (ng/kg)	1,2,3,7,8,9-HxCDD (ng/kg)	1,2,3,4,6,7,8-HpCDD (ng/kg)	1,2,3,4,6,7,8,9-OCDD (ng/kg)	2,3,7,8-TCDF (ng/kg)
SD-5		08/01/97	SD0014R	17.0	14.0	1.3	5.6	4.6	16	12	300	2,100	14 *U*
SD-11		07/24/97	SD0008	8.5	5.2	1.2	2.9 *U*	2.5 *U*	8.6 *U*	6.4 *U*	200	1,600	4.6 *U*
SD-13		08/01/97	SD0037	20.3	18.2	1.6 *U*	6.6	5.1	15	14	340	2,700	5.1 *U*
SD-13	A	08/01/97	SD0038	20.7	18.4	1.6 *U*	6.5	5.4	18	14	360	2,800	9.3 *U*
SD-16		07/29/97	SD0029	12.3	11.6	1.4	3.4 *J*	2.6	8.9	6.2 *J*	220	2,000	5.1 *U*
SD-18		07/23/97	SD0007	1.2	0.07	0.65 *U*	0.75 *U*	0.72 *U*	0.72 *U*	0.73 *U*	10 *U*	72 *J*	0.58 *U*
SD-22		07/22/97	SD0001	9.0	7.6	0.69 *U*	1.6 *U*	1.5	9.7	4.5 *J*	250	1,800	5.4 *U*
SD-23		07/23/97	SD0002	14.6	10.0	1.2 *U*	3.4 *U*	4.5 *U*	16 *J*	9.7 *U*	440	3,200	10 *U*
SD-25		07/24/97	SD0009	20.0	16.0	1.1	3.5 *U*	4.2 *U*	20 *J*	13 *J*	580	4,600	14 *U*
SD-27		07/23/97	SD0005	17.3	12.9	1.4	4.9 *U*	5.1 *U*	18 *J*	13 *J*	440	3,100	8.4 *U*
Moser Bay-Subtidal													
SD-29		07/27/97	SD0022	1.1	0.01	0.75 *U*	0.66 *U*	0.87 *U*	0.87 *U*	0.89 *U*	2 *U*	11 *J*	0.6 *U*
SD-30		07/27/97	SD0023	1.6	0.05	0.85 *U*	1.2 *U*	1.2 *U*	1.1 *U*	1.2 *U*	4.5 *U*	29	0.93 *U*

TABLE A1-4. (cont.)

Station	Field Rep.	Date	Sample Number	1,2,3,7,8-PeCDF (ng/kg)	2,3,4,7,8-PeCDF (ng/kg)	1,2,3,4,7,8-HxCDF (ng/kg)	1,2,3,6,7,8-HxCDF (ng/kg)	1,2,3,7,8,9-HxCDF (ng/kg)	2,3,4,6,7,8-HxCDF (ng/kg)	1,2,3,4,6,7,8-HpCDF (ng/kg)	1,2,3,4,7,8,9-HpCDF (ng/kg)	1,2,3,4,6,7,8,9-OCDF (ng/kg)	Total TCDD (ng/kg)
Toxic Equivalent Factors[c]				0.05	0.5	0.1	0.1	0.1	0.1	0.01	0.01	0.001	NA
1996													
Ward Cove-Subtidal													
W02	1	06/01/96	KW002	4.5	8.1	27 *U*	7.9	2.5 *U*	5.3	120	8.1	240	110
W02	2	06/01/96	KW032	4.6	7.7	29 *U*	7.8	2.1 *U*	7.3	130	9.5	260	120
W03		06/02/96	KW003	4.8	6.9	18 *U*	6.3	1.7 *U*	4.1	73	4.9	130	110
W04		06/02/96	KW004	9.7	15	27 *U*	11	3.5 *U*	10	150	7.7	360	290
W05		06/01/96	KW005	3.0	4.8	10 *U*	3.2	3.9 *U*	3.2 *U*	42	4.4 *U*	120	53
W07		06/02/96	KW007	8.4 *U*	20	85	39	2.4 *U*	30	130	27	280	220
W09		06/02/96	KW009	2.6	3.9	7.1 *U*	2.5	2.6 *U*	3.0	37	3.3 *U*	120	59
W011		05/30/96	KW011	1.3	1.7	3.2 *U*	1.1 *U*	1.7 *U*	1.4 *U*	16	2.3 *U*	38	39
W013		06/04/96	KW013	1.5	2.2	3.5 *U*	2.1 *U*	3.0 *U*	2.5 *U*	18	4.3 *U*	67	27
W016		06/03/96	KW016	1.8 *U*	2.0	3.1	1.8 *U*	2.7 *U*	2.2 *U*	13	4.9 *U*	42	23
W018		05/29/96	KW018	0.57 *U*	0.62 *U*	0.74 *U*	0.75 *U*	1.1 *U*	0.92 *U*	1.0	1.1 *U*	3.8	0.66 *U*
W022		05/28/96	KW022	1.5 *U*	1.6 *U*	2.1	1.8 *U*	2.6 *U*	2.2 *U*	13	2.4 *U*	35	9.3
W023		05/29/96	KW023	1.9 *U*	2.1 *U*	2.9 *U*	3.0 *U*	4.4 *U*	3.6 *U*	14	3.7 *U*	41	3.0 *U*
W025		05/30/96	KW025	4.0	4.2	14 *U*	3.8	4.1 *U*	4.1	95	5.9 *U*	160	34
W027		05/29/96	KW027	3.0 *U*	3.2 *U*	3.0 *U*	3.0 *U*	4.5 *U*	3.7 *U*	6.7	4.5 *U*	20	3.0 *U*
1996 Archived													
Ward Cove-Subtidal													
KW-01		6/4/96	KW001	5.3 *J*	7.3	5.3 *J*	7.6 *J*	1.9 *U*	6.8 *J*	82	4.9 *U*	280	130
KW-06		6/7/96	KW006	4.9 *J*	4 *J*	4.5 *J*	4.7 *J*	1.7 *U*	2.9 *U*	54	3.4 *U*	180	160
KW-12		6/7/96	KW012	4.4 *J*	4.9 *J*	4.9 *J*	4.9 *J*	1.7 *U*	4.7 *U*	48	3.2 *U*	170	130
KW-14		6/7/96	KW014	5.8 *J*	7.1	7.5 *J*	9 *J*	3 *U*	6.5 *J*	65	4.5 *U*	220	250
KW-15		6/4/96	KW015	3.2 *J*	3.7 *J*	3.5 *U*	3.9 *J*	2.1 *U*	3.8 *U*	45	2.6 *U*	140	79
KW-17		6/7/96	KW017	0.61 *U*	0.64 *U*	1.1 *U*	1.5 *U*	1.7 *U*	1.2 *U*	7.4 *J*	1.3 *U*	29 *J*	12
KW-19		6/4/96	KW019	2.9 *J*	2.3 *U*	3.6 *U*	3.3 *U*	1.4 *U*	2.2 *U*	47	2.3 *U*	150	69
KW-20		6/4/96	KW020	3.9 *J*	2.9 *J*	4 *U*	4.8 *J*	1.4 *U*	3.8 *U*	64	3.4 *U*	180	110
KW-21		6/7/96	KW021	3.4 *J*	4.4 *J*	3.9 *U*	4.1 *J*	1.2 *U*	5 *U*	50	2.9 *U*	160	63
KW-24		6/4/96	KW024	3.2 *J*	3.3 *J*	4.3 *J*	5.4 *J*	2.3 *U*	6.2 *J*	310	4 *U*	270	39
KW-26		6/4/96	KW026	3 *J*	3.7 *J*	3.8 *U*	4 *J*	2.9 *U*	4.1 *U*	36	2.8 *U*	100	51
Moser Bay-Subtidal													
KW-30		6/7/96	KW030	1.1 *U*	1.1 *U*	1.3 *U*	1.1 *U*	1.5 *U*	1.2 *U*	1.2 *U*	1.5 *U*	2.6 *U*	1.2 *U*
1997													
Ward Cove-Subtidal													
SD-2		07/24/97	SD0011	5.1 *U*	7.2 *U*	27 *U*	6.9 *U*	1.9 *U*	8.6 *U*	130	8.7 *U*	320	150
SD-3		07/24/97	SD0012	6	7.6 *U*	23 *U*	8.1	2.8 *U*	8.7	96	5	320	130
SD-4		07/24/97	SD0013	7.7 *U*	13	35 *U*	12	2.7 *U*	13	130	8.2	390	170

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TABLE A1-4. (cont.)

Station	Field Rep.	Date	Sample Number	1,2,3,7,8-PeCDF (ng/kg)	2,3,4,7,8-PeCDF (ng/kg)	1,2,3,4,7,8-HxCDF (ng/kg)	1,2,3,6,7,8-HxCDF (ng/kg)	1,2,3,7,8,9-HxCDF (ng/kg)	2,3,4,6,7,8-HxCDF (ng/kg)	1,2,3,4,6,7,8-HpCDF (ng/kg)	1,2,3,4,7,8,9-HpCDF (ng/kg)	1,2,3,4,6,7,8,9-OCDF (ng/kg)	Total TCDD (ng/kg)
SD-5		08/01/97	SD0014R	4.8 *U*	6 *U*	11 *U*	4.5	2.8 *U*	4.8	46	2.9	140	170
SD-11		07/24/97	SD0008	2 *U*	2.5 *U*	7.1 *U*	3.5 *U*	2.1 *U*	2.8 *U*	31	2.8 *U*	98	74
SD-13		08/01/97	SD0037	2.3 *U*	6.4	17 *U*	6.4	2.9 *U*	6.5	65	4	230	110
SD-13	A	08/01/97	SD0038	3.5	5.6	17 *U*	5.9	2.4 *U*	6	63	3.3	220	110
SD-16		07/29/97	SD0029	1.8 *U*	2.9	7.3 *U*	3.3	2 *U*	2.8	32	2.7 *U*	100	84
SD-18		07/23/97	SD0007	0.72 *U*	0.75 *U*	0.78 *U*	0.73 *U*	1 *U*	0.87 *U*	1.9 *U*	1 *U*	6.8 *U*	2.2
SD-22		07/22/97	SD0001	0.96 *U*	1.5	6 *U*	2	1.6 *U*	2.6	38	2	86	22
SD-23		07/23/97	SD0002	2.5 *U*	2.9 *U*	11 *U*	3.9 *U*	2.4 *U*	4.9 *U*	63	3.7 *U*	170	60
SD-25		07/24/97	SD0009	2.8 *U*	3.7 *U*	13 *U*	4.2 *U*	1.5 *U*	5 *U*	98	3.7 *U*	190	53
SD-27		07/23/97	SD0005	3.8 *U*	4.6 *U*	13 *U*	5.2 *U*	1.8 *U*	5.8 *U*	68	4 *U*	210	100
Moser Bay-Subtidal													
SD-29		07/27/97	SD0022	0.55 *U*	0.58 *U*	0.66 *U*	0.61 *U*	1.5 *U*	0.73 *U*	0.78 *U*	0.98 *U*	2.7 *U*	0.75 *U*
SD-30		07/27/97	SD0023	1.2 *U*	1.3 *U*	0.88 *U*	0.73 *U*	2 *U*	0.94 *U*	2.2	1.5 *U*	3.6 *U*	1.3

TABLE A1-4. (cont.)

Station	Field Rep.	Date	Sample Number	Total PeCDD (ng/kg)	Total HxCDD (ng/kg)	Total HpCDD (ng/kg)	Total OCDD (ng/kg)	Total TCDF (ng/kg)	Total PeCDF (ng/kg)	Total HxCDF (ng/kg)	Total HpCDF (ng/kg)	Total OCDF (ng/kg)
Toxic Equivalent Factors[c]				NA	NA	NA	NA	NA	NA	NA	NA	NA
1996												
Ward Cove-Subtidal												
W02	1	06/01/96	KW002	52	130	890	2,600	83	79	190	150	240
W02	2	06/01/96	KW032	54	120	820	2,600	86	74	210	160	260
W03		06/02/96	KW003	42	120	1,700	3,700	63	78	160	90	130
W04		06/02/96	KW004	140	390	3,100	6,100	150	160	280	180	360
W05		06/01/96	KW005	15	63	640	1,600	38	41	73	49	120
W07		06/02/96	KW007	89	190	960	2,600	160	170	370	190	280
W09		06/02/96	KW009	29	92	650	1,500	48	35	64	150	120
W011		05/30/96	KW011	13	56	360	610	28	18	20	19	38
W013		06/04/96	KW013	13	46	330	1,100	24	15	21	21	67
W016		06/03/96	KW016	11	40	260	610	16	10	23	15	42
W018		05/29/96	KW018	0.78 *U*	0.86 *U*	12	26	0.59 *U*	0.6 *U*	0.86 *U*	3.3	3.8
W022		05/28/96	KW022	4.4	28	270	620	4.8	2.9	17	45	35
W023		05/29/96	KW023	2.4 *U*	33	310	680	4.2 *U*	2.8 *U*	15	16	41
W025		05/30/96	KW025	19	160	1,900	3,900	22	45	140	110	160
W027		05/29/96	KW027	2.0 *U*	10	160	320	3.3 *U*	3.1 *U*	4.1	23	20
1996 Archived												
Ward Cove-Subtidal												
KW-01		6/4/96	KW001	40	150	1000	3100	110	74	110	300	280
KW-06		6/7/96	KW006	73	130	510	2000	100	55	58	170	180
KW-12		6/7/96	KW012	67	120	580	1800	88	51	61	170	170
KW-14		6/7/96	KW014	130	240	960	2700	140	87	95	220	220
KW-15		6/4/96	KW015	46	120	760	2100	54	35	53	160	140
KW-17		6/7/96	KW017	9.4	17 *J*	98	240	5.1	3.9 *U*	15 *U*	24	29 *J*
KW-19		6/4/96	KW019	37	100	790	2100	57	31	53	160	150
KW-20		6/4/96	KW020	51	150	1100	3000	85	49	82	200	180
KW-21		6/7/96	KW021	37	120	960	2600	54	38	75	170	160
KW-24		6/4/96	KW024	18	110	1300	3000	35	35	160	640	270
KW-26		6/4/96	KW026	36	120	930	2100	60	29	60	110	100
Moser Bay-Subtidal												
KW-30		6/7/96	KW030	1 *U*	1.3 *U*	6.8 *J*	20 *U*	1.2 *U*	1.1 *U*	1.2 *U*	1.4 *U*	2.6 *U*
1997												
Ward Cove-Subtidal												
SD-2		07/24/97	SD0011	72	170	1,200	3,700	82	74	170	510	320
SD-3		07/24/97	SD0012	110	280	2,500	5,800	170	86	170	370	230
SD-4		07/24/97	SD0013	160	320	2,500	6,300	230	120	230	510	390

TABLE A1-4. (cont.)

Station	Field Rep.	Date	Sample Number	Total PeCDD (ng/kg)	Total HxCDD (ng/kg)	Total HpCDD (ng/kg)	Total OCDD (ng/kg)	Total TCDF (ng/kg)	Total PeCDF (ng/kg)	Total HxCDF (ng/kg)	Total HpCDF (ng/kg)	Total OCDF (ng/kg)
SD-5		08/01/97	SD0014R	93	130	750	2,100	160	49	84	170	140
SD-11		07/24/97	SD0008	35	85 *J*	460	1,600	46 *J*	29 *J*	39 *J*	110	98
SD-13		08/01/97	SD0037	69	160	830	2,700	77	58	74	250	230
SD-13	A	08/01/97	SD0038	69	170	840	2,800	70	58	74	250	220
SD-16		07/29/97	SD0029	37	99	810	2,000	50	24	47	120	100
SD-18		07/23/97	SD0007	0.75 *U*	3.2 *U*	22 *J*	72 *J*	0.58 *U*	0.73 *U*	1.6 *U*	6.3 *U*	6.8 *U*
SD-22		07/22/97	SD0001	17	69	590	1,800	30	15	50	130	86
SD-23		07/23/97	SD0002	31	140	1,200	3,200	42	27 *J*	76 *J*	220	170
SD-25		07/24/97	SD0009	32	230	2,300	4,600	45 *J*	35 *J*	96	300	190
SD-27		07/23/97	SD0005	51	170	1,200	3,100	82	47 *J*	79 *J*	250	210
Moser Bay-Subtidal												
SD-29		07/27/97	SD0022	0.66 *U*	0.88 *U*	4.3 *J*	11 *J*	1	1.5 *U*	1.3 *U*	0.87 *U*	2.7 *U*
SD-30		07/27/97	SD0023	1.2 *U*	1.4 *U*	11	29	0.93 *U*	1.3 *U*	1.7 *U*	4.4	3.6 *U*

Note: All results are reported on a dry weight basis.

All laboratory replicates are averaged.

HpCDD - heptachlorodibenzo-*p*-dioxin
HpCDF - heptachlorodibenzofuran
HxCDD - hexachlorodibenzo-*p*-dioxin
HxCDF - hexachlorodibenzofuran
OCDD - octachlorodibenzo-*p*-dioxin
OCDF - octachlorodibenzofuran
PeCDD - pentachlorodibenzo-*p*-dioxin
PeCDF - pentachlorodibenzofuran
TCDD - tetrachlorodibenzo-*p*-dioxin
TCDF - tetrachlorodibenzofuran
U - undetected

[a] Detection limits are included in the sum at half their value.

[b] Detection limits excluded from the sum.

[c] Toxic equivalent factors are based on U.S. EPA (1989b).

TABLE A1-5. PULP MILL COMPOUNDS IN SURFACE SEDIMENTS COLLECTED IN 1996

				Chlorinated Phenols							Chlorinated Guaiacols			
Station	Field Rep.	Date	Sample Number	4-Chloro-phenol (mg/kg)	2,4-Dichloro-phenol (mg/kg)	2,6-Dichloro-phenol (mg/kg)	2,4,5-Trichloro-phenol (mg/kg)	2,4,6-Trichloro-phenol (mg/kg)	2,3,4,6-Tetrachloro-phenol (mg/kg)	Penta-chloro-phenol (mg/kg)	4-Chloro-guaiacol (mg/kg)	3,4-Dichloro-guaiacol (mg/kg)	4,5-Dichloro-guaiacol (mg/kg)	4,6-Dichloro-guaiacol (mg/kg)
W02	1	06/01/96	KW002	1.6 *U*	1.6 *U*	1.6 *U*	1.6 *U*	1.6 *U*	1.6 *U*	1.6 *U*	1.6 *U*	1.6 *U*	1.6 *U*	1.6 *U*
W02	2	06/01/96	KW032	1.7 *U*	1.7 *U*	1.7 *U*	1.7 *U*	1.7 *U*	1.7 *U*	1.7 *U*	1.7 *U*	1.7 *U*	1.7 *U*	1.7 *U*
W04		06/02/96	KW004	2.0 *U*	2.0 *U*	2.0 *U*	2.0 *U*	2.0 *U*	2.0 *U*	2.0 *U*	2.0 *U*	2.0 *U*	2.0 *U*	2.0 *U*
W07		06/02/96	KW007	1.9 *U*	1.9 *U*	1.9 *U*	1.9 *U*	1.9 *U*	1.9 *U*	1.9 *U*	1.9 *U*	1.9 *U*	1.9 *U*	1.9 *U*
W09		06/02/96	KW009	2.3 *U*	2.3 *U*	2.3 *U*	2.3 *U*	2.3 *U*	2.3 *U*	2.3 *U*	2.3 *U*	2.3 *U*	2.3 *U*	2.3 *U*
W016		06/03/96	KW016	0.8 *U*	0.8 *U*	0.8 *U*	0.8 *U*	0.8 *U*	0.8 *U*	0.8 *U*	0.8 *U*	0.8 *U*	0.8 *U*	0.8 *U*

TABLE A1-5. (cont.)

				Chlorinated Guaiacols				Chlorinated Catechols						
Station	Field Rep.	Date	Sample Number	3,4,5-Trichloro-guaiacol (mg/kg)	3,4,6-Trichloro-guaiacol (mg/kg)	4,5,6-Trichloro-guaiacol (mg/kg)	Tetrachloro-guaiacol (mg/kg)	4-Chloro-catechol (mg/kg)	3,4-Dichloro-catechol (mg/kg)	3,6-Dichloro-catechol (mg/kg)	4,5-Dichloro-catechol (mg/kg)	3,4,5-Trichloro-catechol (mg/kg)	3,4,6-Trichloro-catechol (mg/kg)	Tetrachloro-catechol (mg/kg)
W02	1	06/01/96	KW002	1.6 *U*	1.6 *U*	1.6 *U*	1.6 *U*	1.6 *UJ*	1.6 *UJ*	1.6 *UJ*	1.6 *UJ*	1.6 *UJ*	1.6 *UJ*	1.6 *UJ*
W02	2	06/01/96	KW032	1.7 *U*	1.7 *U*	1.7 *U*	1.7 *U*	1.7 *UJ*	1.7 *UJ*	1.7 *UJ*	1.7 *UJ*	1.7 *UJ*	1.7 *UJ*	1.7 *UJ*
W04		06/02/96	KW004	2.0 *U*	2.0 *U*	2.0 *U*	2.0 *U*	2.0 *UJ*	2.0 *UJ*	2.0 *UJ*	2.0 *UJ*	2.0 *UJ*	2.0 *UJ*	2.0 *UJ*
W07		06/02/96	KW007	1.9 *U*	1.9 *U*	1.9 *U*	1.9 *U*	1.9 *UJ*	1.9 *UJ*	1.9 *UJ*	1.9 *UJ*	1.9 *UJ*	1.9 *UJ*	1.9 *UJ*
W09		06/02/96	KW009	2.3 *U*	2.3 *U*	2.3 *U*	2.3 *U*	2.3 *UJ*	2.3 *UJ*	2.3 *UJ*	2.3 *UJ*	2.3 *UJ*	2.3 *UJ*	2.3 *UJ*
W016		06/03/96	KW016	0.8 *U*	0.8 *U*	0.8 *U*	0.8 *U*	0.8 *UJ*	0.8 *UJ*	0.8 *UJ*	0.8 *UJ*	0.8 *UJ*	0.8 *UJ*	0.8 *UJ*

TABLE A1-5. (cont.)

				Vanillins			Additional Compounds			Resin Acids and Fatty Acids			
Station	Field Rep.	Date	Sample Number	5-Chloro-vanillin (mg/kg)	6-Chloro-vanillin (mg/kg)	5,6-Dichloro-vanillin (mg/kg)	2-Chloro-syringaldehyde (mg/kg)	2,6-Dichloro-syringaldehyde (mg/kg)	Trichloro-syringol (mg/kg)	Abietic Acid (mg/kg)	Dehydroabietic Acid (mg/kg)	12-Chloro-dehydroabietic Acid (mg/kg)	14-Chloro-dehydroabietic Acid (mg/kg)
W02	1	06/01/96	KW002	1.6 *U*	1.6 *U*	1.6 *U*	1.6 *U*	1.6 *U*	1.6 *U*	65.1 *J*	38.1	3.0	1.5 *U*
W02	2	06/01/96	KW032	1.7 *U*	1.7 *U*	1.7 *U*	1.7 *U*	1.7 *U*	1.7 *U*	84.9 *J*	77.7	5.2	1.7
W04		06/02/96	KW004	2.0 *U*	2.0 *U*	2.0 *U*	2.0 *U*	2.0 *U*	2.0 *U*	45.4 *J*	34.4	4.7	1.7 *U*
W07		06/02/96	KW007	1.9 *U*	1.9 *U*	1.9 *U*	1.9 *U*	1.9 *U*	1.9 *U*	145 *J*	151 *J*	22.4 *J*	23.1 *J*
W09		06/02/96	KW009	2.3 *U*	2.3 *U*	2.3 *U*	2.3 *U*	2.3 *U*	2.3 *U*	27.5 *J*	20.2	2.9	1.8 *U*
W016		06/03/96	KW016	0.8 *U*	0.8 *U*	0.8 *U*	0.8 *U*	0.8 *U*	0.8 *U*	17.5 *J*	11.8 *J*	7.2 *UJ*	7.2 *UJ*

TABLE A1-5. (cont.)

				Resin Acids and Fatty Acids					
Station	Field Rep.	Date	Sample Number	Dichloro-dehydroabietic Acid (mg/kg)	9,10-Dichloro-stearic Acid (mg/kg)	Pimaric Acid (mg/kg)	Isopimaric Acid (mg/kg)	Linoleic Acid (mg/kg)	Oleic/-Linolenic Acid (mg/kg)
W02	1	06/01/96	KW002	1.5 *U*	1.5 *U*	1.5 *U*	6.5	1.5 *U*	7.2
W02	2	06/01/96	KW032	1.6 *J*	1.6 *U*	1.6 *U*	8.9	1.6 *U*	17.6
W04		06/02/96	KW004	2.1 *J*	1.7 *U*	1.7 *U*	6.2	1.7 *U*	21.0
W07		06/02/96	KW007	14.1 *J*	6.5 *U*	6.5 *U*	22.0 *J*	6.5 *U*	79.2 *J*
W09		06/02/96	KW009	1.8 *U*	1.8 *U*	1.8 *U*	4.3	1.8 *U*	10.0
W016		06/03/96	KW016	7.2 *UJ*	7.2 *UJ*	7.2 *UJ*	7.2 *UJ*	7.2 *UJ*	7.2 *UJ*

Note: All results reported on a dry weight basis.
All laboratory replicates are averaged.

J - estimated
U - undetected

TABLE A1-6. CONVENTIONAL ANALYTES IN SUBSURFACE SEDIMENTS COLLECTED IN 1997

Station	Field rep.	Date	Sample Number	Upper Depth (in.)	Lower Depth (in.)	Ammonia-nitrogen (mg/kg)	Sulfides (mg/kg)	Total Organic Carbon (percent)	Biological Oxygen Demand (mg/kg)	Chemical Oxygen Demand (mg/kg)	Particles Greater Than 2.0 mm (percent)	Particles 2.0 mm to 1.0 mm (percent)	Particles 1.0 mm to 0.5 mm (percent)	Particles 0.5 mm to 0.25 mm (percent)
Organic-rich Horizons														
SD-1		8/5/97	SD0045A	0	39	770	5,200	39.4	7,850	10,000	25.5	12.8	11.9	10
SD-1		8/5/97	SD0045B	39	79	1,400	2,900	39.5	8,070	10,000	18.8	11.9	13.7	11
SD-1		8/5/97	SD0045C	79	102	1,400	3,700	35	10,800	11,000	3.6	4.6	6.4	9.4
SD-2		8/6/97	SD0050A	0	39	46	3,800	38.8	3,580	7,300	25.2	9.6	7.4	6.6
SD-2		8/6/97	SD0050B	39	79	220	3,700	38.5	7,490	1,300	35.9	13.3	9.5	4.9
SD-2		8/6/97	SD0050C	79	102	70	1,300	35.9	9,840	30,000	40.6	10	5.3	3.4
SD-3		8/5/97	SD0043A	0	39	880	1,900	29.9	5,240	7,800	3	4.1	7.4	11.7
SD-4		8/6/97	SD0054A	0	39	370	7,700	31.2	13,500	5,400	2.8	2.4	5.1	7
SD-4		8/6/97	SD0054B	39	72	480	4,700	28.9	9,110	10,000	0.7	2.3	5.6	9.8
SD-5		8/5/97	SD0044A	0	39	5.7	3,000	39.1	5,740	5,400	41.6	11.2	10.2	12.3
SD-5		8/5/97	SD0044B	39	70	1.6	1,700	33.6	4,080	5,200	60.7	6.9	6.4	5.8
SD-6		8/6/97	SD0051A	0	39	1,600	3,600	34.2	120,000	140,000	7.4	5.6	5.8	7.7
SD-6		8/6/97	SD0051B	39	79	2,800	3,500	35.1	71,000	75,000	4.6	3.7	4.5	7
SD-6		8/6/97	SD0051C	79	105	4,200	4,000	32.7	23,200	24,000	14	10.2	10.9	9.9
SD-7		8/5/97	SD0046A	0	39	340	[a]	20.1	5,030	8,300	2.1	2.4	3.8	6.2
SD-8		8/6/97	SD0052A	0	39	430	2,300	28.1	8,410	9,400	0.5	1.5	2.4	8
SD-8		8/6/97	SD0052B	39	48	480	1,500	26.1	4,480	9,500	3.3	5	9.3	13.6
SD-9		8/6/97	SD0053A	0	39	27	2,100	35.9	5,000	7,400	14.5	6.5	15.2	20.9
SD-9		8/6/97	SD0053B	39	79	6.5	720	39.2	3,730	4,800	7.4	13.1	33.1	37.2
SD-9		8/6/97	SD0053C	79	115	18	1,600	38.7	5,550	7,600	3.1	5.8	19	35.4
SD-12		8/8/97	SD0061A	0	39	500	990	27.6	5,840	16,000	18.75	8.38	8.82	11.33
SD-12		8/8/97	SD0061B	39	56	620	290	23.5	5,350	8,200	31.4	6	4.8	8
SD-12	A	8/8/97	SD0062A	0	39	690	2,800	23.8	7,660	8,000	9.2	4.8	8	15.1
SD-12	A	8/8/97	SD0062B	39	56	490	1,900	24.2	4,100	8,000	4.3	5.4	4.7	9.5
SD-13		8/6/97	SD0055A	0	39	330	2,400	18.3	5,500	6,200	6.3	3.8	4.2	7.8
SD-13		8/6/97	SD0055B	39	57	220	370	10.1	2,970	6,000	1.4	1.3	1.3	2.7
SD-16		8/8/97	SD0063A	0	39	58	26,000	23.8	38,600	13,000	16.6	5.4	7.7	11.4
SD-16		8/8/97	SD0063B	39	79	35	8,000	35.2	9,520	7,400	15.1	3.2	4.6	11.1
SD-16		8/8/97	SD0063C	79	91	40	55,000	37.1	21,900	7,000	26.8	8.2	9.4	14.8
SD-33		8/7/97	SD0056A	0	39	63	3,500	22.6	19,700	3,900	5.8	7.6	11.7	16.7
SD-33		8/7/97	SD0056B	39	57	210	2,500	18.6	8,960	4,800	33.7	4.6	5.1	9.3
SD-36		8/8/97	SD0057A	0	22	13	740	23.4	2,990	4,300	2.2	1.7	3.1	8.4
SD-41		8/7/97	SD0059A	0	34	26	2,300	24.1	3,710	5,000	6.5	4.8	4.3	9
Native Horizons														
SD-7		8/5/97	SD0046B	39	51	110	340	4.39	1,180	2,000	10.5	6.6	4.0	3.4
SD-7		8/5/97	SD0046C	82	110	19 *J*	3.3 *J*	0.36	200 *UJ*	204 *J*	1.1	1.7	2.1	2.7
SD-41		8/7/97	SD0059B	44	47	8.6 *J*	765 *J*	2.45	877 *J*	1,350 *J*	36.7	6.0	5.5	8.3
SD-49		8/6/97	SD0049A	4	16	180		11.8	2,130	5,400	0.1	0.3	0.5	3.5

TABLE A1-6. (cont.)

Station	Field rep.	Date	Sample Number	Particles 0.25 mm to 0.125 mm (percent)	Particles 0.125 mm to 0.062 mm (percent)	Particles 0.062 mm to 0.004 mm (percent)	Particles less than 0.004 mm (percent)	Percent Fines (Particles less than 0.062 mm) (percent)	Total Solids (percent)
Organic-rich Horizons									
SD-1		8/5/97	SD0045A	4.3	3	13.6	21.8	35.4	15
SD-1		8/5/97	SD0045B	4.9	2.6	17.9	21.7	39.6	16.2
SD-1		8/5/97	SD0045C	7.9	7.7	35.5	27.8	63.3	14.9
SD-2		8/6/97	SD0050A	3.5	2.8	12.6	15.9	28.5	20.1
SD-2		8/6/97	SD0050B	2.4	1.7	11.3	18.4	29.7	18.4
SD-2		8/6/97	SD0050C	1.7	1.2	13.5	18.1	31.6	17.5
SD-3		8/5/97	SD0043A	13.1	11.5	26.9	25.1	52	17.1
SD-4		8/6/97	SD0054A	11.1	12.5	36.9	22.4	59.3	16.9
SD-4		8/6/97	SD0054B	10.3	11.1	37.5	21.4	58.9	17.4
SD-5		8/5/97	SD0044A	6.2	3.7	12	14.7	26.7	20.8
SD-5		8/5/97	SD0044B	3.2	1.8	4.8	12.4	17.2	19.2
SD-6		8/6/97	SD0051A	7.6	9.4	20.1	36.7	56.8	11.1
SD-6		8/6/97	SD0051B	5.4	5.1	35.2	35.9	71.1	11.5
SD-6		8/6/97	SD0051C	6.2	4.6	18.7	30.6	49.3	11.4
SD-7		8/5/97	SD0046A	7.9	18.2	60.5	26.8	87.3	18
SD-8		8/6/97	SD0052A	13.1	12.9	36.7	25.4	62.1	17
SD-8		8/6/97	SD0052B	10.1	9.5	27.7	22.9	50.6	20
SD-9		8/6/97	SD0053A	7.6	4.2	20.1	14.6	34.7	19.3
SD-9		8/6/97	SD0053B	7.5	2.1	4.8	12.7	17.5	20.8
SD-9		8/6/97	SD0053C	10.6	5.3	11.4	15.3	26.7	19.1
SD-12		8/8/97	SD0061A	7.88	4.9	25.8	17.2	43	18.6
SD-12		8/8/97	SD0061B	10.2	7.6	30.6	21.3	51.9	20.5
SD-12	A	8/8/97	SD0062A	10.5	7.8	26.3	22.6	48.9	14.5
SD-12	A	8/8/97	SD0062B	10.4	7.6	32.1	20.4	52.5	17.7
SD-13		8/6/97	SD0055A	5.8	5.7	47.6	19.8	67.4	20.3
SD-13		8/6/97	SD0055B	3.2	8.4	58.8	23.2	82	27
SD-16		8/8/97	SD0063A	5.8	4.3	31	17.3	48.3	16.1
SD-16		8/8/97	SD0063B	10.5	10.4	26.1	13.2	39.3	22.7
SD-16		8/8/97	SD0063C	11.6	7.9	17.7	8.9	26.6	27.8
SD-33		8/7/97	SD0056A	12.8	9.4	19.5	9.6	29.1	27.6
SD-33		8/7/97	SD0056B	10.1	6.3	21.1	8.9	30	26.6
SD-36		8/8/97	SD0057A	18.7	24.2	31.3	11.3	42.6	29.9
SD-41		8/7/97	SD0059A	10.5	11.6	33.6	15.2	48.8	25.6
Native Horizons									
SD-7		8/5/97	SD0046B	4.4	18.6	44.2	13.3	57.5	43.2
SD-7		8/5/97	SD0046C	3.8	12.4	51.9	23.8	75.7	68.2
SD-41		8/7/97	SD0059B	12.8	13.8	15.6	5.7	21.3	63.3
SD-49		8/6/97	SD0049A	7.3	9.5	68.9	30.2	99.1	23

Note: All laboratory replicates are averaged.
U - undetected

[a] Laboratory did not perform analysis as requested.

TABLE A1-7. METALS IN SUBSURFACE SEDIMENTS COLLECTED IN 1997

Station	Field rep.	Date	Sample Number	Upper Depth (in.)	Lower Depth (in.)	Cadmium (mg/kg)	Total Mercury (mg/kg)	Zinc (mg/kg)
Organic-rich Horizons								
SD-1		8/5/97	SD0045A	0	39	2.01	0.2 *U*	103
SD-1		8/5/97	SD0045B	39	79	1.53	0.2 *U*	89.7
SD-1		8/5/97	SD0045C	79	102	2.18	0.3	116
SD-2		8/6/97	SD0050A	0	39	1.07	0.2 *U*	122
SD-2		8/6/97	SD0050B	39	79	1.93	0.2 *U*	140
SD-2		8/6/97	SD0050C	79	102	1.21	0.2 *U*	123
SD-3		8/5/97	SD0043A	0	39	2.12	0.2 *U*	98
SD-4		8/6/97	SD0054A	0	39	1.77	0.7	141
SD-4		8/6/97	SD0054B	39	72	1.58	0.2	94.2
SD-5		8/5/97	SD0044A	0	39	0.93	0.2 *U*	86.6
SD-5		8/5/97	SD0044B	39	70	0.36	0.2 *U*	50.2
SD-6		8/6/97	SD0051A	0	39	2.05	0.2 *U*	85.6
SD-6		8/6/97	SD0051B	39	79	2.26	0.2 *U*	110
SD-6		8/6/97	SD0051C	79	105	2.69	0.2 *U*	164
SD-7		8/5/97	SD0046A	0	39	2.93	0.2 *U*	100
SD-8		8/6/97	SD0052A	0	39	4.28	0.3	160
SD-8		8/6/97	SD0052B	39	48	2.12	0.2 *U*	99.7
SD-9		8/6/97	SD0053A	0	39	1.88	0.2 *U*	224
SD-9		8/6/97	SD0053B	39	79	0.43	0.2 *U*	74
SD-9		8/6/97	SD0053C	79	115	0.51	0.2 *U*	34.9
SD-12		8/8/97	SD0061A	0	39	3.6	0.2 *U*	158
SD-12		8/8/97	SD0061B	39	56	3.54	0.5	199
SD-12	A	8/8/97	SD0062A	0	39	4.1	0.2 *U*	142
SD-12	A	8/8/97	SD0062B	39	56	3.04	0.4	150
SD-13		8/6/97	SD0055A	0	39	2.56	0.2	97.8
SD-13		8/6/97	SD0055B	39	57	1.86	0.2 *U*	81.5
SD-16		8/8/97	SD0063A	0	39	2.13	0.2 *U*	91.7
SD-16		8/8/97	SD0063B	39	79	1.78	0.2 *U*	187
SD-16		8/8/97	SD0063C	79	91	1.57	0.2 *U*	171
SD-33		8/7/97	SD0056A	0	39	0.92	0.2 *U*	126
SD-33		8/7/97	SD0056B	39	57	1.13	0.2 *U*	124
SD-36		8/8/97	SD0057A	0	22	1.98	0.2 *U*	143
SD-41		8/7/97	SD0059A	0	34	2.18	0.2 *U*	156
Native Horizons								
SD-7		8/5/97	SD0046B	39	51	0.62	0.2 *U*	56.8
SD-7		8/5/97	SD0046C	82	110	0.11	0.2 *U*	68.2
SD-41		8/7/97	SD0059B	44	47	0.47	0.2 *U*	67.7
SD-49		8/6/97	SD0049A	4	16	3.38	0.2 *U*	96.3

Note: All results are reported on a dry weight basis.

All laboratory replicates are averaged following Rule Set 2.

U - undetected

TABLE A1-8. PHENOLS IN SUBSURFACE SEDIMENTS COLLECTED IN 1997

Station	Field rep.	Date	Sample Number	Upper Depth (in.)	Lower Depth (in.)	Phenols: Phenol (µg/kg)	Phenols: 4-Methyl-phenol[a] (µg/kg)
Organic-rich Horizons							
SD-1		8/5/97	SD0045A	0	39	1,600 *J*	42,000 *J*
SD-1		8/5/97	SD0045B	39	79	1,800 *J*	46,000 *J*
SD-1		8/5/97	SD0045C	79	102	1,000	39,000
SD-2		8/6/97	SD0050A	0	39	560 *J*	12,000 *J*
SD-2		8/6/97	SD0050B	39	79	1,400 *J*	21,000 *J*
SD-2		8/6/97	SD0050C	79	102	700 *J*	9,100 *J*
SD-3		8/5/97	SD0043A	0	39	96	900
SD-4		8/6/97	SD0054A	0	39	86 *J*	2,300 *J*
SD-4		8/6/97	SD0054B	39	72	120	3,300
SD-5		8/5/97	SD0044A	0	39	300	1,200
SD-5		8/5/97	SD0044B	39	70	110	670
SD-6		8/6/97	SD0051A	0	39	4,700 *J*	78,000 *J*
SD-6		8/6/97	SD0051B	39	79	3,700 *J*	67,000 *J*
SD-6		8/6/97	SD0051C	79	105	1,000	26,000
SD-7		8/5/97	SD0046A	0	39	110	1,500
SD-8		8/6/97	SD0052A	0	39	340	4,900
SD-8		8/6/97	SD0052B	39	48	210	2,800
SD-9		8/6/97	SD0053A	0	39	1,100	1,800
SD-9		8/6/97	SD0053B	39	79	210	320
SD-9		8/6/97	SD0053C	79	115	490	420
SD-12		8/8/97	SD0061A	0	39	430	7,300
SD-12		8/8/97	SD0061B	39	56	280	6,200
SD-12	A	8/8/97	SD0062A	0	39	410	15,000
SD-12	A	8/8/97	SD0062B	39	56	380	11,000
SD-13		8/6/97	SD0055A	0	39	54	7,600
SD-13		8/6/97	SD0055B	39	57	90	2,200
SD-16		8/8/97	SD0063A	0	39	500	470
SD-16		8/8/97	SD0063B	39	79	140	490
SD-16		8/8/97	SD0063C	79	91	56	370
SD-33		8/7/97	SD0056A	0	39	450	3,700
SD-33		8/7/97	SD0056B	39	57	190	1,600
SD-36		8/8/97	SD0057A	0	22	110	550
SD-41		8/7/97	SD0059A	0	34	140	180
Native Horizons							
SD-7		8/5/97	SD0046B	39	51	43	350
SD-7		8/5/97	SD0046C	82	110	10 *U*	10 *U*
SD-41		8/7/97	SD0059B	44	47	10	10 *U*
SD-49		8/6/97	SD0049A	4	16	150	220

Note: All results are reported on a dry weight basis.

All laboratory replicates are averaged.

J - estimated

U - undetected

[a] 3- and 4-methylphenol results were quantified as 4-methylphenol.

TABLE A1-9. DIOXINS AND FURANS IN COMPOSITE SUBSURFACE SEDIMENT SAMPLES COLLECTED IN 1997

Station	Field Rep.	Date	Sample Number	Dioxin and Furan Toxic Equivalent Concentration[a] (ng/kg)	Dioxin and Furan Toxic Equivalent Concentration[b] (ng/kg)	2,3,7,8-TCDD (ng/kg)	1,2,3,7,8-PeCDD (ng/kg)	1,2,3,4,7,8-HxCDD (ng/kg)	1,2,3,6,7,8-HxCDD (ng/kg)	1,2,3,7,8,9-HxCDD (ng/kg)	1,2,3,4,6,7,8-HpCDD (ng/kg)	1,2,3,4,6,7,8,9-OCDD (ng/kg)
Toxic Equivalent Factors[c]				NA	NA	1.0	0.5	0.1	0.1	0.1	0.01	0.001
Composite Cores[d]												
SD-A		8/6/97	SD0200	5.1	2.9	1.3 *U*	1.6 *U*	1.7 *U*	4.6	3.3 *J*	86	670
SD-B		8/6/97	SD0201	4.6	3.2	0.7 *U*	1.6 *U*	1.3	3.7	2.3 *U*	72	580
SD-C		8/7/97	SD0202	4.3	2.8	1 *U*	1.4 *U*	1.3	3.6	2.2 *U*	62	510
SD-D		8/8/97	SD0203	4.6	3.3	0.7 *U*	1.4 *U*	1.5	4.7	3 *J*	74	530
SD-E		8/8/97	SD0204	2.7	1.4	0.6 *U*	0.96 *U*	1	2	1.6 *U*	49	390

TABLE A1-9. (cont.)

Station	Field Rep.	Date	Sample Number	2,3,7,8-TCDF (ng/kg)	1,2,3,7,8-PeCDF (ng/kg)	2,3,4,7,8-PeCDF (ng/kg)	1,2,3,4,7,8-HxCDF (ng/kg)	1,2,3,6,7,8-HxCDF (ng/kg)	1,2,3,7,8,9-HxCDF (ng/kg)	2,3,4,6,7,8-HxCDF (ng/kg)	1,2,3,4,6,7,8-HpCDF (ng/kg)	1,2,3,4,7,8,9-HpCDF (ng/kg)
Toxic Equivalent Factors[c]				0.1	0.05	0.5	0.1	0.1	0.1	0.1	0.01	0.01
Composite Cores[d]												
SD-A		8/6/97	SD0200	4.3 *U*	1.3 *U*	1.4 *U*	6.7 *U*	1.9 *U*	1.8 *U*	2.1	29	2.2
SD-B		8/6/97	SD0201	4.7 *U*	0.89	1.6	5.2 *U*	1.9	0.63 *U*	1.7	18	0.82 *U*
SD-C		8/7/97	SD0202	3.2 *U*	0.66	1.2	4.7 *U*	1.9	1.6 *U*	1.5	17	1.5
SD-D		8/8/97	SD0203	4.5 *U*	0.93 *U*	1.5	3.2 *U*	1.5	1.7 *U*	1.5 *U*	18	1.5 *U*
SD-E		8/8/97	SD0204	3.1 *U*	0.86 *U*	0.87 *U*	2 *U*	0.88	1.6 *U*	0.91 *U*	14	1.2 *U*

TABLE A1-9. (cont.)

Station	Field Rep.	Date	Sample Number	1,2,3,4,6,7,8,9-OCDF (ng/kg)	Total TCDD (ng/kg)	Total PeCDD (ng/kg)	Total HxCDD (ng/kg)	Total HpCDD (ng/kg)	Total OCDD (ng/kg)	Total TCDF (ng/kg)	Total PeCDF (ng/kg)	Total HxCDF (ng/kg)	Total HpCDF (ng/kg)	Total OCDF (ng/kg)
Toxic Equivalent Factors[c]				0.001	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Composite Cores[d]														
SD-A		8/6/97	SD0200	41	46	20	35	190	670	23	17	39	100	41
SD-B		8/6/97	SD0201	39	61	14	38	180	580	20	15	32	62	39
SD-C		8/7/97	SD0202	46	43	4.4 *J*	19	150	510	8.8	10	27	61	46
SD-D		8/8/97	SD0203	30	57	21	44	180	530	23	15	24	54	30
SD-E		8/8/97	SD0204	33	17	7.9	17	120	390	7.7	4.1	14	45	33

Note: All results are reported on a dry weight basis.
All laboratory replicates are averaged.
HpCDD - heptachlorodibenzo-*p*-dioxin
HpCDF - heptachlorodibenzofuran
HxCDD - hexachlorodibenzo-*p*-dioxin
HxCDF - hexachlorodibenzofuran
OCDD - octachlorodibenzo-*p*-dioxin
OCDF - octachlorodibenzofuran
PeCDD - pentachlorodibenzo-*p*-dioxin
PeCDF - pentachlorodibenzofuran
TCDD - tetrachlorodibenzo-*p*-dioxin
TCDF - tetrachlorodibenzofuran
J - estimated
U - undetected

[a] Detection limits are included in the sum at half their value.
[b] Detection limits are excluded from the sum.
[c] Toxic equivalent factors are based on U.S. EPA (1989c).
[d] Samples for dioxin analysis were composited from two to four stations, consistent with the field sampling plan (PTI 1997f).
See Table C-2 in Appendix C for interval depths.
SD0200 - composited from Stations 1, 2, and 6.
SD0201 - composited from Stations 7, 8, and 9.
SD0202 - composited from Stations 3, 4, 5, and 33.
SD0203 - composited from Stations 12 and 13.
SD0204 - composited from Stations 16, 36 and 41.

TABLE A1-10. CESIUM-137 AND LEAD-210 IN SUBSURFACE SEDIMENTS COLLECTED IN 1997

Station	Date	Sample Number	Upper Depth (cm)	Lower Depth (cm)	Cesium-137 (dpm/g)	Lead-210 (dpm/g)
SD-40	8/6/97	SD0101	2	4	0.528	2.643
SD-40	8/6/97	SD0103	6	8	1.16	2.806
SD-40	8/6/97	SD0105	10	12	1.3	3.002
SD-40	8/6/97	SD0107	14	16	1.1	2.946
SD-40	8/6/97	SD0109	18	20	0.762	2.832
SD-40	8/6/97	SD0110	20	22		2.461
SD-40	8/6/97	SD0111	22	24		1.38
SD-40	8/6/97	SD0112	24	26		0.735
SD-40	8/6/97	SD0113	26	28	0.0397	0.469
SD-40	8/6/97	SD0114	28	30	0.09 *U*	
SD-40	8/6/97	SD0115	30	32	0.037	
SD-40	8/6/97	SD0116	32	34		0.509
SD-40	8/6/97	SD0117	34	36	0.07 *U*	0.635
SD-40	8/6/97	SD0121	42	44	0.035 *U*	0.965
SD-40	8/6/97	SD0125	50	52	0.078 *U*	0.456
SD-40	8/6/97	SD0129	58	60	0.11 *U*	0.526
SD-40	8/6/97	SD0135	70	72	0.14 *U*	0.395
SD-49	8/6/97	SD0137	0	2		8.37
SD-49	8/6/97	SD0138	2	4	0.626	8.099
SD-49	8/6/97	SD0139	4	6	0.88	7.441
SD-49	8/6/97	SD0140	6	8	0.911	5.534
SD-49	8/6/97	SD0141	8	10	0.64	4.917
SD-49	8/6/97	SD0142	10	12	0.5 *U*	2.272
SD-49	8/6/97	SD0143	12	14	0.41 *U*	3.072
SD-49	8/6/97	SD0144	14	16	0.14 *U*	3.165
SD-49	8/6/97	SD0145	16	18		3.182
SD-49	8/6/97	SD0146	18	20	0.37 *U*	2.408
SD-49	8/6/97	SD0147	20	22		2.048
SD-49	8/6/97	SD0148	22	24		2.427
SD-49	8/6/97	SD0149	24	26		2.194
SD-49	8/6/97	SD0150	26	28	0.565	1.436
SD-49	8/6/97	SD0152	30	32		1.034
SD-49	8/6/97	SD0154	34	36	0.28 *U*	0.851
SD-49	8/6/97	SD0158	42	44	0.27 *U*	0.741
SD-49	8/6/97	SD0164	54	58	0.27 *U*	0.539
SD-49	8/6/97	SD0168	62	64	0.41 *U*	0.563
SD-49	8/6/97	SD0172	70	72	0.53 *U*	0.496

Note: All results are reported on a dry weight basis.
dpm - disintegrations per minute
U - undetected

TABLE A1-11. AMMONIA-NITROGEN IN BOTTOM WATER SAMPLES COLLECTED IN 1997

Station	Date	Sample Number	Sample type	Ammonia-nitrogen whole (mg/L)
SD-2	8/8/97	SW0003	BOTTOM WATER	0.17
SD-8	8/8/97	SW0004	BOTTOM WATER	0.25
SD-16	8/8/97	SW0005	BOTTOM WATER	0.12
SD-41	8/8/97	SW0006	BOTTOM WATER	0.25

TABLE A1-12. CONVENTIONAL ANALYTES IN COMPOSITE ELUTRIATE SAMPLES COLLECTED IN 1997 FOR TESTING OF ENGINEERING PROPERTIES

Sample Number	Station	Date	Sample ID	Sample type	Ammonia-nitrogen whole (mg/L)	Total organic carbon whole (mg/L)	Total organic carbon dissolved (mg/L)
SW0001	Stations 1 and 7 (composite)	8/3/97	COMP1MET	ELUTRIATE	29	170	
SW0001.1	Stations 1 and 7 (composite)	8/3/97	COMP1DRET	ELUTRIATE	3.48	49	
SW0002	Stations 3 and 5 (composite)	8/5/97	COMP2DRET	ELUTRIATE	1.2	13.6	2
SW0002.1	Stations 3 and 5 (composite)	8/5/97	COMP2MET	ELUTRIATE	7.1	48	
WATERQC	WATERQC	8/3/97	WATERQC	SURFWATER	0.34	1.1	0.9

TABLE A1-13. METALS IN COMPOSITE ELUTRIATE SAMPLES COLLECTED IN 1997 FOR TESTING OF ENGINEERING PROPERTIES

Station	Date	Sample Number	Sample ID	Cadmium dissolved (µg/L)	Cadmium whole (µg/L)	Total Mercury dissolved (µg/L)	Total Mercury whole (µg/L)	Zinc dissolved (µg/L)	Zinc whole (µg/L)
Stations 1 and 7 (composite)	8/3/97	SW0001	COMP1MET	4 *U*	4 *U*	0.5 *U*	0.5 *U*	24	58
Stations 1 and 7 (composite)	8/3/97	SW0001.1	COMP1DRET	4 *U*	4 *U*	0.5 *U*	0.5 *U*	17	70
Stations 3 and 5 (composite)	8/5/97	SW0002	COMP2DRET	4 *U*	4 *U*	0.5 *U*	0.5 *U*	11	26
Stations 3 and 5 (composite)	8/5/97	SW0002.1	COMP2MET	4 *U*	4 *U*	0.5 *U*	0.5 *U*	18	86
WATERQC	8/3/97	WATERQC	WATERQC	4 *U*	4 *U*	0.5 *U*	0.5 *U*	23	24

Note: *U* - undetected

TABLE A1-14. PHENOLS IN COMPOSITE ELUTRIATE SAMPLES COLLECTED IN 1997 FOR TESTING OF ENGINEERING PROPERTIES

				Phenol		4-Methylphenol[a]	
Station	Date	Sample Number	Sample ID	dissolved (μg/L)	whole (μg/L)	dissolved (μg/L)	whole (μg/L)
Stations 1 and 7 (composite)	8/3/97	SW0001	COMP1MET	3.9	4.4	0.5 *U*	0.5 *U*
Stations 1 and 7 (composite)	8/3/97	SW0001.1	COMP1DRET	1.2	0.8	0.5 *U*	0.8
Stations 3 and 5 (composite)	8/5/97	SW0002	COMP2DRET	0.2 *U*	0.2 *U*	0.2 *UJ*	0.3 *J*
Stations 3 and 5 (composite)	8/5/97	SW0002.1	COMP2MET	0.5 *U*	0.5 *U*	0.5 *U*	0.5 *U*
WATERQC	8/3/97	WATERQC	WATERQC	0.2 *UJ*	0.2 *U*	0.2 *UJ*	0.2 *UJ*

Note: *J* - estimated
U - undetected

[a] 3- and 4-methylphenol results were quantified as 4-methylphenol.

TABLE A1-15. DIOXINS AND FURANS IN COMPOSITE ELUTRIATE SAMPLES COLLECTED IN 1997 FOR TESTING OF ENGINEERING PROPERTIES

Station	Date	Sample Number	Sample ID	2,3,7,8-TCDD dissolved (pg/L)	2,3,7,8-TCDD whole (pg/L)	1,2,3,7,8-PeCDD dissolved (pg/L)	1,2,3,7,8-PeCDD whole (pg/L)	1,2,3,4,7,8-HxCDD dissolved (pg/L)	1,2,3,4,7,8-HxCDD whole (pg/L)	1,2,3,6,7,8-HxCDD dissolved (pg/L)	1,2,3,6,7,8-HxCDD whole (pg/L)
Stations 1 and 7 (composite)	8/3/97	SW0001	COMP1MET	2.5 *U*	5.1 *U*	2.9 *U*	3 *U*	2.5	3.4 *U*	5.7	8.6
Stations 1 and 7 (composite)	8/3/97	SW0001.1	COMP1DRET	3.5 *U*	3.1 *U*	2.7 *U*	3.1 *U*	3.3 *U*	4.4 *U*	3.1 *U*	4.1 *U*
Stations 3 and 5 (composite)	8/5/97	SW0002	COMP2DRET	1.8 *U*	2.3 *U*	2.3 *U*	3.4 *U*	2.7 *U*	4.1 *U*	2.5 *U*	3.9 *U*
Stations 3 and 5 (composite)	8/5/97	SW0002.1	COMP2MET	3.1 *U*	4.7 *U*	2.8 *U*	4.7 *U*	3.8 *U*	6.5 *U*	3.6 *U*	6.1 *U*
WATERQC	8/3/97	WATERQC	WATERQC	3.8 *U*	2 *U*	3.9 *U*	3.2 *U*	3.8 *U*	3.2 *U*	3.5 *U*	3 *U*

TABLE A1-15. (cont.)

Station	Date	Sample Number	Sample ID	1,2,3,7,8,9-HxCDD dissolved (pg/L)	1,2,3,7,8,9-HxCDD whole (pg/L)	1,2,3,4,6,7,8-HpCDD dissolved (pg/L)	1,2,3,4,6,7,8-HpCDD whole (pg/L)	1,2,3,4,6,7,8,9-OCDD dissolved (pg/L)	1,2,3,4,6,7,8,9-OCDD whole (pg/L)	2,3,7,8-TCDF dissolved (pg/L)
Stations 1 and 7 (composite)	8/3/97	SW0001	COMP1MET	3.2 *U*	4.1	120	230	1,200	2,200	10 *U*
Stations 1 and 7 (composite)	8/3/97	SW0001.1	COMP1DRET	3.3 *U*	4.4 *U*	16	58	170	660	2.4 *U*
Stations 3 and 5 (composite)	8/5/97	SW0002	COMP2DRET	2.7 *U*	4.1 *U*	49	44	490	440	1.9 *U*
Stations 3 and 5 (composite)	8/5/97	SW0002.1	COMP2MET	3.8 *U*	6.5 *U*	85	140	950	1,400	2.5 *U*
WATERQC	8/3/97	WATERQC	WATERQC	3.7 *U*	3.2 *U*	4.4 *U*	4.1 *U*	8.2 *U*	7.8 *U*	2.7 *U*

TABLE A1-15. (cont.)

Station	Date	Sample Number	Sample ID	2,3,7,8-TCDF whole (pg/L)	1,2,3,7,8-PeCDF dissolved (pg/L)	1,2,3,7,8-PeCDF whole (pg/L)	2,3,4,7,8-PeCDF dissolved (pg/L)	2,3,4,7,8-PeCDF whole (pg/L)	1,2,3,4,7,8-HxCDF dissolved (pg/L)	1,2,3,4,7,8-HxCDF whole (pg/L)	1,2,3,6,7,8-HxCDF dissolved (pg/L)
Stations 1 and 7 (composite)	8/3/97	SW0001	COMP1MET	22 *U*	2.6 *U*	3.1 *U*	2.6 *U*	3.2 *U*	13 *U*	19 *U*	4.4
Stations 1 and 7 (composite)	8/3/97	SW0001.1	COMP1DRET	2.8 *U*	2.9 *U*	3.1 *U*	3 *U*	3.1 *U*	3.9 *U*	6.5 *U*	3.2 *U*
Stations 3 and 5 (composite)	8/5/97	SW0002	COMP2DRET	2.4 *U*	2.5 *U*	3.2 *U*	2.5 *U*	3.2 *U*	3.6 *U*	3.6 *U*	2.2 *U*
Stations 3 and 5 (composite)	8/5/97	SW0002.1	COMP2MET	3.2 *U*	2.7 *U*	4.2 *U*	2.8 *U*	4.3 *U*	6.6 *U*	10 *U*	3.5 *U*
WATERQC	8/3/97	WATERQC	WATERQC	1.9 *U*	3.8 *U*	2 *U*	3.9 *U*	2.1 *U*	3.3 *U*	3.4 *U*	2.7 *U*

TABLE A1-15. (cont.)

Station	Date	Sample Number	Sample ID	1,2,3,6,7,8-HxCDF whole (pg/L)	1,2,3,7,8,9-HxCDF dissolved (pg/L)	1,2,3,7,8,9-HxCDF whole (pg/L)	2,3,4,6,7,8-HxCDF dissolved (pg/L)	2,3,4,6,7,8-HxCDF whole (pg/L)	1,2,3,4,6,7,8-HpCDF dissolved (pg/L)	1,2,3,4,6,7,8-HpCDF whole (pg/L)	1,2,3,4,7,8,9-HpCDF dissolved (pg/L)
Stations 1 and 7 (composite)	8/3/97	SW0001	COMP1MET	4.9	4.8 *U*	4 *U*	3.1 *U*	3.2	68	110	5.6
Stations 1 and 7 (composite)	8/3/97	SW0001.1	COMP1DRET	3.4 *U*	5.1 *U*	5.6 *U*	4.1 *U*	4.4 *U*	8	33	4.8 *U*
Stations 3 and 5 (composite)	8/5/97	SW0002	COMP2DRET	3 *U*	4.8 *U*	4.2 *U*	2.8 *U*	3.9 *U*	17	17	3.6 *U*
Stations 3 and 5 (composite)	8/5/97	SW0002.1	COMP2MET	3.8 *U*	5.2 *U*	8.9 *U*	4.5 *U*	4.9 *U*	36	60	4.8 *U*
WATERQC	8/3/97	WATERQC	WATERQC	2.8 *U*	5.5 *U*	5.1 *U*	3.4 *U*	3.6 *U*	5.3	3.2 *U*	3.9 *U*

TABLE A1-15. (cont.)

Station	Date	Sample Number	Sample ID	1,2,3,4,7,8,9-HpCDF whole (pg/L)	1,2,3,4,6,7,8,9-OCDF dissolved (pg/L)	1,2,3,4,6,7,8,9-OCDF whole (pg/L)	Total TCDD dissolved (pg/L)	Total TCDD whole (pg/L)	Total PeCDD dissolved (pg/L)	Total PeCDD whole (pg/L)	Total HxCDD dissolved (pg/L)
Stations 1 and 7 (composite)	8/3/97	SW0001	COMP1MET	6.5	420	440	2.5 *U*	18	3.9 *U*	5.5 *U*	20
Stations 1 and 7 (composite)	8/3/97	SW0001.1	COMP1DRET	5.3 *U*	32 *J*	86	3.5 *U*	3.1 *U*	2.7 *U*	3.1 *U*	3.2 *U*
Stations 3 and 5 (composite)	8/5/97	SW0002	COMP2DRET	4.3 *U*	46 *J*	41 *J*	1.8 *U*	2.3 *U*	2.3 *U*	3.4 *U*	3.1
Stations 3 and 5 (composite)	8/5/97	SW0002.1	COMP2MET	7.4 *U*	130	170	3.1 *U*	4.7 *U*	2.8 *U*	4.7 *U*	6.1
WATERQC	8/3/97	WATERQC	WATERQC	4.1 *U*	280	8.7 *U*	3.8 *U*	2 *U*	3.9 *U*	3.2 *U*	3.7 *U*

TABLE A1-15. (cont.)

Station	Date	Sample Number	Sample ID	Total HxCDD whole (pg/L)	Total HpCDD dissolved (pg/L)	Total HpCDD whole (pg/L)	Total OCDD dissolved (pg/L)	Total OCDD whole (pg/L)	Total TCDF dissolved (pg/L)	Total TCDF whole (pg/L)	Total PeCDF dissolved (pg/L)	Total PeCDF whole (pg/L)	Total HxCDF dissolved (pg/L)	Total HxCDF whole (pg/L)
Stations 1 and 7 (composite)	8/3/97	SW0001	COMP1MET	26	230	440	1200	2200	16	28	16	26	53	93
Stations 1 and 7 (composite)	8/3/97	SW0001.1	COMP1DRET	4.8	31	120	170	660	13 *U*	9.6 *U*	5.7 *U*	16 *U*	4.1 *U*	26
Stations 3 and 5 (composite)	8/5/97	SW0002	COMP2DRET	4 *U*	110	100	490	440	3.7 *U*	2.4 *U*	7.3 *U*	9.7	15 *J*	27
Stations 3 and 5 (composite)	8/5/97	SW0002.1	COMP2MET	8.7	180	300	950	1400	10 *U*	28 *U*	2.9	14	20 *J*	37
WATERQC	8/3/97	WATERQC	WATERQC	3.1 *U*	4.4 *U*	4.1 *U*	8.2 *U*	7.8 *U*	12	1.9 *U*	6.5	2.1 *U*	4.5 *U*	4.1 *U*

TABLE A1-15. (cont.)

Station	Date	Sample Number	Sample ID	Total HpCDF dissolved (pg/L)	Total HpCDF whole (pg/L)	Total OCDF dissolved (pg/L)	Total OCDF whole (pg/L)
Stations 1 and 7 (composite)	8/3/97	SW0001	COMP1MET	200	360	420	440
Stations 1 and 7 (composite)	8/3/97	SW0001.1	COMP1DRET	26	37	32 *J*	86
Stations 3 and 5 (composite)	8/5/97	SW0002	COMP2DRET	53	52	46 *J*	41 *J*
Stations 3 and 5 (composite)	8/5/97	SW0002.1	COMP2MET	41	68	130	170
WATERQC	8/3/97	WATERQC	WATERQC	6	3.6 *U*	280	8.7 *U*

Note: HpCDD - heptachlorodibenzo-*p*-dioxin
HpCDF - heptachlorodibenzofuran
HxCDD - hexachlorodibenzo-*p*-dioxin
HxCDF - hexachlorodibenzofuran
OCDD - octachlorodibenzo-*p*-dioxin
OCDF - octachlorodibenzofuran
PeCDD - pentachlorodibenzo-*p*-dioxin
PeCDF - pentachlorodibenzofuran
TCDD - tetrachlorodibenzo-*p*-dioxin
TCDF - tetrachlorodibenzofuran
J - estimated
U - undetected

TABLE A1-16. METALS IN BLANKS

Station	Date	Sample Number	Sample type	Arsenic (µg/L)	Cadmium (µg/L)	Total Mercury (µg/L)	Zinc (µg/L)
SD-49	8/10/97	SW0007	CBLANK-W	0.9	0.03	0.2 *U*	1
SD-49	8/10/97	SW0008	CBLANK-W	1.3	0.04	0.2 *U*	5
SD-49	8/10/97	SW0009	CBLANK-W	0.5 *U*	0.02 *U*	0.2 *U*	1.7
SD-49	8/10/97	SW0010	CBLANK-W	0.5 *U*	0.02 *U*	0.2 *U*	0.8

TABLE A1-17. SEMIVOLATILE ORGANIC COMPOUNDS IN BLANKS

				LPAHs						
Station	Date	Sample Number	Sample type	Naphthalene (μg/L)	2-Methyl-naphthalene (μg/L)	Acenaphthylene (μg/L)	Acenaphthene (μg/L)	Fluorene (μg/L)	Phenanthrene (μg/L)	Anthracene (μg/L)
SD-49	8/10/97	SW0007	CBLANK-W	0.1 *U*	0.1 *U*	0.1 *U*	0.1 *U*	0.1 *U*	0.1 *U*	0.1 *U*
SD-49	8/10/97	SW0008	CBLANK-W	0.1 *U*	0.1 *U*	0.1 *U*	0.1 *U*	0.1 *U*	0.1 *U*	0.1 *U*
SD-49	8/10/97	SW0009	CBLANK-W	0.1 *U*	0.1 *U*	0.1 *U*	0.1 *U*	0.1 *U*	0.1 *U*	0.1 *U*
SD-49	8/10/97	SW0010	CBLANK-W	0.1 *U*	0.1 *U*	0.1 *U*	0.1 *U*	0.1 *U*	0.1 *U*	0.1 *U*

TABLE A1-17. (cont.)

Station	Date	Sample Number	Sample type	HPAHs Fluoranthene (µg/L)	Pyrene (µg/L)	Benz[a]-anthracene (µg/L)	Chrysene (µg/L)	Benzo[b]-fluoranthene (µg/L)	Benzo[k]-fluoranthene (µg/L)	Benzo[a]-pyrene (µg/L)	Indeno [1,2,3-cd]-pyrene (µg/L)	Dibenz[a,h]-anthracene (µg/L)	Benzo[ghi]-perylene (µg/L)
SD-49	8/10/97	SW0007	CBLANK-W	0.1 *U*	0.1 *U*	0.1 *U*	0.1 *U*	0.1 *U*	0.1 *U*	0.1 *U*	0.1 *U*	0.1 *U*	0.1 *U*
SD-49	8/10/97	SW0008	CBLANK-W	0.1 *U*	0.1 *U*	0.1 *U*	0.1 *U*	0.1 *U*	0.1 *U*	0.1 *U*	0.1 *U*	0.1 *U*	0.1 *U*
SD-49	8/10/97	SW0009	CBLANK-W	0.1 *U*	0.1 *U*	0.1 *U*	0.1 *U*	0.1 *U*	0.1 *U*	0.1 *U*	0.1 *U*	0.1 *U*	0.1 *U*
SD-49	8/10/97	SW0010	CBLANK-W	0.1 *U*	0.1 *U*	0.1 *U*	0.1 *U*	0.1 *U*	0.1 *U*	0.1 *U*	0.1 *U*	0.1 *U*	0.1 *U*

TABLE A1-17. (cont.)

				Phenols		Miscellaneous Oxygenated Compounds	
Station	Date	Sample Number	Sample type	Phenol (µg/L)	4-Methyl-phenol[a] (µg/L)	Benzoic acid (µg/L)	Dibenzofuran (µg/L)
SD-49	8/10/97	SW0007	CBLANK-W	0.2	0.2	0.7 *U*	0.1 *U*
SD-49	8/10/97	SW0008	CBLANK-W	0.2	0.7	0.7 *U*	0.1 *U*
SD-49	8/10/97	SW0009	CBLANK-W	0.1 *U*	0.6	0.7 *U*	0.1 *U*
SD-49	8/10/97	SW0010	CBLANK-W	0.1 *U*	0.1 *U*	0.7 *U*	0.1 *U*

Note: Samples reported as whole.
HPAH - high-molecular-weight polycyclic aromatic hydrocarbon
LPAH - low-moelcular-weight polycyclic aromatic hydrocarbon
U - undetected

[a] 3- and 4-methylphenol results were quantified as 4-methylphenol.

Appendix A2

Data Tables for Sediment Toxicity Tests and Specialized Toxicity Tests

CONTENTS

TABLE A2-1. ORIGINAL DATA FOR SEDIMENT TOXICITY TESTS CONDUCTED FOR WARD COVE IN 1996

				Amphipod Test (*Rhepoxynius abronius*)		Amphipod Test (*Leptocheirus plumulosus*)		Polychaete Test (*Neanthes sp.*)				Echinoderm Embryo Test (*Dendraster excentricus*)		
Sample Number	Station	Collection Date[a]	Replicate	Number of Survivors	Survival (%)	Number of Survivors	Survival (%)	Number of Survivors	Survival (%)	Total Biomass[b] (mg)[c]	Individual Growth Rate[b] (mg/day)[c]	Total Number of Survivors	Number of Normal Survivors	Normal Survival (%)[d]
Control	--	--	1	20	100	20	100	5	100	50.3	0.48	223	217	100 [e]
Control	--	--	2	20	100	20	100	5	100	46.0	0.44	220	210	100
Control	--	--	3	20	100	20	100	2	40	21.4	0.51	247	245	100
Control	--	--	4	20	100	20	100	5	100	66.2	0.64	205	181	100
Control	--	--	5	20	100	20	100	3	60	26.7	0.42	231	225	100
Ward Cove-Subtidal														
KW001	W01	1-Jun	1	17	85	19	95	5	100	71.7	0.69	115	100	46
KW001	W01	1-Jun	2	12	60	20	100	4	80	56.7	0.68	73	48	22
KW001	W01	1-Jun	3	13	65	18	90	5	100	41.5	0.39	129	118	55
KW001	W01	1-Jun	4	8	40	18	90	5	100	62.8	0.61	172	160	74
KW001	W01	1-Jun	5	0	0	18	90	5	100	58.7	0.56	139	123	57
KW002	W02	1-Jun	1	2	10	18	90	5	100	65.9	0.64	117	112	52
KW002	W02	1-Jun	2	5	25	18	90	5	100	74.8	0.72	115	98	45
KW002	W02	1-Jun	3	0	0	19	95	5	100	70.7	0.68	157	154	71
KW002	W02	1-Jun	4	0	0	20	100	5	100	52.3	0.50	118	107	50
KW002	W02	1-Jun	5	0	0	19	95	4	80	52.7	0.64	129	126	58
KW003	W03	2-Jun	1	16	80	19	95	--[d]	--[d]	--[d]	--[d]	148	138	64
KW003	W03	2-Jun	2	19	95	20	100	5	100	51.2	0.49	63	53	25
KW003	W03	2-Jun	3	17	85	19	95	5	100	60.1	0.58	184	182	84
KW003	W03	2-Jun	4	18	90	17	85	5	100	50.5	0.48	128	123	57
KW003	W03	2-Jun	5	20	100	18	90	5	100	63.7	0.61	82	57	26
KW004	W04	2-Jun	1	11	55	18	90	5	100	64.6	0.62	148	135	63
KW004	W04	2-Jun	2	9	45	20	100	5	100	64.7	0.62	114	102	47
KW004	W04	2-Jun	3	17	85	20	100	5	100	69.4	0.67	139	122	57
KW004	W04	2-Jun	4	13	65	17	85	5	100	75.7	0.73	92	65	30
KW004	W04	2-Jun	5	14	70	18	90	5	100	46.6	0.44	187	179	83
KW005	W05	1-Jun	1	9	45	19	95	4	80	43.5	0.52	171	161	75
KW005	W05	1-Jun	2	9	45	19	95	5	100	64.7	0.62	59	23	11
KW005	W05	1-Jun	3	2	10	20	100	5	100	63.3	0.61	102	54	25
KW005	W05	1-Jun	4	4	20	20	100	5	100	58.6	0.56	146	131	61
KW005	W05	1-Jun	5	1	5	20	100	5	100	57.1	0.55	149	144	67
KW006	W06	4-Jun	1	4	20	17	85	5	100	46.6	0.44	74	60	28
KW006	W06	4-Jun	2	0	0	19	95	5	100	72.0	0.70	173	168	78
KW006	W06	4-Jun	3	1	5	19	95	5	100	73.1	0.71	114	104	48
KW006	W06	4-Jun	4	0	0	17	85	5	100	70.7	0.68	162	161	75
KW006	W06	4-Jun	5	0	0	16	80	5	100	59.3	0.57	103	94	44
KW007	W07	2-Jun	1	18	90	20	100	5	100	73.7	0.71	127	104	48
KW007	W07	2-Jun	2	17	85	20	100	5	100	53.3	0.51	160	132	61
KW007	W07	2-Jun	3	19	95	19	95	5	100	56.5	0.54	170	167	77
KW007	W07	2-Jun	4	16	80	20	100	5	100	63.8	0.61	152	151	70
KW007	W07	2-Jun	5	20	100	20	100	4	80	55.1	0.66	143	100	46
KW008	W08	2-Jun	1	4	20	18	90	4	80	50.7	0.61	167	164	76
KW008	W08	2-Jun	2	14	70	13	65	5	100	80.0	0.78	129	96	45
KW008	W08	2-Jun	3	12	60	19	95	2	40	37.2	0.91	126	122	57

TABLE A2-1. (cont.)

Sample Number	Station	Collection Date[a]	Replicate	Amphipod Test (*Rhepoxynius abronius*) Number of Survivors	Survival (%)	Amphipod Test (*Leptocheirus plumulosus*) Number of Survivors	Survival (%)	Polychaete Test (*Neanthes sp.*) Number of Survivors	Survival (%)	Total Biomass[b] (mg)[c]	Individual Growth Rate[b] (mg/day)[c]	Echinoderm Embryo Test (*Dendraster excentricus*) Total Number of Survivors	Number of Normal Survivors	Normal Survival (%)[d]
KW008	W08	2-Jun	4	4	20	19	95	5	100	64.9	0.63	120	96	45
KW008	W08	2-Jun	5	9	45	20	100	5	100	50.4	0.48	150	144	67
KW009	W09	2-Jun	1	12	60	16	80	5	100	72.1	0.70	89	8	4
KW009	W09	2-Jun	2	10	50	20	100	5	100	74.9	0.73	103	100	46
KW009	W09	2-Jun	3	5	25	19	95	4	80	55.4	0.67	127	105	49
KW009	W09	2-Jun	4	14	70	18	90	5	100	58.4	0.56	143	127	59
KW009	W09	2-Jun	5	13	65	19	95	4	80	40.9	0.49	132	128	59
KW010	W010R	3-Jun	1	13	65	20	100	5	100	59.4	0.57	132	124	58
KW010	W010R	3-Jun	2	14	70	19	95	5	100	67.6	0.65	118	115	53
KW010	W010R	3-Jun	3	13	65	20	100	5	100	95.3	0.93	91	88	41
KW010	W010R	3-Jun	4	20	100	18	90	5	100	70.9	0.69	76	73	34
KW010	W010R	3-Jun	5	15	75	19	95	5	100	53.8	0.51	146	144	67
KW011	W011	30-May	1	20	100	20	100	4	80	44.4	0.53	122	118	55
KW011	W011	30-May	2	16	80	20	100	5	100	59.2	0.57	109	21	10
KW011	W011	30-May	3	19	95	20	100	5	100	40.5	0.38	140	132	61
KW011	W011	30-May	4	19	95	18	90	4	80	45.7	0.55	152	151	70
KW011	W011	30-May	5	20	100	19	95	4	80	56.8	0.69	93	85	39
KW012	W012	4-Jun	1	0	0	18	90	4	80	48.7	0.59	62	57	26
KW012	W012	4-Jun	2	1	5	15	75	5	100	70.9	0.69	63	56	26
KW012	W012	4-Jun	3	1	5	20	100	5	100	61.2	0.59	160	147	68
KW012	W012	4-Jun	4	0	0	20	100	5	100	74.0	0.72	130	123	57
KW012	W012	4-Jun	5	1	5	20	100	5	100	57.9	0.56	118	109	51
KW013	W013	4-Jun	1	4	20	19	95	5	100	44.6	0.42	105	102	47
KW013	W013	4-Jun	2	10	50	19	95	5	100	60.0	0.58	110	108	50
KW013	W013	4-Jun	3	8	40	20	100	5	100	45.5	0.43	166	163	76
KW013	W013	4-Jun	4	7	35	20	100	2	40	36.4	0.89	85	77	36
KW013	W013	4-Jun	5	7	35	17	85	4	80	41.5	0.50	121	115	53
KW014	W014	4-Jun	1	18	90	20	100	4	80	40.3	0.48	105	96	45
KW014	W014	4-Jun	2	11	55	20	100	5	100	70.4	0.68	109	102	47
KW014	W014	4-Jun	3	7	35	18	90	5	100	76.0	0.74	232	229	106
KW014	W014	4-Jun	4	14	70	20	100	5	100	74.8	0.72	131	108	50
KW014	W014	4-Jun	5	10	50	20	100	3	60	53.1	0.86	160	157	73
KW015	W015	2-Jun	1	13	65	18	90	5	100	58.2	0.56	126	124	58
KW015	W015	2-Jun	2	11	55	20	100	5	100	74.8	0.73	177	172	80
KW015	W015	2-Jun	3	12	60	17	85	5	100	70.1	0.68	135	132	61
KW015	W015	2-Jun	4	18	90	20	100	5	100	61.1	0.59	165	156	72
KW015	W015	2-Jun	5	13	65	19	95	3	60	44.9	0.73	149	141	65
KW016	W016	3-Jun	1	8	40	20	100	5	100	59.3	0.57	155	152	71
KW016	W016	3-Jun	2	10	50	19	95	5	100	73.2	0.71	84	81	38
KW016	W016	3-Jun	3	5	25	20	100	5	100	64.5	0.62	111	108	50
KW016	W016	3-Jun	4	5	25	19	95	5	100	66.5	0.64	152	148	69
KW016	W016	3-Jun	5	2	10	20	100	5	100	87.5	0.85	77	72	33
KW017	W017R	3-Jun	1	17	85	17	85	5	100	45.4	0.43	162	158	73
KW017	W017R	3-Jun	2	15	75	20	100	2	40	22.0	0.53	118	109	51

TABLE A2-1. (cont.)

				Amphipod Test (*Rhepoxynius abronius*)		Amphipod Test (*Leptocheirus plumulosus*)		Polychaete Test (*Neanthes sp.*)				Echinoderm Embryo Test (*Dendraster excentricus*)		
Sample Number	Station	Collection Date[a]	Replicate	Number of Survivors	Survival (%)	Number of Survivors	Survival (%)	Number of Survivors	Survival (%)	Total Biomass[b] (mg)[c]	Individual Growth Rate[b] (mg/day)[c]	Total Number of Survivors	Number of Normal Survivors	Normal Survival (%)[d]
KW017	W017R	3-Jun	3	20	100	20	100	4	80	50.8	0.61	166	162	75
KW017	W017R	3-Jun	4	16	80	19	95	4	80	33.7	0.40	161	147	68
KW017	W017R	3-Jun	5	20	100	18	90	5	100	62.9	0.61	74	5	2
KW018	W018	29-May	1	18	90	20	100	4	80	43.0	0.51	164	163	76
KW018	W018	29-May	2	20	100	19	95	4	80	55.8	0.67	103	92	43
KW018	W018	29-May	3	18	90	20	100	5	100	55.0	0.53	118	111	51
KW018	W018	29-May	4	20	100	19	95	5	100	53.4	0.51	127	114	53
KW018	W018	29-May	5	19	95	18	90	5	100	54.5	0.52	150	147	68
KW019	W019	1-Jun	1	9	45	20	100	5	100	63.3	0.61	179	175	81
KW019	W019	1-Jun	2	4	20	20	100	5	100	64.1	0.62	182	172	80
KW019	W019	1-Jun	3	14	70	20	100	5	100	69.3	0.67	134	127	59
KW019	W019	1-Jun	4	9	45	20	100	5	100	78.1	0.76	190	160	74
KW019	W019	1-Jun	5	12	60	20	100	5	100	64.3	0.62	220	217	101
KW020	W020	31-May	1	14	70	20	100	5	100	54.8	0.52	102	96	45
KW020	W020	31-May	2	16	80	18	90	3	60	40.8	0.66	173	162	75
KW020	W020	31-May	3	10	50	20	100	4	80	42.5	0.51	199	191	89
KW020	W020	31-May	4	10	50	20	100	4	80	45.0	0.54	141	136	63
KW020	W020	31-May	5	17	85	19	95	3	60	44.1	0.71	186	186	86
KW021	W021	3-Jun	1	19	95	19	95	5	100	72.6	0.70	158	153	71
KW021	W021	3-Jun	2	16	80	18	90	5	100	56.9	0.55	170	163	76
KW021	W021	3-Jun	3	15	75	19	95	5	100	73.0	0.71	201	197	91
KW021	W021	3-Jun	4	12	60	20	100	5	100	60.0	0.58	193	191	89
KW021	W021	3-Jun	5	20	100	20	100	5	100	66.2	0.64	162	159	74
KW022	W022	28-May	1	18	90	20	100	4	80	53.6	0.65	216	207	96
KW022	W022	28-May	2	20	100	19	95	5	100	49.4	0.47	191	186	86
KW022	W022	28-May	3	17	85	20	100	5	100	58.7	0.56	161	129	60
KW022	W022	28-May	4	14	70	14	70	5	100	72.3	0.70	173	170	79
KW022	W022	28-May	5	15	75	19	95	4	80	40.4	0.48	177	170	79
KW023	W023	29-May	1	18	90	20	100	1	20	11.6	0.55	133	124	58
KW023	W023	29-May	2	20	100	19	95	5	100	81.0	0.79	102	100	46
KW023	W023	29-May	3	19	95	18	90	5	100	67.8	0.65	148	145	67
KW023	W023	29-May	4	17	85	19	95	4	80	55.0	0.66	188	184	85
KW023	W023	29-May	5	20	100	18	90	5	100	55.2	0.53	92	79	37
KW024	W024	1-Jun	1	19	95	20	100	5	100	67.3	0.65	154	131	61
KW024	W024	1-Jun	2	18	90	17	85	4	80	45.1	0.54	183	180	83
KW024	W024	1-Jun	3	18	90	20	100	5	100	51.9	0.50	160	149	69
KW024	W024	1-Jun	4	15	75	20	100	5	100	55.7	0.53	162	111	51
KW024	W024	1-Jun	5	19	95	19	95	5	100	67.2	0.65	201	198	92
KW025	W025	30-May	1	0	0	20	100	2	40	36.7	0.89	97	36	17
KW025	W025	30-May	2	0	0	18	90	5	100	76.7	0.74	173	166	77
KW025	W025	30-May	3	0	0	20	100	5	100	68.8	0.67	153	130	60
KW025	W025	30-May	4	1	5	20	100	5	100	70.0	0.68	146	139	64
KW025	W025	30-May	5	2	10	18	90	5	100	76.5	0.74	161	157	73
KW026	W026	30-May	1	20	100	19	95	5	100	70.8	0.68	189	184	85

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TABLE A2-1. (cont.)

Sample Number	Station	Collection Date[a]	Replicate	Amphipod Test (*Rhepoxynius abronius*) Number of Survivors	Survival (%)	Amphipod Test (*Leptocheirus plumulosus*) Number of Survivors	Survival (%)	Polychaete Test (*Neanthes sp.*) Number of Survivors	Survival (%)	Total Biomass[b] (mg)[c]	Individual Growth Rate[b] (mg/day)[c]	Echinoderm Embryo Test (*Dendraster excentricus*) Total Number of Survivors	Number of Normal Survivors	Normal Survival (%)[d]
KW026	W026	30-May	2	19	95	17	85	5	100	48.8	0.46	144	131	61
KW026	W026	30-May	3	18	90	19	95	5	100	66.7	0.64	167	163	76
KW026	W026	30-May	4	20	100	19	95	3	60	37.2	0.60	169	156	72
KW026	W026	30-May	5	19	95	19	95	5	100	51.3	0.49	197	172	80
KW027	W027	29-May	1	18	90	20	100	5	100	70.1	0.68	152	85	39
KW027	W027	29-May	2	17	85	20	100	5	100	81.1	0.79	148	145	67
KW027	W027	29-May	3	15	75	19	95	4	80	49.5	0.60	170	158	73
KW027	W027	29-May	4	17	85	19	95	5	100	53.5	0.51	168	166	77
KW027	W027	29-May	5	18	90	20	100	5	100	70.3	0.68	235	225	104
KW028	W028	29-May	1	13	65	18	90	5	100	57.5	0.55	129	121	56
KW028	W028	29-May	2	14	70	20	100	3	60	48.8	0.79	140	128	59
KW028	W028	29-May	3	6	30	18	90	5	100	66.4	0.64	170	163	76
KW028	W028	29-May	4	19	95	20	100	4	80	46.2	0.55	167	159	74
KW028	W028	29-May	5	17	85	20	100	4	80	52.3	0.63	162	148	69
Moser Bay-Subtidal														
KW029	W029	5-Jun	1	18	90	20	100	5	100	39.0	0.37	186	186	86
KW029	W029	5-Jun	2	19	95	19	95	5	100	49.6	0.47	166	164	76
KW029	W029	5-Jun	3	17	85	19	95	5	100	55.8	0.53	240	236	109
KW029	W029	5-Jun	4	19	95	19	95	5	100	61.0	0.59	189	176	82
KW029	W029	5-Jun	5	18	90	20	100	5	100	44.3	0.42	137	132	61
KW035	W030	5-Jun	1	18	90	20	100	5	100	61.9	0.60	182	179	83
KW035	W030	5-Jun	2	20	100	20	100	5	100	62.0	0.60	211	208	96
KW035	W030	5-Jun	3	18	90	20	100	1	20	15.8	0.77	189	186	86
KW035	W030	5-Jun	4	17	85	20	100	5	100	79.7	0.77	197	194	90
KW035	W030	5-Jun	5	20	100	19	95	4	80	70.7	0.86	163	160	74

[a] All samples were collected in 1996.

[b] Based only on survivors.

[c] Dry weight.

[d] Normal survival was calculated as a percentage of the mean normal survival for the negative controls.

[e] Data were rejected because test chamber was not aerated and test water was not fully renewed during part of the exposure period.

TABLE A2-2. ORIGINAL DATA FOR SEDIMENT TOXICITY TESTS CONDUCTED FOR WARD COVE IN 1997

				Amphipod Test (*Rhepoxynius abronius*)		Echinoderm Embryo Test (*Dendraster excentricus*)		
Sample Number	Station	Collection Date[a]	Replicate	Number of Survivors	Survival (%)	Total Number of Survivors	Number of Normal Survivors	Normal Survival (%)[b]
Ward Cove-Subtidal								
SD0011	SD-2	24-Jul	1	0	0	74	71	56
SD0011	SD-2	24-Jul	2	1	5	44	35	27
SD0011	SD-2	24-Jul	3	0	0	60	55	43
SD0011	SD-2	24-Jul	4	0	0	25	23	18
SD0011	SD-2	24-Jul	5	8	40	91	88	69
SD0012	SD-3	24-Jul	1	12	60	80	76	59
SD0012	SD-3	24-Jul	2	0	0	74	72	56
SD0012	SD-3	24-Jul	3	13	65	28	27	21
SD0012	SD-3	24-Jul	4	11	55	58	56	44
SD0012	SD-3	24-Jul	5	16	80	110	106	83
SD0013	SD-4	24-Jul	1	10	50	39	35	27
SD0013	SD-4	24-Jul	2	12	60	82	71	56
SD0013	SD-4	24-Jul	3	13	65	101	99	77
SD0013	SD-4	24-Jul	4	1	5	102	99	77
SD0013	SD-4	24-Jul	5	2	10	57	54	42
SD0014R	SD-5	24-Jul	1	10	50	53	49	38
SD0014R	SD-5	24-Jul	2	3	15	67	66	52
SD0014R	SD-5	24-Jul	3	4	20	84	79	62
SD0014R	SD-5	24-Jul	4	14	70	90	89	70
SD0014R	SD-5	24-Jul	5	8	40	63	58	45
SD0030	SD-7	24-Jul	1	11	55	86	85	67
SD0030	SD-7	24-Jul	2	9	45	96	94	74
SD0030	SD-7	24-Jul	3	11	55	75	72	56
SD0030	SD-7	24-Jul	4	10	50	85	84	66
SD0030	SD-7	24-Jul	5	17	85	49	44	34
SD0008	SD-11	24-Jul	1	18	90	73	73	57
SD0008	SD-11	24-Jul	2	15	75	93	89	70
SD0008	SD-11	24-Jul	3	17	85	74	73	57
SD0008	SD-11	24-Jul	4	15	75	49	44	34
SD0008	SD-11	24-Jul	5	18	90	78	74	58
SD0039	SD-12	1-Aug	1	3	15	56	56	44
SD0039	SD-12	1-Aug	2	6	30	52	49	38
SD0039	SD-12	1-Aug	3	0	0	63	59	46
SD0039	SD-12	1-Aug	4	4	20	82	81	63
SD0039	SD-12	1-Aug	5	1	5	35	30	23
SD0037	SD-13	1-Aug	1	0	0	56	54	42
SD0037	SD-13	1-Aug	2	1	5	58	57	45
SD0037	SD-13	1-Aug	3	2	10	65	63	49
SD0037	SD-13	1-Aug	4	11	55	66	62	49
SD0037	SD-13	1-Aug	5	1	5	73	72	56
SD0029	SD-16	29-Jul	1	18	90	44	38	30
SD0029	SD-16	29-Jul	2	18	90	87	87	68
SD0029	SD-16	29-Jul	3	19	95	15	14	11
SD0029	SD-16	29-Jul	4	17	85	42	32	25
SD0029	SD-16	29-Jul	5	17	85	33	32	25
SD0031	SD-17	30-Jul	1	0	0	102	98	77
SD0031	SD-17	30-Jul	2	12	60	86	82	64
SD0031	SD-17	30-Jul	3	16	80	48	42	33

TABLE A2-2. (cont.)

Sample Number	Station	Collection Date[a]	Replicate	Amphipod Test (*Rhepoxynius abronius*) Number of Survivors	Survival (%)	Echinoderm Embryo Test (*Dendraster excentricus*) Total Number of Survivors	Number of Normal Survivors	Normal Survival (%)[b]
SD0031	SD-17	30-Jul	4	0	0	78	76	59
SD0031	SD-17	30-Jul	5	15	75	72	69	54
SD0007	SD-18	23-Jul	1	19	95	21	12	9
SD0007	SD-18	23-Jul	2	17	85	71	70	55
SD0007	SD-18	23-Jul	3	16	80	81	78	61
SD0007	SD-18	23-Jul	4	19	95	84	79	62
SD0007	SD-18	23-Jul	5	19	95	83	82	64
SD0024	SD-19	28-Jul	1	11	55	62	61	48
SD0024	SD-19	28-Jul	2	10	50	86	82	64
SD0024	SD-19	28-Jul	3	14	70	71	68	53
SD0024	SD-19	28-Jul	4	9	45	114	106	83
SD0024	SD-19	28-Jul	5	15	75	78	75	59
SD0001	SD-22	22-Jul	1	18	90	76	74	58
SD0001	SD-22	22-Jul	2	18	90	120	119	93
SD0001	SD-22	22-Jul	3	18	90	105	103	81
SD0001	SD-22	22-Jul	4	12	60	112	112	88
SD0001	SD-22	22-Jul	5	18	90	93	91	71
SD0002	SD-23	23-Jul	1	15	75	129	125	98
SD0002	SD-23	23-Jul	2	16	80	58	50	39
SD0002	SD-23	23-Jul	3	10	50	67	66	52
SD0002	SD-23	23-Jul	4	18	90	97	91	71
SD0002	SD-23	23-Jul	5	20	100	76	71	56
SD0009	SD-25	24-Jul	1	0	0	87	81	63
SD0009	SD-25	24-Jul	2	0	0	93	90	70
SD0009	SD-25	24-Jul	3	4	20	42	38	30
SD0009	SD-25	24-Jul	4	0	0	68	64	50
SD0009	SD-25	24-Jul	5	6	30	96	88	69
SD0005	SD-27	23-Jul	1	16	80	31	28	22
SD0005	SD-27	23-Jul	2	16	80	41	20	16
SD0005	SD-27	23-Jul	3	10	50	69	66	52
SD0005	SD-27	23-Jul	4	18	90	77	75	59
SD0005	SD-27	23-Jul	5	0	0	56	54	42
SD0006	SD-28	23-Jul	1	10	50	97	95	74
SD0006	SD-28	23-Jul	2	15	75	85	81	63
SD0006	SD-28	23-Jul	3	1	5	57	47	37
SD0006	SD-28	23-Jul	4	15	75	85	85	67
SD0006	SD-28	23-Jul	5	18	90	67	64	50
SD0015	SD-31	24-Jul	1	0	0	27	27	21
SD0015	SD-31	24-Jul	2	1	5	19	18	14
SD0015	SD-31	24-Jul	3	0	0	34	30	23
SD0015	SD-31	24-Jul	4	2	10	60	59	46
SD0015	SD-31	24-Jul	5	0	0	48	46	36
SD0016	SD-32	25-Jul	1	0	0	98	93	73
SD0016	SD-32	25-Jul	2	0	0	48	46	36
SD0016	SD-32	25-Jul	3	11	55	62	62	49
SD0016	SD-32	25-Jul	4	3	15	60	59	46
SD0016	SD-32	25-Jul	5	14	70	85	85	67
SD0017	SD-33	25-Jul	1	14	70	27	27	21
SD0017	SD-33	25-Jul	2	14	70	61	60	47
SD0017	SD-33	25-Jul	3	14	70	42	41	32

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TABLE A2-2. (cont.)

Sample Number	Station	Collection Date[a]	Replicate	Amphipod Test (*Rhepoxynius abronius*) Number of Survivors	Survival (%)	Echinoderm Embryo Test (*Dendraster excentricus*) Total Number of Survivors	Number of Normal Survivors	Normal Survival (%)[b]
SD0017	SD-33	25-Jul	4	19	95	26	21	16
SD0017	SD-33	25-Jul	5	16	80	33	32	25
SD0033	SD-34	31-Jul	1	0	0	52	51	40
SD0033	SD-34	31-Jul	2	9	45	77	74	58
SD0033	SD-34	31-Jul	3	10	50	59	51	40
SD0033	SD-34	31-Jul	4	6	30	75	74	58
SD0033	SD-34	31-Jul	5	6	30	79	72	56
SD0034	SD-35	31-Jul	1	10	50	70	69	54
SD0034	SD-35	31-Jul	2	17	85	60	58	45
SD0034	SD-35	31-Jul	3	17	85	65	65	51
SD0034	SD-35	31-Jul	4	13	65	45	44	34
SD0034	SD-35	31-Jul	5	18	90	45	42	33
SD0018	SD-37	25-Jul	1	13	65	91	90	70
SD0018	SD-37	25-Jul	2	13	65	113	112	88
SD0018	SD-37	25-Jul	3	10	50	99	98	77
SD0018	SD-37	25-Jul	4	18	90	79	77	60
SD0018	SD-37	25-Jul	5	11	55	59	55	43
SD0010	SD-38	24-Jul	1	0	0	80	79	62
SD0010	SD-38	24-Jul	2	0	0	30	26	20
SD0010	SD-38	24-Jul	3	0	0	34	26	20
SD0010	SD-38	24-Jul	4	0	0	103	102	80
SD0010	SD-38	24-Jul	5	0	0	98	85	67
SD0020	SD-39	25-Jul	1	0	0	86	82	64
SD0020	SD-39	25-Jul	2	11	55	112	110	86
SD0020	SD-39	25-Jul	3	9	45	99	98	77
SD0020	SD-39	25-Jul	4	7	35	63	62	49
SD0020	SD-39	25-Jul	5	6	30	85	85	67
SD0021	SD-40	25-Jul	1	16	80	97	96	75
SD0021	SD-40	25-Jul	2	16	80	130	128	100
SD0021	SD-40	25-Jul	3	1	5	78	77	60
SD0021	SD-40	25-Jul	4	14	70	95	94	74
SD0021	SD-40	25-Jul	5	14	70	98	88	69
SD0032	SD-41	30-Jul	1	19	95	88	86	67
SD0032	SD-41	30-Jul	2	18	90	64	64	50
SD0032	SD-41	30-Jul	3	16	80	32	32	25
SD0032	SD-41	30-Jul	4	19	95	25	23	18
SD0032	SD-41	30-Jul	5	18	90	64	60	47
SD0028	SD-42	29-Jul	1	14	70	82	79	62
SD0028	SD-42	29-Jul	2	18	90	94	90	70
SD0028	SD-42	29-Jul	3	9	45	62	62	49
SD0028	SD-42	29-Jul	4	12	60	67	64	50
SD0028	SD-42	29-Jul	5	15	75	73	71	56
SD0027	SD-43	28-Jul	1	18	90	83	82	64
SD0027	SD-43	28-Jul	2	15	75	62	62	49
SD0027	SD-43	28-Jul	3	13	65	71	71	56
SD0027	SD-43	28-Jul	4	16	80	85	82	64
SD0027	SD-43	28-Jul	5	10	50	88	79	62
SD0035	SD-44	31-Jul	1	0	0	69	67	52
SD0035	SD-44	31-Jul	2	0	0	76	74	58
SD0035	SD-44	31-Jul	3	0	0	91	88	69

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TABLE A2-2. (cont.)

Sample Number	Station	Collection Date[a]	Replicate	Amphipod Test (*Rhepoxynius abronius*) Number of Survivors	Amphipod Test (*Rhepoxynius abronius*) Survival (%)	Echinoderm Embryo Test (*Dendraster excentricus*) Total Number of Survivors	Echinoderm Embryo Test (*Dendraster excentricus*) Number of Normal Survivors	Echinoderm Embryo Test (*Dendraster excentricus*) Normal Survival (%)[b]
SD0035	SD-44	31-Jul	4	1	5	62	60	47
SD0035	SD-44	31-Jul	5	0	0	44	41	32
SD0025	SD-45	28-Jul	1	4	20	53	45	35
SD0025	SD-45	28-Jul	2	14	70	65	54	42
SD0025	SD-45	28-Jul	3	19	95	76	74	58
SD0025	SD-45	28-Jul	4	15	75	87	83	65
SD0025	SD-45	28-Jul	5	2	10	54	53	41
SD0040	SD-47	1-Aug	1	19	95	42	42	33
SD0040	SD-47	1-Aug	2	15	75	70	68	53
SD0040	SD-47	1-Aug	3	14	70	65	59	46
SD0040	SD-47	1-Aug	4	15	75	68	66	52
SD0040	SD-47	1-Aug	5	10	50	77	76	59
SD0026	SD-48	28-Jul	1	0	0	65	65	51
SD0026	SD-48	28-Jul	2	0	0	77	76	59
SD0026	SD-48	28-Jul	3	0	0	84	82	64
SD0026	SD-48	28-Jul	4	2	10	74	70	55
SD0026	SD-48	28-Jul	5	3	15	67	63	49
Moser Bay-Subtidal								
SD0022	SD-29	27-Jul	1	19	95	100	100	78
SD0022	SD-29	27-Jul	2	19	95	77	75	59
SD0022	SD-29	27-Jul	3	19	95	117	114	89
SD0022	SD-29	27-Jul	4	20	100	102	96	75
SD0022	SD-29	27-Jul	5	19	95	89	87	68
SD0023	SD-30	27-Jul	1	19	95	80	78	61
SD0023	SD-30	27-Jul	2	20	100	106	104	81
SD0023	SD-30	27-Jul	3	20	100	128	127	99
SD0023	SD-30	27-Jul	4	19	95	79	79	62
SD0023	SD-30	27-Jul	5	18	90	82	80	63

[a] All samples were collected in 1997.

[b] Normal survival was calculated as a percentage of the mean normal survival for the negative controls.

TABLE A2-3. ORIGINAL DATA FOR SPECIALIZED TOXICITY TESTING OF SEDIMENT CONDUCTED FOR WARD COVE IN 1997

Sample Number	Station	Collection Date[a]	Replicate	Amphipod Test (*Rhepoxynius abronius*) with Preliminary Purging: Number of Survivors	Amphipod Test (*Rhepoxynius abronius*) with Preliminary Purging: Survival (percent)	Amphipod Test (*Rhepoxynius abronius*) with *Ulva* Treatment, Treated: Number of Survivors	Treated: Survival (percent)	Untreated: Number of Survivors	Untreated: Survival (percent)
Control			1	20	100			5	100
Control			2	20	100			5	100
Control			3	20	100			5	100
Control			4	19	95			5	100
Control			5	19	95			--[b]	--
Ward Cove-Subtidal									
SD0030	SD-7	24-Jul	1	17	85	5	100	5	100
SD0030	SD-7	24-Jul	2	12	60	5	100	5	100
SD0030	SD-7	24-Jul	3	20	100	5	100	5	100
SD0030	SD-7	24-Jul	4	18	90	5	100	5	100
SD0030	SD-7	24-Jul	5	20	100	--	--	--	--
SD0039	SD-12	1-Aug	1	13	65	5	100	5	100
SD0039	SD-12	1-Aug	2	12	60	5	100	4	80
SD0039	SD-12	1-Aug	3	5	25	4	80	5	100
SD0039	SD-12	1-Aug	4	8	40	4	80	5	100
SD0039	SD-12	1-Aug	5	17	85	--	--	--	--
SD0037	SD-13	1-Aug	1	15	75	5	100	5	100
SD0037	SD-13	1-Aug	2	11	55	5	100	5	100
SD0037	SD-13	1-Aug	3	13	65	5	100	5	100
SD0037	SD-13	1-Aug	4	8	40	5	100	5	100
SD0037	SD-13	1-Aug	5	2	10	--	--	--	--
SD0029	SD-16	29-Jul	1	17	85	5	100	5	100
SD0029	SD-16	29-Jul	2	16	80	5	100	5	100
SD0029	SD-16	29-Jul	3	20	100	5	100	5	100
SD0029	SD-16	29-Jul	4	14	70	5	100	5	100
SD0029	SD-16	29-Jul	5	19	95	--	--	--	--
SD0031	SD-17	30-Jul	1	9	45	5	100	5	100
SD0031	SD-17	30-Jul	2	15	75	5	100	5	100
SD0031	SD-17	30-Jul	3	19	95	5	100	5	100
SD0031	SD-17	30-Jul	4	19	95	5	100	4	80
SD0031	SD-17	30-Jul	5	10	50	--	--	--	--
SD0033	SD-34	31-Jul	1	16	80	5	100	5	100
SD0033	SD-34	31-Jul	2	5	25	5	100	4	80
SD0033	SD-34	31-Jul	3	16	80	5	100	5	100
SD0033	SD-34	31-Jul	4	9	45	5	100	5	100
SD0033	SD-34	31-Jul	5	20	100	--	--	--	--
SD0034	SD-35	31-Jul	1	2	10	5	100	5	100
SD0034	SD-35	31-Jul	2	15	75	4	80	5	100
SD0034	SD-35	31-Jul	3	3	15	4	80	5	100
SD0034	SD-35	31-Jul	4	13	65	5	100	5	100
SD0034	SD-35	31-Jul	5	6	30	--	--	--	--
SD0035	SD-44	31-Jul	1	7	35	5	100	5	100
SD0035	SD-44	31-Jul	2	14	70	5	100	5	100
SD0035	SD-44	31-Jul	3	0	0	5	100	5	100
SD0035	SD-44	31-Jul	4	0	0	5	100	5	100
SD0035	SD-44	31-Jul	5	4	20	--	--	--	--

[a] All samples were collected in 1997.

[b] Only four replicates were tested.

TABLE A2-4. ORIGINAL DATA FOR SPECIALIZED TOXICITY TESTING OF PORE WATER CONDUCTED FOR WARD COVE IN 1997

				Amphipod Test (*Rhepoxynius abronius*) with Pore Water						
					Aeration		*Ulva* Treatment		Untreated	
Sample Number	Station	Collection Date[a]	Replicate	Concentration (percent)	Number of Survivors	Survival (percent)	Number of Survivors	Survival (percent)	Number of Survivors	Survival (percent)
Ward Cove-Subtidal										
SD0030	SD-7	24-Jul	1	100	5	100	5	100	0	0
SD0030	SD-7	24-Jul	1	50	5	100	4	80	1	20
SD0030	SD-7	24-Jul	1	20	5	100	5	100	5	10
SD0030	SD-7	24-Jul	1	10	5	100	5	100	5	100
SD0030	SD-7	24-Jul	1	5	5	100	5	100	4	80
SD0030	SD-7	24-Jul	1	0	5	100	5	100	5	100
SD0030	SD-7	24-Jul	2	100	5	100	3	60	0	0
SD0030	SD-7	24-Jul	2	50	5	100	5	100	0	0
SD0030	SD-7	24-Jul	2	20	5	100	5	100	5	100
SD0030	SD-7	24-Jul	2	10	5	100	5	100	5	100
SD0030	SD-7	24-Jul	2	5	5	100	5	100	5	100
SD0030	SD-7	24-Jul	2	0	5	100	5	100	5	100
SD0039	SD-12	1-Aug	1	100	3	60	0	0	0	0
SD0039	SD-12	1-Aug	1	50	4	80	0	0	0	0
SD0039	SD-12	1-Aug	1	20	4	80	5	100	0	0
SD0039	SD-12	1-Aug	1	10	5	100	5	100	4	80
SD0039	SD-12	1-Aug	1	5	5	100	5	100	5	100
SD0039	SD-12	1-Aug	1	0	5	100	5	100	5	100
SD0039	SD-12	1-Aug	1							
SD0039	SD-12	1-Aug	1							
SD0039	SD-12	1-Aug	2	100	2	40	0	0	0	0
SD0039	SD-12	1-Aug	2	50	5	100	2	40	0	0
SD0039	SD-12	1-Aug	2	20	5	100	5	100	0	0
SD0039	SD-12	1-Aug	2	10	5	100	5	100	1	20
SD0039	SD-12	1-Aug	2	5	5	100	5	100	5	100
SD0039	SD-12	1-Aug	2	0	5	100	5	100	5	100
SD0039	SD-12	1-Aug	2							
SD0039	SD-12	1-Aug	2							
SD0039	SD-12	1-Aug	3							
SD0039	SD-12	1-Aug	3							
SD0039	SD-12	1-Aug	3							
SD0039	SD-12	1-Aug	3							
SD0039	SD-12	1-Aug	3							
SD0039	SD-12	1-Aug	3							
SD0039	SD-12	1-Aug	3							
SD0039	SD-12	1-Aug	3							
SD0037	SD-13	1-Aug	1	100	3	60	0	0	0	0
SD0037	SD-13	1-Aug	1	50	5	100	4	80	0	0
SD0037	SD-13	1-Aug	1	20	5	100	5	100	0	0
SD0037	SD-13	1-Aug	1	10	5	100	5	100	5	100
SD0037	SD-13	1-Aug	1	5	5	100	5	100	5	100
SD0037	SD-13	1-Aug	1	0	5	100	5	100	5	100
SD0037	SD-13	1-Aug	1							
SD0037	SD-13	1-Aug	1							
SD0037	SD-13	1-Aug	2	100	4	80	0	0	0	0
SD0037	SD-13	1-Aug	2	50	5	100	2	40	0	0
SD0037	SD-13	1-Aug	2	20	5	100	5	100	1	20
SD0037	SD-13	1-Aug	2	10	5	100	5	100	0	0
SD0037	SD-13	1-Aug	2	5	5	100	5	100	5	100
SD0037	SD-13	1-Aug	2	0	5	100	5	100	5	100
SD0037	SD-13	1-Aug	2							

TABLE A2-4. (cont.)

				Amphipod Test (*Rhepoxynius abronius*) with Pore Water						
					Aeration		*Ulva* Treatment		Untreated	
Sample Number	Station	Collection Date[a]	Replicate	Concentration (percent)	Number of Survivors	Survival (percent)	Number of Survivors	Survival (percent)	Number of Survivors	Survival (percent)
SD0037	SD-13	1-Aug	2							
SD0037	SD-13	1-Aug	3							
SD0037	SD-13	1-Aug	3							
SD0037	SD-13	1-Aug	3							
SD0037	SD-13	1-Aug	3							
SD0037	SD-13	1-Aug	3							
SD0037	SD-13	1-Aug	3							
SD0037	SD-13	1-Aug	3							
SD0037	SD-13	1-Aug	3							
SD0029	SD-16	29-Jul	1	100	5	100	5	100	5	100
SD0029	SD-16	29-Jul	1	50	5	100	5	100	5	100
SD0029	SD-16	29-Jul	1	20	5	100	5	100	5	100
SD0029	SD-16	29-Jul	1	10	5	100	5	100	5	100
SD0029	SD-16	29-Jul	1	5	5	100	5	100	5	100
SD0029	SD-16	29-Jul	1	0	5	100	5	100	5	100
SD0029	SD-16	29-Jul	2	100	4	80	5	100	5	100
SD0029	SD-16	29-Jul	2	50	5	100	5	100	5	100
SD0029	SD-16	29-Jul	2	20	5	100	5	100	5	100
SD0029	SD-16	29-Jul	2	10	5	100	5	100	5	100
SD0029	SD-16	29-Jul	2	5	5	100	5	100	5	100
SD0029	SD-16	29-Jul	2	0	5	100	5	100	5	100
SD0031	SD-17	30-Jul	1	100	5	100	5	100	0	0
SD0031	SD-17	30-Jul	1	50	5	100	5	100	0	0
SD0031	SD-17	30-Jul	1	20	5	100	5	100	0	0
SD0031	SD-17	30-Jul	1	10	5	100	5	100	5	100
SD0031	SD-17	30-Jul	1	5	5	100	5	100	5	100
SD0031	SD-17	30-Jul	1	0	5	100	5	100	5	100
SD0031	SD-17	30-Jul	2	100	5	100	5	100	0	0
SD0031	SD-17	30-Jul	2	50	5	100	5	100	0	0
SD0031	SD-17	30-Jul	2	20	5	100	5	100	0	0
SD0031	SD-17	30-Jul	2	10	5	100	5	100	1	20
SD0031	SD-17	30-Jul	2	5	5	100	5	100	5	100
SD0031	SD-17	30-Jul	2	0	5	100	5	100	5	100
SD0033	SD-34	31-Jul	1	100	3	60	1	20	0	0
SD0033	SD-34	31-Jul	1	50	5	100	1	20	0	0
SD0033	SD-34	31-Jul	1	20	5	100	5	100	0	0
SD0033	SD-34	31-Jul	1	10	5	100	5	100	2	40
SD0033	SD-34	31-Jul	1	5	5	100	5	100	5	100
SD0033	SD-34	31-Jul	1	0	5	100	4	80	5	100
SD0033	SD-34	31-Jul	2	100	4	80	1	20	0	0
SD0033	SD-34	31-Jul	2	50	5	100	3	60	0	0
SD0033	SD-34	31-Jul	2	20	5	100	5	100	0	0
SD0033	SD-34	31-Jul	2	10	5	100	5	100	5	100
SD0033	SD-34	31-Jul	2	5	5	100	5	100	5	100
SD0033	SD-34	31-Jul	2	0	5	100	5	100	5	100
SD0034	SD-35	31-Jul	1	100	5	100	2	40	0	0
SD0034	SD-35	31-Jul	1	50	5	100	5	100	0	0
SD0034	SD-35	31-Jul	1	20	5	100	5	100	3	60
SD0034	SD-35	31-Jul	1	10	5	100	5	100	5	100
SD0034	SD-35	31-Jul	1	5	5	100	5	100	5	100
SD0034	SD-35	31-Jul	1	0	5	100	5	100	5	100
SD0034	SD-35	31-Jul	2	100	5	100	3	60	0	0
SD0034	SD-35	31-Jul	2	50	5	100	5	100	1	20

TABLE A2-4. (cont.)

				Amphipod Test (*Rhepoxynius abronius*) with Pore Water						
					Aeration		*Ulva* Treatment		Untreated	
Sample Number	Station	Collection Date[a]	Replicate	Concentration (percent)	Number of Survivors	Survival (percent)	Number of Survivors	Survival (percent)	Number of Survivors	Survival (percent)
SD0034	SD-35	31-Jul	2	20	5	100	5	100	0	0
SD0034	SD-35	31-Jul	2	10	5	100	5	100	5	100
SD0034	SD-35	31-Jul	2	5	5	100	5	100	5	100
SD0034	SD-35	31-Jul	2	0	5	100	5	100	5	100
SD0035	SD-44	31-Jul	1	100	0	0	0	0	0	0
SD0035	SD-44	31-Jul	1	50	0	0	0	0	0	0
SD0035	SD-44	31-Jul	1	20	5	100	5	100	1	20
SD0035	SD-44	31-Jul	1	10	5	100	5	100	5	100
SD0035	SD-44	31-Jul	1	5	5	100	5	100	5	100
SD0035	SD-44	31-Jul	1	0	5	100	5	100	5	100
SD0035	SD-44	31-Jul	1							
SD0035	SD-44	31-Jul	1							
SD0035	SD-44	31-Jul	2	100	0	0	0	0	0	0
SD0035	SD-44	31-Jul	2	50	3	60	3	60	0	0
SD0035	SD-44	31-Jul	2	20	5	100	5	100	1	20
SD0035	SD-44	31-Jul	2	10	5	100	5	100	5	100
SD0035	SD-44	31-Jul	2	5	5	100	5	100	5	100
SD0035	SD-44	31-Jul	2	0	5	100	5	100	5	100
SD0035	SD-44	31-Jul	2							
SD0035	SD-44	31-Jul	2							
SD0035	SD-44	31-Jul	3							
SD0035	SD-44	31-Jul	3							
SD0035	SD-44	31-Jul	3							
SD0035	SD-44	31-Jul	3							
SD0035	SD-44	31-Jul	3							
SD0035	SD-44	31-Jul	3							
SD0035	SD-44	31-Jul	3							
SD0035	SD-44	31-Jul	3							

TABLE A2-4. (cont.)

				Echinoderm Test (*Dendraster excentricus*) with Pore Water						
					Aeration		*Ulva* Treatment		Untreated	
Sample Number	Station	Collection Date[a]	Replicate	Concentration (percent)	Number Normal	Number Abnormal	Number Normal	Number Abnormal	Number Normal	Number Abnormal
SD0030	SD-7	24-Jul	1							
SD0030	SD-7	24-Jul	1							
SD0030	SD-7	24-Jul	1							
SD0030	SD-7	24-Jul	1							
SD0030	SD-7	24-Jul	1							
SD0030	SD-7	24-Jul	1							
SD0030	SD-7	24-Jul	2							
SD0030	SD-7	24-Jul	2							
SD0030	SD-7	24-Jul	2							
SD0030	SD-7	24-Jul	2							
SD0030	SD-7	24-Jul	2							
SD0030	SD-7	24-Jul	2							
SD0039	SD-12	1-Aug	1	40	0	173	0	122	0	185
SD0039	SD-12	1-Aug	1	16	0	34	0	86	0	80
SD0039	SD-12	1-Aug	1	6.4	1	129	36	125	0	105
SD0039	SD-12	1-Aug	1	2.6	172	4	153	7	0	98
SD0039	SD-12	1-Aug	1	1	224	4	167	2	2	86
SD0039	SD-12	1-Aug	1	0.4	173	5	193	7	9	106
SD0039	SD-12	1-Aug	1	0.16	170	5	193	4	132	24
SD0039	SD-12	1-Aug	1	0	192	4	208	8	170	2
SD0039	SD-12	1-Aug	2	40	0	169	0	95	0	198
SD0039	SD-12	1-Aug	2	16	0	51	0	99	0	142
SD0039	SD-12	1-Aug	2	6.4	3	121	47	111	0	113
SD0039	SD-12	1-Aug	2	2.6	200	5	193	9	0	60
SD0039	SD-12	1-Aug	2	1	212	2	185	6	0	53
SD0039	SD-12	1-Aug	2	0.4	209	5	193	2	11	77
SD0039	SD-12	1-Aug	2	0.16	174	1	192	2	168	19
SD0039	SD-12	1-Aug	2	0	170	8	192	2	194	4
SD0039	SD-12	1-Aug	3	40	0	182	0	121	0	159
SD0039	SD-12	1-Aug	3	16	0	21	0	79	0	130
SD0039	SD-12	1-Aug	3	6.4	0	136	47	109	0	80
SD0039	SD-12	1-Aug	3	2.6	156	4	182	12	0	90
SD0039	SD-12	1-Aug	3	1	151	9	169	5	1	80
SD0039	SD-12	1-Aug	3	0.4	203	6	176	5	28	95
SD0039	SD-12	1-Aug	3	0.16	194	4	164	3	149	32
SD0039	SD-12	1-Aug	3	0	192	1	204	7	166	5
SD0037	SD-13	1-Aug	1	40	0	134	0	115	0	78
SD0037	SD-13	1-Aug	1	16	0	66	112	53	0	131
SD0037	SD-13	1-Aug	1	6.4	21	138	178	4	0	95
SD0037	SD-13	1-Aug	1	2.6	206	5	156	7	5	80
SD0037	SD-13	1-Aug	1	1	182	6	189	1	12	49
SD0037	SD-13	1-Aug	1	0.4	180	5	196	1	153	63
SD0037	SD-13	1-Aug	1	0.16	160	5	196	0	160	15
SD0037	SD-13	1-Aug	1	0	172	5	201	1	171	7
SD0037	SD-13	1-Aug	2	40	0	120	0	107	0	110
SD0037	SD-13	1-Aug	2	16	0	78	104	65	0	115
SD0037	SD-13	1-Aug	2	6.4	18	142	168	16	0	114
SD0037	SD-13	1-Aug	2	2.6	202	7	183	6	0	60
SD0037	SD-13	1-Aug	2	1	192	4	207	1	4	79
SD0037	SD-13	1-Aug	2	0.4	199	3	195	2	85	79
SD0037	SD-13	1-Aug	2	0.16	203	2	163	4	127	32

TABLE A2-4. (cont.)

				Echinoderm Test (*Dendraster excentricus*) with Pore Water						
					Aeration		*Ulva* Treatment		Untreated	
Sample Number	Station	Collection Date[a]	Replicate	Concentration (percent)	Number Normal	Number Abnormal	Number Normal	Number Abnormal	Number Normal	Number Abnormal
SD0037	SD-13	1-Aug	2	0	199	1	154	1	185	13
SD0037	SD-13	1-Aug	3	40	0	143	0	111	0	111
SD0037	SD-13	1-Aug	3	16	0	84	95	54	0	158
SD0037	SD-13	1-Aug	3	6.4	17	119	178	8	0	116
SD0037	SD-13	1-Aug	3	2.6	198	7	193	8	1	57
SD0037	SD-13	1-Aug	3	1	197	5	174	5	13	89
SD0037	SD-13	1-Aug	3	0.4	188	7	190	2	95	55
SD0037	SD-13	1-Aug	3	0.16	195	4	187	2	129	36
SD0037	SD-13	1-Aug	3	0	201	3	200	2	176	19
SD0029	SD-16	29-Jul	1							
SD0029	SD-16	29-Jul	1							
SD0029	SD-16	29-Jul	1							
SD0029	SD-16	29-Jul	1							
SD0029	SD-16	29-Jul	1							
SD0029	SD-16	29-Jul	1							
SD0029	SD-16	29-Jul	2							
SD0029	SD-16	29-Jul	2							
SD0029	SD-16	29-Jul	2							
SD0029	SD-16	29-Jul	2							
SD0029	SD-16	29-Jul	2							
SD0029	SD-16	29-Jul	2							
SD0031	SD-17	30-Jul	1							
SD0031	SD-17	30-Jul	1							
SD0031	SD-17	30-Jul	1							
SD0031	SD-17	30-Jul	1							
SD0031	SD-17	30-Jul	1							
SD0031	SD-17	30-Jul	1							
SD0031	SD-17	30-Jul	2							
SD0031	SD-17	30-Jul	2							
SD0031	SD-17	30-Jul	2							
SD0031	SD-17	30-Jul	2							
SD0031	SD-17	30-Jul	2							
SD0031	SD-17	30-Jul	2							
SD0033	SD-34	31-Jul	1							
SD0033	SD-34	31-Jul	1							
SD0033	SD-34	31-Jul	1							
SD0033	SD-34	31-Jul	1							
SD0033	SD-34	31-Jul	1							
SD0033	SD-34	31-Jul	1							
SD0033	SD-34	31-Jul	2							
SD0033	SD-34	31-Jul	2							
SD0033	SD-34	31-Jul	2							
SD0033	SD-34	31-Jul	2							
SD0033	SD-34	31-Jul	2							
SD0033	SD-34	31-Jul	2							
SD0034	SD-35	31-Jul	1							
SD0034	SD-35	31-Jul	1							
SD0034	SD-35	31-Jul	1							
SD0034	SD-35	31-Jul	1							
SD0034	SD-35	31-Jul	1							
SD0034	SD-35	31-Jul	1							
SD0034	SD-35	31-Jul	2							
SD0034	SD-35	31-Jul	2							

TABLE A2-4. (cont.)

Sample Number	Station	Collection Date[a]	Replicate	Echinoderm Test (*Dendraster excentricus*) with Pore Water: Concentration (percent)	Aeration: Number Normal	Aeration: Number Abnormal	*Ulva* Treatment: Number Normal	*Ulva* Treatment: Number Abnormal	Untreated: Number Normal	Untreated: Number Abnormal
SD0034	SD-35	31-Jul	2							
SD0034	SD-35	31-Jul	2							
SD0034	SD-35	31-Jul	2							
SD0034	SD-35	31-Jul	2							
SD0035	SD-44	31-Jul	1	40	0	110	0	149	0	199
SD0035	SD-44	31-Jul	1	16	0	86	0	120	0	127
SD0035	SD-44	31-Jul	1	6.4	0	54	0	50	0	67
SD0035	SD-44	31-Jul	1	2.6	145	63	4	85	0	61
SD0035	SD-44	31-Jul	1	1	172	4	196	6	4	125
SD0035	SD-44	31-Jul	1	0.4	182	5	182	3	110	82
SD0035	SD-44	31-Jul	1	0.16	198	8	169	8	174	25
SD0035	SD-44	31-Jul	1	0	170	5	207	5	166	8
SD0035	SD-44	31-Jul	2	40	0	94	0	116	0	197
SD0035	SD-44	31-Jul	2	16	0	79	0	95	0	138
SD0035	SD-44	31-Jul	2	6.4	0	48	0	38	0	107
SD0035	SD-44	31-Jul	2	2.6	84	108	7	93	0	78
SD0035	SD-44	31-Jul	2	1	166	3	197	4	0	76
SD0035	SD-44	31-Jul	2	0.4	190	4	195	4	45	83
SD0035	SD-44	31-Jul	2	0.16	175	5	189	6	183	8
SD0035	SD-44	31-Jul	2	0	178	2	184	3	190	10
SD0035	SD-44	31-Jul	3	40	0	103	0	154	0	197
SD0035	SD-44	31-Jul	3	16	0	81	0	103	0	132
SD0035	SD-44	31-Jul	3	6.4	0	67	0	61	0	90
SD0035	SD-44	31-Jul	3	2.6	115	82	13	66	0	79
SD0035	SD-44	31-Jul	3	1	188	7	204	3	0	92
SD0035	SD-44	31-Jul	3	0.4	178	3	187	4	41	114
SD0035	SD-44	31-Jul	3	0.16	163	7	193	2	176	17
SD0035	SD-44	31-Jul	3	0	187	5	188	5	191	7

[a] All samples were collected in 1997.

Appendix A3

Summary of Water Quality Parameters for Toxicity Tests and Specialized Toxicity Tests

CONTENTS

TABLE A3-1. SUMMARY OF WATER QUALITY PARAMETERS FROM THE *Rhepoxynius abronius* TOXICITY TEST CONDUCTED IN 1996

Sample Number	Station	Collection Date	Replicate	Day	Temperature (deg C)	Dissolved Oxygen (mg/L)	Salinity (ppt)	pH	Ammonia as Nitrogen (mg/L)
KW001	W01	6/1/96	1	0	14.7	7.5	27.0	8.0	2.5
KW001	W01	6/1/96	1	3	14.8	7.7	27.0	7.7	
KW001	W01	6/1/96	1	5		8.0			
KW001	W01	6/1/96	1	7	15.5	8.1	28.0	8.0	
KW001	W01	6/1/96	1	10	15.7	7.7	29.0	7.8	7.5
KW001	W01	6/1/96	2	0	14.6	7.4	27.0	7.7	2.5
KW001	W01	6/1/96	2	5		8.0			
KW001	W01	6/1/96	2	10	15.8	7.8	28.5	7.8	8.5
KW001	W01	6/1/96	3	0	14.7	7.5	27.0	8.0	2.5
KW001	W01	6/1/96	3	5		8.0			
KW001	W01	6/1/96	3	10	15.9	7.8	28.5	7.9	8.0
KW001	W01	6/1/96	4	0	14.7	7.7	27.0	7.9	2.5
KW001	W01	6/1/96	4	5		8.2			
KW001	W01	6/1/96	4	10	15.9	7.9	28.5	7.8	8.0
KW001	W01	6/1/96	5	0	14.6	7.6	27.0	7.6	2.1
KW001	W01	6/1/96	5	5		8.0			
KW001	W01	6/1/96	5	10	15.4	7.9	28.0	7.7	7.5
KW002	W02	6/1/96	1	0	15.0	7.6	27.0	8.0	2.4
KW002	W02	6/1/96	1	3	15.1	8.0	27.5	7.7	
KW002	W02	6/1/96	1	5		8.0			
KW002	W02	6/1/96	1	7	15.9	8.2	28.0	8.1	
KW002	W02	6/1/96	1	10	15.8	7.8	28.5	8.1	8.0
KW002	W02	6/1/96	2	0	15.0	7.8	27.0	8.0	2.5
KW002	W02	6/1/96	2	5		8.1			
KW002	W02	6/1/96	2	10	15.9	7.8	28.5	8.0	6.5
KW002	W02	6/1/96	3	0	14.8	7.5	27.0	7.9	2.4
KW002	W02	6/1/96	3	5		7.9			
KW002	W02	6/1/96	3	10	15.9	7.9	28.0	7.8	7.5
KW002	W02	6/1/96	4	0	14.5	7.7	27.0	7.9	2.5
KW002	W02	6/1/96	4	5		8.0			
KW002	W02	6/1/96	4	10	15.8	7.6	29.0	7.8	7.5
KW002	W02	6/1/96	5	0	14.9	7.8	27.0	8.0	2.5
KW002	W02	6/1/96	5	5		8.0			
KW002	W02	6/1/96	5	10	15.8	7.9	29.0	8.1	8.0
KW003	W03	6/2/96	1	0	14.6	7.7	27.0	7.9	0.3
KW003	W03	6/2/96	1	3	14.8	7.7	28.0	7.7	
KW003	W03	6/2/96	1	5		7.9			
KW003	W03	6/2/96	1	7	15.5	8.1	28.0	8.1	
KW003	W03	6/2/96	1	10	15.7	7.7	29.0	8.0	1.8
KW003	W03	6/2/96	2	0	15.0	7.8	27.0	7.9	0.1
KW003	W03	6/2/96	2	5		8.1			
KW003	W03	6/2/96	2	10	15.4	7.8	29.0	8.3	0.9
KW003	W03	6/2/96	3	0	14.6	7.8	27.0	7.9	0.3
KW003	W03	6/2/96	3	5		8.1			
KW003	W03	6/2/96	3	10	15.9	7.6	29.0	8.1	2.4
KW003	W03	6/2/96	4	0	14.7	7.8	27.0	7.9	0.4
KW003	W03	6/2/96	4	5		7.9			
KW003	W03	6/2/96	4	10	15.5	7.8	28.5	8.3	1.7
KW003	W03	6/2/96	5	0	14.8	7.6	27.0	8.0	0.2

TABLE A3-1. (cont.)

Sample Number	Station	Collection Date	Replicate	Day	Temperature (deg C)	Dissolved Oxygen (mg/L)	Salinity (ppt)	pH	Ammonia as Nitrogen (mg/L)
KW003	W03	6/2/96	5	5		8.0			
KW003	W03	6/2/96	5	10	15.7	7.8	28.0	8.3	3.8
KW004	W04	6/2/96	1	0	14.6	7.6	27.0	7.9	1.2
KW004	W04	6/2/96	1	3	14.9	7.8	27.5	7.7	
KW004	W04	6/2/96	1	5		8.0			
KW004	W04	6/2/96	1	7	15.5	7.9	28.5	8.0	
KW004	W04	6/2/96	1	10	15.7	7.7	29.0	7.8	4.5
KW004	W04	6/2/96	2	0	14.6	7.6	27.0	8.0	1.3
KW004	W04	6/2/96	2	5		8.0			
KW004	W04	6/2/96	2	10	15.5	7.8	28.5	7.8	3.8
KW004	W04	6/2/96	3	0	14.9	7.7	27.0	8.0	1.3
KW004	W04	6/2/96	3	5		8.0			
KW004	W04	6/2/96	3	10	16.0	7.8	29.0	7.8	4.8
KW004	W04	6/2/96	4	0	14.6	7.6	27.0	8.0	1.4
KW004	W04	6/2/96	4	5		8.1			
KW004	W04	6/2/96	4	10	15.5	7.8	28.0	7.8	2.6
KW004	W04	6/2/96	5	0	14.6	7.6	27.0	8.0	1.2
KW004	W04	6/2/96	5	5		8.0			
KW004	W04	6/2/96	5	10	15.5	7.8	29.0	7.8	4.0
KW005	W05	6/1/96	1	0	15.0	7.8	27.0	7.9	0.6
KW005	W05	6/1/96	1	3	14.9	7.9	27.5	7.5	
KW005	W05	6/1/96	1	5		8.1			
KW005	W05	6/1/96	1	7	15.8	8.3	28.5	8.0	
KW005	W05	6/1/96	1	10	15.6	7.9	29.0	8.0	5.5
KW005	W05	6/1/96	2	0	14.9	7.8	27.0	7.8	0.7
KW005	W05	6/1/96	2	5		8.0			
KW005	W05	6/1/96	2	10	16.0	7.8	27.5	7.7	3.8
KW005	W05	6/1/96	3	0	14.5	7.4	27.0	7.7	0.8
KW005	W05	6/1/96	3	5		8.1			
KW005	W05	6/1/96	3	10	15.9	7.8	28.5	7.7	5.0
KW005	W05	6/1/96	4	0	14.6	7.8	27.0	7.7	0.6
KW005	W05	6/1/96	4	5		8.0			
KW005	W05	6/1/96	4	10	15.8	7.9	29.0	7.8	5.0
KW005	W05	6/1/96	5	0	14.6	7.6	27.0	7.8	0.8
KW005	W05	6/1/96	5	5		8.1			
KW005	W05	6/1/96	5	10	15.8	7.8	28.0	7.6	4.8
KW006	W06	6/4/96	1	0	14.7	7.4	27.0	7.9	2.5
KW006	W06	6/4/96	1	3	14.8	7.8	28.0	7.7	
KW006	W06	6/4/96	1	5		8.0			
KW006	W06	6/4/96	1	7	15.8	8.2	28.5	8.0	
KW006	W06	6/4/96	1	10	15.9	7.8	29.0	7.7	7.0
KW006	W06	6/4/96	2	0	14.6	7.4	27.0	7.8	2.1
KW006	W06	6/4/96	2	5		8.1			
KW006	W06	6/4/96	2	10	15.7	7.8	28.0	7.7	7.0
KW006	W06	6/4/96	3	0	15.0	7.7	27.0	7.9	2.5
KW006	W06	6/4/96	3	5		8.0			
KW006	W06	6/4/96	3	10	15.4	7.8	28.5	8.0	7.0
KW006	W06	6/4/96	4	0	15.1	7.7	27.0	7.7	2.4
KW006	W06	6/4/96	4	5		8.1			

TABLE A3-1. (cont.)

Sample Number	Station	Collection Date	Replicate	Day	Temperature (deg C)	Dissolved Oxygen (mg/L)	Salinity (ppt)	pH	Ammonia as Nitrogen (mg/L)
KW006	W06	6/4/96	4	10	15.4	7.8	28.5	7.8	8.0
KW006	W06	6/4/96	5	0	14.6	7.6	27.0	7.7	1.9
KW006	W06	6/4/96	5	5		8.0			
KW006	W06	6/4/96	5	10	15.6	7.8	28.5	7.7	8.0
KW007	W07	6/2/96	1	0	14.6	7.6	27.0	7.9	0.8
KW007	W07	6/2/96	1	3	14.8	7.8	28.0	7.6	
KW007	W07	6/2/96	1	5		8.0			
KW007	W07	6/2/96	1	7	15.7	8.2	28.0	8.0	
KW007	W07	6/2/96	1	10	15.8	7.8	29.0	7.7	2.8
KW007	W07	6/2/96	2	0	15.0	7.6	27.0	7.9	0.7
KW007	W07	6/2/96	2	5		8.0			
KW007	W07	6/2/96	2	10	15.5	8.0	29.0	8.0	4.0
KW007	W07	6/2/96	3	0	15.0	7.8	27.0	7.9	0.7
KW007	W07	6/2/96	3	5		8.1			
KW007	W07	6/2/96	3	10	15.5	8.0	28.5	8.0	3.9
KW007	W07	6/2/96	4	0	14.9	7.8	27.0	8.0	0.4
KW007	W07	6/2/96	4	5		8.2			
KW007	W07	6/2/96	4	10	15.6	8.0	29.0	8.1	4.1
KW007	W07	6/2/96	5	0	14.6	7.8	27.0	7.9	0.8
KW007	W07	6/2/96	5	5		8.1			
KW007	W07	6/2/96	5	10	15.8	7.9	28.0	7.9	3.6
KW008	W08	6/2/96	1	0	14.9	7.5	27.0	7.9	1.3
KW008	W08	6/2/96	1	3	14.9	8.0	28.0	7.5	
KW008	W08	6/2/96	1	5		8.1			
KW008	W08	6/2/96	1	7	15.8	8.3	28.5	8.0	
KW008	W08	6/2/96	1	10	15.5	7.9	29.0	8.0	6.0
KW008	W08	6/2/96	2	0	14.9	7.8	27.0	7.9	1.0
KW008	W08	6/2/96	2	5		8.1			
KW008	W08	6/2/96	2	10	15.8	7.9	29.0	8.0	5.0
KW008	W08	6/2/96	3	0	14.6	7.6	27.0	8.0	1.3
KW008	W08	6/2/96	3	5		7.9			
KW008	W08	6/2/96	3	10	15.8	7.7	28.5	7.7	0
KW008	W08	6/2/96	4	0	14.5	7.7	27.0	7.7	1.3
KW008	W08	6/2/96	4	5		8.1			
KW008	W08	6/2/96	4	10	15.4	7.8	28.5	7.8	4.1
KW008	W08	6/2/96	5	0	15.0	7.5	27.0	7.9	1.2
KW008	W08	6/2/96	5	5		8.0			
KW008	W08	6/2/96	5	10	15.4	7.6	29.0	8.0	6.0
KW009	W09	6/2/96	1	0	14.7	7.2	27.0	7.7	0.9
KW009	W09	6/2/96	1	3	14.7	8.0	27.0	7.7	
KW009	W09	6/2/96	1	5		8.1			
KW009	W09	6/2/96	1	7	15.4	8.1	28.0	8.1	
KW009	W09	6/2/96	1	10	15.6	7.8	28.5	7.7	4.2
KW009	W09	6/2/96	2	0	14.5	7.3	27.0	7.9	1.2
KW009	W09	6/2/96	2	5		8.1			
KW009	W09	6/2/96	2	10	15.5	7.8	28.5	7.8	5.0
KW009	W09	6/2/96	3	0	14.6	7.8	27.0	7.8	1.0
KW009	W09	6/2/96	3	5		8.0			
KW009	W09	6/2/96	3	10	15.5	7.8	28.5	7.9	4.4

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TABLE A3-1. (cont.)

Sample Number	Station	Collection Date	Replicate	Day	Temperature (deg C)	Dissolved Oxygen (mg/L)	Salinity (ppt)	pH	Ammonia as Nitrogen (mg/L)
KW009	W09	6/2/96	4	0	14.6	7.7	27.0	7.8	1.0
KW009	W09	6/2/96	4	5		8.1			
KW009	W09	6/2/96	4	10	15.9	7.9	29.0	7.8	4.3
KW009	W09	6/2/96	5	0	14.7	7.7	27.0	7.8	1.1
KW009	W09	6/2/96	5	5		8.1			
KW009	W09	6/2/96	5	10	15.8	7.8	29.0	7.8	4.9
KW010	W010R	6/3/96	1	0	15.0	7.6	27.0	7.8	0.9
KW010	W010R	6/3/96	1	3	15.1	8.0	27.5	7.6	
KW010	W010R	6/3/96	1	5		8.1			
KW010	W010R	6/3/96	1	7	15.9	8.3	28.0	8.1	
KW010	W010R	6/3/96	1	10	15.4	8.0	29.0	8.1	4.2
KW010	W010R	6/3/96	2	0	14.7	7.5	27.0	7.8	1.0
KW010	W010R	6/3/96	2	5		8.1			
KW010	W010R	6/3/96	2	10	15.9	7.8	29.0	7.9	4.2
KW010	W010R	6/3/96	3	0	14.6	7.5	27.0	7.8	1.0
KW010	W010R	6/3/96	3	5		8.0			
KW010	W010R	6/3/96	3	10	15.5	7.8	29.0	7.9	4.8
KW010	W010R	6/3/96	4	0	15.0	7.7	27.0	7.9	0.6
KW010	W010R	6/3/96	4	5		8.0			
KW010	W010R	6/3/96	4	10	15.8	7.8	28.5	8.1	3.6
KW010	W010R	6/3/96	5	0	15.0	7.8	27.0	7.9	0.9
KW010	W010R	6/3/96	5	5		8.1			
KW010	W010R	6/3/96	5	10	15.4	8.0	29.0	8.1	4.8
KW011	W011	5/30/96	1	0	15.0	7.8	27.0	7.9	0.7
KW011	W011	5/30/96	1	3	15.2	8.0	28.0	7.7	
KW011	W011	5/30/96	1	5		8.1			
KW011	W011	5/30/96	1	7	15.9	8.2	28.0	8.1	
KW011	W011	5/30/96	1	10	15.7	7.9	29.0	8.2	2.0
KW011	W011	5/30/96	2	0	14.6	7.6	27.0	7.9	0.7
KW011	W011	5/30/96	2	5		8.1			
KW011	W011	5/30/96	2	10	15.5	7.8	29.0	7.9	2.4
KW011	W011	5/30/96	3	0	14.6	7.8	27.0	8.0	0.8
KW011	W011	5/30/96	3	5		8.1			
KW011	W011	5/30/96	3	10	15.5	7.8	28.5	8.0	1.7
KW011	W011	5/30/96	4	0	14.6	7.6	27.0	7.9	0.8
KW011	W011	5/30/96	4	5		8.0			
KW011	W011	5/30/96	4	10	15.9	7.7	29.0	8.0	2.8
KW011	W011	5/30/96	5	0	14.4	7.6	27.0	8.0	0.9
KW011	W011	5/30/96	5	5		8.0			
KW011	W011	5/30/96	5	10	15.8	7.8	27.5	7.9	2.7
KW012	W012	6/4/96	1	0	14.7	7.7	27.0	7.9	0.5
KW012	W012	6/4/96	1	3	15.0	7.8	28.0	7.6	
KW012	W012	6/4/96	1	5		8.2			
KW012	W012	6/4/96	1	7	15.8	8.2	28.5	8.0	
KW012	W012	6/4/96	1	10	15.8	8.0	28.5	7.7	7.0
KW012	W012	6/4/96	2	0	14.7	7.7	27.0	8.0	2.2
KW012	W012	6/4/96	2	5		8.0			
KW012	W012	6/4/96	2	10	15.9	7.6	29.0	7.8	7.5
KW012	W012	6/4/96	3	0	14.9	7.6	27.0	7.9	2.0

TABLE A3-1. (cont.)

Sample Number	Station	Collection Date	Replicate	Day	Temperature (deg C)	Dissolved Oxygen (mg/L)	Salinity (ppt)	pH	Ammonia as Nitrogen (mg/L)
KW012	W012	6/4/96	3	5		8.2			
KW012	W012	6/4/96	3	10	15.7	8.0	29.0	8.0	7.0
KW012	W012	6/4/96	4	0	14.8	7.8	27.0	7.9	2.0
KW012	W012	6/4/96	4	5		8.1			
KW012	W012	6/4/96	4	10	15.8	7.8	29.0	7.8	7.0
KW012	W012	6/4/96	5	0	15.0	7.5	27.0	7.9	2.0
KW012	W012	6/4/96	5	5		8.0			
KW012	W012	6/4/96	5	10	15.8	7.9	29.0	8.1	6.0
KW013	W013	6/4/96	1	0	14.6	7.7	27.0	7.8	0.6
KW013	W013	6/4/96	1	3	14.8	7.7	28.0	7.6	
KW013	W013	6/4/96	1	5		8.0			
KW013	W013	6/4/96	1	7	15.8	8.0	28.5	8.0	
KW013	W013	6/4/96	1	10	15.8	7.8	28.5	7.7	7.5
KW013	W013	6/4/96	2	0	14.9	7.5	27.0	7.8	1.0
KW013	W013	6/4/96	2	5		7.9			
KW013	W013	6/4/96	2	10	15.5	7.8	29.0	8.0	4.8
KW013	W013	6/4/96	3	0	14.9	7.9	27.0	8.0	1.2
KW013	W013	6/4/96	3	5		8.1			
KW013	W013	6/4/96	3	10	16.0	7.8	29.0	7.8	6.0
KW013	W013	6/4/96	4	0	14.6	7.6	27.0	7.7	1.5
KW013	W013	6/4/96	4	5		8.2			
KW013	W013	6/4/96	4	10	15.9	7.8	28.0	7.7	6.0
KW013	W013	6/4/96	5	0	14.9	7.8	27.0	7.9	0.9
KW013	W013	6/4/96	5	5		8.1			
KW013	W013	6/4/96	5	10	15.7	7.9	29.0	8.0	5.2
KW014	W014	6/4/96	1	0	14.5	7.6	27.0	7.7	0.7
KW014	W014	6/4/96	1	3	14.7	7.8	28.0	7.7	
KW014	W014	6/4/96	1	5		7.9			
KW014	W014	6/4/96	1	7	15.4	8.2	28.5	8.1	
KW014	W014	6/4/96	1	10	15.4	7.8	28.5	7.8	3.8
KW014	W014	6/4/96	2	0	14.8	7.9	27.0	7.9	0.4
KW014	W014	6/4/96	2	5		8.1			
KW014	W014	6/4/96	2	10	15.6	8.0	28.0	8.1	4.0
KW014	W014	6/4/96	3	0	14.9	7.6	27.0	7.8	0.5
KW014	W014	6/4/96	3	5		8.0			
KW014	W014	6/4/96	3	10	15.9	7.8	28.0	7.8	4.2
KW014	W014	6/4/96	4	0	14.9	7.8	27.0	7.9	0.4
KW014	W014	6/4/96	4	5		8.0			
KW014	W014	6/4/96	4	10	15.8	8.0	29.0	8.2	3.2
KW014	W014	6/4/96	5	0	14.7	7.1	27.0	7.8	1.2
KW014	W014	6/4/96	5	5		8.2			
KW014	W014	6/4/96	5	10	15.9	7.8	28.5	7.9	5.5
KW015	W015	6/2/96	1	0	15.0	7.4	27.0	7.8	0.6
KW015	W015	6/2/96	1	3	15.0	7.9	27.5	7.6	
KW015	W015	6/2/96	1	5		8.0			
KW015	W015	6/2/96	1	7	15.8	8.2	28.5	7.9	
KW015	W015	6/2/96	1	10	15.5	7.8	29.0	8.0	5.0
KW015	W015	6/2/96	2	0	14.9	7.6	27.0	7.9	0.7
KW015	W015	6/2/96	2	5		8.1			

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TABLE A3-1. (cont.)

Sample Number	Station	Collection Date	Replicate	Day	Temperature (deg C)	Dissolved Oxygen (mg/L)	Salinity (ppt)	pH	Ammonia as Nitrogen (mg/L)
KW015	W015	6/2/96	2	10	15.9	7.8	28.5	7.7	4.6
KW015	W015	6/2/96	3	0	14.8	7.8	27.0	7.9	0.8
KW015	W015	6/2/96	3	5		8.0			
KW015	W015	6/2/96	3	10	16.0	7.8	28.5	7.7	3.8
KW015	W015	6/2/96	4	0	14.6	7.6	27.0	7.8	0.8
KW015	W015	6/2/96	4	5		8.0			
KW015	W015	6/2/96	4	10	15.6	7.7	29.0	7.7	2.8
KW015	W015	6/2/96	5	0	14.9	7.4	27.0	7.9	1.0
KW015	W015	6/2/96	5	5		8.0			
KW015	W015	6/2/96	5	10	16.0	7.8	28.5	7.7	5.0
KW016	W016	6/3/96	1	0	14.9	7.7	27.0	8.0	0.3
KW016	W016	6/3/96	1	3	15.0	8.0	27.0	7.6	
KW016	W016	6/3/96	1	5		8.0			
KW016	W016	6/3/96	1	7	15.8	8.3	28.5	8.1	
KW016	W016	6/3/96	1	10	15.8	7.8	28.0	8.1	3.0
KW016	W016	6/3/96	2	0	14.7	7.6	27.0	7.9	0.5
KW016	W016	6/3/96	2	5		8.0			
KW016	W016	6/3/96	2	10	15.6	7.8	28.5	7.7	1.7
KW016	W016	6/3/96	3	0	14.9	7.6	27.0	7.8	0.3
KW016	W016	6/3/96	3	5		8.0			
KW016	W016	6/3/96	3	10	15.4	8.0	29.0	8.0	2.4
KW016	W016	6/3/96	4	0	14.9	7.7	27.0	7.9	0.4
KW016	W016	6/3/96	4	5		8.0			
KW016	W016	6/3/96	4	10	15.4	7.8	29.0	8.1	3.2
KW016	W016	6/3/96	5	0	14.6	7.2	27.0	7.8	0.6
KW016	W016	6/3/96	5	5		8.1			
KW016	W016	6/3/96	5	10	15.8	7.8	28.0	7.6	3.1
KW017	W017R	6/3/96	1	0	14.8	7.0	27.0	7.6	0.1
KW017	W017R	6/3/96	1	3	15.1	8.0	27.5	7.4	
KW017	W017R	6/3/96	1	5		8.0			
KW017	W017R	6/3/96	1	7	15.9	8.4	28.5	8.0	
KW017	W017R	6/3/96	1	10	15.4	7.7	29.0	8.0	0.4
KW017	W017R	6/3/96	2	0	14.5	7.7	27.0	7.6	0.2
KW017	W017R	6/3/96	2	5		8.1			
KW017	W017R	6/3/96	2	10	15.9	7.8	28.0	7.7	0.6
KW017	W017R	6/3/96	3	0	15.0	7.7	27.0	7.8	0.2
KW017	W017R	6/3/96	3	5		8.0			
KW017	W017R	6/3/96	3	10	15.5	7.8	29.0	8.0	0
KW017	W017R	6/3/96	4	0	14.5	7.7	27.0	7.8	0.1
KW017	W017R	6/3/96	4	5		8.2			
KW017	W017R	6/3/96	4	10	15.8	7.8	29.0	7.6	0.3
KW017	W017R	6/3/96	5	0	14.6	7.5	27.0	7.8	0.3
KW017	W017R	6/3/96	5	5		8.1			
KW017	W017R	6/3/96	5	10	15.7	7.8	29.0	7.7	0.8
KW018	W018	5/29/96	1	0	14.9	7.2	27.0	7.9	0.3
KW018	W018	5/29/96	1	3	15.1	8.0	28.0	7.7	
KW018	W018	5/29/96	1	5		7.9			
KW018	W018	5/29/96	1	7	15.8	8.2	28.5	8.2	
KW018	W018	5/29/96	1	10	15.4	7.8	29.0	8.2	2.0

TABLE A3-1. (cont.)

Sample Number	Station	Collection Date	Replicate	Day	Temperature (deg C)	Dissolved Oxygen (mg/L)	Salinity (ppt)	pH	Ammonia as Nitrogen (mg/L)
KW018	W018	5/29/96	2	0	14.7	7.4	27.0	8.0	0.3
KW018	W018	5/29/96	2	5		8.0			
KW018	W018	5/29/96	2	10	15.9	7.8	27.5	8.0	2.5
KW018	W018	5/29/96	3	0	14.9	7.7	27.0	8.0	1.0
KW018	W018	5/29/96	3	5		7.9			
KW018	W018	5/29/96	3	10	15.9	7.8	28.5	8.2	1.4
KW018	W018	5/29/96	4	0	14.6	7.1	27.0	8.0	1.0
KW018	W018	5/29/96	4	5		8.1			
KW018	W018	5/29/96	4	10	15.7	7.8	27.5	8.1	1.8
KW018	W018	5/29/96	5	0	14.6	7.9	27.0	8.0	0.6
KW018	W018	5/29/96	5	5		8.0			
KW018	W018	5/29/96	5	10	15.7	8.0	29.0	8.1	3.6
KW019	W019	6/1/96	1	0	14.7	7.6	27.0	7.9	0.6
KW019	W019	6/1/96	1	3	14.8	7.8	27.5	7.7	
KW019	W019	6/1/96	1	5		7.9			
KW019	W019	6/1/96	1	7	15.7	8.0	28.0	8.1	
KW019	W019	6/1/96	1	10	15.9	7.7	29.0	7.9	7.0
KW019	W019	6/1/96	2	0	14.5	7.7	27.0	7.4	1.1
KW019	W019	6/1/96	2	5		8.1			
KW019	W019	6/1/96	2	10	15.5	7.8	28.5	7.9	4.0
KW019	W019	6/1/96	3	0	15.0	7.6	27.0	7.9	1.2
KW019	W019	6/1/96	3	5		8.0			
KW019	W019	6/1/96	3	10	15.5	7.9	29.0	8.1	3.6
KW019	W019	6/1/96	4	0	14.9	7.8	27.0	7.9	1.0
KW019	W019	6/1/96	4	5		8.1			
KW019	W019	6/1/96	4	10	15.6	7.9	29.0	8.2	4.4
KW019	W019	6/1/96	5	0	14.6	7.6	27.0	7.7	1.4
KW019	W019	6/1/96	5	5		8.0			
KW019	W019	6/1/96	5	10	15.5	7.8	29.0	7.9	2.4
KW020	W020	5/31/96	1	0	14.7	7.6	27.0	7.8	1.4
KW020	W020	5/31/96	1	3	14.8	7.9	28.0	7.7	
KW020	W020	5/31/96	1	5		8.0			
KW020	W020	5/31/96	1	7	15.6	8.1	28.0	8.1	
KW020	W020	5/31/96	1	10	15.9	7.8	29.0	8.0	2.8
KW020	W020	5/31/96	2	0	14.6	7.7	27.0	7.8	0.4
KW020	W020	5/31/96	2	5		8.1			
KW020	W020	5/31/96	2	10	15.8	7.8	29.0	8.0	4.5
KW020	W020	5/31/96	3	0	14.9	7.7	27.0	8.0	1.1
KW020	W020	5/31/96	3	5		7.9			
KW020	W020	5/31/96	3	10	16.0	7.8	29.0	8.3	3.2
KW020	W020	5/31/96	4	0	14.5	7.6	27.0	7.9	1.4
KW020	W020	5/31/96	4	5		8.0			
KW020	W020	5/31/96	4	10	15.5	7.9	29.0	8.0	3.3
KW020	W020	5/31/96	5	0	14.6	7.6	27.0	7.8	1.4
KW020	W020	5/31/96	5	5		8.2			
KW020	W020	5/31/96	5	10	15.9	8.0	28.5	8.1	3.6
KW021	W021	6/3/96	1	0	14.5	7.7	27.0	7.9	0.8
KW021	W021	6/3/96	1	3	14.8	7.9	28.0	7.7	
KW021	W021	6/3/96	1	5		8.0			

TABLE A3-1. (cont.)

Sample Number	Station	Collection Date	Replicate	Day	Temperature (deg C)	Dissolved Oxygen (mg/L)	Salinity (ppt)	pH	Ammonia as Nitrogen (mg/L)
KW021	W021	6/3/96	1	7	15.6	8.1	28.0	8.0	
KW021	W021	6/3/96	1	10	15.9	7.7	28.5	7.8	3.5
KW021	W021	6/3/96	2	0	14.9	7.8	27.0	7.9	0.5
KW021	W021	6/3/96	2	5		8.1			
KW021	W021	6/3/96	2	10	15.5	7.9	29.0	8.2	3.6
KW021	W021	6/3/96	3	0	15.0	7.6	27.0	8.0	0.8
KW021	W021	6/3/96	3	5		8.0			
KW021	W021	6/3/96	3	10	15.4	7.8	29.0	8.1	4.6
KW021	W021	6/3/96	4	0	15.0	7.7	27.0	8.0	0.7
KW021	W021	6/3/96	4	5		7.9			
KW021	W021	6/3/96	4	10	15.5	7.8	29.0	8.1	3.8
KW021	W021	6/3/96	5	0	14.6	7.6	27.0	7.8	0.9
KW021	W021	6/3/96	5	5		8.0			
KW021	W021	6/3/96	5	10	15.6	7.8	28.5	7.8	3.4
KW022	W022	5/28/96	1	0	14.5	7.7	27.0	8.0	0.4
KW022	W022	5/28/96	1	3	14.9	7.8	27.5	7.7	
KW022	W022	5/28/96	1	5		8.0			
KW022	W022	5/28/96	1	7	15.6	8.2	28.0	8.0	
KW022	W022	5/28/96	1	10	15.6	7.8	29.0	8.0	0
KW022	W022	5/28/96	2	0	15.0	7.6	27.0	8.0	0.2
KW022	W022	5/28/96	2	5		8.0			
KW022	W022	5/28/96	2	10	15.7	7.8	28.0	8.2	0.2
KW022	W022	5/28/96	3	0	14.6	7.6	27.0	8.0	0.3
KW022	W022	5/28/96	3	5		8.0			
KW022	W022	5/28/96	3	10	15.4	7.9	28.5	8.1	0
KW022	W022	5/28/96	4	0	14.6	7.6	27.0	7.9	0.4
KW022	W022	5/28/96	4	5		8.1			
KW022	W022	5/28/96	4	10	15.6	7.8	29.0	8.0	0
KW022	W022	5/28/96	5	0	14.7	7.8	27.0	7.9	0.2
KW022	W022	5/28/96	5	5		8.1			
KW022	W022	5/28/96	5	10	15.8	8.0	29.0	8.0	0
KW023	W023	5/29/96	1	0	14.6	7.4	27.0	7.9	0.3
KW023	W023	5/29/96	1	3	14.8	7.8	27.5	7.6	
KW023	W023	5/29/96	1	5		7.9			
KW023	W023	5/29/96	1	7	15.4	8.2	29.0	8.0	
KW023	W023	5/29/96	1	10	15.5	7.7	29.0	7.9	0
KW023	W023	5/29/96	2	0	14.6	7.4	27.0	8.0	0.1
KW023	W023	5/29/96	2	5		8.0			
KW023	W023	5/29/96	2	10	15.4	7.8	29.0	8.1	0
KW023	W023	5/29/96	3	0	15.0	7.7	27.0	7.9	0.1
KW023	W023	5/29/96	3	5		8.0			
KW023	W023	5/29/96	3	10	15.4	7.8	29.0	8.3	0
KW023	W023	5/29/96	4	0	14.7	7.7	27.0	7.9	0.1
KW023	W023	5/29/96	4	5		8.0			
KW023	W023	5/29/96	4	10	15.8	7.9	29.0	8.2	0.4
KW023	W023	5/29/96	5	0	14.8	7.9	27.0	7.9	0.1
KW023	W023	5/29/96	5	5		8.1			
KW023	W023	5/29/96	5	10	15.8	8.0	29.0	8.0	0.1
KW024	W024	6/1/96	1	0	14.5	7.9	27.0	7.9	0.5

TABLE A3-1. (cont.)

Sample Number	Station	Collection Date	Replicate	Day	Temperature (deg C)	Dissolved Oxygen (mg/L)	Salinity (ppt)	pH	Ammonia as Nitrogen (mg/L)
KW024	W024	6/1/96	1	3	15.1	7.9	28.5	7.6	
KW024	W024	6/1/96	1	5		8.2			
KW024	W024	6/1/96	1	7	15.8	8.3	29.0	8.2	
KW024	W024	6/1/96	1	10	15.7	8.0	29.0	8.2	2.6
KW024	W024	6/1/96	2	0	14.9	7.9	27.0	8.0	0.3
KW024	W024	6/1/96	2	5		8.1			
KW024	W024	6/1/96	2	10	15.7	7.9	29.0	8.4	0.8
KW024	W024	6/1/96	3	0	14.6	7.6	27.0	7.9	0.4
KW024	W024	6/1/96	3	5		8.0			
KW024	W024	6/1/96	3	10	15.7	7.9	28.5	8.2	1.6
KW024	W024	6/1/96	4	0	14.6	7.6	27.0	7.6	0.7
KW024	W024	6/1/96	4	5		7.9			
KW024	W024	6/1/96	4	10	15.5	7.7	29.0	8.0	1.4
KW024	W024	6/1/96	5	0	14.7	7.3	27.0	7.7	0.3
KW024	W024	6/1/96	5	5		8.0			
KW024	W024	6/1/96	5	10	15.5	7.9	29.0	8.4	1.5
KW025	W025	5/30/96	1	0	14.8	7.6	27.0	7.9	2.5
KW025	W025	5/30/96	1	3	14.8	7.8	28.0	7.6	
KW025	W025	5/30/96	1	5		8.1			
KW025	W025	5/30/96	1	7	15.6	8.2	28.5	8.0	
KW025	W025	5/30/96	1	10	15.8	7.8	29.0	7.6	8.0
KW025	W025	5/30/96	2	0	14.6	7.8	27.0	7.9	2.4
KW025	W025	5/30/96	2	5		8.2			
KW025	W025	5/30/96	2	10	15.9	7.8	28.5	7.6	8.0
KW025	W025	5/30/96	3	0	14.6	5.1	27.0	7.7	2.5
KW025	W025	5/30/96	3	5		8.1			
KW025	W025	5/30/96	3	10	15.4	7.8	29.0	7.6	7.5
KW025	W025	5/30/96	4	0	14.6	7.4	27.0	7.7	2.5
KW025	W025	5/30/96	4	5		8.2			
KW025	W025	5/30/96	4	10	15.9	7.8	28.5	7.5	7.5
KW025	W025	5/30/96	5	0	14.6	7.4	27.0	8.0	2.5
KW025	W025	5/30/96	5	5		8.0			
KW025	W025	5/30/96	5	10	16.0	7.8	28.0	7.6	8.0
KW026	W026	5/30/96	1	0	14.7	7.6	27.0	7.9	1.1
KW026	W026	5/30/96	1	3	14.8	7.7	27.0	7.7	
KW026	W026	5/30/96	1	5		8.1			
KW026	W026	5/30/96	1	7	15.8	8.0	28.0	8.1	
KW026	W026	5/30/96	1	10	15.8	7.8	29.0	7.9	3.8
KW026	W026	5/30/96	2	0	15.0	7.7	27.0	7.9	1.0
KW026	W026	5/30/96	2	5		8.0			
KW026	W026	5/30/96	2	10	15.5	7.9	29.0	8.0	3.6
KW026	W026	5/30/96	3	0	14.6	7.6	27.0	7.9	1.2
KW026	W026	5/30/96	3	5		8.1			
KW026	W026	5/30/96	3	10	15.9	7.8	29.0	7.8	3.6
KW026	W026	5/30/96	4	0	14.6	7.6	27.0	7.8	1.0
KW026	W026	5/30/96	4	5		8.0			
KW026	W026	5/30/96	4	10	15.4	7.8	28.0	7.8	1.8
KW026	W026	5/30/96	5	0	15.0	7.7	27.0	8.0	0.9
KW026	W026	5/30/96	5	5		8.0			

TABLE A3-1. (cont.)

Sample Number	Station	Collection Date	Replicate	Day	Temperature (deg C)	Dissolved Oxygen (mg/L)	Salinity (ppt)	pH	Ammonia as Nitrogen (mg/L)
KW026	W026	5/30/96	5	10	15.4	7.8	29.0	8.1	1.4
KW027	W027	5/29/96	1	0	14.6	7.8	27.0	7.7	0.6
KW027	W027	5/29/96	1	3	14.9	8.0	27.0	7.7	
KW027	W027	5/29/96	1	5		8.0			
KW027	W027	5/29/96	1	7	15.4	8.2	28.0	8.1	
KW027	W027	5/29/96	1	10	15.4	7.8	28.0	7.9	2.4
KW027	W027	5/29/96	2	0	14.9	7.6	27.0	7.9	0.5
KW027	W027	5/29/96	2	5		8.1			
KW027	W027	5/29/96	2	10	15.4	7.8	29.0	8.2	2.0
KW027	W027	5/29/96	3	0	14.9	7.8	27.0	7.9	0.9
KW027	W027	5/29/96	3	5		8.0			
KW027	W027	5/29/96	3	10	15.9	7.8	29.0	8.2	2.4
KW027	W027	5/29/96	4	0	15.0	7.7	27.0	7.7	0.8
KW027	W027	5/29/96	4	5		8.0			
KW027	W027	5/29/96	4	10	15.7	7.9	29.0	8.2	2.8
KW027	W027	5/29/96	5	0	14.6	7.6	27.0	7.8	0.8
KW027	W027	5/29/96	5	5		8.1			
KW027	W027	5/29/96	5	10	15.9	7.8	28.5	7.9	2.0
KW028	W028	5/29/96	1	0	14.8	7.5	27.0	7.9	1.3
KW028	W028	5/29/96	1	3	15.3	8.0	27.0	7.7	
KW028	W028	5/29/96	1	5		7.9			
KW028	W028	5/29/96	1	7	15.9	8.2	28.0	8.2	
KW028	W028	5/29/96	1	10	15.8	7.7	27.5	8.3	3.2
KW028	W028	5/29/96	2	0	15.0	7.8	27.0	7.9	1.1
KW028	W028	5/29/96	2	5		8.1			
KW028	W028	5/29/96	2	10	15.6	7.8	28.0	8.5	3.5
KW028	W028	5/29/96	3	0	14.6	7.8	27.0	7.9	1.3
KW028	W028	5/29/96	3	5		7.9			
KW028	W028	5/29/96	3	10	15.5	7.7	28.0	8.1	4.2
KW028	W028	5/29/96	4	0	14.7	7.7	27.0	7.9	1.3
KW028	W028	5/29/96	4	5		8.1			
KW028	W028	5/29/96	4	10	15.9	7.8	29.0	8.3	3.2
KW028	W028	5/29/96	5	0	14.6	7.2	27.0	7.8	1.3
KW028	W028	5/29/96	5	5		8.1			
KW028	W028	5/29/96	5	10	15.5	7.8	28.5	8.3	4.6
KW029	W029	6/5/96	1	0	14.6	7.6	27.0	7.9	0.1
KW029	W029	6/5/96	1	3	14.8	8.0	27.0	7.7	
KW029	W029	6/5/96	1	5		8.0			
KW029	W029	6/5/96	1	7	15.3	8.2	28.0	8.1	
KW029	W029	6/5/96	1	10	15.4	7.8	28.0	7.8	0
KW029	W029	6/5/96	2	0	14.9	7.3	27.0	7.9	0.1
KW029	W029	6/5/96	2	5		8.0			
KW029	W029	6/5/96	2	10	15.5	7.9	28.5	8.1	0
KW029	W029	6/5/96	3	0	14.7	7.2	27.0	7.9	0.4
KW029	W029	6/5/96	3	5		8.1			
KW029	W029	6/5/96	3	10	15.8	7.8	28.0	7.8	0.8
KW029	W029	6/5/96	4	0	14.6	7.7	27.0	7.9	0.2
KW029	W029	6/5/96	4	5		8.2			
KW029	W029	6/5/96	4	10	15.8	7.8	28.5	7.7	0

TABLE A3-1. (cont.)

Sample Number	Station	Collection Date	Replicate	Day	Temperature (deg C)	Dissolved Oxygen (mg/L)	Salinity (ppt)	pH	Ammonia as Nitrogen (mg/L)
KW029	W029	6/5/96	5	0	14.6	7.5	27.0	7.8	0.3
KW029	W029	6/5/96	5	5		7.9			
KW029	W029	6/5/96	5	10	15.5	7.7	29.0	7.9	0.6
KW030	W029B	6/5/96	1	0	14.6	7.8	27.0	7.9	0.4
KW030	W029B	6/5/96	1	3	14.8	7.9	28.0	7.7	
KW030	W029B	6/5/96	1	5		8.1			
KW030	W029B	6/5/96	1	7	15.7	8.2	28.0	8.1	
KW030	W029B	6/5/96	1	10	15.9	7.8	29.0	7.8	0
KW030	W029B	6/5/96	2	0	14.9	7.8	27.0	8.0	0.3
KW030	W029B	6/5/96	2	5		8.0			
KW030	W029B	6/5/96	2	10	15.9	7.8	28.0	8.0	0
KW030	W029B	6/5/96	3	0	14.9	7.7	27.0	7.9	0.2
KW030	W029B	6/5/96	3	5		8.1			
KW030	W029B	6/5/96	3	10	15.7	7.8	28.0	8.1	0
KW030	W029B	6/5/96	4	0	14.6	7.8	27.0	7.9	0.3
KW030	W029B	6/5/96	4	5		8.0			
KW030	W029B	6/5/96	4	10	15.6	7.7	29.0	7.8	0.7
KW030	W029B	6/5/96	5	0	14.6	7.4	27.0	7.9	0.4
KW030	W029B	6/5/96	5	5		8.0			
KW030	W029B	6/5/96	5	10	15.8	7.8	28.0	7.8	0
KW035	W030	6/5/96	1	0	15.0	7.7	27.0	7.9	0.1
KW035	W030	6/5/96	1	3	15.0	7.9	27.5	7.6	
KW035	W030	6/5/96	1	5		8.1			
KW035	W030	6/5/96	1	7	15.8	8.2	29.0	8.1	
KW035	W030	6/5/96	1	10	15.6	7.8	29.0	8.2	0
KW035	W030	6/5/96	2	0	14.6	7.6	27.0	7.9	0.1
KW035	W030	6/5/96	2	5		8.0			
KW035	W030	6/5/96	2	10	15.5	7.9	28.0	7.9	0
KW035	W030	6/5/96	3	0	14.9	7.6	27.0	7.9	0.1
KW035	W030	6/5/96	3	5		8.0			
KW035	W030	6/5/96	3	10	15.5	7.8	29.0	8.2	0.2
KW035	W030	6/5/96	4	0	14.5	7.2	27.0	8.0	0.1
KW035	W030	6/5/96	4	5		8.0			
KW035	W030	6/5/96	4	10	15.5	7.8	27.5	8.0	0
KW035	W030	6/5/96	5	0	14.7	7.7	27.0	7.9	0.1
KW035	W030	6/5/96	5	5		8.1			
KW035	W030	6/5/96	5	10	15.9	7.8	29.0	7.9	0
WBC	Control	NA	1	0	15.0	7.8	27.0	8.0	0.1
WBC	Control	NA	1	3	14.9	8.0	27.5	7.6	
WBC	Control	NA	1	5		8.1			
WBC	Control	NA	1	7	15.6	8.2	28.5	8.1	
WBC	Control	NA	1	10	15.7	7.9	28.5	8.2	1.4
WBC	Control	NA	2	0	15.0	7.9	27.0	8.0	0.1
WBC	Control	NA	2	5		8.2			
WBC	Control	NA	2	10	15.6	8.0	28.5	8.2	1.0
WBC	Control	NA	3	0	14.6	7.7	27.0	8.0	0.1
WBC	Control	NA	3	5		8.1			
WBC	Control	NA	3	10	15.8	8.0	28.0	7.8	1.6
WBC	Control	NA	4	0	14.6	7.5	27.0	7.9	0.2

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TABLE A3-1. (cont.)

Sample Number	Station	Collection Date	Replicate	Day	Temperature (deg C)	Dissolved Oxygen (mg/L)	Salinity (ppt)	pH	Ammonia as Nitrogen (mg/L)
WBC	Control	NA	4	5		8.0			
WBC	Control	NA	4	10	15.9	7.8	27.5	8.0	2.6
WBC	Control	NA	5	0	15.0	7.8	27.0	8.0	0.2
WBC	Control	NA	5	5		8.1			
WBC	Control	NA	5	10	15.7	8.0	29.0	8.2	1.6

Note: An additional reference area sample was collected at Station 29B. Based on field screening of grain-size distribution, it was determined that the grain-size at this station did not match sediment collected onsite. Chemical testing and *L. plumulosus* and *Neanthes* sp. toxicity tests were not performed on this sample.

TABLE A3-2. SUMMARY OF WATER QUALITY PARAMETERS FROM THE *Dendraster excentricus* TOXICITY TEST CONDUCTED IN 1996

Sample Number	Station	Collection Date	Day	Temperature (deg C)	Dissolved Oxygen (mg/L)	Salinity (ppt)	pH
KW001	W01	6/1/96	0	13.9	8.2	31.0	7.7
KW001	W01	6/1/96	1	14.2	8.1	30.5	7.9
KW001	W01	6/1/96	2	14.0	8.1	31.0	7.8
KW001	W01	6/1/96	3	14.2	8.3	31.5	7.7
KW002	W02	6/1/96	0	14.6	8.0	31.0	7.6
KW002	W02	6/1/96	1	14.6	7.9	30.5	7.8
KW002	W02	6/1/96	2	14.6	8.2	31.0	7.8
KW002	W02	6/1/96	3	14.6	8.3	30.5	7.8
KW003	W03	6/2/96	0	13.8	8.2	31.5	7.7
KW003	W03	6/2/96	1	14.3	8.0	30.0	7.8
KW003	W03	6/2/96	2	14.1	8.0	31.0	7.8
KW003	W03	6/2/96	3	14.0	8.4	31.5	7.6
KW004	W04	6/2/96	0	15.2	8.1	31.0	7.7
KW004	W04	6/2/96	1	15.0	7.8	31.0	7.9
KW004	W04	6/2/96	2	14.8	8.0	31.5	7.8
KW004	W04	6/2/96	3	15.0	8.3	30.5	7.7
KW005	W05	6/1/96	0	14.0	7.8	32.0	7.7
KW005	W05	6/1/96	1	14.2	8.1	31.0	7.9
KW005	W05	6/1/96	2	14.2	8.0	31.5	7.7
KW005	W05	6/1/96	3	14.4	8.2	31.0	7.6
KW006	W06	6/4/96	0	14.3	8.1	31.0	7.6
KW006	W06	6/4/96	1	14.5	8.3	31.0	7.8
KW006	W06	6/4/96	2	14.5	8.0	31.5	7.8
KW006	W06	6/4/96	3	14.5	8.2	31.0	7.7
KW007	W07	6/2/96	0	14.0	8.0	31.5	7.6
KW007	W07	6/2/96	1	14.3	8.3	30.5	7.7
KW007	W07	6/2/96	2	14.3	8.0	31.0	7.7
KW007	W07	6/2/96	3	14.2	8.2	31.0	7.7
KW008	W08	6/2/96	0	14.9	8.2	30.5	7.7
KW008	W08	6/2/96	1	15.0	8.1	31.0	7.8
KW008	W08	6/2/96	2	14.8	8.1	31.5	7.8
KW008	W08	6/2/96	3	14.7	8.4	31.0	7.8
KW009	W09	6/2/96	0	13.5	8.1	31.0	7.5
KW009	W09	6/2/96	1	14.3	8.0	31.0	7.7
KW009	W09	6/2/96	2	14.1	8.1	31.5	7.7
KW009	W09	6/2/96	3	14.2	8.2	31.0	7.8
KW010	W010R	6/3/96	0	14.6	7.8	30.5	7.7
KW010	W010R	6/3/96	1	14.7	8.0	31.0	7.8
KW010	W010R	6/3/96	2	14.7	8.0	31.0	7.7
KW010	W010R	6/3/96	3	14.5	8.2	30.5	7.8
KW011	W011	5/30/96	0	13.9	8.2	31.0	7.7
KW011	W011	5/30/96	1	14.3	7.9	30.5	7.9
KW011	W011	5/30/96	2	14.2	7.8	31.0	7.8
KW011	W011	5/30/96	3	14.0	8.4	31.5	7.7
KW012	W012	6/4/96	0	13.6	8.0	31.0	7.6
KW012	W012	6/4/96	1	14.2	8.2	31.0	7.8
KW012	W012	6/4/96	2	14.1	8.0	31.0	7.8
KW012	W012	6/4/96	3	13.9	8.2	31.0	7.7

TABLE A3-2. (cont.)

Sample Number	Station	Collection Date	Day	Temperature (deg C)	Dissolved Oxygen (mg/L)	Salinity (ppt)	pH
KW013	W013	6/4/96	0	14.7	8.1	31.0	7.7
KW013	W013	6/4/96	1	14.9	8.0	31.0	7.8
KW013	W013	6/4/96	2	14.9	8.2	31.0	7.9
KW013	W013	6/4/96	3	14.6	8.2	32.0	7.7
KW014	W014	6/4/96	0	13.9	8.1	31.0	7.7
KW014	W014	6/4/96	1	14.2	8.2	30.5	7.9
KW014	W014	6/4/96	2	14.1	8.0	31.0	7.8
KW014	W014	6/4/96	3	14.1	8.4	31.0	7.7
KW015	W015	6/2/96	0	14.0	8.2	31.5	7.6
KW015	W015	6/2/96	1	14.4	8.0	31.0	7.8
KW015	W015	6/2/96	2	14.1	8.1	31.0	7.8
KW015	W015	6/2/96	3	14.1	8.2	31.0	7.7
KW016	W016	6/3/96	0	14.8	8.0	31.0	7.7
KW016	W016	6/3/96	1	14.8	8.2	31.0	7.8
KW016	W016	6/3/96	2	14.9	8.1	31.5	7.8
KW016	W016	6/3/96	3	14.5	8.1	31.0	7.7
KW017	W017R	6/3/96	0	15.2	8.2	30.5	7.7
KW017	W017R	6/3/96	1	15.0	8.1	31.0	7.8
KW017	W017R	6/3/96	2	14.5	8.0	31.0	7.7
KW017	W017R	6/3/96	3	15.0	8.4	30.5	7.7
KW018	W018	5/29/96	0	13.7	8.1	31.0	7.7
KW018	W018	5/29/96	1	14.2	8.0	31.0	7.9
KW018	W018	5/29/96	2	14.2	7.9	31.5	7.8
KW018	W018	5/29/96	3	14.1	8.2	31.0	7.7
KW019	W019	6/1/96	0	13.9	8.2	31.5	7.7
KW019	W019	6/1/96	1	14.2	8.1	31.0	7.8
KW019	W019	6/1/96	2	14.3	7.9	31.0	7.8
KW019	W019	6/1/96	3	14.0	8.4	32.0	7.7
KW020	W020	5/31/96	0	14.1	8.3	31.0	7.6
KW020	W020	5/31/96	1	14.4	8.1	31.0	7.8
KW020	W020	5/31/96	2	14.3	8.0	31.0	7.8
KW020	W020	5/31/96	3	13.8	8.4	31.5	7.7
KW021	W021	6/3/96	0	14.6	8.1	31.0	7.6
KW021	W021	6/3/96	1	14.7	8.2	31.5	7.8
KW021	W021	6/3/96	2	14.8	8.1	31.0	7.8
KW021	W021	6/3/96	3	14.4	8.2	31.0	7.7
KW022	W022	5/28/96	0	14.6	8.2	30.5	7.7
KW022	W022	5/28/96	1	14.5	8.2	31.0	7.8
KW022	W022	5/28/96	2	14.7	8.0	31.5	7.8
KW022	W022	5/28/96	3	14.4	8.3	31.0	7.7
KW023	W023	5/29/96	0	14.7	8.2	31.0	7.7
KW023	W023	5/29/96	1	14.9	8.2	31.0	7.8
KW023	W023	5/29/96	2	14.8	8.1	31.0	7.8
KW023	W023	5/29/96	3	14.5	8.2	31.0	7.7
KW024	W024	6/1/96	0	15.1	8.2	30.5	7.7
KW024	W024	6/1/96	1	15.1	8.1	31.0	7.9
KW024	W024	6/1/96	2	14.8	8.0	31.5	7.8
KW024	W024	6/1/96	3	14.9	8.3	31.0	7.7
KW025	W025	5/30/96	0	14.2	8.1	30.5	7.7
KW025	W025	5/30/96	1	14.5	8.1	31.0	7.9

TABLE A3-2. (cont.)

Sample Number	Station	Collection Date	Day	Temperature (deg C)	Dissolved Oxygen (mg/L)	Salinity (ppt)	pH
KW025	W025	5/30/96	2	14.4	7.8	31.5	7.8
KW025	W025	5/30/96	3	14.6	8.3	31.0	7.7
KW026	W026	5/30/96	0	14.0	7.4	31.0	7.7
KW026	W026	5/30/96	1	14.2	7.8	31.0	7.9
KW026	W026	5/30/96	2	14.2	8.0	31.0	7.8
KW026	W026	5/30/96	3	14.1	8.4	31.0	7.7
KW027	W027	5/29/96	0	13.6	8.1	31.0	7.6
KW027	W027	5/29/96	1	14.0	8.2	30.5	7.7
KW027	W027	5/29/96	2	14.0	8.2	31.0	7.7
KW027	W027	5/29/96	3	14.0	8.1	32.0	7.8
KW028	W028	5/29/96	0	14.2	8.1	31.0	7.7
KW028	W028	5/29/96	1	14.2	7.9	30.5	7.9
KW028	W028	5/29/96	2	14.2	7.9	31.0	7.8
KW028	W028	5/29/96	3	14.2	8.2	31.0	7.6
KW029	W029	6/5/96	0	15.1	8.0	30.5	7.7
KW029	W029	6/5/96	1	14.8	8.0	30.5	7.8
KW029	W029	6/5/96	2	15.0	7.9	31.0	7.8
KW029	W029	6/5/96	3	14.6	8.1	30.5	7.7
KW030	W029B	6/5/96	0	14.2	8.1	30.5	7.7
KW030	W029B	6/5/96	1	14.4	8.2	31.0	7.8
KW030	W029B	6/5/96	2	14.2	7.9	31.0	7.8
KW030	W029B	6/5/96	3	14.5	8.3	30.5	7.8
KW035	W030	6/5/96	0	14.6	8.3	31.0	7.7
KW035	W030	6/5/96	1	14.5	8.3	31.0	7.9
KW035	W030	6/5/96	2	14.6	8.0	31.5	7.8
KW035	W030	6/5/96	3	14.3	8.4	31.5	7.8
SW	Control	NA	0	14.5	7.9	30.5	7.8
SW	Control	NA	1	14.5	8.0	30.5	7.9
SW	Control	NA	2	14.4	8.0	30.5	7.8
SW	Control	NA	3	14.6	8.2	31.0	7.9

TABLE A3-3. SUMMARY OF WATER QUALITY PARAMETERS FROM THE *Leptocheirus plumulosus* TOXICITY TEST CONDUCTED IN 1996

Sample Number	Station	Collection Date	Replicate	Day	Temperature (deg C)	Dissolved Oxygen (mg/L)	Salinity (ppt)	pH	Ammonia as Nitrogen (mg/L)
KW001	W01	6/1/96	1	0	20.1	6.9	27.0	8.0	4.4
KW001	W01	6/1/96	1	3	20.2	6.5	27.5	7.8	
KW001	W01	6/1/96	1	5		6.9			
KW001	W01	6/1/96	1	7	20.4	7.2	28.0	7.9	
KW001	W01	6/1/96	1	10	20.0	7.0	28.5	7.9	10.5
KW001	W01	6/1/96	2	0	20.1	7.0	27.0	7.9	4.4
KW001	W01	6/1/96	2	5		7.0			
KW001	W01	6/1/96	2	10	19.9	7.0	28.0	7.9	9.0
KW001	W01	6/1/96	3	0	19.9	7.0	27.0	8.0	4.7
KW001	W01	6/1/96	3	5		5.6			
KW001	W01	6/1/96	3	10	19.8	7.0	29.0	8.0	10.5
KW001	W01	6/1/96	4	0	19.9	7.0	27.0	8.0	4.0
KW001	W01	6/1/96	4	5		6.9			
KW001	W01	6/1/96	4	10	20.0	6.2	29.0	7.7	9.0
KW001	W01	6/1/96	5	0	20.2	6.8	27.0	7.8	4.6
KW001	W01	6/1/96	5	5		6.9			
KW001	W01	6/1/96	5	10	20.0	7.0	29.0	7.9	10.0
KW002	W02	6/1/96	1	0	20.1	7.0	27.0	8.0	3.8
KW002	W02	6/1/96	1	3	20.4	6.8	27.5	7.7	
KW002	W02	6/1/96	1	5		6.0			
KW002	W02	6/1/96	1	7	20.6	7.2	27.5	8.0	
KW002	W02	6/1/96	1	10	20.6	6.6	29.0	8.0	8.0
KW002	W02	6/1/96	2	0	19.9	7.0	27.0	8.1	4.0
KW002	W02	6/1/96	2	5		7.0			
KW002	W02	6/1/96	2	10	19.8	7.0	29.0	7.9	9.0
KW002	W02	6/1/96	3	0	19.8	7.1	27.0	8.1	4.0
KW002	W02	6/1/96	3	5		7.0			
KW002	W02	6/1/96	3	10	19.7	5.6	29.0	7.6	8.5
KW002	W02	6/1/96	4	0	19.9	7.0	27.0	8.1	3.9
KW002	W02	6/1/96	4	5		6.8			
KW002	W02	6/1/96	4	10	19.9	6.7	28.0	7.9	10.0
KW002	W02	6/1/96	5	0	20.0	7.1	27.0	8.0	3.7
KW002	W02	6/1/96	5	5		6.6			
KW002	W02	6/1/96	5	10	20.6	6.6	28.5	7.8	10.0
KW003	W03	6/2/96	1	0	20.1	6.9	27.0	8.0	0.3
KW003	W03	6/2/96	1	3	20.2	6.8	27.5	7.9	
KW003	W03	6/2/96	1	5		6.9			
KW003	W03	6/2/96	1	7	20.5	7.2	28.0	8.6	
KW003	W03	6/2/96	1	10	20.0	7.0	29.0	8.5	0.4
KW003	W03	6/2/96	2	0	20.0	7.1	27.0	8.0	0.2
KW003	W03	6/2/96	2	5		6.9			
KW003	W03	6/2/96	2	10	21.0	6.8	27.0	8.5	0.3
KW003	W03	6/2/96	3	0	20.1	6.9	27.0	8.0	0.6
KW003	W03	6/2/96	3	5		6.9			
KW003	W03	6/2/96	3	10	20.0	7.0	28.5	8.5	1.6
KW003	W03	6/2/96	4	0	20.1	6.9	27.0	8.0	0.3
KW003	W03	6/2/96	4	5		6.8			
KW003	W03	6/2/96	4	10	19.9	7.0	29.0	8.5	1.1
KW003	W03	6/2/96	5	0	20.1	6.9	27.0	8.0	0.4

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TABLE A3-3. (cont.)

Sample Number	Station	Collection Date	Replicate	Day	Temperature (deg C)	Dissolved Oxygen (mg/L)	Salinity (ppt)	pH	Ammonia as Nitrogen (mg/L)
KW003	W03	6/2/96	5	5		6.8			
KW003	W03	6/2/96	5	10	20.6	6.9	29.0	8.4	2.4
KW004	W04	6/2/96	1	0	20.1	6.8	27.0	8.0	1.7
KW004	W04	6/2/96	1	3	20.2	6.8	27.5	7.9	
KW004	W04	6/2/96	1	5		7.0			
KW004	W04	6/2/96	1	7	20.5	7.2	28.0	8.0	
KW004	W04	6/2/96	1	10	20.0	7.2	29.0	8.1	5.2
KW004	W04	6/2/96	2	0	20.1	7.0	27.0	7.8	1.9
KW004	W04	6/2/96	2	5		7.0			
KW004	W04	6/2/96	2	10	19.9	7.2	28.5	8.1	5.0
KW004	W04	6/2/96	3	0	19.9	7.0	27.0	8.0	1.4
KW004	W04	6/2/96	3	5		6.8			
KW004	W04	6/2/96	3	10	19.6	6.8	28.5	7.9	5.5
KW004	W04	6/2/96	4	0	20.2	6.9	27.0	7.8	1.8
KW004	W04	6/2/96	4	5		6.9			
KW004	W04	6/2/96	4	10	19.9	7.0	28.5	8.1	6.0
KW004	W04	6/2/96	5	0	20.2	7.1	27.0	7.9	1.1
KW004	W04	6/2/96	5	5		6.9			
KW004	W04	6/2/96	5	10	20.0	6.8	28.5	8.0	4.4
KW005	W05	6/1/96	1	0	20.1	7.1	27.0	8.0	1.1
KW005	W05	6/1/96	1	3	20.3	6.9	27.0	7.6	
KW005	W05	6/1/96	1	5		7.0			
KW005	W05	6/1/96	1	7	20.7	6.6	27.5	7.7	
KW005	W05	6/1/96	1	10	20.9	6.4	27.0	7.6	4.9
KW005	W05	6/1/96	2	0	19.9	7.0	27.0	7.9	1.2
KW005	W05	6/1/96	2	5		6.7			
KW005	W05	6/1/96	2	10	19.8	7.0	29.0	7.8	5.5
KW005	W05	6/1/96	3	0	19.9	7.0	27.0	8.0	0.7
KW005	W05	6/1/96	3	5		6.8			
KW005	W05	6/1/96	3	10	19.8	6.8	28.5	7.8	4.4
KW005	W05	6/1/96	4	0	19.9	7.1	27.0	8.0	1.0
KW005	W05	6/1/96	4	5		7.0			
KW005	W05	6/1/96	4	10	19.9	6.6	28.5	7.8	4.1
KW005	W05	6/1/96	5	0	19.9	7.0	27.0	7.9	1.2
KW005	W05	6/1/96	5	5		6.9			
KW005	W05	6/1/96	5	10	20.0	6.8	29.0	7.8	5.5
KW006	W06	6/4/96	1	0	19.9	7.0	27.0	7.8	3.1
KW006	W06	6/4/96	1	3	20.1	6.9	28.0	7.6	
KW006	W06	6/4/96	1	5		6.9			
KW006	W06	6/4/96	1	7	19.9	6.6	28.0	7.6	
KW006	W06	6/4/96	1	10	19.9	6.4	29.0	7.6	9.0
KW006	W06	6/4/96	2	0	20.2	7.0	27.0	7.9	3.1
KW006	W06	6/4/96	2	5		7.0			
KW006	W06	6/4/96	2	10	20.0	7.0	28.5	7.8	9.5
KW006	W06	6/4/96	3	0	20.1	7.0	27.0	8.0	3.0
KW006	W06	6/4/96	3	5		6.8			
KW006	W06	6/4/96	3	10	20.9	6.6	28.0	7.6	10.0
KW006	W06	6/4/96	4	0	20.0	7.1	27.0	7.8	3.5
KW006	W06	6/4/96	4	5		6.9			

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TABLE A3-3. (cont.)

Sample Number	Station	Collection Date	Replicate	Day	Temperature (deg C)	Dissolved Oxygen (mg/L)	Salinity (ppt)	pH	Ammonia as Nitrogen (mg/L)
KW006	W06	6/4/96	4	10	21.0	6.1	28.0	7.5	9.0
KW006	W06	6/4/96	5	0	20.1	6.9	27.0	7.6	3.0
KW006	W06	6/4/96	5	5		6.9			
KW006	W06	6/4/96	5	10	20.0	6.6	27.0	7.8	9.5
KW007	W07	6/2/96	1	0	19.9	7.0	27.0	8.0	1.3
KW007	W07	6/2/96	1	3	20.1	6.8	27.5	7.7	
KW007	W07	6/2/96	1	5		6.9			
KW007	W07	6/2/96	1	7	20.3	7.2	28.0	7.9	
KW007	W07	6/2/96	1	10	20.0	6.9	28.5	7.9	5.0
KW007	W07	6/2/96	2	0	20.1	7.0	27.0	8.0	1.2
KW007	W07	6/2/96	2	5		6.6			
KW007	W07	6/2/96	2	10	20.9	7.1	27.0	7.9	5.0
KW007	W07	6/2/96	3	0	20.1	7.1	27.0	8.0	1.2
KW007	W07	6/2/96	3	5		7.0			
KW007	W07	6/2/96	3	10	20.8	7.0	28.0	8.0	5.5
KW007	W07	6/2/96	4	0	20.2	7.1	27.0	8.0	1.2
KW007	W07	6/2/96	4	5		6.8			
KW007	W07	6/2/96	4	10	20.8	6.8	27.5	8.0	5.2
KW007	W07	6/2/96	5	0	19.8	7.0	27.0	8.1	1.3
KW007	W07	6/2/96	5	5		6.9			
KW007	W07	6/2/96	5	10	19.8	7.0	29.0	8.0	4.8
KW008	W08	6/2/96	1	0	20.1	7.0	27.0	8.0	1.9
KW008	W08	6/2/96	1	3	20.3	6.9	27.0	7.7	
KW008	W08	6/2/96	1	5		6.8			
KW008	W08	6/2/96	1	7	20.6	7.1	28.0	7.9	
KW008	W08	6/2/96	1	10	20.9	7.0	28.0	7.9	7.0
KW008	W08	6/2/96	2	0	20.1	6.9	27.0	7.9	1.9
KW008	W08	6/2/96	2	5		6.8			
KW008	W08	6/2/96	2	10	20.4	7.0	27.5	7.9	6.0
KW008	W08	6/2/96	3	0	19.8	7.0	27.0	8.0	1.9
KW008	W08	6/2/96	3	5		7.0			
KW008	W08	6/2/96	3	10	20.0	7.0	28.0	7.8	6.0
KW008	W08	6/2/96	4	0	20.2	6.8	27.0	7.8	2.0
KW008	W08	6/2/96	4	5		7.0			
KW008	W08	6/2/96	4	10	20.0	7.1	29.0	8.1	7.0
KW008	W08	6/2/96	5	0	20.0	7.1	27.5	8.0	1.8
KW008	W08	6/2/96	5	5		6.8			
KW008	W08	6/2/96	5	10	20.9	6.6	28.0	7.9	7.5
KW009	W09	6/2/96	1	0	20.2	6.7	27.0	7.8	2.1
KW009	W09	6/2/96	1	3	20.3	6.9	27.5	7.6	
KW009	W09	6/2/96	1	5		6.7			
KW009	W09	6/2/96	1	7	20.9	7.4	28.0	7.8	
KW009	W09	6/2/96	1	10	19.9	7.0	29.0	7.9	7.5
KW009	W09	6/2/96	2	0	20.2	6.8	27.0	7.8	2.2
KW009	W09	6/2/96	2	5		6.8			
KW009	W09	6/2/96	2	10	20.0	7.0	28.5	8.0	6.0
KW009	W09	6/2/96	3	0	20.1	6.9	27.0	7.9	2.3
KW009	W09	6/2/96	3	5		7.0			
KW009	W09	6/2/96	3	10	19.9	7.1	29.0	8.1	6.0

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TABLE A3-3. (cont.)

Sample Number	Station	Collection Date	Replicate	Day	Temperature (deg C)	Dissolved Oxygen (mg/L)	Salinity (ppt)	pH	Ammonia as Nitrogen (mg/L)
KW009	W09	6/2/96	4	0	19.9	7.0	27.0	8.1	2.1
KW009	W09	6/2/96	4	5		7.0			
KW009	W09	6/2/96	4	10	19.8	7.0	29.0	8.0	6.0
KW009	W09	6/2/96	5	0	20.2	7.1	27.0	8.0	2.0
KW009	W09	6/2/96	5	5		7.0			
KW009	W09	6/2/96	5	10	20.0	7.1	28.5	8.0	5.5
KW010	W010R	6/3/96	1	0	20.0	7.1	27.0	8.0	1.5
KW010	W010R	6/3/96	1	3	20.1	6.8	27.5	7.9	
KW010	W010R	6/3/96	1	5		7.0			
KW010	W010R	6/3/96	1	7	20.6	7.0	29.0	8.0	
KW010	W010R	6/3/96	1	10	21.0	6.8	27.0	8.1	6.0
KW010	W010R	6/3/96	2	0	19.9	7.0	27.0	8.0	1.3
KW010	W010R	6/3/96	2	5		7.0			
KW010	W010R	6/3/96	2	10	19.8	6.9	29.0	8.0	6.5
KW010	W010R	6/3/96	3	0	20.2	6.7	27.0	7.7	1.6
KW010	W010R	6/3/96	3	5		6.8			
KW010	W010R	6/3/96	3	10	19.9	7.0	29.0	8.1	4.6
KW010	W010R	6/3/96	4	0	20.0	7.0	27.0	8.0	1.5
KW010	W010R	6/3/96	4	5		6.3			
KW010	W010R	6/3/96	4	10	20.6	7.0	28.5	8.0	5.0
KW010	W010R	6/3/96	5	0	20.1	7.2	27.5	8.0	1.7
KW010	W010R	6/3/96	5	5		7.0			
KW010	W010R	6/3/96	5	10	20.9	6.4	27.0	8.0	6.5
KW011	W011	5/30/96	1	0	20.1	6.8	27.0	8.0	0.9
KW011	W011	5/30/96	1	3	20.3	6.7	28.0	7.9	
KW011	W011	5/30/96	1	5		6.8			
KW011	W011	5/30/96	1	7	20.5	7.2	28.0	8.2	
KW011	W011	5/30/96	1	10	20.5	7.0	29.0	8.3	3.2
KW011	W011	5/30/96	2	0	20.2	7.0	27.0	7.9	0.7
KW011	W011	5/30/96	2	5		7.1			
KW011	W011	5/30/96	2	10	20.0	7.1	29.0	8.3	0.8
KW011	W011	5/30/96	3	0	20.2	7.0	27.0	8.0	0.8
KW011	W011	5/30/96	3	5		6.9			
KW011	W011	5/30/96	3	10	19.9	6.8	28.0	8.1	1.2
KW011	W011	5/30/96	4	0	20.1	6.9	27.0	7.9	1.2
KW011	W011	5/30/96	4	5		7.0			
KW011	W011	5/30/96	4	10	20.0	7.0	28.0	8.2	1.8
KW011	W011	5/30/96	5	0	19.8	7.0	27.5	8.1	1.4
KW011	W011	5/30/96	5	5		6.8			
KW011	W011	5/30/96	5	10	19.9	7.1	29.0	8.3	3.0
KW012	W012	6/4/96	1	0	19.9	7.1	27.0	8.1	3.4
KW012	W012	6/4/96	1	3	20.1	6.9	28.0	7.5	
KW012	W012	6/4/96	1	5		6.8			
KW012	W012	6/4/96	1	7	20.1	7.2	27.5	7.8	
KW012	W012	6/4/96	1	10	19.9	6.6	28.5	7.8	10.0
KW012	W012	6/4/96	2	0	19.9	6.9	27.0	7.9	3.3
KW012	W012	6/4/96	2	5		6.8			
KW012	W012	6/4/96	2	10	20.0	7.0	29.0	8.0	8.5
KW012	W012	6/4/96	3	0	20.2	7.0	27.5	8.0	3.2

TABLE A3-3. (cont.)

Sample Number	Station	Collection Date	Replicate	Day	Temperature (deg C)	Dissolved Oxygen (mg/L)	Salinity (ppt)	pH	Ammonia as Nitrogen (mg/L)
KW012	W012	6/4/96	3	5		5.6			
KW012	W012	6/4/96	3	10	20.6	6.8	29.0	7.9	9.5
KW012	W012	6/4/96	4	0	19.9	7.0	27.5	8.1	3.9
KW012	W012	6/4/96	4	5		7.0			
KW012	W012	6/4/96	4	10	19.8	6.4	29.0	7.8	10.0
KW012	W012	6/4/96	5	0	20.2	7.0	27.0	8.1	3.7
KW012	W012	6/4/96	5	5		6.4			
KW012	W012	6/4/96	5	10	20.6	6.4	29.0	7.8	9.0
KW013	W013	6/4/96	1	0	19.9	7.0	27.0	8.1	1.8
KW013	W013	6/4/96	1	3	20.1	6.6	28.0	7.8	
KW013	W013	6/4/96	1	5		6.9			
KW013	W013	6/4/96	1	7	20.0	7.2	28.0	8.0	
KW013	W013	6/4/96	1	10	19.8	7.0	29.0	8.0	7.0
KW013	W013	6/4/96	2	0	20.0	7.0	27.0	8.0	1.8
KW013	W013	6/4/96	2	5		6.8			
KW013	W013	6/4/96	2	10	21.0	6.2	28.5	7.7	8.0
KW013	W013	6/4/96	3	0	19.9	7.1	27.0	8.0	2.0
KW013	W013	6/4/96	3	5		7.0			
KW013	W013	6/4/96	3	10	19.7	7.0	29.0	7.9	7.0
KW013	W013	6/4/96	4	0	19.9	7.0	27.0	8.0	2.3
KW013	W013	6/4/96	4	5		7.0			
KW013	W013	6/4/96	4	10	19.9	6.4	29.0	7.7	7.5
KW013	W013	6/4/96	5	0	20.1	7.0	27.0	8.1	1.9
KW013	W013	6/4/96	5	5		7.0			
KW013	W013	6/4/96	5	10	20.5	7.0	29.0	8.0	7.0
KW014	W014	6/4/96	1	0	20.1	6.8	27.0	8.0	0.7
KW014	W014	6/4/96	1	3	20.3	6.8	27.5	7.9	
KW014	W014	6/4/96	1	5		6.9			
KW014	W014	6/4/96	1	7	20.7	7.3	28.0	8.1	
KW014	W014	6/4/96	1	10	20.0	7.0	29.0	8.2	3.8
KW014	W014	6/4/96	2	0	20.1	7.1	27.0	7.9	1.1
KW014	W014	6/4/96	2	5		7.0			
KW014	W014	6/4/96	2	10	20.8	7.0	29.0	8.1	4.8
KW014	W014	6/4/96	3	0	19.9	7.0	27.0	8.0	1.2
KW014	W014	6/4/96	3	5		6.8			
KW014	W014	6/4/96	3	10	19.7	6.9	29.0	8.2	6.0
KW014	W014	6/4/96	4	0	20.2	7.0	27.0	8.0	1.2
KW014	W014	6/4/96	4	5		6.8			
KW014	W014	6/4/96	4	10	20.7	6.9	29.0	8.2	5.5
KW014	W014	6/4/96	5	0	19.9	6.7	27.0	7.8	1.5
KW014	W014	6/4/96	5	5		6.8			
KW014	W014	6/4/96	5	10	19.9	7.1	29.0	8.0	6.0
KW015	W015	6/2/96	1	0	20.1	7.0	27.0	8.0	1.5
KW015	W015	6/2/96	1	3	20.2	7.0	27.0	7.7	
KW015	W015	6/2/96	1	5		6.7			
KW015	W015	6/2/96	1	7	20.6	6.8	28.5	7.7	
KW015	W015	6/2/96	1	10	20.9	6.6	28.5	7.7	6.0
KW015	W015	6/2/96	2	0	19.9	7.0	27.0	8.0	1.6
KW015	W015	6/2/96	2	5		6.8			

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TABLE A3-3. (cont.)

Sample Number	Station	Collection Date	Replicate	Day	Temperature (deg C)	Dissolved Oxygen (mg/L)	Salinity (ppt)	pH	Ammonia as Nitrogen (mg/L)
KW015	W015	6/2/96	2	10	19.8	7.0	29.0	8.0	5.5
KW015	W015	6/2/96	3	0	19.9	7.0	27.5	8.1	1.5
KW015	W015	6/2/96	3	5		7.0			
KW015	W015	6/2/96	3	10	19.7	7.1	29.0	7.9	4.6
KW015	W015	6/2/96	4	0	20.2	6.9	27.0	7.9	1.2
KW015	W015	6/2/96	4	5		6.8			
KW015	W015	6/2/96	4	10	20.0	7.1	29.0	7.9	4.4
KW015	W015	6/2/96	5	0	19.8	7.1	27.0	8.0	1.3
KW015	W015	6/2/96	5	5		6.7			
KW015	W015	6/2/96	5	10	19.8	6.8	29.0	7.8	6.0
KW016	W016	6/3/96	1	0	20.1	7.0	27.0	8.0	0.9
KW016	W016	6/3/96	1	3	20.4	6.9	27.5	7.8	
KW016	W016	6/3/96	1	5		6.6			
KW016	W016	6/3/96	1	7	20.6	7.2	27.5	7.9	
KW016	W016	6/3/96	1	10	20.6	6.6	28.5	7.9	3.6
KW016	W016	6/3/96	2	0	20.2	6.9	27.0	7.8	0.8
KW016	W016	6/3/96	2	5		7.1			
KW016	W016	6/3/96	2	10	20.0	7.0	28.5	8.0	2.8
KW016	W016	6/3/96	3	0	20.2	7.1	27.0	8.0	0.8
KW016	W016	6/3/96	3	5		6.7			
KW016	W016	6/3/96	3	10	20.9	6.5	27.0	7.9	2.8
KW016	W016	6/3/96	4	0	20.1	7.0	27.0	8.0	0.9
KW016	W016	6/3/96	4	5		7.0			
KW016	W016	6/3/96	4	10	20.9	6.5	27.5	7.8	4.0
KW016	W016	6/3/96	5	0	19.9	7.1	27.0	8.0	0.9
KW016	W016	6/3/96	5	5		6.8			
KW016	W016	6/3/96	5	10	19.9	6.2	28.5	7.7	2.2
KW017	W017R	6/3/96	1	0	20.0	7.2	27.0	7.9	0.3
KW017	W017R	6/3/96	1	3	20.2	6.8	27.5	7.8	
KW017	W017R	6/3/96	1	5		7.0			
KW017	W017R	6/3/96	1	7	20.2	6.8	29.0	8.2	
KW017	W017R	6/3/96	1	10	20.9	6.6	27.0	8.2	0.6
KW017	W017R	6/3/96	2	0	19.9	7.0	27.0	8.0	0
KW017	W017R	6/3/96	2	5		6.7			
KW017	W017R	6/3/96	2	10	19.9	6.8	28.5	8.2	1.0
KW017	W017R	6/3/96	3	0	20.1	7.0	27.0	7.9	0.1
KW017	W017R	6/3/96	3	5		6.7			
KW017	W017R	6/3/96	3	10	21.0	7.0	27.5	8.3	1.0
KW017	W017R	6/3/96	4	0	20.1	7.0	27.0	7.8	0.1
KW017	W017R	6/3/96	4	5		6.8			
KW017	W017R	6/3/96	4	10	20.0	7.0	29.0	8.3	0
KW017	W017R	6/3/96	5	0	20.2	6.9	27.0	7.8	0.6
KW017	W017R	6/3/96	5	5		7.0			
KW017	W017R	6/3/96	5	10	19.9	7.0	28.5	8.1	1.6
KW018	W018	5/29/96	1	0	20.0	7.1	27.0	8.0	0.9
KW018	W018	5/29/96	1	3	20.2	6.7	27.0	8.0	
KW018	W018	5/29/96	1	5		6.9			
KW018	W018	5/29/96	1	7	20.4	7.0	29.0	8.1	
KW018	W018	5/29/96	1	10	21.0	6.8	27.0	8.2	1.7

TABLE A3-3. (cont.)

Sample Number	Station	Collection Date	Replicate	Day	Temperature (deg C)	Dissolved Oxygen (mg/L)	Salinity (ppt)	pH	Ammonia as Nitrogen (mg/L)
KW018	W018	5/29/96	2	0	19.9	7.0	27.0	8.0	1.3
KW018	W018	5/29/96	2	5		7.0			
KW018	W018	5/29/96	2	10	19.9	6.9	28.0	8.2	3.2
KW018	W018	5/29/96	3	0	19.9	7.0	27.0	8.1	0.9
KW018	W018	5/29/96	3	5		6.7			
KW018	W018	5/29/96	3	10	19.7	7.0	28.5	8.3	2.8
KW018	W018	5/29/96	4	0	20.0	7.1	27.0	8.0	0.8
KW018	W018	5/29/96	4	5		6.9			
KW018	W018	5/29/96	4	10	19.9	7.0	28.0	8.2	2.6
KW018	W018	5/29/96	5	0	19.8	7.1	27.0	8.0	0.9
KW018	W018	5/29/96	5	5		7.1			
KW018	W018	5/29/96	5	10	19.7	7.1	29.0	8.2	2.5
KW019	W019	6/1/96	1	0	19.9	7.0	27.0	8.0	1.6
KW019	W019	6/1/96	1	3	20.1	6.8	28.0	7.9	
KW019	W019	6/1/96	1	5		7.0			
KW019	W019	6/1/96	1	7	20.2	7.2	28.0	8.0	
KW019	W019	6/1/96	1	10	20.0	7.0	29.0	8.1	5.5
KW019	W019	6/1/96	2	0	20.2	7.0	27.0	7.8	1.6
KW019	W019	6/1/96	2	5		6.9			
KW019	W019	6/1/96	2	10	20.0	7.0	29.0	8.1	4.8
KW019	W019	6/1/96	3	0	20.0	7.1	27.0	8.0	1.4
KW019	W019	6/1/96	3	5		6.8			
KW019	W019	6/1/96	3	10	21.0	6.6	27.0	8.0	4.2
KW019	W019	6/1/96	4	0	20.2	7.1	27.0	8.0	1.7
KW019	W019	6/1/96	4	5		6.9			
KW019	W019	6/1/96	4	10	20.7	7.0	29.0	8.1	4.4
KW019	W019	6/1/96	5	0	20.2	7.0	27.0	7.7	1.3
KW019	W019	6/1/96	5	5		6.9			
KW019	W019	6/1/96	5	10	20.0	7.0	28.5	8.1	5.0
KW020	W020	5/31/96	1	0	19.9	7.0	27.0	7.8	1.6
KW020	W020	5/31/96	1	3	20.2	6.8	28.0	8.0	
KW020	W020	5/31/96	1	5		6.8			
KW020	W020	5/31/96	1	7	20.3	7.3	28.0	8.2	
KW020	W020	5/31/96	1	10	19.9	7.0	29.0	8.4	5.5
KW020	W020	5/31/96	2	0	19.8	7.1	27.0	8.0	1.6
KW020	W020	5/31/96	2	5		7.0			
KW020	W020	5/31/96	2	10	19.9	7.0	28.5	8.1	5.0
KW020	W020	5/31/96	3	0	19.9	7.0	27.0	8.1	1.9
KW020	W020	5/31/96	3	5		7.0			
KW020	W020	5/31/96	3	10	19.8	7.0	29.0	8.5	4.8
KW020	W020	5/31/96	4	0	20.2	6.9	27.0	8.1	1.9
KW020	W020	5/31/96	4	5		7.0			
KW020	W020	5/31/96	4	10	20.0	7.0	29.0	8.4	5.0
KW020	W020	5/31/96	5	0	19.9	7.0	27.0	8.0	2.0
KW020	W020	5/31/96	5	5		6.8			
KW020	W020	5/31/96	5	10	19.8	6.8	29.0	8.4	5.5
KW021	W021	6/3/96	1	0	20.2	7.0	27.5	8.0	1.4
KW021	W021	6/3/96	1	3	20.0	7.0	27.0	7.8	
KW021	W021	6/3/96	1	5		6.9			

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TABLE A3-3. (cont.)

Sample Number	Station	Collection Date	Replicate	Day	Temperature (deg C)	Dissolved Oxygen (mg/L)	Salinity (ppt)	pH	Ammonia as Nitrogen (mg/L)
KW021	W021	6/3/96	1	7	20.1	7.4	28.0	8.0	
KW021	W021	6/3/96	1	10	19.9	7.0	29.0	8.1	4.8
KW021	W021	6/3/96	2	0	20.1	7.0	27.0	8.0	1.2
KW021	W021	6/3/96	2	5		7.0			
KW021	W021	6/3/96	2	10	20.8	7.0	27.5	8.1	4.1
KW021	W021	6/3/96	3	0	20.0	7.2	28.0	8.0	1.3
KW021	W021	6/3/96	3	5		7.1			
KW021	W021	6/3/96	3	10	21.0	6.4	27.0	8.0	5.5
KW021	W021	6/3/96	4	0	20.1	7.0	27.5	8.0	1.1
KW021	W021	6/3/96	4	5		7.0			
KW021	W021	6/3/96	4	10	20.9	7.0	28.0	8.1	4.7
KW021	W021	6/3/96	5	0	20.0	7.1	27.0	7.9	1.4
KW021	W021	6/3/96	5	5		7.0			
KW021	W021	6/3/96	5	10	20.0	6.7	28.0	7.9	4.2
KW022	W022	5/28/96	1	0	20.2	7.0	27.0	7.9	0.6
KW022	W022	5/28/96	1	3	20.3	6.8	27.5	7.9	
KW022	W022	5/28/96	1	5		7.0			
KW022	W022	5/28/96	1	7	20.6	7.2	28.0	8.3	
KW022	W022	5/28/96	1	10	20.0	7.0	28.5	8.4	0
KW022	W022	5/28/96	2	0	20.1	7.0	27.0	8.1	0.5
KW022	W022	5/28/96	2	5		6.6			
KW022	W022	5/28/96	2	10	20.7	6.8	28.0	8.2	0.6
KW022	W022	5/28/96	3	0	20.1	6.9	27.0	8.0	0.4
KW022	W022	5/28/96	3	5		7.0			
KW022	W022	5/28/96	3	10	19.9	7.1	29.0	8.3	0
KW022	W022	5/28/96	4	0	20.1	7.0	27.0	7.9	0.4
KW022	W022	5/28/96	4	5		6.9			
KW022	W022	5/28/96	4	10	20.0	7.0	28.5	8.3	0
KW022	W022	5/28/96	5	0	19.8	7.1	27.5	8.0	0.5
KW022	W022	5/28/96	5	5		7.1			
KW022	W022	5/28/96	5	10	19.8	7.0	29.0	8.3	0
KW023	W023	5/29/96	1	0	20.2	6.7	27.0	7.9	0.2
KW023	W023	5/29/96	1	3	20.3	6.9	27.5	7.8	
KW023	W023	5/29/96	1	5		6.8			
KW023	W023	5/29/96	1	7	20.8	7.4	28.0	8.5	
KW023	W023	5/29/96	1	10	20.0	7.0	29.0	8.4	0.1
KW023	W023	5/29/96	2	0	20.1	7.0	27.0	8.0	0.3
KW023	W023	5/29/96	2	5		7.0			
KW023	W023	5/29/96	2	10	20.0	7.0	29.0	8.5	0
KW023	W023	5/29/96	3	0	20.1	7.0	27.0	8.0	0.3
KW023	W023	5/29/96	3	5		6.8			
KW023	W023	5/29/96	3	10	20.9	6.6	27.5	8.4	0.3
KW023	W023	5/29/96	4	0	19.9	6.8	27.5	8.0	0.5
KW023	W023	5/29/96	4	5		6.8			
KW023	W023	5/29/96	4	10	19.7	6.9	29.0	8.4	0.8
KW023	W023	5/29/96	5	0	19.8	7.0	27.0	8.0	0.3
KW023	W023	5/29/96	5	5		7.0			
KW023	W023	5/29/96	5	10	19.8	7.1	29.0	8.4	0
KW024	W024	6/1/96	1	0	19.9	7.1	27.0	8.0	0.7

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TABLE A3-3. (cont.)

Sample Number	Station	Collection Date	Replicate	Day	Temperature (deg C)	Dissolved Oxygen (mg/L)	Salinity (ppt)	pH	Ammonia as Nitrogen (mg/L)
KW024	W024	6/1/96	1	3	20.1	6.8	27.5	7.9	
KW024	W024	6/1/96	1	5		7.1			
KW024	W024	6/1/96	1	7	20.1	7.2	28.0	8.6	
KW024	W024	6/1/96	1	10	19.8	7.0	29.0	8.6	1.8
KW024	W024	6/1/96	2	0	20.0	7.1	27.0	8.0	0.8
KW024	W024	6/1/96	2	5		7.0			
KW024	W024	6/1/96	2	10	19.7	7.1	29.0	8.4	1.0
KW024	W024	6/1/96	3	0	19.9	7.1	27.0	8.0	0.8
KW024	W024	6/1/96	3	5		6.9			
KW024	W024	6/1/96	3	10	19.9	6.6	28.0	8.6	2.4
KW024	W024	6/1/96	4	0	20.1	7.0	27.0	8.0	0.7
KW024	W024	6/1/96	4	5		7.0			
KW024	W024	6/1/96	4	10	19.9	7.0	28.5	8.6	2.8
KW024	W024	6/1/96	5	0	20.0	7.2	27.5	8.0	0.8
KW024	W024	6/1/96	5	5		6.9			
KW024	W024	6/1/96	5	10	20.6	7.0	27.0	8.4	1.0
KW025	W025	5/30/96	1	0	20.1	7.0	27.0	8.0	4.3
KW025	W025	5/30/96	1	3	20.1	6.5	27.0	7.8	
KW025	W025	5/30/96	1	5		7.0			
KW025	W025	5/30/96	1	7	20.3	7.2	28.0	7.8	
KW025	W025	5/30/96	1	10	20.0	7.0	29.0	7.8	11.0
KW025	W025	5/30/96	2	0	20.1	6.9	27.0	7.9	3.9
KW025	W025	5/30/96	2	5		7.0			
KW025	W025	5/30/96	2	10	20.0	7.0	28.0	7.8	9.5
KW025	W025	5/30/96	3	0	20.2	7.0	27.0	7.7	4.4
KW025	W025	5/30/96	3	5		7.0			
KW025	W025	5/30/96	3	10	19.9	5.2	29.0	7.5	8.5
KW025	W025	5/30/96	4	0	19.9	7.0	27.0	7.6	3.7
KW025	W025	5/30/96	4	5		6.8			
KW025	W025	5/30/96	4	10	19.7	6.8	29.0	7.8	8.5
KW025	W025	5/30/96	5	0	19.9	7.0	27.5	8.1	3.9
KW025	W025	5/30/96	5	5		6.9			
KW025	W025	5/30/96	5	10	19.9	6.2	29.0	7.7	8.0
KW026	W026	5/30/96	1	0	19.9	6.9	27.0	8.0	1.0
KW026	W026	5/30/96	1	3	20.1	6.8	27.5	7.8	
KW026	W026	5/30/96	1	5		6.8			
KW026	W026	5/30/96	1	7	20.0	6.8	28.0	7.8	
KW026	W026	5/30/96	1	10	19.9	7.0	29.0	8.0	5.0
KW026	W026	5/30/96	2	0	20.0	7.1	27.5	8.1	1.1
KW026	W026	5/30/96	2	5		7.1			
KW026	W026	5/30/96	2	10	21.0	6.9	27.0	7.9	3.6
KW026	W026	5/30/96	3	0	19.9	7.0	27.0	8.0	1.6
KW026	W026	5/30/96	3	5		6.8			
KW026	W026	5/30/96	3	10	19.9	7.0	29.0	8.0	4.4
KW026	W026	5/30/96	4	0	20.1	6.9	27.0	7.9	1.3
KW026	W026	5/30/96	4	5		6.9			
KW026	W026	5/30/96	4	10	20.0	7.2	29.0	8.0	4.5
KW026	W026	5/30/96	5	0	20.1	7.0	27.5	8.0	1.1
KW026	W026	5/30/96	5	5		6.8			

TABLE A3-3. (cont.)

Sample Number	Station	Collection Date	Replicate	Day	Temperature (deg C)	Dissolved Oxygen (mg/L)	Salinity (ppt)	pH	Ammonia as Nitrogen (mg/L)
KW026	W026	5/30/96	5	10	21.0	6.9	29.0	8.0	3.4
KW027	W027	5/29/96	1	0	20.2	6.8	27.0	8.0	0.7
KW027	W027	5/29/96	1	3	20.2	6.8	27.5	7.9	
KW027	W027	5/29/96	1	5		6.8			
KW027	W027	5/29/96	1	7	20.9	7.4	28.5	8.1	
KW027	W027	5/29/96	1	10	20.0	7.0	29.0	8.3	2.0
KW027	W027	5/29/96	2	0	20.1	7.1	27.5	8.0	1.2
KW027	W027	5/29/96	2	5		6.8			
KW027	W027	5/29/96	2	10	21.0	6.7	27.0	8.3	3.0
KW027	W027	5/29/96	3	0	19.9	7.0	27.0	8.0	1.3
KW027	W027	5/29/96	3	5		6.8			
KW027	W027	5/29/96	3	10	19.7	7.0	29.0	8.3	3.7
KW027	W027	5/29/96	4	0	20.1	7.0	27.0	8.1	1.2
KW027	W027	5/29/96	4	5		6.8			
KW027	W027	5/29/96	4	10	20.3	7.0	29.0	8.3	3.4
KW027	W027	5/29/96	5	0	19.8	7.0	27.0	8.1	0.8
KW027	W027	5/29/96	5	5		6.8			
KW027	W027	5/29/96	5	10	19.9	6.8	29.0	8.3	2.4
KW028	W028	5/29/96	1	0	19.9	7.0	27.0	8.1	1.1
KW028	W028	5/29/96	1	3	20.1	6.9	28.0	7.8	
KW028	W028	5/29/96	1	5		6.6			
KW028	W028	5/29/96	1	7	20.0	7.0	28.0	8.6	
KW028	W028	5/29/96	1	10	19.9	6.8	29.0	8.5	2.1
KW028	W028	5/29/96	2	0	20.1	7.1	27.5	8.0	1.0
KW028	W028	5/29/96	2	5		6.6			
KW028	W028	5/29/96	2	10	20.9	6.4	27.0	8.5	4.0
KW028	W028	5/29/96	3	0	20.2	6.8	27.0	7.9	1.3
KW028	W028	5/29/96	3	5		6.7			
KW028	W028	5/29/96	3	10	20.0	6.8	28.0	8.4	3.2
KW028	W028	5/29/96	4	0	20.1	7.0	27.0	7.9	1.1
KW028	W028	5/29/96	4	5		6.9			
KW028	W028	5/29/96	4	10	19.9	7.0	29.0	8.5	2.5
KW028	W028	5/29/96	5	0	20.2	6.7	27.0	7.8	1.5
KW028	W028	5/29/96	5	5		6.7			
KW028	W028	5/29/96	5	10	20.0	6.5	29.0	8.6	3.6
KW029	W029	6/5/96	1	0	20.2	6.9	27.0	7.8	0.4
KW029	W029	6/5/96	1	3	20.3	6.7	27.5	7.8	
KW029	W029	6/5/96	1	5		6.9			
KW029	W029	6/5/96	1	7	20.8	7.4	27.5	8.2	
KW029	W029	6/5/96	1	10	19.9	7.1	29.0	8.3	0
KW029	W029	6/5/96	2	0	20.0	7.0	27.0	8.0	0.3
KW029	W029	6/5/96	2	5		6.8			
KW029	W029	6/5/96	2	10	20.8	6.8	28.0	8.2	0.2
KW029	W029	6/5/96	3	0	20.1	7.0	27.0	8.0	0.7
KW029	W029	6/5/96	3	5		6.9			
KW029	W029	6/5/96	3	10	19.9	7.1	29.0	8.3	0.6
KW029	W029	6/5/96	4	0	19.9	7.0	27.5	7.7	0.3
KW029	W029	6/5/96	4	5		7.1			
KW029	W029	6/5/96	4	10	19.9	7.0	29.0	8.1	0

TABLE A3-3. (cont.)

Sample Number	Station	Collection Date	Replicate	Day	Temperature (deg C)	Dissolved Oxygen (mg/L)	Salinity (ppt)	pH	Ammonia as Nitrogen (mg/L)
KW029	W029	6/5/96	5	0	20.1	6.9	27.5	7.9	0.4
KW029	W029	6/5/96	5	5		6.9			
KW029	W029	6/5/96	5	10	20.0	7.0	28.0	8.4	0.7
KW035	W030	6/5/96	1	0	20.1	7.0	27.0	8.0	0.1
KW035	W030	6/5/96	1	3	20.3	6.8	27.0	7.9	
KW035	W030	6/5/96	1	5		6.9			
KW035	W030	6/5/96	1	7	20.7	7.4	28.0	8.1	
KW035	W030	6/5/96	1	10	20.8	7.0	28.0	8.2	0.1
KW035	W030	6/5/96	2	0	20.2	6.8	27.0	7.9	0
KW035	W030	6/5/96	2	5		6.9			
KW035	W030	6/5/96	2	10	20.0	7.0	29.0	8.2	0
KW035	W030	6/5/96	3	0	20.1	7.0	27.0	8.0	0.2
KW035	W030	6/5/96	3	5		6.8			
KW035	W030	6/5/96	3	10	20.9	7.0	29.0	8.2	0.2
KW035	W030	6/5/96	4	0	20.2	6.6	27.0	7.9	0
KW035	W030	6/5/96	4	5		6.6			
KW035	W030	6/5/96	4	10	19.9	6.9	29.0	8.3	0
KW035	W030	6/5/96	5	0	20.1	6.8	27.0	7.9	0.1
KW035	W030	6/5/96	5	5		7.0			
KW035	W030	6/5/96	5	10	20.0	7.0	28.5	8.2	0.1
WBC	Control	NA	1	0	20.1	7.1	27.0	8.1	1.8
WBC	Control	NA	1	3	20.3	6.8	27.0	8.0	
WBC	Control	NA	1	5		6.8			
WBC	Control	NA	1	7	20.7	7.1	27.0	8.1	
WBC	Control	NA	1	10	20.8	7.0	27.0	8.1	7.0
WBC	Control	NA	2	0	20.1	7.1	27.0	8.0	1.7
WBC	Control	NA	2	5		6.9			
WBC	Control	NA	2	10	20.8	7.0	27.0	8.0	7.5
WBC	Control	NA	3	0	19.8	7.0	27.0	8.0	2.1
WBC	Control	NA	3	5		6.9			
WBC	Control	NA	3	10	19.8	7.0	27.5	8.1	5.5
WBC	Control	NA	4	0	19.9	7.0	27.0	8.0	2.0
WBC	Control	NA	4	5		7.0			
WBC	Control	NA	4	10	19.9	7.0	27.0	8.1	6.0
WBC	Control	NA	5	0	20.2	7.0	27.0	8.0	2.2
WBC	Control	NA	5	5		6.9			
WBC	Control	NA	5	10	20.8	7.0	27.0	8.1	7.5

TABLE A3-4. SUMMARY OF WATER QUALITY PARAMETERS FROM THE *Neanthes* sp. TOXICITY TEST CONDUCTED IN 1996

Sample Number	Station	Collection Date	Replicate	Day	Temperature (deg C)	Dissolved Oxygen (mg/L)	Salinity (ppt)	pH	Ammonia as Nitrogen (mg/L)
KW001	W01	6/1/96	1	0	20.1	6.9	27.0	7.6	3.9
KW001	W01	6/1/96	1	3	19.5	4.9	28.0	7.5	9.5
KW001	W01	6/1/96	1	5		7.4			
KW001	W01	6/1/96	1	6	19.6	7.1	28.0	8.0	8.0
KW001	W01	6/1/96	1	9	19.5	6.8	29.0	8.0	10.0
KW001	W01	6/1/96	1	10		7.1			
KW001	W01	6/1/96	1	12	20.0	7.0	28.0	8.1	12.3
KW001	W01	6/1/96	1	15	21.0	6.5	28.0	8.0	12.5
KW001	W01	6/1/96	1	18	20.6	7.0	28.0	8.1	12.5
KW001	W01	6/1/96	1	20	20.8	7.0	27.0	8.0	12.5
KW001	W01	6/1/96	2	0	20.2	6.9	27.0	8.1	4.9
KW001	W01	6/1/96	2	5		7.3			
KW001	W01	6/1/96	2	10		7.2			
KW001	W01	6/1/96	2	15		6.7			
KW001	W01	6/1/96	2	20	20.8	7.1	27.5	7.9	12.5
KW001	W01	6/1/96	3	0	20.4	7.2	27.0	7.9	4.4
KW001	W01	6/1/96	3	5		6.4			
KW001	W01	6/1/96	3	10		6.8			
KW001	W01	6/1/96	3	15		6.8			
KW001	W01	6/1/96	3	20	20.9	7.6	27.0	8.1	12.5
KW001	W01	6/1/96	4	0	20.4	7.2	27.0	8.1	4.4
KW001	W01	6/1/96	4	5		7.3			
KW001	W01	6/1/96	4	10		6.9			
KW001	W01	6/1/96	4	15		6.9			
KW001	W01	6/1/96	4	20	21.0	7.6	27.0	8.0	12.5
KW001	W01	6/1/96	5	0	20.3	7.0	27.0	7.7	4.5
KW001	W01	6/1/96	5	5		7.2			
KW001	W01	6/1/96	5	10		6.8			
KW001	W01	6/1/96	5	15		6.7			
KW001	W01	6/1/96	5	20	20.9	7.1	27.0	8.0	10.5
KW002	W02	6/1/96	1	0	20.6	7.2	27.0	8.3	4.2
KW002	W02	6/1/96	1	3	21.0	7.1	28.5	8.0	5.5
KW002	W02	6/1/96	1	5		7.4			
KW002	W02	6/1/96	1	6	21.0	7.2	28.5	8.1	10.0
KW002	W02	6/1/96	1	9	20.4	7.0	29.0	8.1	11.0
KW002	W02	6/1/96	1	10		7.0			
KW002	W02	6/1/96	1	12	19.7	7.2	29.0	8.2	12.5
KW002	W02	6/1/96	1	15	20.2	7.1	28.5	8.1	11.3
KW002	W02	6/1/96	1	18	19.8	7.0	29.0	8.1	9.0
KW002	W02	6/1/96	1	20	20.1	7.6	27.5	8.1	12.0
KW002	W02	6/1/96	2	0	20.6	7.3	27.5	8.3	4.4
KW002	W02	6/1/96	2	5		7.2			
KW002	W02	6/1/96	2	10		7.1			
KW002	W02	6/1/96	2	15		7.0			
KW002	W02	6/1/96	2	20	20.0	7.6	28.0	8.1	12.5
KW002	W02	6/1/96	3	0	20.4	7.1	27.0	8.1	4.1
KW002	W02	6/1/96	3	5		7.0			
KW002	W02	6/1/96	3	10		7.2			
KW002	W02	6/1/96	3	15		6.6			
KW002	W02	6/1/96	3	20	20.6	7.4	28.0	8.0	11.0

TABLE A3-4. (cont.)

Sample Number	Station	Collection Date	Replicate	Day	Temperature (deg C)	Dissolved Oxygen (mg/L)	Salinity (ppt)	pH	Ammonia as Nitrogen (mg/L)
KW002	W02	6/1/96	4	0	20.4	7.2	27.0	8.2	4.1
KW002	W02	6/1/96	4	5		7.2			
KW002	W02	6/1/96	4	10		7.0			
KW002	W02	6/1/96	4	15		6.7			
KW002	W02	6/1/96	4	20	21.0	7.2	28.0	8.1	10.0
KW002	W02	6/1/96	5	0	20.6	7.4	27.0	8.2	3.6
KW002	W02	6/1/96	5	5		7.3			
KW002	W02	6/1/96	5	10		7.0			
KW002	W02	6/1/96	5	15		7.0			
KW002	W02	6/1/96	5	20	20.0	7.5	28.0	8.1	12.0
KW003	W03	6/2/96	1	0	20.2	7.0	27.0	8.1	0
KW003	W03	6/2/96	1	3	19.5	6.1	28.0	7.7	3.9
KW003	W03	6/2/96	1	5					
KW003	W03	6/2/96	1	10					
KW003	W03	6/2/96	1	15		6.6			
KW003	W03	6/2/96	1	20					
KW003	W03	6/2/96	2	0	20.6	7.2	27.0	8.2	0.3
KW003	W03	6/2/96	2	5		7.2			
KW003	W03	6/2/96	2	6	20.7	7.1	28.5	8.3	4.0
KW003	W03	6/2/96	2	9	20.1	7.0	29.0	8.4	3.2
KW003	W03	6/2/96	2	10		7.2			
KW003	W03	6/2/96	2	12	19.7	7.1	29.0	8.4	5.0
KW003	W03	6/2/96	2	15	20.1	7.0	29.0	8.3	6.0
KW003	W03	6/2/96	2	18	19.7	7.0	28.0	8.2	3.5
KW003	W03	6/2/96	2	20	19.8	7.4	28.5	8.2	5.0
KW003	W03	6/2/96	3	0	20.2	6.8	27.0	8.2	0.2
KW003	W03	6/2/96	3	5		7.2			
KW003	W03	6/2/96	3	10		6.9			
KW003	W03	6/2/96	3	15		6.8			
KW003	W03	6/2/96	3	20	20.8	7.0	27.0	8.1	5.5
KW003	W03	6/2/96	4	0	20.3	6.9	27.0	8.0	0.2
KW003	W03	6/2/96	4	5		7.4			
KW003	W03	6/2/96	4	10		7.0			
KW003	W03	6/2/96	4	15		6.6			
KW003	W03	6/2/96	4	20	20.8	7.0	27.0	8.2	7.8
KW003	W03	6/2/96	5	0	20.6	7.2	27.5	8.2	0
KW003	W03	6/2/96	5	5		7.4			
KW003	W03	6/2/96	5	10		7.0			
KW003	W03	6/2/96	5	15		7.0			
KW003	W03	6/2/96	5	20	20.1	7.5	28.0	8.1	5.5
KW004	W04	6/2/96	1	0	20.2	7.0	27.0	8.2	1.2
KW004	W04	6/2/96	1	3	19.5	6.8	28.5	8.0	3.4
KW004	W04	6/2/96	1	5		7.2			
KW004	W04	6/2/96	1	6	19.6	7.1	28.0	8.1	3.5
KW004	W04	6/2/96	1	9	19.6	6.9	29.0	8.1	6.5
KW004	W04	6/2/96	1	10		7.1			
KW004	W04	6/2/96	1	15	20.9	6.7	29.0	8.2	7.3
KW004	W04	6/2/96	1	18	20.7	7.1	28.0	8.2	7.5
KW004	W04	6/2/96	1	20	20.8	7.4	27.0	8.2	7.3
KW004	W04	6/2/96	2	0	20.4	7.2	27.0	8.2	1.3

TABLE A3-4. (cont.)

Sample Number	Station	Collection Date	Replicate	Day	Temperature (deg C)	Dissolved Oxygen (mg/L)	Salinity (ppt)	pH	Ammonia as Nitrogen (mg/L)
KW004	W04	6/2/96	2	5		7.4			
KW004	W04	6/2/96	2	10		7.0			
KW004	W04	6/2/96	2	15		6.6			
KW004	W04	6/2/96	2	20	20.9	7.0	27.0	8.2	4.0
KW004	W04	6/2/96	3	0	20.7	7.2	28.0	8.2	1.4
KW004	W04	6/2/96	3	5		7.5			
KW004	W04	6/2/96	3	10		6.8			
KW004	W04	6/2/96	3	15		7.0			
KW004	W04	6/2/96	3	20	20.1	7.6	28.0	8.3	5.5
KW004	W04	6/2/96	4	0	20.3	7.0	27.5	8.1	1.2
KW004	W04	6/2/96	4	5		7.2			
KW004	W04	6/2/96	4	10		7.0			
KW004	W04	6/2/96	4	15		6.6			
KW004	W04	6/2/96	4	20	20.9	7.0	27.0	8.1	5.0
KW004	W04	6/2/96	5	0	20.3	7.2	27.0	8.2	1.6
KW004	W04	6/2/96	5	5		7.3			
KW004	W04	6/2/96	5	10		7.0			
KW004	W04	6/2/96	5	15		6.7			
KW004	W04	6/2/96	5	20	20.8	7.2	27.0	8.3	12.0
KW005	W05	6/1/96	1	0	20.6	7.1	27.0	8.0	1.1
KW005	W05	6/1/96	1	3	21.0	7.0	28.0	7.9	2.8
KW005	W05	6/1/96	1	5		7.2			
KW005	W05	6/1/96	1	6	20.9	7.0	27.5	7.9	4.3
KW005	W05	6/1/96	1	9	20.3	6.8	29.0	8.0	5.0
KW005	W05	6/1/96	1	10		7.1			
KW005	W05	6/1/96	1	12	19.5	6.9	29.0	8.2	3.4
KW005	W05	6/1/96	1	15	20.2	7.0	29.0	8.0	7.3
KW005	W05	6/1/96	1	18	19.7	7.2	28.5	8.1	10.5
KW005	W05	6/1/96	1	20	20.0	7.6	28.0	8.1	9.0
KW005	W05	6/1/96	2	0	20.4	7.1	27.5	8.0	1.1
KW005	W05	6/1/96	2	5		7.2			
KW005	W05	6/1/96	2	10		7.2			
KW005	W05	6/1/96	2	15		6.5			
KW005	W05	6/1/96	2	20	20.5	7.6	27.0	8.1	10.0
KW005	W05	6/1/96	3	0	20.4	7.1	27.0	8.1	1.4
KW005	W05	6/1/96	3	5		7.3			
KW005	W05	6/1/96	3	10		6.8			
KW005	W05	6/1/96	3	15		6.7			
KW005	W05	6/1/96	3	20	21.0	7.2	27.0	7.9	8.0
KW005	W05	6/1/96	4	0	20.3	7.2	27.0	8.1	1.0
KW005	W05	6/1/96	4	5		7.3			
KW005	W05	6/1/96	4	10		7.0			
KW005	W05	6/1/96	4	15		6.9			
KW005	W05	6/1/96	4	20	21.0	7.4	27.5	8.1	7.5
KW005	W05	6/1/96	5	0	20.3	7.1	27.0	8.1	1.3
KW005	W05	6/1/96	5	5		7.4			
KW005	W05	6/1/96	5	10		7.2			
KW005	W05	6/1/96	5	15		6.6			
KW005	W05	6/1/96	5	20	21.0	7.4	27.0	8.3	10.0
KW006	W06	6/4/96	1	0	20.4	7.1	27.0	7.8	4.0

TABLE A3-4. (cont.)

Sample Number	Station	Collection Date	Replicate	Day	Temperature (deg C)	Dissolved Oxygen (mg/L)	Salinity (ppt)	pH	Ammonia as Nitrogen (mg/L)
KW006	W06	6/4/96	1	3	19.6	6.3	28.0	7.8	10.0
KW006	W06	6/4/96	1	5		7.0			
KW006	W06	6/4/96	1	6	19.6	7.1	27.5	7.8	11.3
KW006	W06	6/4/96	1	9	19.6	6.2	28.0	7.8	11.5
KW006	W06	6/4/96	1	10		7.0			
KW006	W06	6/4/96	1	12	20.0	6.4	28.0	8.0	12.5
KW006	W06	6/4/96	1	15	21.0	6.6	28.0	7.8	10.5
KW006	W06	6/4/96	1	18	19.8	7.0	28.5	7.4	11.0
KW006	W06	6/4/96	1	20	21.0	7.3	27.0	8.1	7.5
KW006	W06	6/4/96	2	0	20.3	7.0	27.0	7.8	4.0
KW006	W06	6/4/96	2	5		7.0			
KW006	W06	6/4/96	2	10		7.1			
KW006	W06	6/4/96	2	15		6.8			
KW006	W06	6/4/96	2	20	20.8	6.9	27.0	8.0	10.5
KW006	W06	6/4/96	3	0	20.6	7.0	27.0	7.8	4.7
KW006	W06	6/4/96	3	5		6.9			
KW006	W06	6/4/96	3	10		6.8			
KW006	W06	6/4/96	3	15		7.0			
KW006	W06	6/4/96	3	20	19.9	7.5	27.0	8.0	12.5
KW006	W06	6/4/96	4	0	20.5	7.2	27.0	8.0	4.8
KW006	W06	6/4/96	4	5		7.3			
KW006	W06	6/4/96	4	10		7.1			
KW006	W06	6/4/96	4	15		7.0			
KW006	W06	6/4/96	4	20	19.8	7.6	27.5	8.0	12.5
KW006	W06	6/4/96	5	0	20.2	6.8	27.0	8.1	6.8
KW006	W06	6/4/96	5	5		7.2			
KW006	W06	6/4/96	5	10		7.0			
KW006	W06	6/4/96	5	15		6.9			
KW006	W06	6/4/96	5	20	20.8	7.1	27.0	8.1	9.8
KW007	W07	6/2/96	1	0	20.4	7.0	27.0	8.1	1.2
KW007	W07	6/2/96	1	3	19.9	6.6	28.5	7.9	2.6
KW007	W07	6/2/96	1	5		7.4			
KW007	W07	6/2/96	1	6	19.7	7.0	28.0	8.0	3.8
KW007	W07	6/2/96	1	9	19.8	7.0	28.0	8.1	7.5
KW007	W07	6/2/96	1	10		7.1			
KW007	W07	6/2/96	1	12	20.2	7.0	28.0	8.3	6.0
KW007	W07	6/2/96	1	15	21.0	6.9	28.0	8.2	8.0
KW007	W07	6/2/96	1	18	20.8	7.0	27.5	8.2	7.3
KW007	W07	6/2/96	1	20	21.0	7.3	27.0	8.2	8.5
KW007	W07	6/2/96	2	0	20.6	7.1	27.5	8.1	1.0
KW007	W07	6/2/96	2	5		7.4			
KW007	W07	6/2/96	2	10		7.1			
KW007	W07	6/2/96	2	15		6.8			
KW007	W07	6/2/96	2	20	20.0	7.5	28.0	8.2	6.1
KW007	W07	6/2/96	3	0	20.6	7.1	27.0	8.1	1.1
KW007	W07	6/2/96	3	5		7.2			
KW007	W07	6/2/96	3	10		7.1			
KW007	W07	6/2/96	3	15		7.0			
KW007	W07	6/2/96	3	20	19.9	7.6	28.0	8.2	9.0
KW007	W07	6/2/96	4	0	20.6	7.1	27.5	8.2	1.2

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TABLE A3-4. (cont.)

Sample Number	Station	Collection Date	Replicate	Day	Temperature (deg C)	Dissolved Oxygen (mg/L)	Salinity (ppt)	pH	Ammonia as Nitrogen (mg/L)
KW007	W07	6/2/96	4	5		7.4			
KW007	W07	6/2/96	4	10		7.0			
KW007	W07	6/2/96	4	15		6.8			
KW007	W07	6/2/96	4	20	20.1	7.4	28.0	8.2	10.0
KW007	W07	6/2/96	5	0	20.4	6.9	27.5	8.1	1.1
KW007	W07	6/2/96	5	5		7.0			
KW007	W07	6/2/96	5	10		7.2			
KW007	W07	6/2/96	5	15		6.2			
KW007	W07	6/2/96	5	20	20.9	7.6	27.0	8.0	7.5
KW008	W08	6/2/96	1	0	20.6	7.1	27.0	8.1	2.0
KW008	W08	6/2/96	1	3	20.7	7.0	28.0	8.0	3.9
KW008	W08	6/2/96	1	5		7.0			
KW008	W08	6/2/96	1	6	20.8	7.1	28.0	7.9	5.0
KW008	W08	6/2/96	1	9	20.3	6.6	29.0	7.9	8.0
KW008	W08	6/2/96	1	10		7.1			
KW008	W08	6/2/96	1	12	19.7	6.9	28.5	8.2	5.0
KW008	W08	6/2/96	1	15	20.1	7.0	28.0	8.2	9.0
KW008	W08	6/2/96	1	18	19.8	7.2	29.0	8.3	12.5
KW008	W08	6/2/96	1	20	19.9	7.5	27.5	8.2	6.0
KW008	W08	6/2/96	2	0	20.7	7.4	27.5	8.2	1.6
KW008	W08	6/2/96	2	5		6.8			
KW008	W08	6/2/96	2	10		7.1			
KW008	W08	6/2/96	2	15		7.0			
KW008	W08	6/2/96	2	20	20.1	7.5	28.0	8.1	7.0
KW008	W08	6/2/96	3	0	20.5	7.0	27.0	8.1	2.1
KW008	W08	6/2/96	3	5		7.2			
KW008	W08	6/2/96	3	10		7.0			
KW008	W08	6/2/96	3	15		6.8			
KW008	W08	6/2/96	3	20	20.9	7.3	27.0	8.3	11.0
KW008	W08	6/2/96	4	0	20.3	7.0	27.0	8.1	2.0
KW008	W08	6/2/96	4	5		7.2			
KW008	W08	6/2/96	4	10		7.0			
KW008	W08	6/2/96	4	15		6.4			
KW008	W08	6/2/96	4	20	20.9	7.1	27.0	8.2	7.5
KW008	W08	6/2/96	5	0	20.6	7.0	27.0	8.1	2.2
KW008	W08	6/2/96	5	5		7.2			
KW008	W08	6/2/96	5	10		7.1			
KW008	W08	6/2/96	5	15		7.0			
KW008	W08	6/2/96	5	20	19.8	7.5	28.0	8.3	10.0
KW009	W09	6/2/96	1	0	20.3	7.0	27.0	8.1	1.5
KW009	W09	6/2/96	1	3	19.7	6.9	28.0	7.9	3.6
KW009	W09	6/2/96	1	5		7.2			
KW009	W09	6/2/96	1	6	19.5	7.0	28.0	8.0	4.1
KW009	W09	6/2/96	1	9	19.6	6.8	28.0	8.0	5.0
KW009	W09	6/2/96	1	10		6.8			
KW009	W09	6/2/96	1	12	20.1	6.9	27.5	8.1	7.0
KW009	W09	6/2/96	1	15	21.0	6.7	28.0	7.8	7.5
KW009	W09	6/2/96	1	18	20.6	7.0	26.5	7.9	7.0
KW009	W09	6/2/96	1	20	20.9	7.2	27.0	8.1	5.0
KW009	W09	6/2/96	2	0	20.3	6.8	27.0	7.9	1.8

TABLE A3-4. (cont.)

Sample Number	Station	Collection Date	Replicate	Day	Temperature (deg C)	Dissolved Oxygen (mg/L)	Salinity (ppt)	pH	Ammonia as Nitrogen (mg/L)
KW009	W09	6/2/96	2	5		6.7			
KW009	W09	6/2/96	2	10		7.0			
KW009	W09	6/2/96	2	12	20.1	7.0	29.0	8.3	5.0
KW009	W09	6/2/96	2	15		5.6			
KW009	W09	6/2/96	2	20	20.9	7.1	27.0	8.2	11.0
KW009	W09	6/2/96	3	0	20.3	7.0	27.0	8.2	2.0
KW009	W09	6/2/96	3	5		7.3			
KW009	W09	6/2/96	3	10		7.1			
KW009	W09	6/2/96	3	15		6.6			
KW009	W09	6/2/96	3	20	20.9	7.0	27.0	8.1	6.0
KW009	W09	6/2/96	4	0	20.4	7.2	27.0	8.2	1.6
KW009	W09	6/2/96	4	5		7.4			
KW009	W09	6/2/96	4	10		6.9			
KW009	W09	6/2/96	4	15		6.8			
KW009	W09	6/2/96	4	20	21.0	7.6	27.0	8.3	6.0
KW009	W09	6/2/96	5	0	20.2	7.0	27.0	8.2	1.8
KW009	W09	6/2/96	5	5		7.2			
KW009	W09	6/2/96	5	10		7.0			
KW009	W09	6/2/96	5	15		6.6			
KW009	W09	6/2/96	5	20	20.8	7.2	27.0	8.3	9.5
KW010	W010R	6/3/96	1	0	20.6	7.1	27.0	8.1	1.6
KW010	W010R	6/3/96	1	3	20.4	6.9	28.0	8.0	3.5
KW010	W010R	6/3/96	1	5		7.4			
KW010	W010R	6/3/96	1	6	20.7	7.0	29.0	8.1	5.0
KW010	W010R	6/3/96	1	9	20.2	7.0	29.0	8.1	5.0
KW010	W010R	6/3/96	1	10		7.1			
KW010	W010R	6/3/96	1	12	19.8	6.9	29.0	8.3	7.5
KW010	W010R	6/3/96	1	15	20.0	6.8	29.0	8.3	8.0
KW010	W010R	6/3/96	1	18	19.8	7.2	28.0	8.4	6.0
KW010	W010R	6/3/96	1	20	19.8	7.4	29.0	8.3	7.8
KW010	W010R	6/3/96	2	0	20.4	7.1	27.0	8.1	1.6
KW010	W010R	6/3/96	2	5		7.2			
KW010	W010R	6/3/96	2	10		7.0			
KW010	W010R	6/3/96	2	15		6.6			
KW010	W010R	6/3/96	2	20	20.9	7.2	27.0	8.4	9.5
KW010	W010R	6/3/96	3	0	20.3	6.7	27.0	7.9	1.5
KW010	W010R	6/3/96	3	5		7.0			
KW010	W010R	6/3/96	3	10		7.1			
KW010	W010R	6/3/96	3	15		7.1			
KW010	W010R	6/3/96	3	15		4.6			
KW010	W010R	6/3/96	3	20	20.9	7.1	27.0	8.2	11.0
KW010	W010R	6/3/96	4	0	20.7	7.4	27.0	8.1	1.6
KW010	W010R	6/3/96	4	5		7.1			
KW010	W010R	6/3/96	4	10		7.0			
KW010	W010R	6/3/96	4	15		7.0			
KW010	W010R	6/3/96	4	20	20.1	7.5	28.0	8.3	12.5
KW010	W010R	6/3/96	5	0	20.6	7.1	27.0	8.1	1.7
KW010	W010R	6/3/96	5	5		7.2			
KW010	W010R	6/3/96	5	10		7.0			
KW010	W010R	6/3/96	5	15		7.0			

TABLE A3-4. (cont.)

Sample Number	Station	Collection Date	Replicate	Day	Temperature (deg C)	Dissolved Oxygen (mg/L)	Salinity (ppt)	pH	Ammonia as Nitrogen (mg/L)
KW010	W010R	6/3/96	5	20	19.9	7.6	28.0	8.3	6.0
KW011	W011	5/30/96	1	0	20.7	7.4	27.5	8.2	0.8
KW011	W011	5/30/96	1	3	21.0	7.0	28.0	8.0	3.4
KW011	W011	5/30/96	1	5		7.3			
KW011	W011	5/30/96	1	6	20.9	7.2	28.0	8.1	3.6
KW011	W011	5/30/96	1	9	20.5	7.0	29.0	8.1	4.0
KW011	W011	5/30/96	1	10		7.0			
KW011	W011	5/30/96	1	12	19.8	7.1	29.0	8.2	3.6
KW011	W011	5/30/96	1	15	20.3	6.8	29.0	8.1	3.8
KW011	W011	5/30/96	1	18	19.8	7.3	28.0	8.1	0.1
KW011	W011	5/30/96	1	20	20.1	7.3	28.5	8.2	0.5
KW011	W011	5/30/96	2	0	20.3	7.2	27.0	8.1	0.8
KW011	W011	5/30/96	2	5		7.1			
KW011	W011	5/30/96	2	10		6.9			
KW011	W011	5/30/96	2	15		6.8			
KW011	W011	5/30/96	2	20	20.9	7.3	27.0	8.2	9.5
KW011	W011	5/30/96	3	0	20.3	7.2	27.0	8.2	0.8
KW011	W011	5/30/96	3	5		7.4			
KW011	W011	5/30/96	3	10		7.0			
KW011	W011	5/30/96	3	15		6.8			
KW011	W011	5/30/96	3	20	20.8	7.3	27.0	8.2	3.0
KW011	W011	5/30/96	4	0	20.2	7.1	27.0	8.1	0.8
KW011	W011	5/30/96	4	5		7.0			
KW011	W011	5/30/96	4	10		7.0			
KW011	W011	5/30/96	4	15		6.8			
KW011	W011	5/30/96	4	20	20.7	7.2	27.0	8.1	9.0
KW011	W011	5/30/96	5	0	20.4	7.2	27.0	8.0	0.6
KW011	W011	5/30/96	5	5		7.3			
KW011	W011	5/30/96	5	10		7.1			
KW011	W011	5/30/96	5	15		5.9			
KW011	W011	5/30/96	5	20	20.9	7.6	27.0	8.1	3.5
KW012	W012	6/4/96	1	0	20.4	7.2	27.0	8.1	3.7
KW012	W012	6/4/96	1	3	19.6	6.9	28.0	7.9	8.0
KW012	W012	6/4/96	1	5		7.4			
KW012	W012	6/4/96	1	6	19.6	7.0	28.0	8.1	9.1
KW012	W012	6/4/96	1	9	19.7	6.9	28.5	8.1	10.0
KW012	W012	6/4/96	1	10		7.1			
KW012	W012	6/4/96	1	12	20.1	6.9	28.0	8.1	12.0
KW012	W012	6/4/96	1	15	20.9	7.0	28.0	8.2	11.0
KW012	W012	6/4/96	1	18	20.8	7.0	28.5	8.3	8.0
KW012	W012	6/4/96	1	20	20.9	7.5	28.0	8.3	10.5
KW012	W012	6/4/96	2	0	20.3	7.2	27.0	8.1	3.2
KW012	W012	6/4/96	2	5		7.3			
KW012	W012	6/4/96	2	10		7.0			
KW012	W012	6/4/96	2	15		6.8			
KW012	W012	6/4/96	2	20	21.0	7.3	27.0	8.2	10.5
KW012	W012	6/4/96	3	0	20.6	7.2	27.5	8.3	3.5
KW012	W012	6/4/96	3	5		7.1			
KW012	W012	6/4/96	3	10		6.9			
KW012	W012	6/4/96	3	15		7.0			

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TABLE A3-4. (cont.)

Sample Number	Station	Collection Date	Replicate	Day	Temperature (deg C)	Dissolved Oxygen (mg/L)	Salinity (ppt)	pH	Ammonia as Nitrogen (mg/L)
KW012	W012	6/4/96	3	20	20.1	7.6	27.0	8.2	5.5
KW012	W012	6/4/96	4	0	20.7	7.3	27.5	8.3	3.9
KW012	W012	6/4/96	4	5		7.0			
KW012	W012	6/4/96	4	10		7.0			
KW012	W012	6/4/96	4	15		7.0			
KW012	W012	6/4/96	4	20	20.1	7.6	27.5	8.2	12.5
KW012	W012	6/4/96	5	0	20.6	7.2	27.0	8.2	3.6
KW012	W012	6/4/96	5	5		7.4			
KW012	W012	6/4/96	5	10		6.9			
KW012	W012	6/4/96	5	15		7.0			
KW012	W012	6/4/96	5	20	20.1	7.4	27.5	8.2	8.8
KW013	W013	6/4/96	1	0	20.4	7.2	27.0	8.2	1.1
KW013	W013	6/4/96	1	3	19.7	6.8	28.0	8.0	5.0
KW013	W013	6/4/96	1	5		7.3			
KW013	W013	6/4/96	1	6	19.7	7.0	28.0	8.1	8.8
KW013	W013	6/4/96	1	9	19.7	6.9	29.0	8.1	9.0
KW013	W013	6/4/96	1	10		7.0			
KW013	W013	6/4/96	1	12	20.2	6.9	28.5	8.3	12.5
KW013	W013	6/4/96	1	15	21.0	6.8	29.0	8.3	10.0
KW013	W013	6/4/96	1	18	20.7	7.2	28.0	8.4	10.8
KW013	W013	6/4/96	1	20	21.0	7.5	27.0	8.4	8.3
KW013	W013	6/4/96	2	0	20.6	7.0	27.0	7.9	2.2
KW013	W013	6/4/96	2	5		7.4			
KW013	W013	6/4/96	2	10		6.9			
KW013	W013	6/4/96	2	15		7.0			
KW013	W013	6/4/96	2	20	19.7	7.4	27.5	8.3	3.1
KW013	W013	6/4/96	3	0	20.7	7.3	27.5	8.2	1.8
KW013	W013	6/4/96	3	5		7.4			
KW013	W013	6/4/96	3	10		7.0			
KW013	W013	6/4/96	3	15		7.0			
KW013	W013	6/4/96	3	20	20.1	7.5	28.5	8.3	11.5
KW013	W013	6/4/96	4	0	20.4	6.9	27.0	8.0	2.4
KW013	W013	6/4/96	4	5		6.7			
KW013	W013	6/4/96	4	10		7.2			
KW013	W013	6/4/96	4	15		5.8			
KW013	W013	6/4/96	4	20	20.9	7.7	27.0	8.2	10.0
KW013	W013	6/4/96	5	0	20.6	7.2	27.5	8.2	2.4
KW013	W013	6/4/96	5	5		7.3			
KW013	W013	6/4/96	5	10		7.1			
KW013	W013	6/4/96	5	15		7.0			
KW013	W013	6/4/96	5	20	20.1	7.5	28.0	8.3	9.0
KW014	W014	6/4/96	1	0	20.3	6.8	27.5	8.1	1.2
KW014	W014	6/4/96	1	3	19.6	6.9	28.5	8.0	3.4
KW014	W014	6/4/96	1	5		7.2			
KW014	W014	6/4/96	1	6	19.5	7.1	28.0	8.1	3.8
KW014	W014	6/4/96	1	9	19.5	6.9	28.0	8.1	7.0
KW014	W014	6/4/96	1	10		7.1			
KW014	W014	6/4/96	1	12	20.1	6.9	28.5	8.3	8.5
KW014	W014	6/4/96	1	15	20.9	6.5	29.0	8.2	8.8
KW014	W014	6/4/96	1	18	20.7	7.0	28.0	8.3	8.8

TABLE A3-4. (cont.)

Sample Number	Station	Collection Date	Replicate	Day	Temperature (deg C)	Dissolved Oxygen (mg/L)	Salinity (ppt)	pH	Ammonia as Nitrogen (mg/L)
KW014	W014	6/4/96	1	20	20.9	7.2	27.0	8.2	9.5
KW014	W014	6/4/96	2	0	20.6	7.2	27.0	8.2	1.6
KW014	W014	6/4/96	2	5		7.4			
KW014	W014	6/4/96	2	10		6.9			
KW014	W014	6/4/96	2	15		7.0			
KW014	W014	6/4/96	2	20	20.1	7.5	27.0	8.3	6.0
KW014	W014	6/4/96	3	0	20.3	7.1	27.5	8.0	1.6
KW014	W014	6/4/96	3	5		7.2			
KW014	W014	6/4/96	3	10		7.2			
KW014	W014	6/4/96	3	15		5.4			
KW014	W014	6/4/96	3	20	20.6	7.2	28.0	8.2	11.0
KW014	W014	6/4/96	4	0	20.6	7.2	27.0	8.2	1.4
KW014	W014	6/4/96	4	5		7.3			
KW014	W014	6/4/96	4	10		7.0			
KW014	W014	6/4/96	4	15		7.0			
KW014	W014	6/4/96	4	20	20.1	7.4	28.0	8.1	9.0
KW014	W014	6/4/96	5	0	20.4	7.0	27.0	8.0	1.6
KW014	W014	6/4/96	5	5		7.2			
KW014	W014	6/4/96	5	10		6.8			
KW014	W014	6/4/96	5	15		6.6			
KW014	W014	6/4/96	5	20	20.9	7.2	27.0	8.3	10.5
KW015	W015	6/2/96	1	0	20.6	7.1	27.5	8.0	1.7
KW015	W015	6/2/96	1	3	20.4	7.2	28.0	8.0	3.9
KW015	W015	6/2/96	1	5		7.2			
KW015	W015	6/2/96	1	6	20.7	7.2	29.0	8.1	4.9
KW015	W015	6/2/96	1	9	20.2	7.0	29.0	8.1	5.0
KW015	W015	6/2/96	1	10		7.1			
KW015	W015	6/2/96	1	12	19.7	7.2	29.0	8.2	8.8
KW015	W015	6/2/96	1	15	20.2	6.9	29.0	8.0	8.0
KW015	W015	6/2/96	1	18	19.8	7.1	28.0	8.1	11.5
KW015	W015	6/2/96	1	20	19.8	7.4	28.0	8.2	9.0
KW015	W015	6/2/96	2	0	20.7	7.2	27.5	8.2	1.8
KW015	W015	6/2/96	2	5		7.4			
KW015	W015	6/2/96	2	10		7.0			
KW015	W015	6/2/96	2	15		6.9			
KW015	W015	6/2/96	2	20	20.1	7.6	28.5	8.3	3.5
KW015	W015	6/2/96	3	0	20.3	7.0	27.0	8.2	1.6
KW015	W015	6/2/96	3	5		7.1			
KW015	W015	6/2/96	3	10		7.1			
KW015	W015	6/2/96	3	15		6.8			
KW015	W015	6/2/96	3	20	20.9	7.4	27.0	8.3	11.5
KW015	W015	6/2/96	4	0	20.3	7.1	27.0	8.1	1.2
KW015	W015	6/2/96	4	5		7.4			
KW015	W015	6/2/96	4	10		7.0			
KW015	W015	6/2/96	4	15		6.7			
KW015	W015	6/2/96	4	20	20.9	7.0	27.0	8.2	6.8
KW015	W015	6/2/96	5	0	20.4	7.0	27.0	8.1	1.7
KW015	W015	6/2/96	5	5		7.1			
KW015	W015	6/2/96	5	10		7.0			
KW015	W015	6/2/96	5	15		6.8			

TABLE A3-4. (cont.)

Sample Number	Station	Collection Date	Replicate	Day	Temperature (deg C)	Dissolved Oxygen (mg/L)	Salinity (ppt)	pH	Ammonia as Nitrogen (mg/L)
KW015	W015	6/2/96	5	20	20.6	7.2	27.0	8.0	9.5
KW016	W016	6/3/96	1	0	20.6	7.3	27.5	8.2	0.8
KW016	W016	6/3/96	1	3	21.0	7.1	28.5	8.0	2.8
KW016	W016	6/3/96	1	5		7.2			
KW016	W016	6/3/96	1	6	20.9	7.2	29.0	8.1	4.4
KW016	W016	6/3/96	1	9	20.4	7.0	29.0	8.1	4.0
KW016	W016	6/3/96	1	10		7.0			
KW016	W016	6/3/96	1	12	19.7	7.2	29.0	8.2	5.0
KW016	W016	6/3/96	1	15	20.2	6.9	29.0	8.1	7.0
KW016	W016	6/3/96	1	18	19.8	7.1	28.0	8.1	6.5
KW016	W016	6/3/96	1	20	20.1	7.4	28.0	8.2	9.3
KW016	W016	6/3/96	2	0	20.3	7.1	27.0	8.1	1.4
KW016	W016	6/3/96	2	5		7.2			
KW016	W016	6/3/96	2	10		7.0			
KW016	W016	6/3/96	2	15		6.6			
KW016	W016	6/3/96	2	20	20.9	7.2	27.0	8.1	11.0
KW016	W016	6/3/96	3	0	20.6	7.1	27.0	8.1	1.2
KW016	W016	6/3/96	3	5		7.3			
KW016	W016	6/3/96	3	10		7.1			
KW016	W016	6/3/96	3	15		7.0			
KW016	W016	6/3/96	3	20	19.9	7.6	28.0	8.1	8.0
KW016	W016	6/3/96	4	0	20.6	7.0	27.5	8.2	1.2
KW016	W016	6/3/96	4	5		7.3			
KW016	W016	6/3/96	4	10		7.0			
KW016	W016	6/3/96	4	15		7.0			
KW016	W016	6/3/96	4	20	19.8	7.6	28.5	8.1	8.5
KW016	W016	6/3/96	5	0	20.4	7.0	27.0	8.0	1.2
KW016	W016	6/3/96	5	5		7.0			
KW016	W016	6/3/96	5	10		7.2			
KW016	W016	6/3/96	5	15		6.1			
KW016	W016	6/3/96	5	20	20.9	7.6	27.0	8.2	7.0
KW017	W017R	6/3/96	1	0	20.6	6.7	27.0	8.1	0.2
KW017	W017R	6/3/96	1	3	20.4	7.0	28.0	8.1	1.8
KW017	W017R	6/3/96	1	5		7.3			
KW017	W017R	6/3/96	1	6	20.9	7.0	28.0	8.2	3.6
KW017	W017R	6/3/96	1	9	19.9	7.0	29.0	8.2	4.3
KW017	W017R	6/3/96	1	10		7.1			
KW017	W017R	6/3/96	1	12	19.7	7.0	29.0	8.2	4.8
KW017	W017R	6/3/96	1	15	19.8	6.9	28.5	8.1	5.8
KW017	W017R	6/3/96	1	18	19.9	7.2	28.5	8.2	4.5
KW017	W017R	6/3/96	1	20	19.9	7.6	28.0	8.2	2.0
KW017	W017R	6/3/96	2	0	20.4	6.9	27.0	8.0	0
KW017	W017R	6/3/96	2	5		7.0			
KW017	W017R	6/3/96	2	10		7.2			
KW017	W017R	6/3/96	2	15		6.2			
KW017	W017R	6/3/96	2	20	21.0	7.6	27.0	8.3	11.0
KW017	W017R	6/3/96	3	0	20.6	7.0	27.0	8.1	0
KW017	W017R	6/3/96	3	5		7.4			
KW017	W017R	6/3/96	3	10		7.0			
KW017	W017R	6/3/96	3	15		7.0			

TABLE A3-4. (cont.)

Sample Number	Station	Collection Date	Replicate	Day	Temperature (deg C)	Dissolved Oxygen (mg/L)	Salinity (ppt)	pH	Ammonia as Nitrogen (mg/L)
KW017	W017R	6/3/96	3	20	19.9	7.6	27.5	8.1	10.0
KW017	W017R	6/3/96	4	0	20.3	7.2	27.0	8.2	0
KW017	W017R	6/3/96	4	5		7.4			
KW017	W017R	6/3/96	4	10		6.9			
KW017	W017R	6/3/96	4	15		6.9			
KW017	W017R	6/3/96	4	20	20.9	7.1	27.0	8.1	8.0
KW017	W017R	6/3/96	5	0	20.1	7.0	27.0	7.9	0
KW017	W017R	6/3/96	5	5		7.0			
KW017	W017R	6/3/96	5	10		7.1			
KW017	W017R	6/3/96	5	15		5.8			
KW017	W017R	6/3/96	5	20	20.9	7.1	27.0	8.2	7.5
KW018	W018	5/29/96	1	0	20.6	7.0	27.0	8.2	0.8
KW018	W018	5/29/96	1	3	20.4	6.9	28.0	8.0	2.2
KW018	W018	5/29/96	1	5		7.3			
KW018	W018	5/29/96	1	6	20.5	7.0	28.0	8.0	5.0
KW018	W018	5/29/96	1	9	20.2	6.8	28.0	8.0	4.8
KW018	W018	5/29/96	1	10		7.1			
KW018	W018	5/29/96	1	12	19.8	7.0	29.0	8.2	3.8
KW018	W018	5/29/96	1	15	20.0	6.9	28.5	8.0	4.5
KW018	W018	5/29/96	1	18	19.8	7.2	28.5	8.1	1.0
KW018	W018	5/29/96	1	20	19.8	7.6	28.0	8.2	0.3
KW018	W018	5/29/96	2	0	20.4	7.2	27.0	8.1	0.8
KW018	W018	5/29/96	2	5		7.2			
KW018	W018	5/29/96	2	10		7.1			
KW018	W018	5/29/96	2	15		6.9			
KW018	W018	5/29/96	2	20	21.0	7.5	27.0	8.3	1.5
KW018	W018	5/29/96	3	0	20.3	7.0	27.5	8.1	0.6
KW018	W018	5/29/96	3	5		7.4			
KW018	W018	5/29/96	3	10		7.0			
KW018	W018	5/29/96	3	15		6.7			
KW018	W018	5/29/96	3	20	20.8	7.4	27.0	8.3	1.5
KW018	W018	5/29/96	4	0	20.2	6.4	27.0	8.2	0.5
KW018	W018	5/29/96	4	5		7.2			
KW018	W018	5/29/96	4	10		7.2			
KW018	W018	5/29/96	4	15		6.7			
KW018	W018	5/29/96	4	20	20.9	7.2	27.0	8.1	9.0
KW018	W018	5/29/96	5	0	20.3	7.2	27.0	8.2	0.7
KW018	W018	5/29/96	5	5		7.4			
KW018	W018	5/29/96	5	10		7.0			
KW018	W018	5/29/96	5	15		6.9			
KW018	W018	5/29/96	5	20	21.0	7.4	27.0	8.3	0.5
KW019	W019	6/1/96	1	0	20.4	7.1	27.0	8.0	1.8
KW019	W019	6/1/96	1	3	19.9	6.8	28.0	7.8	4.3
KW019	W019	6/1/96	1	5		6.6			
KW019	W019	6/1/96	1	6	19.7	7.0	28.0	8.1	4.8
KW019	W019	6/1/96	1	9	19.7	7.0	28.0	8.1	4.3
KW019	W019	6/1/96	1	10		7.0			
KW019	W019	6/1/96	1	12	20.2	6.9	28.5	8.2	11.3
KW019	W019	6/1/96	1	15	21.0	6.8	28.0	8.2	6.5
KW019	W019	6/1/96	1	18	20.8	6.8	27.5	8.2	9.5

TABLE A3-4. (cont.)

Sample Number	Station	Collection Date	Replicate	Day	Temperature (deg C)	Dissolved Oxygen (mg/L)	Salinity (ppt)	pH	Ammonia as Nitrogen (mg/L)
KW019	W019	6/1/96	1	20	21.0	7.3	27.0	8.2	11.5
KW019	W019	6/1/96	2	0	20.2	7.0	27.0	7.9	1.3
KW019	W019	6/1/96	2	5		7.0			
KW019	W019	6/1/96	2	10		7.0			
KW019	W019	6/1/96	2	15		5.6			
KW019	W019	6/1/96	2	20	20.8	7.2	27.0	8.2	8.0
KW019	W019	6/1/96	3	0	20.6	7.2	27.0	8.1	1.8
KW019	W019	6/1/96	3	5		7.2			
KW019	W019	6/1/96	3	10		7.1			
KW019	W019	6/1/96	3	15		7.0			
KW019	W019	6/1/96	3	20	19.8	7.6	28.5	8.1	6.5
KW019	W019	6/1/96	4	0	20.6	7.2	27.5	8.2	1.8
KW019	W019	6/1/96	4	5		6.8			
KW019	W019	6/1/96	4	10		7.0			
KW019	W019	6/1/96	4	15		7.0			
KW019	W019	6/1/96	4	20	20.0	7.5	27.0	8.2	9.0
KW019	W019	6/1/96	5	0	20.3	7.0	27.0	7.7	1.6
KW019	W019	6/1/96	5	5		7.2			
KW019	W019	6/1/96	5	10		6.9			
KW019	W019	6/1/96	5	15		6.6			
KW019	W019	6/1/96	5	20	20.9	7.2	27.0	8.0	8.5
KW020	W020	5/31/96	1	0	20.4	7.0	27.0	8.1	1.6
KW020	W020	5/31/96	1	3	19.9	6.8	28.0	7.9	3.7
KW020	W020	5/31/96	1	5		7.4			
KW020	W020	5/31/96	1	6	19.7	7.0	28.0	8.1	5.0
KW020	W020	5/31/96	1	9	19.8	6.6	28.0	8.1	7.0
KW020	W020	5/31/96	1	10		7.2			
KW020	W020	5/31/96	1	12	20.2	6.9	28.0	8.3	8.8
KW020	W020	5/31/96	1	15	21.0	6.7	28.0	8.1	8.0
KW020	W020	5/31/96	1	18	20.7	7.1	28.0	8.4	7.0
KW020	W020	5/31/96	1	20	21.0	7.4	27.0	8.3	9.5
KW020	W020	5/31/96	2	0	20.4	7.2	27.5	8.2	1.1
KW020	W020	5/31/96	2	5		7.4			
KW020	W020	5/31/96	2	10		7.1			
KW020	W020	5/31/96	2	15		6.8			
KW020	W020	5/31/96	2	20	21.0	7.4	27.0	8.2	5.0
KW020	W020	5/31/96	3	0	20.3	7.0	27.0	8.2	1.3
KW020	W020	5/31/96	3	5		7.4			
KW020	W020	5/31/96	3	10		6.9			
KW020	W020	5/31/96	3	15		6.8			
KW020	W020	5/31/96	3	20	20.9	7.4	27.0	8.1	8.5
KW020	W020	5/31/96	4	0	20.3	7.0	27.0	8.2	1.8
KW020	W020	5/31/96	4	5		7.3			
KW020	W020	5/31/96	4	10		7.1			
KW020	W020	5/31/96	4	15		6.6			
KW020	W020	5/31/96	4	20	20.9	7.2	27.0	8.3	6.5
KW020	W020	5/31/96	5	0	20.4	7.1	27.0	8.1	1.2
KW020	W020	5/31/96	5	5		7.3			
KW020	W020	5/31/96	5	10		6.8			
KW020	W020	5/31/96	5	15		6.5			

TABLE A3-4. (cont.)

Sample Number	Station	Collection Date	Replicate	Day	Temperature (deg C)	Dissolved Oxygen (mg/L)	Salinity (ppt)	pH	Ammonia as Nitrogen (mg/L)
KW020	W020	5/31/96	5	20	20.9	7.6	27.0	8.4	9.0
KW021	W021	6/3/96	1	0	20.3	7.0	27.0	8.0	1.8
KW021	W021	6/3/96	1	3	19.7	6.8	28.5	7.8	3.8
KW021	W021	6/3/96	1	5		7.2			
KW021	W021	6/3/96	1	6	19.6	7.1	28.0	8.0	4.8
KW021	W021	6/3/96	1	9	19.6	6.6	28.0	8.0	4.8
KW021	W021	6/3/96	1	10		7.0			
KW021	W021	6/3/96	1	10		5.1			
KW021	W021	6/3/96	1	12	19.9	6.9	28.0	7.9	5.0
KW021	W021	6/3/96	1	15	21.0	6.7	28.0	8.0	7.5
KW021	W021	6/3/96	1	18	20.7	6.6	28.0	8.1	7.0
KW021	W021	6/3/96	1	20	20.8	7.2	27.0	8.2	9.3
KW021	W021	6/3/96	2	0	20.6	7.1	27.5	8.1	1.5
KW021	W021	6/3/96	2	5		7.4			
KW021	W021	6/3/96	2	10		7.2			
KW021	W021	6/3/96	2	15		6.9			
KW021	W021	6/3/96	2	20	19.9	7.6	28.0	8.2	5.5
KW021	W021	6/3/96	3	0	20.6	7.1	27.5	8.1	1.6
KW021	W021	6/3/96	3	5		7.2			
KW021	W021	6/3/96	3	10		7.0			
KW021	W021	6/3/96	3	15		7.0			
KW021	W021	6/3/96	3	20	19.9	7.6	28.0	8.2	6.5
KW021	W021	6/3/96	4	0	20.6	6.9	27.0	8.2	1.7
KW021	W021	6/3/96	4	5		7.4			
KW021	W021	6/3/96	4	10		7.1			
KW021	W021	6/3/96	4	15		7.0			
KW021	W021	6/3/96	4	20	19.8	7.5	28.0	8.1	9.0
KW021	W021	6/3/96	5	0	20.2	7.2	27.0	8.1	1.6
KW021	W021	6/3/96	5	5		7.2			
KW021	W021	6/3/96	5	10		7.0			
KW021	W021	6/3/96	5	15		6.8			
KW021	W021	6/3/96	5	20	20.8	7.2	27.0	8.2	9.5
KW022	W022	5/28/96	1	0	20.3	7.0	27.0	8.2	0.5
KW022	W022	5/28/96	1	3	19.4	6.8	28.0	8.0	3.0
KW022	W022	5/28/96	1	5		7.2			
KW022	W022	5/28/96	1	6	19.6	7.1	28.0	8.2	2.0
KW022	W022	5/28/96	1	9	19.5	7.0	28.0	8.1	3.2
KW022	W022	5/28/96	1	10		7.0			
KW022	W022	5/28/96	1	12	20.1	7.0	28.0	8.3	3.8
KW022	W022	5/28/96	1	15	21.0	6.7	28.0	8.2	0.5
KW022	W022	5/28/96	1	18	20.6	6.9	28.0	8.2	2.3
KW022	W022	5/28/96	1	20	20.9	7.4	27.0	8.3	1.0
KW022	W022	5/28/96	2	0	20.6	7.2	27.5	8.2	0.6
KW022	W022	5/28/96	2	5		7.4			
KW022	W022	5/28/96	2	10		6.9			
KW022	W022	5/28/96	2	15		7.0			
KW022	W022	5/28/96	2	20	20.0	7.4	28.0	8.2	3.0
KW022	W022	5/28/96	3	0	20.4	7.2	27.0	8.2	0.6
KW022	W022	5/28/96	3	5		7.3			
KW022	W022	5/28/96	3	10		7.2			

TABLE A3-4. (cont.)

Sample Number	Station	Collection Date	Replicate	Day	Temperature (deg C)	Dissolved Oxygen (mg/L)	Salinity (ppt)	pH	Ammonia as Nitrogen (mg/L)
KW022	W022	5/28/96	3	15		6.6			
KW022	W022	5/28/96	3	20	20.9	7.0	27.0	8.2	0.1
KW022	W022	5/28/96	4	0	20.3	7.2	27.0	8.1	0.5
KW022	W022	5/28/96	4	5		7.1			
KW022	W022	5/28/96	4	10		7.0			
KW022	W022	5/28/96	4	15		6.8			
KW022	W022	5/28/96	4	20	20.9	7.3	27.0	8.2	0.5
KW022	W022	5/28/96	5	0	20.3	7.2	27.5	8.2	0.5
KW022	W022	5/28/96	5	5		7.4			
KW022	W022	5/28/96	5	10		7.0			
KW022	W022	5/28/96	5	15		6.8			
KW022	W022	5/28/96	5	20	20.9	7.4	29.0	8.2	2.0
KW023	W023	5/29/96	1	0	20.3	6.4	27.0	8.1	0
KW023	W023	5/29/96	1	3	19.7	6.8	28.0	7.9	2.0
KW023	W023	5/29/96	1	5		7.0			
KW023	W023	5/29/96	1	6	19.5	7.1	28.0	8.1	3.2
KW023	W023	5/29/96	1	9	19.5	7.0	28.0	8.1	3.6
KW023	W023	5/29/96	1	10		7.0			
KW023	W023	5/29/96	1	12	20.1	7.0	29.0	8.3	6.5
KW023	W023	5/29/96	1	15	20.9	6.1	28.0	8.2	6.5
KW023	W023	5/29/96	1	18	20.7	7.0	28.0	8.0	8.5
KW023	W023	5/29/96	1	20	20.9	7.1	27.0	8.0	9.5
KW023	W023	5/29/96	2	0	20.3	7.1	27.0	8.1	0
KW023	W023	5/29/96	2	5		6.7			
KW023	W023	5/29/96	2	10		7.1			
KW023	W023	5/29/96	2	15		6.7			
KW023	W023	5/29/96	2	20	20.8	7.3	27.0	8.2	6.0
KW023	W023	5/29/96	3	0	20.6	6.9	27.0	8.2	0
KW023	W023	5/29/96	3	5		7.2			
KW023	W023	5/29/96	3	10		6.9			
KW023	W023	5/29/96	3	15		7.0			
KW023	W023	5/29/96	3	20	19.9	7.6	27.0	8.3	8.5
KW023	W023	5/29/96	4	0	20.4	7.3	27.0	8.1	0
KW023	W023	5/29/96	4	5		7.3			
KW023	W023	5/29/96	4	10		7.1			
KW023	W023	5/29/96	4	15		7.0			
KW023	W023	5/29/96	4	20	21.0	7.5	27.0	8.3	2.0
KW023	W023	5/29/96	5	0	20.4	7.1	27.0	8.1	0
KW023	W023	5/29/96	5	5		7.2			
KW023	W023	5/29/96	5	10		7.0			
KW023	W023	5/29/96	5	15		6.8			
KW023	W023	5/29/96	5	20	21.0	7.4	27.0	8.3	1.5
KW024	W024	6/1/96	1	0	20.4	7.2	27.0	8.1	0.6
KW024	W024	6/1/96	1	3	19.6	6.8	28.5	7.9	2.6
KW024	W024	6/1/96	1	5		7.4			
KW024	W024	6/1/96	1	6	19.6	7.0	28.0	8.3	3.8
KW024	W024	6/1/96	1	9	19.7	7.0	28.0	8.3	4.4
KW024	W024	6/1/96	1	10		7.0			
KW024	W024	6/1/96	1	12	20.0	6.9	29.0	8.4	6.3
KW024	W024	6/1/96	1	15	20.8	6.8	29.0	8.2	4.5

TABLE A3-4. (cont.)

Sample Number	Station	Collection Date	Replicate	Day	Temperature (deg C)	Dissolved Oxygen (mg/L)	Salinity (ppt)	pH	Ammonia as Nitrogen (mg/L)
KW024	W024	6/1/96	1	18	20.5	7.1	28.0	8.1	0.1
KW024	W024	6/1/96	1	20	20.9	7.4	27.0	8.2	0.5
KW024	W024	6/1/96	2	0	20.7	7.2	27.5	8.2	0.8
KW024	W024	6/1/96	2	5		7.4			
KW024	W024	6/1/96	2	10		7.0			
KW024	W024	6/1/96	2	15		6.9			
KW024	W024	6/1/96	2	20	20.1	7.4	29.0	8.2	7.0
KW024	W024	6/1/96	3	0	20.4	7.4	27.5	8.1	0.6
KW024	W024	6/1/96	3	5		7.4			
KW024	W024	6/1/96	3	10		7.1			
KW024	W024	6/1/96	3	15		6.9			
KW024	W024	6/1/96	3	20	21.0	7.4	27.0	8.2	4.0
KW024	W024	6/1/96	4	0	20.3	7.1	27.0	8.1	1.0
KW024	W024	6/1/96	4	5		7.4			
KW024	W024	6/1/96	4	10		7.1			
KW024	W024	6/1/96	4	15		6.6			
KW024	W024	6/1/96	4	20	20.8	7.3	27.0	8.2	6.0
KW024	W024	6/1/96	5	0	20.5	6.8	27.0	8.0	0.5
KW024	W024	6/1/96	5	5		7.2			
KW024	W024	6/1/96	5	10		7.0			
KW024	W024	6/1/96	5	15		6.8			
KW024	W024	6/1/96	5	20	19.9	7.6	28.0	8.0	2.0
KW025	W025	5/30/96	1	0	20.2	7.0	27.0	7.6	3.8
KW025	W025	5/30/96	1	3	19.7	4.1	28.0	7.3	4.8
KW025	W025	5/30/96	1	5		7.3			
KW025	W025	5/30/96	1	6	19.6	7.0	27.5	7.8	5.0
KW025	W025	5/30/96	1	9	19.6	6.8	29.0	7.9	8.0
KW025	W025	5/30/96	1	10		7.1			
KW025	W025	5/30/96	1	12	20.1	6.8	29.0	8.1	11.0
KW025	W025	5/30/96	1	15	20.9	6.7	28.0	8.0	10.5
KW025	W025	5/30/96	1	18	20.7	7.0	27.0	8.2	8.8
KW025	W025	5/30/96	1	20	20.8	7.2	27.0	8.1	11.3
KW025	W025	5/30/96	2	0	20.3	7.2	27.0	7.8	4.2
KW025	W025	5/30/96	2	5		7.4			
KW025	W025	5/30/96	2	10		7.0			
KW025	W025	5/30/96	2	15		6.8			
KW025	W025	5/30/96	2	20	20.7	7.2	27.0	7.9	12.5
KW025	W025	5/30/96	3	0	20.2	7.2	27.5	8.1	5.5
KW025	W025	5/30/96	3	5		7.4			
KW025	W025	5/30/96	3	10		7.0			
KW025	W025	5/30/96	3	15		6.7			
KW025	W025	5/30/96	3	20	20.9	7.2	27.0	7.9	10.0
KW025	W025	5/30/96	4	0	20.4	7.0	27.0	8.1	3.6
KW025	W025	5/30/96	4	5		7.2			
KW025	W025	5/30/96	4	10		6.9			
KW025	W025	5/30/96	4	15		6.5			
KW025	W025	5/30/96	4	20	21.0	7.0	27.0	8.0	12.5
KW025	W025	5/30/96	5	0	20.4	7.1	27.0	8.2	3.6
KW025	W025	5/30/96	5	5		7.3			
KW025	W025	5/30/96	5	10		6.8			

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TABLE A3-4. (cont.)

Sample Number	Station	Collection Date	Replicate	Day	Temperature (deg C)	Dissolved Oxygen (mg/L)	Salinity (ppt)	pH	Ammonia as Nitrogen (mg/L)
KW025	W025	5/30/96	5	15		6.6			
KW025	W025	5/30/96	5	20	20.9	7.5	27.0	8.2	9.3
KW026	W026	5/30/96	1	0	20.4	7.0	27.0	8.2	1.1
KW026	W026	5/30/96	1	3	19.8	6.6	28.0	8.0	3.7
KW026	W026	5/30/96	1	5		7.3			
KW026	W026	5/30/96	1	6	19.7	6.9	27.5	8.0	4.2
KW026	W026	5/30/96	1	9	19.6	7.0	29.0	8.0	7.5
KW026	W026	5/30/96	1	10		6.9			
KW026	W026	5/30/96	1	12	20.2	6.8	28.0	8.1	7.5
KW026	W026	5/30/96	1	15	21.0	6.7	28.0	8.0	6.5
KW026	W026	5/30/96	1	18	19.8	7.0	28.0	8.1	7.8
KW026	W026	5/30/96	1	20	20.9	7.4	27.0	8.1	8.5
KW026	W026	5/30/96	2	0	20.5	7.2	27.5	8.2	1.2
KW026	W026	5/30/96	2	5		7.4			
KW026	W026	5/30/96	2	10		7.1			
KW026	W026	5/30/96	2	15		6.9			
KW026	W026	5/30/96	2	20	19.8	7.5	28.0	8.1	5.8
KW026	W026	5/30/96	3	0	20.4	7.0	27.0	8.0	1.0
KW026	W026	5/30/96	3	5		6.8			
KW026	W026	5/30/96	3	10		6.9			
KW026	W026	5/30/96	3	15		5.7			
KW026	W026	5/30/96	3	20	21.0	7.4	27.0	8.2	7.7
KW026	W026	5/30/96	4	0	20.3	7.1	27.0	8.2	1.4
KW026	W026	5/30/96	4	5		7.2			
KW026	W026	5/30/96	4	10		7.2			
KW026	W026	5/30/96	4	15		6.8			
KW026	W026	5/30/96	4	20	20.9	7.0	27.0	8.1	6.5
KW026	W026	5/30/96	5	0	20.6	7.0	27.0	8.1	1.2
KW026	W026	5/30/96	5	5		7.2			
KW026	W026	5/30/96	5	10		7.1			
KW026	W026	5/30/96	5	15		7.0			
KW026	W026	5/30/96	5	20	19.9	7.6	28.0	8.3	9.5
KW027	W027	5/29/96	1	0	20.4	7.2	27.0	8.0	1.0
KW027	W027	5/29/96	1	3	19.8	7.0	28.5	7.9	2.6
KW027	W027	5/29/96	1	5		7.2			
KW027	W027	5/29/96	1	6	19.6	7.0	28.0	8.0	3.1
KW027	W027	5/29/96	1	9	19.7	6.8	29.0	8.1	4.3
KW027	W027	5/29/96	1	10		7.1			
KW027	W027	5/29/96	1	12	20.1	7.0	29.0	8.3	5.0
KW027	W027	5/29/96	1	15	21.0	6.6	28.0	8.1	5.5
KW027	W027	5/29/96	1	18	20.7	6.9	28.0	8.1	4.5
KW027	W027	5/29/96	1	20	20.8	7.0	27.0	8.3	2.8
KW027	W027	5/29/96	2	0	20.6	7.1	27.0	8.2	0.8
KW027	W027	5/29/96	2	5		7.4			
KW027	W027	5/29/96	2	10		7.2			
KW027	W027	5/29/96	2	15		7.0			
KW027	W027	5/29/96	2	20	19.8	7.6	27.5	8.1	7.0
KW027	W027	5/29/96	3	0	20.7	7.4	28.0	8.3	0.8
KW027	W027	5/29/96	3	5		7.2			
KW027	W027	5/29/96	3	10		6.9			

TABLE A3-4. (cont.)

Sample Number	Station	Collection Date	Replicate	Day	Temperature (deg C)	Dissolved Oxygen (mg/L)	Salinity (ppt)	pH	Ammonia as Nitrogen (mg/L)
KW027	W027	5/29/96	3	15		7.0			
KW027	W027	5/29/96	3	20	20.1	7.6	28.0	8.1	5.0
KW027	W027	5/29/96	4	0	20.6	7.2	27.0	8.2	0.8
KW027	W027	5/29/96	4	5		7.4			
KW027	W027	5/29/96	4	10		7.0			
KW027	W027	5/29/96	4	15		7.0			
KW027	W027	5/29/96	4	20	20.0	7.6	28.0	8.2	4.0
KW027	W027	5/29/96	5	0	20.4	7.0	27.0	8.1	0.4
KW027	W027	5/29/96	5	5		7.0			
KW027	W027	5/29/96	5	10		6.9			
KW027	W027	5/29/96	5	15		5.8			
KW027	W027	5/29/96	5	20	21.0	7.6	27.0	8.3	6.0
KW028	W028	5/29/96	1	0	20.3	7.0	27.5	8.0	1.0
KW028	W028	5/29/96	1	3	19.7	6.8	28.0	7.8	2.0
KW028	W028	5/29/96	1	5		7.0			
KW028	W028	5/29/96	1	6	20.3	7.1	27.5	8.1	3.5
KW028	W028	5/29/96	1	9	19.7	6.6	28.5	8.2	4.4
KW028	W028	5/29/96	1	10		7.1			
KW028	W028	5/29/96	1	12	19.8	6.7	28.0	8.3	5.0
KW028	W028	5/29/96	1	15	20.5	6.2	29.0	8.1	7.0
KW028	W028	5/29/96	1	18	20.2	7.0	28.0	8.1	4.0
KW028	W028	5/29/96	1	20	20.8	7.4	28.0	8.2	7.5
KW028	W028	5/29/96	2	0	20.6	7.1	27.5	8.2	0.8
KW028	W028	5/29/96	2	5		6.8			
KW028	W028	5/29/96	2	10		7.0			
KW028	W028	5/29/96	2	15		7.0			
KW028	W028	5/29/96	2	20	20.0	7.6	27.0	8.0	12.0
KW028	W028	5/29/96	3	0	20.3	7.0	27.0	8.0	1.2
KW028	W028	5/29/96	3	5		7.0			
KW028	W028	5/29/96	3	10		7.0			
KW028	W028	5/29/96	3	15		5.7			
KW028	W028	5/29/96	3	20	20.8	7.3	27.0	8.1	7.5
KW028	W028	5/29/96	4	0	20.4	7.2	27.0	8.2	1.3
KW028	W028	5/29/96	4	5		7.3			
KW028	W028	5/29/96	4	10		7.0			
KW028	W028	5/29/96	4	15		6.8			
KW028	W028	5/29/96	4	20	21.0	7.4	27.0	8.3	4.5
KW028	W028	5/29/96	5	0	20.3	6.9	27.0	7.9	1.2
KW028	W028	5/29/96	5	5		6.6			
KW028	W028	5/29/96	5	10		7.0			
KW028	W028	5/29/96	5	15		6.7			
KW028	W028	5/29/96	5	20	20.9	7.0	27.0	8.3	10.0
KW029	W029	6/5/96	1	0	20.3	7.2	27.0	8.2	0.8
KW029	W029	6/5/96	1	3	19.7	7.0	28.0	8.1	2.3
KW029	W029	6/5/96	1	5		7.4			
KW029	W029	6/5/96	1	6	19.6	7.0	28.0	8.2	2.8
KW029	W029	6/5/96	1	9	19.6	6.8	29.0	8.1	0.4
KW029	W029	6/5/96	1	10		7.0			
KW029	W029	6/5/96	1	12	20.1	7.0	28.0	8.3	0.4
KW029	W029	6/5/96	1	15	21.0	6.6	28.0	8.1	0.8

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TABLE A3-4. (cont.)

Sample Number	Station	Collection Date	Replicate	Day	Temperature (deg C)	Dissolved Oxygen (mg/L)	Salinity (ppt)	pH	Ammonia as Nitrogen (mg/L)
KW029	W029	6/5/96	1	18	20.6	6.8	27.0	8.2	0.1
KW029	W029	6/5/96	1	20	20.9	7.0	27.0	8.2	0.1
KW029	W029	6/5/96	2	0	20.6	7.1	27.0	8.0	0.6
KW029	W029	6/5/96	2	5		7.1			
KW029	W029	6/5/96	2	10		7.1			
KW029	W029	6/5/96	2	15		7.1			
KW029	W029	6/5/96	2	20	19.9	7.6	28.0	8.2	0.3
KW029	W029	6/5/96	3	0	20.2	6.9	27.0	8.2	0.4
KW029	W029	6/5/96	3	5		7.4			
KW029	W029	6/5/96	3	10		7.2			
KW029	W029	6/5/96	3	15		6.8			
KW029	W029	6/5/96	3	20	20.8	7.0	27.5	8.3	3.0
KW029	W029	6/5/96	4	0	20.4	7.1	27.0	8.1	0.5
KW029	W029	6/5/96	4	5		7.2			
KW029	W029	6/5/96	4	10		7.0			
KW029	W029	6/5/96	4	15		6.7			
KW029	W029	6/5/96	4	20	20.9	7.4	27.0	8.3	0.1
KW029	W029	6/5/96	5	0	20.2	6.2	27.0	8.2	0.6
KW029	W029	6/5/96	5	5		7.4			
KW029	W029	6/5/96	5	10		7.1			
KW029	W029	6/5/96	5	15		6.8			
KW029	W029	6/5/96	5	20	20.8	7.1	27.0	8.3	1.5
KW035	W030	6/5/96	1	0	20.3	7.3	27.0	8.2	0
KW035	W030	6/5/96	1	3	19.8	6.9	28.0	8.0	1.6
KW035	W030	6/5/96	1	5		7.4			
KW035	W030	6/5/96	1	6	19.5	7.1	28.0	8.1	1.6
KW035	W030	6/5/96	1	9	19.7	6.9	28.0	8.1	0.4
KW035	W030	6/5/96	1	10		7.0			
KW035	W030	6/5/96	1	12	20.2	7.0	29.0	8.3	0.4
KW035	W030	6/5/96	1	15	21.0	6.8	28.0	8.2	0.5
KW035	W030	6/5/96	1	18	20.6	7.0	28.0	8.2	0.1
KW035	W030	6/5/96	1	20	20.8	7.2	27.0	8.2	3.5
KW035	W030	6/5/96	2	0	20.3	7.2	27.5	8.1	0
KW035	W030	6/5/96	2	5		7.1			
KW035	W030	6/5/96	2	10		7.1			
KW035	W030	6/5/96	2	15		6.0			
KW035	W030	6/5/96	2	20	20.1	7.6	28.0	8.2	0.5
KW035	W030	6/5/96	3	0	20.6	7.3	27.5	8.2	0
KW035	W030	6/5/96	3	5		7.4			
KW035	W030	6/5/96	3	10		7.1			
KW035	W030	6/5/96	3	15		7.1			
KW035	W030	6/5/96	3	20	20.1	7.6	27.0	8.3	1.0
KW035	W030	6/5/96	4	0	20.3	6.8	27.0	8.1	0
KW035	W030	6/5/96	4	5		7.2			
KW035	W030	6/5/96	4	10		7.0			
KW035	W030	6/5/96	4	15		5.7			
KW035	W030	6/5/96	4	20	20.8	7.2	27.0	8.3	2.0
KW035	W030	6/5/96	5	0	20.4	6.9	27.0	8.1	0
KW035	W030	6/5/96	5	5		6.9			
KW035	W030	6/5/96	5	10		7.0			

TABLE A3-4. (cont.)

Sample Number	Station	Collection Date	Replicate	Day	Temperature (deg C)	Dissolved Oxygen (mg/L)	Salinity (ppt)	pH	Ammonia as Nitrogen (mg/L)
KW035	W030	6/5/96	5	15		5.9			
KW035	W030	6/5/96	5	20	21.0	7.5	27.0	8.4	1.5
Cont	Control	NA	1	0	20.6	7.1	27.5	8.2	0
Cont	Control	NA	2	0	20.6	7.2	27.5	8.2	0
Cont	Control	NA	3	0	20.4	7.0	27.0	8.1	0
Cont	Control	NA	4	0	20.4	7.2	27.0	8.2	0
Cont	Control	NA	5	0	20.6	7.2	27.5	8.2	0.4
Cont	Control	NA	1	3	21.0	7.0	28.0	8.1	2.2
Cont	Control	NA	1	5		7.4			
Cont	Control	NA	2	5		7.2			
Cont	Control	NA	3	5		7.2			
Cont	Control	NA	4	5		7.4			
Cont	Control	NA	5	5		7.4			
Cont	Control	NA	1	6	20.9	7.0	28.0	8.1	4.4
Cont	Control	NA	1	9	20.4	6.9	29.0	8.1	4.4
Cont	Control	NA	1	10		7.0			
Cont	Control	NA	2	10		6.9			
Cont	Control	NA	3	10		6.9			
Cont	Control	NA	4	10		7.1			
Cont	Control	NA	5	10		7.0			
Cont	Control	NA	1	12	19.8	7.1	29.0	8.2	3.5
Cont	Control	NA	1	15	20.2	6.9	29.0	8.0	4.5
Cont	Control	NA	2	15		6.8			
Cont	Control	NA	3	15		6.8			
Cont	Control	NA	4	15		6.8			
Cont	Control	NA	5	15		6.8			
Cont	Control	NA	1	18	19.8	7.0	28.5	8.1	2.0
Cont	Control	NA	1	20	20.0	7.4	28.0	8.2	1.0
Cont	Control	NA	2	20	20.1	7.4	27.0	8.1	1.0
Cont	Control	NA	3	20	20.9	7.5	27.0	8.2	7.0
Cont	Control	NA	4	20	20.9	7.5	27.0	8.1	4.0
Cont	Control	NA	5	20	20.0	7.4	27.5	8.0	1.0

TABLE A3-5. SUMMARY OF WATER QUALITY PARAMETERS FROM THE *Rhepoxynius abronius* TOXICITY TEST CONDUCTED IN 1997

Sample Number	Station	Collection Date	Replicate	Day	Temperature (deg C)	Dissolved Oxygen (mg/L)	Salinity (ppt)	pH	Ammonia as Nitrogen (mg/L)	Sulfide (mg/L)
Control			1	0	14.3	8.0	30.0	7.9	0.2 *U*	0.01 *U*
Control			1	1	15.1	8.1	27.0	7.9		
Control			1	2	14.5	8.0	29.0	7.8		
Control			1	3	14.3	8.1	28.0	7.9		
Control			1	4	15.0	8.2	28.5	7.9		
Control			1	5	15.0	8.2	28.5	8.1		
Control			1	6	14.9	8.2	29.5	8.1		
Control			1	7	14.0	8.2	30.0	8.0		
Control			1	8	14.2	8.4	29.0	8.0		
Control			1	9	14.2	8.3	29.5	8.0		
Control			1	10	14.9	8.2	27.0	8.0	0.2 *U*	0.01 *U*
Control			2	0	14.1	8.2	30.0	7.9		
Control			2	10	14.0	8.1	30.0	8.0		
Control			3	0	15.0	7.8	30.0	7.9		
Control			3	10	14.8	8.0	29.0	8.2		
Control			4	0	15.2	8.3	30.0	7.9		
Control			4	10	15.0	8.2	29.5	8.1		
Control			5	0	14.1	7.9	30.0	7.8		
Control			5	10	13.6	8.2	29.5	8.2		
SD0011	SD-2	07/24/97	1	0	15.2	8.2	30.0	8.1	1.8	0.01 *U*
SD0011	SD-2	07/24/97	1	1	15.4	8.0	27.0	8.0		
SD0011	SD-2	07/24/97	1	2	15.2	8.0	28.0	7.9		
SD0011	SD-2	07/24/97	1	3	15.3	8.2	28.0	8.1		
SD0011	SD-2	07/24/97	1	4	15.6	8.0	29.0	8.1		
SD0011	SD-2	07/24/97	1	5	15.4	8.3	29.5	8.1		
SD0011	SD-2	07/24/97	1	6	15.3	7.9	30.0	8.1		
SD0011	SD-2	07/24/97	1	7	15.1	8.2	30.0	8.1		
SD0011	SD-2	07/24/97	1	8	15.1	8.2	29.5	8.1		
SD0011	SD-2	07/24/97	1	9	14.4	8.2	28.0	8.1		
SD0011	SD-2	07/24/97	1	10	14.8	8.2	30	8.1	3.6	0.01 *U*
SD0011	SD-2	07/24/97	2	0	15.2	8.1	30.0	8.1		
SD0011	SD-2	07/24/97	2	10	14.8	8.1	28.5	8.2		
SD0011	SD-2	07/24/97	3	0	15.2	8.2	30.0	7.9		
SD0011	SD-2	07/24/97	3	10	15	8.2	29.5	8.1		
SD0011	SD-2	07/24/97	4	0	14.9	8.1	30.0	7.8		
SD0011	SD-2	07/24/97	4	10	14.8	8.0	28.5	8.0		
SD0011	SD-2	07/24/97	5	0	14.2	8.2	30.0	7.8		
SD0011	SD-2	07/24/97	5	10	13.7	8.1	30.0	8.2		
SD0012	SD-3	07/24/97	1	0	14.9	8.2	30.0	7.9	2.2	0.01 *U*
SD0012	SD-3	07/24/97	1	1	15.3	8.1	27.0	7.9		
SD0012	SD-3	07/24/97	1	2	15.1	8.1	28.5	7.8		
SD0012	SD-3	07/24/97	1	3	14.7	8.2	27.0	7.9		
SD0012	SD-3	07/24/97	1	4	15.5	8.1	28.0	8.0		
SD0012	SD-3	07/24/97	1	5	15.4	8.2	29.0	8.0		
SD0012	SD-3	07/24/97	1	6	15.3	7.9	30.0	8.0		
SD0012	SD-3	07/24/97	1	7	15.1	8.2	30.0	7.9		
SD0012	SD-3	07/24/97	1	8	14.9	8.2	28.5	8.0		
SD0012	SD-3	07/24/97	1	9	14.3	8.1	28.0	8.0		
SD0012	SD-3	07/24/97	1	10	14.8	8.1	29.0	8.0	3.6	0.01 *U*
SD0012	SD-3	07/24/97	2	0	14.8	8.3	30.0	7.8		
SD0012	SD-3	07/24/97	2	10	14.2	8.1	29.0	8.0		
SD0012	SD-3	07/24/97	3	0	14.0	8.3	30.0	7.9		
SD0012	SD-3	07/24/97	3	10	14.0	8.2	29.5	7.9		
SD0012	SD-3	07/24/97	4	0	15.1	8.3	30	8		
SD0012	SD-3	07/24/97	4	10	15.0	8.2	29.0	8.0		

TABLE A3-5. (cont.)

Sample Number	Station	Collection Date	Replicate	Day	Temperature (deg C)	Dissolved Oxygen (mg/L)	Salinity (ppt)	pH	Ammonia as Nitrogen (mg/L)	Sulfide (mg/L)
SD0012	SD-3	07/24/97	5	0	14.6	8	30	7.9		
SD0012	SD-3	07/24/97	5	10	14.1	8.2	30.0	7.9		
SD0013	SD-4	07/24/97	1	0	15.2	8.3	30	7.9	2.4	0.01 *U*
SD0013	SD-4	07/24/97	1	1	15.4	8.0	27.0	7.8		
SD0013	SD-4	07/24/97	1	2	15.2	8.2	28.5	7.9		
SD0013	SD-4	07/24/97	1	3	15.2	8.1	27.0	8.0		
SD0013	SD-4	07/24/97	1	4	15.7	8.1	29.0	8.0		
SD0013	SD-4	07/24/97	1	5	15.4	8.2	29.0	8.0		
SD0013	SD-4	07/24/97	1	6	15.3	8.0	30.0	8.0		
SD0013	SD-4	07/24/97	1	7	14.9	8.2	30.0	8.0		
SD0013	SD-4	07/24/97	1	8	15.0	8.2	28.0	8.1		
SD0013	SD-4	07/24/97	1	9	14.3	8.1	29.5	8.1		
SD0013	SD-4	07/24/97	1	10	14.8	8.2	28.5	8.1	3.8	0.01 *U*
SD0013	SD-4	07/24/97	2	0	14.1	7.9	30	7.9		
SD0013	SD-4	07/24/97	2	10	13.9	8.2	29.5	8.1		
SD0013	SD-4	07/24/97	3	0	14.7	8.2	30	7.8		
SD0013	SD-4	07/24/97	3	10	14.4	8.2	27.5	8.0		
SD0013	SD-4	07/24/97	4	0	14.9	8.2	30.0	7.9		
SD0013	SD-4	07/24/97	4	10	14.7	8.2	29.0	8.0		
SD0013	SD-4	07/24/97	5	0	14.4	8.0	30.0	8.0		
SD0013	SD-4	07/24/97	5	10	14.0	8.2	29.5	8.2		
SD0014R	SD-5	07/24/97	1	0	14.1	8.4	29.0	8.0	0.2 *U*	0.01 *U*
SD0014R	SD-5	07/24/97	1	1	14.9	8.1	28.0	7.8		
SD0014R	SD-5	07/24/97	1	2	15.0	7.8	28.0	7.8		
SD0014R	SD-5	07/24/97	1	3	14.7	8.3	27.0	7.9		
SD0014R	SD-5	07/24/97	1	4	14.8	8.0	28.5	7.9		
SD0014R	SD-5	07/24/97	1	5	14.9	8.2	29.0	7.9		
SD0014R	SD-5	07/24/97	1	6	14.8	7.9	30.0	7.9		
SD0014R	SD-5	07/24/97	1	7	14.4	8.2	30.0	7.9		
SD0014R	SD-5	07/24/97	1	8	14.0	8.2	29.0	8.0		
SD0014R	SD-5	07/24/97	1	9	14.0	8.2	29.0	8.0		
SD0014R	SD-5	07/24/97	1	10	13.9	8.3	29.5	8.1	1.2	0.01 *U*
SD0014R	SD-5	07/24/97	2	0	14.9	8.0	30.0	8.0		
SD0014R	SD-5	07/24/97	2	10	14.8	8.2	29.5	8.2		
SD0014R	SD-5	07/24/97	3	0	14.0	8.1	30.0	7.9		
SD0014R	SD-5	07/24/97	3	10	13.3	8.3	30.0	8.2		
SD0014R	SD-5	07/24/97	4	0	14.2	8.1	30.0	7.9		
SD0014R	SD-5	07/24/97	4	10	13.7	8.2	29.0	8.1		
SD0014R	SD-5	07/24/97	5	0	15.7	8.1	30.0	8.0		
SD0014R	SD-5	07/24/97	5	10	15.5	8.2	28.5	8.2		
SD0030	SD-7	07/24/97	1	0	15.4	8.0	30.0	8.0	1.6	0.01 *U*
SD0030	SD-7	07/24/97	1	1	15.9	8.0	29.5	7.9		
SD0030	SD-7	07/24/97	1	2	15.5	8.1	28.5	7.9		
SD0030	SD-7	07/24/97	1	3	15.5	8.3	28.0	8.0		
SD0030	SD-7	07/24/97	1	4	15.4	8.1	29.0	8.0		
SD0030	SD-7	07/24/97	1	5	15.4	8.2	29.0	8.0		
SD0030	SD-7	07/24/97	1	6	15.6	8.0	30.0	8.0		
SD0030	SD-7	07/24/97	1	7	15.2	8.2	30.0	7.9		
SD0030	SD-7	07/24/97	1	8	15.1	8.2	28.5	7.9		
SD0030	SD-7	07/24/97	1	9	14.9	8.2	29.0	8.0		
SD0030	SD-7	07/24/97	1	10	15.1	8.3	28.0	8.0	2.5	0.01 *U*
SD0030	SD-7	07/24/97	2	0	14.4	7.0	29.0	7.4		
SD0030	SD-7	07/24/97	2	10	14.9	8.0	29.0	7.9		
SD0030	SD-7	07/24/97	3	0	15.0	8.2	29.0	7.9		
SD0030	SD-7	07/24/97	3	10	14.8	8.1	29.0	8.0		
SD0030	SD-7	07/24/97	4	0	15.3	8.0	30.0	8.0		
SD0030	SD-7	07/24/97	4	10	14.9	8.3	27.5	8.0		

TABLE A3-5. (cont.)

Sample Number	Station	Collection Date	Replicate	Day	Temperature (deg C)	Dissolved Oxygen (mg/L)	Salinity (ppt)	pH	Ammonia as Nitrogen (mg/L)	Sulfide (mg/L)
SD0030	SD-7	07/24/97	5	0	14.1	8.2	30.0	7.9		
SD0030	SD-7	07/24/97	5	10	13.5	8.2	29.0	8.1		
SD0008	SD-11	07/24/97	1	0	14.5	7.8	30.0	7.8	1.6	0.01 *U*
SD0008	SD-11	07/24/97	1	1	14.9	8.2	29.0	7.8		
SD0008	SD-11	07/24/97	1	2	15.0	8.1	29.0	7.7		
SD0008	SD-11	07/24/97	1	3	14.8	8.3	28.0	7.9		
SD0008	SD-11	07/24/97	1	4	14.9	8.2	29.0	7.9		
SD0008	SD-11	07/24/97	1	5	14.8	8.4	29.5	7.9		
SD0008	SD-11	07/24/97	1	6	14.9	8.2	29.0	8.0		
SD0008	SD-11	07/24/97	1	7	14.1	8.3	30.0	8.0		
SD0008	SD-11	07/24/97	1	8	14.2	8.2	29.0	7.9		
SD0008	SD-11	07/24/97	1	9	14.1	8.2	29.0	8.0		
SD0008	SD-11	07/24/97	1	10	14.0	8.3	29.5	8.1	2.5	0.01 *U*
SD0008	SD-11	07/24/97	2	0	15.7	8.0	30.0	7.9		
SD0008	SD-11	07/24/97	2	10	15.4	8.2	27.5	8.3		
SD0008	SD-11	07/24/97	3	0	16.0	7.9	30.0	7.8		
SD0008	SD-11	07/24/97	3	10	15.2	8.0	28.0	8.3		
SD0008	SD-11	07/24/97	4	0	14.9	8.1	30.0	7.9		
SD0008	SD-11	07/24/97	4	10	14.6	8.2	28.0	8.4		
SD0008	SD-11	07/24/97	5	0	14.2	8.1	30.0	7.8		
SD0008	SD-11	07/24/97	5	10	14.0	8.4	29.5	8.2		
SD0039	SD-12	08/01/97	1	0	14.3	7.8	30.0	7.8	4.0	0.01 *U*
SD0039	SD-12	08/01/97	1	1	14.9	8.0	29.0	7.8		
SD0039	SD-12	08/01/97	1	2	14.8	8.0	28.0	7.9		
SD0039	SD-12	08/01/97	1	3	14.6	8.1	28.0	7.9		
SD0039	SD-12	08/01/97	1	4	14.9	8.0	29.0	8.0		
SD0039	SD-12	08/01/97	1	5	14.9	8.2	29.5	7.9		
SD0039	SD-12	08/01/97	1	6	14.9	8.1	29.5	8.0		
SD0039	SD-12	08/01/97	1	7	14.1	8.2	30.0	8.0		
SD0039	SD-12	08/01/97	1	8	14.1	8.3	30.0	7.9		
SD0039	SD-12	08/01/97	1	9	14.1	8.2	29.0	7.9		
SD0039	SD-12	08/01/97	1	10	14.0	8.1	30.0	8.0	7.5	0.01 *U*
SD0039	SD-12	08/01/97	2	0	15.1	8.2	30.0	8.0		
SD0039	SD-12	08/01/97	2	10	14.9	8.2	29.5	8.1		
SD0039	SD-12	08/01/97	3	0	15.2	8.2	30.0	8.0		
SD0039	SD-12	08/01/97	3	10	14.8	8.3	29.5	8.0		
SD0039	SD-12	08/01/97	4	0	15.3	8.0	30.0	8.0		
SD0039	SD-12	08/01/97	4	10	15.0	8.1	29.5	8.1		
SD0039	SD-12	08/01/97	5	0	15.0	8.3	30.0	7.9		
SD0039	SD-12	08/01/97	5	10	14.7	8.3	29.5	8.1		
SD0037	SD-13	08/01/97	1	0	15.0	8.0	30.0	7.8	4.0	0.01 *U*
SD0037	SD-13	08/01/97	1	1	15.7	7.7	29.0	7.8		
SD0037	SD-13	08/01/97	1	2	15.4	8.0	28.0	7.8		
SD0037	SD-13	08/01/97	1	3	15.3	8.2	29.0	7.9		
SD0037	SD-13	08/01/97	1	4	15.3	7.8	29.0	7.9		
SD0037	SD-13	08/01/97	1	5	15.5	8.0	29.5	7.9		
SD0037	SD-13	08/01/97	1	6	15.5	7.8	30.0	7.9		
SD0037	SD-13	08/01/97	1	7	15.1	8.1	30.0	7.9		
SD0037	SD-13	08/01/97	1	8	14.9	8.2	29.0	7.9		
SD0037	SD-13	08/01/97	1	9	14.8	8.2	29.0	8.0		
SD0037	SD-13	08/01/97	1	10	14.7	8.2	28.5	8.0	4.4	0.01 *U*
SD0037	SD-13	08/01/97	2	0	15.7	7.5	30.0	7.7		
SD0037	SD-13	08/01/97	2	10	15.3	8.0	30.0	8.1		
SD0037	SD-13	08/01/97	3	0	14.1	8.3	30.0	7.8		
SD0037	SD-13	08/01/97	3	10	13.6	8.3	28.5	8.0		
SD0037	SD-13	08/01/97	4	0	14.2	8.3	30.0	8.1		
SD0037	SD-13	08/01/97	4	10	13.9	8.2	29.5	8.1		

TABLE A3-5. (cont.)

Sample Number	Station	Collection Date	Replicate	Day	Temperature (deg C)	Dissolved Oxygen (mg/L)	Salinity (ppt)	pH	Ammonia as Nitrogen (mg/L)	Sulfide (mg/L)
SD0037	SD-13	08/01/97	5	0	14.1	8.3	30.0	8.1		
SD0037	SD-13	08/01/97	5	10	14.0	8.4	30.0	8.1		
SD0029	SD-16	07/29/97	1	0	15.3	7.7	30.0	7.6	1.1	0.01 *U*
SD0029	SD-16	07/29/97	1	1	15.9	8.0	28.0	7.8		
SD0029	SD-16	07/29/97	1	2	15.2	8.0	29.0	7.8		
SD0029	SD-16	07/29/97	1	3	14.7	8.2	28.0	7.9		
SD0029	SD-16	07/29/97	1	4	15.8	8.0	29.0	7.9		
SD0029	SD-16	07/29/97	1	5	15.7	8.2	29.0	8.0		
SD0029	SD-16	07/29/97	1	6	15.9	7.9	29.0	7.9		
SD0029	SD-16	07/29/97	1	7	15.5	8.1	29.5	8.0		
SD0029	SD-16	07/29/97	1	8	15.5	8.0	29.0	8.0		
SD0029	SD-16	07/29/97	1	9	15.3	8.2	29.0	7.9		
SD0029	SD-16	07/29/97	1	10	15.3	8.1	27.5	8.1	1.3	0.01 *U*
SD0029	SD-16	07/29/97	2	0	14.3	8.0	30.0	7.8		
SD0029	SD-16	07/29/97	2	10	14.0	8.1	29.5	8.1		
SD0029	SD-16	07/29/97	3	0	14.0	8.0	30.0	7.6		
SD0029	SD-16	07/29/97	3	10	13.5	8.3	30.0	8.2		
SD0029	SD-16	07/29/97	4	0	14.5	8.0	30.0	7.9		
SD0029	SD-16	07/29/97	4	10	14.3	8.2	28.5	8.2		
SD0029	SD-16	07/29/97	5	0	15.4	7.6	30.0	7.8		
SD0029	SD-16	07/29/97	5	10	14.8	8.2	29.5	8.3		
SD0031	SD-17	07/30/97	1	0	14.1	6.9	29.0	7.6	1.6	0.01 *U*
SD0031	SD-17	07/30/97	1	1	14.7	7.9	29.5	7.6		
SD0031	SD-17	07/30/97	1	2	14.5	8.1	29.0	7.7		
SD0031	SD-17	07/30/97	1	3	14.4	8.2	28.5	7.8		
SD0031	SD-17	07/30/97	1	4	14.8	7.8	31.0	7.8		
SD0031	SD-17	07/30/97	1	5	14.8	8.3	29.5	7.8		
SD0031	SD-17	07/30/97	1	6	14.6	8.1	28.0	7.8		
SD0031	SD-17	07/30/97	1	7	13.7	8.1	28.0	7.7		
SD0031	SD-17	07/30/97	1	8	14.0	7.9	28.5	7.7		
SD0031	SD-17	07/30/97	1	9	14.1	8.0	29.5	7.6		
SD0031	SD-17	07/30/97	1	10	14.9	8.1	29.0	7.9	2.3	0.01 *U*
SD0031	SD-17	07/30/97	2	0	15.4	7.9	30.0	7.8		
SD0031	SD-17	07/30/97	2	10	14.3	8.2	28.5	8.2		
SD0031	SD-17	07/30/97	3	0	15.3	7.9	30.0	7.8		
SD0031	SD-17	07/30/97	3	10	15.3	8.1	28.0	8.2		
SD0031	SD-17	07/30/97	4	0	14.1	8.2	30.0	8.0		
SD0031	SD-17	07/30/97	4	10	14.8	5.0	27.5	7.4		
SD0031	SD-17	07/30/97	5	0	14.4	8.1	29.0	7.8		
SD0031	SD-17	07/30/97	5	10	14.1	8.2	29.0	8.2		
SD0007	SD-18	07/23/97	1	0	14.6	8.2	29.0	7.9	1.8	0.01 *U*
SD0007	SD-18	07/23/97	1	1	15.0	8.2	29.0	7.9		
SD0007	SD-18	07/23/97	1	2	15.1	8.0	29.0	7.6		
SD0007	SD-18	07/23/97	1	3	14.8	8.1	27.5	8.0		
SD0007	SD-18	07/23/97	1	4	14.8	8.2	29.0	8.1		
SD0007	SD-18	07/23/97	1	5	14.9	8.4	29.0	8.1		
SD0007	SD-18	07/23/97	1	6	14.8	8.2	29.5	8.1		
SD0007	SD-18	07/23/97	1	7	14.2	8.4	30.0	8.1		
SD0007	SD-18	07/23/97	1	8	14.2	8.3	28.0	8.1		
SD0007	SD-18	07/23/97	1	9	14.3	8.2	29.0	8.1		
SD0007	SD-18	07/23/97	1	10	14.4	8.3	29.0	8.2	2.1	0.01 *U*
SD0007	SD-18	07/23/97	2	0	14.0	7.6	29.0	7.7		
SD0007	SD-18	07/23/97	2	10	15.0	8.0	29.0	8.0		
SD0007	SD-18	07/23/97	3	0	14.4	8.1	30.0	7.9		
SD0007	SD-18	07/23/97	3	10	14.0	8.2	29.0	8.2		
SD0007	SD-18	07/23/97	4	0	14.9	8.1	30.0	8.0		
SD0007	SD-18	07/23/97	4	10	14.7	8.2	27.5	8.3		

TABLE A3-5. (cont.)

Sample Number	Station	Collection Date	Replicate	Day	Temperature (deg C)	Dissolved Oxygen (mg/L)	Salinity (ppt)	pH	Ammonia as Nitrogen (mg/L)	Sulfide (mg/L)
SD0007	SD-18	07/23/97	5	0	15.1	7.7	29.0	7.8		
SD0007	SD-18	07/23/97	5	10	14.6	8.2	28.0	8.4		
SD0024	SD-19	07/28/97	1	0	14.1	8.3	30.0	7.9	1.7	0.01 *U*
SD0024	SD-19	07/28/97	1	1	14.9	8.0	28.0	7.8		
SD0024	SD-19	07/28/97	1	2	14.7	8.2	28.5	7.8		
SD0024	SD-19	07/28/97	1	3	14.4	8.2	29.0	7.8		
SD0024	SD-19	07/28/97	1	4	14.8	8.0	29.0	7.9		
SD0024	SD-19	07/28/97	1	5	15.0	8.2	29.0	7.9		
SD0024	SD-19	07/28/97	1	6	14.8	7.9	30.0	7.9		
SD0024	SD-19	07/28/97	1	7	14.0	8.1	30.5	7.9		
SD0024	SD-19	07/28/97	1	8	14.1	8.1	29.0	7.9		
SD0024	SD-19	07/28/97	1	9	14.0	8.1	28.0	7.9		
SD0024	SD-19	07/28/97	1	10	13.9	8.2	30.0	8.0	2.4	0.01 *U*
SD0024	SD-19	07/28/97	2	0	14.5	8.0	30.0	7.8		
SD0024	SD-19	07/28/97	2	10	14.4	8.2	28.5	8.1		
SD0024	SD-19	07/28/97	3	0	15.3	8.1	30.0	8.0		
SD0024	SD-19	07/28/97	3	10	15.1	8.2	29.5	8.1		
SD0024	SD-19	07/28/97	4	0	15.1	7.9	30.0	7.7		
SD0024	SD-19	07/28/97	4	10	14.8	8.2	29.0	8.1		
SD0024	SD-19	07/28/97	5	0	14.6	8.1	30.0	7.9		
SD0024	SD-19	07/28/97	5	10	14.1	8.3	29.5	8.1		
SD0001	SD-22	07/24/97	1	0	15.2	8.2	30.0	8.0	1.5	0.01 *U*
SD0001	SD-22	07/24/97	1	1	15.5	8.0	28.0	8.0		
SD0001	SD-22	07/24/97	1	2	15.3	8.0	29.0	8.0		
SD0001	SD-22	07/24/97	1	3	15.2	8.2	28.0	8.0		
SD0001	SD-22	07/24/97	1	4	15.6	8.0	29.0	8.2		
SD0001	SD-22	07/24/97	1	5	15.4	8.2	29.5	8.1		
SD0001	SD-22	07/24/97	1	6	15.4	7.9	29.5	8.1		
SD0001	SD-22	07/24/97	1	7	15.2	8.2	30.0	8.1		
SD0001	SD-22	07/24/97	1	8	15.1	8.3	28.5	8.0		
SD0001	SD-22	07/24/97	1	9	14.5	8.1	28.0	8.1		
SD0001	SD-22	07/24/97	1	10	14.9	8.2	29.0	8.2	0.2 *U*	0.01 *U*
SD0001	SD-22	07/24/97	2	0	15.1	8.0	30.0	7.9		
SD0001	SD-22	07/24/97	2	10	14.9	8.2	29.0	8.1		
SD0001	SD-22	07/24/97	3	0	15.2	8.2	30.0	7.9		
SD0001	SD-22	07/24/97	3	10	15.0	8.2	30.0	8.1		
SD0001	SD-22	07/24/97	4	0	15.4	7.3	30.0	7.7		
SD0001	SD-22	07/24/97	4	10	14.5	8.1	28.0	8.2		
SD0001	SD-22	07/24/97	5	0	14.6	8.2	30.0	8.0		
SD0001	SD-22	07/24/97	5	10	14.1	8.2	29.5	8.2		
SD0002	SD-23	07/24/97	1	0	14.7	8.2	30.0	8.0	1.9	0.01 *U*
SD0002	SD-23	07/24/97	1	1	15.2	8.2	28.0	7.9		
SD0002	SD-23	07/24/97	1	2	15.1	8.0	28.5	7.8		
SD0002	SD-23	07/24/97	1	3	15.0	8.4	28.0	8.1		
SD0002	SD-23	07/24/97	1	4	15.3	8.0	29.0	8.0		
SD0002	SD-23	07/24/97	1	5	15.2	8.2	29.0	8.0		
SD0002	SD-23	07/24/97	1	6	15.2	7.9	30.0	8.0		
SD0002	SD-23	07/24/97	1	7	15.1	8.2	30.0	8.1		
SD0002	SD-23	07/24/97	1	8	14.9	8.2	28.5	7.9		
SD0002	SD-23	07/24/97	1	9	14.0	8.2	28.0	8.2		
SD0002	SD-23	07/24/97	1	10	14.3	8.2	29.0	8.4	3.1	0.01 *U*
SD0002	SD-23	07/24/97	2	0	14.5	7.6	30.0	7.7		
SD0002	SD-23	07/24/97	2	10	14.0	8.1	29.5	8.2		
SD0002	SD-23	07/24/97	3	0	14.5	8.0	30.0	7.9		
SD0002	SD-23	07/24/97	3	10	14.2	8.0	29.5	8.1		
SD0002	SD-23	07/24/97	4	0	15.3	8.2	30.0	8.1		
SD0002	SD-23	07/24/97	4	10	14.9	8.2	29.0	8.5		

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TABLE A3-5. (cont.)

Sample Number	Station	Collection Date	Replicate	Day	Temperature (deg C)	Dissolved Oxygen (mg/L)	Salinity (ppt)	pH	Ammonia as Nitrogen (mg/L)	Sulfide (mg/L)
SD0002	SD-23	07/24/97	5	0	15.6	8.0	30.0	8.1		
SD0002	SD-23	07/24/97	5	10	14.3	8.2	28.5	8.5		
SD0009	SD-25	07/24/97	1	0	14.7	8.2	30.0	8.2	3.0	0.01 *U*
SD0009	SD-25	07/24/97	1	1	15.1	8.1	28.0	7.9		
SD0009	SD-25	07/24/97	1	2	15.1	8.0	28.5	7.9		
SD0009	SD-25	07/24/97	1	3	14.9	8.3	28.5	7.9		
SD0009	SD-25	07/24/97	1	4	15.0	7.9	29.0	8.0		
SD0009	SD-25	07/24/97	1	5	15.2	8.2	29.5	7.9		
SD0009	SD-25	07/24/97	1	6	15.0	8.0	30.0	7.9		
SD0009	SD-25	07/24/97	1	7	14.4	8.1	30.0	7.9		
SD0009	SD-25	07/24/97	1	8	14.8	8.3	27.5	8.1		
SD0009	SD-25	07/24/97	1	9	14.1	8.2	28.0	8.0		
SD0009	SD-25	07/24/97	1	10	14.1	8.2	28.0	7.9	10.0	0.01 *U*
SD0009	SD-25	07/24/97	2	0	15.2	8.2	30.0	7.8		
SD0009	SD-25	07/24/97	2	10	14.8	8.2	29.0	7.8		
SD0009	SD-25	07/24/97	3	0	15.3	8.2	30.0	8.1		
SD0009	SD-25	07/24/97	3	10	15.1	8.2	29.5	8.0		
SD0009	SD-25	07/24/97	4	0	14.5	8.0	30.0	7.8		
SD0009	SD-25	07/24/97	4	10	14.1	8.2	29.5	7.9		
SD0009	SD-25	07/24/97	5	0	14.4	7.8	29.0	7.7		
SD0009	SD-25	07/24/97	5	10	14.1	8.1	29.5	7.9		
SD0005	SD-27	07/24/97	1	0	14.9	8.1	30.0	7.8	1.3	0.01 *U*
SD0005	SD-27	07/24/97	1	1	15.3	8.1	27.0	7.9		
SD0005	SD-27	07/24/97	1	2	15.0	8.0	29.0	7.8		
SD0005	SD-27	07/24/97	1	3	15.0	8.2	27.0	8.0		
SD0005	SD-27	07/24/97	1	4	15.6	8.1	28.0	8.0		
SD0005	SD-27	07/24/97	1	5	15.4	8.2	29.5	8.0		
SD0005	SD-27	07/24/97	1	6	15.3	8.0	30.0	8.0		
SD0005	SD-27	07/24/97	1	7	15.1	8.2	30.0	7.9		
SD0005	SD-27	07/24/97	1	8	14.9	8.2	28.0	7.9		
SD0005	SD-27	07/24/97	1	9	14.2	8.1	28.0	8.0		
SD0005	SD-27	07/24/97	1	10	14.4	8.2	28.5	8.0	1.7	0.01 *U*
SD0005	SD-27	07/24/97	2	0	14.0	7.8	30.0	7.8		
SD0005	SD-27	07/24/97	2	10	14.1	8.1	29.0	8.0		
SD0005	SD-27	07/24/97	3	0	15.0	7.8	30.0	7.8		
SD0005	SD-27	07/24/97	3	10	14.9	8.2	29.5	8.0		
SD0005	SD-27	07/24/97	4	0	14.0	8.1	30.0	7.7		
SD0005	SD-27	07/24/97	4	10	14.0	8.1	30.0	8.0		
SD0005	SD-27	07/24/97	5	0	14.2	8.1	30.0	7.7		
SD0005	SD-27	07/24/97	5	10	13.5	8.2	29.0	8.0		
SD0006	SD-28	07/24/97	1	0	15.4	8.0	30.0	7.8	1.7	0.01 *U*
SD0006	SD-28	07/24/97	1	1	15.9	8.2	29.0	7.7		
SD0006	SD-28	07/24/97	1	2	15.6	8.0	29.0	8.0		
SD0006	SD-28	07/24/97	1	3	15.4	8.0	28.5	7.9		
SD0006	SD-28	07/24/97	1	4	14.9	8.2	29.0	7.9		
SD0006	SD-28	07/24/97	1	5	15.0	8.3	29.5	8.0		
SD0006	SD-28	07/24/97	1	6	15.0	8.1	30.0	8.0		
SD0006	SD-28	07/24/97	1	7	14.4	8.3	30.5	8.1		
SD0006	SD-28	07/24/97	1	8	14.3	8.3	30.0	8.1		
SD0006	SD-28	07/24/97	1	9	14.2	8.2	29.0	8.2		
SD0006	SD-28	07/24/97	1	10	14.4	8.2	29.5	8.4	3.4	0.01 *U*
SD0006	SD-28	07/24/97	2	0	14.5	8.0	30.0	7.8		
SD0006	SD-28	07/24/97	2	10	14.3	8.0	30.0	8.5		
SD0006	SD-28	07/24/97	3	0	14.7	8.2	30.0	7.8		
SD0006	SD-28	07/24/97	3	10	14.0	8.2	29.0	8.5		
SD0006	SD-28	07/24/97	4	0	14.9	7.9	30.0	7.7		
SD0006	SD-28	07/24/97	4	10	14.8	8.0	29.5	8.5		

TABLE A3-5. (cont.)

Sample Number	Station	Collection Date	Replicate	Day	Temperature (deg C)	Dissolved Oxygen (mg/L)	Salinity (ppt)	pH	Ammonia as Nitrogen (mg/L)	Sulfide (mg/L)
SD0006	SD-28	07/24/97	5	0	15.7	8.0	30.0	8.0		
SD0006	SD-28	07/24/97	5	10	14.4	8.3	29.0	8.5		
SD0022	SD-29	07/24/97	1	0	14.6	8.0	30.0	7.9	0.8	0.01 *U*
SD0022	SD-29	07/24/97	1	1	15.1	7.9	28.0	7.9		
SD0022	SD-29	07/24/97	1	2	15.1	7.9	28.0	7.9		
SD0022	SD-29	07/24/97	1	3	14.7	8.2	28.0	8.0		
SD0022	SD-29	07/24/97	1	4	15.2	8.0	28.0	7.9		
SD0022	SD-29	07/24/97	1	5	15.1	8.1	28.5	8.0		
SD0022	SD-29	07/24/97	1	6	14.9	7.9	29.5	8.0		
SD0022	SD-29	07/24/97	1	7	14.5	8.0	30.0	8.0		
SD0022	SD-29	07/24/97	1	8	14.4	8.2	27.5	7.8		
SD0022	SD-29	07/24/97	1	9	14.1	8.2	28.0	8.0		
SD0022	SD-29	07/24/97	1	10	14.0	8.2	29.5	8.0	0.2 *U*	0.01 *U*
SD0022	SD-29	07/24/97	2	0	14.5	7.8	29.0	7.7		
SD0022	SD-29	07/24/97	2	10	13.9	8.1	27.5	8.0		
SD0022	SD-29	07/24/97	3	0	14.4	8.0	30.0	7.9		
SD0022	SD-29	07/24/97	3	10	14.0	8.2	29.5	7.9		
SD0022	SD-29	07/24/97	4	0	14.4	8.2	30.0	8.0		
SD0022	SD-29	07/24/97	4	10	13.9	8.2	30.0	8.0		
SD0022	SD-29	07/24/97	5	0	14.0	7.7	29.0	7.6		
SD0022	SD-29	07/24/97	5	10	13.5	8.2	29.0	8.0		
SD0023	SD-30	07/24/97	1	0	14.1	8.0	30.0	7.8	0.2 *U*	0.01 *U*
SD0023	SD-30	07/24/97	1	1	14.9	8.0	29.5	7.7		
SD0023	SD-30	07/24/97	1	2	14.6	8.2	28.5	7.8		
SD0023	SD-30	07/24/97	1	3	14.6	8.1	28.0	7.9		
SD0023	SD-30	07/24/97	1	4	14.8	8.0	29.0	7.9		
SD0023	SD-30	07/24/97	1	5	14.8	8.2	29.0	7.9		
SD0023	SD-30	07/24/97	1	6	14.9	8.0	29.5	7.9		
SD0023	SD-30	07/24/97	1	7	14.0	8.1	30.0	7.9		
SD0023	SD-30	07/24/97	1	8	14.2	8.2	30.0	7.9		
SD0023	SD-30	07/24/97	1	9	14.0	8.2	29.5	7.9		
SD0023	SD-30	07/24/97	1	10	13.5	8.1	30.0	8.0	0.2 *U*	0.01 *U*
SD0023	SD-30	07/24/97	2	0	15.0	8.0	30.0	7.9		
SD0023	SD-30	07/24/97	2	10	14.9	8.0	29.0	8.1		
SD0023	SD-30	07/24/97	3	0	14.9	8.2	30.0	7.9		
SD0023	SD-30	07/24/97	3	10	14.7	8.2	30.0	8.0		
SD0023	SD-30	07/24/97	4	0	15.3	8.0	30.0	7.9		
SD0023	SD-30	07/24/97	4	10	15.4	8.2	28.0	8.0		
SD0023	SD-30	07/24/97	5	0	15.0	7.6	30.0	7.8		
SD0023	SD-30	07/24/97	5	10	14.6	8.2	27.5	8.0		
SD0015	SD-31	07/24/97	1	0	15.9	5.8	30.0	7.7	4.8	0.01 *U*
SD0015	SD-31	07/24/97	1	1	16.0	7.8	29.0	8.0		
SD0015	SD-31	07/24/97	1	2	15.2	8.0	28.5	8.0		
SD0015	SD-31	07/24/97	1	3	15.5	8.2	28.0	8.1		
SD0015	SD-31	07/24/97	1	4	15.6	8.0	29.0	8.1		
SD0015	SD-31	07/24/97	1	5	15.6	8.2	29.5	8.1		
SD0015	SD-31	07/24/97	1	6	15.7	8.0	30.0	8.1		
SD0015	SD-31	07/24/97	1	7	15.4	8.2	30.5	8.2		
SD0015	SD-31	07/24/97	1	8	15.3	8.3	30.0	8.2		
SD0015	SD-31	07/24/97	1	9	15.0	8.2	29.0	8.1		
SD0015	SD-31	07/24/97	1	10	15.0	8.3	28.5	8.3	4.6	0.01 *U*
SD0015	SD-31	07/24/97	2	0	14.9	8.2	30.0	8.2		
SD0015	SD-31	07/24/97	2	10	14.3	8.2	29.5	8.4		
SD0015	SD-31	07/24/97	3	0	14.2	7.2	30.0	7.8		
SD0015	SD-31	07/24/97	3	10	--[a]	--[a]	28.5	--[a]		
SD0015	SD-31	07/24/97	4	0	15.3	8.0	30.0	8.0		
SD0015	SD-31	07/24/97	4	10	14.4	8.2	28.0	8.3		

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TABLE A3-5. (cont.)

Sample Number	Station	Collection Date	Replicate	Day	Temperature (deg C)	Dissolved Oxygen (mg/L)	Salinity (ppt)	pH	Ammonia as Nitrogen (mg/L)	Sulfide (mg/L)
SD0015	SD-31	07/24/97	5	0	15.1	8.2	30.0	8.2		
SD0015	SD-31	07/24/97	5	10	14.9	8.3	30.0	8.3		
SD0016	SD-32	07/24/97	1	0	15.2	8.2	29.0	7.8	1.5	0.01 *U*
SD0016	SD-32	07/24/97	1	1	15.6	8.0	28.0	7.8		
SD0016	SD-32	07/24/97	1	2	14.9	8.0	28.5	7.8		
SD0016	SD-32	07/24/97	1	3	14.7	8.1	28.0	7.9		
SD0016	SD-32	07/24/97	1	4	15.6	7.9	29.0	7.9		
SD0016	SD-32	07/24/97	1	5	15.8	8.2	29.5	7.9		
SD0016	SD-32	07/24/97	1	6	15.9	8.0	29.0	7.9		
SD0016	SD-32	07/24/97	1	7	15.5	8.0	30.0	7.9		
SD0016	SD-32	07/24/97	1	8	15.5	8.0	28.5	7.9		
SD0016	SD-32	07/24/97	1	9	14.6	8.2	29.0	7.9		
SD0016	SD-32	07/24/97	1	10	15.3	8.2	28.0	8.0	2.5	0.01 *U*
SD0016	SD-32	07/24/97	2	0	15.3	7.6	29.0	7.7		
SD0016	SD-32	07/24/97	2	10	15.3	8.1	28.5	8.0		
SD0016	SD-32	07/24/97	3	0	14.4	8.0	30.0	8.0		
SD0016	SD-32	07/24/97	3	10	14.3	8.0	30.0	8.0		
SD0016	SD-32	07/24/97	4	0	14.0	8.4	30.0	7.9		
SD0016	SD-32	07/24/97	4	10	--[a]	--[a]	30.0	--[a]		
SD0016	SD-32	07/24/97	5	0	14.2	7.8	30.0	7.7		
SD0016	SD-32	07/24/97	5	10	13.5	8.2	29.0	8.2		
SD0017	SD-33	07/24/97	1	0	14.0	8.2	30.0	7.9	1.1	0.01 *U*
SD0017	SD-33	07/24/97	1	1	14.8	8.0	29.5	7.7		
SD0017	SD-33	07/24/97	1	2	14.6	8.0	29.0	7.8		
SD0017	SD-33	07/24/97	1	3	14.6	8.1	28.5	7.9		
SD0017	SD-33	07/24/97	1	4	14.6	8.0	29.0	7.8		
SD0017	SD-33	07/24/97	1	5	14.7	8.3	30.0	7.9		
SD0017	SD-33	07/24/97	1	6	14.7	8.0	29.0	7.8		
SD0017	SD-33	07/24/97	1	7	14.0	7.9	29.5	8.0		
SD0017	SD-33	07/24/97	1	8	14.1	8.1	28.0	8.0		
SD0017	SD-33	07/24/97	1	9	14.0	7.9	29.0	8.0		
SD0017	SD-33	07/24/97	1	10	13.3	8.3	28.5	8.3	1.7	0.01 *U*
SD0017	SD-33	07/24/97	2	0	14.4	8.0	30.0	8.0		
SD0017	SD-33	07/24/97	2	10	14.0	8.1	29.0	8.3		
SD0017	SD-33	07/24/97	3	0	14.2	7.8	29.0	7.6		
SD0017	SD-33	07/24/97	3	10	13.6	8.2	29.0	8.1		
SD0017	SD-33	07/24/97	4	0	15.3	7.4	30.0	7.8		
SD0017	SD-33	07/24/97	4	10	15.4	8.0	28.0	8.2		
SD0017	SD-33	07/24/97	5	0	14.9	8.0	30.0	7.9		
SD0017	SD-33	07/24/97	5	10	14.8	8.2	29.0	8.3		
SD0033	SD-34	07/24/97	1	0	15.5	7.7	29.0	7.8	1.9	0.01 *U*
SD0033	SD-34	07/24/97	1	1	16.0	7.9	29.0	7.7		
SD0033	SD-34	07/24/97	1	2	15.6	8.0	29.5	7.8		
SD0033	SD-34	07/24/97	1	3	15.3	8.2	28.0	7.9		
SD0033	SD-34	07/24/97	1	4	14.9	8.0	28.0	7.9		
SD0033	SD-34	07/24/97	1	5	14.9	8.3	28.0	8.0		
SD0033	SD-34	07/24/97	1	6	15.0	7.9	29.5	8.0		
SD0033	SD-34	07/24/97	1	7	14.5	8.1	30.0	7.9		
SD0033	SD-34	07/24/97	1	8	14.4	8.2	28.0	7.9		
SD0033	SD-34	07/24/97	1	9	14.2	8.2	29.0	8.0		
SD0033	SD-34	07/24/97	1	10	14.4	8.2	28.0	8.0	2.8	0.01 *U*
SD0033	SD-34	07/24/97	2	0	14.5	8.2	30.0	8.0		
SD0033	SD-34	07/24/97	2	10	14.1	8.2	28.0	8.1		
SD0033	SD-34	07/24/97	3	0	14.1	8.2	28.0	7.9		
SD0033	SD-34	07/24/97	3	10	13.6	8.2	29.0	8.2		
SD0033	SD-34	07/24/97	4	0	14.3	8.0	28.0	7.7		
SD0033	SD-34	07/24/97	4	10	13.6	8.2	29.0	8.0		

TABLE A3-5. (cont.)

Sample Number	Station	Collection Date	Replicate	Day	Temperature (deg C)	Dissolved Oxygen (mg/L)	Salinity (ppt)	pH	Ammonia as Nitrogen (mg/L)	Sulfide (mg/L)
SD0033	SD-34	07/24/97	5	0	14.3	7.8	28.0	7.9		
SD0033	SD-34	07/24/97	5	10	14.2	8.2	29.0	8.0		
SD0034	SD-35	07/24/97	1	0	15.8	7.4	30.0	7.7	0.3	0.01 *U*
SD0034	SD-35	07/24/97	1	1	16.0	7.9	28.0	7.9		
SD0034	SD-35	07/24/97	1	2	15.3	8.1	28.0	7.7		
SD0034	SD-35	07/24/97	1	3	15.4	8.2	28.0	8.0		
SD0034	SD-35	07/24/97	1	4	15.7	8.0	29.0	8.1		
SD0034	SD-35	07/24/97	1	5	15.6	8.2	29.5	8.1		
SD0034	SD-35	07/24/97	1	6	15.7	8.0	29.0	8.1		
SD0034	SD-35	07/24/97	1	7	15.4	8.2	30.0	8.0		
SD0034	SD-35	07/24/97	1	8	15.4	8.1	29.0	8.0		
SD0034	SD-35	07/24/97	1	9	15.0	8.2	29.0	8.2		
SD0034	SD-35	07/24/97	1	10	15.2	8.2	29.0	8.1	0.8	0.01 *U*
SD0034	SD-35	07/24/97	2	0	14.1	8.2	30.0	7.9		
SD0034	SD-35	07/24/97	2	10	13.6	8.2	29.0	8.2		
SD0034	SD-35	07/24/97	3	0	14.1	8.0	30.0	7.7		
SD0034	SD-35	07/24/97	3	10	13.5	8.2	30.0	8.1		
SD0034	SD-35	07/24/97	4	0	14.3	8.0	30.0	7.7		
SD0034	SD-35	07/24/97	4	10	14.0	7.9	30.0	8.0		
SD0034	SD-35	07/24/97	5	0	14.6	8.0	30.0	7.9		
SD0034	SD-35	07/24/97	5	10	14.1	8.2	30.0	8.1		
SD0018	SD-37	07/24/97	1	0	14.6	8.0	30.0	7.8	0.8	0.01 *U*
SD0018	SD-37	07/24/97	1	1	15.0	8.2	29.0	7.9		
SD0018	SD-37	07/24/97	1	2	15.0	8.2	28.5	7.9		
SD0018	SD-37	07/24/97	1	3	14.8	8.3	28.0	8.1		
SD0018	SD-37	07/24/97	1	4	14.9	8.1	28.5	8.0		
SD0018	SD-37	07/24/97	1	5	14.9	8.2	29.5	8.0		
SD0018	SD-37	07/24/97	1	6	14.7	7.9	30.0	8.0		
SD0018	SD-37	07/24/97	1	7	14.1	8.2	30.5	8.0		
SD0018	SD-37	07/24/97	1	8	14.2	8.2	30.0	8.0		
SD0018	SD-37	07/24/97	1	9	15.0	8.2	29.0	8.1		
SD0018	SD-37	07/24/97	1	10	14.1	8.3	30.0	8.2	1.0	0.01 *U*
SD0018	SD-37	07/24/97	2	0	14.6	7.6	30.0	7.8		
SD0018	SD-37	07/24/97	2	10	14.0	8.1	29.0	8.3		
SD0018	SD-37	07/24/97	3	0	15.0	8.2	30.0	8.0		
SD0018	SD-37	07/24/97	3	10	14.7	8.3	29.5	8.2		
SD0018	SD-37	07/24/97	4	0	14.2	8.2	29.0	7.9		
SD0018	SD-37	07/24/97	4	10	14.0	8.1	29.5	8.2		
SD0018	SD-37	07/24/97	5	0	14.0	8.1	30.0	7.8		
SD0018	SD-37	07/24/97	5	10	14.0	8.2	30.0	8.1		
SD0010	SD-38	07/24/97	1	0	14.9	8.0	30.0	7.9	4.0	0.01 *U*
SD0010	SD-38	07/24/97	1	1	15.4	8.1	27.0	7.8		
SD0010	SD-38	07/24/97	1	2	15.3	8.1	28.0	7.8		
SD0010	SD-38	07/24/97	1	3	15.0	8.3	28.0	8.0		
SD0010	SD-38	07/24/97	1	4	15.7	8.1	29.0	8.0		
SD0010	SD-38	07/24/97	1	5	15.5	8.2	29.0	8.0		
SD0010	SD-38	07/24/97	1	6	15.5	7.9	29.5	8.0		
SD0010	SD-38	07/24/97	1	7	15.1	8.2	30.0	8.0		
SD0010	SD-38	07/24/97	1	8	14.8	8.2	29.5	8.0		
SD0010	SD-38	07/24/97	1	9	14.2	8.1	28.0	8.0		
SD0010	SD-38	07/24/97	1	10	14.7	8.2	29.5	8.0	4.2	0.01 *U*
SD0010	SD-38	07/24/97	2	0	14.4	8.1	30.0	7.9		
SD0010	SD-38	07/24/97	2	10	14.1	8.0	29.5	7.9		
SD0010	SD-38	07/24/97	3	0	14.6	8.0	30.0	7.9		
SD0010	SD-38	07/24/97	3	10	14.1	8.1	29.5	8.0		
SD0010	SD-38	07/24/97	4	0	15.9	7.6	30.0	7.9		
SD0010	SD-38	07/24/97	4	10	15.2	8.1	29.5	8.1		

TABLE A3-5. (cont.)

Sample Number	Station	Collection Date	Replicate	Day	Temperature (deg C)	Dissolved Oxygen (mg/L)	Salinity (ppt)	pH	Ammonia as Nitrogen (mg/L)	Sulfide (mg/L)
SD0010	SD-38	07/24/97	5	0	14.0	8.3	30.0	7.7		
SD0010	SD-38	07/24/97	5	10	14.0	8.3	29.5	8.1		
SD0020	SD-39	07/24/97	1	0	14.9	7.8	30.0	7.8	2.1	0.01 *U*
SD0020	SD-39	07/24/97	1	1	15.7	7.7	28.5	7.7		
SD0020	SD-39	07/24/97	1	2	15.5	8.0	28.0	7.7		
SD0020	SD-39	07/24/97	1	3	15.3	8.0	28.0	7.8		
SD0020	SD-39	07/24/97	1	4	15.1	7.7	29.0	7.9		
SD0020	SD-39	07/24/97	1	5	15.2	8.0	29.0	7.9		
SD0020	SD-39	07/24/97	1	6	15.3	7.6	30.0	7.9		
SD0020	SD-39	07/24/97	1	7	14.8	8.0	30.0	8.1		
SD0020	SD-39	07/24/97	1	8	14.7	8.1	28.0	8.0		
SD0020	SD-39	07/24/97	1	9	14.6	8.2	29.0	8.0		
SD0020	SD-39	07/24/97	1	10	14.7	8.2	28.5	8.1	3.0	0.01 *U*
SD0020	SD-39	07/24/97	2	0	14.3	8.1	29.0	7.8		
SD0020	SD-39	07/24/97	2	10	14.0	8.2	29.5	8.0		
SD0020	SD-39	07/24/97	3	0	15.0	7.8	30.0	8.0		
SD0020	SD-39	07/24/97	3	10	14.7	8.2	29.0	8.0		
SD0020	SD-39	07/24/97	4	0	14.0	8.0	30.0	7.6		
SD0020	SD-39	07/24/97	4	10	13.5	8.2	30.0	8.1		
SD0020	SD-39	07/24/97	5	0	15.9	7.7	30.0	7.8		
SD0020	SD-39	07/24/97	5	10	15.4	8.1	28.0	8.0		
SD0021	SD-40	07/24/97	1	0	14.0	8.3	30.0	7.8	1.6	0.01 *U*
SD0021	SD-40	07/24/97	1	1	14.8	8.2	27.0	7.8		
SD0021	SD-40	07/24/97	1	2	14.6	8.0	28.0	7.8		
SD0021	SD-40	07/24/97	1	3	14.3	8.1	28.5	7.9		
SD0021	SD-40	07/24/97	1	4	14.7	8.1	29.0	7.9		
SD0021	SD-40	07/24/97	1	5	14.9	8.4	29.0	7.9		
SD0021	SD-40	07/24/97	1	6	14.7	8.0	30.0	7.9		
SD0021	SD-40	07/24/97	1	7	14.1	8.3	30.0	7.8		
SD0021	SD-40	07/24/97	1	8	14.1	8.2	28.0	7.8		
SD0021	SD-40	07/24/97	1	9	14.1	8.1	28.0	7.9		
SD0021	SD-40	07/24/97	1	10	14.0	8.2	29.0	7.9	2.4	0.01 *U*
SD0021	SD-40	07/24/97	2	0	15.0	8.2	30.0	8.0		
SD0021	SD-40	07/24/97	2	10	14.7	8.3	29.0	8.0		
SD0021	SD-40	07/24/97	3	0	14.9	8.2	30.0	7.9		
SD0021	SD-40	07/24/97	3	10	14.7	8.2	28.0	7.9		
SD0021	SD-40	07/24/97	4	0	15.1	7.7	30.0	7.7		
SD0021	SD-40	07/24/97	4	10	14.8	8.2	28.0	7.9		
SD0021	SD-40	07/24/97	5	0	15.2	8.3	30.0	7.9		
SD0021	SD-40	07/24/97	5	10	15.0	8.1	30.0	7.9		
SD0032	SD-41	07/24/97	1	0	14.0	8.0	30.0	7.9	0.6	0.01 *U*
SD0032	SD-41	07/24/97	1	1	14.9	8.1	27.0	7.9		
SD0032	SD-41	07/24/97	1	2	14.5	8.1	28.5	7.8		
SD0032	SD-41	07/24/97	1	3	14.3	8.2	28.0	7.9		
SD0032	SD-41	07/24/97	1	4	14.9	8.2	29.0	7.9		
SD0032	SD-41	07/24/97	1	5	15.1	8.3	29.0	8.0		
SD0032	SD-41	07/24/97	1	6	14.8	7.9	29.5	8.0		
SD0032	SD-41	07/24/97	1	7	13.8	8.4	30.0	8.0		
SD0032	SD-41	07/24/97	1	8	14.0	8.4	29.0	8.0		
SD0032	SD-41	07/24/97	1	9	14.0	8.1	28.0	8.1		
SD0032	SD-41	07/24/97	1	10	14.0	8.2	30.0	8.2	0.9	0.01 *U*
SD0032	SD-41	07/24/97	2	0	14.8	8.2	29.0	8.0		
SD0032	SD-41	07/24/97	2	10	14.2	8.2	29.0	8.3		
SD0032	SD-41	07/24/97	3	0	15.7	7.7	30.0	7.9		
SD0032	SD-41	07/24/97	3	10	15.5	8.0	29.0	8.4		
SD0032	SD-41	07/24/97	4	0	14.9	8.0	30.0	7.8		
SD0032	SD-41	07/24/97	4	10	14.8	8.2	28.0	8.3		

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TABLE A3-5. (cont.)

Sample Number	Station	Collection Date	Replicate	Day	Temperature (deg C)	Dissolved Oxygen (mg/L)	Salinity (ppt)	pH	Ammonia as Nitrogen (mg/L)	Sulfide (mg/L)
SD0032	SD-41	07/24/97	5	0	14.9	8.0	30.0	7.9		
SD0032	SD-41	07/24/97	5	10	14.7	8.2	29.0	8.2		
SD0028	SD-42	07/24/97	1	0	16.0	7.7	30.0	7.0	1.6	0.01 *U*
SD0028	SD-42	07/24/97	1	1	16.0	8.0	28.0	7.8		
SD0028	SD-42	07/24/97	1	2	15.3	8.2	29.0	7.8		
SD0028	SD-42	07/24/97	1	3	15.2	8.0	28.0	7.9		
SD0028	SD-42	07/24/97	1	4	15.7	8.0	28.5	8.0		
SD0028	SD-42	07/24/97	1	5	15.6	8.2	29.5	8.0		
SD0028	SD-42	07/24/97	1	6	15.9	7.9	30.0	8.0		
SD0028	SD-42	07/24/97	1	7	15.4	8.1	30.0	7.9		
SD0028	SD-42	07/24/97	1	8	15.4	8.1	30.0	7.8		
SD0028	SD-42	07/24/97	1	9	15.1	8.2	29.0	8.1		
SD0028	SD-42	07/24/97	1	10	15.4	8.1	29.5	8.0	3.2	0.01 *U*
SD0028	SD-42	07/24/97	2	0	14.2	7.8	30.0	7.9		
SD0028	SD-42	07/24/97	2	10	13.6	8.1	29.0	8.0		
SD0028	SD-42	07/24/97	3	0	15.4	7.5	30.0	7.7		
SD0028	SD-42	07/24/97	3	10	15.3	8.2	27.5	8.0		
SD0028	SD-42	07/24/97	4	0	15.3	8.2	30.0	7.9		
SD0028	SD-42	07/24/97	4	10	14.7	8.2	30.0	8.0		
SD0028	SD-42	07/24/97	5	0	14.3	8.2	30.0	7.8		
SD0028	SD-42	07/24/97	5	10	13.7	8.2	29.0	8.1		
SD0027	SD-43	07/24/97	1	0	15.1	7.9	30.0	7.9	2.0	0.01 *U*
SD0027	SD-43	07/24/97	1	1	15.8	7.8	29.5	7.9		
SD0027	SD-43	07/24/97	1	2	15.5	8.2	28.5	7.9		
SD0027	SD-43	07/24/97	1	3	15.4	8.1	28.0	8.0		
SD0027	SD-43	07/24/97	1	4	15.4	8.0	29.0	8.0		
SD0027	SD-43	07/24/97	1	5	15.4	8.0	29.0	8.0		
SD0027	SD-43	07/24/97	1	6	15.6	7.9	30.0	8.0		
SD0027	SD-43	07/24/97	1	7	15.1	8.0	30.0	8.0		
SD0027	SD-43	07/24/97	1	8	15.1	8.0	29.5	8.0		
SD0027	SD-43	07/24/97	1	9	14.8	8.2	29.0	8.0		
SD0027	SD-43	07/24/97	1	10	14.9	8.2	28.5	8.1	2.4	0.01 *U*
SD0027	SD-43	07/24/97	2	0	14.1	8.3	30.0	7.9		
SD0027	SD-43	07/24/97	2	10	14.0	8.2	30.0	8.1		
SD0027	SD-43	07/24/97	3	0	15.2	8.2	30.0	7.9		
SD0027	SD-43	07/24/97	3	10	15.1	8.2	29.0	8.1		
SD0027	SD-43	07/24/97	4	0	14.7	7.8	30.0	7.8		
SD0027	SD-43	07/24/97	4	10	14.1	8.0	28.5	8.0		
SD0027	SD-43	07/24/97	5	0	14.9	8.2	30.0	7.8		
SD0027	SD-43	07/24/97	5	10	14.9	8.2	29.0	8.1		
SD0035	SD-44	07/24/97	1	0	15.2	7.8	30.0	7.9	5.0	0.01 *U*
SD0035	SD-44	07/24/97	1	1	15.5	8.0	28.0	7.9		
SD0035	SD-44	07/24/97	1	2	15.0	8.0	28.0	7.9		
SD0035	SD-44	07/24/97	1	3	15.0	8.2	27.0	8.0		
SD0035	SD-44	07/24/97	1	4	15.8	8.0	29.0	8.0		
SD0035	SD-44	07/24/97	1	5	15.8	8.1	29.0	8.1		
SD0035	SD-44	07/24/97	1	6	16.0	7.9	30.0	8.1		
SD0035	SD-44	07/24/97	1	7	15.6	8.1	30.0	8.0		
SD0035	SD-44	07/24/97	1	8	15.5	8.1	28.0	8.0		
SD0035	SD-44	07/24/97	1	9	15.0	8.1	29.0	8.0		
SD0035	SD-44	07/24/97	1	10	15.4	8.2	27.5	8.1	10.5	0.01 *U*
SD0035	SD-44	07/24/97	2	0	14.0	5.4	29.0	7.5		
SD0035	SD-44	07/24/97	2	10	13.3	8.2	28.0	8.1		
SD0035	SD-44	07/24/97	3	0	15.2	8.3	30.0	8.0		
SD0035	SD-44	07/24/97	3	10	14.8	8.3	29.5	8.2		
SD0035	SD-44	07/24/97	4	0	14.4	8.2	30.0	8.0		
SD0035	SD-44	07/24/97	4	10	13.9	8.1	30.0	8.2		

TABLE A3-5. (cont.)

Sample Number	Station	Collection Date	Replicate	Day	Temperature (deg C)	Dissolved Oxygen (mg/L)	Salinity (ppt)	pH	Ammonia as Nitrogen (mg/L)	Sulfide (mg/L)
SD0035	SD-44	07/24/97	5	0	15.0	8.2	30.0	8.0		
SD0035	SD-44	07/24/97	5	10	14.8	8.2	29.0	8.2		
SD0025	SD-45	07/24/97	1	0	15.1	8.1	30.0	7.8	2.0	0.01 *U*
SD0025	SD-45	07/24/97	1	1	15.6	8.0	28.0	7.9		
SD0025	SD-45	07/24/97	1	2	15.0	7.9	28.5	7.9		
SD0025	SD-45	07/24/97	1	3	15.0	8.2	27.0	8.1		
SD0025	SD-45	07/24/97	1	4	15.8	7.9	29.0	8.0		
SD0025	SD-45	07/24/97	1	5	15.8	8.1	29.5	8.0		
SD0025	SD-45	07/24/97	1	6	16.0	7.8	30.0	8.0		
SD0025	SD-45	07/24/97	1	7	15.6	8.0	30.0	8.1		
SD0025	SD-45	07/24/97	1	8	15.5	8.1	29.0	8.0		
SD0025	SD-45	07/24/97	1	9	15.1	8.2	29.0	8.1		
SD0025	SD-45	07/24/97	1	10	15.3	8.1	28.0	8.1	3.6	0.01 *U*
SD0025	SD-45	07/24/97	2	0	14.3	8.3	30.0	8.0		
SD0025	SD-45	07/24/97	2	10	13.9	8.3	30.0	8.1		
SD0025	SD-45	07/24/97	3	0	15.1	7.5	30.0	7.7		
SD0025	SD-45	07/24/97	3	10	14.8	8.2	29.0	8.2		
SD0025	SD-45	07/24/97	4	0	14.1	8.2	30.0	7.8		
SD0025	SD-45	07/24/97	4	10	13.5	8.2	29.0	8.0		
SD0025	SD-45	07/24/97	5	0	14.3	8.0	30.0	7.7		
SD0025	SD-45	07/24/97	5	10	14.0	7.9	29.5	8.0		
SD0040	SD-47	07/24/97	1	0	14.9	8.0	30.0	7.8	2.2	0.01 *U*
SD0040	SD-47	07/24/97	1	1	15.4	8.1	27.0	7.8		
SD0040	SD-47	07/24/97	1	2	15.4	8.0	28.0	7.9		
SD0040	SD-47	07/24/97	1	3	15.0	8.0	28.0	8.0		
SD0040	SD-47	07/24/97	1	4	15.6	8.0	29.0	8.0		
SD0040	SD-47	07/24/97	1	5	15.4	8.2	29.5	8.0		
SD0040	SD-47	07/24/97	1	6	15.5	7.9	29.5	8.0		
SD0040	SD-47	07/24/97	1	7	15.0	8.1	30.0	8.0		
SD0040	SD-47	07/24/97	1	8	14.9	8.2	28.5	8.0		
SD0040	SD-47	07/24/97	1	9	14.4	8.2	28.0	8.0		
SD0040	SD-47	07/24/97	1	10	14.7	8.1	29.5	8.1	3.8	0.01 *U*
SD0040	SD-47	07/24/97	2	0	14.6	8.0	30.0	7.8		
SD0040	SD-47	07/24/97	2	10	14.1	8.0	28.0	8.1		
SD0040	SD-47	07/24/97	3	0	15.7	7.6	30.0	7.8		
SD0040	SD-47	07/24/97	3	10	15.3	8.1	27.5	8.0		
SD0040	SD-47	07/24/97	4	0	15.0	8.3	29.0	8.0		
SD0040	SD-47	07/24/97	4	10	14.9	8.2	29.5	8.0		
SD0040	SD-47	07/24/97	5	0	14.8	8.2	30.0	7.9		
SD0040	SD-47	07/24/97	5	10	14.5	8.2	29.0	8.0		
SD0026	SD-48	07/24/97	1	0	15.3	7.6	30.0	7.7	4.0	0.01 *U*
SD0026	SD-48	07/24/97	1	1	15.8	7.8	29.0	7.7		
SD0026	SD-48	07/24/97	1	2	15.5	8.0	29.0	7.9		
SD0026	SD-48	07/24/97	1	3	15.4	8.2	28.0	7.8		
SD0026	SD-48	07/24/97	1	4	15.1	7.8	29.0	7.9		
SD0026	SD-48	07/24/97	1	5	15.1	8.2	29.5	7.9		
SD0026	SD-48	07/24/97	1	6	15.2	7.8	30.0	7.9		
SD0026	SD-48	07/24/97	1	7	14.6	8.0	30.0	8.0		
SD0026	SD-48	07/24/97	1	8	14.7	8.1	29.5	7.9		
SD0026	SD-48	07/24/97	1	9	14.4	8.2	29.0	8.0		
SD0026	SD-48	07/24/97	1	10	14.6	8.0	29.0	8.1	7.5	0.01 *U*
SD0026	SD-48	07/24/97	2	0	14.5	8.0	30.0	7.8		
SD0026	SD-48	07/24/97	2	10	14.1	8.2	29.5	8.1		
SD0026	SD-48	07/24/97	3	0	15.6	5.2	30.0	7.7		
SD0026	SD-48	07/24/97	3	10	15.4	8.2	29.5	8.2		
SD0026	SD-48	07/24/97	4	0	15.5	8.1	30.0	7.9		
SD0026	SD-48	07/24/97	4	10	14.5	8.2	29.0	8.2		

TABLE A3-5. (cont.)

Sample Number	Station	Collection Date	Replicate	Day	Temperature (deg C)	Dissolved Oxygen (mg/L)	Salinity (ppt)	pH	Ammonia as Nitrogen (mg/L)	Sulfide (mg/L)
SD0026	SD-48	07/24/97	5	0	14.3	8.3	30.0	8.0		
SD0026	SD-48	07/24/97	5	10	13.9	8.3	29.5	8.2		

[a] Due to laboratory technician error, the overlying water in these test chambers was siphoned off prior to collection of the water quality measurements.

TABLE A3-6. SUMMARY OF WATER QUALITY PARAMETERS FROM THE *Dendraster excentricus* TOXICITY TEST CONDUCTED IN 1997

Sample Number	Station	Collection Date	Day	Temperature (deg C)	Dissolved Oxygen (mg/L)	Salinity (ppt)	pH	Ammonia as Nitrogen (mg/L)	Sulfide (mg/L)
SW Cont	SD-E		0	15.9	8.2	30.5	7.8	0.2 *U*	0.01 *U*
SW Cont	SD-E		1	15.6	8.1	31.0	7.9		
SW Cont	SD-E		2	15.5	8.0	31.0	7.9		
SW Cont	SD-E		3	15.5	8.3	31.0	8.0	0.2 *U*	0.01 *U*
SD0011	SD-2	07/24/97	0	16.0	8.2	30.5	7.8	0.2 *U*	0.01 *U*
SD0011	SD-2	07/24/97	1	15.5	8.1	30.5	8.0		
SD0011	SD-2	07/24/97	2	15.6	8.0	31.0	7.9		
SD0011	SD-2	07/24/97	3	15.3	8.1	31.5	7.9	0.2 *U*	0.01 *U*
SD0012	SD-3	07/24/97	0	16.2	7.2	30.5	7.6	0.2 *U*	0.01 *U*
SD0012	SD-3	07/24/97	1	15.6	8.0	31.0	7.9		
SD0012	SD-3	07/24/97	2	15.4	8.0	31.0	7.8		
SD0012	SD-3	07/24/97	3	15.6	8.2	32.0	7.9	0.2 *U*	0.01 *U*
SD0013	SD-4	07/24/97	0	16.1	8.1	30.5	7.8	0.2	0.01 *U*
SD0013	SD-4	07/24/97	1	15.7	8.0	31.0	8.0		
SD0013	SD-4	07/24/97	2	15.5	8.0	31.0	7.9		
SD0013	SD-4	07/24/97	3	15.3	8.2	31.0	7.9	0.2	0.01 *U*
SD0014R	SD-5	07/24/97	0	16.1	8.0	31.0	7.7	0.2 *U*	0.01 *U*
SD0014R	SD-5	07/24/97	1	15.4	8.2	31.0	8.0		
SD0014R	SD-5	07/24/97	2	15.6	8.0	31.0	7.9		
SD0014R	SD-5	07/24/97	3	15.3	8.3	31.0	8.0	0.2 *U*	0.01 *U*
SD0030	SD-7	07/24/97	0	15.9	8.2	31.0	7.7	0.2 *U*	0.01 *U*
SD0030	SD-7	07/24/97	1	15.5	8.2	31.0	7.9		
SD0030	SD-7	07/24/97	2	15.2	8.0	31.0	7.9		
SD0030	SD-7	07/24/97	3	15.4	8.2	32.0	7.9	0.2 *U*	0.01 *U*
SD0008	SD-11	07/24/97	0	15.8	8.2	31.0	7.6	0.2 *U*	0.01 *U*
SD0008	SD-11	07/24/97	1	15.6	8.1	31.0	7.9		
SD0008	SD-11	07/24/97	2	15.5	8.0	31.0	7.9		
SD0008	SD-11	07/24/97	3	15.4	8.2	31.0	7.9	0.2 *U*	0.01 *U*
SD0039	SD-12	08/01/97	0	16.0	8.2	30.5	7.7	0.3	0.01 *U*
SD0039	SD-12	08/01/97	1	15.5	8.1	31.0	8.0	0.4	0.01 *U*
SD0039	SD-12	08/01/97	2	15.4	8.0	31.0	7.9		
SD0039	SD-12	08/01/97	3	15.3	8.1	31.0	7.9		
SD0037	SD-13	08/01/97	0	16.1	8.2	30.5	7.8		
SD0037	SD-13	08/01/97	1	15.6	8.0	31.0	8.0		
SD0037	SD-13	08/01/97	2	15.6	7.9	31.0	7.9	0.2	0.01 *U*
SD0037	SD-13	08/01/97	3	15.4	8.2	32.0	7.9	0.5	0.01 *U*
SD0029	SD-16	07/29/97	0	16.1	8.2	30.5	7.8	0.2 *U*	0.01 *U*
SD0029	SD-16	07/29/97	1	15.7	8.0	30.5	7.9		
SD0029	SD-16	07/29/97	2	15.7	8.0	31.0	7.8		
SD0029	SD-16	07/29/97	3	15.4	8.2	31.0	7.9	0.2 *U*	0.01 *U*
SD0031	SD-17	07/30/97	0	16.0	8.2	30.5	7.7	0.2 *U*	0.01 *U*
SD0031	SD-17	07/30/97	1	15.6	8.2	31.0	8.0		
SD0031	SD-17	07/30/97	2	15.7	8.0	30.5	8.0		
SD0031	SD-17	07/30/97	3	15.4	8.2	31.0	7.9	0.2 *U*	0.01 *U*
SD0007	SD-18	07/23/97	0	16.0	8.2	31.0	7.7	0.2 *U*	0.01 *U*
SD0007	SD-18	07/23/97	1	15.7	8.0	30.5	7.9		
SD0007	SD-18	07/23/97	2	15.6	7.9	30.5	7.9		

TABLE A3-6. (cont.)

Sample Number	Station	Collection Date	Day	Temperature (deg C)	Dissolved Oxygen (mg/L)	Salinity (ppt)	pH	Ammonia as Nitrogen (mg/L)	Sulfide (mg/L)
SD0007	SD-18	07/23/97	3	15.4	8.2	31.0	7.9	0.2 *U*	0.01 *U*
SD0024	SD-19	07/28/97	0	15.9	8.2	30.5	7.7	0.2 *U*	0.01 *U*
SD0024	SD-19	07/28/97	1	15.5	8.1	30.5	7.9		
SD0024	SD-19	07/28/97	2	15.3	8.0	30.5	7.8		
SD0024	SD-19	07/28/97	3	15.2	8.1	31.0	7.9	0.2 *U*	0.01 *U*
SD0001	SD-22	07/24/97	0	15.9	8.2	31.0	7.8	0.2 *U*	0.01 *U*
SD0001	SD-22	07/24/97	1	15.4	8.2	30.5	7.9		
SD0001	SD-22	07/24/97	2	15.5	8.0	30.5	7.8		
SD0001	SD-22	07/24/97	3	15.4	8.1	31.5	7.9	0.2 *U*	0.01 *U*
SD0002	SD-23	07/24/97	0	16.0	8.2	30.5	7.7	0.2 *U*	0.01 *U*
SD0002	SD-23	07/24/97	1	15.5	8.1	31.0	7.9		
SD0002	SD-23	07/24/97	2	15.4	8.1	31.0	7.9		
SD0002	SD-23	07/24/97	3	15.5	8.2	32.0	7.9	0.2 *U*	0.01 *U*
SD0009	SD-25	07/24/97	0	16.1	7.8	30.5	7.7	0.2	0.01 *U*
SD0009	SD-25	07/24/97	1	15.6	8.1	31.0	7.9		
SD0009	SD-25	07/24/97	2	15.5	8.0	31.0	7.8		
SD0009	SD-25	07/24/97	3	15.3	8.2	32.0	7.8	0.3	0.01 *U*
SD0005	SD-27	07/24/97	0	15.8	8.2	30.5	7.8	0.2 *U*	0.01 *U*
SD0005	SD-27	07/24/97	1	15.6	8.0	30.5	7.9		
SD0005	SD-27	07/24/97	2	15.4	8.0	31.0	7.9		
SD0005	SD-27	07/24/97	3	15.2	8.2	31.5	7.9	0.2 *U*	0.01 *U*
SD0006	SD-28	07/24/97	0	16.0	8.1	30.5	7.7	0.2 *U*	0.01 *U*
SD0006	SD-28	07/24/97	1	15.4	8.1	31.0	7.9		
SD0006	SD-28	07/24/97	2	15.4	7.9	31.0	7.9		
SD0006	SD-28	07/24/97	3	15.3	8.0	31.5	8.0	0.2 *U*	0.01 *U*
SD0022	SD-29	07/24/97	0	16.1	8.2	31.0	7.9	0.2 *U*	0.01 *U*
SD0022	SD-29	07/24/97	1	15.5	8.1	31.0	7.9		
SD0022	SD-29	07/24/97	2	15.6	8.0	31.0	7.9		
SD0022	SD-29	07/24/97	3	15.4	8.2	31.0	7.8	0.2 *U*	0.01 *U*
SD0023	SD-30	07/24/97	0	15.9	8.2	31.0	7.7	0.2 *U*	0.01 *U*
SD0023	SD-30	07/24/97	1	15.7	8.0	30.5	7.9		
SD0023	SD-30	07/24/97	2	15.5	8.0	31.0	7.9		
SD0023	SD-30	07/24/97	3	15.4	8.2	32.0	7.9	0.2 *U*	0.01 *U*
SD0015	SD-31	07/24/97	0	15.9	8.1	30.5	7.7	0.7	0.01 *U*
SD0015	SD-31	07/24/97	1	15.4	8.1	31.0	7.9		
SD0015	SD-31	07/24/97	2	15.3	7.8	31.0	7.9		
SD0015	SD-31	07/24/97	3	15.5	8.2	32.0	7.9	0.6	0.01 *U*
SD0016	SD-32	07/24/97	0	16.1	8.0	30.5	7.7	0.2 *U*	0.01 *U*
SD0016	SD-32	07/24/97	1	15.8	8.0	31.0	7.9		
SD0016	SD-32	07/24/97	2	15.8	8.0	31.0	7.9		
SD0016	SD-32	07/24/97	3	15.5	8.2	31.0	8.0	0.2 *U*	0.01 *U*
SD0017	SD-33	07/24/97	0	16.0	8.2	30.5	7.7	0.2 *U*	0.01 *U*
SD0017	SD-33	07/24/97	1	15.5	8.0	30.5	8.0		
SD0017	SD-33	07/24/97	2	15.5	8.0	30.5	7.8		
SD0017	SD-33	07/24/97	3	15.4	8.2	31.0	7.9	0.2 *U*	0.01 *U*
SD0033	SD-34	07/24/97	0	15.9	7.9	30.5	7.6	0.2 *U*	0.01 *U*
SD0033	SD-34	07/24/97	1	15.6	8.1	30.5	7.9		
SD0033	SD-34	07/24/97	2	15.5	8.0	31.0	7.9		

TABLE A3-6. (cont.)

Sample Number	Station	Collection Date	Day	Temperature (deg C)	Dissolved Oxygen (mg/L)	Salinity (ppt)	pH	Ammonia as Nitrogen (mg/L)	Sulfide (mg/L)
SD0033	SD-34	07/24/97	3	15.4	8.2	32.0	7.9	0.2 *U*	0.01 *U*
SD0034	SD-35	07/24/97	0	16.0	8.2	30.5	7.7	0.2 *U*	0.01 *U*
SD0034	SD-35	07/24/97	1	15.4	8.1	30.5	8.0		
SD0034	SD-35	07/24/97	2	15.4	8.2	31.0	7.8		
SD0034	SD-35	07/24/97	3	15.2	8.2	32.0	7.9	0.2 *U*	0.01 *U*
SD0018	SD-37	07/24/97	0	16.1	8.1	30.5	7.7	0.2 *U*	0.01 *U*
SD0018	SD-37	07/24/97	1	15.6	8.0	30.5	8.0		
SD0018	SD-37	07/24/97	2	15.6	8.0	31.0	7.9		
SD0018	SD-37	07/24/97	3	15.4	8.2	31.0	7.9	0.2 *U*	0.01 *U*
SD0010	SD-38	07/24/97	0	16.2	8.1	30.5	7.7	0.5	0.01 *U*
SD0010	SD-38	07/24/97	1	15.5	8.1	31.0	8.0		
SD0010	SD-38	07/24/97	2	15.4	8.0	31.0	7.9		
SD0010	SD-38	07/24/97	3	15.2	8.2	31.0	7.9	0.4	0.01 *U*
SD0020	SD-39	07/24/97	0	15.8	8.2	30.5	7.7	0.2 *U*	0.01 *U*
SD0020	SD-39	07/24/97	1	15.4	8.1	31.0	7.9		
SD0020	SD-39	07/24/97	2	15.2	8.0	31.0	7.8		
SD0020	SD-39	07/24/97	3	15.3	8.2	32.0	7.9	0.2 *U*	0.01 *U*
SD0021	SD-40	07/24/97	0	16.1	8.2	30.5	7.8	0.2 *U*	0.01 *U*
SD0021	SD-40	07/24/97	1	15.5	8.1	30.5	7.9		
SD0021	SD-40	07/24/97	2	15.6	8.0	31.0	7.9		
SD0021	SD-40	07/24/97	3	15.3	8.2	31.0	7.8	0.2 *U*	0.01 *U*
SD0032	SD-41	07/24/97	0	15.9	8.2	30.5	7.8	0.2 *U*	0.01 *U*
SD0032	SD-41	07/24/97	1	15.5	8.0	30.0	8.0		
SD0032	SD-41	07/24/97	2	15.4	8.0	30.5	7.9		
SD0032	SD-41	07/24/97	3	15.3	8.2	32.0	7.9	0.2 *U*	0.01 *U*
SD0028	SD-42	07/24/97	0	16.0	8.1	31.0	7.7	0.2 *U*	0.01 *U*
SD0028	SD-42	07/24/97	1	15.6	8.1	31.0	7.9		
SD0028	SD-42	07/24/97	2	15.7	8.0	30.5	7.9		
SD0028	SD-42	07/24/97	3	15.3	8.2	31.0	8.0	0.2 *U*	0.01 *U*
SD0027	SD-43	07/24/97	0	15.8	8.1	30.5	7.7	0.2 *U*	0.01 *U*
SD0027	SD-43	07/24/97	1	15.4	8.1	31.0	7.9		
SD0027	SD-43	07/24/97	2	15.3	8.0	30.5	7.8		
SD0027	SD-43	07/24/97	3	15.3	8.2	31.5	7.9	0.2 *U*	0.01 *U*
SD0035	SD-44	07/24/97	0	15.8	8.2	30.5	7.7	0.8	0.01 *U*
SD0035	SD-44	07/24/97	1	15.5	8.1	31.0	8.0		
SD0035	SD-44	07/24/97	2	15.3	8.0	31.0	7.9		
SD0035	SD-44	07/24/97	3	15.2	8.1	31.0	8.0	0.9	0.01 *U*
SD0025	SD-45	07/24/97	0	16.2	7.9	30.5	7.7	0.2 *U*	0.01 *U*
SD0025	SD-45	07/24/97	1	15.5	8.1	31.0	7.9		
SD0025	SD-45	07/24/97	2	15.6	8.1	31.0	7.9		
SD0025	SD-45	07/24/97	3	15.3	8.2	31.5	7.9	0.2 *U*	0.01 *U*
SD0040	SD-47	07/24/97	0	15.8	8.2	30.5	7.8	0.2 *U*	0.01 *U*
SD0040	SD-47	07/24/97	1	15.5	8.1	30.5	7.9		
SD0040	SD-47	07/24/97	2	15.4	8.0	31.0	7.8		
SD0040	SD-47	07/24/97	3	15.5	8.2	32.0	8.0	0.2 *U*	0.01 *U*
SD0026	SD-48	07/24/97	0	15.9	8.1	30.5	7.8	0.2 *U*	0.01 *U*
SD0026	SD-48	07/24/97	1	15.6	8.1	31.0	8.0		
SD0026	SD-48	07/24/97	2	15.5	8.0	30.5	7.9		
SD0026	SD-48	07/24/97	3	15.4	8.1	32.0	8.0	0.4	0.01 *U*

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TABLE A3-7. SUMMARY OF WATER QUALITY PARAMETERS FROM THE *Rhepoxynius abronius* SPECIALIZED TOXICITY TEST WITH PRELIMINARY SEDIMENT PURGING CONDUCTED IN 1997

Test	Sample Number	Station	Collection Date	Replicate	Day	Temperature (°C)	Dissolved Oxygen (mg/L)	Salinity (ppt)	pH	Ammonia as Nitrogen (mg/L)	Sulfide (mg/L)
Purging Period											
	Control		8/13/97	5	1	16.8	7.8	28.0	8.1		
	Control		8/14/97	5	2	15.9	8.4	27.5	8.0		
	Control		8/15/97	5	3	15.9	8.2	27.5	8.0		
	Control		8/16/97	5	4	15.3	8.2	27.0	8.0		
	Control		8/17/97	5	5	15.6	8.1	28.0	8.0		
	Control		8/18/97	5	6	15.4	8.1	28.0	8.1		
	Control		8/19/97	5	7	14.9	8.1	28.0	8.0		
	Control		8/20/97	5	8	14.8	8.2	28.0	8.1		
	Control		8/21/97	5	9	14.0	8.3	28.0	7.9		
	SD0030	SD-7	8/13/97	5	1	16.1	8.0	28.0	8.0		
	SD0030	SD-7	8/14/97	5	2	15.3	8.4	28.0	7.9		
	SD0030	SD-7	8/15/97	5	3	15.1	8.2	27.5	7.9		
	SD0030	SD-7	8/16/97	5	4	14.7	8.2	28.0	7.9		
	SD0030	SD-7	8/17/97	5	5	15.6	8.2	27.0	7.9		
	SD0030	SD-7	8/18/97	5	6	15.2	8.2	27.5	7.9		
	SD0030	SD-7	8/19/97	5	7	14.7	8.3	28.0	7.8		
	SD0030	SD-7	8/20/97	5	8	14.8	8.1	28.0	7.9		
	SD0030	SD-7	8/21/97	5	9	14.0	8.2	28.0	7.9		
	SD0039	SD-12	8/13/97	5	1	16.1	7.9	28.0	8.2		
	SD0039	SD-12	8/14/97	5	2	15.1	8.5	27.5	8.0		
	SD0039	SD-12	8/15/97	5	3	15.1	8.2	27.5	8.0		
	SD0039	SD-12	8/16/97	5	4	14.6	8.3	28.0	8.0		
	SD0039	SD-12	8/17/97	5	5	15.1	8.2	28.0	8.0		
	SD0039	SD-12	8/18/97	5	6	15.1	8.3	28.0	8.0		
	SD0039	SD-12	8/19/97	5	7	14.9	8.3	28.0	7.9		
	SD0039	SD-12	8/20/97	5	8	14.4	8.3	28.0	8.0		
	SD0039	SD-12	8/21/97	5	9	14.0	8.3	28.0	7.9		
	SD0037	SD-13	8/13/97	5	1	17.0	7.8	28.0	8.0		
	SD0037	SD-13	8/14/97	5	2	16.2	8.5	27.5	7.9		
	SD0037	SD-13	8/15/97	5	3	16.0	8.0	27.5	7.8		
	SD0037	SD-13	8/16/97	5	4	15.4	8.2	27.0	7.9		
	SD0037	SD-13	8/17/97	5	5	15.7	8.1	28.0	8.0		
	SD0037	SD-13	8/18/97	5	6	14.9	8.1	28.0	8.0		
	SD0037	SD-13	8/19/97	5	7	14.7	8.1	28.0	7.9		
	SD0037	SD-13	8/20/97	5	8	14.8	8.2	28.0	8.0		
	SD0037	SD-13	8/21/97	5	9	14.4	8.3	28.0	8.0		
	SD0029	SD-16	8/13/97	5	1	16.1	8.0	28.0	8.1		
	SD0029	SD-16	8/14/97	5	2	15.4	8.5	27.5	8.0		
	SD0029	SD-16	8/15/97	5	3	15.3	8.3	27.5	8.0		
	SD0029	SD-16	8/16/97	5	4	14.9	8.3	27.0	8.0		
	SD0029	SD-16	8/17/97	5	5	15.2	8.2	28.0	8.0		
	SD0029	SD-16	8/18/97	5	6	15.1	8.0	28.0	8.0		
	SD0029	SD-16	8/19/97	5	7	14.7	8.2	28.0	7.9		
	SD0029	SD-16	8/20/97	5	8	14.5	8.2	28.0	8.0		
	SD0029	SD-16	8/21/97	5	9	14.1	8.3	28.0	7.9		
	SD0031	SD-17	8/13/97	5	1	16.1	7.9	28.0	8.1		
	SD0031	SD-17	8/14/97	5	2	15.1	8.4	28.0	8.0		
	SD0031	SD-17	8/15/97	5	3	15.1	8.1	27.5	7.9		
	SD0031	SD-17	8/16/97	5	4	14.6	8.2	28.0	8.0		

TABLE A3-7. (cont.)

Test	Sample Number	Station	Collection Date	Replicate	Day	Temperature (°C)	Dissolved Oxygen (mg/L)	Salinity (ppt)	pH	Ammonia as Nitrogen (mg/L)	Sulfide (mg/L)
	SD0031	SD-17	8/17/97	5	5	15.4	8.2	28.0	7.9		
	SD0031	SD-17	8/18/97	5	6	14.8	8.3	28.0	8.0		
	SD0031	SD-17	8/19/97	5	7	14.8	8.3	28.0	7.9		
	SD0031	SD-17	8/20/97	5	8	14.2	8.2	28.0	8.0		
	SD0031	SD-17	8/21/97	5	9	14.1	8.2	28.0	8.0		
	SD0033	SD-34	8/13/97	5	1	16.1	7.8	27.0	8.1		
	SD0033	SD-34	8/14/97	5	2	15.7	8.4	27.5	7.9		
	SD0033	SD-34	8/15/97	5	3	15.6	8.2	27.5	8.0		
	SD0033	SD-34	8/16/97	5	4	15.1	8.1	27.0	7.9		
	SD0033	SD-34	8/17/97	5	5	15.4	8.3	28.0	8.0		
	SD0033	SD-34	8/18/97	5	6	15.3	8.1	27.5	8.0		
	SD0033	SD-34	8/19/97	5	7	14.8	8.1	28.0	7.9		
	SD0033	SD-34	8/20/97	5	8	14.5	8.1	28.0	8.0		
	SD0033	SD-34	8/21/97	5	9	14.0	8.2	28.0	7.9		
	SD0034	SD-35	8/13/97	5	1	16.5	7.9	27.0	8.1		
	SD0034	SD-35	8/14/97	5	2	15.9	8.4	27.5	7.9		
	SD0034	SD-35	8/15/97	5	3	15.8	8.2	27.5	8.0		
	SD0034	SD-35	8/16/97	5	4	15.1	8.2	27.0	7.9		
	SD0034	SD-35	8/17/97	5	5	15.6	8.2	28.0	8.0		
	SD0034	SD-35	8/18/97	5	6	15.3	8.0	27.5	8.0		
	SD0034	SD-35	8/19/97	5	7	14.9	8.2	28.0	7.9		
	SD0034	SD-35	8/20/97	5	8	14.8	8.3	28.0	8.0		
	SD0034	SD-35	8/21/97	5	9	14.0	8.3	28.0	8.1		
	SD0035	SD-44	8/13/97	5	1	16.1	7.9	28.0	8.2		
	SD0035	SD-44	8/14/97	5	2	15.5	8.5	27.5	7.9		
	SD0035	SD-44	8/15/97	5	3	15.4	8.2	27.5	8.0		
	SD0035	SD-44	8/16/97	5	4	14.9	8.2	27.0	7.9		
	SD0035	SD-44	8/17/97	5	5	15.3	8.1	28.0	8.0		
	SD0035	SD-44	8/18/97	5	6	15.2	8.2	27.5	8.1		
	SD0035	SD-44	8/19/97	5	7	14.7	8.1	28.0	7.9		
	SD0035	SD-44	8/20/97	5	8	14.5	8.2	28.0	8.0		
	SD0035	SD-44	8/21/97	5	9	14.0	8.2	28.0	7.9		
Testing Period											
	Control		8/22/97	1	0	13.7	8.1	28.0	8.0		
	Control		8/22/97	2	0	13.0	8.1	27.5	7.9		
	Control		8/22/97	3	0	14.0	8.0	28.0	8.0		
	Control		8/22/97	4	0	14.1	8.1	28.0	7.9		
	Control		8/22/97	5	0	14.1	8.1	28.0	8.0	<0.2	<0.01
	Control		8/23/97	5	1	13.8	8.2	29.0	8.0		
	Control		8/24/97	5	2	14.9	7.9	28.5	8.0		
	Control		8/25/97	5	3	15.0	7.8	29.5	8.0		
	Control		8/26/97	5	4	15.9	8.2	29.0	7.9		
	Control		8/27/97	5	5	15.1	8.1	29.5	8.0		
	Control		8/28/97	5	6	15.2	8.0	29.5	8.1		
	Control		8/29/97	5	7	15.5	8.0	30.0	8.0		
	Control		8/30/97	5	8	14.9	7.9	28.0	8.0		
	Control		8/31/97	5	9	15.6	7.8	28.0	8.0		
	Control		9/1/97	1	10	15.7	8.1	29.0	8.1		
	Control		9/1/97	2	10	14.9	8.2	28.0	8.1		
	Control		9/1/97	3	10	15.8	8.1	28.0	8.2		
	Control		9/1/97	4	10	15.6	8.1	29.0	8.1		
	Control		9/1/97	5	10	15.6	8.2	28.0	8.2	<0.2	<0.01

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TABLE A3-7. (cont.)

Test	Sample Number	Station	Collection Date	Replicate	Day	Temperature (°C)	Dissolved Oxygen (mg/L)	Salinity (ppt)	pH	Ammonia as Nitrogen (mg/L)	Sulfide (mg/L)
	SD0030	SD-7	8/22/97	1	0	13.5	8.1	28.0	7.9		
	SD0030	SD-7	8/22/97	2	0	14.0	8.0	28.0	7.9		
	SD0030	SD-7	8/22/97	3	0	13.3	8.0	28.0	7.8		
	SD0030	SD-7	8/22/97	4	0	13.4	8.1	28.0	7.9		
	SD0030	SD-7	8/22/97	5	0	14.4	8.0	28.0	7.7	<0.2	<0.01
	SD0030	SD-7	8/23/97	5	1	13.3	8.0	29.0	7.9		
	SD0030	SD-7	8/24/97	5	2	14.9	8.1	29.0	7.7		
	SD0030	SD-7	8/25/97	5	3	14.4	8.0	29.5	7.7		
	SD0030	SD-7	8/26/97	5	4	15.2	8.2	29.0	7.6		
	SD0030	SD-7	8/27/97	5	5	14.7	8.0	29.5	7.8		
	SD0030	SD-7	8/28/97	5	6	15.1	7.9	29.5	7.8		
	SD0030	SD-7	8/29/97	5	7	14.8	8.0	30.0	7.7		
	SD0030	SD-7	8/30/97	5	8	14.4	7.9	28.5	7.8		
	SD0030	SD-7	8/31/97	5	9	15.3	7.9	28.0	8.0		
	SD0030	SD-7	9/1/97	1	10	14.6	8.3	30.0	8.1		
	SD0030	SD-7	9/1/97	2	10	15.8	8.1	28.0	8.2		
	SD0030	SD-7	9/1/97	3	10	14.5	8.2	28.0	8.1		
	SD0030	SD-7	9/1/97	4	10	14.3	8.3	28.0	8.0		
	SD0030	SD-7	9/1/97	5	10	14.0	8.3	28.0	7.8	0.8	<0.01
	SD0039	SD-12	8/22/97	1	0	13.6	8.1	28.0	7.9		
	SD0039	SD-12	8/22/97	2	0	13.5	8.0	28.0	7.9		
	SD0039	SD-12	8/22/97	3	0	13.8	8.0	27.5	7.8		
	SD0039	SD-12	8/22/97	4	0	13.7	8.0	28.0	7.8		
	SD0039	SD-12	8/22/97	5	0	13.4	8.2	28.0	7.9	0.2	<0.01
	SD0039	SD-12	8/23/97	5	1	13.2	8.2	29.0	8.0		
	SD0039	SD-12	8/24/97	5	2	14.8	8.0	29.0	8.0		
	SD0039	SD-12	8/25/97	5	3	14.7	7.8	29.5	7.9		
	SD0039	SD-12	8/26/97	5	4	15.6	8.2	29.0	7.8		
	SD0039	SD-12	8/27/97	5	5	14.7	7.9	29.5	8.0		
	SD0039	SD-12	8/28/97	5	6	14.8	8.0	29.5	7.9		
	SD0039	SD-12	8/29/97	5	7	15.2	8.0	30.0	8.0		
	SD0039	SD-12	8/30/97	5	8	14.5	8.0	28.0	8.1		
	SD0039	SD-12	8/31/97	5	9	15.5	8.0	29.0	8.0		
	SD0039	SD-12	9/1/97	1	10	14.0	8.4	28.0	7.9		
	SD0039	SD-12	9/1/97	2	10	14.6	8.2	28.0	8.0		
	SD0039	SD-12	9/1/97	3	10	15.4	8.2	28.0	8.1		
	SD0039	SD-12	9/1/97	4	10	14.0	8.3	30.0	7.8		
	SD0039	SD-12	9/1/97	5	10	14.0	8.5	28.0	8.0	1.4	<0.01
	SD0037	SD-13	8/22/97	1	0	13.7	8.1	28.0	7.9		
	SD0037	SD-13	8/22/97	2	0	14.6	8.0	27.5	7.8		
	SD0037	SD-13	8/22/97	3	0	13.9	8.1	28.0	7.9		
	SD0037	SD-13	8/22/97	4	0	14.0	8.1	28.0	7.8		
	SD0037	SD-13	8/22/97	5	0	14.7	8.0	27.5	7.8	0.2	<0.01
	SD0037	SD-13	8/23/97	5	1	13.9	8.1	29.0	7.9		
	SD0037	SD-13	8/24/97	5	2	14.8	8.0	28.5	7.8		
	SD0037	SD-13	8/25/97	5	3	15.0	7.9	29.5	7.8		
	SD0037	SD-13	8/26/97	5	4	16.0	8.2	29.5	7.9		
	SD0037	SD-13	8/27/97	5	5	15.1	8.1	29.5	7.8		
	SD0037	SD-13	8/28/97	5	6	15.3	8.0	29.5	7.8		
	SD0037	SD-13	8/29/97	5	7	15.6	8.0	29.0	7.9		
	SD0037	SD-13	8/30/97	5	8	14.8	8.0	28.0	8.0		
	SD0037	SD-13	8/31/97	5	9	15.7	7.9	28.5	8.0		
	SD0037	SD-13	9/1/97	1	10	15.1	8.2	29.0	7.9		

TABLE A3-7. (cont.)

Test	Sample Number	Station	Collection Date	Replicate	Day	Temperature (°C)	Dissolved Oxygen (mg/L)	Salinity (ppt)	pH	Ammonia as Nitrogen (mg/L)	Sulfide (mg/L)
	SD0037	SD-13	9/1/97	2	10	15.7	8.1	28.0	8.2		
	SD0037	SD-13	9/1/97	3	10	15.7	8.2	29.0	8.0		
	SD0037	SD-13	9/1/97	4	10	14.0	8.4	29.0	7.9		
	SD0037	SD-13	9/1/97	5	10	15.7	8.1	28.0	8.0	2.0	<0.01
	SD0029	SD-16	8/22/97	1	0	13.7	8.0	28.0	7.9		
	SD0029	SD-16	8/22/97	2	0	13.6	8.0	28.0	7.9		
	SD0029	SD-16	8/22/97	3	0	13.8	8.2	28.0	7.9		
	SD0029	SD-16	8/22/97	4	0	14.0	8.1	28.0	7.9		
	SD0029	SD-16	8/22/97	5	0	13.1	8.2	27.5	7.8	<0.2	<0.01
	SD0029	SD-16	8/23/97	5	1	13.6	8.2	29.0	8.0		
	SD0029	SD-16	8/24/97	5	2	14.6	8.0	28.5	7.9		
	SD0029	SD-16	8/25/97	5	3	14.5	7.8	29.5	8.0		
	SD0029	SD-16	8/26/97	5	4	15.6	8.2	29.5	8.0		
	SD0029	SD-16	8/27/97	5	5	15.0	8.0	29.5	8.1		
	SD0029	SD-16	8/28/97	5	6	15.2	7.9	29.0	8.1		
	SD0029	SD-16	8/29/97	5	7	15.3	7.9	30.0	8.1		
	SD0029	SD-16	8/30/97	5	8	14.8	8.0	28.5	8.2		
	SD0029	SD-16	8/31/97	5	9	15.5	7.8	28.5	8.0		
	SD0029	SD-16	9/1/97	1	10	15.2	8.2	28.0	8.2		
	SD0029	SD-16	9/1/97	2	10	15.5	8.1	28.0	8.2		
	SD0029	SD-16	9/1/97	3	10	15.3	8.0	28.0	8.1		
	SD0029	SD-16	9/1/97	4	10	15.5	8.2	28.0	8.2		
	SD0029	SD-16	9/1/97	5	10	15.0	8.2	28.0	8.0	0.2	<0.01
	SD0031	SD-17	8/22/97	1	0	14.4	8.0	28.0	8.0		
	SD0031	SD-17	8/22/97	2	0	14.1	8.1	28.0	7.9		
	SD0031	SD-17	8/22/97	3	0	13.3	8.1	28.0	7.9		
	SD0031	SD-17	8/22/97	4	0	13.5	8.1	28.0	7.9		
	SD0031	SD-17	8/22/97	5	0	13.5	8.1	28.0	7.8	<0.2	<0.01
	SD0031	SD-17	8/23/97	5	1	13.3	8.1	29.0	7.9		
	SD0031	SD-17	8/24/97	5	2	14.8	8.1	29.0	7.8		
	SD0031	SD-17	8/25/97	5	3	14.2	7.9	29.5	7.8		
	SD0031	SD-17	8/26/97	5	4	15.0	8.2	29.5	7.7		
	SD0031	SD-17	8/27/97	5	5	14.7	8.0	29.5	7.8		
	SD0031	SD-17	8/28/97	5	6	14.9	8.0	29.5	7.8		
	SD0031	SD-17	8/29/97	5	7	14.9	8.0	30.0	7.9		
	SD0031	SD-17	8/30/97	5	8	14.6	8.0	28.0	7.9		
	SD0031	SD-17	8/31/97	5	9	15.4	8.0	28.0	8.0		
	SD0031	SD-17	9/1/97	1	10	15.8	8.2	28.0	8.2		
	SD0031	SD-17	9/1/97	2	10	15.7	8.2	28.0	8.2		
	SD0031	SD-17	9/1/97	3	10	14.6	8.2	28.0	8.1		
	SD0031	SD-17	9/1/97	4	10	15.3	8.1	28.0	7.9		
	SD0031	SD-17	9/1/97	5	10	14.0	8.4	28.0	8.0	0.5	<0.01
	SD0033	SD-34	8/22/97	1	0	13.3	8.1	28.0	7.8		
	SD0033	SD-34	8/22/97	2	0	13.2	8.1	28.0	7.8		
	SD0033	SD-34	8/22/97	3	0	14.6	8.1	28.0	7.7		
	SD0033	SD-34	8/22/97	4	0	13.6	8.0	28.0	7.9		
	SD0033	SD-34	8/22/97	5	0	13.8	8.1	28.0	7.8	<0.2	<0.01
	SD0033	SD-34	8/23/97	5	1	13.7	8.1	29.0	8.0		
	SD0033	SD-34	8/24/97	5	2	14.4	8.0	28.5	7.8		
	SD0033	SD-34	8/25/97	5	3	14.5	7.8	29.0	7.8		
	SD0033	SD-34	8/26/97	5	4	15.8	8.2	29.0	7.7		
	SD0033	SD-34	8/27/97	5	5	14.9	8.0	29.5	7.9		
	SD0033	SD-34	8/28/97	5	6	14.9	8.0	29.5	7.9		

TABLE A3-7. (cont.)

Test	Sample Number	Station	Collection Date	Replicate	Day	Temperature (°C)	Dissolved Oxygen (mg/L)	Salinity (ppt)	pH	Ammonia as Nitrogen (mg/L)	Sulfide (mg/L)
	SD0033	SD-34	8/29/97	5	7	15.3	8.0	30.0	7.9		
	SD0033	SD-34	8/30/97	5	8	14.8	7.7	28.0	8.0		
	SD0033	SD-34	8/31/97	5	9	15.6	7.9	28.0	8.0		
	SD0033	SD-34	9/1/97	1	10	14.1	8.4	28.0	8.0		
	SD0033	SD-34	9/1/97	2	10	14.6	8.2	28.0	8.1		
	SD0033	SD-34	9/1/97	3	10	14.2	8.4	28.0	7.8		
	SD0033	SD-34	9/1/97	4	10	15.6	8.2	29.0	8.0		
	SD0033	SD-34	9/1/97	5	10	15.1	8.2	28.0	8.1	1.1	<0.01
	SD0034	SD-35	8/22/97	1	0	14.1	8.2	28.0	7.9		
	SD0034	SD-35	8/22/97	2	0	14.1	8.0	28.0	7.9		
	SD0034	SD-35	8/22/97	3	0	13.3	8.0	28.0	7.9		
	SD0034	SD-35	8/22/97	4	0	14.0	8.0	28.0	7.9		
	SD0034	SD-35	8/22/97	5	0	13.5	8.0	28.0	7.9	<0.2	<0.01
	SD0034	SD-35	8/23/97	5	1	13.6	8.1	29.0	7.9		
	SD0034	SD-35	8/24/97	5	2	14.5	8.0	28.5	7.9		
	SD0034	SD-35	8/25/97	5	3	14.5	8.0	29.0	7.9		
	SD0034	SD-35	8/26/97	5	4	15.7	8.0	29.0	7.8		
	SD0034	SD-35	8/27/97	5	5	15.0	8.0	29.5	7.9		
	SD0034	SD-35	8/28/97	5	6	14.9	8.0	29.5	8.0		
	SD0034	SD-35	8/29/97	5	7	15.4	8.0	30.0	7.9		
	SD0034	SD-35	8/30/97	5	8	14.9	8.0	28.5	7.9		
	SD0034	SD-35	8/31/97	5	9	15.5	8.0	28.0	8.0		
	SD0034	SD-35	9/1/97	1	10	15.6	8.2	29.0	8.1		
	SD0034	SD-35	9/1/97	2	10	15.7	8.0	28.0	8.2		
	SD0034	SD-35	9/1/97	3	10	14.3	8.3	28.0	8.0		
	SD0034	SD-35	9/1/97	4	10	15.7	8.1	28.0	8.1		
	SD0034	SD-35	9/1/97	5	10	15.3	8.2	29.0	8.1	0.2	<0.01
	SD0035	SD-44	8/22/97	1	0	13.5	8.1	28.0	7.9		
	SD0035	SD-44	8/22/97	2	0	13.8	8.0	28.0	7.8		
	SD0035	SD-44	8/22/97	3	0	14.0	8.0	28.0	7.9		
	SD0035	SD-44	8/22/97	4	0	14.3	8.0	28.0	7.9		
	SD0035	SD-44	8/22/97	5	0	13.7	8.0	28.0	7.9	0.4	<0.01
	SD0035	SD-44	8/23/97	5	1	13.7	8.1	29.0	8.0		
	SD0035	SD-44	8/24/97	5	2	14.4	8.0	28.5	7.9		
	SD0035	SD-44	8/25/97	5	3	14.6	7.9	29.0	7.9		
	SD0035	SD-44	8/26/97	5	4	15.9	8.2	29.0	7.7		
	SD0035	SD-44	8/27/97	5	5	14.8	8.0	29.5	7.9		
	SD0035	SD-44	8/28/97	5	6	15.0	8.0	29.0	8.0		
	SD0035	SD-44	8/29/97	5	7	15.4	8.0	30.0	7.9		
	SD0035	SD-44	8/30/97	5	8	14.8	8.0	28.5	8.0		
	SD0035	SD-44	8/31/97	5	9	15.5	7.9	28.5	8.0		
	SD0035	SD-44	9/1/97	1	10	15.3	8.1	28.0	7.9		
	SD0035	SD-44	9/1/97	2	10	14.0	8.4	28.0	7.9		
	SD0035	SD-44	9/1/97	3	10	15.7	8.2	29.0	8.0		
	SD0035	SD-44	9/1/97	4	10	15.7	8.2	28.0	8.0		
	SD0035	SD-44	9/1/97	5	10	15.1	8.2	28.0	8.0	>2.5	<0.01

TABLE A3-8. SUMMARY OF WATER QUALITY PARAMETERS FROM THE *Rhepoxynius abronius* SPECIALIZED TOXICITY TEST WITH *ULVA* TREATMENTS CONDUCTED IN 1997

Test	Sample Number	Station	Collection Date	Replicate	Day	Temperature (°C)	Dissolved Oxygen (mg/L)	Salinity (ppt)	pH	Ammonia as Nitrogen (mg/L)	Sulfide (mg/L)
With *Ulva* Treatment											
	SD0030	SD-7	8/27/97	5	0	15.1	8.0	30.0	7.9	<0.5	<2.5
	SD0030	SD-7	8/28/97	5	1	15.2	7.8	30.0	8.0		
	SD0030	SD-7	8/29/97	5	2	15.2	7.9	31.0	7.9	<0.5	<0.5
	SD0039	SD-12	8/27/97	5	0	15.3	7.9	30.0	8.2	0.5	<2.5
	SD0039	SD-12	8/28/97	5	1	15.0	8.0	30.0	8.2		
	SD0039	SD-12	8/29/97	5	2	15.0	8.0	31.0	8.1	2	<0.5
	SD0037	SD-13	8/27/97	5	0	15.4	8.0	30.0	8.1	0.5	<2.5
	SD0037	SD-13	8/28/97	5	1	15.5	7.7	30.0	8.2		
	SD0037	SD-13	8/29/97	5	2	15.2	8.0	31.0	8.2	<0.5	<0.5
	SD0029	SD-16	8/27/97	5	0	14.8	8.1	29.0	7.7	<0.5	<2.5
	SD0029	SD-16	8/28/97	5	1	15.3	7.7	30.0	7.8		
	SD0029	SD-16	8/29/97	5	2	15.4	7.9	31.0	7.9	<0.5	<0.5
	SD0031	SD-17	8/27/97	5	0	15.6	8.0	30.0	8.0	0.5	<2.5
	SD0031	SD-17	8/28/97	5	1	15.1	8.0	30.0	8.1		
	SD0031	SD-17	8/29/97	5	2	15.1	7.9	31.0	8.0	<0.5	<0.5
	SD0033	SD-34	8/27/97	5	0	15.7	8.0	30.0	8.1	<0.5	<2.5
	SD0033	SD-34	8/28/97	5	1	15.3	7.8	30.0	8.2		
	SD0033	SD-34	8/29/97	5	2	15.2	8.0	31.0	8.1	<0.5	<0.5
	SD0034	SD-35	8/27/97	5	0	15.6	7.9	30.0	8.1	0.5	<2.5
	SD0034	SD-35	8/28/97	5	1	15.2	7.9	30.0	8.1		
	SD0034	SD-35	8/29/97	5	2	14.9	8.0	31.0	8.0	0.5	<0.5
	SD0035	SD-44	8/27/97	5	0	15.2	8.1	30.0	8.3	0.5	<2.5
	SD0035	SD-44	8/28/97	5	1	15.1	8.0	30.0	8.3		
	SD0035	SD-44	8/29/97	5	2	14.9	8.0	31.0	8.3	0.5	<0.5
Without *Ulva* Treatment											
	Control		8/27/97	5	0	15.7	8.2	30.0	7.9		
	Control		8/28/97	5	1	15.5	8.2	30.0	8.1		
	Control		8/29/97	5	2	15.2	8.2	31.0	8.1		
	SD0030	SD-7	8/27/97	5	0	15.0	8.0	30.0	8.0	3	<2.5
	SD0030	SD-7	8/28/97	5	1	15.0	7.8	30.0	8.0		
	SD0030	SD-7	8/29/97	5	2	15.3	7.9	31.0	7.9	3	<0.5
	SD0039	SD-12	8/27/97	5	0	15.4	7.8	30.0	8.2	9.5	1.9
	SD0039	SD-12	8/28/97	5	1	15.0	7.8	30.0	8.1		
	SD0039	SD-12	8/29/97	5	2	15.2	8.0	31.0	8.2	10	<0.5
	SD0037	SD-13	8/27/97	5	0	15.2	8.1	30.0	8.2	7.5	3.1
	SD0037	SD-13	8/28/97	5	1	15.3	7.9	30.0	8.2		
	SD0037	SD-13	8/29/97	5	2	15.1	8.1	31.0	8.2	8	<0.5
	SD0029	SD-16	8/27/97	5	0	14.4	8.0	30.0	7.9	2	<2.5
	SD0029	SD-16	8/28/97	5	1	15.3	7.8	30.0	7.9		
	SD0029	SD-16	8/29/97	5	2	15.4	8.0	31.0	7.9	1.5	<0.5
	SD0031	SD-17	8/27/97	5	0	15.5	8.0	30.0	8.0	4	<2.5
	SD0031	SD-17	8/28/97	5	1	14.9	7.9	30.0	8.1		
	SD0031	SD-17	8/29/97	5	2	15.1	8.0	31.0	8.0	3	<0.5
	SD0033	SD-34	8/27/97	5	0	15.7	8.1	30.0	8.1	4	<2.5
	SD0033	SD-34	8/28/97	5	1	15.0	8.0	30.0	8.1		
	SD0033	SD-34	8/29/97	5	2	15.1	8.1	31.0	8.0	3	<0.5
	SD0034	SD-35	8/27/97	5	0	15.6	8.0	30.5	8.2	2.5	<0.6
	SD0034	SD-35	8/28/97	5	1	15.0	8.0	30.5	8.1		
	SD0034	SD-35	8/29/97	5	2	15.0	8.0	31.0	8.0	2.5	<0.5
	SD0035	SD-44	8/27/97	5	0	14.9	7.9	30.0	8.4	12	5.3
	SD0035	SD-44	8/28/97	5	1	14.9	8.0	30.0	8.3		
	SD0035	SD-44	8/29/97	5	2	15.0	8.1	31.0	8.2	12	<0.5

TABLE A3-9. SUMMARY OF WATER QUALITY PARAMETERS FROM THE *Rhepoxynius abronius* SPECIALIZED TOXICITY TEST WITH PORE WATER CONDUCTED IN 1997

Test	Sample Number	Station	Collection Date	Replicate	Day	Concentration (percent)	Temperature (°C)	Dissolved Oxygen (mg/L)	Salinity (ppt)	pH	Ammonia as Nitrogen (mg/L)	Sulfide (mg/L)
With Aeration												
	SD0030	SD-7	8/21/97	2	0	0	15.8	7.6	30.0	8.1		
	SD0030	SD-7	8/21/97	2	0	5	15.8	7.6	30.0	8.3		
	SD0030	SD-7	8/21/97	2	0	10	15.9	7.6	30.0	8.4		
	SD0030	SD-7	8/21/97	2	0	20	15.9	7.6	30.5	8.5		
	SD0030	SD-7	8/21/97	2	0	50	15.9	7.6	30.5	8.7		
	SD0030	SD-7	8/21/97	2	0	100	15.8	7.6	30.5	8.8	17.5	5
	SD0030	SD-7	8/22/97	2	1	0	15.1	7.8	30.0	7.8		
	SD0030	SD-7	8/22/97	2	1	5	14.9	7.9	30.0	7.9		
	SD0030	SD-7	8/22/97	2	1	10	14.9	7.9	30.0	8.1		
	SD0030	SD-7	8/22/97	2	1	20	14.9	7.8	30.0	8.2		
	SD0030	SD-7	8/22/97	2	1	50	14.8	7.7	30.0	8.5		
	SD0030	SD-7	8/22/97	2	1	100	14.8	7.6	30.0	8.7		
	SD0030	SD-7	8/23/97	2	2	0	14.3	8.0	30.0	8.2		
	SD0030	SD-7	8/23/97	2	2	5	14.4	7.9	30.0	8.1		
	SD0030	SD-7	8/23/97	2	2	10	14.3	7.9	30.0	8.1		
	SD0030	SD-7	8/23/97	2	2	20	14.4	7.9	30.0	8.2		
	SD0030	SD-7	8/23/97	2	2	50	14.3	8.0	30.0	8.4		
	SD0030	SD-7	8/23/97	2	2	100	14.2	8.0	30.0	8.6		
	SD0039	SD-12	8/21/97	2	0	0	15.7	7.9	30.0	8.1		
	SD0039	SD-12	8/21/97	2	0	5	15.7	7.9	30.0	8.5		
	SD0039	SD-12	8/21/97	2	0	10	15.7	7.8	30.5	8.6		
	SD0039	SD-12	8/21/97	2	0	20	15.7	7.8	30.0	8.7		
	SD0039	SD-12	8/21/97	2	0	50	15.8	7.5	30.5	8.8		
	SD0039	SD-12	8/21/97	2	0	100	15.8	6.5	31.0	8.9	57.5	11.3
	SD0039	SD-12	8/22/97	2	1	0	14.8	8.0	30.0	8.0		
	SD0039	SD-12	8/22/97	2	1	5	14.7	8.0	30.0	8.1		
	SD0039	SD-12	8/22/97	2	1	10	14.8	8.0	30.0	8.3		
	SD0039	SD-12	8/22/97	2	1	20	14.8	8.0	30.0	8.5		
	SD0039	SD-12	8/22/97	2	1	50	14.8	8.0	30.5	8.7		
	SD0039	SD-12	8/22/97	2	1	100	14.8	7.9	30.5	8.9		
	SD0039	SD-12	8/23/97	2	2	0	14.4	8.0	30.0	8.1		
	SD0039	SD-12	8/23/97	2	2	5	14.4	8.0	30.0	8.2		
	SD0039	SD-12	8/23/97	2	2	10	14.3	8.0	30.0	8.3		
	SD0039	SD-12	8/23/97	2	2	20	14.3	8.0	30.5	8.4		
	SD0039	SD-12	8/23/97	2	2	50	14.3	8.0	30.5	8.6		
	SD0039	SD-12	8/23/97	2	2	100	14.3	8.0	31.0	8.7		
	SD0037	SD-13	8/21/97	2	0	0	15.7	7.8	30.0	8.1		
	SD0037	SD-13	8/21/97	2	0	5	15.8	7.8	30.0	8.5		
	SD0037	SD-13	8/21/97	2	0	10	15.8	7.8	30.5	8.7		
	SD0037	SD-13	8/21/97	2	0	20	15.7	7.8	30.5	8.8		
	SD0037	SD-13	8/21/97	2	0	50	15.6	7.8	30.5	8.9		
	SD0037	SD-13	8/21/97	2	0	100	15.6	7.7	31.5	9.0	42.5	7.5
	SD0037	SD-13	8/22/97	2	1	0	14.8	8.0	30.0	8.0		
	SD0037	SD-13	8/22/97	2	1	5	14.8	8.0	30.0	8.1		
	SD0037	SD-13	8/22/97	2	1	10	14.8	8.1	30.0	8.3		
	SD0037	SD-13	8/22/97	2	1	20	14.8	8.1	30.0	8.6		
	SD0037	SD-13	8/22/97	2	1	50	14.7	8.1	30.5	8.8		
	SD0037	SD-13	8/22/97	2	1	100	14.8	8.1	30.5	8.9		
	SD0037	SD-13	8/23/97	2	2	0	14.5	8.0	30.0	8.1		

TABLE A3-9. (cont.)

Test	Sample Number	Station	Collection Date	Replicate	Day	Concentration (percent)	Temperature (°C)	Dissolved Oxygen (mg/L)	Salinity (ppt)	pH	Ammonia as Nitrogen (mg/L)	Sulfide (mg/L)
	SD0037	SD-13	8/23/97	2	2	5	14.3	7.9	30.0	8.2		
	SD0037	SD-13	8/23/97	2	2	10	14.3	7.9	30.0	8.3		
	SD0037	SD-13	8/23/97	2	2	20	14.3	7.9	30.0	8.4		
	SD0037	SD-13	8/23/97	2	2	50	14.2	8.0	30.5	8.7		
	SD0037	SD-13	8/23/97	2	2	100	14.2	8.0	31.0	8.8		
	SD0029	SD-16	8/21/97	2	0	0	15.8	7.6	30.0	8.1		
	SD0029	SD-16	8/21/97	2	0	5	15.9	7.6	30.0	8.2		
	SD0029	SD-16	8/21/97	2	0	10	16.0	7.6	30.0	8.3		
	SD0029	SD-16	8/21/97	2	0	20	16.0	7.6	30.0	8.4		
	SD0029	SD-16	8/21/97	2	0	50	15.9	7.6	30.0	8.6		
	SD0029	SD-16	8/21/97	2	0	100	16.0	7.6	30.0	8.8	7.5	<2.5
	SD0029	SD-16	8/22/97	2	1	0	14.7	7.7	30.0	7.9		
	SD0029	SD-16	8/22/97	2	1	5	14.8	7.8	29.5	7.9		
	SD0029	SD-16	8/22/97	2	1	10	14.9	7.8	30.0	8.0		
	SD0029	SD-16	8/22/97	2	1	20	14.8	7.9	30.0	8.1		
	SD0029	SD-16	8/22/97	2	1	50	14.9	7.9	30.0	8.4		
	SD0029	SD-16	8/22/97	2	1	100	14.9	7.9	30.5	8.6		
	SD0029	SD-16	8/23/97	2	2	0	14.4	7.4	30.0	8.2		
	SD0029	SD-16	8/23/97	2	2	5	14.3	7.6	30.0	8.1		
	SD0029	SD-16	8/23/97	2	2	10	14.4	7.8	30.0	8.1		
	SD0029	SD-16	8/23/97	2	2	20	14.2	7.8	30.0	8.2		
	SD0029	SD-16	8/23/97	2	2	50	14.3	7.9	30.0	8.4		
	SD0029	SD-16	8/23/97	2	2	100	14.3	8.0	30.0	8.6		
	SD0031	SD-17	8/21/97	2	0	0	16.0	7.8	30.0	8.1		
	SD0031	SD-17	8/21/97	2	0	5	16.0	7.8	30.0	8.3		
	SD0031	SD-17	8/21/97	2	0	10	16.1	7.8	30.0	8.5		
	SD0031	SD-17	8/21/97	2	0	20	15.9	7.7	30.0	8.6		
	SD0031	SD-17	8/21/97	2	0	50	15.9	7.7	30.0	8.8		
	SD0031	SD-17	8/21/97	2	0	100	16.0	7.6	30.0	8.9	20	5
	SD0031	SD-17	8/22/97	2	1	0	15.0	8.0	30.0	8.2		
	SD0031	SD-17	8/22/97	2	1	5	15.0	8.0	29.5	8.0		
	SD0031	SD-17	8/22/97	2	1	10	14.9	7.9	29.5	8.2		
	SD0031	SD-17	8/22/97	2	1	20	14.8	8.0	30.0	8.3		
	SD0031	SD-17	8/22/97	2	1	50	14.8	8.0	30.0	8.6		
	SD0031	SD-17	8/22/97	2	1	100	14.7	8.0	30.5	8.8		
	SD0031	SD-17	8/23/97	2	2	0	14.3	8.0	30.0	8.2		
	SD0031	SD-17	8/23/97	2	2	5	14.3	8.0	30.0	8.1		
	SD0031	SD-17	8/23/97	2	2	10	14.3	8.0	30.0	8.2		
	SD0031	SD-17	8/23/97	2	2	20	14.3	8.0	30.0	8.3		
	SD0031	SD-17	8/23/97	2	2	50	14.3	8.0	30.0	8.5		
	SD0031	SD-17	8/23/97	2	2	100	14.2	8.1	30.0	8.7		
	SD0033	SD-34	8/21/97	2	0	0	16.0	7.7	30.0	8.1		
	SD0033	SD-34	8/21/97	2	0	5	16.0	7.8	30.0	8.4		
	SD0033	SD-34	8/21/97	2	0	10	15.9	7.7	30.0	8.6		
	SD0033	SD-34	8/21/97	2	0	20	15.9	7.7	30.0	8.8		
	SD0033	SD-34	8/21/97	2	0	50	15.8	7.7	30.0	8.9		
	SD0033	SD-34	8/21/97	2	0	100	15.9	7.6	29.5	9.0	22.5	6.3
	SD0033	SD-34	8/22/97	2	1	0	14.9	8.0	30.0	7.9		
	SD0033	SD-34	8/22/97	2	1	5	14.9	8.0	29.0	8.1		
	SD0033	SD-34	8/22/97	2	1	10	14.9	8.0	30.0	8.3		
	SD0033	SD-34	8/22/97	2	1	20	14.9	8.0	30.0	8.5		
	SD0033	SD-34	8/22/97	2	1	50	14.7	8.0	30.0	8.8		
	SD0033	SD-34	8/22/97	2	1	100	14.7	8.1	29.5	9.0		

TABLE A3-9. (cont.)

Test	Sample Number	Station	Collection Date	Replicate	Day	Concentration (percent)	Temperature (°C)	Dissolved Oxygen (mg/L)	Salinity (ppt)	pH	Ammonia as Nitrogen (mg/L)	Sulfide (mg/L)
	SD0033	SD-34	8/23/97	2	2	0	14.4	8.0	30.0	8.2		
	SD0033	SD-34	8/23/97	2	2	5	14.3	8.0	30.0	8.2		
	SD0033	SD-34	8/23/97	2	2	10	14.3	8.0	30.0	8.3		
	SD0033	SD-34	8/23/97	2	2	20	14.3	8.0	29.5	8.4		
	SD0033	SD-34	8/23/97	2	2	50	14.2	8.0	29.5	8.6		
	SD0033	SD-34	8/23/97	2	2	100	14.3	8.0	29.0	8.9		
	SD0034	SD-35	8/21/97	2	0	0	15.9	7.8	30.0	8.1		
	SD0034	SD-35	8/21/97	2	0	5	15.8	7.8	30.0	8.4		
	SD0034	SD-35	8/21/97	2	0	10	15.8	7.8	30.0	8.5		
	SD0034	SD-35	8/21/97	2	0	20	15.8	7.7	30.0	8.6		
	SD0034	SD-35	8/21/97	2	0	50	15.9	7.7	30.0	8.8		
	SD0034	SD-35	8/21/97	2	0	100	16.0	7.6	30.5	8.9	20	2.5
	SD0034	SD-35	8/22/97	2	1	0	15.0	8.1	30.0	7.9		
	SD0034	SD-35	8/22/97	2	1	5	14.9	8.0	30.0	8.0		
	SD0034	SD-35	8/22/97	2	1	10	14.9	8.0	30.0	8.1		
	SD0034	SD-35	8/22/97	2	1	20	14.8	8.0	30.0	8.4		
	SD0034	SD-35	8/22/97	2	1	50	14.8	8.0	30.0	8.7		
	SD0034	SD-35	8/22/97	2	1	100	14.7	8.0	30.5	8.8		
	SD0034	SD-35	8/23/97	2	2	0	14.1	7.9	30.0	8.1		
	SD0034	SD-35	8/23/97	2	2	5	14.3	7.9	30.0	8.1		
	SD0034	SD-35	8/23/97	2	2	10	14.3	7.9	30.0	8.2		
	SD0034	SD-35	8/23/97	2	2	20	14.3	8.0	30.0	8.3		
	SD0034	SD-35	8/23/97	2	2	50	14.3	8.0	30.0	8.5		
	SD0034	SD-35	8/23/97	2	2	100	14.4	8.0	30.5	8.7		
	SD0035	SD-44	8/21/97	2	0	0	15.9	7.8	30.0	8.1		
	SD0035	SD-44	8/21/97	2	0	5	15.8	7.8	30.5	8.5		
	SD0035	SD-44	8/21/97	2	0	10	15.9	7.8	30.5	8.6		
	SD0035	SD-44	8/21/97	2	0	20	15.9	7.8	30.5	8.7		
	SD0035	SD-44	8/21/97	2	0	50	15.8	7.7	31.0	8.8		
	SD0035	SD-44	8/21/97	2	0	100	15.8	7.6	32.0	8.8	60	11.3
	SD0035	SD-44	8/22/97	2	1	0	14.9	8.1	30.0	7.9		
	SD0035	SD-44	8/22/97	2	1	5	14.9	8.0	30.0	8.1		
	SD0035	SD-44	8/22/97	2	1	10	14.8	8.0	30.0	8.3		
	SD0035	SD-44	8/22/97	2	1	20	14.8	8.1	30.5	8.6		
	SD0035	SD-44	8/22/97	2	1	50	14.7	8.1	30.5	8.8		
	SD0035	SD-44	8/22/97	2	1	100	14.7	8.0	31.0	8.9		
	SD0035	SD-44	8/23/97	2	2	0	14.5	8.0	30.0	8.1		
	SD0035	SD-44	8/23/97	2	2	5	14.4	7.9	30.0	8.1		
	SD0035	SD-44	8/23/97	2	2	10	14.4	7.9	30.0	8.3		
	SD0035	SD-44	8/23/97	2	2	20	14.4	8.0	30.5	8.4		
	SD0035	SD-44	8/23/97	2	2	50	14.3	8.0	31.0	8.7		
	SD0035	SD-44	8/23/97	2	2	100	14.4	8.0	31.5	8.8		
With *Ulva* Treatment												
	SD0030	SD-7	8/21/97	2	0	0	15.9	7.4	30.0	7.5		
	SD0030	SD-7	8/21/97	2	0	5	15.9	7.4	29.5	7.6		
	SD0030	SD-7	8/21/97	2	0	10	15.9	7.4	30.0	7.8		
	SD0030	SD-7	8/21/97	2	0	20	16.0	7.4	30.0	7.8		
	SD0030	SD-7	8/21/97	2	0	50	16.0	6.8	30.0	8.1		
	SD0030	SD-7	8/21/97	2	0	100	16.1	5.8	29.5	8.2	3.3	23
	SD0030	SD-7	8/22/97	2	1	0	15.5	7.8	30.0	7.8		
	SD0030	SD-7	8/22/97	2	1	5	15.6	7.8	30.0	7.8		
	SD0030	SD-7	8/22/97	2	1	10	15.5	7.6	30.0	7.8		

TABLE A3-9. (cont.)

Test	Sample Number	Station	Collection Date	Replicate	Day	Concentration (percent)	Temperature (°C)	Dissolved Oxygen (mg/L)	Salinity (ppt)	pH	Ammonia as Nitrogen (mg/L)	Sulfide (mg/L)
	SD0030	SD-7	8/22/97	2	1	20	15.3	6.8	30.5	7.8		
	SD0030	SD-7	8/22/97	2	1	50	15.3	4.8	30.5	8.0		
	SD0030	SD-7	8/22/97	2	1	100	15.2	3.2	30.5	8.3		
	SD0030	SD-7	8/23/97	2	2	0	14.8	8.0	30.0	8.1		
	SD0030	SD-7	8/23/97	2	2	5	14.8	7.9	30.0	8.0		
	SD0030	SD-7	8/23/97	2	2	10	14.8	8.0	30.0	8.1		
	SD0030	SD-7	8/23/97	2	2	20	14.7	8.0	30.0	8.2		
	SD0030	SD-7	8/23/97	2	2	50	14.7	8.0	30.5	8.3		
	SD0030	SD-7	8/23/97	2	2	100	14.7	7.8	30.5	8.4		
	SD0039	SD-12	8/21/97	2	0	0	15.7	7.4	30.0	7.6		
	SD0039	SD-12	8/21/97	2	0	5	15.7	7.3	30.0	7.8		
	SD0039	SD-12	8/21/97	2	0	10	15.8	6.7	30.0	7.9		
	SD0039	SD-12	8/21/97	2	0	20	15.8	5.7	30.0	8.1		
	SD0039	SD-12	8/21/97	2	0	50	15.7	3.8	30.0	8.3		
	SD0039	SD-12	8/21/97	2	0	100	15.7	3.6	30.5	8.4	33.4	60
	SD0039	SD-12	8/22/97	2	1	0	15.7	7.8	30.0	7.8		
	SD0039	SD-12	8/22/97	2	1	5	15.6	7.8	30.0	7.9		
	SD0039	SD-12	8/22/97	2	1	10	15.6	7.3	30.0	8.1		
	SD0039	SD-12	8/22/97	2	1	20	15.5	6.8	30.5	8.3		
	SD0039	SD-12	8/22/97	2	1	50	15.4	6.8	30.5	8.5		
	SD0039	SD-12	8/22/97	2	1	100	15.4	7.2	31.0	8.7		
	SD0039	SD-12	8/23/97	2	2	0	14.8	7.4	30.0	8.1		
	SD0039	SD-12	8/23/97	2	2	5	14.9	7.3	30.0	8.3		
	SD0039	SD-12	8/23/97	2	2	10	14.8	7.6	30.0	8.3		
	SD0039	SD-12	8/23/97	2	2	20	14.8	7.3	30.5	8.3		
	SD0039	SD-12	8/23/97	2	2	50	14.8	6.8	30.5	8.5		
	SD0039	SD-12	8/23/97	2	2	100	14.7	5.2	31.0	8.7		
	SD0037	SD-13	8/21/97	2	0	0	15.9	7.2	30.0	7.5		
	SD0037	SD-13	8/21/97	2	0	5	15.8	7.2	30.0	7.8		
	SD0037	SD-13	8/21/97	2	0	10	15.8	7.0	30.5	8.0		
	SD0037	SD-13	8/21/97	2	0	20	15.8	6.2	30.0	8.1		
	SD0037	SD-13	8/21/97	2	0	50	15.7	4.2	30.5	8.2		
	SD0037	SD-13	8/21/97	2	0	100	15.7	3.5	31.0	8.3	26.7	65
	SD0037	SD-13	8/22/97	2	1	0	15.5	7.8	30.0	7.9		
	SD0037	SD-13	8/22/97	2	1	5	15.5	7.6	30.5	8.0		
	SD0037	SD-13	8/22/97	2	1	10	15.5	7.4	30.5	8.1		
	SD0037	SD-13	8/22/97	2	1	20	15.4	7.1	30.5	8.3		
	SD0037	SD-13	8/22/97	2	1	50	15.4	7.0	30.5	8.5		
	SD0037	SD-13	8/22/97	2	1	100	15.3	7.2	31.5	8.6		
	SD0037	SD-13	8/23/97	2	2	0	14.8	7.5	30.0	8.1		
	SD0037	SD-13	8/23/97	2	2	5	14.9	7.6	30.0	8.1		
	SD0037	SD-13	8/23/97	2	2	10	14.8	7.6	30.0	8.2		
	SD0037	SD-13	8/23/97	2	2	20	14.7	7.6	30.0	8.3		
	SD0037	SD-13	8/23/97	2	2	50	14.6	6.2	30.5	8.5		
	SD0037	SD-13	8/23/97	2	2	100	14.6	6.2	31.0	8.8		
	SD0029	SD-16	8/21/97	2	0	0	15.9	7.2	29.0	7.6		
	SD0029	SD-16	8/21/97	2	0	5	15.8	7.4	30.0	7.7		
	SD0029	SD-16	8/21/97	2	0	10	15.9	7.3	29.5	7.7		
	SD0029	SD-16	8/21/97	2	0	20	15.8	7.2	30.0	7.8		
	SD0029	SD-16	8/21/97	2	0	50	15.7	7.1	29.5	7.9		
	SD0029	SD-16	8/21/97	2	0	100	15.7	7.0	30.0	8.0	<1.7	<1.7
	SD0029	SD-16	8/22/97	2	1	0	15.0	7.2	30.0	7.8		
	SD0029	SD-16	8/22/97	2	1	5	15.3	7.4	30.0	7.9		

TABLE A3-9. (cont.)

Test	Sample Number	Station	Collection Date	Replicate	Day	Concentration (percent)	Temperature (°C)	Dissolved Oxygen (mg/L)	Salinity (ppt)	pH	Ammonia as Nitrogen (mg/L)	Sulfide (mg/L)
	SD0029	SD-16	8/22/97	2	1	10	15.3	7.4	30.0	7.9		
	SD0029	SD-16	8/22/97	2	1	20	15.3	7.6	30.5	8.1		
	SD0029	SD-16	8/22/97	2	1	50	15.2	7.7	30.5	8.2		
	SD0029	SD-16	8/22/97	2	1	100	15.2	7.7	30.5	8.3		
	SD0029	SD-16	8/23/97	2	2	0	14.5	8.1	30.0	8.1		
	SD0029	SD-16	8/23/97	2	2	5	14.7	8.0	30.0	8.1		
	SD0029	SD-16	8/23/97	2	2	10	14.7	8.0	30.0	8.1		
	SD0029	SD-16	8/23/97	2	2	20	14.7	8.0	30.5	8.2		
	SD0029	SD-16	8/23/97	2	2	50	14.7	8.0	30.5	8.3		
	SD0029	SD-16	8/23/97	2	2	100	14.7	8.0	30.5	8.5		
	SD0031	SD-17	8/21/97	2	0	0	16.0	7.5	29.5	7.6		
	SD0031	SD-17	8/21/97	2	0	5	15.9	7.4	29.5	7.7		
	SD0031	SD-17	8/21/97	2	0	10	16.0	7.4	29.5	7.8		
	SD0031	SD-17	8/21/97	2	0	20	16.0	7.2	29.5	7.9		
	SD0031	SD-17	8/21/97	2	0	50	16.1	7.2	30.0	8.1		
	SD0031	SD-17	8/21/97	2	0	100	16.0	6.7	30.0	8.2	1.7	15
	SD0031	SD-17	8/22/97	2	1	0	15.5	7.6	30.0	7.8		
	SD0031	SD-17	8/22/97	2	1	5	15.5	7.6	30.0	7.9		
	SD0031	SD-17	8/22/97	2	1	10	15.4	7.6	30.0	7.9		
	SD0031	SD-17	8/22/97	2	1	20	15.4	6.4	30.0	8.0		
	SD0031	SD-17	8/22/97	2	1	50	15.3	4.9	30.0	8.3		
	SD0031	SD-17	8/22/97	2	1	100	15.2	5.6	30.0	8.4		
	SD0031	SD-17	8/23/97	2	2	0	14.7	7.9	30.0	8.2		
	SD0031	SD-17	8/23/97	2	2	5	14.8	7.9	30.0	8.1		
	SD0031	SD-17	8/23/97	2	2	10	14.7	7.9	30.0	8.1		
	SD0031	SD-17	8/23/97	2	2	20	14.6	7.9	30.0	8.2		
	SD0031	SD-17	8/23/97	2	2	50	14.7	8.0	30.0	8.4		
	SD0031	SD-17	8/23/97	2	2	100	14.7	6.0	30.0	8.4		
	SD0033	SD-34	8/21/97	2	0	0	15.8	7.4	29.0	7.5		
	SD0033	SD-34	8/21/97	2	0	5	15.9	7.3	29.0	7.8		
	SD0033	SD-34	8/21/97	2	0	10	15.8	7.2	29.0	7.9		
	SD0033	SD-34	8/21/97	2	0	20	15.8	6.8	29.0	8.1		
	SD0033	SD-34	8/21/97	2	0	50	15.9	5.0	29.0	8.3		
	SD0033	SD-34	8/21/97	2	0	100	15.9	3.3	29.0	8.3	3.3	50
	SD0033	SD-34	8/22/97	2	1	0	15.5	7.5	30.0	7.9		
	SD0033	SD-34	8/22/97	2	1	5	15.5	7.5	30.0	7.9		
	SD0033	SD-34	8/22/97	2	1	10	15.5	6.8	30.0	8.0		
	SD0033	SD-34	8/22/97	2	1	20	15.4	6.8	30.0	8.2		
	SD0033	SD-34	8/22/97	2	1	50	15.3	5.4	30.0	8.4		
	SD0033	SD-34	8/22/97	2	1	100	15.2	5.2	29.5	8.6		
	SD0033	SD-34	8/23/97	2	2	0	14.7	7.5	30.0	8.1		
	SD0033	SD-34	8/23/97	2	2	5	14.9	7.6	30.0	8.1		
	SD0033	SD-34	8/23/97	2	2	10	14.8	7.8	30.0	8.1		
	SD0033	SD-34	8/23/97	2	2	20	14.7	7.8	30.0	8.3		
	SD0033	SD-34	8/23/97	2	2	50	14.7	7.0	29.5	8.4		
	SD0033	SD-34	8/23/97	2	2	100	14.7	5.7	29.0	8.6		
	SD0034	SD-35	8/21/97	2	0	0	15.8	7.2	30.0	7.5		
	SD0034	SD-35	8/21/97	2	0	5	15.8	7.4	30.0	7.7		
	SD0034	SD-35	8/21/97	2	0	10	15.8	7.3	30.0	7.8		
	SD0034	SD-35	8/21/97	2	0	20	15.7	7.2	30.0	7.9		
	SD0034	SD-35	8/21/97	2	0	50	15.7	6.4	30.0	8.1		
	SD0034	SD-35	8/21/97	2	0	100	15.7	4.6	30.0	8.2	6.7	30
	SD0034	SD-35	8/22/97	2	1	0	15.5	7.7	30.5	7.9		

TABLE A3-9. (cont.)

Test	Sample Number	Station	Collection Date	Replicate	Day	Concentration (percent)	Temperature (°C)	Dissolved Oxygen (mg/L)	Salinity (ppt)	pH	Ammonia as Nitrogen (mg/L)	Sulfide (mg/L)
	SD0034	SD-35	8/22/97	2	1	5	15.5	7.6	30.0	7.8		
	SD0034	SD-35	8/22/97	2	1	10	15.4	7.0	30.0	7.9		
	SD0034	SD-35	8/22/97	2	1	20	15.4	6.4	30.5	8.1		
	SD0034	SD-35	8/22/97	2	1	50	15.3	5.9	30.5	8.3		
	SD0034	SD-35	8/22/97	2	1	100	15.1	5.9	30.5	8.6		
	SD0034	SD-35	8/23/97	2	2	0	14.9	7.5	30.0	8.1		
	SD0034	SD-35	8/23/97	2	2	5	15.0	7.5	30.0	8.1		
	SD0034	SD-35	8/23/97	2	2	10	15.0	7.6	30.0	8.1		
	SD0034	SD-35	8/23/97	2	2	20	14.8	7.8	30.0	8.3		
	SD0034	SD-35	8/23/97	2	2	50	14.7	6.8	30.5	8.4		
	SD0034	SD-35	8/23/97	2	2	100	14.8	6.6	30.5	8.7		
	SD0035	SD-44	8/21/97	2	0	0	15.7	7.5	30.0	7.5		
	SD0035	SD-44	8/21/97	2	0	5	15.7	7.4	30.0	7.8		
	SD0035	SD-44	8/21/97	2	0	10	15.7	6.8	30.5	7.9		
	SD0035	SD-44	8/21/97	2	0	20	15.6	6.4	30.5	8.1		
	SD0035	SD-44	8/21/97	2	0	50	15.6	4.6	31.0	8.2		
	SD0035	SD-44	8/21/97	2	0	100	15.7	3.5	32.0	8.2	36.7	58
	SD0035	SD-44	8/22/97	2	1	0	15.4	7.6	30.0	7.8		
	SD0035	SD-44	8/22/97	2	1	5	15.4	7.6	30.0	8.0		
	SD0035	SD-44	8/22/97	2	1	10	15.4	7.2	30.5	8.1		
	SD0035	SD-44	8/22/97	2	1	20	15.3	7.2	30.5	8.3		
	SD0035	SD-44	8/22/97	2	1	50	15.3	7.2	30.5	8.5		
	SD0035	SD-44	8/22/97	2	1	100	15.2	7.3	31.0	8.6		
	SD0035	SD-44	8/23/97	2	2	0	14.9	7.7	30.0	8.1		
	SD0035	SD-44	8/23/97	2	2	5	14.9	7.7	30.0	8.2		
	SD0035	SD-44	8/23/97	2	2	10	14.8	7.8	30.0	8.3		
	SD0035	SD-44	8/23/97	2	2	20	14.8	7.8	30.5	8.4		
	SD0035	SD-44	8/23/97	2	2	50	14.7	7.6	31.0	8.7		
	SD0035	SD-44	8/23/97	2	2	100	14.7	7.1	31.0	8.8		
Without Treatment												
	SD0030	SD-7	8/21/97	2	0	0	14.7	7.8	30.0	7.9		
	SD0030	SD-7	8/21/97	2	0	5	15.0	7.8	30.0	7.9		
	SD0030	SD-7	8/21/97	2	0	10	15.1	7.7	30.5	7.9		
	SD0030	SD-7	8/21/97	2	0	20	15.1	7.5	30.5	7.9		
	SD0030	SD-7	8/21/97	2	0	50	15.0	5.7	30.5	7.9		
	SD0030	SD-7	8/21/97	2	0	100	15.0	4.0	31.0	7.9	17.5	65
	SD0030	SD-7	8/22/97	2	1	0	15.0	7.9	30.0	7.8		
	SD0030	SD-7	8/22/97	2	1	5	14.8	7.9	30.0	7.9		
	SD0030	SD-7	8/22/97	2	1	10	15.0	7.9	30.0	7.9		
	SD0030	SD-7	8/22/97	2	1	20	14.9	7.9	30.0	8.0		
	SD0030	SD-7	8/22/97	2	1	50	14.9	6.6	30.0	8.1		
	SD0030	SD-7	8/22/97	2	1	100	15.0	5.9	30.0	8.3		
	SD0030	SD-7	8/23/97	2	2	0	14.2	8.0	30.0	8.2		
	SD0030	SD-7	8/23/97	2	2	5	14.2	8.0	30.0	8.1		
	SD0030	SD-7	8/23/97	2	2	10	14.2	8.0	30.0	8.1		
	SD0030	SD-7	8/23/97	2	2	20	14.2	8.0	30.0	8.2		
	SD0030	SD-7	8/23/97	2	2	50	14.2	8.0	30.0	8.3		
	SD0030	SD-7	8/23/97	2	2	100	14.2	7.9	31.0	8.5		
	SD0039	SD-12	8/21/97	2	0	0	15.5	7.5	30.0	8.0		
	SD0039	SD-12	8/21/97	2	0	5	15.6	7.1	30.0	8.0		
	SD0039	SD-12	8/21/97	2	0	10	15.6	6.7	30.0	8.1		
	SD0039	SD-12	8/21/97	2	0	20	15.6	6.4	30.5	8.1		

TABLE A3-9. (cont.)

Test	Sample Number	Station	Collection Date	Replicate	Day	Concentration (percent)	Temperature (°C)	Dissolved Oxygen (mg/L)	Salinity (ppt)	pH	Ammonia as Nitrogen (mg/L)	Sulfide (mg/L)
	SD0039	SD-12	8/21/97	2	0	50	15.5	5.4	30.5	8.1		
	SD0039	SD-12	8/21/97	2	0	100	15.5	3.3	31.0	8.2	57.5	125
	SD0039	SD-12	8/22/97	2	1	0	15.0	8.0	30.0	7.9		
	SD0039	SD-12	8/22/97	2	1	5	15.0	8.0	30.0	8.0		
	SD0039	SD-12	8/22/97	2	1	10	15.0	8.0	30.0	8.1		
	SD0039	SD-12	8/22/97	2	1	20	14.9	7.8	30.0	8.3		
	SD0039	SD-12	8/22/97	2	1	50	14.9	7.2	30.0	8.4		
	SD0039	SD-12	8/22/97	2	1	100	14.8	6.9	30.5	8.6		
	SD0039	SD-12	8/23/97	2	2	0	14.2	7.7	30.0	8.2		
	SD0039	SD-12	8/23/97	2	2	5	14.4	7.5	30.0	8.2		
	SD0039	SD-12	8/23/97	2	2	10	14.3	7.8	30.0	8.2		
	SD0039	SD-12	8/23/97	2	2	20	14.3	7.8	30.0	8.4		
	SD0039	SD-12	8/23/97	2	2	50	14.3	7.8	30.5	8.5		
	SD0039	SD-12	8/23/97	2	2	100	14.3	4.0	31.0	8.7		
	SD0037	SD-13	8/21/97	2	0	0	15.7	7.4	30.0	8.0		
	SD0037	SD-13	8/21/97	2	0	5	15.8	7.4	30.5	8.0		
	SD0037	SD-13	8/21/97	2	0	10	15.9	6.6	30.5	8.1		
	SD0037	SD-13	8/21/97	2	0	20	15.8	5.6	30.5	8.1		
	SD0037	SD-13	8/21/97	2	0	50	15.8	5.2	30.5	8.2		
	SD0037	SD-13	8/21/97	2	0	100	15.8	3.9	31.0	8.3	47.5	125
	SD0037	SD-13	8/22/97	2	1	0	15.0	8.0	30.0	7.9		
	SD0037	SD-13	8/22/97	2	1	5	15.0	8.0	30.0	8.0		
	SD0037	SD-13	8/22/97	2	1	10	15.0	8.0	30.0	8.1		
	SD0037	SD-13	8/22/97	2	1	20	15.0	7.9	30.0	8.3		
	SD0037	SD-13	8/22/97	2	1	50	14.9	7.6	30.5	8.5		
	SD0037	SD-13	8/22/97	2	1	100	14.9	7.2	31.0	8.6		
	SD0037	SD-13	8/23/97	2	2	0	14.3	7.8	30.0	8.2		
	SD0037	SD-13	8/23/97	2	2	5	14.4	7.8	30.0	8.1		
	SD0037	SD-13	8/23/97	2	2	10	14.4	7.8	30.0	8.2		
	SD0037	SD-13	8/23/97	2	2	20	14.3	7.9	30.0	8.3		
	SD0037	SD-13	8/23/97	2	2	50	14.3	8.0	30.5	8.5		
	SD0037	SD-13	8/23/97	2	2	100	14.3	6.2	31.0	8.7		
	SD0029	SD-16	8/21/97	2	0	0	14.8	8.0	30.0	7.9		
	SD0029	SD-16	8/21/97	2	0	5	15.0	8.0	30.0	7.9		
	SD0029	SD-16	8/21/97	2	0	10	15.1	7.8	30.0	7.9		
	SD0029	SD-16	8/21/97	2	0	20	15.0	7.8	30.0	7.9		
	SD0029	SD-16	8/21/97	2	0	50	14.9	7.5	30.0	7.8		
	SD0029	SD-16	8/21/97	2	0	100	14.9	6.8	30.0	7.8	7.5	<10
	SD0029	SD-16	8/22/97	2	1	0	15.0	8.1	29.5	7.9		
	SD0029	SD-16	8/22/97	2	1	5	15.1	8.0	30.0	7.9		
	SD0029	SD-16	8/22/97	2	1	10	15.1	8.0	30.0	8.0		
	SD0029	SD-16	8/22/97	2	1	20	15.0	8.0	30.0	8.0		
	SD0029	SD-16	8/22/97	2	1	50	15.1	7.9	30.0	8.2		
	SD0029	SD-16	8/22/97	2	1	100	15.0	7.8	30.0	8.3		
	SD0029	SD-16	8/23/97	2	2	0	14.0	8.1	30.0	7.8		
	SD0029	SD-16	8/23/97	2	2	5	14.0	8.0	30.0	7.9		
	SD0029	SD-16	8/23/97	2	2	10	14.1	8.0	30.0	8.0		
	SD0029	SD-16	8/23/97	2	2	20	14.2	8.0	30.0	8.2		
	SD0029	SD-16	8/23/97	2	2	50	14.2	8.0	30.0	8.3		
	SD0029	SD-16	8/23/97	2	2	100	14.2	8.1	30.0	8.5		
	SD0031	SD-17	8/21/97	2	0	0	15.0	7.6	30.0	8.0		
	SD0031	SD-17	8/21/97	2	0	5	15.1	7.6	30.0	7.9		
	SD0031	SD-17	8/21/97	2	0	10	15.1	7.6	30.0	7.9		

TABLE A3-9. (cont.)

Test	Sample Number	Station	Collection Date	Replicate	Day	Concentration (percent)	Temperature (°C)	Dissolved Oxygen (mg/L)	Salinity (ppt)	pH	Ammonia as Nitrogen (mg/L)	Sulfide (mg/L)
	SD0031	SD-17	8/21/97	2	0	20	15.0	7.4	30.0	7.9		
	SD0031	SD-17	8/21/97	2	0	50	15.1	5.8	30.0	7.9		
	SD0031	SD-17	8/21/97	2	0	100	15.0	4.8	30.0	7.9	25	80
	SD0031	SD-17	8/22/97	2	1	0	14.9	7.8	30.0	7.8		
	SD0031	SD-17	8/22/97	2	1	5	14.9	7.8	30.0	7.7		
	SD0031	SD-17	8/22/97	2	1	10	15.0	7.9	30.0	8.0		
	SD0031	SD-17	8/22/97	2	1	20	15.0	7.8	30.0	8.1		
	SD0031	SD-17	8/22/97	2	1	50	15.1	7.4	30.0	8.3		
	SD0031	SD-17	8/22/97	2	1	100	15.1	7.4	30.0	8.4		
	SD0031	SD-17	8/23/97	2	2	0	14.2	7.9	30.0	8.4		
	SD0031	SD-17	8/23/97	2	2	5	14.3	8.0	30.0	8.2		
	SD0031	SD-17	8/23/97	2	2	10	14.2	8.0	30.0	8.2		
	SD0031	SD-17	8/23/97	2	2	20	14.2	8.0	30.0	8.3		
	SD0031	SD-17	8/23/97	2	2	50	14.3	8.0	30.0	8.4		
	SD0031	SD-17	8/23/97	2	2	100	14.2	8.0	30.0	8.5		
	SD0033	SD-34	8/21/97	2	0	0	15.1	7.6	30.0	8.0		
	SD0033	SD-34	8/21/97	2	0	5	15.1	7.6	30.0	8.0		
	SD0033	SD-34	8/21/97	2	0	10	15.1	7.3	30.0	8.0		
	SD0033	SD-34	8/21/97	2	0	20	15.1	6.2	30.0	8.0		
	SD0033	SD-34	8/21/97	2	0	50	15.3	4.2	30.0	8.1		
	SD0033	SD-34	8/21/97	2	0	100	15.2	3.4	30.0	8.2	20	115
	SD0033	SD-34	8/22/97	2	1	0	15.1	8.0	30.0	7.9		
	SD0033	SD-34	8/22/97	2	1	5	15.1	8.0	30.0	8.0		
	SD0033	SD-34	8/22/97	2	1	10	15.1	7.9	30.0	8.1		
	SD0033	SD-34	8/22/97	2	1	20	15.1	7.5	30.0	8.2		
	SD0033	SD-34	8/22/97	2	1	50	15.0	6.6	30.0	8.4		
	SD0033	SD-34	8/22/97	2	1	100	14.9	6.8	30.0	8.6		
	SD0033	SD-34	8/23/97	2	2	0	14.2	8.1	30.0	8.1		
	SD0033	SD-34	8/23/97	2	2	5	14.4	8.0	30.0	8.1		
	SD0033	SD-34	8/23/97	2	2	10	14.4	8.0	30.0	8.2		
	SD0033	SD-34	8/23/97	2	2	20	14.3	8.0	30.0	8.3		
	SD0033	SD-34	8/23/97	2	2	50	14.2	8.0	30.0	8.5		
	SD0033	SD-34	8/23/97	2	2	100	14.2	8.0	30.0	8.6		
	SD0034	SD-35	8/21/97	2	0	0	15.4	7.5	30.0	8.0		
	SD0034	SD-35	8/21/97	2	0	5	15.4	7.5	30.0	8.0		
	SD0034	SD-35	8/21/97	2	0	10	15.5	7.4	30.0	8.0		
	SD0034	SD-35	8/21/97	2	0	20	15.6	6.9	30.0	7.9		
	SD0034	SD-35	8/21/97	2	0	50	15.5	5.2	30.0	7.9		
	SD0034	SD-35	8/21/97	2	0	100	15.5	3.8	30.0	8.0	22.5	75
	SD0034	SD-35	8/22/97	2	1	0	14.8	7.4	30.0	7.9		
	SD0034	SD-35	8/22/97	2	1	5	14.8	7.7	30.0	7.9		
	SD0034	SD-35	8/22/97	2	1	10	15.0	7.8	30.0	8.0		
	SD0034	SD-35	8/22/97	2	1	20	14.8	7.8	30.0	8.1		
	SD0034	SD-35	8/22/97	2	1	50	15.0	7.1	30.0	8.3		
	SD0034	SD-35	8/22/97	2	1	100	14.9	6.8	30.0	8.4		
	SD0034	SD-35	8/23/97	2	2	0	14.2	7.9	30.0	8.2		
	SD0034	SD-35	8/23/97	2	2	5	14.3	7.9	30.0	8.1		
	SD0034	SD-35	8/23/97	2	2	10	14.3	7.9	30.0	8.2		
	SD0034	SD-35	8/23/97	2	2	20	14.2	8.0	30.0	8.3		
	SD0034	SD-35	8/23/97	2	2	50	14.2	8.0	30.0	8.4		
	SD0034	SD-35	8/23/97	2	2	100	14.3	8.1	30.0	8.6		
	SD0035	SD-44	8/21/97	2	0	0	15.6	7.5	30.0	8.0		
	SD0035	SD-44	8/21/97	2	0	5	15.7	7.5	30.0	8.0		

TABLE A3-9. (cont.)

Test	Sample Number	Station	Collection Date	Replicate	Day	Concentration (percent)	Temperature (°C)	Dissolved Oxygen (mg/L)	Salinity (ppt)	pH	Ammonia as Nitrogen (mg/L)	Sulfide (mg/L)
	SD0035	SD-44	8/21/97	2	0	10	15.7	7.1	30.5	8.0		
	SD0035	SD-44	8/21/97	2	0	20	15.6	6.0	30.5	8.0		
	SD0035	SD-44	8/21/97	2	0	50	15.6	3.9	31.0	8.1		
	SD0035	SD-44	8/21/97	2	0	100	15.5	3.3	32.5	8.0	62.5	130
	SD0035	SD-44	8/22/97	2	1	0	15.1	7.9	30.0	7.9		
	SD0035	SD-44	8/22/97	2	1	5	15.0	8.0	30.0	8.1		
	SD0035	SD-44	8/22/97	2	1	10	15.0	8.0	30.0	8.2		
	SD0035	SD-44	8/22/97	2	1	20	15.0	8.0	30.0	8.3		
	SD0035	SD-44	8/22/97	2	1	50	15.0	7.7	30.0	8.4		
	SD0035	SD-44	8/22/97	2	1	100	14.9	6.8	31.0	8.5		
	SD0035	SD-44	8/23/97	2	2	0	14.2	8.0	30.0	8.1		
	SD0035	SD-44	8/23/97	2	2	5	14.4	7.9	30.0	8.2		
	SD0035	SD-44	8/23/97	2	2	10	14.4	7.9	30.0	8.2		
	SD0035	SD-44	8/23/97	2	2	20	14.3	8.0	30.0	8.3		
	SD0035	SD-44	8/23/97	2	2	50	14.3	7.9	30.0	8.6		
	SD0035	SD-44	8/23/97	2	2	100	14.3	7.6	31.0	8.7		

TABLE A3-10. SUMMARY OF WATER QUALITY PARAMETERS FROM THE *Dendraster excentricus* SPECIALIZED TOXICITY TEST WITH PORE WATER CONDUCTED IN 1997

Test	Sample Number	Station	Collection Date	Replicate	Day	Concentration (percent)	Temperature (°C)	Dissolved Oxygen (mg/L)	Salinity (ppt)	pH	Ammonia as Nitrogen (mg/L)	Sulfide (mg/L)
With Aeration												
	SD0039	SD-12	9/4/97	3	0	0	16.0	7.8	30.0	7.9		
	SD0039	SD-12	9/7/97	3	3	0	14.6	8.1	30.0	8.1		
	SD0039	SD-12	9/4/97	3	0	0.16	16.0	7.8	30.0	7.9		
	SD0039	SD-12	9/7/97	3	3	0.16	14.6	8.1	30.0	8.1		
	SD0039	SD-12	9/4/97	3	0	0.4	16.0	7.8	30.0	7.9		
	SD0039	SD-12	9/7/97	3	3	0.4	14.6	8.1	30.0	8.1		
	SD0039	SD-12	9/4/97	3	0	1	16.0	7.8	30.0	8.1		
	SD0039	SD-12	9/7/97	3	3	1	14.5	8.1	30.0	8.1		
	SD0039	SD-12	9/4/97	3	0	2.6	16.0	7.8	30.0	8.3		
	SD0039	SD-12	9/7/97	3	3	2.6	14.6	8.0	30.0	8.2		
	SD0039	SD-12	9/4/97	3	0	6.4	16.0	7.8	30.0	8.5		
	SD0039	SD-12	9/7/97	3	3	6.4	14.6	7.9	30.0	8.3		
	SD0039	SD-12	9/4/97	3	0	16	16.0	7.8	30.0	8.7		
	SD0039	SD-12	9/7/97	3	3	16	14.4	7.9	30.0	8.6		
	SD0039	SD-12	9/4/97	3	0	40	16.0	7.9	30.0	8.9	17	<2.5
	SD0039	SD-12	9/7/97	3	3	40	14.5	7.8	30.0	8.9		
	SD0037	SD-13	9/4/97	3	0	0	16.0	7.7	30.0	8.1		
	SD0037	SD-13	9/7/97	3	3	0	14.4	8.0	30.0	8.1		
	SD0037	SD-13	9/4/97	3	0	0.16	16.0	7.8	30.0	8.1		
	SD0037	SD-13	9/7/97	3	3	0.16	14.4	8.0	30.0	8.1		
	SD0037	SD-13	9/4/97	3	0	0.4	16.0	7.8	30.0	8.1		
	SD0037	SD-13	9/7/97	3	3	0.4	14.6	8.0	30.0	8.1		
	SD0037	SD-13	9/4/97	3	0	1	16.0	7.8	30.0	8.1		
	SD0037	SD-13	9/7/97	3	3	1	14.5	8.0	30.0	8.1		
	SD0037	SD-13	9/4/97	3	0	2.6	16.0	7.8	30.0	8.3		
	SD0037	SD-13	9/7/97	3	3	2.6	14.5	8.0	30.0	8.2		
	SD0037	SD-13	9/4/97	3	0	6.4	16.0	7.8	30.0	8.5		
	SD0037	SD-13	9/7/97	3	3	6.4	14.5	8.0	30.0	8.4		
	SD0037	SD-13	9/4/97	3	0	16	16.0	7.8	30.0	8.8		
	SD0037	SD-13	9/7/97	3	3	16	14.5	7.9	30.0	8.6		
	SD0037	SD-13	9/4/97	3	0	40	16.0	7.8	30.0	8.9	12	<2.5
	SD0037	SD-13	9/7/97	3	3	40	14.6	7.8	30.5	8.9		
	SD0035	SD-44	9/4/97	3	0	0	16.0	7.8	30.0	8.1		
	SD0035	SD-44	9/7/97	3	3	0	14.3	8.1	30.0	8.1		
	SD0035	SD-44	9/4/97	3	0	0.16	16.0	7.8	30.0	8.1		
	SD0035	SD-44	9/7/97	3	3	0.16	14.3	8.1	30.0	8.0		
	SD0035	SD-44	9/4/97	3	0	0.4	16.0	7.8	30.0	8.1		
	SD0035	SD-44	9/7/97	3	3	0.4	14.2	8.0	30.0	8.0		
	SD0035	SD-44	9/4/97	3	0	1	16.0	7.8	30.0	8.1		
	SD0035	SD-44	9/7/97	3	3	1	14.2	8.0	30.0	8.1		
	SD0035	SD-44	9/4/97	3	0	2.6	16.0	7.8	30.0	8.2		
	SD0035	SD-44	9/7/97	3	3	2.6	14.1	8.0	30.0	8.2		
	SD0035	SD-44	9/4/97	3	0	6.4	16.0	7.8	30.0	8.4		
	SD0035	SD-44	9/7/97	3	3	6.4	14.2	8.0	30.5	8.4		
	SD0035	SD-44	9/4/97	3	0	16	16.0	7.8	30.0	8.6		
	SD0035	SD-44	9/7/97	3	3	16	14.1	8.0	30.5	8.7		
	SD0035	SD-44	9/4/97	3	0	40	16.0	7.7	30.0	8.9	20	<2.5
	SD0035	SD-44	9/7/97	3	3	40	14.2	7.7	31.0	8.9		

TABLE A3-10. (cont.)

Test	Sample Number	Station	Collection Date	Replicate	Day	Concentration (percent)	Temperature (°C)	Dissolved Oxygen (mg/L)	Salinity (ppt)	pH	Ammonia as Nitrogen (mg/L)	Sulfide (mg/L)
With *Ulva* Treatment												
	SD0039	SD-12	9/4/97	3	0	0	16.0	7.0	30.0	7.5		
	SD0039	SD-12	9/7/97	3	3	0	14.8	8.0	30.0	7.6		
	SD0039	SD-12	9/4/97	3	0	0.16	16.0	7.0	30.0	7.8		
	SD0039	SD-12	9/7/97	3	3	0.16	14.8	8.0	30.0	8.0		
	SD0039	SD-12	9/4/97	3	0	0.4	16.0	7.1	30.0	7.9		
	SD0039	SD-12	9/7/97	3	3	0.4	14.8	7.9	30.0	8.0		
	SD0039	SD-12	9/4/97	3	0	1	16.0	7.6	30.0	7.9		
	SD0039	SD-12	9/7/97	3	3	1	14.8	7.9	30.0	8.0		
	SD0039	SD-12	9/4/97	3	0	2.6	16.0	7.6	30.0	8.0		
	SD0039	SD-12	9/7/97	3	3	2.6	14.9	7.8	30.0	8.0		
	SD0039	SD-12	9/4/97	3	0	6.4	16.0	7.6	30.0	8.1		
	SD0039	SD-12	9/7/97	3	3	6.4	14.8	6.6	30.0	8.0		
	SD0039	SD-12	9/4/97	3	0	16	16.0	7.2	30.0	8.3		
	SD0039	SD-12	9/7/97	3	3	16	14.9	5.2	30.5	8.1		
	SD0039	SD-12	9/4/97	3	0	40	16.0	6.0	30.0	8.4	8	<2.5
	SD0039	SD-12	9/7/97	3	3	40	14.9	5.0	30.0	8.4		
	SD0037	SD-13	9/4/97	3	0	0	16.0	6.8	30.0	7.5		
	SD0037	SD-13	9/7/97	3	3	0	14.8	7.9	30.0	7.8		
	SD0037	SD-13	9/4/97	3	0	0.16	16.0	7.2	30.0	7.8		
	SD0037	SD-13	9/7/97	3	3	0.16	14.9	7.9	30.0	8.0		
	SD0037	SD-13	9/4/97	3	0	0.4	16.0	7.4	30.0	7.8		
	SD0037	SD-13	9/7/97	3	3	0.4	14.9	7.8	30.0	8.0		
	SD0037	SD-13	9/4/97	3	0	1	16.0	7.6	30.0	7.8		
	SD0037	SD-13	9/7/97	3	3	1	14.9	7.8	30.0	8.0		
	SD0037	SD-13	9/4/97	3	0	2.6	16.0	7.5	30.0	7.9		
	SD0037	SD-13	9/7/97	3	3	2.6	14.8	7.8	30.0	8.1		
	SD0037	SD-13	9/4/97	3	0	6.4	16.0	7.4	30.0	8.1		
	SD0037	SD-13	9/7/97	3	3	6.4	14.8	7.8	30.0	8.1		
	SD0037	SD-13	9/4/97	3	0	16	16.0	6.7	30.0	8.2		
	SD0037	SD-13	9/7/97	3	3	16	14.8	6.5	30.0	8.1		
	SD0037	SD-13	9/4/97	3	0	40	16.0	5.4	30.0	8.3	4	<2.5
	SD0037	SD-13	9/7/97	3	3	40	14.8	5.8	30.5	8.4		
	SD0035	SD-44	9/4/97	3	0	0	16.0	7.5	30.0	7.5		
	SD0035	SD-44	9/7/97	3	3	0	14.5	7.9	30.0	7.8		
	SD0035	SD-44	9/4/97	3	0	0.16	16.0	7.2	30.0	7.3		
	SD0035	SD-44	9/7/97	3	3	0.16	14.6	7.9	30.0	7.9		
	SD0035	SD-44	9/4/97	3	0	0.4	16.0	7.4	30.0	7.8		
	SD0035	SD-44	9/7/97	3	3	0.4	14.7	7.9	30.0	8.0		
	SD0035	SD-44	9/4/97	3	0	1	16.0	7.6	30.0	7.8		
	SD0035	SD-44	9/7/97	3	3	1	14.6	7.9	30.0	8.0		
	SD0035	SD-44	9/4/97	3	0	2.6	16.0	6.4	30.0	7.6		
	SD0035	SD-44	9/7/97	3	3	2.6	14.5	7.8	30.0	8.1		
	SD0035	SD-44	9/4/97	3	0	6.4	16.0	6.6	30.0	7.9		
	SD0035	SD-44	9/7/97	3	3	6.4	14.5	7.8	30.0	8.1		
	SD0035	SD-44	9/4/97	3	0	16	16.0	4.8	30.0	8.0		
	SD0035	SD-44	9/7/97	3	3	16	14.4	7.0	30.0	8.3		
	SD0035	SD-44	9/4/97	3	0	40	16.0	3.2	30.0	8.0	16	17.5
	SD0035	SD-44	9/7/97	3	3	40	14.4	5.2	31.0	8.6		

TABLE A3-10. (cont.)

Test	Sample Number	Station	Collection Date	Replicate	Day	Concentration (percent)	Temperature (°C)	Dissolved Oxygen (mg/L)	Salinity (ppt)	pH	Ammonia as Nitrogen (mg/L)	Sulfide (mg/L)
Without Treatment												
	SD0039	SD-12	9/4/97	3	0	0	16.0	7.9	30.0	7.9		
	SD0039	SD-12	9/7/97	3	3	0	14.0	8.1	30.0	8.1		
	SD0039	SD-12	9/4/97	3	0	0.16	16.0	7.9	30.0	7.9		
	SD0039	SD-12	9/7/97	3	3	0.16	14.0	8.0	30.0	8.1		
	SD0039	SD-12	9/4/97	3	0	0.4	16.0	7.9	30.0	7.9		
	SD0039	SD-12	9/7/97	3	3	0.4	14.0	7.9	30.0	8.1		
	SD0039	SD-12	9/4/97	3	0	1	16.0	7.9	30.0	7.9	0.5	2.5
	SD0039	SD-12	9/7/97	3	3	1	14.0	7.8	30.0	8.1		
	SD0039	SD-12	9/4/97	3	0	2.6	16.0	7.8	30.0	7.8		
	SD0039	SD-12	9/7/97	3	3	2.6	14.1	7.9	30.0	8.2		
	SD0039	SD-12	9/4/97	3	0	6.4	16.0	7.4	30.0	7.7	3.8	12.5
	SD0039	SD-12	9/7/97	3	3	6.4	14.0	7.9	30.0	8.3		
	SD0039	SD-12	9/4/97	3	0	16	16.0	6.8	30.0	7.6		
	SD0039	SD-12	9/7/97	3	3	16	14.1	7.2	30.5	8.3		
	SD0039	SD-12	9/4/97	3	0	40	16.0	5.1	30.0	7.6	22	56.3
	SD0039	SD-12	9/7/97	3	3	40	14.1	5.0	30.0	8.5		
	SD0037	SD-13	9/4/97	3	0	0	16.0	7.9	30.0	7.9		
	SD0037	SD-13	9/7/97	3	3	0	14.1	8.1	30.0	8.1		
	SD0037	SD-13	9/4/97	3	0	0.16	16.0	7.9	29.0	7.9		
	SD0037	SD-13	9/7/97	3	3	0.16	14.0	8.0	30.0	8.1		
	SD0037	SD-13	9/4/97	3	0	0.4	16.0	7.9	30.0	7.9		
	SD0037	SD-13	9/7/97	3	3	0.4	14.1	8.0	30.0	8.1		
	SD0037	SD-13	9/4/97	3	0	1	16.0	7.8	30.0	7.9	0.25	1.8
	SD0037	SD-13	9/7/97	3	3	1	14.0	8.0	30.0	8.1		
	SD0037	SD-13	9/4/97	3	0	2.6	16.0	7.4	30.0	7.9		
	SD0037	SD-13	9/7/97	3	3	2.6	14.0	7.9	30.0	8.1		
	SD0037	SD-13	9/4/97	3	0	6.4	16.0	7.1	30.0	7.8	2.8	12
	SD0037	SD-13	9/7/97	3	3	6.4	14.0	7.9	30.0	8.2		
	SD0037	SD-13	9/4/97	3	0	16	16.0	6.4	30.0	7.7		
	SD0037	SD-13	9/7/97	3	3	16	14.0	7.0	30.0	8.2		
	SD0037	SD-13	9/4/97	3	0	40	16.0	4.4	30.0	7.5	14	42.5
	SD0037	SD-13	9/7/97	3	3	40	14.1	5.2	30.5	8.5		
	SD0035	SD-44	9/4/97	3	0	0	16.0	7.7	30.0	7.8		
	SD0035	SD-44	9/7/97	3	3	0	14.2	8.1	30.0	8.1		
	SD0035	SD-44	9/4/97	3	0	0.16	16.0	7.7	30.0	7.8		
	SD0035	SD-44	9/7/97	3	3	0.16	14.2	7.9	30.0	8.1		
	SD0035	SD-44	9/4/97	3	0	0.4	16.0	7.7	30.0	7.8		
	SD0035	SD-44	9/7/97	3	3	0.4	14.2	7.8	30.0	8.1		
	SD0035	SD-44	9/4/97	3	0	1	16.0	7.6	30.0	7.8	0.5	2.3
	SD0035	SD-44	9/7/97	3	3	1	14.2	7.9	30.0	8.2		
	SD0035	SD-44	9/4/97	3	0	2.6	16.0	7.4	30.0	7.8		
	SD0035	SD-44	9/7/97	3	3	2.6	14.2	7.9	30.0	8.2		
	SD0035	SD-44	9/4/97	3	0	6.4	16.0	7.2	30.0	7.6	5	11.5
	SD0035	SD-44	9/7/97	3	3	6.4	14.2	7.7	30.0	8.3		
	SD0035	SD-44	9/4/97	3	0	16	16.0	4.2	30.0	7.4		
	SD0035	SD-44	9/7/97	3	3	16	14.2	7.1	30.0	8.4		
	SD0035	SD-44	9/4/97	3	0	40	16.0	3.0	30.0	7.4	22	43.8
	SD0035	SD-44	9/7/97	3	3	40	14.3	7.4	31.0	8.6		

Appendix A4

Summary of Porewater Analyses for Specialized Toxicity Tests

CONTENTS

TABLE A4-1. POREWATER CHEMISTRY FOR SEDIMENT PURGING TESTS USING *Rhepoxynius abronius*[a]

Station	Porewater Ammonia (mg/L) Day 2	Day 5	Day 9	Day 17	Porewater Sulfide (mg/L) Day 2	Day 5	Day 9	Day 17
Subarea 1								
12	14	4.5	5.5	4.5	36	14	23	2.5 *U*
13	10	6.5	2.0	2.0	39	36	14	2.8
44	16	6.0	6.0	6.0	35	30	23	3.0
Subarea 2								
16	4.0	2.0	1.0	0.5 *U*	3.8	2.5 *U*	2.5 *U*	2.5 *U*
17	8.5	2.5	2.0	0.5 *U*	21	11	6.3	2.5 *U*
35	6.2	4.0	1.0	1.0	26	17	14	5.5
Subarea 3								
7	5.5	2.5	0.5	1.0	18	7.5	2.5 *U*	2.5 *U*
34	9.5	2.5	2.0	2.0	39	18	10	3.8

Note: *U* - undetected at the concentration listed

[a] Sediment was loaded into test chamber on Day 0, purging began on Day 1,test initiation with amphipods began on Day 10, and test termination occurred on Day 20.

TABLE A4-2. WATER CHEMISTRY FOR SEDIMENT *Ulva* TESTS USING *Rhepoxynius abronius*

	Ammonia (mg/L)				Sulfide (mg/L)			
	Untreated		*Ulva* Treated		Untreated		*Ulva* Treated	
Station	Day 0	Day 2	Day 0	Day 2	Day 0	Day 2	Day 0	Day 2
Subarea 1								
12	9.5	10	0.5	2.0	1.9	0.5 *U*	2.5 *U*	0.5 *U*
13	7.5	8.0	0.5	0.5 *U*	3.1	0.5 *U*	2.5 *U*	0.5 *U*
44	12	12	0.5	0.5	5.3	0.5 *U*	2.5 *U*	0.5 *U*
Subarea 2								
16	2.0	1.5	0.5 *U*	0.5 *U*	2.5 *U*	0.5 *U*	2.5 *U*	0.5 *U*
17	4.0	3.0	0.5	0.5 *U*	2.5 *U*	0.5 *U*	2.5 *U*	0.5 *U*
35	2.5	2.5	0.5 *U*	0.5 *U*	0.6 *U*	0.5 *U*	2.5 *U*	0.5 *U*
Subarea 3								
7	3.0	3.0	0.5 *U*	0.5 *U*	2.5 *U*	0.5 *U*	2.5 *U*	0.5 *U*
34	4.0	3.0	0.5 *U*	0.5 *U*	2.5 *U*	0.5 *U*	2.5 *U*	0.5 *U*

Note: *U* - undetected at the concentration listed

TABLE A4-3. POREWATER TESTS USING *Rhepoxynius abronius*

	Ammonia (mg/L)			Sulfide (mg/L)		
Station	B	A	U	B	A	U
Subarea 1						
12	58	58	33	125	11	60
13	48	43	27	125	7.5	65
44	63	60	37	130	11	58
Subarea 2						
16	7.5	8	2 *U*	10 *U*	2.5 *U*	5.0 *U*
17	25	20	2	80	5.0	15
35	23	20	7	75	2.5	30
Subarea 3						
7	18	18	3	65	5.0	23
34	20	23	3	115	6.3	50

Note: B - baseline conditions
A - results for aeration procedure
U - results for *Ulva* procedure
U - undetected at concentration listed

TABLE A4-4. POREWATER TESTS USING *Dendraster excentricus*

	Ammonia (mg/L)			Sulfide (mg/L)		
Station	B	A	U	B	A	U
Subarea 1						
12	22	17	8.0	56	2.5 *U*	2.5 *U*
13	14	12	4.0	43	2.5 *U*	2.5 *U*
44	22	20	16	44	2.5 *U*	18

Note:
B - baseline conditions
A - results for aeration procedure
U - results for *Ulva* procedure
U - undetected at concentration listed

Appendix A5

Data Tables and Graphs for Engineering Properties Tests

REPORT OF
ELUTRIATE TESTING
and
ENGINEERING PROPERTIES
for the
WARD COVE SEDIMENT REMEDIATION PROJECT

PREPARED BY:

SOIL TECHNOLOGY INC.

BAINBRIDGE ISLAND, WASHINGTON

September 1997

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APPENDICES

Ketchican Pulp
Project # CBOW 1201
Elutriate Testing

Table 1 : Modified Elutriate Total Suspended Solids (TSS)

Sample	Total Suspended Solids[1] mg/L
Composite 1	229
Composite 2	338

Table 2 : Dredging Elutriate Total Suspended Solids (TSS)

Sample	Total Suspended Solids[1] mg/L
Composite 1	140
Composite 2	167

[1]TSS determined using a 0.45 micron cellulose acetate membrane filter.

Methodology

Two different types of elutriate tests were performed on each composite sediment: a modified elutriate and a dredging elutriate. Composite 1 was composed of sediments from Station 1 and 7 (samples SD0041) and Composite 2 of sediments from Stations 3 and 5 (samples SD0042). The elutriate test sediments were composited and analyzed under ambient atmospheric conditions. The Composite 1 modified test was started on 8/13/97 and was sampled 8/14/97; the Composite 2 modified test started 8/14/97 and was sampled 8/15/97; the Composite 1 dredging test ran on 8/14/97 and the Composite 2 dredging test ran on 8/18/97.

The modified elutriate test was performed in general accordance with U.S. COE methodology, "Modified Elutriate Analysis, 'Interim Guidance for Prediction Quality of Effluent Discharged from Confined Dredged Material Disposal Areas -- Test Procedures', EEDP-04-2: Environmental Effects of Dredging, Technical Notes. 1985, and the statement of work, Exhibit A, PTI Lab Services Agreement No. S11CBOW. The sediment and water were mixed at a ratio of 150 g of sediment to 1 liter of site water and aerated for 1 hour, then allowed to settle for 24 hours. Supematant was siphoned off and split into two fractions, one for total organics and one for total metals analysis. Additional supematant was centrifuged in stainless steel bottles to separate the 0.45 micron particles and the resultant supematant designated for dissolved organics analysis. The dissolved metals samples were prepared by centrifuging the elutriate supernatant in polycarbonate bottles and then filtering it through a 0.45 micron filter. A QA/QC sample was prepared from site water subjected to the same process as the sediment. All samples were preserved if necessary, and shipped to the specified chemical labs for chemical analysis.

The dredging elutriate test was performed similar to the modified elutriate test except that the sediment to water ratio was 10 g sediment to 1 liter site water and the settling time was 1 hour.

Total suspended solids (TSS) were determined on subsamples from each composite and tested by STI in accordance with EPA Method 160.2 (U.S. EPA 1983), modified to include the use of a 0.45 micron cellulose acetate membrane filter rather than a glass fiber filter.

Table 3: Parameter Determinations

Sample ID	Specific Gravity[1]	Total Solids[2] (g/L)	Initial Concentration[3] (g/L)
Composite 1	2.11	94	65

[1] ASTM D854 Methodology. This value determined by averaging the specific gravity of each sample included in the composite.

[2] Initial dredge slurry total solids concentration determined averaging four Port sample concentrations at Time Zero.

[3] Dissolved solids concentration (29 g/L) of dredge slurry subtracted from total solids concentration. Dissolved solids concentration determined using a hand refractometer.

Methodology and Observations:
A composite sample was prepared from Station 1 and 7 sediment (samples SD0041) and, due to limited sample quantity, the settled material from the completed MET and DRET analyses. The composite sediment was mixed with site seawater (sample SW0001) to a concentration of 94g (dry solids)/Liter concentration. After mixing with a mechanical stirrer, the slurry was delivered to the settling column. To limit particle settling during the process, compressed air was applied to the base of the column producing a circulation effect, mixing the solids in the slurry until delivery was complete. Analysis was initiated (Time Zero) when the flow of compressed air was stopped. The solids settled slowly but steadily for the first 48 hours, but the coarse material interface was only observable for the first 24 hours. The resultant supernatant was very dark in color making observation difficult. At the 288 hour interval an increase in total suspended solids was recorded accompanied by a slight increase in the turbidity values, possibly due to microbial activity. Settling Column analysis was initiated 8/20/97 and concluded 9/4/97.

Table 4: Total Suspended Solids

Collection Intervals, Concentration, and Percent of Initial Concentration

Elapsed Time (hours)	Port Height from Base (ft)	Total Suspended Solids (mg/L)	% of Initial Concentration[1]
2	6.5	1188	100.0%
4	6.5	1136	95.6%
4	6.0	1153	97.1%
4	5.5	880	74.1%
6	6.5	864	72.7%
6	6.0	827	69.6%
6	5.5	940	79.1%
6	5.0	850	71.5%
12	6.5	779	65.6%
12	6.0	1048	88.2%
12	5.5	800	67.3%
12	5.0	750	63.1%
12	4.5	508	42.8%
12	4.0	571	48.1%
24	6.5	600	50.5%
24	6.0	582	49.0%
24	5.5	535	45.0%
24	5.0	531	44.7%
24	4.5	394	33.2%
24	4.0	453	38.1%
48	6.5	189	15.9%
48	6.0	133	11.2%
48	5.5	132	11.1%
48	5.0	176	14.8%
48	4.5	148	12.5%
48	4.0	200	16.8%
96	6.5	282	23.7%
96	6.0	119	10.0%
96	5.5	147	12.4%
96	5.0	140	11.8%
96	4.5	123	10.4%
96	4.0	148	12.5%
96	3.0	137	11.5%
144	6.0	177	14.9%
144	5.5	173	14.6%
144	5.0	177	14.9%
144	4.5	180	15.2%
144	4.0	144	12.1%
144	3.0	218	18.4%
216	6.0	159	13.4%
216	5.5	175	14.7%
216	5.0	150	12.6%
216	4.5	129	10.9%
216	4.0	147	12.4%
216	3.0	255	21.5%

[1] Initial Concentration: 65 g/L.

Table 4 (Cont'd): Total Suspended Solids

Collection Intervals, Concentration, and Percent of Initial Concentration

Elapsed Time (hours)	Port Height from Base (ft)	Total Suspended Solids (mg/L)	% of Initial Concentration[1]
288	6.0	1821	153.3%
288	5.5	563	47.4%
288	5.0	600	50.5%
288	4.5	240	20.2%
288	4.0	379	31.9%
288	3.0	468	39.4%
360	6.0	132	11.1%
360	5.5	90	7.6%
360	5.0	139	11.7%
360	4.5	152	12.8%
360	4.0	135	11.4%
360	3.0	145	12.2%

[1] Initial Concentration: 65 g/L.

Table 5: Turbidity Determinations
Sample Collection Intervals and Turbidity (NTU)

Elapsed Time (hours)	Port Height from Base (ft)	Turbidity [1] (NTU)
2	6.5	722
4	6.5	612
4	6.0	673
4	5.5	643
6	6.5	576
6	6.0	596
6	5.5	617
6	5.0	640
12	6.5	539
12	6.0	610
12	5.5	623
12	5.0	689
12	4.5	670
12	4.0	633
24	6.5	632
24	6.0	623
24	5.5	615
24	5.0	599
24	4.5	608
24	4.0	590
48	6.5	533
48	6.0	565
48	5.5	463
48	5.0	498
48	4.5	557
48	4.0	555
96	6.5	595
96	6.0	605
96	5.5	579
96	5.0	588
96	4.5	587
96	4.0	596
96	3.0	714
144	6.0	432
144	5.5	425
144	5.0	427
144	4.5	463
144	4.0	441
144	3.0	449
216	6.0	373
216	5.5	380
216	5.0	380
216	4.5	387
216	4.0	403
216	3.0	388

[1] Turbidity analysis performed following ASTM D1889 using a photoelectric nephelometer.

Table 5 (Cont'd): Turbidity Determinations
Sample Collection Intervals, and Turbidity (NTU)

Elapsed Time (hours)	Port Height from Base (ft)	Turbidity[1] (NTU)
288	6.0	464
288	5.5	540
288	5.0	552
288	4.5	570
288	4.0	650
288	3.0	500
360	6.0	301
360	5.5	314
360	5.0	315
360	4.5	313
360	4.0	328
360	3.0	328

[1] Turbidity analysis performed following ASTM D1889 using a photoelectric nephelometer.

Ketchican Pulp
Column Settling Analyses

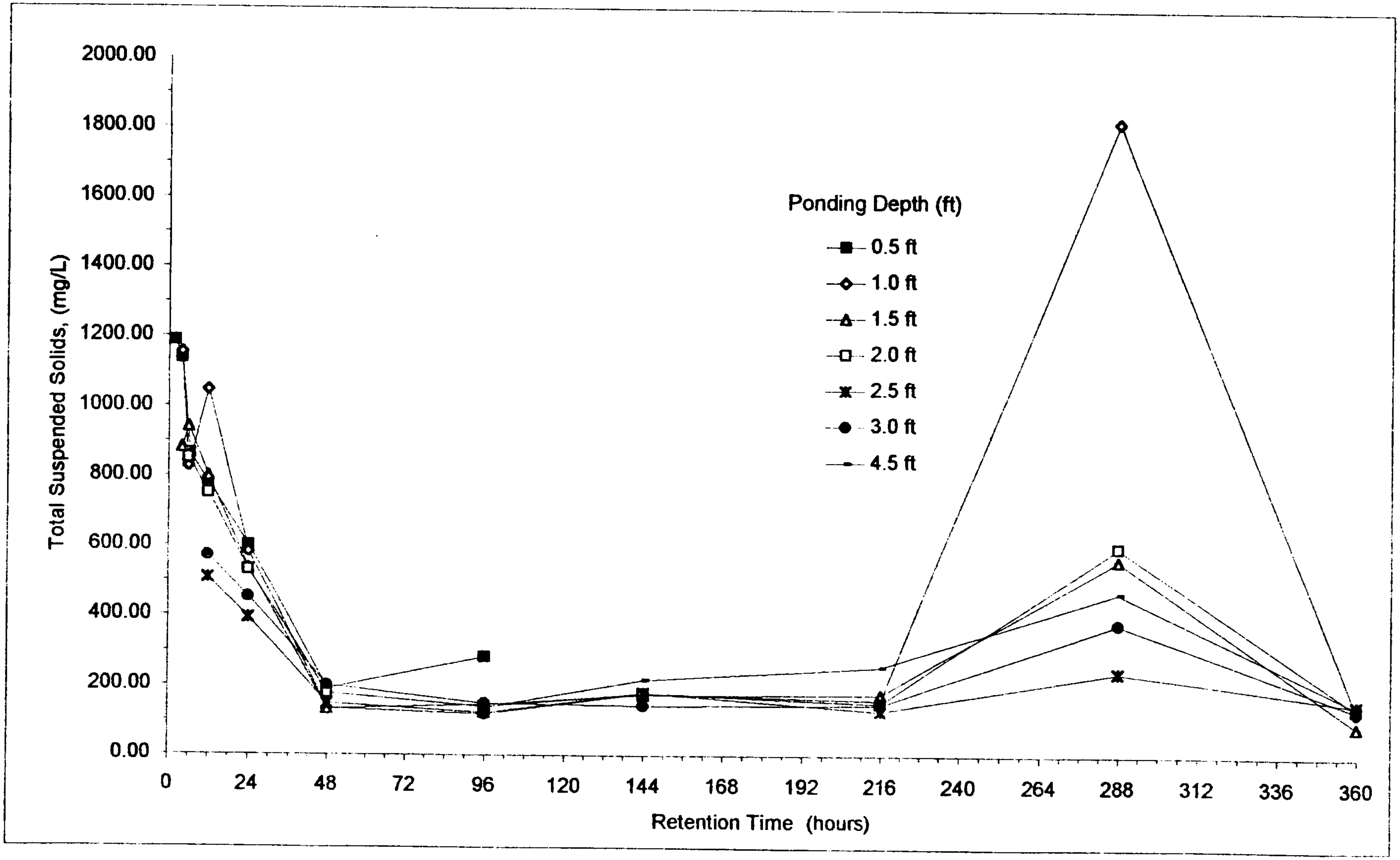
Composite 1

Table 6: Interface Heights

Elapsed Time (hours)	Surface Water Height from base (ft)	Solids Interface Height from base (ft)	Coarse Material Height from base (ft) & comments
0	6.95	6.95	-
1	6.95	6.50	2.00
2	6.95	6.14	2.50
4	6.92	5.38	3.00
6	6.88	4.52	3.20
12	6.82	3.88	3.40
24	6.75	3.45	3.45
48	6.68	3.13	indistinguishable
96	6.60	2.88	indistinguishable
144	6.52	2.79	indistinguishable
216	6.49	2.82	indistinguishable
288	6.42	2.73	indistinguishable
360	6.33	2.61	indistinguishable

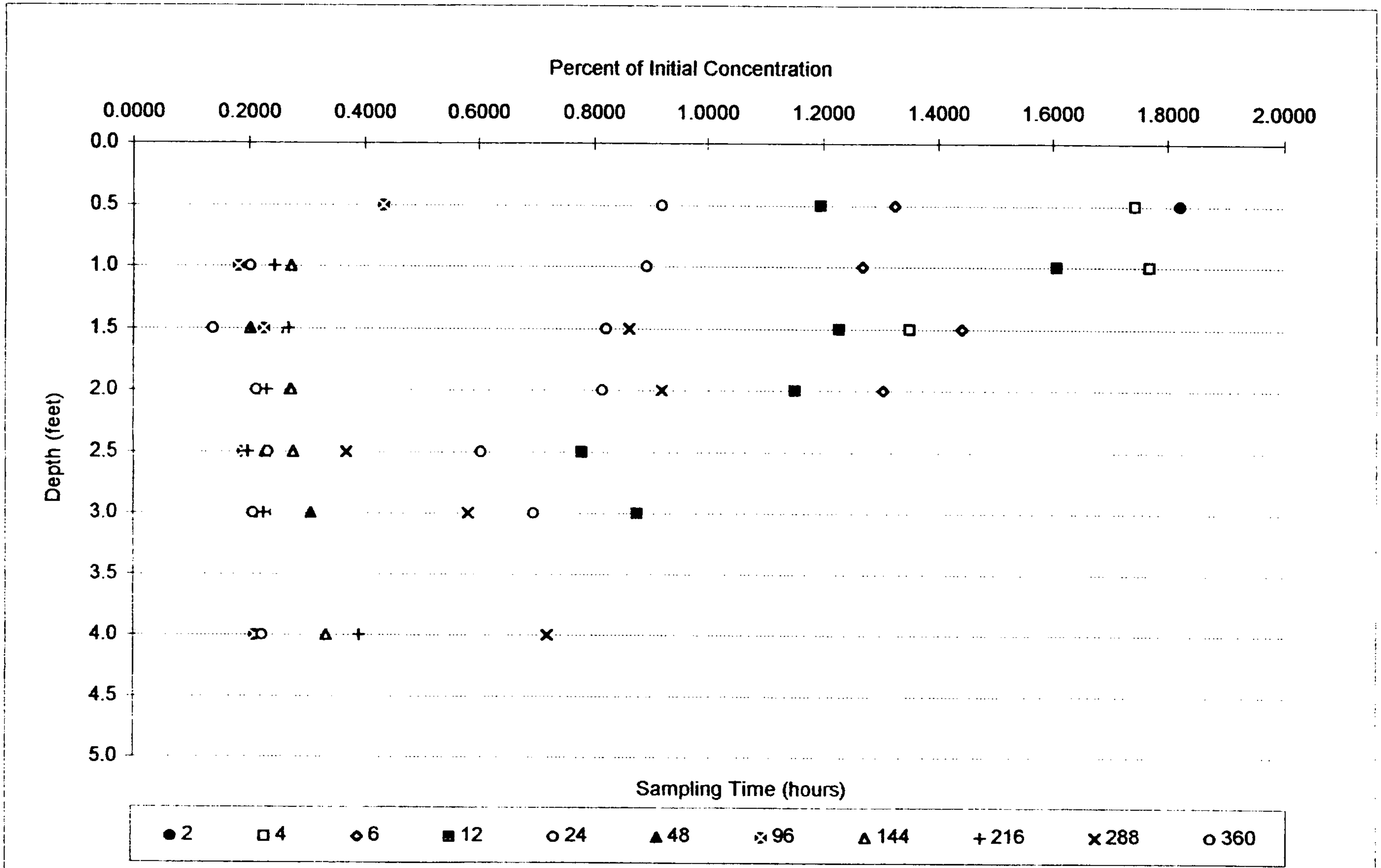
Ketchican Pulp
Column Settling Analyses

Graph 1: Retention Time vs. Total Suspended Solids



K[illegible]ican Pulp
Column Settling Analyses

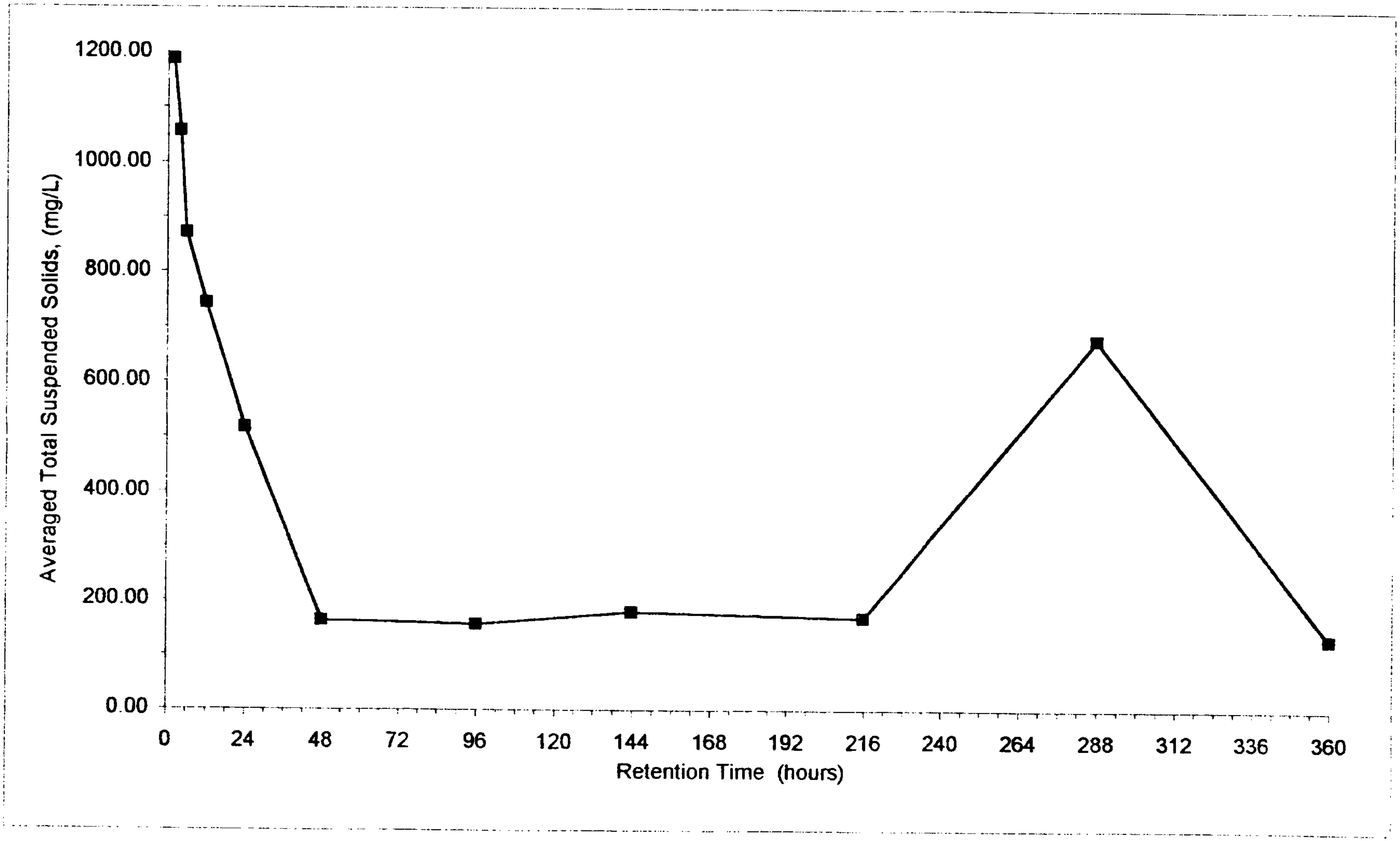
Graph 2: Concentration Profile[1]



Ketchican Pulp
Column Settling Analyses

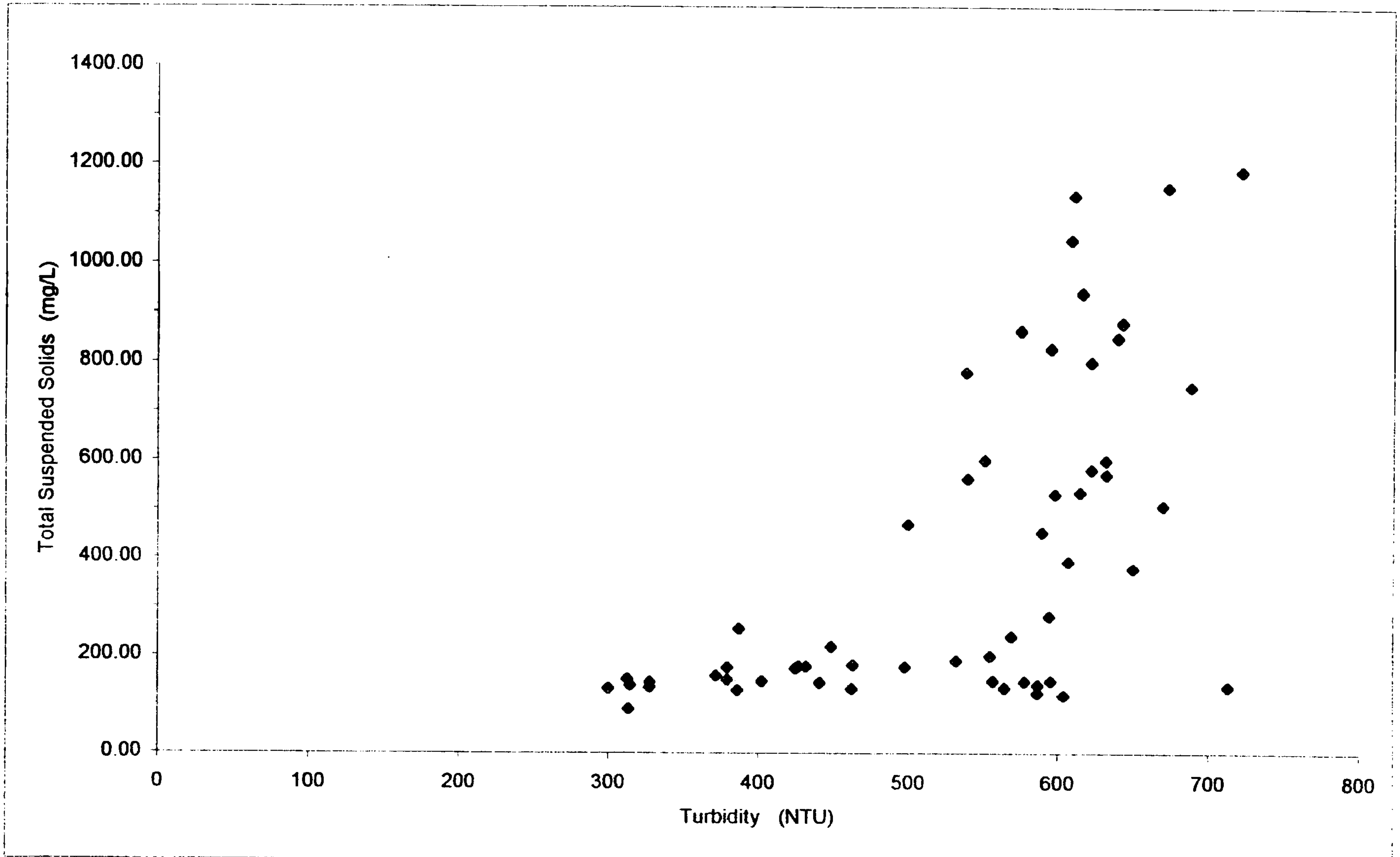
Composite 1

Graph 3: Retention Time vs. Averaged Total Suspended Solids [1]



[1] TSS plotted are averages calculated from all TSS values taken at a given time interval.

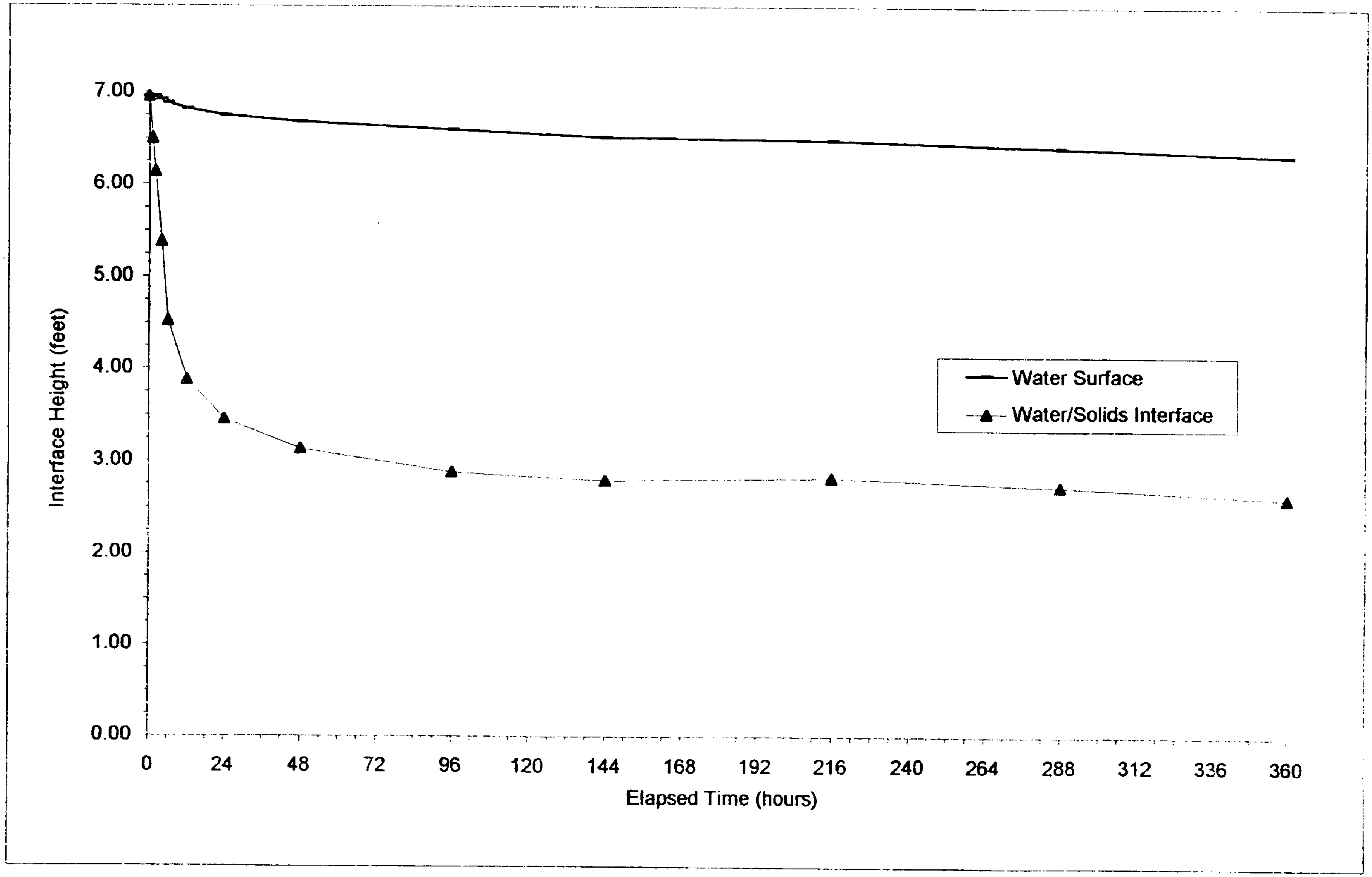
Graph 4: Turbidity vs. Total Suspended Solids



Ketchican Pulp
Settling Column Analyses

Composite 1

Graph 5: Elapsed Time vs. Interface Heights [1]



[1] Apparent decrease in water surface height reflects cumulative volume loss due to sample extraction.

Ketchican Pulp
Column Settling Analyses

Table 7: Parameter Determinations

Sample ID	Specific Gravity[1]	Total Solids[2] (g/L)	Initial Concentration[3] (g/L)
Composite 2	2.22	75	46

[1] ASTM D854 Methodology. This value determined by averaging the specific gravity of each sample included in the composite.

[2] Initial dredge slurry total solids concentration determined averaging four Port sample concentrations at Time Zero.

[3] Dissolved solids concentration (29 g/L) of dredge slurry subtracted from total solids concentration. Dissolved solids concentration determined using a hand refractometer.

Methodology and Observations:

A composite sample was prepared from Station 3 and 5 sediment (samples SD0042) and, due to limited sample quantity, the settled material from the completed MET and DRET analyses. The composite sediment was mixed with site seawater (sample SW0002) to a concentration of 75g (dry solids)/Liter concentration. After mixing with a mechanical stirrer, the slurry was delivered to the settling column. To limit particle settling during the process, compressed air was applied to the base of the column producing a circulation effect, mixing the solids in the slurry until delivery was complete. Analysis was initiated (Time Zero) when the flow of compressed air was stopped. The coarse material (woody fragments) settled rapidly while the finer solids settled slowly but steadily for the first 48 hours. The resultant supernatant was very dark in color making continuous observation difficult. Settling Column analysis was initiated 8/20/97 and concluded 9/4/97.

Table 8: Total Suspended Solids

Collection Intervals, Concentration, and Percent of Initial Concentration

Elapsed Time (hours)	Port Height from Base (ft)	Total Suspended Solids (mg/L)	% of Initial Concentration[1]
2	6.0	978	100.0%
4	6.0	991	101.3%
4	5.5	882	90.2%
4	5.0	1010	103.3%
4	4.5	850	86.9%
6	6.0	950	97.1%
6	5.5	736	75.3%
6	5.0	883	90.3%
6	4.5	873	89.3%
6	4.0	920	94.1%
12	6.0	424	43.4%
12	5.5	422	43.1%
12	5.0	510	52.1%
12	4.5	514	52.6%
12	4.0	519	53.1%
24	6.0	463	47.3%
24	5.5	522	53.4%
24	5.0	489	50.0%
24	4.5	560	57.3%
24	4.0	237	24.2%
48	6.0	193	19.7%
48	5.5	170	17.4%
48	5.0	180	18.4%
48	4.5	203	20.8%
48	4.0	166	17.0%
48	3.0	160	16.4%
96	6.0	232	23.7%
96	5.5	184	18.8%
96	5.0	216	22.1%
96	4.5	153	15.6%
96	4.0	273	27.9%
96	3.0	217	22.2%
144	5.5	151	15.4%
144	5.0	200	20.4%
144	4.5	185	18.9%
144	4.0	181	18.5%
144	3.0	220	22.5%
216	5.5	210	21.5%
216	5.0	168	17.2%
216	4.5	170	17.4%
216	4.0	244	24.9%
216	3.0	230	23.5%

[1] Initial Concentration: 46 g/L.

Table 8 (Cont'd): Total Suspended Solids

Collection Intervals, Concentration, and Percent of Initial Concentration

Elapsed Time (hours)	Port Height from Base (ft)	Total Suspended Solids (mg/L)	% of Initial Concentration[1]
288	5.5	345	35.3%
288	5.0	155	15.8%
288	4.5	229	23.4%
288	4.0	112	11.5%
288	3.0	70	7.2%
360	5.5	123	12.6%
360	5.0	74	7.6%
360	4.5	88	9.0%
360	4.0	112	11.5%
360	3.0	132	13.5%

[1] Initial Concentration: 46 g/L.

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Table 9: Turbidity Determinations

Sample Collection Intervals and Turbidity (NTU)

Elapsed Time (hours)	Port Height from Base (ft)	Turbidity [1] (NTU)
2	6.0	12
4	6.0	24
4	5.5	22
4	5.0	20
4	4.5	18
6	6.0	36
6	5.5	33
6	5.0	30
6	4.5	27
6	4.0	24
12	6.0	72
12	5.5	66
12	5.0	60
12	4.5	54
12	4.0	48
24	6.0	144
24	5.5	132
24	5.0	120
24	4.5	108
24	4.0	96
48	6.0	288
48	5.5	264
48	5.0	240
48	4.5	216
48	4.0	192
48	3.0	144
96	6.0	576
96	5.5	528
96	5.0	480
96	4.5	432
96	4.0	384
96	3.0	288
144	5.5	792
144	5.0	720
144	4.5	648
144	4.0	576
144	3.0	432
216	5.5	1188
216	5.0	1080
216	4.5	972
216	4.0	864
216	3.0	648

[1] Turbidity analysis performed following ASTM D1889 using a photoelectric nephelometer.

Table 9 (Cont'd): Turbidity Determinations
Sample Collection Intervals and Turbidity (NTU)

Elapsed Time (hours)	Port Height from Base (ft)	Turbidity [1] (NTU)
288	5.5	1584
288	5.0	1440
288	4.5	1296
288	4.0	1152
288	3.0	864
360	5.5	1980
360	5.0	1800
360	4.5	1620
360	4.0	1440
360	3.0	1080

[1] Turbidity analysis performrd following ASTM D1889 using a photoelectric nephelometer.

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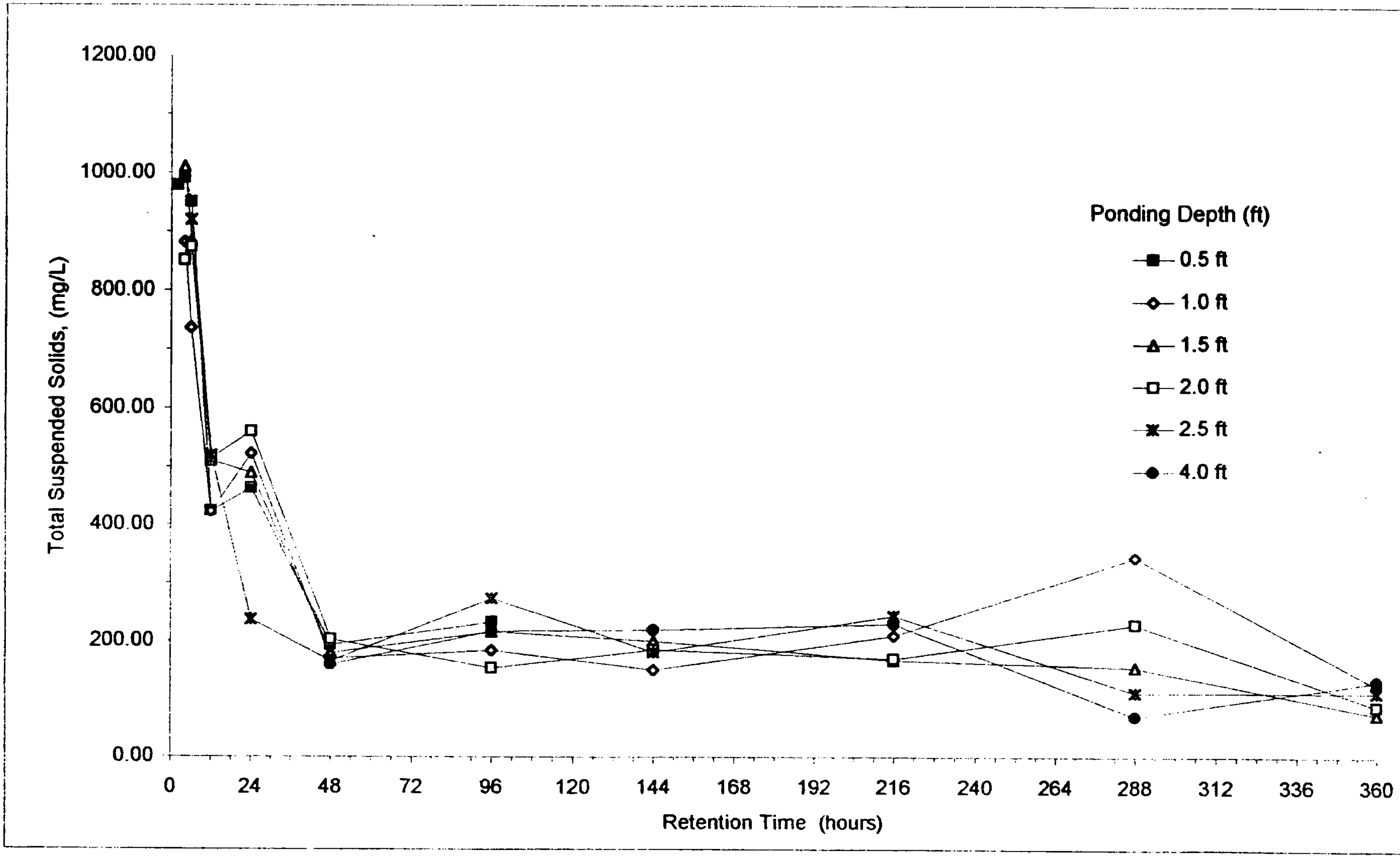
Table 10: Interface Heights

Elapsed Time (hours)	Surface Water Height from base (ft)	Solids Interface Height from base (ft)	Coarse Material Height from base (ft) & comments
0	6.52	-	-
1	6.52	6.01	2.30
2	6.52	5.46	3.00
4	6.50	4.28	Indistinguishable
6	6.44	3.97	Indistinguishable
12	6.38	3.54	Indistinguishable
24	6.31	3.15	Indistinguishable
48	6.21	2.94	Indistinguishable
96	6.02	2.82	Indistinguishable
144	5.94	2.78	Indistinguishable
216	5.85	2.75	Indistinguishable
288	5.78	2.73	Indistinguishable
360	5.69	2.72	Indistinguishable

Graph 6: Retention Time vs. Total Suspended Solids



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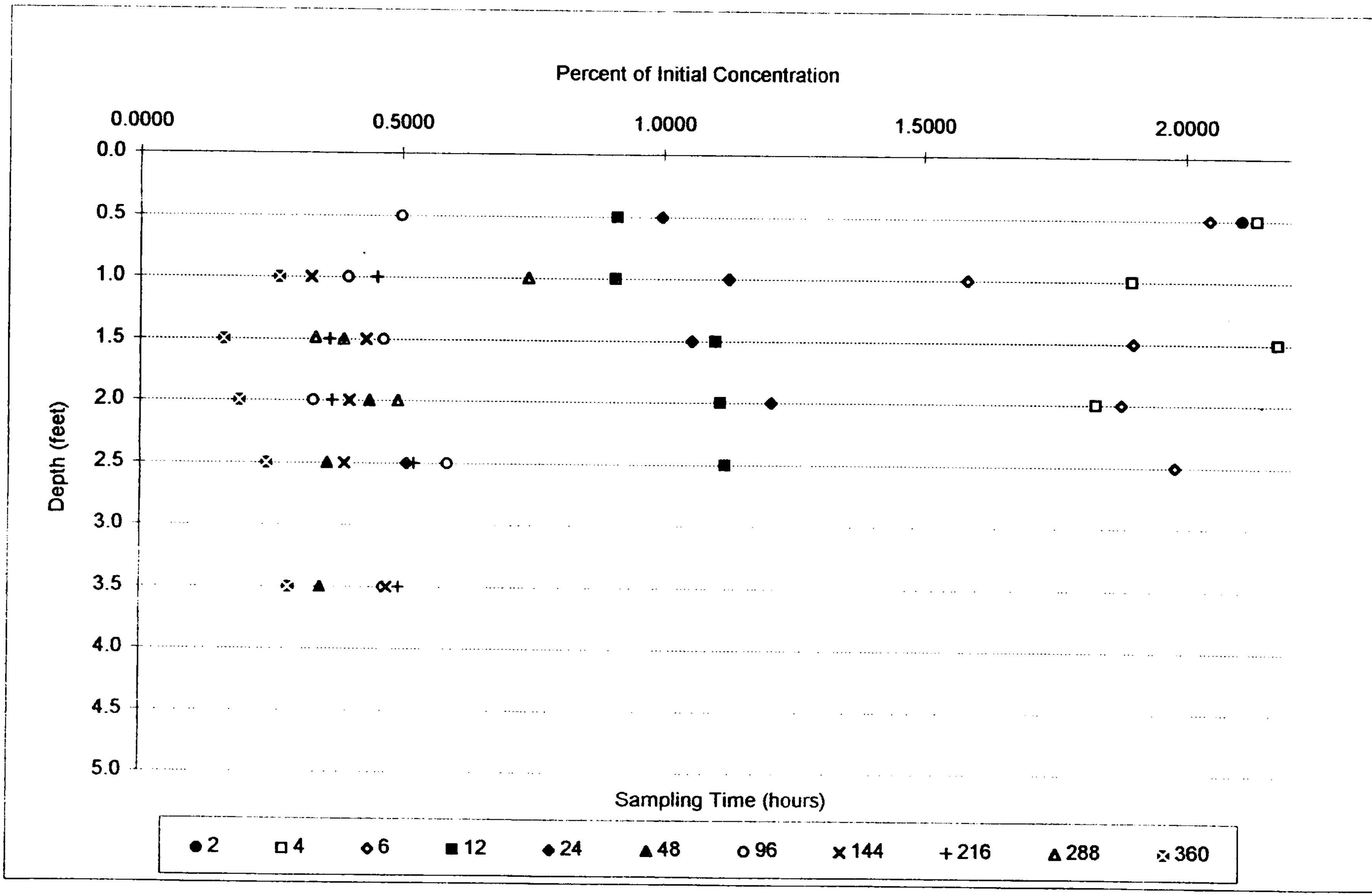
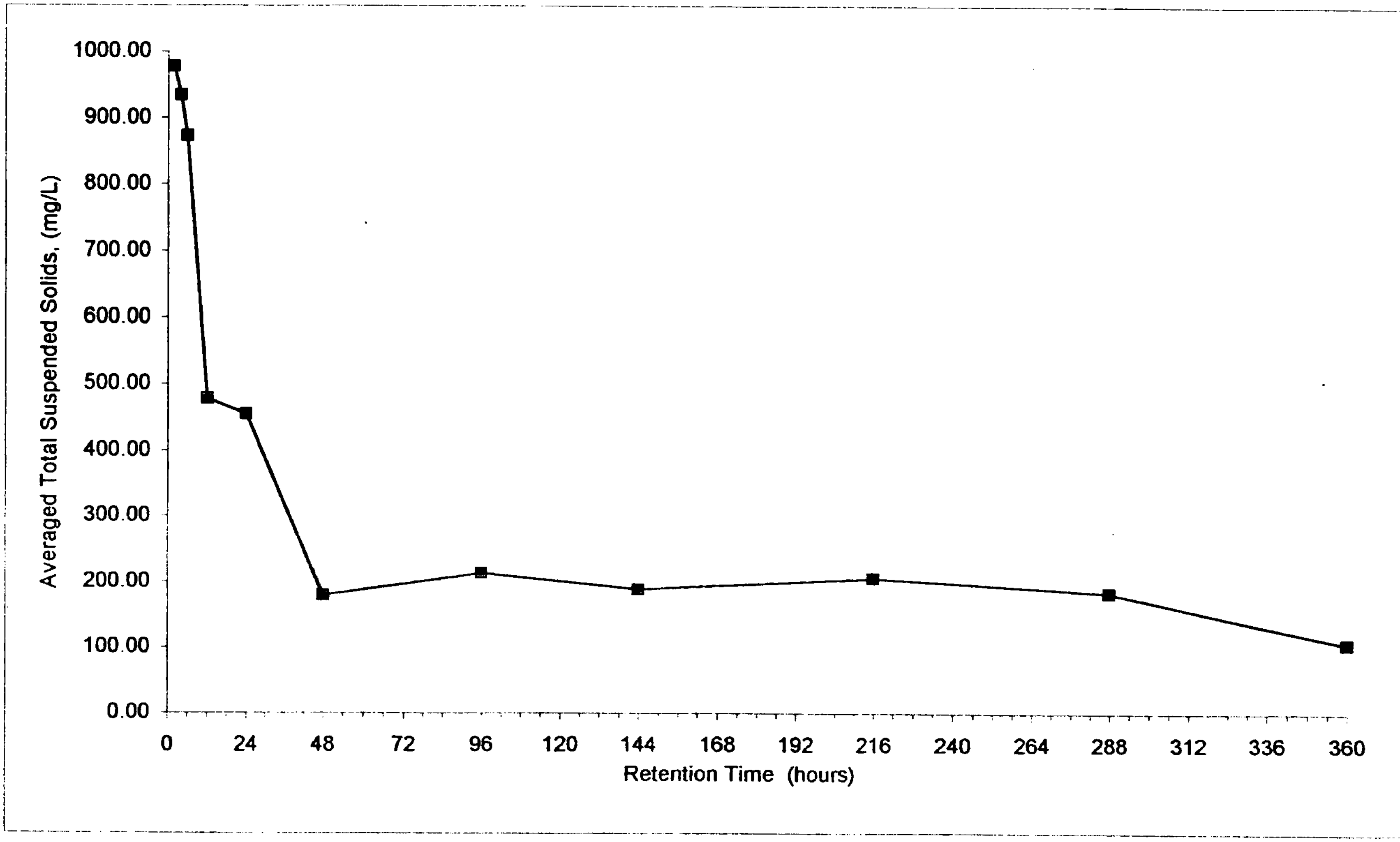
Graph 7: Concentration Profile[1]



Graph 8: Retention Time vs. Averaged Total Suspended Solids [1]



[1] TSS plotted are averages calculated from all TSS values taken at a given time interval.

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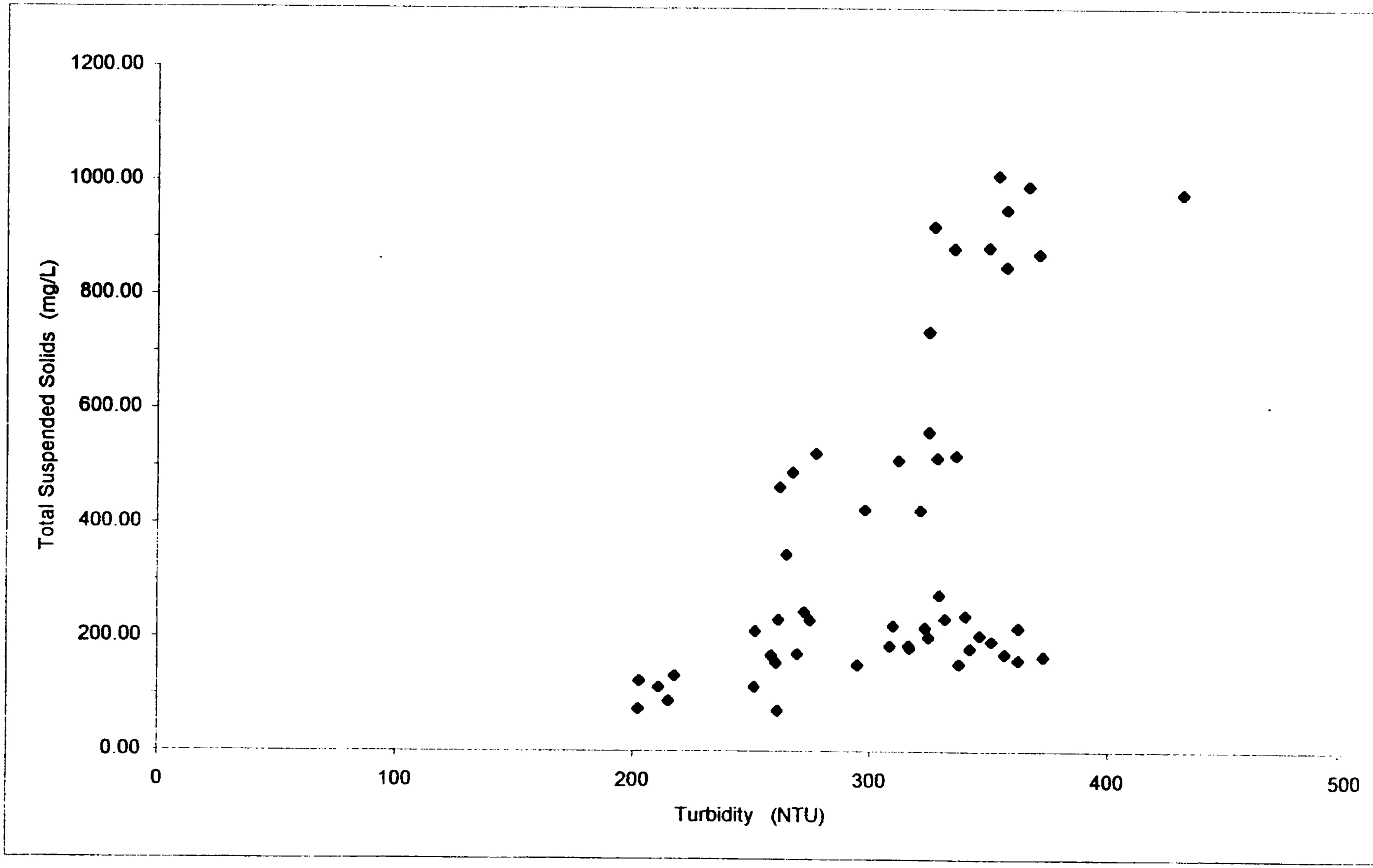
Graph 9: Turbidity vs. Total Suspended Solids



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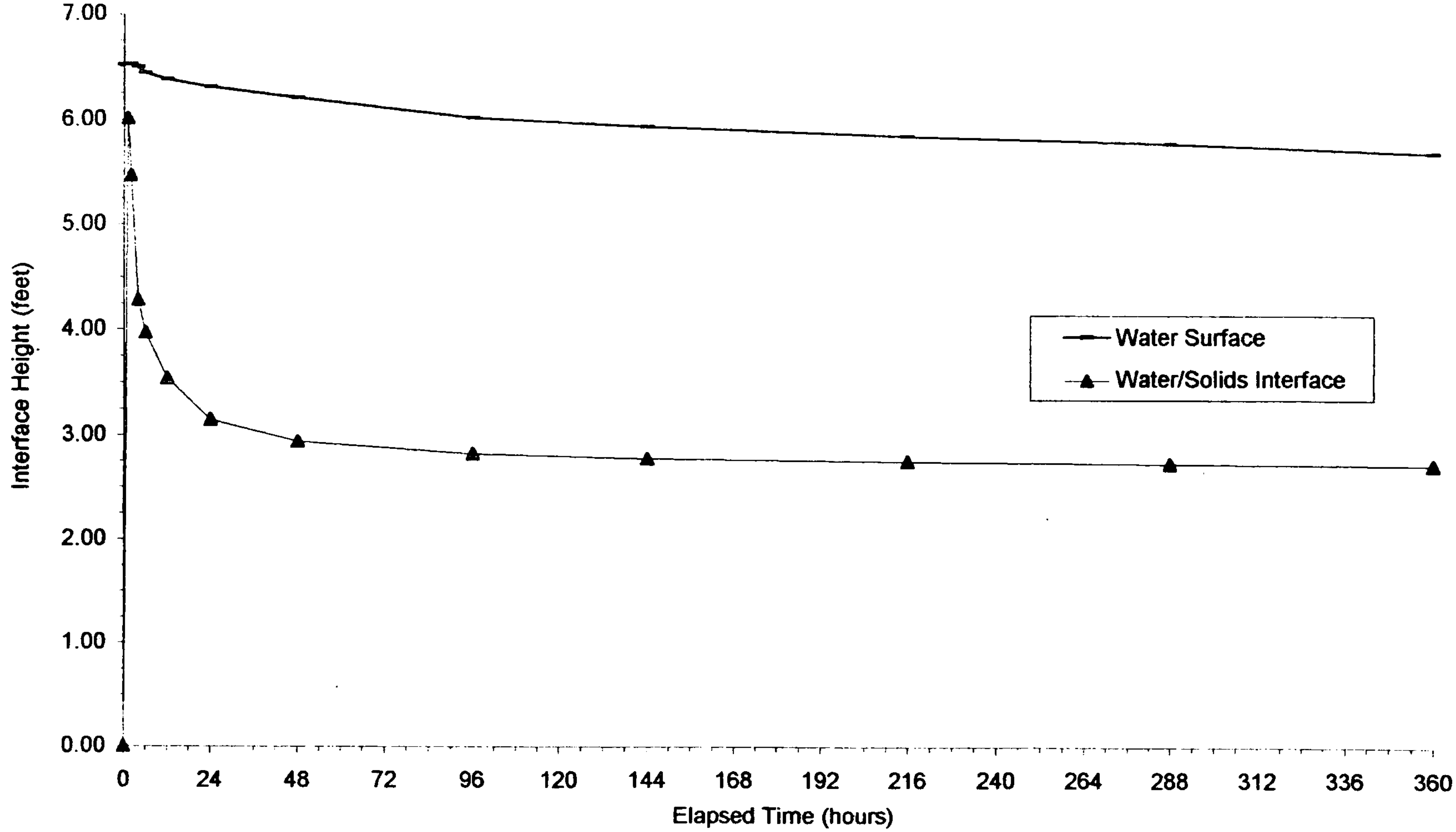
Graph 10: Elapsed Time vs. Interface Heights [1]



[1] Apparent decrease in water surface height reflects cumulative volume loss due to sample extractions.

Physical Testing Methodologies

PSEP Grain Size

Grain size distribution was determined on indicated samples following the Puget Sound Estuary Protocol 1986b (PSEP). The samples were homogenized and subsampled for determination of water content and grain size. The grain size subsample was washed with deionized water over a U.S. sieve No. 230 (62.5 micron). The +No. 230 sieve fraction was dried at 90 ° C, weighed, mechanically separated over a nested sieve set comprised of the following mesh sizes: #4, #10, #18, #35, #60, #120, #230. Each fraction retained on an individual sieve was then weighed. That portion passing the No. 230 sieve was collected in a 1-liter graduated cylinder. A chemical dispersant was added to the sample slurry to inhibit particulate flocculation. The sample volume in the cylinder was brought to 1 liter and the cylinder initially agitated for one minute. Sample extractions were done by pipetting a known amount of slurry at specific times and depths. These extractions were dried at 90°C and weighed. Fractional and passing percentages for the sieves and phi intervals and % solids are reported in Table 12.

Water Content

Water content was performed on indicated samples in accordance with U.S. COE Engineer Manual No. 1110-2-1906, Appendix I. The samples were oven dried at 110°C to a constant dry weight. Gravimetric water content was then calculated as weight of water lost divided by total dry weight. Results are found in Table 12.

Void Ratio (Remolded)

Void ratio was calculated on indicated samples in accordance with U.S. COE Engineer Manual No. 1110-2-1906, Appendix II. The jar samples tested were remolded and are not to be considered in-place void ratios. The sediment was placed in a ring of known volume in several lifts. During placement the sediment was placed in such a manner to minimize large void spaces, then leveled off and weighed for a density determination. The sediment was dried and the moisture content used to calculate the quantity of dry sediment in the ring. The void ratio was then calculated from the volume of voids (volume of ring minus volume of solids) divided by volume of solids (weight of dry sediment / specific gravity of sediment).

Specific Gravity

Specific Gravity was performed on requested samples in accordance with U.S. COE Engineer Manual No. 1110-2-1906, Appendix IV. The wet sediment was passed over a U.S. No. 10 sieve and the material passing transferred to a calibrated pycnometer. Deionized water was added and the pycnometer subjected to a vacuum until trapped air was expelled. The contents were brought to the indicated volume with deionized water and weighed at a known temperature. The sample was quantitatively transferred to a stainless steel pan, dried at 110° C, and weighed. The specific gravity was then calculated and normalized to 20°C and reported in Table 12.

Atterberg Limits (Plasticity)

Liquid limits and plastic limits were determined on requested samples in accordance with U.S. COE Engineer Manual No. 1110-2-1906, Appendix III. The results of the Atterberg Limits analysis and the plasticity characteristics are summarized in Table 13.

Total Volatile Solids (TVS)

TVS was determined on requested samples in accordance with ASTM D2974 methodology. Samples were dried at 110° C, weighed, combusted at 440°C. in a muffle furnace and weighed again. The TVS was then calculated from the amount of ash resulting from the original sample weight.

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Apparent Sediment Grain Size Distribution [1]
Table 11

Sample ID: SD0041A 113929 — 14 % SOLIDS

Sieve Size -->	No. 4:	No. 10:	No 18:	No. 35:	No. 60:	No. 120	No. 230:								
Finer than Phi Size -->								4	5	6	7	8	9	10	Balance
Grain Size -->	> 4750 microns	4750-2000 microns	2000-1000 microns	1000-500 microns	500-250 microns	250-125 microns	125-62.4 microns	62.5-31.2 microns	31.2-15.6 microns	15.6-7.8 microns	7.8-3.9 microns	3.9-1.9 microns	1.9-0.9 microns	<0.9 microns	
Percent Passing (%) -->	96	77	60	46	39	35	33	32	30	25	20	19	18	0	
Fractional Percent (%) -->	4	19	17	14	7	4	2	1	2	5	5	1	1	18	0

Sample ID: SD0041B 113930 — 15 % SOLIDS

Sieve Size -->	No. 4:	No. 10:	No. 18:	No. 35:	No. 60:	No. 120:	No. 230:								
Finer than Phi Size -->								4	5	6	7	8	9	10	Balance
Grain Size -->	> 4750 microns	4750-2000 microns	2000-1000 microns	1000-500 microns	500-250 microns	250-125 microns	125-62.4 microns	62.5-31.2 microns	31.2-15.6 microns	15.6-7.8 microns	7.8-3.9 microns	3.9-1.9 microns	1.9-0.9 microns	<0.9 microns	
Percent Passing (%) -->	98	82	64	50	43	40	37	37	33	28	25	24	22	4	
Fractional Percent (%) -->	2	16	18	14	7	3	3	0	4	5	3	1	2	18	4

Sample ID: SD0041C 113931 — 14 % SOLIDS

Sieve Size -->	No. 4:	No. 10:	No. 18:	No. 35:	No. 60:	No. 120:	No. 230:								
Finer than Phi Size -->								4	5	6	7	8	9	10	Balance
Grain Size -->	> 4750 microns	4750-2000 microns	2000-1000 microns	1000-500 microns	500-250 microns	250-125 microns	125-62.4 microns	62.5-31.2 microns	31.2-15.6 microns	15.6-7.8 microns	7.8-3.9 microns	3.9-1.9 microns	1.9-0.9 microns	<0.9 microns	
Percent Passing (%) -->	95	81	65	51	42	38	36	35	32	26	24	21	20	2	
Fractional Percent (%) -->	5	14	16	14	9	4	2	1	3	6	2	3	1	18	2

Sample ID: SD0041D 113932 Trip 1 — 17 % SOLIDS

Sieve Size -->	No. 4:	No. 10:	No. 18:	No. 35:	No. 60:	No. 120:	No. 230:								
Finer than Phi Size -->								4	5	6	7	8	9	10	Balance
Grain Size -->	> 4750 microns	4750-2000 microns	2000-1000 microns	1000-500 microns	500-250 microns	250-125 microns	125-62.4 microns	62.5-31.2 microns	31.2-15.6 microns	15.6-7.8 microns	7.8-3.9 microns	3.9-1.9 microns	1.9-0.9 microns	<0.9 microns	
Percent Passing (%) -->	93	90	86	79	71	66	61	53	39	30	25	20	16	0	
Fractional Percent (%) -->	7	3	4	7	8	5	5	8	14	9	5	5	4	16	0

[1] Organics included. Uncorrected for dissolved solids.

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Apparent Sediment Grain Size Distribution [1]
Table 11 (Cont'd)

Sample ID: SD0041D 113932 Trip 2 — 17 % SOLIDS

Sieve Size -->	No. 4:	No. 10:	No. 18:	No. 35:	No. 60:	No. 120:	No. 230:								
Finer than Phi Size -->								4	5	6	7	8	9	10	Balance
Grain Size -->	> 4750 microns	4750-2000 microns	2000-1000 microns	1000-500 microns	500-250 microns	250-125 microns	125-62.4 microns	62.5-31.2 microns	31.2-15.6 microns	15.6-7.8 microns	7.8-3.9 microns	3.9-1.9 microns	1.9-0.9 microns	<0.9 microns	
Percent Passing (%) -->	100	98	94	87	77	70	64	59	46	37	31	26	21	2	
Fractional Percent (%) -->	0	2	4	7	10	7	6	5	13	9	6	5	5	19	2

Sample ID: SD0041D 113932 Trip 3 — 17 % SOLIDS

Sieve Size -->	No. 4:	No. 10:	No. 18:	No. 35:	No. 60:	No. 120:	No. 230:								
Finer than Phi Size -->								4	5	6	7	8	9	10	Balance
Grain Size -->	> 4750 microns	4750-2000 microns	2000-1000 microns	1000-500 microns	500-250 microns	250-125 microns	125-62.4 microns	62.5-31.2 microns	31.2-15.6 microns	15.6-7.8 microns	7.8-3.9 microns	3.9-1.9 microns	1.9-0.9 microns	<0.9 microns	
Percent Passing (%) -->	100	98	95	87	75	67	61	56	44	35	29	24	19	0	
Fractional Percent (%) -->	0	2	3	8	12	8	6	5	12	9	6	5	5	19	0

Sample ID: SD0041E 113933 — 20 % SOLIDS

Sieve Size -->	No. 4:	No. 10:	No. 18:	No. 35:	No. 60:	No. 120:	No. 230:								
Finer than Phi Size -->								4	5	6	7	8	9	10	Balance
Grain Size -->	> 4750 microns	4750-2000 microns	2000-1000 microns	1000-500 microns	500-250 microns	250-125 microns	125-62.4 microns	62.5-31.2 microns	31.2-15.6 microns	15.6-7.8 microns	7.8-3.9 microns	3.9-1.9 microns	1.9-0.9 microns	<0.9 microns	
Percent Passing (%) -->	100	95	89	81	71	64	53	39	29	23	20	15	13	0	
Fractional Percent (%) -->	0	5	6	8	10	7	11	14	10	6	3	5	2	13	0

Sample ID: SD0041F 113934 — 28 % SOLIDS

Sieve Size -->	No. 4:	No. 10:	No. 18:	No. 35:	No. 60:	No. 120:	No. 230:								
Finer than Phi Size -->								4	5	6	7	8	9	10	Balance
Grain Size -->	> 4750 microns	4750-2000 microns	2000-1000 microns	1000-500 microns	500-250 microns	250-125 microns	125-62.4 microns	62.5-31.2 microns	31.2-15.6 microns	15.6-7.8 microns	7.8-3.9 microns	3.9-1.9 microns	1.9-0.9 microns	<0.9 microns	
Percent Passing (%) -->	98	87	75	66	60	55	46	29	22	16	15	12	10	0	
Fractional Percent (%) -->	2	11	12	9	6	5	9	17	7	4	3	3	2	10	0

[1] Organics included Uncorrected for dissolved solids.

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Apparent Sediment Grain Size Distribution [1]
Table 11 (Cont'd)

Sample ID: SD0042A 113940 — 19 % SOLIDS

Sieve Size -->	No. 4:	No. 10:	No. 18:	No. 35:	No. 60:	No. 120:	No. 230:								
Finer than Phi Size -->								4	5	6	7	8	9	10	Balance
Grain Size -->	> 4750 microns	4750-2000 microns	2000-1000 microns	1000-500 microns	500-250 microns	250-125 microns	125-62.4 microns	62.5-31.2 microns	31.2-15.6 microns	15.6-7.8 microns	7.8-3.9 microns	3.9-1.9 microns	1.9-0.9 microns	<0.9 microns	
Percent Passing (%) -->	40	22	18	14	11	9	9	8	7	7	6	6	5	0	
Fractional Percent (%) -->	60	18	4	4	3	2	0	1	1	0	1	0	1	5	0

Sample ID: SD0042B 113941 — 14 % SOLIDS

Sieve Size -->	No. 4:	No. 10:	No. 18:	No. 35:	No. 60:	No. 120:	No. 230:								
Finer than Phi Size -->								4	5	6	7	8	9	10	Balance
Grain Size -->	> 4750 microns	4750-2000 microns	2000-1000 microns	1000-500 microns	500-250 microns	250-125 microns	125-62.4 microns	62.5-31.2 microns	31.2-15.6 microns	15.6-7.8 microns	7.8-3.9 microns	3.9-1.9 microns	1.9-0.9 microns	<0.9 microns	
Percent Passing (%) -->	77	57	45	37	31	28	26	25	24	22	21	20	19	4	
Fractional Percent (%) -->	23	20	12	8	6	3	2	1	1	2	1	1	1	15	4

Sample ID: SD0042C 113942 — 18 % SOLIDS

Sieve Size -->	No. 4:	No. 10:	No. 18:	No. 35:	No. 60:	No. 120:	No. 230:								
Finer than Phi Size -->								4	5	6	7	8	9	10	Balance
Grain Size -->	> 4750 microns	4750-2000 microns	2000-1000 microns	1000-500 microns	500-250 microns	250-125 microns	125-62.4 microns	62.5-31.2 microns	31.2-15.6 microns	15.6-7.8 microns	7.8-3.9 microns	3.9-1.9 microns	1.9-0.9 microns	<0.9 microns	
Percent Passing (%) -->	88	74	62	49	38	31	26	26	24	20	19	17	15	3	
Fractional Percent (%) -->	12	14	12	13	11	7	3	2	2	4	1	2	2	12	3

Sample ID: SD0042D 113949 — 18 % SOLIDS

Sieve Size -->	No. 4:	No. 10:	No. 18:	No. 35:	No. 60:	No. 120:	No. 230:								
Finer than Phi Size -->								4	5	6	7	8	9	10	Balance
Grain Size -->	> 4750 microns	4750-2000 microns	2000-1000 microns	1000-500 microns	500-250 microns	250-125 microns	125-62.4 microns	62.5-31.2 microns	31.2-15.6 microns	15.6-7.8 microns	7.8-3.9 microns	3.9-1.9 microns	1.9-0.9 microns	<0.9 microns	
Percent Passing (%) -->	100	98	93	83	70	58	49	43	33	27	25	21	17	1	
Fractional Percent (%) -->	0	2	5	10	13	12	9	6	10	6	2	4	4	16	1

[1] Organics included Uncorrected for dissolved solids.

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Apparent Sediment Grain Size Distribution [1]

Table 11 (Cont'd)

Sample ID: SD0042E 113950 — 20 % SOLIDS

Sieve Size -->	No. 4:	No. 10:	No. 18:	No. 35:	No. 60:	No. 120:	No. 230:								
Finer than Phi Size -->								4	5	6	7	8	9	10	Balance
Grain Size -->	> 4750 microns	4750-2000 microns	2000-1000 microns	1000-500 microns	500-250 microns	250-125 microns	125-62.4 microns	62.5-31.2 microns	31.2-15.6 microns	15.6-7.8 microns	7.8-3.9 microns	3.9-1.9 microns	1.9-0.9 microns	<0.9 microns	
Percent Passing (%) -->	100	98	93	84	73	62	52	43	31	26	22	19	16	2	
Fractional Percent (%) -->	0	2	5	9	11	11	10	9	12	5	4	3	3	14	2

Sample ID: SD0042F 113951 — 40 % SOLIDS

Sieve Size -->	No. 4:	No. 10:	No. 18:	No. 35:	No. 60:	No. 120:	No. 230:								
Finer than Phi Size -->								4	5	6	7	8	9	10	Balance
Grain Size -->	> 4750 microns	4750-2000 microns	2000-1000 microns	1000-500 microns	500-250 microns	250-125 microns	125-62.4 microns	62.5-31.2 microns	31.2-15.6 microns	15.6-7.8 microns	7.8-3.9 microns	3.9-1.9 microns	1.9-0.9 microns	<0.9 microns	
Percent Passing (%) -->	96	84	76	69	61	52	37	26	18	14	12	10	8	2	
Fractional Percent (%) -->	4	12	8	7	8	9	15	11	8	4	2	2	2	6	2

[1] Organics included. Uncorrected for dissolved solids.

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Table 12: Soil Parameters

Sample Number	Tag Number	Moisture Content[1] %	Specific Gravity[2]	Void Ratio[3]	Total Volatile Solids[4] %
SD0041A	113929	574	1.93	11.62	27.1
SD0041B	113930	565	1.93	11.35	26.8
SD0041C	113931	659	2.02	13.77	32.3
SD0041D	113932	501	2.10	10.75	54.4
SD0041E Dup 1	113933	410	2.18	9.12	66.5
SD0041E Dup 2	113933	ND	2.22	ND	ND
SD0041F	113934	290	2.42	7.18	78.2
SD0042A	113940	418	2.08	8.97	16.2
SD0042B	113941	558	2.38	14.36	22.5
SD0042C	113942	474	2.03	9.93	28.1
SD0042D Dup 1	113949	495	2.10	10.52	49.5
SD0042D Dup 2	113949	483	ND	10.31	48.9
SD0042E	113950	423	2.20	9.54	55.7
SD0042F	113951	137	2.52	3.59	86.4

[1] Moisture Content determined following U.S. COE Engineer Manual No. 1110-2-1906, Appendix I methodology.

[2] Specific Gravity determined following U.S. COE Engineer Manual No. 1110-2-1906, Appendix IV methodology.

[3] Void Ratio determined following U.S. COE Engineer Manual No. 1110-2-1906, Appendix II methodology.

[4]Total Volatile Solids determined following ASTM D2974, Method C.

ND = Not determined

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Table13: Atterberg Limits[1]

Sample Number	Tag Number	Liquid Limit %	Plastic Limit %	Plasticity Index	Soil Classification
SD0041A	113929	ND	ND	ND	PT (Organic matter-coarse wood fibers)
SD0041B	113930	ND	ND	ND	PT (Organic matter-coarse wood fibers)
SD0041C	113931	324	90	234	PT (Organic matter-fine wood fibers)
SD0041D	113932	302	122	180	OH (Woody organic soil)
SD0041E	113933	215	95	120	OH (Woody organic soil)
SD0041F	113934	132	53	79	PT (Organic matter)
SD0042A	113940	ND	ND	ND	PT (Organic matter-wood fibers)
SD0042B	113941	ND	ND	ND	PT (Organic matter-coarse wood fibers)
SD0042C	113942	ND	ND	ND	PT (Organic matter-coarse wood fibers)
SD0042D	113949	246	145	101	PT (Organic matter-fine wood fibers)
SD0042E	113950	240	121	119	OH (Woody organic soil)
SD0042F	113951	92	60	32	PT (Organic matter-fine wood fibers)

[1] Atterberg Limits determined following U.S. COE Engineer Manual No. 1110-2-1906, Appendix III methodology.

ND = Not determined due to the coarse, granular, organic nature of the material and the insufficient amount of fines.

Case Narrative

Samples **SD0041C, SD0041D, SD0041E, SD0041F, SD0042D**, SD0042E, and **SD0042F** were analyzed without air-drying and passage over the U.S. No. 40 sieve as the method states because it was felt that the plasticity properties of this high organic matter sediment would be permanently changed if dried, and the data would not reflect the true nature of the material. Samples **SD0041A, SD0041B, SD0042A, SD0042B**, and **SD0042C** were not analyzed for Atterberg Limits because of the above reason and because the major constituent of these samples was coarse wood fiber. If the samples had been air dried and sieved according to the method, insufficient fines (material passing the U.S. No. 40 sieve) would have been available for the procedure.

SOIL
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LETTER OF TRANSMITTAL

TO: **PTI Environmental Services**
15375 SE 30th Place
Suite 250
Bellevue, WA 98007

Date: October 9, 1997
Job No. J-1082

ATTENTION: **James McAteer**

SUBJECT: **Ketchican Pulp**

We are sending the following items:

Date	Description
10/6/97	Composite 1 Consolidation Summary (Table)
10/6/97	Consolidation Test Results (Graph)
10/6/97	Original Invoice No. 1522

These are transmitted for your use.

REMARKS: Submitting new transmittal and invoice with correct company listed. Disregard previous paperwork issued on October 6, 1997.

Best Regards,
SOIL TECHNOLOGY, INC.

Richard G. Sheets,
Executive Vice President

Ketc[illegible]n Pulp

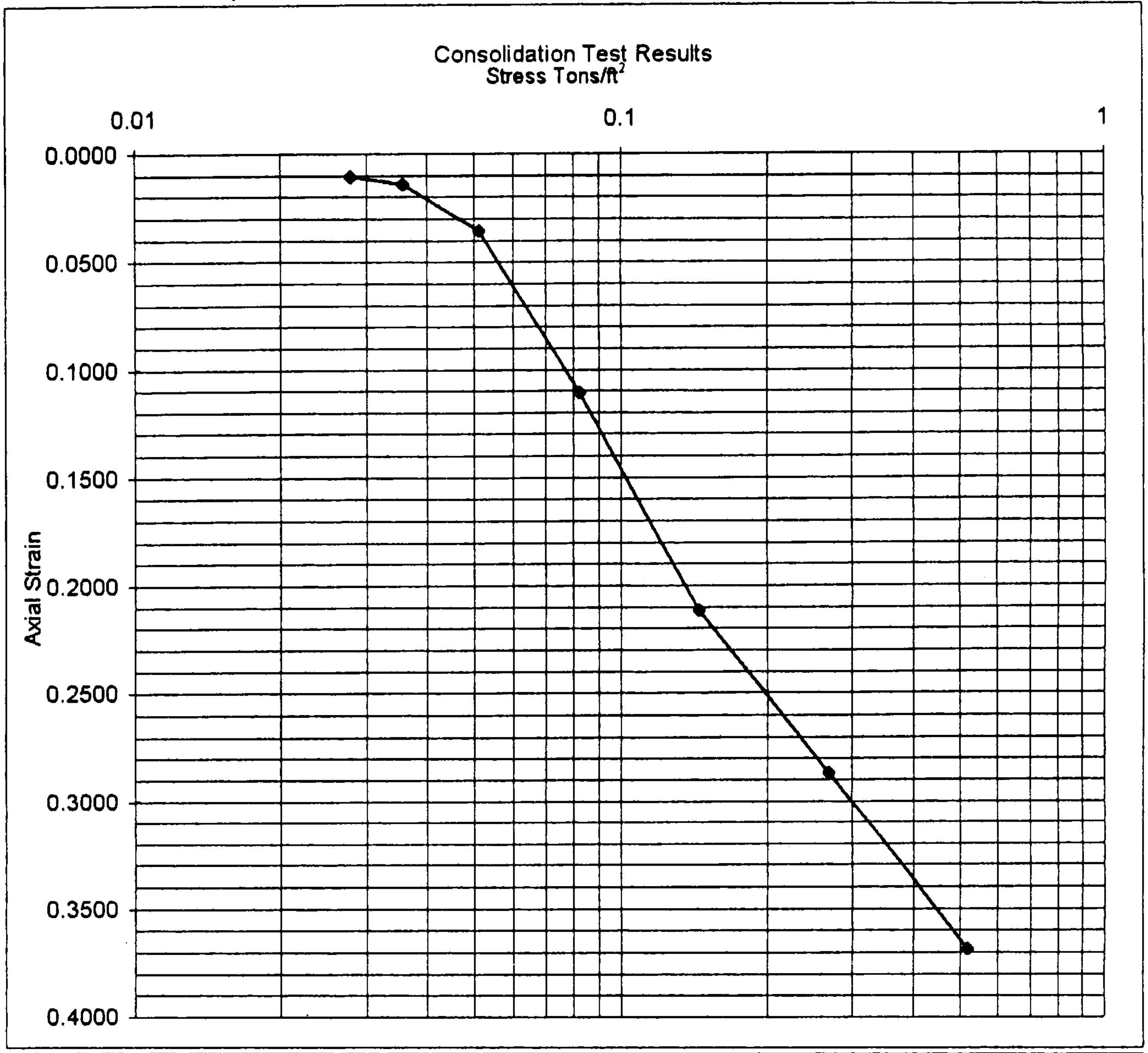
Composite 1 After Settling Column 37 Days Compression

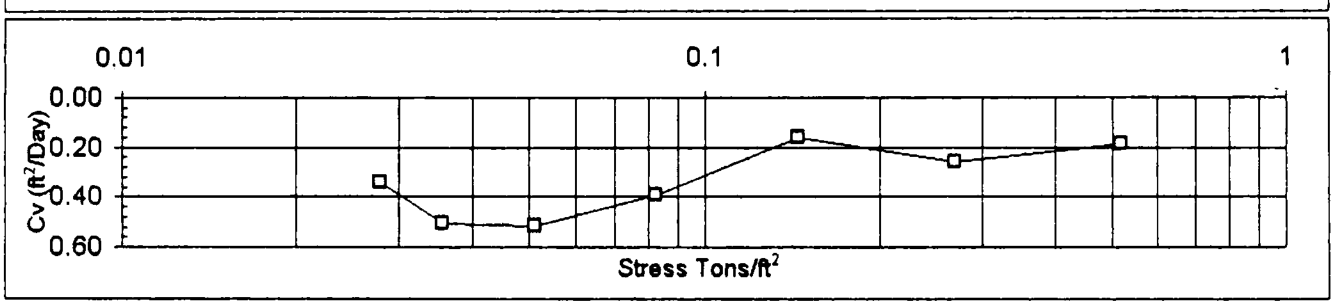
Consol Summary

		d0	d90	d100	df	t90	$\bar{T}$	Cv ft^2/day	Load tsf	Strain Ratio
Job #	J-1082	91.2	102.2	103.4	104	6	9803.4	0.34	0.027864	0.0105
Exploration #	Composite 1	114	137	139.6	140	4	9774.0	0.51	0.035676	0.0141
Sample ID #		150	237	246.7	352	3.8	9650.0	0.52	0.051301	0.0356
Sample Depth (ft)		415.0	980.0	1042.8	1098.0	4.5	9144.5	0.39	0.08255	0.1109
Type of Test	CONSOL	1162.0	1993.0	2085.3	2094.0	9	8273.0	0.16	0.14505	0.2115
Date	9/24/97	2150.0	2750.0	2816.7	2843.0	4.5	7404.5	0.26	0.27005	0.2871
Test by	RS	2890.0	3557.0	3631.1	3647.0	5	6632.5	0.19	0.52005	0.3683
Initial Length (in x 10^{-4})	9901									
Area (ft**2)	0.002841									

Soil Technology, Inc.
J-1082

Ketchican Pulp
Composite 1 After Settling Column 37 Days Compression





Exploration Number	Sample Number	Depth ft	Moisture Content %		Atterberg Limits			Wet Density pcf	Description
			Before	After	LL	PL	PI		
Composite 1	Column	After	317	210	NA	NA	NA	70	Organic Silt PT/OH

Soil Technology, Inc.
J-1082

Appendix B

Appendix B

Quality Assurance Review Summaries—Chemical Analyses and Sediment Toxicity Tests Conducted in 1996 and 1997 and Specialized Toxicity Testing Conducted in 1997

CONTENTS

Appendix B1

Quality Assurance Review Summary—Chemical Analyses Conducted in 1996

QUALITY ASSURANCE REVIEW SUMMARY—CHEMICAL ANALYSES CONDUCTED IN 1996

INTRODUCTION

Exponent performed a quality assurance review of data for chemical analyses of sediment collected in support of the Ward Cove sediment remediation project (PTI 1996). The results of that quality assurance review are presented herein. Details of the sampling procedures are provided in the field sampling plan (PTI 1996). Descriptions of the procedures used for chemical analyses, data validation, and data processing are provided in the quality assurance project plan (PTI 1996) and Section 2 of the main text of this document.

The quality assurance review was conducted to verify that the laboratory quality assurance and quality control procedures were documented and that the quality of the data is sufficiently high to meet the project data quality objectives (DQOs) and support the use of the data for human and ecological risk assessment. Data validation procedures were based on U.S. Environmental Protection Agency (EPA) functional guidelines for evaluating inorganic and organic analyses (U.S. EPA 1994a,b). Data validation was completed to EPA Level 3 specifications (PSEP 1991). Data qualifiers were assigned, as necessary, during the quality assurance reviews in accordance with U.S. EPA (1994a,b), quality control requirements stated in the methods, and the DQOs established for the project (PTI 1996). The following laboratory deliverables were reviewed during the data validation process:

- Chain-of-custody documentation to verify completeness of the data
- The case narrative discussing analytical problems (if any) and procedures
- Sample preparation logs or data summary sheets to verify analytical holding times
- Instrument tuning (organic analyses only), instrument calibration, and calibration blank results to assess instrument performance
- Method blanks associated with each sample delivery group to check for laboratory contamination
- Results for all laboratory quality control check samples including surrogate compounds (organic analyses only), laboratory control samples (LCSs), matrix spikes, laboratory duplicate and triplicate sample

analyses, and internal standards (organic analyses only) to check analytical accuracy and precision

- Instrument and method detection limits (MDLs) for all target analytes.

In addition, results for all field quality control samples (equipment blanks, reference material samples, and duplicate field samples) were reviewed. These results provide additional information in support of the quality assurance review.

A summary of analytes measured at each station is provided in Table 2-1 in the main text. A summary of data for the chemical analyses of the sediment samples is provided in Tables A1-1 through A1-5 in Appendix A1. A complete analyte list is provided in Table B1-1. A summary of laboratory methods used to analyze the samples is provided in Table B1-2.

The compounds 3-methylphenol and 4-methylphenol were not separated by the chromatographic column used for their analysis. These compounds coeluted and were quantified as a single peak that represented the sum of the two compounds. The term 3-/4-methylphenol is used in this report to refer to the sum of these compounds. The sum is expected to represent the concentration of 4-methylphenol exclusively, because 3-methylphenol was previously found to be absent (i.e., less than 20 μg/kg) at the site (ENSR 1995).

COMPLETENESS

The results reported by the laboratory were 100-percent complete. No data were rejected during the quality assurance review.

HOLDING TIMES AND SAMPLE PRESERVATION

The analytical holding time constraints and sample preservation requirements specified in PTI (1996) were met for all samples and analyses, with the exception of analyses conducted for ammonia and biochemical oxygen demand (BOD). Analyses for ammonia on all 34 samples were conducted between 13 and 21 days after the date of collection and met the 28-day holding time constraint specified in U.S. EPA (1983) for water samples. Analyses for BOD on all 32 samples were started between 5 and 10 days from the date of collection. Some of these analyses did not meet the 7-day holding time constraint specified in Puget Sound Estuary Program (PSEP 1986) for sediment samples.

Results reported for BOD were not qualified as estimated because the holding time constraints specified in U.S. EPA (1983) are for water samples and may not be applicable to the analysis of sediment samples. Because the samples were stored in appropriate containers at 4°C until the analyses were initiated, any biological activity (either aerobic or anaerobic) that may affect the concentration of BOD in the environment is expected to be minimal.

TABLE B1-1. SUMMARY OF TARGET ANALYTES

Analyte
Polychlorinated Dibenzo-*p*-dioxin and Polychlorinated Dibenzofuran Congeners
2,3,7,8-Tetrachlorodibenzo-*p*-dioxin (TCDD)
2,3,7,8-Tetrachlorodibenzofuran (TCDF)
1,2,3,7,8-Pentachlorodibenzo-*p*-dioxin (PeCDD)
1,2,3,7,8-Pentachlorodibenzofuran (PeCDF)
2,3,4,7,8-Pentachlorodibenzofuran
1,2,3,4,7,8-Hexachlorodibenzo-*p*-dioxin (HxCDD)
1,2,3,6,7,8-Hexachlorodibenzo-*p*-dioxin
1,2,3,7,8,9-Hexachlorodibenzo-*p*-dioxin
1,2,3,4,7,8-Hexachlorodibenzofuran (HxCDF)
1,2,3,6,7,8-Hexachlorodibenzofuran
1,2,3,7,8,9-Hexachlorodibenzofuran
2,3,4,6,7,8-Hexachlorodibenzofuran
1,2,3,4,6,7,8-Heptachlorodibenzo-*p*-dioxin (HpCDD)
1,2,3,4,6,7,8-Heptachlorodibenzofuran (HpCDF)
1,2,3,4,7,8,9-Heptachlorodibenzofuran
Octachlorodibenzo-*p*-dioxin (OCDD)
Octachlorodibenzofuran (OCDF)
Total TCDD
Total TCDF
Total PeCDD
Total PeCDF
Total HxCDD
Total HxCDF
Total HpCDD
Total HpCDF
Semivolatile Organic Compounds
Low Molecular Weight Polycyclic Aromatic Hydrocarbons
Naphthalene
2-Methylnaphthalene
Acenaphthylene
Acenaphthene
Fluorene
Phenanthrene
Anthracene
High Molecular Weight Polycyclic Aromatic Hydrocarbons
Fluoranthene
Pyrene

TABLE B1-1. (cont.)

Analyte
Benz[a]anthracene
Chrysene
Benzo[b]fluoranthene
Benzo[k]fluoranthene
Benzo[a]pyrene
Indeno[1,2,3-cd]pyrene
Dibenz[a,h]anthracene
Benzo[ghi]perylene
Phenols and Miscellaneous Compounds
Phenol
4-Methylphenol
Benzoic acid
Resin Acids, Fatty Acids, and Bleach Plant Derivatives
Linoleic acid
Oleic acid/linolenic acid
Pimaric acid
Isopimaric acid
Dehydroabietic acid
Abietic acid
9,10-Dichlorostearic acid
14-Chlorodehydroabietic acid
12-Chlorodehydroabietic acid
Dichlorodehydroabietic acid
Chlorinated Phenolic and Related Compounds
Chlorinated Phenols
4-Chlorophenol
2,4-Dichlorophenol
2,6-Dichlorophenol
2,4,5-Trichlorophenol
2,4,6-Trichlorophenol
2,3,4,6-Tetrachlorophenol
Pentachlorophenol
Guaiacols
4-Chloroguaiacol
3,4-Dichloroguaiacol
4,5-Dichloroguaiacol
4,6-Dichloroguaiacol
3,4,5-Trichloroguaiacol
3,4,6-Trichloroguaiacol
4,5,6-Trichloroguaiacol
Tetrachloroguaiacol

TABLE B1-1. (cont.)

Analyte
Catechols
4-Catechol
3,4-Dichlorocatechol
3,6-Dichlorocatechol
4,5-Dichlorocatechol
3,4,5-Trichlorocatechol
3,4,6-Trichlorocatechol
Tetrachlorocatechol
Vanillins
5-Chlorovanillin
6-Chlorovanillin
5,6-Dichlorovanillin
Syringaldehydes
2-Chlorosyringaldehyde
2,6-Dichlorosyringaldehyde
Trichlorosyringol
Metals
Total mercury
Methylmercury
Arsenic
Cadmium
Zinc
Conventional Analytes
Ammonia
Total organic carbon
Total sulfides
Acid-volatile sulfide
Biochemical oxygen demand
Chemical oxygen demand
Grain size
Total solids
Extractable organic halides
Toxicity Tests
Amphipod mortality (*Rhepoxynius abronius)*
Amphipod mortality (*Leptocheirus plumulosus)*
Echinoderm abnormality (*Dendraster excentricus)*
Polychaete growth (*Neanthes* sp.)

TABLE B1-2. SUMMARY OF ANALYTICAL METHODS

Analysis	Preparation Method	Preparation Technique	Analysis Method	Analysis Technique	Method Modification	Laboratory
Conventional Analytes						
Total ammonia	Plumb (1981)	KCl extraction	EPA 350.1M[f]	Colorimetry	Sediment extraction	CAS
Acid-volatile sulfide	EPA Draft 12/91	Acidification/purge and trap	EPA Draft 12/91	Colorimetry	None	CAS
Total sulfide	Plumb (1981)	Distillation/zinc acetate trap	EPA 9030M[a]	Colorimetry	Analysis of sediment	CAS
Total organic carbon	ASTM D4129-82M[e]	Combustion	ASTM D4129-82M[e]	Colorimetry	None	CAS
Biochemical oxygen demand	EPA 405.1M[f]	Incubation	EPA 405.1M[f]	Winkler titration	Analysis of sediment	CAS
Chemical oxygen demand	EPA 410.1M[f]	Oxidation	EPA 410.1M[f]	Titration	Analysis of sediment	CAS
Extractable organic halides	EPA 9020M[a]	Carbon absorption	EPA 9020M[a]	Titration	Analysis of sediment	CAS
Particle size	PSEP (1986)	Desiccation	PSEP (1986)	Sieve and pipet	None	CAS
Total solids	PSEP (1986)	Desiccation, 105°C	PSEP (1986)	Gravimetry	None	CAS
Metals						
Arsenic	EPA 3050[a]	Strong acid digestion	EPA 200.8[f]	ICP/MS	None	CAS
Cadmium	EPA 3050[a]	Strong acid digestion	EPA 200.8[f]	ICP/MS	None	CAS
Methylmercury	Bloom (1989)	Distillation/aqueous phase ethylation	Bloom (1989)	CVAFS	None	FGS
Total mercury	EPA 7471[a]	Acid/permanganate oxidation	EPA 7471[a]	CVAA	None	CAS
Zinc	EPA 3050[a]	Strong acid digestion	EPA 200.8[f]	ICP/MS	None	CAS
Extractable Organic Compounds						
Site SVOCs	EPA 3550[a]	Ultrasonic extraction	EPA 8270[a]	GC/MS-SIM	SIM	CAS
Chlorinated phenolic compounds	EPA 3550[a]	Ultrasonic extraction	EPA 1653[b]	GC/MS	Sediment extraction	CAS
Resin acids and fatty acids	EPA 3550[a]	Ultrasonic extraction	NCASI 85.01[c]	GC/MS	Sediment extraction	CAS
Dioxins and furans	EPA 3540[a]	Automated soxhlet extraction	EPA 8290[d]	HRGC/HRMS	none	Zenon

Note:
ASTM - American Society for Testing and Materials
CAS - Columbia Analytical Services, Inc., Kelso, WA
CVAA - cold vapor atomic absorption
CVAFS - cold vapor atomic fluorescence
EPA - U.S. Environmental Protection Agency
FGS - Frontier Geosciences, Inc., Seattle, WA
GC/MS - gas chromatography/mass spectrometry
GC/MS-SIM - gas chromatography/mass spectrometry-selected ion monitoring
HRGC/HRMS - high resolution gas chromatography/mass spectrometry
ICP/MS - inductively coupled plasma/mass spectrometry
NCASI - National Council of the Paper Industry for Air and Stream Improvement, Inc.
SVOC - semivolatile organic compounds: PAHs, phenol, 3-/4-methylphenol, benzoic acid
Zenon - Zenon Environmental Laboratories, Ontario, Canada

[a] U.S. EPA (1991a).
[b] U.S. EPA (1991b).
[c] NCASI (1986).
[d] U.S. EPA (1994c).
[e] APHA (1985).
[f] U.S. EPA (1983).

INSTRUMENT PERFORMANCE

The performance of the analytical instrument, as documented by the laboratory, was acceptable. No changes in instrument performance that would have resulted in the degradation of data quality were indicated during any analysis sequence.

Initial and Continuing Calibration

Initial and continuing calibrations were completed for all applicable target analytes and met the criteria for acceptable performance and frequency of analysis, with four exceptions. For resin acid and fatty acid analyses, the control limit of ±25 percent difference for continuing calibration verification (CCV) was not met for one compound on June 19, 1996, and for three compounds on June 27, 1996. Data were qualified as described in the following paragraphs.

A relative difference of −252 percent was reported for linoleic acid in the CCV performed on June 19, 1996. This large and negative relative difference reflects an increase in the instrument sensitivity. The instrument response factor for linoleic acid in the CCV (0.237) was greater than the average instrument response factor for the initial calibration (0.067). Samples associated with this CCV included an equipment rinsate blank (Sample KW034) and a method blank. No results were qualified for the CCV exceedance because linoleic acid was not detected in these blanks and the greater instrument sensitivity minimizes the potential for the reporting of false negatives.

For the CCV performed on June 27, 1996, relative differences of −325 percent, +25.7 percent, and −38.1 percent were reported for linoleic acid, 12-chlorodehydroabietic acid, and dichlorodehydroabietic acid, respectively. The affected samples included KW002, KW004, KW007, KW009, KW016, and KW032. The following actions were taken to address the CCV exceedances during the quality assurance review:

- Linoleic acid was not detected in the six samples associated with this CCV. The results (i.e., detection limit values) for these samples were not qualified because the high negative relative difference was the result of increased instrument sensitivity. The response factor for this compound in the CCV (0.287) was greater than the average instrument response factor (0.067) obtained from the initial calibration.

- Results reported for 12-chlorodehydroabietic acid were not qualified because the control limit was exceeded by less than 1 percent.

- Results for dichlorodehydroabietic acid in samples where this compound was detected (Samples KW032, KW004, and KW007) were qualified as estimated (*J*). Dichlorodehydroabietic acid was undetected in the remaining three samples, and the results (i.e., detection limit values) were not qualified. The instrument response factor for this compound in the CCV (0.261) was greater than the average instrument response factor from the initial calibration (0.189).

The CCVs described above and associated samples were not reanalyzed (as was required according to the quality assurance project plan) because of an oversight by the laboratory. However, the overall quality of the affected data was acceptable. Additional support for the acceptable accuracy of the data was provided by the results for the LCSs, which met control limits for linoleic acid (94 percent recovery), 12-chlorodehydroabietic acid (106 percent recovery), and dichlorodehydroabietic acid (84 percent recovery) despite the variations in sensitivity of the analytical system.

Initial and Continuing Calibration Blanks

The initial and continuing calibration blank (ICB and CCB) results met the criteria for acceptable performance. No target analytes were detected in ICBs and CCBs, with one exception. Cadmium was detected in one CCB at a concentration of 0.3 μg/L, which exceeded the instrument detection limit of 0.02 μg/L. No results required qualification for the CCB exceedance because cadmium was present in the 15 associated samples at concentrations greater than 5 times the concentration in the affected CCB.

Method Blank Analyses

Total octachlorodibenzo-*p*-dioxin (OCDD) and 1,2,3,4,6,7,8,9-OCDD were the only analytes detected in any method blank. No results reported for these two analytes required qualification because these analytes were detected in the sediment samples at concentrations greater than 5 times the concentration in the method blank.

ACCURACY

The accuracy of the analytical results is evaluated in the following sections in terms of analytical bias (surrogate compound, matrix spike, LCS recoveries, and internal standards) and precision (duplicate matrix spikes, duplicate LCSs, duplicate sample analyses, or triplicate sample analyses).

Surrogate Compound Recoveries

The recoveries reported by the laboratory for all surrogate compounds (added to all field and quality control samples analyzed for organic compounds) met the criteria for acceptable performance, with the exceptions noted below.

Semivolatile Organic Compounds

Recoveries for the six surrogate compounds added to all samples for semivolatile organic compound (SVOC) analysis could be reported only for Samples KW018, KW033 (an equipment rinsate blank), and KW037 (a reference material sample), all LCSs, and all method blanks. Most of the surrogate compound recoveries could not be reported because the concentrations of specific target analytes were above the upper instrument calibration range, and dilutions were required to bring the target analytes into the calibration range. As a result, surrogate concentrations fell below quantifiable limits. Of the surrogate results that were reported, the following recoveries were below the lower control limit of 50 percent:

- For the LCS extracted on June 6, 1996, low recoveries were reported for 2-fluorophenol (41 percent), 2,4,6-tribromophenol (31 percent), and nitrobenzene-d_5 (39 percent). Low recoveries were also reported for 2-fluorophenol (28 percent), phenol-d_6 (45 percent), and 2,4,6-tribromophenol (3 percent) in the associated method blank.

- For one of two LCSs and the associated method blank extracted on June 11, 1996, low recoveries were reported for 2,4,6-tribromophenol (27 percent and 30 percent, respectively).

- For the LCS extracted on June 14, 1996, low recoveries were reported for 2-fluorophenol (9 percent), phenol-d_6 (30 percent), 2,4,6-tribromophenol (4 percent), and nitrobenzene-d_5 (17 percent). Low recoveries were also reported for 2-fluorophenol (23 percent), phenol-d_6 (40 percent), 2,4,6-tribromophenol (6 percent), and nitrobenzene-d_5 (36 percent) in the associated method blank.

- For Sample KW033 (an equipment rinsate blank), low recoveries were reported for 2-fluorophenol (37 percent), phenol-d_6 (44 percent), and 2,4,6-tribromophenol (8 percent).

- For Sample KW037 (a reference material sample), low recoveries were reported for 2-fluorophenol (36 percent), phenol-d_6 (41 percent), nitrobenzene-d_5 (33 percent), and 2-fluorobiphenyl (36 percent).

Surrogate compound recoveries could be calculated for only three samples (KW018, KW033, and KW037). The low acid surrogate compound recoveries in the LCSs, method blanks, and two of the three samples for which recoveries could be calculated indicate that the acid target analytes (phenol, 3-/4-methylphenol, and benzoic acid) are not efficiently extracted. Because low recoveries were reported for these field and laboratory quality control samples, all results reported for phenol, 3-/4-methylphenol, and benzoic acid in these samples analyzed for SVOCs were qualified as estimated (*J*) during the quality assurance review. These qualified results may exhibit a negative bias.

Phenols

For analyses conducted only for phenol and 3-/4-methylphenol, recoveries for the surrogate compound phenol-d_6 were reported only for Samples KW029, KW034 (an equipment rinsate blank), KW035, KW038 (a reference material sample), all LCSs, and all method blanks. Most of the phenol-d_6 recoveries could not be reported because the concentrations of one or more of the target analytes were above the upper instrument calibration range. The subsequent dilutions conducted on the affected samples resulted in surrogate compound concentrations below quantifiable limits. Of the phenol-d_6 surrogate results that were reported, the following recoveries were below the lower control limit of 50 percent:

- For the two LCSs and two method blanks associated with the sediment samples, recoveries were 50, 30, 45, and 40 percent.
- For Sample KW029, the matrix spike and matrix spike duplicate analyses conducted on Sample KW029, and Sample KW035, recoveries were 18, 45, 45, and 48 percent, respectively.
- For one of the two LCSs associated with the equipment rinsate blank (Sample KW034), a recovery was not reported because the laboratory believes the surrogate compound was not added.

Although recoveries could not be calculated for phenol-d_6 for only four samples, the low phenol-d_6 surrogate compound recoveries reported for the two LCSs, two method blanks, two samples, and duplicate matrix spikes indicate that the phenol and 3-/4-methylphenol may have been extracted with only 20–50 percent efficiency. Because low phenol-d_6 surrogate compound recoveries were reported for the laboratory quality control samples (LCSs and method blanks), all results reported for phenol and 3-/4-methylphenol were qualified as estimated (*J*) during the quality assurance review, except the two samples (KW034 and KW038) for which surrogate recoveries met control limits. These samples were, however, qualified because LCS and matrix spike recoveries did not meet control limits.

Chlorinated Phenolic Compounds

For analyses conducted for chlorinated phenolic compounds (chlorinated phenols, guaiacols, catechols, vanillins, and syringaldehydes), recoveries of several of the isotopically labeled surrogate compounds were below the lower control limits specified in the analytical method. The exceedances are summarized below.

Sample	Percent Recovery							
	2,4-DCP	4-CG	5-CV	4,5-DCC	4,5,6-TCG	PCP	TCG	TCC
KW002	47	42	36	30	35	✓	27	9
KW004	✓	✓	49	9	45	✓	✓	1
KW007	✓	✓	✓	13	✓	✓	✓	11
KW009	✓	✓	✓	20	✓	✓	✓	3
KW016	✓	✓	✓	18	✓	✓	✓	10
KW032	✓	✓	✓	✓	✓	✓	✓	5
KW032 matrix spike	✓	✓	✓	✓	✓	✓	✓	9
KW032 matrix spike duplicate	✓	✓	✓	32	✓	✓	✓	4
KW037	✓	✓	✓	3	✓	✓	✓	10
LCS	21	1,818	24	1	16	✓	17	2
LCS	✓	✓	✓	10	✓	✓	✓	✓
Method blank	42	43	✓	8	✓	✓	✓	✓
Method blank	3	✓	✓	✓	✓	✓	✓	✓
Quality Control Limits	58–135	59–121	51–126	33–129	48–131	8–143	35–120	14–118

Note: 2,4-DCP - 2,4-dichlorophenol-d_3
4-CG - 4-chloroguaiacol-$^{13}C_6$
4,5-DCC - 4,5-dichlorocatechol-$^{13}C_6$
TCG - tetrachloroguaiacol-$^{13}C_6$
✓ - recovery within control limit
4,5,6-TCG - 4,5,6-trichloroguaiacol-$^{13}C_6$
5-CV - 5-chlorovanillin-$^{13}C_6$
PCP - pentachlorophenol-$^{13}C_6$
TCC - tetrachlorocatechol-$^{13}C_6$

The low surrogate compound recoveries reported for Sample KW002, one LCS, and one method blank may be the result of variable extraction efficiency or may reflect incomplete addition of the spiking solution. Both surrogate compound recoveries for catechols were below the lower control limit for all analyses, with the exception of Sample KW032 (only 1 surrogate compound for catechols met control limits), the matrix spike conducted on Sample KW032, and one method blank. The surrogate recovery data suggest generally low extraction efficiency for catechols; therefore, the results reported for all chlorinated catechols were qualified as estimated (*J*) during the quality assurance review.

Resin Acids and Fatty Acids

Recoveries of 33 and 25 percent reported for the two surrogate compounds for resin acids and fatty acids (heptadecanoic acid and *o*-methylpodocarpic acid, respectively) were below the lower control limit of 50 percent in Sample KW016. Results for the 10 target analytes reported for this sample were qualified as estimated (*J*) during the quality assurance review. For Sample KW007, a recovery of 174 percent was reported for *o*-methylpodocarpic acid, which exceeds the upper control limit of 150 percent. The seven target analytes detected in this sample were qualified as estimated (*J*) during the quality assurance review; undetected results are acceptable as reported.

Matrix Spike Recoveries

The recoveries reported by the laboratory for matrix and duplicate matrix spike analyses and the frequency of analysis met the criteria for acceptable performance, with the exceptions noted below. Matrix spike data were not reported for the semivolatile analyses because the samples required dilutions to bring the analytes into calibration range. As a result of the dilutions, the spiking compounds could not be detected.

Phenols

The lower control limit of 50 percent recovery for phenols was not met in two instances. Recoveries of 43 and 48 percent were reported for phenol for the matrix spike and matrix spike duplicate analyses, respectively, conducted on Sample KW029. The results for phenol and 3-/4-methylphenol in Samples KW034 and KW038 were qualified as estimated for this exceedance. The remaining sample results were not additionally qualified for these exceedances because all phenol and 3-/4-methylphenol data were previously qualified for surrogate compound exceedances.

Chlorinated Phenolic Compounds

The lower control limit of 50 percent recovery was not met for 6 of the 56 spike recoveries reported for chlorinated phenolic compounds. For the matrix spike analysis conducted on Sample KW032, low recoveries were reported for 3,4,6-trichlorocatechol (32 percent) and 3,4,5-trichlorocatechol (46 percent). For the matrix spike duplicate sample, low recoveries were reported for 3,6-dichlorocatechol (15 percent); 3,4,6-trichlorocatechol (8 percent); 3,4,5-trichlorocatechol (11 percent); and tetrachlorocatechol (19 percent). Although the catechol target analytes were previously qualified because of low surrogate compound recoveries, the matrix spike data further indicate all results reported for the catechol target analytes are biased low.

Resin Acids and Fatty Acids

The upper control limit of 150 percent recovery was exceeded for 3 of the 24 spike recoveries reported for resin acids and fatty acids. The affected spiking compounds included the coeluted compounds oleic acid/linolenic acid (162 percent), dehydroabietic acid (159 percent), and abietic acid (185 percent) in the matrix spike duplicate analysis conducted on Sample KW018. Results reported for the affected analytes were not qualified because the recoveries reported for these compounds in the primary matrix spike sample were acceptable.

Polychlorinated Dibenzo-*p*-dioxins and Polychlorinated Dibenzofurans

The upper control limit of 135 percent recovery was exceeded for one spiking compound. Recoveries of 164 and 146 percent were reported for 1,2,3,4,6,7,9-OCDD in the matrix spike and matrix spike duplicate analysis, respectively, conducted on Sample KW027. Results reported for this compound were not qualified because sample data are not qualified solely on the basis on matrix spike results, and results reported for other quality control measurement data (surrogate and LCS recoveries) were acceptable.

Laboratory Control Sample Recoveries

The recoveries reported by the laboratory for all LCS and duplicate LCS analyses and the frequency of analysis met the criteria for acceptable performance, with the exceptions noted below.

Conventional Analytes

For acid-volatile sulfides, the lower control limit of 50 percent recovery was not met for two LCS analyses (47 and 49 percent). No data were qualified for these exceedances because all matrix spike recoveries were acceptable, and the LCS recoveries were only slightly below the lower control limit.

Semivolatile Organic Compounds

The lower control limit of 50 percent recovery was not met for acenaphthene (46 percent) in one set of duplicate LCSs and phenol (46 percent) in a separate LCS. No data were qualified for these exceedances because results reported for these compounds in all other LCS analyses were acceptable.

Chlorinated Phenolic Compounds

For chlorinated phenolic compounds, the lower control limit of 50 percent recovery was not met for 10 of the 56 LCS recoveries reported. For two sets of LCSs, low recoveries were reported for 4-chlorocatechol (less than 1 and 0 percent); 3,6-dichlorocatechol (16 and 3 percent); 3,4-dichlorocatechol (4 and 3 percent); 3,4,6-trichlorocatechol (25 and 3 percent); and 3,4,5-trichlorocatechol (37 and 8 percent). Although the catechol target analytes were previously qualified for low surrogate compound recoveries, the LCS data provide further indication that the results reported for catechol target analytes are biased low.

Resin Acids and Fatty Acids

The upper control limit of 150 percent recovery was exceeded for abietic acid (640 and 434 percent) for two LCS analyses. Because the LCS recoveries were highly elevated, all detected results reported for abietic acid were qualified as estimated (*J*) during the quality assurance review.

Internal Standard Performance

Criteria for retention time and area count were met of all internal standards added to all samples analyzed for organic target analytes, with the exceptions noted below.

Semivolatile Organic Compounds

The upper control limit for internal standard area was exceeded for perylene-d_{12} on analyses of SVOCs conducted on Samples KW003, KW004, and KW018. The detected results reported for Samples KW003 and KW004 for the four target analytes quantified using the perylene-d_{12} internal standard were qualified as estimated (*J*); the affected analytes are benzo[b]fluoranthene, benzo[k]fluoranthene, benzo[a]pyrene, and indeno[1,2,3-cd]pyrene. Results reported for Sample KW018 did not require qualification because the affected analytes were not detected in this sample.

Chlorinated Phenolic Compounds

The lower control limit for the sample matrix internal standard (3,4,5-trichlorophenol) area was not met for analyses of chlorinated phenolic compounds conducted on Sample KW002, one LCS, and one method blank. Results reported for Sample KW002 were previously qualified as estimated (*J*) for low surrogate recoveries, and were not additionally qualified. Results reported for the affected LCS and method blank were not qualified because these data are used for quality control purposes only.

Resin Acids and Fatty Acids

The lower control limit for the internal standard area was not met for perylene-d_{12} for analyses of resin acids and fatty acids conducted on Samples KW004 and KW007. The only analyte quantified using the internal standard perylene-d_{12} is dichlorodehydroabietic acid. The results reported for this analyte in Samples KW004 and KW007 were previously qualified as estimated (*J*) for calibration exceedances.

Precision

The results reported by the laboratory for duplicate analyses and applicable triplicate analyses and the frequency of analysis met the criteria for acceptable performance, with three exceptions. The control limit of ±50 percent difference for matrix spike duplicate analyses was not met for three resin acid and fatty acid analytes. The affected analytes were linoleic acid (57 percent), coeluted oleic acid/linolenic acid (70 percent), and abietic acid (60 percent). No data were qualified for the duplicate matrix spike differences because data are not qualified solely on the basis of these results.

METHOD DETECTION LIMITS AND METHOD REPORTING LIMITS

For the analysis of polycyclic aromatic hydrocarbons (PAHs), phenol, and 3-/4-methylphenol, both MDLs and method reporting limits (MRLs) were reported by the laboratory. The MDLs and MRLs met project DQOs (PTI 1996); however, elevated MRLs were reported for some samples and target analytes. Elevated MRLs were reported because dilutions were necessary to conduct the analyses because elevated concentrations of target analytes, matrix interferences present in the samples, or both prevented reliable identification and quantification of the target analytes. Additionally, results reported as detected at concentrations above the MDL but less than the MRL were qualified as estimated (*J*) by the laboratory. These results were qualified because quantifications of concentrations in this range are less precise than concentrations above the MRL.

FIELD QUALITY CONTROL SAMPLES

The results for all field quality control samples were acceptable. The field quality control samples included two equipment rinsate blanks, two sets of field duplicate samples, and three reference material samples.

Equipment Rinsate Blanks

Two equipment rinsate blanks (Samples KW033 and KW034) were submitted to the laboratory. Analyses were conducted for all target analytes, with the exception of BOD, chemical oxygen demand, grain size distribution, and total solids. No target analytes were detected at concentrations above the MRLs. A summary of results for the equipment rinsate blanks is presented in Table B1-3.

Field Duplicates

Results were reported for two sets of field duplicates. Samples KW002 and KW032 (Station 2) constitute one set of field duplicates and Samples KW024 and KW031

TABLE B1-3. RESULTS FOR EQUIPMENT RINSATE BLANKS

Analyte	Units	W033 06/05/96 08:05 KW033 EBLANK	W034 06/05/96 13:40 KW034 EBLANK
Conventional Analytes			
Ammonia-nitrogen	mg/L	0.80 *U*	0.80 *U*
Acid-volatile sulfide	mg/L	2.0 *U*	
Sulfides	mg/L	20 *U*	20 *U*
Total organic carbon	percent	0.050 *U*	0.050 *U*
Extractable organic halides	mg/L	10 *U*	
Metals			
Arsenic	mg/L	0.10 *U*	
Cadmium	mg/L	0.0040 *U*	0.0040 *U*
Total mercury	mg/L	0.10 *U*	0.10 *U*
Methylmercury	µg/L	0.00020	
Zinc	mg/L	0.10 *U*	0.10 *U*
Semivolatile Organic Compounds			
Benz[a]anthracene	µg/L	10 *U*	
Benzo[b]fluoranthene	µg/L	10 *U*	
Benzo[k]fluoranthene	µg/L	10 *U*	
Total benzofluoranthenes (b + k)	µg/L	20 *U*	
Benzo[a]pyrene	µg/L	10 *U*	
Chrysene	µg/L	10 *U*	
Indeno[1,2,3-cd]pyrene	µg/L	10 *U*	
Fluoranthene	µg/L	10 *U*	
Pyrene	µg/L	10 *U*	
Dibenzo[a,h]pyrene	µg/L	10 *U*	
Benzo[ghi]perylene	µg/L	10 *U*	
Acenaphthene	µg/L	10 *U*	
Anthracene	µg/L	10 *U*	
Fluorene	µg/L	10 *U*	
Naphthalene	µg/L	10 *U*	
2-Methylnaphthalene	µg/L	10 *U*	
Acenaphthylene	µg/L	10 *U*	
Phenanthrene	µg/L	10 *U*	
Phenol	µg/L	20 *U*	20 *U*
3- and 4-Methylphenol	µg/L	20 *U*	20 *U*
Benzoic acid	µg/L	100 *U*	
Dibenzofuran	µg/L	10 *U*	
Pulp Mill Compounds			
4-Chlorophenol (parachlorophenol)	mg/L		0.50 *U*
2,4-Dichlorophenol	mg/L		0.50 *U*
2,6-Dichlorophenol	mg/L		0.50 *U*
2,4,5-Trichlorophenol	mg/L		0.50 *U*
2,4,6-Trichlorophenol	mg/L		0.50 *U*
2,3,4,6-Tetrachlorophenol	mg/L		0.50 *U*
Pentachlorophenol	mg/L		0.50 *U*
4-Chloroguaiacol	mg/L		0.50 *U*
3,4-Dichloroguaiacol	mg/L		0.50 *U*
4,5-Dichloroguaiacol	mg/L		0.50 *U*
4,6-Dichloroguaiacol	mg/L		0.50 *U*
3,4,5-Trichloroguaiacol	mg/L		0.50 *U*
3,4,6-Trichloroguaiacol	mg/L		0.50 *U*
4,5,6-Trichloroguaiacol	mg/L		0.50 *U*
Tetrachloroguaiacol	mg/L		0.50 *U*
4-Chlorocatechol	mg/L		0.50 *U*

TABLE B1-3. (cont.)

Analyte	Units	W033 06/05/96 08:05 KW033 EBLANK	W034 06/05/96 13:40 KW034 EBLANK
3,4-Dichlorocatechol	mg/L		0.50 *U*
3,6-Dichlorocatechol	mg/L		0.50 *U*
4,5-Dichlorocatechol	mg/L		0.50 *U*
3,4,5-Trichlorocatechol	mg/L		0.50 *U*
3,4,6-Trichlorocatechol	mg/L		0.50 *U*
Tetrachlorocatechol	mg/L		0.50 *U*
5-Chlorovanillin	mg/L		0.50 *U*
6-Chlorovanillin	mg/L		0.50 *U*
5,6-Dichlorovanillin	mg/L		0.50 *U*
2-Chlorosyringaldehyde	mg/L		0.50 *U*
2,6-Dichlorosyringaldehyde	mg/L		0.50 *U*
Trichlorosyringol	mg/L		0.50 *U*
Abietic acid	µg/L		40 *U*
Dehydroabietic acid	µg/L		40 *U*
12-Chlorodehydroabietic acid	µg/L		40 *U*
14-Chlorodehydroabietic acid	µg/L		40 *U*
Dichlorodehydroabietic acid	µg/L		40 *U*
9,10-Dichlorostearic acid	µg/L		40 *U*
Pimaric acid	µg/L		40 *U*
Isopimaric acid	µg/L		40 *U*
Linoleic acid	µg/L		40 *U*
Oleic/Linolenic acid	µg/L		40 *U*
Dioxins and Furans			
2,3,7,8-Tetrachlorodibenzodioxin	pg/L	0.016 *U*	
1,2,3,7,8-Pentachlorodibenzo-*p*-dioxin	pg/L	0.017 *U*	
1,2,3,4,7,8-Hexachlorodibenzo-*p*-dioxin	pg/L	0.017 *U*	
1,2,3,6,7,8-Hexachlorodibenzo-*p*-dioxin	pg/L	0.017 *U*	
1,2,3,7,8,9-Hexachlorodibenzo-*p*-dioxin	pg/L	0.017 *U*	
1,2,3,4,6,7,8-Heptachlorodibenzo-*p*-dioxin	pg/L	0.043 *U*	
1,2,3,4,6,7,8,9-Octachlorodibenzo-*p*-dioxin	pg/L	0.050	
2,3,7,8-Tetrachlorodibenzofuran	pg/L	0.015 *U*	
1,2,3,7,8-Pentachlorodibenzofuran	pg/L	0.014 *U*	
2,3,4,7,8-Pentachlorodibenzofuran	pg/L	0.015 *U*	
1,2,3,4,7,8-Hexachlorodibenzofuran	pg/L	0.013 *U*	
1,2,3,6,7,8-Hexachlorodibenzofuran	pg/L	0.014 *U*	
1,2,3,7,8,9-Hexachlorodibenzofuran	pg/L	0.020 *U*	
2,3,4,6,7,8-Hexachlorodibenzofuran	pg/L	0.017 *U*	
1,2,3,4,6,7,8-Heptachlorodibenzofuran	pg/L	0.023 *U*	
1,2,3,4,7,8,9-Heptachlorodibenzofuran	pg/L	0.033 *U*	
1,2,3,4,6,7,8,9-Octachlorodibenzofuran	pg/L	0.048 *U*	
Total tetrachlorodibenzo-*p*-dioxins	pg/L	0.016 *U*	
Total pentachlorodibenzo-*p*-dioxins	pg/L	0.017 *U*	
Total hexachlorodibenzo-*p*-dioxins	pg/L	0.017 *U*	
Total heptachlorodibenzo-*p*-dioxins	pg/L	0.043 *U*	
Octachlorodibenzo-*p*-dioxin	pg/L	0.050	
Total tetrachlorodibenzofurans	pg/L	0.015 *U*	
Total pentachlorodibenzofurans	pg/L	0.014 *U*	
Total hexachlorodibenzofurans	pg/L	0.016 *U*	
Total heptachlorodibenzofurans	pg/L	0.027 *U*	
Octachlorodibenzofuran	pg/L	0.048 *U*	

Note: *U* - undetected

(Station 24) constitute the second set of field duplicates. The field duplicates collected are co-located samples. They provide information regarding variability in analyte concentration in the area from which they were collected and are not used to assess laboratory precision.

Reference Material Samples

Five reference material samples (three for metals and two for SVOCs) were submitted to the laboratory.

Reference material samples for metals consisted of two samples of BCSS-1 (an estuarine sediment from the Gulf of St. Lawrence prepared by the National Resource Council of Canada, Ontario, Canada) and one sample of PACS-1 (a sediment from Esquimalt Harbor in British Columbia). One sample of BCSS-1 (Sample KW0036A) was analyzed for cadmium and zinc. A recovery of 64 percent reported for zinc in this sample is below the lower control limit of 75 percent. The other sample of BCSS-1 (Sample KW036B) was analyzed for arsenic, cadmium, and zinc. Recoveries of 62 and 66 percent were reported for arsenic and zinc, respectively, and were below the lower control limit of 75 percent. Sample results were not qualified for these exceedances because the results reported for the matrix spike and LCS analyses were acceptable. Recoveries for cadmium in both of the BCSS-1 reference material samples met control limits. The sample of PACS-1 was analyzed for total mercury, and the recovery met control limits.

Two samples of the SQ-1 reference material (a marine sediment prepared by the National Oceanic and Atmospheric Administration, Seattle, Washington) were submitted to the laboratory for the analysis of selected organic compounds. For one SQ-1 reference material, analyses were conducted for 16 PAHs, phenol, pentachlorophenol, and tetrachloroguaiacol. Recoveries were below the lower control limit (50 percent) for 2-methylnaphthalene (21 percent); acenaphthene (34 percent); acenaphthylene (16 percent); benzo(ghi)perylene (40 percent); and naphthalene (13 percent). Recoveries were not calculated for phenol, pentachlorophenol, and tetrachloroguaiacol in Sample KW037 because these analytes were reported as undetected. The second SQ-1 sample was analyzed for phenol only, and no recovery was calculated because this compound was reported as undetected. Additional qualifiers were not applied to the sediment sample results on the basis of the low reference material recoveries because these recoveries were generally not consistent with results for surrogate compounds, matrix spikes, and LCSs. A summary of results for the reference materials is presented in Table B1-4.

REFERENCES

APHA. 1985. Standard methods for the examination of water and wastewater. 16th Edition. American Public Health Association, Washington, DC.

TABLE B1-4. ANALYTE RECOVERY FROM REFERENCE MATERIALS

Sample Number	Analyte	True Value	Sample Result	Percent Recovery
SRM BCSS-1, NRCC Estuarine Sediment (mg/kg)				
KW036A	Cadmium	0.25	0.26	104
	Zinc	119	75.6	64
KW036B	Arsenic	11.1	6.9	62
	Cadmium	0.25	0.27	108
	Zinc	119	78.2	66
SRM PACS-1 (mg/kg)				
KW036	Mercury	4.57	5	109
SRM SQ-1A, Sequim Bay Sediment (μg/kg)				
KW037	2-Methylnaphthalene	170	36	21
	Dibenz[a,h]anthracene	170	100	59
	3- and 4-Methylphenol	509	130	26
	Pentachlorophenol	509	1,600 *U*	-- [a]
	Acenaphthene	170	57	34
	Acenaphthylene	170	28	16
	Anthracene	170	98	58
	Benz[a]anthracene	170	110	63
	Benz[a]pyrene	170	10 *U*	-- [a]
	Benzo[b]fluoranthene	170	95	56
	Benzo[ghi]perylene	170	84	49
	Chrysene	170	92	54
	Fluoranthrene	170	130	75
	Fluorene	170	80	47
	Indeno[1,2,3-cd]pyrene	170	10 *U*	-- [a]
	Naphthalene	170	22	13
	Phenanthrene	170	120	69
	Phenol	560	29	5.2
	Pyrene	170	110	66
	Tetrachloroguaiacol	509	1,600 *U*	-- [a]
KW038	3- and 4-Methylphenol	509	31	6.1
	Phenol	560	16	2.9

Note: Samples analyzed by Columbia Analytical Services as part of sample delivery group BOWKW0220.

[a] The analyte was undetected in the sample.

Bloom, N. 1989. Determination of picogram levels of methylmercury by aqueous phase ethylation, followed by cryogenic gas phase ethylation with cold vapor atomic fluorescence detection. Can. J. Fish Aq. Sci. 7:1131.

ENSR. 1995. Annual sediment monitoring report, NPDES Permit No. AK-000092-2. Prepared for Ketchikan Pulp Company, Ketchikan, AK. ENSR Consulting and Engineering.

NCASI. 1986. Procedures for the analysis of resin and fatty acids in pulp mill effluents. National Council of the Paper Industry for Air and Stream Improvement, Inc., New York, NY.

Plumb, R.H., Jr. 1981. Procedures for handling and chemical analyses of sediment and water samples. Technical Report EPA/CE-81-1. U.S. Environmental Protection Agency and U.S. Army Corps of Engineers, Waterways Experiment Station, Vicksburg, MS.

PSEP. 1986. Recommended protocols for measuring conventional sediment variables in Puget Sound. Prepared for U.S. Environmental Protection Agency Region 10, Office of Puget Sound, Seattle, WA.

PSEP. 1991. A project manager's guide to requesting and evaluating chemical analyses. Prepared by PTI Environmental Services, Bellevue, WA. U.S. Environmental Protection Agency Region 10, Puget Sound Estuary Program, Seattle, WA.

PTI. 1996. Ward Cove sediment remediation project technical studies work plan. Prepared for Ketchikan Pulp Company, Ketchikan, Alaska. PTI Environmental Services, Bellevue, WA.

U.S. EPA. 1983. Methods for chemical analysis of water and wastes. EPA 600/4-79-020. U.S. Environmental Protection Agency Environmental Monitoring and Support Laboratory, Cincinnati, OH.

U.S. EPA. 1991a. Test methods for evaluating solid waste – physical/chemical methods, SW-846. Revised Methods. Third Edition. U.S. Environmental Protection Agency, Washington, DC.

U.S. EPA 1991b. Method 1653. Chlorinated phenolics in waste water by *in-situ* acetylation and GCMS. U.S. Environmental Protection Agency, Washington, DC.

U.S. EPA. 1994a. USEPA contract laboratory program national functional guidelines for inorganic data review. U.S. Environmental Protection Agency, Office of Solid Waste and Emergency Response, Washington, DC.

U.S. EPA. 1994b. USEPA contract laboratory program national functional guidelines for organic data review. U.S. Environmental Protection Agency, Office of Solid Waste and Emergency Response, Washington, DC.

U.S. EPA. 1994c. Polychlorinated dibenzo-*p*-dioxins (PCDDs) and polychlorinated dibenzofurans (PCDFs) by high resolution gas chromatography/high resolution mass spectrometry (HRGC/HRMS). SW-846 Method 8290. Revision 0. U.S. Environmental Protection Agency, Washington, DC.

Appendix B2

Quality Assurance Review Summary—Chemical Analyses Conducted in 1997

QUALITY ASSURANCE REVIEW SUMMARY— CHEMICAL ANALYSES CONDUCTED IN 1997

INTRODUCTION

Exponent performed a quality assurance review of data for chemical analyses of surface sediment, subsurface sediment, bottom water, elutriate, and equipment rinsate blanks and for engineering properties (i.e., geotechnical parameters) of sediment samples collected in support of the Ward Cove Phase 2 sediment remediation project (PTI 1997). The results of that quality assurance review are presented herein. Details of the sampling procedures are provided in the field sampling plan (PTI 1997). Descriptions of the procedures used for chemical analyses, data validation, and data processing are provided in the quality assurance project plans (QAPPs) (PTI 1996 and 1997) and Section 2 of the main text of this document.

The quality assurance review was conducted to verify that the laboratory quality assurance and quality control procedures were documented and that the quality of the data is sufficient to meet the project data quality objectives (DQOs) and support the use of the data for its intended purposes. Data validation procedures and qualifier assignments were based on U.S. Environmental Protection Agency (EPA) Contract Laboratory Program national functional guidelines for dioxin/furan data validation (U.S. EPA 1993), inorganic data review (U.S. EPA 1994d), and organic data review (U.S. EPA 1994f), as applicable. Modifications of data validation procedures were made, as appropriate, to accommodate project-specific DQOs and quality control requirements for methods not specifically addressed by the national functional guidelines documents (e.g., conventional analyses). Data validation was completed to EPA Level 3 specifications (U.S. EPA 1995, PSEP 1991). The following laboratory deliverables were reviewed during the data validation process:

- Chain-of-custody documentation to verify completeness of the data
- The case narrative discussing analytical problems (if any) and procedures
- Sample preparation logs or data summary sheets to verify analytical holding times
- Applicable instrument tuning, instrument calibration, and calibration blank results to assess instrument performance
- Applicable method blanks associated with each sample delivery group (SDG) to check for laboratory contamination

- Results for all applicable laboratory quality control check samples including surrogate compounds (organic analyses only), laboratory control samples (LCSs), matrix spikes, laboratory duplicate and triplicate sample analyses, and internal standards (metals and organic analyses only) to check analytical accuracy and precision

- Applicable instrument and method detection limits for all target analytes.

In addition, results for all field quality control samples (equipment blanks and duplicate field samples) were reviewed. These results provide additional information in support of the quality assurance review.

A summary of data for the chemical and geotechnical parameters of the samples for all matrices collected in 1997 is provided in Appendix A1 and Appendix A4. A complete analyte list is provided in Table B2-1. Summaries of the DQOs and analytical methods used to analyze the samples are provided in Tables B2-2 and B2-3, respectively.

The compounds 3-methylphenol and 4-methylphenol were not separated by the chromatographic column used for their analysis on all samples. These compounds coeluted and were quantified as a single peak that represented the sum of the two compounds. The term 3-/4-methylphenol is used in this report to refer to the sum of these compounds. The sum is expected to represent the concentration of 4-methylphenol exclusively, because 3-methylphenol was previously found to be absent (i.e., less than 20 μg/kg) at the site (ENSR 1995).

COMPLETENESS

The results reported by the laboratory were 99.9-percent complete. No data were rejected during the quality assurance review. Analyses for extractable organic halides (EOX) in surface sediment Sample SD0023 and sulfides in subsurface sediment Sample SD0046A collected from Station SD-7 and Sample SD0049A collected from Station SD-49 were not completed because of an error by the laboratory. Desiccation characteristics could not be determined by the laboratory because the samples were predominantly composed of organic matter and not cohesive sediment, which is required to determine desiccation characteristics. The lack of this data is not a reflection of poor laboratory performance, but is due to the physical nature of the material collected.

TABLE B2-1. TARGET ANALYTES FOR THE PHASE 2 SEDIMENT INVESTIGATION

Surface Sediment Characterization

Sediment Toxicity Tests
- 10-Day amphipod test (static)
- 10-Day amphipod test (static-renewal)
- 96-Hour echinoderm embryo test
- Specialized toxicity tests (described in Appendix F of the FSP)

Sediment Chemistry
- Total ammonia
- Total organic carbon
- Total sulfide
- Acid-volatile sulfide[a]
- Biochemical oxygen demand
- Chemical oxygen demand
- Grain size
- Total solids
- Arsenic[a]
- Cadmium[a]
- Methylmercury[a]
- Total mercury[a]
- Zinc[a]
- Phenol[a]
- 4-Methylphenol
- Dioxin and furan congeners[a]
- Polycyclic aromatic hydrocarbons[a]
- Benzoic acid[a]
- Extractable organic halides[a]

Pore Water Analyses (to support specialized toxicity tests)
- Total ammonia
- Total sulfide
- Salinity
- pH

Sediment Accumulation Testing
- Cesium-137
- Lead-210
- Grain size
- Total solids

Sediment Column Characterization

Sediment Chemistry
- Total ammonia
- Total organic carbon
- Total sulfide
- Biochemical oxygen demand
- Chemical oxygen demand
- Grain size
- Total solids
- Cadmium
- Total mercury
- Zinc
- Phenol
- 4-Methylphenol
- Dioxin and furan congeners

Engineering Properties
- Modified elutriate test
- Dredging elutriate test
- Water samples (to support elutriate tests; analyzed for TSS)
- Column settling test
- One-dimensional consolidation test
- Desiccation characteristics
- Physical properties
- Grain size
- Water content and void ratio
- Specific gravity
- Atterberg limits (liquid and plasticity limits)

Sediment Elutriate Chemistry
- Total ammonia
- Total suspended solids
- Cadmium (total and dissolved)
- Total mercury (total and dissolved)
- Zinc (total and dissolved)
- Phenol (total and dissolved)
- 4-Methylphenol (total and dissolved)
- Dioxin and furan congeners (total and dissolved)

Note: See Table 3-1 in the main text of the FSP (PTI 1997) for a summary of analytes by station.

FSP - field sampling plan
NPDES - National Pollutant Discharge Elimination System
TSS - total suspended solids

[a] NPDES stations only.

TABLE B2-2. SUMMARY OF DATA QUALITY OBJECTIVES

Analysis	Method Reference	Units	Method Reporting Limit[a]	Bias (percent)	Precision (RPD)	Completeness (percent)
Sediment[b]						
Toxicity Tests						
Amphipod mortality (*R. abronius*)	PSEP (1995)	percent survival, percent non-reburial	--	--	--	100
Echinoderm abnormality (*D. excentricus*)	PSEP (1995)	percent survival, percent normality	--	--	--	100
Conventional Analyses						
Total ammonia	EPA 350.1M	mg/kg	1	75–125	±35	95
Total organic carbon	PSEP (1986)	percent	0.05	75–125	±35	95
Total sulfide	EPA 9030	mg/kg	20	50–150	±50	95
Acid-volatile sulfide	EPA Draft 12/91	mg/kg	4	50–150	±50	95
Biochemical oxygen demand	PSEP (1986)	mg/kg	200	75–125	±25	95
Chemical oxygen demand	EPA 410.1M	mg/kg	500	75–125	±25	95
Grain size	PSEP (1986)	percent	0.1	--	±35	95
Total solids	EPA 160.3M	weight percent	0.1	--	±35	95
Metals						
Arsenic	EPA 200.8	mg/kg	0.5	75–125	±35	95
Cadmium	EPA 200.8	mg/kg	0.02	75–125	±35	95
Methylmercury	Bloom (1989)	µg/kg	0.05	50–150	±50	95
Total mercury	EPA 7471	mg/kg	0.2	75–125	±35	95
Zinc	EPA 200.8	mg/kg	0.5	75–125	±35	95
Organic Compounds						
Phenol, 4-methylphenol	GC/MS with SIM	µg/kg	10	50–150	±50	95
Dioxin and furan congeners	EPA 8290/1613	ng/kg	1–10	50–150	±50	95

TABLE B2-2. (cont.)

Analysis	Method Reference	Units	Method Reporting Limit[a]	Bias (percent)	Precision (RPD)	Completeness (percent)
PAHs, benzoic acid	GC/MS with SIM	μg/kg	10	50–150	±50	95
Extractable organic halides	EPA 9020M	mg/kg	150	50–150	±50	95
Radionuclides						
Cesium-137	Laboratory SOP[b]	dpm/g	0.1	75–125	±35	95
Lead-210	Laboratory SOP[b]	dpm/g	0.1	75–125	±35	95
Engineering Properties						
Column settling testing	U.S. COE (1987)				±15	95
Consolidation testing	U.S. COE (1980, 1987)	coefficient of consolidation and stress vs. strain		--	±15	95
Desiccation characteristics	Stark (1989)		--	--	±15	95
Physical Properties						
Grain size	PSEP (1986)	percent	0.5	--	±35	95
Water content	U.S. COE (1980)	percent	0.1	--	±15	95
Void ratio	U.S. COE (1980)	--	--	--	±15	95
Specific gravity	U.S. COE (1980)	--	--	--	±15	95
Atterberg limits						
Liquid limit	U.S. COE (1980)	percent	1.0	--	±15	95
Plasticity limit	U.S. COE (1980)	percent	1.0	--	±15	95
Extracted Pore Water						
Ammonia	EPA 350.1	mg N/L	0.05	75–125	±25	95
Total sulfide	EPA 376.2	mg/L	0.05	65–135	±35	95
Salinity	EPA Standard Method 2520B	ppt	--	90–110	±0.1	95
pH	EPA 150.1	pH units	--	0.1 unit	±0.1 unit	95
Sediment Elutriate						
Total ammonia	EPA 350.1	mg N/L	0.05	75–125	±25	95

TABLE B2-2. (cont.)

Analysis	Method Reference	Units	Method Reporting Limit[a]	Bias (percent)	Precision (RPD)	Completeness (percent)
Total suspended solids	EPA 160.2	mg/L	5	85–115	±20	95
Cadmium (total and dissolved)	EPA 200.7	µg/L	4	75–125	±25	95
Total mercury (total and dissolved)	EPA 245.1	µg/L	0.5	75–125	±25	95
Zinc (total and dissolved)	EPA 200.7	µg/L	10	75–125	±25	95
Phenol (total and dissolved)	GC/MS with SIM	µg/L	0.5	70–130	±30	95
4-Methylphenol (total and dissolved)	GC/MS with SIM	µg/L	0.5	70–130	±30	95
Dioxin and furan congeners (total and dissolved)	EPA 8290	pg/L	10–100	50–150	±20	95

Note: EPA - U.S. Environmental Protection Agency
GC/MS - gas chromatography/mass spectrometry
PAH - polycyclic aromatic hydrocarbon
RPD - relative percent difference
SIM - selective ion monitoring
SOP - standard operating procedure
-- - not applicable

[a] For organic analytes, the practical quantification limit is given. For inorganic analytes, the method reporting limit is the instrument detection limit adjusted for sample size and dilution during sample preparation.

[b] For example, Battelle Marine Sciences Laboratory (Sequim, Washington) SOPs: Pb^{210} Dating Digestion and Analysis *and* Laboratory Method for Cs^{137}.

TABLE B2-3. SUMMARY OF ANALYTICAL METHODS

	Preparation Method	Preparation Technique	Analysis Method	Analysis Technique	Method Modification	Laboratory
Conventional Analytes						
Total ammonia (sediment)	Plumb (1981)	KCl extraction	Plumb (1981)	Colorimetry	Sediment extraction	CAS
Total ammonia (water)	EPA 350.1[a]	Alkaline phenol and hypochlorite reaction	EPA 350.1[a]	Colorimetry	None	CAS
Acid-volatile sulfide	EPA Draft 12/91	Acidification/purge and trap	EPA Draft 12/91	Colorimetry	None	CAS
Total sulfide	Plumb (1981)	Distillation/zinc acetate trap	Plumb (1981)	Colorimetry	Analysis of sediment	CAS
Total organic carbon (sediment)	PSEP (1986)	Combustion	PSEP (1986)	Infrared detection	None	CAS
Total organic carbon (water)	EPA 415.1[a]	Combustion	EPA 415.1[a]	Infrared detection	None	CAS
Biochemical oxygen demand	PSEP (1986)	Incubation	PSEP (1986)	Winkler titration	Analysis of sediment	CAS
Chemical oxygen demand	EPA 410.1M[a]	Oxidation	EPA 410.1M[a]	Titration	Analysis of sediment	CAS
Extractable organic halides	EPA 9020M[b]	Carbon absorption	EPA 9020M[b]	Titration	Analysis of sediment	CAS
Grain size	PSEP (1986)	Desiccation	PSEP (1986)	Sieve and pipet	None	CAS
Total solids	EPA 160.3M[a]	Desiccation, 105°C	EPA 160.3M[a]	Gravimetry	Analysis of sediment	CAS
Metals						
Arsenic (sediment)	EPA 3050A[c]	Strong acid digestion	EPA 200.8[d]	ICP-MS	None	CAS
Arsenic (water)	EPA 3010A[c]	Strong acid digestion	EPA 6010A[c]	ICP-AES	None	CAS
Cadmium (sediment)	EPA 3050A[c]	Strong acid digestion	EPA 200.8[d]	ICP-MS	None	CAS
Cadmium (water)	EPA 3010A[c]	Strong acid digestion	EPA 6010A[c]	ICP-AES	None	CAS
Methylmercury	Bloom (1989)	Distillation/aqueous phase ethylation	Bloom (1989)	CVAFS	None	FGS
Total mercury (sediment)	EPA 7471A[b]	Acid/permanganate oxidation	EPA 7471A	CVAA	None	CAS
Total mercury (water)	EPA 7440A[b]	Acid/permanganate oxidation	EPA 7440A	CVAA	None	CAS

TABLE B2-3. (cont.)

	Preparation Method	Preparation Technique	Analysis Method	Analysis Technique	Method Modification	Laboratory
Zinc (sediment)	EPA 3050A[c]	Strong acid digestion	EPA 200.8[d]	ICP-MS	None	CAS
Zinc (water)	EPA 3010A[c]	Strong acid digestion	EPA 6010A[c]	ICP-AES	None	
Extractable Organic Compounds						
Site SVOCs (sediment)	EPA 3550A[b]	Ultrasonic extraction	EPA 8270B[b]	GC/MS-SIM	SIM	CAS
Site SVOCs (water)	EPA 3520A[b]	Liquid/Liquid extraction	EPA 8270B[b]	GC/MS-SIM	SIM	CAS
Dioxins and furans (sediment)	EPA 3541A[b]	Automated soxhlet extraction	EPA 8290 /EPA 1613[b,e]	HRGC/HRMS	None	Zenon
Dioxins and furans (water)	EPA 3520A[b]	Liquid/Liquid extraction	EPA 8290 /EPA 1613[b,e]	HRGC/HRMS	None	Zenon
Engineering Properties						
Elutriate Testing						
MET	Palermo 1986	Compositing and slurry preparation	Palermo 1986	Settling	None	Soil Technology
DRET	DiGiano et al. 1995	Compositing and slurry preparation	DiGiano et al. 1995	Settling	None	Soil Technology
Geotechnical Properties						
Column settling testing	EM 1110-2-5027[f]	Compositing and slurry preparation	EM 1110-2-5027[f]	Settling	None	Soil Technology
Consolidation testing	EM 1110-2-5027 and EM 1110-2-1906[f]	Compositing	EM 1110-2-5027 and EM 1110-2-1906[f,g]	Compression	None	Soil Technology
Desiccation characteristics	USCOE Instruction Report D91-1, PCDDF89	Compositing	Stark 1989	Shrinkage	None	Soil Technology
Grain size	PSEP (1986)	Desiccation	PSEP (1986)	Sieve and pipet	None	Soil Technology
Water content	EM 1110-2-1906[g]	Desiccation, 105°C	EM 1110-2-1906[g]	Gravimetry	None	Soil Technology
Void ratio	EM 1110-2-1906[g]		EM 1110-2-1906[g]		None	Soil Technology
Specific gravity	EM 1110-2-1906[g]	Gravimetry	EM 1110-2-1906[g]	Gravimetry	None	Soil Technology
Atterberg Limits						
Liquid limit	EM 1110-2-1906[g]		EM 1110-2-1906[g]		None	Soil Technology
Plasticity limit	EM 1110-2-1906[g]		EM 1110-2-1906[g]		None	Soil Technology

Footnotes on next page.

TABLE B2-3. (cont.)

Note:	CAS	-	Columbia Analytica Services, Inc., Kelso, WA
	CVAA	-	cold vapor atomic absorption spectrometry
	CVAFS	-	cold vapor atomic fluorescence
	DRET	-	dredging elutriate test
	EPA	-	U.S. Environmental Protection Agency
	FGS	-	Frontier Geosciences, Inc., Seattle, WA
	GC/MS	-	gas chromatography/mass spectrometry
	GC/MS-SIM	-	gas chromatography/mass spectrometry-selected ion monitoring
	HRGC/HRMS	-	high resolution gas chromatography/mass spectrometry
	ICP-AES	-	inductively coupled plasma-atomic emission spectrometry
	ICP-MS	-	inductively coupled plasma-mass spectrometry
	MET	-	modified elutriate test
	Soil Technology	-	Soil Technology, Inc., Bainbridge Island, WA
	SVOC	-	semivolatile organic compound
	Zenon	-	Zenon Environmental Laboratories, Ontario, Canada

[a] U.S. EPA (1983).

[b] U.S. EPA (1994d).

[c] U.S. EPA (1992).

[d] U.S. EPA (1994b).

[e] U.S. EPA (1994a).

[f] U.S. COE (1987).

[g] U.S. COE (1980).

HOLDING TIMES AND SAMPLE PRESERVATION

The analytical holding time constraints and sample preservation requirements specified in (PTI 1996, 1997) were met for all samples and analyses, with the following exceptions:

- For the reanalysis of total sulfides in surface sediment samples, 14 results were qualified as estimated (*J*) because the holding time constraint of 14 days for completion of analysis was exceeded by 17 to 27 days. The original sample analyses were completed within the 14-day holding time constraint; however, the hard copy of these data was not printed at the time of acquisition and the electronic files were inadvertently deleted. Because the initial analytical data could not be retrieved, the affected 14 samples had to be reanalyzed outside of holding times.

- For the semivolatile organic compound (SVOC) analyses of the surface sediment samples, 238 polycyclic aromatic hydrocarbon (PAH), 14 phenol, 15 4-methylphenol, 14 benzoic acid, and 14 dibenzofuran analytical results were qualified as estimated (*J*) for exceeding holding time constraints. Specifically, the holding time constraint of 40 days for completion of analysis of the sample extracts was exceeded from between 2 and 5 days for the analysis of 14 samples for PAHs, phenol, 4-methylphenol, benzoic acid, and dibenzofuran, and by 8 days for one sample (SD0028) analyzed for 4-methylphenol. The sample extracts were analyzed past the 40-day holding time constraint because of laboratory scheduling errors.

- For the analysis of phenols in elutriate samples, four results (two dissolved and two whole fractions) reported for 4-methylphenol were qualified as estimated (*J*) for exceeding holding time constraints. Specifically, the holding time constraint of 40 days for completion of analysis of the sample extracts was exceeded by 4 days. The sample extracts were analyzed past the 40-day holding time constraint because of laboratory scheduling errors.

Analyses conducted for ammonia in 17 surface sediment samples and 35 subsurface sediment samples were completed between 1 and 7 days after the date of collection. Analyses for chemical oxygen demand (COD) in 35 subsurface sediment samples were completed between 6 and 13 days after the date of collection. All ammonia and COD analyses met the 28-day holding time constraint specified in EPA (U.S. EPA 1983) for water samples. Results reported for ammonia and COD in the affected samples were not qualified as estimated because there are no known EPA method-specific holding time constraints for the analysis of ammonia and COD in sediment samples. Because the samples were stored in appropriate containers at 4°C until the analyses were initiated, any biological activity (either aerobic or anaerobic) that may affect the concentration of ammonia or COD is expected to be minimal. Although these data were not qualified, a greater degree of uncertainty may be associated with these results than with results reported for samples analyzed within matrix-specific holding time constraints.

Two archive subsurface samples, collected in August 1997 and kept frozen at −20°C since that date, were analyzed for ammonia, biochemical oxygen demand (BOD), COD, and total sulfide. Analyses were completed between 96 and 118 days after the date of collection. These archive samples (SD0046C and SD0059C) were analyzed to provide additional chemical data on native subsurface sediments. Because the analyses exceeded the applicable holding time constraints, results for these analyses were qualified as estimated (*J*).

Extractions of the 12 surface sediment samples archived frozen at −20°C since their date of collection in June 1996 and used for the analysis of polychlorinated dibenzo-*p*-dioxins and polychlorinated dibenzofurans (PCDDs/Fs) were conducted past the 35-day holding time constraint specified by SW-846 Method 8290 (U.S. EPA 1994c) and the 1-year holding time constraint recommended by EPA Method 1613 (U.S. EPA 1994a). These samples were extracted between 38 and 41 days past the recommended 1-year holding time (U.S. EPA 1994a). None of these results were qualified because the samples were stored frozen and, as stated in EPA Method 1613 (U.S. EPA 1994a), there are no demonstrated maximum holding times associated with PCDDs/Fs in aqueous, solid, semi-solid, tissue, or other matrices.

ANALYTICAL METHODS

The analyses for all target analytes were generally completed according to procedures specified in the QAPPs (PTI 1996, 1997). Laboratory personnel made substitutions for several methods specified in the QAPPs to accommodate their standard analytical procedures, as follows:

- Puget Sound Estuary Program (PSEP) method (PSEP 1986) was used for the analysis of TOC rather than Standard Method 5310B (APHA 1989)
- PSEP methods (PSEP 1986) were used for the analysis of BOD rather than EPA Method 405.1M (U.S. EPA 1983)
- EPA Method 160.3 (U.S. EPA 1983) was used for the analysis total solids rather than the PSEP method (PSEP 1986)
- EPA Method 8290 (U.S. EPA 1994c) for the analysis of PCDDs/Fs was modified to include some of the quality control criteria specified in EPA Method 1613B (U.S. EPA 1994a) and a greater number of isotopically labeled internal standards
- EPA Method 6010A (U.S. EPA 1992) using inductively coupled plasma-atomic emission spectrometry (ICP-AES) was used for the

analysis of metals in the elutriate samples rather than EPA Method 200.7 (U.S. EPA 1994b) using ICP-AES

- EPA Method 200.8 (U.S. EPA 1994b) using inductively coupled plasma-mass spectrometry (ICP-MS) was used for the analysis of metals rather than EPA Method 200.7 (U.S. EPA 1994b) to achieve lower detection limits in the equipment rinsate blank samples

- SW-846 Method 7470A (U.S. EPA 1994d) was used for the analysis of mercury in elutriate and equipment rinsate blank samples rather than EPA Method 245.1 (U.S. EPA 1994b).

Because the substituted methods are similar to the methods specified in the QAPPs (PTI 1996, 1997), the quality and usability of the data were not affected by any of the substitutions. A summary of laboratory methods used to analyze the samples is provided in Table B2-2.

INSTRUMENT PERFORMANCE

The performance of the analytical instruments, as documented by the laboratory, was acceptable. No changes in instrument performance that would have resulted in the degradation of data quality were indicated during any analysis sequence.

Initial and Continuing Calibration

Initial and continuing calibrations were completed for all applicable target analytes and met the criteria for acceptable performance and frequency of analysis.

Initial and Continuing Calibration Blanks

The initial and continuing calibration blank (ICB and CCB) analyses were completed for all applicable target analytes and met the criteria for acceptable performance. No target analytes were detected in the applicable ICBs and CCBs at a concentration above applicable action limits.

Method Blank Analyses

No target analytes were detected in any applicable method blank at a concentration above applicable action limits, with the exception of analyses conducted for PCDDs/Fs.

Concentrations of PCDDs/Fs are determined using a very sensitive analytical technique. The low detection limits that may be achieved using this method require that extreme care be taken during sample collection and analysis to minimize sample contamination. In many cases, the source of the contamination and the level of contamination may not be constant (e.g., the reagents used for the analyses and laboratory glassware may contain residual contamination from samples containing high concentrations of PCDDs/Fs). Because such low detection can be achieved, and the importance of these data in completing risk assessments, a more conservative approach was used to qualify these data than the guidelines specified by the analytical methods (U.S. EPA 1994a,c) and the EPA national functional guidelines for dioxin/furan data validation (U.S. EPA 1993), as discussed below.

During data validation, sample results were evaluated with respect to the PCDD/F concentration present in the associated method blanks. Sample results were compared to the applicable method blank, and results were qualified using the following criteria:

- If any PCDDs/Fs were present in a sample at a concentration ≤2 times the concentration found in the associated method blank, the sample results were restated as undetected (*U*) at the concentration reported by the laboratory
- If any PCDDs/Fs were present at a concentration >2 times but ≤5 times the concentration found in the associated method blank, the sample results were qualified as estimated (*J*) at the concentration reported by the laboratory
- If any PCDDs/Fs were present at a concentration >5 times the concentration found in the associated method blank, the sample results were considered acceptable without qualification.

For the PCDD/F analyses completed on surface sediment samples archived from the 1996 Phase 1 investigation, a total of 300 results was reported. Of these results, 53 were qualified as estimated (*J*) and 35 were restated as undetected (*U*) at the concentration reported by the laboratory. The results of the PCDDs/Fs detected in the method blank associated with this data set, including the action limits, are presented the table below.

PCDD/PCDF	Concentration (pg/g)	2x Action Limit (pg/g)	5x Action Limit (pg/g)
Total TCDF	0.67 *U*	--	--
Total PCDF	2.7	5.4	13.5
Total HxCDF	9.2	18.4	46
Total HpCDF	4.6	9.2	23
OCDF	6.3	12.6	32
Total TCDD	0.77 *U*	--	--
Total PCDD	1.8	3.6	9
Total HxCDD	3.7	7.4	19
Total HpCDD	3.3	6.6	17
OCDD	30	60	150
2,3,7,8-TCDF (DB-5)	0.67 *U*	--	--
2,3,7,8-TCDD	0.77 *U*	--	--
1,2,3,7,8-PCDF	1.4	2.8	7
2,3,4,7,8-PCDF	1.4	2.8	7
1,2,3,7,8,-PCDD	1.8	3.6	9
1,2,3,4,7,8-HxCDD	1.5	3.0	8
1,2,3,6,7,8-HxCDF	1.9	3.8	10
2,3,4,6,7,8-HxCDF	2.6	5.2	13
1,2,3,7,8,9-HxCDF	3.5	7.0	18
1,2,3,4,7,8-HxCDD	2.0	4.6	10
1,2,3,6,7,8-HxCDD	1.5 *U*	--	--
1,2,3,7,8,9-HxCDD	1.7	3.4	9
1,2,3,4,6,7,8-HpCDF	2.1	4.2	11
1,2,3,4,7,8,9-HpCDF	2.6	5.2	13
1,2,3,4,6,7,8-HpCDF	3.3	6.6	17
1,2,3,4,6,7,8,9-OCDF	6.3	12.6	32
1,2,3,4,6,7,8-OCDD	30	60	150

Note: *U* - undetected at the detection limit shown

For the PCDDs/Fs analyses completed on the surface sediment samples collected for the 1997 Phase 2 investigation, a total of 540 results were reported. Of these results, 30 were qualified as estimated (*J*), and 66 were restated as undetected (*U*) at the concentration reported by the laboratory. The results of the PCDDs/Fs detected in the method blank associated with this data set, including the action limits, are presented the table below.

PCDD/PCDF	Blank #1 (9/5/97) Concentration (pg/g)	2x Action Limit (pg/g)	5x Action Limit (pg/g)	Blank #2 (9/9/97) Concentration (pg/g)	2x Action Limit (pg/g)	5x Action Limit (pg/g)
Total TCDF	1.1 *U*	--	--	0.49 *U*	--	--
Total PCDF	10	20	50	0.74 *U*	--	--
Total HxCDF	25	50	12.5	1.9	3.8	9.5
Total HpCDF	12	24	60	1.1 *U*	--	--
OCDF	14	28	70	3.9	7.8	19.5
Total TCDD	1.2 *U*	--	--	0.69 *U*	--	--
Total PCDD	5.1	10.2	25.5	1.0	2	5
Total HxCDD	18	36	90	1.4	2.8	7
Total HpCDD	7.4	14.8	37	1.1	2.2	5.5
OCDD	15	30	75	4.3	8.6	21.5
2,3,7,8-TCDF (DB-5)	1.1 *U*	--	--	0.49 *U*	--	--
2,3,7,8-TCDD	1.2 *U*	--	--	0.69 *U*	--	--
1,2,3,7,8-PCDF	4.6	9.2	23	0.73 *U*	--	--
2,3,4,7,8-CDF	5.6	11.2	25.5	0.74 *U*	--	--
1,2,3,7,8,-PCDD	5.1	10.2	26.5	1.0	2	5
1,2,3,4,7,8-HxCDD	5.3	10.6	29	1.1 *U*	--	--
1,2,3,6,7,8-HxCDF	5.8	11.6	33	0.91 *U*	--	--
2,3,4,6,7,8-HxCDF	6.6	13.2	39.5	1.2 *U*	--	--
1,2,3,7,8,9-HxCDF	7.9	15.8	32	2.3	4.6	11.5
1,2,3,4,7,8-HxCDD	6.4	12.8	29.5	1.1 *U*	--	--
1,2,3,6,7,8-HxCDD	5.9	11.8	30	1.0 *U*	--	--
1,2,3,7,8,9-HxCDD	6.0	12	29.5	1.4	2.8	7
1,2,3,4,6,7,8-HpCDF	5.9	11.8	32.5	0.98 *U*	--	--
1,2,3,4,7,8,9-HpCDF	6.5	13	37	1.3 *U*	--	--
1,2,3,4,6,7,8-HpCDF	7.4	14.8	70	1.1	2.2	5.5
1,2,3,4,6,7,8,9-OCDF	14	28	75	3.9	7.8	19.5
1,2,3,4,6,7,8-OCDD	15	30		4.3	8.6	21.5

Note: *U* - undetected at the detection limit shown

For the PCDD/F analyses completed on the elutriate samples collected for the 1997 Phase 2 investigation, a total of 270 results was reported. Of these results, 8 were qualified as estimated (*J*), and 12 were restated as undetected (*U*) at the concentration reported by the laboratory. The results of the PCDDs/Fs detected in the method blank associated with this data set, including the action limits, are presented the table below.

PCDD/PCDF	Concentration (pg/L)	2x Action Limit (pg/L)	5x Action Limit (pg/L)
Total TCDF	2.3 *U*	--	--
Total PCDF	3.3 *U*	--	--
Total HxCDF	5.3	10.3	25.8
Total HpCDF	4.2 *U*		
OCDF	15	30	75
Total TCDD	2.9 *U*	--	--
Total PCDD	3.3 *U*	--	--
Total HxCDD	3.0 *U*	--	
Total HpCDD	4.6 *U*		
OCDD	22	22	55
2,3,7,8-TCDF (DB-5)	2.3 *U*	--	--
2,3,7,8-TCDD	2.9 *U*	--	--
1,2,3,7,8-PCDF	3.2 *U*	--	--
2,3,4,7,8-PCDF	3.3 *U*	--	--
1,2,3,7,8,-PCDD	3.3 *U*	--	--
1,2,3,4,7,8-HxCDD	2.9 *U*	--	--
1,2,3,6,7,8-HxCDF	2.4 *U*	--	--
2,3,4,6,7,8-HxCDF	3.1 *U*	--	--
1,2,3,7,8,9-HxCDF	6.6	13.2	33
1,2,3,4,7,8-HxCDD	3.0 *U*	--	--
1,2,3,6,7,8-HxCDD	2.9 *U*	--	--
1,2,3,7,8,9-HxCDD	3.0 *U*	--	--
1,2,3,4,6,7,8-HpCDF	3.7 *U*	--	--
1,2,3,4,7,8,9-HpCDF	4.8 *U*	--	--
1,2,3,4,6,7,8-HpCDF	4.6 *U*	--	--
1,2,3,4,6,7,8,9-OCDF	15	30	75
1,2,3,4,6,7,8-OCDD	11	22	55

Note: *U* - undetected at the detection limit shown

ACCURACY

The accuracy of the analytical results is evaluated in the following sections in terms of analytical bias (surrogate compound, matrix spike, LCS recoveries, and internal standards) and precision (duplicate matrix spikes, duplicate LCSs, duplicate sample analyses, or triplicate sample analyses).

Surrogate Compound Recoveries

The recoveries reported by the laboratory for all surrogate compounds (added to all field and quality control samples analyzed for organic compounds) met the criteria for acceptable performance, with the exceptions noted below.

Semivolatile Organic Compounds

For analyses conducted on surface sediment samples in one SDG, the recovery of the surrogate compound 2-fluorophenol reported for the matrix spike (48 percent) and the matrix spike duplicate (34 percent) conducted on Sample SD0019 (analyzed for 4-methylphenol) was below the lower project-specific control limit of 50 percent. The exceedances in the matrix spikes did not require qualification of the sample data because surrogate recovery data are sample-specific and these exceedances do not affect the entire data set. In the same SDG, five of six surrogate recoveries reported for the analysis of Sample SD0023 (35 to 47 percent) and all six recoveries reported for Sample SD0006 (31 to 42 percent) were below the lower project-specific control limit of 50 percent. The results reported for these samples were previously qualified for not meeting holding time constraints; therefore, no additional action was required. Also, the recovery of the surrogate compound 2-fluorophenol (40 and 17 percent) reported for the two method blanks associated with this one SDG were below the lower project-specific control limit of 50 percent. The exceedances in the method blanks did not require qualification of the sample data because surrogate recovery data are sample-specific and exceedances do not affect the entire data set.

For analyses conducted on surface sediment samples in another SDG, recoveries of 26 and 9 percent were reported for 2-fluorophenol and 2,4,6-tribromophenol, respectively, for the associated method blank. In addition, a recovery of 33 percent was reported for the surrogate compound 2,4,6-tribromophenol in the associated LCS. Although these recoveries were below the lower project-specific control limit of 50 percent in the method blank and LCS, the exceedances in the method blank and LCS did not require qualification of the sample data because surrogate recovery data are sample-specific and these exceedances do not affect the entire data set.

For analyses conducted on subsurface sediment samples in one SDG, recoveries for the surrogate compounds for 2-fluorophenol and 2,4,6-tribromophenol were above the upper project-specific control limit of 150 percent in five samples (SD0045A, SD0045B, SD0050A, SD0050B, and SD0050C). In addition, recoveries for the surrogate compounds for 2-fluorophenol and 2,4,6-tribromophenol were below the lower project-specific control limit of 50 percent in three samples (SD0051A, SD0051G, and SD0054A). The results reported for phenol and 4-methylphenol in these eight samples were qualified as estimated (*J*) for exceeding the surrogate compound control limits.

For analyses conducted on elutriate samples in one SDG, recoveries for the surrogate compounds 2-fluorophenol (45 percent) and phenol-d_6 (40 percent) were below the lower project-specific control limit of 70 percent in the dissolved fraction of sample number WATERQC (i.e., site water). The results reported for dissolved phenol and dissolved 4-methylphenol in this sample were qualified as estimated (*J*).

Matrix Spike Recoveries

The recoveries reported by the laboratory for applicable matrix and duplicate matrix spike analyses and the frequency of analysis met the criteria for acceptable performance, with the exceptions noted below. Some matrix spike data were not reported if the samples required dilutions to bring the analytes into calibration range and, therefore, the spiking compounds could not be detected. In other instances, matrix spike data were not reported if the concentration of one or more analytes used in the spiking solution were present in the sample selected for spiking at a concentration significantly above the spiking concentration.

Conventional Analytes

For the analysis of EOX on surface sediment samples in one SDG, a duplicate matrix spike recovery of 167 percent was above the project-specific upper control limit of 150 percent. No sample data required qualification for this exceedance because the recoveries of the matrix spike (134 percent) and the associated LCS were acceptable.

For the analysis of ammonia on subsurface sediment samples in one SDG, a recovery of 56 percent was reported for the matrix spike conducted on Sample SD0045A, which is below the lower project-specific upper control limit of 75 percent. No sample data required qualification for this exceedance because the recoveries for the other matrix spikes and all LCSs in this SDG were within control limits.

Metals

Four matrix spike recoveries were below the project-established control limit of 50 percent. For the analysis of methylmercury in surface sediment samples using the distillation technique for sample preparation, recoveries of 20.4 percent and 18.4 percent were reported for the duplicate matrix spikes conducted on Sample SD0014R. The laboratory analyzed another set of duplicate matrix spikes on Sample SD0014R in an attempt to identify the problem that may have caused the low recoveries; however, recoveries of 20 and 16 percent were obtained. The laboratory generated a third set of duplicate matrix spikes on Sample SD0001 and obtained recoveries of 12 and 39 percent. The average recovery of these matrix spikes is 22 percent.

To explore the problem of the low recoveries obtained using the distillation technique for sample preparation, the laboratory conducted a matrix spike on Sample SD0014R using the extraction technique for sample preparation. A recovery of 72 percent was obtained, which is 3.3 times greater than the average recovery obtained using the distillation preparation technique. Also, the concentration of methylmercury in Sample SD0014R using the extraction technique was 2.9 ng/g, which is 5.3 times greater than the average concentration of 0.55 ng/g obtained for the analyses conducted on Sample SD0014R using the distillation technique for sample preparation.

The comparison of the matrix spike data obtained using the distillation and extraction preparation techniques, including the sample results, suggest that the specific nature of the sediment samples may inhibit the quantitative recovery of methylmercury using the distillation technique for sample preparation. The comparison of these data indicate that the results reported for methylmercury may exhibit a negative bias and the true results may be underestimated by a factor of 5 times. However, the methylmercury data reported for the 1996 and 1997 investigations from the same sampling stations are generally comparable. The distillation technique for sample preparation was used for the analysis of methylmercury in the 1996 samples, and matrix spike recoveries of 93 and 92 percent were reported. Because excellent matrix spike recoveries were obtained for 1996 analyses using the distillation technique, but very low recoveries were obtained for 1997 analyses using the same distillation technique, no definitive reasons can be provided to explain the low matrix spike recoveries reported for the 1997 analyses. The recoveries for the LCSs were acceptable, so there is no indication of laboratory error.

No sample data were qualified for the low matrix spike/matrix spike duplicate recoveries obtained using the distillation preparation technique because data are not qualified solely on the basis of these data; however, the methylmercury data reported may be negatively biased by a factor of 5.

Semivolatile Organic Compounds

In two SDGs for the analysis of 3-/4-methylphenol and 4-methylphenol in surface sediment samples and one SDG for the analysis of phenol and 4-methylphenol in subsurface sediment samples, no matrix spike or duplicate matrix spike data could be reported. Matrix spike data were not reported because the concentration of the 4-methylphenol in the unspiked sample was approximately 20 times greater than the concentration of 4-methylphenol in the spiking solution. No data required qualification as a result of the absence of matrix results.

In one SDG for the analysis of phenol and 4-methylphenol in subsurface sediment samples, a recovery of 43 percent was reported for the matrix spike conducted on Sample SD0046A. Recoveries of 17 and 35 percent were reported for phenol for the duplicate matrix spikes conducted on Sample SD0061A. These three recoveries are below the lower control limits of 50 percent. No data required qualification for these exceedances because results are not qualified solely on the basis of matrix spike recoveries.

Laboratory Control Sample Recoveries

The recoveries reported by the laboratory for all applicable LCS and duplicate LCS analyses and the frequency of analysis met the criteria for acceptable performance, with two exceptions.

For the analysis of phenol and 3-/4-methylphenol in surface sediment samples in one SDG, no LCS recovery was reported for these analytes in one SDG. The laboratory suspects that the LCS spiking solution was not added prior to extraction. The 12 results reported for 3-/4-methylphenol in this SDG were qualified as estimated (*J*) because there were no matrix spike recovery data or LCS recovery data to assess the accuracy of the results reported.

For the analysis of phenol and 4-methylphenol in surface sediment samples in another SDG, a recovery of 25 percent was reported for 4-methylphenol, which is below the lower project-established control limit of 50 percent. The 10 results reported for 4-methylphenol in this SDG were qualified as estimated (*J*) because there were no matrix spike recovery data and LCS recovery data to assess the accuracy of the results reported.

Internal Standard Performance

Criteria for retention time and area count were met of all internal standards added to all samples analyzed for organic target analytes, with the following exceptions.

For the analysis of PCDDs/Fs in surface sediment samples in one SDG, the recovery of the internal standard 2,3,7,8-TCDD-13C12 was below the lower method-specific control limit of 40 percent in one method blank (26 percent), the LCS (27 percent), and the duplicate LCS (25 percent). Because internal standard data apply only to the samples to which internal standards are added, no sample results required qualification.

For the analysis of PCDDs/Fs in the archived sediment samples, recoveries of 23 and 30 percent were reported for the internal standard 2,3,7,8-TCDD-13C12, and recoveries of 34 and 35 percent were reported for the internal standard 2,3,7,8-TCDF-13C12 for the duplicate matrix spikes conducted on Sample KW030. Because internal standard data apply only to the samples to which internal standards are added, no sample results required qualification.

Precision

The results reported by the laboratory for duplicate analyses and applicable triplicate analyses and the frequency of analysis met the criteria for acceptable performance, with the exceptions noted below.

Conventional Analytes

A relative standard deviation of 81 percent was reported for the particle size fraction less than 0.004 mm (clay) for the triplicate analyses conducted on the surface sediment Sample SD0001. The percent relative standard deviations of the other seven size fractions were within control limits. No data were qualified because of the difficulty of subsampling three completely homogenized aliquots from one sample container.

A 54 relative percent difference (RPD) reported for the sulfide duplicate sample analyses conducted on surface sediment Sample SD0013 in one SDG is above the control limit of 50 RPD. Because all sulfide results in this SDG were previously qualified for exceeding holding time constraints, no further action was required.

Metals

An RPD of 64 percent reported for zinc for the duplicate sample analyses conducted on subsurface sediment Sample SD0053A in one SDG is above the control limit of 35 RPD. No sample results were qualified for this exceedance because the RPD for zinc in the other duplicate sample analyses were within control limits, indicating this exceedance is an isolated occurrence.

Semivolatile Organic Compounds

An RPD of 69 percent reported for phenol for one set of duplicate matrix spikes conducted on subsurface sediment Sample SD0061A in one SDG is above the control limit of 50 RPD. No data required qualification for these exceedances because results are not qualified solely on the basis of matrix spike recoveries and because this result was the only exceedance to the RPD criterion associated with the subsurface sediment sample analyses.

METHOD DETECTION LIMITS AND METHOD REPORTING LIMITS

The method detection limits (MDLs) and method reporting limits (MRLs) used by the laboratories met project DQOs (PTI 1996, 1997); however, elevated MRLs were reported for some samples and target analytes. Elevated MRLs were reported because dilutions were necessary to conduct the analyses because elevated concentrations of target analytes, matrix interferences present in the samples, or both, prevented reliable identification and quantification of the target analytes.

FIELD QUALITY CONTROL SAMPLES

The results for all field quality control samples were acceptable. The field quality control samples included four equipment rinsate blanks and multiple sets of field duplicate samples for the different matrices.

Equipment Rinsate Blanks

Four equipment rinsate blanks were submitted for the analysis of metals and SVOCs. Two equipment rinsate blanks (Samples SW0007 and SW0008) were collected from rinsing the van Veen sampler, and two equipment rinsate blanks (Samples SW0009 and SW0010) were collected from rinsing the stainless steel bowls used to homogenize the sediment samples. Arsenic was detected in Samples SW0007 and SW0008 at concentrations of 0.9 and 1.3 μg/L, respectively. Cadmium was detected in Samples SW0007 and SW0008 at concentrations of 0.03 and 0.04 μg/L, respectively. Zinc was detected in Samples SW0007, SW0008, SW0009, and SW0010 at concentrations of 1, 5, 1.7, and 0.8 μg/L, respectively. Phenol was detected in Samples SW0007 and SW0008 at a concentration of 0.2 μg/L. 4-Methylphenol was detected in Samples SW0007, SW0008, and SW0009 at concentrations of 0.2, 0.7, and 0.6 μg/L, respectively.

To assess the impact of the analytes detected in the equipment rinsate blanks and potential reporting of false positives for the sediment samples, the highest concentration of the analytes detected in the equipment rinsate blanks was normalized for sample weight and final volume to determine the concentration in units of mg/kg for metals and μg/kg for SVOCs. These normalized concentrations (arsenic at 0.26 mg/kg, cadmium at 0.008 mg/kg, zinc at 1 mg/kg, phenol at 6.7 μg/kg, and 4-methylphenol at 23 μg/kg) were then subjected to the 5-times rule to determine an action limit. The derived action limits for arsenic, zinc, and 4-methylphenol were 1.3 mg/kg, 5 mg/kg, and 115 μg/kg, respectively. No action limits were required for cadmium and phenol because the normalized concentrations of these analytes (0.008 mg/kg and 6.7 μg/kg, respectively) were below the laboratory MRLs (cadmium at 0.2 mg/kg and phenol at 10 μg/kg); therefore, these data were not applicable for assessing blank contamination.

No results reported as detected for arsenic, zinc, or 4-methylphenol in the sediment samples required qualification based on the results of the equipment rinsate blanks because these analytes were detected at concentrations greater than the 5 times action limit. A summary of results for the equipment rinsate blanks is presented in Appendix A1.

Field Duplicates

Results were reported for multiple sets of field duplicates. The field duplicates associated with the surface sediment samples included Samples SD0037 and SD0038 (Station SD-13); Samples SD0018 and SD0019 (Station SD-37); and Samples SD0035 and

SD0036 (Station SD-44). The field duplicates associated with the subsurface sediment samples included Samples SD0061A and SD0062A (Station SD-12, depth interval 0.0 to 29.4 in.) and Samples SD0061B and SD0062B (Station SD-12, depth interval 39.2 to 55.5 in.).

The field duplicates collected are co-located samples. They provide information regarding variability in analyte concentration in the area from which they were collected and are not used to assess laboratory precision. The results of the co-located samples were acceptable.

REFERENCES

APHA. 1989. Standard methods for the analysis of water and wastewater. 17th ed. American Public Health Association, American Water Works Association, Water Pollution Control Federation, Washington, DC.

Bloom, N. 1989. Determination of picogram levels of methylmercury by aqueous phase ethylation, followed by cryogenic gas phase ethylation with cold vapor atomic fluorescence detection. Can. J. Fish Aq. Sci. 7:1131.

DiGiano, F.A., C.T. Miller, and J. Yoon. 1995. Dredging elutriate test (DRET) development. Contract Report D-95-1. Prepared for U.S. Army Corps of Engineers, Washington, DC. University of North Carolina, Chapel Hill, NC.

ENSR. 1995. Annual sediment monitoring report, NPDES Permit No. AK-000092-2. Prepared for Ketchikan Pulp Company, Ketchikan, AK. ENSR Consulting and Engineering.

Palermo, M.R. 1986. Development of a modified elutriate test for estimating the quality of effluent from confined dredged material disposal areas. Technical Report D-86-4. Prepared for the U.S. Department of the Army, U.S. Army Corps of Engineers. U.S. Army Engineer Waterways Experiment Station, Environmental Laboratory, Vicksburg, MS.

Plumb, R.H., Jr. 1981. Procedures for handling and chemical analyses of sediment and water samples. Technical Report EPA/CE-81-1. U.S. Environmental Protection Agency and U.S. Army Corps of Engineers, Waterways Experiment Station, Vicksburg, MS.

PSEP. 1986. Recommended protocols for measuring conventional sediment variables in Puget Sound. Prepared for U.S. Environmental Protection Agency Region 10, Office of Puget Sound, Puget Sound Estuary Program, Seattle, WA.

PSEP. 1991. A project manager's guide to requesting and evaluating chemical analyses. Prepared by PTI Environmental Services, Bellevue, WA. U.S. Environmental Protection Agency Region 10, Puget Sound Estuary Program, Seattle, WA.

PSEP. 1995. Recommended guidelines for conducting laboratory bioassays on Puget Sound sediments. U.S. Environmental Protection Agency Region 10, Office of Puget Sound, Puget Sound Estuary Program, Seattle, WA, and Puget Sound Water Quality Authority, Olympia, WA.

PTI. 1996. Ward Cove sediment remediation project technical studies work plan. Prepared for Ketchikan Pulp Company, Ketchikan, AK. PTI Environmental Services, Bellevue, WA.

PTI. 1997. Ward Cove Sediment remediation project, technical studies: field sampling plan for the Phase 2 investigation. Prepared for Ketchikan Pulp Company, Ketchikan, AK. PTI Environmental Services, Bellevue, WA.

Stark, T.D. 1989. Program documentation and users guide: PCDDF89, primary consolidation and desiccation of dredged fill. Instruction Report D-91-1, 1989. Prepared for the Department of the Army, U.S. Army Corps of Engineers, Washington, DC. San Diego State University, Department of Civil Engineering, San Diego, CA.

U.S. COE. 1980. Engineering design, laboratory soils testing. Engineer Manual No. 1110-2-1906, May 1980. Department of the Army, U.S. Army Corps of Engineers, Washington, DC.

U.S. COE. 1987. Engineering and design, confined disposal of dredged material. Engineer Manual No. 1110-2-5027, September 30, 1987. Department of the Army, U.S. Army Corps of Engineers, Washington, DC.

U.S. EPA. 1983. Methods for chemical analysis of water and wastes. EPA 600/4-79-020. U.S. Environmental Protection Agency Environmental Monitoring and Support Laboratory, Cincinnati, OH.

U.S. EPA. 1992. Test methods for evaluating solid waste – physical/chemical methods (SW-846). Final Update I, July 1992. Office of Solid Waste and Emergency Response, U.S. Environmental Protection Agency, Washington, DC.

U.S. EPA. 1993. USEPA contract laboratory program national functional guidelines for dioxin/furan data validation. Draft, April 1993. Office of Solid Waste and Emergency Response, U.S. Environmental Protection Agency, Washington, DC.

U.S. EPA 1994a. EPA Method 1613: Tetra-through octa-chlorinated dioxins and furans by isotope dilution HRGC/HRMS. EPA 821/B-94-005 Revision B, October 1994. Office of Water, Engineering and Analysis Division, U.S. Environmental Protection Agency, Washington, DC.

U.S. EPA. 1994b. Methods for the determination of metals in environmental samples. EPA-600/R-94-111. May 1994. Determination of trace elements in waters and wastes by inductively coupled plasma - mass spectrometry (EPA Method 200.8, Revision 5.4) Environmental Monitoring Systems Laboratory. Office of Research and Development. U.S. Environmental Protection Agency, Cincinnati, Ohio.

U.S. EPA. 1994c. Polychlorinated dibenzo-*p*-dioxins (PCDDs) and polychlorinated dibenzofurans (PCDFs) by high resolution gas chromatography/high resolution mass spectrometry (HRGC/HRMS). SW-846 Method 8290. Revision 0. U.S. Environmental Protection Agency, Washington, DC.

U.S. EPA. 1994d. Test methods for evaluating solid waste – physical/chemical methods (SW-846). Final Update II, Revision 1, September 1994. Office of Solid Waste and Emergency Response, U.S. Environmental Protection Agency, Washington, DC.

U.S. EPA. 1994e. USEPA contract laboratory program national functional guidelines for inorganic data review. EPA 540/R-94/013. February 1994. Office of Solid Waste and Emergency Response, U.S. Environmental Protection Agency, Washington, DC.

U.S. EPA. 1994f. USEPA contract laboratory program national functional guidelines for organic data review. EPA 540/R-94/012. February 1994. Office of Solid Waste and Emergency Response, U.S. Environmental Protection Agency, Washington, DC.

U.S. EPA. 1995. QA/QC guidance for sampling and analysis of sediments, water, and tissues for dredged material evaluations–chemical evaluations. EPA 823-B-95-001. April 1995. Office of Water, Office of Science and Technology, Standards and Applied Science Division, U.S. Environmental Protection Agency, Washington, DC.

Appendix B3

Quality Assurance Review Summary—Amphipod, Echinoderm, and Polychaete Sediment Toxicity Tests Conducted in 1996

QUALITY ASSURANCE REVIEW SUMMARY—AMPHIPOD, ECHINODERM, AND POLYCHAETE SEDIMENT TOXICITY TESTS CONDUCTED IN 1996

Exponent performed a quality assurance review of the data generated in 1996 for the amphipod, echinoderm, and polychaete sediment toxicity tests, as part of the Ward Cove sediment remediation project. The results of that quality assurance review are presented herein. The quality assurance review was conducted to ensure that toxicity testing was performed in accordance with the specifications of the work plan (PTI 1996) and field sampling plan (PTI 1996, Appendix A) and that the data are acceptable for use in future stages of the remedial investigation and feasibility study (RI/FS).

The quality assurance review consisted of an evaluation of the following major elements for each of the toxicity tests:

- **Field Methods**—Were the specifications of the field sampling procedures followed, as described in the field sampling plan (PTI 1996, Appendix A)?
- **Laboratory Methods**—Were the specifications of the laboratory testing procedures followed, as described in the quality assurance project plan (PTI 1996, Appendix B)?
- **Sediment Holding Time**—Was each sediment sample analyzed within the specified holding time after field collection?
- **Water Quality Conditions**—Were water quality conditions within the specified ranges for each test chamber?
- **Negative Controls**—Were the responses in the negative controls within specified limits?
- **Positive Controls**—Did the positive controls indicate that the test organisms were suitably responsive for testing?
- **Test Results**—Were there any unusual results that may not be representative of the true test results?

Throughout this report, the term "sample" refers to the whole sediment sample collected from each station in the field for each kind of toxicity test. The term "replicate" refers to one of the five subsamples of each field-collected sediment sample that was subjected to toxicity testing in the laboratory. The five replicates for each sample are distinguished by the letters A–E following each sample number.

In general, when the quality assurance review indicated that the result for a replicate was questionable, the result for the affected replicate was compared with the mean result for the unaffected replicates from the same sample (i.e., those replicates for which the results were considered acceptable). These comparisons were made with a *t*-test, a statistical test that is used to compare a single observation with the mean of several observations (Sokal and Rohlf 1981). If the result for the unaffected replicate was not significantly different ($P>0.05$) from the mean result for the unaffected replicates, it was not rejected because it was not considered to be substantially influenced by the problem identified during the quality assurance review. However, if the result for the affected replicate was significantly different ($P\ll0.05$) from the mean result for the unaffected replicates, it was rejected because it appeared to be substantially influenced by the problem identified during the quality assurance review.

An overview of biological results indicated that *Rhepoxynius abronius* was affected by many of the sediment samples in this study. The effects are indicated both in the total effective mortality (TEM) and also in the records of emergence. Of the 30 sediment samples, 12 had an average TEM of 50 percent or greater. In general, high TEM was associated with higher numbers of sediment emergence events. *Leptocheirus plumulosus*, however, was largely unaffected by any of the test sediments. The percent TEM exceeded 10 percent in only two of the samples (Stations 6 and 8).

AMPHIPOD TOXICITY TEST USING *Rhepoxynius abronius*

An amphipod toxicity test was performed to determine percent survival and failure to rebury in adult amphipods (*R. abronius*) exposed for 10 days to test sediment.

Methods

The recommended protocols were closely followed during testing. Samples were collected and stored properly, and all testing was started within the maximum time limit of 14 days after sediment collection.

Water Quality

All water quality parameters (temperature, dissolved oxygen, salinity, pH, ammonia, and sulfides) were measured in the overlying water in all the replicates on Days 0 and 10 (i.e., test initiation and test termination). In addition, temperature, dissolved oxygen, salinity, and pH were measured in one replicate of each test sample on Days 3 and 7. Dissolved oxygen was monitored in all replicates on Day 5. Temperature was monitored daily in three designated temperature-monitoring beakers.

The specified temperature range of 15 ± 1°C (i.e., 14–16°C) was exceeded on Day 6 in two of the three temperature-monitoring beakers (maximum 16.5°C). There were no other deviations from the specified temperature.

The test organisms were acclimated at 28.9 ± 2.0 parts per thousand (ppt) saline prior to testing. There were no deviations from the specified salinity range of 28 ± 1 ppt during the test.

Concentrations of dissolved oxygen were greater than the recommended minimum level of 5.0 mg/L for all control and test sediment replicates. The lowest dissolved oxygen concentration was 5.0 mg/L in a single test replicate. The air supply to this replicate was not operating on Day 7. The malfunction was corrected. The dissolved oxygen levels in the other replicates were all above 7.1 mg/L. The mean dissolved oxygen concentration in all test replicates was 7.8 ± 0.2 mg/L. Values of pH ranged from 7.4 to 8.5 and were all within the desirable range of 7.0 to 9.0. The concentration of ammonia nitrogen ranged from less than 0.1 to 8.0 mg/L, and the concentration of total sulfide was less than 0.01 mg/L. Following the 1-day pretest equilibration period, three of the replicates contained from 0.85 to 11.3 mg/L sulfide in the overlying water. Following an increase in aeration rates, the sulfide levels declined to below the detection limit within 1 hour.

Controls

A negative control, containing sediment from West Beach, Washington, was tested for each analytical group. The mean mortality value for the control sediment was 0 percent. The mean mortality values for sediment from the two reference area samples were 7 and 9 percent, respectively. These results suggest that the test organisms were sufficiently healthy for testing.

A positive control was tested using cadmium chloride as the reference toxicant. The positive control exhibited a 96-hour LC50 value of 1.77 mg/L cadmium, which is within the testing laboratory's control chart limits for this test. The observed LC50 value suggests that the test organisms were suitably sensitive for testing.

Response Variability

Several of the amphipod tests using *R. abronius* displayed unusually high variability (i.e., standard deviation greater than 15) among the five replicates for an individual sediment sample. This level of response variability may substantially reduce the power of statistical comparisons made with these data (Barrick et al. 1988).

AMPHIPOD TOXICITY TEST USING *Leptocheirus plumulosus*

An amphipod toxicity test was performed to determine percent survival and failure to rebury in adult amphipods (*L. plumulosus*) exposed for 10 days to test sediment.

Methods

The recommended protocols were closely followed during testing. Samples were collected and stored properly, and all testing was started within the maximum time limit of 14 days after sediment collection.

Water Quality

All water quality parameters (temperature, dissolved oxygen, salinity, pH, ammonia, and sulfides) were measured in the overlying water in all the replicates on Days 0 and 10 (i.e., test initiation and test termination). In addition, temperature, dissolved oxygen, salinity, and pH were measured in one replicate of each test sample on Days 3 and 7. Dissolved oxygen was monitored in all replicates on Day 5. Temperature was monitored daily in three temperature beakers.

The specified temperature range of 20 ± 1°C (i.e., 19–21°C) was maintained throughout the exposure period.

The test organisms were acclimated at 25.1 ± 2.2 ppt saline prior to testing. There were no deviations from the specified salinity range of 28 ± 1 ppt during the test.

Concentrations of dissolved oxygen were greater than the recommended minimum level of 5.0 mg/L for all control and test sediment replicates. The lowest dissolved oxygen concentration was 5.2 mg/L in a single test replicate. The mean dissolved oxygen concentration in all test replicates was 6.9 ± 0.2 mg/L. Values of pH ranged from 7.5 to 8.6 and were all within the desirable range of 7.0 to 9.0. The concentration of ammonia nitrogen ranged from less than 0.1 to 10.5 mg/L and the concentration of total sulfide was less than 0.01 mg/L.

Controls

A negative control, containing sediment from York River Marsh (culture media from the amphipod supplier), was tested for each analytical group. The mean mortality value for the control sediment was 0 percent. The mean mortality values for sediment from the two reference area samples were 1 and 3 percent, respectively. These results suggest that the test organisms were sufficiently healthy for testing.

A positive control was tested using cadmium chloride as the reference toxicant. The positive control exhibited a 96-hour LC50 value of 3.26 mg/L cadmium. Although the laboratory does not have control chart limits for this test species, this result is similar to an earlier reference toxicant test performed by the laboratory using *Leptocheirus*. The observed LC50 value suggests that the test organisms were suitably sensitive for testing.

Response Variability

None of the amphipod tests using *L. plumulosus* displayed unusually high variability (i.e., standard deviation greater than 15) among the five replicates for an individual sediment sample. This level of response variability is not expected to substantially reduce the power of statistical comparisons made with these data (Barrick et al. 1988).

ECHINODERM TOXICITY TEST USING *Dendraster excentricus*

An echinoderm toxicity test was performed to determine the percent survival and abnormality of echinoderm embryos (*Dendraster excentricus*) exposed for 48–96 hours to test sediment.

Methods

The recommended protocols were closely followed during testing. Samples were collected and stored properly, and all testing was started within the maximum time limit of 14 days after sediment collection.

Water Quality

All water quality parameters (temperature, dissolved oxygen, salinity, pH, ammonia, and sulfides) were measured in the overlying water in a water quality beaker daily. There were slight deviations from the specified temperature range of 15 ± 1°C (i.e., 14–16°C). Temperatures in eight replicates on Day 0 were below the specified temperature range with a minimum temperature of 13.5°C. In addition, temperatures in two replicates on Day 3 were below the specified temperature range with a minimum temperature of 13.8°C.

The test organisms were acclimated at 31.7 ± 0.6 ppt saline prior to testing. There were no deviations from the specified salinity range of 31 ± 1 ppt during the test.

Concentrations of dissolved oxygen were greater than the recommended minimum level of 5.0 mg/L for all control and test sediment replicates. The lowest dissolved oxygen concentration was 7.8 mg/L. Values of pH ranged from 7.5 to 7.9 and were all within the desirable range of 7.0 to 9.0. The concentration of ammonia nitrogen ranged from less than 0.1 to 0.7 mg/L and the concentration of total sulfide was less than 0.01 mg/L.

Controls

A negative control, containing seawater from Yaquina Bay, Oregon, was tested for each analytical group. Normal larvae were produced by 90.6 percent of the embryos in the negative seawater control. Normal larvae were produced by 75.1 percent and 77.9 percent of the embryos in the two reference area samples, respectively. These percentages exceed the test criterion of 70 percent specified in the July 1995 revision of the Puget Sound Estuary Protocols (PSEP) for laboratory bioassays These results suggest that the test organisms were sufficiently healthy for testing.

A positive control was tested using cadmium chloride as the reference toxicant. The positive control exhibited a 48–96 hour EC50 value of 8.61 mg/L cadmium. This result is within the laboratory's control chart limits for this test. The observed EC50 value suggests that the test organisms were suitably sensitive for testing.

Response Variability

Several of the echinoderm tests using *D. excentricus* displayed unusually high variability (i.e., standard deviation greater than 15) among the five replicates for an individual sediment sample. This level of response variability may substantially reduce the power of statistical comparisons made with these data (Barrick et al. 1988).

POLYCHAETE TOXICITY TEST USING *Neanthes* sp.

A polychaete toxicity test was performed to measure mortality and biomass in juvenile polychaetes (*Neanthes* sp.) exposed for 20 days to test sediment.

Methods

The recommended protocols were followed closely during testing and few methodological departures were made. Samples were collected and stored properly, and all testing was started within the maximum time limit of 14 days after sediment collection.

Water Quality

All water quality parameters (temperature, dissolved oxygen, salinity, pH, ammonia, and sulfides) were measured in the overlying water in all replicates on Days 0 and 20 (i.e., test initiation and test termination). In addition, temperature, dissolved oxygen, salinity, pH, and ammonia were monitored in one replicate at 3-day intervals and were monitored in all replicates at 5-day intervals. Temperature was monitored daily in three temperature-monitoring beakers.

There were no deviations from the specified temperature range of 20 ± 1°C (i.e., 19–21°C) during the test.

The test organisms were acclimated at 33.1 ± 3.8 ppt saline prior to testing. There were no deviations from the specified salinity range of 28 ± 2 ppt during the test.

Concentrations of dissolved oxygen were generally greater than the recommended minimum level of 5.0 mg/L. However, the dissolved oxygen concentration was less than 5.0 mg/L in three test replicates. The lowest dissolved oxygen concentration was 4.1 mg/L on Day 3. In all three test replicates the aeration rate was immediately adjusted. The mean dissolved oxygen concentration in all test replicates was 7.0 ± 0.3 mg/L.

On Day 4, an air line was left out of one of the replicates. In addition, the replacement water for renewal had not been added to that replicate (i.e., the replicate contained only half the required amount of overlying seawater). The dissolved oxygen level in this replicate was 1.0 mg/L. The polychaetes were climbing the sides of the beaker, and one polychaete had desiccated on the side of the beaker. This replicate was removed from further testing, and water quality monitoring was reassigned to another replicate for the same sample.

Values of pH ranged from 7.3 to 8.4 and were all within the desirable range of 7.0 to 9.0. The concentration of ammonia nitrogen ranged from less than 0.2 to 12.5 mg/L, and the concentration of total sulfide was less than 0.01 mg/L.

Controls

A negative control, containing sediment from West Beach, Washington, was tested for each analytical group. The mean mortality value for the control sediment was 20 percent, which fails to meet the mortality limits specified by Puget Sound Dredged Disposal Analysis (i.e., 10 percent). PSEP does not specify a minimum control survival. However, the mean biomass value for the control sediment met the performance criterion of a minimum growth rate of 0.38 mg dry weight/individual-day. The mortality values for the reference area samples were 0 and 20 percent, respectively, and the growth values for the reference area samples were well above the performance criterion. These results suggest that the health of the test organisms was questionable for testing purposes.

A positive control was tested using cadmium chloride as the reference toxicant. The positive control exhibited a 96-hour LC50 value of 8.68 mg/L cadmium. This result is within the laboratory's control chart limits for this test. The observed LC50 value suggests that the test organisms were suitably sensitive for testing.

Response Variability

Several of the polychaete tests using *Neanthes* sp. displayed unusually high variability (i.e., standard deviation greater than 15) among the five replicates for an individual sediment sample. This level of response variability may substantially reduce the power of statistical comparisons made with these data (Barrick et al. 1988).

REFERENCES

Barrick, R.C., D.S. Becker, L.J. Brown, H.R. Beller, and R.A. Pastorok. 1988. Sediment quality values refinement: 1988 update and evaluation of Puget Sound AET. Vol. I. Final Report. Prepared for Tetra Tech, Inc. and U.S. Environmental Protection Agency Region 10, Office of Puget Sound, PTI Environmental Services, Bellevue, WA. 74 pp. + appendices.

Sokal, R.R., and F.J. Rohlf. 1981. Biometry. Second Edition. W.H. Freeman and Company, San Francisco, CA.

PTI. 1996. Ward Cove sediment remediation project: technical studies work plan. Prepared for Ketchikan Pulp Company. PTI Environmental Services, Bellevue, WA.

Appendix B4

Quality Assurance Review Summary—Amphipod and Echinoderm Sediment Toxicity Tests Conducted in 1997

QUALITY ASSURANCE REVIEW SUMMARY—AMPHIPOD AND ECHINODERM SEDIMENT TOXICITY TESTS CONDUCTED IN 1997

This report documents the results of the quality assurance review of the data generated in 1997 for the amphipod and echinoderm sediment toxicity tests, as part of the Ward Cove sediment remediation project. The quality assurance review was conducted to ensure that toxicity testing was consistent with the specifications of the work plan (PTI 1996) and field sampling plan (PTI 1997) and that the data are acceptable for use in future stages of the remedial investigation and feasibility study (RI/FS).

The quality assurance review consisted of an evaluation of the following major elements for each of the two toxicity tests:

- **Field Methods**—Were the major specifications of the field sampling procedures followed, as described in the field sampling plan (PTI 1997)?
- **Laboratory Methods**—Were the major specifications of the laboratory testing procedures followed, as described in the quality assurance project plan (PTI 1997, Appendix B)?
- **Sediment Holding Time**—Was each sediment sample analyzed within the specified holding time after field collection?
- **Water Quality Conditions**—Were water quality conditions within the specified ranges for each test chamber?
- **Negative Controls**—Were the responses in the negative controls within specified limits?
- **Positive Controls**—Did the positive controls indicate that the test organisms were suitably responsive for testing?
- **Test Results**—Were there any unusual results that may not be representative of the true test results?

Throughout this report, the term "sample" refers to the whole sediment sample collected from each station in the field for each kind of toxicity test. The term "replicate" refers to one of the five subsamples of each sediment sample collected in the field that was subjected to toxicity testing in the laboratory. In the data tables in Appendices A2 and A3, the five replicates for each sample are distinguished by the numbers 1–5.

The following section of this report presents the results of the quality assurance and quality control (QA/QC) evaluation for the toxicity tests. QA/QC considerations are then summarized, and conclusions are presented in the final section.

QA/QC EVALUATION

Amphipod Toxicity Test Using *Rhepoxynius abronius*

The amphipod toxicity test using *Rhepoxynius abronius* determines percent survival and failure to rebury in adult amphipods (*R. abronius*) exposed for 10 days to test sediment.

Methods

Overall, the recommended protocols were followed closely during testing. All biological testing was in compliance with *Recommended Protocols for Conducting Laboratory Bioassays on Puget Sound Sediments* (PSEP 1995), appropriate modifications as specified by PSDDA (1989), public workshops, and the PSDDA annual review process. Samples were collected and stored properly.

Because extra sediment samples (i.e., additional stations) were unexpectedly collected in the field, additional test organisms were required immediately prior to test initiation. Therefore, some of the test organisms were not gradually acclimated to the specified test conditions (e.g., temperature and salinity of the overlying water prior to test initiation). The test protocol specifies that the test must be started within 14 days of sediment collection. The specified holding time of 14 days was exceeded for five of the samples because additional test organisms needed to be collected. Four samples (SD0002, SD0005, SD0006, and SD0007) exceeded the holding time by 1 day, and one sample (SD0001) exceeded the holding time by 2 days. These exceedances of the recommended holding time are minor, and it is unlikely that they affected the quality of the test results.

Water Quality

The procedure used by the toxicity testing laboratory for daily water quality monitoring of the amphipod test was modified from the procedure stipulated in the quality assurance plan (PTI 1997, Appendix B), which included daily measurement of water quality conditions in each test chamber. All water quality parameters (temperature, dissolved oxygen, salinity, pH, ammonia, and sulfide) were measured in the overlying water in all the replicates on Days 0 and 10 (i.e., test initiation and test termination). In addition, temperature, dissolved oxygen, salinity, and pH were measured daily in one replicate (i.e., water quality beaker) of each test sample. The procedure employed by the testing laboratory is considered acceptable because it provides a means of reducing sample disturbance during the testing period. In addition, Puget Sound Estuary Program protocols (PSEP 1995) do not specifically state that water quality measurements must be conducted in each test chamber.

Temperature—Prior to testing, the test organisms were acclimated at 12.6 ± 0.2°C, which is lower than the specified temperature range of 15 ± 1°C (deviation of 1.4°C). Temperatures measured during the testing period also deviated from the specified temperature range of 15 ± 1°C (i.e., 14–16°C) in two cases. On Day 7, the temperature in 2 of the 36 water quality beakers was 13.7 and 13.8°C, respectively (deviation of 0.3–0.4°C); on Day 10, the temperature in 31 of the 180 test replicates ranged from 13.3 to 13.9°C (deviation of 0.1–0.7°C). There were no other deviations from the specified temperature. On Day 10, two test replicates (one replicate from SD0015 and SD0016, respectively) were siphoned before the final water quality measurements were collected. The mean temperature in all test replicates was 14.8 ± 0.6°C. In general, elevated temperatures tend to stress the test organisms more so than temperature reductions. Because the temperature reductions were minor relative to the specified range, it is unlikely that they affected the quality of the test results.

Salinity—Prior to testing, the test organisms were acclimated to a salinity of 31.7 ± 1.4 parts per thousand (ppt), which is higher than the specified salinity range of 28 ± 1 ppt (exceedance of 1.3 ppt). The specified salinity range of 28 ± 1 ppt was often exceeded during the testing period. On Day 0 (i.e., test initiation), the salinity in 162 of the 180 test replicates ranged from 29.5 to 30.0 ppt (exceedance of 0.5–1.0 ppt). The laboratory added 10 mL of Milli-Q® deionized water to all test replicates on Day 0 in an effort to correct the higher than specified salinities. On Day 1, the salinity in 5 of the 36 water quality beakers was 29.5 ppt (exceedance of 0.5 ppt). On Day 4, the salinity in 1 of the 36 water quality beakers was 31.0 ppt (exceedance of 2 ppt). The laboratory added Milli-Q® deionized water to the beaker. On Day 5, the salinity in 19 of the 36 water quality beakers ranged from 29.5 to 31.0 ppt (exceedance of 0.5–2.0 ppt). The laboratory added Milli-Q® deionized water to all beakers in which salinity was 30 ppt or greater. On Day 6, the laboratory noted that evaporation had occurred in a large number of beakers (i.e., 93 beakers). The salinity was checked in these beakers (salinity ranged from 29.5 to 31.0 ppt; exceedance of 0.5–2.0 ppt), and Milli-Q® deionized water was added to decrease the salinity. On Day 7, the salinity in 35 of the 36 water quality beakers ranged from 29.5 to 30.5 ppt (exceedance of 0.5–1.5 ppt). The laboratory added Milli-Q® deionized water to all the beakers. On Day 8, the salinity in 10 of the 36 beakers ranged from 29.5 to 30.0 ppt (exceedance of 0.5–1.0 ppt). No Milli-Q® deionized water was added by the laboratory. On Day 9, the salinity in 4 of the 36 beakers was 29.5 ppt (exceedance of 0.5 ppt). Again, no Milli-Q® deionized water was added by the laboratory. On Day 0 (i.e., test termination), the salinity in 75 of the 180 replicate beakers exceeded the specified salinity range of 28 ± 1 ppt (salinity ranged from 29.5 to 30.0 ppt; exceedance of 0.5–1.0 ppt). The mean salinity in all test replicates was 29.3 ± 0.9 ppt. In general, reduced salinities tend to stress the test organisms more so than elevated salinities.

Because the salinity elevations were minor relative to the specified range, it is unlikely that they affected the quality of the test results.

Dissolved Oxygen—Concentrations of dissolved oxygen were greater than or equal to the recommended minimum level of 5.0 mg/L for all control and test sediment replicates. The lowest dissolved oxygen concentration was 5.0 mg/L in a single test replicate. The sediment in this beaker was accidentally stirred prior to collection of the water quality measurements on Day 10. On Day 10, two test replicates (one replicate from SD0015 and SD0016, respectively) were siphoned before the final water quality measurements were collected. The dissolved oxygen levels in the other replicates ranged from 5.2 to 8.4 mg/L with the majority of the replicates above 7.0 mg/L. The mean dissolved oxygen concentration in all test replicates was 8.1 ± 0.3 mg/L.

Other Water Quality Variables—Values for pH ranged from 7.4 to 8.5 and were all within the recommended range of 7.0–9.0. On Day 10, two test replicates (one replicate from SD0015 and SD0016, respectively) were siphoned before the final water quality measurements were collected. The mean pH value in all test replicates was 8.0 ± 0.2. The concentration of ammonia nitrogen (ammonia-N) in the overlying water during the testing period ranged from less than 0.2 mg/L (detection limit) to 10.5 mg/L. Ammonia-N concentrations in the pore water of the test sediments at test termination ranged from less than 1.0 to 14 mg/L. Porewater ammonia-N concentrations were 10 mg/L or greater in 6 of the 35 samples. The concentration of total sulfide in the overlying water was less than 0.01 mg/L (detection limit). Sulfide concentrations in the pore water of the test sediments at test termination ranged from less than 1.3 to 28.1 mg/L. Porewater sulfide concentrations were 20 mg/L or greater in 11 of the 35 samples.

Interstitial Salinity

Interstitial salinity of the test sediments was measured when the sediments were received by the laboratory. The interstitial salinity of the test sediments at test initiation ranged from 26.0 to 31.0 ppt. Interstitial salinity at test initiation in the sediment control was 34.5 ppt. The final interstitial salinities ranged from 27.0 to 30.0 ppt. For the *R. abronius* toxicity test, an interstitial water salinity of 25.0 ppt or greater is necessary to ensure that there are no salinity effects (PSEP 1995).

Controls

A negative control consisting of sediment from Yaquina Bay, Oregon, was used in each analytical group. Mean survival for the control sediment was 100 percent. Mean survival for sediment from the two reference area samples were both 96 percent. These results suggest that the test organisms were sufficiently healthy for testing.

A positive control was tested using cadmium chloride as the reference toxicant. Because the supply of test organisms was limited, fewer test organisms and fewer replicates were used in the reference toxicant test for this study. The positive control exhibited a 96-hour LC50 value of 0.61 mg/L, which is within the testing laboratory's control chart warning limits for this test. The observed LC50 value suggests that the test organisms were suitably sensitive for testing.

Response Variability

Several of the amphipod tests using *R. abronius* displayed unusually high variability (i.e., standard deviation greater than 15) among the five replicates for an individual sediment sample, which may substantially reduce the power of statistical comparisons made using these data (Barrick et al. 1988). In several cases, the high variability was due to low survival in a single replicate.

Echinoderm Toxicity Test Using *Dendraster excentricus*

The echinoderm toxicity test using *Dendraster excentricus* determines percent mortality and abnormality of echinoderm embryos exposed to test sediment for 48–96 hours.

Methods

Overall, the recommended protocols were followed closely during testing. All biological testing was in compliance with *Recommended Protocols for Conducting Laboratory Bioassays on Puget Sound Sediments* (PSEP 1995), appropriate modifications as specified by PSDDA (1989), public workshops, and the PSDDA annual review process. Samples were collected and stored properly. The test protocol specifies that the test must be started within 14 days of sediment collection. The specified holding time of 14 days was exceeded for five of the samples. Four samples (SD0002, SD0005, SD0006, and SD0007) exceeded the holding time by 1 day, and one sample (SD0001) exceeded the holding time by 2 days. These exceedances of the recommended holding time are minor, and it is unlikely that they affected the quality of the test results.

As determined by the laboratory, the initial concentration of test organisms in the test chambers was 17.3 test organisms/mL. The protocol specifies a range of 20–30 test organisms/mL. It is unlikely that this minor deviation from the specified range affected the quality of the test results.

Exposure time for the test was increased from 48 to 56 hours to allow the embryos to develop to the four-armed pluteus stage. The test protocols (PSEP 1995) allow for a slightly longer exposure period if necessary to achieve adequate development of embryos in the seawater control, but the exposure time cannot exceed 96 hours for an acceptable test.

Water Quality

All water quality parameters (temperature, dissolved oxygen, salinity, pH, ammonia, and sulfide) were measured in the overlying water in all water quality replicates at test initiation and test termination and in a water quality beaker daily.

Temperature—Prior to testing, the test organisms were acclimated at 12°C, which is lower than the specified temperature range of 15 ± 1°C (deviation of 2°C). On Day 0 (i.e., test initiation), the temperature in 12 of the 36 water quality replicates deviated by 0.1–0.2°C. There were no deviations from the specified temperature (i.e., 14–16°C) during testing. The mean temperature in all test replicates was 15.6 ± 0.3°C.

Salinity—Prior to test initiation, the laboratory received adult echinoderms that were ready to spawn. The laboratory did not measure the salinity of the water in which the adult echinoderms were shipped, the resulting embryos were maintained at 30 ppt until test initiation. During the testing period, there were no deviations from the specified salinity of 31 ± 1 ppt. The mean salinity in all test replicates was 30.9 ± 0.4 ppt.

Dissolved Oxygen—Concentrations of dissolved oxygen were greater than the recommended minimum level of 5.0 mg/L for all control and test sediment replicates. The lowest dissolved oxygen concentration was 7.2 mg/L in a single test replicate. The dissolved oxygen levels in the other replicates ranged from 7.8 to 8.3 mg/L with the majority of the replicates above 8.0 mg/L. The mean dissolved oxygen concentration in all test replicates was 8.1 ± 0.1 mg/L.

Other Water Quality Variables—Values for pH ranged from 7.6 to 8.0 and were all within the recommended range of 7.0–9.0. The mean pH value in all test replicates was 7.9 ± 0.1. Total sulfide and ammonia-N were measured on Days 0 and 3. The concentration of ammonia-N in the water during the testing period ranged from less than 0.2 mg/L (detection limit) to 0.9 mg/L. All concentrations of total sulfide in the water were less than 0.01 mg/L (detection limit).

Controls

A negative control consisting of seawater from Yaquina Bay, Oregon, was used in each analytical group. The mean percent survival for the clean seawater negative control was

78.6 ± 6.4. The mean percent normality for the clean seawater negative control was 93.8 ± 4.9. The mean percent normal survival was 73.8 ± 7.8. This value exceeds the test acceptance criterion of 70 percent (PSEP 1995). These results suggest that the test organisms were sufficiently healthy for testing.

A positive control was tested using cadmium chloride as the reference toxicant. The positive control exhibited an EC50 value of 11.2 mg/L, which is within the laboratory's control chart warning limits (4.66 to 11.9 mg/L). The observed EC50 value suggests that the test organisms were suitably sensitive for testing.

Response Variability

Several of the echinoderm tests using *D. excentricus* displayed unusually high variability (i.e., standard deviation greater than 15) among the five replicates for an individual sediment sample, which may substantially reduce the power of statistical comparisons made using these data (Barrick et al. 1988).

SUMMARY OF QA/QC CONSIDERATIONS

The following protocol deviations were noted during the QA/QC evaluation:

- **Amphipod Test**
  - Additional test organisms were collected immediately prior to test initiation and, therefore, were not gradually acclimated to the test conditions prior to test initiation.
  - The specified sediment holding time of 14 days was exceeded for five of the samples (exceedance of 1–2 days).
  - Temperatures measured during acclimation (12.6 ± 0.2°C) and on Days 7 and 10 during the testing period (13.3–13.9°C) deviated from the specified temperature range of 14–16°C.
  - The specified salinity range of 27–29 ppt was exceeded during acclimation of the test organisms, at test initiation, and throughout the testing period. The salinity range was exceeded on Days 0, 1, 4, 5, 6, 7, 8, 9, and 10. A maximum salinity of 31.0 ppt was observed in several test chambers on Days 4, 5, and 6. The maximum interstitial salinity of the test sediments that were received by the laboratory was 31.0 ppt. The higher interstitial salinities could have contributed to the ongoing problem that the laboratory encountered in maintaining the salinity of the test chambers to the specified range of 28 ± 1 ppt.

- **Echinoderm Test**
  - The specified sediment holding time of 14 days was exceeded for five of the samples (exceedance of 1–2 days).
  - The specified temperature range of 14–16°C was exceeded on Day 1 during the testing period (16.1–16.2°C).
  - The protocol specifies 20–30 test organisms/mL at test initiation. The initial concentration of test organisms used in this study was 17.3 organisms/mL.

CONCLUSIONS

All of the amphipod bioassay data are considered acceptable for characterizing sediment toxicity. However, uncertainty in unacclimated organisms may have contributed to the high variability seen in numerous samples. The test sediments received by the laboratory had a maximum interstitial salinity of 31.0 ppt. The higher interstitial salinities could have contributed to the ongoing problem that the laboratory encountered in maintaining the salinity of the test chambers to the specified range of 28 ± 1 ppt. However, the mean mortality observed in the negative controls was well below the maximum acceptable level, suggesting that the test organisms were suitably responsive for testing.

All of the echinoderm test data are considered acceptable for characterizing sediment toxicity. However, the results may have been influenced to some degree by the lower initial concentration of test organisms. The combined mean percent mortality and abnormality of the negative control for this test was 73 percent, which is just above the criterion for acceptability (i.e., 70 percent combined mean percent mortality and abnormality).

REFERENCES

Barrick, R.C., D.S. Becker, L.J. Brown, H.R. Beller, and R.A. Pastorok. 1988. Sediment quality values refinement: 1988 update and evaluation of Puget Sound AET. Vol. I. Final Report. Prepared for Tetra Tech, Inc. and U.S. Environmental Protection Agency Region 10, Office of Puget Sound, PTI Environmental Services, Bellevue, WA. 74 pp. + appendices.

PSDDA. 1989. PSDDA Phase II management plan report. Chapter 5 and Appendix A. Prepared by the Puget Sound Dredged Disposal Analysis Program. U.S. Army Corps of Engineers, Seattle District, Seattle, WA

PSEP. 1995. Recommended protocols for conducting laboratory bioassays on Puget Sound sediments. Prepared for U.S. Environmental Protection Agency Region 10, Office of Puget Sound, Puget Sound Estuary Program, Seattle, WA. PTI Environmental Services, Bellevue, WA.

PTI. 1996. Ward Cove sediment remediation project: technical studies work plan. Prepared for Ketchikan Pulp Company, Ketchikan, AK. PTI Environmental Services, Bellevue, WA.

PTI. 1997. Ward Cove sediment remediation project: technical studies field sampling plan for the Phase 2 investigation. Prepared for Ketchikan Pulp Company, Ketchikan, AK. PTI Environmental Services, Bellevue, WA.

Appendix B5

Quality Assurance Review Summary—Specialized Toxicity Testing Conducted in 1997

QUALITY ASSURANCE REVIEW SUMMARY—SPECIALIZED TOXICITY TESTING CONDUCTED IN 1997

This report documents the results of the quality assurance review of the data generated in 1997 for the specialized toxicity tests, as part of the Ward Cove sediment remediation project. The methods used to evaluate the toxicity of total ammonia and total sulfide were based on modifications of the procedures used by the U.S. Environmental Protection Agency (EPA) to conduct toxicity identification evaluation testing of marine effluents and receiving waters (U.S. EPA 1996). Several of these procedures were modified for application to marine sediments (Ho et al. 1997, unpublished). In addition, another procedure recommended by EPA (U.S. EPA 1993, 1994) for evaluating ammonia toxicity as part of dredged material testing was used in the present study.

The quality assurance review was conducted to ensure that toxicity testing was consistent with the specifications of the field sampling plan (PTI 1997, Appendices B and F) and that the data are acceptable for use in future stages of the remedial investigation and feasibility study (RI/FS). The quality assurance review consisted of an evaluation of the following major elements for each of the four types of analyses performed during this study:

- **Field Methods**—Were the major specifications of the field sampling procedures followed, as described in the field sampling plan (PTI 1997)?
- **Laboratory Methods**—Were the major specifications of the laboratory testing procedures followed, as described in the quality assurance project plan (PTI 1997, Appendix B)?
- **Sediment Holding Time**—Was each sediment sample analyzed within the specified holding time after field collection?
- **Water Quality Conditions**—Were water quality conditions within the specified ranges for each test chamber?
- **Negative Controls**—Were the responses in the negative controls within specified limits?
- **Positive Controls**—Did the positive controls indicate that the test organisms were suitably responsive for testing?
- **Test Results**—Were there any unusual results that may not be representative of the true test results?

Throughout this report, the term "sample" refers to the whole sediment sample collected from each station in the field for each kind of toxicity test. The term "replicate" refers to one of the five subsamples of each sediment sample collected in the field that was subjected to toxicity testing in the laboratory. In the data tables in Appendices A2 and A3, the five replicates for each sample are distinguished by the letters A–E following each sample number.

The following section of this report presents the results of the quality assurance and quality control (QA/QC) evaluation for the analyses. QA/QC considerations are then summarized, and conclusions are presented in the final section.

QA/QC EVALUATION

Amphipod Toxicity Test with Preliminary Purging

The amphipod toxicity test with preliminary purging determines percent survival and failure to rebury in adult amphipods (*Rhepoxynius abronius*) exposed for 10 days to test sediment. Prior to test initiation, the sediment was purged of excessive ammonia nitrogen (ammonia-N) until the levels in the sediment pore water declined to less than 20 mg/L ammonia-N.

Methods

The experimental design used in this study is based on the ammonia purging procedure of U.S. EPA (1993). The EPA procedure calls for twice daily replacement of overlying water in the test chambers containing test sediments until the concentration of ammonia-N in sediment pore water falls below 20 mg/L. The 10-day test exposure is then initiated by addition of amphipods (*R. abronius*) to test chambers.

In this study, porewater ammonia-N concentrations were less than 20 mg/L within 2 days of test chamber setup (1 day after initiating purging). The purging procedure was continued, however, for 10 days after the test chamber was set up because high concentrations of sulfide were evident in the pore water. Although the initial concentrations of ammonia-N and sulfide differed substantially between samples, all samples were treated equally and purged for 10 days. Approximately 80–90 percent of overlying test water was replaced twice a day during the 10-day period. Amphipods (*R. abronius*) were added to test chambers at the conclusion of the purging process.

In this study, five replicates, each containing 20 amphipods, were used for each treatment. In addition, five additional test chambers were set up without amphipods and were used for analysis of ammonia-N and sulfide in the pore water.

After purging, the recommended protocols for the amphipod mortality test were closely followed during testing. The amphipod mortality test was in compliance with *Recommended Protocols for Conducting Laboratory Bioassays on Puget Sound Sediments* (PSEP 1995), appropriate modifications as specified by PSDDA (1989), public workshops, and the annual review process. Samples were collected and stored properly at 4°C. The sediment was stored in glass jars with Teflon®-lined lids and placed under nitrogen atmosphere to extend the holding time prior to test initiation.

Water Quality

To monitor water quality during the purging period, temperature, dissolved oxygen, salinity, and pH were measured in the overlying water in the water quality replicate daily before the initial water replacement.

To monitor water quality during the testing period, all water quality parameters (temperature, dissolved oxygen, salinity, and pH) were measured in the overlying water in all replicates on Days 0 and 10 (i.e., test initiation and test termination). Ammonia and sulfide were measured in one replicate on Days 0 and 10. In addition, temperature, dissolved oxygen, salinity, and pH were measured daily in one replicate (i.e., water quality beaker) of each test sample.

Temperature—Prior to testing, the test organisms were acclimated at 13.3 ± 0.7°C, which is lower than the specified temperature range of 15 ± 1°C (deviation of 0.7°C).

Temperatures measured during the purging period also deviated from the specified temperature range of 15 ± 1°C (i.e., 14–16°C). On Day 0 of the purging period, the temperature in the test replicates ranged from 16.1 to 17.0°C (exceedance of 0.9–1.0°C). There were no other deviations from the specified temperature during the purging procedure. For the purging period, the mean temperature in all test replicates was 15.1 ± 0.7°C.

Temperatures measured during the testing period also deviated from the specified temperature range of 15 ± 1°C (i.e., 14–16°C). On Day 0 of the testing period, the temperature in 28 of the 45 test replicates ranged from 13.0 to 13.9°C (deviation of 0.1–1.0°C); on Day 1, the temperature in all of the water quality beakers ranged from 13.2 to 13.8°C (deviation of 0.2–0.8°C). There were no other deviations from the specified temperature during the testing period. For the testing period, the mean temperature in all test replicates was 14.6 ± 0.8°C. In general, elevated temperatures tend to stress the test organisms more so than temperature reductions. Because the temperature reductions were minor relative to the specified range, it is unlikely that they affected the quality of the test results.

Salinity—Prior to testing, the test organisms were acclimated to a salinity of 35.0 parts per thousand (ppt), which is higher than the specified salinity range of 28 ± 1 ppt (exceedance of 6 ppt).

There were no deviations from the specified salinity during the purging period. For the purging period, the mean salinity in all test replicates was 27.8 ± 0.3 ppt.

The specified salinity range of 28 ± 1 ppt was often exceeded during the testing period. On Day 3, the salinity in six of the nine water quality beakers was 29.5 ppt (exceedance of 0.5 ppt); on Day 4, the salinity in three of the nine water quality beakers was 29.5 ppt (exceedance of 0.5 ppt); on Day 5, the salinity in all nine water quality beakers was 29.5 ppt (exceedance of 0.5 ppt); on Day 6, the salinity in seven of the nine water quality beakers was 29.5 ppt (exceedance of 0.5 ppt); and on Day 7, the salinity in eight of the nine water quality beakers was 30.0 ppt (exceedance of 1.0 ppt). The laboratory added Milli-Q® deionized water to all test replicates on Day 7 in an effort to correct the higher than specified salinities. On Day 10 (i.e., test termination), the salinity in 2 of the 45 test replicates was 30.0 ppt (exceedance of 1.0 ppt). The mean salinity in all test replicates during the testing period was 28.6 ± 0.7 ppt. Because the salinity elevations were minor relative to the specified range, it is unlikely that they affected the quality of the test results.

Dissolved Oxygen—Concentrations of dissolved oxygen were greater than the recommended minimum level of 5.0 mg/L for all control and test sediment replicates during acclimation, the purging period, and the testing period. The lowest dissolved oxygen concentration was 7.7 mg/L in a single test replicate. The dissolved oxygen levels in the other replicates ranged from 7.8 to 8.5 mg/L with the majority of the replicates above 8.0 mg/L. The mean dissolved oxygen concentration in all test replicates during the purging period was 8.2 ± 0.2 mg/L. The mean dissolved oxygen concentration in all test replicates during the testing period was 8.1 ± 0.1 mg/L.

Other Water Quality Variables—During both the purging period and the testing period, pH values ranged from 7.7 to 8.2 and were all within the recommended range of 7.0–9.0. The mean pH value in all test replicates was 8.0 ± 0.1 for the purging period and 7.9 ± 0.1 for the testing period.

Overlying water and pore water were analyzed for ammonia-N and sulfide on Days 2, 5, 9, and 17 after test chamber setup. The initial three measurements were taken daily during the purging period. The last sample for porewater measurements was collected on Day 7 of the testing period.

Ammonia-N concentrations in overlying water declined during the initial phases of the purging period. Ammonia-N concentrations were less than 0.5 mg/L for all test sediments on Days 5 and 9. The concentrations of ammonia-N in the overlying water had substantially risen again by Day 17, 7 days after the end of the purging period. On Day 2, ammonia-N in the pore water ranged from 4.0 to 16.0 mg/L. On Day 5, ammonia-N concentrations were substantially reduced (2.0–6.5 mg/L). Porewater ammonia-N concentrations were only moderately lower on Day 9 (after test chamber setup) and remained unchanged after 7 days into the testing period. In general, the concentrations of ammonia-N observed in the overlying water seemed to correlate with concentrations observed in the sediment pore water.

Sulfide in overlying water of the water quality beakers was below the detection limit (0.01 mg/L) for all samples. Porewater concentrations of sulfide on the initial day of test chamber setup (i.e., Day 2 after sediment was placed in the test chambers) ranged from 3.8 to 38.8 mg/L. In nearly all samples, the sulfide concentration exhibited a gradual rate of decline throughout the 17-day monitoring period; by Day 17, the highest porewater sulfide concentration was 5.5 mg/L. On Day 9 (after test chamber setup), 1 day before initiation of the testing period, porewater sulfide concentrations ranged from less than 2.5 to 22.5 mg/L.

Interstitial Salinity

Interstitial salinity of the test sediments was measured when the sediments were received by the laboratory. The interstitial salinity of the test sediments at test initiation ranged from 26.0 to 30.5 ppt, which is within the accepted range for *R. abronius*. Interstitial salinity at test initiation in the sediment control was 34.5 ppt. The final interstitial salinities ranged from 26.0 to 29.5 ppt.

Controls

A negative control consisting of sediment from Yaquina Bay, Oregon, was used in each analytical group. The mean survival for the control sediment was 98 percent. These results suggest that the test organisms were sufficiently healthy for testing.

A positive control was tested using cadmium chloride as the reference toxicant. The positive control exhibited a 96-hour LC50 value of 0.78 mg/L, which is within the testing laboratory's control chart warning limits for this test. The observed LC50 value suggests that the test organisms were suitably sensitive for testing.

Response Variability

Several of the amphipod tests using *R. abronius* displayed unusually high variability (i.e., standard deviation greater than 15) among the five replicates for an individual sediment sample, which may substantially reduce the power of statistical comparisons made using these data (Barrick et al. 1988).

Amphipod Test with *Ulva* Treatment

The amphipod test with *Ulva* treatment determines percent survival in adult amphipods (*Rhepoxynius abronius*) exposed for 48 hours to test sediment. Prior to exposure, one-half of the test sediment was incubated for 24 hours with the alga *Ulva* sp.

Methods

The experimental design used in this study is based on Ho et al. (1997, unpublished). Untreated test sediments were set up side-by-side with treated sediments. For treated sediments, fresh *Ulva* was added to the beaker containing sediment and water and incubated with gentle aeration and light exposure for 24 hours. The *Ulva* was then removed and the 48-hour test exposure was initiated by addition of amphipods (*R. abronius*) to the test chambers.

In this study, four replicates, each containing five amphipods, were used for each treatment. In addition, two additional test chambers for each treatment were set up without amphipods and were used for analysis of ammonia-N and sulfide in the pore water.

After the incubation period, the recommended protocols for the amphipod mortality test were closely followed during testing. The amphipod mortality test was conducted consistent with the methods in U.S. EPA (1993). Samples were collected and stored properly at 4°C. The sediment was stored in glass jars with Teflon®-lined lids and placed under nitrogen atmosphere to extend the holding time prior to test initiation.

Water Quality

To monitor water quality during the testing period, all water quality parameters (i.e., temperature, dissolved oxygen, salinity, and pH) were measured daily in the overlying water in one test replicate. In addition, ammonia-N and sulfide were measured in one replicate on Days 0 and 10 (i.e., test initiation and test termination).

Temperature—Prior to testing, test organisms were acclimated at 12.7 ± 0.7°C, which is lower than the specified temperature range of 15 ± 1°C (deviation of 2.3°C). There were no deviations from the specified temperature during the testing period. For the testing period, the mean temperature in all test replicates was 15.2 ± 0.3°C.

Salinity—Prior to testing, test organisms were acclimated to a salinity of 34.0 ppt, which is higher than the specified salinity range of 28 ± 1 ppt (exceedance of 5.0 ppt). The salinity range of 28 ± 1 ppt that was specified in the laboratory's statement of work was constantly exceeded during the testing period. On Day 0 (i.e., test initiation), the salinity in 18 of the 19 test chambers ranged from 30.0 to 31.0 ppt; on Day 1, the salinity in all 19 test chambers ranged from 30.0 to 31.0 ppt; and on Day 2, the salinity in all 19 test chambers was 31.0 ppt. The mean salinity in all test replicates was 30.3 ± 0.5 ppt. These exceedances are noted in this report because they are greater than the salinity range specified in the laboratory's statement of work. U.S. EPA (1993) specifies a salinity range of 30 ± 1 ppt for effluent (i.e., water only) tests.

Dissolved Oxygen—Concentrations of dissolved oxygen were greater than the recommended minimum level of 5.0 mg/L for all control and test sediment replicates during the testing period. The lowest dissolved oxygen concentration was 7.7 mg/L. The dissolved oxygen levels ranged from 7.7 to 8.2 mg/L. The mean dissolved oxygen concentration in all test replicates during the testing period was 8.0 ± 0.1 mg/L.

Other Water Quality Variables—During the testing period, pH values ranged from 7.7 to 8.4 and were all within the recommended range of 7.0–9.0. The mean pH value in all test replicates for the testing period was 8.1 ± 0.1.

Sediment pore water was analyzed for ammonia-N and sulfide on Days 0 and 2 (i.e., test initiation and test termination). On Days 0 and 2, ammonia-N concentrations in the untreated samples (i.e., no *Ulva*) ranged from 2.0 to 12.0 mg/L. On Day 0, concentrations of ammonia-N in sediment pore water from *Ulva* treated samples were 0.5 mg/L or less. On Day 2, concentrations of ammonia-N in sediment pore water from the majority of the *Ulva* treated samples were less than 0.5 mg/L; one sample, however, had an ammonia-N concentration of 2.0 mg/L.

The concentrations of sulfide in the pore water of untreated samples on Day 0 were below the detection limit for five of the eight samples and ranged from 1.9 to 5.3 mg/L in the remaining three samples. On Day 2, sulfide was not detected in any of the untreated samples. On Days 0 and 2, sulfide was not detected in any of the sediment porewater samples following the *Ulva* treatment.

Interstitial Salinity

Interstitial salinity of the test sediments was measured when the sediments were received by the laboratory. The interstitial salinity of the test sediments at test initiation ranged from 26.0 to 30.5 ppt, which is within the accepted range for *R. abronius*. Interstitial salinity at test initiation in the sediment control and final interstitial salinities of the test sediments were not reported by the laboratory.

Controls

A negative control consisting of sediment from Yaquina Bay, Oregon, was used with the untreated sediment. The mean survival for the control sediment was 100 percent. These results suggest that the test organisms were sufficiently healthy for testing.

A positive control was tested using cadmium chloride as the reference toxicant. The positive control exhibited a 96-hour LC50 value of 0.78 mg/L, which is within the testing laboratory's control chart warning limits for this test. The observed LC50 value suggests that the test organisms were suitably sensitive for testing.

Response Variability

None of the amphipod tests using *R. abronius* displayed unusually high variability (i.e., standard deviation greater than 15) among the four replicates for an individual sediment sample. Therefore, response variability in these samples should not affect the power of statistical comparisons made using these data (Barrick et al. 1988).

Amphipod Toxicity Test Using Pore Water

The amphipod toxicity test using pore water determines percent survival in adult amphipods (*Rhepoxynius abronius*) exposed for 48 hours to test sediment. In this study, eight test sediment samples were centrifuged, and the resulting pore water was subjected to aeration and *Ulva* treatments.

Methods

The experimental design used in this study is based on U.S. EPA (1993, 1996). Porewater samples were prepared using test sediments. The test sediments were centrifuged, and a concentration series was developed for the resulting pore water (i.e., 100, 50, 20, 10, 5, and 0 percent [control]). Three types of treatment were used in this test: 1) baseline (i.e., untreated dilution water and porewater samples were used to test for background toxicity), 2) aeration (sediment porewater concentration series was aerated for testing period), and *Ulva* treatment (*U. lactuca* was placed in the test chambers [U.S. EPA 1996]). The 48-hour test exposure was initiated by addition of amphipods (*R. abronius*) to the test chambers.

In this study, two replicates, each containing five amphipods, were used for each treatment. After the treatment types and concentration series were set up, the recommended protocols for the amphipod mortality test were closely followed during testing (U.S. EPA 1993). Samples were collected and stored in polypropylene jars with no headspace at 4°C. The sediment holding time for the sediments prior to test initiation was exceeded. This test was initiated 23 days after sediment collection.

Water Quality

To monitor water quality during the testing period, all water quality parameters (i.e., temperature, dissolved oxygen, salinity, and pH) were measured daily in the overlying water in one test replicate. In addition, ammonia-N and sulfide were measured in the treated dilution water and baseline pore water on Day 0 (i.e., test initiation).

Temperature—Prior to testing, test organisms were acclimated at 12.7 ± 0.2°C, which is lower than the specified temperature range of 15 ± 1°C (deviation of 2.3°C). The specified temperature range was not exceeded during the testing period. The mean temperature in all test replicates was 15.1 ± 0.6°C.

Salinity—Prior to testing, test organisms were acclimated to a salinity of 35.0 ppt, which is higher than the specified salinity range of 28 ± 1 ppt (exceedance of 6.0 ppt). The specified salinity range of 28 ± 1 ppt was exceeded in the majority of the test replicates during the testing period. On Day 0 (i.e., test initiation), the salinity in 137 of the 144 test chambers ranged from 29.5 to 32.5 ppt (exceedance of 0.5–3.5 ppt); on Day 1, the salinity in all 144 test chambers ranged from 29.5 to 31.0 ppt (exceedance of 0.5–2.0 ppt); and on Day 2, the salinity in 143 of the 144 test chambers ranged from 29.5 to 31.0 ppt (exceedance of 0.5–2.0 ppt). The mean salinity in all test replicates was 30.1 ± 0.4 ppt. The mean salinity in all test replicates was 30.3 ± 0.5 ppt. These exceedances are noted in this report because they are greater than the salinity range specified in the laboratory's statement of work. U.S. EPA (1993) specifies a salinity range of 30 ± 1 ppt for effluent (i.e., water only) tests.

Dissolved Oxygen—Dissolved oxygen concentrations were at acceptably high levels (i.e., greater than 5.0 mg/L) at all concentrations of the aeration treated samples. Concentrations of dissolved oxygen were sometimes less than the recommended minimum level of 5.0 mg/L in the *Ulva* and baseline tests, usually at the 100 percent and occasionally at the 50 percent porewater concentrations. Dissolved oxygen concentrations were less than 5.0 mg/L in 17 of the 144 test chambers on Day 0. Dissolved oxygen levels were also less than 5.0 mg/L in 3 of the 144 test chambers on Day 1 and in 1 of the 144 test chambers on Day 2. The lowest dissolved oxygen concentration was 3.2 mg/L on Day 1 in a test chamber for the 100 percent concentration of the *Ulva* test. The dissolved oxygen levels ranged from 3.2 to 8.1 mg/L. The mean dissolved oxygen concentration in all test replicates during the testing period was 7.4 ± 1.0 mg/L.

Other Water Quality Variables—During the testing period, pH values ranged from 7.8 to 9.0 and were all within the recommended range of 7.0–9.0. The mean pH value in all test replicates for the testing period was 8.2 ± 0.3.

Sediment pore water was analyzed for ammonia-N and sulfide on Day 0 (i.e., test initiation). Ammonia-N concentrations in the baseline porewater samples (i.e., no *Ulva*, no aeration) ranged from 7.5 to 62.5 mg/L. Ammonia-N concentrations in the sediment pore water from *Ulva* treated samples ranged from 0 to 36.7 mg/L. Ammonia-N concentrations in the sediment porewater samples that were aerated ranged from 7.5 to 57.5 mg/L. Sulfide concentrations in the baseline porewater samples (i.e., no *Ulva*, no aeration) ranged from 0 to 130 mg/L. Sulfide concentrations in the sediment pore water from *Ulva* treated samples ranged from 0 to 65 mg/L. Sulfide concentrations in the sediment porewater samples that were aerated ranged from 0 to 11.3 mg/L.

Interstitial Salinity

Interstitial salinity of the test sediments was measured when the sediments were received by the laboratory. The interstitial salinity of the test sediments at test initiation ranged from 26.0 to 30.5 ppt. Interstitial salinity at test initiation in the sediment control and final interstitial salinities of the test sediments were not reported by the laboratory.

Controls

Seawater from Yaquina Bay, Oregon, was used as a negative control. The mean survival for the control sediment was 100 percent. These results suggest that the test organisms were sufficiently healthy for testing.

A positive control was tested using cadmium chloride as the reference toxicant. The positive control exhibited a 96-hour LC50 value of 0.78 mg/L, which is within the testing laboratory's control chart warning limits for this test. The observed LC50 value suggests that the test organisms were suitably sensitive for testing.

Echinoderm Toxicity Test Using Pore Water

The echinoderm toxicity test using pore water determines percent survival in echinoderm embryos (*Dendraster excentricus*) exposed for 48 hours to test sediment. In this study, eight test sediment samples were centrifuged, and the resulting pore water was subjected to aeration and *Ulva* treatments.

Methods

The experimental design used in this study is based on ASTM (1995) and U.S. EPA (1995, 1996). Porewater samples were prepared using test sediments. The test sediments were centrifuged, and a concentration series was developed for the resulting pore water (i.e., 40, 16, 6.4, 2.6, 1.0, 0.4, 0.16, and 0 percent [control]). Three types of treatments were used in this test: 1) baseline (i.e., untreated dilution water and porewater samples were used to test for background toxicity), 2) aeration (sediment porewater concentration series was aerated for testing period), and 3) *Ulva* treatment (*U. lactuca* was placed in the test chambers [U.S. EPA 1996]). The test exposure period was initiated by addition of echinoderm embryos (*D. excentricus*) to the test chambers.

The protocol specifies a range of 20–30 test organisms/mL. As determined by the laboratory, the initial concentration of test organisms in the test chambers was 19.1 test organisms/mL. After the treatment types and concentration series were set up, the recommended protocols for the echinoderm test were closely followed during testing (ASTM 1995; U.S. EPA 1995). Samples were collected and stored in polypropylene jars with no headspace at 4°C. The sediment holding time for the sediments prior to test initiation was exceeded. This test was initiated 35 days after sediment collection.

Exposure time for the test was increased from 48 to 65 hours to allow the embryos to develop to the four-armed pluteus stage. PSEP (1995) allows for a slightly longer exposure period if necessary to achieve adequate development of embryos in the seawater control, but the exposure time cannot exceed 96 hours for an acceptable test.

On the day following test initiation, an additional study was initiated to characterize the possible degradation of ammonia-N and sulfide in the 10-mL test volumes employed in the toxicity test. The untreated stock porewater samples were used to prepare 20 percent porewater solutions at a final volume of 10 mL in 30-mL glass test vials. Six replicates were prepared of each sample to allow for "destructive sampling."

Water Quality

To monitor water quality during the testing period, all water quality parameters (i.e., temperature, dissolved oxygen, salinity, and pH) were measured in a separate water quality beaker on Days 0 and 2 (i.e., test initiation and test termination). Ammonia-N and sulfide were measured in the water quality replicates of the 40, 6.4, and 1.0 percent test concentrations on Day 0 (i.e., test initiation). In addition, samples were analyzed for ammonia-N at 0, 1, 3, 7, 30, and 51.5 hours and for sulfide at 0, 1, 3, 7, and 30 hours as part of the ammonia and sulfide degradation experiment.

Temperature—Prior to testing, the test organisms were acclimated at 12°C, which is lower than the specified temperature range of 15 ± 1°C (deviation of 2°C). There were no exceedances of the specified temperature range of 15 ± 1°C (i.e., 14–16°C) during the testing period. The mean temperature in all test replicates was 15.2 ± 0.8°C.

Salinity—Prior to test initiation, the laboratory received adult echinoderms that were ready to spawn. The laboratory did not measure the salinity of the water in which the adult echinoderms were shipped. The resulting embryos were maintained at 30 ppt until test initiation. There was only one deviation from the specified salinity range of 31 ± 1 ppt during the testing period. On Day 0 (i.e., test initiation), the salinity in one of the test chambers was 29.0 ppt (deviation of 1.0 ppt). The salinity in all other test chambers ranged from 30.0 to 31.5 ppt. The mean salinity in all test replicates was 30.0 ± 0.2 ppt.

Dissolved Oxygen—Dissolved oxygen concentrations were at acceptably high levels (i.e., greater than 5.0 mg/L) at all concentrations of the aeration treated samples. Concentrations of dissolved oxygen were sometimes less than the recommended minimum level of 5.0 mg/L in the *Ulva* and baseline tests, usually at the 100 percent and occasionally at the 50 percent porewater concentrations (5 of the 189 test chambers). The lowest dissolved oxygen concentration was 3.0 mg/L on Day 0 in a test chamber for the 100 percent concentration of the baseline test. The dissolved oxygen levels ranged from 3.0 to 8.1 mg/L. The mean dissolved oxygen concentration in all test replicates during the testing period was 7.4 ± 1.0 mg/L.

Other Water Quality Variables—During the testing period, pH values ranged from 7.3 to 8.9 and were all within the recommended range of 7.0–9.0. The mean pH value in all test replicates for the testing period was 8.1 ± 0.3.

Sediment pore water was analyzed for ammonia-N and sulfide on Day 0 (i.e., test initiation). Ammonia-N concentrations in the baseline porewater samples (i.e., no *Ulva*, no aeration) ranged from 0.25 to 22.0 mg/L. Ammonia-N concentrations in the sediment porewater from *Ulva* treated samples ranged from 4.0 to 16.0 mg/L. Ammonia-N concentrations in the sediment porewater samples that were aerated ranged from 12.0 to 20.0 mg/L. Sulfide concentrations in the baseline porewater samples (i.e., no *Ulva*, no aeration) ranged from 1.8 to 56.3 mg/L. Sulfide concentrations in the sediment pore water from *Ulva* treated samples ranged from less than 2.5 to 17.5 mg/L. Sulfide concentrations in the sediment porewater samples that were aerated were less than 2.5 mg/L.

Interstitial Salinity

Interstitial salinity of the test sediments was measured when the sediments were received by the laboratory. The interstitial salinity of the test sediments at test initiation was 30.0 ppt. Interstitial salinity at test initiation in the sediment control and final interstitial salinities of the test sediments were not reported by the laboratory.

Controls

A negative control consisting of seawater from Yaquina Bay, Oregon, was used in each analytical group. The test is considered to be acceptable because more than 80 percent of the inoculated embryos produced normal pluteus larvae in the seawater controls. In addition, the coefficient of variation of the six "zero time" measurements of inoculated embryos was 6.4 percent and is less than the acceptance criterion of less than 15 percent. These results suggest that the test organisms were sufficiently healthy for testing.

A positive control was tested using cadmium chloride as the reference toxicant. The positive control exhibited a 72-hour (actual 65.2-hour) EC50 value of 10.8 mg/L, which is within the testing laboratory's control chart warning limits for this test. The observed EC50 value suggests that the test organisms were suitably sensitive for testing.

SUMMARY OF QA/QC CONSIDERATIONS

The following protocol deviations were noted during the QA/QC evaluation:

- **Amphipod Test with Preliminary Purging**
  - Temperatures measured during acclimation (13.3 ± 0.7°C) and on Day 0 during the purging period (16.1–17.0°C) deviated from the specified temperature range of 14–16°C. Temperatures measured on Days 0 and 1 of the testing period (13.0–13.9°C) also deviated from the specified temperature range.
  - The specified salinity range of 27–29 ppt was exceeded during acclimation of the test organisms (35.0 ppt) and during the testing period (29.5–30.0 ppt). The salinity range was exceeded on Days 3, 4, 5, 6, 7, and 10. A maximum salinity of 30.0 ppt was observed in several test chambers on Days 7 and 10.

- **Amphipod Test with *Ulva* Treatment**
  - Temperatures measured during acclimation (12.7 ± 0.7°C) deviated from the specified temperature range of 14–16°C.
  - The specified salinity range of 27–29 ppt was exceeded during acclimation (34.0 ppt) and during the testing period (30–31 ppt).
- **Amphipod Test Using Porewater**
  - Temperatures measured during acclimation (12.7 ± 0.7°C) deviated from the specified temperature range of 14–16°C.
  - The specified salinity range of 27–29 ppt was exceeded during acclimation of the test organisms (35.0 ppt) and during the testing period (29.5–32.5 ppt).
  - The minimum recommended dissolved oxygen level of 5.0 mg/L was not met in some of the baseline and *Ulva* test treatments.
  - The holding time was exceeded prior to test initiation. The test was initiated 23 days after sediment collection.
- **Echinoderm Test Using Porewater**
  - Temperatures measured during acclimation (12.7 ± 0.7°C) deviated from the specified temperature range of 14–16°C.
  - There was only one deviation from the specified salinity range of 30–32 ppt during the testing period. Salinities recorded during the testing period ranged from 29.0 (single occurrence) to 31.0 ppt.
  - The minimum recommended dissolved oxygen level of 5.0 mg/L was not met in some of the baseline and *Ulva* test treatments.
  - The test chambers were stocked with 19 test organisms/mL, whereas the protocol specifies a range of 20–30 test organisms/mL.
  - The holding time was exceeded prior to test initiation. The test was initiated 35 days after sediment collection.

CONCLUSIONS

All of the specialized test data are considered acceptable for characterizing sediment toxicity. It is unlikely that the results were influenced by the temperature deviations that occurred during the acclimation periods prior to testing and at the beginning of the amphipod test with preliminary purging. It is also unlikely that the elevated salinity of the overlying water used by the laboratory adversely affected the porewater tests. Because the interstitial salinity of the test sediments received by the laboratory had a maximum salinity of 30.5 ppt and effluent (i.e., water only) tests are routinely performed at 30±1 ppt (U.S. EPA 1993), the testing laboratory increased the salinity of the overlying water for these tests. In addition, the mean mortality observed in all of the negative controls was well below the maximum acceptable level, suggesting that the test organisms were suitably responsive for testing.

It is unlikely that the results of the untreated porewater and *Ulva* treated porewater tests were affected by the lower dissolved oxygen levels (i.e., less than 5.0 mg/L) that were noted in the some of test replicates. Dissolved oxygen requirements are unknown for *R. abronius* and *D. excentricus*. However, actively motile species (e.g., trout) require high dissolved oxygen levels (i.e., greater than 5.0 mg/L) to maintain a satisfactory respiratory rate and prevent these organisms from experiencing respiratory stress. It can be assumed that more sedentary species such as *R. abronius* and *D. excentricus* could require lower dissolved oxygen levels (i.e., greater than 2.0 mg/L) to maintain a satisfactory respiratory rate and prevent the test organisms from experiencing respiratory stress (Caldwell 1997, pers. comm.). It is therefore unlikely that the lower dissolved oxygen levels (i.e., 3.0 mg/L) that were reported in some replicates in the untreated porewater and *Ulva* treated porewater tests adversely affected the test results.

REFERENCES

ASTM. 1995. Standard guide for conducting static acute toxicity test with echinoid embryos. ASTM Standard Method No. E 1563-95. American Society for Testing and Materials, Philadelphia, PA.

Barrick, R.C., D.S. Becker, L.J. Brown, H.R. Beller, and R.A. Pastorok. 1988. Sediment quality values refinement: 1988 update and evaluation of Puget Sound AET. Vol. I. Final Report. Prepared for Tetra Tech, Inc. and U.S. Environmental Protection Agency Region 10, Office of Puget Sound, PTI Environmental Services, Bellevue, WA. 74 pp. + appendices.

Caldwell, D. 1997. Personal communication (telephone conversation on January 12, 1998 with J. Sexton of PTI Environmental Services, Bellevue, WA, regarding dissolved oxygen requirements of test species). Northwestern Aquatic Sciences, Newport, OR.

Ho, K.T., J.Q. Word, D.K. Niyogi, L.T. Ross, T. Dillon, and D.W. Moore. 1997 Unpublished manuscript. Methods to distinguish pH dependent toxicity in marine waters and sediments. Part I: Ulva lactuca. U.S. Environmental Protection Agency, Narragansett, RI.

PSDDA. 1989. PSDDA Phase II management plan report. Chapter 5 and Appendix A. Prepared by the Puget Sound Dredged Disposal Analysis Program. U.S. Army Corps of Engineers, Seattle District, Seattle, WA

PSEP. 1995. Recommended protocols for conducting laboratory bioassays on Puget Sound sediments. Prepared for U.S. Environmental Protection Agency Region 10, Office of Puget Sound, Puget Sound Estuary Program, Seattle, WA. PTI Environmental Services, Bellevue, WA.

PTI. 1996. Ward Cove sediment remediation project: technical studies work plan. Prepared for Ketchikan Pulp Company, Ketchikan, AK. PTI Environmental Services, Bellevue, WA.

PTI. 1997. Ward Cove sediment remediation project technical studies: field sampling plan for the Phase 2 investigation. Prepared for Ketchikan Pulp Company, Ketchikan, AK. PTI Environmental Services, Bellevue, WA.

U.S. EPA. 1993. Methods for measuring the acute toxicity of effluents to freshwater and marine organisms. Fourth Edition. EPA 600/4-90/027F. U.S. Environmental Protection Agency, Washington, DC.

U.S. EPA. 1994. Methods for assessing the toxicity of sediment-associated contaminants with estuarine and marine amphipods. EPA/600/R-94/025. U.S. Environmental Protection Agency, Office of Research and Development, Washington, DC.

U.S. EPA. 1995. Purple urchin, *Strongylocentrotus purpuratus*, and sand dollar, *Dendraster excentricus*, larval development test method. Section 15. In: Short-term Methods for Estimating the Chronic Toxicity of Effluents and Receiving Water to West Coast Marine and Estuarine Organisms. EPA/600/R-95/136. U.S. Environmental Protection Agency, Washington, DC.

U.S. EPA. 1996. Marine toxicity identification evaluation (TIE). Phase I guidance document. EPA/600/R-96/054. U.S. Environmental Protection Agency, Office of Research and Development, Washington, DC. 54 pp.

Appendix C

Appendix C

Sediment Core and Compositing Information and Detailed Core Logs

CONTENTS

TABLE C-1. SEDIMENT CORE INFORMATION

Sample ID	Station	Recorded Depths (in.)[a] Upper	Recorded Depths (in.)[a] Lower	Description	PTI ID	Calculated Depths (in.)[b] Upper	Calculated Depths (in.)[b] Lower
SD0043	3	0.0	39.0	non-native organic material	A	0.0	39.0
		39.0	70.5	water break			
		70.5	96.9	native clay/silt		39.0	65.4
SD0044	5	0.0	39.4	non-native organic material	A	0.0	39.4
		39.4	70.1	non-native organic material	B	39.4	70.1
		70.1	94.5	water break			
		94.5	106.7	non-native organic material		70.1	82.3
		106.7	114.0	native clay/silt		82.3	89.6
SD0045	1	0.0	39.4	non-native organic material	A	0.0	39.4
		39.4	78.7	non-native organic material	B	39.4	78.7
		78.7	102.4	non-native organic material (no native)	C	78.7	102.4
SD0046	7	0.0	39.4	non-native organic material	A	0.0	39.4
		39.4	51.2	native clay/silt	B	39.4	51.2
		51.2	83.1	water break			
		83.1	111.6	native clay/silt	C	51.2	79.7
SD0049	49	0.0	3.9	non-native organic material		0.0	3.9
		3.9	63.8	native clay/silt	A	3.9	15.9[c]
SD0050	2	0.0	39.4	non-native organic material	A	0.0	39.4
		39.4	78.7	non-native organic material	B	39.4	78.7
		78.7	102.0	non-native organic material (no native)	C	78.7	102.0
SD0051	6	0.0	39.4	non-native organic material	A	0.0	39.4
		39.4	78.7	non-native organic material	B	39.4	78.7
		78.7	105.1	non-native organic material (no native)	C	78.7	105.1
SD0052	8	0.0	39.4	non-native organic material	A	0.0	39.4
		39.4	47.6	non-native organic material	B	39.4	47.6
		47.6	116.1	native clay/silt		47.6	116.1
SD0053	9	0.0	39.4	non-native organic material	A	0.0	39.4
		39.4	78.7	non-native organic material	B	39.4	78.7
		78.7	114.6	non-native organic material (no native)	C	78.7	114.6
SD0054	4	0.0	39.4	non-native organic material	A	0.0	39.4
		39.4	72.4	non-native organic material	B	39.4	72.4
		72.4	89.8	water break			
		89.8	108.7	native clay/silt		72.4	91.3
SD0055	13	0.0	39.4	non-native organic material	A	0.0	39.4
		39.4	57.5	non-native organic material	B	39.4	57.5
		57.5	87.4	native clay/silt		57.5	87.4

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TABLE C-1. (cont.)

		Recorded Depths (in.)[a]				Calculated Depths (in.)[b]	
Sample ID	Station	Upper	Lower	Description	PTI ID	Upper	Lower
SD0056	33	0.0	39.4	non-native organic material	A	0.0	39.4
		39.4	56.7	non-native organic material	B	39.4	56.7
		56.7	67.7	native clay/silt		56.7	67.7
SD0057	36	0.0	22.0	non-native organic material	A	0.0	22.0
		22.0	47.6	native clay/silt		22.0	47.6
SD0058	47	0.0	6.3	non-native organic material		0.0	6.3
		6.3	51.6	native clay/silt		6.3	51.6
SD0059	41	0.0	33.9	non-native organic material	A	0.0	33.9
		33.9	47.6	native clay/silt	B	33.9	47.6
SD0060	46	0.0	4.7	non-native organic material		0.0	4.7
		4.7	67.7	native clay/silt		4.7	67.7
SD0061	12	0.0	39.4	non-native organic material	A	0.0	39.4
		39.4	56.3	non-native organic material	B	39.4	56.3
		56.3	75.2	water break			
		75.2	92.1	native clay/silt		56.3	73.2
SD0062[d]	12A	0.0	39.4	non-native organic material	A	0.0	39.4
		39.4	51.2	non-native organic material	B	39.4	51.2
		51.2	65.4	water break			
		65.4	69.7	non-native organic material		51.2	55.5
		69.7	81.1	water break			
		81.1	103.9	native clay/silt		55.5	78.3
SD0063	16	0.0	39.4	non-native organic material	A	0.0	39.4
		39.4	78.7	non-native organic material	B	39.4	78.7
		78.7	90.6	non-native organic material	C	78.7	90.6
		90.6		native clay/silt[e]			

Note: Interval depths for samples submitted for chemical analysis are boxed. These depths should correspond to depth values in VAST.

[a] These depths were measured in field and recorded in logbook. At stations where more than one core was collected, the largest depth interval is used in this table.

[b] These depths reflect the subtraction of water breaks from the recorded interval depths. Water breaks were a result of the sampling techniques (i.e., piston coring) and do not reflect sediment stratigraphy.

[c] The top 1 ft (30.5 cm) of native materials was collected for analysis.

[d] Field duplicate collected at Station 12.

[e] Native materials were present only in nose cone of sampler; therefore, not enough material was available for analysis.

TABLE C-2. COMPOSITING OF SEDIMENT CORES FOR DIOXIN ANALYSIS

		Calculated Depths (in.)[a]		
Sample ID	Station[a]	Upper	Lower	Description
SD0200	1	0	102.4	non-native organic material
	2	0	105.5	non-native organic material
	6	0	105.1	non-native organic material
SD0201	7	0	51.2	non-native organic material
	8	0	47.6	non-native organic material
	9	0	114.6	non-native organic material
SD0202	3	0	39.0	non-native organic material
	4	0	72.4	non-native organic material
	5	0	82.3	non-native organic material
	33	0	56.7	non-native organic material
SD0203	12	0	56.3	non-native organic material
	13	0	57.5	non-native organic material
SD0204	16	0	90.6	non-native organic material
	36	0	22.0	non-native organic material
	41	0	33.9	non-native organic material

[a] Samples for dioxin analysis were composited from 2–4 stations, consistent with the field sampling plan. Interval depths from each station are provided.

PTI ENVIRONMENTAL SERVICES FIELD SEDIMENT CORE FORM

Client/Owner KPC / Ward Cove Station Number 1

Project No. CBOW-1201

Start Date 8.5.97 Finish Date 8.5.97

Field Geologist Doran / Borden

Contractor/Operator F/V Zephyr

Drill Type/Method Piston core (P/c)

Sample No.	Sampler Type	Odor	Sheen			H20 Breaks	Depth Scale (cm)	Unified Symbol	Sediment Description	Comments
SD046A (↑ to ↓)	PC	—	—				0	PT	0-260 cm: Organic silty material; w/ light-brown globules (?) (<1%) and wood debris (10%); black	
							50			
						PT	100			
SD046B (↑ to ↓)							150			
SD046C (↑ to ↓)							200			
							250			
									Total depth = 260 cm	
							300			

Sampler: D/M, SPT, Thinwall (TW), Shelby Tube (S), Bulk (B), etc. (Add 'C' to sampler type if a catcher is used)

Sheet 1 of 1

PTI ENVIRONMENTAL SERVICES FIELD SEDIMENT CORE FORM

Client/Owner KPC / Ward Cove Station Number 2

Project No. CBOW-1201

Start Date 8.6.97 Finish Date 8.6.97

Field Geologist Doran / Borden

Contractor/Operator F/V Zephyr

Drill Type/Method Piston core (P/c)

Sample No.	Sampler Type	Odor	Sheen			- H20 Breaks	Depth Scale (cm)	Unified Symbol	Sediment Description	Comments
A 50000050	P/C	M-H H_2S	SS-MS				0		0-259 cm: Organic silty material; w/ wood debris (30%), homogeneous, black.	
							50			
							100			
								PT		
B 50000050							150			
C 50000050							200			
							250			
									Total depth = 259 cm.	
							300			

Sampler: D/M, SPT, Thinwall (TW), Shelby Tube (S), Bulk (B), etc. (Add 'C' to sampler type if a catcher is used)

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PTI ENVIRONMENTAL SERVICES FIELD SEDIMENT CORE FORM

Client/Owner KPC / Ward Cove Station Number 3

Project No. CBOW-1201

Start Date 8.5.97 Finish Date 8.5.97

Field Geologist Doran / Borden

Contractor/Operator F/V Zephyr

Drill Type/Method Piston core (P/c)

Sample No.	Sampler Type	Odor	Sheen			H2O Breaks	Depth Scale (cm)	Unified Symbol	Sediment Description	Comments
SD004BA	P/c	H_2S	–				0–50	PT	0-99 cm: Organic silty material; w/ clay (60%), wood pulp material (20%), silt (20%); black	
		–	MS				100–150	H_2O	99-179 cm: Water break	
		–	–				200–250	CL	179-246 cm: Sandy, silty native CLAY, w/ shell and schist fragments, minor organic debris (roots and natural wood chips), thin lenses of sandy/gravelly layers (0.5-2.5 cm thick, clam shells; gray	
							300		Total depth = 246 cm	

Sampler: D/M, SPT, Thinwall (TW), Shelby Tube (S), Bulk (B), etc. (Add 'C' to sampler type if a catcher is used)

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PTI ENVIRONMENTAL SERVICES FIELD SEDIMENT CORE FORM

Client/Owner KPC / Nard Cove Station Number 4

Project No. CB0N-1201

Start Date 8.6.97 Finish Date 8.6.97

Field Geologist Doran / Borden

Contractor/Operator F/V Zephyr

Drill Type/Method Piston core (P/c)

Sample No.	Sampler Type	Odor	Sheen			- H20 Breaks	Depth Scale (cm)	Unified Symbol	Sediment Description	Comments
SD00514A (0–92)	P/C	—	—			↑ (0–184)	0	PT	0-184 cm: Organic silty material; wood debris (5-10%), soupy; black	
							50			
SD00516B (92–184)							100			
							150			
		–	SS			ML/CL	200	H_2O	184-228 cm: Water break	
		—	—				250	ML/CL	228-276 cm: Native clayey SILT; w/ some shells and mica flakes; gray	
							300		Total depth = 276 cm.	

Sampler: D/M, SPT, Thinwall (TW), Shelby Tube (S), Bulk (B), etc. (Add 'C' to sampler type if a catcher is used)

PTI ENVIRONMENTAL SERVICES FIELD SEDIMENT CORE FORM

Client/Owner: KPC / Ward Cove Station Number: 5

Project No.: CB0W-1201

Start Date: 8.5.97 Finish Date: 8.5.97

Field Geologist: Doran / Borden

Contractor/Operator: F/V Zephyr

Drill Type/Method: Piston core (P/c)

Sample No.	Sampler Type	Odor	Sheen			H20 Breaks	Depth Scale (cm)	Unified Symbol	Sediment Description	Comments
5D0044A	P/C	S H_2S	MS				0	PT	0-178 cm: Organic silty material; w/ wood material ranging from bark to <0.5 cm diameter; black	
							50			
							100			
5D0044B							150			
		–	MS					H_2O	178-240 cm: Water break	
							200			
		–	–				250	PT	240-271: Additional organic silty material; black	
		–	–					CL	271-289.5 cm: Native silty CLAY, w/ shell content (15%), root fragments (5%), rounded schist gravel (<5%); gray	
							300		Total depth = 289.5 cm	

Sampler: D/M, SPT, Thinwall (TW), Shelby Tube (S), Bulk (B), etc. (Add 'C' to sampler type if a catcher is used)

Sheet 1 of 1

PTI ENVIRONMENTAL SERVICES

FIELD SEDIMENT CORE FORM

Client/Owner KPC / Ward Cove Station Number 6

Project No. CBOW-1201

Start Date 8.6.97 Finish Date 8.6.97

Field Geologist Doran / Borden

Contractor/Operator F/V Zephyr

Drill Type/Method Piston core (P/c)

Sample No.	Sampler Type	Odor	Sheen			H20 Breaks	Depth Scale (cm)	Unified Symbol	Sediment Description	Comments
5000051A	P/c	H_2S	–			PT	0	PT	0-267 cm: organic silty material; Soupy, w/ wood debris in middle of core (1-5%) and decreasing wood content toward bottom (< 1%); high gas content; black	
							50			
5000051B							100			
							150			
5000051C							200			
							250			
									Total depth = 267 cm.	
							300			

Sampler: D/M, SPT, Thinwall (TW), Shelby Tube (S), Bulk (B), etc. (Add 'C' to sampler type if a catcher is used)

PTI ENVIRONMENTAL SERVICES FIELD SEDIMENT CORE FORM

Client/Owner: KPC/Ward Cove   Station Number: 7

Project No.: CB0W-1201

Start Date: 8.5.97   Finish Date: 8.5.97

Field Geologist: Doran / Bardin

Contractor/Operator: F/V Zephyr

Drill Type/Method: Piston Core (P/C)

Sample No.	Sampler Type	Odor	Sheen			- H20 Breaks	Depth Scale (cm)	Unified Symbol	Sediment Description	Comments
SD0046 (0–100 cm)	P/C	H_2S	—			PT	0	PT	0-100 cm: Organic, clayey, silty material; shell fragments (5%), minimal wood debris; black	
SD0046B (100–130 cm)		—	—				100	CL	100-130 cm: Transition material, predominantly native CLAY, w/ fewer shell fragments (< 5%); gray	
		—	SS			J	150	H_2O	130-211 cm: Water break	
		—	—				200, 250	CL	211-283.5 cm: Native CLAY, w/ some mica specks, high homogeneity; gray	
							300		Total depth = 283.5 cm	

Sampler: D/M, SPT, Thinwall (TW), Shelby Tube (S), Bulk (B), etc. (Add 'C' to sampler type if a catcher is used)

PTI ENVIRONMENTAL SERVICES FIELD SEDIMENT CORE FORM

Client/Owner KPC / Ward Cove Station Number 8

Project No. CB0N-1201

Start Date 8.6.97 Finish Date 8.7.97

Field Geologist Doran / Borden

Contractor/Operator F/V Zephyr

Drill Type/Method Piston core (P/c)

Sample No.	Sampler Type	Odor	Sheen			- H2O Breaks	Depth Scale (cm)	Unified Symbol	Sediment Description	Comments
SD0052A	P/c	M-H H_2S	SS			PT	0–121	PT	0-121 cm: Organic silty material; w/ fine roots, minimal wood debris to some wood debris (10-30%), some clay (5%); dark gray to black	
SD0052B		—	—			CL	121–295		121-295 cm: Native silty CLAY; w/ some mica fragments; shells and roots (1%); gray-brown to dark olive green	
									136-138 cm: shell fragment layer	
									141-146 cm: fine-grained sand lense	
									Total depth = 295 cm	(NOTE: Descriptive information taken from 2 cores.)

Depth scale marks: 0, 50, 100, 150, 200, 250, 300

Sampler: D/M, SPT, Thinwall (TW), Shelby Tube (S), Bulk (B), etc. (Add 'C' to sampler type if a catcher is used)

Sheet 1 of 1

PTI ENVIRONMENTAL SERVICES

FIELD SEDIMENT CORE FORM

Client/Owner: KPC | Ward Cove Station Number: 9

Project No.: CBOW-1201

Start Date: 8.6.97 Finish Date: 8.6.97

Field Geologist: Doran / Borden

Contractor/Operator: F/V Zephyr

Drill Type/Method: Piston core (P/c)

Sample No.	Sampler Type	Odor	Sheen			H20 Breaks	Depth Scale (cm)	Unified Symbol	Sediment Description	Comments
SD0053 A	P/C	—	—				0		0-92 cm: Organic silty material, w/ some wood debris (20%); soupy, black	
							50			
		—	SS				100		92-291 cm Wood pulp (90%); redish-purple	
SD0053 B						PT	150	PT		
SD0053 C							200			
							250			
							300		Total depth = 291 cm.	

Sampler: D/M, SPT, Thinwall (TW), Shelby Tube (S), Bulk (B), etc. (Add 'C' to sampler type if a catcher is used)

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PTI ENVIRONMENTAL SERVICES

FIELD SEDIMENT CORE FORM

Client/Owner: KPC / Ward Cove Station Number: 12

Project No.: CBOW-1201

Start Date: 8.8.97 Finish Date: 8.8.97

Field Geologist: Borden

Contractor/Operator: F/V Zephyr

Drill Type/Method: Piston core (P/c)

Sample No.	Sampler Type	Odor	Sheen			- H20 Breaks	Depth Scale (cm)	Unified Symbol	Sediment Description	Comments
SD0061A	P/C	S H_2S	SS			PT	0		0-143 cm: Organic silty material, w/ wood debris (<5%), black	
							50	PT	0-10 cm: red and white amphipod layer	
									88-86 cm: sandy lense (20% sand)	
SD0061B							100		123-143 cm: Shell fragments (<10%)	
		—	SS			CL	150	H_2O	143-191 cm: Water break	
		—	—				200	CL	191-234 cm: Native silty CLAY; w/ Shell fragments (<5%), silt (5%), and bark (5%); green-gray	
							250		Total depth= 234 cm	
							300			

Sampler: D/M, SPT, Thinwall (TW), Shelby Tube (S), Bulk (B), etc. (Add 'C' to sampler type if a catcher is used)

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FIELD SEDIMENT CORE FORM

Client/Owner: KPC / Ward Cove
Station Number: 12A

Project No.: CBOW-1201

Date: 8.8.97

Field Scientist: Bordon

Contractor/Operator: F/V Zephyr

Core Type/Method: Piston Core (P/C)

* This log was taken from a duplicate core at Station 12 for field quality assurance.

Sample No.	Odor	Sheen	Sampler Type	-H20 Breaks	Depth Scale (cm)	Unified Symbol	Sediment Description	Comments
SD0062A	—	SS	P/C	PT	0	PT	0-177 cm: Organic silty material; w/ wood chips (1%); black	
					50		50-177: Sandy silty lense w/ especially sandy layer (20%) from 78-81 cm	
SD0062B					100		130-166 cm: water break	
	—	SS		CL	150	H_2O	177-206 cm: water break	
						PT		
					200	H_2O	206-264 cm: Native silty CLAY, w/ silt (5%) and shell fragments (5%); green/gray	
					250	CL	254 cm: Shell-filled laminae w/ 10% shell content and 1% schist pebbles	
					300		236 cm: Clay becomes more cohesive	
							Total depth = 264 cm	

PTI ENVIRONMENTAL SERVICES

FIELD SEDIMENT CORE FORM

Client/Owner KPC / Ward Cove Station Number 13

Project No. CB0N-1201

Start Date 8.6.97 Finish Date 8.6.97

Field Geologist Doran / Borden

Contractor/Operator F/V Zephyr

Drill Type/Method Piston core (P/C)

Sample No.	Sampler Type	Odor	Sheen			- H20 Breaks	Depth Scale (cm)	Unified Symbol	Sediment Description	Comments
SD0053A (0–110); SD0055B (120–145)	P/C	–	SS-HS			PT (0–146)	0	PT	0-146 cm: Organic silty material, wood content decreases from 15% near top to 5% near bottom, soupy; black	
							50			
							100			
		–	–			CL (146–222)	150	CL	146-222 cm Native Silty CLAY, w/ Shell horizon 200-205 cm; gray to olive green	
							200			
							250		Total depth = 222 cm.	
							300			

Sampler: D/M, SPT, Thinwall (TW), Shelby Tube (S), Bulk (B), etc. (Add 'C' to sampler type if a catcher is used)

Sheet 1 of 1

PTI ENVIRONMENTAL SERVICES FIELD SEDIMENT CORE FORM

Client/Owner KPC / Ward Cove   Station Number 16

Project No. CB0W-1201

Start Date 8.8.97   Finish Date 8.8.97

Field Geologist Borden

Contractor/Operator F/V Zephyr

Drill Type/Method Piston core (P/C)

Sample No.	Sampler Type	Odor	Sheen			- H20 Breaks	Depth Scale (cm)	Unified Symbol	Sediment Description	Comments
SD0063A	P/C	H_2S	SS				0	PT	0-230 cm: Organic silty material, w/ wood debris (5-10%), sand (<1-3%), black	
							50		0-180 cm: mostly liquefied w/ no structure	
SD0063B						PT	100		210-212 cm: clay ball layer (40%), w/ greater coarse-grained sand content (5%), more compacted	
							150			
SD0063C		—	—				200	ML/CL	230 cm: Native clayey SILT in nosecone; gray to green	
							250		Total depth = 230 cm.	
							300			

Sampler: D/M, SPT, Thinwall (TW), Shelby Tube (S), Bulk (B), etc. (Add 'C' to sampler type if a catcher is used)

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PTI ENVIRONMENTAL SERVICES FIELD SEDIMENT CORE FORM

Client/Owner KPC / Ward Cove Station Number 33

Project No. CBOW-1201

Start Date 8.7.97 Finish Date 8.7.97

Field Geologist Borden

Contractor/Operator F/V Zephyr

Drill Type/Method Piston core (P/C)

Sample No.	Sampler Type	Odor	Sheen			- H20 Breaks	Depth Scale (cm)	Unified Symbol	Sediment Description	Comments
SD0056A (0–~80 cm); SD0056B (~80–~144 cm)	PC	M H2S	SS-MS			PT	0–144	PT	0-144 cm: organic silty material; w/ wood chips (10-30%); black	
		—	—			P	144–172	CL	144-172 cm Native CLAY; w/ shell fragments (25%) and silt (1%); gray	
									Total depth= 172 cm.	

Sampler: D/M, SPT, Thinwall (TW), Shelby Tube (S), Bulk (B), etc. (Add 'C' to sampler type if a catcher is used)

PTI ENVIRONMENTAL SERVICES FIELD SEDIMENT CORE FORM

Client/Owner: KPC / Ward cove
Station Number: 36
Project No.: CB0W-1201
Start Date: 8.7.97
Finish Date: 8.7.97

Field Geologist: Borden
Contractor/Operator: F/V Zephyr
Drill Type/Method: Piston core (P/c)

Sample No.	Sampler Type	Odor	Sheen			- H2O Breaks	Depth Scale (cm)	Unified Symbol	Sediment Description	Comments
3001057A (0–56)	P/C	S H2S	SS			PT	0	PT	0-56 cm: Organic silty material; w/ mica flakes (2%); black	
						CL	50	CL	56-99 cm: Native sandy/silty CLAY; gray to green	
						ML/CL	100	ML/CL	71-96 cm. Sand coarsens downward (consists of fine-grained schist fragments); w/ shell fragments (10%)	
							150		96-98 cm coarse shell fragments (80%)	
							200		98-99 cm schist pebbles (70%)	
							250		99-121 cm: Native clayey SILT, w/ shell fragments (3%); gray to green	
							300		Total depth = 121 cm.	

Sampler: D/M, SPT, Thinwall (TW), Shelby Tube (S), Bulk (B), etc. (Add 'C' to sampler type if a catcher is used)

PTI ENVIRONMENTAL SERVICES FIELD SEDIMENT CORE FORM

Client/Owner KPC / Ward Cove Station Number 40 - Accumulation

Project No. CBOW-1201

Start Date 8.6.97 Finish Date 8.6.97

Field Geologist Doran / Borden

Contractor/Operator F/V Zephyr

Drill Type/Method Piston core (P/C)

Sample No.	Sampler Type	Odor	Sheen			- H20 Breaks	Depth Scale (cm)	Unified Symbol	Sediment Description	Comments
See logbook (SD0040-0001B6 at 2 cm intervals)	P/C	—	—				0–83.5	PT	0-83.5 cm: Organic silty material; w/ some bark (5%), watery, black	
									22-38 cm: Greater clay content; Schist fragments, shell fragments, some pebbles near 38 cm	
									38-83.5 cm: black → dark gray; w/ sandier, siltier sediments, fewer schist fragments	
									64 cm: transition from gray → green toward bottom	(NOTES: Information on descriptions taken from 2 cores. Different scales used for accumulation cores.)
									71 cm: sandy lense	
									Total depth = 83.5 cm	

Sampler: D/M, SPT, Thinwall (TW), Shelby Tube (S), Bulk (B), etc. (Add 'C' to sampler type if a catcher is used)

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PTI ENVIRONMENTAL SERVICES

FIELD SEDIMENT CORE FORM

Client/Owner KPC / Ward Cove Station Number 41

Project No. CBOW-1701

Start Date 8.7.97 Finish Date 8.7.97

Field Geologist Borden

Contractor/Operator F/V Zephyr

Drill Type/Method Piston core (P/C)

Sample No.	Sampler Type	Odor	Sheen			- H20 Breaks	Depth Scale (cm)	Unified Symbol	Sediment Description	Comments
D00594	P/C	—	—			PT	0	PT	0-86 cm: Organic silty material, w/ wood debris (10%), black	
							50			
		—	—			CL	100	CL	86-121 cm: Native silty CLAY, w/ schist pebbles (10%), shell fragments (2%), gray.	
							150		112 cm: lense of schist pebbles (40%)	
									117 cm: lense of schist pebbles (40%)	
							200			
									Total depth = 121 cm.	
							250			
							300			

Sampler: D/M, SPT, Thinwall (TW), Shelby Tube (S), Bulk (B), etc. (Add 'C' to sampler type if a catcher is used)

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PTI ENVIRONMENTAL SERVICES

FIELD SEDIMENT CORE FORM

Client/Owner KPC / Ward Cove Station Number 46

Project No. CB0W-1201

Start Date 8.7.97 Finish Date 8.7.97

Field Geologist Borden

Contractor/Operator F/V Zephyr

Drill Type/Method Piston core (P/C)

Sample No.	Sampler Type	Odor	Sheen			- H2O Breaks	Depth Scale (cm)	Unified Symbol	Sediment Description	Comments
	P/C	—	—			PT	0	PT	0-12 cm: Organic silty material, w/ minor wood fragments (2%) and clay; disturbed; dark to olive green	
		—	—			CL		CL	12-172 cm: Silty native CLAY, w/ shell fragments (1%), increasing silt content toward bottom of core (1-5%)	
							50			
							100			
							150			
									Total depth = 172 cm.	
							200			
							250			
							300			

Sampler: D/M, SPT, Thinwall (TW), Shelby Tube (S), Bulk (B), etc. (Add 'C' to sampler type if a catcher is used)

PTI ENVIRONMENTAL SERVICES FIELD SEDIMENT CORE FORM

Client/Owner KPC / Ward Cove Station Number 47

Project No. CB0W-1201

Start Date 8.7.97 Finish Date 8.7.97

Field Geologist Borden

Contractor/Operator F/V Zephyr

Drill Type/Method Piston core (P/c)

Sample No.	Sampler Type	Odor	Sheen			- H20 Breaks	Depth Scale (cm)	Unified Symbol	Sediment Description	Comments
N/C	P/C	—	—				0	PT	0-16 cm: Organic silty material; w/ wood chips (5%), soupy and no coherent beds until 16 cm; black	
		—	—				50	CL	16-131 cm: Native CLAY; w/ minor organic matter and silt; gray to green	
							100			
							150		51-131 cm: Shell fragments (30%), Silt (5%), and schist pebbles (1%)	
							200		Total depth = 131 cm.	
							250			
							300			

Sampler: D/M, SPT, Thinwall (TW), Shelby Tube (S), Bulk (B), etc. (Add 'C' to sampler type if a catcher is used)

PTI ENVIRONMENTAL SERVICES FIELD SEDIMENT CORE FORM

Client/Owner KPC / Ward Cove Station Number 49 - Accumulation

Project No. CBOW-1201

Start Date 8.6.97 Finish Date 8.6.97

Field Geologist Doran / Borden

Contractor/Operator F/V Zephyr

Drill Type/Method Piston core (P/c)

Sample No.	Sampler Type	Odor	Sheen			- H20 Breaks	Depth Scale (cm)	Unified Symbol	Sediment Description	Comments
See logbook (SD0137-SD0173 @ 2 cm interval)	P/C	—	—			5	0	PT	0-6 cm: Organic silty material; w/ some wood chips, homogeneous, gray to black	
		—	—				5			
							10			
							15			
							20			
							25		6-104 cm: Native silty CLAY; homogeneous, olive green to gray	
							30			
							35			
							40		30 cm: olive green/gray → light olive green	
							45			
						CL	50	CL	34-35 cm: sandy, shell fragment layer	
							55			
							60		46-104 cm: amphipod tubes	
							65			
							70			
							75		(NOTES: Descriptions taken from 2 cores. Different scale used for accumulation cores.)	
							80			
							85			
							90			
							95			
							100		Total depth 104 cm.	

Sampler: D/M, SPT, Thinwall (TW), Shelby Tube (S), Bulk (B), etc. (Add 'C' to sampler type if a catcher is used)

PTI ENVIRONMENTAL SERVICES

FIELD SEDIMENT CORE FORM

Client/Owner: KPC / Ward Cove
Station Number: 49 - Accumulation (A)
Project No.: CBOW-1201
Start Date: 8.6.97
Finish Date: 8.6.97

Field Geologist: Doran / Borden
Contractor/Operator: F/V Zephyr
Drill Type/Method: Piston core (P/C)

Sample No.	Sampler Type	Odor	Sheen			- H20 Breaks	Depth Scale (cm)	Unified Symbol	Sediment Description	Comments
See logbook (SD0137-SD0173 82 cm interval)	P/C	—	—			PT	0–5	PT	0-6 cm: Organic silty material; w/ some wood chips, homogeneous, gray to black	
		—	—			CL	10–100	CL	6-104 cm: Native silty CLAY; homogeneous, olive green to gray	
									28 cm: olive green/gray → light olive green	
									34-35 cm: sandy, shell fragment layer	
									46-104 cm: amphipod tubes	
							100		Total depth 104 cm.	

Sampler: D/M, SPT, Thinwall (TW), Shelby Tube (S), Bulk (B), etc. (Add 'C' to sampler type if a catcher is used)

PTI ENVIRONMENTAL SERVICES FIELD SEDIMENT CORE FORM

Client/Owner KPC / Ward Cove Station Number 49 - Accumulation (B)

Project No. CB0W-1201

Start Date 8.6.97 Finish Date 8.6.97

Field Geologist Doran / Borden

Contractor/Operator F/V Zephyr

Drill Type/Method Piston core (P/c)

Sample No.	Sampler Type	Odor	Sheen			- H20 Breaks	Depth Scale (cm)	Unified Symbol	Sediment Description	Comments
See logbook (SD0137-SD0173 @ 2 cm interval)	P/C	—	—			PT	0–5	PT	0-6 cm: organic silty material; w/ some wood chips, homogeneous, gray to black	
		—	—			CL	6–100	CL	6-100 cm: Native silty CLAY; homogeneous, olive green to gray	
									30 cm: olive green/gray → light olive green	
									63-100 cm: amphipod tubes	
							100		Total depth 100 cm.	

Sampler: D/M, SPT, Thinwall (TW), Shelby Tube (S), Bulk (B), etc. (Add 'C' to sampler type if a catcher is used)

PTI ENVIRONMENTAL SERVICES FIELD SEDIMENT CORE FORM

Client/Owner: KPC / Ward Cove
Station Number: 49- Chemistry

Project No.: CBOW-1201

Start Date: 8·6·97
Finish Date: 8·8·97

Field Geologist: Dorn / Borden

Contractor/Operator: F/V Zephyr

Drill Type/Method: Piston core (P/c)

SD ØØ49A

Sample No.	Sampler Type	Odor	Sheen			- H2O Breaks	Depth Scale (cm)	Unified Symbol	Sediment Description	Comments
	P/C	S H_2S	–				0	PT	0-10 cm: Organic silty material;	
		–	–						brown to black	
							50			
									10-162 cm: Native silty CLAY;	
								CL	homogeneous, greenish-gray	
							100			
									11-19 cm: Shell horizon	
							150			
									Total depth = 162 cm.	
							200			
									(NOTE: Descriptive information taken	
							250		from 5 different cores.)	
							300			

Sampler: D/M, SPT, Thinwall (TW), Shelby Tube (S), Bulk (B), etc. (Add 'C' to sampler type if a catcher is used)

PTI
ENVIRONMENTAL SERVICES

FIELD SEDIMENT CORE FORM

Client/Owner KPC / Ward Cove Station Number 49-A

Project No. CBCW-1201

Date 8.6.97 1530

Field Scientist Darant Borden

Contractor/Operator F/V Zephyr

Core Type/Method Piston core

Sample No.	Odor	Sheen	-H20 Breaks	Depth Scale	Unified Symbol	Sediment Description	Comments
	--			5	PT	0-6 cm: organic silty material,	
	-	-		10		brown to black	
				15			
				20		6-162 cm. Native silty CLAY,	
				25		homogeneous except for	
				30			
				35		11-14 cm: shell horizon;	
				40			
				45		greenish-gray.	
				50			
				55	CL	Top 6 cm collected for	
				60		compositing; top 1 ft. of	
				65		native collected for archive,	
				70		frozen.	
				75			
				80			
				85			
				90			
				95			
				100			
				160		Total depth: 162 cm	

PTI
ENVIRONMENTAL SERVICES

FIELD SEDIMENT CORE FORM

Client/Owner KPC / Ward Cove Station Number 49 - B

Project No. CBOW-1201

Date 8.7.97 14:45

Field Scientist Bardon

Contractor/Operator F/V Zephyr

Core Type/Method Piston Core

Sample No.	Odor	Sheen			H20 Breaks	Depth Scale	Unified Symbol	Sediment Description	Comments
	H2S	-			5	0			
						5	PT	0-6 cm: organic silty material;	
	-	-				10		black	
						15			
						20		6-bottom: Native silty CLAY;	
						25		greenish, w/ minor organics	
						30			
						35			
						40		Top organic material collected	
						45		for compositing w/ other	
						50	CL	station cores	
						55			
						60			
						65			
						70			
						75			
						80			
						85			
						90			
						95			
						100			

PTI
ENVIRONMENTAL SERVICES

FIELD SEDIMENT CORE FORM

Client/Owner KPC / Ward Cove Station Number 49-C

Project No. CBnw-1201

Date 8 7.97 14:45

Field Scientist Bordon

Contractor/Operator F/V Zephyr

Core Type/Method Piston Core

Sample No.	Odor	Sheen			-H20 Breaks	Depth Scale	Unified Symbol	Sediment Description	Comments
	S H2S	–				0	PT		
						5		0-2 cm: Organic silty material, black	
						10			
						15			
						20		2-bottom Native silty CLAY; greenish, w/ minor organics	
						25			
						30			
						35			
						40	CL		
						45		Top organic material collected for compositing w/ other station cores.	
						50			
						55			
						60			
						65			
						70			
						75			
						80			
						85			
						90			
						95			
						100			

PTI
ENVIRONMENTAL SERVICES

FIELD SEDIMENT CORE FORM

Client/Owner KPC / Ward Cove Station Number 49-D

Project No. CB0W-1201

Date 8-7-97 14:45

Field Scientist Burdon

Contractor/Operator F/V Zephyr

Core Type/Method Piston Core

Sample No.	Odor	Sheen			-H20 Breaks	Depth Scale	Unified Symbol	Sediment Description	Comments
	S H_2S	–				0			
						5	PT	0-10 cm: Organic silty material, black	
	–	–				10			
						15			
						20		10 - bottom: Native silty CLAY, greenish; w/ minor organics	
						25			
						30			
						35			
						40			
						45		Top 10 cm of organic material collected for compositing w/ other station cores.	
						50			
						55	CL		
						60			
						65			
						70			
						75			
						80			
						85			
						90			
						95			
						100			

PTI
ENVIRONMENTAL SERVICES

FIELD SEDIMENT CORE FORM

Client/Owner KPC / Ward Cove
Station Number 49 - E
Project No. CBCW-1201
Date 8.8.97 10:00
Field Scientist Borden
Contractor/Operator F/V Zephyr
Core Type/Method Piston Core

Sample No.	Odor	Sheen	-H20 Breaks	Depth Scale (cm)	Unified Symbol	Sediment Description	Comments
	—	—		0	?		
	—	—		5		0-5 cm: Liquified	
				10		5-94 cm: Native silty CLAY,	
				15		green to gray	
				20			
				25		Top 1 ft. collected for	
				30		~~compositing with other~~	
				35	CL	~~station cores~~ SD, archive	
				40		frozen.	
				45		Top 5 cm collected for	
				50		compositing with other	
				55		station cores.	
				60			
				65			
				70			
				75			
				80			
				85			
				90			
				95			
				100		Total depth - 94 cm.	

Appendix D

Appendix D

Historical Bioaccumulation Data

CONTENTS

Appendix D1

Data for Ward Cove

TABLE D1-1. SUMMARY OF 2,3,7,8-TCDF IN COMPOSITE SAMPLES OF SALMON COLLECTED NEAR WARD COVE IN 1990

Station[a]	Species	Sample Size[b]	Sample Type	2,3,7,8-TCDF[c] (ng/kg wet weight)
I	Pink salmon	3	Whole fish	1.4
I	Sockeye salmon	7	Whole fish	1.4
II	Pink salmon	3	Whole fish	0.54
II	Pink salmon	3	Whole fish minus livers	0.45
II	Pink salmon	3	Livers	1.8

Source: Spannagel (1991).

Note: TCDF - tetrachlorodibenzofuran

[a] Station I was located in Ward Creek, and Station II was located in Signal Creek.

[b] Number of individual fish in each composite sample.

[c] No other dioxin or furan congeners were detected.

TABLE D1-2. SUMMARY OF DIOXINS AND FURANS IN COMPOSITE SAMPLES OF CRABS AND FISHES COLLECTED IN OR NEAR WARD COVE IN 1991

Location	Stations	Species	Sample Size[a]	Sample Type	2,3,7,8-TCDD	2,3,7,8-TCDF	TCDD TEC[b]
Ward Cove	1 and 6	Dungeness crab	5	Muscle	0.11	1.1	0.35
Ward Cove	1 and 6	Dungeness crab	5	Hepatopancreas	0.93	69	10
Ward Cove	8 and 9	Rockfish	5	Fillet	0.10 *U*	0.39	0.26
Mountain Point[c]	--	Pink salmon	5	Fillet	0.10 *U*	0.12	0.23

Source: Spannagel (1991)

Note: Concentrations are ng/kg wet weight. See also Table D1-4.

TCDD - tetrachlorodibenzo-*p*-dioxin
TCDF - tetrachlorodibenzofuran
TEC - toxic equivalent concentration based on data for 2,3,7,8-tetrachlorodibenzo-*p*-dioxin
TEF - toxicity equivalence factor
U - undetected at concentration listed

[a] Number of organisms in each composite sample.

[b] TEC calculations based on TEFs provided in U.S. EPA (1989), using one-half the detection limit (ND = 1/2 dl).

[c] Reference location.

TABLE D1-3. CONCENTRATIONS OF PCDDs/Fs IN BLUBBER OF SEALS KILLED IN THE KETCHIKAN AREA

Analyte	TEF	13829	13830	13831	13832	13833
2,3,7,8-TCDD	1	4.7 ND	8.3 ND	3 ND	3.1 ND	3.1 ND
1,2,3,7,8-PeCDD	0.5	7.6 ND	13.1 ND	4.3 ND	4.5 ND	4.7 ND
1,2,3,4,7,8-HxCDD	0.1	10 ND	17.6 ND	4.8 ND	6.1 ND	6.5 ND
1,2,3,6,7,8-HxCDD	0.1	9.2 ND	14.9 ND	0.71 E	5.5 ND	6 ND
1,2,3,7,8,9-HxCDD	0.1	8.9 ND	15.4 ND	4.3 ND	5.4 ND	5.7 ND
1,2,3,4,6,7,8-HpCDD	0.01	15.1 ND	23 ND	5.9 ND	9.5 ND	10.2 ND
OCDD	0.001	25.2 ND	38.2 ND	8.9 ND	16.2 ND	7.9 E
2,3,7,8-TCDF	0.1	3.7 ND	6.1 ND	6.7	2.3 ND	2.4 ND
1,2,3,7,8-PeCDF	0.05	4.6 ND	7.9 ND	2.7 ND	2.8 ND	2.9 ND
2,3,4,7,8-PeCDF	0.5	4.4 ND	7.8 ND	2.7 ND	2.7 ND	2.8 ND
1,2,3,4,7,8-HxCDF	0.1	6.6 ND	10.7 ND	3.4 ND	4.2 ND	4.5 ND
1,2,3,6,7,8-HxCDF	0.1	5.3 ND	8.3 ND	2.7 ND	3.4 ND	3.6 ND
2,3,4,6,7,8-HxCDF	0.1	6.5 ND	10.9 ND	3.2 E	4.2 ND	4.5 ND
1,2,3,7,8,9-HxCDF	0.1	7.3 ND	12 ND	3.7 ND	4.7 ND	5 ND
1,2,3,4,6,7,8-HpCDF	0.01	6.8 ND	11.6 ND	3.1 ND	4.6 ND	5.1 ND
1,2,3,4,7,8,9-HpCDF	0.01	10.6 ND	18.2 ND	4.8 ND	7.1 ND	7.9 ND
OCDF	0.001	21.7 ND	28.7 ND	7.6 ND	5.32 ND	15.7 ND
TEC excluding detection limit		0.00 ND	0.00 ND	0.40	0.00 ND	0.0079
TEC with detection limit at 1/2[a]		8.53 ND	14.66 ND	5.40	5.33 ND	5.54
TEC with full detection limit[a]		17.1 ND	29.3 ND	9.74	10.7 ND	11.1

Source: National Marine Fisheries data analyzed September 1996 (Triangle Labs 1996).

Note: Concentrations in ng/kg wet weight.

E - estimated maximum possible concentration
ND - not detected
PCDD/F - polychlorinated dibenzo-*p*-dioxin and polychlorinated dibenzofuran
TEC - toxic equivalent concentration based on data for 2,3,7,8-tetrachlorodibenzo-*p*-dioxin
TEF - toxicity equivalence factor provided by U.S. EPA (1989)

[a]TEC calculations based on TEFs provided in U.S. EPA (1989). Undetected congeners included as indicated.

TABLE D1-4. ADDITIONAL BACKGROUND ON DATA FROM SPANNAGEL (1991)

		Ward Cove			Mountain Point Reference Station
		Stations 1 and 6		Stations 8 and 9	
Analyte	TEF	Crab Muscle	Crab Hepatopancreas	Rockfish	Pink Salmon
2,3,7,8-TCDD	1	0.11	0.93	0.1 *U*	0.1 *U*
1,2,3,7,8-PeCDD	0.5	0.07 *U*	1.4 *NJ*	0.2 *U*	0.2 *U*
1,2,3,4,7,8-HxCDD	0.1	0.2 *U*	1.0	0.2 *U*	0.2 *U*
1,2,3,6,7,8-HxCDD	0.1	0.1 *U*	3.8	0.11	0.1 *U*
1,2,3,7,8,9-HxCDD	0.1	0.1 *U*	1.6	0.2 *U*	0.2 *U*
1,2,3,4,6,7,8-HpCDD	0.01	0.77 *J*	14.2 *J*	0.3 *U*	0.2 *U*
1,2,3,4,6,7,8,9-OCDD	0.001	22 *J*	28.1	2.2 *J*	2.7 *J*
Total TCDD					
Total PeCDD					
Total HxCDD					
Total HpCDD					
2,3,7,8-TCDF	0.1	1.1 *J*	68.7 *J*	0.39 *J*	0.12 *NJ*
1,2,3,7,8-PeCDF	0.05	0.08 *U*	1.1	0.2 *U*	0.2 *U*
2,3,4,7,8-PeCDF	0.5	0.08 *U*	1.5	0.2 *U*	0.2 *U*
1,2,3,4,7,8-HxCDF	0.1	0.1 *U*	1.3	0.1 *U*	0.1 *U*
1,2,3,6,7,8-HxCDF	0.1	0.08 *U*	0.49	0.1 *U*	0.1 *U*
1,2,3,7,8,9-HxCDF	0.1	0.1 *U*	0.1 *U*	0.2 *U*	0.1 *U*
2,3,4,6,7,8-HxCDF	0.1	0.13 *J*	0.63 *J*	0.1 *U*	0.19
1,2,3,4,6,7,8-HpCDF	0.01	0.5 *N*	3.8 *J*	0.1 *U*	0.08 *U*
1,2,3,4,7,8,9-HpCDF	0.01	0.2 *U*	0.1 *U*	0.2 *U*	0.1 *U*
1,2,3,4,6,7,8,9-OCDF	0.001	5.3 *J*	4.5 *J*	0.5 *U*	0.4 *NJ*
Total TCDF					
Total PeCDF					
Total HxCDF					
Total HpCDF					
TEC excluding detection limit		0.27	10	0.05	0.03
TEC with detection limit at 1/2[a]		0.35	10	0.26	0.23
TEC with full detection limit[a]		0.42	10	0.46	0.43

Source: Spannagel (1991)

Note: Concentrations in ng/kg wet weight.

J - estimated
TCDD - tetrachlorodibenzo-*p*-dioxin
TCDF - tetrachlorodibenzofuran
TEC - toxic equivalent concentration based on data for 2,3,7,8-tetrachlorodibenzo-*p*-dioxin
TEF - toxicity equivalence factor
U - undetected at concentrations listed

[a]TEC calculations based on TEFs provided in U.S. EPA (1989). Undetected congeners included as indicated.

TABLE D1-5. PCDD/F AND MERCURY DATA FROM EVS (1996)

Analyte	Station ID	Mussel Tissues							Clam Tissues					
		MB-01	MB-02	WC-01	WC-02	WC-03	WC-04	WC-05	MB-01	WC-01	WC-02	WC-03	WC-04	WC-05
PCDD/PCDFs (ng/kg wet weight)														
	TEF													
2,3,7,8-TCDD	1	0.065	0.13	0.08	0.08	0.074	0.08	0.067	0.054 *U*	0.064 *U*	0.11 *U*	0.066 *U*	0.15 *U*	0.032 *U*
1,2,3,7,8-PeCDD	0.5	0.041	0.18	0.06	0.05	0.07	0.075	0.09	0.045 *U*	0.057 *U*	0.092 *U*	0.053 *U*	0.084 *U*	0.046 *U*
1,2,3,4,7,8-HxCDD	0.1	0.071	0.15	0.05	0.05	0.04	0.07	0.07	0.046 *U*	0.043 *U*	0.034 *U*	0.044 *U*	0.034 *U*	0.029 *U*
1,2,3,6,7,8-HxCDD	0.1	0.08	0.15	0.5	0.36	0.51	0.45	0.43	0.049 *U*	0.07 *U*	0.14 *U*	0.15 *U*	0.093 *U*	0.12 *U*
1,2,3,7,8,9-HxCDD	0.1	0.075	0.16	0.17	0.19	0.2	0.22	0.2	0.083 *U*	0.046 *U*	0.13 *U*	0.089 *U*	0.076 *U*	0.092 *U*
1,2,3,4,6,7,8-HpCDD	0.01	0.58	1.02	10.8	15	15	15	14	0.22 *U*	0.51 *U*	1.2 *U*	1.4 *U*	0.67 *U*	1.2 *U*
1,2,3,4,6,7,8,9-OCDD	0.001	15	22	257	360	360	283	350	1.6 *U*	5.3 *J*	12	12	6 *J*	10
Total TCDD		0.21	0.34	1.4	1.3	1.5	1.4	1.03	0.19 *U*	0.27 *U*	0.52	0.54	0.33 *U*	0.4 *U*
Total PeCDD		0.08	0.12	0.23	0.22	0.21	0.18	0.16	0.045 *U*	0.1 *U*	0.24 *U*	0.18 *U*	0.16 *U*	0.12 *U*
Total HxCDD		0.14	0.28	0.7	0.73	0.9	0.85	0.77	0.083 *U*	0.16 *U*	0.34 *U*	0.32 *U*	0.2 *U*	0.26 *U*
Total HpCDD		1.1	3.5	31	49	58	48	43	0.25 *U*	0.58 *U*	1.5 *U*	1.6 *U*	0.82 *U*	1.8 *U*
2,3,7,8-TCDF	0.1	0.1	0.16	0.15	0.13	0.15	0.15	0.17	0.051 *U*	0.16 *U*	0.29 *U*	0.2 *U*	0.075 *U*	0.16 *U*
1,2,3,7,8-PeCDF	0.05	0.07	0.09	0.08	0.056	0.079	0.076	0.11	0.058 *U*	0.043 *U*	0.071 *U*	0.068 *U*	0.06 *U*	0.078 *U*
2,3,4,7,8-PeCDF	0.5	0.06	0.08	0.07	0.06	0.08	0.07	0.09	0.027 *U*	0.036 *U*	0.059 *U*	0.056 *U*	0.049 *U*	0.065 *U*
1,2,3,4,7,8-HxCDF	0.1	0.018	0.044	0.06	0.07	0.06	0.06	0.06	0.036 *U*	0.044 *U*	0.062 *U*	0.06 *U*	0.015 *U*	0.047 *U*
1,2,3,6,7,8-HxCDF	0.1	0.02	0.054	0.04	0.041	0.038	0.049	0.07	0.038 *U*	0.055 *U*	0.034 *U*	0.04 *U*	0.019 *U*	0.049 *U*
1,2,3,7,8,9-HxCDF	0.1	0.03	0.078	0.041	0.03	0.039	0.049	0.11	0.064 *U*	0.08 *U*	0.026 *U*	0.027 *U*	0.028 *U*	0.071 *U*
2,3,4,6,7,8-HxCDF	0.1	0.022	0.052	0.06	0.07	0.04	0.07	0.07	0.04 *U*	0.054 *U*	0.038 *U*	0.044 *U*	0.019 *U*	0.038 *U*
1,2,3,4,6,7,8-HpCDF	0.01	0.06	0.09	0.43	0.46	0.43	0.48	0.41	0.098 *U*	0.14 *U*	0.25 *U*	0.3 *U*	0.12 *U*	0.29 *U*
1,2,3,4,7,8,9-HpCDF	0.01	0.051	0.088	0.09	0.11	0.11	0.11	0.14	0.058 *U*	0.11 *U*	0.093 *U*	0.085 *U*	0.022 *U*	0.037 *U*
1,2,3,4,6,7,8,9-OCDF	0.001	0.14	0.33	5.5	2.3	4	1.9	1.7	0.37 *U*	0.61 *U*	1.4 *U*	1.5 *U*	0.49 *U*	1 *U*
Total TCDF		0.33	0.35	2.1	2	1.9	1.8	1.5	0.12 *U*	0.16 *U*	0.29 *U*	0.2 *U*	0.084 *U*	0.17 *U*
Total PeCDF		0.07	0.09	0.21	0.2	0.17	0.16	0.13	0.058 *U*	0.084 *U*	0.14 *U*	0.14 *U*	0.06 *U*	0.097 *U*
Total HxCDF		0.05	0.09	0.33	0.34	0.32	0.34	0.3	0.064 *U*	0.077 *U*	0.17 *U*	0.19 *U*	0.097 *U*	0.17 *U*
Total HpCDF		0.1	0.13	2.9	2.2	2.7	2.1	1.2	0.098 *U*	0.27 *U*	0.61 *U*	0.66 *U*	0.25 *U*	0.47 *U*
Toxic Equivalent Concentration[a]														
TEC excluding detection limit		0.18	0.38	0.63	0.75	0.78	0.71	0.78	0	0.005	0.012	0.012	0.006	0.010
TEC with detection limit at 1/2		0.18	0.38	0.63	0.75	0.78	0.71	0.78	0.070	0.093	0.15	0.12	0.14	0.094
TEC with full detection limit		0.18	0.38	0.63	0.75	0.78	0.71	0.78	0.14	0.18	0.29	0.22	0.27	0.18
EVS reported TEC		0.53	1.02	1.88	2.23	2.32	2.11	2.32	0.070	0.093	0.15	0.11	0.14	0.094
Mercury (mg/kg dry weight)														
Total Mercury		0.0961	0.0885	0.0771	0.0768	0.0852	0.0884	0.0855	0.202	0.137	0.123	0.183	0.116	0.138
Methylmercury		0.0038	0.0044	0.0004	0.0019	0.0038	0.0027	0.0048	0.0255	0.0028	0.0052	0.0054	0.0063	0.0091
Mercury (mg/kg wet weight)														
Total Mercury		0.017	0.016	0.013	0.013	0.015	0.015	0.014	0.021	0.019	0.017	0.026	0.011	0.018
Methylmercury		0.0007	0.0008	0.0001	0.0003	0.0007	0.0005	0.0008	0.0027	0.0004	0.0007	0.0008	0.0006	0.0012
Percent Lipids		3.5	3.1	2.4	3.9	3.5	2.9	2.8	1.6	2	1.8	2.8	2.7	2.8
Total Solids (% dry weight)		18.1	18	17.1	16.6	17.6	17.4	16.7	10.5 *J*	13.9 *J*	13.7 *J*	14.4 *J*	9.57 *J*	12.9 *J*

Source: EVS (1996)

Note:
J - estimated
PCDD/F - polychlorinated dibenzo-*p*-dioxin and polychlorinated dibenzofuran
TEC - toxic equivalent concentration based on data for 2,3,7,8-tetrachlorodibenzo-*p*-dioxin
TEF - toxicity equivalence factor
U - undetected at concentration listed

[a] TECs reported in EVS (1996) were incorrect and were modified per Salazar (1998, pers. comm.). TECs shown here were modified to average replicates prior to averaging them with remaining values.

Figure D-1. Locations of stations at which organisms were collected for bioaccumulation analysis in 1990 and 1991.

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DATA FROM EVS (1996)

Locations of mussels deployed in Ward Cove by EVS (1996) are presented in Figure 1-2 of EVS (1996), and sample results are summarized in Table D1-5. Sample results for mussels at each of the five stations in Table D1-5 represent three composites of 100 mussels each.

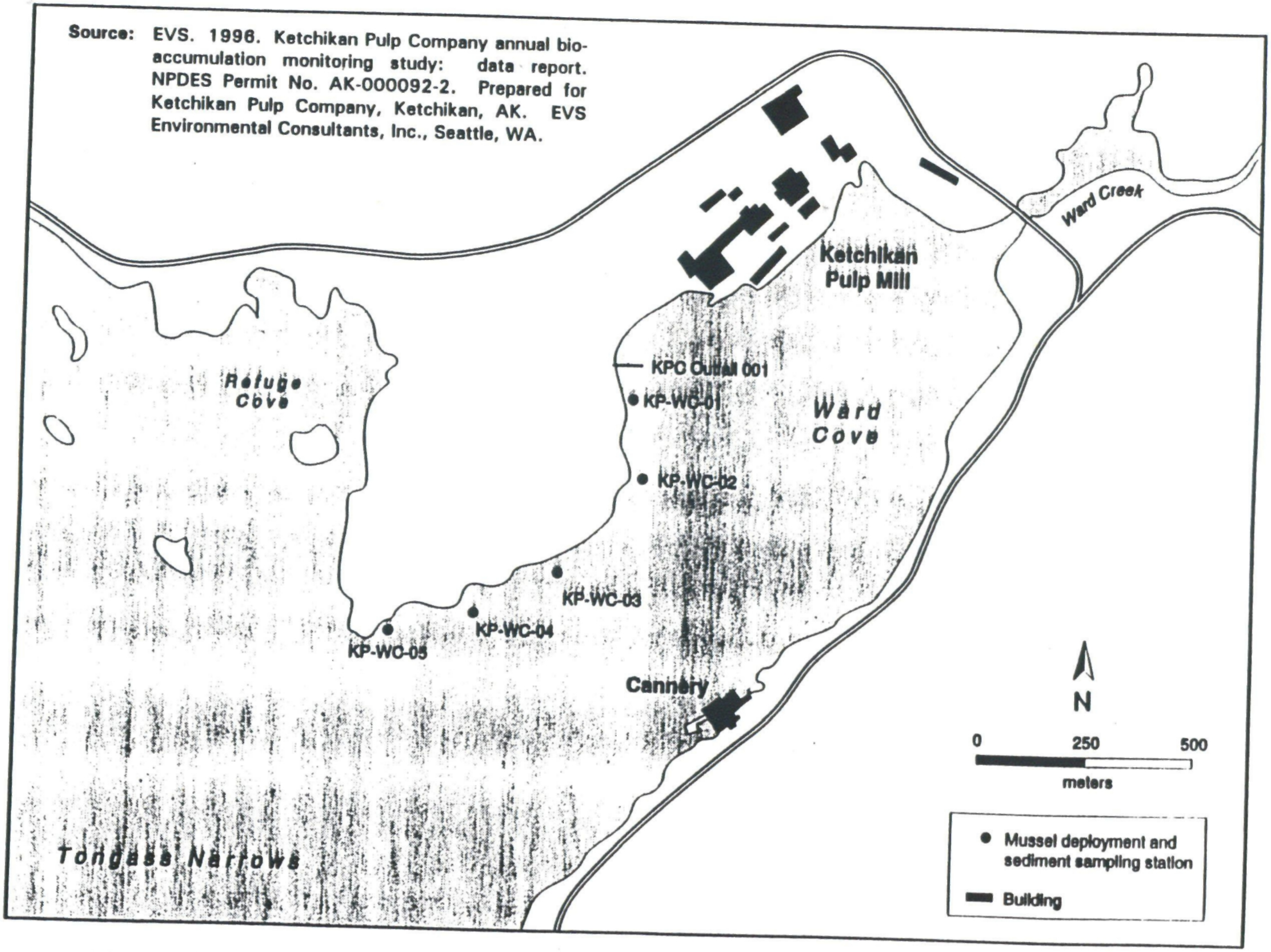

Figure 1-2. Locations of mussel deployment and sediment sampling stations in Ward Cove

Table 3-7. Mean concentrations of dioxins/furans, total mercury, methylmercury, percent lipids, and total solids in mussel tissues

ANAYLTES	T_0	STATION ID						
		MB-01	MB-02	WC-01	WC-02	WC-03	WC-04	WC-05
PCDDs/PCDFs (ng/kg)								
TCDD2378	0.024	0.065	0.13	0.08	0.08	0.074	0.08	0.067
PeCDD12378	0.036	0.041	0.18	0.06	0.05	0.07	0.075	0.09
HxCDD123478	0.029	0.071	0.15	0.05	0.05	0.04	0.07	0.07
HxCDD123678	0.058	0.08	0.15	0.5	0.36	0.51	0.45	0.43
HxCDD123789	0.071	0.075	0.16	0.17	0.19	0.2	0.22	0.2
HpCDD1234678	0.6	0.58	1.02	10.8	15	15	15	14
OCDD12346789	9.2	15	22	257	360	360	283	350
Total TCDD	0.13	0.21	0.34	1.4	1.3	1.5	1.4	1.03
Total PeCDD	0.036	0.08	0.12	0.23	0.22	0.21	0.18	0.16
Total HxCDD	0.16	0.14	0.28	0.7	0.73	0.9	0.85	0.77
Total HpCDD	1.4	1.1	3.5	31	49	58	48	43
TCDF2378	0.08	0.1	0.16	0.15	0.13	0.15	0.15	0.17
PeCDF12378	0.034	0.07	0.09	0.08	0.056	0.079	0.076	0.11
PeCDF23478	0.028	0.06	0.08	0.07	0.06	0.08	0.07	0.09
HxCDF123478	0.019	0.018	0.044	0.06	0.07	0.06	0.06	0.06
HxCDF123678	0.024	0.02	0.054	0.04	0.041	0.038	0.049	0.07
HxCDF123789	0.035	0.03	0.078	0.041	0.03	0.039	0.049	0.11
HxCDF234678	0.024	0.022	0.052	0.06	0.07	0.04	0.07	0.07
HpCDF1234678	0.043	0.06	0.09	0.43	0.46	0.43	0.48	0.41
HpCDF1234789	0.07	0.051	0.088	0.09	0.11	0.11	0.11	0.14
OCDF12346789	0.21	0.14	0.33	5.5	2.3	4	1.9	1.7
Total TCDF	0.31	0.33	0.35	2.1	2	1.9	1.8	1.5

Table 3-7. continued

ANAYLTES	T_0	STATION ID						
		MB-01	MB-02	WC-01	WC-02	WC-03	WC-04	WC-05
Total PeCDF	0.052	0.07	0.09	0.21	0.2	0.17	0.16	0.13
Total HxCDF	0.076	0.05	0.09	0.33	0.34	0.32	0.34	0.3
Total HpCDF	0.08	0.1	0.13	2.9	2.2	2.7	2.1	1.2
TEQ	0.32	0.53	1.02	1.88	2.23	2.32	2.11	2.32
Mercury (mg/kg dry weight)								
Total mercury	0.0606	0.0961	0.0885	0.0771	0.0768	0.0852	0.0884	0.0855
Methylmercury	0.0036	0.0038	0.0044	0.0004	0.0019	0.0038	0.0027	0.0048
Percent lipids	3.9	3.5	3.1	2.4	3.9	3.5	2.9	2.8
Total solids (% DW)	17.8	18.1	18	17.1	16.6	17.6	17.4	16.7

NOTE: T_0 - time zero, test initiation
TEQ - toxicity equivalence concentration

Source: EVS. 1996. Ketchikan Pulp Company annual bio-accumulation monitoring study: data report. NPDES Permit No. AK-000092-2. Prepared for Ketchikan Pulp Company, Ketchikan, AK. EVS Environmental Consultants, Inc., Seattle, WA.

Table 3-9. Concentrations of dioxins/furans, total mercury, methylmercury, percent lipids, and total solids in clam tissues

	Station ID							
Analytes	**MB-01**	**WC-01**	**WC-02**	**WC-03**	**WC-04**	**WC-05**	**T_0**	**Control Sediment**
PCDDs/PCDFs (ng/kg)								
TCDD2378	0.054 U	0.064 U	0.11 U	0.066 U	0.15 U	0.032 U	0.046 U	0.087 U
PeCDD12378	0.045 U	0.057 U	0.092 U	0.053 U	0.084 U	0.046 U	0.059 U	0.05 U
HxCDD123478	0.046 U	0.043 U	0.034 U	0.044 U	0.034 U	0.029 U	0.041 U	0.037 U
HxCDD123678	0.049 U	0.07 U	0.14 U	0.15 U	0.093 U	0.12 U	0.13 U	0.11 U
HxCDD123789	0.083 U	0.046 U	0.13 U	0.089 U	0.076 U	0.092 U	0.1 U	0.11 U
HpCDD1234678	0.22 U	0.51 U	1.2 U	1.4 U	0.67 U	1.2 U	1.2 U	1.3
OCDD12346789	1.6 U	5.3 J	12	12	6 J	10	8.9 J	9.9 J
TotalTCDD	0.19 U	0.27 U	0.52	0.54	0.33 U	0.4 U	0.15 U	0.12 U
TotalPeCDD	0.045 U	0.1 U	0.24 U	0.18 U	0.16 U	0.12 U	0.068 U	0.05 U
TotalHxCDD	0.083 U	0.16 U	0.34 U	0.32 U	0.2 U	0.26 U	0.27 U	0.3 U
TotalHpCDD	0.25 U	0.58 U	1.5 U	1.6 U	0.82 U	1.8 U	1.5 U	1.7 U
TCDF2378	0.051 U	0.16 U	0.29 U	0.2 U	0.075 U	0.16 U	0.11 U	0.09 U
PeCDF12378	0.058 U	0.043 U	0.071 U	0.068 U	0.06 U	0.078 U	0.064 U	0.076 U
PeCDF23478	0.027 U	0.036 U	0.059 U	0.056 U	0.049 U	0.065 U	0.052 U	0.062 U
HxCDF123478	0.036 U	0.044 U	0.062 U	0.06 U	0.015 U	0.047 U	0.027 U	0.035 U
HxCDF123678	0.038 U	0.055 U	0.034 U	0.04 U	0.019 U	0.049 U	0.034 U	0.038 U
HxCDF123789	0.064 U	0.08 U	0.026 U	0.027 U	0.028 U	0.071 U	0.049 U	0.055 U
HxCDF234678	0.04 U	0.054 U	0.038 U	0.044 U	0.019 U	0.038 U	0.033 U	0.047 U
HpCDF1234678	0.098 U	0.14 U	0.25 U	0.3 U	0.12 U	0.29 U	0.28 U	0.25 U
HpCDF1234789	0.058 U	0.11 U	0.093 U	0.085 U	0.022 U	0.037 U	0.16 U	0.075 U
OCDF12346789	0.37 U	0.61 U	1.4 U	1.5 U	0.49 U	1 U	1 U	0.87 U
TotalTCDF	0.12 U	0.16 U	0.29 U	0.2 U	0.084 U	0.17 U	0.19 U	0.14 U
TotalPeCDF	0.058 U	0.084 U	0.14 U	0.14 U	0.06 U	0.097 U	0.18 U	0.15 U

Table 3-9. continued

ANALYTES	STATION ID						T₀	CONTROL SEDIMENT
	MB-01	WC-01	WC-02	WC-03	WC-04	WC-05		
TotalHxCDF	0.064 U	0.077 U	0.17 U	0.19 U	0.097 U	0.17 U	0.18 U	0.19 U
TotalHpCDF	0.098 U	0.27 U	0.61 U	0.66 U	0.25 U	0.47 U	0.48 U	0.48 U
TEQ	0.070	0.093	0.15	0.11	0.14	0.094	0.096	0.12
Mercury (mg/kg dry weight)								
Total mercury	0.202	0.137	0.123	0.183	0.116	0.138	0.19	0.24
Methylmercury	0.0255	0.0028	0.0052	0.0054	0.0063	0.0091	0.0341	0.049
Percent Lipids	1.6	2	1.8	2.8	2.7	2.8	2.4	1.8
Total Solids (%DW)	10.5 J	13.9 J	13.7 J	14.4 J	9.57 J	12.9 J	11.6 J	13 J

NOTE: T_0 - time zero, test initiation
U - undetected
J - estimate
TEQ - toxicity equivalence concentration

Source: EVS. 1996. Ketchikan Pulp Company annual bioaccumulation monitoring study: data report. NPDES Permit No. AK-000092-2. Prepared for Ketchikan Pulp Company, Ketchikan, AK. EVS Environmental Consultants, Inc., Seattle, WA.

REFERENCES

EVS. 1996. Ketchikan Pulp Company annual bioaccumulation monitoring study: data report. NPDES Permit No. AK-000092.2. Prepared for Ketchikan Pulp Company, Ketchikan, AK. EVS Environmental Consultants, Inc., Seattle, WA.

Salazar, S. 1998. Personal communication (telephone conversation with A. Templeton, Exponent, Bellevue, WA, on October 5, 1998, regarding dioxin data for mussel tissue reported in 6/96 report). EVS Environmental Consultants, Inc., Seattle, WA.

Spannagel, U. 1991. Ward Cove dioxin sampling II. State of Alaska Department of Environmental Conservation, Southeast Regional Office.

Triangle Labs. 1996. Letter to J. Lewis, National Marine Fisheries, Douglas, AK, dated October 30, 1996, regarding toxicity equivalents reports for analysis of seal blubber for dioxins and furans. Triangle Laboratories, Inc., Durham, NC.

U.S. EPA. 1989. Interim procedures for estimating risks associated with exposures to mixtures of chlorinated dibenzo-dioxins and furans (CDDs and CDFs). EPA/625/3-89/016. U.S. Environmental Protection Agency, Washington, DC.

Appendix D2

Data for Sawmill Cove and Nearby Areas

TABLE D2-1. PCDD/F CONCENTRATIONS IN TISSUE AND SEDIMENT SAMPLES FROM THE APC INVESTIGATION

Site	Sample Type	Species	Analyte	Number of Samples	Detection Frequency	Undetected Minimum	Undetected Maximum	Detected Minimum	Detected Maximum	Detected Mean	Units (dry weight)[a]
West Sawmill Cove											
	Tissue										
		Mussel									
			Total Solids	4	100	NA	NA	11.5	20.0	14.0	percent
			PCDD/F (TEC)[b]	4	--	2.63	11.8	3.01	39.3	15.4	ng/kg
			PCDD/F (TEC)[b,c]					0.37	4.5		ng/kg (wet wt)
		Rockfish Fillets									
			Total Solids	1	100	NA	NA	19.9	19.9	NA	percent
			PCDD/F (TEC)[b]	1	--	1.23	1.23	0.02	0.02	NA	ng/kg
			PCDD/F (TEC)[b,c]					0.004	0.004		ng/kg (wet wt)
	Sediments										
			TOC	26	100	NA	NA	10.6	42.1	26.5	percent
			Total Solids	26	100	NA	NA	10.7	25.3	17.0	percent
			PCDD/F (TEC)[b]	26	--	2.86	4.44	4.13	54.0	17.4	ng/kg
East Sawmill Cove											
	Tissue										
		Mussel									
			Total Solids	3	100	NA	NA	12.6	13.0	12.7	percent
			PCDD/F (TEC)[b]	3	--	2.96	10.2	0.42	0.51	3.57	ng/kg
		Dungeness Crab Hepatopancreas									
			Total Solids	1	100	NA	NA	37.8	37.8	NA	percent
			PCDD/F (TEC)[b]	1	--	2.84	2.84	2.25	2.25	NA	ng/kg
		Dungeness Crab Muscle									
			Total Solids	1	100	NA	NA	26.1	26.1	NA	percent
			PCDD/F (TEC)[b]	1	--	1.05	1.05	0.17	0.17	NA	ng/kg
		Rockfish Fillets									
			Total Solids	3	100	NA	NA	21.9	30.3	25.2	percent
			PCDD/F (TEC)[b]	3	--	0.74	1.09	0.10	0.13	0.53	ng/kg
	Sediments										
			TOC	3	100	NA	NA	1.25	16.3	7.90	percent
			Total Solids	3	100	NA	NA	22.1	66.1	41.7	percent
			PCDD/F (TEC)[b]	3	--	0.69	0.71	2.84	6.05	3.79	ng/kg

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TABLE D2-1. (cont.)

Site	Sample Type	Species	Analyte	Number of Samples	Detection Frequency	Undetected		Detected			Units
						Minimum	Maximum	Minimum	Maximum	Mean	(dry weight)[a]
Bucko Point											
	Tissue										
		Mussel									
			Total Solids	3	100	NA	NA	12.2	17.7	14.6	percent
			PCDD/F (TEC)[b]	3	--	2.38	2.38	6.17	19.7	8.36	ng/kg
		Dungeness Crab Hepatopancreas									
			Total Solids	3	100	NA	NA	84.3	119	100	percent
			PCDD/F (TEC)[b]	3	--	2.60	2.83	4.24	6.79	4.94	ng/kg
		Dungeness Crab Muscle									
			Total Solids	3	100	NA	NA	19.4	23.2	21.6	percent
			PCDD/F (TEC)[b]	3	--	1.78	5.41	0.22	0.26	1.67	ng/kg
		Flatfish Fillets									
			Total Solids	1	100	NA	NA	18.3	18.3	NA	percent
			PCDD/F (TEC)[b]	1	--	1.86	1.86	0.16	0.16	NA	ng/kg
		Rockfish Fillets									
			Total Solids	3	100	NA	NA	19.9	25.3	21.7	percent
			PCDD/F (TEC)[b]	3	--	0.65	1.47	0.27	1.20	1.05	ng/kg
	Sediments										
			TOC	4	100						percent
			Total Solids	4	100	NA	NA	18.4	46.2	31.5	percent
			PCDD/F (TEC)[b]	4	--	0.66	0.71	2.59	12.2	5.76	ng/kg
Herring Cove											
	Tissue										
		Mussel									
			Total Solids	3	100	NA	NA	9.2	21.8	15.4	percent
			PCDD/F (TEC)[b]	3	--	1.66	3.11	0.29	0.34	1.60	ng/kg
		Rockfish Fillets									
			Total Solids	3	100	NA	NA	20.3	21.6	20.9	percent
			PCDD/F (TEC)[b]	3	--	1.34	1.73	0.50	0.60	1.16	ng/kg
	Sediments										
			TOC	6	100	NA	NA	19.4	31.7	25.9	percent
			Total Solids	6	100	NA	NA	15.2	19.5	16.8	percent
			PCDD/F (TEC)[b]	6	--	1.69	2.12	1.31	8.15	3.62	ng/kg

TABLE D2-1. (cont.)

Site	Sample Type	Species	Analyte	Number of Samples	Detection Frequency	Undetected Minimum	Undetected Maximum	Detected Minimum	Detected Maximum	Detected Mean	Units (dry weight)[a]
Thimbleberry Bay											
	Tissue										
		Mussel									
			Total Solids	3	100	NA	NA	15.0	17.0	15.7	percent
			PCDD/F (TEC)[b]	3	--	1.87	2.30	1.03	9.10	4.29	ng/kg
		Flatfish Fillets									
			Total Solids	3	100	NA	NA	16.3	18.0	17.3	percent
			PCDD/F (TEC)[b]	3	--	1.22	5.01	0.18	0.26	1.47	ng/kg
		Rockfish Fillets									
			Total Solids	3	100	NA	NA	20.7	21.7	21.2	percent
			PCDD/F (TEC)[b]	3	--	1.18	3.35	0.21	0.24	1.07	ng/kg
	Sediments										
			Total Solids	4	100	NA	NA	37.2	55.4	48.7	percent
			PCDD/F (TEC)[b]	4	--	1.63	2.01	1.68	4.50	2.74	ng/kg
Jamestown Bay											
	Tissue										
		Mussel									
			Total Solids	3	100	NA	NA	8.34	15.9	12.7	percent
			PCDD/F (TEC)[b]	3	--	2.91	4.76	0.71	1.37	2.85	ng/kg
		Flatfish Fillets									
			Total Solids	3	100	NA	NA	15.8	20.1	18.2	percent
			PCDD/F (TEC)[b]	3	--	2.10	5.30	0.20	0.24	1.85	ng/kg
		Rockfish Fillets									
			Total Solids	3	100	NA	NA	20.5	22.7	21.5	percent
			PCDD/F (TEC)[b]	3	--	1.32	4.74	0.21	0.28	1.87	ng/kg
	Sediments										
			Total Solids	4	100	NA	NA	30.2	53.5	45.2	percent
			PCDD/F (TEC)[b]	4	--	1.06	1.61	3.08	7.86	5.33	ng/kg
Galankin Island											
	Tissue										
		Mussel									
			Total Solids	3	100	NA	NA	14.0	16.1	15.2	percent
			PCDD/F (TEC)[b]	3	--	3.79	14.90	0.94	1.23	4.62	ng/kg

TABLE D2-1. (cont.)

Site	Sample Type	Species	Analyte	Number of Samples	Detection Frequency	Undetected Minimum	Undetected Maximum	Detected Minimum	Detected Maximum	Detected Mean	Units (dry weight)[a]
	Tissue (cont.)										
		Flatfish Fillets									
			Total Solids	3	100	NA	NA	18.0	18.4	18.2	percent
			PCDD/F (TEC)[b]	3	--	0.97	1.22	0.24	0.30	0.82	ng/kg
		Rockfish Fillets									
			Total Solids	3	100	NA	NA	22.8	23.9	23.4	percent
			PCDD/F (TEC)[b]	3	--	0.83	5.52	0.32	0.39	1.43	ng/kg
	Sediments										
			Total Solids	2	100	NA	NA	53.8	59.4	56.6	percent
			PCDD/F (TEC)[b]	2	--	0.15	1.68	1.17	1.31	1.69	ng/kg

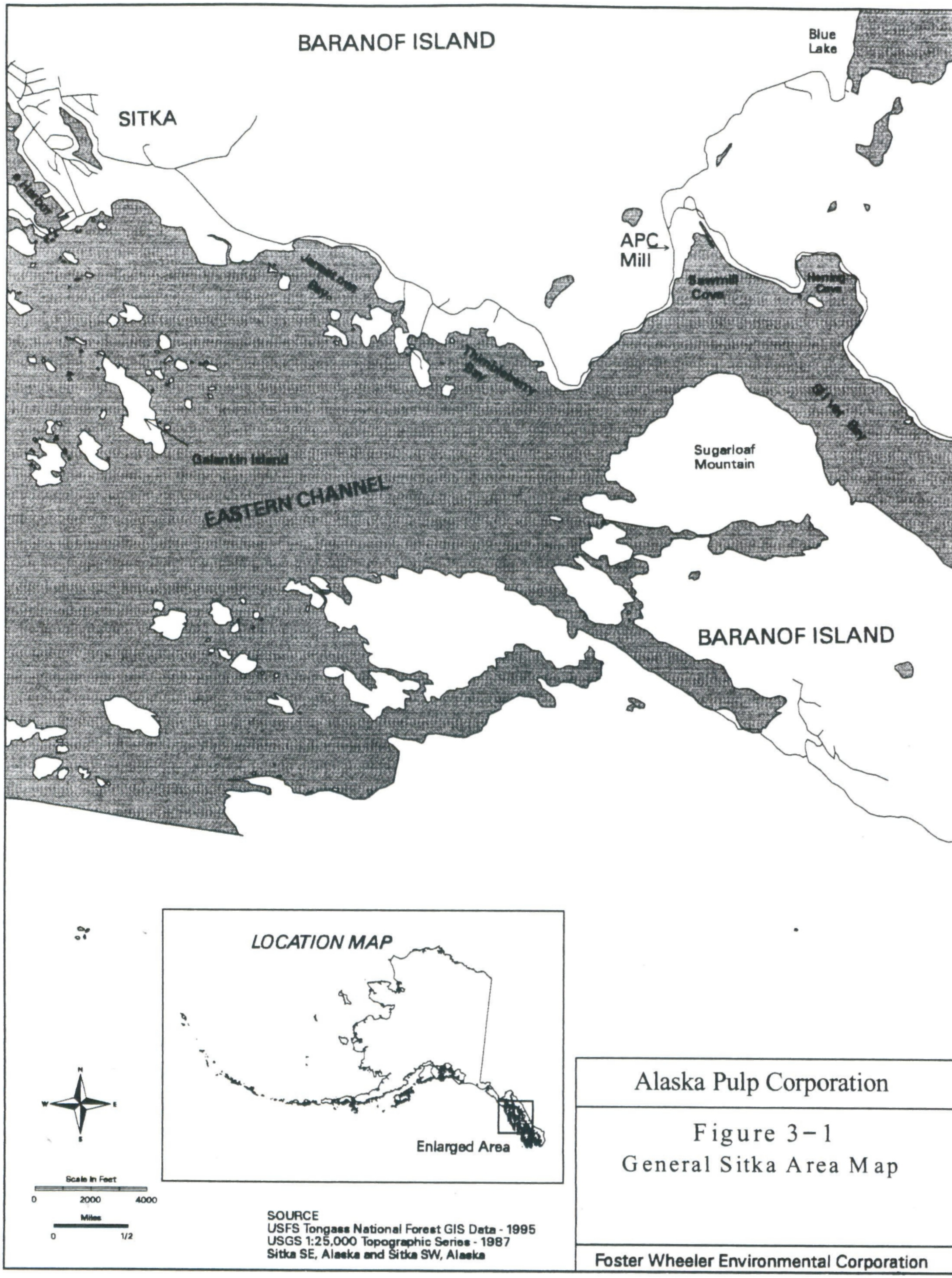
Source: Foster Wheeler (1998)

Note: NA - not applicable
PCDD/F - polychlorinated dibenzo-*p*-dioxin and polychlorinated dibenzofuran
TEC - toxic equivalent concentration based on data for 2,3,7,8-tetrachlorodibenzo-*p*-dioxin
TEF - toxicity equivalence factor
-- - detection frequency varies with individual PCDD/F congener

[a] Dry weight, except as indicated.

[b] TEC calculations based on TEFs provided in U.S. EPA (1989). In calculating TECs, one-half the detection limit was used for those congeners that were not detected. In cases where the data set appeared to be strongly biased, distributional methods such as the robust method as described by Helsel (1990) were used. Use of nondetected compounds in averages results in mean values greater than the maximum concentration.

[c] Wet weight conversion derived by Exponent using total solids data provided by Foster Wheeler.



Alaska Pulp Corporation

Figure 3-1
General Sitka Area Map

Foster Wheeler Environmental Corporation

REFERENCES

Foster Wheeler. 1997. Evaluation of risks attributed to chemical releases associated with Alaska Pulp Corporation's Sitka mill site. Volume 1 of 3: human health risk assessment. Prepared for Alaska Pulp Corporation. Foster Wheeler Environmental Corporation, Bellevue, WA.

Helsel, D.R. 1990. Less than obvious: statistical treatment of data below the detection limit. Environ. Sci. Technol. 24(12):1766–1774.

Appendix E

Appendix E

ENSR Investigation of Sediment Distribution

ENSR INVESTIGATION OF SEDIMENT DISTRIBUTION

Two study elements of Phase 1 of the Ward Cove technical studies, the assessment of the vertical extent of mill-impacted sediments and the determination of total organic carbon (TOC) in sediments predating mill activities, were determined from sampling activities associated with a solids deposition study conducted in 1995 (ENSR 1996). This study was conducted to meet the requirements of the Ketchikan Pulp Company's (KPC) National Pollutant Discharge Elimination System (NPDES) permit (No. AK-000092-2). The following results and discussion were abstracted from ENSR (1996) to address these study elements. Details of sampling and analytical activities associated with the solids deposition can be found in ENSR (1996).

VERTICAL EXTENT OF MILL-IMPACTED SEDIMENTS

One of the primary objectives of the sediment coring program was to characterize the thickness of the upper, organic-rich sediment horizon. Thirteen sediment cores were collected in Ward Cove from the locations shown in Figure 5-13 using a gravity corer. Cores ranged in length from 14 to 70 in. and generally contained three basic zones of material. The upper zone in all cores consisted of a watery, black, silty organic material that typically had a rotten-egg-like odor. The second zone for those cores in the vicinity of the KPC dock consisted primarily of wood debris (e.g., bark fragments, wood chips). In some cores, these materials were also mixed with the overlying organic material or underlying silts and clay. The deepest zone for all cores of sufficient length consisted of what appeared to be native sediment (i.e., clayey silts and silty clays). Shell fragments were often associated with the upper portion of this lower zone.

A series of sediment cross-sections was developed by ENSR (1996) to more effectively portray the thickness and locations of the various sediment horizons (Figures 5-14 through 5-17). The thickness of the black, organic-rich upper layer varied between cores, but ranged from 2 to 25 in. and was typically less than 12 in. The upper and middle horizons together generally reflect releases attributable to the mill. The total thickness of these combined horizons is generally 2 ft or less, except for a localized area near the mill where organic material attributable to the mill reaches a thickness of approximately 4 ft.

ORGANIC CARBON CONTENT OF DEEP HORIZON SEDIMENTS

Concentrations of chemical oxygen demand, total solids, total volatile solids, and TOC in selected core horizons are reported in Table 5-2. Grain size is reported in Table 5-3. Samples representing pre-mill deposits (i.e., the deepest sediment horizon) were identified on the basis of the depth horizon represented by the samples in the core and the core log descriptions. TOC concentrations typically ranged from 0.6 to 6 percent, with an average TOC concentration of approximately 4 percent. This value is consistent with the TOC content measured in sediments of the reference area, Moser Bay, where the two surface sediment samples had TOC content of 4 and 5 percent.

REFERENCE

ENSR. 1996. Draft study of solids deposition. Document No. 4025-042-500. Prepared for Ketchikan Pulp Company, Ketchikan, AK. ENSR Consulting and Engineering.

TABLE 5-2

Sediment Conventional Analytical Results

Station	Depth (inches)	Percent: Chemical Oxygen Demand*	Percent: Total Solids*	Percent: Total Volatile Solids*	Percent: Total Organic Carbon*
SD3	12"	39	16.4	54.1	29.5
SD3	36"	20	27.4	83.8	36.6
SD4	17"	45	17.4	58.1	30.4
SD4	27"	7.9	51.6	9.07	3.18
SD4	36"	3.3	64.6	2.97	0.64
SD5A	12"	16	16.8	68.0	35.4
SD5A	38"	32	24.9	74.7	37.0
SD5A	60"	34	25.8	71.3	52.5
SD6	5"	43	15.9	57.3	16.7
SD6	13"	13	43.3	21.5	19.1
SD7	12"	17	25.3	27.3	8.24
SD7	21"	7.9	51.4	8.28	4.12
SD7	33"	1.0	76.1	2.17	0.60
SD8A	10"	23	30.7	14.5	6.09
SD8A	32"	11	38.9	13.0	5.62
SD9	12"	13	32.9	15.1	6.26
SD9	36"	10	43.8	10.5	4.33
SD9	60"	14	36.2	12.2	5.04
SD10A	10"	23	20.5	31.8	14.4
SD10A	20"	11	37.4	13.1	6.08
SD10A	44"	10	37.3	12.5	5.24
SD11A	12"	18	27.5	33.7	16.1
SD11A	32"	24	24.8	35.5	17.2
SD11A	51"	6.3	47.2	7.54	2.71
SD12	3"	24	23.8	28.1	11.6
SD12	12"	2.5	63.0	3.08	1.18
SD12	22"	1.0	77.9	1.91	0.41
SD13	10"	43	13.7	52.9	26.4
SD13	10"(D)	48	13.3	50.7	26.2
SD13	32"	7.0	33.2	84.7	41.0
SD13	32"(D)	6.7	27.7	82.9	40.7

(D) = Field duplicate sample.
* = % dry weight basis

TABLE 5-3

Sediment Grain Size Distribution

Station	Depth	Grain Size (percent)							
			Sand						
		Gravel	Very Coarse	Coarse	Medium	Fine	Very Fine	Silt	Clay
		>2 mm	2-1 mm	1-0.5 mm	0.5 - 0.25 mm	0.25-0.125 mm	0.125-0.0625 mm	0.0625-0.04 mm	<0.04 mm
SD3	12"	0.34	1.96	3.99	9.59	15.9	12.4	30.7	24.0
SD3	36"	26.0	8.66	15.0	20.0	8.97	2.59	5.12	7.78
SD4	17"	3.81	6.42	13.7	18.5	9.37	5.93	22.2	23.4
SD4	27"	23.4	8.43	6.99	5.88	7.69	14.4	29.1	8.65
SD4	36"	5.23	1.49	0.93	0.92	3.14	15.6	64.4	20.1
SD5A	12"	4.45	10.9	19.0	19.1	12.7	6.25	13.7	17.2
SD5A	38"	22.2	12.8	17.9	20.7	9.48	4.51	8.94	10.5
SD5A	60"	9.03	10.8	17.7	19.6	14.5	8.65	11.2	13.0
SD6	5"	7.27	9.19	7.81	7.27	7.80	7.02	30.2	24.2
SD6	13"	11.6	3.24	2.63	3.65	6.80	13.9	39.5	11.7
SD7	12"	11.6	5.71	6.43	8.62	9.00	15.9	34.5	17.5
SD7	21"	9.09	5.06	3.95	4.51	7.04	22.4	38.0	11.3
SD7	33"	0.00	1.01	0.75	0.40	1.91	14.0	58.0	19.2
SD8A	10"	0.60	0.80	1.62	5.53	10.9	11.4	47.8	20.9
SD8A	32"	0.82	1.68	1.71	3.37	2.92	8.68	58.2	21.7
SD9	12"	0.36	1.69	3.46	8.75	4.32	9.27	55.8	19.1
SD9	36"	8.47	1.45	1.86	3.69	3.77	10.2	51.3	17.3

TABLE 5-3 (Cont'd)

Sediment Grain Size Distribution

Station	Depth	Grain Size (percent)							
			Sand						
		Gravel	Very Coarse	Coarse	Medium	Fine	Very Fine	Silt	Clay
		>2 mm	2-1 mm	1-0.5 mm	0.5 - 0.25 mm	0.25-0.125 mm	0.125-0.0625 mm	0.0625-0.04 mm	<0.04 mm
SD9	60"	3.25	1.68	3.80	3.82	9.85	8.77	50.2	25.5
SD10A	10"	5.68	3.18	5.04	6.85	5.71	7.72	51.6	23.5
SD10A	20"	1.14	1.22	1.26	4.27	3.77	11.5	58.0	19.6
SD10A	44"	0.54	1.19	2.04	3.18	2.57	8.53	61.2	18.6
SD11A	12"	3.11	3.59	6.63	18.8	22.3	11.1	18.2	11.2
SD11A	32"	3.52	3.92	4.40	12.0	22.8	15.6	24.4	14.2
SD11A	51"	41.6	8.72	5.30	5.35	12.9	15.9	17.5	7.85
SD12	3"	9.61	7.86	8.30	10.7	12.2	10.8	25.1	15.2
SD12	12"	20.0	13.2	11.3	11.0	18.1	21.0	13.8	3.87
SD12	22"	4.36	4.17	3.66	4.40	15.7	17.4	42.6	7.12
SD13	10"	3.62	5.89	10.5	14.6	9.83	6.58	28.0	27.0
SD13	10"(D)	3.20	4.66	9.28	14.0	9.17	5.03	37.9	27.5
SD13	32"	8.59	17.5	33.8	31.0	6.49	0.70	1.23	5.41
SD13	32"(D)	8.79	17.7	37.1	29.4	5.30	0.68	1.69	7.68

(D) = Field duplicate sample.

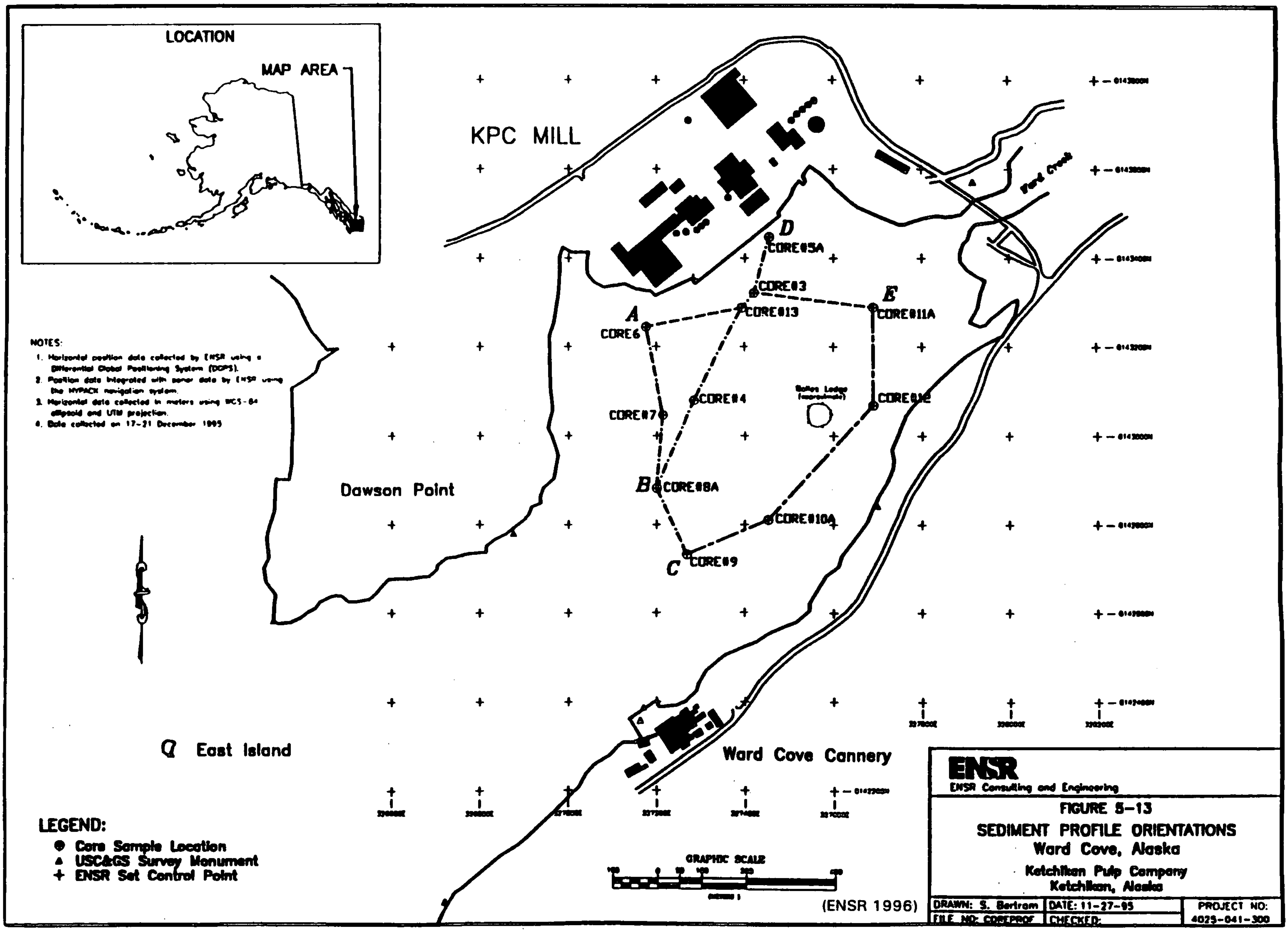
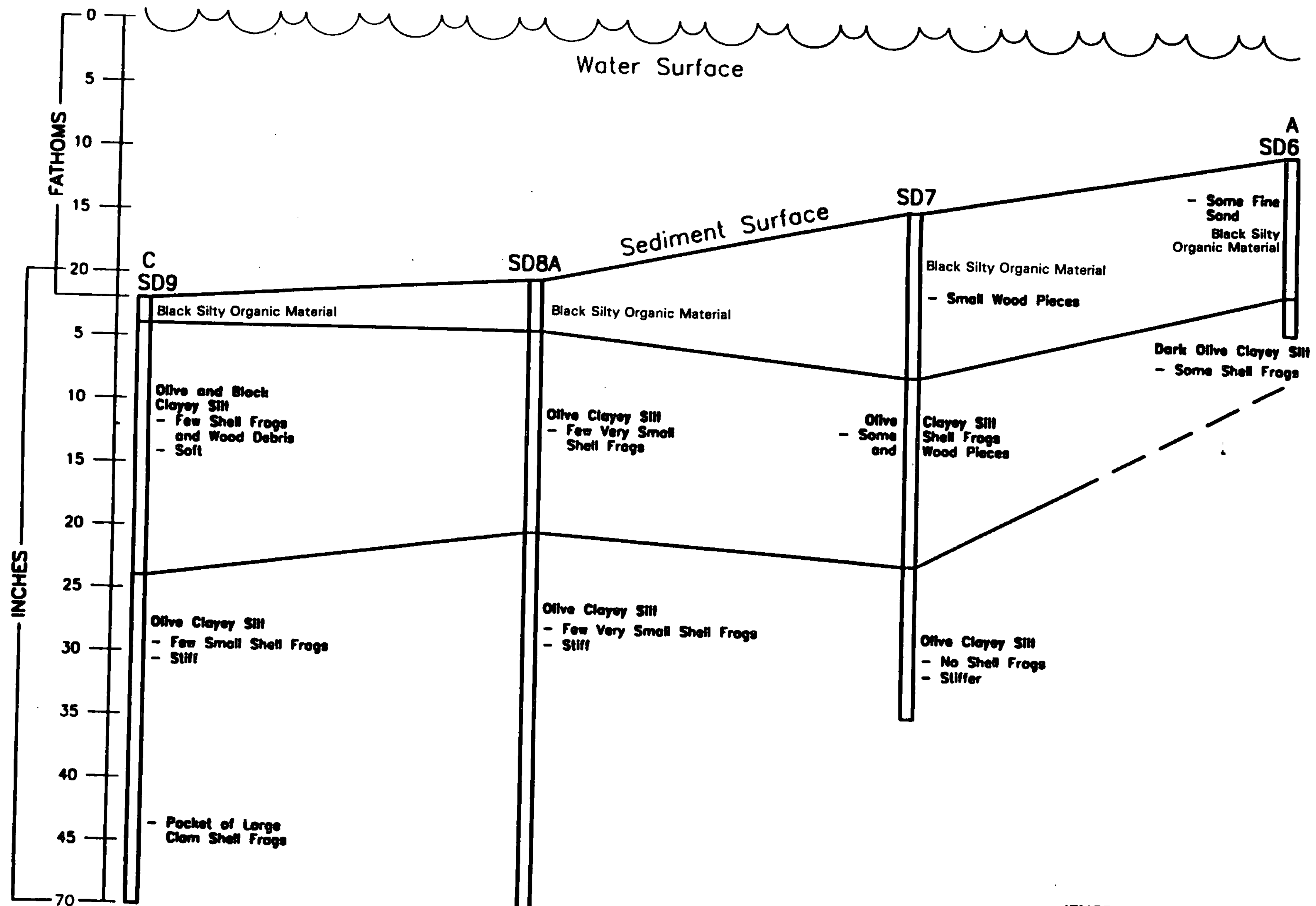

LOCATION
MAP AREA
KPC MILL
Ward Creek
D
CORE#5A
CORE#3
E
CORE#13
A
CORE#11A
CORE6
CORE#4
CORE#12
CORE#7
B
CORE#8A
CORE#10A
CORE#9
C
Dawson Point
East Island
Ward Cove Cannery
NOTES:
1. Horizontal position data collected by ENSR using a Differential Global Positioning System (DGPS).
2. Position data integrated with sonar data by ENSR using the HYPACK navigation system.
3. Horizontal data collected in meters using WGS-84 ellipsoid and UTM projection.
4. Data collected on 17-21 December 1995
LEGEND:
Core Sample Location
USC&GS Survey Monument
ENSR Set Control Point
GRAPHIC SCALE
(ENSR 1996)
ENSR
ENSR Consulting and Engineering
FIGURE 5-13
SEDIMENT PROFILE ORIENTATIONS
Ward Cove, Alaska
Ketchikan Pulp Company
Ketchikan, Alaska
DRAWN: S. Bertram
DATE: 11-27-95
PROJECT NO:
4025-041-300
FILE NO: COREPROF
CHECKED:

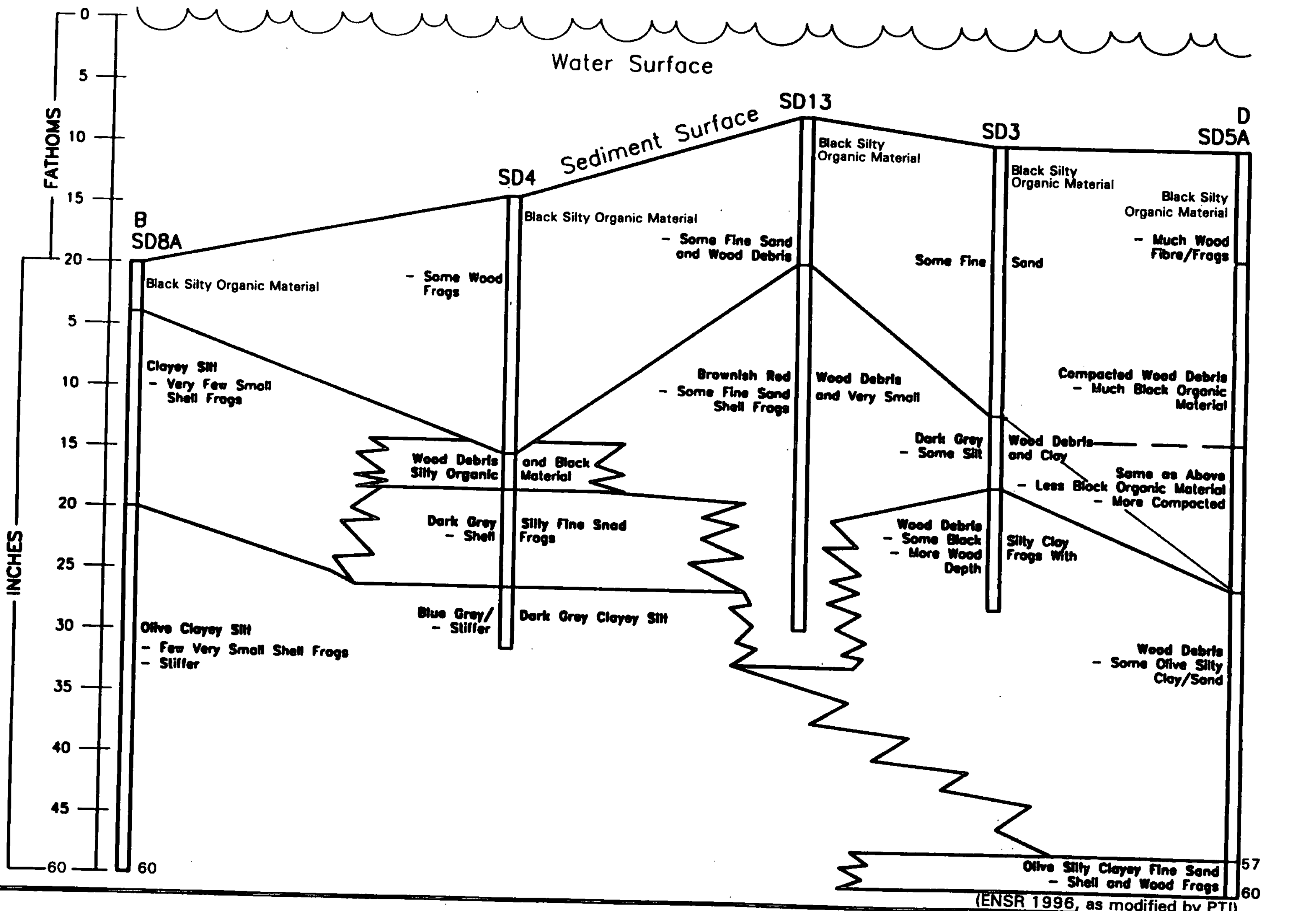
FIGURE 5-14
WARD COVE SEDIMENT PROFILE C-A



(ENSR 1996, as modified by PTI)

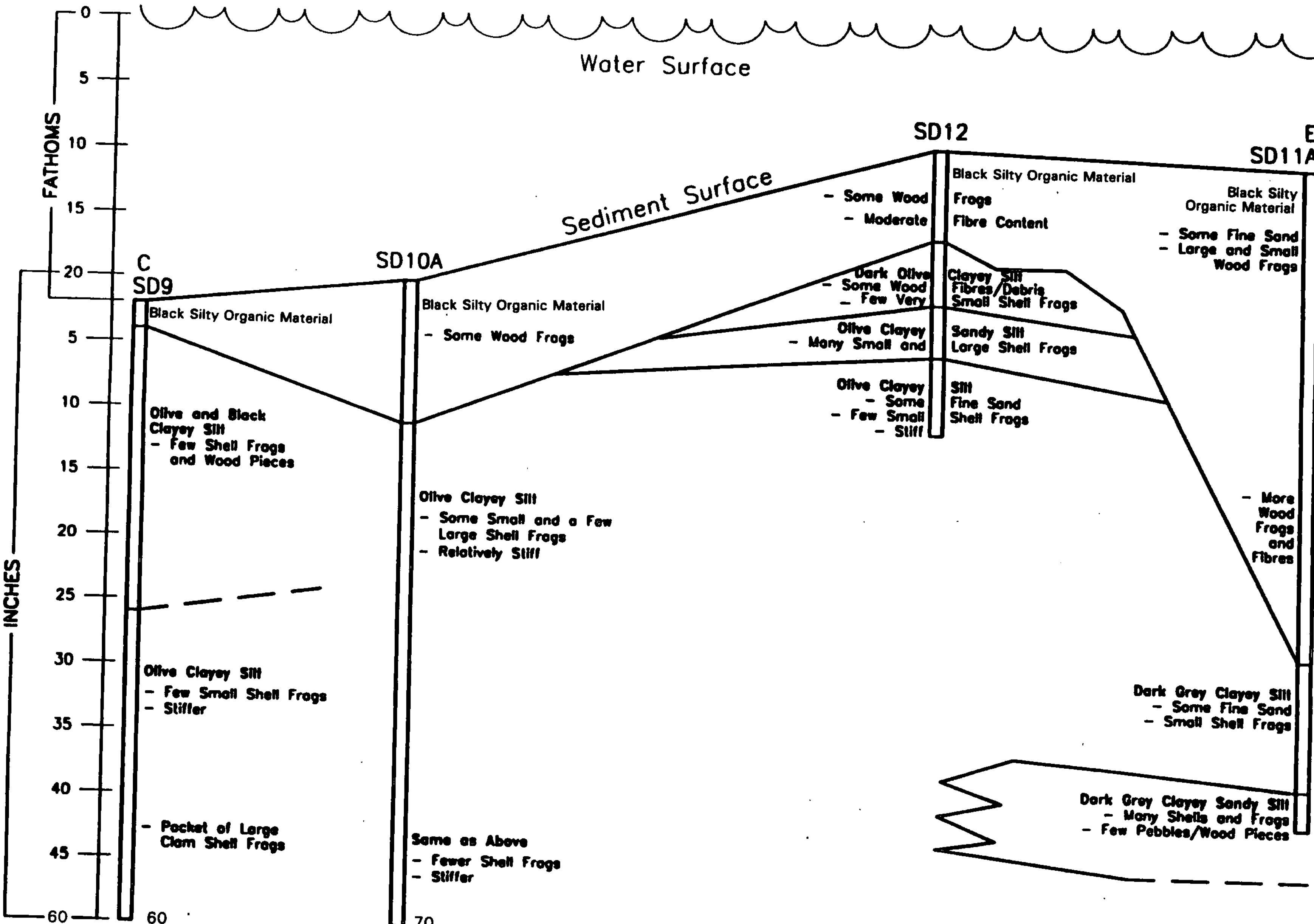
KP042500 January 10, 1996

FIGURE 5-15
WARD COVE SEDIMENT PROFILE B-D



KP042501 January 10, 1996

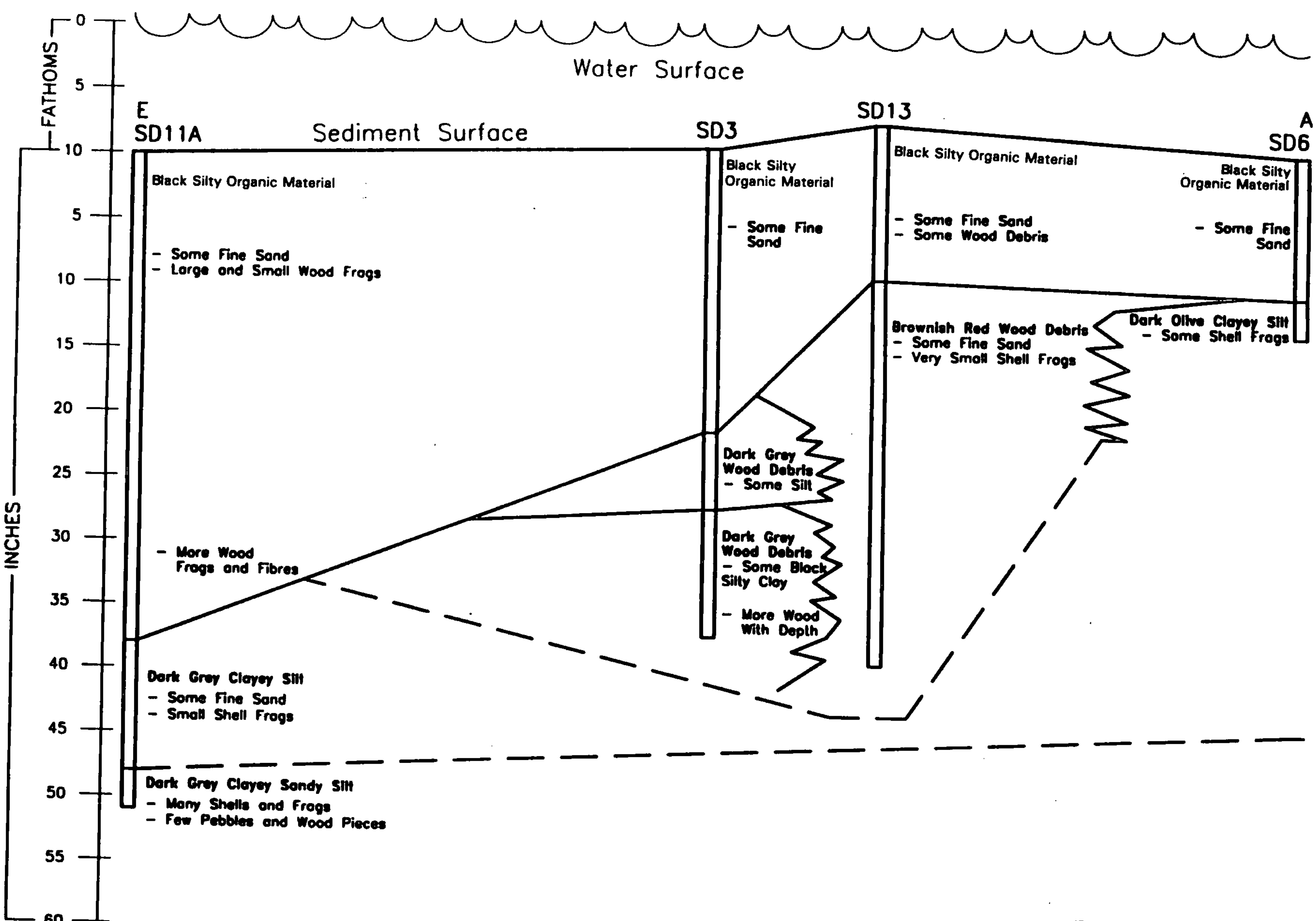
FIGURE 5-16
WARD COVE SEDIMENT PROFILE C-E



(ENSR 1996, as modified by PTI)

KP042502 January 10, 1996

FIGURE 5-17
WARD COVE SEDIMENT PROFILE E-A



(ENSR 1996, as modified by PTI)

KP042503 January 10, 1996

Appendix F

Appendix F

Final Natural Recovery Modeling of Ward Cove Sediments

NOTE:

The sediment quality values used for modeling purposes are as follows:

- **Total Organic Carbon**—0.30 and 0.31 kg/kg
- **4-Methylphenol**—670 μg/kg
- **Ammonia**—88 and 99 mg/kg.

These values are generally lower than the site-specific sediment quality values developed in Section 7 and thus provide a protective indication (i.e., overestimate) of the natural recovery time frame. During review of the agency draft of this report, the development of a sediment quality value for sulfide was determined to be of limited value because the sulfide was measured as total sulfide in sediment but the toxicity data inferred that dissolved sulfide was the causative agent. For the purpose of the modeling presented here, a total sulfide value of 4,300 mg/kg was used to estimate natural recovery rates for sulfide.

Ketchikan Pulp Co.
Ward Cove, Alaska

Exponent
Environmental Group

FINAL
Natural Recovery Modeling of Ward Cove Sediments

June 1998

ENSR Document Number 5543-007-700a

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TABLES

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FIGURES

APPENDIX

1.0 INTRODUCTION

1.1 Background

Since 1954, Ketchikan Pulp Company (KPC) has operated a dissolving grade sulfite pulp mill located on the northern shore of Ward Cove in Ketchikan, Alaska. An average of 30 to 40 million gallons per day (MGD) of wastewater produced during mill operations was discharged to Ward Cove through three outfalls located along the north shore.

Water column data collected by KPC in Ward Cove as part of their NPDES monitoring program showed that the dissolved oxygen (DO) concentrations periodically dropped below the State of Alaska standards during the critical low flow summer months. Studies by State of Alaska officials indicated reduced DO in the receiving water column and the high organic content in the Ward Cove sediments were potential causes for the declining marine environment (USGS 1992).

In September 1995, KPC entered into a consent decree with the U.S. Environmental Protection Agency (EPA) to address environmental problems related to KPC's facility. Although KPC ceased its paper pulp operations and shut down the mill in 1997, KPC agreed to address the contaminated sediments in the cove as part of the consent decree. Major phases of the project include developing a technical studies work plan, implementing technical studies, preparing a remedial action plan, and implementing remedial actions.

The *Ward Cove Sediment Remediation Project Technical Studies: Phase 1 Results and Phase 2 Study Design* (PTI 1996a), prepared as a part of the remediation project, provided an identification of several contaminants of potential concern (CoPCs). The CoPCs included the metals cadmium, mercury, zinc, and the organic compounds phenol, 4-methylphenol, dioxins, and furans. For conventional variables, the CoPCs included total organic carbon (TOC), total sulfide, ammonia, biochemical oxygen demand (BOD), and chemical oxygen demand (COD). This list was then re-evaluated based on sediment toxicity concerns. Those CoPCs causing potential ecological and human health risks included polynuclear aromatic hydrocarbons (PAHs), arsenic, and methylmercury.

In Phase 1 of the remediation project, Ward Cove sediment samples were collected and analyzed from 28 stations. Except zinc, all CoPCs exceeded either existing Washington State Sediment Quality Standards (SQS) or Ward Cove Sediment Quality Values (WCSQVs) developed specifically for this project (PTI 1996a). However, after evaluation of human health and ecological impacts, a smaller set of CoPCs were identified. These include TOC, ammonia, sulfide, BOD, COD, and 4-methylphenol (PTI March 1997b). On the basis of exceedances of SQS and sediment toxicity tests, areas of focus (AOF) were identified and delineated. These AOFs are considered sufficiently affected by elevated concentrations of CoPCs or toxicity to warrant further evaluation for cleanup activities.

One of the activities of Phase 2 of the project involves analysis of natural recovery of Ward Cove sediments (PTI 1997a). In the absence of effluent discharge from KPC, and gradual phasing out of the log-raft and log transfer facilities, loading of CoPCs to Ward Cove is expected to stop. Further, concentrations of CoPCs in the sediments are expected to decrease. With the help of natural processes such as 1) burial by deposition of clean sediments, 2) mixing of contaminated sediments with newly deposited clean sediments by burrowing benthic organisms or currents, and 3) chemical or biological degradation.

This report describes development of screening level and three dimensional (3-D) models of the fate and transport processes occurring in Ward Cove. The 3-D modeling accounts for tide-induced circulation and transport within Ward Cove, effluent loading to Ward Cove, sedimentation of the discharged solids, solids decay, and toxics fate kinetics. The report also describes the setup and calibration of the models and their use for computing the time required for natural recovery following mill shutdown.

1.2 Objective

The overall objective of this study is to develop a 3-D model of Ward Cove, capable of conducting long term simulation of fate and transport of CoPCs in sediments and the water column through processes such as burial, degradation, biotransformation, transport across the sediment water interface, sorption/desorption, and tidal hydrodynamic flushing. The objective is to use the model to predict future CoPCs concentrations in the sediments to provide input for development of cleanup levels and sediment removal/capping alternatives.

Specific objectives of this study are as follows.

- Setup a screening level 0-D box model of Ward Cove (Tier-1). This model will support finalizing of loading rates, formulation of fate and transport mechanisms for the CoPCs, and development of reaction rates, as well as provide an estimate of the overall natural recovery period.

- Setup and calibrate a 3-D hydrodynamic model of Ward Cove (Tier-2). The model will simulate tide induced circulation in Ward Cove, accounting for the surface brackish layer and lateral variation in currents due to bathymetric changes, and the influence of Ward Creek along the southeast bank.

- Setup a sediment processes model to simulate organic particulate matter discharged by the mill, its deposition, diagenesis, and resulting fluxes of selected CoPCs.

- Setup a 3-D toxics kinetics model (Tier-2) to simulate the fate and transport of the organic and inorganic CoPCs, taking into consideration processes such as sedimentation, burial, partitioning into particulate and dissolved components, decay, and biodegradation.

- Estimate the natural recovery periods for the CoPCs using the developed 3-D model.

2.0 SCREENING LEVEL BOX MODEL OF WARD COVE (TIER-1)

To develop an understanding of the processes occurring in Ward Cove and help formulate the overall framework for the application of a 3-D model, a screening level model of Ward Cove was first set up. The model used was TOXI5, which is the toxics modeling component of the EPA's WASP5 model (Ambrose *et al.* 1993). The primary focus of this analysis was the simulation of sediment and toxics kinetics for a steady state hydrodynamic condition. The screening level model allowed efficient calibration of model reaction rate constants and formulation of fate and transport mechanisms for the CoPCs. The calibrated Tier-1 model also provided a first approximation of the overall natural recovery period for each CoPC.

2.1 Conceptual Model of Ward Cove

Ward Cove is a small estuary located about 8 km north of Ketchikan, Alaska, in a fjordal setting on the Tongass Narrows waterbody. Like most fjordal systems, Ward Cove is a narrow estuary with a width of 0.8 km, a length of 1.6 km, and steep slopes. Ward Creek, which enters Ward Cove at its head, is the primary source of fresh water. The average depth of Ward Cove is about 30 meters. Although Ward Cove does not have a distinct sill common to most fjords in the region, the observed circulation and stratification shows distinct characteristics of fjordal circulation. Fresh water input from Ward Creek, KPC's effluent, and precipitation results in a brackish upper layer which extends to a depth of 5 meters. A two-layer vertical circulation pattern forms where net transport of brackish water out of Ward Cove occurs in the upper layer and saline water enters Ward Cove through the lower layer.

KPC's effluent was discharged at the surface, and mostly remained trapped in the upper layer above the pycnocline, where it was transported out during the ebb tide. The solids that entered Ward Cove through the effluent remained in the upper layer during the process of initial dilution. As the effluent plume began its far-field transport towards Tongass Narrows, the effluent particles settled out of the plume and reached the sediments of Ward Cove.

The inorganic and organic toxics and other CoPCs accumulated in the sediments through several different mechanisms. Conventional CoPCs, such as TOC, accumulated in the sediment through pure settling of the discharged organic particles. CoPCs such as ammonia, sulfide, and COD were the result of decomposition of the settled organic matter. Inorganic and organic toxics such as metals and hydrocarbons had a tendency to adsorb to organic particles and were carried to the bed sediments through the settling of suspended solids.

The conceptual model of Ward Cove consists of the following:

- A two-layer vertical circulation system
- Fresh water inflow from Ward Creek

- Effluent flow loading in the upper layer
- Effluent sediment and CoPC loading in the upper layer
- Transport of CoPCs to the bed sediments through settling of organic particles
- Transport of CoPCs to the bed sediments through diffusion
- Production of some CoPCs in the sediments through decay of organic matter
- Transport of CoPCs out of bed sediments through diffusion

Figure 2-1 shows a schematic representation of the conceptual model of Ward Cove, which also forms the basis for setting up the configuration of the 0-D box model of WASP5.

The following subsections summarize the information used for setting up the numerical models.

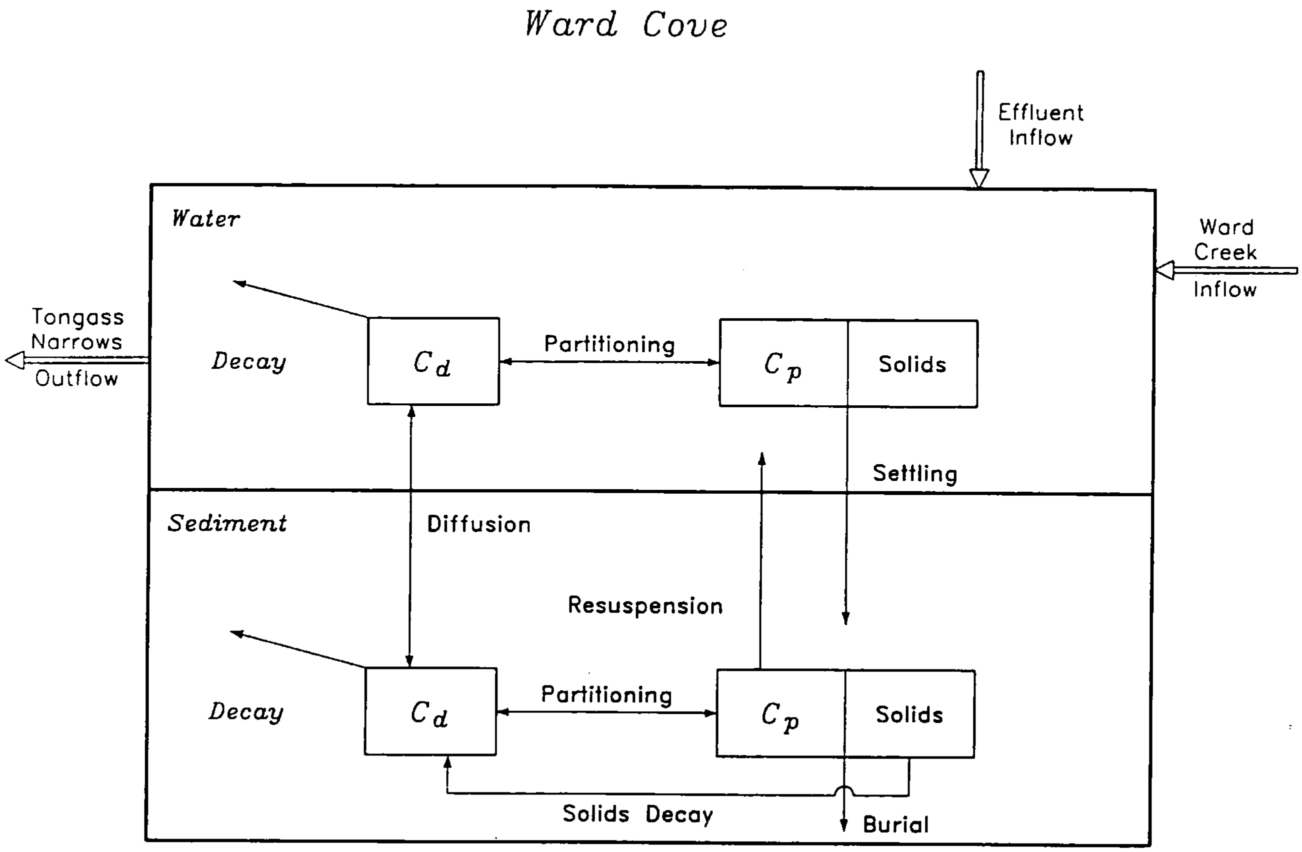
2.2 Box Model Setup and Configuration for WASP5

2.2.1 Model Inputs

Setup of a coupled hydrodynamic and toxics fate and transport model requires specification of the model geometry, boundary conditions such as currents or elevation, water depths, volumes, and effluent loading information. Oceanographic and sediment data were collected specifically to provide the required information for modeling (Nielsen 1997). Other required data for model input were derived from many different sources: AWPCB (1957), FWQA (1970), USACE (1971), Higgins and Amoth (1995), Jones and Stokes (1989), ENSR (1996b), Thibodeaux (1996), PTI (1997a), and NIH (1997). Effluent loading data were also obtained from historical records of KPC's discharge monitoring reports (DMRs).

Model inputs included effluent flow rates from KPC, inflow from Ward Creek, and outflow from Ward Cove. The model also required the effluent concentrations of CoPCs and settleable solids discharged from KPC and the discharge concentrations of native solids from Ward Creek. Sediment concentrations of CoPCs were also needed to calibrate the model. Because the distribution and deposition of solids is the primary mechanism controlling CoPCs in sediments, the settling characteristics of discharged solids and the sediment density were also needed for model input. The model inputs developed for the Tier-1 box model are described below.

<u>Flows</u>: Flows for the screening model were calculated from the recently collected velocity data for Ward Cove (Orders Assoc. 1997). A flow plane was imposed across the width of Ward Cove, and normal (perpendicular) velocities were computed from the observed direction and magnitude data for



C_d = Dissolved Concentration

C_p = Particulate Concentration

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FIGURE 2-1

CONCEPTUAL MODEL OF WARD COVE

Exponent Environmental Group

Bellevue, Washington

DRAWN: K. Mongar	DATE: May 26, 1998	PROJECT NO:
FILE NO: EEG0780S	CHECKED: T. Khangaonkar	5543-007-800

stations C and D (Figure 2-2). The velocity data were collected at a depth below the upper brackish layer and are not fully representative of the surface layer. An average normal velocity for the lower layer was computed for the observation period (33 days), which was multiplied by the layer's cross-section in the vertical plane to give inflow and outflow. The inflow for the lower hydrodynamic layer was found to be 1.0 m^3/s. The inflow also moves vertically into the upper layer through mass conservation. The upper layer outflow is the sum of Ward Creek, KPC effluent, and lower layer inflows. The setup of flows in this manner is representative of a typical fjord circulation.

Sediment Concentration of CoPCs: Chemical data for sediment CoPCs collected in Summer 1997 (Nielsen 1997) were averaged, because the screening model encompasses the entire surface area of Ward Cove. Area weighted averages were computed to account for non-uniform distributions of sampling locations. These values are listed in Table 2-1.

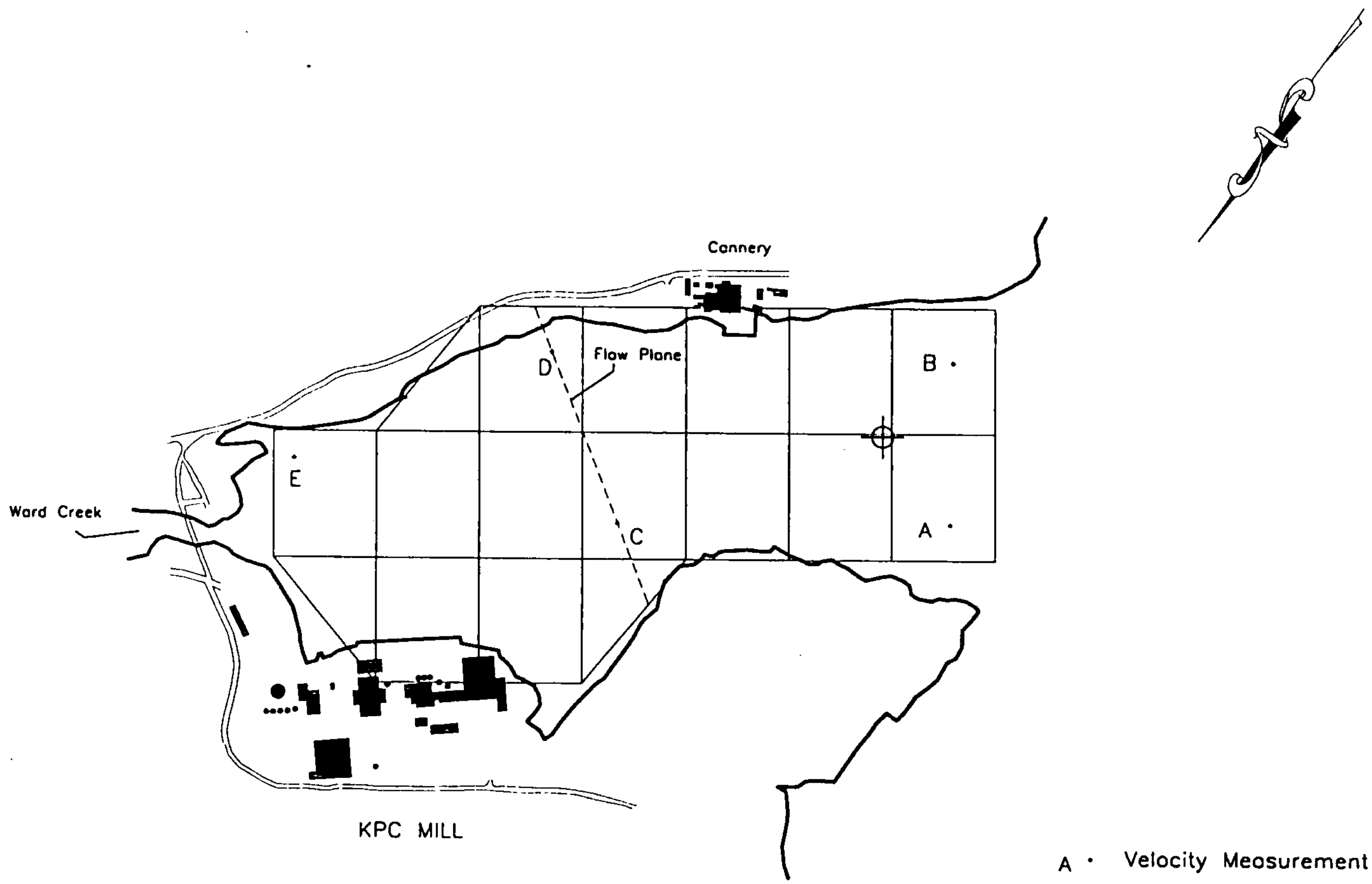
Table 2-1

Area-Weighted Sediment Concentrations of CoPCs for Ward Cove (1997 Sample Data, top 10 cm)

CoPCs	Area Weighted Concentration	SQS† or WCSQV
4-methylphenol	2,650 µg/kg	670 µg/kg†
TOC	0.106 kg/kg	30% [1] 31% [2]
NH_3	122 mg/kg	88 mg/kg [1] 99 mg/kg [2]
COD	9,850 mg/kg	550 g/kg [1] 620 g/kg [2]
BOD	-	10 g/kg [1] 11 g/kg [2]
Sulfide	3,523 mg/kg	4,300 mg/kg [1] 5,500 mg/kg [2]

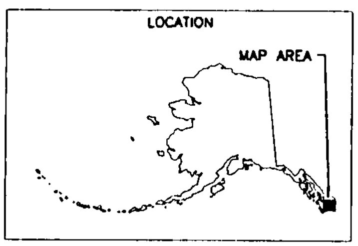
† Sediment quality standard (SQS)
1 Ward Cove sediment quality value - type 1
2 Ward Cove sediment quality value - type 2

Discharge of Solids and CoPCs: Effluent discharge data were summarized from various historical reports and discharge permits; these are included in Table 2-2. The total suspended solids (TSS) data reflect pulp production at the mill and timing of effluent treatment. For example, primary treatment was installed in 1971, resulting in a large drop in TSS. Time series data of effluent constituents such as 4-methylphenol and ammonia concentrations were not available, so constant values were used over the entire simulation period.



A · Velocity Measurement Location

⌖ Cs and Pb Core Location



Note: Data collected by Orders Associates, (1997).

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FIGURE 2-2

VELOCITY PROFILE AND SEDIMENT DEPOSITION MONITORING LOCATIONS

Exponent Environmental Group
Bellevue, Washington

DRAWN: wb/km	DATE: May 26, 1998	PROJECT NO:
FILE NO: VELLOCS1	CHECKED:T. Khangaonkar	5543-007-800

Table 2-2
KPC Effluent Discharge Data Used in TOXI5 Screening Model for Ward Cove

Effluent Discharge Constituents	Value	Source
TSS (mg/L)	265 (1955-1971)[†] 40 (1971-1980) 56 (1980-1988) 82 (1988-1996)	Higgins and Amoth (1995)
Flow (mgd)	45.4 (1955-1971) 38.8 (1971-1980) 38.8 (1980-1988) 35.2 (1988-1996)	AWPCB (1957) FWQA (1970) Jones and Stokes (1989)
Organic content (%)	31	ENSR (1996b)
4-methylphenol (mg/L)	0.114 (51)[‡]	1989 effluent scan
Ammonia (mg N/L)	1-2	USACE (1971)

† **Values in parentheses indicate the years over which the value was applied.**
‡ **Lower value is for 4-methylphenol while the larger is for total phenols.**

Solids Settling Rates and Sediment Density: Effluent solids deposition rates and settling velocities have been previously measured (ENSR 1996b). A mass weighted average deposition rate of 0.0074 cm/s (6.4 m/day) was computed based on these data. It was assumed that this rate applied for the entire simulation period.

Sediment Density: Effluent solids specific gravity has been measured at 1.27 (ENSR 1996b). This is used for computation of dry weight solids density. Using an average sediment total solids content of 19.2 percent, and average total volatile solids (TVS) content of 40.7 percent (PTI 1997a), and assuming a specific gravity of 2.65 for other solids, an overall particle density of 2,088 kg/m^3 and a bulk density of 1,111 kg/m^3 were obtained. These data result in a dry weight density for sediment of 220 kg/m^3; this value was one of the inputs to the model. Note that the TVS content in the sediment was assumed to be derived entirely from effluent solids, using their corresponding specific gravity.

2.2.2 Model Geometry

In plan view, the screening model encompasses all of Ward Cove. The model splits the water column vertically into two segments, to provide the hydrodynamic layering typically found in fjords. A small initial mixing segment was used to receive and distribute the effluent discharge from KPC to the upper water column segment. Sediment segment splitting was also done to improve chemical distribution resolution during calibration.

Recently collected bathymetric data (Nielsen 1997) were used to compute necessary geometric model inputs: TOXI5 segment volumes, depths, and areas. The projected area was 998,836 m^2. The volume of the upper water column layer was 23,697,000 m^3, while the lower volume is 6,387,000 m^3. These numbers were based on layer thicknesses of 26 m and 14 m, respectively. The volume of the initial mixing segment for the KPC discharge was 1,200 m^3.

Sediment layers were split vertically into 12 segments, with 2 cm thick layers in the first 20 cm (each with a volume of 19,977 m^3), 8 cm for the next layer (volume of 799,070 m^3), and 1 m for the final layer (volume of 988,360 m^3). Figure 2-3 illustrates the screening level model structure.

2.3 Screening Level Model Calibration

Model calibration was conducted in a series of steps. First, using the effluent solids loading information, the model was calibrated to match the observed overall sediment accumulation rate in Ward Cove. This provided the equivalent organic sediment decay rate for Ward Cove. Using the decay rate, the model was calibrated to match the observed sediment CoPC concentrations by adjusting the yield coefficients for *in situ* production of each CoPC due to organic matter decomposition.

2.3.1 Sediment Accumulation

Because solids loading from KPC is the primary factor in the accumulation of CoPCs, the Tier-1 model was first calibrated to reliably predict the sediment accumulation in Ward Cove. The actual solids accumulation rate in Ward Cove was estimated using cesium-137 and excess lead-210 deposition data from one sampling location (Figure 2-2). Only one sample site had reliable sediment accumulation data, and it was located at the mouth of Ward Cove. Although, this site may not accurately reflect accumulation near KPC's discharge, the data were used as lower end estimate for the screening level model application. The lead-210 data indicate that the net sediment accumulation rate was approximately 0.33 cm/yr at this location, although the cesium 137 data indicate a range of 0.21 to 0.71 cm/yr, the latter rate considered fairly uncertain (Nielsen 1997).

TOXI5 in its original form was inadequate for solving the sediment accumulation problem encountered at Ward Cove, because the model was not designed for decade-long simulations. The variable volume procedure in TOXI5 squeezes the pore water back into the overlying water column during compaction, and its fixed volume procedure increases the solids density over time. Also, no solids decay is allowed even for particles with a high organic fraction. Modifications to TOXI5 were made to eliminate these concerns. A "flow through," constant thickness sediment procedure was implemented, which fixes the upper sediment segment boundary to the surface, and holds the total sediment thickness to a constant value. This approach results in a velocity through the simulated segments proportional to the solids

Ward Cove Screening Level Model Configuration

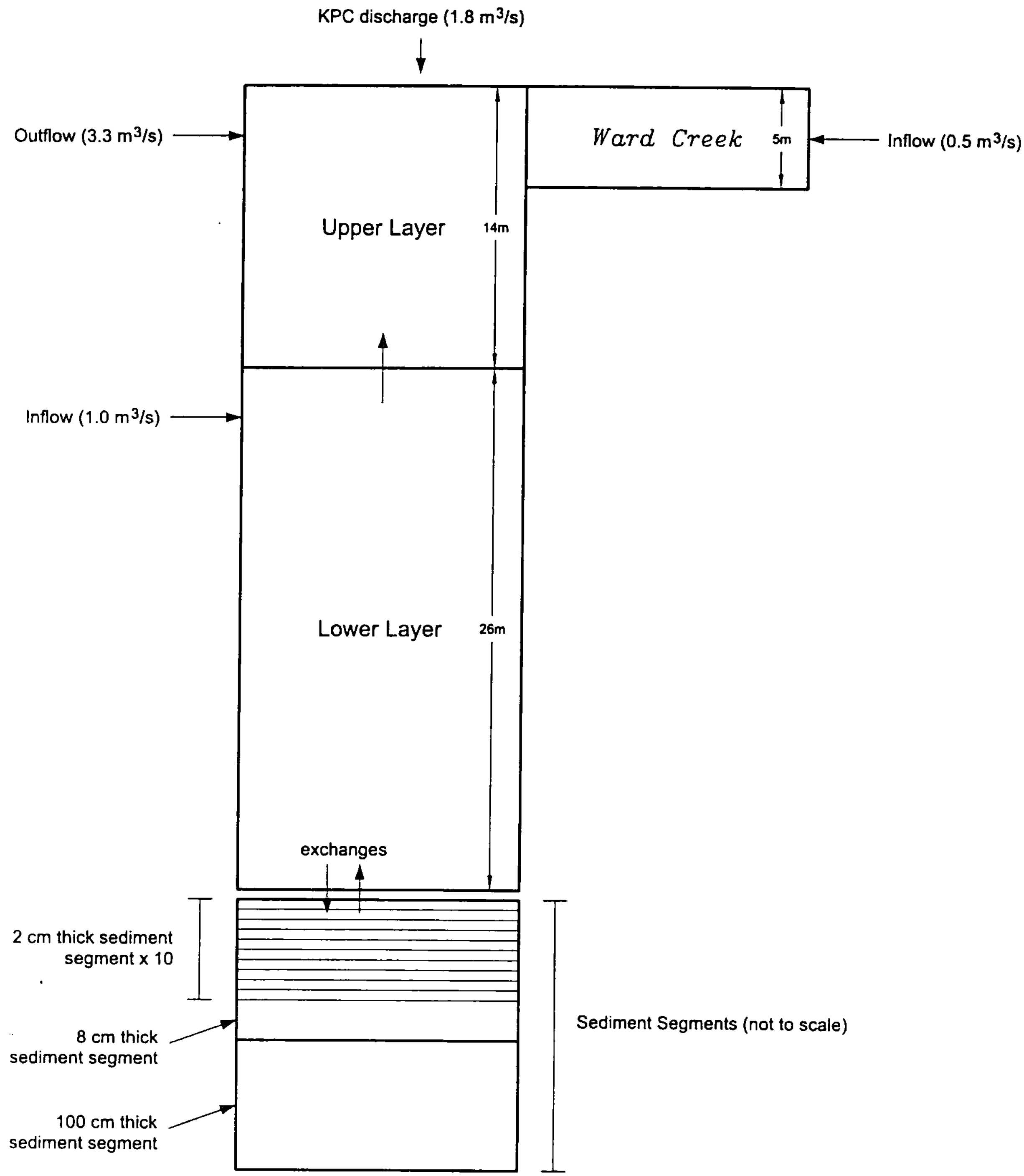

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FIGURE 2-3
WASP5 SCREENING LEVEL MODEL CONFIGURATION FOR WARD COVE
Exponent Environmental Group
Bellevue, Washington

DRAWN: K. Mongor	DATE: June 2, 1998	PROJECT NO:
FILE NO: EEG0780T	CHECKED: T. Khangaonkar	5543-007-800

settling rate and water column concentration. Decay of organic solids was also added. Because mass continuity is required, this results in flux through the sediment that is proportional to the sediment depth, organic solids concentration, and decay rate. These modifications are discussed in detail in the Appendix.

The model was discretized to provide relatively high resolution within the sediment layers to resolve the movement of a tracer that is highly bound to sediment particles. The tracer simulates radioactive cesium generated by atmospheric nuclear tests in the 1950s and early 1960s. Model runs were made with two solids, one representing KPC effluent solids, which decay, and another representing native material.

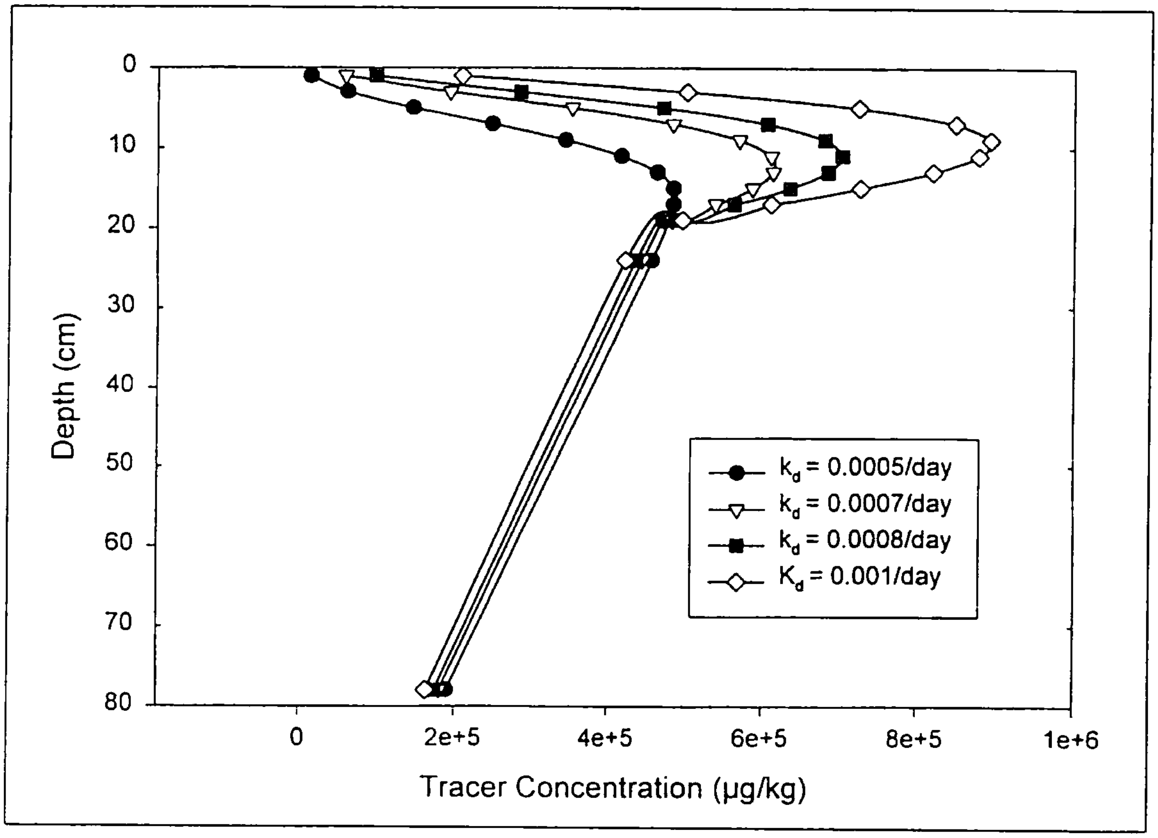
Model simulations began in 1954 and continued through 1997 for calibration (43 years of simulation). A pulse of tracer was applied in 1963 for a 1-year period, and the tracer pulse was followed through the sediment up to 1997. Adjustments to the organic decay rate were made until the peak tracer concentration indicated a net accumulation rate of approximately 0.33 cm/yr. An organic decay rate of 0.0008/day was obtained using this method (Figure 2-4).

2.3.2 Total Organic Carbon

With the organic solids decay rate defined, the next important constituent was TOC, because its level affects CoPCs by binding the constituent (i.e., 4-methylphenol) or serving as the primary source of CoPCs generated during degradation of organic matter (i.e., ammonia, 4-methylphenol, sulfide). The data used for TOC calibration included measured KPC effluent solids with an organic content of 31 percent, estimates of suspended solids loading (Table 2-1), the organic decay rate determined above (0.0008/day), and the measured solids settling rate (6.4 m/day). The initial condition for the sediment at year 1954 used data for native Ward Cove solids only, with their corresponding organic fraction. As effluent solids are added to the water column, they settle out, and concentrate in the sediment. Because the two solids have different organic fractions, the total sediment TOC changes as the proportion of effluent and native solids changes. It was assumed all TOC was in the particulate form. The calibration parameter used was the native solids organic fraction, which was altered until the TOC level matched that observed in 1997 (Table 2-1) after 43 simulation years. Iterative modeling runs indicated that the native solids content would have to be set too low (< 1 percent) if the model was calibrated using an organic decay rate of 0.0008/day. To overcome this limitation, the decay rate was increased slightly to 0.0009/day. The final model calibration required a native solids organic content of 1 percent. The slightly higher decay rate of 0.0009/day used to calibrate the model gave a sediment accumulation rate of 0.29 cm/yr (Figure 2-5). The final model-predicted TOC concentration was 12.7 percent compared to the measured 1997 concentration of 10.6 percent.

2.3.3 4-Methylphenol

The sorption of 4-methylphenol to organic particulates is relatively low, with a log K_{OW} of 1.94 (NIH 1997). However, the solids concentration in sediments is very high, which allows substantial levels of



Note:
Solids decay rates were varied to determine sediment accumulation rates. Two solids were used, with settling velocities of 6.4 m/day and 20 m/day. Results for simulation day 15695, 34 years after 1963 atmospheric nuclear tests.

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FIGURE 2-4

TIER 1 MODEL – WARD COVE SEDIMENT ACCUMULATION RESULTS

Exponent Environmental Group
Bellevue, Washington

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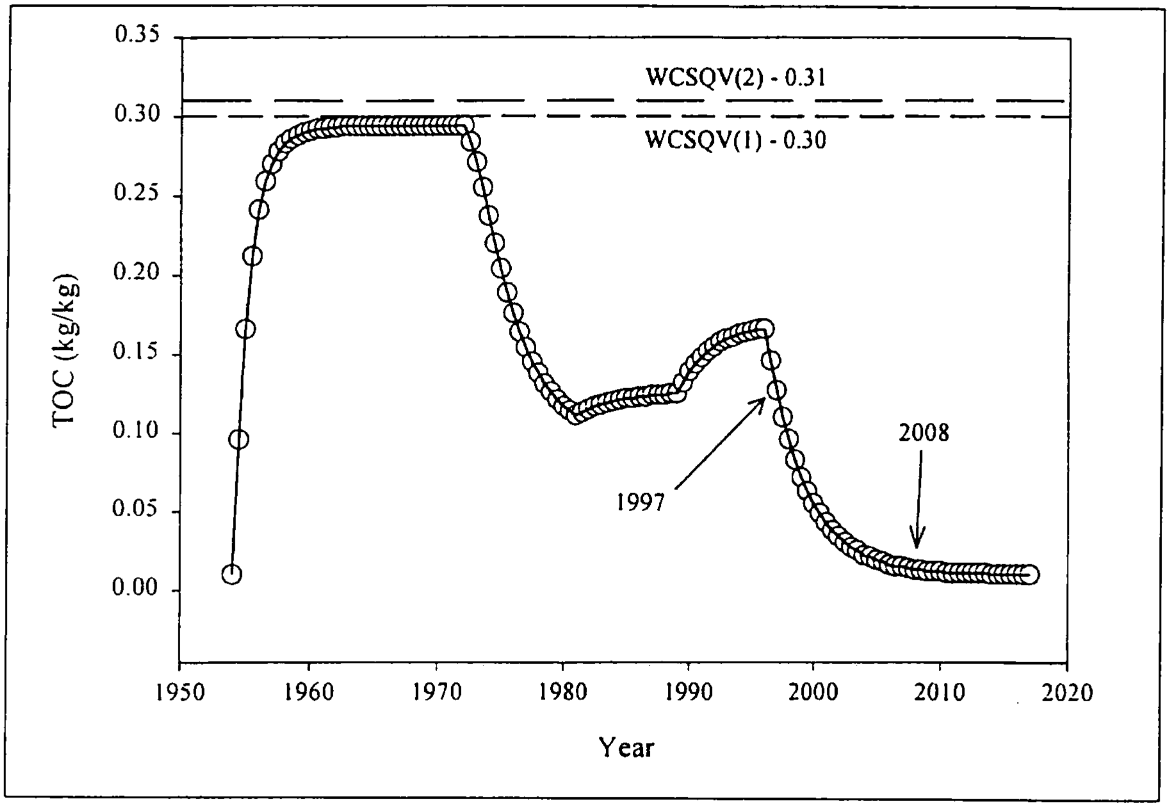
FILE NO: EEG0780N	CHECKED: S. Breithaupt	5543-007-800



Note:
TOC concentrations are for the top 10 cm of sediment with two solids used in the simulation. Also indicated are the WCSQVs, sample date (1997), and year when concentrations return to the initial condition (0.01 Kg/Kg). WCSQV = Ward Cove Sediment Quality Value.

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FIGURE 2-5

TIER 1 MODEL – PREDICTED TOC CONCENTRATIONS IN WARD COVE SEDIMENTS

Exponent Environmental Group
Bellevue, Washington

DRAWN: cd/km	DATE: May 26, 1998	PROJECT NO:
FILE NO: EEG07800	CHECKED: S. Breithaupt	5543-007-800

4-methylphenol to build over time. Additionally, 4-methylphenol can also be generated in situ through the degradation of lignin compounds (Hatcher 1988). To model the generation of 4-methylphenol in situ, TOXI5 was further modified to generate 4-methylphenol through the first-order decay of organic solids. This modification is described in more detail in the Appendix.

Model calibration was conducted using the KPC effluent 4-methylphenol concentration of 0.114 mg/L, measured in 1989, as the discharge concentration. Exchange of 4-methylphenol between the sediment and water column is assumed to be governed by its diffusivity (0.871×10^{-5} cm^2/sec) and an assumed tortuosity (1.41) (Thibodeaux 1996). The sorption of 4-methylphenol to solids was modeled using a log K_{OW} of 1.94. The 4-methylphenol was also considered to undergo aerobic decay in the water column and anaerobic decay in the sediments at 0.390 and 0.026/day, respectively (Howard et al 1991). Other input values were the same as those used and obtained through model calibration to determine TOC accumulation. A yield coefficient of 2.08×10^{-5} g 4-methylphenol/g solid resulted in a reasonable match to the area-weighted 4-methylphenol sediment concentration as measured in 1997 for the top 10 cm of sediment (Table 2-1). The model-predicted concentration was 2,672 µg/kg compared to the measured 1997 concentration of 2,650 µg/kg.

2.3.4 Ammonia

Ammonia was apparently added during the pulp waste treatment process to help break down wood fibers. The data submitted for the U.S. Army Corps of Engineer's dredging permit indicate 1 to 2 mg/L of ammonia may have been discharged (USACE 1971). When a value of 1 mg/L is used, the simulated results within the sediment for a 43-year simulation are much too small. It is assumed that decay of organic solids is the most likely source of ammonia, because some nitrogen would be present in the organic matrix of the solids. The same TOXI5 model used for generating 4-methylphenol from organic solids decay was used to generate sediment ammonia. As in the case of 4-methylphenol, the exchange of ammonia between the sediment and water column is also assumed to be governed by its diffusivity (1.76×10^{-5} cm^2/s) and an assumed tortuosity (1.41) (Thibodeaux 1996). Other input values were the same as those used and obtained through calibration for TOC accumulation. For the current situation, ammonia is assumed not to sorb to the solids but to only occur in the dissolved state. Matching the observed sediment concentration in the top 10 cm (Table 2-1) required a yield coefficient of 0.0065 g NH_3-N/g solid. The model-predicted concentration was 122.5 mg NH_3-N/kg compared to the measured 1997 concentration of 122 mg/kg.

2.3.5 Sulfide

The primary process considered was sulfide generation from sulfate reduction during anaerobic decay of sediment organic matter (Westrich and Berner 1984). Other sources of sulfate (KPC effluent and Ward Creek) were considered to be negligible. The discharge of sulfide in KPC effluent (<0.7 mg/L, ENSR September 1996) was considered to be an insignificant source of sulfide to the sediment. The relatively low concentration of sulfide in KPC effluent is rapidly oxidized to sulfate in the oxygenated surface waters of Ward Cove. TOXI5 was modified to simulate a second-order rate process governed by the diffusion of sulfate into the sediment and the decay of organic matter. This modification is described in more detail in the Appendix. The exchange of sulfide between the sediment and water column is assumed to be governed by its diffusivity (1.07×10^{-5} cm^2/sec) and an assumed tortuosity (1.41) (Thibodeaux 1996). A seawater sulfate concentration of 3,648 mg/L (p. 217, Snoeyink and Jenkins 1980) was used as the concentration of sulfate in the marine water flowing into Ward Cove. Other input values were the same as used and calibrated for TOC accumulation. For the current situation, sulfide is assumed not to sorb to the solids but to only occur in the dissolved state. Matching the observed sediment concentration in the top 10-cm (Table 2-1) required a yield coefficient of 5.4×10^{-5} g S/g solid. The model-predicted concentration was 3,551 mg/kg compared to the measured 1997 concentration of 3,523 mg/kg.

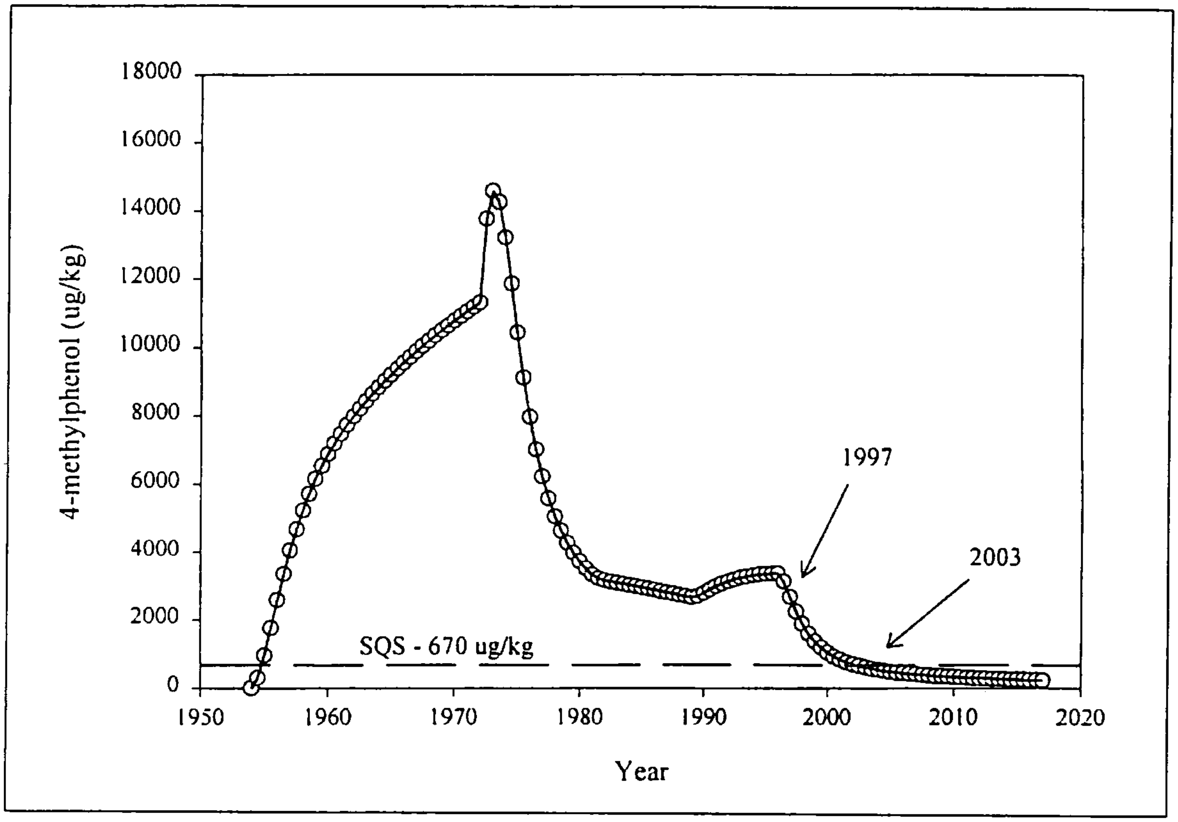
Sulfate penetrated deep into the sediment (< 1 m) with concentrations approximately one-third that of seawater. This result is consistent with published measurements of pore water sulfate in anoxic marine sediments. The model results are also consistent with the conceptual model of sulfide generation in anoxic sediments: the rate of sulfide generation is limited by the organic matter degradation rate and not by the supply of the electron acceptor sulfate (Westrich and Berner 1984).

2.4 Box Model Application

To determine sediment recovery time, that is, the time for sediment concentrations to return below sediment quality standards, model runs were conducted 20 years beyond the time when effluent discharges from KPC to Ward Cove were terminated (1996). Model run times were on the order of 20 minutes on a 200 MHz dual Pentium Pro processor computer for the 63 years of simulation with 16 segments.

The percent TOC never exceeded the Ward Cove Sediment Quality Values (WCSQVs) during the 43 years when KPC discharge was present, because the model averaged the entire surface area of Ward Cove and did not consider the local variations used to establish the sediment quality values. TOC recovery refers to the time it takes to return to the initial condition of 1 percent (Figure 2-5). This process takes 11 years in the screening level model runs. The CoPC, 4-methylphenol, takes 6 years for recovery (Figure 2-6), while ammonia requires 2 years (Figure 2-7). Because of the same model limitations noted for TOC, sulfide accumulation in sediment indicates recovery occurred in 1996 (Figure 2-8).

A significant limitation of the screening level modeling approach is its simplicity, which sacrifices the horizontal spatial resolution of the natural system and disregards important transport processes. This is especially relevant to sediment accumulation data collected at one location and applied over the entire cove. The effluent is discharged at a location over 1 km from the sampling site where the sediment accumulation rate was estimated. It is expected that solids settling occurred as the plume traveled this distance, reducing solids flux to the bed at the sampled location. Elsewhere, the solids flux would likely have been greater, especially near the discharge. The transport cannot be quantified in this screening model and requires qualification of the screening model recovery results. The implication of lower



Note:
4-Methylphenol concentrations are for the top 10 cm of sediment with two solids used in the simulation. Also indicated are the SQS, sample date (1997), and the year when concentrations return to below the SQS (2003). SQS = Sediment Quality Standards.

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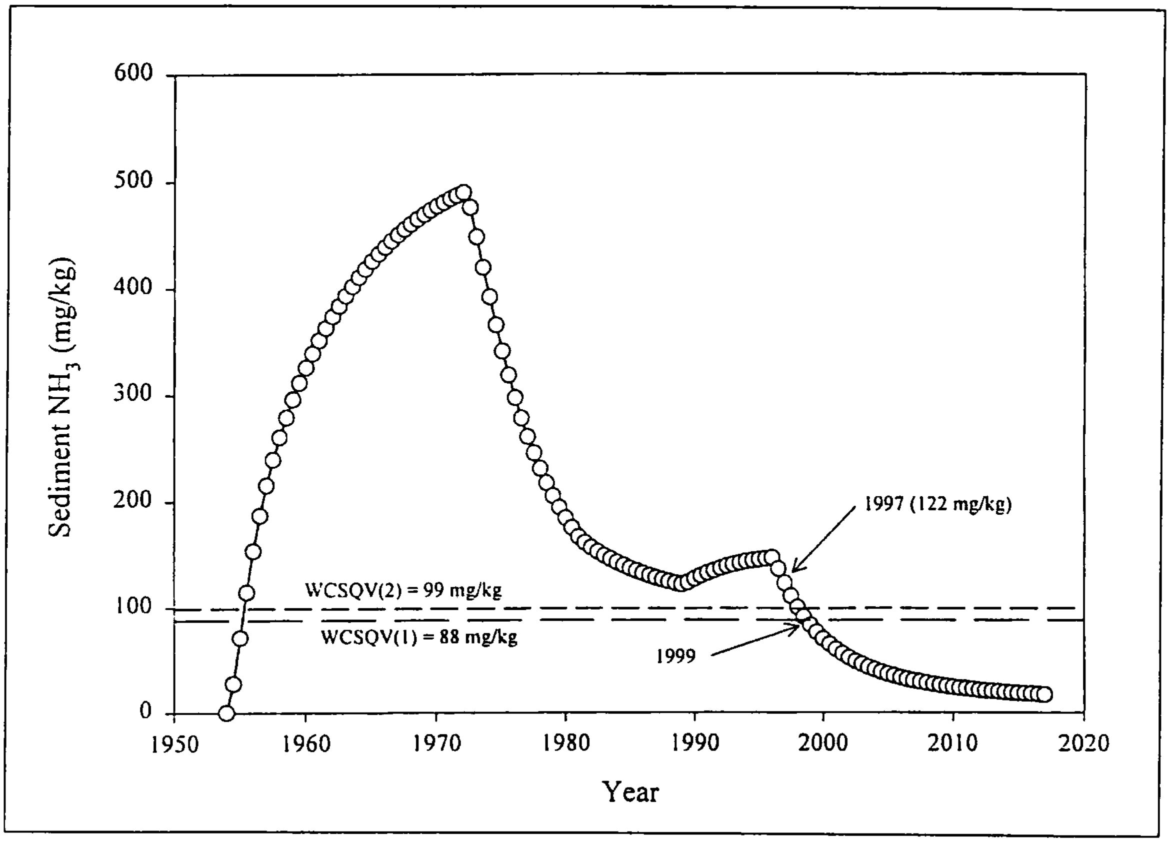
FIGURE 2-6
TIER 1 MODEL – PREDICTED 4-METHYLPHENOL CONCENTRATIONS IN WARD COVE SEDIMENTS
Exponent Environmental Group
Bellevue, Washington

DRAWN: cd/km	DATE: May 26, 1998	PROJECT NO:
FILE NO: EEG0780P	CHECKED: S. Breithaupt	5543-007-800



Note:
NH_3 concentrations are for the top 10 cm of sediment with two solids used in the simulation. Also indicated are the WCSQV (1), sample date, and the year when concentrations return to below the WCSQV (1). WCSQV = Ward Cove Sediment Quality Value.

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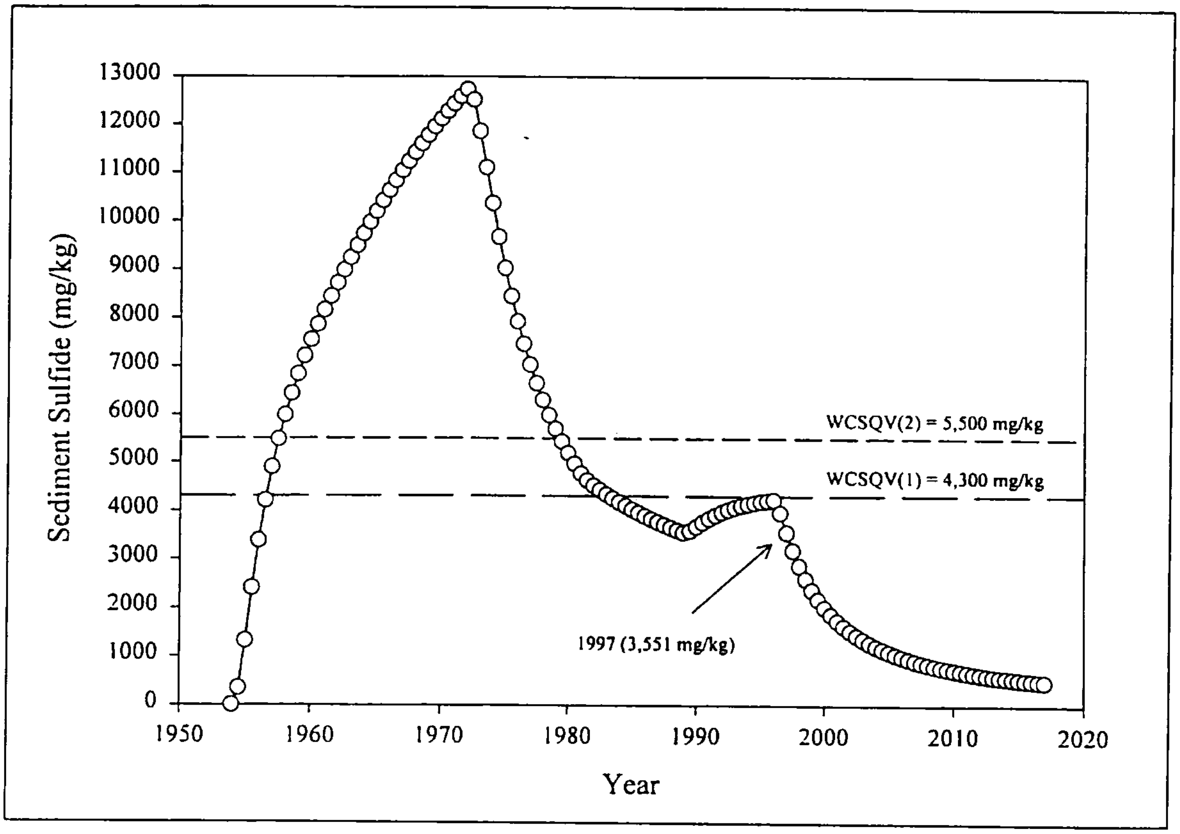
FIGURE 2-7

TIER 1 MODEL – PREDICTED AMMONIA CONCENTRATIONS IN WARD COVE SEDIMENTS

Exponent Environmental Group
Bellevue, Washington

DRAWN: cd/km	DATE: May 26, 1998	PROJECT NO:
FILE NO: EEG0780Q	CHECKED: S. Breithaupt	5543-007-800



Note:
Sulfide concentrations are for the top 10 cm of sediment with two solids used in the simulation. Also Indicated are the WCSQVs and sample date. WCSQV = Ward Cove Sediment Quality Value.

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FIGURE 2-8

TIER 1 MODEL – PREDICTED SULFIDE CONCENTRATIONS IN WARD COVE SEDIMENTS

Exponent Environmental Group
Bellevue, Washington

DRAWN: cd/km	DATE: May 26, 1998	PROJECT NO:
FILE NO: EEG0780R	CHECKED: S. Breithaupt	5543-007-800

solids flux is an overestimation of the organic decay rate, which affects the recovery results for all CoPCs. It is likely that recovery periods would be longer in localized spots in the study area than modeled by the Tier-1 screening level model. The development and application of a more detailed 3-D model which addresses many of these issues is described in the following sections.

3.0 HYDRODYNAMIC (3-D) MODEL OF WARD COVE (TIER-2)

Although the screening level model provided an efficient screening tool for evaluation of the relevant fate pathways and natural recovery periods, a fully 3-D dynamic model is needed to accurately describe the spatial details of Ward Cove and their relationship to constituent transport. The model EFDC (Environmental Fluid Dynamics Code; Hamrick 1996) was used to simulate the effects of tidal dynamics, Ward Creek inflow, and KPC discharge on circulation in Ward Cove. EFDC uses a finite volume numerical method to solve hydrodynamic equations, which creates a segment-like structure that translates well to TOXI5, thus coupling toxics fate and transport to hydrodynamics. EFDC produces a set of hydrodynamic files for input to TOXI5. With the coordinated use of these two models, fate and transport are described at a higher resolution and accuracy than with the simplified screening level model.

3.1 EFDC Model Setup

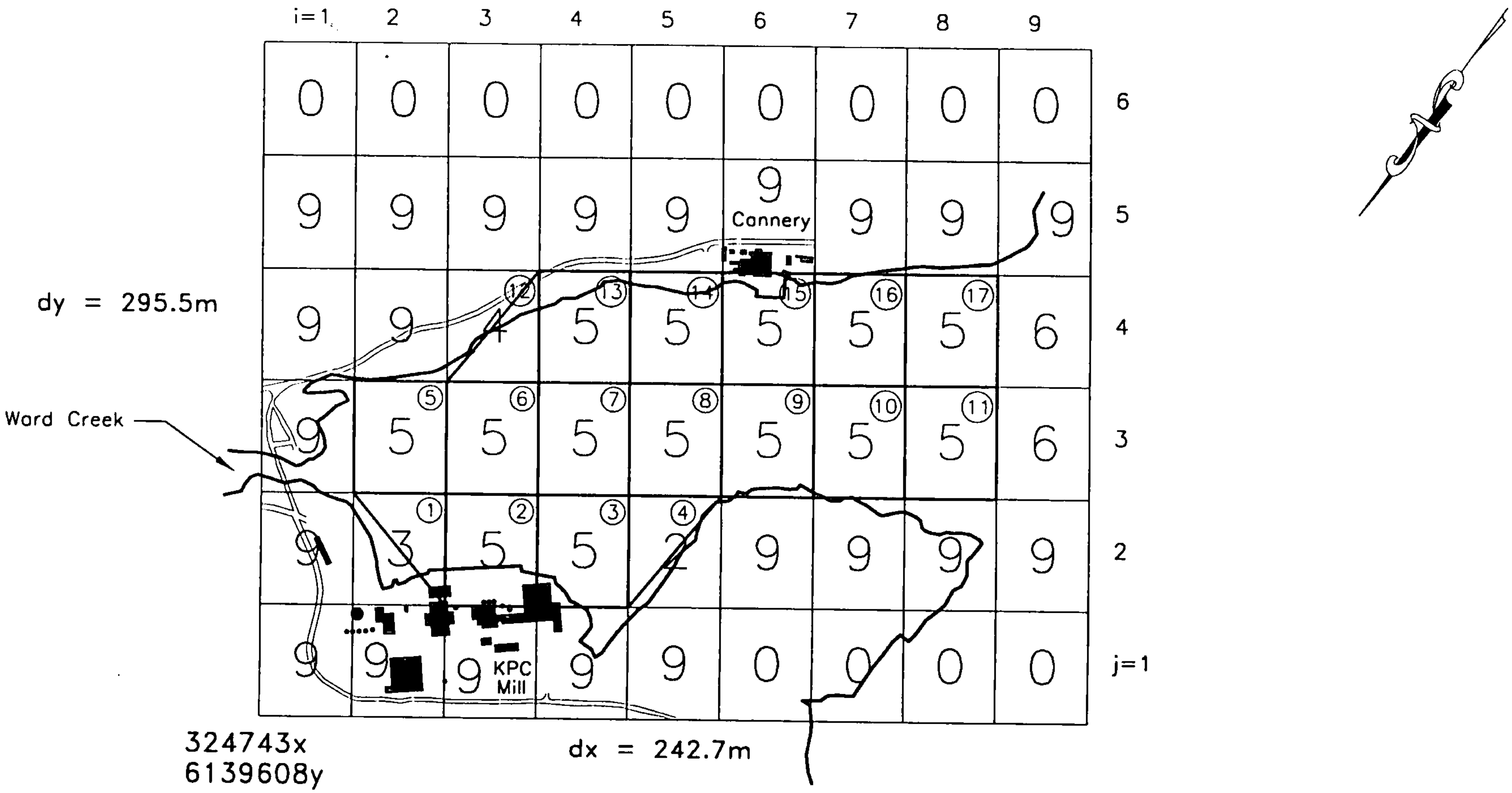
3.1.1 Geometric and Bathymetric Data

A grid representing Ward Cove was created for use by EFDC (Figure 3-1). The numbers shown in the cell centers are the cell type used by EFDC for geometry and output file generation. The numbers in the upper left of the cells are the cell indices. Three layers were specified to give vertical velocity distribution. The upper layer thickness was set at 12.5 percent of the total depth, while the thicknesses of the two deeper layers were each 43.75 percent of the total depth. A thinner surface layer was used to better simulate the velocity profile resulting from the freshwater inflows (Ward Creek and KPC discharge) into Ward Cove. The actual thickness varied with time, because a dynamic tidal boundary condition was used, causing the water surface elevation and depth to vary. Bathymetric data collected during summer 1997 (Nielsen 1997) were used to generate cell depths.

3.1.2 Model Inputs and Boundary Conditions

EFDC synthesizes the tidal boundary condition based on tidal period, tidal phase, and tidal component amplitude. Only the principal lunar component (M2) was used, with an amplitude of 2.54 meters and a period of 44,714.16 seconds. The amplitude was derived from observations in Ward Cove, Alaska.

Other inflow boundary conditions were set to constants representative of freshwater in the case of Ward Creek and the KPC discharge. These conditions were a salinity concentration of 0.05 ‰ for both, and temperature of 6°C and 15°C, respectively. The sea water conditions at the open boundary were set to 29 ‰ for salinity and 6°C for temperature. The greater buoyancy of fresh water causes a surface outflow, with a subsurface return flow.



Key:
0 Dry land cell not bordering a water cell on a side or corner
1 Tiangular water cell with land to the northeast
2 Triangular water cell with land to the southeast
3 Triangular water cell with land to the southwest
4 Triangular water cell with land to the northwest
5 Quadrilateral water cell
6 Open Boundary
9 Dry land cell bordering a water cell on a side or corner or a fictitious dry land cell bordering an open boundary water cell on a side or a corner

Note: Numbers in upper right of cells are cell indices.

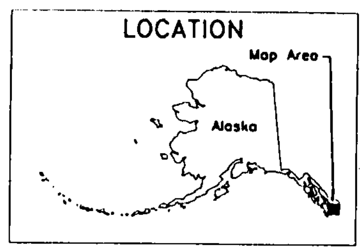


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FIGURE 3-1
PRELIMINARY COARSE GRID
EFDC – HYDRODYNAMIC MODEL
WARD COVE, KETCHIKAN, ALASKA
Exponent Environmental Group
Bellevue, Washington

DRAWN: wb/km	DATE: May 26, 1998	PROJECT NO:
FILE NO: Modgrid2	CHECKED: S. Breithaupt	5543-007-800

The bed roughness was set to 0.02 meters. Because the cove is deep at the mouth (approximately 40 meters), roughness does not have a significant effect on circulation. The model time step was set to approximately 25.8 seconds based on numerical stability considerations.

3.2 EFDC Model Calibration and Application

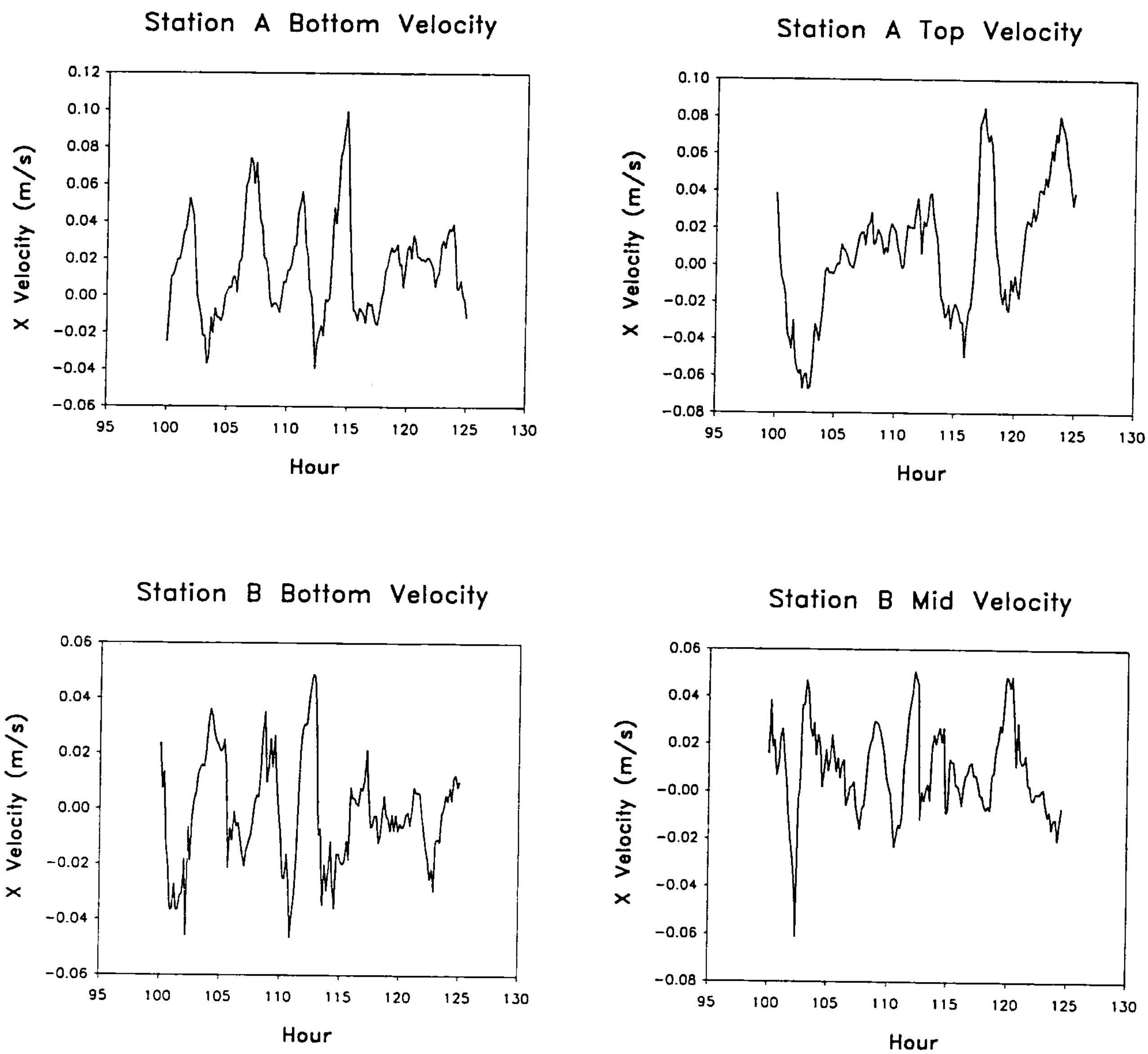
Velocity data were measured in Ward Cove during summer 1997. The velocity data are reported to be "weak and variable" (Orders Associates 1997) and show considerable scatter and noise, which is troublesome for hydrodynamic model calibration. Example velocity plots for a 25-hour period at the mouth of Ward Cove are illustrated in Figure 3-2. The velocities are small and do not show any apparent tidal periodicity. Examination of the data shows median values from 0.01 to 0.02 m/s. The peak magnitude observed was 0.28 m/s, but this was an isolated occurrence. This is indicated by the 90th percentile values ranging from 0.02 to 0.07 m/s.

Tidal data were also measured during summer 1997 (Nielsen 1997). Observations show the tidal variation ranges from 4.63 to 5.60 meters. Figure 3-3 shows the observed tide on July 24,1997, which had an intermediate amplitude of 2.53 meters, approximately the value used for EFDC input.

Because the velocity profiles did not show significant tidal trends, EFDC input was set to obtain velocity magnitudes in the observed ranges. The tidal amplitude used in the model (2.54 m) was the mean value observed. Adjusting the layer thickness, so the surface layer was 12.5 percent of the total depth, resulted in acceptable velocities which also resulted in a better simulation of a fjord type flow with surface outflow and subsurface inflow. Figures 3-4 and 3-5 show velocity vectors during the peak ebb and flood tides, respectively. The cell center velocities are shown for each of the layers.

The surface layers have the largest velocities directed toward the mouth of Ward Cove, clearly showing the effect of density stratification and the flushing of freshwater flows over the surface of the saline marine waters (Figures 3-4 and 3-5). In the subsurface layers, a circulation pattern is evident in cells near the mouth where flow enters at cell 17 and exits through cell 11. This feature occurs during both ebb and flood (Figures 3-4 and 3-5). Model sensitivity tests show that this pattern is not an artifact of model input but is likely the result of Ward Cove geometry. Sediment data support the existence of this circulation, because many sediment constituents have higher concentrations along the north shore. For settleable materials, this circulation pattern would tend to produce deposition along the north shore. Near the head of Ward Cove, circulation shows surface outflow and subsurface inflow. Particularly relevant is velocity at cell 3, which has inflow in the subsurface layers, and weak outflow at the surface. This is the cell where discharge occurs, so that any material settling out of the surface layer into the subsurface layers will be transported towards the head of Ward Cove. Material not settling out of the surface layer has the opportunity to settle along the shore as it is transported out of the cove.

Velocity time series in cells 11 and 17 are shown in Figures 3-6 and 3-7. These show the surface outflow in both cells, with subsurface inflow in cell 17 and subsurface outflow in cell 11. The tidal variations



Note:
Station locations are illustrated in Figure 2-2 (Orders Associates, 1997).

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FIGURE 3-2
OBSERVED VELOCITIES AT STATIONS A AND B IN WARD COVE
Exponent Environmental Group
Bellevue, Washington

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FILE NO: EEG0780H	CHECKED: S. Breithaupt	5543-007-800

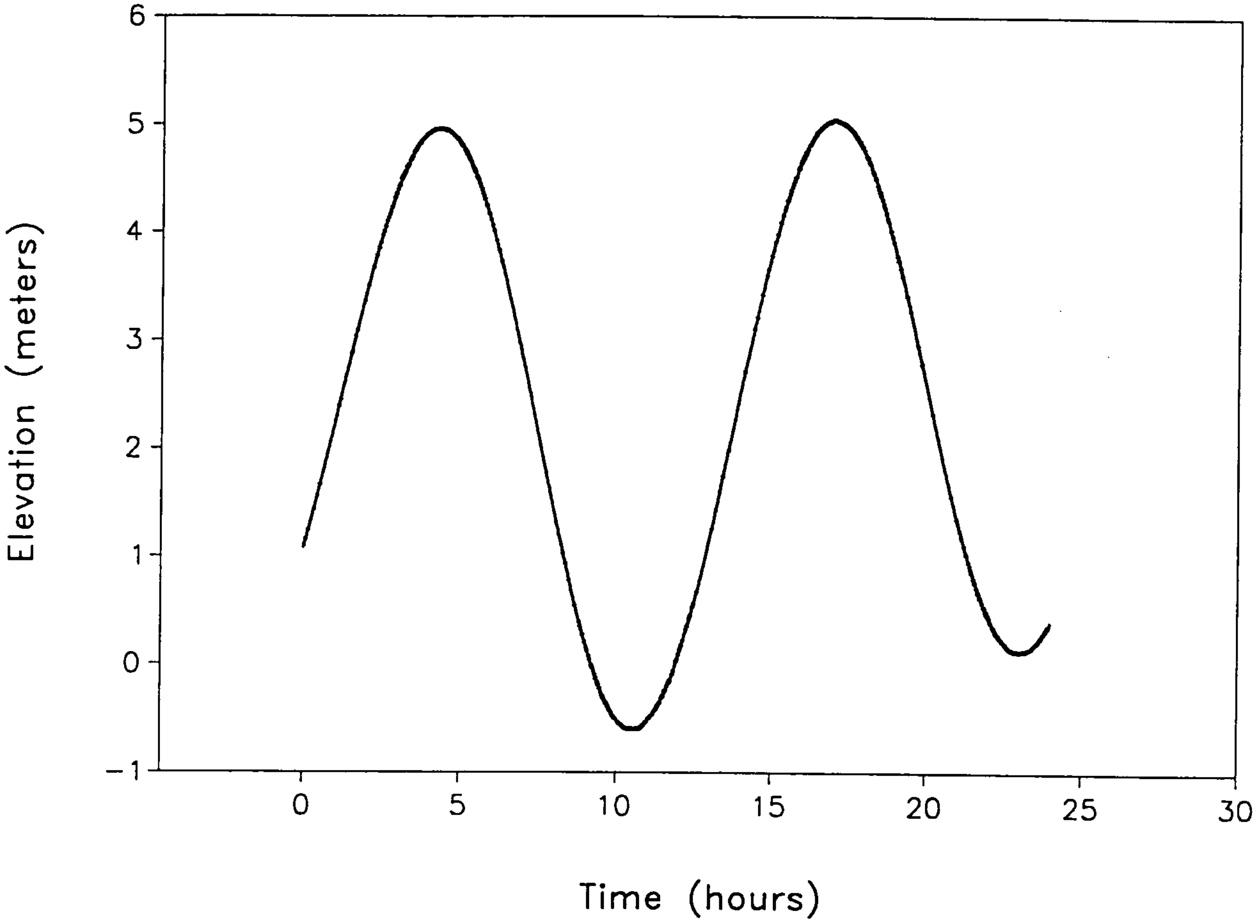

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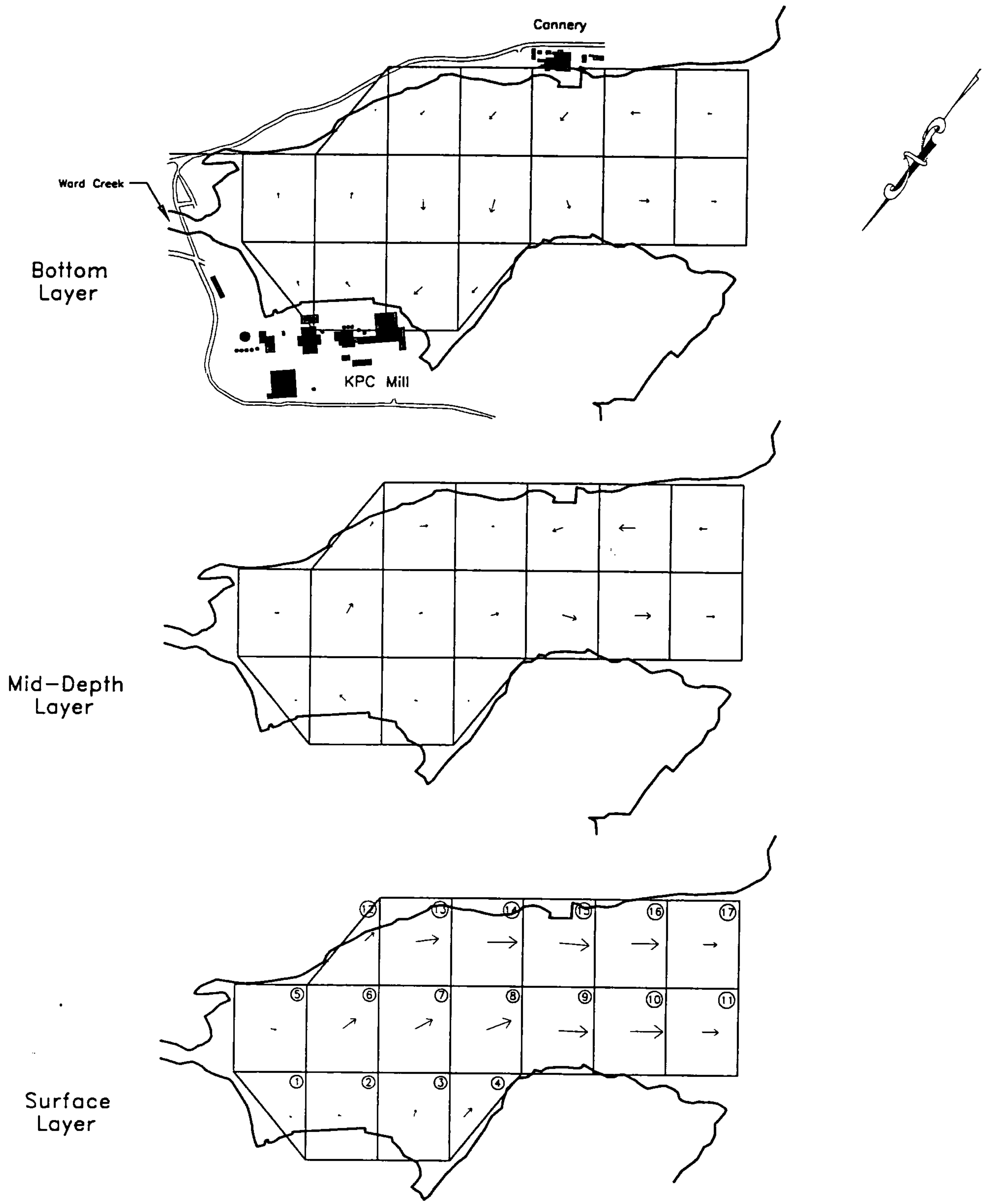
FIGURE 3–3
OBSERVED TIDE IN WARD COVE
JULY 24, 1997

Exponent Environmental Group
Bellevue, Washington

DRAWN: sb/km	DATE: May 26, 1998	PROJECT NO:
FILE NO: EEG0780D	CHECKED: S. Breithaupt	5543-007-800



Scale: ← 0.05 m/s

Note: Numbers in upper right of cell are cell indices.

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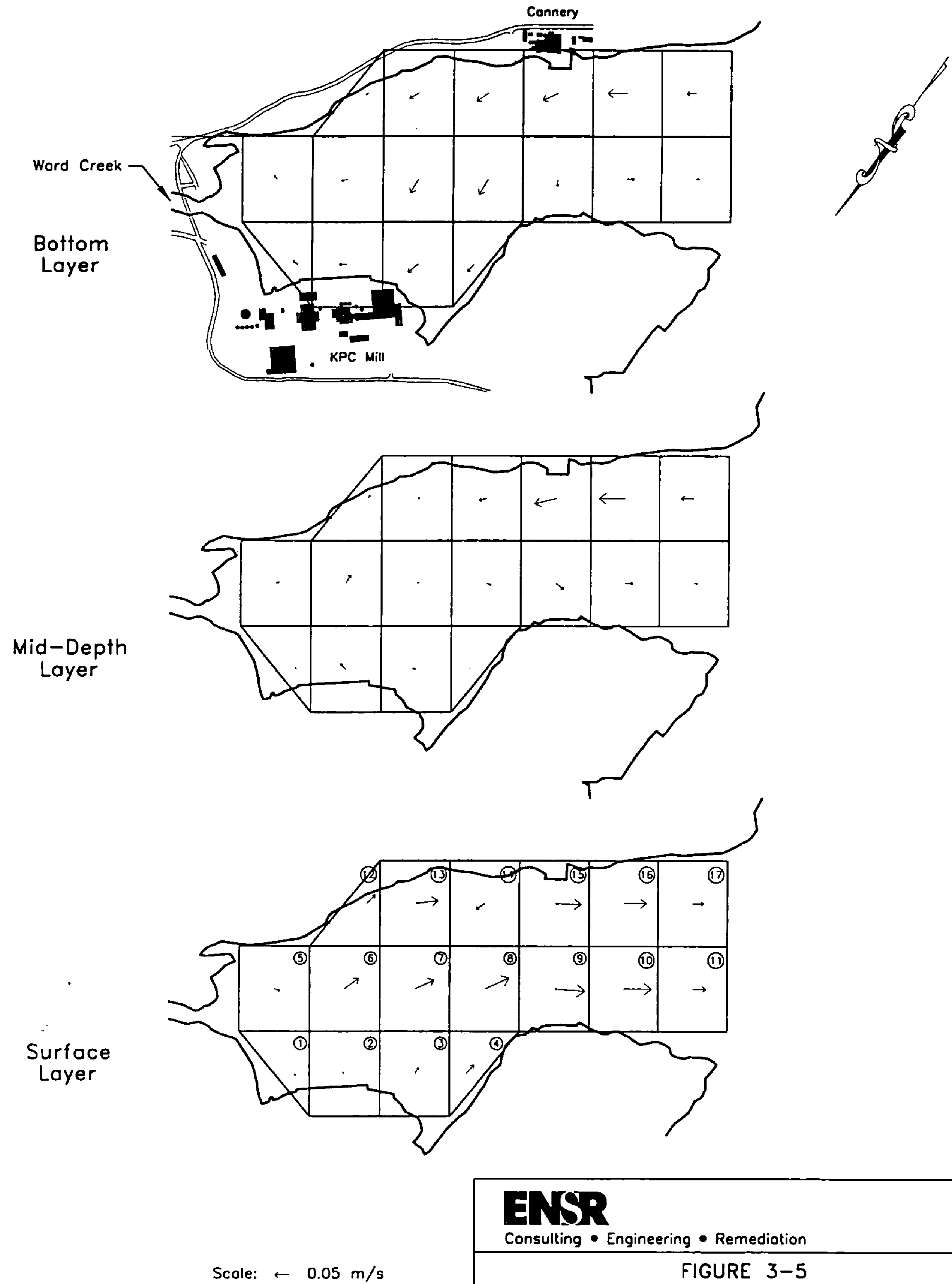
FIGURE 3-4
EBB TIDE VELOCITY VECTORS
PREDICTED BY EFDC MODEL
Exponent Environmental Group
Bellevue, Washington

DRAWN: wb/km	DATE: May 26, 1998	PROJECT NO:
FILE NO: Outflow1	CHECKED: S. Breithaupt	5543-007-800



Note: Numbers in upper right of cell are cell indices.

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FIGURE 3-5
FLOOD TIDE VELOCITY VECTORS PREDICTED BY EFDC MODEL
Exponent Environmental Group
Bellevue, Washington

DRAWN: wb/km	DATE: May 26, 1998	PROJECT NO:
FILE NO: Inflow1	CHECKED: S. Breithaupt	5543-007-800

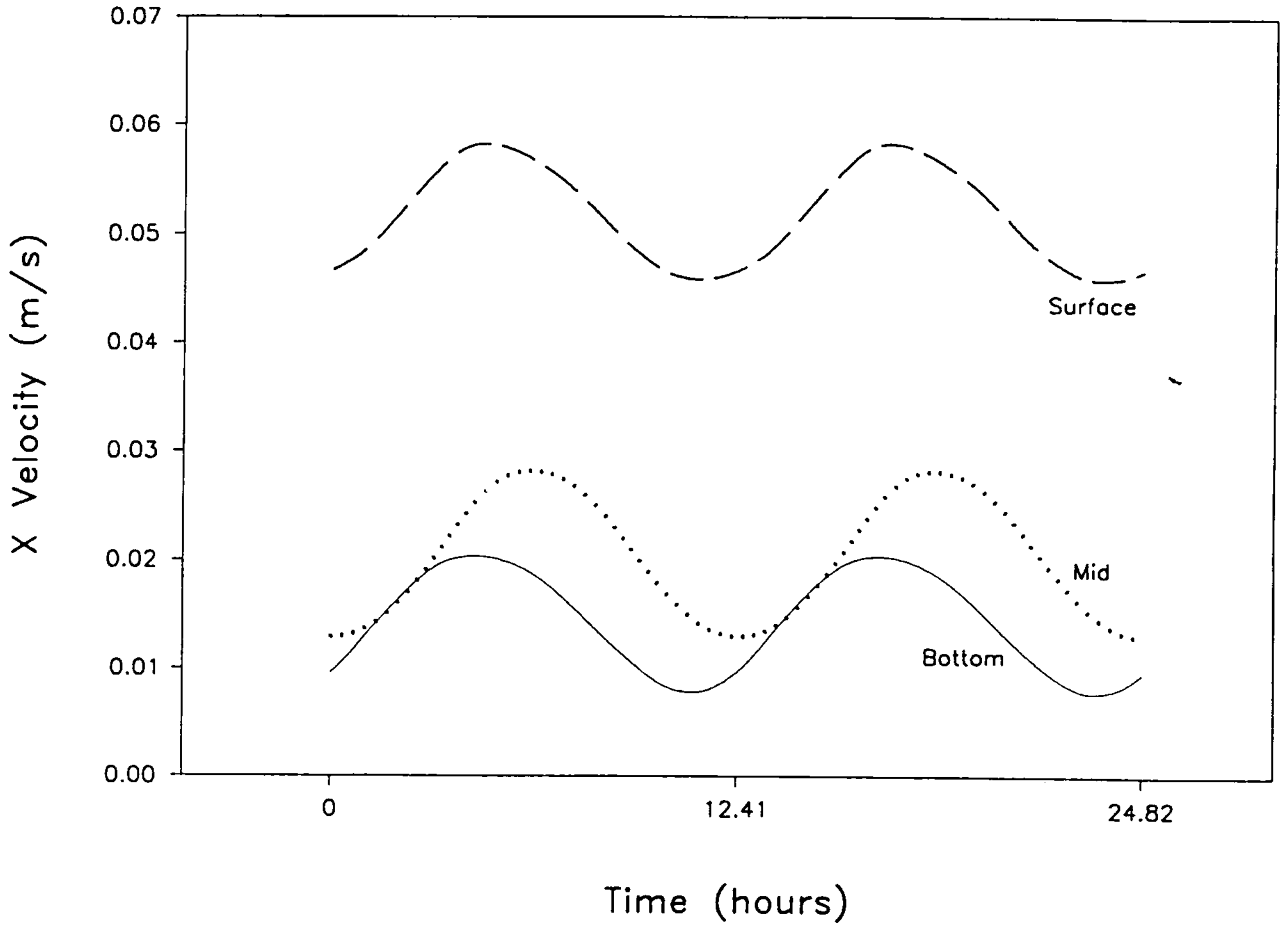

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FIGURE 3-6
EFDC CELL 11 LAYERS 1-3
PREDICTED VELOCITY TIME SERIES
TIDE AMPLITUDE - 2.54m
Exponent Environmental Group
Bellevue, Washington

DRAWN: sb/km	DATE: May 26, 1998	PROJECT NO:
FILE NO: EEG0780F	CHECKED: S. Breithaupt	5543-007-800

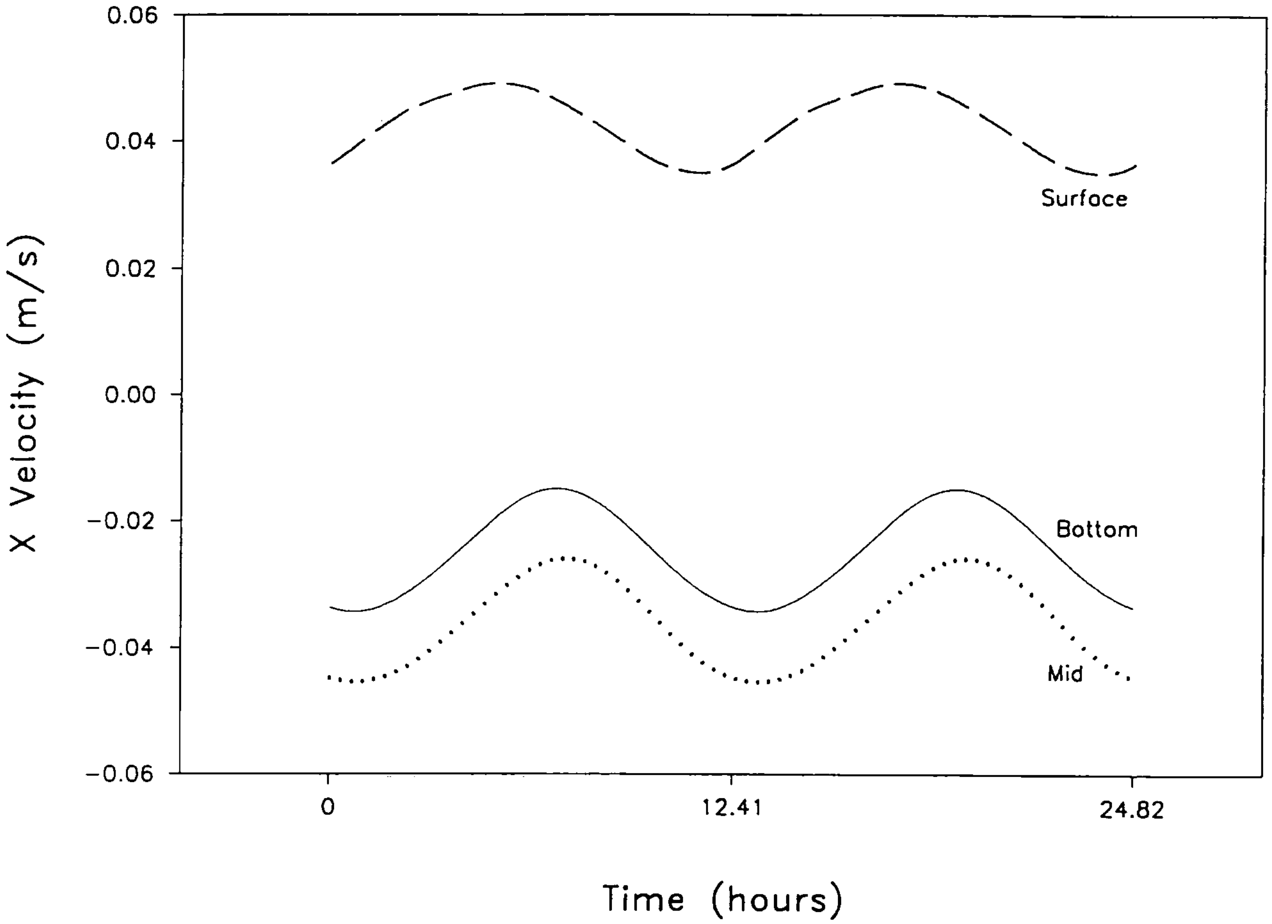

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FIGURE 3–7
EFDC CELL 17 LAYERS 1–3
PREDICTED VELOCITY TIME SERIES
TIDE AMPLITUDE – 2.54m
Exponent Environmental Group
Bellevue, Washington

DRAWN: sb/km	DATE: May 26, 1998	PROJECT NO:
FILE NO: EEG0780G	CHECKED: S. Breithaupt	5543–007–800

cause little variation in surface velocities, although subsurface layer velocities diminish toward 0.0 m/s in cell 17 during the ebb and in cell 11 during flood. The magnitudes produced are comparable to observed velocities.

EFDC can generate a WASP hydrodynamic input file, using the cell configuration as a basis for segment generation. It also generates initial segment volumes and exchange surfaces. A hydrodynamic run was made for 7 days, until the model stabilized, when oscillations from initial conditions were damped. The last two tidal cycles were used to create the WASP hydrodynamic input. This encompassed a 24.84 hour period. To satisfy numerical constraints in WASP, it was necessary to write this data out at 23.3 minute intervals, or every 54th time step.

4.0 TOXICS AND SEDIMENT PROCESS (3-D) MODEL (TIER-2)

As discussed in Section 2.4, the discharge of effluent solids, solids transport through Ward Cove, and solids settling affected the bottom sediment characteristics while KPC was discharging. However, the screening level (Tier-1) model did not consider the effects of horizontal transport of CoPCs on sediment recovery. Hence, the calibrated value of the organic solids decay rate used for recovery time estimates in Section 2 may have been overestimated. In the case of Ward Cove and its contaminated sediments, a 3-D model would be useful for identifying regions that could recover naturally within a reasonable period and regional hotspots where remediation may be necessary. To accomplish this, 3-D modeling was performed using EFDC (Section 3) and TOXI5 in combination. TOXI5 was developed to simulate toxic materials, including processes for sorption, decay, and water column-sediment exchange, among others (Ambrose et al. 1993). As discussed in Section 2 and in the Appendix, TOXI5 was modified to handle solids decay, which was a necessary process for evaluating sediment recovery in Ward Cove. The box model calibration assumed that the solids settling rate was constant throughout the discharge period (Section 2.2.1). However, the data obtained were for solids after primary treatment; primary treatment was instituted in 1971 (Higgins and Amoth 1995). Prior to primary treatment, it is likely the solids settling velocity was higher than after treatment. However, no pre-1971 settling data are available. A refined calibration approach for Tier-2 using solids transport in the water column, organic solids decay rate, and pre-1971 settling velocity is described in detail below.

4.1 Tier-2 (3-D) Model Setup and Calibration

As discussed in the hydrodynamic model of Ward Cove (Section 3), EFDC generates the initial geometry for 3-D transport modeling. It also generates exchange surfaces and a hydrodynamics file that can be read by TOXI5. The initial geometry also includes a sediment layer. For application to Ward Cove, the number of sediment segments selected for each cell was 12, the same as used in the screening level model. These segments were stacked within the input file and were sequentially numbered from the surface to the deepest segment of sediment. This method simplified initial evaluation of model results because the model output was provided for each segment sequentially.

As stated previously, a refined approach was implemented to account for solids transport, the organic solids decay, and solids settling rate prior to primary treatment. Accounting for horizontal transport of KPC effluent implies that the solids mass deposited near the effluent discharge would be greater after multi-year simulations than locations away from the discharge location. The Tier-1 box model had a bottom-most sediment segment that was 1 meter thick (Section 2.2.2 and Figure 2-3). During initial phases of the Tier-2 calibration, this thickness proved inadequate, since significant concentrations of effluent solids penetrated greater than 28 cm into the bottom-most sediment segment, especially near the discharge location. It was necessary to increase the bottom-most segment thickness to 10 meters to prevent this layer from attaining too large of concentrations of deposited effluent solids.

4.1.1 Sediment Organic Solids Calibration

For sediment organics solids calibration it was assumed that the concentration of organic carbon in the bottom sediment was a function of the organic solids decay rate and the settling velocity of effluent solids; these values were selected as the calibration parameters. Additionally, it was assumed that the penetration of tracer (sediment accumulation) was also a function of the organic solids decay rate and the settling velocity of effluent solids. If the organic carbon concentration of the bottom sediment was represented by the area-weighted average for Ward Cove, these assumptions result in two equations and two unknowns. [1]

The sediment accumulation was reliably measured at only one location near the mouth of Ward Cove. Although this location is relatively far removed from the KPC discharge, TOC concentrations above the estimated background concentration of 0.05 kg/kg (PTI 1997a) indicate the influence of effluent solids at this location. The equations used are:

$$funcFOC(k_d, V_{sett}) = \overline{C_{wcsed}}$$

$$funcSedAccum(k_d, V_{sett}) = R_{sa}$$

where:
k_d = the organic sediment decay rate
V_{sett} = the solids settling rate
$\overline{C_{wcsed}}$ = area-weighted average organic content of sediment for Ward Cove
R_{sa} = net sediment accumulation rate at sampling station 40

These functions are the model equations and algorithms that produced the desired values. The value used for $\overline{C_{wcsed}}$ was 10.6 percent, and that used for R_{sa} was 0.33 cm/yr. The goal was to find values of k_d and V_{sett} that gave the desired outputs for $\overline{C_{wcsed}}$ and R_{sa}. Since V_{sett} was measured after the implementation of primary treatment, only the settling rate prior to that time was varied.

A pair of parameter values was selected for each of these calibration runs. Settling velocity was varied from 6.4 to 300 m/day, while the organic solids decay rate was varied from 1.8×10^{-5} to 9.0×10^{-4}/day. The model results were compared to the values for $\overline{C_{wcsed}}$ and R_{sa} and adjustments made to the

[1] Note: Calibration to individual cell concentrations would require much more information than was available, such as effluent solid settling velocity distributions before and after primary treatment. This would allow site specific calibration rather than using cove-wide values.

calibration parameters until satisfactory results were obtained. The final values obtained are listed in Table 4-1. While not equal to the calibration values, they are considered adequate, given the amount of uncertainty inherent in the available data for solids settling velocities and sediment accumulation rates. The resulting sediment accumulation rate of 0.26 cm/yr is consistent with the most reliable estimates of sediment accumulation rates in Ward Cove (0.21-0.33 cm/yr) (Nielsen 1997).

Table 4-1

Refined Calibration Parameter Values and Function Results

Parameter/Function	Value
k_d	2.0×10^{-4}/day
V_{sett}	225 m/day (1954 – 1971) 6.4 m/day (1971 - 1997)
$\overline{C_{wcsed}}$	11.0%
R_{sa}	0.26 cm/yr

4.1.2 Calibration of Sediment Ammonia, 4-methylphenol, and Sulfide

The processes assumed for ammonia, 4-methylphenol, and sulfide fate and transport were the same as those considered in the Tier-1 screening level modeling work, with the exception of the seawater concentration of sulfate. In the Tier-2 model, a more typical seawater sulfate concentration was used (2,700 mg/L; p. 3, Snoeyink and Jenkins 1980). As in the Tier-1 model calibration, the yield coefficient was adjusted to calibrate the model for each CoPC. The area-weighted average model result in the top 10 cm for each CoPC was compared to its observed 1997 area-weighted average concentration in the top 10 cm of sediment after a 43-year simulation period. Table 4-2 shows the yield coefficient required to match area-weighted observed values for each of the CoPCs.

Table 4-2

Yield Coefficients for Production of Ammonia, 4-Methylphenol, and Sulfide from Decay of Organic Solids

CoPC	Yield Coefficient
Ammonia	3.06×10^{-2} g NH_3/g solid
4-methylphenol	1.085×10^{-4} g 4-methylphenol /g solid
Sulfide	3.03×10^{-4} g S/g solid

The calibrated model precisely predicted the 1997 observed area-weighed average concentration of ammonia (122 mg/kg), 4-methylphenol (2,650 µg/kg), and slightly underpredicted the observed concentration of total sulfide (3,521 vs. 3,523 mg/kg).

4.2 Tier-2 (3-D) Model Application

Running the spatially distributed model for 20 or more years with no KPC effluent discharge allows evaluation of natural recovery periods within the cell boundaries specified for the model geometry. Although the grid spacing may be considered relatively coarse, it adequately covers the Areas of Focus identified in the Phase I evaluation to assist in remediation decisions (PTI 1997a).

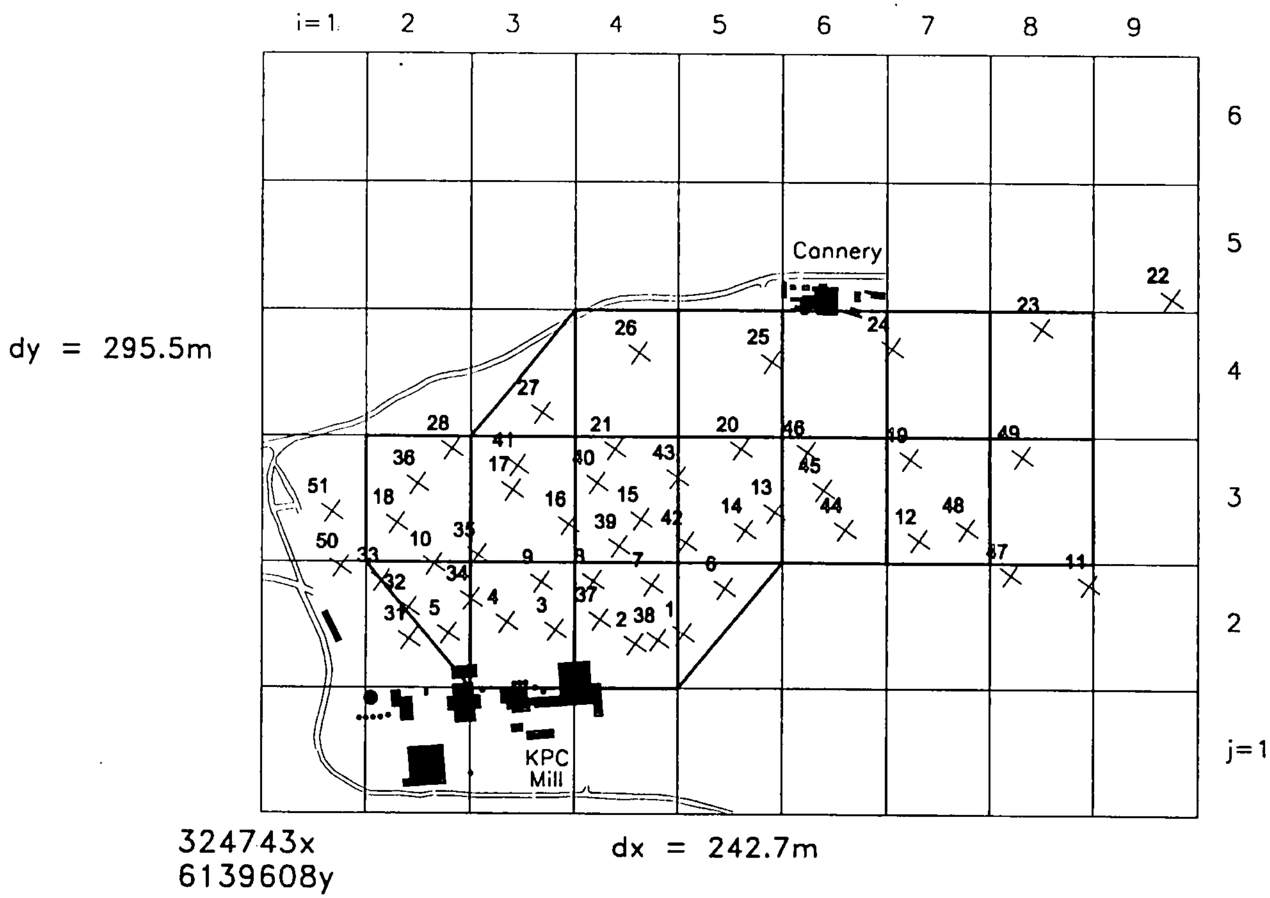
4.2.1 Tier-2 Model Initial Conditions

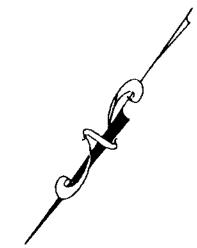
The initial condition for each sediment constituent was derived from the 1997 observed sediment concentrations and the final values of the calibrated Tier-2 model at day 15695 (year 1997). This is 43 years from the beginning of discharge by KPC and 1 year after the termination of discharge. The 1997 observed area-weighted sediment concentrations for each model cell were used to scale the calibrated Tier-2 model results to generate initial conditions for recovery modeling. This was necessary since the calibration used area-weighted values. (As stated in Section 4.1.1., more data would be necessary for individual cell calibrations). Figure 4-1 shows the 1997 sampling locations in relation to the model grid. Data within each cell were used to compute the area-weighted average constituent concentration; the computed area-weighted values are provided below for each CoPC modeled.

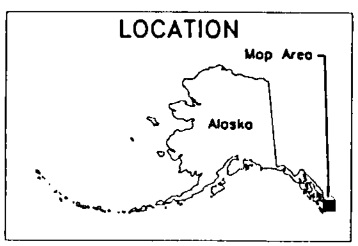
4.2.1.1 Initial Solids Distribution

For recovery runs, the initial distribution of sediment solids must be correctly partitioned between solids1 (effluent solids) and solids2 (native solids). During calibration, as effluent solids were deposited, the model run showed that native solids were displaced downwards at a rate that kept a constant solids density (222 kg/m^3; Section 2.2.1.) throughout the sediment column. Simply scaling solids1 and solids2 by area-weighted concentrations in each cell would not maintain the required sediment solids density. A method was developed so that in each cell, the density distribution value of the sediment solids obtained from final calibration was adjusted so the top 10-cm average value matched the observed TOC values in that cell, while preserving the shape of the solids distribution pattern.

Because the model-predicted distribution of sediment solids had the shape of a logistic growth curve, the solid1 data were fitted using a logistic growth model to generate solids initial conditions for the spatially distributed Tier-2 model. The equation for the logistic growth curve is:







Note:
The numbers correspond to the sediment sampling stations listed in PTI (March 1997a).

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FIGURE 4-1
PHASE II SAMPLING LOCATIONS
WITH RESPECT TO THE MODEL GRID
WARD COVE, KETCHIKAN, ALASKA
Exponent Environmental Group
Bellevue, Washington

DRAWN: wb/km	DATE: May 26, 1998	PROJECT NO:
FILE NO: EEG0780L	CHECKED: S. Breithaupt	5543-007-800

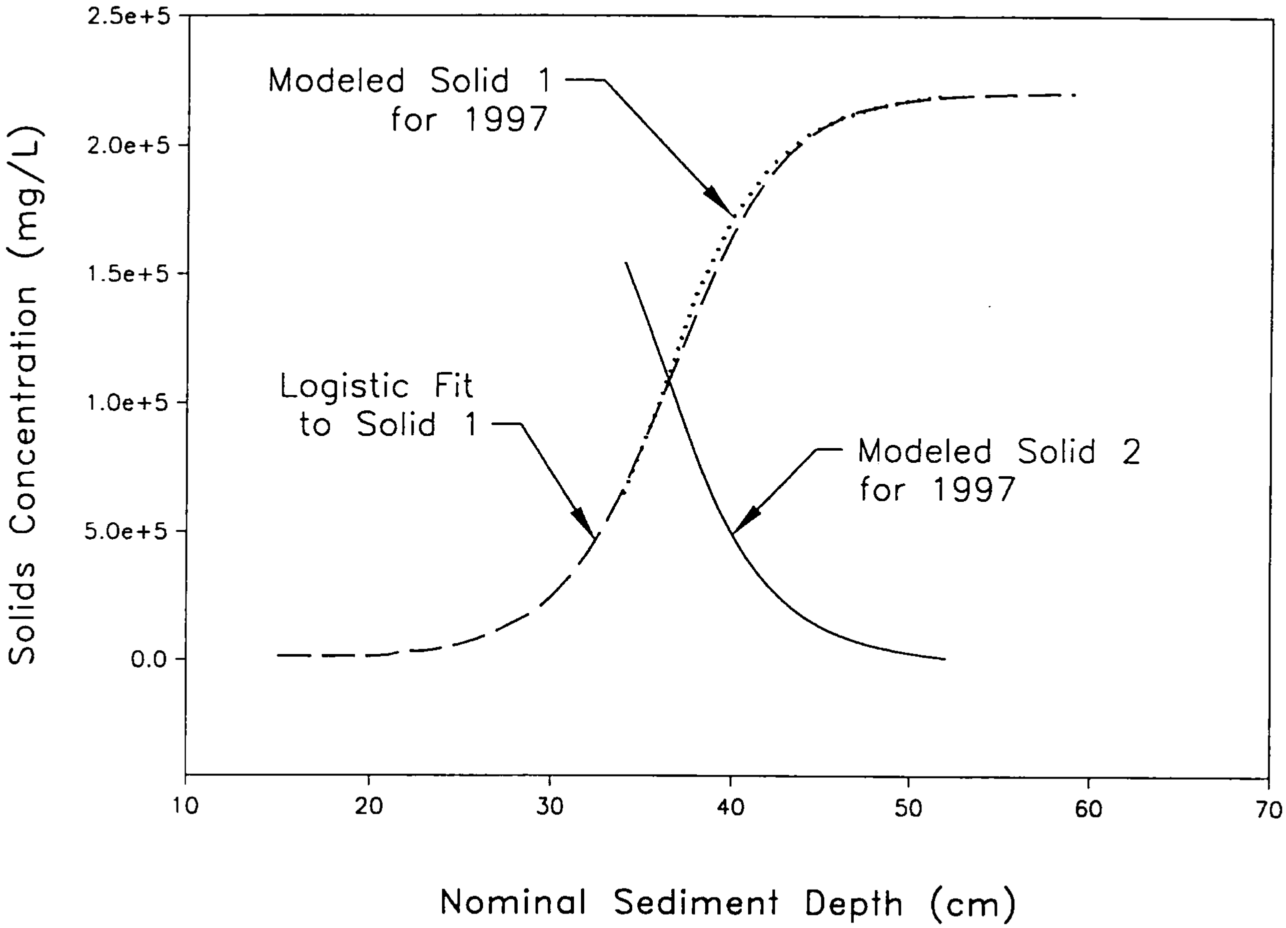
$$\frac{dC}{dz} = aC - bC^2$$

where: C = concentration
z = depth
a and b = fitting coefficients

It was necessary to adjust the fitting coefficients for each cell to give adequate fits to solids1 density distribution data. Equating depth to time (due to solids deposition over time) and plotting modeled and fitted solids data gave the results shown in Figure 4-2 for a = 0.8 and b = 3.63. The excellent fit between modeled solid1 data and the logistic curve provides the means to estimate solid1 concentration profiles in the various deposition areas in Ward Cove. A corresponding profile for solid2 was obtained by subtracting the solid1 fit from the sediment density of 222 kg/m^3.

Observed area-weighted 1997 sediment TOC concentrations for each cell are shown in Table 4-3. Measured concentrations for cells 11 to 17 were low and were set to zero. For both fitted solid1 and solid2 distributions, the organic content of the moving 10-cm sections was computed. An example is given for cell 4 in Table 4-4. The corresponding nominal start depth in the fitted solids distribution was selected to match the area-weighted average TOC value. Using the selected start depth, the fitted sediment solids distribution that produced the average TOC value (given in Table 4-3) was selected and used as the initial condition for that cell's sediment column[2]. For the Tier-2 recovery model, Table 4-5 shows the initial concentrations for solids1, solids2, and the corresponding TOC values for each model cell and sediment layer calculated using this method. The top 10-cm average TOC concentration is also provided for comparison to the observed sediment concentrations in Table 4-5. Exact fits were not obtained due to the use of discrete values (1-cm interval) for the logistic growth curve values.

[2] Note: Cell 4 has an area-weighted TOC value of 0.362 kg/kg, but the corresponding value in Table 4-4 has a value of 0.308 kg/kg. Because the model specifies the solid1 organic fraction as 0.31 (i.e., the maximum level possible if all of the sediment consists of solid1), it was not possible to represent the weighted value exactly, but the closest possible value was selected.



Note:
These curves allow generation of sediment solids initial conditions for 3-D modeling. 1997 modeled data is from the screening level model from which average sediment conditions were obtained. In cells with different deposition rates, the expected solids distribution can be obtained from this figure.

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FIGURE 4-2

EXAMPLE CURVE FOR EXTRAPOLATION OF SOLIDS INITIAL CONDITIONS

Exponent Environmental Group
Bellevue, Washington

DRAWN: sb/km	DATE: June 2, 1998	PROJECT NO:
FILE NO: EEG0780E	CHECKED: S. Breithaupt	5543-007-800

Table 4-3

1997 Observed Area-Weighted Sediment Concentrations of TOC for Each Tier-2 Model Cell (top 10 cm)

Cell	TOC (kg/kg)
1	0.239
2	0.130
3	0.184
4	0.362
5	0.135
6	0.280
7	0.248
8	0.237
9	0.256
10	0.250
11	0.118
12	0
13	0
14	0
15	0
16	0
17	0

Data Source: PTI 1997a
Note: Cell locations are referenced to Figure 3-1.

Table 4-4

Example Average TOC Values in a Moving 10-cm Thick Sediment Layer for Various Nominal Start Depths Using the Solids Distribution Found in Figure 1; Values are Those used for Cell 4 [a]

Nominal Start Depth for Average 10-cm section (cm)	Average Solids1 Organic Content (mg/L)	Average Solids1 Content (mg/L)	Average Solids2 Organic Content (mg/L)	Average Solids2 Content (mg/L)	Average TOC Content (kg/kg)	Corresponding 3-D Model Cell
1	67853.0	218880.7	14.2	1419.3	0.308	
2	67853.0	218880.7	14.2	1419.3	0.308	
3	67853.0	218880.7	14.2	1419.3	0.308	
4	67853.0	218880.7	14.2	1419.3	0.308	
5	67853.0	218880.7	14.2	1419.3	0.308	
6	67853.0	218880.7	14.2	1419.3	0.308	
7	67853.0	218880.7	14.2	1419.3	0.308	
8	67853.0	218880.7	14.2	1419.3	0.308	
9	67853.0	218880.7	14.2	1419.3	0.308	
10	67853.0	218880.7	14.2	1419.3	0.308	
11	67853.0	218880.7	14.2	1419.3	0.308	
12	67853.0	218880.7	14.2	1419.3	**0.308**	Cell 4
13	67832.6	218814.7	14.9	1485.3	0.308	
14	67742.5	218524.3	17.8	1775.7	0.308	
15	67652.5	218233.9	20.7	2066.1	0.308	
16	67505.3	217759.1	25.4	2540.9	0.307	
17	67278.4	217026.9	32.7	3273.1	0.306	
18	66940.8	215938.0	43.6	4362.0	0.304	
19	66451.5	214359.7	59.4	5940.3	0.302	
20	65757.0	212119.3	81.8	8180.7	0.299	
21	64865.3	209242.8	110.6	11057.2	0.295	
22	63662.9	205364.0	149.4	14936.0	0.290	
23	62112.0	200361.3	199.4	19938.7	0.283	
24	60054.1	193723.0	265.8	26577.0	0.274	
25	57467.9	185380.3	349.2	34919.7	0.263	
26	54323.1	175235.8	450.6	45064.2	0.249	
27	50636.1	163342.1	569.6	56957.9	0.233	
28	46476.3	149923.7	703.8	70376.3	0.214	
29	41962.7	135363.4	849.4	84936.6	0.195	
30	37174.8	119918.6	1003.8	100381.4	0.174	
31	32340.8	104325.3	1159.7	115974.7	0.152	
32	27635.8	89147.8	1311.5	131152.2	0.132	
33	23223.4	74914.3	1453.9	145385.7	0.112	
34	19241.6	62069.7	1582.3	158230.3	0.095	
35	15788.1	50929.5	1693.7	169370.5	0.079	
36	12910.5	41646.8	1786.5	178653.2	0.067	
37	10603.8	34205.8	1860.9	186094.2	0.057	
38	8819.4	28449.8	1918.5	191850.2	0.049	
39	7481.2	24132.9	1961.7	196167.1	0.043	
40	6506.6	20988.9	1993.1	199311.1	0.039	
41	5808.1	18735.7	2015.6	201564.3	0.036	

Note: Data were generated using the logistic growth curve calibrated to the cell 4 initial solids1 distribution and averaged over 10-cm sections. Organic content for each solid is obtained after multiplication of the solids density by its organic fraction (f_{oc1} = 0.31 and f_{oc2} = 0.01).

[a] The solids distribution used was similar to that shown in Figure 4-2. Values in the above table are those used for cell 4.

Table 4-5

Tier-2 Recovery Model Initial Conditions for Solids and TOC.

Sediment Depth (cm)	Cell 1 Solids1 (mg/L)	Cell 1 Solids2 (mg/L)	Cell 1 TOC kg/kg	Cell 2 Solids1 (mg/L)	Cell 2 Solids2 (mg/L)	Cell 2 TOC kg/kg	Cell 3 Solids1 (mg/L)	Cell 3 Solids2 (mg/L)	Cell 3 TOC kg/kg	Cell 4 Solids1 (mg/L)	Cell 4 Solids2 (mg/L)	Cell 4 TOC kg/kg	Cell5 Solids1 (mg/L)	Cell5 Solids2 (mg/L)	Cell5 TOC kg/kg	Cell 6 Solids1 (mg/L)	Cell 6 Solids2 (mg/L)	Cell 6 TOC kg/kg	Cell 7 Solids1 (mg/L)	Cell 7 Solids2 (mg/L)	Cell 7 TOC kg/kg
1	203332	16968	0.287	129697	90603	0.187	176115	44185	0.250	218942	1419	0.308	115887	104413	0.168	213396	6904	0.301	207392	12908	0.292
3	192048	28252	0.272	93267	127033	0.137	147378	72922	0.211	218942	1419	0.308	76746	143554	0.115	207392	12908	0.292	202787	17513	0.286
5	171890	48410	0.244	61696	158604	0.094	112016	108284	0.163	218942	1419	0.308	45416	174884	0.072	198390	21910	0.280	198390	21910	0.280
7	143052	77248	0.205	39773	180527	0.064	77552	142748	0.116	218942	1419	0.308	25385	194915	0.045	181599	38701	0.257	191006	29294	0.270
9	108267	112033	0.157	26859	193441	0.047	51065	169235	0.080	218942	1419	0.308	14414	205886	0.030	155970	64330	0.222	181599	38701	0.257
11	74236	146064	0.111	19995	200305	0.037	34309	185991	0.057	216909	4033	0.305	8921	211379	0.022	122344	97956	0.177	169938	50362	0.241
13	47332	172968	0.074	16548	203752	0.033	25015	195285	0.044	215710	5692	0.302	6296	214004	0.019	86228	134072	0.127	155970	64330	0.222
15	29532	190768	0.050	15017	205283	0.030	20239	200061	0.038	211941	11220	0.295	5176	215124	0.017	55150	165150	0.085	139919	80381	0.201
17	19138	201162	0.036	14130	206170	0.029	17882	202418	0.034	205279	21583	0.281	4552	215748	0.016	33274	187026	0.055	122344	97956	0.177
19	13514	206786	0.028	13707	206593	0.029	16844	203456	0.033	195673	36922	0.262	4264	216036	0.016	20022	200278	0.037	104106	116194	0.152
24	9611	210689	0.023	13436	206864	0.028	16038	204262	0.032	103521	116779	0.151	4089	216211	0.016	9487	210813	0.023	86228	134072	0.127
528	7839	212461	0.021	13352	206948	0.028	15744	204556	0.031	18265	202035	0.035	4037	216263	0.015	5393	214907	0.017	69674	150626	0.105
10 cm average	**163718**	**56582**	**0.233**	**70258**	**150042**	**0.106**	**112825**	**107475**	**0.164**	**218942**	**1419**	**0.308**	**55570**	**164730**	**0.086**	**191349**	**28951**	**0.271**	**196235**	**24065**	**0.277**

Sediment Depth (cm)	Cell 8 Solids1 (mg/L)	Cell 8 Solids2 (mg/L)	Cell 8 TOC kg/kg	Cell 9 Solids1 (mg/L)	Cell 9 Solids2 (mg/L)	Cell 9 TOC kg/kg	Cell 10 Solids1 (mg/L)	Cell 10 Solids2 (mg/L)	Cell 10 TOC kg/kg	Cell 11 Solids1 (mg/L)	Cell 11 Solids2 (mg/L)	Cell 11 TOC kg/kg	Cell 12 Solids1 (mg/L)	Cell 12 Solids2 (mg/L)	Cell 12 TOC kg/kg	Cell 13 Solids1 (mg/L)	Cell 13 Solids2 (mg/L)	Cell 13 TOC kg/kg	Cell 14 Solids1 (mg/L)	Cell 14 Solids2 (mg/L)	Cell 14 TOC kg/kg
1	207392	12908	0.292	210802	9498	0.297	210804	9496	0.297	106218	114082	0.155	0	220300	0.010	0	220300	0.010	0	220300	0.010
3	202787	17513	0.286	206646	13654	0.291	206651	13649	0.291	69849	150451	0.105	0	220300	0.010	0	220300	0.010	0	220300	0.010
5	198390	21910	0.280	200827	19473	0.283	200837	19463	0.283	42151	178149	0.067	0	220300	0.010	0	220300	0.010	0	220300	0.010
7	191006	29294	0.270	192836	27464	0.273	192856	27444	0.273	24830	195470	0.044	0	220300	0.010	0	220300	0.010	0	220300	0.010
9	181599	38701	0.257	185097	35203	0.262	185131	35169	0.262	15336	204964	0.031	0	220300	0.010	0	220300	0.010	0	220300	0.010
11	169938	50362	0.241	172102	48198	0.244	172165	48135	0.244	10511	209789	0.024	0	220300	0.010	0	220300	0.010	0	220300	0.010
13	155970	64330	0.222	155885	64415	0.222	156000	64300	0.222	8155	212145	0.021	0	220300	0.010	0	220300	0.010	0	220300	0.010
15	139919	80381	0.201	136737	83563	0.196	136932	83368	0.196	7126	213174	0.020	0	220300	0.010	0	220300	0.010	0	220300	0.010
17	122344	97956	0.177	115578	104722	0.167	115888	104412	0.168	6539	213761	0.019	0	220300	0.010	0	220300	0.010	0	220300	0.010
19	104106	116194	0.152	93888	126412	0.138	94345	125955	0.138	6261	214039	0.019	0	220300	0.010	0	220300	0.010	0	220300	0.010
24	86228	134072	0.127	73343	146957	0.110	73965	146335	0.111	6095	214205	0.018	0	220300	0.010	0	220300	0.010	0	220300	0.010
528	69674	150626	0.105	55326	164974	0.085	56117	164183	0.086	6040	214260	0.018	0	220300	0.010	0	220300	0.010	0	220300	0.010
10 cm average	**196235**	**24065**	**0.277**	**199242**	**21058**	**0.281**	**199256**	**21044**	**0.281**	**51677**	**168623**	**0.080**	**0**	**220300**	**0.010**	**0**	**220300**	**0.010**	**0**	**220300**	**0.010**

Sediment Depth (cm)	Cell 15 Solids1 (mg/L)	Cell 15 Solids2 (mg/L)	Cell 15 TOC kg/kg	Cell 16 Solids1 (mg/L)	Cell 16 Solids2 (mg/L)	Cell 16 TOC kg/kg	Cell 17 Solids1 (mg/L)	Cell 17 Solids2 (mg/L)	Cell 17 TOC kg/kg
1	0	220300	0.010	0	220300	0.010	0	220300	0.010
3	0	220300	0.010	0	220300	0.010	0	220300	0.010
5	0	220300	0.010	0	220300	0.010	0	220300	0.010
7	0	220300	0.010	0	220300	0.010	0	220300	0.010
9	0	220300	0.010	0	220300	0.010	0	220300	0.010
11	0	220300	0.010	0	220300	0.010	0	220300	0.010
13	0	220300	0.010	0	220300	0.010	0	220300	0.010
15	0	220300	0.010	0	220300	0.010	0	220300	0.010
17	0	220300	0.010	0	220300	0.010	0	220300	0.010
19	0	220300	0.010	0	220300	0.010	0	220300	0.010
24	0	220300	0.010	0	220300	0.010	0	220300	0.010
528	0	220300	0.010	0	220300	0.010	0	220300	0.010
10 cm average	**0**	**220300**	**0.010**	**0**	**220300**	**0.010**	**0**	**220300**	**0.010**

Notes: The fraction of organic carbon in Solids1 and Solids2 is 0.31 and 0.01 kg/kg, respectively.
The sediment solids density is 0.220 mg/L.

4.2.1.2 *Initial CoPC Distributions*

The initial sediment concentrations of 4-methylphenol for each cell were generated by scaling the calibrated Tier-2 model output in the top 10 cm for 1997 (day 15695) by the 1997 observed area-weighted top 10 cm concentration (Table 4-6), using the ratio of the observed concentration to the model-predicted concentration.[3] Table 4-7 provides the scaled Tier-2 model initial sediment concentrations of 4-methylphenol for each model cell and sediment layer. The top 10-cm average concentration is also shown for comparison to the observed 1997 sediment concentrations in Table 4-6.

Sediment ammonia initial concentrations were computed using the same method as that used for 4-methylphenol. Table 4-8 shows the 1997 area-weighted 10-cm average sediment ammonia concentrations. Table 4-9 lists the scaled Tier-2 model initial sediment concentrations of ammonia for each model cell and sediment layer. The top 10-cm average concentration is also shown for comparison to the observed 1997 sediment concentrations in Table 4-8.

Sediment sulfide initial concentrations were computed using the same method as that used for 4-methylphenol and ammonia. Table 4-10 shows the 1997 area-weighted 10-cm average sediment sulfide concentrations. Table 4-11 lists the scaled Tier-2 model initial sediment concentrations of sulfide for each model cell and sediment layer. The top 10-cm average concentration is also shown for comparison to the observed 1997 sediment concentrations in Table 4-10. In addition to sulfide, the model also required the initial conditions for sulfate to be specified. The initial conditions for sulfate were not scaled. They were taken directly from the output of the calibrated Tier-2 model for calibration of the sulfide yield coefficient.

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[3] Scaling works for dissolved CoPCs, since there is no need to maintain a constant density throughout the sediment column.

Table 4-6

1997 Observed Area-Weighted Sediment Concentrations of 4-Methylphenol within Each Tier-2 Model Cell (top 10 cm)

Cell	4-methylphenol (µg/kg)
1	11,490
2	7,813
3	11,870
4	25,190
5	397
6	734
7	1,781
8	5,926
9	6,455
10	3,157
11	220
12	0
13	0
14	0
15	0
16	0
17	0

Data Source: PTI 1997a
Note: Cell locations are referenced to Figure 3-1.

Table 4-7

Tier-2 Recovery Model Inititial Conditions for 4-Methylphenol

	Initial Model Concentration (mg/L)						
Sediment Depth (cm)	Cell 1	Cell 2	Cell 3	Cell 4	Cell5	Cell 6	Cell 7
1	1.181	1.045	1.626	2.263	0.056	0.110	0.200
3	2.309	1.772	2.715	4.845	0.089	0.177	0.360
5	2.975	1.991	2.972	6.538	0.095	0.177	0.424
7	3.173	1.944	2.911	7.176	0.097	0.170	0.468
9	3.003	1.842	2.833	6.937	0.099	0.167	0.510
11	2.667	1.771	2.818	6.294	0.103	0.169	0.554
13	2.353	1.746	2.865	5.641	0.107	0.173	0.599
15	2.145	1.757	2.951	5.200	0.111	0.178	0.644
17	2.042	1.790	3.057	4.990	0.115	0.184	0.687
19	2.007	1.833	3.167	4.948	0.119	0.189	0.726
24	2.216	2.127	3.737	5.669	0.130	0.207	0.875
528	7.248	13.358	24.707	33.449	0.360	1.081	8.241
10-cm average (µg/kg)	11,492	7,813	11,870	25,236	397	729	1,783
	Cell 8	Cell 9	Cell 10	Cell 11	Cell 12	Cell 13	Cell 14
1	0.677	0.794	0.425	0.029	0.000	0.000	0.000
3	1.227	1.388	0.683	0.043	0.000	0.000	0.000
5	1.458	1.630	0.769	0.050	0.000	0.000	0.000
7	1.555	1.695	0.804	0.056	0.000	0.000	0.000
9	1.609	1.695	0.832	0.061	0.000	0.000	0.000
11	1.664	1.694	0.869	0.067	0.000	0.000	0.000
13	1.732	1.717	0.915	0.071	0.000	0.000	0.000
15	1.813	1.765	0.966	0.076	0.000	0.000	0.000
17	1.898	1.829	1.018	0.080	0.000	0.000	0.000
19	1.978	1.895	1.066	0.084	0.000	0.000	0.000
24	2.325	2.191	1.253	0.096	0.000	0.000	0.000
528	10.530	8.231	7.246	0.643	0.000	0.000	0.000
10-cm average (µg/kg)	5,932	6,548	3,193	217	0	0	0
	Cell 15	Cell 16	Cell 17				
1	0.000	0.000	0.000				
3	0.000	0.000	0.000				
5	0.000	0.000	0.000				
7	0.000	0.000	0.000				
9	0.000	0.000	0.000				
11	0.000	0.000	0.000				
13	0.000	0.000	0.000				
15	0.000	0.000	0.000				
17	0.000	0.000	0.000				
19	0.000	0.000	0.000				
24	0.000	0.000	0.000				
528	0.000	0.000	0.000				
10-cm average (µg/kg)	0	0	0				
Note: The sediment solids density is 0.220 mg/L							

Table 4-8

1997 Observed Area-Weighted Sediment Concentrations of Ammonia within Each Tier-2 Model Cell (top 10 cm)

Cell	Ammonia (mg/kg)
1	232
2	143
3	254
4	976
5	32.4
6	83.2
7	97.5
8	245
9	408
10	355
11	180
12	0
13	0
14	0
15	0
16	0
17	0

Data Source: PTI 1997a
Note: Cell locations are referenced to Figure 3-1.

Table 4-9

Tier-2 Recovery Model Initial Conditions for Ammonia

	Initial Model Concentration (mg/L)						
Sediment Depth (cm)	Cell 1	Cell 2	Cell 3	Cell 4	Cell5	Cell 6	Cell 7
1	20.259	12.096	20.887	70.225	3.247	8.007	6.930
3	39.910	23.539	41.669	149.937	5.915	14.967	14.660
5	54.993	32.905	58.945	223.537	7.670	19.683	21.823
7	66.480	40.887	73.638	291.002	8.902	23.133	28.658
9	75.368	47.938	86.442	352.330	9.845	25.916	35.280
11	82.408	54.341	97.871	407.713	10.621	28.353	41.758
13	88.092	60.260	108.310	457.119	11.292	30.576	48.129
15	92.777	65.782	118.025	501.096	11.886	32.601	54.414
17	96.749	70.958	127.174	540.232	12.419	34.429	60.616
19	100.216	75.807	135.840	575.501	12.896	36.085	66.729
24	112.343	93.934	168.728	728.579	14.594	41.947	89.565
528	1108.734	1751.467	3492.815	728.579	125.729	634.526	2691.226
10-cm average (mg/kg)	234	143	256	988	32	83	98
	Cell 8	Cell 9	Cell 10	Cell 11	Cell 12	Cell 13	Cell 14
1	19.257	32.285	28.078	18.258	0.000	0.000	0.000
3	39.084	66.231	57.211	32.633	0.000	0.000	0.000
5	55.968	95.185	81.820	42.524	0.000	0.000	0.000
7	70.790	119.757	102.706	49.604	0.000	0.000	0.000
9	84.120	140.539	120.574	54.981	0.000	0.000	0.000
11	96.353	158.488	136.330	59.300	0.000	0.000	0.000
13	107.735	174.159	150.440	62.927	0.000	0.000	0.000
15	118.407	188.067	163.275	66.071	0.000	0.000	0.000
17	128.439	200.529	175.038	68.850	0.000	0.000	0.000
19	137.853	211.680	185.786	71.339	0.000	0.000	0.000
24	170.537	246.757	220.867	80.312	0.000	0.000	0.000
528	2963.596	2138.661	2597.364	771.795	0.000	0.000	0.000
10-cm average (mg/kg)	245	413	355	180	0	0	0
	Cell 15	Cell 16	Cell 17				
1	0.000	0.000	0.000				
3	0.000	0.000	0.000				
5	0.000	0.000	0.000				
7	0.000	0.000	0.000				
9	0.000	0.000	0.000				
11	0.000	0.000	0.000				
13	0.000	0.000	0.000				
15	0.000	0.000	0.000				
17	0.000	0.000	0.000				
19	0.000	0.000	0.000				
24	0.000	0.000	0.000				
528	0.000	0.000	0.000				
10-cm average (mg/kg)	0	0	0				
Note: The sediment solids density is 0.220 mg/L							

Table 4-10

1997 Observed Area-Weighted Sediment Concentrations of Sulfide within Each Tier-2 Model Cell

(top 10 cm)

Cell	Sulfide (mg/kg)
1	7,350
2	4,140
3	4,420
4	3,210
5	1,880
6	8,140
7	7,410
8	5,200
9	4,140
10	4,150
11	2,300
12	2,500
13	4,500
14	3,800
15	3,800
16	3,800
17	3,800

Data Source: PTI 1997a
Note: Cell locations are referenced to Figure 3-1.

Table 4-11

Tier-2 Recovery Model Initial Conditions for Sulfide

	Initial Model Concentration (mg/L)						
Sediment Depth (cm)	Cell 1	Cell 2	Cell 3	Cell 4	Cell5	Cell 6	Cell 7
1	557.674	333.108	343.986	260.402	154.011	626.264	528.360
3	1235.730	707.073	759.975	577.787	336.696	1389.396	1170.546
5	1743.331	983.339	1066.305	785.911	452.915	1965.628	1687.997
7	2113.423	1187.761	1297.539	929.203	529.680	2387.177	2112.365
9	2381.272	1342.719	1477.374	1034.063	583.903	2692.279	2466.895
11	2575.291	1463.742	1621.097	1115.306	625.019	2916.688	2768.421
13	2715.565	1560.565	1738.586	1180.141	657.842	3084.958	3027.926
15	2816.897	1639.034	1835.880	1233.091	684.718	3210.358	3252.037
17	2890.678	1702.659	1916.323	1276.117	706.774	3301.576	3444.102
19	2944.817	1753.492	1981.617	1310.398	724.530	3366.749	3605.604
24	3094.912	1910.963	2185.221	1469.128	779.385	3529.805	4065.811
528	239.877	236.831	331.352	352.374	43.955	326.172	702.523
10-cm average (mg/kg)	**7,301**	**4,140**	**4,496**	**3,261**	**1,870**	**8,237**	**7,242**
	Cell 8	Cell 9	Cell 10	Cell 11	Cell 12	Cell 13	Cell 14
1	388.380	304.615	306.515	193.345	209.392	382.548	327.062
3	860.401	675.243	679.448	410.357	444.440	811.963	694.197
5	1234.588	959.097	965.446	553.969	604.009	1090.356	923.899
7	1540.745	1185.928	1194.137	651.480	710.149	1271.531	1069.549
9	1797.771	1372.912	1382.785	720.849	782.010	1393.602	1165.293
11	2017.888	1533.357	1544.696	772.565	832.412	1479.572	1231.147
13	2208.460	1672.584	1685.217	812.513	869.073	1542.685	1278.531
15	2373.675	1793.987	1807.729	844.031	896.517	1590.402	1313.867
17	2515.551	1899.005	1913.676	869.040	917.392	1626.966	1340.728
19	2634.999	1987.841	2003.277	888.684	933.270	1654.940	1361.156
24	2976.114	2235.899	2253.698	948.741	980.679	1738.715	1422.005
528	631.377	493.242	509.722	85.795	62.161	100.442	63.253
10-cm average (mg/kg)	**5,293**	**4,089**	**4,117**	**2,300**	**2,500**	**4,500**	**3,800**
	Cell 15	Cell 16	Cell 17				
1	355.440	380.652	407.813				
3	754.462	808.010	865.684				
5	942.650	952.719	948.917				
7	1037.988	1006.861	971.967				
9	1089.460	1031.758	985.620				
11	1119.522	1047.086	996.935				
13	1138.810	1058.724	1006.723				
15	1152.353	1068.263	1015.067				
17	1162.450	1076.082	1021.967				
19	1170.113	1082.249	1027.390				
24	1192.503	1100.346	1043.172				
528	38.696	30.673	24.512				
10-cm average (mg/kg)	**3,800**	**3,800**	**3,800**				
Note: The sediment solids density is 0.220 mg/L							

4.2.2 Tier-2 Recovery Modeling

The same partition and diffusion coefficients specified in the Tier-1 screening-level model were applied in the spatially distributed Tier-2 model. Their values are listed above in Section 2. The time step of the model was set to approximately 23.3 minutes, as required by the hydrodynamic output and TOXI5 numerical constraints. The model-predicted sediment recovery for each of the CoPCs is discussed below.

4.2.2.1 Total Organic Carbon

Representative TOC recovery results are illustrated in Figure 4-3. The initial values are approximately the same as the observed area-weighted averages; they are not exactly the same due to the discrete data used to fit the model solids distribution (Section 4.2.1.1). Only Cell 4 TOC levels exceeded the WCSQV(1) (0.30 kg/kg)[4] since the TOC content of solids1 was set to 0.31 kg/kg; all other model cells had lower initial levels. As a result, the recovery period was evaluated using a return to the estimated background concentration of 0.05 kg/kg (PTI 1997a). The initial conditions in model cells 12 through 17 were below the background TOC concentration and are not discussed further. Since solids organic decay is a first-order reaction, the recovery was modeled using exponential decay.

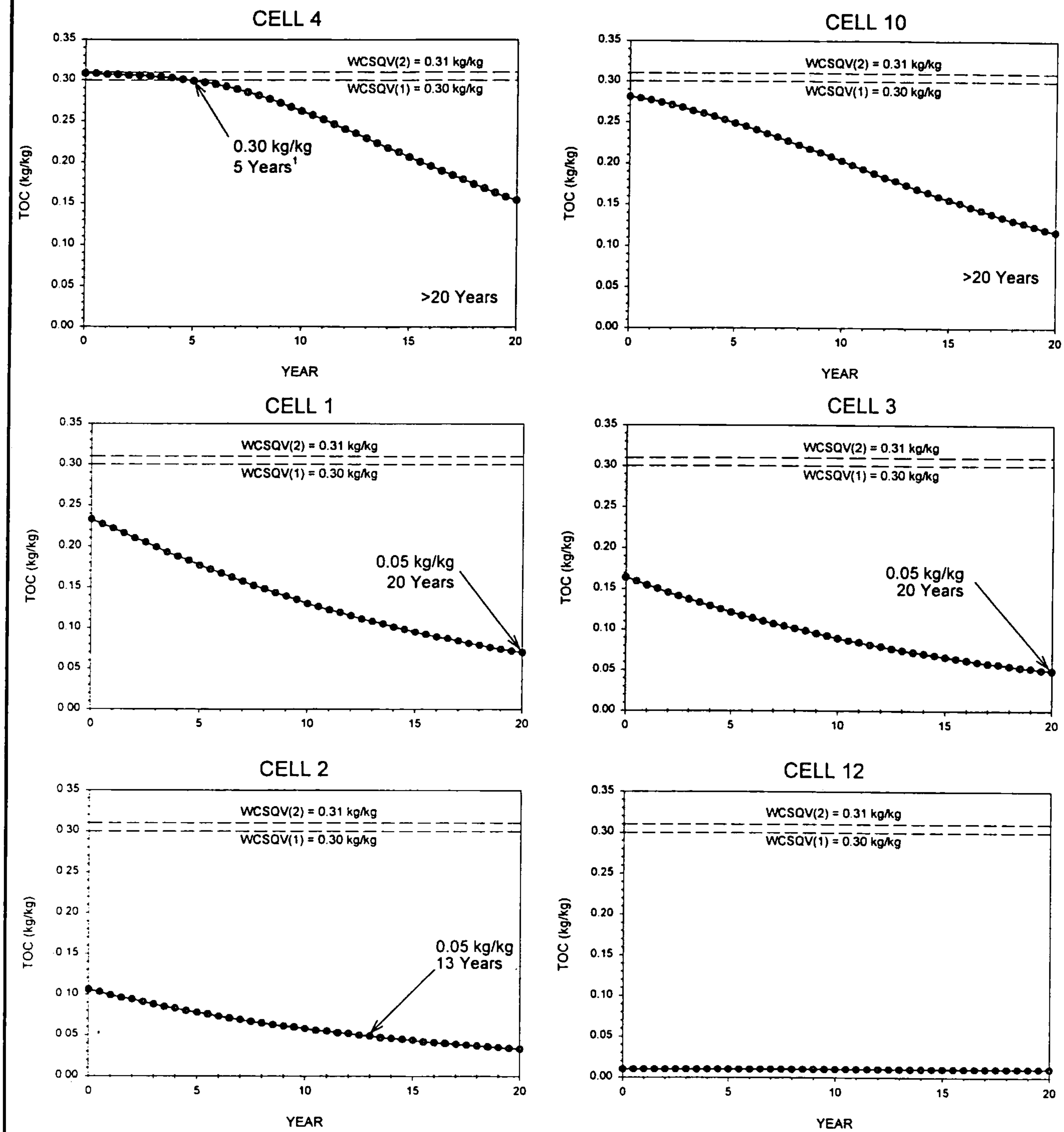
Figure 4-4 provides an overview of recovery times for all model cells. The Tier-2 model predicted sediment TOC recovery to be greater than 20 years for cell 1 and 4, and cells 6 through 10. Cells 5 and 11 were predicted to recover within 10 years. In general, modeled TOC recovery depends largely on the initial conditions and the calibrated solids organic decay rate. The deposition of sediment delivered from Ward Creek (which has a much lower TOC content than the historical KPC discharge) has a minimal effect on recovery, as demonstrated in the following discussion of the sensitivity analysis:

Contour plots of model-predicted sediment TOC concentrations in 1997 (Year 0), 2007 (Year 10), and 2017 (Year 20) are provided in Figure 4-5. This time series of sediment recovery shows that the highest levels of TOC decrease throughout the cove. After 20 years, concentrations exceeding the background TOC level (0.05 kg/kg) persist in the central basin and along the outer northern shore of the cove.

4.2.2.2 4-Methylphenol

Results for sediment 4-methylphenol recovery are illustrated in Figure 4-6 for several representative cells. Figure 4-7 provides an overview of recovery periods for all model cells. The initial conditions in model cells 5, 11, and 12 through 17 were below the SQS of 670 µg/kg and are not discussed further. The model-predicted recovery times were greater than 20 years for cells 1, 3, 4, 8, and 9 as expected

[4] Recovery time to the WCSQV(1) in cell 4 was 5 years.



Note:
Since TOC levels were less than the Ward Cove Sediment Quality Value (WCSQV) in all but Cell 4, the time to recovery was determined as the time to approach the estimated background TOC content of 0.05 kg/kg.
Results are for the top 10 cm of sediment.
Units are kg TOC/kg dry sediment solids.
[1] 5 Year recovery time to WCSQV(1).

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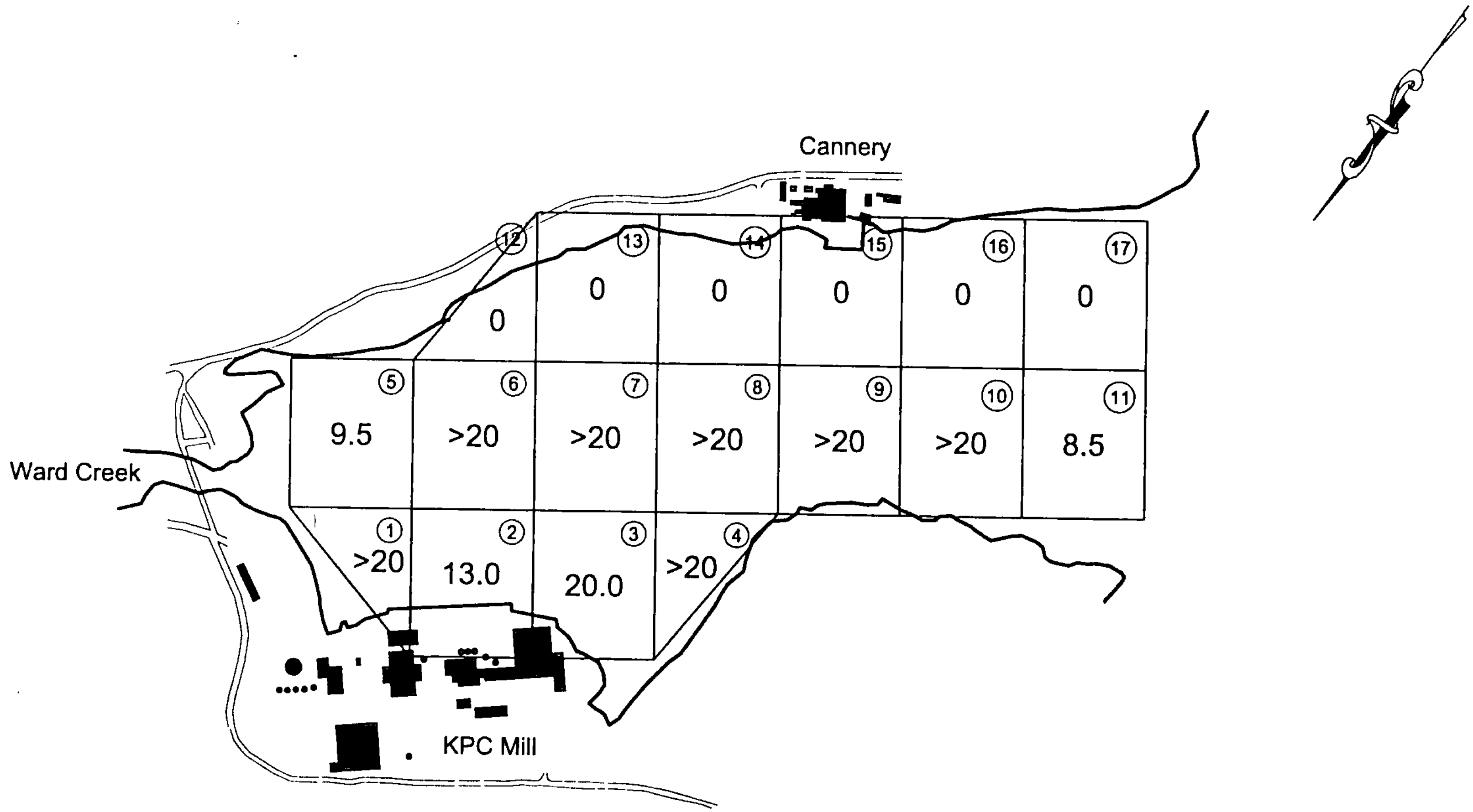
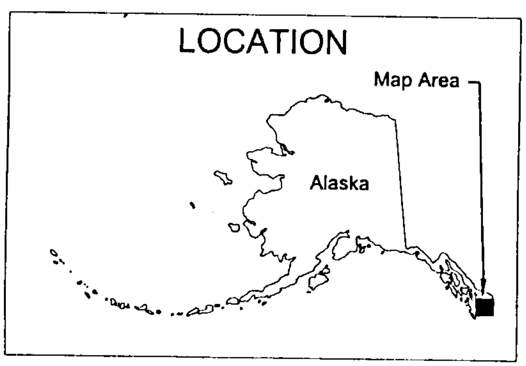
FIGURE 4-3
TOTAL ORGANIC CARBON SEDIMENT RECOVERY MODELING RESULTS

Exponent Environmental Group
Bellevue, Washington

DRAWN: N. Chin	DATE: May 29, 1998	PROJECT NO: 5543-007-700
FILE NO: 5543-007.jnb	CHECKED: C. DeGasperi	





Note: Numbers in upper right corner of segments are segment indices.

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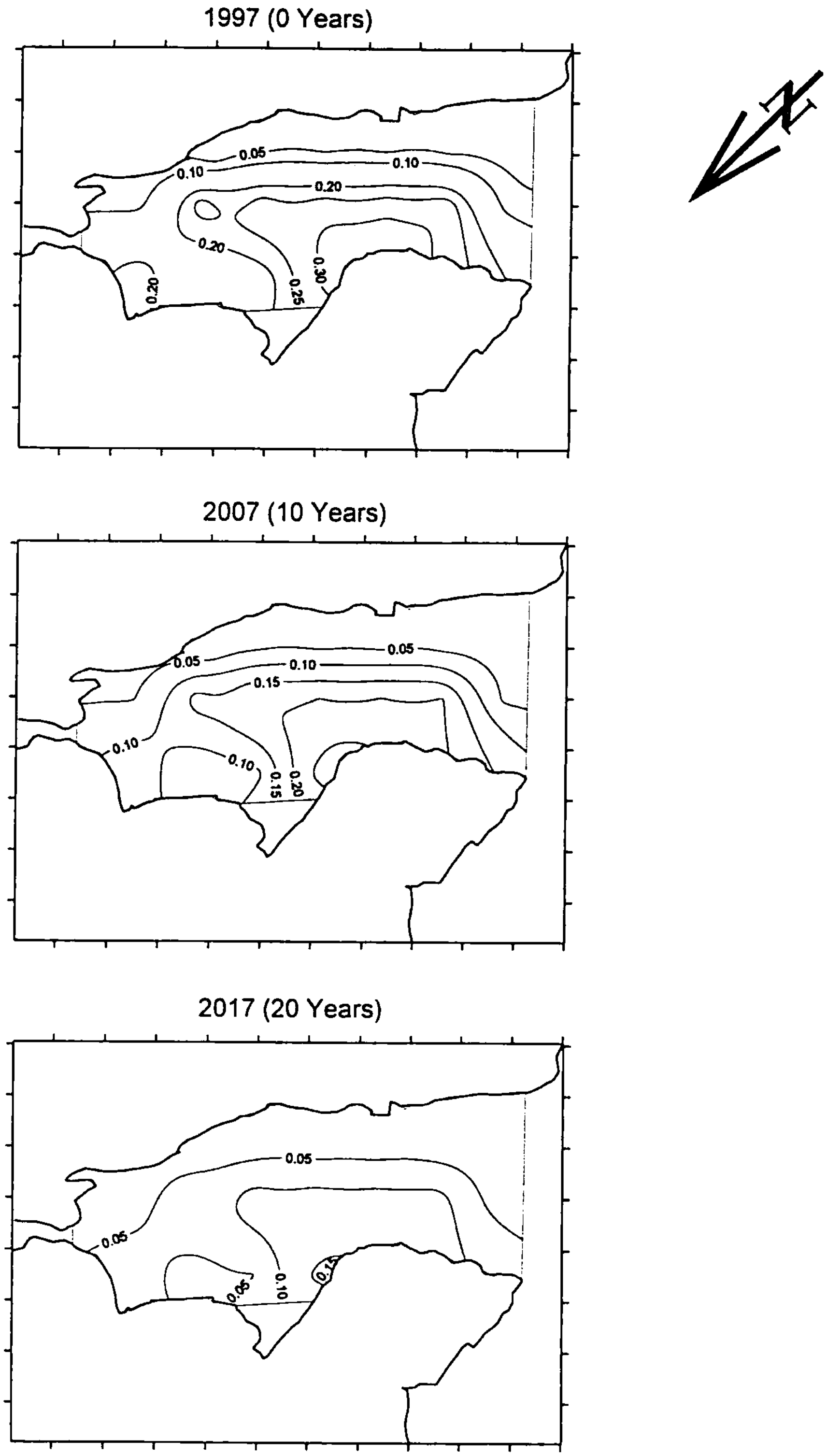
FIGURE 4-4

SUMMARY OF RECOVERY RESULTS FOR TOC, WITH RETURN TO A LEVEL OF 0.05 Kg/Kg – VALUES IN YEARS

Exponent Environmental Group
Bellevue, Washington

DRAWN: K. Mongor	DATE: June 1, 1998	PROJECT NO:
FILE NO: EEG0780U	CHECKED: S. Breithaupt	5[illegible]-007-800



Note:
Results are for 20 years of simulation. Contours of average model predicted concentrations in the top 10 cm of sediment. Units are kg TOC/kg of dry sediment solids. The WCSQV(2) = 0.31 kg/kg and WCSQV(1) = 0.30 kg/kg. Estimated background TOC content is 0.05 kg/kg. WCSQV = Ward Cove Sediment Quality Value.

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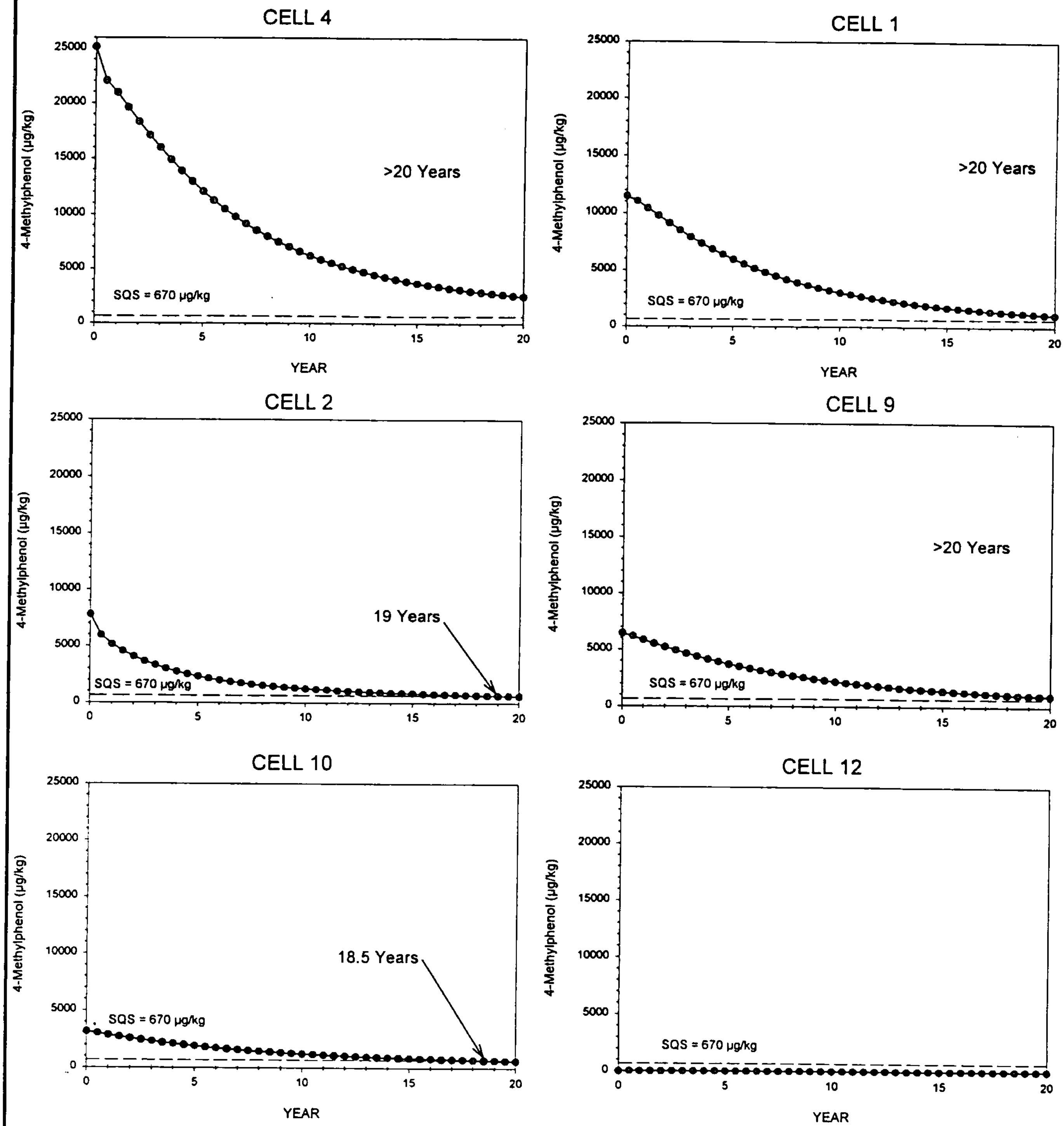
FIGURE 4-5
TOTAL ORGANIC CARBON SEDIMENT RECOVERY IN WARD COVE

Exponent Environmental Group
Bellevue, Washington

DRAWN: N. Chin	DATE: June 2, 1998	PROJECT NO: 5543-007-700
FILE NO: 5543-007.jnb	CHECKED: C. DeGasperi	



Note:
Results are for the top 10 cm of sediment.
Units are µg/kg dry sediment solids.
Sediment Quality Standard (SQS)
= 670 µg/kg.

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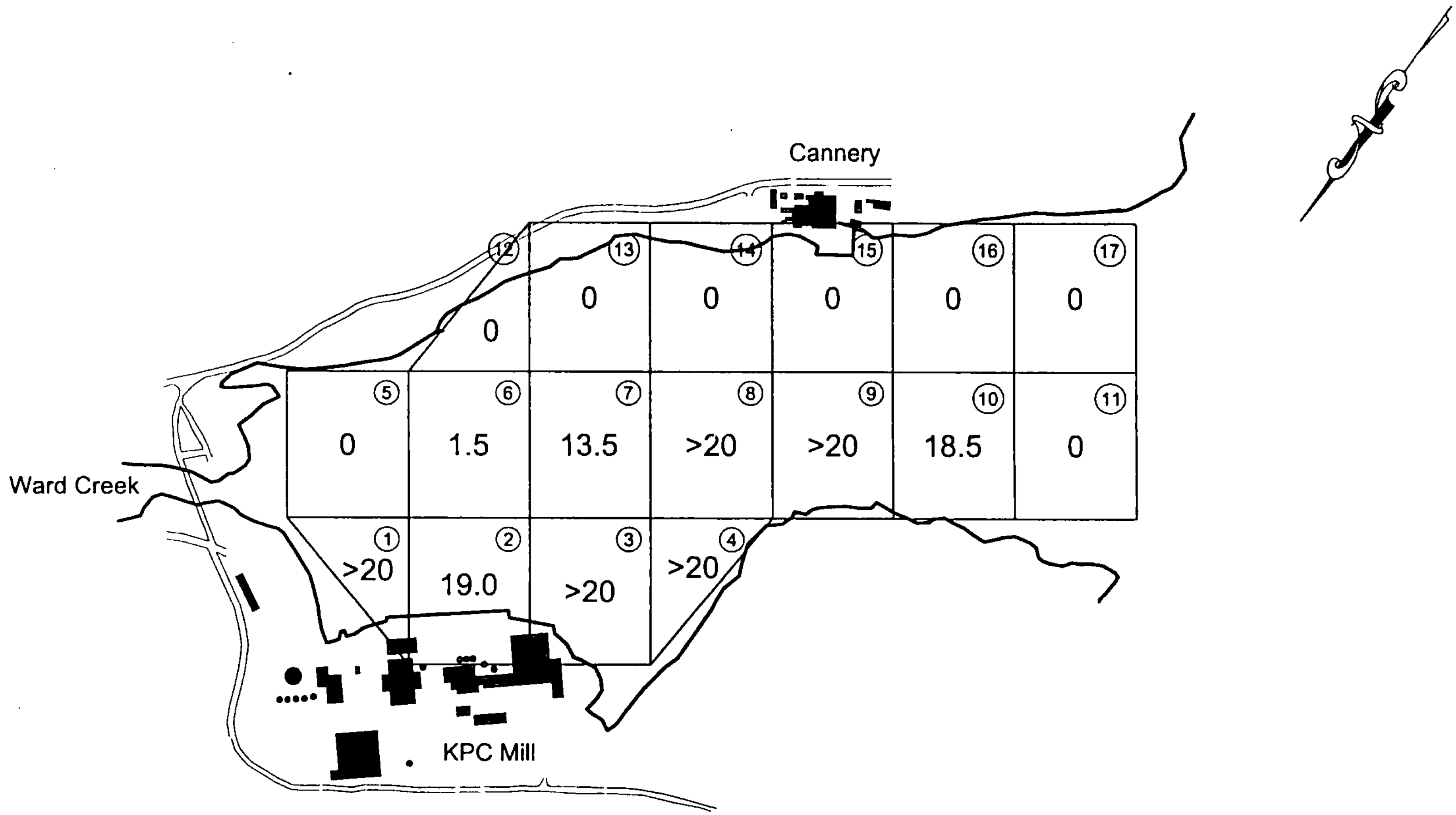
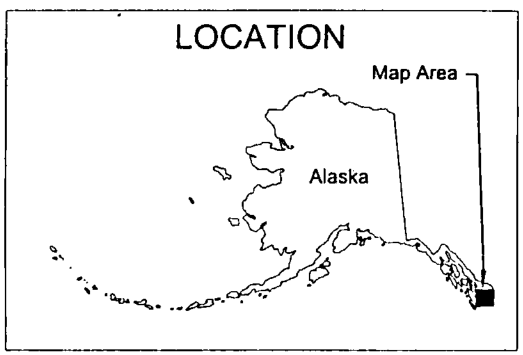
FIGURE 4-6
4-METHYLPHENOL SEDIMENT RECOVERY MODELING RESULTS

Exponent Environmental Group
Bellevue, Washington

DRAWN: N. Chin	DATE: June 2, 1998	PROJECT NO: 5543-007-700
FILE NO: 5543-007.jnb	CHECKED: C. DeGasperi	





Note: Numbers in upper right corner of segments are segment indices.

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FIGURE 4-7
SUMMARY OF RECOVERY RESULTS FOR 4-METHYLPHENOL, WITH RETURN TO LEVELS OF <670 $\mu g/Kg$ - VALUES IN YEARS

Exponent Environmental Group
Bellevue, Washington

DRAWN: K. Mongor	DATE: June 2, 1998	PROJECT NO:
FILE NO: EEG0780V	CHECKED: S. Breithaupt	5543-007-800

due to their proximity to the former KPC discharge. The high sediment concentrations of effluent solids at these locations would result in continued generation of 4-methylphenol *in situ*. Recovery in less than 10 years was predicted for cell 6 (1.5 years).

In general, recovery of sediments results from diffusion of 4-methylphenol from the sediment to the water column and a decrease in sediment organic matter content, with a corresponding decrease in the yield of 4-methylphenol from organic matter decay.

The initial level of sediment contamination, as determined from observed data, is also important. For example, the very high values attained in cell 4 during the discharge period allowed for the buildup of high levels of 4-methylphenol deeper in the sediment; this accumulation can continue to diffuse into the upper sediment layers.

Sediment deposition from native solids has minimal impact on recovery due to low loading and settling rates of solids discharged from Ward Creek (Section 4.3.3.).

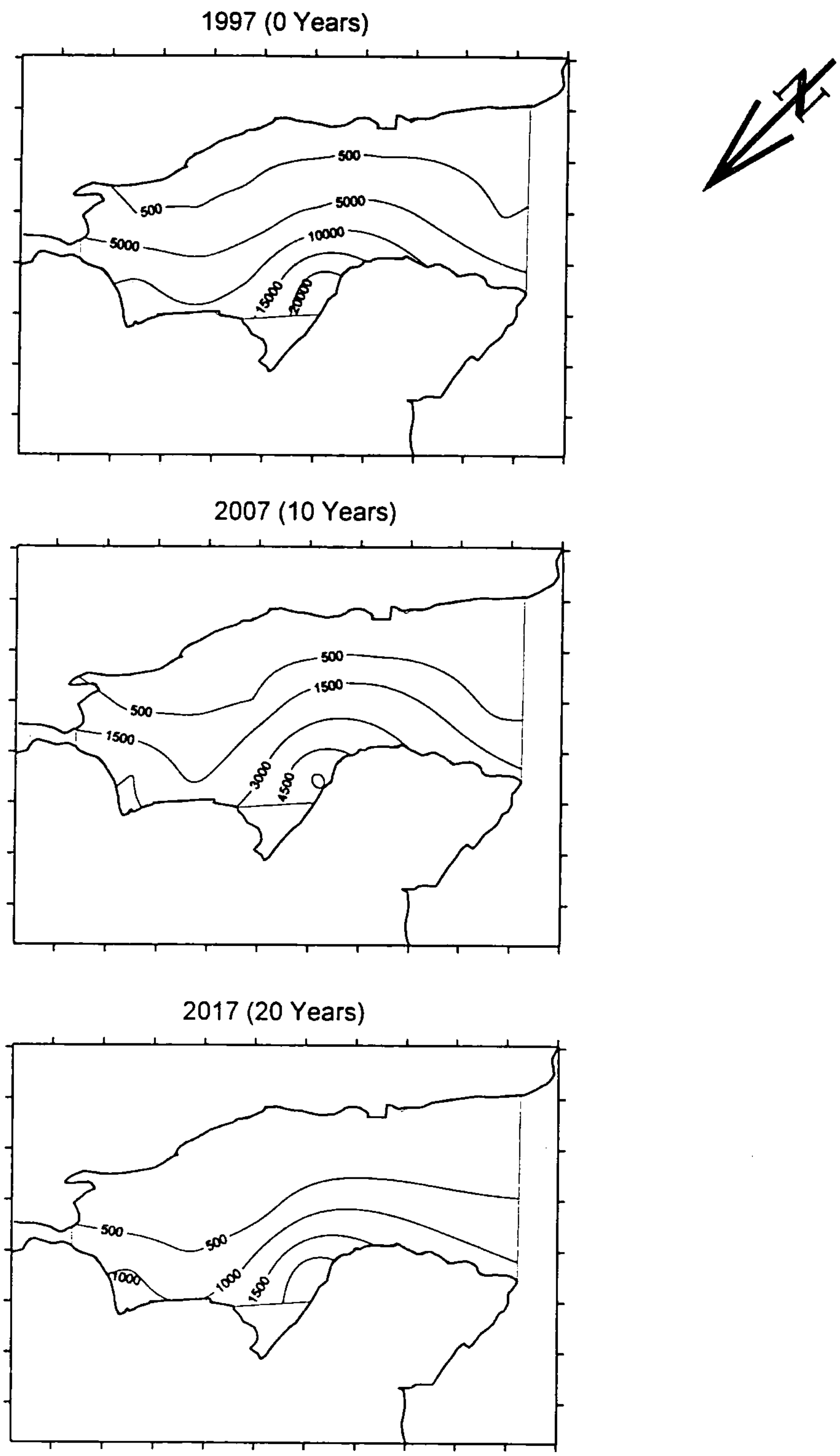
Contour plots of model-predicted sediment 4-methylphenol concentrations in 1997 (Year 0), 2007 (Year 10), and 2017 (Year 20) are provided in Figure 4-8. This time series of sediment recovery shows that the highest levels of 4-methylphenol decrease throughout the cove. After 20 years, concentrations exceeding the SQS (670 μg/kg) persist along the northern shore of the cove.

4.2.2.3 Ammonia

Sediment ammonia recovery results for selected cells are illustrated in Figure 4-9. Figure 4-10 provides an overview of recovery periods for all model cells. The initial conditions in model cells 5 and 6, and 12-17 were below the WCSQV(1) of 88 mg/kg and are not discussed further. The model-predicted recovery times were greater than 20 years (to below WCSQV[1] of 88 mg/kg) for cells 3, 4, 8, 9, and 10; this was expected due to their proximity to the former discharge. Recovery in less than 10 years (to below WCSQV[1]) was predicted for cells 7 and 11. Recovery in cell 2 to below the WCSQV(1) was predicted to require 13.5 years, but recovery to the WCSQV(2) of 99 mg/kg was predicted to take 9.5 years.

Similar to 4-methylphenol, recovery of sediments from ammonia contamination would result from diffusion to the water column from the sediment and a decrease in sediment organic matter content. As with 4-methylphenol, the very high values attained in cell 4 during the discharge period allowed for the buildup of high levels of ammonia deeper in the sediment. Sediment deposition from native solids has minimal impact on recovery due to low loading and settling rates of Ward Cove-derived solids (Section 4.3.3).

Contour plots of model-predicted sediment ammonia concentrations in 1997 (Year 0), 2007 (Year 10), and 2017 (Year 20) are provided in Figure 4-11. This time series of sediment recovery shows that the



Note:
Results are for 20 years of simulation. Contours of average model predicted concentrations in the top 10 cm of sediment. Units are µg/kg of dry sediment solids. The SQS = 670 µg/kg. SQS = Sediment Quality Standard.

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FIGURE 4-8

4-METHYLPHENOL SEDIMENT RECOVERY IN WARD COVE

Exponent Environmental Group
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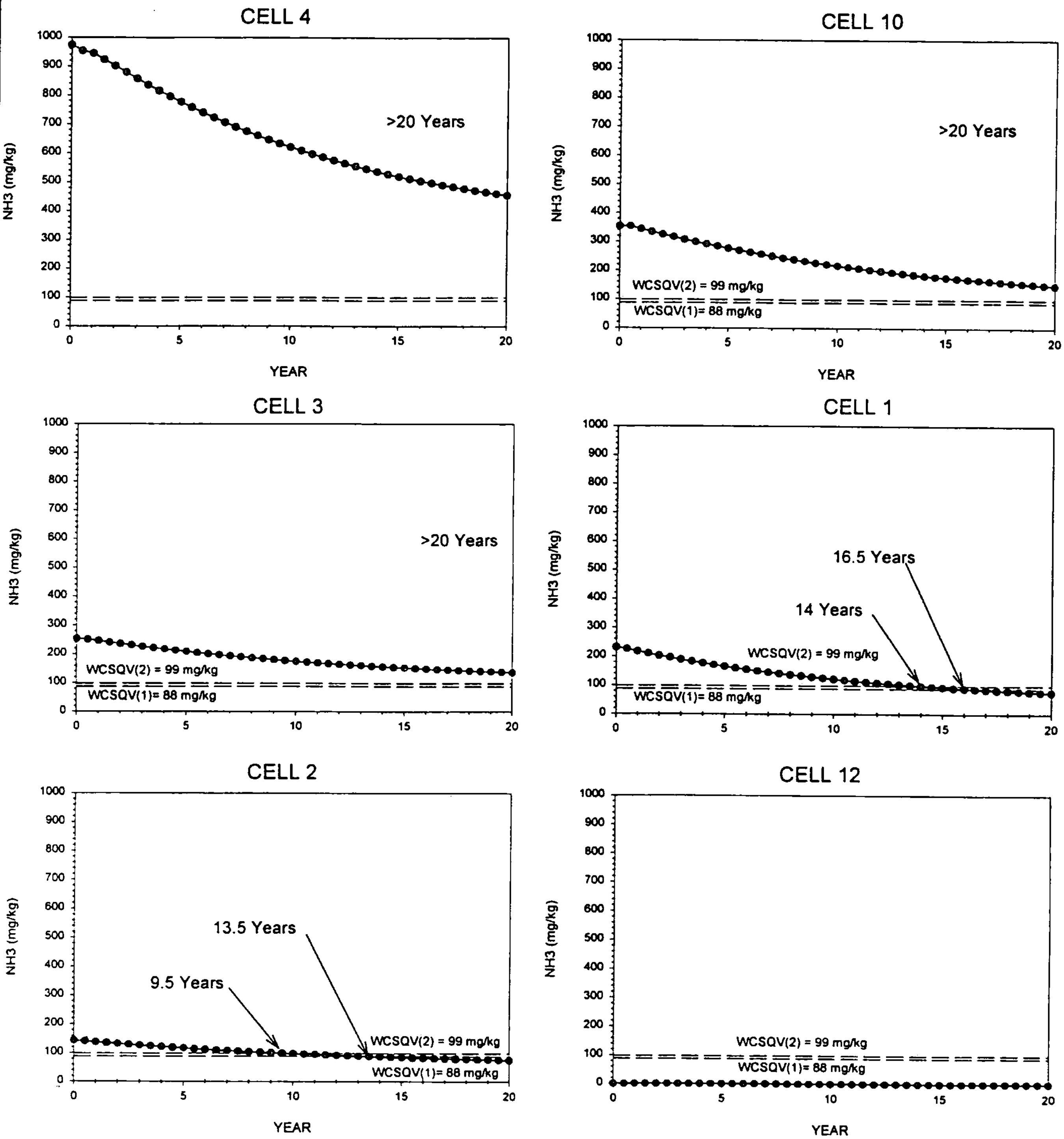
DRAWN: N. Chin	DATE: June 2, 1998	PROJECT NO: 5543-007-700
FILE NO: 5543-007.jnb	CHECKED: C. DeGasperi	



Note:
Results are for the top 10 cm of sediment.
Units are in mg/kg dry sediment solids.
Ward Cove Sediment Quality Value
(WCSQV) = 88 AND 99 mg/kg.

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FIGURE 4-9
AMMONIA SEDIMENT
RECOVERY MODELING RESULTS

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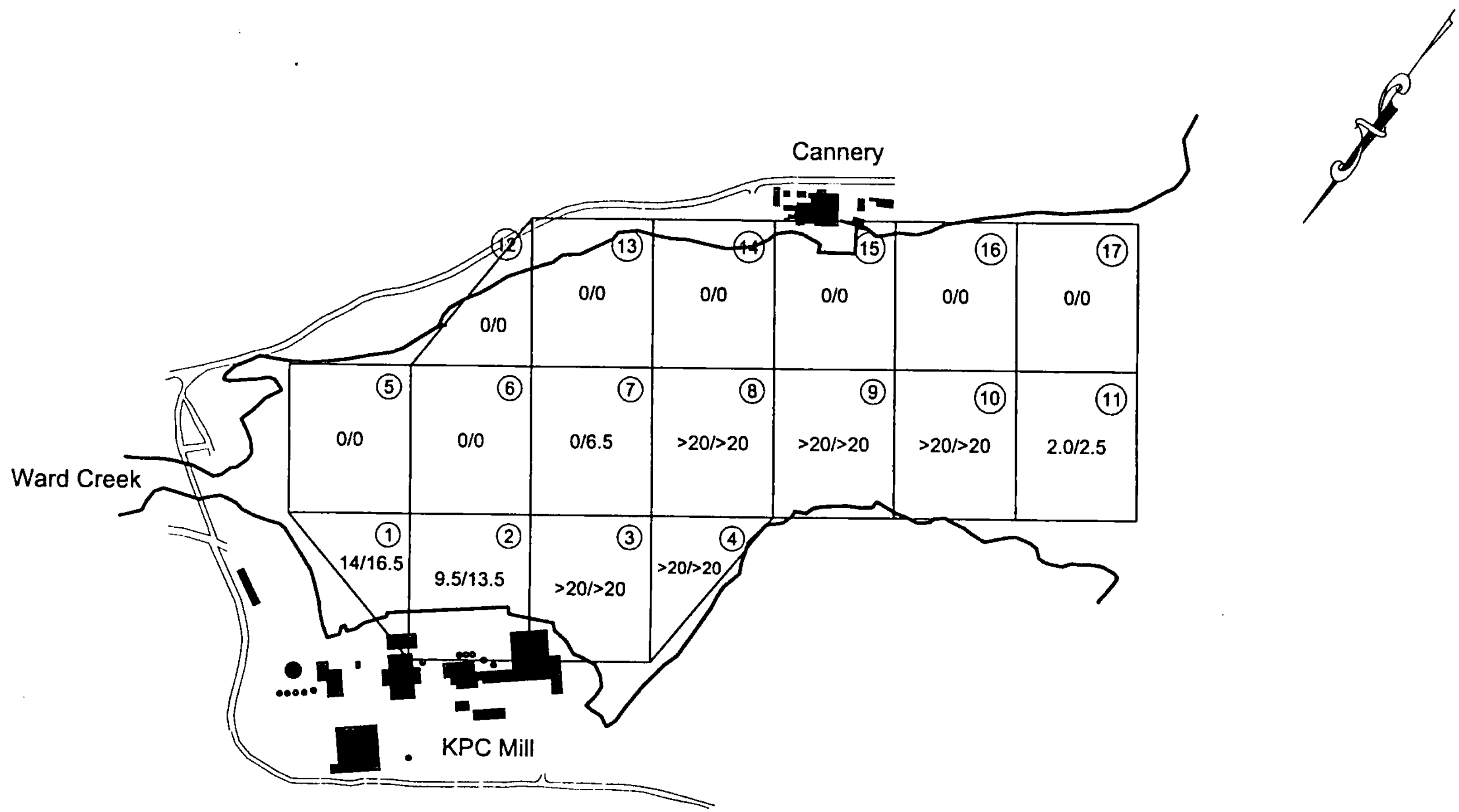

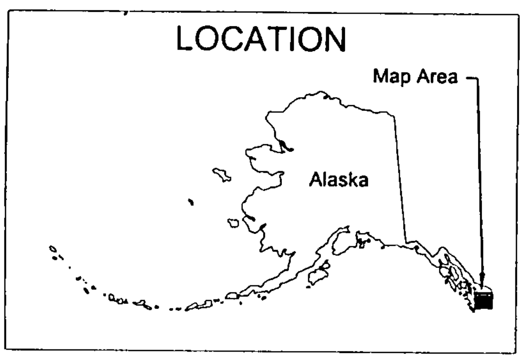

Note: Numbers in upper right corner of segments are segment indices.

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FIGURE 4-10
SUMMARY OF RECOVERY RESULTS FOR AMMONIA, WITH RETURN TO LEVELS <99 AND <88 mg/Kg - VALUES IN YEARS
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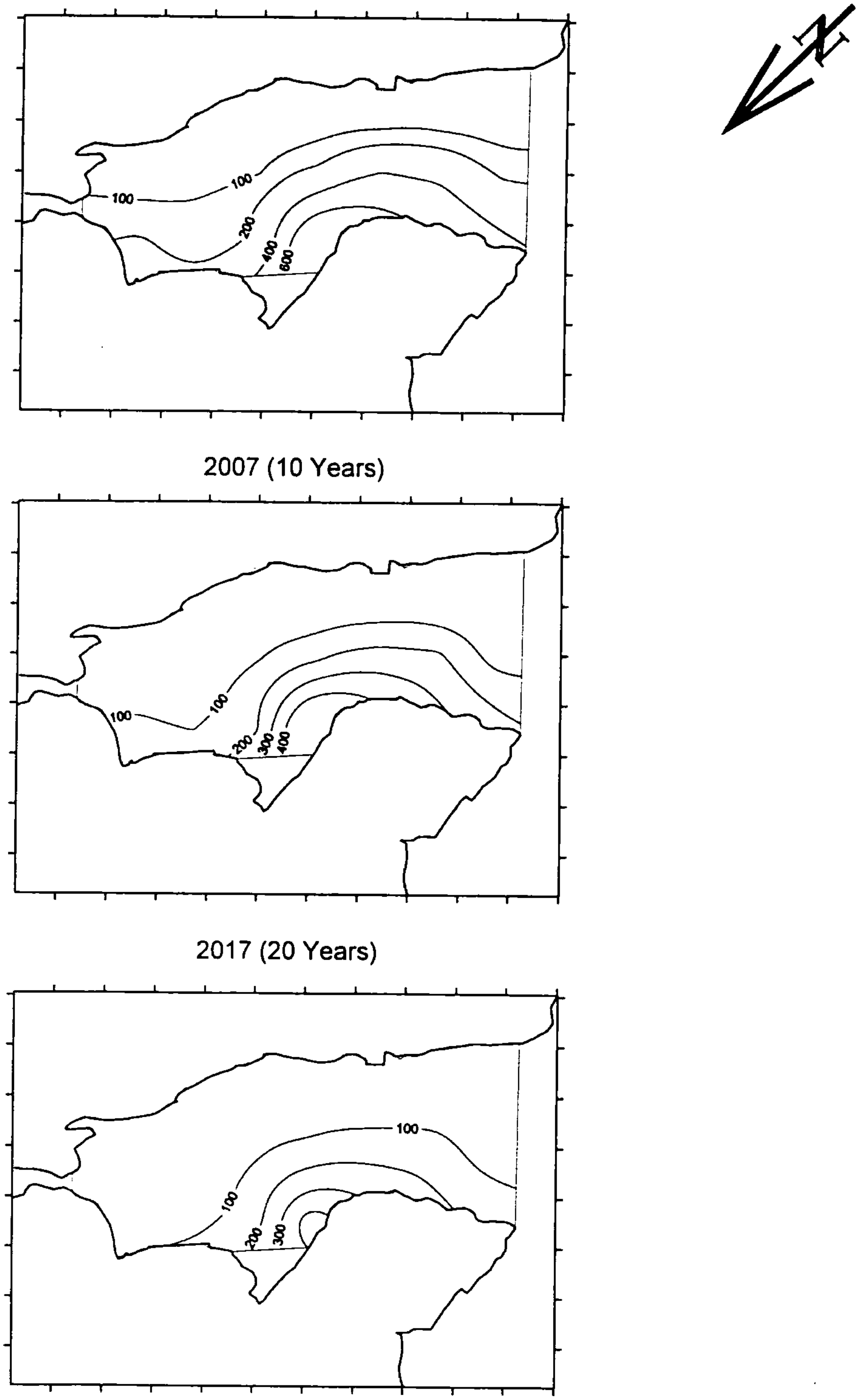
FILE NO: EEG0780W	CHECKED: S. Breithaupt	5543-007-800

1997 (0 Years)

2007 (10 Years)

2017 (20 Years)



Note:
Results are for 20 years of simulation. Contours of average model predicted concentrations in the top 10 cm of sediment. Units are mg/kg of dry sediment solids. The WCSQV(2) = 99 mg/kg and WCSQV(1) = 88 mg/kg. WCSQV = Ward Cove Sediment Quality Value.

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FIGURE 4-11
AMMONIA SEDIMENT RECOVERY IN WARD COVE

Exponent Environmental Group
Bellevue, Washington

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FILE NO: 5543-007.jnb	CHECKED: C. DeGasperi	

highest levels of ammonia decrease throughout the cove, with concentrations that exceed the WCSQVs persisting along the northern shore.

4.2.2.4 Sulfide

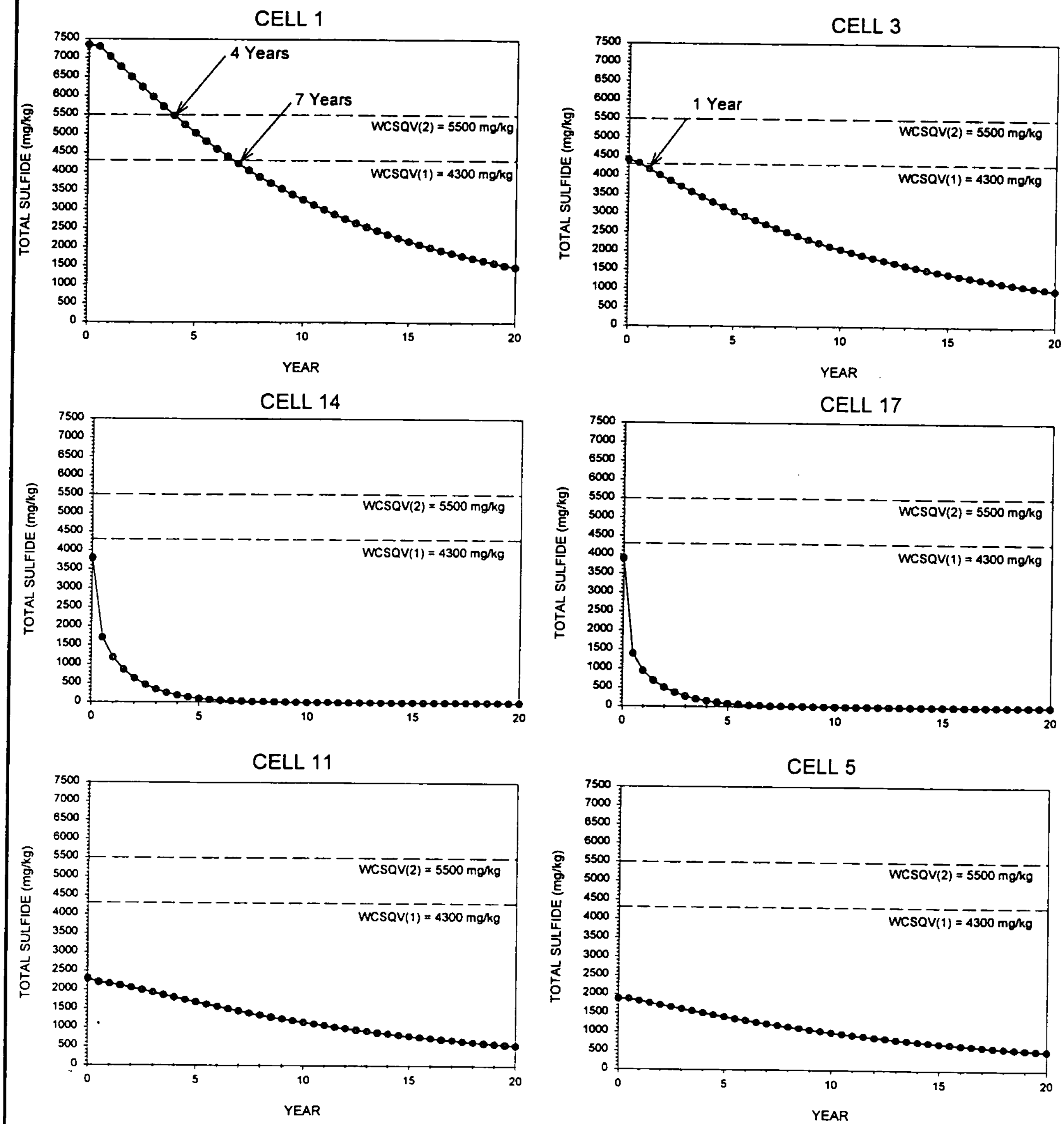
Sulfide recovery results for selected cells are illustrated in Figure 4-12. Figure 4-13 provides an overview of recovery periods for all model cells. The initial conditions in model cells 2, 4, and 5, 9-12, and 14-17 were below the WCSQV(1) of 4,300 mg/kg. The initial distribution of sulfide is consistent with the observed 1997 distribution, which shows concentrations greater than 6,000 mg/kg in the inner-central portion of the cove and another area of elevated concentration just offshore of the KPC facility. Recovery in less than 10 years was predicted for all cells with an initial concentration greater than the WCSQV(1). The longest recovery time (to the WCSQV[1]) was predicted for cells 6 and 7 (7.5 years). These cells are located in the inner-central portion of the cove.

In general, recovery of sediments from sulfide contamination results from diffusion from the sediments to the water column and a decrease in sediment organic matter content, with a corresponding decrease in the yield of sulfide from reduction of sulfate during anaerobic organic matter decay. The initial level of sediment contamination (as determined from observed data) is also important. As with 4-methylphenol, sulfide located deep within the sediment can also continue to diffuse into the upper sediment layers, though this is not as important as the other dissolved constituents.

Contour plots of model-predicted sediment sulfide concentrations in 1997 (Year 0), 2007 (Year 10), and 2017 (Year 20) are provided in Figure 4-14. This time series of sediment recovery shows that the highest levels of sulfide decrease throughout the cove, with concentrations falling below the WCSQVs within 10 years.

4.3 Tier-2 Model Sensitivity Analysis

Model sensitivity analyses were performed to evaluate the effect of perturbations of rate coefficients or configuration parameters on the model-predicted recovery times. Four analyses were performed: 1) sensitivity of the model to changes in the calibrated organic solids decay rate (K_d), 2) sensitivity to a change in the thickness of the surficial sediment segment, 3) sensitivity to a change in the native solids settling velocity, and 4) sensitivity of the model-predicted recovery of 4-methylphenol to the aerobic and anaerobic decay rate specified in the model. The results of the first three sensitivity analyses are summarized in Table 4-12.



Note:
Results are for the top 10 cm of sediment.
Units are mg/kg dry sediment solids.
Ward Cove Sediment Quality Value
(WCSQV) = 4300 and 5500 mg/kg.

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FIGURE 4-12
SULFIDE SEDIMENT
RECOVERY MODELING RESULTS

Exponent Environmental Group
Bellevue, Washington

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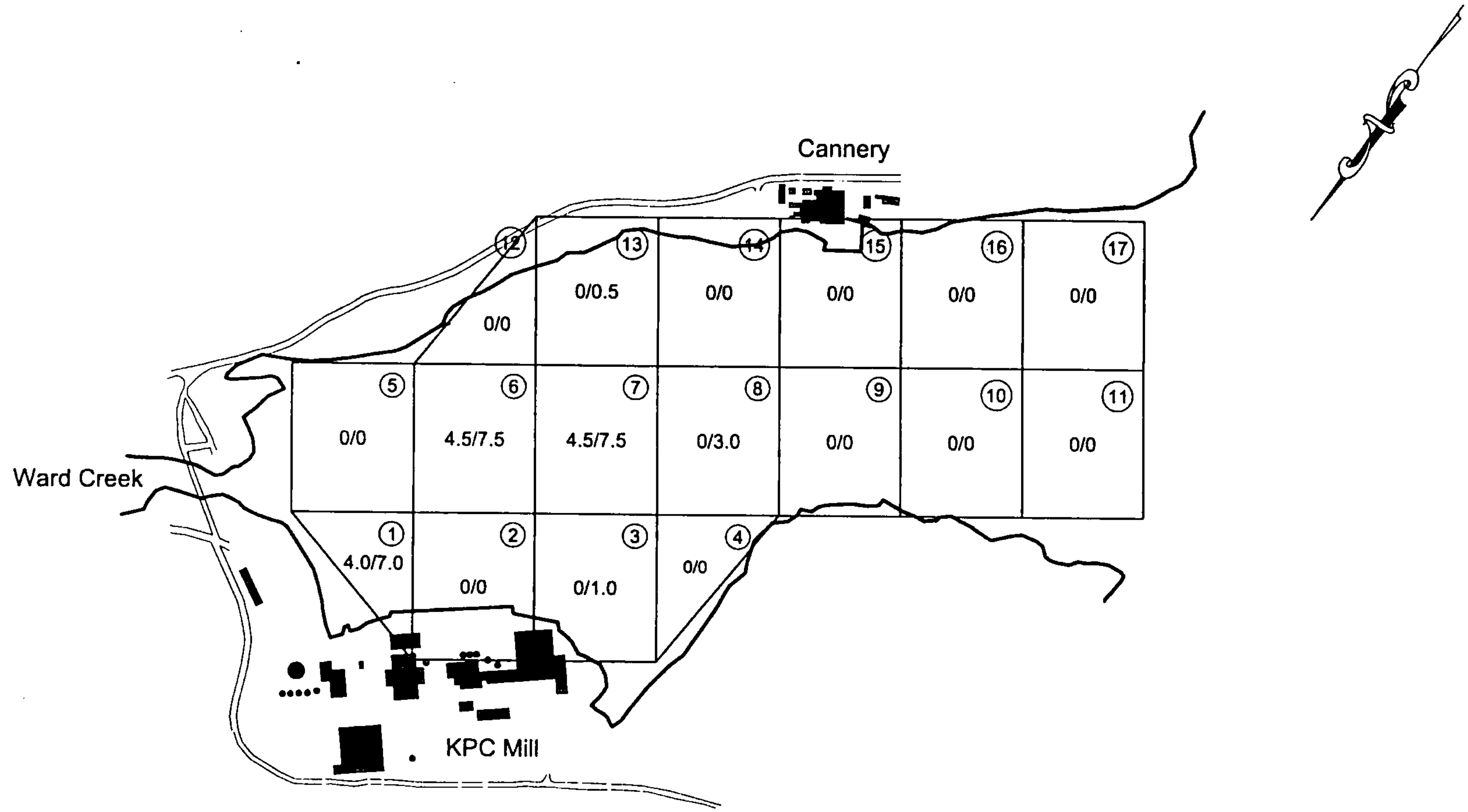

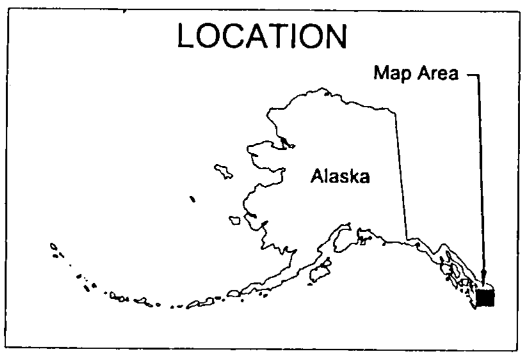

Note: Numbers in upper right corner of segments are segment indices.

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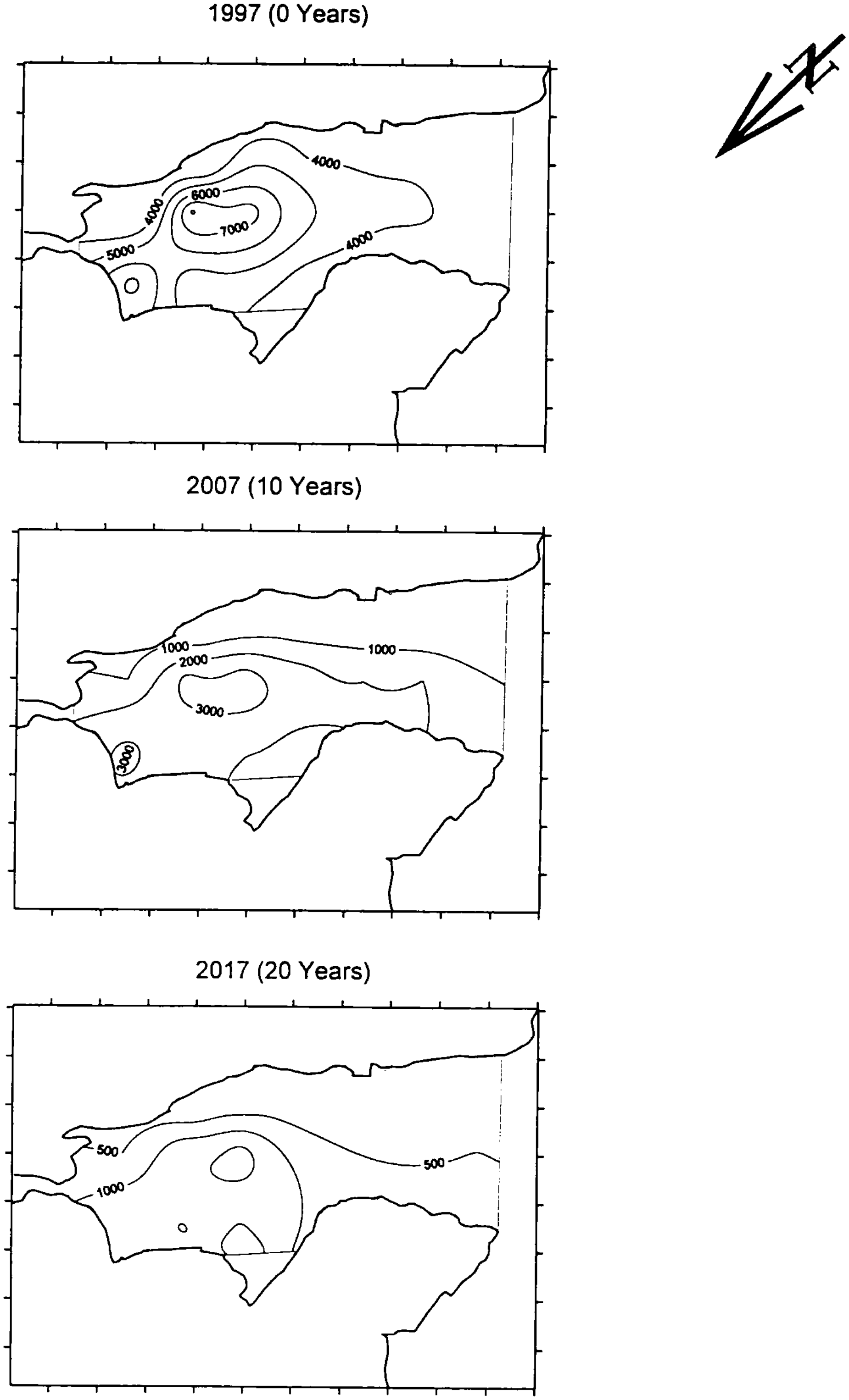
FIGURE 4-13
SUMMARY OF RECOVERY RESULTS FOR SULFIDE, WITH RETURN TO LEVELS <5500 AND <4300 Kg/Kg – VALUES IN YEARS

Exponent Environmental Group
Bellevue, Washington

DRAWN: K. Mongar	DATE: June 1, 1998	PROJECT NO:
FILE NO: EEG0780X	CHECKED: S. Breithaupt	5543-007-800



Note:
Results are for 20 years of simulation. Contours of average model predicted concentrations in the top 10 cm of sediment. Units are mg/kg of dry sediment solids. The WCSQV(2) = 5500 mg/kg and WCSQV(1) = 4300 mg/kg. WCSQV = Ward Cove Sediment Quality Value.

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FIGURE 4-14
SULFIDE SEDIMENT
RECOVERY MODELING RESULTS

Exponent Environmental Group
Bellevue, Washington

DRAWN: N. Chin	DATE: June 2, 1998	PROJECT NO: 5543-007-700
FILE NO: 5543-007.jnb	CHECKED: C. DeGasperi	

Table 4-12

Summary of Tier-2 Model Sensitivity Analysis Results

Cell	Kd= 1.0e-04/day[a]	Base Run[b] Kd= 2.0e-04/day	Kd= 4.0e-04/day[c]	Sediment Segment Resolution[d]	$V_{solids2}$= 40 m/day[e]
	TOC Recovery Time in Years[d]				
1	>20	>20	13	>20	>20
2	>20	13	6.5	12.5	13
3	>20	20	10	19.5	20
4	>20 (-/9.5)	>20 (-/5)	19.5 (-/3)	>20 (-/2.5)	>20 (-/5)
5	18	9.5	5	9	9
6	>20	>20	15	>20	>20
7	>20	>20	17.5	>20	>20
8	>20	>20	17.5	>20	>20
9	>20	>20	17.5	>20	>20
10	>20	>20	17.5	>20	>20
11	16.5	8.5	4.5	8.5	8.5
12	-	-	-	-	-
13	-	-	-	-	-
14	-	-	-	-	-
15	-	-	-	-	-
16	-	-	-	-	-
17	-	-	-	-	-
	Ammonia Recovery Time in Years[g]				
1	18/>20	14/16.5	7.5/8.5	18/>20	14.5/17
2	3.5/10.5	9.5/13.5	5.5/7.5	17/>20	10/14
3	>20/>20	>20/>20	>20/>20	>20/>20	>20/>20
4	>20/>20	>20/>20	>20/>20	>20/>20	>20/>20
5	-/-	-/-	-/-	-/-	-/-
6	-/-	-/-	-/-	-/-	-/-
7	-/13.5	-/6.5	-/4	-/5	-/7
8	>20/>20	>20/>20	20/>20	>20/>20	>20/>20
9	>20/>20	>20/>20	19.5/>20	>20/>20	>20/>20
10	>20/>20	>20/>20	>20/>20	>20/>20	>20/>20
11	0.5/1	2.0/2.5	5/6	12/15	1.5/2.5
12	-/-	-/-	-/-	-/-	-/-
13	-/-	-/-	-/-	-/-	-/-
14	-/-	-/-	-/-	-/-	-/-
15	-/-	-/-	-/-	-/-	-/-
16	-/-	-/-	-/-	-/-	-/-
17	-/-	-/-	-/-	-/-	-/-

Cell	Kd= 1.0e-04/day[a]	Base Run[b] Kd= 2.0e-04/day	Kd= 4.0e-04/day[c]	Sediment Segment Resolution[d]	$V_{solids2}$= 40 m/day[e]
	4-Methylphenol Recovery Time in Years[f]				
1	>20	>20	14.5	>20	>20
2	>20	19	13	>20	19.5
3	>20	>20	17.5	>20	>20
4	>20	>20	>20	>20	>20
5	-	-	-	-	-
6	2	1.5	1	1.5	1.5
7	>20	13.5	6.5	18	14.5
8	>20	>20	13	>20	>20
9	>20	>20	12.5	>20	>20
10	>20	18.5	9.5	>20	19
11	-	-	-	-	-
12	-	-	-	-	-
13	-	-	-	-	-
14	-	-	-	-	-
15	-	-	-	-	-
16	-	-	-	-	-
17	-	-	-	-	-
	Sulfide Recovery Time in Years[f]				
1	0.5/1.5	4/7	2/3.5	1/2	2.5/4.5
2	-/-	-/-	-/-	-/-	-/-
3	-/0.5	-/1	-/0.5	-/0.5	-/0.5
4	-/-	-/-	-/-	-/-	-/-
5	-/-	-/-	-/-	-/-	-/-
6	1.5/3	4.5/7.5	2.5/3.5	2.5/4	4/6
7	5/11	4.5/7.5	2.5/4	4/7	4.5/8
8	-/1.5	-/3	-/1.5	-/3	-/3
9	-/-	-/-	-/-	-/-	-/-
10	-/-	-/-	-/-	-/-	-/-
11	-/-	-/-	-/-	-/-	-/-
12	-/-	-/-	-/-	-/-	-/-
13	-/0.5	-/0.5	-/0.5	-/0.5	-/0.5
14	-/-	-/-	-/-	-/-	-/-
15	-/-	-/-	-/-	-/-	-/-
16	-/-	-/-	-/-	-/-	-/-
17	-/-	-/-	-/-	-/-	-/-

"-" = Model initial condition was below the applicable Sediment Quality Standard (SQS) or Ward Cove Sediment Quality Value (WCSQV).
[a] Model run with a organic solids decay rate half that used in the Base Run (K_d=1.0x10^{-4}).
[b] The Base Run (calibrated Tier 2 model) has 2-cm thick segments in the top20 cm and a solids2 settling velocity of 20 m/day.
[c] Model run with a organic solids decay rate twice that used in the Base Run (K_d=4.0x10^{-4}).
[d] The 10-cm sediment segment run has two 10-cm thick segments in the top 20 cm.
[e] Model run with a native solids (solids2) settling velocity twice that used in the Base Run (40 m/day).
[d] Recovery time to the background sediment. Results in parentheses for cell 4 are for: Recovery time to WCSQV(2) [0.31 kg/kg]/WCSQV(1) [0.30 kg/kg].
[f] Recovery time to WCSQV(2) [99 mg/kg]/Recovery time to WCSQV(1) [88 mg/kg].
[g] Recovery time to WCSQV(2) [5500 mg/kg]/Recovery time to WCSQV(1) [4300 mg/kg].

4.3.1 Organic Solids Decay Rate

To evaluate the sensitivity of the model to the organic solids decay rate (K_d), model recovery runs were conducted by either increasing or decreasing the calibrated decay rate (2.0×10^{-4}) by a factor of two. Example recovery results for each of the four CoPCs modeled are shown in Figure 4-15, using a representative model cell.

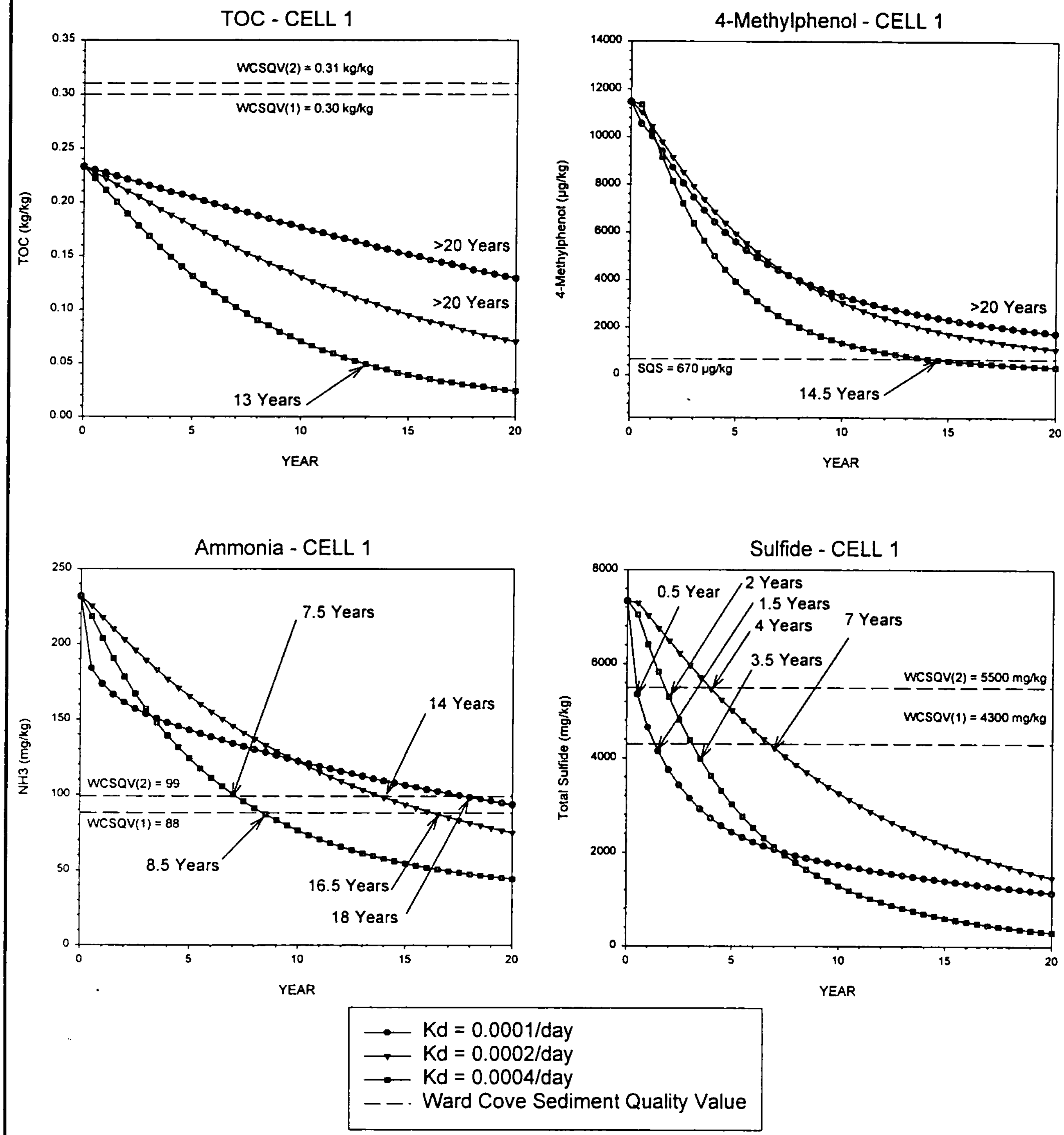
The effect of increasing or decreasing the organic solids decay rate on TOC recovery times is straightforward. Increasing the decay rate increases the rate of organic mater decay and decreases the predicted recovery times (Table 4-12). Decreasing the decay rate has the opposite effect. For example, the model run using a value half of the calibrated model decay rate resulted in an approximate doubling of the model-predicted recovery time for TOC in cell 11 (16.5 vs. 8.5 years). A doubling of the decay rate approximately halved the model-predicted recovery time in the same cell (4.5 vs. 8.5 years).

The effect on the other CoPCs modeled is more complicated due to the interaction of organic solids decay and diffusion of CoPCs generated from deeper, TOC-rich sediments accumulated during the period of KPC discharge. For example, the recovery rate for sediment sulfide in cell 1 at the lowest decay rate is initially more rapid than that at higher modeled decay rates (Figure 4-15). This is due to slower generation of sulfide from deeper sediments and diffusion of sulfide from the sediment to the water column. However, as time progresses, diffusion of sulfide from deeper sediments and the slower decay of sediment TOC, which causes sulfide production, slows the recovery process so that the rate of decline decreases in comparison with the base run. This same process is evident with 4-methylphenol and ammonia, as well. It shows the sediment column reestablishing equilibrium.

4.3.2 Sediment Segment Resolution

Sensitivity of the model to a change in the thickness of the uppermost sediment segments was evaluated by altering the model configuration for these segments. The Tier-2-calibrated model consisted of 12 sediment segments in each model cell with 2-cm thick segments in the top 20-cm, followed by an 8-cm layer, and a 10-m bottom layer. This configuration was altered so the model had two 10-cm thick segments in the top 20 cm, followed by 8-cm and 10-m thick segments. The modification of the sediment segments also required re-scaling the initial conditions of the recovery model. Model recovery runs were then conducted using the revised configuration and initial conditions for each CoPC. Example recovery results for each of the four CoPCs modeled, for a representative model cell, are shown in Figure 4-16.

The effect of changing the sediment segment resolution on TOC recovery was negligible. This was expected because accumulated sediment TOC mass would not be affected by changes in the sediment segment thickness. However, changes in the sediment segment resolution did affect the predicted recovery of the other CoPCs. Because of the interaction of diffusion and the generation of the modeled CoPCs from the decay of organic matter, the effect of this change in the model configuration varied for



Note:
Results are for the top 10 cm of sediment.

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FIGURE 4-15
ORGANIC SOLIDS DECAY RATE SENSITIVITY ANALYSIS FOR CELL 1

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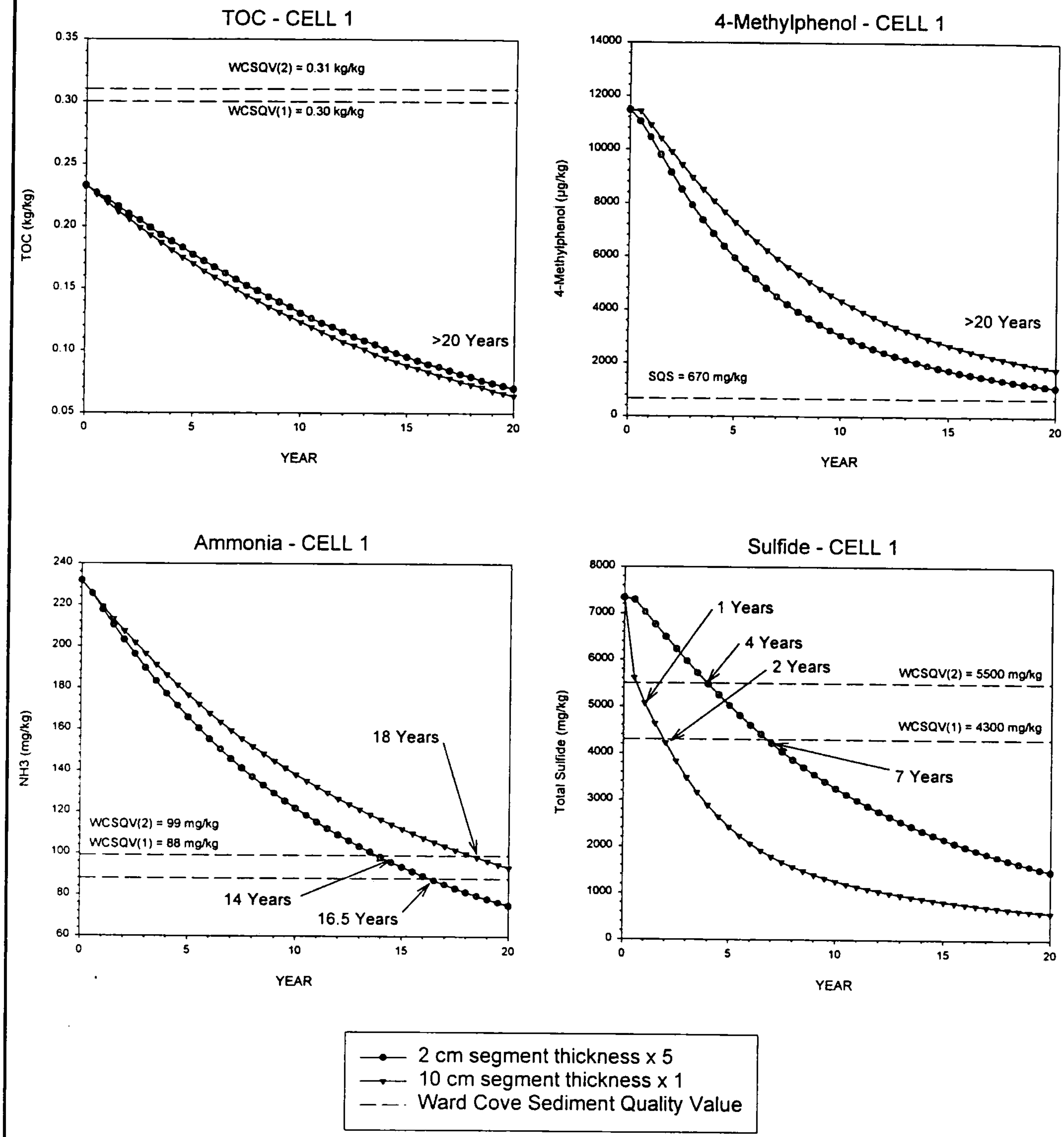

Note:
Results are for the top 10 cm of sediment.

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FIGURE 4-16
SEDIMENT SEGMENT RESOLUTION SENSITIVITY ANALYSIS FOR CELL 1

Exponent Environmental Group
Bellevue, Washington

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each CoPC. For example, the model-predicted recovery time for sediment 4-methylphenol and ammonia increased in cell 1, while the recovery time for sulfide decreased (Figure 4-16).

Increasing the thickness of the surface sediment segments increases the distance over which diffusion occurs. This results in slower diffusion of CoPCs from the sediment to the water column and an increase in model-predicted recovery times for sediment 4-methylphenol and ammonia. A slower diffusion rate has the opposite effect on sediment sulfide recovery because sulfide production is dependent on the diffusion of sulfate into the sediment. Slower penetration of sulfate into the sediment reduces the production of sediment sulfide and decreases the model-predicted recovery times (Figure 4-16: Sulfide Cell 1).

4.3.3 Native Solids Settling Velocity

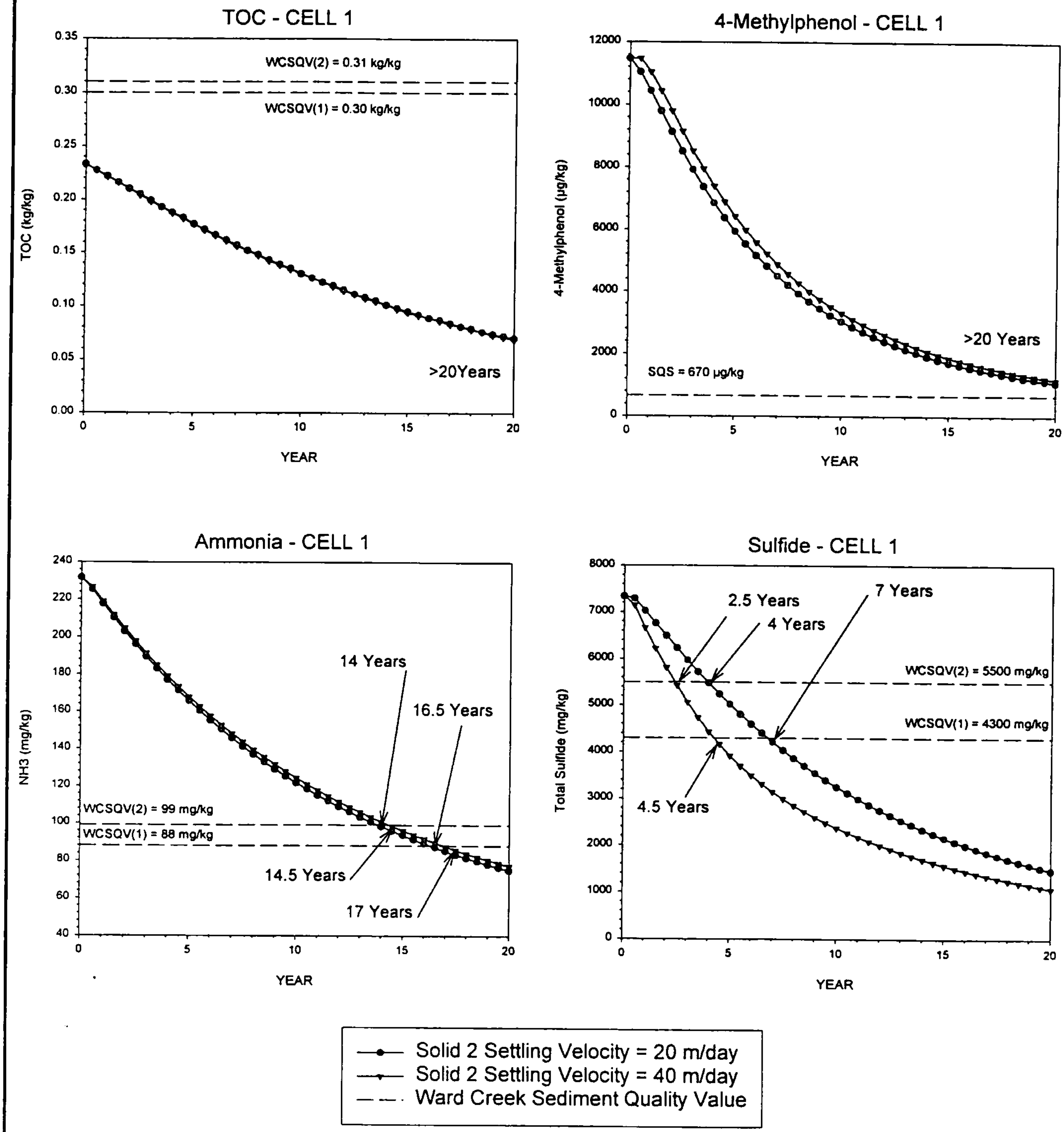
To evaluate the model sensitivity to a change in the settling velocity of native solids (solids2), the Tier-2 calibration value of 20 m/day (0.023 cm/s) was increased to 40 m/day (0.046 cm/s). Model recovery runs were then conducted using the revised native solids settling velocity. Because the source of native solids is Ward Creek at the head of the cove, an increase in the solids2 settling velocity will result in greater sediment deposition (and increased burial rates) near the mouth of the creek (i.e., Tier-2 model cell 5). Example recovery results for each of the four CoPCs modeled, for a representative model cell, are shown in Figure 4-17.

The effect of increasing the native solids settling velocity on TOC recovery times was insignificant (Figure 4-17). Model-predicted recovery times for 4-methylphenol and ammonia in sediment were also relatively insensitive to the solids2 settling velocity increase. Model-predicted recovery times were unaffected or increased by a half-year. However, a doubling of the solids2 settling velocity significantly decreased model-predicted recovery times for sulfide. For example, recovery time to WCSQV(1) in cell 1 decreased from 7 to 4.5 years with a doubling of the solids2 settling velocity from 20 to 40 m/day.

It might be expected that increasing the native solids settling velocity would decrease recovery times near the mouth of Ward Creek and increase recovery times at locations farther from the creek mouth. However, burial of CoPCs also increases the distance over which diffusion of CoPCs (and sulfate) occurs by displacing solids1 (deposited effluent solids) downward. As with the sediment segment resolution analysis, increasing this distance slows diffusion losses of CoPCs and slows the penetration of sulfate into the sediment. The overall effect is to slightly increase model-predicted recovery times for 4-methylphenol and ammonia and decrease recovery times for sulfide.

4.3.4 4-Methylphenol Decay Rate

Sensitivity of the model to prediction of sediment recovery times for 4-methylphenol was evaluated by reducing the aerobic and anaerobic 4-methylphenol decay rates used by a factor of two. The aerobic decay rate of 0.390/day applied to the water column was reduced to 0.195/day, and the anaerobic decay rate of 0.026/day applied to sediment was reduced to 0.013/day. The recovery model run using the lower 4-methylphenol decay rate showed no significant change in the model-predicted recovery times for this CoPC. This result indicates that the model-predicted recovery time for 4-methylphenol is relatively insensitive to the model decay rate for this compound.



Note:
Results are for the top 10 cm of sediment. The source of Solid 2 is Ward Creek.

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FIGURE 4-17
SOLID 2 SETTLING VELOCITY SENSITIVITY ANALYSIS FOR CELL 1

Exponent Environmental Group
Bellevue, Washington

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FILE NO: 5543-007.jnb	CHECKED: C. DeGasperi	

5.0 CONCLUSIONS

A conceptual model of the significant fate and transport processes governing the concentrations of four sediment CoPCs (TOC, 4-methylphenol, ammonia, and sulfide) was developed. Based on this conceptual model, EPA's WASP toxics model (TOXI5) was modified and a screening-level box model (the Tier-1 model) was calibrated to the sediment measurements made in 1997 (PTI 1997a). The calibrated model was then applied to predict Ward Cove sediment recovery. Calibration of the model and evaluation of sediment recovery was based on comparison of the model-predicted concentrations in the top 10-cm of sediment to the appropriate SQS or WCSQV.

Because the area-weighted average TOC content of the cove was less than the WCSQVs, the model initial condition was used as the criterion for recovery. The Tier-1 model predicted recovery of TOC concentrations to the model initial condition within 11 years. The model-predicted recovery time for 4-methylphenol was 6 years and the predicted ammonia recovery time was 2 years. The area-weighted average sulfide concentration measured in 1997 was also below the WCSQVs. Therefore, the model-predicted sediment recovery occurred before 1997. The Tier-1 model-predicted recovery times do not consider the transport processes that occur in the cove, particularly solids transport from the KPC effluent discharge. This was found to have a significant effect on estimates of organic solids decay rate.

To account for spatially distributed processes, the development of the Tier-2 model was initiated through the development of a model grid and calibration of EFDC, a 3-D hydrodynamic tidal model that was coupled to the modified version of TOXI5. The model grid divided Ward Cove into 17 discrete plan cells with an area of 71,717.85 m^2 (771,964 ft^2). Calibration of EFDC to the observed Ward Cove tidal data (Nielsen 1997) resulted in current velocities and directions comparable to the observed velocities and circulation patterns in Ward Cove.

With the addition of a hydrodynamic input file, the Tier-2 model (with the same grid resolution as the hydrodynamic EFDC model) was first calibrated to the observed sediment accumulation rate at a location near the mouth of the cove and the area-weighted sediment TOC content. Calibration in this step was conducted by varying the organic solids decay rate and the pre-1971 effluent solids settling rate, two unknown model parameters. The second step was calibration of the model yield coefficients for 4-methylphenol, ammonia, and sulfide to the area-weighted concentrations measured in 1997. The sediment distributions of CoPCs in the final results of the calibrated model were adjusted to match observed sediment data for the top 10 cm. The model calibration served primarily to estimate rate and yield coefficients.

The Tier-2 model was then applied to predict recovery times for the modeled CoPCs in each of the 17 model cells. Because the area-weighted average TOC content in each modeled cell was less than the WCSQVs, the estimated background concentration of TOC (0.05 kg/kg) was used as the criterion for recovery. The Tier-2 model-predicted recovery times for return of TOC concentrations to background levels ranged from greater than 20 years for model cells most heavily influenced by the previous KPC discharge to 8.5 years for cell 11 located near the mouth of the cove. The recovery times in cells with initial 4-methylphenol concentrations that exceeded the SQS ranged from greater than 20 years to 1.5 years in cell 6. Ammonia recovery times ranged from greater than 20 years to 2.5 years for the recovery of cell 11 to levels below the WCSQV(1). The model predicted the most rapid recovery for sulfide. Recoveries in cells with initial concentrations exceeding the WCSQVs ranged from 7.5 years in cells 6 and 7 to less than 0.5 years in cell 13.

Apart from the uncertainties associated with the field and laboratory data that were input to the model, there are also uncertainties inherent in the rate constants and coefficients that were selected or calibrated for use in the model. To evaluate the sensitivity of the model to changes in model coefficients and to changes in the vertical grid resolution, sensitivity analyses were performed on the organic solids decay rate, the model resolution of the sediment thickness, the settling velocity of the native solids, and the 4-methylphenol decay rate. Overall, the model was most sensitive to the organic solids decay rate. If additional site-specific data were collected on the decay rate of sediment organic matter, further refinement of the model-calibrated organic solids decay rate could be performed. The effects of changes to the model sediment segment resolution and native solids settling velocity, were relatively minor and generally did not affect conclusions regarding a first-order level of prediction accuracy (i.e., recovery occurs within 10 years or within 20 years). Lowering the 4-methylphenol decay rate by a factor of two had an insignificant effect on model-predicted recovery times.

In addition to model uncertainty, there are limitations inherent in the model configuration. The model assumed the primary source of sediment constituents was the KPC effluent discharge. The major constituent considered was organic solids settling onto the sediment. Because the KPC facility processed logs stored in rafts floating on Ward Cove, it is possible that a significant portion of organic solids found in the sediment originated from deposition sloughed off the logs. However, there are no quantitative data for the magnitude or history of this source. Decay of this woody material may extend recovery periods if decay of woody debris differs from that utilized in the model.

Further increasing the resolution of the grid would provide better hydrodynamic results of flow patterns within Ward Cove. Increased grid resolution would also more precisely pinpoint CoPC hotspots. Additional data concerning solids settling velocity distributions would allow calibration to individual cell values, rather than relying on cove-wide values.

Other CoPCs not evaluated in this report include BOD and COD. Dioxins may also be important. The modeling procedure for Ward Cove has been established, and analysis of additional constituents is possible.

This work has demonstrated the capabilities of advanced spatially-distributed modeling. Defining recovery regions in more detail using a 3-D approach rather than a simple screening level model allows remediation strategies to be evaluated with greater precision and cost efficiency. Additionally, detailed understanding and knowledge of the model (especially its computer code) allows tailoring the model to fit particular situations that could not otherwise be handled by off-the-shelf models. Modifying TOXI5 to include solids organic decay is such an example; this was crucial in modeling the conceptualized sediment processes for Ward Cove.

6.0 REFERENCES

Alaska Water Pollution Control Board (AWPCB). 1957. Ward Cove Survey, Ketchikan, Alaska 1949-1957, First Draft.

Ambrose, R.B., Wool, T.A., and Martin, J.L. 1993. The Water Quality Analysis Simulation Program, WASP5. Env. Res. Lab. Athens and AScI Corp.

ENSR. 1996a. Response to ADEC Questions on KPC's Mixing Zone Request Document A: Tongass Narrows Mixing Zone Modeling and Outfall Extension. Prepared for Ketchikan Pulp Co., Ketchikan, AK.

ENSR 1996b. Study of Solids Deposition. Prepared for Ketchikan Pulp Co., Ketchikan, AK.

Federal Water Quality Administration (FWQA) 1970. Effects of Pulp Mill Wastes on Receiving Waters at Ward Cove, Alaska. NW Region, Alaska Oper. Off., Anchorage, AK.

Hamrick, J.M. 1996. User's Manual for Environmental Fluid Dynamics Computer Code. Special Report No. 331 by Applied Science and Ocean Engineering. Department of Physical Sciences, School of Marine Sciences, Virginia Institute of Marine Sciences, The College of William and Mary, Gloucester Point, VA.

Hatcher, P.G. 1988. Dipolar-dephasing ^{13}C NMR Studies of Decomposed Wood and Coalified Xylem Tissue: Evidence for Chemical Structural Changes Associated with Defunctionalization of Lignin Structural Units during Coalification. Energy & Fuels 2:48-58.

Howard, P.H., Boethling, W.S., Jarvis, W.F., Meylan, W.M., and Michalenko, E.M. 1991. Handbook of Environmental Degradation Rates. Lewis Publishers, Inc. Chelsea, MI.

Higgins, B. and Amoth, A. 1995. Environmental Achievements and Future Enhancements at Ketchikan Pulp Company. Internal report by KPC and CH2M HILL.

Jones and Stokes, Inc. 1989. Ward Cove Water Quality Assessment. Work Assign. No. 16 - EPA Contract 68-02-4381. Prepared with Kinnetic Lab.

National Institutes of Health (NIH). 1997. Hazardous Substances Databank (HSDB), TOXNET. http://www.nlm.nih.gov

Nielsen, D. 1997. Personal communications (with S. Breithaupt and T. Khangaonkar, ENSR, Redmond, WA). PTI, Bellevue, WA.

Orders Assoc. 1997. Ketchikan Pulp/Ward Cove Current Meter Survey. Prepared for PTI Env. Serv.

PTI Env. Serv. 1996. Ward Cove Sediment Remediation Project Technical Studies Work Plan. Prepared for Ketchikan Pulp Co., Ketchikan, AK

PTI Env. Serv. 1997a. Ward Cove Sediment Remediation Project - Technical Studies: Phase 1 Results and Phase 2 Study Design. Prepared for Ketchikan Pulp Co., Ketchikan, Alaska.

PTI Env. Serv. 1997b. Ward Cove Sediment Remediation Project Technical Studies: Geophysical Survey and Field Sampling Plan. Prepared for Ketchikan Pulp Co., Ketchikan, Alaska.

Snoeyink, V.L. and D. Jenkins. 1980. Water Chemistry. John Wiley & Sons, NY.

Thibodeaux, L.J. 1996. Environmental Chemodynamics - Movement of Chemicals in Air, Water, and Soil. J. Wiley. NY

U.S. Army Corps of Engineers (USACE). 1971. KPC Application Form for Discharges or Work in Navigable Waters and their Tributaries.

U.S. Geological Survey. 1992. Problem Assessment: Ward Cove, USGS Hydrological Unit 1910102.

Westrich, J.T. and Berner, R.A. 1984. The Role of Sedimentary Organic Matter in Bacterial Sulfate Reduction: The Go Model Tested. Limnol. Oceanogr. 29(2): 236-249.

APPENDIX

MODIFICATIONS TO TOX15

MODIFICATIONS TO TOXI5

The standard form of TOXI5 has two methods for handling sediment processes: a fixed volume method and a variable volume method. In the first method the solids concentration and porosity vary as sediment enters the segment. Over extended simulation periods, such as those required for sediment remediation, this would lead to unrealistic solids and porosity values. In the second method, the upper sediment segment's volume varies as solids enter it. Porosity and solids density remain constant, so the volume increases. At specified time intervals, the volume is reset to its original value: the solids are transferred to the next lower segment, but the pore water is ejected back into the water column. This latter process is considered unrealistic. Each of these processes does not consider any particle decay; presumably particles are only considered as inorganic sand, silt, or clay.

To handle the extended simulation period and to consider the effect of a highly organic solid, a modification to the above mentioned processes has been made. A constant volume and constant total solids density is assumed. The latter is relaxed when decay effects are considered. Solids flux onto the sediment surface produces a transport velocity which displaces solids, causing them to flow into lower segments. Essentially the control volume position is fixed to the sediment surface; as material is deposited, the control volume moves upwards. This leads to a relative velocity, appearing as a transport velocity. Both solids and chemicals sorped to the solids are transported in this way.

The mass balance for "flow-through" sediment segments is

$$V\frac{dC_s}{dt} = v_i A C_{s,i} - v_o A C_s \tag{1}$$

where:
- V = segment volume
- C_s = solids concentration in the sediment
- v_i = inflowing sedimentation/accumulation rate
- A = segment's area in the horizontal plane
- $C_{s,i}$ = inflowing solids concentration in the adjacent segment
- v_o = outflowing transport velocity (equal to the next segment's inflowing accumulation rate or the sediment accumulation rate)

The term v_o is defined by

$$v_o = v_w C_w / C_{dep} \tag{2}$$

where:
- v_w = solid's settling velocity in the water column
- C_w = solids concentration in the water column segment adjacent to sediment segments

C_{dep} = deposited solids concentration, which would occur in that segment without decay

An additional process added is solids decay within the sediment. The concept is based on mass conservation, in that, when solid's mass is lost by decay, that mass will be replaced by solids deeper in the sediment. The key assumption is that holes are filled by compaction and settling. Since the volume is fixed and the control volume's position is fixed to the sediment surface, it appears there is a material flow upwards. This material flow rate varies with sediment depth, being zero at the surface and increasing with depth. Figure A1 illustrates the concept.

The equation describing this includes loss within the segment, sedimentation transport, and decay-induced transport.

$$V\frac{dC_{s,i}}{dt} = v_{i-1}AC_{s.i-1} - v_iAC_{s,i} + v_{d,i}AC_{s,i+1} - v_{d,i-1}AC_{s,i} - k_dC_{s,i}V \tag{3}$$

where: $C_{s,i}$ = solids concentration in ith segment

v_{i-1} = sedimentation velocity from the i-1 segment

$C_{s,i-1}$ = solids in the i-1 segment

v_i = sedimentation velocity from the ith segment

$v_{d,i}$ = decay induced velocity at the bottom on the ith segment

$C_{s,i+1}$ = solids concentration in the i+1 segment

$v_{d,i-1}$ = decay induced velocity at the bottom of the i-1 segment

k_d =solids decay rate

The indexing is illustrated in Figure 1(d).

Having solids decay allows for generation of soluble decay products. This has been implemented in this modeling study to generate several constituents within the sediment, namely ammonia, 4-methylphenol, and sulfide.

For ammonia and 4-methylphenol, the reaction is considered first-order, in that it only depends on the concentration of deposited solids, originating from the KPC effluent. The actual amount produced is determined by a yield coefficient, the value of which is determined during calibration. The reaction is described by the following equation:

$$V\frac{dC_{C1,i}}{dt} = Yk_d C_{s,i} V \qquad (4)$$

where: $C_{C1,i}$ = chemical 1 concentration in the the ith segment
Y = yield coefficient

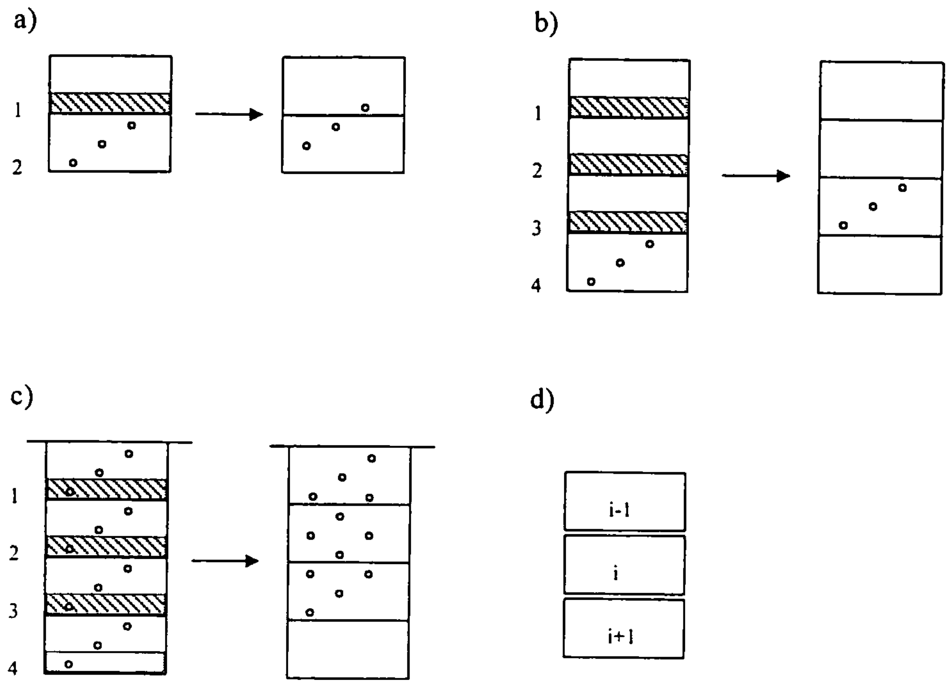
Sulfide is generated internally, from the decay of organic solids where sulfate is utilized by anaerobic bacteria as an electron acceptor. This is a second-order reaction, in that it depends on the concentration of decomposable solids and sulfate, with the sulfate originating from seawater sulfate diffusing into the sediment. This reaction is described by the following equation

$$V\frac{dC_{C1,i}}{dt} = Yk_d C_{s,i} C_{C2,i} V \qquad (5)$$

where: $C_{C2,i}$ = chemical 2 concentration in the the ith segment

Figure A-1

Illustration of inert particle transport from sediment decay. a) Two adjacent sediment segments, where decay in the upper segment transports solids upwards. Mass lost is indicated by the cross-hatched region. b) Decay in a series of sediment segments results in cumulative transport effect deeper in the sediment. Mass lost is indicated by the cross-hatched region. c) The net effect of decay increases the mass of non-decaying materials higher in the sediment column. d) Segment indexing for equation (3).



Appendix G

Appendix G

Evaluation of Maximum Sediment Chemical Concentrations

EVALUATION OF MAXIMUM SEDIMENT CHEMICAL CONCENTRATIONS

In Section 4.4 of the main text, tissue concentrations were estimated using maximum sediment chemical concentrations identified during the Exponent 1996 and 1997 investigations (see Tables A1-2, A1-3, and A1-4). Two additional sources of data were available for Ward Cove sediments. Historical data are available from investigations conducted by ENSR (ENSR 1995, 1996) as part of annual sediment monitoring. In addition, a separate expanded site investigation (ESI) of both the Ward Cove and Upland operable units was conducted recently by Ecology and Environment (E&E) for the U.S. Environmental Protection Agency (EPA) (E&E 1998) to provide EPA with adequate information to determine whether the site should be placed on the EPA hazard ranking system. ENSR data from 1994 and 1995 are summarized in Tables 7-27, 7-28, and 7-29 of the main report, and Attachment G1 provides a summary of analytical results of Ward Cove sediment samples and the sampling locations for the ESI conducted for EPA by E&E. Some discrepancies were noted in the sample locations as reported in the EPA ESI and are described in U.S. EPA (1998). Station numbers are reported in the attached tables as they are reported in the ESI comments. Data from all three investigations were evaluated, but only the most recent data from the Exponent investigation were used to delineate the area of concern.

Although additional sources of data were available, tissue concentration estimates provided in Section 4.4 were based on the Exponent 1996 and 1997 investigations because they represent current conditions and are a comprehensive evaluation of 28 sampling locations throughout Ward Cove, for which samples were analyzed for a suite of chemicals using high and well-defined data quality objectives. Earlier sediment concentration data were used in screening site chemicals and in designing the sampling plan for the Phase 1 investigation (PTI 1996). Concentrations of some chemicals, however, were somewhat higher in other data sets than in samples analyzed in the Exponent 1996 and 1997 investigations. This appendix provides an evaluation of site risks based on the maximum concentrations identified in other investigations conducted in 1994 through 1997.

COMPARISON OF SEDIMENT CONCENTRATION DATA IN EXPONENT AND ENSR INVESTIGATIONS

Data from 1994 and 1995 sediment investigations (ENSR 1995, 1996) and for corresponding stations from the subsequent Exponent investigations in 1996 and 1997 were reviewed to identify maximum concentrations of chemicals in sediments. Sediment concentration data for tetrachlorodibenzo-*p*-dioxin (TCDD) (as toxic equivalent concentrations [TECs]) and carcinogenic polycyclic aromatic hydrocarbons (PAHs) (as relative potency concentrations [RPCs]) were evaluated, and where necessary, data were recalculated to represent TECs and RPCs using one-half of the detection limit for undetected concentrations (see Tables 7-28 and 7-29).

Maximum sediment chemical concentrations were selected for use in estimating tissue concentrations, with two exceptions: 1) maximum sediment concentrations for zinc reported in data collected in 1995 appear to be inaccurate; and 2) the assessment excluded maximum sediment concentrations that occurred at stations near the cannery or state air-plane ramp (see Section 4.4.1). In reference to historical data for zinc, although data packages were not available for review, data presented in Table 7-27 of the main report suggest that zinc concentrations were consistently overestimated in the 1995 data set reported in ENSR (1996). Specifically, zinc concentrations in sediment samples from the 1995 investigation were 2–16 times higher than those reported in 1994 or in 1996. Because the overestimates occur at all locations and are not supported by prior or subsequent investigations, the zinc concentrations in samples collected in 1995 were considered suspect and were not included in the evaluation. Instead, the maximum zinc concentration of 470 mg/kg from the 1994 investigation (ENSR 1995) was used as the basis for tissue concentration estimates shown in Table G-1.

Maximum sediment concentrations for arsenic, zinc, polychlorinated dibenzo-*p*-dioxin and polychlorinated dibenzofuran (PCDD/F) (TECs), carcinogenic PAHs, and anthracene were identified in previous investigations (ENSR 1994, 1995), whereas the maximum concentrations of all other chemicals of potential concern (CoPCs) were identified in the present investigation (Table G-1). In general, previous investigations reported sediment concentrations similar to those identified in the present investigation; that is, the largest difference was a four-fold increase in the mercury concentration identified in the 1994 investigation over that reported in the present investigation, whereas other chemical concentrations in sediments reported in previous investigations were less than 2 times higher or were lower than values from co-located samples reported in the current investigation.

In this appendix, maximum sediment concentrations were used to estimate tissue concentrations using methods described in Section 4.4. The estimated values were carried into risk calculations for human health and ecological assessment parallel to those described in Sections 6.2 and 7.2, respectively.

EVALUATION OF MAXIMUM TISSUE CHEMICAL CONCENTRATION ESTIMATES FOR HUMAN HEALTH RISKS

In the human health evaluation, tissue chemical concentration estimates were compared with risk-based concentrations for chemicals in fish or shellfish tissues derived using methods described in Section 6. Chemicals were identified as chemicals of concern (CoCs) in instances where estimated or measured tissue concentrations exceeded both background and risk-based concentrations. The use of maximum chemical concentrations

TABLE G-1. ESTIMATED TISSUE CONCENTRATIONS FOR CHEMICALS DETECTED IN WARD COVE SEDIMENTS IN 1994, 1995, 1996, OR 1997

	Maximum Sediment Concentration[a]		Fish Tissue[b]		Crab Tissue[c]		Bivalve Tissue[d]		Shrimp Tissue[e]		Gastropod Tissue[f]	
Chemical	mg/kg dw	TOC Fraction	BSAF[g]	mg/kg ww	BSAF[g]	mg/kg ww	BSAF[g]	mg/kg ww	BSAF[g]	mg/kg ww	BSAF[g]	mg/kg ww
Metals and Organometallic Compounds (maximum sediment concentration)												
Arsenic[h]	40	NA	0.12	0.12	0.022	0.023	0.71	0.50	--	--	0.7	0.50
Cadmium	7.3	NA	2	3.7	3	5.7	7.5	9.9	44	71	39	51
Total mercury (sediments; methylmercury in tissues)	0.7	NA	0.38	0.067	0.13	0.024	4.5	0.57	1	0.15	2	0.25
Zinc[i]	470	NA	5	590	3.2	390	7.3	620	0.16	17	5	420
Organic Compounds												
Phenol[j]	0.91	0.10	0.63	0.47	--	--	--	--	--	--	--	--
4-Methylphenol[j]	17	0.10	0.63	8.8	--	--	--	--	--	--	--	--
PCDD/F (TEC)[k]												
Max. Sediment Conc. (ERA)	6.2×10^{-5}	0.10	1.04	6.6×10^{-5} [l]	1.04	9.0×10^{-6}	0.9	1.6×10^{-5}	0.7	7.4×10^{-6}	0.9	8.4×10^{-6}
Max. Sediment Conc. (HHRA)	6.2×10^{-5}	0.10	1.04	5.3×10^{-5} [m]	1.04	9.0×10^{-6}	0.9	1.6×10^{-5}	0.7	7.4×10^{-6}	0.9	8.4×10^{-6}
PAHs[k,n]												
Carcinogenic PAH												
HHRA (RPC)	0.42	0.10	NA	0	0.63	0.037	0.63	0.074	0.63	0.046	0.63	0.040
ERA (maximum)	0.42	0.10	NA	0	0.63	0.037	0.63	0.074	0.63	0.046	0.63	0.040
Fluoranthene	2.2	0.10	NA	0	0.63	0.19	0.63	0.39	--	--	--	--
Pyrene	1.8	0.10	NA	0	0.63	0.16	0.63	0.32	--	--	--	--
Acenaphthene	0.50	0.10	NA	0	0.63	0.044	0.63	0.088	--	--	--	--
Anthracene[k]	0.32	0.10	NA	0	0.63	0.028	0.63	0.056	--	--	--	--
Fluorene	0.47	0.10	NA	0	0.63	0.041	0.63	0.083	--	--	--	--

Note:
-- - not available
BSAF - biota-sediment accumulation factor
dw - dry weight
ERA - ecological risk assessment
HHRA - human health risk assessment
NA - not available
PAH - polycyclic aromatic hydrocarbon
RPC - relative potency concentration for carcinogenic PAH
PCDD/F - polychlorinated dibenzo-*p*-dioxin and polychlorinated dibenzofuran
TEC - toxic equivalent concentration based on data for 2,3,7,8-tetrachlorodibenzo-*p*-dioxin
TOC - total organic carbon
ww - wet weight

[a] Maximum sediment concentrations were found in Exponent 1996 and 1997 investigations, except as indicated. TOC assumed to be 10 percent where station-specific TOC was 10 percent or greater (see text). For undetected concentrations, one-half the detection limit was used in the RPC and TEC calculations.

[b] Fish tissue is assumed to be 25 percent solids based on U.S. EPA (1993).

[c] Crab tissue is assumed to be 26 percent solids based on U.S. EPA (1993). Lipid content of 1.4 percent is based on Sidwell (1981).

[d] Bivalve tissue is assumed to be 18 percent solids based on U.S. EPA (1993). Lipid content of 2.8 percent is based on Ferraro et al. (1990).

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[e] Shrimp tissue is assumed to be 22 percent solids based on average of pink, white, and brown shrimp reported in Sidwell (1981). Lipid content of 1.73 percent is based on Burkett (1995).

[f] Gastropod tissue is assumed to be 18 percent solids based on averaged data for snails, as reported in Sidwell (1981). Lipid content of 1.5 percent is based on averaged data for snails, as reported in Sidwell (1981).

[g] BSAFs are based on data PTI (1995a) for nonpolar organic compounds or from PTI (1995b) and Boese and Lee (1992) for metals and polar organic compounds.

[h] Maximum concentration for arsenic was from samples collected in 1995 (ENSR 1996) (see Table 7-27 in this report). Estimated total arsenic concentrations are adjusted by 10 percent to reflect proportion of inorganic arsenic (ICF Kaiser 1996).

[i] Maximum zinc concentration of 470 mg/kg was from samples collected in 1994 (ENSR 1995) (see Table 7-27 in this report), and excludes a value of 530 mg/kg collected in 1997 from Station 25 near the cannery.

[j] BSAFs are not available for phenol or 4-methylphenol; BSAF for benzo[a]pyrene is used (PTI 1995b). Maximum value for phenol of 0.91 mg/kg excludes values of 1.6 mg/kg and 0.99 mg/kg at Station 25.

[k] Maximum PCDD/F (as TEC), carcinogenic PAHs (as RPC), and anthracene concentrations were from samples collected in 1995 (ENSR 1995) (see Tables 7-27 and 7-29 in this report). Maximum RPC value of 0.42 mg/kg and maximum value of 0.32 mg/kg for anthracene exclude higher values detected at Stations 23 and 25 near the cannery and state airplane ramp.

[l] For ecological receptors, assumptions are 70 percent consumption of herring with lipid content of 13.88 percent (Burkett 1995) and 30 percent consumption of rockfish with lipid content of 1.57 percent (Burkett 1995).

[m] For human health, assumptions are 30 percent consumption of rockfish with lipid content of 1.57 percent (Burkett 1995) and 70 percent consumption of salmon with lipid content of 11 percent (Sidwell 1981). Consumption percentage assumptions from Howe et al. (1995, 1996).

[n] BSAF for PAHs in shellfish from PTI (1995b) is used to estimate concentrations in crabs and bivalves. PAHs are assumed not to bioaccumulate in fish because they are rapidly metabolized (ATSDR 1989).

from 1994 or 1995 did not change the conclusions of the main report. Specifically, PCDDs/Fs were identified as a CoC based on estimated concentrations in fish and shellfish, but measured concentrations were lower than risk-based concentrations. Thus, because measured concentrations in fish and shellfish provide a more accurate basis for comparison, no CoCs were identified (Table G-2, Table 6-1 in the main report).

Table G-2 also provides risk-based concentrations derived using a fractional intake assumption of 10 percent and using the assumption that people consume seafood over a 70-year exposure duration in addition to a 30-year duration. Although 30 years is identified as the 90th percentile of years spent in one residence for U.S. citizens, a 70-year duration was evaluated to provide a worst-case analysis.

Only estimated and measured PCDD/F concentrations (TECs) exceeded risk-based concentrations. As described in Section 6.3, concentrations estimated using biota-sediment accumulation factors (BSAFs) tend to overestimate concentrations, and thus measured concentrations provide a more reliable basis for comparison. The maximum measured PCDD/F concentration (TEC) in seafood of 0.78×10^{-6} mg/kg is less than the risk-based concentration of 1.5×10^{-6} mg/kg derived using a fractional intake of 10 percent and the risk-based concentrations of 1.3×10^{-6} and derived assuming a 70-year exposure duration and fractional intake of 5 and is only marginally higher than the 6.4×10^{-7} derived based on a 70-year duration and fractional intake of 10 percent. In addition, the risk-based concentration for arsenic of 0.064 mg/kg calculated assuming a fractional intake of 10 percent and a 70-year exposure duration exceeds the estimated tissue concentration of 0.12 mg/kg. However, this risk-based concentration of 0.064 mg/kg is well below the background concentration for inorganic arsenic in seafood of 0.15 mg/kg, and thus arsenic is not considered a CoC.

Thus, the use of the 10 percent fractional intake or the increased exposure duration does not result in identification of any additional CoCs, even when maximum concentrations from 1994 and 1995 are also considered. Further discussion regarding uncertainties in the consumption rates and fractional intake estimates used in the human health risk assessment is provided in Appendix H.

Based on these evaluations, the use of maximum sediment concentrations from the present investigation and the use of an assumed fractional intake of 5 percent as described in Section 6 do not underestimate site risks. Instead, many aspects of the approach described in Section 6 and this appendix tend to overestimate risks, if any, associated with consumption of seafood from Ward Cove. Factors tending to overestimate risks include the use of maximum sediment concentrations, an assumed subsistence level fish and shellfish consumption rate, and the application of BSAFs, which results in tissue concentrations that are higher than measured concentrations.

TABLE G-2. IDENTIFICATION OF CHEMICALS OF CONCERN FOR HUMAN HEALTH BASED ON MAXIMUM ESTIMATED OR MEASURED SEAFOOD CONCENTRATIONS

Substance	Maximum Sediment Conc.[a] (mg/kg dw)	Maximum Seafood Conc.[b] (mg/kg ww)	Background Concentration (mg/kg ww)	Assuming 30-Year Duration: Risk-Based[c,d] Conc. (mg/kg ww) FI=5%	FI=10%	Identified as CoC for Human Health FI=5%	FI=10%	Assuming 70-Year Duration: Risk-Based[c,d] Conc. (mg/kg ww) FI=5%	FI=10%	Identified as CoC for Human Health FI=5%	FI=10%
Metals and Organometallic Compounds											
Arsenic (inorganic)[e]	40	0.12	0.15 [e]	0.30	0.15	No	No	0.13	0.064	No	No
Cadmium	7.3	3.7	NA	19	10	No	No	8.1	4.1	No	No
Total mercury (sediments; methylmercury in tissues)	0.7	0.067	NA [f]	1.9	1.0	No	No	0.82	0.41	No	No
Total mercury (measured)		0.026	NA [f]	1.9	1.0	No	No	0.82	0.41	No	No
Zinc[g]	470	590	NA	5,800	2,900	No	No	2,500	1,200	No	No
Organic Compounds											
Phenol	0.91	0.47	NA	12,000	5,800	No	No	4,900	2,500	No	No
4-Methylphenol	17	8.8	NA	96	48	No	No	41	21	No	No
PCDD/F (TEC)[h]	6.2×10^{-5}	5.3×10^{-5}	0.2×10^{-6} [i]	3.0×10^{-6}	1.5×10^{-6}	Yes	Yes	1.3×10^{-6}	6.4×10^{-7}	Yes	Yes
PCDD/F (TEC) (measured)		0.78×10^{-6} [i]	0.2×10^{-6} [i]	3.0×10^{-6}	1.5×10^{-6}	No	No	1.3×10^{-6}	6.4×10^{-7}	Yes	Yes
PAHs[h]											
Carcinogenic PAH	0.42	0.074	NA	0.42	0.21	No	No	0.18	0.090	No	No
Fluoranthene	2.2	0.39	NA	5,300	2,700	No	No	2,300	1,100	No	No
Pyrene	1.8	0.32	NA	4,000	2,000	No	No	1,700	860	No	No
Acenaphthene	0.50	0.088	NA	8,000	4,000	No	No	3,400	1,700	No	No
Anthracene[h]	0.32	0.056	NA	40,000	20,000	No	No	17,000	8,600	No	No
Fluorene	0.47	0.083	NA	5,300	2,700	No	No	2,300	1,100	No	No

Note:
BSAF - biota-sediment accumulation factor
CoC - chemical of concern
CSF - carcinogenic slope factor
dw - dry weight
EPA - U.S. Environmental Protection Agency
NA - not available
FI - fractional intake
ND - not determined by EPA or not considered to be a carcinogen
PAH - polycyclic aromatic hydrocarbon
RfD - reference dose
RPC - relative potency concentration for carcinogenic PAH
PCDD/F - polychlorinated dibenzo-*p*-dioxin and polychlorinated dibenzofuran
TEC - toxic equivalent concentration based on data for 2,3,7,8-tetrachloro-dibenzo-*p*-dioxin
TOC - total organic carbon
ww - wet weight

[a] Maximum sediment concentrations were identified in the present investigation, except as indicated. For undetected concentrations, one-half the detection limit was used in the RPC and TEC calculations. TOC assumed to be 10 percent where station-specific TOC was 10 percent or greater (see text).

[b] Concentrations estimated using BSAFs (see text and Table 4-4 of this report). Concentrations for all substances except PAHs were estimates for fish tissues. Higher estimated concentrations of some chemicals in shellfish would be offset by lower (or absent) site-related intake. PAHs were evaluated based on highest estimated shellfish concentrations because PAHs are assumed not to bioaccumulate in fish (ATSDR 1989).

[c] Toxicity values obtained from either the EPA Health Effects Assessment Summary Tables (HEAST) (May 1995) or EPA Integrated Risk Information System (see Table 6-1).

TABLE G-2. (cont.)

[d] Risk-based concentrations were derived on the basis of consumption of fish and shellfish combined, for all substances except PAHs. Risk-based concentrations for PAHs were based on consumption of shellfish only because PAHs are assumed not to bioaccumulate in fish.

[e] Maximum concentration for arsenic was from samples collected in 1994 (ENSR 1994) (see Table 7-27 in this report). Estimated total arsenic concentration adjusted assuming 10 percent inorganic arsenic (ICF Kaiser 1996). Background concentration was a measured inorganic arsenic concentration reported in Eisler (1994).

[f] Although a background concentration of 1.8 mg/kg for mercury was identified in U.S. EPA (1992), this was the highest concentration in the data set, which included seafood from industrial areas and, therefore, was not included here.

[g] Maximum zinc concentration was from samples collected in 1994 and reported in ENSR (1995) (see Table 7-27 in this report) and excludes a value of 530 mg/kg from Station 25 near the cannery.

[h] Maximum PCDD/F (as TEC), carcinogenic PAHs (as RPC), and anthracene concentrations were from samples collected in 1995 (ENSR 1995) (see Tables 7-28 and 7-29 in this report). Maximum RPC value of 0.42 mg/kg and maximum anthracene concentration of 0.32 mg/kg exclude higher concentrations detected at Stations 23 and 25 near the cannery and airplane ramp.

[i] Maximum TEC in mussels (whole body) in EVS (1996). TECs derived using one-half the detection limit for undetected congeners.

[j] Background concentration identified in a study near Sitka, Alaska, in Delta Toxicology (1995).

EVALUATION OF MAXIMUM TISSUE CHEMICAL CONCENTRATION ESTIMATES FOR ECOLOGICAL FOOD-WEB ASSESSMENT

For the ecological food-web assessment, tissue concentration estimates based on maximum recorded sediment concentrations were used to determine risk to harbor seals, river otters, marbled murrelets, and pelagic cormorants using methods described in Section 7.2. This comparison identified PCDDs/Fs as a CoPC for river otters and cadmium as a CoPC for marbled murrelets. These receptor and chemical combinations are the same as those identified based on 1996 and 1997 sediment chemistry data.

The use of maximum sediment concentrations from the present investigation does not underestimate site risks. However, the evaluation of risk based on maximum sediment concentrations and the use of a BSAF approach to estimate tissue concentrations in prey species results is very conservative, and it overestimates risks, if any, to receptors at Ward Cove.

COMPARISION OF SEDIMENT CONCENTRATIONS IN ALL INVESTIGATIONS

Maximum sediment concentrations reported in the EPA ESI were compared with maximum sediment concentrations identified in investigations conducted by Exponent and ENSR (Table G-3). In each data set, samples from near the cannery and the state airplane ramp were excluded in identifying maximum concentrations because these areas are removed from the site and represent alternative sources. As indicated in Table G-3, concentrations in the three investigations are generally similar, with the ESI samples showing the highest concentrations of most chemicals. Maximum concentrations of chemicals detected in the ESI were used to derive maximum tissue concentrations estimates. The tissue concentration estimates were then applied in the human health and ecological risk assessment methods described in Sections 6 and 7, and in the previous section of this appendix. No additional chemicals of concern were identified in these analyses, indicating that the expanded site investigation yielded results that were consistent with the findings of this investigation.

REFERENCES

ATSDR. 1989. Draft toxicological profile for polycyclic aromatic hydrocarbons. U.S. Public Health Service. Agency for Toxic Substances and Disease Registry. Atlanta, GA.

Boese, B.L., and H. Lee II. 1992. Synthesis of methods to predict bioaccumulation of sediment pollutants. Environmental Research Laboratory, U.S. Environmental Protection Agency, Newport, OR.

TABLE G-3. COMPARISON OF MAXIMUM SEDIMENT CONCENTRATIONS FOR EXPONENT, ENSR, AND E&E INVESTIGATIONS

Chemical (mg/kg dry weight)	Exponent 1996/1997[a]	ENSR 1994/1995[b]	E&E 1998[c]
Metals and Organometallic Compounds			
Arsenic	39	40	37.4 [d]
Cadmium	7.3	6.7 [e]	7.0
Total mercury	0.7	0.2	0.87
Zinc	400 [f]	470	1,730 [g]
Organic Compounds			
Phenol	0.91 [h]	0.90	4.3
4-Methylphenol	17	15	83 [i]
PCDD/F (TEC)	4.6×10^{-5}	6.2×10^{-5}	5.4×10^{-5}
PAH			
Carcinogenic PAH	0.41 [j]	0.42	0.88
Fluoranthene	2.2	1.6	2.23
Pyrene	1.8	1.1	2.0
Acenaphthene	0.50	0.26	0.55
Anthracene	0.26 [k]	0.32	0.51
Fluorene	0.47	0.24	0.53

Note: PAH - polycylic aromatic hydrocarbon
PCDD/F - polychlorinated dibenzo-*p*-dioxin and polychlorinated dibenzofuran
RPC - relative potency concentration for carcinogenic PAHs
TEC - toxic equivalent concentration based on data for 2,3,7,8-tetrachloro-dibenzo-*p*-dioxin

[a] See tables in Appendix A.

[b] See Tables 7-27, 7-28, and 7-29, columns for 1994 and 1995.

[c] See Table G1-1 in Attachment G1.

[d] Excludes a higher concentration of 66.8 mg/kg at Site 17 near the cannery.

[e] Excludes a higher concentration of 6.9 mg/kg at Station 25 at the cannery.

[f] Excludes higher concentrations of 450 and 530 mg/kg at Stations 24 and 25 at the cannery.

[g] Outlier value, second highest concentration of 370 mg/kg at Site 4.

[h] Excludes a higher concentration of 0.99 mg/kg at Station 25 at the cannery.

[i] Excludes a higher concentration of 113 mg/kg at Site 15 near the cannery.

[j] Excludes higher concentrations of 0.89 mg/kg at Station 23 at the state airplane ramp and 0.59 and 1.1 mg/kg at Station 25 at the cannery.

[k] Excludes higher concentrations of 0.36 mg/kg at Station 23 at the state airplane ramp and 0.33 and 0.38 mg/kg at Station 25 at the cannery.

Burkett, E.E. 1995. Marbled murrelet food habits and prey ecology. pp. 223–246. In: Ecology and Conservation of the Marbled Murrelet. C.J. Ralph, G.L. Hunt, Jr., M.G. Raphael, and J.F. Piatt (eds). Gen. Tech. Rept. Pacific Southwest Research Station, No. 152.

Delta Toxicology. 1995. Dioxins in the Sitka environment. Focus and findings of site-specific and area studies conducted in 1990–1995 and preliminary interpretation of health effects. Prepared for Alaska Pulp Corporation, Sitka, AK. Delta Toxicology, Inc., Seattle, WA.

E&E. 1998. Final Ketchikan Pulp Company expanded site inspection report, Ketchikan, AK. Prepared for U.S. Environmental Protection Agency Region 10, Seattle, WA. Ecology and Environment, Inc., Seattle, WA.

Eisler, R. 1994. A review of arsenic hazards to plants and animals with emphasis on fishery and wildlife resources. Chapter 11. In: Arsenic in the Environment. Part II: Human Health and Ecosystem Effects. J.O. Nriagu (ed). John Wiley & Sons, New York, NY.

ENSR. 1995. Annual sediment monitoring report. NPDES Permit No. AK-000092-2. Document No. 4025-043-300. Prepared for Ketchikan Pulp Company, Ketchikan, AK. ENSR Consulting and Engineering.

ENSR. 1996. Response to ADEC questions on KPC's mixing zone request. Document D: revised ecological and human health risk assessment. ENSR Consulting and Engineering.

EVS. 1996. Ketchikan Pulp Company annual bioaccumulation monitoring study: data report. NPDES Permit No. AK-000092-2. Prepared for Ketchikan Pulp Company, Ketchikan, AK. EVS Environmental Consultants, Inc., Seattle, WA.

Ferraro, S.P., J. Lee II, R.J. Ozretich, and D.T. Specht. 1990. Predicting bioaccumulation potential: a test of a fugacity based model. Arch. Environ. Contamin. Toxicol. 19:386–394.

Howe, A.L., G. Fidler, and M.J. Mills. 1995. Harvest, catch, and participation in Alaska sport fisheries during 1994. Alaska Department of Fish and Game, Division of Sport Fish.

Howe, A.L., G. Fidler, A.E. Bingham, and M.J. Mills. 1996. Harvest, catch, and participation in Alaska sport fisheries during 1995. Alaska Department of Fish and Game, Division of Sport Fish.

ICF Kaiser. 1996. Toxicity and exposure concerns related to arsenic in seafood: an arsenic literature review for risk assessments. ICF Kaiser, Seattle, WA.

PTI. 1995a. Analysis of BSAF values for nonpolar organic compounds in finfish and shellfish. Prepared for Washington State Department of Ecology, Olympia, WA. PTI Environmental Services, Bellevue, WA.

PTI. 1995b. Bioaccumulation factor approach analysis for metals and polar organic compounds. Submitted to Washington State Department of Ecology, Olympia, WA. PTI Environmental Services, Bellevue, WA.

PTI. 1996. Ward Cove sediment remediation project technical studies work plan. Prepared for Ketchikan Pulp Company, Ketchikan, Alaska. PTI Environmental Services, Bellevue, WA.

Sidwell, V.D. 1981. Chemical and nutritional composition of finfishes, whales, crustaceans, mollusks, and their products. NOAA Technical Memorandum NMF F/SEC-11. National Oceanic and Atmospheric Administration.

U.S. EPA. 1992. National study of chemical residues in fish. Volume II. EPA 823-R-92-008b. U.S. Environmental Protection Agency, Office of Science and Technology, Washington, DC.

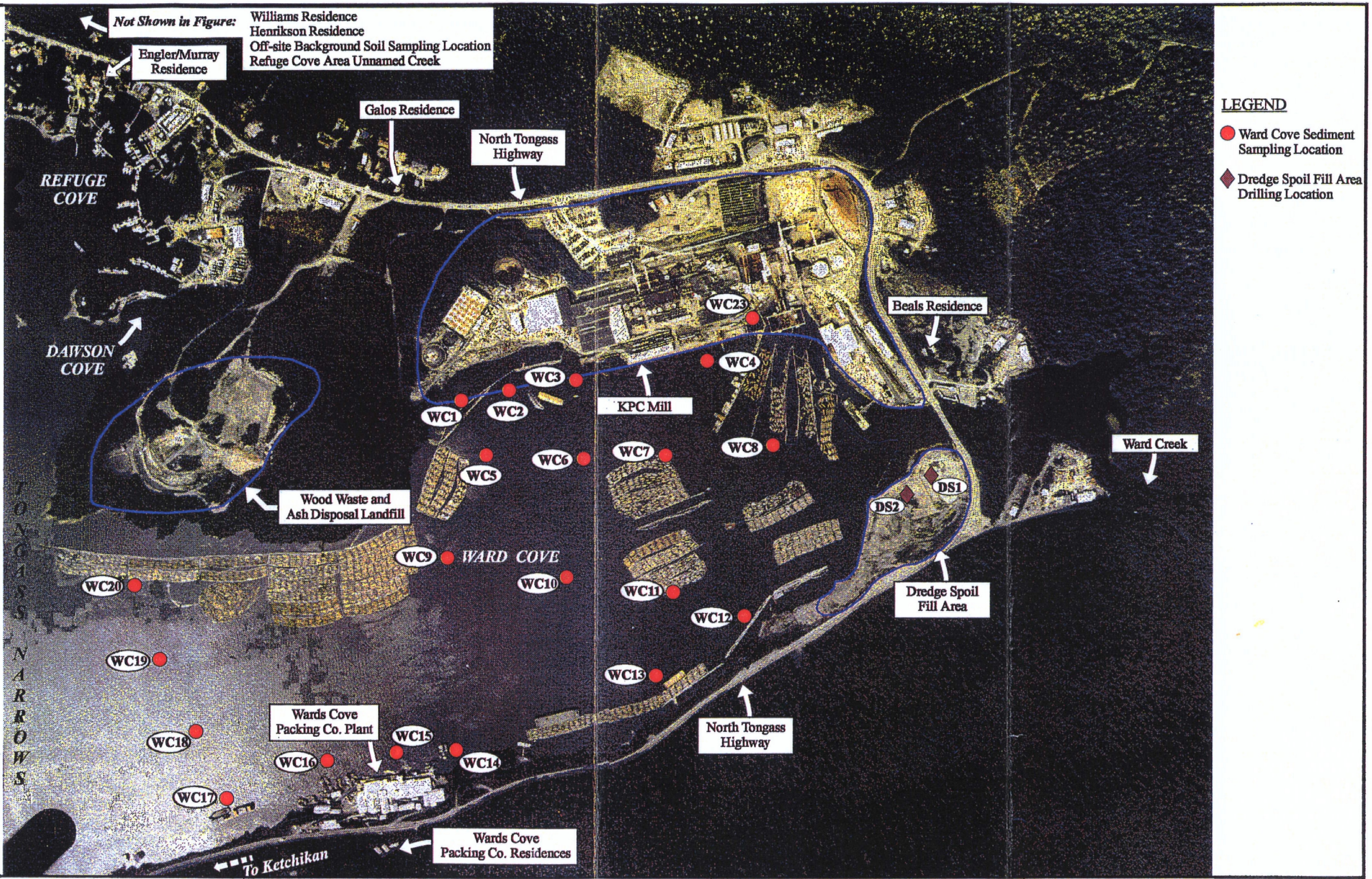
U.S. EPA. 1993. Wildlife exposure factors handbook. EPA/600/R-93/187a. U.S. Environmental Protection Agency.

U.S. EPA. 1998. Memorandum from K. Keeley, EPA Region 10 Environmental Cleanup Office, Seattle, WA, to EPA Region 10 Ketchikan Pulp Company site file, Seattle, WA, regarding problems associated with accuracy of EPA expanded site investigation (ESI) station locations in Ward Cove, Ketchikan, Alaska. U.S. Environmental Protection Agency, Region 10, Seattle, WA.

Attachment G1

Expanded Site Investigation
(Ecology and Environment, 1998)

Summary of Analytical
Results for Ward Cove
Sediment Samples



ecology and environment, inc.
International Specialists in the Environment
Seattle, Washington

SOURCE: Aeromap U.S. Inc., Ward Cove Aerial Photo 1-4, 8/28/95
Approximate Scale: 1" = 1200'

KETCHIKAN PULP COMPANY
Ketchikan, Alaska

Figure 5-3
KETCHIKAN PULP COMPANY ESI
EXTENDED AREA SAMPLING LOCATIONS

Drawn:	Date	Job No.	Dwg.No.
AES	10/31/97	BB1901SRT0	BB1901F7

TABLE G1-1. EXPANDED SITE INVESTIGATION, SUMMARY OF ANALYTICAL RESULTS FOR WARD COVE SEDIMENT SAMPLES

Sample Location	Marine Sediment Background		Site 1	Site 2	Site 3	Site 4	Site 5	Site 6
EPA Sample ID	97304751	Exponent	97304717	97304718	97304719	97304720	97304721	97304722
E&E Sample ID	MB01	Background	WC01	WC02	WC03	WC04	WC05	WC06
Depth (cm)	0–10	Sediment	0–10	0–10	0–10	0–10	0–10	0–10
Dioxin/Furan (ng/kg)								
2,3,7,8-TCDF	0.31		7.4	20	0.67	11 *JH*	11	5.3 *JH*
Total TCDF	1.1		92	210	8.1	120 *JH*	69	61 *JH*
2,3,7,8-TCDD	0.64 *U*		1.6	3.5	0.35 *U*	2.7	1.3	0.36
Total TCDD	0		190	330	13	230	150	22
1,2,3,7,8-PeCDF	4.5 *U*		5.8 *U*	12 *U*	0.46	11 *U*	3.8 *U*	1.6
2,3,4,7,8-PeCDF	1.2 *U*		8.4 *JL*	21	0.82 *JL*	20 *JL*	5.6 *JL*	3.5
Total PeCDF	0.53		64 *JL*	120	6 *JL*	97 *JL*	45 *JL*	27
1,2,3,7,8-PeCDD	1.5 *U*		10 *U*	20	0.15 *U*	18	5.5	1.1
Total PeCDD	0.57		110	370	6.1	200	89	17
1,2,3,4,7,8-HxCDF	1.8 *U*		12	30	0.81	20	9.6 *U*	11
1,2,3,6,7,8-HxCDF	1.5 *U*		7.3	17	0.58	10	4.9	3
2,3,4,6,7,8-HxCDF	1.4 *U*		7.9	17	1.1	13	5.9	3.3
1,2,3,7,8,9-HxCDF	1 *U*		2.7 *U*	9.5	0.57 *U*	7.6	2.6	1.6
Total HxCDF	0		73	310	11	390	96	64
1,2,3,4,7,8-HxCDD	1.8 *U*		7.4	15	0.53 *JH*	14	4.9	1.3
1,2,3,6,7,8-HxCDD	1.7 *U*		18	40	1.5 *JH*	53	17	5.8
1,2,3,7,8,9-HxCDD	1.3 *U*		9.5	15	1.8 *U*	23	8.6	2.7
Total HxCDD	4.5		180	510	20 *JH*	430	160	30
1,2,3,4,6,7,8-HpCDF	6.9 *U*		57	130	6.5	120	60	47
1,2,3,4,7,8,9-HpCDF	3.9 *U*		6.4	13	0.72	6.8	4.8	4.9 *U*
Total HpCDF	14 *JH*		63	450	18	400	260	170
1,2,3,4,6,7,8-HpCDD	53		270	560	23	930	300	97
Total HpCDD	79		820	1,400	67	3,000	850	190
OCDF	22		380	410	15	270	310	160
OCDD	470		2,500	4,100	170	6,500	2,600	880
Total 2,3,7,8-TCDD TEC[a]	1.1	0 *U*	19	52	1.4	54	19	8.6
Total 2,3,7,8-TCDD TEC[b,c]	2.7	4.9 (max)	22	52	1.8	54	19	8.6
BNA (μg/kg)								
2-Methylnaphthalene	95.6 *U*	-	220	912	18.7	424	239	212
4-Methylphenol	95.6 *U*	-	23,200	83,400	1,650	16,100	57,700	4,910
Bis(2-ethylhexyl) phthalate	191 *U*	-	690 *U*	930 *U*	155 *U*	2,750 (275) *JH*	738 *U*	291 *U*
Carbazole	95.6 *U*	-	46.7 *U*	146	11.8 *U*	76.9	50.6 *U*	35.4 *JQ*
Di-*n*-butyl phthalate	170 *U*	-	187 *U*	1,480 *U*	144 *U*	159 *U*	202 *U*	145 *U*
Dibenzofuran	95.6 *U*	-	46.7 *U*	382	15	314	52.2	64.1
Hexachlorobenzene	95.6 *U*	-	187 *U*	186 *U*	103	159 *U*	202 *U*	145 *U*
Phenol	95.6 *U*	-	2,890	4,330	65.5	1,580	1,680	252
Carcinogenic PAHs								
Benz[a]anthracene[d]	95.6 *U*	-	63.3	270	53.4	286	68.6	266
Benzo[a]pyrene[d]	95.6 *U*	-	46.7 *U*	67.1	19.6	73.1	50.6 *U*	170
Benzo[b]fluoranthene[d]	95.6 *U*	-	50.7	220	58.2	268	50.8 *U*	184

TABLE G1-1. (cont.)

Sample Location EPA Sample ID E&E Sample ID Depth (cm)	Marine Sediment Background 97304751 MB01 0–10	Exponent Background Sediment		Site 1 97304717 WC01 0–10	Site 2 97304718 WC02 0–10	Site 3 97304719 WC03 0–10	Site 4 97304720 WC04 0–10	Site 5 97304721 WC05 0–10	Site 6 97304722 WC06 0–10
Benzo[k]fluoranthene[d]	95.6 *U*	-		46.7 *U*	45.4	13.2	61.4	50.6 *U*	48.7
Chrysene[d]	95.6 *U*	-		87.1	284	65.2	458	94.2	326
Dibenz[a,h]anthracene[d]	95.6 *U*	-		46.7 *U*	39.5 *U*	11.8 *U*	39.8 *U*	50.6 *U*	31.2 *JQ*
Indeno[1,2,3-cd]pyrene[d]	95.6 *U*	-		46.7 *U*	39.5 *U*	13.2	34.1 *JQ*	50.6 *U*	48.2
Relative potency concentration[a,d]	-	-		11	117	32	133	7.0	252
Relative potency concentration[b,d]	-	-		61	139	38	153	63	252
Noncarcinogenic PAHs									
Acenaphthene	95.6 *U*	-		89.4	550	23.1	547	85.7	79.8
Acenaphthylene	95.6 *U*	-		46.7 *U*	40.6	11.8 *U*	31.7 *JQ*	50.6 *U*	36.4 *U*
Anthracene	95.6 *U*	-		56.1	228	23.9	263	53.4	230
Benzo[ghi]perylene	95.6 *U*	-		46.7 *U*	39.5 *U*	11 *JQ*	39.8 *U*	50.6 *U*	55.3
Fluoranthene	95.6 *U*	-		663	1840	207	1980	696	902
Fluorene	95.6 *U*	-		88.5	513	25.2	478	98.2 *JQ*	175
Naphthalene	95.6 *U*	-		289	1110	24.4	710	209	154
Phenanthrene	95.6 *U*	-		445	1320	119	1090	328	610
Pyrene	95.6 *U*	-		392	1100	99.8	1420	411	628
Metals (mg/kg)									
Aluminum	15,500	23,300	(max)	3,610	5,540	13,800	4,910	5,450	12,700
Arsenic	1.67 (CRDL = 3.6) *JQK*	1.5	(max)	13.6	30.7	10	12.1 *JQ*	25.4	4.79 *U*
Cadmium	0.356 *U*	0.2 *U*		2.36 *JQ*	2.14 *JQ*	0.355 *U*	1.92 *JQ*	3.74 *JQ*	2.29 *JQ*
Calcium	3,310	-		5,160 *JQ*	6,440	15,900	23,700	9,540	7,030
Chromium	21.3	4,640	(max)	28.3	44.3	21.3	26.5	40.9	28.4
Copper	34.5 (42.09) *JK*	18.9	(max)	70.8	108	59.1	83.4	86.1	59.7
Iron	26,000 *JK*	43,500	(max)	8,330	17,100	28,900	28,800	10,300	10,200
Lead	1.79	17	(max)	28.9	65.7	17.7	43.7	36.8	68.9
Magnesium	11,900	12,300	(max)	8,460	9,610	9,380	10,700	12,700	10,000
Manganese	179	540	(max)	97.2	203	289	146	142	90
Mercury	0.0891 *U*	0.06 *U*		0.281 *U*	0.872	0.0888 *U*	0.323 *U*	0.379 *U*	0.299 *U*
Nickel	10 (CRDL = 14.3) *JQ*	20	(max)	19.9 *JQ*	29.5 *JQ*	17.6	22.4 *JQ*	28.7 *JQ*	14.8 *JQ*
Potassium	3,370	6,240	(max)	2,560 *JQ*	2,710 *JQ*	1,660 *JQ*	2,990 *JQ*	3,930 *JQ*	3,010 *JQ*
Selenium	1.07 *U*	0.1 *U*		3.37 *U*	3.7 *QH*	1.46 *JQH*	3.87 *U*	4.58 *JQH*	3.59 *U*
Sodium	8,550	1,550	(max)	42,100	40,600	8,550	51,100	66,900	48,900
Vanadium	64.4	95	(max)	50 *JQ*	57.2	37.4	40.1 *JQ*	63.8 *JQ*	48 *JQ*
Zinc	76 (114) *JL*	68	(max)	202	1,730	144	370	249	99.1
Pest/PCB (µg/kg)									
Aroclor® 1254	NA	-		NA	NA	NA	NA	NA	NA
Aroclor® 1260	NA	-		NA	NA	NA	NA	NA	NA
TOC (percent carbon)	1.65			22.21	21.27	1.94	15.4	25.04	17.16

TABLE G1-1. (cont.)

Sample Location	Site 7	Site 8	Site 9	Site 10	Site 11	Site 12	Site 13	Site 14
EPA Sample ID	97304723	97304724	97304725	97304727	97304728	97304729	97304730	97304731
E&E Sample ID	WC07	WC08	WC09	WC10	WC11	WC12	WC13	WC14
Depth (cm)	0–10	0–10	0–10	0–10	0–10	0–10	0–10	0–10
Dioxin/Furan (ng/kg)								
2,3,7,8-TCDF	20	5.8	15	1.3 *U*	9.1 *JK*	0.89 *U*	6.4 *JK*	5.2 *JK*
Total TCDF	200	930	140	8.1 *JH*	87 *JK*	7.2 *JK*	58 *JK*	46 *JK*
2,3,7,8-TCDD	3.3	2.2	2.2	0.17 *U*	1.2 *JH*	0.22 *U*	0.82 *JH*	0.72 *JK*
Total TCDD	280	150	290	10	96 *JH*	8.8	70 *JH*	60 *JK*
1,2,3,7,8-PeCDF	12 *U*	4.5 *U*	9.2 *U*	0.4 *U*	3.8 *U*	0.35	2.7 *U*	2
2,3,4,7,8-PeCDF	18 *JL*	7.7	11	0.53	6	0.57	4	4
Total PeCDF	81 *JL*	60	90	3.3	41	3.9	27	28
1,2,3,7,8-PeCDD	25	12	19	0.54 *U*	6.6	0.72 *U*	5.9	4.6
Total PeCDD	290	160	300	7.3	110	8	79	57
1,2,3,4,7,8-HxCDF	18 *U*	7.8	15	0.64	6.6 *U*	0.8	5	6.7
1,2,3,6,7,8-HxCDF	11	5.7	8.2	0.42	4.3	0.55	3.2	3.7
2,3,4,6,7,8-HxCDF	13	7.5	12	0.83 *U*	5.7	0.91 *U*	4.5	5
1,2,3,7,8,9-HxCDF	6.3	2.2	3.1	0.36	1.7 *JH*	0.59 *JH*	1.8 *U*	3.2 *UU*
Total HxCDF	230	110	180	7.9	83 *JH*	13 *JH*	71	110
1,2,3,4,7,8-HxCDD	16	8.1	12	0.55	5.5	0.86 *JK*	4.4	2.6 *JH*
1,2,3,6,7,8-HxCDD	45	22	36	1.6	19	2.7	13	10
1,2,3,7,8,9-HxCDD	23	12	20	0.93	9.3	1.1	7.1	6.5
Total HxCDD	450	210	360	14	160	38 *JK*	140	160 *JH*
1,2,3,4,6,7,8-HpCDF	110	53	79	4	48	6.9	34	100
1,2,3,4,7,8,9-HpCDF	8.5	4.6	7.8	0.43 *JH*	3.9 *JK*	0.56 *JK*	2.7 *JK*	4.3 *JK*
Total HpCDF	380	190	290	11 *JH*	160 *JK*	22 *JK*	110 *JK*	240 *JK*
1,2,3,4,6,7,8-HpCDD	700	310	420	21	280	54	250	360
Total HpCDD	2,100	590	1,300	53	760	230	850	1,400
OCDF	470	240	300	12	150 *JK*	24	110 *JK*	100 *JK*
OCDD	5,500	2,600	3,600	170	2,400	470	1,900	2,600
Total 2,3,7,8-TCDD TEC[a]	52	26	38	1.4	19	2.3	15	16
Total 2,3,7,8-TCDD TEC[b,c]	54	26	39	1.5	19	2.5	15	17
BNA (µg/kg)								
2-Methylnaphthalene	598	32.4 *U*	285	346	113	207	103	88
4-Methylphenol	13,000	1,240 *U*	27,300	8,990	1,690	1,360	1,240	2,670
Bis(2-ethylhexyl) phthalate	829 *U*	275 *U*	656 *U*	610 *U*	700 *U*	279 *U*	588 *U*	905
Carbazole	156	32.4 *U*	49.7 *U*	37 *U*	37.7 *U*	64.7	37.5 *U*	234
Di-*n*-butyl phthalate	952 *U*	372 *U*	199 *U*	1,040 *U*	2,780 *U*	129 *U*	1,260 *U*	4,320
Dibenzofuran	411	32.4 *U*	73.4	160	68.4 *U*	309	101	54
Hexachlorobenzene	140 *U*	130 *U*	199 *U*	148 *U*	151 *U*	125 *U*	150 *U*	84.4 *U*
Phenol	761	179	595	527	224	186	150 *U*	156
Carcinogenic PAHs								
Benz[a]anthracene[d]	329	26.4 *JQ*	51.8	185	147	657	404	485
Benzo[a]pyrene[d]	79	32.4 *U*	49.7 *U*	66	86.6	317	264	362
Benzo[b]fluoranthene[d]	269	32.4 *U*	51.9	204	224	712	448	763

TABLE G1-1. (cont.)

Sample Location	Site 7	Site 8	Site 9	Site 10	Site 11	Site 12	Site 13	Site 14
EPA Sample ID	97304723	97304724	97304725	97304727	97304728	97304729	97304730	97304731
E&E Sample ID	WC07	WC08	WC09	WC10	WC11	WC12	WC13	WC14
Depth (cm)	0–10	0–10	0–10	0–10	0–10	0–10	0–10	0–10
Benzo[k]fluoranthene[d]	69.1	32.4 *U*	49.7 *U*	46.3	59.3	261	183	282
Chrysene[d]	410	33.4	103	276	264	817	458	786
Dibenz[a,h]anthracene[d]	35.1 *U*	32.4 *U*	49.7 *U*	37 *U*	37.7 *U*	45.3	44.6	47
Indeno[1,2,3-cd]pyrene[d]	35.4	32.4 *U*	49.7 *U*	38.4	44.2	109	111	139
Relative potency concentration	143	2.7	10	109	129	514	407	551
Relative potency concentration	161	38	63	128	148	514	407	551
Noncarcinogenic PAHs								
Acenaphthene	494	32.4 *U*	62.3	79.5	49.6 *U*	308	82.9	49.1
Acenaphthylene	39.1	32.4 *U*	49.7 *U*	42.8	37.7 *U*	41.4	37.5 *U*	50
Anthracene	370	32.4 *U*	67.5	189	175	507	289	330
Benzo[ghi]perylene	29.2 *JQ*	32.4 *U*	49.7 *U*	43.5	38.9	87.1	85.9	235
Fluoranthene	2,230	225	667	964	713	2,160	1,490	1,540
Fluorene	525	25.3 *JQ*	98.6	195	80.4 *U*	314	160	127
Naphthalene	789	29.6 *JQ*	276	322	90.1	434	186	117
Phenanthrene	1,450	72.6	469	590	374	748	434	775
Pyrene	1,280	144	342	579	538	2,010	1,010	1,200
Metals (mg/kg)								
Aluminum	8,870	6,990	8,550	11,300	9,160	9,590	6,600	13,700
Arsenic	33.5	18.8	37.4	32.2	26.6	19.2	24.5	25
Cadmium	4.46 *JQ*	1.97 *JQ*	5.82 *JQ*	5.66 *JQ*	4.87 *JQ*	2.32 *JQ*	3.03 *JQ*	3.04 *JQ*
Calcium	7,180	6,230	8,550	7,630	6,480	7,110	5,940	8,810
Chromium	34.5	18.9	40.4	37.4	29.7	22.9	21.7	32.3
Copper	78.4	43.3	78.2	80.4	76.5	55.8	60.8	67.8
Iron	15,000	15,200	13,500	16,400	15,400	21,600	14,000	24,200
Lead	31.8	13.3	30.7	34.5 *JL*	26.4 *JL*	28.6 *JL*	20 *JL*	44.1 *JL*
Magnesium	11,300	9,540	14,100	13,200	11,200	9,990	9,630	11,900
Manganese	147	99.7	148	183	135	151	111	191
Mercury	0.27 *U*	0.245 *U*	0.35 *U*	0.287 *UJL*	0.263 *UJL*	0.216 *UJL*	0.255 *UJL*	0.179 *JQL*
Nickel	26.2 *JQ*	12.6 *JQ*	28.4 *JQ*	27.9 *JQ*	19.6 *JQ*	14.9 *JQ*	13.9 *JQ*	18.8 *JQ*
Potassium	3,400 *JQ*	2,860 *JQ*	4,590 *JQ*	4,260 *JQ*	3,790 *JQ*	2,900 *JQ*	3,060 *JQ*	3,270 *JQ*
Selenium	4.96 *JQH*	2.94 *U*	4.54 *JQH*	4.8 *JQ*	3.17 *JQ*	3.11 *JQ*	5.32	2.71 *JQ*
Sodium	44,600	41,000	65,600	50,700	47,000	33,200	40,800	24,300
Vanadium	81.9	47.2 *JQ*	80.1	95.4	72.2	55	55.4	71
Zinc	307	147	207	181	153	241	146	230
Pest/PCB (μg/kg)								
Aroclor® 1254	NA	NA	NA	NA	NA	NA	NA	NA
Aroclor® 1260	NA	NA	NA	NA	NA	NA	NA	NA
TOC (percent carbon)	17.77	14.78	19.46	14.85	13.93	9.94	16.83	6.51

TABLE G1-1. (cont.)

Sample Location	Site 15	Site 16	Site 17	Site 18	Site 19	Site 20	Site 23
EPA Sample ID	97304732	97304733	97304734	97304735	97304736	97304737	97314726
E&E Sample ID	WC15	WC16	WC17	WC18	WC19	WC20	WC23
Depth (cm)	0-10	0-10	0-10	0-10	0-10	0-10	0-10
Dioxin/Furan (ng/kg)							
2,3,7,8-TCDF	3.8 *JK*	8.4 *JK*	3.1 *U*	0.65 *U*	14 *JK*	6.3 *JK*	0.7
Total TCDF	28 *JK*	82 *JK*	26 *JH*	4.2 *JK*	39 *JK*	87 *JK*	5.9
2,3,7,8-TCDD	0.41 *JK*	1.1 *U*	0.43 *JK*	0.19 *U*	0.74 *U*	0.86 *JH*	1.3 *U*
Total TCDD	37 *JK*	130	30 *JK*	5.4	19	170 *JH*	7.5
1,2,3,7,8-PeCDF	1.6 *U*	5.8 *U*	1.2 *U*	0.33 *U*	1.7 *U*	4 *U*	22 *U*
2,3,4,7,8-PeCDF	4.3	6.4	2.2	0.5	1.7	4.7	3.6 *U*
Total PeCDF	26	51	15	2.2	10	31	0
1,2,3,7,8-PeCDD	2.3 *JH*	9.6	1.9 *U*	0.64 *U*	1.4 *U*	4.9 *JH*	1.8 *U*
Total PeCDD	26 *JH*	180	21	2.8	15	82 *JH*	0
1,2,3,4,7,8-HxCDF	6.6	8.4	2.6	0.48	1.7	5	5.6 *U*
1,2,3,6,7,8-HxCDF	2.9	4.6	1.9	0.4	1.1	2.7	3.2 *U*
2,3,4,6,7,8-HxCDF	4.6	7.6	2.6	0.77 *U*	1.4 *U*	4.2	3.4 *U*
1,2,3,7,8,9-HxCDF	7.6 *U*	6.1 *U*	1.1 *JH*	0.27 *U*	0.72	1.6 *JK*	2.6 *U*
Total HxCDF	120	190	55 *JH*	6.7 *JH*	21 *JH*	59 *JK*	7.4
1,2,3,4,7,8-HxCDD	5.5 *U*	5.3 *JH*	2	0.46	1.1	3.3	4.2 *U*
1,2,3,6,7,8-HxCDD	6.6	21	9.1	1.1	3.8	11	3
1,2,3,7,8,9-HxCDD	5.6 *U*	8.9	4	0.7	1.7	4.8	3.7 *U*
Total HxCDD	80	210 *JH*	87	10	30	110	8.2
1,2,3,4,6,7,8-HpCDF	65	150	33	4.1	9.1	27	13
1,2,3,4,7,8,9-HpCDF	3 *U*	5.6 *JK*	2.5 *JK*	0.47	0.87 *U*	2.6 *JK*	8.3 *U*
Total HpCDF	180	390 *JK*	110 *JK*	11	30	81 *JK*	13
1,2,3,4,6,7,8-HpCDD	260	410	200	23	59	160	95
Total HpCDD	850	1,200	640	63	150	410	170
OCDF	25 *JK*	110	150	11	38	74 *JK*	130
OCDD	2,800	3,200	1,700	160	480	1,200	1,100
Total 2,3,7,8-TCDD TEC[a]	12	23	8.4	1.2	4.6	13	2.7
Total 2,3,7,8-TCDD TEC[b,c]	13	24	8.7	1.4	5.3	13	6.4
BNA (µg/kg)							
2-Methylnaphthalene	80.4	180	110	93.3	149	577	66.2
4-Methylphenol	113,000	2,240	941	1,920	5,380	13,700	517
Bis(2-ethylhexyl) phthalate	742	487 *U*	390 *U*	642 *U*	716 *U*	489 *U*	134 *U*
Carbazole	46.4	43.2	74.7	269	36.8 *U*	50.6 *U*	12.4 *JQ*
Di-*n*-butyl phthalate	1,370 *U*	659 *U*	258 *U*	1,780 *U*	2,030 *U*	202 *U*	142 *U*
Dibenzofuran	75.3 *JQ*	92.5	112	57.1	67.2	102	56.4
Hexachlorobenzene	89.1 *U*	117 *U*	106 *U*	143 *U*	147 *U*	202 *U*	45 *U*
Phenol	89.1 *U*	117 *U*	294	206	383	849	182
Carcinogenic PAHs							
Benz[a]anthracene[d]	908	604	580	196	184	63.4	50
Benzo[a]pyrene[d]	588	441	416	150	82.8	50.6 *U*	18.8
Benzo[b]fluoranthene[d]	1,160	870	662	268	208	62.3	36.6

TABLE G1-1. (cont.)

Sample Location EPA Sample ID E&E Sample ID Depth (cm)	Site 15 97304732 WC15 0–10	Site 16 97304733 WC16 0–10	Site 17 97304734 WC17 0–10	Site 18 97304735 WC18 0–10	Site 19 97304736 WC19 0–10	Site 20 97304737 WC20 0–10	Site 23 97314726 WC23 0–10
Benzo[k]fluoranthene[d]	141	301	334	69	53.5	50.6 *U*	13.2 *JQ*
Chrysene[d]	902	845	560	229	257	129	51.5
Dibenz[a,h]anthracene[d]	62.9	58.4	65.9	34.9	36.8 *U*	50.6 *U*	15 *U*
Indeno[1,2,3-cd]pyrene[d]	445 *U*	169	203	71.7	50.5	50.6 *U*	15 *U*
Relative potency concentration[a]	860	668	630	239	128	13	28
Relative potency concentration[b]	882	668	630	239	146	66	36
Noncarcinogenic PAHs							
Acenaphthene	98.3	81.9	122	41.4	38.8	73.7	76.8
Acenaphthylene	104	95.7	30.3	37.3	36.8 *U*	50.6 *U*	15 *U*
Anthracene	391	252	322	156	155	102	47.2
Benzo[ghi]perylene	293	279	250	58.3	47	50.6 *U*	15 *U*
Fluoranthene	1,430	981	1,600	708	706	875	237
Fluorene	156	184	149	68.6	85.5	207	67.3
Naphthalene	145	296	120	165	160	357	129
Phenanthrene	697	587	714	330	382	624	197
Pyrene	1,450	1,310	1,450	566	473	412	161
Metals (mg/kg)							
Aluminum	11,300	17,300	8,160	17,700	10,100	6,080	12,400
Arsenic	16.4	27.7	66.8	22.2	26.7	27.1	20
Cadmium	1.98 *JQ*	4.42	2.42 *JQ*	3.84 *JQ*	3.97 *JQ*	7.02 *JQ*	0.302 *JQ*
Calcium	38,400	8,740	13,000	13,100	7,750	16,800	4,990
Chromium	27.6	42.4	24.9	43.5	30.8	35.7	26.9
Copper	80.5	103	85.5	82.9	57.8	61.1	65.8 (53.9) *JH*
Iron	19,800	28,000	22,000	29,400	15,200	9,140	26,600
Lead	27.1 *JL*	49.9 *JL*	56.4 *JL*	42.2 *JL*	25.8 *JL*	24.2 *JL*	24.8
Magnesium	10,600	14,200	10,100	15,600	11,300	13,100	7,990
Manganese	159	271	143	305	171	115	265 *JL*
Mercury	0.158 *UJL*	0.195 *UJL*	0.211 *UJL*	0.276 *UJL*	0.262 *UJL*	0.397 *UJL*	0.0649 *U*
Nickel	14.8 *JQ*	25.3 *JQ*	14.2 *JQ*	28.5 *JQ*	19 *JQ*	32.7 *JQ*	13
Potassium	2,640 *JQ*	4,600	3,170 *JQ*	5,290 *JQ*	3,890 *JQ*	4,050 *JQ*	709 *JQ*
Selenium	2.88 *JQ*	5.48	3.52 *JQ*	4.24 *JQ*	3.99 *JQ*	4.76 *U*	1.72
Sodium	22,100	33,900	37,200	46,000	42,200	63,700	2,690
Vanadium	59.1	89	53.2	84.5	62.8	99.9	34.5
Zinc	250	223	350	173	139	273	229
Pest/PCB (μg/kg)							
Aroclor® 1254	NA	NA	NA	NA	NA	NA	73
Aroclor® 1260	NA	NA	NA	NA	NA	NA	29
TOC (percent carbon)	8.48	8.78	10.12	9.87	15.91	24.76	NA

Footnotes on following page.

TABLE G1-1. (cont.)

Source: E&E (1998)

Note: Values in parentheses are the adjusted concentration per U.S. EPA (1996, as cited by E&E 1998).

BNA	-	base/neutral and acid extractable organic compounds
CRDL	-	contract-required detection limit
H	-	high biased
J	-	estimated
K	-	unknown biased
L	-	low biased
NA	-	not analyzed
ND	-	not detected
PAH	-	polycyclic aromatic hydrocarbon
Pest/PCB	-	pesticides/polychlorinated biphenyls
Q	-	sample detected above the instrument detection limit, but below the CRDL
TEC	-	toxic equivalent concentration based on data for 2,3,7,8-tetrachlorodibenzo-*p*-dioxin
U	-	undetected at the detection limit shown

[a] Calculated using zero for undetected analytes.

[b] Calculated using one-half the detection limit for undetected analytes.

[c] TECs calculated by Exponent based on toxicity equivalence factors provided in U.S. EPA (1989).

[d] Relative potency concentrations calculated by Exponent for carcinogenic PAHs based on toxicity equivalence factors provided in U.S. EPA (1993).

REFERENCES

E&E. 1998. Final Ketchikan Pulp Company expanded site inspection report, Ketchikan, AK. Prepared for U.S. Environmental Protection Agency Region 10, Seattle, WA. Ecology and Environment, Inc., Seattle, WA.

U.S. EPA. 1989. Interim procedures for estimating risks associated with exposure to mixtures of chlorinated dibenzo-*p*-dioxins and furans (CDDs and CDFs). EPA/625/3-89/016. U.S. Environmental Protection Agency, Washington, DC.

U.S. EPA. 1993. Internal memorandum from C. Sweeney to S. Thomas, regarding risk assessment for PAH mixtures, dated November 16, 1993. U.S. Environmental Protection Agency Region 10, Seattle, WA.

U.S. EPA. 1996. Using qualified data to document an observed release and observed contamination. EPA/540/F-94/028. U.S. Environmental Protection Agency, Office of Emergency and Remedial Response, Washington, DC. (not seen, as cited in E&E 1998).

Appendix H

Appendix H

Uncertainties in the Human Health Risk Assessment

UNCERTAINTIES IN THE HUMAN HEALTH RISK ASSESSMENT

Because risk characterization serves as a bridge between risk assessment and risk management, major assumptions, scientific judgments, and estimates of uncertainties must be described in the assessment. Risk assessment methods are designed to be highly conservative to address the uncertainties associated with each step in the risk assessment process. Thus, "true" site risks are likely to be less than, and may be significantly less than, risks estimated using standard risk assessment methods. Key factors in the risk assessment methodology that are likely to result in overestimates of site risks include the following:

- Use of the U.S. Environmental Protection Agency's (EPA) carcinogenic slope factor (CSF) for polychlorinated dibenzo-*p*-dioxins and polychlorinated dibenzofurans (PCDDs/Fs) (toxic equivalent concentrations, or TECs), which is based on the assumption that any exposure to a carcinogen is associated with some risk of cancer, is likely to overestimate risks.
- Use of studies conducted in experimental animals dosed at high levels to derive the CSF for PCDD/F is likely to overestimate risks in human populations exposed at much lower levels.
- The assumed exposure duration of 30 years is likely to represent an overestimate for most visitors to Ward Cove because this duration represents the 90th percentile of time that people live at one residence (U.S. EPA 1989).

Uncertainties also exist in site-specific aspects of the risk assessment. The following sections evaluate uncertainties in the seafood consumption rates used in this assessment, risks associated with exposure to PCDDs/Fs through consumption of seal meat and blubber, and risks related to the potential for direct contact with chemicals in sediments. In addition, Appendix G presents an evaluation of uncertainties related to maximum concentrations of chemicals of concern (CoCs) in sediments reported in 1994, 1995, 1996, and 1997 (i.e., as reported in ENSR [1994, 1995] and in the present investigation). As discussed there, application of the slightly higher concentrations of chemicals in sediments reported in prior investigations did not identify any additional CoCs and thus use of data from the present investigation did not result in underestimates of site risks.

SEAFOOD CONSUMPTION RATES

The human health risk assessment provided in Section 6 evaluates risks related to consumption of seafood that had bioaccumulated chemicals from sediments. Seafood consumption rates are difficult to identify precisely and may differ greatly between population groups. The Ketchikan area includes communities that rely heavily on seafood in their diet (i.e., subsistence populations). Therefore, although recreational anglers are the most likely current and future site users, human health risk analyses were based on subsistence level seafood consumption, to conservatively evaluate potential risks for all populations that might use affected areas of Ward Cove now, or in the future. Specifically, the risk assessment incorporated conservative consumption rates of 65 g/day of fish and 11 g/day of shellfish, based on harvest rates compiled by the Alaska Department of Fish and Game (ADFG) and described as representative of average fish consumption rates for a subsistence community (Wolfe 1995, pers. comm.). These rates were the average per-capita harvest rates of all fish and shellfish for the community of Saxman, Alaska, a predominantly Native Alaskan community.

Seafood consumption rates used in the human health risk assessment are expected to provide a conservative means to evaluate risks associated with all potential marine biota consumed. Fish consumption rates represented all fish, and the shellfish consumption rates are based on the total of all marine invertebrates including abalone, crab, clams, chitons, octopus, sea cucumber, sea urchin, shrimp, and "unknown" categories (Wolfe 1995, pers. comm.). The only other marine biota categories identified by Wolfe (1995, pers. comm.) were marine mammals and birds. The total combined average consumption rate for these groups was 3.8 g/day, which is about 5 percent of the 76 g/day consumption rate assumed for fish and shellfish combined. In addition, migration of marine mammals and birds would also reduce the potential for site-related bioaccumulation. Risk estimates for consumption of PCDDs/Fs in seals are provided in the next section of this appendix.

Seafood consumption rates were combined with a fractional intake estimate of 5 percent to account for the availability of other fishing locations in the area and for the fact that salmon, the most popular fish species for human consumption in the area, are migratory, thus limiting (or eliminating) the opportunity for salmon to bioaccumulate chemicals from Ward Cove sediments. While there is some uncertainty associated with the use of this fractional intake estimate, an evaluation presented in Appendix G indicates that even when a fractional intake of 10 percent is used, no CoCs were identified based on the potential for exposure to chemicals in seafood that have bioaccumulated from Ward Cove sediments. Similarly, evaluations based on a 70-year exposure duration conducted as a worst-case means to consider exposure did not identify any additional CoCs. (See Table G-2 and Appendix G text.)

Another source of information suggests that seafood consumption rates and the fractional intake used here may overestimate exposures for many site visitors. Specifically, the consumption rate used here of 3.8 g/day (derived by combining the consumption rate of 76 g/day with the fractional intake of 0.05) is nearly identical to the comparable seafood consumption rate, of 3.9 g/day, used in human health risk evaluations for subsistence anglers in Tongass Narrows (ENSR 1996). Table H-1 provides a comparison of consumption rates and fractional intake estimates used in the present risk assessment with those used in the risk assessment for Tongass Narrows.

CONSUMPTION OF PCDDs/Fs IN SEALS

Subsistence populations in the Ketchikan area may consume seal meat and blubber. The primary concern would be chemicals such as PCDDs/Fs that bioaccumulate readily in fat. Risks associated with consumption of PCDDs/Fs in seals were evaluated using data reported by the National Marine Fisheries (Triangle Labs 1996) (see Section 2.2.3.1). PCDDs/Fs were predominantly undetected in blubber from five seals killed by subsistence hunters in the Ketchikan area (i.e., four near Tatoosh Island and one in Coon Cove) (Triangle Labs 1996) (Table D1-3 in Appendix D). Toxic equivalent concentrations (TECs) for PCDDs/Fs of 5.4 and 5.5 ng/kg were calculated for the two samples with at least one detected congener, using a value of one-half the detection limit for each relevant undetected PCDD/F congener. TECs of 0.40 ng/kg and 0.0079 ng/kg were calculated when undetected congeners were excluded from the calculations (Table D1-3 in Appendix D). For the three samples in which congeners were not detected, a maximum TEC of 29.3 ng/kg was calculated using the full detection limits for undetected congeners and a maximum TEC of 14.7 ng/kg was calculated using one-half the detection limits for undetected congeners (Table D1-3 in Appendix D). Use of such an assumption greatly overestimates actual concentrations.

A risk-based concentration for consumption of seals was calculated by applying methods used to derive risk-based concentrations for fish and shellfish in Ward Cove (Section 6). ADFG (Wolfe 1995, pers. comm.) provided an average harvest rate for all edible parts of marine mammals of 3 g/day. This harvest rate was used with the remaining assumptions used in calculating risk-based concentrations in Section 6 (i.e., a fractional intake of 5 percent and a target risk level of 10^{-5}) to calculate a risk-based concentration of 76 ng/kg for PCDDs/Fs in marine mammals. This risk-based concentration is more than 10 times higher than the highest TEC detected in seal blubber of 5.5 ng/kg calculated using one-half the detection limits for undetected congeners.

The risk-based concentration of 76 ng/kg for consumption of marine mammals is 2 times higher than the highest TEC calculated for undetected congeners using the full detection limits (i.e., 29.3 ng/kg). Moreover, consideration of PCDDs/Fs in seal blubber provides a conservative basis to evaluate exposure to PCDDs/Fs through consumption of seal meat and blubber, because consumers would be expected to eat both meat and blubber and PCDD/F concentrations are likely to be higher in blubber than in meat. Thus, because PCDD/F TECs are well below risk-based concentrations even when conservative assumptions are used, risks, if any, associated with exposure to PCDDs/Fs in seals appear to be well within levels considered acceptable by regulatory agencies.

TABLE H-1. CONSUMPTION RATES ASSUMED FOR WARD COVE AND TONGASS NARROWS

Consumption of Fish and Shellfish (g/day)	Ward Cove[a]	Tongass Narrows[b]
Urban Subsistence Angler Scenario		
Daily Consumption of Fish and Shellfish		
Fish		
Resident	- -	27
Migratory	- -	38
All	65	65
Shellfish		
Crab	- -	2.9
All	11 [c]	2.9
Total Combined Consumption	76	67.9
Consumption from Affected Area (Fractional Intake)		
Fish	0.05	0.016
Shellfish	0.05	1
Total Consumption from Affected Area	3.8	3.9
Recreational Angler Scenario		
Daily Consumption of Fish and Shellfish		
Fish		
Resident	- -	0.012
Migratory	- -	0.017
All	- -	0.029
Shellfish		
Crab	- -	2.9
All	- -	2.9
Total Combined Consumption	- -	2.9
Consumption from Affected Area (Fractional Intake)		
Fish	- -	0.016
Shellfish	- -	1
Total Consumption from Affected Area	- -	2.9

[a] Ward Cove values used in deriving risk-based concentrations in the present study based on data from the Alaska Department of Fish and Game (ADFG), Division of Subsistence (Wolfe 1995, pers. comm.).

[b] Tongass Narrows values used in the risk assessment for the KPC mixing zone request (Table 5-2 in ENSR 1996), based on data from ADFG.

[c] Shellfish consumption rates are based on the total of all marine invertebrates identified by Wolfe (1995, pers. comm.): abalone, clams, chitons, octopus, sea cucumber, sea urchin, shrimp, and "unknown" categories.

DIRECT CONTACT WITH SEDIMENTS

People could hypothetically be exposed to chemicals in sediments through direct contact with sediments (i.e., incidental ingestion or dermal contact). As described in Section 6 of the main text, however, direct contact with sediments was not considered a likely exposure pathway because there are no exposed sediments that could potentially be affected by site-related chemicals in the vicinity of the site. Instead, sediments abutting the site are under deep water even during low tide, limiting or eliminating direct contact with chemicals in these sediments. People could come into contact with sediments, however, at the mouth of Ward Creek, in an area used for recreational fishing and wading. Based on the distribution of chemicals observed in Ward Cove, site-related chemicals are not expected to be elevated in or near Ward Creek because concentrations decrease in samples between the site and Ward Creek. No sampling data are available for sediments in Ward Creek.

Human health risk estimates are developed here, however, to provide a worst-case analysis. These calculations were based on maximum chemical concentrations detected in Ward Cove sediments in Exponent's 1996 or 1997 investigations or in investigations conducted in 1994 or 1995 (see Table G-1). For example, concentrations of selected metals and PAHs in two intertidal sediment stations, Stations 50 and 51, were low and consistently well below the maximum concentrations identified near the site (Tables A-1 through A-3 in Appendix A). Because concentrations further upstream in Ward Creek sediments are likely to be substantially less than concentrations in Ward Cove or at Stations 50 and 51, evaluations based on maximum concentrations in Ward Cove provide a conservative means to evaluate potential risks, if any, associated with exposure to sediments in Ward Creek. These estimates also provide a conservative means to evaluate any risks associated with any contact with sediments that might occur during fishing in Ward Cove (e.g., potential sediment contact related to handling fish, shellfish, fish nets, or crab pots). Actual risks associated with these activities would be less than suggested by these risk estimates because the degree of exposure during these activities would be less than assumed in these calculations.

Screening to Identify CoCs Based on Direct Contact with Sediments

In the risk assessment presented in Section 6, sediment chemical concentration data were screened on the basis of the potential for bioaccumulation of chemicals in sediments into fish or shellfish consumed by people. Direct contact with sediments could result in a different level of exposure to chemicals than that resulting from bioaccumulation. Therefore, to identify CoCs based on direct contact with sediments, maximum sediment chemical concentration data were compared with risk-based concentrations derived by EPA Region 3 for use in identifying CoCs in residential soil (Table H-2). The EPA risk-based concentrations used in this evaluation provide a protective means to identify CoCs because they were derived using the following assumptions: exposure to chemicals in soil 350 days per year for 30 years and ingestion of 200 mg/day of soil by children and

TABLE H-2. SCREENING COMPARISON OF MAXIMUM SEDIMENT CONCENTRATIONS WITH RISK-BASED CONCENTRATIONS IN SOIL

Substance	Sediment[a] (mg/kg dw)	Risk-Based[b] Concentration (mg/kg)	Risks Calculated for Direct Contact
Metals			
Arsenic (inorganic)	39	4.3	Yes
Cadmium	7.3	78	No
Total mercury	0.7	23	No
Zinc[c]	470	23,000	No
Organic Compounds			
Phenol	0.91	47,000	No
4-Methylphenol	17	390	No
PCDD/F (TEC)[d]	6.2×10^{-5}	4.3×10^{-5}	No
PAHs[d]			
Benzo[a]pyrene (RPC)	0.42	0.87	No
Fluoranthene	2.2	3,100	No
Pyrene	1.8	2,300	No
Acenaphthene	0.50	4,700	No
Anthracene[d]	0.32	23,000	No
Fluorene	0.47	3,100	No

Note:
CDI - chronic daily intake
dw - dry weight
EPA - U.S. Environmental Protection Agency
PAH - polycyclic aromatic hydrocarbons
RfD - reference dose
RPC - relative potency concentration for carcinogenic PAH
PCDD/F - polychlorinated dibenzo-*p*-dioxin and polychlorinated dibenzofuran
TEC - toxic equivalent concentration based on data for 2,3,7,8-tetrachlorodibenzo-*p*-dioxin

[a] Concentrations are maximum sediment concentrations identified in this investigation except as indicated.

[b] Risk-based concentrations for daily ingestion of soil in a residential setting from U.S. EPA (1998) adjusted to reflect a 10^{-5} target risk level consistent with draft guidance from ADEC (1998). Risk-based concentration for cadmium based on the RfD for food. Risk-based concentration for mercury based on mercuric chloride in sediments.

[c] Maximum zinc concentrations were from samples collected in 1994 (ENSR 1994) (see Table 7-27 in this report).

[d] Maximum PCDD/F (as TEC), PAH (as RPC), and anthracene concentrations were from samples collected in 1995 (ENSR 1996) (see Tables 7-28 and 7-29 in this report).

100 mg/day by adults in a residential setting. The EPA risk-based concentrations are also based on a 1×10^{-6} excess target risk level for carcinogens or a hazard index of 1 for non-carcinogenic effects. To be consistent with the draft Alaska Department of Environmental Conservation (ADEC) guidance (ADEC 1998) and the approach used in risk evaluations presented in Section 6 of this report, however, EPA risk-based concentrations were adjusted to reflect a 1×10^{-5} excess target risk level for carcinogens. Maximum concentrations of PCDD/F (TECs) and arsenic in sediments exceeded their respective risk-based concentrations (Table H-2). Risk estimates were calculated for arsenic only, however, because of the many conservative aspects of this screening approach and the marginal exceedance of the PCDD/F sediment concentration of 6.2×10^{-5} in comparison with the risk-based concentration of 4.3×10^{-5} (Table H-2).

No risk-based concentrations were available for ammonia or sulfide in sediments. Both of these chemicals primarily present inhalation hazards but can also be caustic to the skin and mucous membranes. Surface sediments contain up to 640 mg/kg of ammonia and up to 6,000 mg/kg of sulfide. These elevated concentrations predominantly occur under deep water (see Figures 4-5 and 4-7), but also occur in some near-shore areas. For comparison, caustic household cleaners contain ammonia at approximately 10 percent and toilet bowl cleaners contain sulfuric acid at 10 percent (Clayton and Clayton 1993). While these cleaning materials can be hazardous, they represent concentrations of 100,000 mg/kg, which is 16- to 160-fold higher than concentrations found in sediments. In addition, any contact with these chemicals in sediments would be greatly reduced through dilution in the water column. Thus, ammonia and sulfide are not considered further here.

Exposure to CoCs in Sediments

Potential exposure to arsenic in sediments was evaluated assuming contact during fishing or walking in intertidal areas near the mouth of Ward Creek. Such uses would result in higher exposure levels than would be expected to result from fishing in Ward Cove. Thus, this evaluation also provides a conservative means to evaluate risks related to direct contact with Ward Cove sediments. Human exposure could result through incidental ingestion or dermal contact with arsenic in sediments.

Ingestion of CoCs in Sediments

Risk estimates were calculated for ingestion of arsenic in sediments using maximum concentrations in Ward Cove and the algorithm provided in EPA guidance (U.S. EPA 1989) (Table H-3). The evaluation focused on adults and included the following conservative assumptions:

- Concentrations of chemicals in sediments near the mouth of Ward Creek are represented by maximum sediment chemical concentrations

TABLE H-3. EXPOSURE ALGORITHM FOR INCIDENTAL INGESTION OF SEDIMENTS

$$\text{Chronic Daily Intake (mg/kg-day)} = \frac{CS \times IR \times CF \times FI \times EF \times ED}{BW \times AT}$$

where:

CS	=	chemical concentration in sediments (mg/kg)
IR	=	ingestion rate (mg sediment/day)
CF	=	conversion factor (10^{-6} kg/mg)
FI	=	fraction ingested from contaminated source (unitless)
EF	=	exposure frequency (visits/year)
ED	=	exposure duration (years)
BW	=	body weight (kg)
AT	=	averaging time – carcinogenic effects: 70-year lifetime × 365 days/year

Exposure Assumptions[a]

Parameter	Recreational Scenario
CS	39 mg/kg (maximum concentration)
IR	100 mg sediment/day (adult)
FI	1
EF	25 visits/year[b]
ED	30 years
BW	70 kg (adult)

Sample Calculation

Chronic Daily Intake (for carcinogenic effects, based on the maximum arsenic concentration in sediments of 39 mg/kg)

$$= \frac{39 \text{ mg/kg} \times 100 \text{ mg/day} \times 10^{-6} \text{ kg/mg} \times 25 \text{ visits/year} \times 30 \text{ years}}{70 \text{ kg } (70 \text{ years} \times 365 \text{ days/year})}$$

$$1.6 \times 10^{-6} \text{ mg/kg-day}$$

[a] All exposure assumptions from U.S. EPA (1991) unless otherwise noted.

[b] Assumes exposure to sediments during 25 visits per year based on best professional judgment.

in Ward Cove. In fact, site data suggest that site-related chemicals would not be found in Ward Creek.

- A person visits the area 25 times a year each year for 30 years. This area is mostly used for fishing while salmon are running and thus this exposure frequency and duration would be expected to represent an upper end estimate of site use.

- A person ingests 100 mg of sediments during each visit. This intake assumption is recommended by EPA as the total daily ingestion rate of soil and sediment for adults and older children.

Dermal Contact with CoCs in Sediments

Human exposure could also occur through dermal contact with PCDD/F and arsenic in sediments.

Potential exposures associated with dermal contact with arsenic in sediments were estimated using the algorithm provided by EPA (U.S. EPA 1989) (Table H-4). Like estimates for incidental ingestion of sediments, the dermal exposure estimate for arsenic was based on the maximum concentration of arsenic in sediments and the assumption that a person might contact sediments containing this arsenic concentration during 25 visits per year, each year for 30 years. In addition, upper-end exposure assumptions provided in applicable EPA guidance documents were used in exposure estimates (U.S. EPA 1992, 1995, 1997).

- Dermal absorption of 3.2 percent of arsenic based on U.S. EPA (1995)

- More than 25 percent of the body surface of an adult would be in contact with affected sediments, that is, a surface area of 5,800 cm^2 including contact with sediments on arms, legs, head, and neck (also identified as an upper-end estimate in U.S. EPA [1997])

- Dermal adherence of sediments would be 1 mg/cm^2 (U.S. EPA [1992] identified a range of 0.2–1 mg/cm^2).

No toxicity values are available for evaluating dermal effects. As noted in EPA guidance (U.S. EPA 1989), it is possible to extrapolate from oral toxicity factors to evaluate risks associated with dermal exposures. Such an extrapolation requires that oral toxicity values be adjusted to reflect an absorbed dose. Consistent with EPA guidance (U.S. EPA 1989), the toxicity value for arsenic (i.e., the EPA-derived CSF) was evaluated to determine whether it was necessary to adjust the oral CSF to reflect an absorbed dose by dividing by the percentage oral absorption. Oral absorption of arsenic was assumed to be complete based on studies reviewed by ATSDR (1993) indicating greater than 90 percent absorption. Thus, no adjustment was made in the oral CSF for arsenic.

TABLE H-4. EXPOSURE ALGORITHM FOR DERMAL CONTACT WITH SEDIMENTS

$$\text{Absorbed Dose (mg/kg-day)} = \frac{CS \times CF \times SA \times AF \times ABS \times EF \times ED}{BW \times AT}$$

where:

CS	=	chemical concentration in sediment (mg/kg)
CF	=	conversion factor (10^{-6} kg/mg)
SA	=	skin surface area available for contact (cm^2/event)
AF	=	sediment-to-skin adherence factor (mg/cm^2)
ABS	=	absorption factor (unitless)
EF	=	exposure frequency (visits/year)
ED	=	exposure duration (years)
BW	=	body weight (kg)
AT	=	averaging time – carcinogenic effects: 70-year lifetime × 365 days/year

Exposure Assumptions[a]

Parameter	Recreational Scenario
CS	39 mg/kg (maximum concentration)
SA	5,800 cm^2/event[b]
AF	1[c]
ABS	3.2 percent[d]
EF	25 visits/year[e]
ED	30 years
BW	70 kg

Sample Calculation

Absorbed Dose (for carcinogenic effects, based on the maximum arsenic concentration in sediments of 39 mg/kg)

$$\frac{39\ \text{mg/kg} \times 10^{-6}\ \text{kg/mg} \times 5{,}800\ \text{cm}^2/\text{event} \times 1\ \text{mg/cm}^2 \times 0.032 \times 25\ \text{visits/year} \times 30\ \text{years}}{70\ \text{kg}\left(70\ \text{years} \times 365\ \text{days/year}\right)}$$

$$3 \times 10^{-6}\ \text{mg/kg-day}$$

[a] Exposure algorithm provided by U.S. EPA (1989). This exposure term is combined with an oral toxicity value that has been adjusted, if necessary, to reflect the degree of oral absorption.

[b] Upper-bound estimate recommended by U.S. EPA (1997); represents 25 percent of the surface area of an adult.

[c] Upper end of range in U.S. EPA (1992).

[d] Dermal absorption of 3.2 percent for arsenic (U.S. EPA 1995).

[e] Assumes exposure during 25 visits per year based on best professional judgment.

Risk Characterization

Risk estimates are calculated by combining exposure estimates with toxicity values. Because arsenic is carcinogenic, excess lifetime cancer risks were evaluated by multiplying the exposure estimates for arsenic by the CSF for arsenic of 1.5 $(mg/kg\text{-}day)^{-1}$. The risk estimate related to ingestion of arsenic in sediments was 2×10^{-6}, the risk estimate for dermal exposure to arsenic was 5×10^{-6}, and the total risk estimate related to ingestion and dermal contact combined was 7×10^{-6} (Table H-5).

Thus, the total risk estimate of 7×10^{-6} is well below the upper end of the EPA and ADEC risk range of 10^{-4} to 10^{-6}. Thus, even if sediment concentrations near or within Ward Creek were as high as the highest values in Ward Cove, risks, if any, would not be expected to be above acceptable levels. Actual risks related to site chemicals in or near Ward Creek are expected to be much lower, or nonexistent, because transport of chemicals from the site to Ward Creek is not expected. In addition, conservative exposure assumptions used here (i.e., use of maximum concentrations, assumed exposure 25 days per year for 30 years and conservative dermal exposure assumptions) are expected to overestimate risk.

REFERENCES

ADEC. 1998. Contaminated sites remediation program, risk assessment procedures manual for Method 4.0. Draft. Alaska Department of Environmental Conservation.

ATSDR. 1993. Toxicological profile for arsenic. U.S. Department of Health and Human Services, Agency for Toxic Substances and Disease Registry, Atlanta, GA.

Clayton, G.D., and F.E. Clayton (eds). 1993. Patty's industrial hygiene and toxicology. Fourth Edition. Volume II, Part A: Toxicology. John Wiley & Sons, Inc., New York, NY.

ENSR. 1994. Annual sediment monitoring report NPDES Permit No. AK-000092-2. Document No. 4025-27-240. Prepared for Ketchikan Pulp Company, Ketchikan, AK. ENSR Consulting and Engineering.

ENSR. 1995. Annual sediment monitoring report. NPDES Permit No. AK-000092-2. Document No. 4025-043-300. Prepared for Ketchikan Pulp Company, Ketchikan, AK. ENSR Consulting and Engineering.

ENSR. 1996. Response to ADEC questions on KPC's mixing zone request. Document D: revised ecological and human health risk assessment. Prepared for Ketchikan Pulp Company, Ketchikan, AK. ENSR Consulting and Engineering.

TABLE H-5. RISK ESTIMATES FOR INGESTION AND DERMAL CONTACT WITH CHEMICALS OF POTENTIAL CONCERN IN SEDIMENTS

	Concentration[a] (mg/kg)	Absorption Factor[b]	Carcinogenic Effects		
			CDI[b] (mg/kg-day)	Oral CSF $(mg/kg\text{-}day)^{-1}$	Risk
Ingestion					
Arsenic	39	1	1.6×10^{-6}	1.5	2×10^{-6}
Dermal Contact					
Arsenic	39	0.032	3.0×10^{-6}	1.5	5×10^{-6}
Total Cancer Risk:					7×10^{-6}

Note: CDI - chronic daily intake
CSF - carcinogenic slope factor

[a] Single highest arsenic value in sediments including data from 1994, 1995 (ENSR 1994, 1995), and the present investigation. Arsenic concentration is from the present investigation (see Table H-3).

[b] See text and Tables H-3 and H-4 for basis of exposure assumptions.

Triangle Labs. 1996. Letter to J. Lewis, National Marine Fisheries, Douglas, AK, dated October 30, 1996, regarding toxicity equivalents reports for analysis of seal blubber for dioxins and furans. Triangle Laboratories, Inc., Durham, NC.

U.S. EPA. 1989. Risk assessment guidance for Superfund. Human Health Evaluation Manual. Interim Final. Part A. U.S. Environmental Protection Agency, Office of Solid Waste and Emergency Response. Washington, DC.

U.S. EPA. 1991. Risk assessment guidance for Superfund. Volume I: human health evaluation manual. Standard default exposure factors. Interim Final. U.S. Environmental Protection Agency, Office of Emergency and Remedial Response, Toxics Integration Branch, Washington, DC.

U.S. EPA. 1992. Dermal exposure assessment: principles and applications. EPA/600/8-9-91. U.S. Environmental Protection Agency, Office of Health and Environmental Assessment, Washington, DC.

U.S. EPA. 1995. Assessing dermal exposure from soil. EPA/903/K-95/003. U.S. Environmental Protection Agency, Region III, Hazardous Waste Management Division, Office of Superfund Programs, Philadelphia, PA.

U.S. EPA. 1997. Exposure factors handbook. Volume I: general factors. EPA/600/P-95/002Ba. U.S. Environmental Protection Agency, Office of Research and Development, National Center for Environmental Assessment, Washington, DC.

U.S. EPA. 1998. Memorandum from R.L. Smith to RBC Table mailing list, regarding updated risk-based concentration table, dated April 15, 1998. U.S. Environmental Protection Agency, Region 3, Philadelphia, PA.

Wolfe, R. 1995. Personal communication (letter and document to L. Yost, PTI Environmental Services, Bellevue, WA, dated March 13, 1995, regarding harvests of seafood and wildlife in Saxman, Alaska). State of Alaska, Department of Fish and Game, Division of Subsistence, Juneau, AK.

Appendix I

Appendix I

Scatter Plots for CoPC Concentrations and Sediment Toxicity Results for 1996 and 1997

CONTENTS

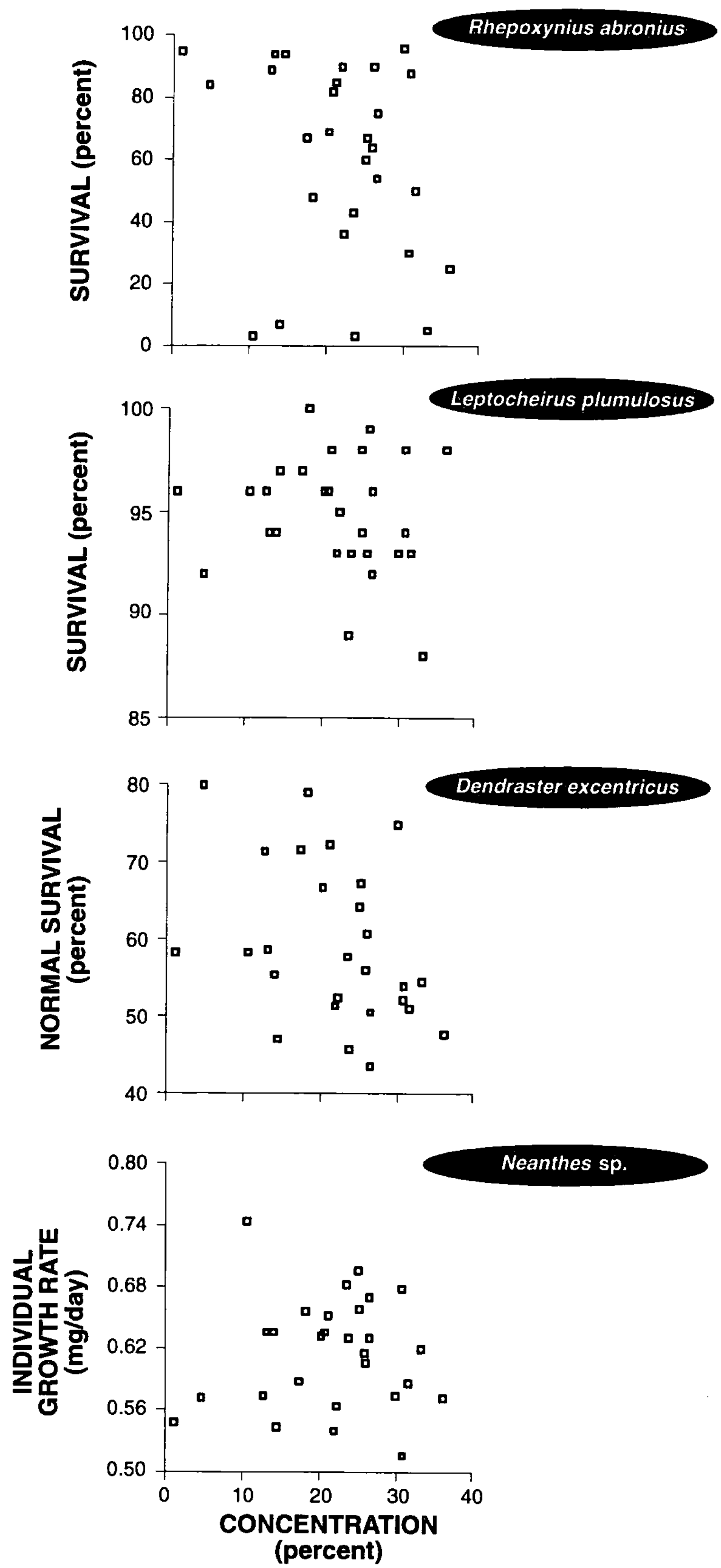


Figure I-1. Comparison of sediment toxicity results with sediment total organic carbon concentrations in Ward Cove in 1996.

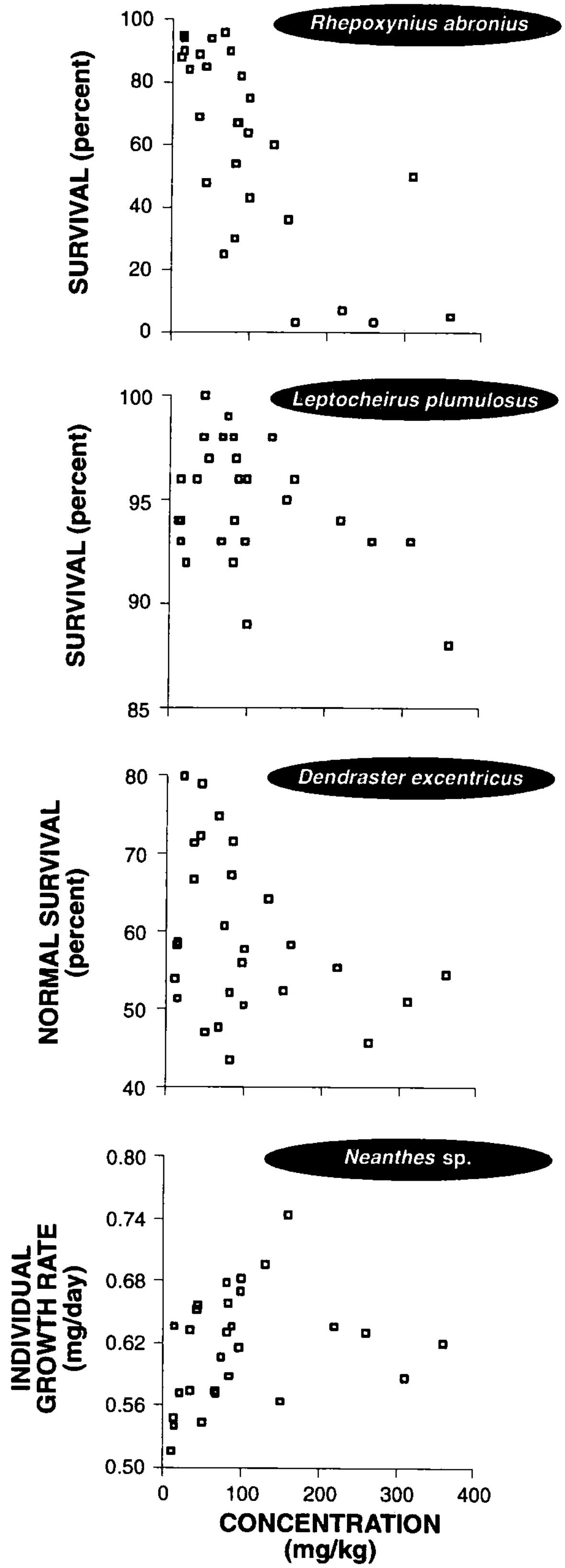


Figure I-2. Comparison of sediment toxicity results with sediment ammonia concentrations in Ward Cove in 1996.

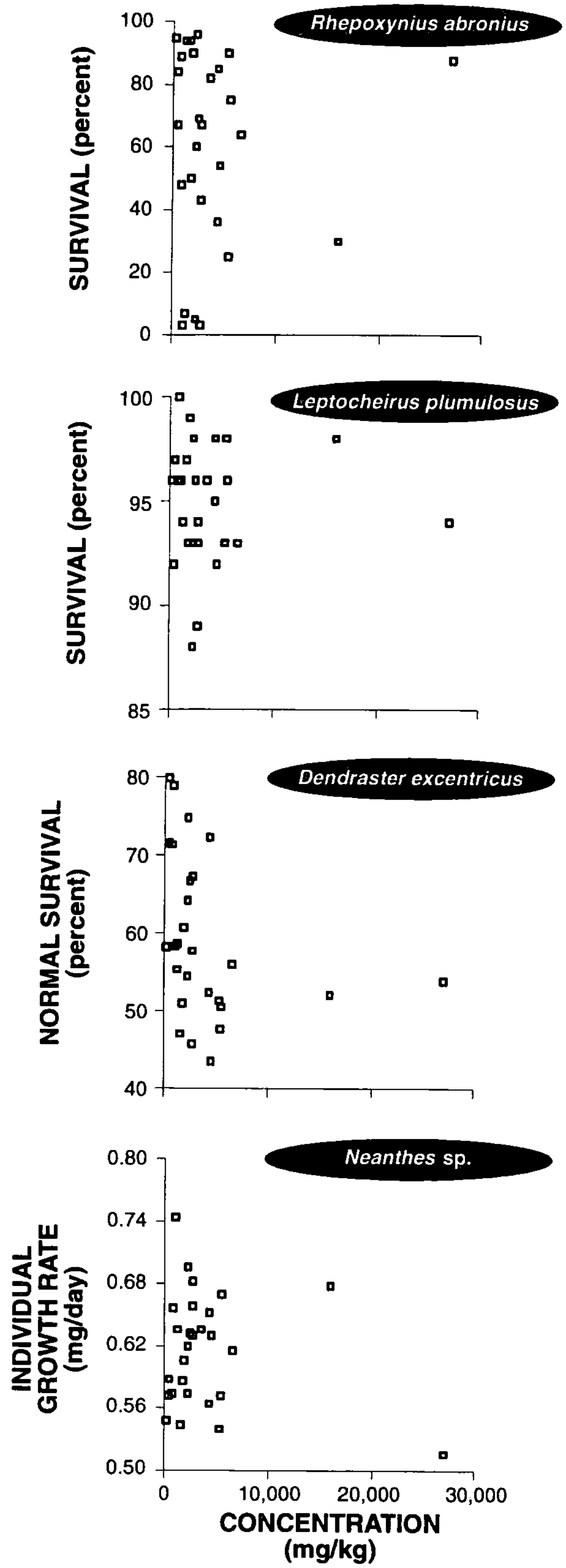


Figure I-3. Comparison of sediment toxicity results with sediment sulfide concentrations in Ward Cove in 1996.

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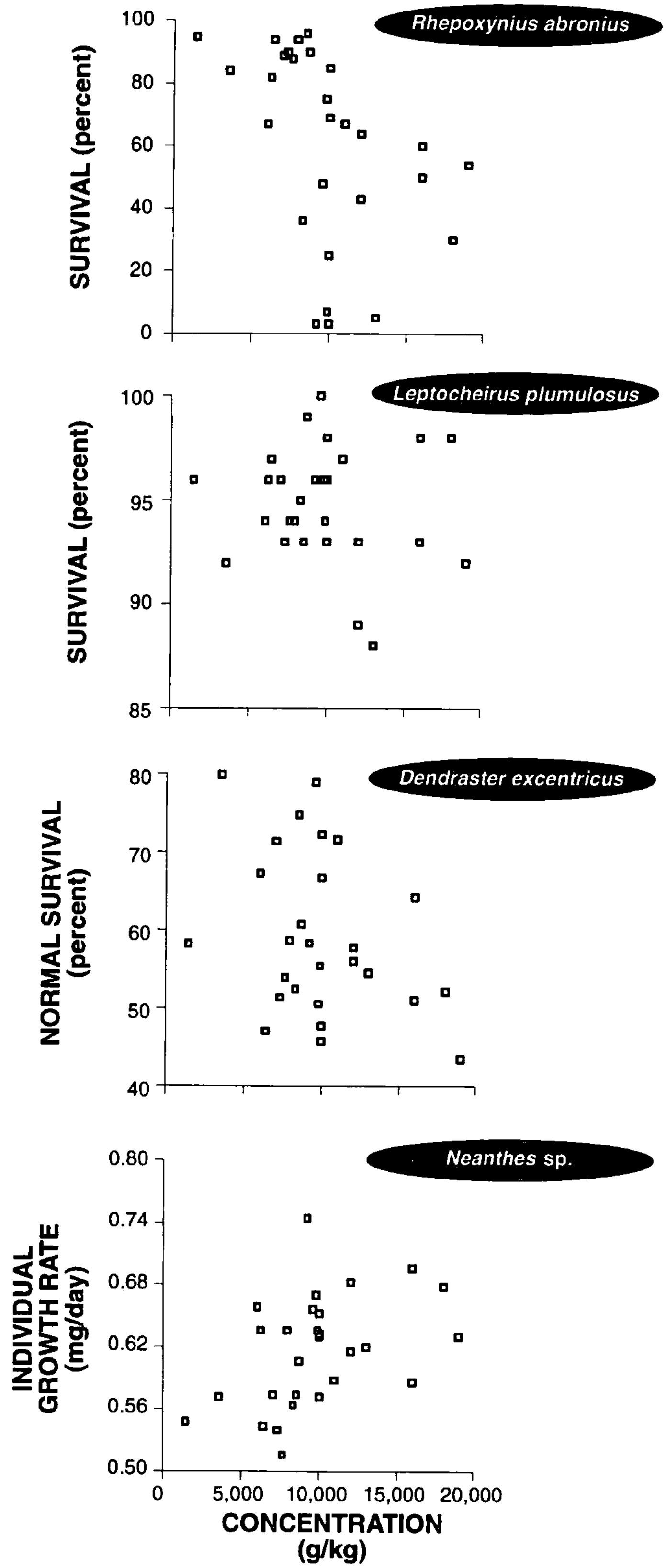

Figure I-4. Comparison of sediment toxicity results with sediment BOD concentrations in Ward Cove in 1996.

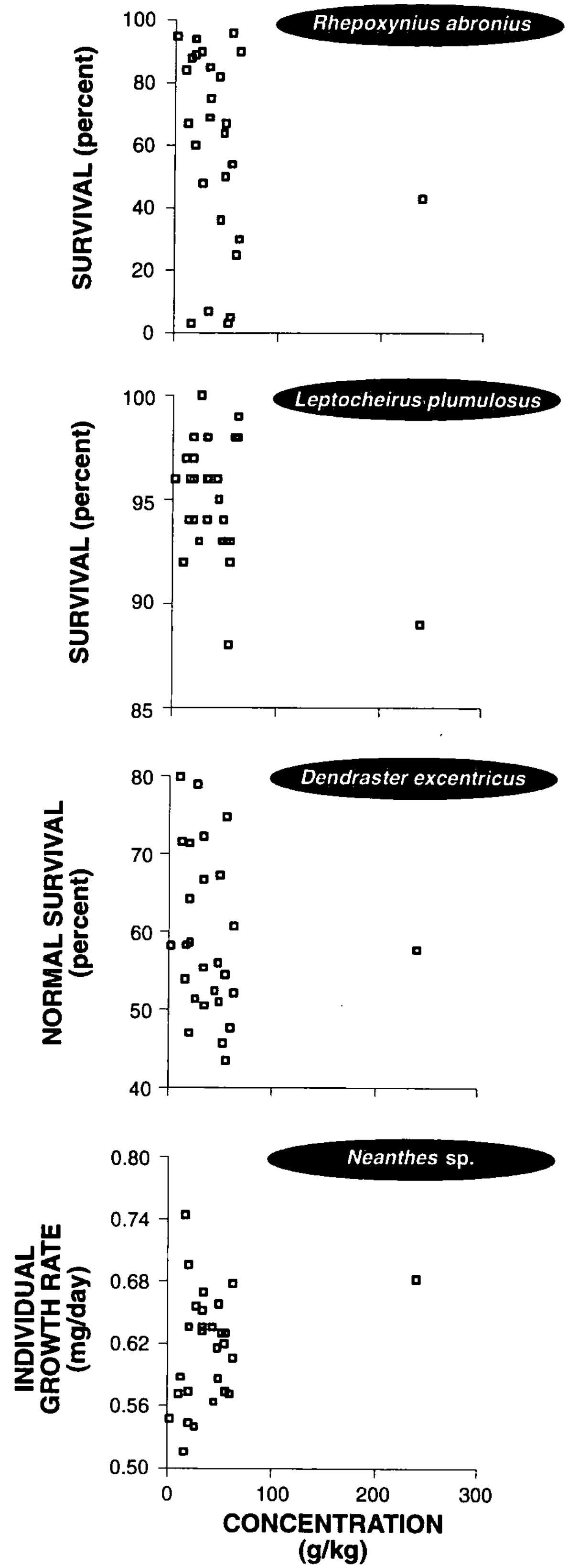

Figure I-5. Comparison of sediment toxicity results with sediment COD concentrations in Ward Cove in 1996.

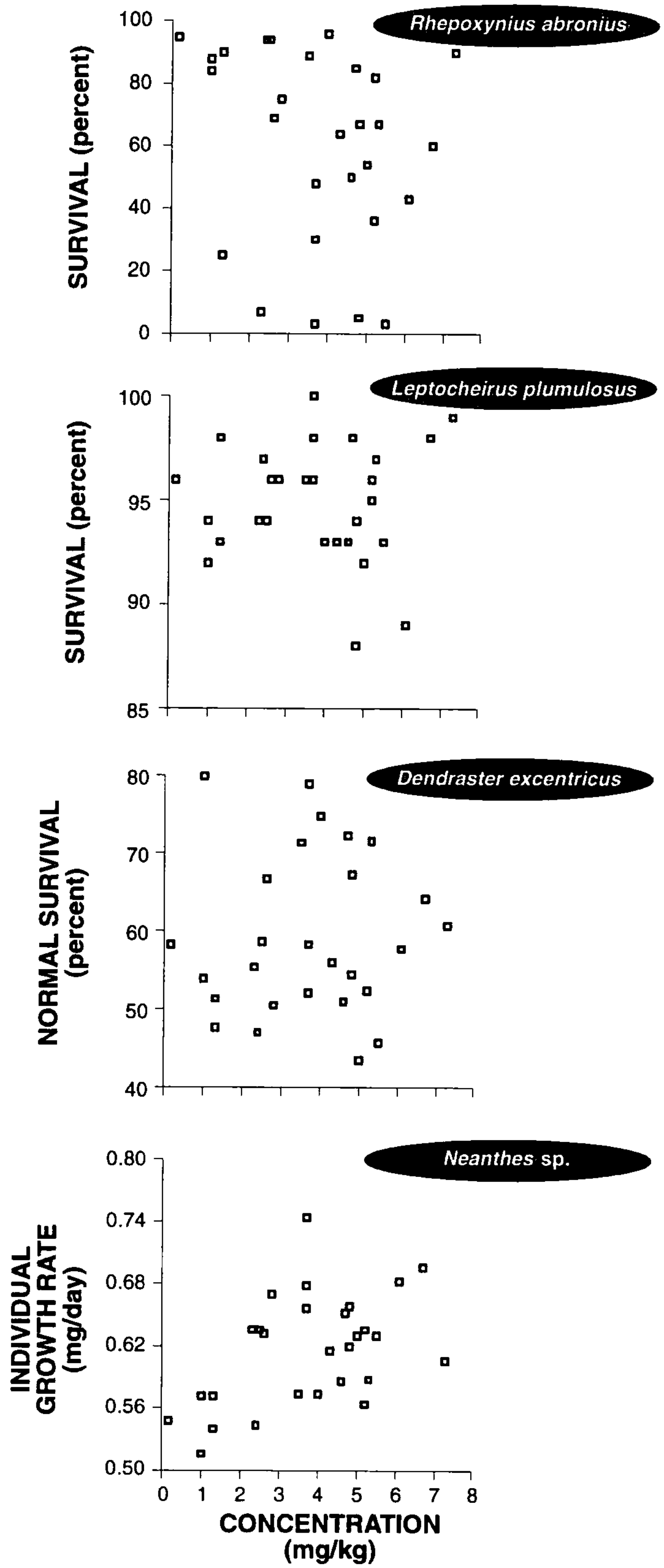

Figure I-6. Comparison of sediment toxicity results with sediment cadmium concentrations in Ward Cove in 1996.

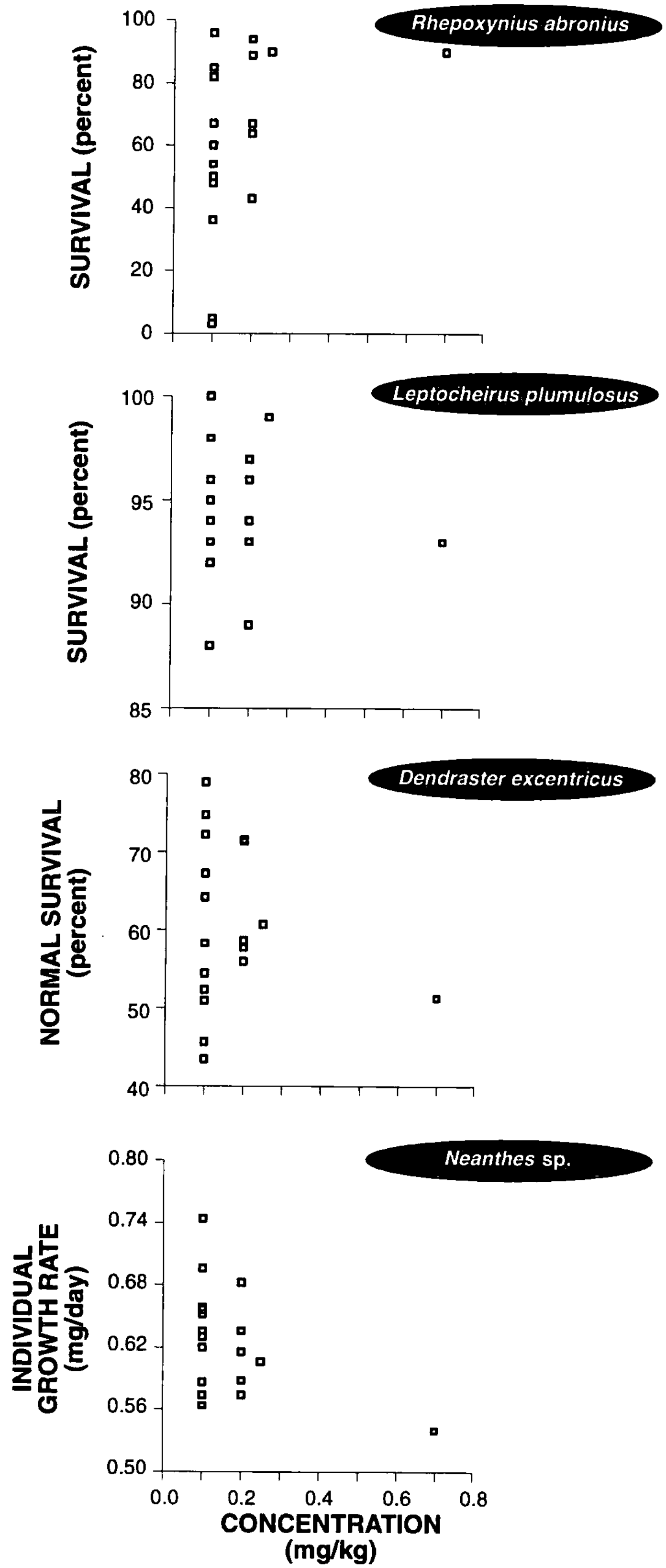

Figure I-7. Comparison of sediment toxicity results with sediment mercury concentrations in Ward Cove in 1996.

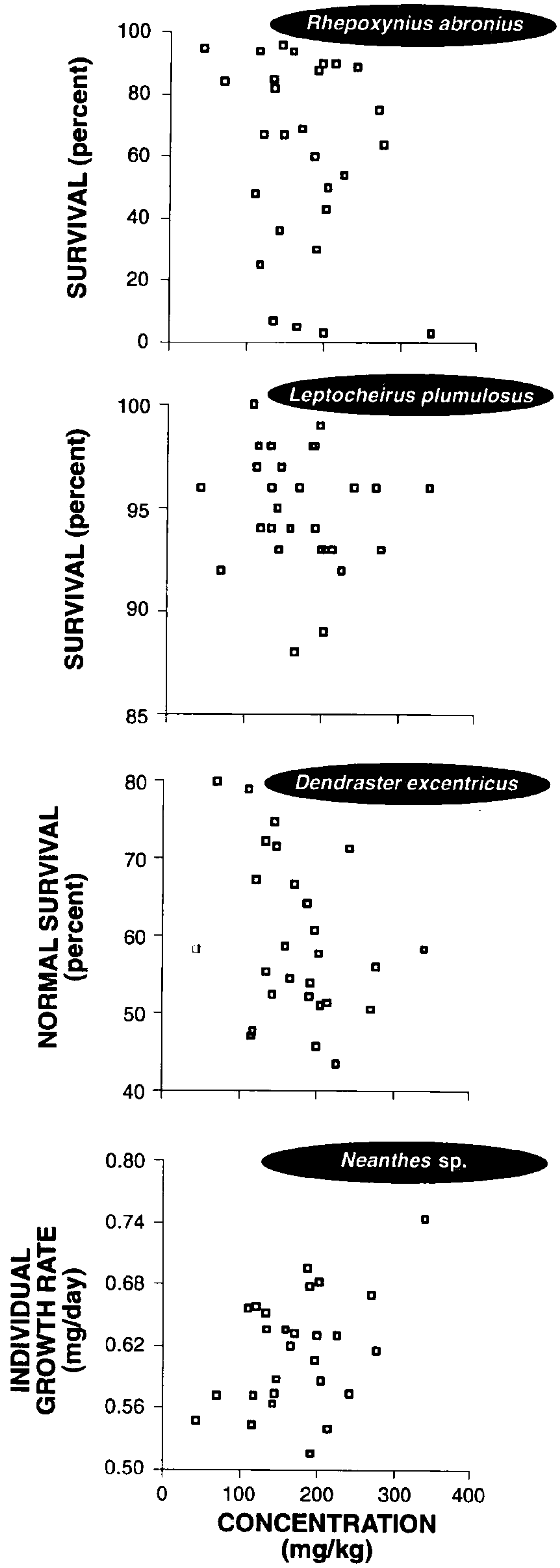

Figure I-8. Comparison of sediment toxicity results with sediment zinc concentrations in Ward Cove in 1996.

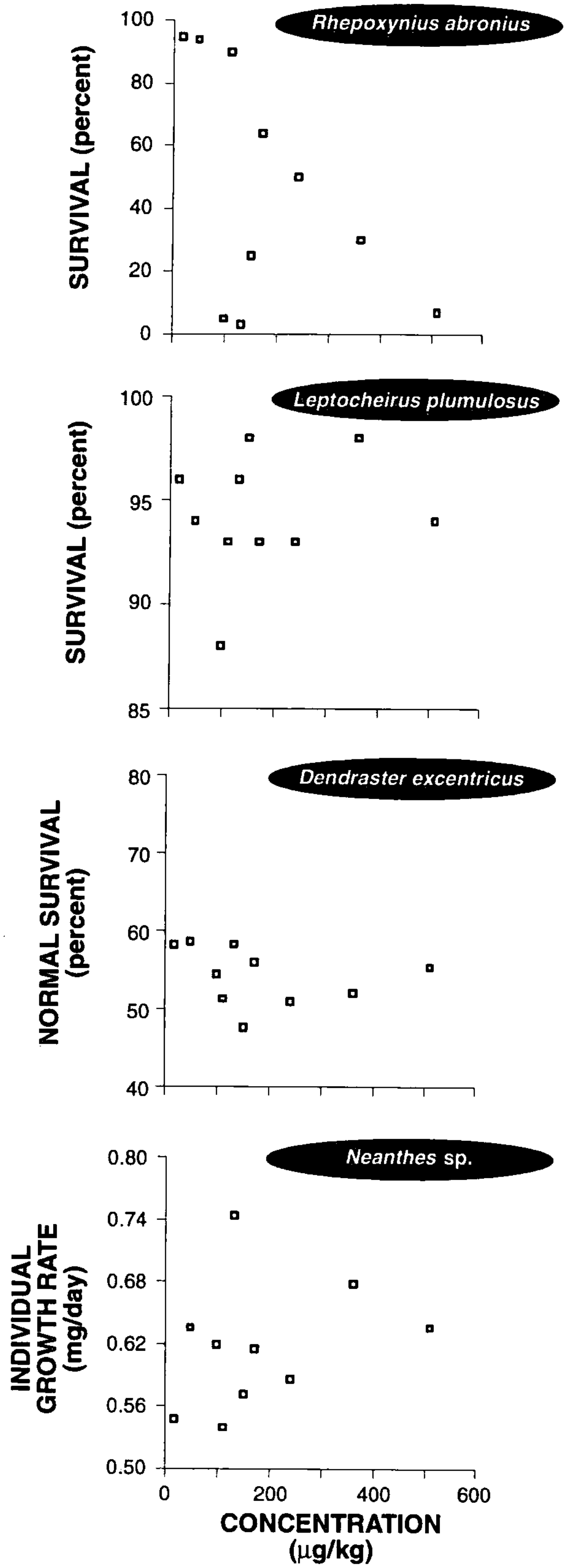

Figure I-9. Comparison of sediment toxicity results with sediment phenol concentrations in Ward Cove in 1996.

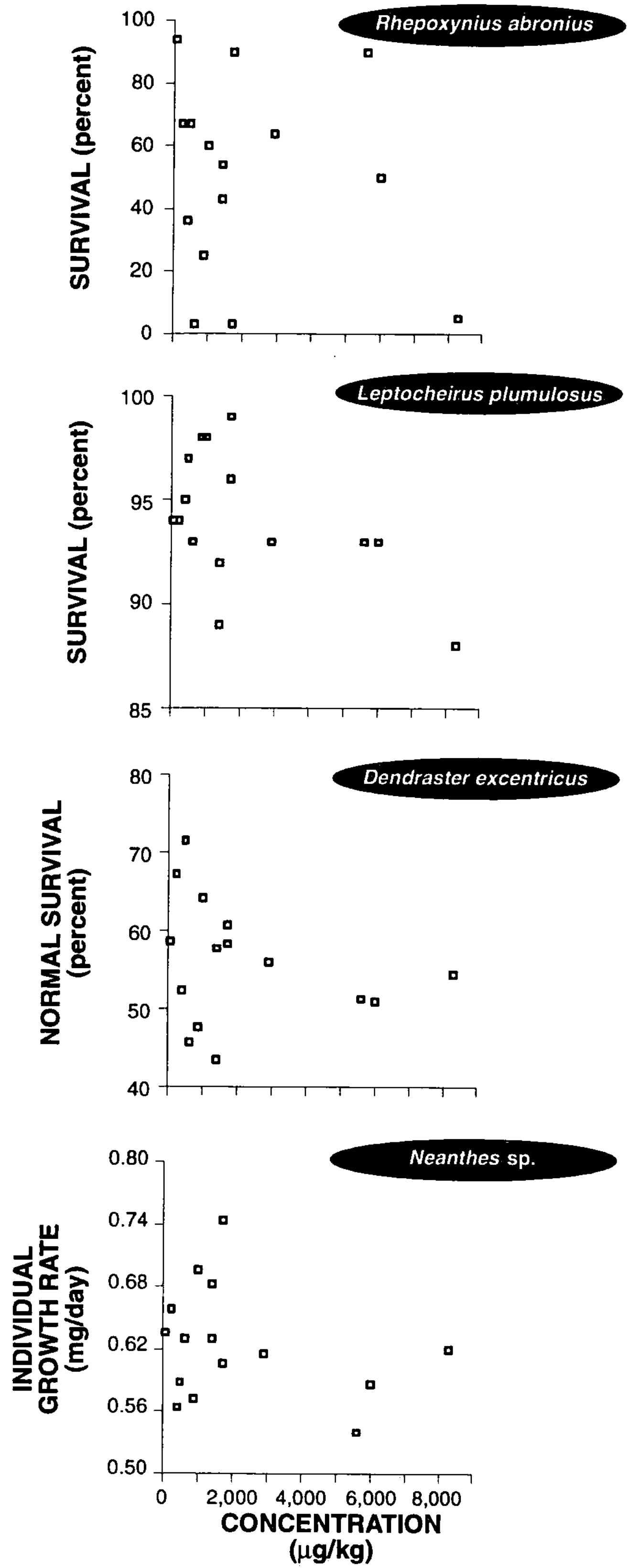

Figure I-10. Comparison of sediment toxicity results with sediment 4-methylphenol concentrations in Ward Cove in 1996.

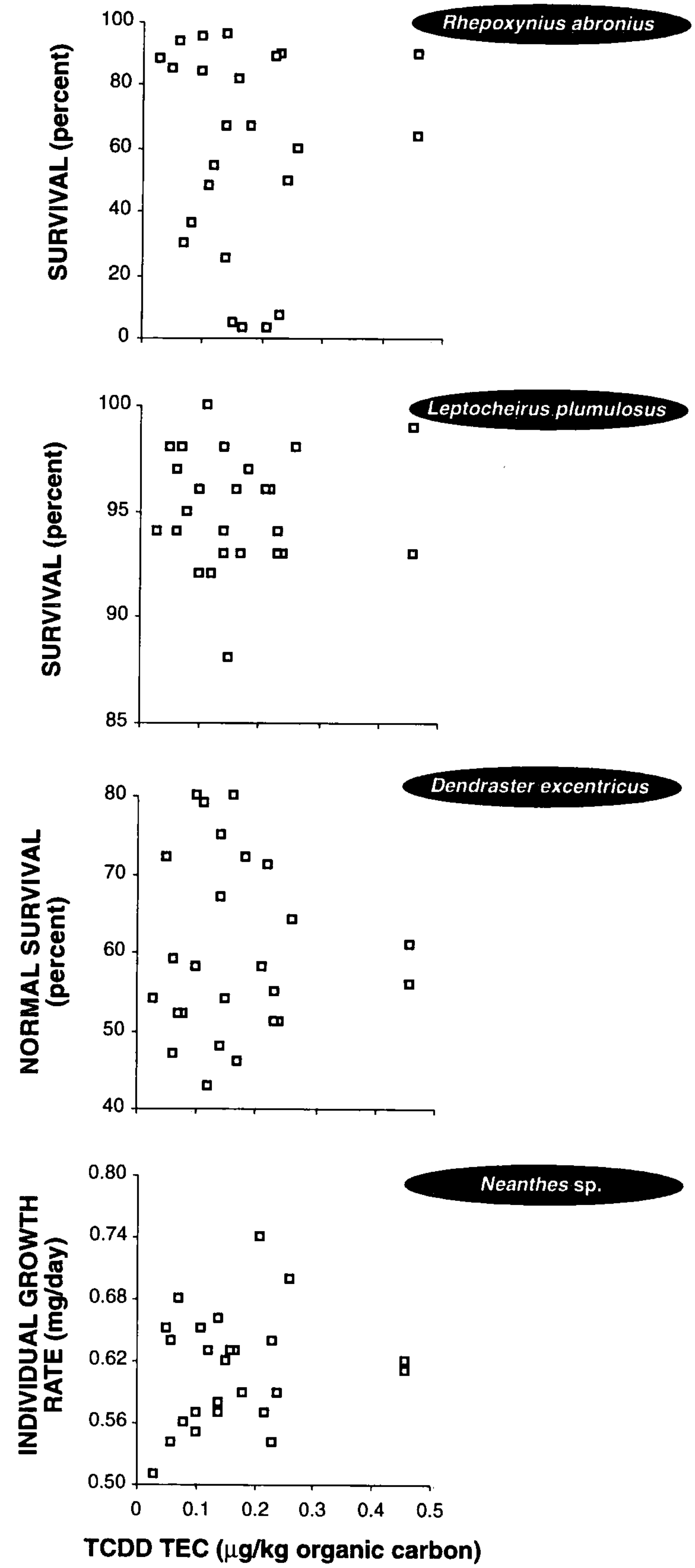

Figure I-11. Comparison of sediment toxicity results with sediment TCDD toxic equivalent concentrations in Ward Cove in 1996.

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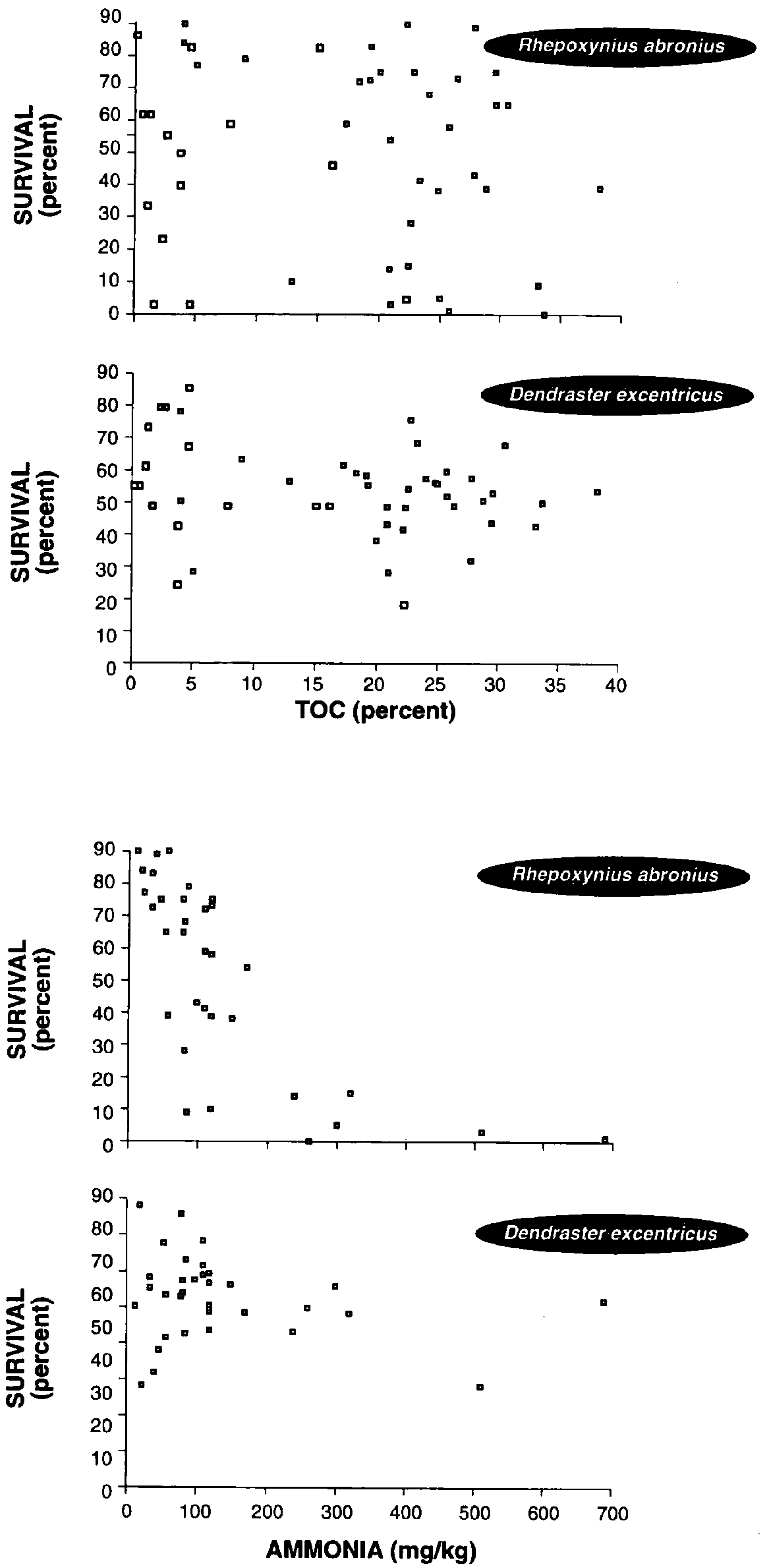

Figure I-12. Comparison of sediment toxicity results with sediment total organic carbon and ammonia concentrations in Ward Cove in 1997.

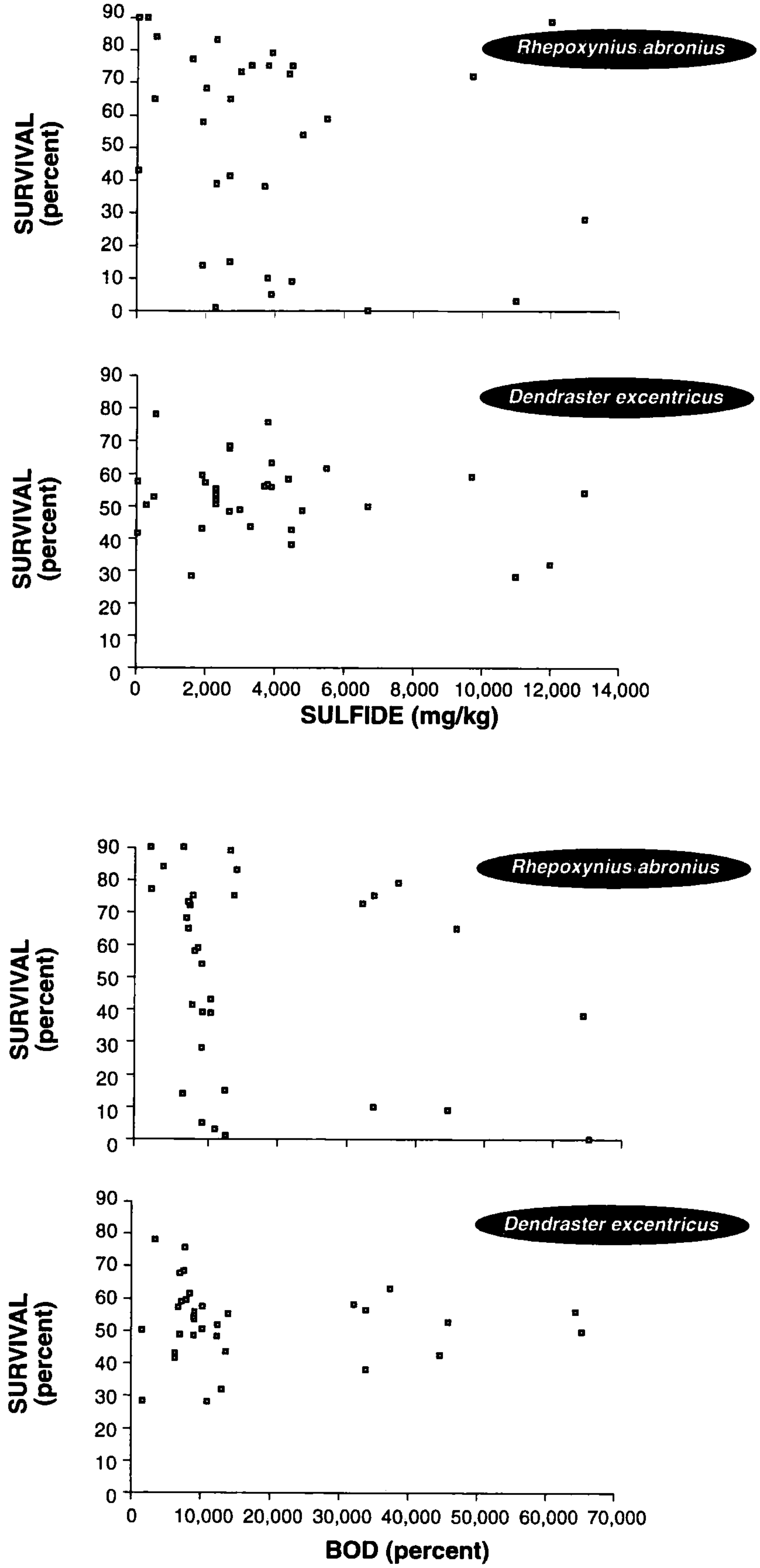

Figure I-13. Comparison of sediment toxicity results with sediment sulfide and BOD concentrations in Ward Cove in 1997.

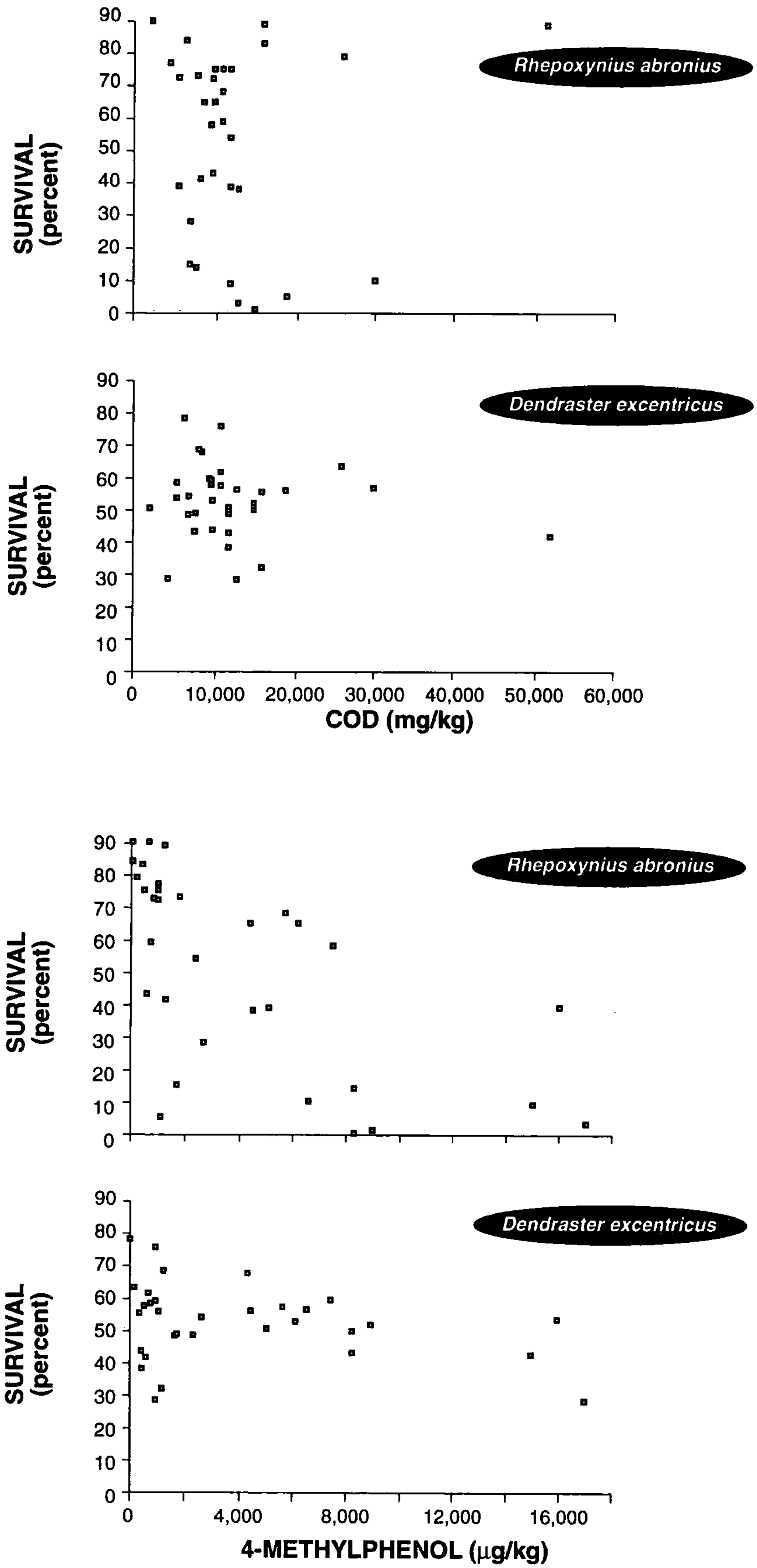

Figure I-14. Comparison of sediment toxicity results with sediment COD and 4-methylphenol concentrations in 1997.

Appendix J

Appendix J

Comparison of Various Sediment Quality Values for Metals and for PAH Compounds and Total PCBs

TABLE J-1. COMPARISON OF VARIOUS SEDIMENT QUALITY VALUES FOR METALS[a]

	Long and Morgan (1991)		Persaud et al. (1992)		Long et al. (1995)		Ecology (1995)		MacDonald et al. (1996)		Ingersoll et al. (1996)					Enviro Canada (1994)	
Metal	ERL	ERM	LEL	SEL	ERL	ERM	SQS	MCUL	TEL	PEL	ERL	TEL	ERM	PEL	**NEC**	TEL	PEL
Arsenic	33	85	**6.0** *	**33** *	8.2	70	57	93	7.2	42	13	11	50	48	**100**	7.2	42
Cadmium	5.0	**9.0** *	**0.6** *	10	1.2	9.6	5.1	6.7	0.68	4.2	0.70	0.58	3.9	3.2	**8.0**	0.68	4.2
Chromium	80	150	**26** *	**110** *	81	370	260	270	52	160	39	36	270	120	**95**	52	160
Copper	70	390	**16** *	**110** *	34	270	390	390	19	110	41	28	190	100	**580**	19	110
Lead	35	**110** *	**31** *	250	47	220	450	530	30	110	55	37	99	82	**130**	30	110
Manganese	--	--	**460** *	**1,100** *	--	--	--	--	--	--	730	630	1,700	1,200	**4,500**	--	--
Mercury	**0.15** *	**1.3** *	0.20	2.0	0.15	0.71	0.41	0.59	0.13	0.70	--	--	--	--	--	0.13	0.70
Nickel	30	**50** *	**16** *	75	21	52	--	--	16	43	24	20	45	33	**43**	16	43
Silver	**1.0** *	**2.2** *	--	--	1.0	3.7	6.1	6.1	0.73	1.8	--	--	--	--	--	0.73	1.8
Zinc	**120** *	**270** *	**120** *	820	150	410	410	960	120	270	110	98	550	540	**1,300**	120	270

Note:

ERL	-	effects range-low
ERM	-	effects range-median
LEL	-	lowest effect level
MCUL	-	minimum cleanup level
NEC	-	no-effect concentration
SEL	-	severe effect level
SQS	-	sediment quality standard
TEL	-	threshold effects level
PEL	-	probable effects level
--	-	no sediment quality value available
*	-	basis for the NYSDEC (1994) sediment criterion

[a] All values are reported as mg/kg dry weight to two significant figures.

TABLE J-2. COMPARISON OF VARIOUS SEDIMENT QUALITY VALUES FOR PAH COMPOUNDS AND TOTAL PCBs[a,b]

Chemical	Long and Morgan (1991)		Persaud et al. (1992)		Long et al. (1995)		Ecology (1995)		MacDonald et al. (1996)		Ingersoll et al. (1996)					Enviro Canada (1994)	
	ERL	ERM	LEL	SEL[c]	ERL	ERM	SQS[c]	MCUL[c]	TEL	PEL	ERL	TEL	ERM	PEL	**NEC**	TEL	PEL
Naphthalene	340	2,100	--	--	160	2,100	990	1,700	35	390	13	15	98	140	**1,400**	35	390
Acenaphthylene	--	--	--	--	44	640	660	660	5.9	130	--	--	--	--	--	5.9	130
Acenaphthene	150	650	--	--	16	500	160	570	6.7	89	--	--	--	--	--	6.7	89
Fluorene	35	640	190	1,600	19	540	230	790	21	140	10	10	140	150	**3,000**	21	140
Phenanthrene	230	1,400	560	9,500	240	1,500	1,000	4,800	87	540	27	19	350	410	**20,000**	87	540
Anthracene	85	960	220	3,700	86	1,100	2,200	12,000	47	250	10	10	140	170	**2,000**	47	250
2-Methylnaphthalene	65	670	--	--	70	670	380	640	20	200	--	--	--	--	--	20	200
Fluoranthene	600	3,600	750	10,000	600	5,100	1,600	12,000	110	1,500	33	31	180	320	**10,000**	110	1,500
Pyrene	350	2,200	490	8,500	670	2,600	10,000	14,000	150	1,400	40	44	350	490	**9,000**	150	1,400
Benz[a]anthracene	230	1,600	320	15,000	260	1,600	1,100	2,700	75	690	19	16	300	280	**3,000**	75	690
Chrysene	400	2,800	340	4,600	380	2,800	1,100	4,600	110	850	30	27	500	410	**3,000**	110	850
Benzo[b,k]fluoranthene	--	--	240 [d]	13,000 [d]	--	--	2,300	4,500	--	--	37	27	71	160	**4,000**	--	--
Benzo[a]pyrene	400	2,500	370	14,000	430	1,600	990	2,100	89	760	84	32	470	320	**1,000**	89	760
Indeno[1,2,3-cd]pyrene	--	--	200	3,200	--	--	340	880	--	--	30	17	250	240	**770**	--	--
Dibenz[a,h]anthracene	60	260	60	1,300	63	260	120	330	6.2	140	10	10	15	28	**870**	6.2	140
Benzo[ghi]perylene	--	--	170	3,200	--	--	310	780	--	--	13	16	280	250	**1,200**	--	--
Total PCBs	50	400	70	5,300	23	180	120	650	22	190	50	32	730	240	**190**	22	190

Note:

ERL	-	effects range-low	SQS	-	sediment quality standard
ERM	-	effects range-median	TEL	-	threshold effects level
LEL	-	lowest effect level	PAH	-	polycyclic aromatic hydrocarbon
MCUL	-	minimum cleanup level	PCB	-	polychlorinated biphenyl
NEC	-	no-effect concentration	PEL	-	probable effects level
SEL	-	severe effect level	--	-	no sediment quality value available

[a] All values are reported as μg/kg dry weight to two significant figures.

[b] **The NYSDEC (1994) chronic sediment criteria are:**

Acenaphthylene[c] - **1,400 (chronic fresh water) and 2,400 (chronic salt water)**
Phenanthrene[c] - **1,200 (chronic freshwater) and 1,600 (chronic salt water)**
Fluoranthene[c] - **10,000 (chronic fresh water) and 13,000 (chronic salt water)**
Total PCBs[c] - **193 (chronic fresh water) and 410 (chronic salt water)**
28,000 (acute fresh water) and 140,000 (acute salt water).

[c] The original sediment quality values were normalized to organic carbon content of the sediments. For this table, an assumed organic carbon content of 1.0 percent was used to convert the sediment quality values to concentrations based on dry weight.

[d] Benzo[k]fluoranthene only.

REFERENCES

Ecology. 1995. Sediment management standards. Chapter 173-204 WAC. Washington State Department of Ecology, Sediment Management Unit, Olympia, WA

Enviro Canada. 1994. Draft sediment quality values. Environment Canada, Ottawa, Canada.

Ingersoll, C.G., P.S. Haverland, E.L. Brunson, T.J. Canfield, F.J. Dwyer, C.E. Henke, N.E. Kemble, and D.R. Mount. 1996. Calculation and evaluation of sediment effect concentrations for the amphipod *Hyalella azteca* and the midge *Chironomus riparius*. (in review) J. Great Lakes Res.

Long, E.R., and L.G. Morgan. 1991. The potential for biological effects of sediment-sorbed contaminants tested in the National Status and Trends Program. NOAA Technical Memorandum NOS OMA 52. U.S. Department of Commerce, National Oceanic and Atmospheric Administration, Seattle, WA.

Long, E.R., D.D. MacDonald, S.L. Smith, and F.D. Calder. 1995. Incidence of adverse biological effects within ranges of chemical concentrations in marine and estuarine sediments. Environ. Manage. 19(1):81–97.

MacDonald, D.D., R.S. Carr, F.D. Calder, E.R. Long, and C.G. Ingersoll. 1996. Development and evaluation of sediment quality guidelines for Florida coastal waters. Ecotoxicology 5:253–278.

NYSDEC. 1994. Technical guidance for screening contaminated sediments. New York State Department of Environmental Conservation, Division of Fish and Wildlife, Albany, NY.

Persaud, D., R. Jaagumagi, and A. Hayton. 1992. Guidelines for the protection and management of aquatic sediment quality in Ontario. Ontario Ministry of Environment, Ontario.

Appendix K

Appendix K

Cap Placement and Berm Construction

CAP PLACEMENT AND BERM CONSTRUCTION

PLACEMENT OF CAPPING MATERIAL

The method to place capping material will depend upon the selected remediation action alternative. Alternative placement techniques have the following advantages and disadvantages:

Surface release from barges is a technique where the clean sediment is slowly released from a split hull barge as the barge is slowly towed over the contaminated sediment area. This technique will work with fine sand, but fine-grained silts and clays may cause the material to bridge over and then collapse in a lump or wash out in a dense slurry in a matter of seconds. Also the finer-grained silt and clay will not settle as quickly to the bed, resulting in greater water quality and sediment loss during construction. This method may be applicable to the Ward Cove confined aquatic disposal (CAD) and in-place capping sites.

Tremie tube or submerged diffuser placement of capping material is a method to control the capping material as it passes through the water column for deep water capping sites. The material is pumped from the barge as described above but the diffuser is placed under water, near the bed surface. The tremie tube placement uses a clamshell, which drops the material into a hopper where it then falls through a long tube suspended above and near the bottom over the contaminated sediment. The submerged diffuser placement method is probably more applicable to the apparently soft Ward Cove sediment and would be applicable to the deep water CAD site.

Hydraulic washing is a technique where the clean sediment is washed off of a barge with large water hoses. This technique has been successfully used at the Eagle Harbor project in Bainbridge Island, Washington. This method allows the clean sediment to *rain* down over the contaminated sediment. It is applicable at sites where the contaminated sediment on the bed has a high *in situ* water content. This method would be applicable to the Ward Cove CAD and in-place capping sites.

Pipeline with baffle box or diffuser placement of capping material uses a pump-out system to transport the capping material from the barge to the capping area. The material is pumped from the barge through a floating pipeline and into either a baffle box or diffuser, which reduces the slurry velocity and allows the capping material to fall gradually over the contaminated sediment area. The floating pipeline and baffle box or diffuser is moved through the contaminated sediment area to spread the capping material. This method would be applicable to the Ward Cove CAD and in-place capping sites.

Direct mechanical placement of capping material uses a clamshell dredge to place the capping material. The disadvantage of this method is that material is placed in thicker (heavier) layers, which may cause displacement of fine-grained soft contaminated sediment either by resuspension or by mud wave. This method may be applicable to the Ward Cove capping applications.

Depending upon the sediment characteristics of the contaminated sediment to be covered with capping material and the characteristics of the site, one of the above capping methods would be selected. Experience on other sites has demonstrated that these techniques can be used with minimal resuspension of sediment.

BERM CONSTRUCTION

Berm emplacement in Ward Cove is complicated by steep slopes, the presence of logs, water depth, and very soft organic material on the bottom. Depending on water depth, currents, and bottom types, berms can be constructed with sand, stiff clay, or rubble material; however, there is not a ready source of such material in the local area to construct a berm. Whenever rubble or rock is used, it is as armor to protect silty sand, sand, or gravelly sand material. The rubble material would require a design that incorporates some sand or clay to fill the resulting voids and eliminate the potential for confined material moving downslope through the berm. Berms can be put in place by a variety of techniques using bottom dump barges/hoppers, down tubes (tremie tubes), crane-mounted barges, and hydraulic off-loading from haul barge.

The selection of placement technique depends on the type of material and the depth of water. Controlled dumping of sand can be accomplished in up to 40 ft of water to build a well-defined berm using minimal material. Current positioning techniques and quick placement barges (split hull) allow for almost instantaneous placement of material on the bottom. As the water becomes deeper, the footprint of the sand on the bottom becomes larger and placement becomes more effective through a tremie tube.

Stiff clay and rubble material would normally be placed by a clamshell off-loading from a barge. This process would be slower than the tremie or the bottom dump barge, because the clamshell would be required to release the material either on or near the bottom. This would require the clamshell to cycle through the water column for each load. All these techniques work well on hard bottoms.

Construction on soft bottoms will require additional analyses to take into account the strength of the bottom and which of the following options is better:

- Displace the bottom to construct the berm
- Remove soft material and expose a suitable foundation sediment layer

- Construct a wider berm requiring additional material
- Reinforce the bottom with geotextiles.

Bottom displacement simply means that the berm will displace some amount of the *in situ* bottom sediment and will require additional berm material. If soft material on the bottom is very thick (greater than 2–3 ft), the additional amount of material required to build a berm will be significant. An alternative to displacement or geotextile reinforcement is to increase materials and build an extremely wide berm footprint to balance the berm as it is constructed vertically. Another common option is to dredge out the soft sediment before starting berm construction, so that the berm is supported directly by firmer sediment.

Geotextiles have been used to reinforce soft sediment in upland or intertidal areas. Geotextiles could add strength to the bottom but must be accurately and carefully placed to provide good support. It is difficult to place geotextile material below the low tide level and not possible to place geotextiles under water at depths more than a few feet. Therefore, geotextile reinforcement is not an option for the Ward Cove site.

MAXIMUM SLOPES FOR CAD OR NCDF SITES

Berm construction for CAD or near-shore confined disposal facility (NCDF) sites is not considered to be technically feasible where the existing sediment slope is greater than 8H:1V. The maximum practical slope criterion is based on static stability of the berm and dredged fill on similar projects and on the maximum slope angle of dredged fill placed upslope of a berm on previous projects.

Static slope stability is analyzed using limit equilibrium methods. The factor of safety of a slope is defined as the ratio of the available strength of the soil divided by the forces pushing sediment downslope. In water depths of less than approximately 50 ft, berms with slopes as steep as 2H:1V have been constructed on projects such as Terminal 91 in the Port of Seattle and the Port of Everett. Berms this steep are constructed with gravel fill placed on firm sediments. In the Terminal 91 project, for example, approximately 10 ft of existing very soft silt/clay sediment was excavated in the berm area, and then the berm was constructed with imported gravel.

For the Ward Cove CAD and NCDF sites, it is assumed that removal of the very soft organic material is not practical. For the Milwaukee Waterway closure berm in the Port of Tacoma, the closure berm was designed to be built directly over soft silt using silty sand material. The maximum slope for this situation was calculated to be 6H:1V (Otten 1989). More recently, Hartman Consulting Corporation performed stability calculations for a similar project, and the maximum slope was 6H:1V to 8H:1V, depending on the height of the berm and the sediment type used for the berm construction. An upland landfill was constructed using wood fibers that settled out of a primary clarifier (e.g., where the fibers settle out of water by gravity without any other type of treatment) from a pulp mill in southern Washington (Korman et al. 1990). The landfill was constructed with 3H:1V slopes, but difficulties arose during construction. When the fill was 8 ft high, a 2-ft thick layer of sand was placed for drainage. Within a few days, the compacted material had moved 3–4 ft laterally.

Another factor in determining the maximum slope for a CAD site is the maximum slope that dredged material will be stable. When the seafloor bed slopes up, the capacity of a CAD site is significantly reduced, unless the top of the dredged material also slopes up behind the perimeter berms. The theoretical maximum slope for static stability can be calculated using limit equilibrium methods, but the actual maximum will be less because of the dynamic force from the momentum of the sediment falling to the seafloor. The U.S. Army Corps of Engineers is researching design calculation methods and developing models for predicting the maximum slope for various sediments (Otten 1998, pers. comm.); however, there are no established methods at this time. For the Everett Homeport project, the U.S. Navy conducted physical model tests (Otten and Fuglevand 1986). The model predicted that clayey silt sediment with shear strengths of 20–50 lb/ft^2 would flow to slopes of 7H:1V to 15H:1V at a CAD site. Based on the above and experience with other dredge disposal projects, the organic-rich sediments from Ward Cove are expected to be flatter than 8H:1V when placed in a CAD site.

Based on the above analyses and engineering judgment, a maximum slope of 8H:1V is appropriate for the Ward Cove CAD and NCDF sites. With steeper slopes, there would be an increasing risk that the stability of the slope would fail for both the berm and the sediment behind the berm. Slope stability failures occur through a zone where the resisting forces are the lowest. For a CAD or NCDF site, the critical zone would exist below the bottom of the berm and the deeper firm native sediment. It is expected that the existing organic sediment and near-surface soft silt/clay sediment would provide a continuous surface of low-strength material that would not have sufficient strength to provide stability.

MAXIMUM SLOPES FOR SAND CAP PLACEMENT

The maximum static stable slope for a sand cap can be calculated using limit equilibrium methods. For sand on a dry slope or a submerged slope in calm water, the maximum slope is approximately equal to the angle of internal friction or angle of repose of the sand. For a slope with seepage forces, the maximum slope is approximately half of the dry slope. For sand, the static slope in static water would be about 1.5H:1V (33 degrees). With seepage forces, the maximum slope would be about 3H:1V (18 degrees). These values are based on the methods described in Taylor (1948).

As a result of the momentum of the sand falling through the water to the seafloor, the actual slopes will be less than the dry static slope. Based on experience with similar sites, the maximum slope for sand placed by mechanical or hydraulic dredging is generally between 2H:1V and 4H:1V. Because of the water depths and nature of the sediment at the Ward Cove site, it is not considered technically feasible to cap slopes steeper than 4H:1V.

REFERENCES

Korman, M.E., S. Young, J.H. Kleppe, and M.T. Otten. 1990. The effect of variable sludge properties on landfill performance. Presented at the Technical Association of Pulp and Paper Industry 1990 Environmental Conference. Seattle, WA.

Otten, M.T. 1989. Stability and settlement analysis of dredged material for waterway fill development. Proceedings of the 22nd Annual Dredging Seminar sponsored by the Texas A&M University Center for Dredging Studies, Tacoma, WA.

Otten, M. 1998. Personal communication (information regarding research on new methods for calculating maximum slope for various sediments from J. Clausner, Coastal and Hydraulics Laboratory, Coastal Sediments and Engineering Division, Waterways Experiment Station, Vicksburg, MS). Hartman Consulting Corporation, Seattle, WA.

Otten, M.T., and P.F. Fuglevand. 1986. Letter report. Clamshell/longpipe disposal system model, Naval Station Puget Sound, prepared by Hart Crowser, Inc., Seattle WA, for Western Division, Naval Facilities Engineering Command.

Taylor, D.W. 1948. Fundamentals of Soil Mechanics. John Wiley & Sons, New York, NY.

Appendix L

Appendix L

Potential ARARs and TBC Criteria for the Ward Cove Sediment Remediation Project

CONTENTS

LIST OF TABLES

ACRONYMS AND ABBREVIATIONS

2,3,7,8-TCDD	2,3,7,8-tetrachlorodibenzo-*p*-dioxin
ADEC	Alaska Department of Environmental Conservation
ARAR	applicable or relevant and appropriate requirement
BOD	biochemical oxygen demand
CAA	Clean Air Act
CoC	chemical of concern
COD	chemical oxygen demand
Corps	U.S. Army Corps of Engineers
CWA	Clean Water Act
EPA	U.S. Environmental Protection Agency
KPC	Ketchikan Pulp Company
MCL	maximum contaminant level
MCLG	maximum contaminant level goal
NAAQS	national ambient air quality standards
NPDES	National Pollutant Discharge Elimination System
NTR	National Toxics Rule
RCRA	Resource Conservation and Recovery Act
SDWA	Safe Drinking Water Act
SMCL	secondary maximum contaminant level
SQS	sediment quality standards
TBC	to be considered
TCLP	toxicity characteristic leaching procedure
TEC	toxic equivalent concentration
TOC	total organic carbon
WCSQV	Ward Cove sediment quality value

POTENTIAL ARARs AND TBC CRITERIA FOR THE WARD COVE SEDIMENT REMEDIATION PROJECT

INTRODUCTION

This appendix presents the potential applicable or relevant and appropriate requirements (ARARs) and criteria to be considered (TBC) by the Ketchikan Pulp Company (KPC) for remediation of contaminated sediments in Ward Cove, Alaska. The information in this appendix supports the detailed evaluation of remedial action alternatives in Section 10 of the main text of this report.

ARARs AND TBC CRITERIA

An ARAR describes a federal or state regulatory requirement against which the remedial action alternatives are reviewed. ARARs are defined as follows:

- An *applicable requirement* is a promulgated federal or state standard that specifically addresses a hazardous constituent, remedial action, location, or other circumstance at a site. To be applicable, the remedial actions or the circumstances at the site must be within the intended scope and authority of the requirement.
- A *relevant and appropriate requirement* is a promulgated federal or state requirement that addresses problems or situations similar to those encountered at a site, even though the requirement is not legally applicable.

Criteria in nonpromulgated federal and state standards and policies and guidance documents are TBC when a site is being remediated to protect human health and the environment. These nonpromulgated, nonbinding criteria, referred to as TBC criteria, are not formal ARARs.

SUBSTANTIVE AND ADMINISTRATIVE REQUIREMENTS

U.S. Environmental Protection Agency (EPA) guidance (U.S. EPA 1988) defines substantive requirements as those requirements that pertain directly to actions or conditions in the environment. For example, quantitative health- or risk-based restrictions upon exposure to types of hazardous constituents (e.g., drinking water maximum contaminant levels [MCLs]), technology-based requirements for actions taken upon hazardous constituents, and restrictions upon activities in special locations are all substantive requirements (U.S. EPA 1988).

Administrative requirements are defined as those mechanisms that facilitate the implementation of the substantive requirements of a statute or regulation. For example, the approval of or consultation with administrative bodies, issuance of permits, documentation, reporting, record keeping, and enforcement are all administrative requirements. It is important to recognize that while *onsite* remediation activities are exempt from administrative requirements by the Comprehensive Environmental Response, Compensation and Liability Act of 1980 §121(e), *offsite* remedies are required to have all necessary permits and to comply with administrative requirements (U.S. EPA 1988).

TYPES OF ARARs

There are three types of ARARs: chemical-specific, action-specific, and location-specific. Chemical-specific ARARs are human-health-risk- or ecological-risk-based concentration limits for specific constituents (e.g., federal and state drinking water standards). Action-specific ARARs are technology-based requirements that are prompted by the type of remedial action under consideration (e.g., National Pollutant Discharge Elimination System [NPDES] requirements for point source discharges to surface water). Location-specific ARARs restrict certain activities based on the location of the site (e.g., in a wetlands, floodplain, or historical site area).

TBC criteria include nonpromulgated policies, advisories, and guidance issued by the federal or state government (e.g., health effects assessments).

IDENTIFICATION PROCESS FOR ARARs AND TBC CRITERIA

Potential ARARs and TBC criteria were identified using the following steps:

- Identification of chemicals of concern (CoCs) and affected media
- Evaluation of the CoCs and current or potential uses of affected media to identify chemical-specific ARARs and TBC criteria
- Review of potential remedial action methods in relation to site-specific CoCs to identify action-specific ARARs and TBC criteria
- Review of the site setting to identify location-specific ARARs and TBC criteria.

In the following sections, only those potential ARARs that appear to be the most likely to pertain to site remediation activities are summarized.

CHEMICAL-SPECIFIC ARARs AND TBC CRITERIA

Chemicals in sediments at the site that have been detected most frequently and at elevated concentrations have been identified as CoCs. The CoCs include total organic carbon (TOC), total ammonia, total sulfide, biochemical oxygen demand (BOD), chemical oxygen demand (COD), 4-methylphenol, and dioxins and furans.

The chemical-specific ARARs and TBC criteria identified and discussed in this section apply to water, air, and sediment quality. No federal or Alaska state sediment criteria have yet been established. However, the State of Washington had adopted sediment quality standards (SQSs), and these standards were used to conduct a screening level evaluation of KPC sediments. Subsequent to this evaluation, site-specific Ward Cove sediment quality values (WCSQVs) for specific CoCs were developed. Use of sediment quality values is discussed further under *Washington State and Ward Cove Site-Specific Sediment Quality Values* below.

Federal Ambient Water Quality Criteria/National Toxics Rule

EPA is required under the Clean Water Act (CWA; 33 USC §1251 et seq.) to publish water quality criteria for the protection of human health and welfare and freshwater and marine aquatic life. These federal water quality criteria are nonenforceable guidelines that may be used by states to set water quality standards for surface water. The water quality criteria are based on protection of human health (risk levels based on ingestion of water and organisms and on ingestion of organisms only) and aquatic life (freshwater acute and chronic and marine acute and chronic). Of the CoCs identified for Ward Cove sediments, criteria have been published for dioxin, phenol, ammonia and sulfide (Table L-1).

In 1992, EPA adopted numeric criteria for priority toxic pollutants (commonly referred to as the "National Toxics Rule (NTR)," 57 FR 60848-60923) on behalf of states that had not adopted water quality standards for these pollutants as required by §303 of the CWA. Only a subset of the published criteria were determined to apply to the State of Alaska (Alaska had adopted some standards of its own that were determined to comply with CWA §303 requirements). On October 10, 1997, EPA removed 19 of the NTR acute aquatic life criteria from the list of criteria applicable to Alaska, because the state had provided clarification that criteria previously adopted for these 19 constituents were no less stringent than the acute aquatic life water quality criteria contained in the federal regulations. Federal aquatic life criteria for five pollutants (none of concern in Ward Cove) and federal human health criteria for carcinogens (including dioxin and phenol) continue to apply to Alaska (62 FR 53212-53214; see Table L-1).

TABLE L-1. FEDERAL WATER QUALITY CRITERIA AND ALASKA WATER QUALITY STANDARDS

Source	CoPC (mg/L)	Marine		Human Health[a]	
		Acute	Chronic	Ingestion of Water and Organisms	Ingestion of Organisms Only
U.S. EPA (1986)					
	2,3,7,8-TCDD	—	—	1.3×10^{-10}	1.4×10^{-10}
	Phenol	5.8[b]	—	3.5	—
	Ammonia[c]	—	—	—	—
	Sulfide[d]	—	0.002	—	—
NTR[e]					
	2,3,7,8-TCDD	—	—	1.3×10^{-10}	1.4×10^{-10}
	Phenol	—	—	21	4,600
	Ammonia[c]	—	—	—	—
	Sulfide	—	—	—	—
Alaska					
	2,3,7,8-TCDD	—	—	—	—
	Phenol	5.8[f]	—	—	—
	Ammonia[c]	—	—	—	—
	Sulfide[d]	—	0.002	—	—
	Turbidity[g]	—	—	—	—

Notes: ARAR - applicable or relevant and appropriate requirement
CoPC - chemical of potential concern
NTR - National Toxics Rule
TCDD - tetrachlorodibenzo-*p*-dioxin

[a] Consistent with the NTR, human health criteria for carcinogens are expressed at a risk level of 10^{-5}.

[b] The marine acute value shown is the lowest reported toxic concentration.

[c] State and federal ammonia criteria are for fresh water only.

[d] Sulfide criteria are expressed as hydrogen sulfide.

[e] Only values for Alaska are shown.

[f] Value presented is the lowest-observed-effect level.

[g] Alaska has identified the turbidity standard for marine waters as the only ARAR for the proposed remedial action (Reges 1999, pers. comm.).

Federal Safe Drinking Water Act

The Safe Drinking Water Act (SDWA; 42 USC §1401 et seq.) regulates levels of constituents in drinking water supplies through the use of drinking water standards. EPA has developed two sets of drinking water standards, referred to as primary and secondary standards, to protect human health and ensure the aesthetic quality of drinking water, respectively. Primary standards consist of chemical-specific standards, known as MCLs. MCLs are set as close as feasible to maximum contaminant level goals (MCLGs), which are non-enforceable concentrations protective of adverse health effects. Secondary drinking water standards, referred to as secondary MCLs (SMCLs), consist primarily of limits to regulate the aesthetic quality of water supplies. EPA recommends them to states as reasonable goals, but federal law does not require water systems to comply with them. Additional federal regulations set drinking water standards for a limited number of chemicals that are referred to as action levels.

MCLs, SMCLs, and action levels apply to waters that are utilized as public drinking water supplies. MCLs are usually only legally applicable under the SDWA to the quality of drinking water at the tap. MCLs are generally considered relevant and appropriate to surface water or groundwater that is or may be used for drinking. Water from Ward Cove is not used for drinking, and thus no drinking water standards are not applicable to remediation activities conducted onsite. Drinking water standards would be applicable if disposal of dredged sediments could impact drinking water supplies.

Federal Clean Air Act

Under the federal Clean Air Act (CAA; 42 USC §7401 et seq.), EPA has established national ambient air quality standards (NAAQSs) for certain constituents (40 CFR 50). These standards are national limitations on ambient air concentrations intended to protect health and welfare. Pursuant to the 42 USC §7412, EPA is also to develop a list of hazardous air pollutants and then establish emissions standards for source types that emit the listed pollutants. These standards are known as national emissions standards for hazardous air pollutants.

Specific air quality standards established under the CAA may be applicable to remediation of the Ward Cove sediments if contaminated materials are exposed to air (e.g., dredged materials) or if treatment such as air stripping or incineration is used. Any incineration would be required to comply with applicable requirements of the CAA and would be closely coordinated with the Alaska Department of Environmental Conservation (ADEC). Generally, it is expected that the incineration of woody debris will be in compliance with ARARs relating to state and federal air requirements.

Alaska Water Quality Standards

The Alaska water quality standards (18 AAC 70; see also ADEC 1991) contain two distinct elements: 1) designated uses and 2) numerical or narrative criteria designed to protect and measure attainment of those uses (the regulations also contain an antidegradation policy). Use designations include water supply; recreation; growth and propagation of fish, shellfish, other aquatic life, and wildlife; and harvesting for consumption of raw mollusks or other raw aquatic life (18 AAC 70.020). Alaska has adopted the federal criteria published through 1985 but has not adopted any more recent federal values. Alaska water quality standards include standards for dissolved oxygen concentrations and for toxic and other deleterious organic and inorganic substances. Alaska water quality standards were considered during the identification, development, and evaluation of technologies and remedial alternatives. Alaska water quality standards may be ARARs that must be complied with during either capping or dredging activities (see Table L-1).

Alaska Drinking Water Regulations

The Alaska drinking water regulations (18 AAC 80) are the state equivalent to the federal SDWA regulations. Similar to the federal MCL and SMCLs, Alaska's drinking water regulations set forth primary and secondary maximum contaminant concentrations for public water systems. Secondary maximum contaminant concentrations are described as goals for drinking water quality and serve as a guideline for public water suppliers (18 AAC 80.50(b)). Of the CoCs identified for Ward Cove, a primary maximum contaminant concentration is identified for dioxin only (none are included in the list of secondary concentrations). As discussed in the section on the SDWA above, drinking water standards would be applicable to remediation of Ward Cove sediments only if disposal of dredged sediments could impact drinking water supplies.

Alaska Air Quality Control

Under the authority of the Alaska Air Quality Control statute (Alaska Statutes §46.14), Alaska has established ambient air quality standards and air emission standards for specific industrial sources. These standards are set forth in Alaska's Air Quality Control regulations, 18 AAC 50. Applicability of Alaska air quality standards to sediment remediation activities within Ward Cove would be the same as those discussed above under *Federal Clean Air Act*. As noted above, any incineration of contaminated materials would be coordinated with ADEC, the primary regulatory agency for air emissions.

Washington State and Ward Cove Site-Specific Sediment Quality Values

At present, sediment quality criteria are not available for the State of Alaska (i.e., there are no sediment ARARs for the Ward Cove project). However, standards for the quality of sediments have been promulgated in the State of Washington as part of the state's sediment management standards (WAC 173-204, Ecology 1995). Therefore, chemical concentrations and toxicity test results for Ward Cove sediments were evaluated using criteria consistent with the Washington State sediment management standards. The

Washington State sediment management standards are considered pertinent for evaluation of sediment chemical concentrations in Ward Cove for several reasons. First, they are environmentally protective because they have been adopted by the State of Washington to "correspond to a sediment quality that will result in no adverse effects, including no acute or chronic adverse effects on biological resources." Second, they are credible because they have received extensive scientific and public review. Finally, they have some natural applicability to the marine waters of southeast Alaska because they are considered protective of Puget Sound marine species, many of which are found in southeast Alaska, including Ward Cove.

The Washington State sediment management standards specify two progressively adverse levels for each chemical or toxicity response. The lower degree of adverse effects is represented by sediment quality standards (SQSs), which are used to evaluate whether sediments may be toxic and therefore warrant further study. A higher degree of adverse effects is represented by minimum cleanup levels (MCULs), which are used in cleanup evaluations. Washington State SQSs/MCULs are not available for most of the constituents ultimately determined to be CoPCs for Ward Cove, including TOC, total ammonia, total sulfide, BOD, COD, 2,3,7,8-tetrachlorodibenzo-*p*-dioxin (2,3,7,8-TCDD), and TCDD toxic equivalent concentrations (TECs) of dioxins and furans. Site-specific WCSQVs were therefore developed for all of these CoPCs, except total sulfide, 2,3,7,8-TCDD, and TCDD TECs. The site-specific WCSQVs include both $WCSQV_{(1)}$ (analogous to an SQS) and $WCSQV_{(2)}$ (analogous to an MCUL). Although there is a Washington State SQS/MCUL for 4-methylphenol, following the screening evaluation using the Washington State sediment management standards, WCSQVs were developed for this constituent because the range of concentrations found in Ward Cove was considerably higher than the range of concentrations used to generate the standards for Puget Sound. The development of site-specific values is appropriate because organisms may be tolerant of higher concentrations than those predicted by the more limited data set for Puget Sound. WCSQVs were not developed for other chemicals evaluated in Ward Cove sediments for which Washington State SQSs are available, because the concentration ranges found in Ward Cove were not substantially higher than the standards.

The Washington State SQS/MCUL values are TBC criteria. The WCSQVs are site-specific values developed for this project and are neither ARARs nor TBC criteria. The use of the Washington State sediment management standards and derivation of site-specific WCSQVs are discussed in Section 7 of the main text of this report.

ACTION-SPECIFIC ARARs

The following sections summarize action-specific ARARs that may pertain to site remedial activities. Remedial activities conducted onsite under CERCLA would be required to meet only the substantive aspects of ARARs, not the corresponding administrative requirements (i.e., federal, state, or local permits would not need to be obtained for the onsite activity). Substantive and administrative requirements are discussed further on page L-2 of this appendix.

Federal Resource Conservation and Recovery Act

Sediments dredged during site remediation would not likely be Resource Conservation and Recovery Act (RCRA; 42 USC §6901 et. seq.) hazardous wastes. Toxic characteristic wastes (40 CFR 261.24) are determined by testing using the toxicity characteristic leaching procedure (TCLP). The sediment is processed using an extraction solution and the resulting leachate is analyzed. If concentrations of selected constituents in the leachate exceed regulatory levels, then the waste is considered to be a characteristic waste. The only CoC that has a TCLP regulatory level is 4-methylphenol (*p*-cresol; 200 mg/L). The highest detected concentration of 4-methylphenol in Ward Cove sediment is 16 mg/kg. Assuming all the 4-methylphenol would leach out of the sediment during the TCLP extraction procedure and a liquid/solid (extraction fluid/sediment) ratio of 20:1 in accordance with the TCLP analytical procedure, the approximate concentration of 4-methylphenol in the extract would be 0.8 mg/L. Because this value is significantly lower than the regulatory level of 200 mg/L for 4-methylphenol, sediments are unlikely to be hazardous wastes. Therefore, RCRA hazardous waste regulations are not expected to be ARARs for sediment remediation at Ward Cove.

EPA has also proposed that dredged material be excluded from RCRA hazardous waste requirements. The dredged material exclusion is included in the proposed Hazardous Waste Identification Rule for Contaminated Media, or HWIR-Media (April 29, 1996, 61 FR 18780). EPA proposed that dredged material disposed in accordance with a permit issued under Section 404 of the CWA or a permit issued under Section 103 of the Marine Protection, Research, and Sanctuaries Act would not be subject to Subtitle C or RCRA. The final rule is currently planned for mid to late 1998.

RCRA Subtitle D addresses the management of solid wastes that are not hazardous wastes. EPA criteria for municipal solid waste landfills address location restrictions, operating criteria, design criteria, groundwater monitoring, and closure and post-closure care (40 CFR 258). Cover requirements for landfill closure include a low-permeability layer and an erosion protection layer capable of sustaining native plant growth or equivalent protection. RCRA solid waste requirements may be applicable to sediments dredged from Ward Cove if those sediments are disposed of at an upland location on KPC property or if the material is transported to a solid waste landfill.

Federal Clean Water Act

The objective of the CWA is to restore and maintain the chemical, physical, and biological integrity of the nation's water. The CWA regulates point source discharges of wastewater to surface water by establishing ambient water quality criteria (previously discussed) and effluent standards. Discharges to surface water are regulated under the NPDES program. Effluent standards are based on prescribed treatment technologies (e.g., best conventional technology or best demonstrated available technology). Actions taken to remediate sediments within Ward Cove would be subject to the water quality criteria as discussed previously. If remediation activities include a point source discharge of wastewater back to the Cove (e.g., if sediments are dewatered prior to transport to a disposal facility), or if source control of a facility-related discharge is included in the remedy, an NPDES permit and associated State 401 certification could be required.

Federal Dredge and Fill Standards

Dredge and fill activities are managed under Section 10 of the Rivers and Harbors Act (33 USC §410 et seq.) and Section 404 of the CWA. One of the primary purposes of the regulations promulgated under these acts is to protect aquatic habitats and wetlands. The U.S. Army Corps of Engineers (Corps) is responsible for issuing permits for dredge and fill operations. The decision whether to issue a permit for dredge or fill activities is based on an evaluation of the probable impacts, including cumulative impacts, of the proposed activity and its intended use on the public interest.

The Corps can issue three different types of permits that address dredge-and-fill activities: nationwide permits, regional permits, and individual permits. The level of documentation and required activities prior to permit issuance vary from one type of permit to the next. The individual permit authorizes a specific activity and requires the most effort prior to a permit decision; for example, an evaluation of whether an environmental impact statement will be required and, if so, completion of the environmental impact statement.

The other two types of permits are referred to jointly as general permits and authorize a category or categories of activities nationwide or in specific geographical regions. A general permit is defined as:

> "...a Department of Army [Corps] authorization that is issued on a nationwide or regional basis for a category or categories of activities when: 1) Those activities are substantially similar in nature and cause only minimal individual and cumulative environmental impacts; or 2) The general permit would result in avoiding unnecessary duplication of the regulatory control exercised by another Federal, state, or local agency provided it has been determined that the environmental consequences of the action are individually and cumulatively minimal." (33 CFR §322.2(f))

These general permits (particularly the nationwide permit) are designed to regulate with little, if any, delay or paperwork certain activities that have minimal impacts (33 CFR §330.1(b)). If an activity is covered by one of the general permits, a Corps permit application may not have to be completed. However, notification of the district engineer may be required (33 CFR §330 Appendix A, Part C(13)), and submitting a completed application may be the most effective way to ensure that notification requirements are met. In addition, general permits may include other conditions that a permittee must meet to satisfy requirements of law for a Corps permit. One condition that will likely be included in an authorization to dredge or fill within Ward Cove is a limitation on the time during which these activities may be conducted in order to minimize impacts on migrating fish. The preferred time for allowing such activities in southeast Alaska is January–February;

however, some flexibility to start earlier in the winter or extend later into the spring would likely be allowed (Winn 1997, pers. comm.).

The applicability of a general permit to the Ward Cove site may depend on such factors as the quantity of material to be dredged and the severity of potential ecological impacts associated with that dredging. Two nationwide permits that could be applicable to the Ward Cove site include the following:

- Permit No. 19: *Minor Dredging*. This permit would apply if the quantity of material to be dredged does not exceed 25 yd^3 below the plane of the ordinary high water mark.
- Permit No. 38: *Cleanup of Hazardous and Toxic Wastes*. This permit authorizes specific activities required to effect the containment, stabilization, or removal of hazardous or toxic waste material that are performed, ordered, or sponsored by a government agency with established legal or regulatory authority. Notification of and approval by the Corps is required prior to conducting any activities under this permit.

Alaska's Project Questionnaire and Certification Statement

The State of Alaska has developed a multiple agency coordinated system for reviewing and processing all resource-related permits, leases and other authorizations which are required for proposed projects in or affecting coastal areas of Alaska. The system is designed to improve management of Alaska's coastal land and water uses. Under this system, project proponents complete a questionnaire that determines which state and federal agencies need to be notified and what permits will be required. Agencies specifically identified include the following:

- U.S. Forest Service
- U.S. Coast Guard
- Corps
- EPA
- Alaska Department of Natural Resources
- Alaska Department of Fish and Game
- ADEC.

When an application for a Corps permit is submitted, the Corps takes responsibility for informing other potentially interested federal agencies including those identified above and the U.S. Fish and Wildlife Service if endangered species may be involved (endangered species are not expected to be a significant issue in Ward Cove [Winn 1977, pers. comm.]). This Corps notification, combined with the project proponent contacting state agencies as appropriate based on the questionnaire answers, is a very efficient process for ensuring that many of the ARARs identified in this document are identified and achieved.

Federal Fish and Wildlife Coordination Act

The Fish and Wildlife Coordination Act (16 USC §661 et seq.) requires consideration of the effect that water-related projects, involving the control or structural modification of a natural stream or body of water, would have upon fish and wildlife, and actions to prevent loss or damage to those resources. Pursuant to §662 of this act, consultation with federal and state wildlife agencies is required if alteration of the water resource will occur as a result of remedial activities.[1] The purpose of this consultation is to develop measures to prevent, mitigate, or compensate for project-related losses to fish and wildlife. The lead agency must first determine whether the action will result in the control or structural modification of a body of water. Several types of actions fall under the jurisdiction of this act, including discharges of industrial wastes or the placement of fill materials into a water body or wetland, and projects involving construction of structures in a waterway or that divert or relocate a waterway. Federal regulations associated with the NPDES program require compliance with the act (40 CFR 122.49). The act also requires coordination with the U.S. Fish & Wildlife Service and state environmental agencies when issuing a CWA §404 permit. Consultation with appropriate agencies in relation to active sediment remediation in Ward Cove will occur as part of the Corps permitting process, as discussed under *Alaska Project Questionnaire and Certification Statement* above.

Federal Clean Air Act

The purpose of the CAA is to protect and enhance the quality of the nation's air resources to promote public health and welfare. The CAA regulates air quality, in part, by establishing NAAQSs for certain constituents and national emission standards for specific listed hazardous constituents. Ambient air quality standards and emission standards are implemented through state implementation plans. Applicability of the CAA to Ward Cove will depend on the specific activities conducted, as discussed under *Chemical-Specific ARARs and TBC Criteria, Federal Clean Air Act* above.

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[1] Where the remedial activity undertaken is a CERCLA response action, consultation is not required, but recommended, for onsite activity and is required for offsite activity. U.S. EPA. 1989. CERCLA §121(e)(1), and 55 FR 8666, 8756–57.

Alaska Hazardous Waste Management Regulations

The Alaska hazardous waste management regulations (18 AAC 62) are the state equivalent to the federal RCRA regulations. These regulations address the management of hazardous wastes including identification of hazardous wastes, standards for generators and transporters of hazardous wastes, and requirements for treatment, storage, and disposal facilities. As discussed under the federal RCRA section above, sediment dredged from Ward Cove is not likely to exceed TCLP regulatory levels. Therefore, Alaska hazardous waste management regulations are not expected to be ARARs for sediment remediation at Ward Cove.

Alaska Solid Waste Management Regulations

The Alaska solid waste management regulations (18 AAC 60) address the management of solid waste disposal facilities. These regulations could be applicable to remediation of Ward Cove sediments if the sediments are determined to be a solid waste and are disposed of either in an approved onsite disposal facility or in an approved offsite solid waste disposal facility (see the discussion of RCRA Subtitle D under *Action-Specific ARARs* above).

Alaska Wastewater Disposal Regulations

Pursuant to the Alaska wastewater disposal regulations (18 AAC 72), a permit issued by ADEC is required to dispose of non-domestic wastewater into or onto land, surface water, or groundwater in Alaska. These regulations may be applicable to remediation of Ward Cove sediments if sediments are dredged and require dewatering (with discharge of water back into the Cove) prior to disposal (see also Alaska administrative procedures and permit regulations, 18 AAC 15, which discusses NPDES permit requirements).

Alaska Water Quality Standards

As discussed under *Chemical-Specific ARARs* above, the Alaska these water quality standards (18 AAC 70; see also ADEC 1991) contain two distinct elements: 1) designated uses and 2) numerical or narrative criteria designed to protect and measure attainment of those uses (the regulations also contain an antidegradation policy).

Alaska water quality standards may be ARARs that must be complied with during either capping or dredging activities. ADEC can authorize a mixing zone (18 AAC 70.032) or a zone of deposit (18 AAC 70.033) within which exceedances of water quality standards would be allowed. ADEC can also authorize a short-term variance to compliance with the water quality standards under Section 404 of the CWA. Such a permit or variance may be needed during Ward Cove remediation activities to ensure that those activities are conducted in compliance with the water quality standards.

Alaska Air Quality Control Regulations

Alaska's air quality control regulations (Alaska Statutes §46.14, 18 AAC 50), which include ambient air quality standards and air emission standards, may be applicable to sediment remedial actions undertaken in Ward Cove, if those activities would result in emissions of constituents into the air in excess of specified standards.

LOCATION-SPECIFIC ARARs

Location-specific ARARs include those regulations that may pertain to the Cove, streams, and wetlands that are located within or in the vicinity of the site. These ARARs may include the Fish and Wildlife Coordination Act and Section 404 of the CWA. Both of these potential ARARs were discussed in the section on action-specific ARARs.

REFERENCES

ADEC. 1991. Alaska water quality standards workbook. Alaska Department of Environmental Conservation, Juneau, AK.

Ecology. 1995. Sediment management standards. Chapter 173-204. Washington State Department of Ecology, Olympia, WA.

Reges, Jr., R.K. 1999. Personal communication (letter to K. Keeley and T. Gold, U.S. Environmental Protection Agency, Region 10, Seattle, WA, dated May 10, 1999, regarding WQS and ARARs at KPC). Counsel of Record, State of Alaska, Ruddy, Bradley & Kolkhorst, Juneau, AK.

U.S. EPA. 1986. Quality criteria for water. EPA/440/5-86/001. U.S. Environmental Protection Agency, Office of Water Regulations and Standards, Washington, DC.

U.S. EPA. 1988. CERCLA compliance with other laws manual: interim final. EPA/540/G-89/006. U.S. Environmental Protection Agency, Office of Emergency and Remedial Response, Washington, DC.

U.S. EPA. 1989. CERCLA compliance with other laws manual: Part II. Clean Air Act and other environmental statutes and state requirements. EPA/540/G-89/009. U.S. Environmental Protection Agency, Office of Solid Waste and Remedial Response, Washington, DC.

Winn, R. 1997. Personal communication (telephone conversation with W. Graham, PTI Environmental Services, Bellevue, WA, on November 4, 1997, regarding Corps permitting process). U.S. Army Corps of Engineers, Anchorage, AK.