MONTGOMERY WATSON

January 14, 1997

Mr. Michael Gill
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U.S. EPA Region IX, MS H-9-3
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San Francisco, CA 94105

Contract No.: Navy CLEAN N62474-88-D-5086
Contract Task Order 0235

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Subject: Technical Memoranda Responding to Regulatory Agency Comments on the Draft Final Phase II Site-Wide Ecological Assessment Report Moffett Federal Airfield

Dear Mr. Gill:

We are submitting the enclosed technical memoranda (tech memos) referenced in the Response to Agency Comments (RTC) on the Draft Final Phase II Site-Wide Ecological Assessment (SWEA) Report submitted November 7, 1996. The primary author of the tech memos is Bill Desmond/PRC EMI Dallas. If you have any technical questions on the content of the tech memos it may be most efficient to direct them to Bill Desmond. He can be reached at (214) 740-2022.

It is our understanding that this completes our initial RTC on the Draft Final SWEA Report. We understand that you provided informal comments on the RTC in a meeting on December 11, 1996. We will prepare a letter clarifying our RTC for your information. Please contact us at (510) 975-3400, if you would like to discuss the tech memos or your comments on the RTC package further.

Sincerely,

Chris Petersen, R.G.
Project Manager

Kim Walsh
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cc:

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The following technical memorandum addresses Issue No. 2 from the Navy's introduction to responses to EPA comments (letter dated November 7, 1996) and EPA's Specific Comments Nos. 17, 22, 42, 44, 52, 66, 85, 89, 93, and 110.

TECHNICAL MEMORANDUM

CORRELATION ANALYSIS AND X-Y SCATTER PLOTS OF SEDIMENT BIOASSAY RESPONSE DATA AND COPEC CONCENTRATION DATA

1.0 INTRODUCTION

Sediment data collected under the MFA site-wide ecological assessment were analyzed and plotted to identify chemicals of potential ecological concern (COPEC) that may be responsible for (1) reductions in survival of juvenile amphipods (*Eohaustorius estuarius*), and (2) reductions in survival and normal development of larval echinoderms (*Dendraster excentricus*) . The analyses support the ecological assessment of the sediment habitats at the airfield, which include the Eastern and Western Diked Marshes, Storm Water Retention Ponds, and ditches.

Presented below are the supplemental amphipod analyses performed in response to EPA comments on the draft final SWEA report. Supplemental echinoderm analyses will be submitted in a follow-up technical memorandum.

2.0 SUPPLEMENTAL AMPHIPOD ANALYSES

Correlation analyses and scatter plots were performed with the SPSS Base 7.0 for Windows statistical software (SPSS 1996). Several combinations of collocated amphipod data and bulk sediment data were analyzed with Spearman's rank correlation test to identify possible chemical and physical stressors that might be responsible for reductions in amphipod survival. The identification numbers for the 11 subject samples include:

- SSRP-18 through SSRP-20 (N=3)
- SSRP-26 through SSRP-32 (N=7)
- SSWL-32

2.1 CORRELATION ANALYSES

The Spearman rank correlation test was selected because it is a distribution-free test (that is, it does not require the data to be normally distributed). Spearman correlation coefficients were computed for:

- amphipod survival vs specific COPEC concentration
- amphipod survival vs TOC-normalized COPEC concentration
- amphipod survival vs SEM-metal molar concentration
- amphipod survival vs SEM-metal:AVS ratio
- amphipod survival vs percent fines
- amphipod reburial vs COPEC concentration
- amphipod reburial vs TOC-normalized COPEC concentration
- amphipod reburial vs SEM-metal molar concentration
- amphipod reburial vs SEM-metal:AVS ratio
- amphipod reburial vs percent fines

Correlation coefficients for all stressor combinations (such as cadmium vs chromium) were also computed; however, the correlations between amphipod endpoints and the stressors is the main focus of this memorandum. Correlation coefficient significance was evaluated at the 95 percent significance level.
Note that data reported as "less than" were set equal to one-half the detection limit. This approach has a bearing on the interpretation of the correlation coefficients for several COPECs that were not detected in the samples used for amphipod bioassay analysis. Table 1 summarizes information on COPEC frequency of detection.

Spearman correlation coefficients for amphipod survival vs stressor and amphipod reburial vs stressor, as well as all stressor vs stressor combinations, are presented in Attachments 1 through 6.

Table 2 summarizes the nine statistically significant ($p<0.05$) correlation coefficients. These include several metals and DDT. The DDT correlation coefficient should be interpreted cautiously because this COPEC was detected in only 2 of the 11 samples.

A negative correlation coefficient implies that decreases in amphipod survival was associated with increases in stressor concentration. However, only two negative correlation coefficients were computed—amphipod reburial vs arsenic concentration, and amphipod survival vs TOC-normalized arsenic concentration.

Statistically significant correlation coefficients for the following stressors (including TOC-normalized concentrations) are not significant because they were not detected in any of the samples:

- dieldrin
- endosulfan sulfate
- endosulfan II
- endrin
- endrin ketone
- endrin aldehyde
- γ-BHC
- α-chlordane
- γ-chlordane
- heptachlor

2.2 SCATTER PLOTS

Scatter plots on combinations with significant correlation coefficients were prepared to identify dose-response trends. Amphipod survival was set as the "Y" (dependent) variable, and the stressors were set as the "X" (independent) variable. Scatter plots of combinations not statistically significant were not prepared because these combinations showed no association and, therefore, provide no increased value.

The scatter plots of the statistically significant combinations are presented in Attachment 7. These figures graphically portray the various combinations of amphipod survival and reburial, and COPEC concentration.

2.3 DISCUSSION

The correlation analysis shows that decreased amphipod survival is associated with increased arsenic concentration. The analysis also shows, however, that increased amphipod survival is associated with increased concentrations of other COPECs. These results are consistent with the evidence about the utility and strength of bulk sediment bioassays presented in Issue 1 of the response to EPA comments on the Draft Final SWEA report.

TABLE 1

FREQUENCY OF DETECTION OF COPECS IN SAMPLES ALSO ANALYZED WITH AMPHIPOD BIOASSAY

COPEC	Number of Analyses	Number of Detections	COPEC	Number of Analyses	Number of Detection
Antimony	4	2	gamma-Chlordane	11	0
Arsenic	11	11	DDD	11	5
Cadmium	11	11	DDE	11	6
Chromium	11	11	DDT	11	2
Copper	11	11	Dieldrin	11	0
Lead	11	11	Endosulfan II	11	0
Manganese	11	11	Endosulfan sulfate	11	0
Mercury	11	11	Endrin	11	0
Nickel	11	11	Endrin aldehyde	11	0
Selenium	11	11	Endrin ketone	11	0
Silver	11	10	Heptachlor	11	0
Thallium	11	3	TPH-Diesel	11	0
Zinc	11	11	TPH-JP5	11	0
Aroclor 1254	11	2	TPH-Motor oil	11	0
Aroclor 1260	11	4	TPH-Unknown	11	11
gamma-BHC	11	0	Total LMW PAH	11	11
alpha-Chlordane	11	0	Total HMW PAH	11	7

TABLE 2

SUMMARY OF STATISTICALLY SIGNIFICANT CORRELATION COEFFICIENTS

Combination	Spearman Correlation Coefficient	Significance Level
Bulk Sediment COPECs		
Amphipod Survival vs Cadmium	0.607	0.048
Amphipod Survival vs Zinc	0.615	0.044
Amphipod Reburial vs Arsenic	-0.651	0.030
Amphipod Reburial vs Copper	0.716	0.013
Amphipod Reburial vs Zinc	0.625	0.040
Amphipod Reburial vs DDT	0.738	0.009
TOC-Normalized COPECs		
Amphipod Survival vs Arsenic-TOC	-0.682	0.021
Amphipod Reburial vs Copper-TOC	0.679	0.022
Amphipod Reburial vs Zinc-TOC	0.763	0.006

ATTACHMENT 1

CORRELATION COEFFICIENTS FOR METALS

Nonparametric Correlations

Correlations

			SURVIVAL	REBURIAL	AG	AS	CD	CR
Spearman's rho	Correlation Coefficient	SURVIVAL	1.000	.349	.192	-.600	.607*	.555
		REBURIAL	.349	1.000	.322	-.651*	.491	.591
		AG	.192	.322	1.000	.000	.539	.315
		AS	-.600	-.651*	.000	1.000	-.708*	-.645*
		CD	.607*	.491	.539	-.708*	1.000	.489
		CR	.555	.591	.315	-.645*	.489	1.000
		CU	.355	.716*	.721*	-.373	.584	.427
		HG	-.387	-.016	.023	.232	-.304	.269
		MN	.255	.414	.237	-.573	.781**	.100
		NI	-.427	-.591	.110	.936**	-.571	-.627*
		PB	.401	.238	.867**	-.246	.762**	.428
		SB	-.894	.236	-.894	.000	-.707	.000
		SE	.223	.476	.254	-.579	.730*	.109
		TL	.058	-.107	.479	.052	.273	-.017
		ZN	.615*	.625*	.735*	-.556	.870**	.601
	Sig. (2-tailed)	SURVIVAL	.	.293	.572	.051	.048	.077
		REBURIAL	.293	.	.333	.030	.125	.056
		AG	.572	.333	.	1.000	.087	.345
		AS	.051	.030	1.000	.	.015	.032
		CD	.048	.125	.087	.015	.	.127
		CR	.077	.056	.345	.032	.127	.
		CU	.285	.013	.012	.259	.059	.190
		HG	.239	.962	.947	.492	.363	.424
		MN	.450	.205	.482	.066	.005	.770
		NI	.190	.056	.748	.000	.067	.039
		PB	.222	.481	.001	.466	.006	.189
		SB	.106	.764	.106	1.000	.293	1.000
		SE	.509	.139	.451	.062	.011	.749
		TL	.866	.755	.136	.879	.417	.960
		ZN	.044	.040	.010	.076	.001	.050
	N	SURVIVAL	13	11	11	11	11	11
		REBURIAL	11	13	11	11	11	11
		AG	11	11	13	11	11	11
		AS	11	11	11	13	11	11
		CD	11	11	11	11	13	11
		CR	11	11	11	11	11	13
		CU	11	11	11	11	11	11
		HG	11	11	11	11	11	11
		MN	11	11	11	11	11	11
		NI	11	11	11	11	11	11
		PB	11	11	11	11	11	11
		SB	4	4	4	4	4	4
		SE	11	11	11	11	11	11
		TL	11	11	11	11	11	11
		ZN	11	11	11	11	11	11

Correlations

			CU	HG	MN	NI	PB	SB	SE
Spearman's rho	Correlation Coefficient	SURVIVAL	.355	-.387	.255	-.427	.401	-.894	.223
		REBURIAL	.716*	-.016	.414	-.591	.238	.236	.476
		AG	.721*	.023	.237	.110	.867**	-.894	.254
		AS	-.373	.232	-.573	.936**	-.246	.000	-.579
		CD	.584	-.304	.781**	-.571	.762**	-.707	.730*
		CR	.427	.269	.100	-.627*	.428	.000	.109
		CU	1.000	.096	.382	-.300	.610*	.000	.374
		HG	.096	1.000	-.510	-.023	.025	-.447	-.263
		MN	.382	-.510	1.000	-.427	.323	.894	.674*
		NI	-.300	-.023	-.427	1.000	-.159	.000	-.583
		PB	.610*	.025	.323	-.159	1.000	-.894	.477
		SB	.000	-.447	.894	.000	-.894	1.000	-.447
		SE	.374	-.263	.674*	-.583	.477	-.447	1.000
		TL	.283	-.322	.364	.283	.362	.577	-.145
		ZN	.861**	-.016	.519	-.442	.829**	-.707	.523
	Sig. (2-tailed)	SURVIVAL	.285	.239	.450	.190	.222	.106	.509
		REBURIAL	.013	.962	.205	.056	.481	.764	.139
		AG	.012	.947	.482	.748	.001	.106	.451
		AS	.259	.492	.066	.000	.466	1.000	.062
		CD	.059	.363	.005	.067	.006	.293	.011
		CR	.190	.424	.770	.039	.189	1.000	.749
		CU	.	.780	.247	.370	.046	1.000	.258
		HG	.780	.	.109	.947	.942	.553	.435
		MN	.247	.109	.	.190	.332	.106	.023
		NI	.370	.947	.190	.	.640	1.000	.060
		PB	.046	.942	.332	.640	.	.106	.138
		SB	1.000	.553	.106	1.000	.106	.	.553
		SE	.258	.435	.023	.060	.138	.553	.
		TL	.399	.335	.271	.399	.274	.423	.671
		ZN	.001	.963	.102	.174	.002	.293	.099
	N	SURVIVAL	11	11	11	11	11	4	11
		REBURIAL	11	11	11	11	11	4	11
		AG	11	11	11	11	11	4	11
		AS	11	11	11	11	11	4	11
		CD	11	11	11	11	11	4	11
		CR	11	11	11	11	11	4	11
		CU	13	11	11	11	11	4	11
		HG	11	13	11	11	11	4	11
		MN	11	11	13	11	11	4	11
		NI	11	11	11	13	11	4	11
		PB	11	11	11	11	13	4	11
		SB	4	4	4	4	4	13	4
		SE	11	11	11	11	11	4	13
		TL	11	11	11	11	11	4	11
		ZN	11	11	11	11	11	4	11

Correlations

			TL	ZN
Spearman's rho	Correlation Coefficient	SURVIVAL	.058	.615*
		REBURIAL	-.107	.625*
		AG	.479	.735*
		AS	.052	-.556
		CD	.273	.870**
		CR	-.017	.601
		CU	.283	.861**
		HG	-.322	-.016
		MN	.364	.519
		NI	.283	-.442
		PB	.362	.829**
		SB	.577	-.707
		SE	-.145	.523
		TL	1.000	.258
		ZN	.258	1.000
	Sig. (2-tailed)	SURVIVAL	.866	.044
		REBURIAL	.755	.040
		AG	.136	.010
		AS	.879	.076
		CD	.417	.001
		CR	.960	.050
		CU	.399	.001
		HG	.335	.963
		MN	.271	.102
		NI	.399	.174
		PB	.274	.002
		SB	.423	.293
		SE	.671	.099
		TL	.	.444
		ZN	.444	.
	N	SURVIVAL	11	11
		REBURIAL	11	11
		AG	11	11
		AS	11	11
		CD	11	11
		CR	11	11
		CU	11	11
		HG	11	11
		MN	11	11
		NI	11	11
		PB	11	11
		SB	4	4
		SE	11	11
		TL	13	11
		ZN	11	13

*. Correlation is significant at the .05 level (2-tailed).

**. Correlation is significant at the .01 level (2-tailed).

SEE COMMENT PAGE TWO

ATTACHMENT 2

CORRELATION COEFFICIENTS FOR ORGANOCHLORINE PESTICIDES

Nonparametric Correlations

Correlations

			SURVIVAL	REBURIAL	a-Chlor	DDE	DDD	DDT
Spearman's rho	Correlation Coefficient	SURVIVAL	1.000	.349	.602*	.547	.658*	.151
		REBURIAL	.349	1.000	.424	.436	.393	.738**
		a-Chlor	.602*	.424	1.000	.309	.492	.402
		DDE	.547	.436	.309	1.000	.931**	.439
		DDD	.658*	.393	.492	.931**	1.000	.326
		DDT	.151	.738**	.402	.439	.326	1.000
		DIELDRIN	.602*	.424	1.000**	.309	.492	.402
		Eslf slf	.602*	.424	1.000**	.309	.492	.402
		Endo II	.602*	.424	1.000**	.309	.492	.402
		End ket	.602*	.424	1.000**	.309	.492	.402
		End ald	.602*	.424	1.000**	.309	.492	.402
		Endr/TOC	.602*	.424	1.000**	.309	.492	.402
		g-BHC	.602*	.424	1.000**	.309	.492	.402
		g-Chlor	.602*	.424	1.000**	.309	.492	.402
		HEPT	.602*	.424	1.000**	.309	.492	.402
	Sig. (2-tailed)	SURVIVAL	.	.293	.050	.082	.028	.658
		REBURIAL	.293	.	.194	.180	.232	.009
		a-Chlor	.050	.194	.	.356	.124	.221
		DDE	.082	.180	.356	.	.000	.176
		DDD	.028	.232	.124	.000	.	.328
		DDT	.658	.009	.221	.176	.328	.
		DIELDRIN	.050	.194	.000	.356	.124	.221
		Eslf slf	.050	.194	.000	.356	.124	.221
		Endo II	.050	.194	.000	.356	.124	.221
		End ket	.050	.194	.000	.356	.124	.221
		End ald	.050	.194	.000	.356	.124	.221
		Endr/TOC	.050	.194	.000	.356	.124	.221
		g-BHC	.050	.194	.000	.356	.124	.221
		g-Chlor	.050	.194	.000	.356	.124	.221
		HEPT	.050	.194	.000	.356	.124	.221
	N	SURVIVAL	13	11	11	11	11	11
		REBURIAL	11	13	11	11	11	11
		a-Chlor	11	11	13	11	11	11
		DDE	11	11	11	13	11	11
		DDD	11	11	11	11	13	11
		DDT	11	11	11	11	11	13
		DIELDRIN	11	11	11	11	11	11
		Eslf slf	11	11	11	11	11	11
		Endo II	11	11	11	11	11	11
		End ket	11	11	11	11	11	11
		End ald	11	11	11	11	11	11
		Endr/TOC	11	11	11	11	11	11
		g-BHC	11	11	11	11	11	11
		g-Chlor	11	11	11	11	11	11
		HEPT	11	11	11	11	11	11

Correlations

			DIELDRIN	Eslf slf	Endo II	End ket	End ald	Endr/TOC
Spearman's rho	Correlation Coefficient	SURVIVAL	.602*	.602*	.602*	.602*	.602*	.602*
		REBURIAL	.424	.424	.424	.424	.424	.424
		a-Chlor	1.000**	1.000**	1.000**	1.000**	1.000**	1.000**
		DDE	.309	.309	.309	.309	.309	.309
		DDD	.492	.492	.492	.492	.492	.492
		DDT	.402	.402	.402	.402	.402	.402
		DIELDRIN	1.000	1.000**	1.000**	1.000**	1.000**	1.000**
		Eslf slf	1.000**	1.000	1.000**	1.000**	1.000**	1.000**
		Endo II	1.000**	1.000**	1.000	1.000**	1.000**	1.000**
		End ket	1.000**	1.000**	1.000**	1.000	1.000**	1.000**
		End ald	1.000**	1.000**	1.000**	1.000**	1.000	1.000**
		Endr/TOC	1.000**	1.000**	1.000**	1.000**	1.000**	1.000
		g-BHC	1.000**	1.000**	1.000**	1.000**	1.000**	1.000**
		g-Chlor	1.000**	1.000**	1.000**	1.000**	1.000**	1.000**
		HEPT	1.000**	1.000**	1.000**	1.000**	1.000**	1.000**
	Sig. (2-tailed)	SURVIVAL	.050	.050	.050	.050	.050	.050
		REBURIAL	.194	.194	.194	.194	.194	.194
		a-Chlor	.000	.000	.000	.000	.000	.000
		DDE	.356	.356	.356	.356	.356	.356
		DDD	.124	.124	.124	.124	.124	.124
		DDT	.221	.221	.221	.221	.221	.221
		DIELDRIN	.	.000	.000	.000	.000	.000
		Eslf slf	.000	.	.000	.000	.000	.000
		Endo II	.000	.000	.	.000	.000	.000
		End ket	.000	.000	.000	.	.000	.000
		End ald	.000	.000	.000	.000	.	.000
		Endr/TOC	.000	.000	.000	.000	.000	.
		g-BHC	.000	.000	.000	.000	.000	.000
		g-Chlor	.000	.000	.000	.000	.000	.000
		HEPT	.000	.000	.000	.000	.000	.000
	N	SURVIVAL	11	11	11	11	11	11
		REBURIAL	11	11	11	11	11	11
		a-Chlor	11	11	11	11	11	11
		DDE	11	11	11	11	11	11
		DDD	11	11	11	11	11	11
		DDT	11	11	11	11	11	11
		DIELDRIN	13	11	11	11	11	11
		Eslf slf	11	13	11	11	11	11
		Endo II	11	11	13	11	11	11
		End ket	11	11	11	13	11	11
		End ald	11	11	11	11	13	11
		Endr/TOC	11	11	11	11	11	13
		g-BHC	11	11	11	11	11	11
		g-Chlor	11	11	11	11	11	11
		HEPT	11	11	11	11	11	11

Correlations

			g-BHC	g-Chlor	HEPT
Spearman's rho	Correlation Coefficient	SURVIVAL	.602*	.602*	.602*
		REBURIAL	.424	.424	.424
		a-Chlor	1.000**	1.000**	1.000**
		DDE	.309	.309	.309
		DDD	.492	.492	.492
		DDT	.402	.402	.402
		DIELDRIN	1.000**	1.000**	1.000**
		Eslf slf	1.000**	1.000**	1.000**
		Endo II	1.000**	1.000**	1.000**
		End ket	1.000**	1.000**	1.000**
		End ald	1.000**	1.000**	1.000**
		Endr/TOC	1.000**	1.000**	1.000**
		g-BHC	1.000	1.000**	1.000**
		g-Chlor	1.000**	1.000	1.000**
		HEPT	1.000**	1.000**	1.000
	Sig. (2-tailed)	SURVIVAL	.050	.050	.050
		REBURIAL	.194	.194	.194
		a-Chlor	.000	.000	.000
		DDE	.356	.356	.356
		DDD	.124	.124	.124
		DDT	.221	.221	.221
		DIELDRIN	.000	.000	.000
		Eslf slf	.000	.000	.000
		Endo II	.000	.000	.000
		End ket	.000	.000	.000
		End ald	.000	.000	.000
		Endr/TOC	.000	.000	.000
		g-BHC	.	.000	.000
		g-Chlor	.000	.	.000
		HEPT	.000	.000	.
	N	SURVIVAL	11	11	11
		REBURIAL	11	11	11
		a-Chlor	11	11	11
		DDE	11	11	11
		DDD	11	11	11
		DDT	11	11	11
		DIELDRIN	11	11	11
		Eslf slf	11	11	11
		Endo II	11	11	11
		End ket	11	11	11
		End ald	11	11	11
		Endr/TOC	11	11	11
		g-BHC	13	11	11
		g-Chlor	11	13	11
		HEPT	11	11	13

*. Correlation is significant at the .05 level (2-tailed).

**. Correlation is significant at the .01 level (2-tailed).

ATTACHMENT 3

CORRELATION COEFFICIENTS FOR TPH COMPOUNDS AND TOC-NORMALIZED TPH COMPOUNDS

Nonparametric Correlations

Correlations

			SURVIVAL	REBURIAL	TPH-d	TPH-JP5	TPH-MO	TPH-Unk
Spearman's rho	Correlation Coefficient	SURVIVAL	1.000	.349	.187	.187	.187	.536
		REBURIAL	.349	1.000	.084	.084	.084	.428
		TPH-d	.187	.084	1.000	1.000**	1.000**	.548
		TPH-JP5	.187	.084	1.000**	1.000	1.000**	.548
		TPH-MO	.187	.084	1.000**	1.000**	1.000	.548
		TPH-Unk	.536	.428	.548	.548	.548	1.000
		d/TOC	.127	.330	.708*	.708*	.708*	.364
		JP5/TOC	.127	.330	.708*	.708*	.708*	.364
		MO/TOC	.127	.330	.708*	.708*	.708*	.364
		Unk/TOC	.564	.423	.470	.470	.470	.964**
	Sig. (2-tailed)	SURVIVAL	.	.293	.581	.581	.581	.089
		REBURIAL	.293	.	.806	.806	.806	.189
		TPH-d	.581	.806	.	.000	.000	.081
		TPH-JP5	.581	.806	.000	.	.000	.081
		TPH-MO	.581	.806	.000	.000	.	.081
		TPH-Unk	.089	.189	.081	.081	.081	.
		d/TOC	.709	.321	.015	.015	.015	.272
		JP5/TOC	.709	.321	.015	.015	.015	.272
		MO/TOC	.709	.321	.015	.015	.015	.272
		Unk/TOC	.071	.194	.144	.144	.144	.000
	N	SURVIVAL	13	11	11	11	11	11
		REBURIAL	11	13	11	11	11	11
		TPH-d	11	11	13	11	11	11
		TPH-JP5	11	11	11	13	11	11
		TPH-MO	11	11	11	11	13	11
		TPH-Unk	11	11	11	11	11	13
		d/TOC	11	11	11	11	11	11
		JP5/TOC	11	11	11	11	11	11
		MO/TOC	11	11	11	11	11	11
		Unk/TOC	11	11	11	11	11	11

Correlations

			d/TOC	JP5/TOC	MO/TOC	Unk/TOC
Spearman's rho	Correlation Coefficient	SURVIVAL	.127	.127	.127	.564
		REBURIAL	.330	.330	.330	.423
		TPH-d	.708*	.708*	.708*	.470
		TPH-JP5	.708*	.708*	.708*	.470
		TPH-MO	.708*	.708*	.708*	.470
		TPH-Unk	.364	.364	.364	.964**
		d/TOC	1.000	1.000**	1.000**	.418
		JP5/TOC	1.000**	1.000	1.000**	.418
		MO/TOC	1.000**	1.000**	1.000	.418
		Unk/TOC	.418	.418	.418	1.000
	Sig. (2-tailed)	SURVIVAL	.709	.709	.709	.071
		REBURIAL	.321	.321	.321	.194
		TPH-d	.015	.015	.015	.144
		TPH-JP5	.015	.015	.015	.144
		TPH-MO	.015	.015	.015	.144
		TPH-Unk	.272	.272	.272	.000
		d/TOC	.	.000	.000	.201
		JP5/TOC	.000	.	.000	.201
		MO/TOC	.000	.000	.	.201
		Unk/TOC	.201	.201	.201	.
	N	SURVIVAL	11	11	11	11
		REBURIAL	11	11	11	11
		TPH-d	11	11	11	11
		TPH-JP5	11	11	11	11
		TPH-MO	11	11	11	11
		TPH-Unk	11	11	11	11
		d/TOC	13	11	11	11
		JP5/TOC	11	13	11	11
		MO/TOC	11	11	13	11
		Unk/TOC	11	11	11	13

**. Correlation is significant at the .01 level (2-tailed).

*. Correlation is significant at the .05 level (2-tailed).

ATTACHMENT 4

CORRELATION COEFFICIENTS FOR TOC-NORMALIZED METALS

Nonparametric Correlations

Correlations

			SURVIVAL	REBURIAL	Ag/TOC	As/TOC	Cd/TOC	Cr/TOC
Spearman's rho	Correlation Coefficient	SURVIVAL	1.000	.349	.418	-.682*	.318	.400
		REBURIAL	.349	1.000	.502	-.507	.572	.582
		Ag/TOC	.418	.502	1.000	-.364	.773**	.682*
		As/TOC	-.682*	-.507	-.364	1.000	-.318	-.391
		Cd/TOC	.318	.572	.773**	-.318	1.000	.927**
		Cr/TOC	.400	.582	.682*	-.391	.927**	1.000
		Cu/TOC	.218	.679*	.818**	-.209	.845**	.745**
		Hg/TOC	-.118	.251	.300	.145	.609*	.655*
		Mn/TOC	.155	.405	.518	-.409	.618*	.436
		Ni/TOC	-.260	-.035	.360	.510	.446	.296
		Pb/TOC	.255	.456	.918**	-.218	.909**	.809**
		Sb/TOC	-.800	.105	-.800	.400	-.400	-.400
		Se/TOC	.273	.530	.727*	-.227	.964**	.827**
		Tl/TOC	.269	.063	.360	-.100	.273	.241
		Zn/TOC	.473	.763**	.873**	-.427	.891**	.818**
	Sig. (2-tailed)	SURVIVAL	.	.293	.201	.021	.340	.223
		REBURIAL	.293	.	.115	.111	.066	.061
		Ag/TOC	.201	.115	.	.272	.005	.021
		As/TOC	.021	.111	.272	.	.340	.235
		Cd/TOC	.340	.066	.005	.340	.	.000
		Cr/TOC	.223	.061	.021	.235	.000	.
		Cu/TOC	.519	.022	.002	.537	.001	.008
		Hg/TOC	.729	.456	.370	.670	.047	.029
		Mn/TOC	.650	.217	.102	.212	.043	.180
		Ni/TOC	.441	.919	.277	.109	.169	.377
		Pb/TOC	.450	.159	.000	.519	.000	.003
		Sb/TOC	.200	.895	.200	.600	.600	.600
		Se/TOC	.417	.093	.011	.502	.000	.002
		Tl/TOC	.424	.854	.277	.769	.416	.474
		Zn/TOC	.142	.006	.000	.190	.000	.002
	N	SURVIVAL	13	11	11	11	11	11
		REBURIAL	11	13	11	11	11	11
		Ag/TOC	11	11	13	11	11	11
		As/TOC	11	11	11	13	11	11
		Cd/TOC	11	11	11	11	13	11
		Cr/TOC	11	11	11	11	11	13
		Cu/TOC	11	11	11	11	11	11
		Hg/TOC	11	11	11	11	11	11
		Mn/TOC	11	11	11	11	11	11
		Ni/TOC	11	11	11	11	11	11
		Pb/TOC	11	11	11	11	11	11
		Sb/TOC	4	4	4	4	4	4
		Se/TOC	11	11	11	11	11	11
		Tl/TOC	11	11	11	11	11	11
		Zn/TOC	11	11	11	11	11	11

Correlations

			Cu/TOC	Hg/TOC	Mn/TOC	Ni/TOC	Pb/TOC	Sb/TOC	Se/TOC
Spearman's rho	Correlation Coefficient	SURVIVAL	.218	-.118	.155	-.260	.255	-.800	.273
		REBURIAL	.679*	.251	.405	-.035	.456	.105	.530
		Ag/TOC	.818**	.300	.518	.360	.918**	-.800	.727*
		As/TOC	-.209	.145	-.409	.510	-.218	.400	-.227
		Cd/TOC	.845**	.609*	.618*	.446	.909**	-.400	.964**
		Cr/TOC	.745**	.655*	.436	.296	.809**	-.400	.827**
		Cu/TOC	1.000	.645*	.518	.442	.864**	-.400	.809**
		Hg/TOC	.645*	1.000	.064	.278	.573	-.800	.482
		Mn/TOC	.518	.064	1.000	.292	.518	1.000**	.718*
		Ni/TOC	.442	.278	.292	1.000	.433	.000	.583
		Pb/TOC	.864**	.573	.518	.433	1.000	-.800	.845**
		Sb/TOC	-.400	-.800	1.000**	.000	-.800	1.000	.400
		Se/TOC	.809**	.482	.718*	.583	.845**	.400	1.000
		Tl/TOC	.187	-.132	.510	.196	.323	.800	.346
		Zn/TOC	.936**	.491	.582	.333	.864**	-.400	.855**
	Sig. (2-tailed)	SURVIVAL	.519	.729	.650	.441	.450	.200	.417
		REBURIAL	.022	.456	.217	.919	.159	.895	.093
		Ag/TOC	.002	.370	.102	.277	.000	.200	.011
		As/TOC	.537	.670	.212	.109	.519	.600	.502
		Cd/TOC	.001	.047	.043	.169	.000	.600	.000
		Cr/TOC	.008	.029	.180	.377	.003	.600	.002
		Cu/TOC	.	.032	.102	.174	.001	.600	.003
		Hg/TOC	.032	.	.853	.408	.066	.200	.133
		Mn/TOC	.102	.853	.	.384	.102	.000	.013
		Ni/TOC	.174	.408	.384	.	.184	1.000	.060
		Pb/TOC	.001	.066	.102	.184	.	.200	.001
		Sb/TOC	.600	.200	.000	1.000	.200	.	.600
		Se/TOC	.003	.133	.013	.060	.001	.600	.
		Tl/TOC	.582	.699	.109	.563	.332	.200	.297
		Zn/TOC	.000	.125	.060	.318	.001	.600	.001
	N	SURVIVAL	11	11	11	11	11	4	11
		REBURIAL	11	11	11	11	11	4	11
		Ag/TOC	11	11	11	11	11	4	11
		As/TOC	11	11	11	11	11	4	11
		Cd/TOC	11	11	11	11	11	4	11
		Cr/TOC	11	11	11	11	11	4	11
		Cu/TOC	13	11	11	11	11	4	11
		Hg/TOC	11	13	11	11	11	4	11
		Mn/TOC	11	11	13	11	11	4	11
		Ni/TOC	11	11	11	13	11	4	11
		Pb/TOC	11	11	11	11	13	4	11
		Sb/TOC	4	4	4	4	4	13	4
		Se/TOC	11	11	11	11	11	4	13
		Tl/TOC	11	11	11	11	11	4	11
		Zn/TOC	11	11	11	11	11	4	11

Correlations

			Tl/TOC	Zn/TOC
Spearman's rho	Correlation Coefficient	SURVIVAL	.269	.473
		REBURIAL	.063	.763**
		Ag/TOC	.360	.873**
		As/TOC	-.100	-.427
		Cd/TOC	.273	.891**
		Cr/TOC	.241	.818**
		Cu/TOC	.187	.936**
		Hg/TOC	-.132	.491
		Mn/TOC	.510	.582
		Ni/TOC	.196	.333
		Pb/TOC	.323	.864**
		Sb/TOC	.800	-.400
		Se/TOC	.346	.855**
		Tl/TOC	1.000	.214
		Zn/TOC	.214	1.000
	Sig. (2-tailed)	SURVIVAL	.424	.142
		REBURIAL	.854	.006
		Ag/TOC	.277	.000
		As/TOC	.769	.190
		Cd/TOC	.416	.000
		Cr/TOC	.474	.002
		Cu/TOC	.582	.000
		Hg/TOC	.699	.125
		Mn/TOC	.109	.060
		Ni/TOC	.563	.318
		Pb/TOC	.332	.001
		Sb/TOC	.200	.600
		Se/TOC	.297	.001
		Tl/TOC	.	.527
		Zn/TOC	.527	.
	N	SURVIVAL	11	11
		REBURIAL	11	11
		Ag/TOC	11	11
		As/TOC	11	11
		Cd/TOC	11	11
		Cr/TOC	11	11
		Cu/TOC	11	11
		Hg/TOC	11	11
		Mn/TOC	11	11
		Ni/TOC	11	11
		Pb/TOC	11	11
		Sb/TOC	4	4
		Se/TOC	11	11
		Tl/TOC	13	11
		Zn/TOC	11	13

*. Correlation is significant at the .05 level (2-tailed).

**. Correlation is significant at the .01 level (2-tailed).

ATTACHMENT 5

CORRELATION COEFFICIENTS FOR TOC-NORMALIZED ORGANOCHLORINE PESTICIDES

Nonparametric Correlations

Correlations

			SURVIVAL	REBURIAL	a-C/TOC	DDD/TOC	DDE/TOC	DDT/TOC
Spearman's rho	Correlation Coefficient	SURVIVAL	1.000	.349	.355	.518	.582	.091
		REBURIAL	.349	1.000	.395	.340	.381	.544
		a-C/TOC	.355	.395	1.000	.364	.491	.718*
		DDD/TOC	.518	.340	.364	1.000	.955**	.491
		DDE/TOC	.582	.381	.491	.955**	1.000	.564
		DDT/TOC	.091	.544	.718*	.491	.564	1.000
		Diel/TOC	.355	.395	1.000**	.364	.491	.718*
		E II/TOC	.355	.395	1.000**	.364	.491	.718*
		Enal/TOC	.355	.395	1.000**	.364	.491	.718*
		Endk/TOC	.355	.395	1.000**	.364	.491	.718*
		Endo II	.602*	.424	.616*	.363	.418	.510
		ENDR_TOC	.355	.395	1.000**	.364	.491	.718*
		Eslf/TOC	.355	.395	1.000**	.364	.491	.718*
		g-B/TOC	.355	.395	1.000**	.364	.491	.718*
		g-C/TOC	.355	.395	1.000**	.364	.491	.718*
		Hept/TOC	.355	.395	1.000**	.364	.491	.718*
	Sig. (2-tailed)	SURVIVAL	.	.293	.285	.102	.060	.790
		REBURIAL	.293	.	.229	.307	.247	.083
		a-C/TOC	.285	.229	.	.272	.125	.013
		DDD/TOC	.102	.307	.272	.	.000	.125
		DDE/TOC	.060	.247	.125	.000	.	.071
		DDT/TOC	.790	.083	.013	.125	.071	.
		Diel/TOC	.285	.229	.000	.272	.125	.013
		E II/TOC	.285	.229	.000	.272	.125	.013
		Enal/TOC	.285	.229	.000	.272	.125	.013
		Endk/TOC	.285	.229	.000	.272	.125	.013
		Endo II	.050	.194	.044	.272	.200	.109
		ENDR_TOC	.285	.229	.000	.272	.125	.013
		Eslf/TOC	.285	.229	.000	.272	.125	.013
		g-B/TOC	.285	.229	.000	.272	.125	.013
		g-C/TOC	.285	.229	.000	.272	.125	.013
		Hept/TOC	.285	.229	.000	.272	.125	.013
	N	SURVIVAL	13	11	11	11	11	11
		REBURIAL	11	13	11	11	11	11
		a-C/TOC	11	11	13	11	11	11
		DDD/TOC	11	11	11	13	11	11
		DDE/TOC	11	11	11	11	13	11
		DDT/TOC	11	11	11	11	11	13
		Diel/TOC	11	11	11	11	11	11
		E II/TOC	11	11	11	11	11	11
		Enal/TOC	11	11	11	11	11	11
		Endk/TOC	11	11	11	11	11	11
		Endo II	11	11	11	11	11	11
		ENDR_TOC	11	11	11	11	11	11
		Eslf/TOC	11	11	11	11	11	11
		g-B/TOC	11	11	11	11	11	11
		g-C/TOC	11	11	11	11	11	11
		Hept/TOC	11	11	11	11	11	11

Correlations

			Diel/TOC	E II/TOC	Enal/TOC	Endk/TOC	Endo II	ENDR_TOC
Spearman's rho	Correlation Coefficient	SURVIVAL	.355	.355	.355	.355	.602*	.355
		REBURIAL	.395	.395	.395	.395	.424	.395
		a-C/TOC	1.000**	1.000**	1.000**	1.000**	.616*	1.000**
		DDD/TOC	.364	.364	.364	.364	.363	.364
		DDE/TOC	.491	.491	.491	.491	.418	.491
		DDT/TOC	.718*	.718*	.718*	.718*	.510	.718*
		Diel/TOC	1.000	1.000**	1.000**	1.000**	.616*	1.000**
		E II/TOC	1.000**	1.000	1.000**	1.000**	.616*	1.000**
		Enal/TOC	1.000**	1.000**	1.000	1.000**	.616*	1.000**
		Endk/TOC	1.000**	1.000**	1.000**	1.000	.616*	1.000**
		Endo II	.616*	.616*	.616*	.616*	1.000	.616*
		ENDR_TOC	1.000**	1.000**	1.000**	1.000**	.616*	1.000
		Eslf/TOC	1.000**	1.000**	1.000**	1.000**	.616*	1.000**
		g-B/TOC	1.000**	1.000**	1.000**	1.000**	.616*	1.000**
		g-C/TOC	1.000**	1.000**	1.000**	1.000**	.616*	1.000**
		Hept/TOC	1.000**	1.000**	1.000**	1.000**	.616*	1.000**
	Sig. (2-tailed)	SURVIVAL	.285	.285	.285	.285	.050	.285
		REBURIAL	.229	.229	.229	.229	.194	.229
		a-C/TOC	.000	.000	.000	.000	.044	.000
		DDD/TOC	.272	.272	.272	.272	.272	.272
		DDE/TOC	.125	.125	.125	.125	.200	.125
		DDT/TOC	.013	.013	.013	.013	.109	.013
		Diel/TOC	.	.000	.000	.000	.044	.000
		E II/TOC	.000	.	.000	.000	.044	.000
		Enal/TOC	.000	.000	.	.000	.044	.000
		Endk/TOC	.000	.000	.000	.	.044	.000
		Endo II	.044	.044	.044	.044	.	.044
		ENDR_TOC	.000	.000	.000	.000	.044	.
		Eslf/TOC	.000	.000	.000	.000	.044	.000
		g-B/TOC	.000	.000	.000	.000	.044	.000
		g-C/TOC	.000	.000	.000	.000	.044	.000
		Hept/TOC	.000	.000	.000	.000	.044	.000
	N	SURVIVAL	11	11	11	11	11	11
		REBURIAL	11	11	11	11	11	11
		a-C/TOC	11	11	11	11	11	11
		DDD/TOC	11	11	11	11	11	11
		DDE/TOC	11	11	11	11	11	11
		DDT/TOC	11	11	11	11	11	11
		Diel/TOC	13	11	11	11	11	11
		E II/TOC	11	13	11	11	11	11
		Enal/TOC	11	11	13	11	11	11
		Endk/TOC	11	11	11	13	11	11
		Endo II	11	11	11	11	13	11
		ENDR_TOC	11	11	11	11	11	13
		Eslf/TOC	11	11	11	11	11	11
		g-B/TOC	11	11	11	11	11	11
		g-C/TOC	11	11	11	11	11	11
		Hept/TOC	11	11	11	11	11	11

Correlations

			Eslf/TOC	g-B/TOC	g-C/TOC	Hept/TOC
Spearman's rho	Correlation Coefficient	SURVIVAL	.355	.355	.355	.355
		REBURIAL	.395	.395	.395	.395
		a-C/TOC	1.000**	1.000**	1.000**	1.000**
		DDD/TOC	.364	.364	.364	.364
		DDE/TOC	.491	.491	.491	.491
		DDT/TOC	.718*	.718*	.718*	.718*
		Diel/TOC	1.000**	1.000**	1.000**	1.000**
		E II/TOC	1.000**	1.000**	1.000**	1.000**
		Enal/TOC	1.000**	1.000**	1.000**	1.000**
		Endk/TOC	1.000**	1.000**	1.000**	1.000**
		Endo II	.616*	.616*	.616*	.616*
		ENDR_TOC	1.000**	1.000**	1.000**	1.000**
		Eslf/TOC	1.000	1.000**	1.000**	1.000**
		g-B/TOC	1.000**	1.000	1.000**	1.000**
		g-C/TOC	1.000**	1.000**	1.000	1.000**
		Hept/TOC	1.000**	1.000**	1.000**	1.000
	Sig. (2-tailed)	SURVIVAL	.285	.285	.285	.285
		REBURIAL	.229	.229	.229	.229
		a-C/TOC	.000	.000	.000	.000
		DDD/TOC	.272	.272	.272	.272
		DDE/TOC	.125	.125	.125	.125
		DDT/TOC	.013	.013	.013	.013
		Diel/TOC	.000	.000	.000	.000
		E II/TOC	.000	.000	.000	.000
		Enal/TOC	.000	.000	.000	.000
		Endk/TOC	.000	.000	.000	.000
		Endo II	.044	.044	.044	.044
		ENDR_TOC	.000	.000	.000	.000
		Eslf/TOC	.	.000	.000	.000
		g-B/TOC	.000	.	.000	.000
		g-C/TOC	.000	.000	.	.000
		Hept/TOC	.000	.000	.000	.
	N	SURVIVAL	11	11	11	11
		REBURIAL	11	11	11	11
		a-C/TOC	11	11	11	11
		DDD/TOC	11	11	11	11
		DDE/TOC	11	11	11	11
		DDT/TOC	11	11	11	11
		Diel/TOC	11	11	11	11
		E II/TOC	11	11	11	11
		Enal/TOC	11	11	11	11
		Endk/TOC	11	11	11	11
		Endo II	11	11	11	11
		ENDR_TOC	11	11	11	11
		Eslf/TOC	13	11	11	11
		g-B/TOC	11	13	11	11
		g-C/TOC	11	11	13	11
		Hept/TOC	11	11	11	13

*. Correlation is significant at the .05 level (2-tailed).

**. Correlation is significant at the .01 level (2-tailed).

ATTACHMENT 6

CORRELATION COEFFICIENTS FOR SEM METALS AND SEM-METAL:ACID VOLATILE SULFIDE RATIOS

Nonparametric Correlations

Correlations

			SURVIVAL	REBURIAL	PCB1254	PCB1260	1254/TOC	1260/TOC
Spearman's rho	Correlation Coefficient	SURVIVAL	1.000	.349	.583	.346	.318	.355
		REBURIAL	.349	1.000	.504	.406	.535	.507
		PCB1254	.583	.504	1.000	.801**	.656*	.624*
		PCB1260	.346	.406	.801**	1.000	.369	.346
		1254/TOC	.318	.535	.656*	.369	1.000	.991**
		1260/TOC	.355	.507	.624*	.346	.991**	1.000
	Sig. (2-tailed)	SURVIVAL	.	.293	.060	.297	.340	.285
		REBURIAL	.293	.	.114	.216	.090	.111
		PCB1254	.060	.114	.	.003	.028	.040
		PCB1260	.297	.216	.003	.	.264	.297
		1254/TOC	.340	.090	.028	.264	.	.000
		1260/TOC	.285	.111	.040	.297	.000	.
	N	SURVIVAL	13	11	11	11	11	11
		REBURIAL	11	13	11	11	11	11
		PCB1254	11	11	13	11	11	11
		PCB1260	11	11	11	13	11	11
		1254/TOC	11	11	11	11	13	11
		1260/TOC	11	11	11	11	11	13

**. Correlation is significant at the .01 level (2-tailed).

*. Correlation is significant at the .05 level (2-tailed).

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MOFFETT FIELD
SSIC NO. 5090.3

ATTACHMENT 6 – CORRELATION COEFFICIENTS FOR SEM METALS AND SEM-METAL: ACID VOLATILE SULFIDE RATIOS

PAGES 2 THROUGH 5

TECHNICAL MEMORANDA IN RESPONSE TO COMMENTS ON THE DRAFT FINAL PHASE II SITE-WIDE ECOLOGICAL ASSESSMENT REPORT

THE ABOVE IDENTIFIED PAGES ARE NOT AVAILABLE.

EXTENSIVE RESEARCH WAS PERFORMED BY NAVFAC SOUTHWEST TO LOCATE THESE PAGES. THIS PAGE HAS BEEN INSERTED AS A PLACEHOLDER AND WILL BE REPLACED SHOULD THE MISSING ITEMS BE LOCATED.

QUESTIONS MAY BE DIRECTED TO:

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Correlations

			S/A_CD	S/A_CU	S/A_HG	HMW_PAH	LMW_PAH	S/A_NI
Spearman's rho	Correlation Coefficient	S/A_CD	1.000	.609*	.764**	.011	.300	.727*
		S/A_CU	.609*	1.000	.909**	.147	.300	.918**
		S/A_HG	.764**	.909**	1.000	.190	.300	.964**
		HMW_PAH	.011	.147	.190	1.000	.579	.242
		LMW_PAH	.300	.300	.300	.579	1.000	.300
		S/A_NI	.727*	.918**	.964**	.242	.300	1.000
		S/A_PB	.909**	.827**	.900**	.084	.300	.845**
		%_FINES	.060	-.065	-.175	-.059	-.152	.018
		REBURIAL	.191	-.138	-.105	.044	-.052	-.153
		SEM_CD	-.487	-.916**	-.761**	.127	-.200	-.806**
		SEM_CU	-.187	.524	.287	.475	.401	.305
		SEM_HG	.775*	.775*	.775*	-.030	.206	.685
		SEM_NI	-.287	.223	.082	.396	.451	.210
		SEM_PB	-.582	-.518	-.518	.369	.200	-.591
		SEM_ZN	-.560	-.752**	-.729*	.179	-.200	-.761**
		SURVIVAL	-.369	-.428	-.560	-.243	-.301	-.524
		S/A_ZN	.800**	.800**	.873**	.074	.200	.800**
	Sig. (2-tailed)	S/A_CD	.	.047	.006	.975	.370	.011
		S/A_CU	.047	.	.000	.665	.370	.000
		S/A_HG	.006	.000	.	.577	.370	.000
		HMW_PAH	.975	.665	.577	.	.062	.473
		LMW_PAH	.370	.370	.370	.062	.	.370
		S/A_NI	.011	.000	.000	.473	.370	.
		S/A_PB	.000	.002	.000	.806	.370	.001
		%_FINES	.861	.851	.607	.864	.655	.957
		REBURIAL	.574	.685	.759	.897	.878	.654
		SEM_CD	.128	.000	.007	.711	.555	.003
		SEM_CU	.582	.098	.392	.140	.222	.361
		SEM_HG	.041	.041	.041	.949	.658	.090
		SEM_NI	.392	.509	.811	.228	.164	.536
		SEM_PB	.060	.102	.102	.265	.555	.056
		SEM_ZN	.073	.008	.011	.598	.555	.007
		SURVIVAL	.264	.189	.073	.472	.369	.098
		S/A_ZN	.003	.003	.000	.829	.555	.003
	N	S/A_CD	11	11	11	11	11	11
		S/A_CU	11	11	11	11	11	11
		S/A_HG	11	11	11	11	11	11
		HMW_PAH	11	11	11	11	11	11
		LMW_PAH	11	11	11	11	11	11
		S/A_NI	11	11	11	11	11	11
		S/A_PB	11	11	11	11	11	11
		%_FINES	11	11	11	11	11	11
		REBURIAL	11	11	11	11	11	11
		SEM_CD	11	11	11	11	11	11
		SEM_CU	11	11	11	11	11	11
		SEM_HG	7	7	7	7	7	7
		SEM_NI	11	11	11	11	11	11
		SEM_PB	11	11	11	11	11	11
		SEM_ZN	11	11	11	11	11	11
		SURVIVAL	11	11	11	11	11	11
		S/A_ZN	11	11	11	11	11	11

Correlations

			S/A_PB	%_FINES	REBURIAL	SEM_CD	SEM_CU	SEM_HG
Spearman's rho	Correlation Coefficient	S/A_CD	.909**	.060	.191	-.487	-.187	.775*
		S/A_CU	.827**	-.065	-.138	-.916**	.524	.775*
		S/A_HG	.900**	-.175	-.105	-.761**	.287	.775*
		HMW_PAH	.084	-.059	.044	.127	.475	-.030
		LMW_PAH	.300	-.152	-.052	-.200	.401	.206
		S/A_NI	.845**	.018	-.153	-.806**	.305	.685
		S/A_PB	1.000	-.092	.234	-.661*	.150	.775*
		%_FINES	-.092	1.000	.029	-.106	-.268	.073
		REBURIAL	.234	.029	1.000	.284	-.045	-.055
		SEM_CD	-.661*	-.106	.284	1.000	-.406	-.564
		SEM_CU	.150	-.268	-.045	-.406	1.000	-.091
		SEM_HG	.775*	.073	-.055	-.564	-.091	1.000
		SEM_NI	-.191	-.099	-.552	-.247	.616*	-.209
		SEM_PB	-.545	-.493	.014	.674*	.292	-.180
		SEM_ZN	-.588	-.088	.394	.886**	-.096	-.342
		SURVIVAL	-.323	.340	.452	.356	-.205	-.191
		S/A_ZN	.955**	-.106	.257	-.606*	.205	.811*
	Sig. (2-tailed)	S/A_CD	.000	.861	.574	.128	.582	.041
		S/A_CU	.002	.851	.685	.000	.098	.041
		S/A_HG	.000	.607	.759	.007	.392	.041
		HMW_PAH	.806	.864	.897	.711	.140	.949
		LMW_PAH	.370	.655	.878	.555	.222	.658
		S/A_NI	.001	.957	.654	.003	.361	.090
		S/A_PB	.	.788	.489	.027	.659	.041
		%_FINES	.788	.	.933	.756	.426	.877
		REBURIAL	.489	.933	.	.397	.895	.907
		SEM_CD	.027	.756	.397	.	.215	.188
		SEM_CU	.659	.426	.895	.215	.	.846
		SEM_HG	.041	.877	.907	.188	.846	.
		SEM_NI	.573	.771	.078	.465	.043	.653
		SEM_PB	.083	.123	.967	.023	.384	.699
		SEM_ZN	.057	.797	.230	.000	.779	.452
		SURVIVAL	.332	.307	.163	.282	.544	.682
		S/A_ZN	.000	.756	.445	.048	.545	.027
	N	S/A_CD	11	11	11	11	11	7
		S/A_CU	11	11	11	11	11	7
		S/A_HG	11	11	11	11	11	7
		HMW_PAH	11	11	11	11	11	7
		LMW_PAH	11	11	11	11	11	7
		S/A_NI	11	11	11	11	11	7
		S/A_PB	11	11	11	11	11	7
		%_FINES	11	11	11	11	11	7
		REBURIAL	11	11	11	11	11	7
		SEM_CD	11	11	11	11	11	7
		SEM_CU	11	11	11	11	11	7
		SEM_HG	7	7	7	7	7	11
		SEM_NI	11	11	11	11	11	7
		SEM_PB	11	11	11	11	11	7
		SEM_ZN	11	11	11	11	11	7
		SURVIVAL	11	11	11	11	11	7
		S/A_ZN	11	11	11	11	11	7

Correlations

			SEM_NI	SEM_PB	SEM_ZN	SURVIVAL	S/A_ZN
Spearman's rho	Correlation Coefficient	S/A_CD	-.287	-.582	-.560	-.369	.800**
		S/A_CU	.223	-.518	-.752**	-.428	.800**
		S/A_HG	.082	-.518	-.729*	-.560	.873**
		HMW_PAH	.396	.369	.179	-.243	.074
		LMW_PAH	.451	.200	-.200	-.301	.200
		S/A_NI	.210	-.591	-.761**	-.524	.800**
		S/A_PB	-.191	-.545	-.588	-.323	.955**
		%_FINES	-.099	-.493	-.088	.340	-.106
		REBURIAL	-.552	.014	.394	.452	.257
		SEM_CD	-.247	.674*	.886**	.356	-.606*
		SEM_CU	.616*	.292	-.096	-.205	.205
		SEM_HG	-.209	-.180	-.342	-.191	.811*
		SEM_NI	1.000	.319	-.148	-.354	-.214
		SEM_PB	.319	1.000	.761**	.073	-.464
		SEM_ZN	-.148	.761**	1.000	.568	-.451
		SURVIVAL	-.354	.073	.568	1.000	-.182
		S/A_ZN	-.214	-.464	-.451	-.182	1.000
	Sig. (2-tailed)	S/A_CD	.392	.060	.073	.264	.003
		S/A_CU	.509	.102	.008	.189	.003
		S/A_HG	.811	.102	.011	.073	.000
		HMW_PAH	.228	.265	.598	.472	.829
		LMW_PAH	.164	.555	.555	.369	.555
		S/A_NI	.536	.056	.007	.098	.003
		S/A_PB	.573	.083	.057	.332	.000
		%_FINES	.771	.123	.797	.307	.756
		REBURIAL	.078	.967	.230	.163	.445
		SEM_CD	.465	.023	.000	.282	.048
		SEM_CU	.043	.384	.779	.544	.545
		SEM_HG	.653	.699	.452	.682	.027
		SEM_NI	.	.339	.663	.286	.527
		SEM_PB	.339	.	.007	.831	.151
		SEM_ZN	.663	.007	.	.068	.164
		SURVIVAL	.286	.831	.068	.	.592
		S/A_ZN	.527	.151	.164	.592	.
	N	S/A_CD	11	11	11	11	11
		S/A_CU	11	11	11	11	11
		S/A_HG	11	11	11	11	11
		HMW_PAH	11	11	11	11	11
		LMW_PAH	11	11	11	11	11
		S/A_NI	11	11	11	11	11
		S/A_PB	11	11	11	11	11
		%_FINES	11	11	11	11	11
		REBURIAL	11	11	11	11	11
		SEM_CD	11	11	11	11	11
		SEM_CU	11	11	11	11	11
		SEM_HG	7	7	7	7	7
		SEM_NI	11	11	11	11	11
		SEM_PB	11	11	11	11	11
		SEM_ZN	11	11	11	11	11
		SURVIVAL	11	11	11	11	11
		S/A_ZN	11	11	11	11	11

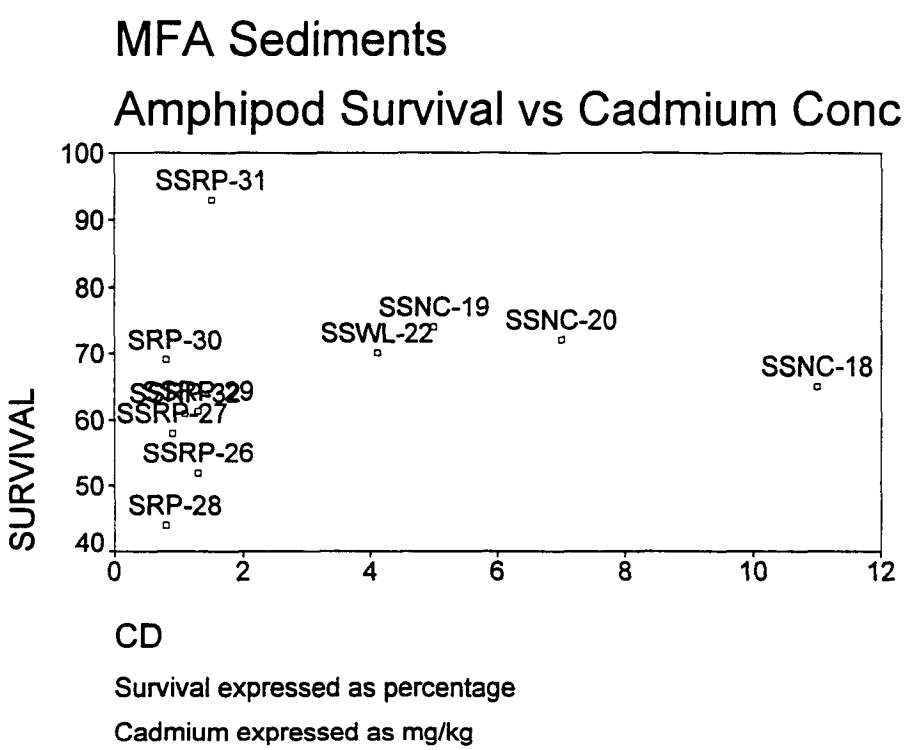
*. Correlation is significant at the .05 level (2-tailed).

**. Correlation is significant at the .01 level (2-tailed).

ATTACHMENT 7

SCATTER PLOTS OF COPECS WITH SIGNIFICANT CORRELATION COEFFICIENTS

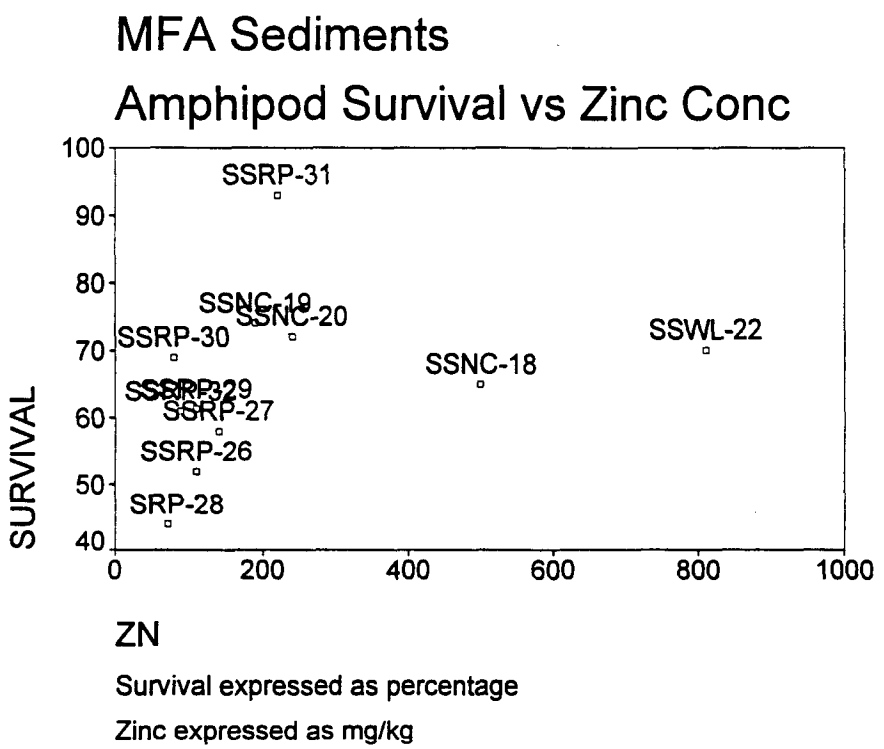
Graph



Survival expressed as percentage

Cadmium expressed as mg/kg

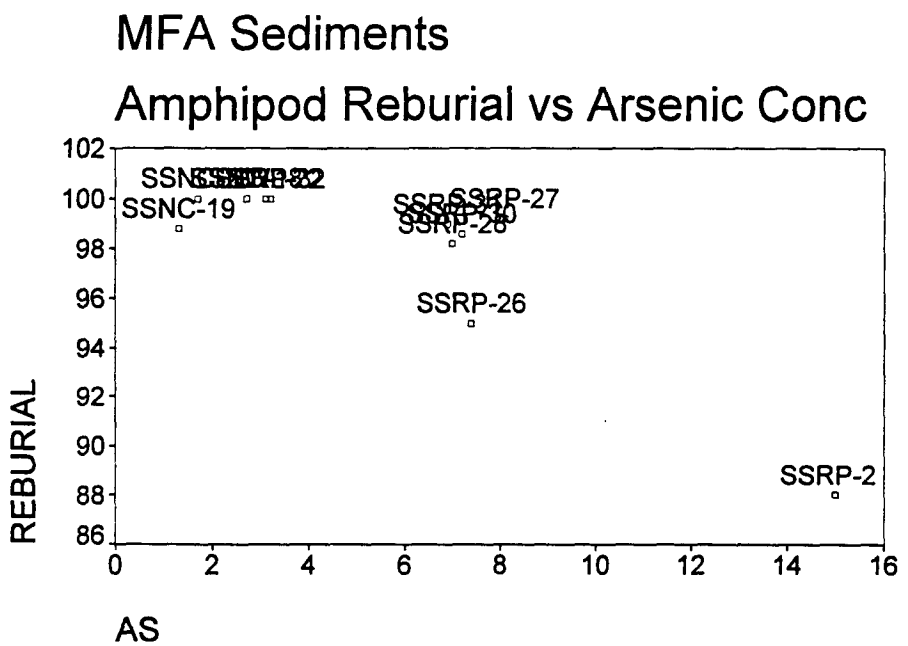
Graph



Survival expressed as percentage

Zinc expressed as mg/kg

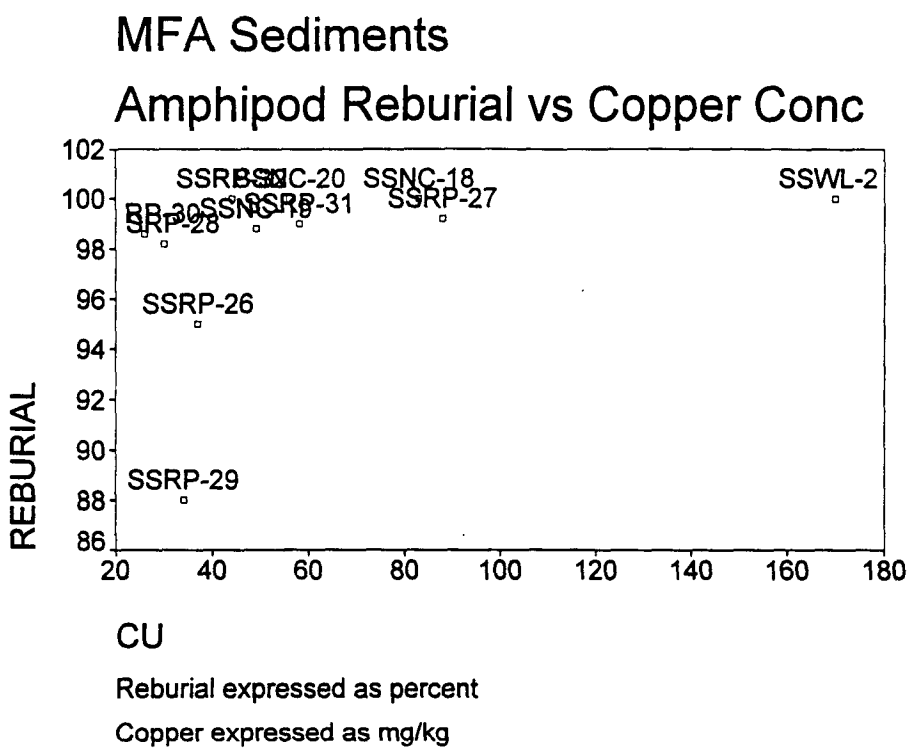
Graph



Reburial expressed as percent

Arsenic expressed as mg/kg

Graph



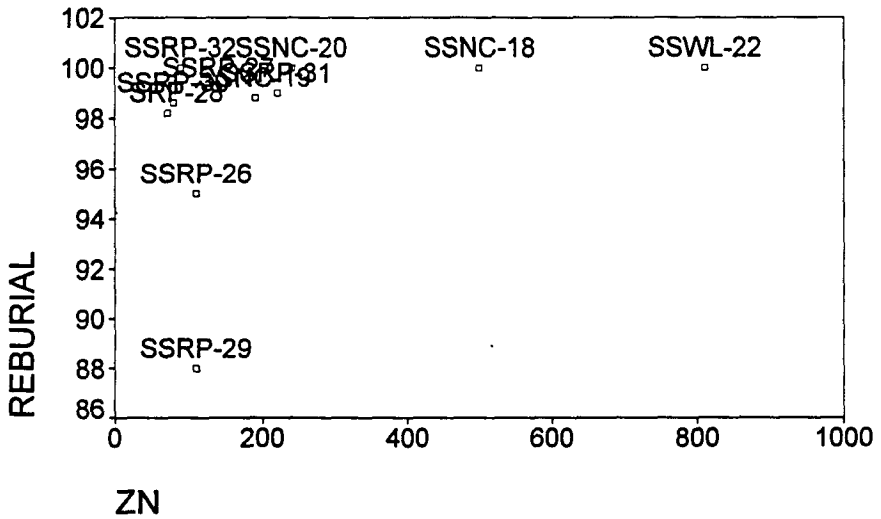
Reburial expressed as percent

Copper expressed as mg/kg

Graph

MFA Sediments

Amphipod Reburial vs Zinc Conc

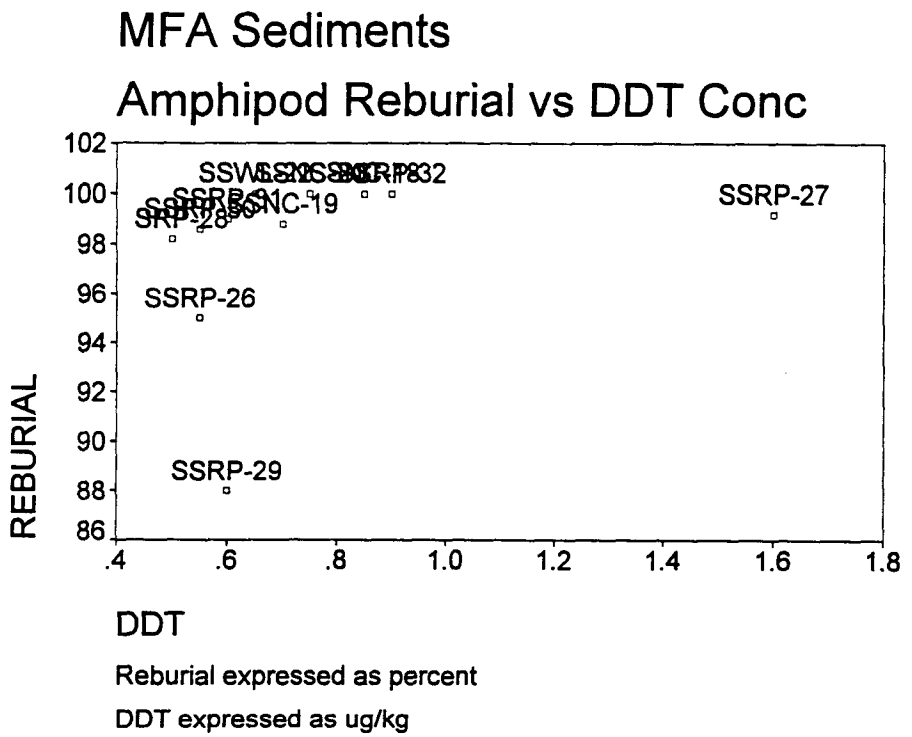


ZN

Reburial expressed as percentage

Zinc expressed as mg/kg

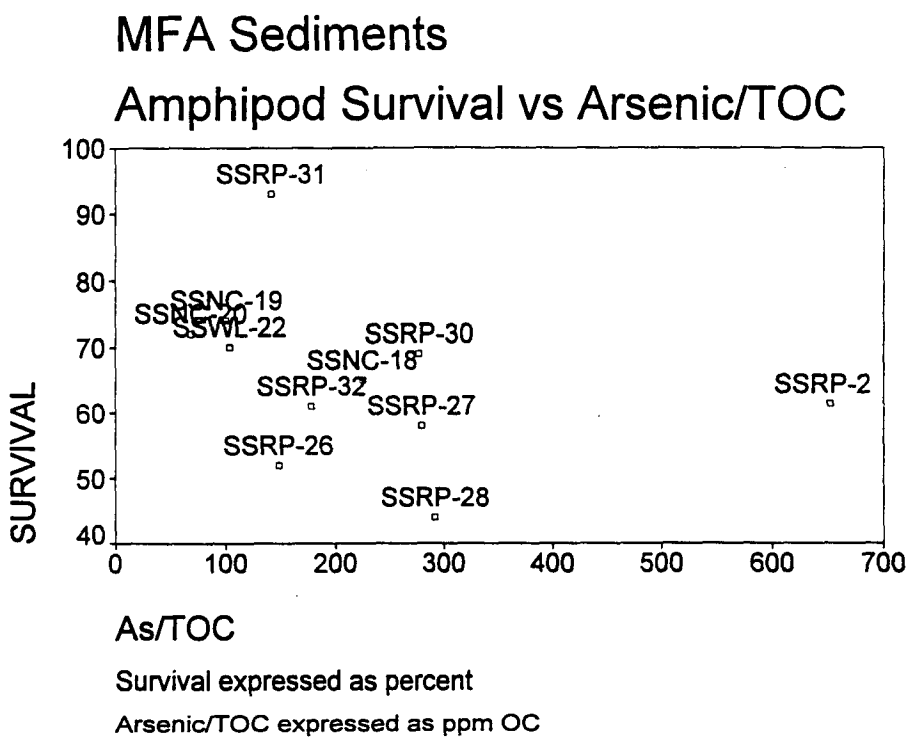
Graph



Reburial expressed as percent

DDT expressed as ug/kg

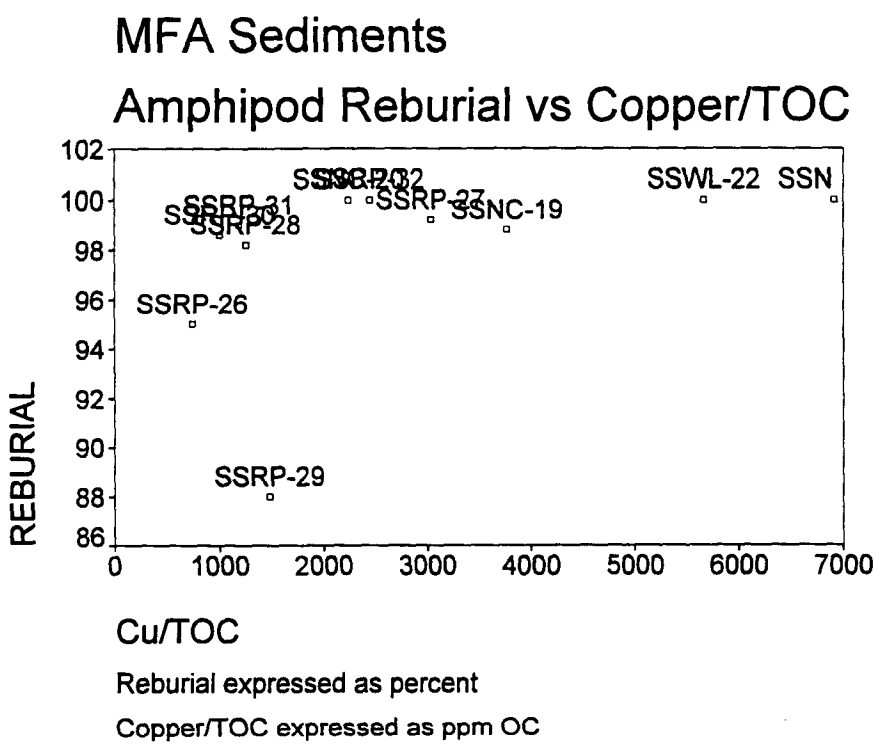
Graph



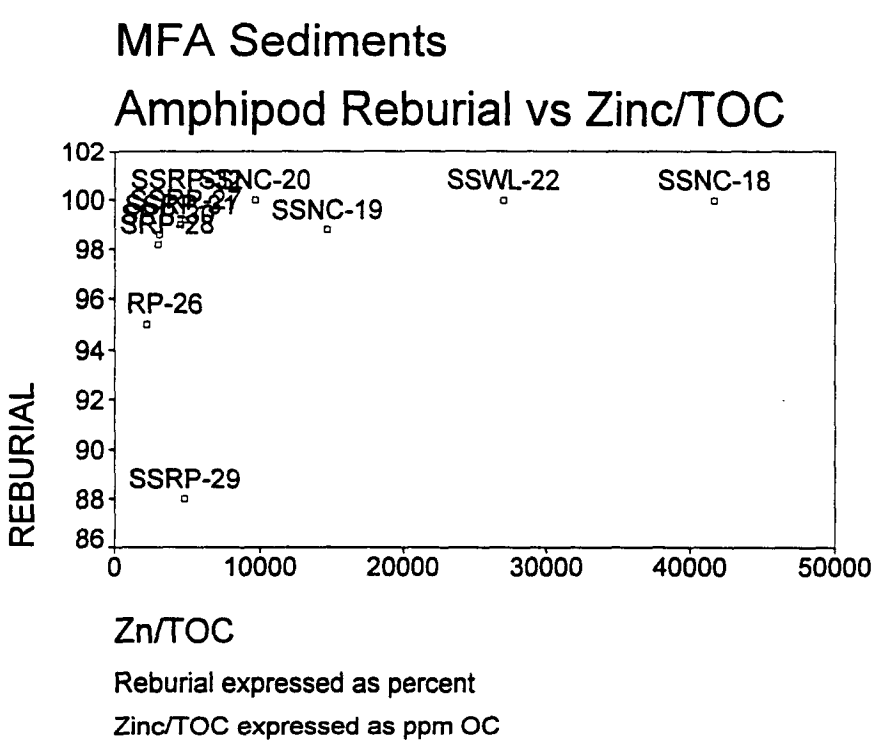
Survival expressed as percent

Arsenic/TOC expressed as ppm OC

Graph


MFA Sediments
Amphipod Reburial vs Copper/TOC
REBURIAL
102
100
98
96
94
92
90
88
86
0
1000
2000
3000
4000
5000
6000
7000
SSWL-22
SSN
SSNC-19
SSRP-26
SSRP-29
Cu/TOC
Reburial expressed as percent
Copper/TOC expressed as ppm OC

Graph



Reburial expressed as percent

Zinc/TOC expressed as ppm OC

The following technical memorandum addresses EPA's Specific Comment No. 16.

TECHNICAL MEMORANDUM

SUPPLEMENTAL ANALYSIS OF ECHINODERM DOSE-RESPONSE DATA FROM SEDIMENT PORE WATER TOXICITY TESTS AND CHEMICAL ANALYSES

The Navy computed lowest-observed-adverse-effect-levels (LOAEL) and no-observed-adverse-effect-levels (NOAEL) for chemical stressors based on data from two echinoderm sediment pore water toxicity tests (PWNC-18 and PWNC-19). The stressors include COPECs, ammonia, and sulfides. This information is presented in Section 9.2.5.3 of the Draft Final Phase II SWEA. The EPA has requested that dose-response curves be prepared to show, for sediment pore water, the relationship between echinoderm response (survival and development) and chemical stressor concentration. Note that the chemical concentration data were not collected from the bioassay samples per se; that is, chemistries were collected from one subsample and toxicity was measured in a sister subsample..

Dose-response line charts for samples PWNC-18 and PWNC-19 showing echinoderm percent survival and percent normal development plotted against chemical stressor concentration, as a function of test concentration, were prepared to visually depict the stressor concentrations at which echinoderm survival and development were adversely impacted. These charts are presented in Attachments 1 and 2. The two sets of stressor dose-response data were further evaluated to try to identify specific chemical stressors—COPECs as well as non-COPECs—that might be responsible for adverse effects observed in the echinoderm bioassays.

The shapes of the survival and normal development dose-response curves are very similar for each stressor, likely the result of the dilution series used in the toxicity tests. Echinoderm survivorship and development exhibit a precipitous reduction between two pore water test concentrations. The shapes of the curves probably would begin to differ if additional intermediate concentrations were tested, or if a different maximum concentration were tested. Regardless, the stressor concentration at which a precipitous drop in development and survival begins is the threshold concentration.

Listed below are the threshold concentrations for the stressors detected in the samples used in the two toxicity tests. The threshold concentrations represent "no effect" levels for normal development.

Stressor Threshold Concentrations for Normal Development					
Stressor	PWNC-19 Threshold Concentration (ug/L)	PWNC-18 Threshold Concentration (ug/L)	Stressor	PWNC-19 Threshold Concentration (ug/L)	PWNC-18 Threshold Concentration (ug/L)
Silver	0.09	0.63	Selenium	0.31	ND
Ammonia	1188	1,581	Sulfide	5,688	4,080
Cadmium	0.04	0.34	Zinc	3.75	34.0
Chromium	1.31	9.18	Antimony	ND	0.51
Copper	6.25	10.20	PCB 1254	ND	0.15
Manganese	75.0	425	PCB 1260	ND	0.14
Mercury	0.005	0.03	Arsenic	ND	0.34
Nickel	1.19	3.06	TPH-Diesel	ND	146.2
Lead	1.31	6.97	TPH-Motor Oil	ND	799

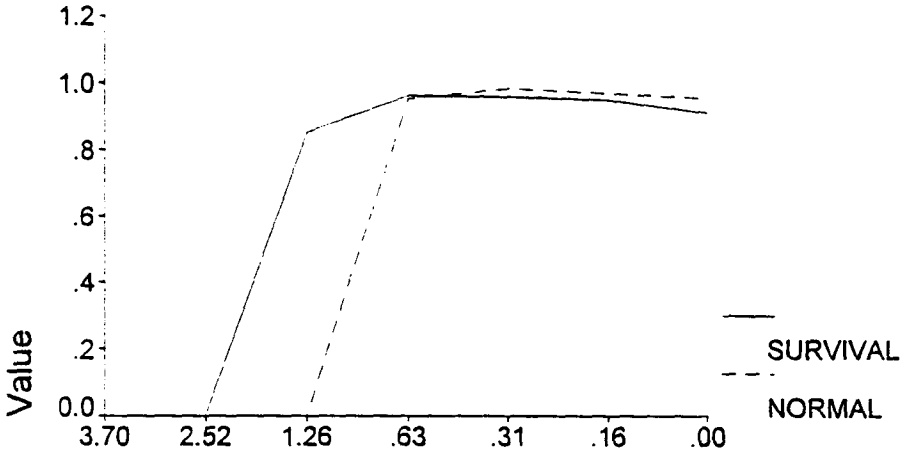
All of the PWNC-18 stressor threshold concentrations, except one, exceed the respective threshold concentrations for PWNC-19 stressors. Because the PWNC-18 stressor threshold concentrations for normal development generally exceed those in PWNC-19, they can be inferred to represent "no effect" levels. From this information, one may further infer about the identity of stressors in PWNC-19 which might not be responsible for adverse effects to the echinoderm—to narrow down the candidate stressors. For example, the threshold concentration for silver in PWNC-18 equals 0.63 ug/L (that is, the echinoderm was not adversely affected at this concentration). Because 0.63 ug/L exceeds 0.09 ug/L--the threshold concentration for silver in PWNC-19--silver probably was not responsible for adverse effects in PWNC-19. This holds true for cadmium, chromium, manganese, nickel, lead, and zinc in PWNC-19—that is, these COPECs likely are not responsible for adverse effect. The stressors remaining include ammonia, copper, mercury, and sulfides. This approach is not applicable to selenium, which was not detected in PWNC-18. For ammonia, copper, and sulfides, the threshold concentrations in each sample are within 40 percent. For mercury, the threshold concentrations differ by 500 percent; however, the low concentrations may reduce the significance of the difference, if any.

ATTACHMENT 1

DOSE-RESPONSE CURVES FOR STRESSORS DETECTED IN PWNC-18

PWNC-18

Echinoderm response vs Ag Conc



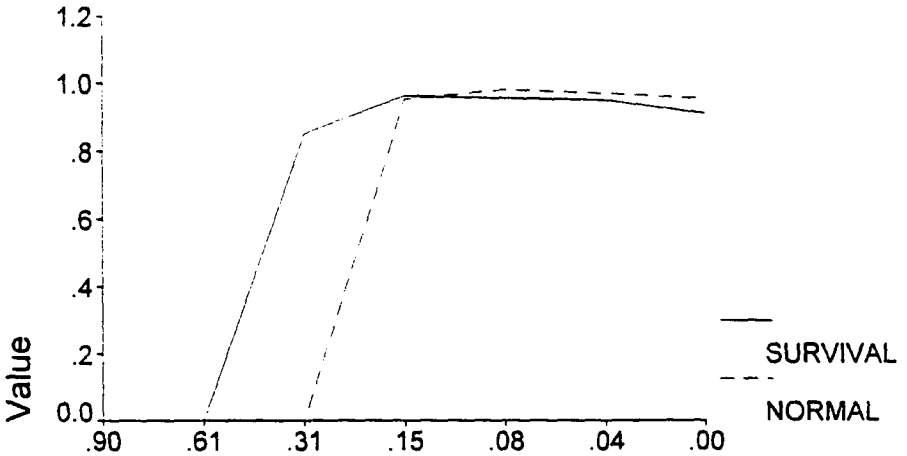
AG

Values for survival and normal development expressed as percent

Silver conc (ug/L) estimated from dilution series

PWNC-18

Echinoderm response vs Aroc 1254 C



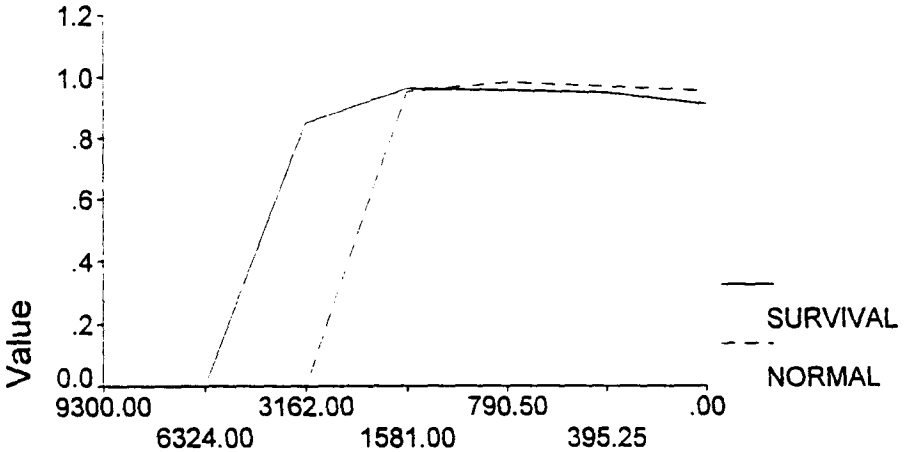
AROC1254

Values for survival and normal development expressed as percent

Aroclor 12 conc (ug/L) estimated from dilution series

PWNC-18

Echinoderm response vs NH3 Conc



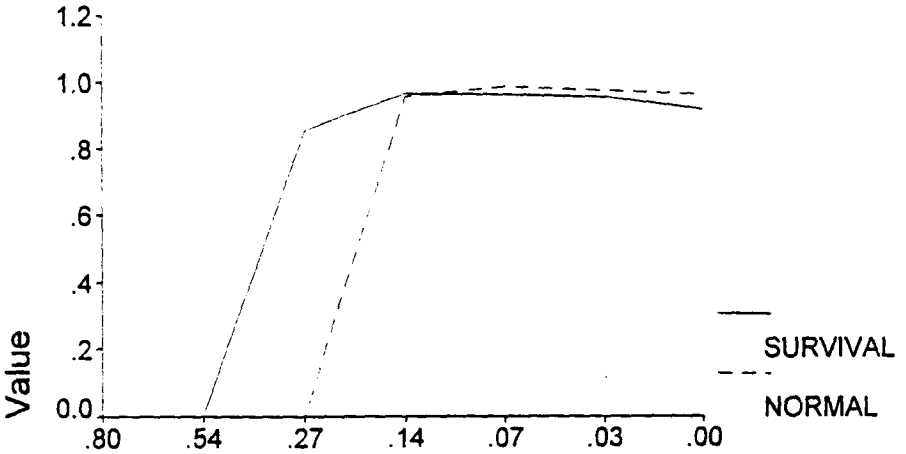
AMMONIA

Values for survival and normal development expressed as percent

Total ammonia conc (ug/L) estimated from dilution series

PWNC-18

Echinoderm response vs Aroc 1260 C



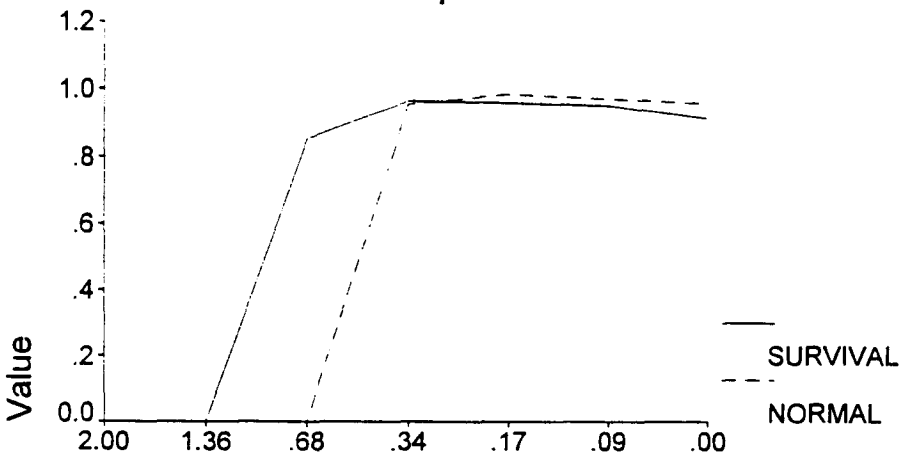
AROC1260

Values for survival and normal development expressed as percent

Aroclor 1260 conc (ug/L) estimated from dilution series

PWNC-18

Echinoderm response vs As Conc



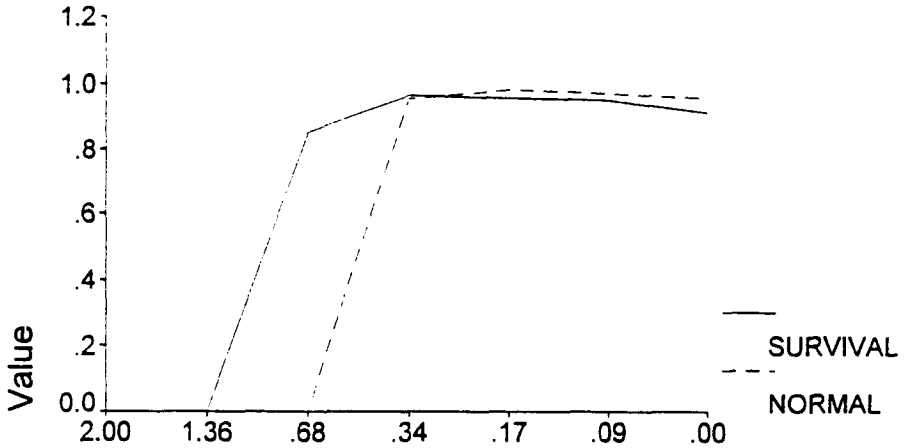
AS

Values for survival and normal development expressed as percent

Arsenic conc (ug/L) estimated from dilution series

PWNC-18

Echinoderm Response vs Cd Conc



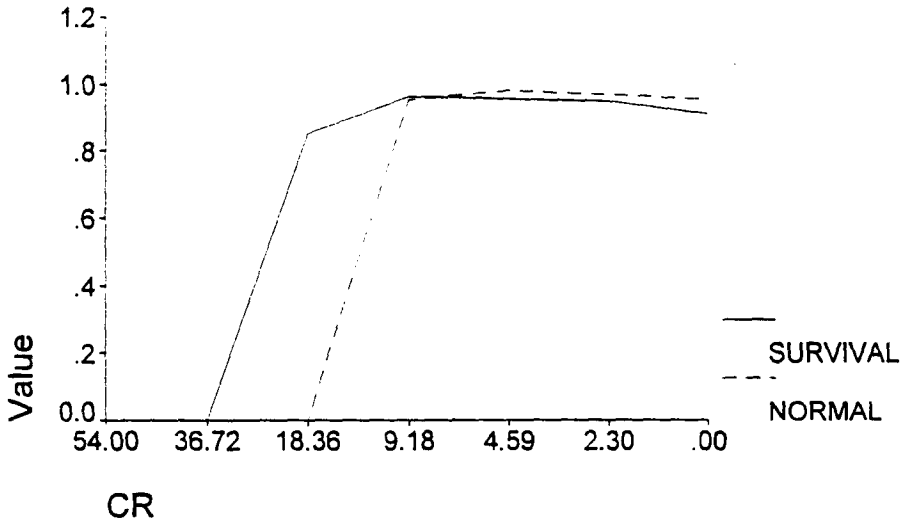
CD

Values for survival and normal development expressed as percent

Cadmium conc (ug/L) estimated from dilution series

PWNC-18

Echinoderm Response vs Cr Conc

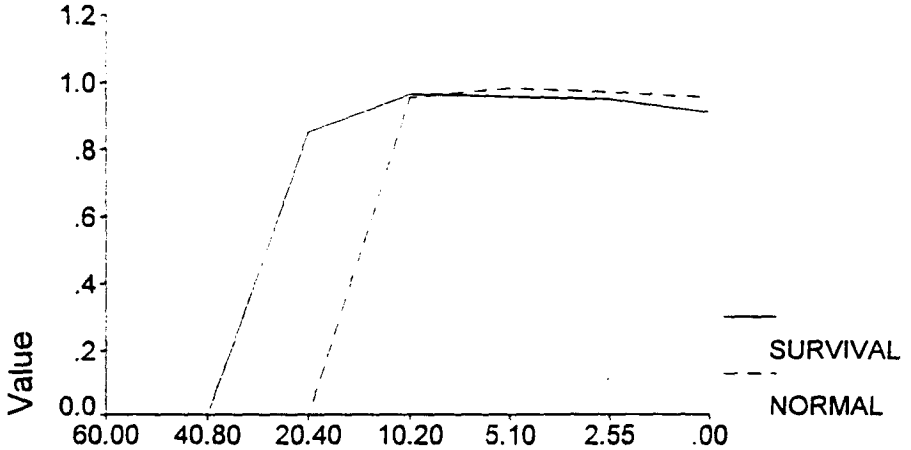


Values for survival and normal development expressed as percent

Chromium conc (ug/L) estimated from dilution series

PWNC-18

Echinoderm Response vs Cu Conc



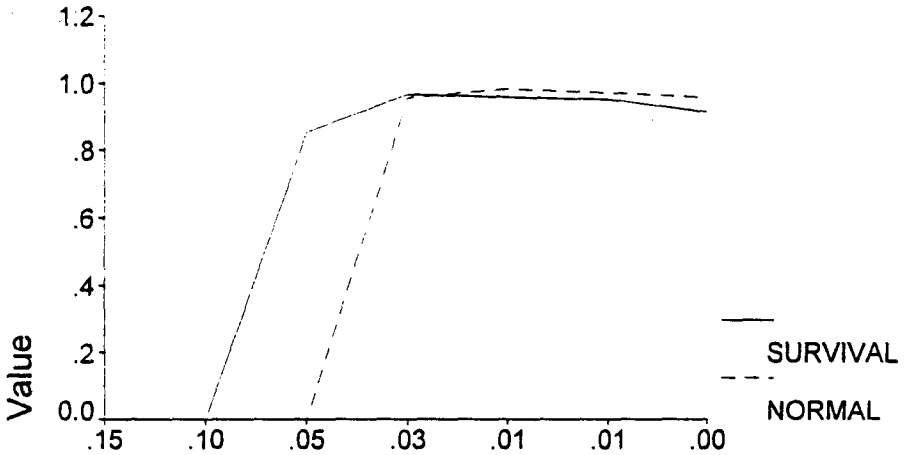
CU

Values for survival and normal development expressed as percent

Copper conc (ug/L) estimated from dilution series

PWNC-18

Echinoderm Response vs Hg Conc



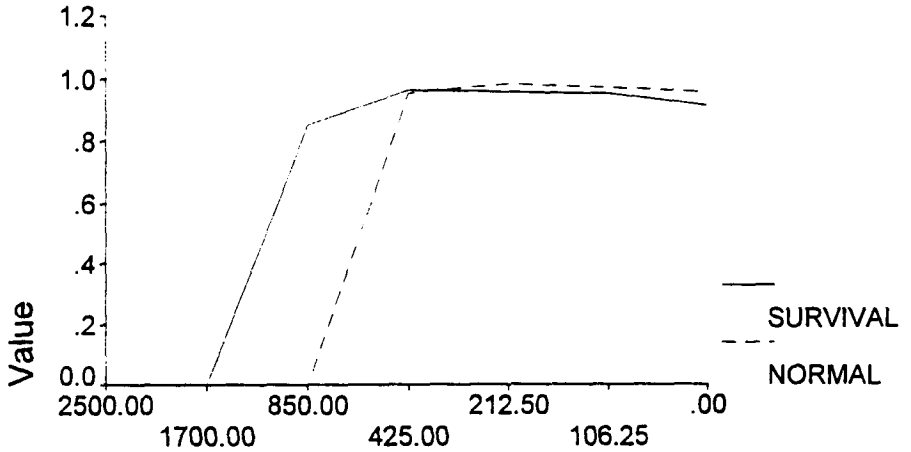
HG

Values for survival and normal development expressed as percent

Mercury conc (ug/L) estimated from dilution series

PWNC-18

Echinoderm Response vs Mn Conc



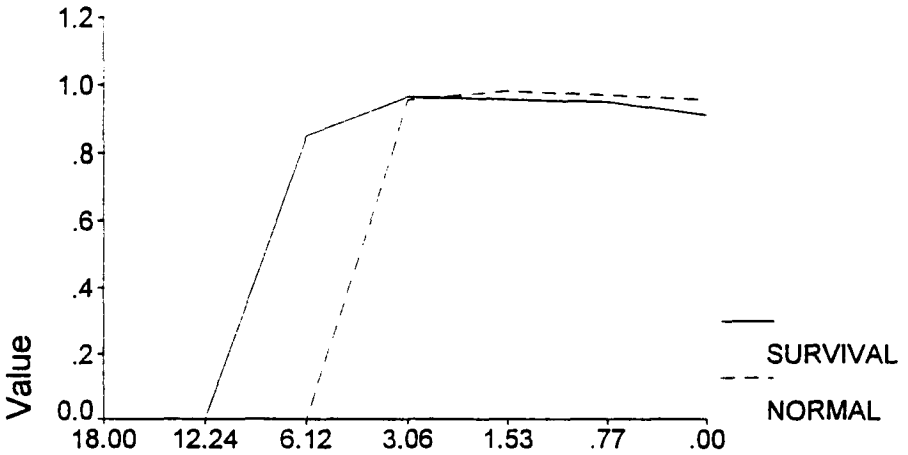
MN

Values for survival and normal development expressed as percent

Manganese conc (ug/L) estimated from dilution series

PWNC-18

Echinoderm Response vs Ni Conc



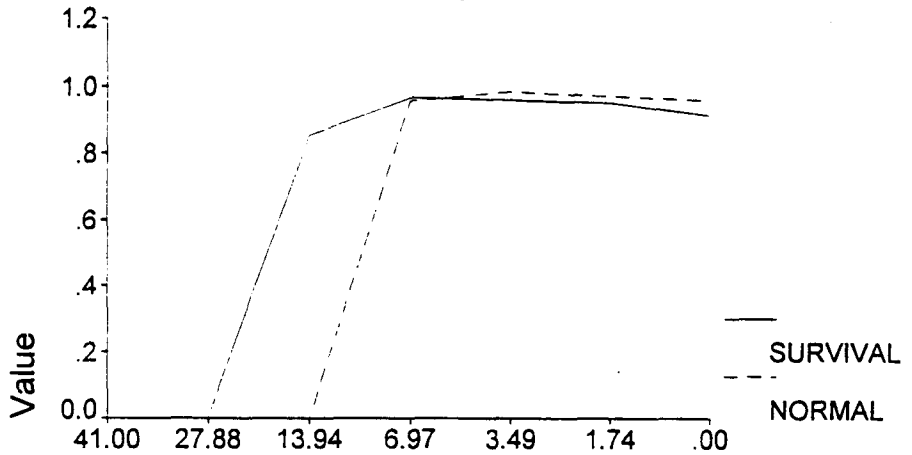
NI

Values for survival and normal development expressed as percent

Nickel conc (ug/L) estimated from dilution series

PWNC-18

Echinoderm Response vs Pb Conc



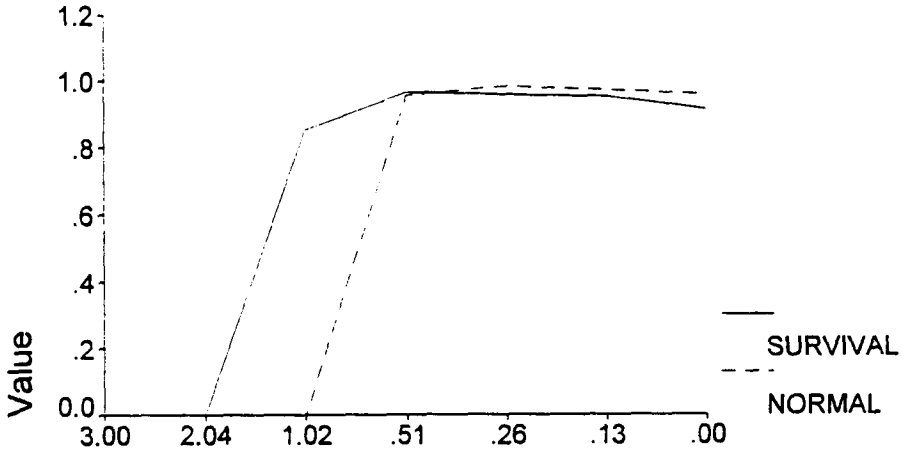
PB

Values for survival and normal development expressed as percent

Lead conc (ug/L) estimated from dilution series

PWNC-18

Echinoderm Response vs Sb Conc



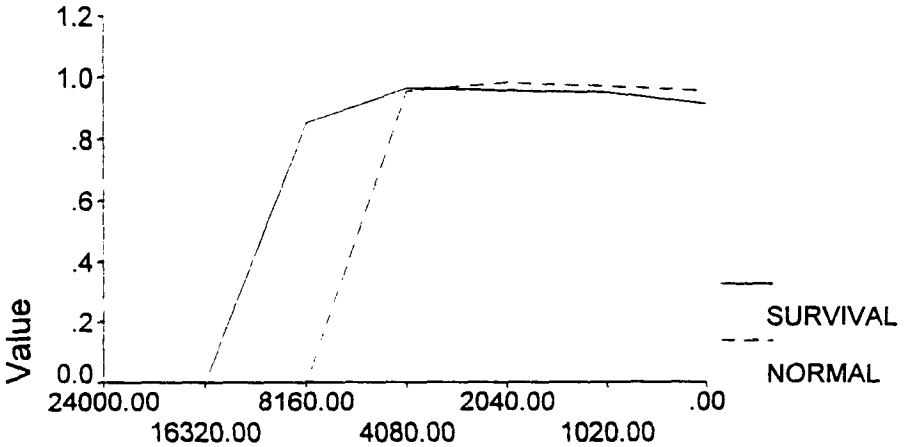
SB

Values for survival and normal development expressed as percent

Antimony conc (ug/L) estimated from dilution series

PWNC-18

Echinoderm Response vs Sulfide Con



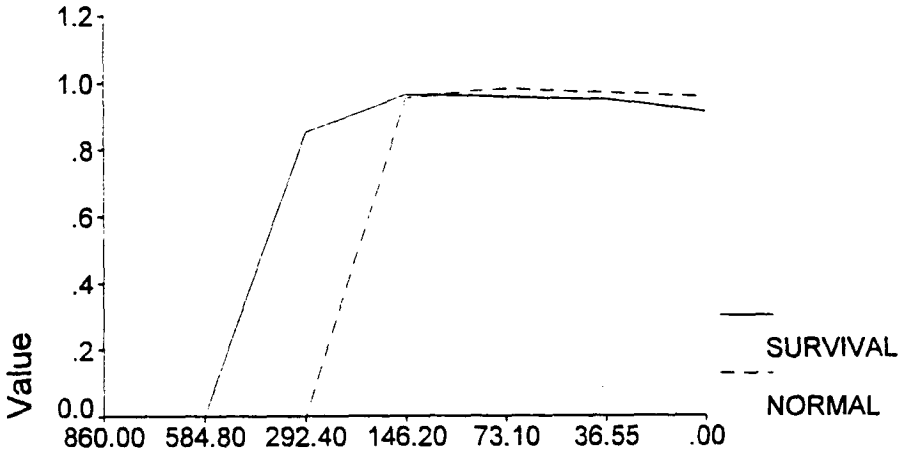
SULFIDE

Values for survival and normal development expressed as percent

Sulfide conc (ug/L) estimated from dilution series

PWNC-18

Echinoderm Response vs TPH-D Con



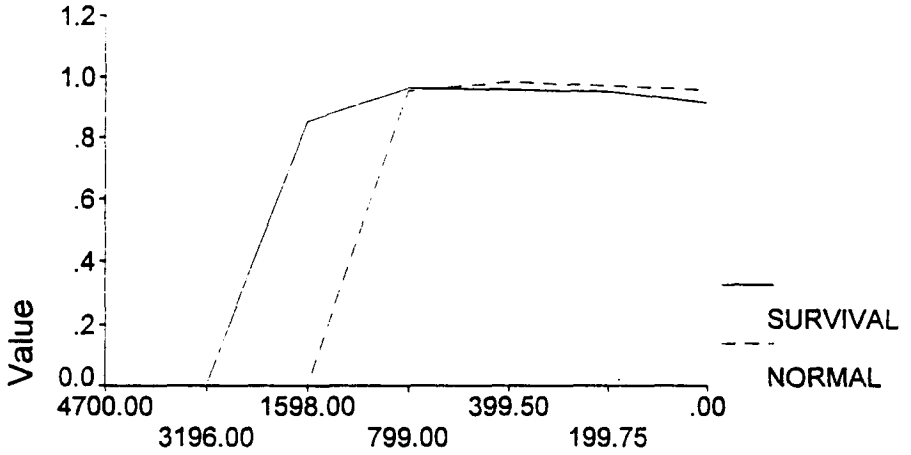
TPH_D

Values for survival and normal development expressed as percent

TPH-Diesel conc (ug/L) estimated from dilution series

PWNC-18

Echinoderm Response vs TPH-MO Co



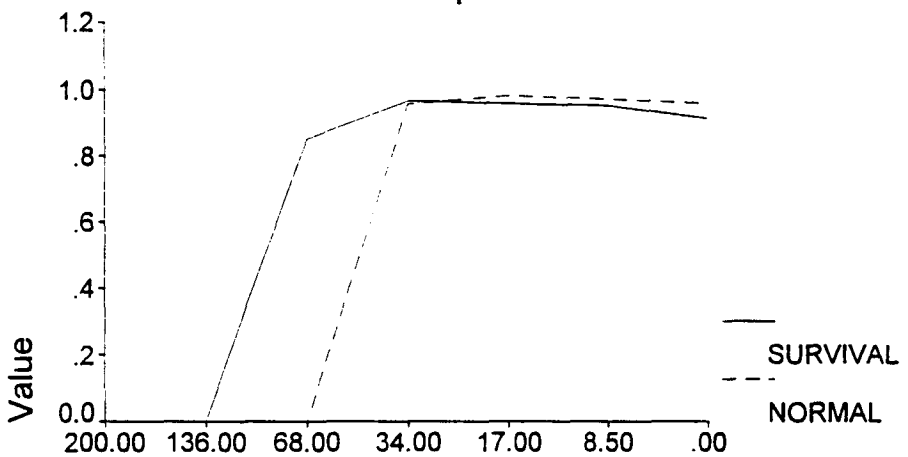
TPH_MO

Values for survival and normal development expressed as percent

TPH-Motor Oil conc (ug/L) estimated from dilution series

PWNC-18

Echinoderm Response vs Zn Conc



ZN

Values for survival and normal development expressed as percent

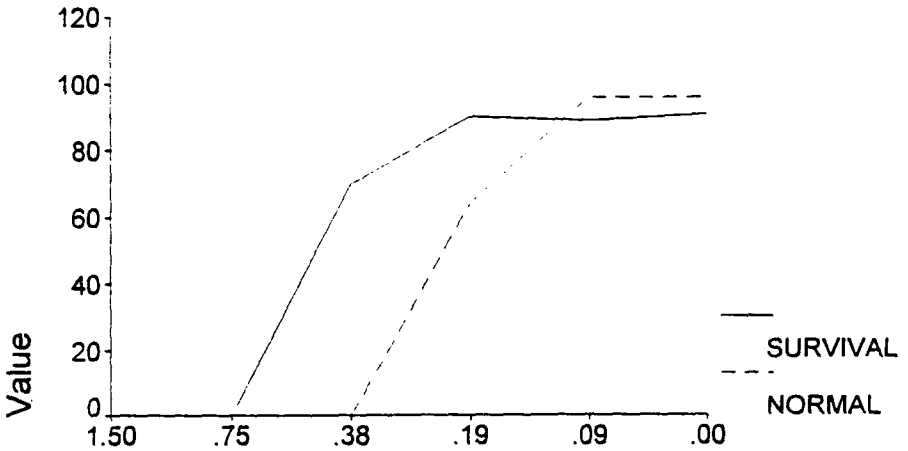
Zinc conc (ug/L) estimated from dilution series

ATTACHMENT 2

DOSE-RESPONSE CURVES FOR STRESSORS DETECTED IN PWNC-19

PWNC-19

Echinoderm Response vs Ag Conc



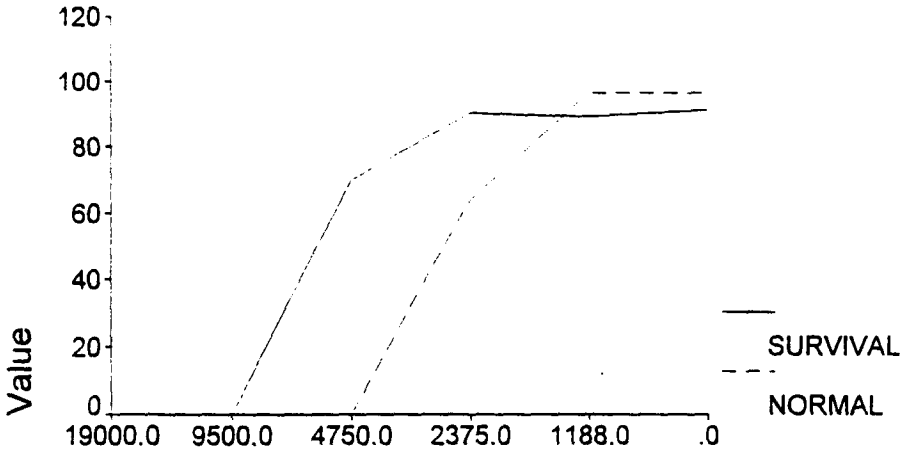
AG

Values for survival and normal development expressed as percent

Silver conc (ug/L) estimated from dilution series

PWNC-19

Echinoderm Response vs NH3 Conc



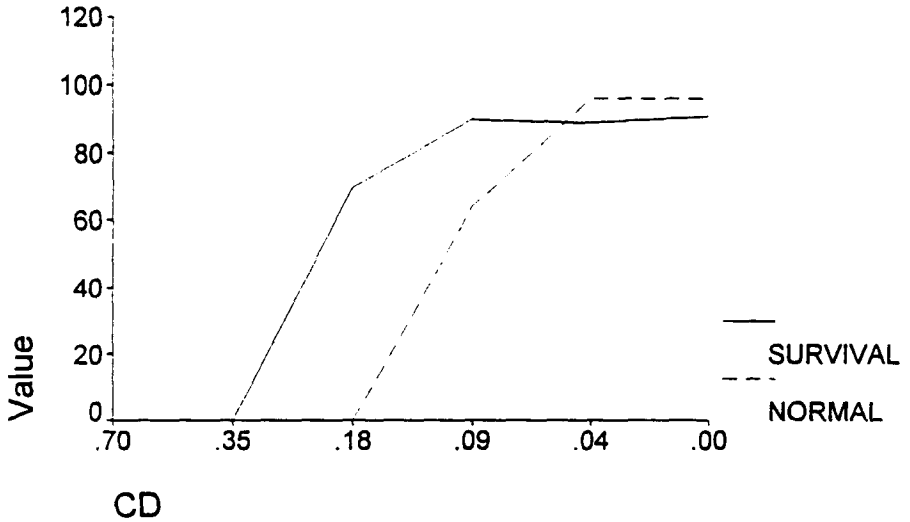
AMMONIA

Values for survival and normal development expressed as percent

Total ammonia conc (ug/L) estimated from dilution series

PWNC-19

Echinoderm Response vs Cd Conc

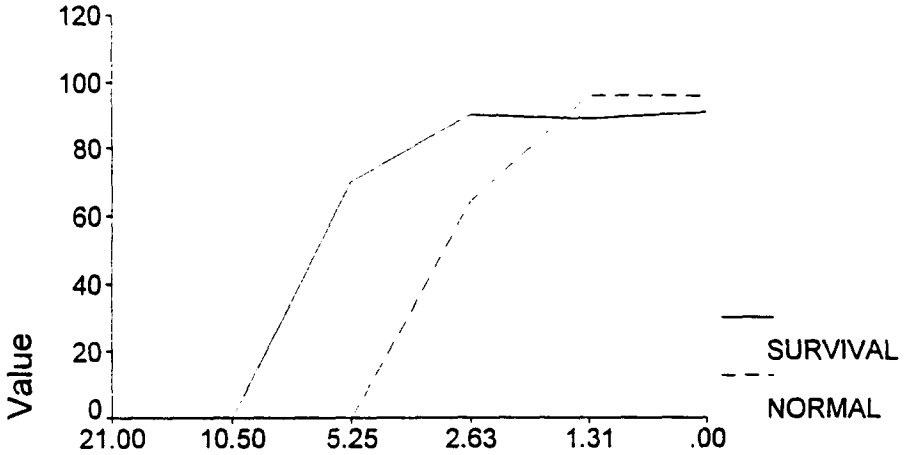


Values for survival and normal development expressed as percent

Cadmium conc (ug/L) estimated from dilution series

PWNC-19

Echinoderm Response vs Cr Conc



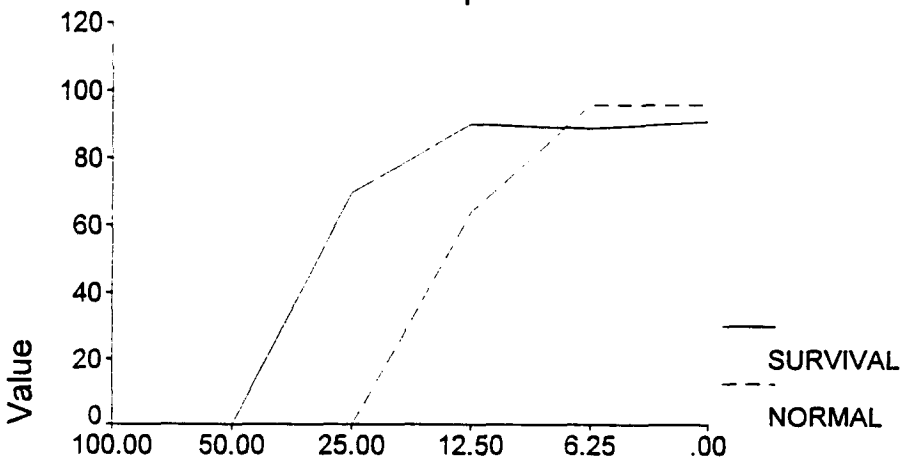
CR

Values for survival and normal development expressed as percent

Chromium conc (ug/L) estimated from dilution series

PWNC-19

Echinoderm Response vs Cu Conc



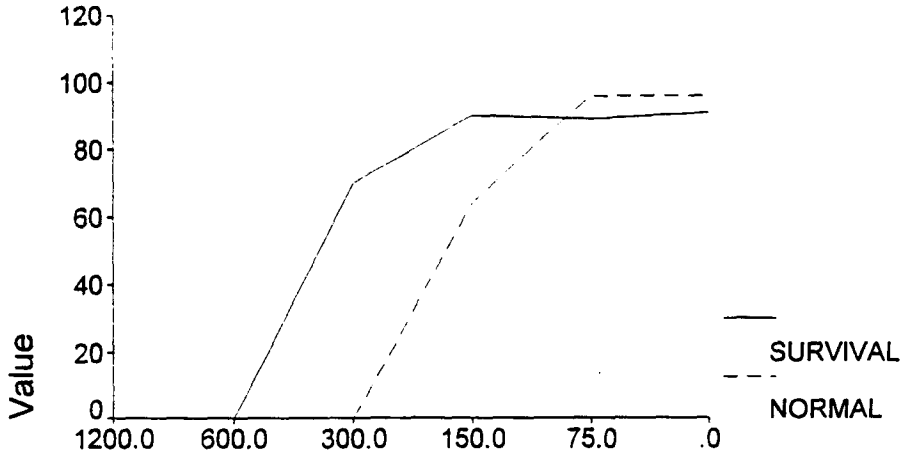
CU

Values for survival and normal development expressed as percent

Copper conc (ug/L) estimated from dilution series

PWNC-19

Echinoderm Response vs Mn Conc



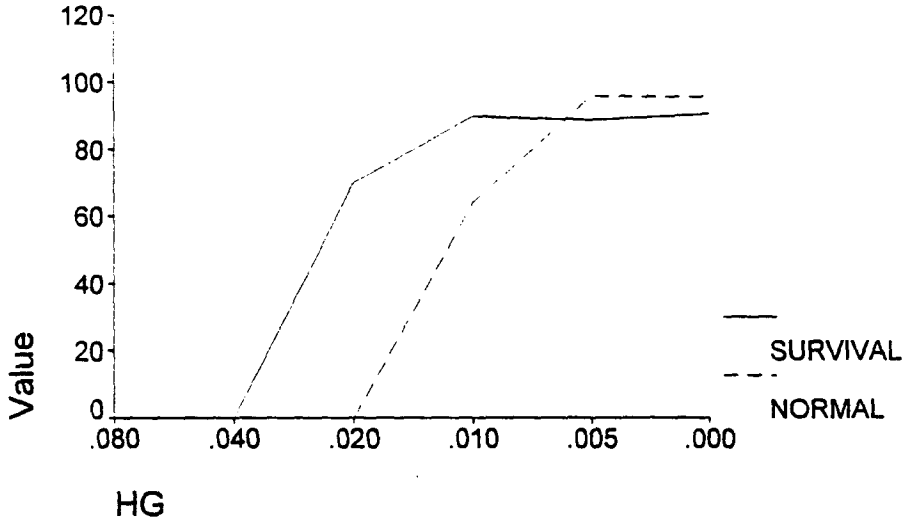
MN

Values for survival and normal development expressed as percent

Manganese conc (ug/L) estimated from dilution series

PWNC-19

Echinoderm Response vs Hg Conc

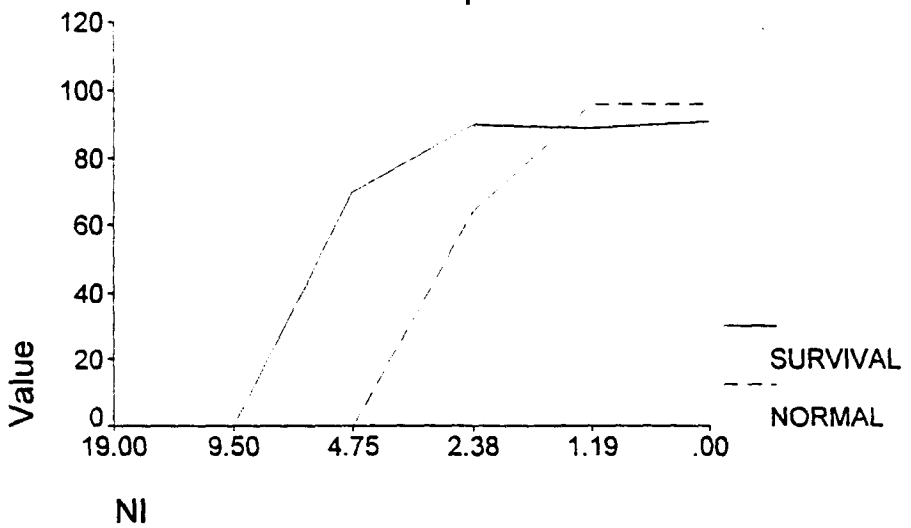


Values for survival and normal development expressed as percent

Mercury conc (ug/L) estimated from dilution series

PWNC-19

Echinoderm Response vs Ni Conc

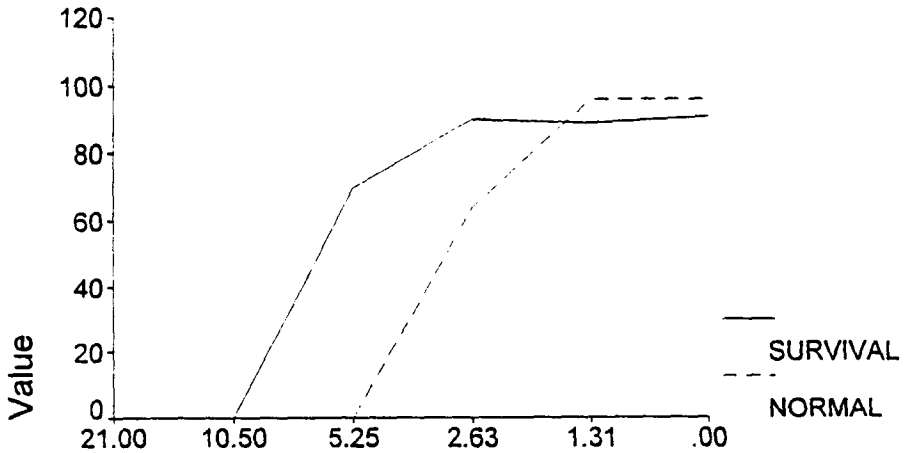


Values for survival and normal development expressed as percent

Nickel conc (ug/L) estimated from dilution series

PWNC-19

Echinoderm Response vs Pb Conc



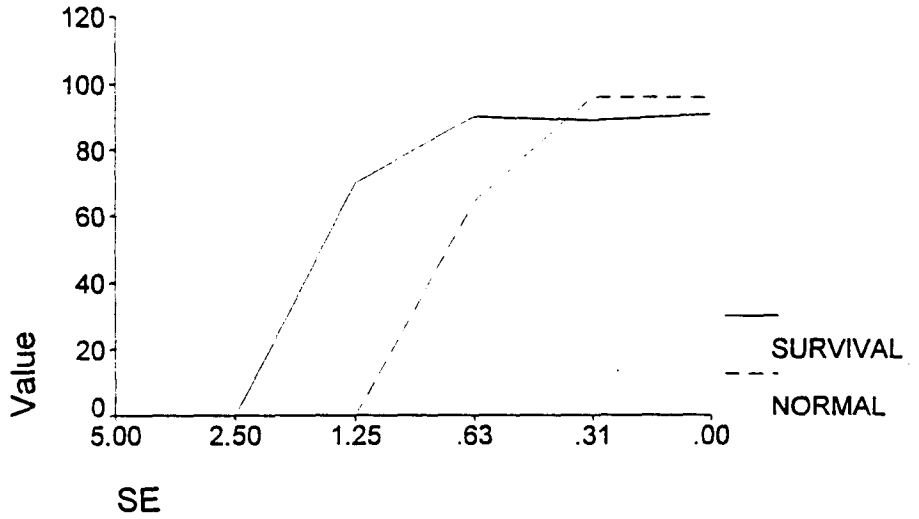
PB

Values for survival and normal development expressed as percent

Lead conc (ug/L) estimated from dilution series

PWNC-19

Echinoderm Response vs Se Conc

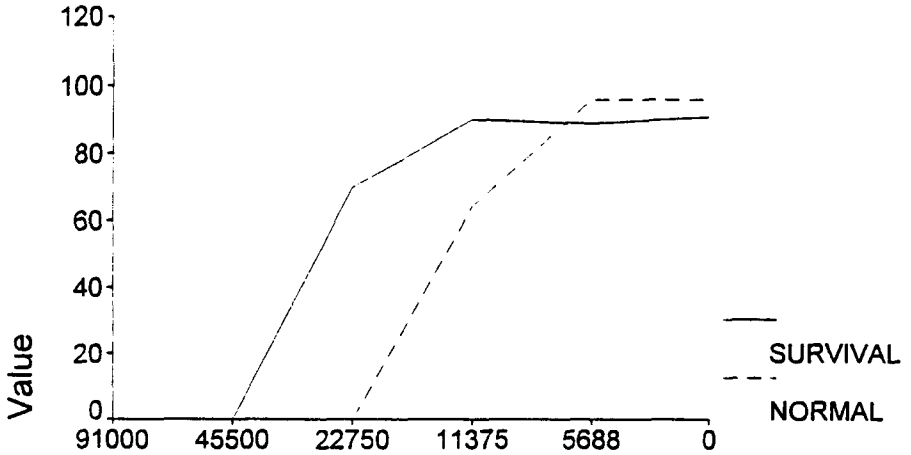


Values for survival and normal development expressed as percent

Selenium conc (ug/L) estimated from dilution series

PWNC-19

Echinoderm Response vs Sulfide Con



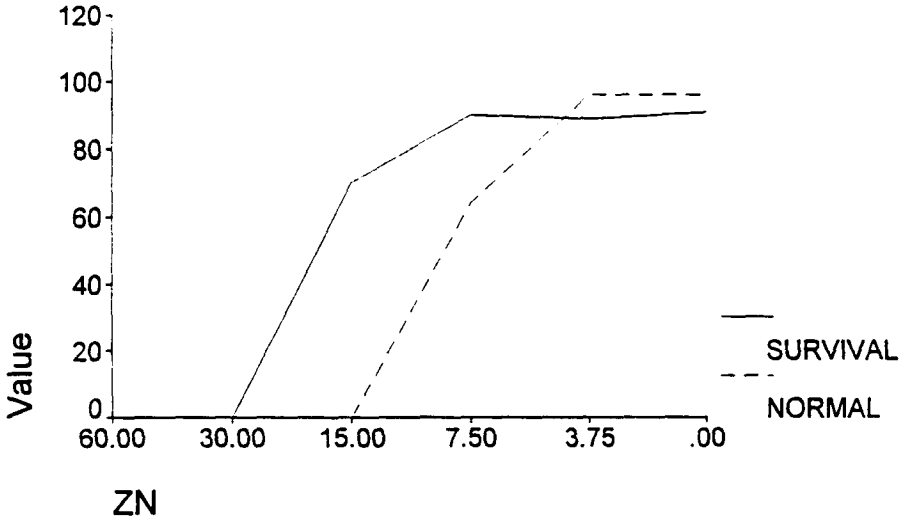
SULFIDE

Values for survival and normal development expressed as percent

Sulfide conc (ug/L) estimated from dilution series

PWNC-19

Echinoderm Response vs Zn Conc



Values for survival and normal development expressed as percent

Zinc conc (ug/L) estimated from dilution series

The following technical memorandum addresses EPA's Specific Comment No. 17.

Response to EPA Comment Number 17

Amphipod toxicity tests were performed on 10 bulk sediment samples collected from various stations at Moffett Federal Airfield. Amphipod survival responsed to exposures to the sediment. Amphipod reburial was an artifact (that is, reduced reburial was due to reduced survival). Therefore, no additional information is gained by analyzing the reburial data in addition to the survival data. Amphipod survival in sample number SSRP-31 was 93 percent. Data from other stations showing greater mortality were compared to the SSRP-31 data to determine if survival at the other stations was significantly lower than survival at SSRP-31.

Independent sample t tests were performed by comparing mean survival in SSRP-31 to mean survival in each of the other samples. Tests were performed at a 95 percent significance level. Significant differences in mean survival were determined by comparing the calculated t value with the tabular t value (one-tail) at 8 degrees of freedom, which equals 1.860 (Zar 1979). Tests were performed with the SPSS for Windows Release 6.0 (SPSS Inc. 1996).

The statistical tests demonstrated that amphipod survival in all other samples was significantly less than survival in SSRP-31. The salient information from the statistical tests is presented below. More detailed information may be found in the SPSS printouts from each comparison.

Sample	Survival		Computed t value[1]	Significance Level[2]	Significantly lower than survival in SSRP-31?
	Mean	Std Dev			
SSRP-31	93.0	7.58	—	—	—
SSNC-18	65.0	17.32	3.311	0.0055	Yes
SSNC-19	74.0	10.84	3.212	0.006	Yes
SSNC-20	72.0	13.51	3.031	0.008	Yes
SSRP-26	46.0	8.22	9.400	<0.001	Yes
SSRP-27	59.0	15.17	4.484	0.001	Yes
SSRP-28	44.0	10.84	8.283	<0.001	Yes
SSRP-29	50.0	32.21	2.906	0.01	Yes
SSRP-30	69.0	10.25	4.210	0.0015	Yes
SSWL-22	72.0	10.37	3.656	0.003	Yes

1 If the computed t value is greater than tabular t value of 1.860, then sample survival is statistically less than survival in SSRP-31.

2 The significance level is the probability of committing a Type II error. For example, for SSRP-31 vs SSNC-19, the probability that the difference between mean survival is due to randomness is less than 6 chances in 1,000. The significance value equals one-half the value of the two-tailed significance level listed in the sixth column of the Independent Samples Test tables that are attached (see SPSS printouts attached). One-half the value was taken because the value listed in the SPSS printouts is for a two-tailed test. The two-tail value is a default parameter for this particular statistical test with the SPSS software.

Two-sample t test on amphipod survival: SSRP-31 vs SSNC-18

Group Statistics

	GROUPVAR	N	Mean	Std. Deviation	Std. Error Mean
PERCSURV	31	5	93.000	7.583	3.391
	18	5	65.000	17.321	7.746

Independent Samples Test

		Levene's Test for Equality of Variances		t-test for Equality of Means				
		F	Sig.	t	df	Sig. (2-tailed)	Mean Difference	Std. Error Difference
PERCSURV	Equal variances assumed	4.711	.062	3.311	8	.011	28.000	8.456
	Equal variances not assumed			3.311	5.479	.019	28.000	8.456

Independent Samples Test

		t-test for Equality of Means	
		95% Confidence Interval of the Mean	
		Lower	Upper
PERCSURV	Equal variances assumed	8.501	47.499
	Equal variances not assumed	6.823	49.177

Two-sample t test on amphipod survival: SSRP-31 vs SSNC-19

Group Statistics

	GROUPVAR	N	Mean	Std. Deviation	Std. Error Mean
PERCSURV	31	5	93.000	7.583	3.391
	19	5	74.000	10.840	4.848

Independent Samples Test

		Levene's Test for Equality of Variances		t-test for Equality of Means				
		F	Sig.	t	df	Sig. (2-tailed)	Mean Difference	Std. Error Difference
PERCSURV	Equal variances assumed	2.178	.178	3.212	8	.012	19.000	5.916
	Equal variances not assumed			3.212	7.159	.014	19.000	5.916

Independent Samples Test

		t-test for Equality of Means	
		95% Confidence Interval of the Mean	
		Lower	Upper
PERCSURV	Equal variances assumed	5.357	32.643
	Equal variances not assumed	5.073	32.927

Two-sample t test on amphipod survival: SSRP-31 vs SSNC-20

Group Statistics

	GROUPVAR	N	Mean	Std. Deviation	Std. Error Mean
PERCSURV	31	5	93.000	7.583	3.391
	20	5	72.000	13.509	6.042

Independent Samples Test

		Levene's Test for Equality of Variances		t-test for Equality of Means				
		F	Sig.	t	df	Sig. (2-tailed)	Mean Difference	Std. Error Difference
PERCSURV	Equal variances assumed	6.563	.034	3.031	8	.016	21.000	6.928
	Equal variances not assumed			3.031	6.293	.022	21.000	6.928

Independent Samples Test

		t-test for Equality of Means	
		95% Confidence Interval of the Mean	
		Lower	Upper
PERCSURV	Equal variances assumed	5.024	36.976
	Equal variances not assumed	4.237	37.763

Two-sample t test on amphipod survival: SSRP-31 vs SSRP-26

Group Statistics

	GROUPVAR	N	Mean	Std. Deviation	Std. Error Mean
PERCSURV	31	5	93.000	7.583	3.391
	26	5	46.000	8.216	3.674

Independent Samples Test

		Levene's Test for Equality of Variances		t-test for Equality of Means				
		F	Sig.	t	df	Sig. (2-tailed)	Mean Difference	Std. Error Difference
PERCSURV	Equal variances assumed	.050	.829	9.400	8	.000	47.000	5.000
	Equal variances not assumed			9.400	7.949	.000	47.000	5.000

Independent Samples Test

		t-test for Equality of Means	
		95% Confidence Interval of the Mean	
		Lower	Upper
PERCSURV	Equal variances assumed	35.470	58.530
	Equal variances not assumed	35.457	58.543

Two-sample t test on amphipod survival: SSRP-31 vs SSRP-27

Group Statistics

	GROUPVAR	N	Mean	Std. Deviation	Std. Error Mean
PERCSURV	31	5	93.000	7.583	3.391
	27	5	59.000	15.166	6.782

Independent Samples Test

		Levene's Test for Equality of Variances		t-test for Equality of Means				
		F	Sig.	t	df	Sig. (2-tailed)	Mean Difference	Std. Error Difference
PERCSURV	Equal variances assumed	6.502	.034	4.484	8	.002	34.000	7.583
	Equal variances not assumed			4.484	5.882	.004	34.000	7.583

Independent Samples Test

		t-test for Equality of Means	
		95% Confidence Interval of the Mean	
		Lower	Upper
PERCSURV	Equal variances assumed	16.514	51.486
	Equal variances not assumed	15.355	52.645

Two-sample t test on amphipod survival: SSRP-31 vs SSRP-28

Group Statistics

	GROUPVAR	N	Mean	Std. Deviation	Std. Error Mean
PERCSURV	31	5	93.000	7.583	3.391
	28	5	44.000	10.840	4.848

Independent Samples Test

		Levene's Test for Equality of Variances		t-test for Equality of Means				
		F	Sig.	t	df	Sig. (2-tailed)	Mean Difference	Std. Error Difference
PERCSURV	Equal variances assumed	1.067	.332	8.283	8	.000	49.000	5.916
	Equal variances not assumed			8.283	7.159	.000	49.000	5.916

Independent Samples Test

		t-test for Equality of Means	
		95% Confidence Interval of the Mean	
		Lower	Upper
PERCSURV	Equal variances assumed	35.357	62.643
	Equal variances not assumed	35.073	62.927

Two-sample t test on amphipod survival: SSRP-31 vs SSRP-29

Group Statistics

	GROUPVAR	N	Mean	Std. Deviation	Std. Error Mean
PERCSURV	31	5	93.000	7.583	3.391
	29	5	50.000	32.210	14.405

Independent Samples Test

		Levene's Test for Equality of Variances		t-test for Equality of Means				
		F	Sig.	t	df	Sig. (2-tailed)	Mean Difference	Std. Error Difference
PERCSURV	Equal variances assumed	4.783	.060	2.906	8	.020	43.000	14.799
	Equal variances not assumed			2.906	4.442	.039	43.000	14.799

Independent Samples Test

		t-test for Equality of Means	
		95% Confidence Interval of the Mean	
		Lower	Upper
PERCSURV	Equal variances assumed	8.874	77.126
	Equal variances not assumed	3.476	82.524

Two-sample t test on amphipod survival: SSRP-31 vs SSRP-30

Group Statistics

	GROUPVAR	N	Mean	Std. Deviation	Std. Error Mean
PERCSURV	31	5	93.000	7.583	3.391
	30	5	69.000	10.247	4.583

Independent Samples Test

		Levene's Test for Equality of Variances		t-test for Equality of Means				
		F	Sig.	t	df	Sig. (2-tailed)	Mean Difference	Std. Error Difference
PERCSURV	Equal variances assumed	.069	.800	4.210	8	.003	24.000	5.701
	Equal variances not assumed			4.210	7.370	.004	24.000	5.701

Independent Samples Test

		t-test for Equality of Means	
		95% Confidence Interval of the Mean	
		Lower	Upper
PERCSURV	Equal variances assumed	10.854	37.146
	Equal variances not assumed	10.656	37.344

Tso-sample t test on amphipod survival: SSRP-31 vs SSWL-22

Group Statistics

	GROUPVAR	N	Mean	Std. Deviation	Std. Error Mean
PERCSURV	31	5	93.000	7.583	3.391
	22	5	72.000	10.368	4.637

Independent Samples Test

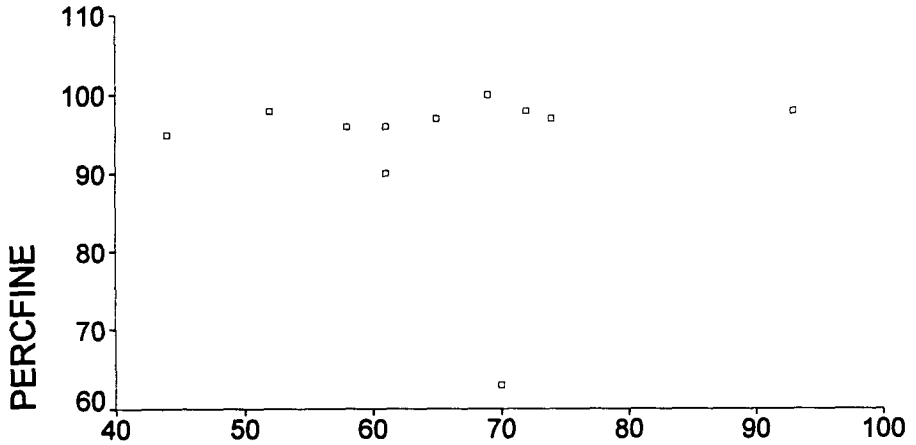
		Levene's Test for Equality of Variances		t-test for Equality of Means				
		F	Sig.	t	df	Sig. (2-tailed)	Mean Difference	Std. Error Difference
PERCSURV	Equal variances assumed	.781	.403	3.656	8	.006	21.000	5.745
	Equal variances not assumed			3.656	7.327	.007	21.000	5.745

Independent Samples Test

		t-test for Equality of Means	
		95% Confidence Interval of the Mean	
		Lower	Upper
PERCSURV	Equal variances assumed	7.753	34.247
	Equal variances not assumed	7.538	34.462

The following scatter plot and evaluation of amphipod survival and sediment grain size addresses EPA's Specific Comment No. 51. The scatter plot depicting amphipod survival as a function of grain size (as percent fines) indicates that percent fines in the amphipod bulk sediment toxicity tests did not influence amphipod response.

Moffett Federal Airfield--Bulk Sedimen
Amphipod Surv vs Grain Size



SURVIVAL

Survival expressed as percent

Grain size expressed as percent fines

The following discussion on the effect of petroleum and nonpetroleum hydrocarbons on echinoderms addresses the RWQCB's Specific Comment No. 9.

Effect of Petroleum and Non-petroleum Hydrocarbons on Echinoderms

Low levels of total petroleum hydrocarbon (as TPH-diesel and TPH-motor oil) were measured in sample number PWNC-18. The Navy reviewed the scientific literature for information of the aquatic toxicity of petroleum hydrocarbons to evaluate the likelihood that adverse responses by the echinoderm larvae may have been caused by diesel oil and motor oil. Information indicates that hazard is due to relatively low molecular weight aromatic constituents with some solubility in water. These generally include mono, di, and tricyclic structures. Information indicates that polycylic structures are relatively insoluble and would be strongly sorbed to the solid phase of the sediments.

The toxicity of water soluble components of petroleum hydrocarbons is relevant to the sediment pore water bioassays with the echinoderm larvae because pore water would contain the fraction of contaminants that are dissolved (soluble) in the sediments. In 1978, the U.S. Army issued the report entitled *Environmental Aspects of Diesel Fuels and Fog Oils SGF No. 1 and SGF No. 2 and Smoke Screens Generated From Them* (Liss-Suter and Villaume 1978). The authors reviewed literature on the acute toxicity of water soluble fractions (WSF) of No. 2 fuel oil to several marine and estuarine taxa. Among the studies, different exposure regimes were used, and the concentrations of petroleum hydrocarbons are expressed in many different ways. The toxicity information on polychaetes and sand dollars is expressed in terms that are relatively comparable to the data from the MFA sediment pore water toxicity tests. This information is discussed below.

Rossi, Anderson, and Ward (1976) evaluated the effect of the WSF of No. 2 fuel oil on mortality of the polychaete *Neanthes arenacoendentata*. They reported a 48-hour median tolerance limit of 3.2 mg/L total hydrocarbons, a concentration representing 37 percent of the WSF of a mixture of 1 part oil and 9 parts seawater.

Nicol and others (1977) evaluated the toxicity of the WSF of No. 2 fuel oil mixture (1 part oil:8 parts seawater) to the sand dollar, *Melitta quinquiesperforata* (Leske). The effect of the WSF on several sand dollar endpoints were evaluated, including sperm viability, egg permeability, fertilization, cleavage, and development of embryos. The authors reported that WSF concentrations exceeding 4 percent (4 parts WSF:96 parts seawater) reduced fertilization, adversely affected larval development, and reduced the number of larvae produced. The authors noted that di- and tricyclic aromatic hydrocarbons were detected in the WSF in concentrations greater than 0.1 mg/L, and they speculated that these compounds may be responsible for adverse effects.

This information indicates that low levels of petroleum hydrocarbons in the sediment pore water may adversely affect echinoderm survival and development. The likelihood of effects would depend on the specific petroleum hydrocarbons and their concentrations in the diesel oil and motor oil detected in sample PWNC-18.

References Cited

Liss-Suter, D., and J.E. Villaume. 1978. *Environmental Aspects of Diesel Fuels and Fog Oils SGF No. 1 and SGF No. 2 and Smoke Screens Generated From Them.* U.S. Army Medical Research and Development Command, Fort Detrick, Maryland. April.

Nicol, J.A.C., and others. 1977. "Chemical Composition and Effects of Water Extracts of petroleum on Eggs of the Sand Dollar *Melitta quinquiesperforata*. *Marine Biology*. Volume 40, Pages 309-316.

Rossi, S.S., J.W. Anderson, and G.S. Ward. 1976. "Toxicity of Water-Soluble Fractions of Four Test Oils for the Polychaetous Annelids, *Neanthes arenacoedentata* and *Capitella capitata*." *Environmental Pollution*. Volume 10, Pages 9-18.

The following technical memorandum addresses the RWQCB's Specific Comment No. 21.

Explanation of the rationale behind the equation used to identify risk drivers for sediments at Moffett Federal Airfield. .

The risk driver approach for sediment was implemented to identify a subset of chemicals likely responsible for most of the ecological risk of sediments. This step was necessary because there are 45 chemicals of potential ecological concern (COPECs) for sediments at MFA, most of them have been found in bulk sediment samples, and there was little information on which chemicals are more bioavailable. With this in mind, the risk driver approach was developed. This approach was not used for surface water because, compared to the sediments, relatively few COPECs were measured in surface water samples.

The risk driver equation computes scoring values for chemicals of potential ecological concern (COPEC) to identify COPECs responsible for most of the ecological risk. The equation was applied to benthic receptors in sediments in each of 4 areas: (1) ditches and channels, (2) eastern diked marsh, (3) western diked marsh, and (4) storm water retention ponds. However, it can be applied to any-sized area, depending on spatial coverage and resolution of sampling data.

The equation accounts for (1) the potential for exposure by a benthic receptor, (2) the potential to be adversely affected, and (3) the magnitude of adverse effect if exposure occurs. The application of the equation assumes that the sediment sampling data used in the MFA SWEA approximate the spatial distribution of chemicals and distribution of chemical concentrations in the 4 areas.

The equation is as follows:

$$\text{Risk scoring value} = (FD) \times (FHQ>1) \times (RMHQ)$$

where, FD = COPEC frequency of detection
FHQ>1 = fraction of HQ values equal to or greater than 1
RMHQ = reasonable maximum HQ value

Frequency of detection is an estimate of the likelihood that a benthic receptor will contact a COPC. The fraction of HQ ≥ 1 is an estimate of the likelihood that a benthic receptor may be adversely affected if contact occurs between a receptor and a COPC. The product of these two terms is an estimate of the potential for a benthic receptor to be adversely affected by a COPC. The maximum HQ value is an estimate of the severity of adverse effect that may occur if a benthic receptor is exposed to a COPEC.

There are 2 major uncertainties associated with the use of this equation. The first is whether the COPECs are bioavailable. COPECs detected in pore water samples provide some insight into which COPECs might be bioavailable--these include mainly metals, and some low levels of PCBs and TPH compounds. The second uncertainty is due to the biased sampling design, which focused on areas of suspected contamination.