

Summary of Literature-Derived Invertebrate Tissue Toxicity Data for the Baseline Ecological Risk Assessment

Halaco Superfund Site, Oxnard, California

Remedial Investigation

Prepared for
U.S. Environmental Protection Agency
Region 9



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CH2MHILL®

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Acronyms and Abbreviations

BERA	baseline ecological risk assessment
Halaco	Halaco Engineering Co.
LOEC	lowest observed effects concentration
NOEC	no observed effects concentration
Site	Halaco Engineering Co. Superfund Site

Summary of Literature-Derived Invertebrate Tissue Toxicity Data

F.1 Objectives

Whole-body invertebrate tissue benchmarks were developed for metals and dioxins and furans as available data supported. Studies that reported invertebrate tissue levels associated with no and lowest adverse effects to survival, reproduction, or growth were extracted from a data compilation titled *Linkage of effects to tissue residues: development of a comprehensive database for aquatic organisms exposed to inorganic and organic chemicals* (Jarvinen and Ankley, 1999). Original literature was not reviewed and all values selected represent those presented in Jarvinen and Ankley (1999). Tissue effects data were available for arsenic, cadmium, chromium, copper, lead, mercury, selenium, zinc, and dioxin/furans. These data are presented in Tables F-1 through F-9.

For each analyte with data, the invertebrate test species were categorized to best represent the taxa collected at the Halaco Engineering Co. Superfund Site (Halaco Site, or Site). For example, a midge test species was classified as an arthropod and an insect (Table F-2). The lowest value among the lowest observed effects concentrations (LOECs) for a taxa category was selected as the baseline ecological risk assessment (BERA) LOEC for that group. When possible, the no observed effects concentration (NOEC) of the same study was selected as the BERA NOEC. If a NOEC for the same study was not available, the highest NOEC below the lowest LOEC was selected as the BERA NOEC. The highlighted studies in Tables F-1 through F-9 were selected as representative NOEC and LOEC values for use in the BERA. A summary of the selected studies and the Halaco tissues most similar to the test species is shown in Table F-10.

F.2 References

Jarvinen, A.W. and G.T. Ankley. 1999. "Linkage of effects to tissue residues: development of a comprehensive database for aquatic organisms exposed to inorganic and organic chemicals." Society of Environmental Toxicology and Chemistry (SETAC). Pensacola, FL. 364 pp.

Tables

TABLE F-1

Whole-body Invertebrate Tissue Toxicity Data for Arsenic
Baseline Ecological Risk Assessment, Halaco Site, Oxnard, California

Chemical	Species	Species Type	Species Type2	Media	Life Stage	Test Site	Test Condition	Exposure Route	Exposure Concentration	Test Exp	Tissue	Result (µg/g)	Effect	Effect2	Reference*
Arsenic (Sodium arsenate)	Grass shrimp, Palaemonetes pugio (Sw)	Arthropod	Crustacean	Marine	Juvenile	Lab	Static aerated	Water	10 µg/L	28	Whole body	1.15	Growth - No effect	No	259
Arsenic (Sodium arsenate)	Grass shrimp, Palaemonetes pugio (Sw)	Arthropod	Crustacean	Marine	Juvenile	Lab	Static aerated	Water; Diet	10 µg/L; 17.2 µg/g	28	Whole body	1.28	Growth - No effect	No	259

Notes:

Shaded rows represent the benchmarks selected for use in the risk assessment.

All information presented in this table was extracted from Jarvinen and Ankley, 1999.

* For references, please see the Jarvinen and Ankley, 1999 paper.

Sw = saltwater

µg/L = micrograms per liter

µg/g = micrograms per gram

TABLE F-2

Whole-body Invertebrate Tissue Toxicity Data for Cadmium

Baseline Ecological Risk Assessment, Halaco Site, Oxnard, California

Chemical	Species	Species Type	Species Type2	Media	Life Stage	Test Site	Test Condition	Exposure Route	Exposure Concentration	Test Exp	Tissue	Result (µg/g)	Effect	Effect2	Effect3	Reference*	Comments
Cadmium (Cadmium chloride)	Snail, <i>Physa integra</i> (Fw)	Mollusc		Freshwater	6 - 15mm	Lab	Flow-through	Water	8.3 µg/L	28	Whole body	10	Survival - No effect	No		419	
Cadmium (Cadmium chloride)	Snail, <i>Helisoma</i> sp. (Fw)	Mollusc		Freshwater	Adult	Lab	Flow-through	Sediment	<1 mg/g	10	Whole body	78	Survival - No effect	No		77	
Cadmium (Cadmium chloride)	Snail, <i>Helisoma</i> sp. (Fw)	Mollusc		Freshwater	Adult	Lab	Flow-through	Water	0.144 mg/L	10	Whole body	90	Survival - No effect	No		77	
Cadmium (Cadmium chloride)	Snail, <i>Physa integra</i> (Fw)	Mollusc		Freshwater	6 - 15mm	Lab	Flow-through	Water	27.5 µg/L	28	Whole body	30	Survival - Reduced = 80%	Yes		419	
Cadmium (Cadmium chloride)	Snail, <i>Helisoma</i> sp. (Fw)	Mollusc		Freshwater	Adult	Lab	Flow-through	Water	0.278 mg/L	10	Whole body	125	Survival - Reduced 50%	Yes		77	Residues in surviving organisms
Cadmium (Cadmium chloride)	Sydney rock oyster, <i>Saccostrea commercialis</i> (Sw)	Mollusc		Marine	Adult	Lab	Flow-through	Water	10 µg/L	112	Whole body	25	Survival - No effect	No		479	
Cadmium	Mussel, <i>Mytilus galloprovincialis</i> (Sw)	Mollusc		Marine	Adult	Lab	Renewal, 1 - 2/d	Water	0.25 mg/L	30	Whole body	28.7	Survival - No effect	No		352	Radiotracer study
Cadmium	Mussel, <i>Mytilus galloprovincialis</i> (Sw)	Mollusc		Marine	Adult	Lab	Renewal, 1 - 2/d	Water	0.5 mg/L	33	Whole body	39	Survival - Reduced 90%	Yes		352	Radiotracer study; Residues in surviving organisms
Cadmium (Cadmium chloride)	Sydney rock oyster, <i>Saccostrea commercialis</i> (Sw)	Mollusc		Marine	Adult	Lab	Flow-through	Water	150 µg/L	112	Whole body	85	Survival-Reduced 100% in 28 d	Yes		479	
Cadmium (Cadmium chloride)	Sydney rock oyster, <i>Saccostrea commercialis</i> (Sw)	Mollusc		Marine	Adult	Lab	Flow-through	Water	25 µg/L	112	Whole body	48-72	Survival-Reduced 100% in 60 d	Yes		479	
Cadmium (Cadmium chloride)	Mayfly, <i>Hexagenia rigida</i> (Fw)	Arthropod	Insects	Freshwater	Nymph	Lab	Static, microcosm	Water	10 µg/L	15	Whole body	0.7	Survival, Growth - No effect	Survival	No	335	
Cadmium (Cadmium chloride)	Mayfly, <i>Hexagenia rigida</i> (Fw)	Arthropod	Insects	Freshwater	Nymph	Lab	Static, microcosm	Sediment	10 mg/kg	15	Whole body	2.1	Survival, Growth - No effect	Survival	No	335	
Cadmium (Cadmium chloride)	Midge, <i>Chironomus riparius</i> (Fw)	Arthropod	Insects	Freshwater	Larvae	Lab	Renewal, wkly	Water	5.6 µg/L	28 - 56	Whole body	5.6	Survival - No effect	Survival	No	364	
Cadmium (Cadmium chloride)	Midge, <i>Chironomus riparius</i> (Fw)	Arthropod	Insects	Freshwater	Larvae	Lab	Renewal, wkly	Water	16.2 µg/L	28 - 56	Whole body	7.6	Growth, Reproduction - No effect	Growth	No	364	
Cadmium (Cadmium chloride)	Midge, <i>Chironomus riparius</i> (Fw)	Arthropod	Insects	Freshwater	Larvae-Adult	Lab	Renewal	Water	1.9 µg/L	180	Whole body	17.8	Survival, Reproduction - No effect	Survival	No	365	No effects on generations one to five
Cadmium (Cadmium chloride)	Midge, <i>Chironomus riparius</i> (Fw)	Arthropod	Insects	Freshwater	Larvae, 4th instar	Lab	Renewal, 1 d	Water	19.8 µg/L	14	Whole body	67.4	Survival - No effect	Survival	No	366	
Cadmium (Cadmium chloride)	Midge, <i>Chironomus riparius</i> (Fw)	Arthropod	Insects	Freshwater	Larvae	Lab	Renewal, wkly	Water	16.2 µg/L	28 - 56	Whole body	7.6	Survival - Reduced	Reduced Survival	Yes	364	
Cadmium (Cadmium chloride)	Midge, <i>Chironomus riparius</i> (Fw)	Arthropod	Insects	Freshwater	Larvae-Adult	Lab	Renewal	Water	6.1 µg/L	180	Whole body	33	Survival, Reproduction - Reduced	Reduced Survival	Yes	365	Survival reduced by third generation, reproduction after the fourth generation
Cadmium (Cadmium chloride)	Midge, <i>Chironomus riparius</i> (Fw)	Arthropod	Insects	Freshwater	Larvae-Adult	Lab	Renewal	Water	17.9 µg/L	180	Whole body	66	Survival, Reproduction - Reduced	Reduced Survival	Yes	365	First generation survival reduced, reproduction reduced by the third generation
Cadmium	Midge, <i>Chironomus riparius</i> (Fw)	Arthropod	Insects	Freshwater	1st - 4th instar	Lab	Static	Water	0.01 mg/L	42	Whole body	22.6 - 40	Survival - Reduced 55%	Reduced Survival	Yes	453	
Cadmium	Midge, <i>Chironomus riparius</i> (Fw)	Arthropod	Insects	Freshwater	1st - 4th instar	Lab	Static	Water	0.025 mg/L	35	Whole body	43.4 - 50.8	Survival - Reduced 71%	Reduced Survival	Yes	453	
Cadmium (Cadmium nitrate)	Amphipod, <i>Hyalella azteca</i> (Fw)	Arthropod	Amphipod	Freshwater	Juvenile-Adult	Lab	Static	Water	250 ng/L	10	Whole body	0.61	Survival - No effect	Survival	No	431	

TABLE F-2

Whole-body Invertebrate Tissue Toxicity Data for Cadmium

Baseline Ecological Risk Assessment, Halaco Site, Oxnard, California

Chemical	Species	Species Type	Species Type2	Media	Life Stage	Test Site	Test Condition	Exposure Route	Exposure Concentration	Test Exp	Tissue	Result (µg/g)	Effect	Effect2	Effect3	Reference*	Comments
Cadmium (Cadmium chloride)	Amphipod, Pontoporeia affinis (Sw)	Arthropod	Amphipod	Marine	Juvenile	Lab	Flow-through microcosm	Water	6.3 µg/L	265	Whole body	2.3	Survival - No effect	Survival	No	435	
Cadmium (Cadmium chloride)	Amphipod, Hyalella azteca (Fw)	Arthropod	Amphipod	Freshwater	Young	Lab	Renewal, wkly	Water*	0.56 µg/L	42	Whole body	2.6	Survival - No effect	Survival	No	39	*8 HQ (8 - hydroxyquinoline) added
Cadmium (Cadmium chloride)	Amphipod, Hyalella azteca (Fw)	Arthropod	Amphipod	Freshwater	Young	Lab	Renewal, wkly	Water	0.56 µg/L	42	Whole body	4.6	Survival - No effect	Survival	No	39	
Cadmium (Cadmium chloride)	Amphipod, Hyalella azteca (Fw)	Arthropod	Amphipod	Freshwater	Young	Lab	Renewal, wkly	Water*	10 µg/L	42	Whole body	4.6	Survival - No effect	Survival	No	39	*EDTA added
Cadmium (Cadmium chloride)	Amphipod, Pontoporeia affinis (Sw)	Arthropod	Amphipod	Marine	Adult, female	Lab	Flow-through microcosm	Water	41 µg/L	105	Whole body	6	Survival - No effect	Survival	No	435	
Cadmium (Cadmium chloride)	Amphipod, Hyalella azteca (Fw)	Arthropod	Amphipod	Freshwater	Young	Lab	Renewal, wkly	Water*	3.2 µg/L	42	Whole body	6.4	Survival - No effect	Survival	No	39	*Humic acid added
Cadmium (Cadmium chloride)	Amphipod, Hyalella azteca (Fw)	Arthropod	Amphipod	Freshwater	Young	Lab	Renewal, wkly	Water*	0.56 µg/L	42	Whole body	8.4	Survival - No effect	Survival	No	39	*90% distilled water added
Cadmium (Cadmium chloride)	Amphipod, Hyalella azteca (Fw)	Arthropod	Amphipod	Freshwater	Young	Lab	Static	Water*	1000 µg/L	28	Whole body	9.4	Survival - No effect	Survival	No	39	*Sediment A added
Cadmium (Cadmium chloride)	Amphipod, Pontoporeia affinis (Sw)	Arthropod	Amphipod	Marine	Adult, female	Lab	Flow-through microcosm	Water	127 µg/L	105	Whole body	11.4	Reproduction (no. eggs/ female)-No effect	Reproduction	No	435	
Cadmium (Cadmium chloride)	Amphipod, Hyalella azteca (Fw)	Arthropod	Amphipod	Freshwater	Young	Lab	Static	Water*	3200 µg/L	28	Whole body	12.4	Survival - No effect	Survival	No	39	*Sediment B added
Cadmium (Cadmium chloride)	Amphipod, Pontoporeia affinis (Sw)	Arthropod	Amphipod	Marine	Juvenile	Lab	Flow-through microcosm	Water	41 µg/L	265	Whole body	15.6	Growth - No effect	Growth	No	435	
Cadmium (Cadmium chloride hydrate)	Amphipod, Gammarus fossarum (Fw)	Arthropod	Amphipod	Freshwater	Adult	Lab	Renewal, 2 d	Water	0.3 mg/L	14	Whole body	53.4	Survival - No effect	Survival	No	2	Hard water, 83 - 87 mg/L; Animals not fed
Cadmium (Cadmium chloride)	Amphipod, Pontoporeia affinis (Sw)	Arthropod	Amphipod	Marine	Adult, female	Lab	Flow-through microcosm	Water	6.3 µg/L	105	Whole body	3	Reproduction (% normal eggs)-Reduced	Reduced Reproduction	Yes	435	
Cadmium (Cadmium chloride)	Amphipod, Gammarus pulex (Fw)	Arthropod	Amphipod	Freshwater	Adult, >7-8mm	Lab	Renewal, 1 d	Diet	150-170 µg/g	13	Whole body	4.4	Survival - Reduced	Reduced Survival	Yes	121	
Cadmium (Cadmium chloride)	Amphipod, Hyalella azteca (Fw)	Arthropod	Amphipod	Freshwater	Young	Lab	Renewal, wkly	Water*	1.0 µg/L	42	Whole body	5.6	Survival - Reduced	Reduced Survival	Yes	39	*8 HQ (8 - hydroxyquinoline) added
Cadmium (Cadmium chloride)	Amphipod, Hyalella azteca (Fw)	Arthropod	Amphipod	Freshwater	Young	Lab	Renewal, wkly	Water	1.0 µg/L	42	Whole body	6	Survival - Reduced	Reduced Survival	Yes	39	
Cadmium (Cadmium chloride)	Amphipod, Hyalella azteca (Fw)	Arthropod	Amphipod	Freshwater	Young	Lab	Renewal, wkly	Water	1.6 µg/L	42	Whole body	7.6	Survival - Reduced 50%	Reduced Survival	Yes	39	
Cadmium (Cadmium chloride)	Amphipod, Hyalella azteca (Fw)	Arthropod	Amphipod	Freshwater	Young	Lab	Renewal, wkly	Water*	5.6 µg/L	42	Whole body	7.8	Survival - Reduced	Reduced Survival	Yes	39	*Humic acid added
Cadmium (Cadmium chloride)	Amphipod, Hyalella azteca (Fw)	Arthropod	Amphipod	Freshwater	Young	Lab	Renewal, wkly	Water*	18 µg/L	42	Whole body	7.8	Survival - Reduced	Reduced Survival	Yes	39	*EDTA added
Cadmium (Cadmium chloride)	Amphipod, Hyalella azteca (Fw)	Arthropod	Amphipod	Freshwater	Young	Lab	Renewal, wkly	Water*	7.0 µg/L	42	Whole body	8.8	Survival - Reduced 50%	Reduced Survival	Yes	39	*Humic acid added
Cadmium (Cadmium chloride)	Amphipod, Hyalella azteca (Fw)	Arthropod	Amphipod	Freshwater	Young	Lab	Renewal, wkly	Water*	22 µg/L	42	Whole body	8.8	Survival - Reduced 50%	Reduced Survival	Yes	39	*EDTA added

TABLE F-2

Whole-body Invertebrate Tissue Toxicity Data for Cadmium

Baseline Ecological Risk Assessment, Halaco Site, Oxnard, California

Chemical	Species	Species Type	Species Type2	Media	Life Stage	Test Site	Test Condition	Exposure Route	Exposure Concentration	Test Exp	Tissue	Result (µg/g)	Effect	Effect2	Effect3	Reference*	Comments
Cadmium (Cadmium chloride)	Amphipod, Pontoporeia affinis (Sw)	Arthropod	Amphipod	Marine	Adult, female	Lab	Flow-through microcosm	Water	127 µg/L	105	Whole body	11.4	Survival - Reduced	Reduced Survival	Yes	435	One adult female that survived 265d had a body burden of 30 µg/g
Cadmium (Cadmium chloride)	Amphipod, Hyalella azteca (Fw)	Arthropod	Amphipod	Freshwater	Young	Lab	Renewal, wkly	Water*	1.0 µg/L	42	Whole body	15.2	Survival - Reduced	Reduced Survival	Yes	39	*90% distilled water added
Cadmium (Cadmium chloride)	Amphipod, Pontoporeia affinis (Sw)	Arthropod	Amphipod	Marine	Juvenile	Lab	Flow-through microcosm	Water	41 µg/L	265	Whole body	15.6	Survival - Reduced	Reduced Survival	Yes	435	
Cadmium (Cadmium chloride)	Amphipod, Hyalella azteca (Fw)	Arthropod	Amphipod	Freshwater	Young	Lab	Renewal, wkly	Water*	1.2 µg/L	42	Whole body	15.8	Survival - Reduced 50%	Reduced Survival	Yes	39	*90% distilled water added
Cadmium (Cadmium chloride)	Amphipod, Hyalella azteca (Fw)	Arthropod	Amphipod	Freshwater	Young	Lab	Static	Water*	2000 µg/L	28	Whole body	17.2	Survival - Reduced 50%	Reduced Survival	Yes	39	*Sediment A added
Cadmium (Cadmium chloride)	Amphipod, Hyalella azteca (Fw)	Arthropod	Amphipod	Freshwater	Young	Lab	Static	Water*	1800 µg/L	28	Whole body	17.4	Survival - Reduced	Reduced Survival	Yes	39	*Sediment A added
Cadmium (Cadmium chloride)	Amphipod, Hyalella azteca (Fw)	Arthropod	Amphipod	Freshwater	Young	Lab	Static	Water*	6300 µg/L	28	Whole body	19.6	Survival - Reduced 50%	Reduced Survival	Yes	39	*Sediment B added
Cadmium (Cadmium chloride)	Amphipod, Eohaustorius estuarius (Sw)	Arthropod	Amphipod	Marine	Adult	Lab	Static	Water	14.5 mg/L	4	Whole body	20	Survival - Reduced 50%	Reduced Survival	Yes	295	Organisms held in the lab for 121 d before testing
Cadmium (Cadmium chloride)	Amphipod, Hyalella azteca (Fw)	Arthropod	Amphipod	Freshwater	Young	Lab	Static	Water*	5600 µg/L	28	Whole body	29.6	Survival - Reduced	Reduced Survival	Yes	39	*Sediment B added
Cadmium (Cadmium chloride)	Amphipod, Allochrestes compressa (Sw)	Arthropod	Amphipod	Marine	Juvenile, 1st instar	Lab	Flow-through	Water	45 µg/L	28	Whole body	36	Survival - Reduced 57%	Reduced Survival	Yes	8	
Cadmium (Cadmium chloride hydrate)	Amphipod, Gammarus fossarum (Fw)	Arthropod	Amphipod	Freshwater	Adult	Lab	Renewal, 2 d	Water	0.015 mg/L	14	Whole body	53.4	Survival - Reduced	Reduced Survival	Yes	2	Soft water, 4.0 - 4.4 mg/L; Animals not fed
Cadmium (Cadmium chloride)	Amphipod, Allochrestes compressa (Sw)	Arthropod	Amphipod	Marine	Juvenile, 1st instar	Lab	Flow-through	Water	79-84 µg/L	28	Whole body	60	Survival, Growth - Reduced >70%	Reduced Survival	Yes	8	
Cadmium (Cadmium chloride hydrate)	Amphipod, Gammarus fossarum (Fw)	Arthropod	Amphipod	Freshwater	Adult	Lab	Renewal, 2 d	Water	1.0 mg/L	14	Whole body	101.6	Survival - Reduced	Reduced Survival	Yes	2	Hard water, 83 - 87 mg/L; Animals not fed
Cadmium (Cadmium chloride hydrate)	Amphipod, Gammarus fossarum (Fw)	Arthropod	Amphipod	Freshwater	Adult	Lab	Renewal, 2 d	Diet	450 µg/g	20	Whole body	48 - 61	Survival - Reduced	Reduced Survival	Yes	2	Soft water, 4.0 - 4.4 mg/L
Cadmium (Cadmium chloride hydrate)	Amphipod, Gammarus pulex (Fw)	Arthropod	Amphipod	Freshwater	Adult, post-molt	Lab	Renewal, 1 d	Water	0.01-0.1 mg/L	3	Whole body	5.4 - 54	Survival - Reduced - Death	Reduced Survival	Yes	492	
Cadmium (Cadmium chloride hydrate)	Amphipod, Gammarus fossarum (Fw)	Arthropod	Amphipod	Freshwater	Adult	Lab	Renewal, 2 d	Diet	450 µg/g	20	Whole body	53 - 64	Survival - Reduced	Reduced Survival	Yes	2	Hard water, 83 - 87 mg/L
Cadmium (Cadmium chloride)	Amphipod, Eohaustorius estuarius (Sw)	Arthropod	Amphipod	Marine	Adult	Lab	Static	Water	36.1 - 41.9 mg/L	4	Whole body	72 - 88	Survival - Reduced 50%	Reduced Survival	Yes	295	Organisms held in the lab for 11-17 d before testing
Cadmium (Cadmium chloride)	Mysid, Mysidopsis bahia (Sw)	Arthropod	Crustacean	Marine	Adult	Lab	Flow-through	Water	N/A	33	Whole body	0.08	Growth - No effect	Growth	No	79	
Cadmium (Cadmium chloride)	Crayfish, Orconectes virilis (Fw)	Arthropod	Crustacean	Freshwater	Adult	Lab	Flow-through	Water	Control	14	Whole body	0.9	Survival - No effect	Survival	No	306	
Cadmium (Cadmium chloride)	Grass shrimp, Palaemonetes pugio (Sw)	Arthropod	Crustacean	Marine	Adult, male	Lab	Renewal, 2 d	Water	50 µg/L	21	Whole body	4.6	Growth - No effect*	Growth	No	468	Molting stimulated; Salinity 10 ppt

TABLE F-2

Whole-body Invertebrate Tissue Toxicity Data for Cadmium

Baseline Ecological Risk Assessment, Halaco Site, Oxnard, California

Chemical	Species	Species Type	Species Type2	Media	Life Stage	Test Site	Test Condition	Exposure Route	Exposure Concentration	Test Exp	Tissue	Result (µg/g)	Effect	Effect2	Effect3	Reference*	Comments
Cadmium (Cadmium chloride)	Crayfish, <i>Cambarus latimanus</i> (Fw)	Arthropod	Crustacean	Freshwater	Adult	Outdoors	Flow-through	Water	5 µg/L	150	Whole body	14.9	Survival - No effect	Survival	No	452	Organisms tested at ambient winter temperatures
Cadmium (Cadmium chloride)	Crayfish, <i>Cambarus latimanus</i> (Fw)	Arthropod	Crustacean	Freshwater	Adult	Outdoors	Flow-through	Water	10 µg/L	150	Whole body	21.96	Growth - No effect	Growth	No	452	Organisms tested at ambient winter temperatures
Cadmium (Cadmium chloride)	Crayfish, <i>Orconectes propinquus</i> (Fw)	Arthropod	Crustacean	Freshwater	Adult	Lab	Renewal, 1 at 4 d	Water	1 mg/L	7.9	Whole body	534.4	Survival - No effect	Survival	No	150	Radiotracer study
Cadmium (Cadmium chloride)	Mysid, <i>Mysidopsis bahia</i> (Sw)	Arthropod	Crustacean	Marine	Adult	Lab	Flow-through	Water	4 µg/L	33	Whole body	1.3	Survival - No effect; Growth - Reduced	Reduced Growth	Yes	79	
Cadmium (Cadmium chloride)	Grass shrimp, <i>Palaemonetes pugio</i> (Sw)	Arthropod	Crustacean	Marine	Adult, male	Lab	Renewal, 2 d	Water	50 µg/L	21	Whole body	1.8	Survival - Reduced 5% or less	Reduced Survival	Yes	468	Salinity 20 ppt
Cadmium (Cadmium chloride)	Mysid, <i>Mysidopsis bahia</i> (Sw)	Arthropod	Crustacean	Marine	Adult	Lab	Flow-through	Water	8 µg/L	33	Whole body	2.4	Reproduction - No effect; Survival - Reduced 50%	Reduced Survival	Yes	79	
Cadmium (Cadmium chloride)	Mysid, <i>Mysidopsis bahia</i> (Sw)	Arthropod	Crustacean	Marine	Adult	Lab	Flow-through	Water	16 µg/L	33	Whole body	4.4	Survival, Reproduction - Reduced	Reduced Survival	Yes	79	
Cadmium (Cadmium chloride)	Grass shrimp, <i>Palaemonetes pugio</i> (Sw)	Arthropod	Crustacean	Marine	Adult, male	Lab	Renewal, 2 d	Water	50 µg/L	21	Whole body	4.6	Survival - Reduced 10%	Reduced Survival	Yes	468	Salinity 10 ppt
Cadmium (Cadmium chloride)	Crayfish, <i>Orconectes virilis</i> (Fw)	Arthropod	Crustacean	Freshwater	Adult	Lab	Flow-through	Water	0.4 mg/L	14	Whole body	5.7	Survival - Reduced 25%	Reduced Survival	Yes	306	
Cadmium (Cadmium chloride)	Grass shrimp, <i>Palaemonetes pugio</i> (Sw)	Arthropod	Crustacean	Marine	Adult, male	Lab	Renewal, 2 d	Water	50 µg/L	21	Whole body	8	Survival - Reduced 20-25%	Reduced Survival	Yes	468	Salinity 5 ppt
Cadmium (Cadmium chloride)	Grass shrimp, <i>Palaemonetes pugio</i> (Sw)	Arthropod	Crustacean	Marine	Adult, male	Lab	Renewal, 2 d	Water	50 µg/L	21	Whole body	8	Growth - Reduced*	Reduced Growth	Yes	468	Molting inhibited; Salinity 5 ppt
Cadmium (Cadmium chloride)	Crayfish, <i>Orconectes virilis</i> (Fw)	Arthropod	Crustacean	Freshwater	Adult	Lab	Flow-through	Water	1.1 mg/L	14	Whole body	11.2	Survival - Reduced 74%	Reduced Survival	Yes	306	
Cadmium (Cadmium chloride)	Crayfish, <i>Orconectes virilis</i> (Fw)	Arthropod	Crustacean	Freshwater	Adult	Lab	Flow-through	Water	2.4 mg/L	14	Whole body	17.8	Survival - Reduced Death	Reduced Survival	Yes	306	
Cadmium (Cadmium chloride)	Crayfish, <i>Cambarus latimanus</i> (Fw)	Arthropod	Crustacean	Freshwater	Adult	Outdoors	Flow-through	Water	10 µg/L	150	Whole body	21.96	Survival - Reduced	Reduced Survival	Yes	452	Organisms tested at ambient winter temperatures
Cadmium (Cadmium chloride)	Crayfish, <i>Orconectes virilis</i> (Fw)	Arthropod	Crustacean	Freshwater	Adult	Lab	Flow-through	Water	4.4-7.2 mg/L	10	Whole body	19.6-29.3	Survival - Reduced Death	Reduced Survival	Yes	306	

Notes:

Shaded rows represent the benchmarks selected for use in the risk assessment.

All information presented in this table was extracted from Jarvinen and Ankley, 1999.

* For references, please see the Jarvinen and Ankley, 1999 paper.

Fw = freshwater

mg/kg = milligram per kilogram

mg/L = milligrams per liter

Sw = saltwater

µg/g = micrograms per gram

µg/L = micrograms per liter

TABLE F-3

Whole-body Invertebrate Tissue Toxicity Data for Chromium

Baseline Ecological Risk Assessment, Halaco Site, Oxnard, California

Chemical	Species	Species Type	Species Type2	Media	Life Stage	Test Site	Test Condition	Exposure Route	Exposure Concentration	Test Exp	Tissue	Result (µg/g)	Effect	Effect2	Reference*	Comments
Chromium (Potassium dichromate)	Amphipod, Allorchestes compressa (Sw)	Arthropod	Amphipod	Marine	Juvenile, 1st instar	Lab	Flow-through	Water	251 µg/L	28	Whole body	9.2	Survival, Growth - No effect	No	8	
Chromium (Potassium dichromate)	Sand crab, Portunus pelagicus (Sw)	Arthropod	Crustacean	Marine	Juvenile	Lab	Renewal, 1 day	Water	0.1 mg/L	40	Whole body	1	Growth - No effect	No	310	2 instar stage
Chromium (Potassium dichromate)	Sand crab, Portunus pelagicus (Sw)	Arthropod	Crustacean	Marine	Juvenile	Lab	Renewal, 1 day	Water	0.3 mg/L	40	Whole body	3.2	Growth - No effect	No	310	3 - 6 instar stage
Chromium (Potassium dichromate)	Sand crab, Portunus pelagicus (Sw)	Arthropod	Crustacean	Marine	Juvenile	Lab	Renewal, 1 day	Water	0.3 mg/L	40	Whole body	3.2	Growth - Reduced	Yes	310	2 instar stage
Chromium (Potassium dichromate)	Sand crab, Portunus pelagicus (Sw)	Arthropod	Crustacean	Marine	Juvenile	Lab	Renewal, 1 day	Water	1.0 mg/L	40	Whole body	6.3	Growth - Reduced	Yes	310	3 - 6 instar stage

Notes:

Shaded rows represent the benchmarks selected for use in the risk assessment.

All information presented in this table was extracted from Jarvinen and Ankley, 1999.

* For references, please see the Jarvinen and Ankley, 1999 paper.

mg/L = milligrams per liter

Sw = saltwater

µg/g = micrograms per gram

µg/L = micrograms per liter

TABLE F-4

Whole-body Invertebrate Tissue Toxicity Data for Copper

Baseline Ecological Risk Assessment, Halaco Site, Oxnard, California

Chemical	Species	Species Type	Species Type2	Media	Life Stage	Test Site	Test Condition	Exposure Route	Exposure Concentration	Test Exp	Tissue	Result (µg/g)	Effect	Effect2	Reference*	Comments
Copper (Copper chloride)	Amphipod, <i>Hyailella azteca</i> (Fw)	Arthropod	Amphipod	Freshwater	<1wk	Lab	Static, aerated	Sediment	363 mg/kg	28	Whole body	29.2	Survival - No effect	No	38	
Copper (Copper chloride)	Amphipod, <i>Hyailella azteca</i> (Fw)	Arthropod	Amphipod	Freshwater	<-1wk	Lab	Static, aerated	Sediment	299 mg/kg	28	Whole body	30.4	Growth - No effect	No	38	
Copper (Copper chloride)	Amphipod, <i>Hyailella azteca</i> (Fw)	Arthropod	Amphipod	Freshwater	<1wk	Lab	Static, aerated	Sediment	363 mg/kg	28	Whole body	29.2	Growth - Reduced	Yes	38	
Copper (Copper chloride)	Amphipod, <i>Hyailella azteca</i> (Fw)	Arthropod	Amphipod	Freshwater	<1wk	Lab	Static, aerated	Sediment	1119 mg/kg	28	Whole body	32.8	Survival - Reduced 55%	Yes	38	
Copper (Copper chloride)	Amphipod, <i>Hyailella azteca</i> (Fw)	Arthropod	Amphipod	Freshwater	<1wk	Lab	Static, aerated	Sediment	2678 mg/kg	28	Whole body	81.2	Survival - Reduced - Death	Yes	38	
Copper (Copper sulfate)	Amphipod, <i>Allorchestes compressa</i> (Sw)	Arthropod	Amphipod	Marine	Juvenile, 1st instar	Lab	Flow-through	Water	10 µg/L	28	Whole body	100	Growth - Reduced	Yes	8	Survival data were not used because of inconsistency
Copper (Copper sulfate)	Crayfish, <i>Orconectes rusticus</i> (Fw)	Arthropod	Crustacean	Freshwater	Adult	Lab	Static	Water	3 mg/L	2	Whole body	50	Survival - No effect	No	131	
Copper (Copper sulfate)	Midge, <i>Chironomus decorus</i> (Fw)	Arthropod	Insect	Freshwater	4th instar	Lab	Static	Water	0.75-1.02 mg/L	2	Whole body	140.4-169.4	Survival - Reduced > 50%	Yes	242	
Copper (Copper sulfate)	Midge, <i>Chironomus decorus</i> (Fw)	Arthropod	Insect	Freshwater	4th instar	Lab	Static	Food / Substrate	5477-7475 mg/kg	3	Whole body	154 - 190	Survival - Reduced 40 - 70%	Yes	242	
Copper (Copper sulfate)	Midge, <i>Chironomus decorus</i> (Fw)	Arthropod	Insect	Freshwater	4th instar	Lab	Static	Food / Substrate	7286-7800 mg/kg	3	Whole body	179 - 197	Survival - Reduced 80 - 90%	Yes	242	
Copper (Copper sulfate)	Midge, <i>Chironomus decorus</i> (Fw)	Arthropod	Insect	Freshwater	4th instar	Lab	Static	Water	2.45-3.29 mg/L	2	Whole body	779 - 1200	Survival - Reduced 100%	Yes	242	

Notes:

Shaded rows represent the benchmarks selected for use in the risk assessment.

All information presented in this table was extracted from Jarvinen and Ankley, 1999.

* For references, please see the Jarvinen and Ankley, 1999 publication.

Fw = freshwater

mg/kg = milligram per kilogram

mg/L = milligrams per liter

Sw = saltwater

µg/g = micrograms per gram

µg/L = micrograms per liter

TABLE F-5

Whole-body Invertebrate Tissue Toxicity Data for Lead

Baseline Ecological Risk Assessment, Halaco Site, Oxnard, California

Chemical	Species	Species Type	Species Type2	Media	Life Stage	Test Site	Test Condition	Exposure Route	Exposure Concentration	Test Exp	Tissue	Result (µg/g)	Effect	Effect2	Reference*
Lead (Lead nitrate)	Amphipod, Gammarus pseudolimnaeus (Fw)	Arthropod	Amphipod	Freshwater	5-7mm	Lab	Flow-through	Water	32 µg/L	28	Whole body	98	Survival - Reduced >50%	Yes	419
Lead (Lead nitrate)	Caddisfly, Brachycentrus sp. (Fw)	Arthropod	Insect	Freshwater	5-8mm	Lab	Flow-through	Water	565 µg/L	28	Whole body	260	Survival - No effect	No	419
Lead (Lead nitrate)	Stonefly, Pteronarcys dorsata (Fw)	Arthropod	Insect	Freshwater	20-40mm	Lab	Flow-through	Water	565 µg/L	28	Whole body	340	Survival - No effect	No	419
Lead (Lead nitrate)	Snail, Physa integra (Fw)	Mollusc	Mollusc	Freshwater	6 - 15mm	Lab	Flow-through	Water	565 µg/L	28	Whole body	200	Survival - No effect		419

Notes:

Shaded rows represent the benchmarks selected for use in the risk assessment.

All information presented in this table was extracted from Jarvinen and Ankley, 1999.

* For references, please see the Jarvinen and Ankley, 1999 paper.

Fw = freshwater

mm = millimeters

µg/g = micrograms per gram

µg/L = micrograms per liter

TABLE F-6

Whole-body Invertebrate Tissue Toxicity Data for Mercury

Baseline Ecological Risk Assessment, Halaco Site, Oxnard, California

Chemical	Species	Species Type	Species Type2	Media	Life Stage	Test Site	Test Condition	Exposure Route	Exposure Concentration	Test Exp	Tissue	Result (µg/g)	Effect	Effect2	Reference*	Comments
Mercury (Mercuric chloride)	Cladoceran, Daphnia magna (Fw)	Arthropod	Crustacean	Freshwater	<24h-Adult	Lab	Flow-through	Water	0.72 µg/L	21	Whole body	3.05	Reproduction - No effect	No	32	
Mercury (Mercuric chloride)	Cladoceran, Daphnia magna (Fw)	Arthropod	Crustacean	Freshwater	<24h-Adult	Lab	Flow-through	Water	1.28 µg/L	21	Whole body	4.66	Survival - No effect	No	32	
Mercury (Methylmercuric chloride)	Cladoceran, Daphnia pulex (Fw)	Arthropod	Crustacean	Freshwater	Adult, female	Lab	Flow-through	Water; Diet	5.0 µg/L; 136 ng/mg	14	Whole body	5	Survival, Reproduction - No effect	No	260	Residues were determined in separate water or diet 3 d studies that showed 4.6 µg/g uptake from the water and 0.8 µg/g from the food
Mercury (Methylmercuric chloride)	Cladoceran, Daphnia magna (Fw)	Arthropod	Crustacean	Freshwater	<24h - Adult	Lab	Flow-through	Water	0.26 µg/L	21	Whole body	36.75	Survival - No effect	No	32	0.26 µg/L was the highest concentration tested
Mercury (Mercuric chloride)	Grass shrimp, Palaemonetes pugio (Sw)	Arthropod	Crustacean	Marine	Egg carrying female	Lab	Static	Water	50 µg/L	30	Whole body	1.1 - 2.1	Survival - No effect	No	18	
Mercury (Methylmercuric chloride)	Cladoceran, Daphnia magna (Fw)	Arthropod	Crustacean	Freshwater	<24h - Adult	Lab	Flow-through	Water	0.04 µg/L	21	Whole body	3.28	Reproduction - Reduced	Yes	32	0.04 µg/L was the lowest concentration tested
Mercury (Mercuric chloride)	Cladoceran, Daphnia magna (Fw)	Arthropod	Crustacean	Freshwater	<24h-Adult	Lab	Flow-through	Water	1.28 µg/L	21	Whole body	4.66	Reproduction - Reduced	Yes	32	
Mercury (Mercuric chloride)	Mayfly, Hexagenia rigida (Fw)	Arthropod	Insect	Freshwater	Nymph	Lab	Static, microcosm	Sediment	0.5 mg/kg	9	Whole body	0.04	Growth - No effect	No	389	Radiotracer study
Mercury (Methylmercuric chloride)	Mayfly, Hexagenia rigida (Fw)	Arthropod	Insect	Freshwater	Nymph	Lab	Static, microcosm	Water	1.8 µg/L	15	Whole body	1	Survival, Growth - No effect	No	335	
Mercury (Methylmercuric chloride)	Mayfly, Hexagenia rigida (Fw)	Arthropod	Insect	Freshwater	Nymph	Lab	Static, microcosm	Sediment	0.5 mg/kg	9	Whole body	2.1	Growth - No effect	No	389	Radiotracer study
Mercury (Mercuric chloride)	Mayfly, Hexagenia rigida (Fw)	Arthropod	Insect	Freshwater	Nymph	Lab	Static, microcosm	Water	23 µg/L	9	Whole body	3.76	Growth - No effect	No	389	Radiotracer study
Mercury (Methylmercuric chloride)	Mayfly, Hexagenia rigida (Fw)	Arthropod	Insect	Freshwater	Nymph	Lab	Static, microcosm	Water	30-36 µg/L	9	Whole body	7.5	Growth - No effect	No	389	Radiotracer study
Mercury (Methylmercuric chloride)	Mayfly, Hexagenia rigida (Fw)	Arthropod	Insect	Freshwater	Nymph	Lab	Static, microcosm	Sediment	2.98 mg/kg	15	Whole body	16	Survival, Growth - No effect	No	335	
Mercury (Mercuric chloride)	Midge, Chironomus riparius (Fw)	Arthropod	Insect	Freshwater	Adult	Lab	Flow-through	Water	5.5 µg/L	30	Whole body	40	Survival - No effect	No	380	
Mercury (Mercuric chloride)	Midge, Chironomus riparius (Fw)	Arthropod	Insect	Freshwater	Pupal exuviae	Lab	Flow-through	Water	5.5 µg/L	30	Whole body	88	Survival - No effect	No	380	
Mercury (Mercuric chloride)	Midge, Chironomus riparius (Fw)	Arthropod	Insect	Freshwater	Larvae, 4th instar	Lab	Flow-through	Water	5.5 µg/L	30	Whole body	107.6	Survival - No effect	No	380	
Mercury (Mercuric chloride)	Mayfly, Hexagenia rigida (Fw)	Arthropod	Insect	Freshwater	Nymph	Lab	Static, microcosm	Sediment	5.0 µg/g	15	Whole body	2 - 2.4	Survival, Growth - No effect	No	334	Tested at 10, 18, and 26°C
Mercury (Methylmercuric chloride)	Mayfly, Hexagenia rigida (Fw)	Arthropod	Insect	Freshwater	Nymph	Lab	Static, microcosm	Sediment	0.5 µg/g	15	Whole body	2.6 - 4.5	Survival, Growth - No effect	No	334	Tested at 10, 18, and 26°C
Mercury (Methylmercury)	Mussel, Pyganodon grandis (Fw)	Mollusc	Mollusc	Freshwater	Adult	Field	Pond	Water	2.3 ng/L	88	Whole body	0.045	Survival, Growth, Reproduction-No effect	No	273	
Mercury (Mercuric chloride)	Slipper limpet, Crepidula fornicata (Sw)	Mollusc	Mollusc	Marine	Adult	Lab	Renewal, 1 day	Water	0.25 µg/L	112	Whole body	38450	Reproduction - No effect	No	448	
Mercury (Mercuric chloride)	Slipper limpet, Crepidula fornicata (Sw)	Mollusc	Mollusc	Marine	Adult	Lab	Renewal, 1 day	Water	0.42 µg/L	112	Whole body	38642	Growth - No effect	No	448	
Mercury (Mercuric chloride)	Slipper limpet, Crepidula fornicata (Sw)	Mollusc	Mollusc	Marine	Adult	Lab	Renewal, 1 day	Water	0.25 µg/L	112	Whole body	38450	Settlement of spat - Reduced*	Yes	448	*Only occurred after 3rd spawning
Mercury (Mercuric chloride)	Slipper limpet, Crepidula fornicata (Sw)	Mollusc	Mollusc	Marine	Adult	Lab	Renewal, 1 day	Water	0.42 µg/L	112	Whole body	38642	Reproduction (fecundity) - Reduced	Yes	448	

TABLE F-6

Whole-body Invertebrate Tissue Toxicity Data for Mercury

Baseline Ecological Risk Assessment, Halaco Site, Oxnard, California

Chemical	Species	Species Type	Species Type2	Media	Life Stage	Test Site	Test Condition	Exposure Route	Exposure Concentration	Test Exp	Tissue	Result (µg/g)	Effect	Effect2	Reference*	Comments
Mercury (Mercuric chloride)	Slipper limpet, <i>Crepidula fornicata</i> (Sw)	Mollusc	Mollusc	Marine	Adult	Lab	Renewal, 1 day	Water	1 µg/L	112	Whole body	22 - 48	Growth - Reduced	Yes	448	

Notes:

Shaded rows represent the benchmarks selected for use in the risk assessment.

All information presented in this table was extracted from Jarvinen and Ankley, 1999.

* For references, please see the Jarvinen and Ankley, 1999 paper.

Fw = freshwater

mg/kg = milligram per kilogram

mm = millimeters

Sw = saltwater

ng/kg = nanogram per kilogram

ng/L = nanograms per liter

µg/g = micrograms per gram

µg/L = micrograms per liter

TABLE F-7

Whole-body Invertebrate Tissue Toxicity Data for Selenium
Baseline Ecological Risk Assessment, Halaco Site, Oxnard, California

Chemical	Species	Species Type	Species Type2	Media	Life Stage	Test Site	Test Condition	Exposure Route	Exposure Concentration	Test Exp	Tissue	Result (µg/g)	Effect	Effect2	Reference*	Comments
Selenium (6:1 mixture selenate to selenite)	Cladoceran, Daphnia magna (Fw)	Arthropod	Crustacean	Freshwater	<24h	Lab	Flow-through	Water	5 µg/L	21	Whole body	0.26	Growth, Reproduction - No effect	No	215	A conservative residue value (see footnote#)
Selenium (Sodium selenate)	Cladoceran, Daphnia magna (Fw)	Arthropod	Crustacean	Freshwater	Adult	Lab	Renewal, 1 day	Water	491µg/L	3	Whole body	1.37	Survival - No effect	No	337	9.63 mg/L sulfate added (sulfate hinders bioaccumulation of Se)
Selenium (Sodium selenite)	Cladoceran, Daphnia magna (Fw)	Arthropod	Crustacean	Freshwater	4 - 5d	Lab	Static	Diet	13.8-18.3 µg/g	14	Whole body	1.8	Survival, Growth - No effect	No	30	Radiotracer study
Selenium (Seleno-L-methionine)	Cladoceran, Daphnia magna (Fw)	Arthropod	Crustacean	Freshwater	4 - 5d	Lab	Renewal, 2 day	Diet	15.6-19.9 µg/g	14	Whole body	2.42	Survival, Growth - No effect	No	30	Radiotracer study
Selenium (Sodium selenite)	Cladoceran, Daphnia magna (Fw)	Arthropod	Crustacean	Freshwater	4 - 5d	Lab	Static	Water	100 µg/L	4	Whole body	4.36	Survival, Growth - No effect	No	30	Radiotracer study
Selenium (Sodium selenate)	Cladoceran, Daphnia magna (Fw)	Arthropod	Crustacean	Freshwater	Neonate, 24h	Lab	Renewal, 1	Water	0.71 mg/L	2	Whole body	6.62	Survival, No effect	No	177	Selenium: sulfur ratio 1:15
Selenium (6:1 mixture selenate to selenite)	Cladoceran, Daphnia magna (Fw)	Arthropod	Crustacean	Freshwater	<24h	Lab	Flow-through	Water	711 µg/L	21	Whole body	10.22	Survival - No effect	No	215	
Selenium (Sodium selenate)	Cladoceran, Daphnia magna (Fw)	Arthropod	Crustacean	Freshwater	4 - 5d	Lab	Static	Water	1000 µg/L	4	Whole body	13	Survival, Growth - No effect	No	30	Radiotracer study
Selenium (Seleno-DL-methionine)	Cladoceran, Daphnia magna (Fw)	Arthropod	Crustacean	Freshwater	4 - 5d	Lab	Renewal, 2 day	Water	1 µg/L	4	Whole body	20.4	Survival, Growth - No effect	No	30	Radiotracer study
Selenium (Sodium selenate)	Cladoceran, Daphnia magna (Fw)	Arthropod	Crustacean	Freshwater	4 - 5d	Lab	Static	Diet	1-1.4 µg/g	14	Whole body	0.22	Survival, Growth - Reduced	Yes	30	Radiotracer study
Selenium (Sodium selenate)	Cladoceran, Daphnia magna (Fw)	Arthropod	Crustacean	Freshwater	Adult	Lab	Renewal, 1 day	Water	481 µg/L	3	Whole body	3.42	Survival - Reduced 95%	Yes	337	No sulfate added
Selenium (6:1 mixture selenate to selenite)	Cladoceran, Daphnia magna (Fw)	Arthropod	Crustacean	Freshwater	<24h	Lab	Flow-through	Water	348 µg/L	21	Whole body	6.34	Growth, Reproduction - Reduced	Yes	215	
Selenium (Sodium selenate)	Cladoceran, Daphnia magna (Fw)	Arthropod	Crustacean	Freshwater	Neonate, 24h	Lab	Renewal, 1	Water	0.71 mg/L	1	Whole body	15.42	Survival - Reduced >50%*	Yes	177	Immobilized; selenium: sulfur ratio 1:3
Selenium (Seleno-DL-methionine)	Cladoceran, Daphnia magna (Fw)	Arthropod	Crustacean	Freshwater	4 - 5d	Lab	Renewal, 2 day	Water	10 µg/L	4	Whole body	29.6	Survival, Growth - Reduced	Yes	30	Radiotracer study
Selenium (Sodium selenate)	Midge, Chironomus decorus (Fw)	Arthropod	Insect	Freshwater	Larvae, 4th instar	Lab	Renewal, 1	Water	5.92 mg/L	2	Whole body	5.08	Survival - No effect	No	177	Selenium: sulfur ratios 1:1 to 1:25
Selenium (Sodium selenate)	Midge, Chironomus decorus (Fw)	Arthropod	Insect	Freshwater	Larvae, 4th instar	Lab	Renewal, 1 day	Water	23.7 µg/L	2	Whole body	12.6	Survival - Reduced 50%	Yes	272	
Selenium (Sodium selenite)	Midge, Chironomus decorus (Fw)	Arthropod	Insect	Freshwater	Larvae, 4th instar	Lab	Renewal, 1 day	Water	48.2 µg/L	2	Whole body	17	Survival - Reduced 50%	Yes	272	

Notes:

Shaded rows represent the benchmarks selected for use in the risk assessment.
 All information presented in this table was extracted from Jarvinen and Ankley, 1999.
 * For references, please see the Jarvinen and Ankley, 1999 paper.

Fw = freshwater
 mg/kg = milligram per kilogram
 mg/L = milligram per liter
 mm = millimeters
 µg/g = micrograms per gram
 µg/L = micrograms per liter

TABLE F-8

Whole-body Invertebrate Tissue Toxicity Data for Zinc

Baseline Ecological Risk Assessment, Halaco Site, Oxnard, California

Chemical	Species	Species Type	Species Type2	Media	Life Stage	Test Site	Test Condition	Exposure Route	Exposure Concentration	Test Exp	Tissue	Result (µg/g)	Effect	Effect2	Reference*	Comments
Zinc (Zinc sulfate)a	Amphipod, Allorchestes compressa (Sw)	Arthropod	Amphipod	Marine	Juvenile, 1st instar	Lab	Flow-through	Water	70 µg/L	28	Whole body	26	Survival - No effect	No	8	
Zinc (Zinc chloride)a	Amphipod, Hyalella azteca (Fw)	Arthropod	Amphipod	Freshwater	0 - 1wk	Lab	Static, aerated	Sediment	41.4 µmol/g	28	Whole body	53.6	Survival - No effect	No	38	
Zinc (Zinc chloride)a	Amphipod, Hyalella azteca (Fw)	Arthropod	Amphipod	Freshwater	0 - 1wk	Lab	Static, aerated	Sediment	70.0 µmol/g	28	Whole body	60.8	Growth - No effect	No	38	
Zinc (Zinc sulfate)a	Amphipod, Allorchestes compressa (Sw)	Arthropod	Amphipod	Marine	Juvenile, 1st instar	Lab	Flow-through	Water	264 µg/L	28	Whole body	24	Survival - Reduced 90%	Yes	8	Residues in surviving organisms
Zinc (Zinc sulfate)a	Amphipod, Allorchestes compressa (Sw)	Arthropod	Amphipod	Marine	Juvenile, 1st instar	Lab	Flow-through	Water	264 µg/L	28	Whole body	24	Growth - Reduced	Yes	8	Residues in surviving organisms
Zinc (Zinc sulfate)a	Amphipod, Allorchestes compressa (Sw)	Arthropod	Amphipod	Marine	Juvenile, 1st instar	Lab	Flow-through	Water	136 µg/L	28	Whole body	30	Survival - Reduced 30%	Yes	8	Residues in surviving organisms
Zinc (Zinc chloride)a	Amphipod, Hyalella azteca (Fw)	Arthropod	Amphipod	Freshwater	0 - 1wk	Lab	Static, aerated	Sediment	70.0 µmol/g	28	Whole body	60.8	Survival - Reduced	Yes	38	
Zinc (Zinc chloride)a	Amphipod, Hyalella azteca (Fw)	Arthropod	Amphipod	Freshwater	0 - 1wk	Lab	Static, aerated	Sediment	98.5 µmol/g	28	Whole body	117.8	Survival - Reduced - Death	Yes	38	
Zinc (Zinc sulfate)a	Crayfish, Orconectes virilis (Fw)	Arthropod	Crustacean	Freshwater	Adult	Lab	Flow-through	Water	12.2 µg/L	14	Whole body	12.7	Survival - No effect	No	305	Authors state that the crayfish may have been adapted to low concentrations of zinc prior to testing
Zinc (Zinc sulfate)a	Crayfish, Orconectes virilis (Fw)	Arthropod	Crustacean	Freshwater	Adult	Lab	Flow-through	Water	26.8 µg/L	14	Whole body	35.2	Survival - Reduced 22%	Yes	305	Authors state that the crayfish may have been adapted to low concentrations of zinc prior to testing
Zinc (Zinc sulfate)a	Crayfish, Orconectes virilis (Fw)	Arthropod	Crustacean	Freshwater	Adult	Lab	Flow-through	Water	63.3 µg/L	14	Whole body	37.8	Survival - Reduced 42%	Yes	305	Authors state that the crayfish may have been adapted to low concentrations of zinc prior to testing
Zinc (Zinc sulfate)a	Crayfish, Orconectes virilis (Fw)	Arthropod	Crustacean	Freshwater	Adult	Lab	Flow-through	Water	130 mg/L	14	Whole body	69.2	Survival - Reduced 61%	Yes	305	Authors state that the crayfish may have been adapted to low concentrations of zinc prior to testing
Zinc	Midge, Chironomus riparius (Fw)	Arthropod	Insect	Freshwater	1st - 4th instar	Lab	Static	Water	1.0 mg/L	77	Whole body	524	Survival - No effect	No	453	Development was significantly retarded

Notes:

Shaded rows represent the benchmarks selected for use in the risk assessment.

All information presented in this table was extracted from Jarvinen and Ankley, 1999.

* For references, please see the Jarvinen and Ankley, 1999 paper.

Fw = freshwater

mg/L = milligram per liter

mm = millimeters

µg/g = micrograms per gram

µg/L = micrograms per liter

umol/g = micromole per gram

TABLE F-9

Whole-body Invertebrate Tissue Toxicity Data for Dioxin/Furans
Baseline Ecological Risk Assessment, Halaco Site, Oxnard, California

Chemical	Species	Species Type	Species Type2	Life Stage	Test Site	Test Condition	Exposure Route	Exposure Concentration	Test Exp	Tissue	Result (µg/g)	Effect	Effect2	Reference*	Comments
2,3,7,8-Tetrachlorodibenzo-p-dioxin (TCDD)	Worm, Lumbriculus variegatus (Fw)	Annelid		Adult-Young	Lab	Renewal	Diet	1266.4 ng/g	28	Whole body	0.167	Survival, Growth, Reproduction - No effect	N	481	Radiotracer study
2,3,7,8-Tetrachlorodibenzo-p-dioxin (TCDD)	Snail, Physa sp. (Fw)	Mollusc		Adult	Lab	Model ecosystem	Water	3.1 ng/L	32	Whole body	0.0097	Survival - No effect	N	216, 217	Radiotracer study
2,3,7,8-Tetrachlorodibenzo-p-dioxin (TCDD)	Cladoceran, Daphnia magna (Fw)	Arthropod	Crustacean	Adult	Lab	Model ecosystem	Water	3.1 ng/L	32	Whole body	0.017	Survival - No effect	N	216, 217	Radiotracer study
2,3,7,8-Tetrachlorodibenzo-p-dioxin (TCDD)	Midge, Chironomus tentans (Fw)	Arthropod	Insect	Larvae-Adult	Lab	Renewal	Diet	310 ng/g	35	Whole body	0.138	Survival, Growth, Reproduction - No effect	N	481	Radiotracer study

Notes:

Shaded rows represent the benchmarks selected for use in the risk assessment.

All information presented in this table was extracted from Jarvinen and Ankley, 1999.

* For references, please see the Jarvinen and Ankley, 1999 paper.

Fw = freshwater

ng/g = nanogram per gram

ng/L = nanogram per liter

µg/g = micrograms per gram

TABLE F-10

Literature-based Invertebrate Whole-body Tissue Benchmarks (µg/g, wet weight)
Baseline Ecological Risk Assessment, Halaco Site, Oxnard, California

Analyte	Form	Test Species Type	NOEC			LOEC			Most Similar Halaco Tissue
			NOEC	Test Species	Test Endpoint	LOEC	Test Species	Effect	
Arsenic	Sodium arsenate	Crustacean	1.28	Grass shrimp	Growth	--	--	--	crayfish
Cadmium	Cadmium chloride	Insect	5.6	Midge, Chironomus riparius (Fw)	Survival	7.6	Midge, Chironomus riparius (Fw)	Reduced survival	terrestrial and aquatic insects and spiders
Cadmium	Cadmium chloride	Amphipods	2.6	Amphipod, Hyalella azteca (Fw)	Survival	3	Amphipod, Pontoporeia affinis (Sw)	Reduced reproduction	beach hoppers
Cadmium	Cadmium chloride	Crustacean	--	--	--	1.3	Mysid, Mysidopsis bahia (Sw)	Reduced growth	crayfish
Cadmium	Cadmium chloride	Crayfish	0.9	Crayfish, Orconectes virilis (Fw)	Survival	5.7	Crayfish, Orconectes virilis (Fw)	25% reduction in survival	crayfish
Cadmium	Cadmium chloride	Mollusc	10	Snail, Physa integra (Fw)	Survival	30	Snail, Physa integra (Fw)	80% reduction in survival	snails
Chromium	Potassium dichromate	Amphipods	9.2	Amphipod, Allorchestes compressa (Sw)	Survival, growth	--	--	--	beach hoppers
Chromium	Potassium dichromate	Crustacean	1	Sand crab, Portunus pelagicus (Sw)	Growth	3.2	Sand crab, Portunus pelagicus (Sw)	Reduced growth	crayfish
Copper	Copper chloride	Insect	--	--	--	140.4	Midge, Chironomus decorus (Fw)	50% reduction in survival	terrestrial and aquatic insects and spiders
Copper	Copper sulfate	Amphipods	--	--	--	29.2	Amphipod, Hyalella azteca (Fw)	Reduced growth	beach hoppers
Copper	Copper sulfate	Crustacean	50	Crayfish, Orconectes rusticus (Fw)	Survival	--	--	--	crayfish
Lead	Lead nitrate	Insect	260	Caddisfly, Brachycentrus sp. (Fw)	Survival	--	--	--	terrestrial and aquatic insects and spiders
Lead	Lead nitrate	Amphipods	--	--	--	98	Amphipod, Gammarus pseudolimnaeus (Fw)	50% reduction in survival	beach hoppers
Lead	Lead nitrate	Mollusc	200	Snail, Physa integra (Fw)	Survival	--	--	--	snails
Mercury	Mercuric chloride	Insect	107.6	Midge, Chironomus riparius (Fw)	Survival	--	--	--	terrestrial and aquatic insects and spiders
Mercury	Mercuric chloride	Crustacean	2.1	Grass shrimp, Palaemonetes pugio (Sw)	Survival	--	--	--	crayfish
Mercury	Mercuric chloride	Mollusc	--	--	--	22	Slipper limpet, Crepidula fornicata (Sw)	Reduced growth	snails
Selenium	Sodium selenate	Insect	5.08	Midge, Chironomus decorus (Fw)	Survival	12.6	Midge, Chironomus decorus (Fw)	50% reduction in survival	terrestrial and aquatic insects and spiders
Selenium	6:1 mixture selenate to selenite	Crustacean	0.26	Cladoceran, Daphnia magna (Fw)	Growth, reproduction	6.34	Cladoceran, Daphnia magna (Fw)	Reduced growth and reproduction	crayfish
Zinc		Insect	524	Midge, Chironomus riparius (Fw)	Survival	--	--	--	terrestrial and aquatic insects and spiders
Zinc	Zinc sulfate	Amphipods	--	--	--	24	Amphipod, Allorchestes compressa (Sw)	Reduced growth	beach hoppers
Zinc	Zinc sulfate	Crustacean	12.7	Crayfish, Orconectes virilis (Fw)	Survival	35.2	Crayfish, Orconectes virilis (Fw)	22% reduction in survival	crayfish
2,3,7,8-TCDD		Insect	0.138	Midge, Chironomus tentans (Fw)	Survival, growth, reproduction	--	--	--	terrestrial and aquatic insects and spiders
2,3,7,8-TCDD		Crustacean	0.017	Cladoceran, Daphnia magna (Fw)	Survival	--	--	--	crayfish
2,3,7,8-TCDD		Mollusc	0.0097	Snail, Physa sp. (Fw)	Survival	--	--	--	snails

Notes:

Data extracted from Jarvinen and Ankley (1999)

-- = no data available

LOEC = lowest observed effect concentration

NOEC = no observed effect concentration