Ecological Soil Screening Levels for Chromium

Interim Final

OSWER Directive 9285.7- 66

U.S. Environmental Protection Agency
Office of Solid Waste and Emergency Response
1200 Pennsylvania Avenue, N.W.
Washington, DC 20460

March 2005
Revised April 2008

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TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

LIST OF APPENDICES

1.0 INTRODUCTION

Ecological Soil Screening Levels (Eco-SSLs) are concentrations of contaminants in soil that are protective of ecological receptors that commonly come into contact with and/or consume biota that live in or on soil. Eco-SSLs are derived separately for four groups of ecological receptors: plants, soil invertebrates, birds, and mammals. As such, these values are presumed to provide adequate protection of terrestrial ecosystems. Eco-SSLs are derived to be protective of the conservative end of the exposure and effects species distribution, and are intended to be applied at the screening stage of an ecological risk assessment. These screening levels should be used to identify the contaminants of potential concern (COPCs) that require further evaluation in the site-specific baseline ecological risk assessment that is completed according to specific guidance (U.S. EPA, 1997, 1998, and 1999). The Eco-SSLs are not designed to be used as cleanup levels and the United States (U.S.) Environmental Protection Agency (EPA) emphasizes that it would be inappropriate to adopt or modify the intended use of these Eco-SSLs as national cleanup standards.

The detailed procedures used to derive Eco-SSL values are described in separate documentation (U.S. EPA, 2003). The derivation procedures represent the collaborative effort of a multi-stakeholder team consisting of federal, state, consulting, industry, and academic participants led by the U.S. EPA, Office of Solid Waste and Emergency Response.

This document provides the Eco-SSL values for chromium and the documentation for their derivation. This document provides guidance and is designed to communicate national policy on identifying chromium concentrations in soil that may present an unacceptable ecological risk to terrestrial receptors. The document does not, however, substitute for EPA's statutes or regulations, nor is it a regulation itself. Thus, it does not impose legally-binding requirements on EPA, states, or the regulated community, and may not apply to a particular situation based upon the circumstances of the site. EPA may change this guidance in the future, as appropriate. EPA and state personnel may use and accept other technically sound approaches, either on their own initiative, or at the suggestion of potentially responsible parties, or other interested parties. Therefore, interested parties are free to raise questions and objections about the substance of this document and the appropriateness of the application of this document to a particular situation. EPA welcomes public comments on this document at any time and may consider such comments in future revisions of this document.

2.0 SUMMARY OF ECO-SSLs FOR CHROMIUM

Chromium is the 21st most common element in the earth's crust. Chromium ore deposits are primarily used for metallurgical applications such as the production of stainless steel. Other uses include wood preservation, leather tanning, pigments, and refractories (Barnhardt, 1997). In the natural environment, chromium occurs as two oxidation states or valences: chromium (III) and chromium (VI).

Chromium speciation in soils is complex. Among the factors that affect the speciation of chromium in soil and water and its uptake into animals and plants include: organic matter content, ferrous ion content, redox state, and pH (Outridge and Scheuhammer, 1993; CCME, 1996). In general, chromium (VI) is favored by higher pH, aerobic conditions, low amounts of organic matter and the presence of manganese and iron oxides which oxidize chromium (III). Transformation of chromium (VI) to the trivalent form tends to occur in acidic, anoxic soils with high organic content. Chromium (III) is cationic and adsorbs onto clay particles, organic matter, metal oxyhydroxides, and other negatively charged particles in contrast to chromium (VI) which does not interact significantly with clay or organic matter. As a result, chromium (VI) is more water-soluble and mobile than chromium (III) (Outridge and Scheuhammer, 1993).

Plants are reported to play a major role in the geochemistry of chromium as they contain a significant fraction of the biologically active pool of chromium, approximately three orders of magnitude greater than that found in animal tissues. In contrast to animals, chromium (III) uptake by plants occurs more rapidly than chromium (VI). It is uncertain, however, if chromium is an essential element for plant nutrition although some investigators have observed a stimulatory effect of chromium on plant growth (Outridge and Scheuhammer, 1993).

Chromium has, however, been shown to be an essential nutrient for humans and animals (NRC, 1997). Several reviews are available concerning its role in nutrition (Anderson, 1987; Anderson, 1988; Borel and Anderson, 1984; Prasad, 1978; Underwood, 1977). Chromium (III) has been shown to have antioxidative properties in vivo and it is integral in activating enzymes and maintaining the stability of proteins and nucleic acids. Its primarily metabolic role is to potentiate the action of insulin through its presence in an organometallic molecule called the glucose tolerance factor (GTF).

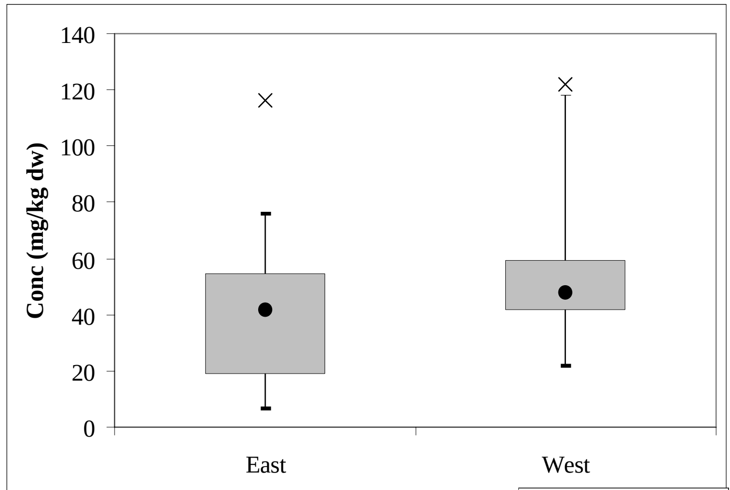
The hexavalent forms of chromium are absorbed three to five times better in the intestine compared to chromium (III) forms. Some evidence suggests that ingested orally, most of the chromium (VI) is believed to be reduced to chromium (III) before reaching sites of absorption in the small intestine (Outridge and Scheuhammer, 1993). Anionic forms of both chromium (III) and chromium (VI) are absorbed more rapidly than the cationic forms (Eastin et al., 1980). Chromium in synthetic organic forms is more readily absorbed and accumulated into tissues compared to the inorganic forms of chromium (NRC, 1997). Chromium toxicosis in ruminants is associated with severe congestion and inflammation of the digestive tract, and kidney and liver damage, with the precipitating properties of chromium believed to be the basis of the tissue damage (Thompson et al., 1991).

The Eco-SSL values derived to date for chromium are summarized in Table 2.1.

Table 2.1 Chromium Eco-SSLs (mg/kg dry weight in soil)

Plants	Soil Invertebrates	Wildlife	
		Avian	Mammalian
Not enough data to derive Eco-SSL.	Not enough data to derive Eco-SSL.	Cr III - 26 Cr VI - NA	Cr III - 34 Cr VI - 130

Eco-SSL values for trivalent chromium were derived for avian and mammalian wildlife. Eco-SSL values for hexavalent chromium were derived for mammalian wildlife. Data were insufficient to derive Eco-SSLs for plants or soil invertebrates. The Eco-SSLs for trivalent chromium range from 26 mg/kg dry weight (dw) for birds to 34 mg/kg dw for mammals. The Eco-SSL for hexavalent chromium for mammals is equal to 130 mg/kg dw. The Eco-SSL values are lower than the 50^{th} percentile of reported background concentrations for both eastern and western U.S. soils (Figure 2.1). Background concentrations reported for many metals in U.S. soils are described in Attachment 1-4 of the Eco-SSL guidance (U.S. EPA, 2003).



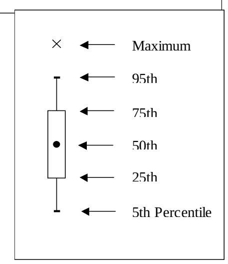


Figure 2.1 Typical Background Concentrations of Chromium in U.S. Soils

3.0 ECO-SSL FOR TERRESTRIAL PLANTS

Of the papers identified from the literature search process, 150 were selected for acquisition for further review. Of those papers acquired, 11 met all 11 Study Acceptance Criteria (U.S. EPA, 2003; Attachment 3-1). Each of these papers were reviewed and the studies were scored according to the Eco-SSL guidance (U.S. EPA, 2003; Attachment 3-2). Thirteen studies received an Evaluation Score greater than ten. These studies are listed in Table 3.1. An Eco-SSL for terrestrial plants could not be calculated from these studies as the endpoints are not acceptable for Eco-SSL derivation (U.S. EPA, 2003). The endpoints are either unbounded values, or EC_{50} values (concentration adversely affecting 50% of the test population) or values that could not be determined.

4.0 ECO-SSL FOR SOIL INVERTEBRATES

Of the papers identified from the literature search process, 31 were selected for acquisition for further review. Of those papers acquired, 4 met all 11 Study Acceptance Criteria (U.S. EPA, 2003; Attachment 3-1). Each of these papers were reviewed and the studies were scored according to the Eco-SSL guidance (U.S. EPA, 2003; Attachment 3-2). Two studies received an Evaluation Score greater than ten. These studies are listed in Table 4.1. There are only two studies eligible for Eco-SSL derivation. At least three studies are required to derive an Eco-SSL for soil invertebrates (U.S. EPA, 2003; Attachment 3-2). An Eco-SSL for soil invertebrates could not be calculated for chromium.

Table 3.1 Plant Toxicity Data - Chromium

Reference	IP Number	Study ID	Test Organism		Soil pH	OM%	Bio-availability Score	ERE	Tox Parameter	Tox Value (Soil Conc mg/kg dw)	Total Evaluation Score	Eligible for Eco-SSL Derivation?	Used for Eco-SSL?
Adema and Henzen, 1989	2125	a	Oat	*Avena sativa*	5.1	3.7	2	GRO	NOAEC	21	13	N	N
Adema and Henzen, 1989	2125	b	Tomato	*Lycopersicon esculentum*	5.1	3.7	2	GRO	NOAEC	20	13	N	N
Adema and Henzen, 1989	2125	c	Lettuce	*Latuca sativa*	5.1	3.7	2	GRO	cnbd	cnbd	13	N	N
Adema and Henzen, 1989	2125	d	Oat	*Avena sativa*	7.5	1.4	1	GRO	NOAEC	24	13	N	N
Adema and Henzen, 1989	2125	e	Tomato	*Lycopersicon esculentum*	7.5	1.4	1	GRO	NOAEC	23	13	N	N
Adema and Henzen, 1989	2125	f	Lettuce	*Latuca sativa*	7.5	1.4	1	GRO	NOAEC	20.4	13	N	N
Gunther and Pestemer, 1990	7099	a	Oat	*Avena sativa*	6.1	2.2	1	GRO	EC_{50}	9	14	N	N
Gunther and Pestemer, 1990	7099	b	Turnip	*Brassica rapa*	6.1	2.2	1	GRO	EC_{50}	3	14	N	N
Kadar and Morvai, 1998	12988	a	Carrot	*Daucus carota*	7.0	1.0	1	GRO	LOAEC	15	11	N	N
Kadar and Morvai, 1998	12988	b	Pea	*Pisum sativum*	7.0	1.0	1	GRO	NOAEC	109	11	N	N
Kadar and Morvai, 1998	12988	c	Carrot	*Daucus carota*	7.0	1.0	1	GRO	NOAEC	138	11	N	N
Kadar and Morvai, 1998	12988	d	Pea	*Pisum sativum*	7.0	1.0	1	GRO	NOAEC	138	11	N	N
Singh and Jeng, 1993	12400		Ryegrass	*Lolium perenne*	5.6	0.7	1	GRO	NOAEC	50	14	N	N

cnbd = could not be determined
EC_{50} = Effect concentration for 50% of test population
ERE = Ecologically relevant endpoint
GRO = Growth
LOAEC = Lowest observed adverse effect concentration
N = No
NOAEC = No observed adverse effect concentration
OM = Organic matter content
Bioavailability Score described in *Guidance for Developing Eco-SSLs* (U.S. EPA, 2003)
Total Evaluation Score described in *Guidance for Developing Eco-SSLs* (U.S. EPA, 2003)

Table 4.1 Invertebrate Toxicity Data - Chromium

Reference	IP Number	Study ID	Test Organism		Soil pH	OM%	Bio-availability Score	ERE	Tox Parameter	Tox Value (Soil Conc. mg/kg dw)	Total Evaluation Score	Eligible for Eco-SSL Derivation?	Used for Eco-SSL?
Van Gestel et al., 1992	12874	a	Earthworm	*Eisenia andrei*	6.7	10.0	1	REP	MATC	57	16	Y	N
Van Gestel et al., 1993	6828		Earthworm	*Eisenia andrei*	6.0	10.0	1	REP	MATC	57	12	Y	N

ERE = Ecologically relevant endpoint
LOAEC = Lowest observed adverse effect concentration
MATC = Maximum acceptable toxicant concentration = geometric mean of NOAEC and LOAEC
N = No
NOAEC = No observed adverse effect concentration
OM = Organic matter content
REP = Reproduction
Y = Yes
Bioavailability Score described in *Guidance for Developing Eco-SSLs* (USEPA, 2003)
Total Evaluation Score described in *Guidance for Developing Eco-SSLs* (USEPA, 2003)

5.0 ECO-SSL FOR AVIAN WILDLIFE

The derivation of the Eco-SSL for avian wildlife was completed as two parts. First, the toxicity reference value (TRV) was derived according to the Eco-SSL guidance (U.S. EPA, 2003; Attachment 4-5). Second, the Eco-SSL (soil concentration) was back-calculated for each of three surrogate species based on the wildlife exposure model (USEPA, 2003; Attachment 4-1), and the TRV (U.S. EPA, 2003).

5.1 Avian TRV

The literature search completed according to the Eco-SSL guidance (U.S. EPA, 2003; Attachment 4-2) identified 704 papers with possible toxicity data for chromium for either avian or mammalian species. Of these papers, 649 were rejected for use as described in Section 7.5. Of the remaining papers, 13 contained data for avian test species. These papers were reviewed and the data were extracted and scored according to the Eco-SSL guidance (U.S. EPA, 2003; Attachment 4-3 and 4-4). The results of the data extraction and review are summarized in Table 5.1 for trivalent chromium. The complete results are included as Appendix 5-1. A TRV could not be derived for hexavalent chromium as there were not enough study results to meet the minimum data requirements. The available hexavalent chromium data extracted and reviewed are included as Appendix 5-2.

Within the reviewed papers, there are 28 results for trivalent chromium for biochemical (BIO), behavior (BEH), physiology (PHY), pathology (PTH), reproduction (REP), growth (GRO), and survival (MOR) effects that meet the Data Evaluation Score of >65 for use to derive the TRV (U.S. EPA, 2003; Attachment 4-4). These data are plotted in Figure 5.1 and correspond directly with the data presented in Table 5.1. The no-observed adverse effect level (NOAEL) results for growth and reproduction are used to calculate a geometric mean NOAEL. This mean NOAEL is examined in relationship to the lowest bounded lowest-observed adverse effect level (LOAEL) for reproduction, growth, and survival to derive the TRV according to procedures in the Eco-SSL guidance (U.S. EPA, 2003; Attachment 4-5).

A geometric mean of the NOAEL values for reproduction and growth was calculated at 2.66 mg chromium/kg bw/day. This value is lower than the lowest bounded LOAEL for reproduction, growth, or survival (Figure 5.1). Therefore, the TRV is equal to the geometric mean of the NOAEL values for reproduction and growth and is equal to 2.66 mg chromium/kg bw/day.

5.2 Estimation of Dose and Calculation of the Eco-SSL

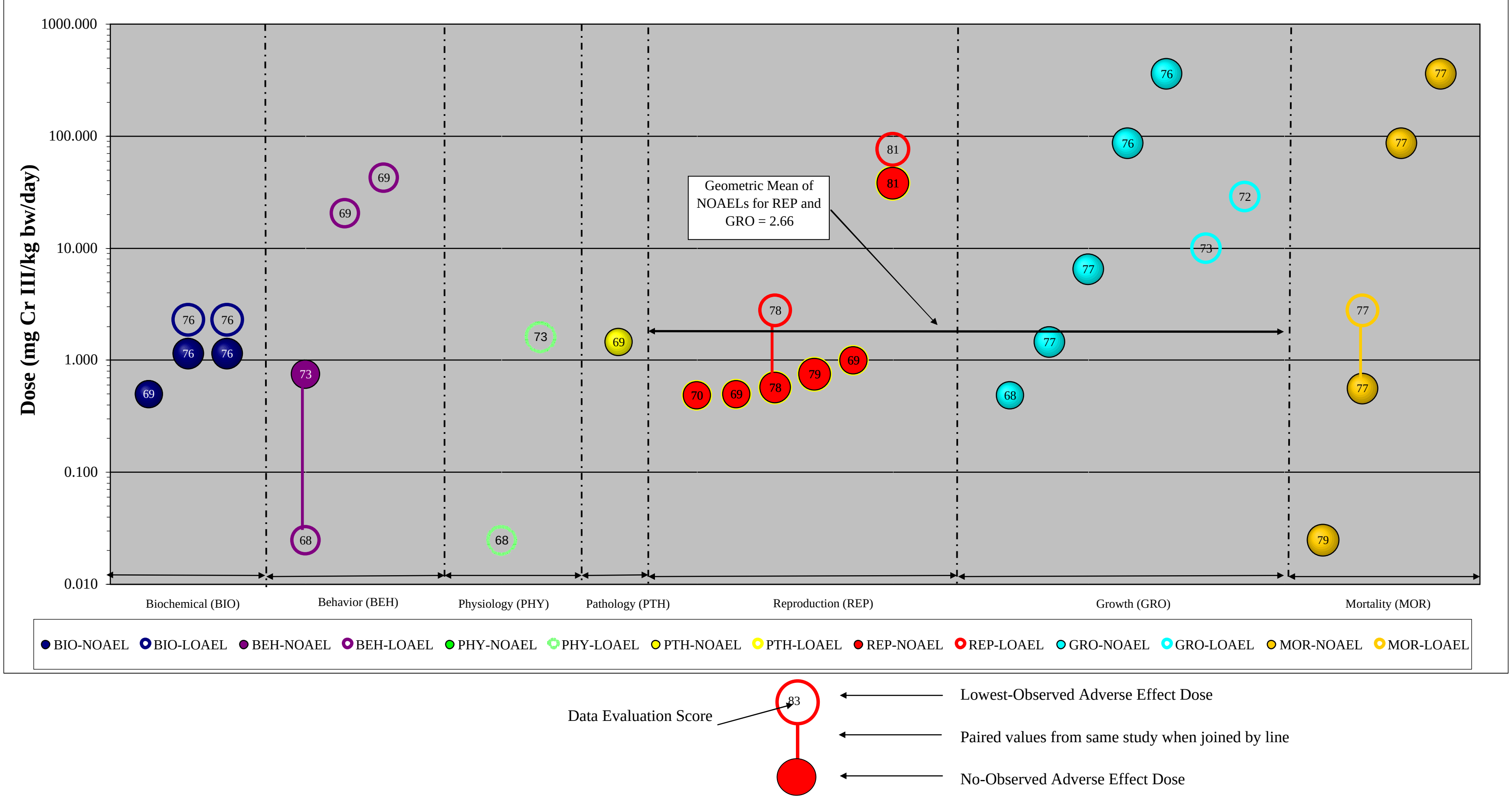
Three separate Eco-SSL values were calculated for avian wildlife, one each for three receptor groups representing different trophic levels. The avian Eco-SSLs for trivalent chromium were calculated according to the Eco-SSL guidance (U.S. EPA, 2003) and are summarized in Table 5.2.

Table 5.1 Avian Toxicity Data Extracted for Wildlife Toxicity Reference Value (TRV)
Trivalent Chromium
Page 1

Result #	Reference	Ref No.	Test Organism	# of Conc/ Doses	Method of Analyses	Route of Exposure	Exposure Duration	Duration Units	Age	Age Units	Lifestage	Sex	Effect Type	Effect Measure	Response Site	NOAEL Dose (mg/kg bw/day)	LOAEL Dose (mg/kg bw/day)	Data Evaluation Score
Biochemical																		
1	Jensen and Maurice, 1980	9749	Chicken (*Gallus domesticus*)	2	U	FD	4	w	NR	NR	LB	F	CHM	GLUC	BL	0.494		69
2	Guerra et al., 2002	25909	Chicken (*Gallus domesticus*)	3	U	FD	28	d	32	w	JV	F	ENZ	GENZ	LI	1.14	2.28	76
3	Guerra et al., 2002	25909	Chicken (*Gallus domesticus*)	3	U	FD	28	d	32	w	JV	F	ENZ	GENZ	LI	1.14	2.28	76
Behavior																		
4	Sauveur and Thapon, 1983	9621	Chicken (*Gallus domesticus*)	2	U	FD	8	w	40	w	AD	F	FDB	FCNS	WO	0.744		73
5	Hossain et al, 1998	11682	Chicken (*Gallus domesticus*)	2	U	FD	19	d	28	d	JV	B	FDB	FCNS	WO		0.0247	68
6	Motozono et al., 1998	3067	Chicken (*Gallus domesticus*)	3	U	FD	35	d	7	d	JV	F	FDB	FCNS	WO		20.4	69
7	Meluzzi et al., 1996	2771	Chicken (*Gallus domesticus*)	4	U	FD	75	d	22	w	AD	F	FDB	FCNS	WO		42.4	69
Physiology																		
8	Hossain et al, 1998	11682	Chicken (*Gallus domesticus*)	2	U	FD	19	d	28	d	JV	B	PHY	FDCV	WO		0.0247	68
9	Steele and Rosebrough, 1979	13720	Turkey (*Meleagris gallopavo*)	4	U	FD	14	d	1	w	JV	B	PHY	FDCV	WO		1.61	73
Pathology																		
10	Cupo and Donaldson, 1987	5971	Chicken (*Gallus domesticus*)	2	U	FD	21	d	1	d	JV	M	ORW	ORWT	LI	1.45		69
Reproduction																		
11	Jensen and Maurice, 1980	9749	Chicken (*Gallus domesticus*)	2	U	FD	4	w	NR	NR	LB	F	REP	TPRD	WO	0.238		78
12	Maurice and Jensen, 1979	12571	Chicken (*Gallus domesticus*)	2	U	FD	12	w	40	w	LB	F	REP	TPRD	WO	0.483		70
13	Jensen and Maurice, 1980	9749	Chicken (*Gallus domesticus*)	2	U	FD	4	w	NR	NR	LB	F	REP	TPRD	WO	0.494		69
14	Haseltine et al., unpublished	3739	Black duck (*Anas rubripes*)	3	U	FD	180-190	d	NR	NR	LB	F	REP	RSUC	WO	0.569	2.78	78
15	Sauveur and Thapon, 1983	9621	Chicken (*Gallus domesticus*)	2	U	FD	8	w	40	w	LB	F	REP	TPRD	WO	0.744		79
16	Ousterhout and Berg, 1981	6508	Chicken (*Gallus domesticus*)	2	U	FD	6	d	50	w	LB	F	EGG	ESQU	SL	0.988		69
17	Meluzzi et al., 1996	2771	Chicken (*Gallus domesticus*)	4	U	FD	15	d	22	w	LB	F	EGG	ALWT	EG	37.7	75.4	81
Growth																		
18	Maurice and Jensen, 1979	12571	Chicken (*Gallus domesticus*)	2	U	FD	12	w	40	w	SM	F	GRO	BDWT	WO	0.483		68
19	Cupo and Donaldson, 1987	5971	Chicken (*Gallus domesticus*)	2	U	FD	21	d	1	d	JV	M	GRO	BDWT	WO	1.45		77
20	Steele and Rosebrough, 1979	13720	Turkey (*Meleagris gallopavo*)	4	U	FD	14	d	1	w	JV	B	GRO	BDWT	WO	6.42		77
21	Hill, 1974	92	Chicken (*Gallus domesticus*)	2	U	FD	2	w	1	d	JV	B	GRO	BDWT	WO	85.9		76
22	Hafez and Kratzer, 1976	8663	Chicken (*Gallus domesticus*)	3	U	FD	4	w	1	d	AD	M	GRO	BDWT	WO	359		76
23	Motozono et al., 1998	3067	Chicken (*Gallus domesticus*)	3	U	FD	35	d	7	d	JV	F	GRO	BDWT	WO		9.91	73
24	Nielsen et al, 1980	15690	Chicken (*Gallus domesticus*)	2	U	FD	4	w	1	d	JV	M	GRO	BDWT	WO		28.7	72
Survival																		
25	Hossain et al, 1998	11682	Chicken (*Gallus domesticus*)	2	U	FD	19	d	28	d	JV	B	MOR	MORT	WO	0.0248		79
26	Haseltine et al., unpublished	3739	Black duck (*Anas rubripes*)	3	U	FD	10	m	NR	NR	MA	M	MOR	MORT	WO	0.557	2.78	77
27	Hill, 1974	92	Chicken (*Gallus domesticus*)	2	U	FD	5	w	1	d	JV	B	MOR	MORT	WO	85.9		77
28	Hafez and Kratzer, 1976	8663	Chicken (*Gallus domesticus*)	3	U	FD	4	w	1	d	AD	M	MOR	MORT	WO	359		77

AD = adult; ALWT = albumin weight; B = both sexes; BDWT = body weight changes; BL = blood; CHM = chemical changes; d = days; EG = egg; EGG = effects on eggs; ENZ = enzyme changes; ESQU = eggshell quality; F= female; FCNS = food comsumption; FD =food; FDB = feeding behavior; FDCV = feed conversion efficiency; GENZ = general enzyme changes; GLUC = glucose; GRO= growth; JV = juvenile; LB = laying bird; LI = liver; m = months; M = male; MA = mature; MOR = effects on survival; MORT = mortality; NR = not reported; ORW = organ weight changes; ORWT = Organ weight changes; PHY = physiology; REP = reproductive effects; RSUC = reproductive success; SL = spleen; SM = sexually mature; TPRD = total production; U = unmeasured; w = weeks; WO = whole organism.

Figure 5.1 Avian TRV Derivation for Trivalent Chromium



<u>Wildlife TRV Derivation Process</u>

1) There are at least three results available for two test species within the growth, reproduction, and mortality effect groups. There are enough data to derive a TRV.

2) There are three NOAEL results available for calculation of a geometric mean.

4) The geometric mean is equal to 2.66 mg/kg bw/d and is higher than the lowest bounded LOAEL within the reproduction, growth, and survival effect groups.

5) The avian wildlife TRV for trivalent chromium is equal to 2.66 mg chromium/kg bw/day which is the geometric mean of NOAEL values for growth, and reproduction.

Table 5.2 Calculation of the Avian Eco-SSLs for Trivalent Chromium					
Surrogate Receptor Group	**TRV for Trivalent Chromium (mg dw/kg bw/d)** [1]	**Food Ingestion Rate (FIR)**[2] **(kg dw/kg bw/d)**	**Soil Ingestion as Proportion of Diet (P_s)**[2]	**Concentration of Chromium in Biota Type (i)**[2,3] **(B_i) (mg/kg dw)**	**Eco-SSL (mg/kg dw)**[4]
Avian herbivore (dove)	2.66	0.190	0.139	B_i = 0.041 * $Soil_j$ where i = plants	78
Avian ground insectivore (woodcock)	2.66	0.214	0.164	B_i = 0.306 * $Soil_j$ where i = earthworms	26
Avian carnivore (hawk)	2.66	0.0353	0.057	$\ln(B_i)$ = 0.7338 * $\ln(Soil_j)$ - 1.4599 where i = mammals	780

[1] The process for derivation of wildlife TRVs is described in Attachment 4-5 of U.S. EPA (2003).
[2] Parameters (FIR, P_s, B_i values, regressions) are provided in U.S. EPA (2003) Attachment 4-1 (revised February 2005).
[3] B_i = Concentration in biota type (i) which represents 100% of the diet for the respective receptor.
[4] HQ = FIR * ($Soil_j$ * P_s + B_i) / TRV) solved for HQ=1 where $Soil_j$ = Eco-SSL (Equation 4-2; U.S. EPA, 2003).
NA = Not Applicable

6.0 ECO-SSL FOR MAMMALIAN WILDLIFE

The derivation of the Eco-SSL for mammalian wildlife was completed as two parts. First, the TRV was derived according to the Eco-SSL guidance (U.S. EPA, 2003; Attachment 4-5). Second, the Eco-SSL (soil concentration) was back-calculated for each of three surrogate species based on the wildlife exposure model (USEPA, 2003; Attachment 4-1), and the TRV (U.S. EPA, 2003).

6.1 Mammalian TRV

The literature search was completed according to the Eco-SSL guidance (U.S. EPA, 2003; Attachment 4-2) and identified 704 papers with possible toxicity data for chromium for either avian or mammalian species. Of these studies, 649 were rejected for use as described in Section 7.5. Of the remaining papers, 20 contained data for mammalian test species. These papers were reviewed and the data were extracted and scored according to the Eco-SSL guidance (U.S. EPA, 2003; Attachment 4-3). The results of the data extraction and review are summarized in Table 6.1 for trivalent chromium and Table 6.2 for hexavalent chromium. The complete results are provided in Appendices 6-1 and 6-2 for trivalent and hexavalent chromium, respectively.

Within the 20 papers there are 33 results for biochemical (BIO), behavioral (BEH), physiology (PHY), pathology (PTH), reproduction (REP), growth (GRO), and survival (MOR) endpoints with a total Data Evaluation Score >65 that were used to derive the TRV (U.S. EPA, 2003; Attachment 4-4) for trivalent chromium. These data are plotted in Figure 6.1 and correspond directly with the data presented in Table 6.1. There are 71 results for hexavalent chromium. These data are plotted in Figure 6.2 and correspond directly with the data presented in Table 6.2. The NOAEL results for growth and reproduction are used to calculate a geometric mean NOAEL. This mean NOAEL is examined in relationship to the lowest bounded LOAEL for reproduction, growth, and survival to derive the TRV according to procedures in the Eco-SSL guidance (U.S. EPA, 2003; Attachment 4-5).

For trivalent chromium, a geometric mean of the NOAEL values for reproduction and growth was calculated at 2.40 mg chromium/kg bw/day. There are no bounded LOAEL values for reproduction, growth or mortality results for comparison. Therefore, the TRV is equal to the geometric mean of NOAEL values for reproduction and growth and is equal to 2.40 mg chromium/kg bw/day.

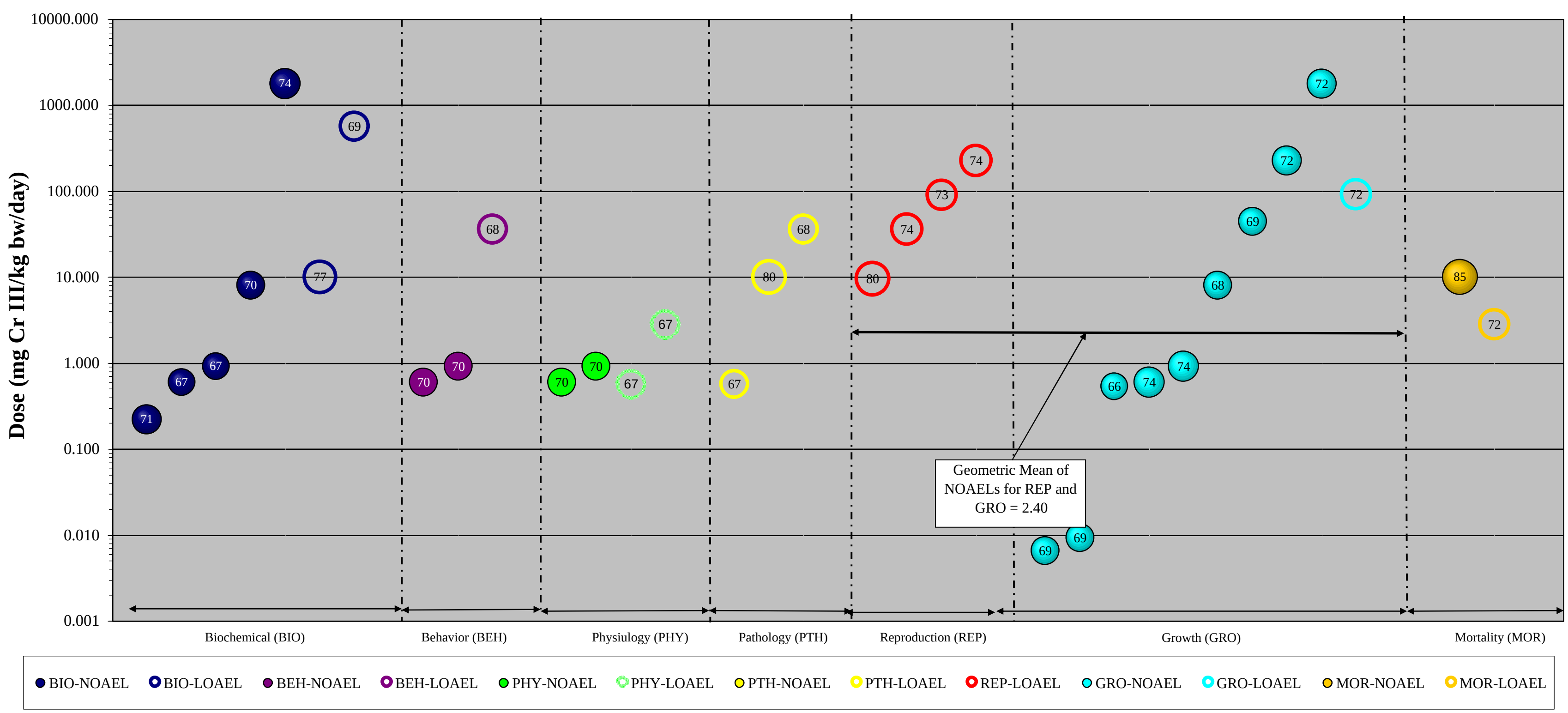
For hexavalent chromium, a geometric mean of the NOAEL values for reproduction and growth was calculated at 9.24 mg chromium/kg bw/day. The geometric mean is lower than the lowest bounded LOAEL value for reproduction, growth and survival results. Therefore, the TRV is equal to the geometric mean of NOAEL values for reproduction and growth and is equal to 9.24 mg chromium/kg bw/day.

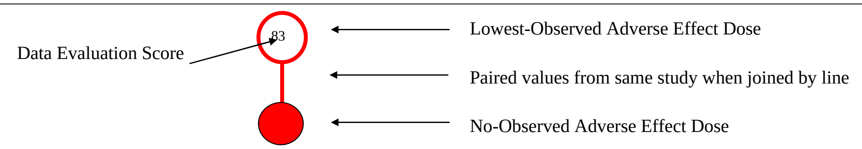
Table 6.1 Mammalian Toxicity Data Extracted for Wildlife Toxicity Reference Value (TRV)
Trivalent Chromium
Page 1 of 1

Result #	Reference	Ref No.	Test Organism	# of Conc/ Doses	Method of Analyses	Route of Exposure	Exposure Duration	Duration Units	Age	Age Units	Lifestage	Sex	Effect Type	Effect Measure	Response Site	NOAEL Dose (mg/kg bw/day)	LOAEL Dose (mg/kg bw/day)	Data Evaluation Score
Biochemical																		
1	Samsell and Spears, 1989	13415	Sheep (*Ovis aries*)	2	U	FD	28	d	9	mo	JV	F	CHM	GLUC	PL	0.222		71
2	Mooney and Cromwell, 1997	25905	Pig (*Sus scrofa*)	2	M	FD	103	d	NR	NR	JV	B	CHM	PRTL	SR	0.595		67
3	Mooney and Cromwell, 1997	25905	Pig (*Sus scrofa*)	3	M	FD	35	d	NR	NR	JV	B	CHM	PRTL	SR	0.927		67
4	Anderson et al., 1997	3004	Rat (*Rattus norvegicus*)	5	U	FD	20	w	4	w	JV	NR	CHM	GLUC	SR	8.09		70
5	Ivankovic and Preussmann, 1975	3729	Rat (*Rattus norvegicus*)	3	U	FD	90	d	100	d	SM	F	CHM	HMGL	BL	1770		74
6	Meenakshi et al., 1989	3061	Rat (*Rattus norvegicus*)	2	U	GV	60	d	NR	NR	JV	M	CHM	GLUC	BL		10.0	77
7	Cobo et al 1995	15198	Rat (*Rattus norvegicus*)	2	M	DR	8	w	NR	NR	JV	M	CHM	GBIO	BL		565	69
Behavior																		
8	Mooney and Cromwell, 1997	25905	Pig (*Sus scrofa*)	2	M	FD	103	d	NR	NR	JV	B	FDB	FCNS	WO	0.595		70
9	Mooney and Cromwell, 1997	25905	Pig (*Sus scrofa*)	3	M	FD	35	d	NR	NR	JV	B	FDB	FCNS	WO	0.927		70
10	Bataineh et al., 1997	3009	Rat (*Rattus norvegicus*)	2	U	DR	12	w	NR	NR	AD	M	BEH	AGGT	WO		36.2	68
Physiology																		
11	Mooney and Cromwell, 1997	25905	Pig (*Sus scrofa*)	2	M	FD	103	d	NR	NR	JV	B	PHY	FDCV	WO	0.595		70
12	Mooney and Cromwell, 1997	25905	Pig (*Sus scrofa*)	3	M	FD	35	d	NR	NR	JV	B	PHY	FDCV	WO	0.927		70
13	Kanisawa and Schroeder, 1969	15061	Rat (*Rattus norvegicus*)	2	U	DR	17	mo	21	d	JV	B	PHY	BLPR	BL		0.569	67
14	Mercado and Bibby 1973	757	Rat (*Rattus norvegicus*)	2	U	DR	50	d	23	d	JV	M	PHY	GPHY	TH		2.82	67
Pathology																		
15	Kanisawa and Schroeder, 1969	15061	Rat (*Rattus norvegicus*)	2	U	DR	30	mo	21	d	JV	B	HIS	GSLN	KI		0.569	67
16	Meenakshi et al., 1989	3061	Rat (*Rattus norvegicus*)	2	U	GV	60	d	NR	NR	JV	M	HIS	NCRO	LI		10.0	80
17	Bataineh et al., 1997	3009	Rat (*Rattus norvegicus*)	2	U	DR	12	w	NR	NR	AD	M	GRS	BDWT	WO		36.2	68
Reproduction																		
18	Zahid et al., 1990	3098	Mouse (*Mus musculus*)	4	U	FD	35	d	21	d	JV	M	REP	SPCL	TE		9.62	80
19	Bataineh et al., 1997	3009	Rat (*Rattus norvegicus*)	2	U	DR	12	w	NR	NR	AD	M	REP	TEWT	TE		36.2	74
20	Elbetieha and Al-Hamood, 1997	3025	Mouse (*Mus musculus*)	3	U	DR	12	w	50	d	JV	F	REP	PROG	WO		91.1	73
21	Elbetieha and Al-Hamood, 1997	3025	Mouse (*Mus musculus*)	2	U	DR	12	w	50	d	JV	M	REP	ORWT	OV		228	74
Growth																		
22	Van Heugten and Spears, 1997	25908	Pig (*Sus scrofa*)	2	U	FD	32	d	3	w	JV	NR	GRO	BDWT	WO	0.00663		69
23	Kegley and Spears, 1995	25914	Cattle (*Bos taurus*)	2	U	FD	56	d	NR	NR	JV	M	GRO	BDWT	WO	0.00933		69
24	Shroeder et al., 1963	14446	Rat (*Rattus norvegicus*)	2	U	DR	60	d	28	d	JV	M	GRO	BDWT	WO	0.537		66
25	Mooney and Cromwell, 1997	25905	Pig (*Sus scrofa*)	2	M	FD	103	d	NR	NR	JV	B	GRO	BDWT	WO	0.595		74
26	Mooney and Cromwell, 1997	25905	Pig (*Sus scrofa*)	3	M	FD	35	d	NR	NR	JV	B	GRO	BDWT	WO	0.927		74
27	Anderson et al., 1997	3004	Rat (*Rattus norvegicus*)	5	U	FD	20	w	4	w	JV	NR	GRO	BDWT	WO	8.09		68
28	Zahid et al., 1990	3098	Mouse (*Mus musculus*)	4	U	FD	35	d	21	d	JV	M	GRO	BDWT	WO	44.6		69
29	Elbetieha and Al-Hamood, 1997	3025	Mouse (*Mus musculus*)	2	U	DR	12	w	50	d	JV	M	GRO	BDWT	WO	228		72
30	Ivankovic and Preussmann, 1975	3729	Rat (*Rattus norvegicus*)	3	U	FD	90	d	100	d	SM	F	GRO	BDWT	WO	1770		72
31	Elbetieha and Al-Hamood, 1997	3025	Mouse (*Mus musculus*)	3	U	DR	12	w	50	d	JV	M	GRO	BDWT	WO		92.1	72
Survival																		
32	Meenakshi et al., 1989	3061	Rat (*Rattus norvegicus*)	2	U	GV	60	d	NR	NR	JV	M	MOR	MORT	WO	10.0		85
33	Mercado and Bibby 1973	757	Rat (*Rattus norvegicus*)	2	U	DR	50	d	23	d	JV	M	MOR	MORT	WO		2.82	72

AD = adult; AGGT = aggression; B = both; BEH = behavior; BDWT = body weight changes; BEH = behavior; BL = blood; BLPR = blood pressure; CHM = chemical changes; d = days; DR = drinking; F = female; FCNS= food consumption; FD = food; FDB = feeding behavior; FDCV = food conversion efficiency; GBIO = general biochemical; GLUC = glucose; GPHY = general physiology; GRO = growth; GRS = gross body weight changes; GSLN = gross lesions; GV = gavage; HMGL = hemoglobin; HIS = histology; JV = juvenile; KI = kidney; LI = liver; M = male; M = measured; mo = months; MOR = effects on survival; MORT = mortality; NCRO = necrosis; NR = not reported; ORWT = organ weight changes; OV = ovary; PHY = physiology; PL = plasma; PROG = progeny counts or numbers; PRTL = total protein; REP = reproduction; SM = sexually mature; SPCL = sperm cell counts; SR = serum; TE = testes; TEWT = testes weight; TH = teeth; U = unmeasured; w = weeks; WO = whole organism.

Figure 6.1 Mammalian TRV Derivation for Trivalent Chromium





<u>Wildlife TRV Derivation Process</u>

1) There are at least three results available for two test species within the growth, reproduction, and mortality effect groups. There are enough data to derive a TRV.

2) There are three NOAEL results available for calculation of a geometric mean.

4) The geometric mean is equal to 2.40 mg/kg bw/d. There are no bounded LOAEL values for comparison.

5) The mammalian wildlife TRV for trivalent chromium is equal to 2.40 mg chromium/kg bw/day which is the geometric mean NOAEL for effects on growth and reproduction.

Table 6.2 Mammalian Toxicity Data Extracted for Wildlife Toxicity Reference Value (TRV)
Hexavalent Chromium

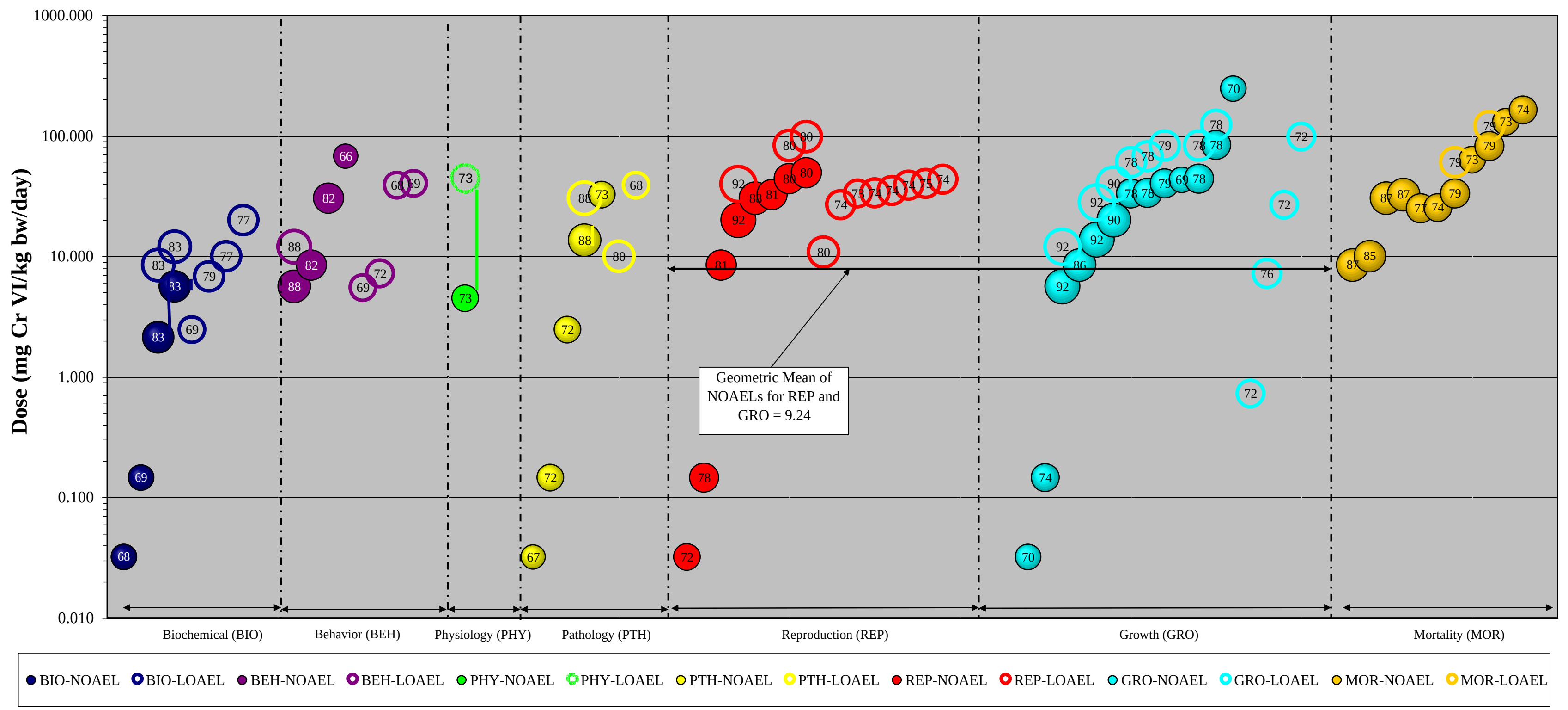
Result #	Reference	Ref No.	Test Organism	# of Conc/ Doses	Method of Analyses	Route of Exposure	Exposure Duration	Duration Units	Age	Age Units	Lifestage	Sex	Effect Type	Effect Measure	Response Site	NOAEL Dose (mg/kg bw/day)	LOAEL Dose (mg/kg bw/day)	Data Evaluation Score
Biochemical																		
1	Rao et al, 1983	3074	Mouse (*Mus musculus*)	2	M	FD	1	yr	NR	NR	JV	M	CHM	HMGL	BL	0.0322		68
2	Rao et al., 1981	3073	Rat (*Rattus norvegicus*)	2	M	FD	1	yr	NR	NR	JV	F	CHM	HMGL	BL	0.146		69
3	R.O.W. Sciences, Inc.	25925	Rat (*Rattus norvegicus*)	5	UX	FD	9	w	9	w	JV	M	CHM	MCPV	BL	2.12	8.48	83
4	R.O.W. Sciences, Inc.	25927	Mouse (*Mus musculus*)	5	UX	FD	3	w	9	w	JV	M	CHM	MCPV	BL	5.66	12.0	83
5	Vyskocil et al., 1993	3095	Rat (*Rattus norvegicus*)	2	U	DR	6	mo	8	w	JV	F	CHM	ALBM	UR		2.47	69
6	R.O.W.Sciences Inc, 1997	25926	Mouse (*Mus musculus*)	4	UX	FD	14	w	10	w	GE	F	CHM	MCPV	BL		6.86	79
7	Meenakshi et al., 1989	3061	Rat (*Rattus norvegicus*)	2	U	GV	60	d	NR	NR	JV	F	CHM	GLUC	BL		10.0	77
8	Chowdhury and Mitra, 1995	3020	Rat (*Rattus norvegicus*)	4	U	GV	90	d	NR	NR	JV	M	HRM	TSTR	SR		20.0	77
Behavior																		
9	R.O.W. Sciences, Inc.	25927	Mouse (*Mus musculus*)	5	UX	FD	9	w	9	w	JV	M	FDB	WCON	WO	5.66	12.0	88
10	R.O.W. Sciences, Inc.	25925	Rat (*Rattus norvegicus*)	5	UX	FD	9	w	9	w	JV	M	FDB	FCNS	WO	8.48		82
11	R.O.W.Sciences Inc, 1997	25926	Mouse (*Mus musculus*)	4	UX	FD	14	w	10	w	GE	F	FDB	FCNS	WO	30.3		82
12	Al-Hamood et al., 1998	3003	Mouse (*Mus musculus*)	2	U	DR	29	d	NR	NR	GE	F	FDB	WCON	WO	68.1		66
13	Gribble, 1974	11440	Mouse (*Mus musculus*)	2	U	DR	7	d	7	w	JV	F	FDB	WCON	WO		5.50	69
14	Gates et al, 1947	3029	Rat (*Rattus norvegicus*)	4	U	DR	5	d	NR	NR	JV	B	FDB	WCON	WO		7.20	72
15	Bataineh et al., 1997	3009	Rat (*Rattus norvegicus*)	2	U	DR	12	w	NR	NR	AD	M	BEH	AGGT	WO		38.7	68
16	Trivedi et al., 1989	31	Mouse (*Mus musculus*)	4	U	DR	19	d	NR	NR	GE	F	FDB	WCON	WO		40.5	69
Physiology																		
17	Diaz-Mayans et al., 1986	3023	Rat (*Rattus norvegicus*)	3	U	DR	28	d	NR	NR	SM	M	PHY	EXCR	UR	4.47	44.7	73
Pathology																		
18	Rao et al, 1983	3074	Mouse (*Mus musculus*)	2	M	FD	1	yr	NR	NR	JV	M	ORW	SMIX	KI	0.0322		67
19	Rao et al., 1981	3073	Rat (*Rattus norvegicus*)	2	M	FD	1	yr	NR	NR	JV	F	ORW	SMIX	LI	0.146		72
20	Vyskocil et al., 1993	3095	Rat (*Rattus norvegicus*)	2	U	DR	6	mo	8	w	JV	F	ORW	SMIX	KI	2.47		72
21	R.O.W.Sciences Inc, 1997	25926	Mouse (*Mus musculus*)	4	UX	FD	14	w	10	w	GE	F	ORW	ORWT	LI	13.6	30.3	88
22	R.O.W. Sciences, Inc.	25927	Mouse (*Mus musculus*)	5	UX	FD	9	w	9	w	JV	M	HIS	GHIS	MT	32.5		73
23	Meenakshi et al., 1989	3061	Rat (*Rattus norvegicus*)	2	U	GV	60	d	NR	NR	JV	F	HIS	NCRO	LI		10.0	80
24	Bataineh et al., 1997	3009	Rat (*Rattus norvegicus*)	2	U	DR	12	w	NR	NR	AD	M	GRS	BDWT	WO		38.7	68
Reproduction																		
25	Rao et al, 1983	3074	Mouse (*Mus musculus*)	2	M	FD	1	yr	NR	NR	JV	M	REP	TEWT	TE	0.0322		72
26	Rao et al., 1981	3073	Rat (*Rattus norvegicus*)	2	M	FD	1	yr	NR	NR	JV	M	REP	TEWT	TE	0.146		78
27	R.O.W. Sciences, Inc.	25925	Rat (*Rattus norvegicus*)	5	UX	FD	9	w	9	w	JV	M	REP	SPCL	TE	8.48		81
28	Chowdhury and Mitra, 1995	3020	Rat (*Rattus norvegicus*)	4	U	GV	90	d	NR	NR	JV	M	REP	TEWT	TE	20.0	40.0	92
29	R.O.W.Sciences Inc, 1997	25926	Mouse (*Mus musculus*)	4	UX	FD	14	w	10	w	GE	F	REP	PROG	WO	30.3		88
30	R.O.W. Sciences, Inc.	25927	Mouse (*Mus musculus*)	5	UX	FD	9	w	9	w	JV	M	REP	GREP	SM	32.5		81
31	Junaid et al., 1996	3047	Mouse (*Mus musculus*)	4	U	DR	8	d	NR	NR	GE	F	REP	PROG	WO	44.2	82.9	80
32	Elbetieha and Al-Hamood, 1997	3025	Mouse (*Mus musculus*)	5	U	DR	12	w	50	d	JV	M	REP	TEWT	TE	49.4	98.7	80
33	Zahid et al., 1990	3098	Mouse (*Mus musculus*)	4	U	FD	35	d	21	d	JV	M	REP	TEDG	TE		10.8	80
34	Kanojia et al., 1996	3049	Rat (*Rattus norvegicus*)	4	U	DR	39	d	120	d	GE	F	REP	PROG	WO		26.8	74
35	Kanojia et al., 1998	3050	Rat (*Rattus norvegicus*)	4	U	DR	3	mo	50	d	JV	F	REP	PRWT	WO		33.2	73
36	Junaid et al., 1995	3045	Mouse (*Mus musculus*)	4	U	DR	6	d	4	mo	GE	F	REP	PRWT	WO		33.7	74
37	Murthy et al., 1996	3068	Mouse (*Mus musculus*)	4	U	DR	20	d	90	d	SM	F	REP	GREP	OV		35.1	74
38	Bataineh et al., 1997	3009	Rat (*Rattus norvegicus*)	2	U	DR	12	w	NR	NR	AD	M	REP	TEWT	TE		38.7	74
39	Trivedi et al., 1989	31	Mouse (*Mus musculus*)	4	U	DR	19	d	NR	NR	GE	F	REP	RSEM	WO		40.5	75
40	Junaid et al., 1996	3046	Mouse (*Mus musculus*)	4	U	DR	20	d	4	mo	GE	F	REP	PRWT	WO		43.7	74
41	Elbetieha and Al-Hamood, 1997	3025	Mouse (*Mus musculus*)	3	U	DR	12	w	50	d	JV	M	REP	TEWT	TE		98.7	74
42	Elbetieha and Al-Hamood, 1997	3025	Mouse (*Mus musculus*)	2	U	DR	12	w	50	d	JV	F	REP	ORWT	OV		246	74
Growth																		
43	Rao et al, 1983	3074	Mouse (*Mus musculus*)	2	M	FD	1	yr	NR	NR	JV	M	GRO	BDWT	WO	0.0322		70
44	Rao et al., 1981	3073	Rat (*Rattus norvegicus*)	2	M	FD	1	yr	NR	NR	JV	M	GRO	BDWT	WO	0.146		74
45	R.O.W. Sciences, Inc.	25927	Mouse (*Mus musculus*)	5	UX	FD	3	w	9	w	JV	F	GRO	BDWT	WO	5.66	12.0	92
46	R.O.W. Sciences, Inc.	25925	Rat (*Rattus norvegicus*)	5	UX	FD	9	w	9	w	JV	M	GRO	BDWT	WO	8.48		86
47	R.O.W.Sciences Inc, 1997	25926	Mouse (*Mus musculus*)	4	UX	FD	16	w	10	w	LC	F	GRO	BDWT	WO	13.8	28.0	92
48	Chowdhury and Mitra, 1995	3020	Rat (*Rattus norvegicus*)	4	U	GV	90	d	NR	NR	JV	M	GRO	BDWT	WO	20.0	40.0	90
49	Kanojia et al., 1998	3050	Rat (*Rattus norvegicus*)	4	U	DR	3	mo	50	d	JV	F	GRO	BDWT	WO	33.2	60.6	78
50	Junaid et al., 1995	3045	Mouse (*Mus musculus*)	4	U	DR	6	d	4	mo	GE	F	GRO	BDWT	WO	33.7	67.4	78
51	Trivedi et al., 1989	31	Mouse (*Mus musculus*)	4	U	DR	19	d	NR	NR	GE	F	GRO	BDWT	WO	40.5	82.8	79
52	Zahid et al., 1990	3098	Mouse (*Mus musculus*)	4	U	FD	35	d	21	d	JV	M	GRO	BDWT	WO	43.2		69
53	Junaid et al., 1996	3047	Mouse (*Mus musculus*)	4	U	DR	8	d	NR	NR	GE	F	GRO	BDWT	WO	44.2	82.9	78
54	Junaid et al., 1996	3046	Mouse (*Mus musculus*)	4	U	DR	20	d	4	mo	GE	F	GRO	BDWT	WO	84.0	123	78
55	Elbetieha and Al-Hamood, 1997	3025	Mouse (*Mus musculus*)	2	U	DR	12	w	50	d	JV	F	GRO	BDWT	WO	246		70
56	Schroeder and Mitchener, 1971	3085	Mouse (*Mus musculus*)	2	U	DR	10	d	19-20	d	JV	M	GRO	BDWT	WO		0.730	72
57	Gates et al, 1947	3029	Rat (*Rattus norvegicus*)	4	U	DR	5	d	NR	NR	JV	B	GRO	BDWT	WO		7.20	76

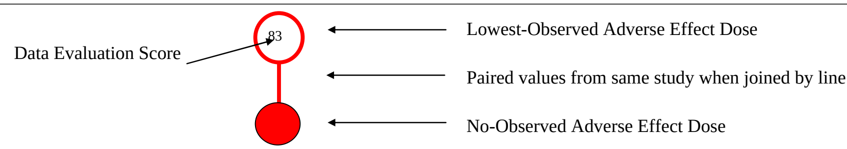
Table 6.2 Mammalian Toxicity Data Extracted for Wildlife Toxicity Reference Value (TRV)
Hexavalent Chromium
2 of 2

Result #	Reference	Ref No.	Test Organism	# of Conc/ Doses	Method of Analyses	Route of Exposure	Exposure Duration	Duration Units	Age	Age Units	Lifestage	Sex	Effect Type	Effect Measure	Response Site	NOAEL Dose (mg/kg bw/day)	LOAEL Dose (mg/kg bw/day)	Data Evaluation Score
58	Kanojia et al., 1996	3049	Rat (*Rattus norvegicus*)	4	U	DR	39	d	120	d	GE	F	GRO	BDWT	WO		26.8	72
59	Elbetieha and Al-Hamood, 1997	3025	Mouse (*Mus musculus*)	3	U	DR	12	w	50	d	JV	M	GRO	BDWT	WO		98.7	72
Survival																		
60	R.O.W. Sciences, Inc.	25925	Rat (*Rattus norvegicus*)	5	UX	FD	9	w	9	w	JV	M	MOR	MORT	WO	8.48		87
61	Meenakshi et al., 1989	3061	Rat (*Rattus norvegicus*)	2	U	GV	60	d	NR	NR	JV	F	MOR	MORT	WO	10.0		85
62	R.O.W.Sciences Inc, 1997	25926	Mouse (*Mus musculus*)	4	UX	FD	14	w	10	w	GE	F	MOR	MORT	WO	30.3		87
63	R.O.W. Sciences, Inc.	25927	Mouse (*Mus musculus*)	5	UX	FD	9	w	9	w	JV	M	MOR	MORT	WO	32.5		87
64	Gates et al, 1947	3029	Rat (*Rattus norvegicus*)	4	U	DR	25	d	NR	NR	JV	B	MOR	MORT	WO	25.0		77
65	Diaz-Mayans et al., 1986	3023	Rat (*Rattus norvegicus*)	3	U	DR	28	d	NR	NR	SM	M	MOR	MORT	WO	25.4		74
66	Kanojia et al., 1998	3050	Rat (*Rattus norvegicus*)	4	U	DR	3	mo	50	d	JV	F	MOR	MORT	WO	33.2	60.6	79
67	Kanojia et al., 1996	3049	Rat (*Rattus norvegicus*)	4	U	DR	39	d	120	d	GE	F	MOR	MORT	WO	63.7		73
68	Junaid et al., 1996	3046	Mouse (*Mus musculus*)	4	U	DR	20	d	4	mo	SM	F	MOR	MORT	WO	82.1	121	79
69	Junaid et al., 1996	3047	Mouse (*Mus musculus*)	4	U	DR	8	d	NR	NR	GE	F	MOR	MORT	WO	131		73
70	Trivedi et al., 1989	31	Mouse (*Mus musculus*)	4	U	DR	19	d	NR	NR	GE	F	MOR	MORT	WO	163		74

AD = adult; AGGT = agression; ALBM = albumins; B = both; BEH = behavior; BDWT = body weight changes; BEH = behavior; BL = blood; CHM = chemical changes; d = days; DR = drinking water; EXCR = excretion; F = female; FCNS = food consumption; FD = food; FDB = feeding behavior; GE = gestational; GHIS = general histology; GLUC = glucose; GREP = general reproduction; GRO = growth; GRS = gross body weight changes; GV = gavage; HIS = histology; HMGL = hemoglobin; HRM = hormone changes; JV = juvenile; KI = kidney; LC = lactation; LI = liver; M = male; M = measured; MCPV = mean corpuscular volume; mo = months; MOR = mortality; MORT = mortality; MT = multiple; NCRO = necrosis; NR = not reported; ORW = organ weight changes ORWT = organ weight changes (absolute); OV = oviduct; PHY = physiology; PROG = progeny counts or numbers; PRWT = progeny weight; REP = reproduction; RSEM = resorbed embryos; SM = sexually mature; SM = sperm;SMIX = weight relative to body weight; SPCL = sperm cell counts; SR = serum; TE = testes; TEDG = testes degeneration; TEWT = testes weight; TSTR = testosterone; U = unmeasured; UR = urine; UX = measured but concentrations not reported; w = weeks; WCON = water consumption; WO = whole organism; yr = years.

Figure 6.2 Mammalian TRV Derivation for Hexavalent Chromium





<u>Wildlife TRV Derivation Process</u>

1) There are at least three results available for two test species within the growth, reproduction, and mortality effect groups. There are enough data to derive a TRV.

2) There are three NOAEL results available for calculation of a geometric mean.

4) The geometric mean is equal to 9.24 mg/kg bw/d. The geometric mean is lower than the lowest bounded LOAEL for growth, reproduction or mortality.

5) The mammalian wildlife TRV for hexavalent chromium is equal to 9.24 mg chromium/kg bw/day which is equal to the geometric mean of NOAEL values for reproduction and growth.

6.2 Estimation of Dose and Calculation of the Eco-SSL

Three separate Eco-SSL values are calculated for mammalian wildlife, one each for three receptor groups representing different trophic levels. The mammalian Eco-SSLs derived for chromium are calculated according to the Eco-SSL guidance (U.S. EPA 2003) and are summarized in Table 6.3 for trivalent chromium and 6.4 for hexavalent chromium.

Table 6.3 Calculation of the Mammalian Eco-SSLs for Trivalent Chromium

Surrogate Receptor Group	TRV for Trivalent Chromium (mg dw/kg bw/d) [1]	Food Ingestion Rate (FIR)[2] (kg dw/kg bw/d)	Soil Ingestion as Proportion of Diet (P_s)[2]	Concentration of Chromium in Biota Type (i)[2,3] (B_i) (mg/kg dw)	Eco-SSL (mg/kg dw)[4]
Mammalian herbivore (vole)	2.40	0.0875	0.032	$B_i = 0.041 * Soil_j$ where i = plants	380
Mammalian ground insectivore (shrew)	2.40	0.209	0.030	$B_i = 0.306 * Soil_j$ where i = earthworms	34
Mammalian carnivore (weasel)	2.40	0.130	0.043	$\ln(B_i) = 0.7338 * \ln(Soil_j) - 1.4599$ where i = mammals	180

[1] The process for derivation of wildlife TRVs is described in Attachment 4-5 of U.S. EPA (2003).
[2] Parameters (FIR, P_s, B_i values, regressions) are provided in U.S. EPA (2003) Attachment 4-1 (revised February 2005).
[3] B_i = Concentration in biota type (i) which represents 100% of the diet for the respective receptor.
[4] $HQ = FIR * (Soil_j * P_s + B_i) / TRV$ solved for HQ=1 where $Soil_j$ = Eco-SSL (Equation 4-2; U.S. EPA, 2003).
NA = Not Applicable

Table 6.4 Calculation of the Mammalian Eco-SSLs for Hexavalent Chromium

Surrogate Receptor Group	TRV for Hexavalent Chromium (mg dw/kg bw/d) [1]	Food Ingestion Rate (FIR)[2] (kg dw/kg bw/d)	Soil Ingestion as Proportion of Diet (P_s)[2]	Concentration of Chromium in Biota Type (i)[2,3] (B_i) (mg/kg dw)	Eco-SSL (mg/kg dw)[4]
Mammalian herbivore (vole)	9.24	0.0875	0.032	$B_i = 0.041 * Soil_j$ where i = plants	1400
Mammalian ground insectivore (shrew)	9.24	0.209	0.030	$B_i = 0.306 * Soil_j$ where i = earthworms	130
Mammalian carnivore (weasel)	9.24	0.130	0.043	$\ln(B_i) = 0.7338 * \ln(Soil_j) - 1.4599$ where i = mammals	870

[1] The process for derivation of wildlife TRVs is described in Attachment 4-5 of U.S. EPA (2003).
[2] Parameters (FIR, P_s, B_i values, regressions) are provided in U.S. EPA (2003) Attachment 4-1 (revised February 2005).
[3] B_i = Concentration in biota type (i) which represents 100% of the diet for the respective receptor.
[4] $HQ = FIR * (Soil_j * P_s + B_i) / TRV$ solved for HQ=1 where $Soil_j$ = Eco-SSL (Equation 4-2; U.S. EPA, 2003).
NA = Not Applicable

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Literature Rejection Categories		
Rejection Criteria	**Description**	**Receptor**
ABSTRACT (Abstract)	Abstracts of journal publications or conference presentations.	Wildlife Plants and Soil Invertebrates
ACUTE STUDIES (Acu)	Single oral dose or exposure duration of three days or less.	Wildlife
AIR POLLUTION (Air P)	Studies describing the results for air pollution studies.	Wildlife Plants and Soil Invertebrates
ALTERED RECEPTOR (Alt)	Studies that describe the effects of the contaminant on surgically-altered or chemically-modified receptors (e.g., right nephrectomy, left renal artery ligature, hormone implant, etc.).	Wildlife
AQUATIC STUDIES (Aquatic)	Studies that investigate toxicity in aquatic organisms.	Wildlife Plants and Soil Invertebrates
ANATOMICAL STUDIES (Anat)	Studies of anatomy. Instance where the contaminant is used in physical studies (e.g., silver nitrate staining for histology).	Wildlife
BACTERIA (Bact)	Studies on bacteria or susceptibility to bacterial infection.	Wildlife Plants and Soil Invertebrates
BIOACCUMULATION SURVEY (Bio Acc)	Studies reporting the measurement of the concentration of the contaminant in tissues.	Wildlife Plants and Soil Invertebrates
BIOLOGICAL PRODUCT (BioP)	Studies of biological toxicants, including venoms, fungal toxins, *Bacillus thuringiensis*, other plant, animal, or microbial extracts or toxins.	Wildlife Plants and Soil Invertebrates
BIOMARKER (Biom)	Studies reporting results for a biomarker having no reported association with an adverse effect and an exposure dose (or concentration).	Wildlife
CARCINOGENICITY STUDIES (Carcin)	Studies that report data only for carcinogenic endpoints such as tumor induction. Papers that report systemic toxicity data are retained for coding of appropriate endpoints.	Wildlife Plants and Soil Invertebrates
CHEMICAL METHODS (Chem Meth)	Studies reporting methods for determination of contaminants, purification of chemicals, etc. Studies describing the preparation and analysis of the contaminant in the tissues of the receptor.	Wildlife Plants and Soil Invertebrates
CONFERENCE PROCEEDINGS (CP)	Studies reported in conference and symposium proceedings.	Wildlife Plants and Soil Invertebrates
DEAD (Dead)	Studies reporting results for dead organisms. Studies reporting field mortalities with necropsy data where it is not possible to establish the dose to the organism.	Wildlife Plants and Soil Invertebrates
DISSERTATIONS (Diss)	Dissertations are excluded. However, dissertations are flagged for possible future use.	Wildlife
DRUG (Drug)	Studies reporting results for testing of drug and therapeutic effects and side-effects. Therapeutic drugs include vitamins and minerals. Studies of some minerals may be included if there is potential for adverse effects.	Wildlife Plants and Soil Invertebrates
DUPLICATE DATA (Dup)	Studies reporting results that are duplicated in a separate publication. The publication with the earlier year is used.	Wildlife Plants and Soil Invertebrates

Literature Rejection Categories		
Rejection Criteria	**Description**	**Receptor**
ECOLOGICAL INTERACTIONS (Ecol)	Studies of ecological processes that do not investigate effects of contaminant exposure (e.g., studies of "silver" fox natural history; studies on ferrets identified in iron search).	Wildlife Plants and Soil Invertebrates
EFFLUENT (Effl)	Studies reporting effects of effluent, sewage, or polluted runoff.	Wildlife Plants and Soil Invertebrates
ECOLOGICALLY RELEVANT ENDPOINT (ERE)	Studies reporting a result for endpoints considered as ecologically relevant but is not used for deriving Eco-SSLs (e.g., behavior, mortality).	Plants and Soil Invertebrates
CONTAMINANT FATE/METABOLISM (Fate)	Studies reporting what happens to the contaminant, rather than what happens to the organism. Studies describing the intermediary metabolism of the contaminant (e.g., radioactive tracer studies) without description of adverse effects.	Wildlife Plants and Soil Invertebrates
FOREIGN LANGUAGE (FL)	Studies in languages other than English.	Wildlife Plants and Soil Invertebrates
FOOD STUDIES (Food)	Food science studies conducted to improve production of food for human consumption.	Wildlife
FUNGUS (Fungus)	Studies on fungus.	Wildlife Plants and Soil Invertebrates
GENE (Gene)	Studies of genotoxicity (chromosomal aberrations and mutagenicity).	Wildlife Plants and Soil Invertebrates
HUMAN HEALTH (HHE)	Studies with human subjects.	Wildlife Plants and Soil Invertebrates
IMMUNOLOGY (IMM)	Studies on the effects of contaminants on immunological endpoints.	Wildlife Plants and Soil Invertebrates
INVERTEBRATE (Invert)	Studies that investigate the effects of contaminants on terrestrial invertebrates are excluded.	Wildlife
IN VITRO (In Vit)	*In vitro* studies, including exposure of cell cultures, excised tissues and/or excised organs.	Wildlife Plants and Soil Invertebrates
LEAD SHOT (Lead shot)	Studies administering lead shot as the exposure form. These studies are labeled separately for possible later retrieval and review.	Wildlife
MEDIA (Media)	Authors must report that the study was conducted using natural or artificial soil. Studies conducted in pore water or any other aqueous phase (e.g., hydroponic solution), filter paper, petri dishes, manure, organic or histosoils (e.g., peat muck, humus), are not considered suitable for use in defining soil screening levels.	Plants and Soil Invertebrates
METHODS (Meth)	Studies reporting methods or methods development without usable toxicity test results for specific endpoints.	Wildlife Plants and Soil Invertebrates
MINERAL REQUIREMENTS (Mineral)	Studies examining the minerals required for better production of animals for human consumption, unless there is potential for adverse effects.	Wildlife
MIXTURE (Mix)	Studies that report data for combinations of single toxicants (e.g. cadmium and copper) are excluded. Exposure in a field setting from contaminated natural soils or waste application to soil may be coded as Field Survey.	Wildlife Plants and Soil Invertebrates

Literature Rejection Categories		
Rejection Criteria	**Description**	**Receptor**
MODELING (Model)	Studies reporting the use of existing data for modeling, i.e., no new organism toxicity data are reported. Studies which extrapolate effects based on known relationships between parameters and adverse effects.	Wildlife Plants and Soil Invertebrates
NO CONTAMINANT OF CONCERN (No COC)	Studies that do not examine the toxicity of Eco-SSL contaminants of concern.	Wildlife Plants and Soil Invertebrates
NO CONTROL (No Control)	Studies which lack a control or which have a control that is classified as invalid for derivation of TRVs.	Wildlife Plants and Soil Invertebrates
NO DATA (No Data)	Studies for which results are stated in text but no data is provided. Also refers to studies with insufficient data where results are reported for only one organism per exposure concentration or dose (wildlife).	Wildlife Plants and Soil Invertebrates
NO DOSE or CONC (No Dose)	Studies with no usable dose or concentration reported, or an insufficient number of doses/concentrations are used based on Eco-SSL SOPs. These are usually identified after examination of full paper. This includes studies which examine effects after exposure to contaminant ceases. This also includes studies where offspring are exposed in utero and/or lactation by doses to parents and then after weaning to similar concentrations as their parents. Dose cannot be determined.	Wildlife Plants and Soil Invertebrates
NO DURATION (No Dur)	Studies with no exposure duration. These are usually identified after examination of full paper.	Wildlife Plants and Soil Invertebrates
NO EFFECT (No Efct)	Studies with no relevant effect evaluated in a biological test species or data not reported for effect discussed.	Wildlife Plants and Soil Invertebrates
NO ORAL (No Oral)	Studies using non-oral routes of contaminant administration including intraperitoneal injection, other injection, inhalation, and dermal exposures.	Wildlife
NO ORGANISM (No Org) or NO SPECIES	Studies that do not examine or test a viable organism (also see in vitro rejection category).	Wildlife Plants and Soil Invertebrates
NOT AVAILABLE (Not Avail)	Papers that could not be located. Citation from electronic searches may be incorrect or the source is not readily available.	Wildlife Plants and Soil Invertebrates
NOT PRIMARY (Not Prim)	Papers that are not the original compilation and/or publication of the experimental data.	Wildlife Plants and Soil Invertebrates
NO TOXICANT (No Tox)	No toxicant used. Publications often report responses to changes in water or soil chemistry variables, e.g., pH or temperature. Such publications are not included.	Wildlife Plants and Soil Invertebrates
NO TOX DATA (No Tox Data)	Studies where toxicant used but no results reported that had a negative impact (plants and soil invertebrates).	Plants and Soil Invertebrates
NUTRIENT (Nutrient)	Nutrition studies reporting no concentration related negative impact.	Plants and Soil Invertebrates
NUTRIENT DEFICIENCY (Nut def)	Studies of the effects of nutrient deficiencies. Nutritional deficient diet is identified by the author. If reviewer is uncertain then the administrator should be consulted. Effects associated with added nutrients are coded.	Wildlife
NUTRITION (Nut)	Studies examining the best or minimum level of a chemical in the diet for improvement of health or maintenance of animals in captivity.	Wildlife
OTHER AMBIENT CONDITIONS (OAC)	Studies which examine other ambient conditions: pH, salinity, DO, UV, radiation, etc.	Wildlife Plants and Soil Invertebrates

Literature Rejection Categories		
Rejection Criteria	**Description**	**Receptor**
OIL (Oil)	Studies which examine the effects of oil and petroleum products.	Wildlife Plants and Soil Invertebrates
OM, pH (OM, pH)	Organic matter content of the test soil must be reported by the authors, but may be presented in one of the following ways; total organic carbon (TOC), particulate organic carbon (POC), organic carbon (OC), coarse particulate organic matter (CPOM), particulate organic matter (POM), ash free dry weight of soil, ash free dry mass of soil, percent organic matter, percent peat, loss on ignition (LOI), organic matter content (OMC). With the exception of studies on non-ionizing substances, the study must report the pH of the soil, and the soil pH should be within the range of $4 and #8.5. Studies that do not report pH or report pH outside this range are rejected.	Plants and Soil Invertebrates
ORGANIC METAL (Org Met)	Studies which examine the effects of organic metals. This includes tetraethyl lead, triethyl lead, chromium picolinate, phenylarsonic acid, roxarsone, 3-nitro-4-phenylarsonic acid,, zinc phosphide, monomethylarsonic acid (MMA), dimethylarsinic acid (DMA), trimethylarsine oxide (TMAO), or arsenobetaine (AsBe) and other organo metallic fungicides. Metal acetates and methionines are not rejected and are evaluated.	Wildlife
LEAD BEHAVIOR OR HIGH DOSE MODELS (Pb Behav)	There are a high number of studies in the literature that expose rats or mice to high concentrations of lead in drinking water (0.1, 1 to 2% solutions) and then observe behavior in offspring, and/or pathology changes in the brain of the exposed dam and/or the progeny. Only a representative subset of these studies were coded. Behavior studies examining complex behavior (learned tasks) were also not coded.	Wildlife
PHYSIOLOGY STUDIES (Phys)	Physiology studies where adverse effects are not associated with exposure to contaminants of concern.	Wildlife
PLANT (Plant)	Studies of terrestrial plants are excluded.	Wildlife
PRIMATE (Prim)	Primate studies are excluded.	Wildlife
PUBL AS (Publ as)	The author states that the information in this report has been published in another source. Data are recorded from only one source. The secondary citation is noted as Publ As.	Wildlife Plants and Soil Invertebrates
QSAR (QSAR)	Derivation of Quantitative Structure-Activity Relationships (QSAR) is a form of modeling. QSAR publications are rejected if raw toxicity data are not reported or if the toxicity data are published elsewhere as original data.	Wildlife Plants and Soil Invertebrates
REGULATIONS (Reg)	Regulations and related publications that are not a primary source of data.	Wildlife Plants and Soil Invertebrates
REVIEW (Rev)	Studies in which the data reported in the article are not primary data from research conducted by the author. The publication is a compilation of data published elsewhere. These publications are reviewed manually to identify other relevant literature.	Wildlife Plants and Soil Invertebrates

Literature Rejection Categories		
Rejection Criteria	**Description**	**Receptor**
SEDIMENT CONC (Sed)	Studies in which the only exposure concentration/dose reported is for the level of a toxicant in sediment.	Wildlife Plants and Soil Invertebrates
SCORE (Score)	Papers in which all studies had data evaluation scores at or lower then the acceptable cut-off (#10 of 18) for plants and soil invertebrates).	Plants and Soil Invertebrates
SEDIMENT CONC (Sed)	Studies in which the only exposure concentration/dose reported is for the level of a toxicant in sediment.	Wildlife Plants and Soil Invertebrates
SLUDGE	Studies on the effects of ingestion of soils amended with sewage sludge.	Wildlife Plants and Soil Invertebrates
SOIL CONC (Soil)	Studies in which the only exposure concentration/dose reported is for the level of a toxicant in soil.	Wildlife
SPECIES	Studies in which the species of concern was not a terrestrial invertebrate or plant or mammal or bird.	Plants and Soil Invertebrates Wildlife
STRESSOR (QAC)	Studies examining the interaction of a stressor (e.g., radiation, heat, etc.) and the contaminant, where the effect of the contaminant alone cannot be isolated.	Wildlife Plants and Soil Invertebrates
SURVEY (Surv)	Studies reporting the toxicity of a contaminant in the field over a period of time. Often neither a duration nor an exposure concentration is reported.	Wildlife Plants and Soil Invertebrates
REPTILE OR AMPHIBIAN (Herp)	Studies on reptiles and amphibians. These papers flagged for possible later review.	Wildlife Plants and Soil Invertebrates
UNRELATED (Unrel)	Studies that are unrelated to contaminant exposure and response and/or the receptor groups of interest.	Wildlife
WATER QUALITY STUDY (Wqual)	Studies of water quality.	Wildlife Plants and Soil Invertebrates
YEAST (Yeast)	Studies of yeast.	Wildlife Plants and Soil Invertebrates

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Appendix 5-1

Avian Toxicity Data Extracted and Reviewed for Wildlife Toxicity Reference Value (TRV) - Trivalent Chromium

April 2008

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Appendix 5.1 Avian Toxicity Data Extracted for Wildlife Toxicity Reference Value (TRV)
Trivalent Chromium
Page 1 of 1

Ref																									Effects						onversion to mg/kg bw/da				Result		Data Evaluation Score									
Result #	Ref N.		Chemical Form	MW%	Test Species	Phase #	# of Conc/ Doses	Conc/ Doses	Conc/Dose Units	Wet Weight Reported?	Percent Moisture	Application Frequency	Method of Analyses	Route of Exposure	Endpoint Number	Exposure Duration	Duration Units	Age	Age Units	Lifestage	Sex	Control Type	Critical Lifestage?	Test Location	General Effect Group	Effect Type	Effect Measure	Response Site	Study NOAEL	Study LOAEL	Body Weight Reported?	Body Weight in kg	Ingestion Rate Reported?	Ingestion Rate in kg or L/day	NOAEL Dose (mg/kg/day)	LOAEL Dose (mg/kg/day)	Data Source	Dose Route	Test Concentrations	Chemical form	Dose Quantification	Endpoint	Dose Range	Statistical Power	Exposure Duration	Test Conditions	Total
Biochemical																																														
1	9749	Jensen and Maurice, 1980	Chromium chloride hexahydrate	100	Chicken (*Gallus domesticus*)		2	0/10	mg/kg diet	N	na	ADL	U	FD	1	4	w	NR	NR	LB	F	C	Y	Lab	BIO	CHM	GLUC	BL	10		N	1.6	N	0.0790	0.494		10	10	5	10	5	1	4	10	3	4	69
2	25909	Guerra et al., 2002	Chromium yeast	100	Chicken (*Gallus domesticus*)	2	3	0/25/50	mg/kg diet	N	na	ADL	U	FD	1	28	d	32	w	JV	F	C	N	Lab	BIO	ENZ	GENZ	LI	25	50	Y	2.0	N	0.0914	1.14	2.28	10	10	5	10	6	1	10	10	10	4	76
3	25909	Guerra et al., 2002	Chromium chloride	100	Chicken (*Gallus domesticus*)	1	3	0/25/50	mg/kg diet	N	na	ADL	U	FD	1	28	d	32	w	JV	F	C	N	Lab	BIO	ENZ	GENZ	LI	25	50	Y	2.0	N	0.0914	1.14	2.28	10	10	5	10	6	1	10	10	10	4	76
Behavior																																														
4	9621	Sauveur and Thapon, 1983	Chromium chloride hexahydrate	100	Chicken (*Gallus domesticus*)	1	2	0/10	mg/kg diet	N	na	ADL	U	FD	2	8	w	40	w	AD	F	C	Y	Lab	BEH	FDB	FCNS	WO	10		N	1.6	Y	0.119	0.744		10	10	5	10	6	4	4	10	10	4	73
5	11682	Hossain et al, 1998	Chromium yeast	100	Chicken (*Gallus domesticus*)	2	2	0/400	ug/kg diet	N	na	ADL	U	FD	2	19	d	28	d	JV	B	C	Y	Lab	BEH	FDB	FCNS	WO		400	Y	2.33	Y	0.144		0.0247	10	10	5	4	7	4	4	10	10	4	68
6	3067	Motozono et al., 1998	Chomium in yeast	100	Chicken (*Gallus domesticus*)	1	3	0/200/400	mg/kg diet	N	na	NR	U	FD	1	35	d	7	d	JV	F	C	Y	Lab	BEH	FDB	FCNS	WO	400		Y	2.01	Y	0.1026		20.4	10	10	5	5	7	4	4	10	10	4	69
7	2771	Meluzzi et al., 1996	Chromium chloride	100	Chicken (*Gallus domesticus*)	1	4	0/500/1000/2000	mg/kg diet	N	na	NR	U	FD	1	75	d	22	w	AD	F	C	N	Lab	BEH	FDB	FCNS	WO		500	N	1.6	Y	0.1356		42.4	10	10	5	10	6	4	4	10	6	4	69
Physiology																																														
8	11682	Hossain et al, 1998	Chromium yeast	100	Chicken (*Gallus domesticus*)	2	2	0/400	ug/kg diet	N	na	ADL	U	FD	3	19	d	28	d	JV	B	C	Y	Lab	PHY	PHY	FDCV	WO		400	Y	2.33	Y	0.144		0.0247	10	10	5	4	7	4	4	10	10	4	68
9	13720	Steele and Rosebrough, 1979	Chromium chloride hexahydrate	100	Turkey (*Meleagris gallopavo*)	1	4	0/20/40/80	mg/kg diet	N	na	ADL	U	FD	2	14	d	1	w	JV	B	C	Y	Lab	PHY	PHY	FDCV	WO		20	Y	0.398	N	0.0319		1.61	10	10	5	10	6	4	4	10	10	4	73
Pathology																																														
10	5971	Cupo and Donaldson, 1987	Chromium chloride hexahydrate	100	Chicken (*Gallus domesticus*)	1	2	0/20	mg/kg diet	N	na	ADL	U	FD	2	21	d	1	d	JV	M	C	Y	Lab	PTH	ORW	ORWT	LI	20		Y	0.534	N	0.0387	1.45		10	10	5	10	6	4	4	6	10	4	69
Reproduction																																														
11	9749	Jensen and Maurice, 1980	Chromium chloride hexahydrate	100	Chicken (*Gallus domesticus*)	3	3	0/5	mg/kg diet	N	na	ADL	U	FD	1	4	w	NR	NR	LB	F	C	Y	Lab	REP	REP	TPRD	WO	5		Y	1.775	N	0.0850	0.238		10	10	5	10	6	10	4	1	10	4	70
12	12571	Maurice and Jensen, 1979	Chromium chloride hexahydrate	100	Chicken (*Gallus domesticus*)	1	2	0/10	ug/g diet	N	na	ADL	U	FD	2	12	w	40	w	LB	F	C	Y	Lab	REP	REP	TPRD	WO	10		Y	1.70	N	0.0823	0.483		10	10	5	10	6	10	4	1	10	4	70
13	9749	Jensen and Maurice, 1980	Chromium chloride hexahydrate	100	Chicken (*Gallus domesticus*)	1	2	0/10	mg/kg diet	N	na	ADL	U	FD	1	4	w	NR	NR	LB	F	C	Y	Lab	REP	REP	TPRD	WO	10		N	1.6	N	0.0790	0.494		10	10	5	10	5	10	4	1	10	4	69
14	3739	Haseltine et al., unpublished	Chrome alum doceahydrate	100	Black duck (*Anas rubripes*)	1	3	0/10/50	mg/kg diet	Y	1	NR	U	FD	1	180 -190	d	NR	NR	LB	F	C	N	FieldA	REP	REP	RSUC	WO	10	50	Y	1.17	N	0.0619	0.569	2.84	10	10	5	5	6	10	8	10	10	4	78
15	9621	Sauveur and Thapon, 1983	Chromium chloride hexahydrate	100	Chicken (*Gallus domesticus*)	1	2	0/10	mg/kg diet	N	na	ADL	U	FD	1	8	w	40	w	LB	F	C	Y	Lab	REP	REP	TPRD	WO	10		N	1.6	Y	0.119	0.744		10	10	5	10	6	10	4	10	10	4	79
16	6508	Ousterhout and Berg, 1981	Chromium chloride hexahydrate	100	Chicken (*Gallus domesticus*)	1	2	0/20	mg/kg diet	N	na	ADL	U	FD	1	6	d	50	w	LB	F	C	Y	Lab	REP	EGG	ESQU	SL	20		N	1.60	N	0.0790	0.988		10	10	5	10	5	10	4	1	10	4	69
17	2771	Meluzzi et al., 1996	Chromium chloride	100	Chicken (*Gallus domesticus*)	1	4	0/500/1000/2000	mg/kg diet	N	na	NR	U	FD	2	15	d	22	w	LB	F	C	N	Lab	REP	EGG	ALWT	EG	500	1000	N	1.6	Y	0.1356	37.7	75.4	10	10	5	10	6	10	10	10	6	4	81
Growth																																														
18	12571	Maurice and Jensen, 1979	Chromium chloride hexahydrate	100	Chicken (*Gallus domesticus*)	1	2	0/10	ug/g diet	N	na	ADL	U	FD	1	12	w	40	w	SM	S	C	Y	Lab	GRO	GRO	BDWT	WO	10		Y	1.70	N	0.0823	0.483		10	10	5	10	6	8	4	1	10	4	68
19	5971	Cupo and Donaldson, 1987	Chromium chloride hexahydrate	100	Chicken (*Gallus domesticus*)	1	2	0/20	mg/kg diet	N	na	ADL	U	FD	1	21	d	1	d	JV	M	C	Y	Lab	GRO	GRO	BDWT	WO	20		Y	0.534	N	0.0387	1.45		10	10	5	10	6	8	4	10	10	4	77
20	13720	Steele and Rosebrough, 1979	Chromium chloride hexahydrate	100	Turkey (*Meleagris gallopavo*)	1	4	0/20/40/80	mg/kg diet	N	na	ADL	U	FD	1	14	d	1	w	JV	B	C	Y	Lab	GRO	GRO	BDWT	WO	80		Y	0.398	N	0.0319	6.42		10	10	5	10	6	8	4	10	10	4	77
21	92	Hill, 1974	Chromium chloride	100	Chicken (*Gallus domesticus*)	1	2	0/1000	mg/kg diet	N	na	ADL	U	FD	1	2	w	1	d	JV	B	C	Y	Lab	GRO	GRO	BDWT	WO	1000		N	0.328	N	0.0282	85.9		10	10	5	10	5	8	4	10	10	4	76
22	8663	Hafez and Kratzer, 1976	Chromium chloride hexahydrate	100	Chicken (*Gallus domesticus*)	1	3	0/1000/2000	mg/kg diet	N	na	ADL	U	FD	1	4	w	1	d	AD	M	C	Y	Lab	GRO	GRO	BDWT	WO	2000		N	1.04	N	0.0598	359		10	10	5	10	5	8	4	10	10	4	76
23	3067	Motozono et al., 1998	Chomium in yeast	100	Chicken (*Gallus domesticus*)	1	3	0/200/400	mg/kg diet	N	na	NR	U	FD	1	35	d	7	d	JV	F	C	Y	Lab	GRO	GRO	BDWT	WO		200	Y	2.08	Y	0.1030		9.91	10	10	5	5	7	8	4	10	10	4	73
24	15690	Nielsen et al, 1980	Chromium acetate	100	Chicken (*Gallus domesticus*)	1	2	0/500	ug/g diet	N	na	DLY	U	FD	1	4	w	1	d	JV	M	C	Y	Lab	GRO	GRO	BDWT	WO		500	Y	1.044	N	0.0599		28.7	10	10	5	5	6	8	4	10	10	4	72
Survival																																														
25	11682	Hossain et al, 1998	Chromium yeast	100	Chicken (*Gallus domesticus*)	2	2	0/400	ug/kg diet	N	na	ADL	U	FD	4	19	d	28	d	JV	B	C	Y	Lab	MOR	MOR	MORT	WO	400		Y	2.33	Y	0.1440	0.0248		10	10	5	10	7	9	4	10	10	4	79
26	3739	Haseltine et al., unpublished	Chrome alum doceahydrate	100	Black duck (*Anas rubripes*)	1	3	0/10/50	mg/kg diet	Y	1	NR	U	FD	3	10	m	NR	NR	MA	M	C	N	FieldA	MOR	MOR	MORT	WO	10	50	Y	1.17	N	0.0640	0.557	2.78	10	10	5	5	6	9	8	10	10	4	77
27	92	Hill, 1974	Chromium chloride	100	Chicken (*Gallus domesticus*)	1	2	0/1000	mg/kg diet	N	na	ADL	U	FD	2	5	w	1	d	JV	B	C	Y	Lab	MOR	MOR	MORT	NR	1000		N	0.328	N	0.0282	85.9		10	10	5	10	5	9	4	10	10	4	77
28	8663	Hafez and Kratzer, 1976	Chromium chloride hexahydrate	100	Chicken (*Gallus domesticus*)	1	3	0/1000/2000	mg/kg diet	N	na	ADL	U	FD	2	4	w	1	d	AD	M	C	Y	Lab	MOR	MOR	MORT	WO	2000		N	1.04	N	0.0598	359		10	10	5	10	5	9	4	10	10	4	77
Data Not Used to Derive Wildlife Toxicity Reference Value																																														
29	11682	Hossain et al, 1998	Chromium yeast	100	Chicken (*Gallus domesticus*)	3	3	0/150/300	ug/kg diet	N	na	ADL	U	FD	1	6	w	0	d	JV	B	C	Y	Lab	GRO	GRO	BDWT	WO	300		Y	2.39	Y	0.0754	0.00946		10	10	5	4	7	8	4	1	10	4	63
30	11682	Hossain et al, 1998	Chromium yeast	100	Chicken (*Gallus domesticus*)	3	3	0/150/300	ug/kg diet	N	na	ADL	U	FD	2	6	w	0	d	JV	B	C	Y	Lab	BEH	FDB	FCNS	WO	300		Y	2.39	N	0.0754	0.00946		10	10	5	4	6	4	4	1	10	4	58
31	11682	Hossain et al, 1998	Chromium yeast	100	Chicken (*Gallus domesticus*)	3	3	0/150/300	ug/kg diet	N	na	ADL	U	FD	3	6	w	0	d	JV	B	C	Y	Lab	PHY	PHY	FDCV	WO	300		Y	2.39	Y	0.0754	0.00946		10	10	5	4	7	4	4	1	10	4	59
32	11682	Hossain et al, 1998	Chromium yeast	100	Chicken (*Gallus domesticus*)	2	2	0/400	ug/kg diet	N	na	ADL	U	FD	1	19	d	28	d	JV	B	C	Y	Lab	GRO	GRO	BDWT	WO	400		Y	2.33	Y	0.144	0.0247		10	10	5	4	7	8	4	1	10	4	63
33	11682	Hossain et al, 1998	Chromium yeast	100	Chicken (*Gallus domesticus*)	1	3	0/300/600	ug/kg diet	N	na	ADL	U	FD	1	20	d	1	d	JV	M	C	Y	Lab	GRO	GRO	BDWT	WO	600		Y	0.85	Y	0.0577	0.0407		10	10	5	4	7	8	4	1	10	4	63
34	11682	Hossain et al, 1998	Chromium yeast	100	Chicken (*Gallus domesticus*)	1	3	0/300/600	ug/kg diet	N	na	ADL	U	FD	2	20	d	1	d	JV	M	C	Y	Lab	BEH	FDB	FCNS	WO	600		Y	0.85	Y	0.0577	0.0407		10	10	5	4	7	4	4	1	10	4	59
35	11682	Hossain et al, 1998	Chromium yeast	100	Chicken (*Gallus domesticus*)	1	3	0/300/600	ug/kg diet	N	na	ADL	U	FD	3	20	d	1	d	JV	M	C	Y	Lab	PHY	PHY	FDCV	WO	600		Y	0.85	Y	0.0577	0.0407		10	10	5	4	7	4	4	1	10	4	59
36	9749	Jensen and Maurice, 1980	Chromium chloride hexahydrate	100	Chicken (*Gallus domesticus*)	3	3	0/5	mg/kg diet	N	na	ADL	U	FD	1	4	w	NR	NR	SM	F	C	Y	Lab	PTH	GRS	BDWT	WO	5		Y	1.775	N	0.0850	0.238		10	10	5	10	6	4	4	1	3	4	57
37	12571	Maurice and Jensen, 1979	Chromium chloride hexahydrate	100	Chicken (*Gallus domesticus*)	1	2	0/10	ug/g diet	N	na	ADL	U	FD	3	12	w	40	w	SM	F	C	Y	Lab	PTH	ORW	SMIX	LI	10		Y	1.70	N	0.0823	0.483		10	10	5	10	6	4	4	1	10	4	64
38	12571	Maurice and Jensen, 1979	Chromium chloride hexahydrate	100	Chicken (*Gallus domesticus*)	1	2	0/10	ug/g diet	N	na	ADL	U	FD	4	12	w	40	w	SM	F	C	Y	Lab	BIO	CHM	LIPD	PL	10		Y	1.70	N	0.0823	0.483		10	10	5	10	6	1	4	1	10	4	61
39	5971	Cupo and Donaldson, 1987	Chromium chloride hexahydrate	100	Chicken (*Gallus domesticus*)	1	2	0/20	mg/kg diet	N	na	ADL	U	FD	3	21	d	1	d	JV	M	C	Y	Lab	BEH	FDB	FCNS	WO	20		Y	0.534	N	0.0387	1.45		10	10	5	10	6	4	4	1	10	4	64
40	3739	Haseltine et al., unpublished	Chrome alum doceahydrate	100	Black duck (*Anas rubripes*)	1	3	0/10/50	mg/kg diet	Y	1	NR	U	FD	7	10	m	NR	NR	MA	M	C	N	FieldA	BIO	ENZ	ASAT	BL	50		Y	1.17	N	0.0640	2.78		10	10	5	5	6	1	4	3	10	4	58
41	3739	Haseltine et al., unpublished	Chrome alum doceahydrate	100	Black duck (*Anas rubripes*)	1	3	0/10/50	mg/kg diet	Y	1	NR	U	FD	6	10	m	NR	NR	MA	M	C	N	FieldA	PTH	ORW	ORWT	LI	50		Y	1.17	N	0.0640	2.78		10	10	5	10	6	4	4	1	10	4	64
42	15690	Nielsen et al, 1980	Chromium acetate	100	Chicken (*Gallus domesticus*)	1	2	0/500	ug/g diet	N	na	DLY	U	FD	2	32	d	1	d	JV	M	C	Y	Lab	BIO	CHM	HMCT	BL		500	Y	1.044	N	0.0599		28.7	10	10	5	5	6	1	4	10	10	4	65

The abbreviations and definitions used in coding data are provided in Attachment 4-3 of the Eco-SSL Guidance (U.S.EPA, 2003).

Eco-SSL

Ecological Soil Screening Levels

Appendix 5-2

Avian Toxicity Data Extracted and Reviewed for Wildlife Toxicity Reference Value (TRV) - Hexavalent Chromium

April 2008

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Ref																									Effects						Conversion to mg/kg bw/day				Result		Data Evaluation Score										
Result #	Ref N.		Chemical Form	MW%	Test Species	Phase #	# of Conc/ Doses	Conc/ Doses	Conc/Dose Units	Wet Weight Reported?	Percent Moisture	Application Frequency	Method of Analyses	Route of Exposure	Endpoint Number	Exposure Duration	Duration Units	Age	Age Units	Lifestage	Sex	Control Type	Critical Lifestage?	Test Location	General Effect Group	Effect Type	Effect Measure	Response Site	Study NOAEL	Study LOAEL	Body Weight Reported?	Body Weight in kg	Ingestion Rate Reported?	Ingestion Rate in kg or L/day	NOAEL Dose (mg/kg/day)	LOAEL Dose (mg/kg/day)	Data Source	Dose Route	Test Concentrations	Chemical form	Dose Quantification	Endpoint	Dose Range	Statistical Power	Exposure Duration	Test Conditions	Total
Behavior																																															
1	3008	Asmatullah et al, 1999	Potassium dichromate	35.35	Chicken (*Gallus domesticus*)	1	3	0/250/500	mg/kg diet	N	na	ADL	U	FD	1	17	w	1	d	JV	B	C	Y	Lab	BEH	FDB	FCNS	NR	250	500	Y	1.48	N	0.0752	4.48	8.97	10	10	5	10	6	4	10	10	10	4	79
Pathology																																															
2	3074	Rao et al, 1983	Sodium chromate	100	Chicken (*Gallus domesticus*)	2	2	0/40.9	ug/org/d	N	na	NR	M	FD	4	1	yr	1	d	JV	M	C	Y	Lab	PTH	ORW	SMIX	LI	40.9		Y	1.708	N	0.0820	0.0240		10	10	10	4	7	4	4	3	10	4	66
3	3008	Asmatullah et al, 1999	Potassium dichromate	35.35	Chicken (*Gallus domesticus*)	1	3	0/250/500	mg/kg diet	N	na	ADL	U	FD	3	32	w	1	d	JV	B	C	Y	Lab	PTH	ORW	SMIX	RC		250	Y	2.02	N	0.0920		4.02	10	10	5	10	6	4	4	10	10	4	73
Reproduction																																															
4	3074	Rao et al, 1983	Sodium chromate	100	Chicken (*Gallus domesticus*)	2	2	0/40.9	ug/org/d	N	na	NR	M	FD	3	1	yr	1	d	JV	M	C	Y	Lab	REP	REP	TEWT	GO	40.9		Y	1.708	N	0.0820	0.0240		10	10	10	4	7	10	4	8	10	4	77
5	9749	Jensen and Maurice, 1980	Potassium chromate	100	Chicken (*Gallus domesticus*)	2	2	0/5	mg/kg diet	N	na	ADL	U	FD	1	4	w	NR	NR	LB	F	C	Y	Lab	REP	REP	TPRD	WO	5.0		N	1.740	N	0.0830	0.240		10	10	5	10	5	10	4	1	10	4	69
6	3008	Asmatullah et al, 1999	Potassium dichromate	35.35	Chicken (*Gallus domesticus*)	1	3	0/250/500	mg/kg diet	N	na	ADL	U	FD	4	32	w	1	d	JV	B	C	Y	Lab	REP	EGG	ESTH	EG		250	Y	2.02	N	0.0920		4.02	10	10	5	10	6	10	4	10	10	4	79
Growth																																															
7	3074	Rao et al, 1983	Sodium chromate	100	Chicken (*Gallus domesticus*)	2	2	0/40.9	ug/org/d	N	na	NR	M	FD	1	1	yr	1	d	JV	M	C	Y	Lab	GRO	GRO	BDWT	WO	40.9		Y	1.708	N	0.0820	0.0240		10	10	10	4	7	8	4	10	10	4	77
8	3740	Romoser et al., 1961	Sodium dichromate	100	Chicken (*Gallus domesticus*)	1	3	0/30/100	mg/kg diet	N	na	ADL	U	FD	1	21	d	11	d	JV	M	C	Y	Lab	GRO	GRO	BDWT	WO	100		N	0.328	N	0.0282	8.59		10	10	5	10	5	8	4	1	10	4	67
9	3008	Asmatullah et al, 1999	Potassium dichromate	35.35	Chicken (*Gallus domesticus*)	1	3	0/250/500	mg/kg diet	N	na	ADL	U	FD	2	32	w	1	d	JV	B	C	Y	Lab	GRO	GRO	BDWT	WO		250	Y	2.02	N	0.0920		4.02	10	10	5	10	6	8	4	10	10	4	77
Survival																																															
10	3740	Romoser et al., 1961	Sodium dichromate	100	Chicken (*Gallus domesticus*)	1	3	0/30/100	mg/kg diet	N	na	ADL	U	FD	1	21	d	11	d	JV	M	C	Y	Lab	MOR	MOR	MORT	WO	100		N	0.328	N	0.0282	8.59		10	10	5	5	5	9	4	10	10	4	72
Data Not Used to Derive Wildlife Toxicity Reference Value																																															
11	3074	Rao et al, 1983	Sodium chromate	100	Chicken (*Gallus domesticus*)	2	2	0/40.9	ug/org/d	N	na	NR	M	FD	2	1	yr	1	d	JV	M	C	Y	Lab	BIO	CHM	HMGL	BL	40.9		Y	1.708	N	0.0820	0.0240		10	10	10	4	7	1	4	3	10	4	63
12	9749	Jensen and Maurice, 1980	Potassium chromate	100	Chicken (*Gallus domesticus*)	2	2	0/5	mg/kg diet	N	na	ADL	U	FD	1	4	w	NR	NR	SM	F	C	N	Lab	PTH	GRS	BDWT	WO	5.0		Y	1.740	N	0.0830	0.240		10	10	5	10	6	4	4	1	3	4	57
13	3740	Romoser et al., 1961	Sodium dichromate	100	Chicken (*Gallus domesticus*)	1	3	0/30/100	mg/kg diet	N	na	ADL	U	FD	1	21	d	11	d	JV	M	C	Y	Lab	PHY	PHY	FDCV	WO	100		N	0.328	N	0.0282	8.59		10	10	5	10	5	4	4	1	10	4	63

The abbreviations and definitions used in coding data are provided in Attachment 4-3 of the Eco-SSL Guidance (U.S.EPA, 2003).

Appendix 6-1

Mammalian Toxicity Data Extracted and Reviewed for Wildlife Toxicity Reference Value (TRV) - Trivalent Chromium

April 2008

Appendix 6.1 Mammalian Toxicity Data Extracted for Wildlife Toxicity Reference Value (TRV)
Trivalent Chromium

Ref																									Effects					Conversion to mg/kg bw/day				Result		Data Evaluation Score										
Result #	Ref N.		Chemical Form	MW%	Test Species	Phase #	# of Conc/ Doses	Conc/ Doses	Conc/Dose Units	Wet Weight Reported?	Percent Moisture	Application Frequency	Method of Analyses	Route of Exposure	Endpoint Number	Exposure Duration	Duration Units	Age	Age Units	Lifestage	Sex	Control Type	Critical Lifestage?	Test Location	Effect Type	Effect Measure	Response Site	Study NOAEL	Study LOAEL	Body Weight Reported?	Body Weight in kg	Ingestion Rate Reported?	Ingestion Rate in kg or L/day	NOAEL Dose (mg/kg/day)	LOAEL Dose (mg/kg/day)	Data Source	Dose Route	Test Concentrations	Chemical form	Dose Quantification	Endpoint	Dose Range	Statistical Power	Exposure Duration	Test Conditions	Total
Biochemical																																														
1	13415	Samsell and Spears, 1989	Chromium chloride hexahydrate	100	Sheep (*Ovis aries*)	1	2	0/10	ug/g	N	na	DLY	U	FD	1	28	d	9	mo	JV	F	C	Y	Lab	CHM	GLUC	PL	10		Y	45	Y	1.0	0.222		10	10	5	10	7	1	4	10	10	4	71
2	25905	Mooney and Cromwell, 1997	Chromium chloride hexahydrate	100	Pig (*Sus scrofa*)	2	2	0/25200	ug/kg	N	na	ADL	M	FD	4	103	d	NR	NR	JV	B	C	Y	Lab	CHM	TOPR	SR	25200		Y	108.34	Y	2.56	0.595		10	10	10	10	7	1	4	1	10	4	67
3	25905	Mooney and Cromwell, 1997	Chromium chloride hexahydrate	100	Pig (*Sus scrofa*)	1	3	0/5100/25300	ug/kg	N	na	ADL	M	FD	4	35	d	NR	NR	JV	B	C	Y	Lab	CHM	TOPR	SR	25300		Y	42.58	Y	1.56	0.927		10	10	10	10	7	1	4	1	10	4	67
4	3004	Anderson et al., 1997	Chromium chloride	100	Rat (*Rattus norvegicus*)	1	5	0/5/25/50/100	mg/kg diet	N	na	NR	U	FD	2	20	w	4	w	JV	NR	C	Y	Lab	CHM	GLUC	SR	100		Y	0.4	N	0.03235	8.09		10	10	5	10	6	1	4	10	10	4	70
5	3729	Ivanksvic and Preussmann, 1975	Chromium oxide green	100	Rat (Rattus norvegicus)	1	3	0/0.8/1.77	g/kg bw/d	N	na	5 per w	U	FD	2	90	d	100	d	SM	F	C	Y	Lab	CHM	HMGL	BL	1.77		Y	0.200	Y	0.015	1770		10	10	5	10	10	1	4	10	10	4	74
6	3061	Meenakshi et al., 1989	Chromium chloride hexahydrate	100	Rat (*Rattus norvegicus*)	1	2	0/10	mg/kg bw/d	N	na	1 per d	U	GV	2	60	d	NR	NR	JV	M	C	Y	Lab	CHM	GLUC	BL		10.0	Y	0.05	N	0.005855		10.0	10	8	10	10	10	1	4	10	10	4	77
7	15198	Cobo et al 1995	Chromium chloride hexahydrate	19.514	Rat (*Rattus norvegicus*)	2	2	0/2.95	mg/g bw	N	na	ADL	M	DR	1	8	w	NR	NR	JV	M	C	Y	Lab	CHM	GBIO	BL		2.95	Y	0.338	N	0.03730		565	10	5	5	10	10	1	4	10	10	4	69
Behavior																																														
8	25905	Mooney and Cromwell, 1997	Chromium chloride hexahydrate	100	Pig (*Sus scrofa*)	2	2	0/25200	ug/kg	N	na	ADL	M	FD	2	103	d	NR	NR	JV	B	C	Y	Lab	FDB	FCNS	WO	25200		Y	108.34	Y	2.56	0.595		10	10	10	10	7	4	4	1	10	4	70
9	25905	Mooney and Cromwell, 1997	Chromium chloride hexahydrate	100	Pig (*Sus scrofa*)	1	3	0/5100/25300	ug/kg	N	na	ADL	M	FD	2	35	d	NR	NR	JV	B	C	Y	Lab	FDB	FCNS	WO	25300		Y	42.58	Y	1.56	0.927		10	10	10	10	7	4	4	1	10	4	70
10	3009	Bataineh et al., 1997	Chromium chloride	32.83	Rat (*Rattus norvegicus*)	1	2	0/1000	mg/L	N	na	ADL	U	DR	1	12	w	NR	NR	AD	M	C	N	Lab	BEH	AGGT	WO		1000	Y	0.3405	N	0.03754		36.2	10	5	5	10	6	4	4	10	10	4	68
Physiology																																														
11	25905	Mooney and Cromwell, 1997	Chromium chloride hexahydrate	100	Pig (*Sus scrofa*)	2	2	0/25200	ug/kg	N	na	ADL	M	FD	3	103	d	NR	NR	JV	B	C	Y	Lab	PHY	FDCV	WO	25200		Y	108.34	Y	2.56	0.595		10	10	10	10	7	4	4	1	10	4	70
12	25905	Mooney and Cromwell, 1997	Chromium chloride hexahydrate	100	Pig (*Sus scrofa*)	1	3	0/5100/25300	ug/kg	N	na	ADL	M	FD	3	35	d	NR	NR	JV	B	C	Y	Lab	PHY	FDCV	WO	25300		Y	42.58	Y	1.56	0.927		10	10	10	10	7	4	4	1	10	4	70
13	15061	Kanisawa and Schroeder, 1969	Chromium acetate	100	Rat (*Rattus norvegicus*)	1	2	0/5	mg/L	N	na	ADL	U	DR	2	17	mo	21	d	JV	B	C	Y	Lab	PHY	BLPR	BL		5.0	N	0.248	N	0.02823		0.569	10	5	5	10	5	4	4	10	10	4	67
14	757	Mercado and Bibby 1973	Chromium chloride hexahydrate	100	Rat (*Rattus norvegicus*)	1	2	0/25	mg/L	N	na	ADL	U	DR	1	50	d	23	d	JV	M	C	Y	Lab	PHY	GPHY	NR		25.0	N	0.267	N	0.03016		2.82	10	5	5	10	5	4	4	10	10	4	67
Pathology																																														
15	15061	Kanisawa and Schroeder, 1969	Chromium acetate	100	Rat (*Rattus norvegicus*)	1	2	0/5	mg/L	N	na	ADL	U	DR	1	30	mo	21	d	JV	B	C	Y	Lab	HIS	GSLN	KI		5.0	N	0.248	N	0.02823		0.569	10	5	5	10	5	4	4	10	10	4	67
16	3061	Meenakshi et al., 1989	Chromium chloride hexahydrate	100	Rat (*Rattus norvegicus*)	1	2	0/10	mg/kg bw/d	N	na	1 per d	U	GV	1	60	d	NR	NR	JV	M	C	Y	Lab	HIS	NCRO	LI		10.0	Y	0.05	N	0.005855		10.0	10	8	10	10	10	4	4	10	10	4	80
17	3009	Bataineh et al., 1997	Chromium chloride	32.83	Rat (*Rattus norvegicus*)	1	2	0/1000	mg/L	N	na	ADL	U	DR	3	12	w	NR	NR	AD	M	C	N	Lab	GRS	BDWT	WO		1000	Y	0.34052	N	0.03755		36.2	10	5	5	10	6	4	4	10	10	4	68
Reproduction																																														
18	3098	Zahid et al., 1990	Chromium sulfate	38.02	Mouse (*Mus musculus*)	1	4	0/100/200/400	mg/kg diet	N	na	ADL	U	FD	3	35	d	21	d	JV	M	C	Y	Lab	REP	SPCL	TE		100	Y	0.0249	Y	0.0063		9.62	10	10	5	10	7	10	4	10	10	4	80
19	3009	Bataineh et al., 1997	Chromium chloride	32.83	Rat (*Rattus norvegicus*)	1	2	0/1000	mg/L	N	na	ADL	U	DR	2	12	w	NR	NR	AD	M	C	N	Lab	REP	TEWT	TE		1000	Y	0.34052	N	0.03755		36.2	10	5	5	10	6	10	4	10	10	4	74
20	3025	Elbetieha and Al-Hamood, 1997	Chromium chloride	32.83	Mouse (*Mus musculus*)	1	3	0/2000/5000	mg/L	N	na	NR	U	DR	1	12	w	50	d	JV	F	C	Y	Lab	REP	PROG	WO		2000	N	0.0342	N	0.004745		91.1	10	5	5	10	5	10	4	10	10	4	73
21	3025	Elbetieha and Al-Hamood, 1997	Chromium chloride	32.83	Mouse (*Mus musculus*)	2	2	0/5000	mg/L	N	na	NR	U	DR	2	12	w	50	d	JV	M	C	Y	Lab	REP	ORWT	OV		5000	Y	0.034	N	0.004288		228	10	5	5	10	6	10	4	10	10	4	74
Growth																																														
22	25908	Van Heugten and Spears, 1997	Chromium chloride	100	Pig (*Sus scrofa*)	1	2	0/0.2	mg/kg diet	N	na	ADL	U	FD	1	32	d	3	w	JV	NR	C	Y	Lab	GRO	BDWT	WO	0.20		Y	16.3	Y	0.54000002	0.00663		10	10	5	10	7	8	4	1	10	4	69
23	25914	Kegley and Spears, 1995	Chromium chloride hexahydrate	100	Cattle (*Bos taurus*)	1	2	0/0.4	mg/kg diet	N	na	ADL	U	FD	1	56	d	NR	NR	JV	M	C	Y	Lab	GRO	BDWT	WO	0.40		Y	263.7	Y	6.15	0.00933		10	10	5	10	7	8	4	1	10	4	69
24	25905	Mooney and Cromwell, 1997	Chromium chloride hexahydrate	100	Pig (*Sus scrofa*)	2	2	0/25200	ug/kg	N	na	ADL	M	FD	1	103	d	NR	NR	JV	B	C	Y	Lab	GRO	BDWT	WO	25200		Y	108.34	Y	2.56	0.595		10	10	10	10	7	8	4	1	10	4	74
25	14446	Shroeder et al., 1963	Trivalent chromium	100	Rat (*Rattus norvegicus*)	1	2	0/5	mg/L	N	na	ADL	U	DR	1	332	d	28	d	JV	M	C	Y	Lab	GRO	BDWT	WO	5		Y	0.4407	N	0.04730	0.537		10	5	5	4	6	8	4	10	10	4	66
26	25905	Mooney and Cromwell, 1997	Chromium chloride hexahydrate	100	Pig (*Sus scrofa*)	1	3	0/5100/25300	ug/kg	N	na	ADL	M	FD	1	35	d	NR	NR	JV	B	C	Y	Lab	GRO	BDWT	WO	25300		Y	42.58	Y	1.56	0.927		10	10	10	10	7	8	4	1	10	4	74
27	3004	Anderson et al., 1997	Chromium chloride	100	Rat (*Rattus norvegicus*)	1	5	0/5/25/50/100	mg/kg diet	N	na	NR	U	FD	1	20	w	4	w	JV	NR	C	Y	Lab	GRO	BDWT	WO	100		Y	0.4	N	0.03235	8.09		10	10	5	10	6	8	4	1	10	4	68
28	3098	Zahid et al., 1990	Chromium sulfate	38.02	Mouse (*Mus musculus*)	1	4	0/100/200/400	mg/kg diet	N	na	ADL	U	FD	2	35	d	21	d	JV	M	C	Y	Lab	GRO	BDWT	WO	400		Y	0.0249	Y	0.0073	44.6		10	10	5	10	7	8	4	1	10	4	69
29	3025	Elbetieha and Al-Hamood, 1997	Chromium chloride	32.83	Mouse (*Mus musculus*)	2	2	0/5000	mg/L	N	na	NR	U	DR	2	12	w	50	d	JV	M	C	Y	Lab	GRO	BDWT	WO	5000		Y	0.034	N	0.004288	228		10	5	5	10	6	8	4	10	10	4	72
30	3729	Ivanksvic and Preussmann, 1975	Chromium oxide green	100	Rat (Rattus norvegicus)	1	3	0/0.8/1.77	g/kg bw/d	N	na	5 per w	U	FD	1	90	d	100	d	SM	F	C	Y	Lab	GRO	BDWT	WO	1.77		Y	0.200	Y	0.015	1770		10	10	5	10	10	8	4	1	10	4	72
31	3025	Elbetieha and Al-Hamood, 1997	Chromium chloride	32.83	Mouse (*Mus musculus*)	2	3	0/2000/5000	mg/L	N	na	NR	U	DR	2	12	w	50	d	JV	M	C	Y	Lab	GRO	BDWT	WO		2000	Y	0.03056	N	0.004288		92.1	10	5	5	10	6	8	4	10	10	4	72
Survival																																														
32	3061	Meenakshi et al., 1989	Chromium chloride hexahydrate	100	Rat (*Rattus norvegicus*)	1	2	0/10	mg/kg bw/d	N	na	1 per d	U	GV	1	60	d	NR	NR	JV	M	C	Y	Lab	MOR	MORT	WO	10.0		Y	0.05	N	0.005855	10.0		10	8	10	10	10	9	4	10	10	4	85
33	757	Mercado and Bibby 1973	Chromium chloride hexahydrate	100	Rat (*Rattus norvegicus*)	1	2	0/25	mg/L	N	na	ADL	U	DR	2	50	d	23	d	JV	M	C	Y	Lab	MOR	MORT	NR		25.0	N	0.267	N	0.03016		2.82	10	5	5	10	5	9	4	10	10	4	72
Data Not Used to Derive Wildlife Toxicity Reference Value																																														
34	25908	Van Heugten and Spears, 1997	Chromium chloride	100	Pig (*Sus scrofa*)	1	2	0/0.2	mg/kg diet	N	na	ADL	U	FD	4	32	d	3	w	JV	NR	C	Y	Lab	HRM	CRTS	SR	0.2		Y	16.3	Y	0.54000002	0.00663		10	10	5	10	7	1	4	1	10	4	62
35	25908	Van Heugten and Spears, 1997	Chromium chloride	100	Pig (*Sus scrofa*)	1	2	0/0.2	mg/kg diet	N	na	ADL	U	FD	2	32	d	3	w	JV	NR	C	Y	Lab	FDB	FCNS	WO	0.2		Y	16.3	Y	0.54000002	0.00663		10	10	5	10	7	4	4	1	10	4	65
36	25908	Van Heugten and Spears, 1997	Chromium chloride	100	Pig (*Sus scrofa*)	1	2	0/0.2	mg/kg diet	N	na	ADL	U	FD	3	32	d	3	w	JV	NR	C	Y	Lab	PHY	FDCV	WO	0.2		Y	16.3	Y	0.54000002	0.00663		10	10	5	10	7	4	4	1	10	4	65
37	25914	Kegley and Spears, 1995	Chromium chloride hexahydrate	100	Cattle (*Bos taurus*)	1	2	0/0.4	mg/kg diet	N	na	ADL	U	FD	4	56	d	NR	NR	JV	M	C	Y	Lab	CHM	GLUC	SR	0.4		Y	263.7	Y	6.15	0.00933		10	10	5	10	7	1	4	1	10	4	62
38	25914	Kegley and Spears, 1995	Chromium chloride hexahydrate	100	Cattle (*Bos taurus*)	1	2	0/0.4	mg/kg diet	N	na	ADL	U	FD	3	56	d	NR	NR	JV	M	C	Y	Lab	PHY	FDCV	WO	0.4		Y	263.7	Y	6.15	0.00933		10	10	5	10	7	4	4	1	10	4	65
39	25914	Kegley and Spears, 1995	Chromium chloride hexahydrate	100	Cattle (*Bos taurus*)	1	2	0/0.4	mg/kg diet	N	na	ADL	U	FD	2	56	d	NR	NR	JV	M	C	Y	Lab	FDB	FCNS	WO	0.4		Y	263.7	Y	6.15	0.00972		10	10	5	10	7	4	4	1	10	4	65
40	25914	Kegley and Spears, 1995	Chromium yeast	100	Cattle (*Bos taurus*)	2	2	0/0.4	mg/kg diet	N	na	ADL	U	FD	4	56	d	NR	NR	JV	M	C	Y	Lab	CHM	GLUC	SR	0.4		Y	263.2	Y	6.41	0.00974		10	10	5	5	7	1	4	1	10	4	57
41	25914	Kegley and Spears, 1995	Chromium yeast	100	Cattle (*Bos taurus*)	2	2	0/0.4	mg/kg diet	N	na	ADL	U	FD	2	56	d	NR	NR	JV	M	C	Y	Lab	FDB	FCNS	WO	0.4		Y	263.2	Y	6.41	0.00974		10	10	5	5	7	4	4	1	10	4	60
42	25914	Kegley and Spears, 1995	Chromium yeast	100	Cattle (*Bos taurus*)	2	2	0/0.4	mg/kg diet	N	na	ADL	U	FD	3	56	d	NR	NR	JV	M	C	Y	Lab	PHY	FDCV	WO	0.4		Y	263.2	Y	6.41	0.00974		10	10	5	5	7	4	4	1	10	4	60
43	25914	Kegley and Spears, 1995	Chromium yeast	100	Cattle (*Bos taurus*)	2	2	0/0.4	mg/kg diet	N	na	ADL	U	FD	1	56	d	NR	NR	JV	M	C	Y	Lab	GRO	BDWT	WO	0.4		Y	263.2	Y	6.41	0.00974		10	10	5	5	7	8	4	1	10	4	64
44	10159	Arthington et al, 1997	Chromium yeast	100	Cattle (*Bos taurus*)	1	2	0/3	mg/d	N	na	ADL	U	FD	1	53	d	6-8	w	JV	M	C	Y	Lab	GRO	BDWT	WO	3		Y	118.9	N	3.49	0.0252		10	10	5	5	6	8	4	1	10	4	63
45	10159	Arthington et al, 1997	Chromium yeast	100	Cattle (*Bos taurus*)	1	2	0/3	mg/d	N	na	ADL	U	FD	2	53	d	6-8	w	JV	M	C	Y	Lab	CHM	HMGL	BL	3		Y	118.9	N	3.49	0.0252		10	10	5	5	6	1	4	10	10	4	65
46	25907	Pechova et al, 2002	Chromium yeast	100	Cattle (*Bos taurus*)	1	2	0/10	mg/org/d	N	na	ADL	U	FD	1	51	d	NR	NR	LC	F	C	Y	Lab	CHM	GLUC	BL	10		N	272	N	6.89	0.0368		10	10	5	5	5	1	4	10	10	4	64
47	10473	Bruckdorfer et al, 1971	Chromium acetate	100	Rat (*Rattus norvegicus*)	1	2	0/0.14	mg/d	N	na	ADL	U	FD	4	9	w	30	d	JV	M	C	Y	Lab	CHM	LIPD	LI	0.14		N	0.523	N	0.04032	0.268		10	10	5	5	5	1	4	1	10	4	55

Result #	Ref N.		Chemical Form	MW%	Test Species	Phase #	# of Conc/ Doses	Conc/ Doses	Conc/Dose Units	Wet Weight Reported?	Percent Moisture	Application Frequency	Method of Analyses	Route of Exposure	Endpoint Number	Exposure Duration	Duration Units	Age	Age Units	Lifestage	Sex	Control Type	Critical Lifestage?	Test Location	Effect Type	Effect Measure	Response Site	Study NOAEL	Study LOAEL	Body Weight Reported?	Body Weight in kg	Ingestion Rate Reported?	Ingestion Rate in kg or L/day	NOAEL Dose (mg/kg/day)	LOAEL Dose (mg/kg/day)	Data Source	Dose Route	Test Concentrations	Chemical form	Dose Quantification	Endpoint	Dose Range	Statistical Power	Exposure Duration	Test Conditions	Total
48	10473	Bruckdorfer et al, 1971	Chromium acetate	100	Rat (*Rattus norvegicus*)	1	2	0/0.14	mg/d	N	na	ADL	U	FD	2	9	w	30	d	JV	M	C	Y	Lab	PHY	FDCV	WO	0.14		N	0.523	N	0.04032	0.268		10	10	5	5	5	4	4	1	10	4	58
49	10473	Bruckdorfer et al, 1971	Chromium acetate	100	Rat (*Rattus norvegicus*)	1	2	0/0.14	mg/d	N	na	ADL	U	FD	3	9	w	30	d	JV	M	C	Y	Lab	ORW	SMIX	LI	0.14		N	0.523	N	0.04032	0.268		10	10	5	5	5	4	4	1	10	4	58
50	10473	Bruckdorfer et al, 1971	Chromium acetate	100	Rat (*Rattus norvegicus*)	1	2	0/0.14	mg/d	N	na	ADL	U	FD	1	9	w	30	d	JV	M	C	Y	Lab	GRO	BDWT	WO	0.14		N	0.523	N	0.04032	0.268		10	10	5	5	5	8	4	1	10	4	62
51	14446	Shroeder et al., 1963	Trivalent chromium	100	Rat (*Rattus norvegicus*)	1	2	0/5	mg/L	N	na	ADL	U	DR	2	332	d	28	d	JV	M	C	Y	Lab	MOR	SURV	WO	5		Y	0.441	N	0.04730	0.537		10	5	5	4	6	9	4	1	10	4	58
52	3701	Kanisawa and Schroeder, 1969	Chromium acetate	100	Rat (*Rattus norvegicus*)	1	2	0/5	mg/L	N	na	ADL	U	DR	2	1189	d	21	d	JV	B	C	Y	Lab	MOR	LFSP	WO	5		N	0.248	N	0.02823	0.569		10	5	5	5	5	9	4	1	10	4	58
53	15198	Cobo et al 1995	Organic Cr+3	100	Rat (*Rattus norvegicus*)	1	2	0/13.08	mg/L	N	na	ADL	M	DR	2	8	w	NR	NR	JV	M	C	N	Lab	FDB	WCON	WO	13.1		Y	0.338	N	0.03730	1.44		10	5	10	4	6	4	4	1	10	4	58
54	757	Mercado and Bibby 1973	Chromium chloride hexahydrate	100	Rat (*Rattus norvegicus*)	1	2	0/25	mg/L	N	na	ADL	U	DR	3	50	d	23	d	JV	M	C	Y	Lab	GRO	BDWT	WO	25.0		N	0.267	N	0.03016	2.82		10	5	5	10	5	8	4	1	10	4	62
55	3098	Zahid et al., 1990	Chromium sulfate	38.02	Mouse (*Mus musculus*)	1	4	0/100/200/400	mg/kg diet	N	na	ADL	U	FD	1	35	d	21	d	JV	M	C	Y	Lab	FDB	FCNS	WO	400		Y	0.0249	Y	0.0073	44.6		10	10	5	10	7	4	4	1	10	4	65
56	3003	Al-Hamood et al., 1998	Chromium chloride	32.83	Mouse (*Mus musculus*)	1	2	0/1000	mg/L	N	na	NR	U	DR	1	29	d	NR	NR	GE	F	C	Y	Lab	FDB	WCON	WO	1000		Y	0.025	Y	0.0064	84.0		10	5	5	10	7	4	4	6	10	4	65
57	15198	Cobo et al 1995	Chromium chloride hexahydrate	19.514	Rat (*Rattus norvegicus*)	2	2	0/2.95	mg/g bw	N	na	ADL	M	DR	2	8	w	NR	NR	JV	M	C	Y	Lab	FDB	WCON	WO	2.95		Y	0.338	N	0.03730	565		10	5	5	10	10	4	4	1	10	4	63
58	15198	Cobo et al 1995	Organic Cr+3	100	Rat (*Rattus norvegicus*)	1	2	0/13.08	mg/L	N	na	ADL	M	DR	1	8	w	NR	NR	JV	M	C	N	Lab	CHM	GLUC	BL		13.08	Y	0.338	N	0.03730		1.44	10	5	10	4	6	1	4	10	10	4	64
59	15506	Schroeder, 1968	Chromium acetate	100	Rat (*Rattus norvegicus*)	1	2	0/3.596	mg/kg bw/d	N	na	ADL	U	DR	1	487	d	21-23	d	JV	M	C	Y	Lab	CHM	CHOL	SR		3.596	N	0.235	N	0.02689		3.60	10	5	5	5	10	1	4	10	10	4	64

The abbreviations and definitions used in coding data are provided in Attachment 4-3 of the Eco-SSL Guidance (U.S.EPA, 2003).

Appendix 6-2

Mammalian Toxicity Data Extracted and Reviewed for Wildlife Toxicity Reference Value (TRV) - Hexavalent Chromium

April 2008

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Ref																									Effects						Conversion to mg/kg bw/day				Result		Data Evaluation Score										
Result #	Ref N.		Chemical Form	MW%	Test Species	Phase #	# of Conc/ Doses	Conc/ Doses	Conc/Dose Units	Wet Weight Reported?	Percent Moisture	Application Frequency	Method of Analyses	Route of Exposure	Endpoint Number	Exposure Duration	Duration Units	Age	Age Units	Lifestage	Sex	Control Type	Critical Lifestage?	Test Location	General Effect Group	Effect Type	Effect Measure	Response Site	Study NOAEL	Study LOAEL	Body Weight Reported?	Body Weight in kg	Ingestion Rate Reported?	Ingestion Rate in kg or L/day	NOAEL Dose (mg/kg/day)	LOAEL Dose (mg/kg/day)	Data Source	Dose Route	Test Concentrations	Chemical form	Dose Quantification	Endpoint	Dose Range	Statistical Power	Exposure Duration	Test Conditions	Total
Biochemical																																															
1	3074	Rao et al, 1983	Sodium chromate	100	Mouse (*Mus musculus*)	1	2	0/1.5	ug/org/d	N	na	NR	M	FD	3	1	yr	NR	NR	JV	M	C	Y	Lab	BIO	CHM	HMGL	BL	1.50		Y	0.0466	N	0.005525	0.0322		10	10	10	4	7	1	4	8	10	4	68
2	3073	Rao et al., 1981	Sodium chromate	100	Rat (*Rattus norvegicus*)	1	2	0/1.8	mg/kg diet	N	na	NR	M	FD	2	1	yr	NR	NR	JV	M	C	Y	Lab	BIO	CHM	HMGL	BL	1.80		Y	0.3902	N	0.03170	0.146		10	10	10	4	6	1	4	10	10	4	69
3	25925	R.O.W. Sciences, Inc.	Potassium dichromate	35.35	Rat (*Rattus norvegicus*)	1	5	0/1/3/6/24	mg/kg bw/d	N	na	ADL	UX	FD	5	9	w	9	w	JV	M	C	Y	Lab	BIO	CHM	MCPV	BL	6	24	Y	0.5285	Y	0.0912	2.12	8.48	10	10	10	10	10	1	8	10	10	4	83
4	25927	R.O.W. Sciences, Inc.	Potassium dichromate	35.35	Mouse (*Mus musculus*)	2	5	0/5/16/34/137	mg/kg bw/d	N	na	ADL	UX	FD	5	3	w	9	w	JV	F	C	Y	Lab	BIO	CHM	MCPV	BL	16.0	34.0	Y	0.02036	Y	0.007	5.66	12.0	10	10	10	10	10	1	8	10	10	4	83
5	3095	Vyskocil et al., 1993	Potassium dichromate	100	Rat (*Rattus norvegicus*)	1	2	0/2.47	mg/kg bw/d	N	na	NR	U	DR	1	6	mo	8	w	JV	F	C	Y	Lab	BIO	CHM	ALBM	UR		2.47	N	0.156	N	0.01860		2.47	10	5	5	10	10	1	4	10	10	4	69
6	25926	R.O.W.Sciences Inc, 1997	Potassium dichromate	35.35	Mouse (*Mus musculus*)	1	4	0/19.4/38.6/85.7	mg/kg bw/d	N	na	ADL	UX	FD	4	14	w	10	w	GE	F	C	Y	Lab	BIO	CHM	MCPV	BL		19.4	Y	0.03246	Y	0.00605		6.86	10	10	10	10	10	1	4	10	10	4	79
7	3061	Meenakshi et al., 1989	Potassium dichromate	100	Rat (*Rattus norvegicus*)	2	2	0/10	mg/kg bw/d	N	na	1 per d	U	GV	2	60	d	NR	NR	JV	F	C	Y	Lab	BIO	CHM	GLUC	BL		10.0	Y	0.05	N	0.005855		10.0	10	8	10	10	10	1	4	10	10	4	77
8	3020	Chowdhury and Mitra, 1995	Sodium dichromate	100	Rat (*Rattus norvegicus*)	1	4	0/20/40/60	mg/kg bw/d	N	na	DLY	U	GV	3	90	d	NR	NR	JV	M	C	Y	Lab	BIO	HRM	TSTR	SR		20.0	Y	0.3085	N	0.02613		20.0	10	8	10	10	10	1	4	10	10	4	77
Behavior																																															
9	25927	R.O.W. Sciences, Inc.	Potassium dichromate	35.35	Mouse (*Mus musculus*)	2	5	0/5/16/34/137	mg/kg bw/d	N	na	ADL	UX	FD	4	1	w	9	w	JV	F	C	Y	Lab	BEH	FDB	WCNS	WO	16.0	34.0	Y	0.01893	Y	0.00546	5.66	12.0	10	10	10	10	10	4	10	10	10	4	88
10	25925	R.O.W. Sciences, Inc.	Potassium dichromate	35.35	Rat (*Rattus norvegicus*)	1	5	0/1/3/6/24	mg/kg bw/d	N	na	ADL	UX	FD	4	9	w	9	w	JV	M	C	Y	Lab	BEH	FDB	FCNS	WO	24.0		Y	0.5285	Y	0.0912	8.48		10	10	10	10	10	4	4	10	10	4	82
11	25926	R.O.W.Sciences Inc, 1997	Potassium dichromate	35.35	Mouse (*Mus musculus*)	1	4	0/19.4/38.6/85.7	mg/kg bw/d	N	na	ADL	UX	FD	3	14	w	10	w	GE	F	C	Y	Lab	BEH	FDB	FCNS	WO	85.7		Y	0.03052	Y	0.00702	30.3		10	10	10	10	10	4	4	10	10	4	82
12	3003	Al-Hamood et al., 1998	Potassium dichromate	35.35	Mouse (*Mus musculus*)	2	2	0/1000	mg/l	N	na	NR	U	DR	1	29	d	NR	NR	GE	F	C	Y	Lab	BEH	FDB	WCON	WO	1000		Y	0.025	Y	0.0050	68.1		10	5	5	10	6	4	4	8	10	4	66
13	11440	Gribble, 1974	Chromate ion	44.83	Mouse (*Mus musculus*)	1	2	0/400	mg/L	N	na	ADL	U	DR	2	7	d	7	w	JV	F	C	Y	Lab	BEH	FDB	WCON	WO		400	Y	0.031	Y	0.00095		5.50	10	5	5	10	7	4	4	10	10	4	69
14	3029	Gates et al, 1947	Potassium dichromate	100	Rat (*Rattus norvegicus*)	1	4	0/7.2/13.1/25.0	mg/kg bw/d	N	na	ADL	U	DR	3	5	d	NR	NR	JV	B	C	Y	Lab	BEH	FDB	WCON	WO		7.20	Y	0.08	Y	0.0134		7.20	10	5	5	10	10	4	4	10	10	4	72
15	3009	Bataineh et al., 1997	Potassium dichromate	35.35	Rat (*Rattus norvegicus*)	2	2	0/1000	mg/l	N	na	ADL	U	DR	1	12	w	NR	NR	AD	M	C	N	Lab	BEH	BEH	AGGT	WO		1000	Y	0.36133	N	0.03960		38.7	10	5	5	10	6	4	4	10	10	4	68
16	31	Trivedi et al., 1989	Potassium dichromate	100	Mouse (*Mus musculus*)	1	4	0/1.76/3.6/7.03	mg/org/d	N	na	ADL	U	DR	1	19	d	NR	NR	GE	F	C	N	Lab	BEH	FDB	WCON	WO		1.76	Y	0.043	Y	0.007050		40.5	10	5	5	10	7	4	4	10	10	4	69
Physiology																																															
17	3023	Diaz-Mayans et al., 1986	Sodium chromate	100	Rat (*Rattus norvegicus*)	1	3	0/0.07/0.7	g/L	N	na	ADL	U	DR	3	28	d	NR	NR	SM	M	C	N	Lab	PHY	PHY	EXCR	UR	0.070	0.70	Y	0.26	Y	0.0166	4.47	44.7	10	5	5	10	7	4	8	10	10	4	73
Pathology																																															
18	3074	Rao et al, 1983	Sodium chromate	100	Mouse (*Mus musculus*)	1	2	0/1.5	ug/org/d	N	na	NR	M	FD	2	1	yr	NR	NR	JV	M	C	Y	Lab	PTH	ORW	SMIX	KI	1.50		Y	0.0466	N	0.005525	0.0322		10	10	10	5	7	4	4	3	10	4	67
19	3073	Rao et al., 1981	Sodium chromate	100	Rat (*Rattus norvegicus*)	1	2	0/1.8	mg/kg diet	N	na	NR	M	FD	4	1	yr	NR	NR	JV	M	C	Y	Lab	PTH	ORW	SMIX	LI	1.80		Y	0.3902	N	0.03170	0.146		10	10	10	4	6	4	4	10	10	4	72
20	3095	Vyskocil et al., 1993	Potassium dichromate	100	Rat (*Rattus norvegicus*)	1	2	0/2.47	mg/kg bw/d	N	na	NR	U	DR	2	6	mo	8	w	JV	F	C	Y	Lab	PTH	ORW	SMIX	KI	2.47		N	0.156	N	0.01860	2.47		10	5	5	10	10	4	4	10	10	4	72
21	25926	R.O.W.Sciences Inc, 1997	Potassium dichromate	35.35	Mouse (*Mus musculus*)	1	4	0/19.4/38.6/85.7	mg/kg bw/d	N	na	ADL	UX	FD	5	14	w	10	w	GE	F	C	Y	Lab	PTH	ORW	ORWT	LI	38.6	85.7	Y	0.0259	Y	0.00702	13.6	30.3	10	10	10	10	10	4	10	10	10	4	88
22	25927	R.O.W. Sciences, Inc.	Potassium dichromate	35.35	Mouse (*Mus musculus*)	1	5	0/3/10/21/92	mg/kg bw/d	N	na	ADL	UX	FD	2	9	w	9	w	JV	M	C	Y	Lab	PTH	HIS	GHIS	MT	92.0		Y	0.02684	Y	0.00546	32.5		10	10	10	10	10	4	4	1	10	4	73
23	3061	Meenakshi et al., 1989	Potassium dichromate	100	Rat (*Rattus norvegicus*)	2	2	0/10	mg/kg bw/d	N	na	1 per d	U	GV	1	60	d	NR	NR	JV	F	C	Y	Lab	PTH	HIS	NCRO	LI		10.0	Y	0.05	N	0.005855		10.0	10	8	10	10	10	4	4	10	10	4	80
24	3009	Bataineh et al., 1997	Potassium dichromate	35.35	Rat (*Rattus norvegicus*)	2	2	0/1000	mg/l	N	na	ADL	U	DR	3	12	w	NR	NR	AD	M	C	N	Lab	PTH	GRS	BDWT	WO		1000	Y	0.36133	N	0.03960		38.7	10	5	5	10	6	4	4	10	10	4	68
Reproduction																																															
25	3074	Rao et al, 1983	Sodium chromate	100	Mouse (*Mus musculus*)	1	2	0/1.5	ug/org/d	N	na	NR	M	FD	4	1	yr	NR	NR	JV	M	C	Y	Lab	REP	REP	TEWT	TE	1.50		Y	0.0466	N	0.005525	0.0322		10	10	10	4	7	10	4	3	10	4	72
26	3073	Rao et al., 1981	Sodium chromate	100	Rat (*Rattus norvegicus*)	1	2	0/1.8	mg/kg diet	N	na	NR	M	FD	3	1	yr	NR	NR	JV	M	C	Y	Lab	REP	REP	TEWT	TE	1.80		Y	0.3902	N	0.03170	0.146		10	10	10	4	6	10	4	10	10	4	78
27	25925	R.O.W. Sciences, Inc.	Potassium dichromate	35.35	Rat (*Rattus norvegicus*)	1	5	0/1/3/6/24	mg/kg bw/d	N	na	ADL	UX	FD	3	9	w	9	w	JV	M	C	Y	Lab	REP	REP	SPCL	TE	24.0		Y	0.5285	Y	0.0912	8.48		10	10	10	10	10	10	4	3	10	4	81
28	3020	Chowdhury and Mitra, 1995	Sodium dichromate	100	Rat (*Rattus norvegicus*)	1	4	0/20/40/60	mg/kg bw/d	N	na	DLY	U	GV	2	90	d	NR	NR	JV	M	C	Y	Lab	REP	REP	TEWT	TE	20.0	40.0	Y	0.3084	N	0.02612	20.0	40.0	10	8	10	10	10	10	10	10	10	4	92
29	25926	R.O.W.Sciences Inc, 1997	Potassium dichromate	35.35	Mouse (*Mus musculus*)	1	4	0/19.4/38.6/85.7	mg/kg bw/d	N	na	ADL	UX	FD	6	14	w	10	w	GE	F	C	Y	Lab	REP	REP	PROG	WO	85.7		Y	0.03052	Y	0.00702	30.3		10	10	10	10	10	10	4	10	10	4	88
30	25927	R.O.W. Sciences, Inc.	Potassium dichromate	35.35	Mouse (*Mus musculus*)	1	5	0/3/10/21/92	mg/kg bw/d	N	na	ADL	UX	FD	6	9	w	9	w	JV	M	C	Y	Lab	REP	REP	GREP	SM	92.0		Y	0.02684	Y	0.00546	32.5		10	10	10	10	10	10	4	3	10	4	81
31	3047	Junaid et al., 1996	Potassium dichromate	100	Mouse (*Mus musculus*)	1	4	0/2.0/3.75/5.47	mg/org/d	N	na	ADL	U	DR	3	8	d	NR	NR	GE	F	C	Y	Lab	REP	REP	PROG	WO	2.0	3.75	Y	0.04521	N	0.006100	44.2	82.9	10	5	5	10	6	10	10	10	10	4	80
32	3025	Elbetieha and Al-Hamood, 1997	Potassium dichromate	35.35	Mouse (*Mus musculus*)	2	5	0/1000/2000/4000/5000	mg/l	N	na	NR	U	DR	2	12	w	50	d	JV	M	C	Y	Lab	REP	REP	TEWT	TE	1000	2000	N	0.03080	N	0.004480	49.4	98.7	10	5	5	10	5	10	10	10	10	4	79
33	3098	Zahid et al., 1990	Potassium dichromate	35.35	Mouse (*Mus musculus*)	2	4	0/100/200/400	mg/kg diet	N	na	ADL	U	FD	3	35	d	21	d	JV	M	C	Y	Lab	REP	REP	TEDG	TE		100	Y	0.0249	Y	0.0076		10.8	10	10	5	10	7	10	4	10	10	4	80
34	3049	Kanojia et al., 1996	Potassium dichromate	100	Rat (*Rattus norvegicus*)	1	4	0/6.44/12.2/15.28	mg/org/d	N	na	NR	U	DR	2	39	d	120	d	GE	F	C	Y	Lab	REP	REP	PROG	WO		6.44	Y	0.24002	N	0.02741		26.8	10	5	5	10	6	10	4	10	10	4	74
35	3050	Kanojia et al., 1998	Potassium dichromate	100	Rat (*Rattus norvegicus*)	1	4	0/5.57/10.18/13.56	mg/org/d	N	na	NR	U	DR	3	3	mo	50	d	JV	F	C	Y	Lab	REP	REP	PRWT	WO		5.57	N	0.168	N	0.01988		33.2	10	5	5	10	5	10	4	10	10	4	73
36	3045	Junaid et al., 1995	Potassium dichromate	100	Mouse (*Mus musculus*)	1	4	0/250/500/750	mg/l	N	na	ADL	U	DR	2	6	d	4	mo	GE	F	C	Y	Lab	REP	REP	PRWT	WO		250	Y	0.04537	N	0.006120		33.7	10	5	5	10	6	10	4	10	10	4	74
37	3068	Murthy et al., 1996	Potassium dichromate	100	Mouse (*Mus musculus*)	1	4	0/250/500/750	mg/L	N	na	ADL	U	DR	1	20	d	90	d	SM	F	C	N	Lab	REP	REP	GREP	OV		250	Y	0.03	N	0.004217		35.1	10	5	5	10	6	10	4	10	10	4	74
38	3009	Bataineh et al., 1997	Potassium dichromate	35.35	Rat (*Rattus norvegicus*)	2	2	0/1000	mg/l	N	na	ADL	U	DR	2	12	w	NR	NR	AD	M	C	N	Lab	REP	REP	TEWT	TE		1000	Y	0.36133	N	0.03960		38.7	10	5	5	10	6	10	4	10	10	4	74
39	31	Trivedi et al., 1989	Potassium dichromate	100	Mouse (*Mus musculus*)	1	4	0/1.76/3.6/7.03	mg/org/d	N	na	ADL	U	DR	3	19	d	NR	NR	GE	F	C	Y	Lab	REP	REP	RSEM	WO		1.76	Y	0.0435	Y	0.007050		40.5	10	5	5	10	7	10	4	10	10	4	75
40	3046	Junaid et al., 1996	Potassium dichromate	100	Mouse (*Mus musculus*)	1	4	0/1.9/3.56/5.23	mg/org/d	N	na	ADL	U	DR	3	20	d	4	mo	GE	F	C	Y	Lab	REP	REP	PRWT	WO		1.90	Y	0.04343	N	0.005884		43.7	10	5	5	10	6	10	4	10	10	4	74
41	3025	Elbetieha and Al-Hamood, 1997	Potassium dichromate	35.35	Mouse (*Mus musculus*)	4	3	0/2000/5000	mg/l	N	na	NR	U	DR	1	12	w	50	d	JV	M	C	Y	Lab	REP	REP	TEWT	TE		2000	Y	0.03080	N	0.004480		98.7	10	5	5	10	6	10	4	10	10	4	74
42	3025	Elbetieha and Al-Hamood, 1997	Potassium dichromate	35.35	Mouse (*Mus musculus*)	5	2	0/5000	mg/l	N	na	NR	U	DR	1	12	w	50	d	JV	F	C	Y	Lab	REP	REP	ORWT	OV		5000	Y	0.03273	N	0.004480		246	10	5	5	10	6	10	4	10	10	4	74
Growth																																															
43	3074	Rao et al, 1983	Sodium chromate	100	Mouse (*Mus musculus*)	1	2	0/1.5	ug/org/d	N	na	NR	M	FD	1	1	yr	NR	NR	JV	M	C	Y	Lab	GRO	GRO	BDWT	WO	1.50		Y	0.0466	N	0.005525	0.0322		10	10	10	4	7	8	4	3	10	4	70
44	3073	Rao et al., 1981	Sodium chromate	100	Rat (*Rattus norvegicus*)	1	2	0/1.8	mg/kg diet	N	na	NR	M	FD	1	1	yr	NR	NR	JV	M	C	Y	Lab	GRO	GRO	BDWT	WO	1.80		Y	0.3902	N	0.03170	0.146		10	10	10	4	6	8	4	8	10	4	74
45	25927	R.O.W. Sciences, Inc.	Potassium dichromate	35.35	Mouse (*Mus musculus*)	2	5	0/5/16/34/137	mg/kg bw/d	N	na	ADL	UX	FD	1	3	w	9	w	JV	F	C	Y	Lab	GRO	GRO	BDWT	WO	16.0	34.0	Y	0.2036	Y	0.00546	5.66	12.0	10	10	10	10	10	8	10	10	10	4	92
46	25925	R.O.W. Sciences, Inc.	Potassium dichromate	35.35	Rat (*Rattus norvegicus*)	1	5	0/1/3/6/24	mg/kg bw/d	N	na	ADL	UX	FD	2	9	w	9	w	JV	M	C	Y	Lab	GRO	GRO	BDWT	WO	24.0		Y	0.5285	Y	0.0912	8.48		10	10	10	10	10	8	4	10	10	4	86
47	25926	R.O.W.Sciences Inc, 1997	Potassium dichromate	35.35	Mouse (*Mus musculus*)	2	4	0/39.11/79.26/164	mg/kg bw/d	N	na	ADL	UX	FD	1	16	w	10	w	LC	F	C	Y	Lab	GRO	GRO	BDWT	WO	39.11	79.26	Y	0.03456	N	0.004322	10.5	21.2	10	10	10	10	10	8	10	10	10	4	92
48	3020	Chowdhury and Mitra, 1995	Sodium dichromate	100	Rat (*Rattus norvegicus*)	1	4	0/20/40/60	mg/kg bw/d	N	na	DLY	U	GV	1	90	d	NR	NR	JV	M	C	Y	Lab	GRO	GRO	BDWT	WO	20.0	40.0	Y	0.3084	N	0.02612	20.0	40.0	10	8	10	10	10	8	10	10	10	4	90
49	3050	Kanojia et al., 1998	Potassium dichromate	100	Rat (*Rattus norvegicus*)	1	4	0/5.57/10.18/13.56	mg/org/d	N	na	NR	U	DR	1	3	mo	50	d	JV	F	C	Y	Lab	GRO	GRO	BDWT	WO	5.57	10.2	Y	0.168	N	0.01988	33.2	60.6	10	5	5	10	6	8	10	10	10	4	78

Result #	Ref N.		Chemical Form	MW%	Test Species	Phase #	# of Conc/ Doses	Conc/ Doses	Conc/Dose Units	Wet Weight Reported?	Percent Moisture	Application Frequency	Method of Analyses	Route of Exposure	Endpoint Number	Exposure Duration	Duration Units	Age	Age Units	Lifestage	Sex	Control Type	Critical Lifestage?	Test Location	General Effect Group	Effect Type	Effect Measure	Response Site	Study NOAEL	Study LOAEL	Body Weight Reported?	Body Weight in kg	Ingestion Rate Reported?	Ingestion Rate in kg or L/day	NOAEL Dose (mg/kg/day)	LOAEL Dose (mg/kg/day)	Data Source	Dose Route	Test Concentrations	Chemical form	Dose Quantification	Endpoint	Dose Range	Statistical Power	Exposure Duration	Test Conditions	Total
50	3045	Junaid et al., 1995	Potassium dichromate	100	Mouse (*Mus musculus*)	1	4	0/250/500/750	mg/l	N	na	ADL	U	DR	1	6	d	4	mo	GE	F	C	Y	Lab	GRO	GRO	BDWT	WO	250	500	Y	0.04537	N	0.006120	33.7	67.4	10	5	5	10	6	8	10	10	10	4	78
51	31	Trivedi et al., 1989	Potassium dichromate	100	Mouse (*Mus musculus*)	1	4	0/1.76/3.6/7.03	mg/org/d	N	na	ADL	U	DR	2	19	d	NR	NR	GE	F	C	Y	Lab	GRO	GRO	BDWT	WO	1.76	3.60	Y	0.0435	Y	0.007200	40.5	82.8	10	5	5	10	7	8	10	10	10	4	79
52	3098	Zahid et al., 1990	Potassium dichromate	35.35	Mouse (*Mus musculus*)	2	4	0/100/200/400	mg/kg diet	N	na	ADL	U	FD	2	35	d	21	d	JV	M	C	Y	Lab	GRO	GRO	BDWT	WO	400		Y	0.0249	Y	0.0076	43.2		10	10	5	10	7	8	4	1	10	4	69
53	3047	Junaid et al., 1996	Potassium dichromate	100	Mouse (*Mus musculus*)	1	4	0/2.0/3.75/5.47	mg/org/d	N	na	ADL	U	DR	2	8	d	NR	NR	GE	F	C	Y	Lab	GRO	GRO	BDWT	WO	2.0	3.75	Y	0.04521	N	0.006100	44.2	82.9	10	5	5	10	6	8	10	10	10	4	78
54	3046	Junaid et al., 1996	Potassium dichromate	100	Mouse (*Mus musculus*)	1	4	0/1.9/3.56/5.23	mg/org/d	N	na	ADL	U	DR	2	20	d	4	mo	GE	F	C	Y	Lab	GRO	GRO	BDWT	WO	3.56	5.23	Y	0.04238	N	0.005755	84.0	123	10	5	5	10	6	8	10	10	10	4	78
55	3025	Elbetieha and Al-Hamood, 1997	Potassium dichromate	35.35	Mouse (*Mus musculus*)	5	2	0/5000	mg/l	N	na	NR	U	DR	1	12	w	50	d	JV	F	C	Y	Lab	GRO	GRO	BDWT	WO	5000		Y	0.03273	N	0.004480	246		10	5	5	10	6	8	4	8	10	4	70
56	3085	Schroeder and Mitchener, 1971	Potassium dichromate	100	Mouse (*Mus musculus*)	1	2	0/5	mg/l	N	na	NR	U	DR	1	10	d	19-20	d	JV	M	C	Y	Lab	GRO	GRO	BDWT	WO		5.0	Y	0.0206	N	0.003007		0.730	10	5	5	10	6	8	4	10	10	4	72
57	3029	Gates et al, 1947	Potassium dichromate	100	Rat (*Rattus norvegicus*)	1	4	0/7.2/13.1/25.0	mg/kg bw/d	N	na	ADL	U	DR	1	5	d	NR	NR	JV	B	C	Y	Lab	GRO	GRO	BDWT	WO		7.20	Y	0.08	Y	0.0157		7.20	10	5	5	10	10	8	4	10	10	4	76
58	3049	Kanojia et al., 1996	Potassium dichromate	100	Rat (*Rattus norvegicus*)	1	4	0/6.44/12.2/15.28	mg/org/d	N	na	NR	U	DR	3	39	d	120	d	GE	F	C	Y	Lab	GRO	GRO	BDWT	WO		6.44	Y	0.24002	N	0.02741		26.8	10	5	5	10	6	8	4	10	10	4	72
59	3025	Elbetieha and Al-Hamood, 1997	Potassium dichromate	35.35	Mouse (*Mus musculus*)	4	3	0/2000/5000	mg/l	N	na	NR	U	DR	2	12	w	50	d	JV	M	C	Y	Lab	GRO	GRO	BDWT	WO		2000	Y	0.03080	N	0.004480		98.7	10	5	5	10	6	8	4	10	10	4	72
Survival																																															
60	25925	R.O.W. Sciences, Inc.	Potassium dichromate	35.35	Rat (*Rattus norvegicus*)	1	5	0/1/3/6/24	mg/kg bw/d	N	na	ADL	UX	FD	1	9	w	9	w	JV	M	C	Y	Lab	MOR	MOR	MORT	WO	24.0		Y	0.5285	Y	0.0912	8.48		10	10	10	10	10	9	4	10	10	4	87
61	3061	Meenakshi et al., 1989	Potassium dichromate	100	Rat (*Rattus norvegicus*)	2	2	0/10	mg/kg bw/d	N	na	1 per d	U	GV	1	60	d	NR	NR	JV	F	C	Y	Lab	MOR	MOR	MORT	WO	10.0		Y	0.05	N	0.005855	10.0		10	8	10	10	10	9	4	10	10	4	85
62	25926	R.O.W.Sciences Inc, 1997	Potassium dichromate	35.35	Mouse (*Mus musculus*)	1	4	0/19.4/38.6/85.7	mg/kg bw/d	N	na	ADL	UX	FD	2	14	w	10	w	GE	F	C	Y	Lab	MOR	MOR	MORT	WO	85.7		Y	0.03052	Y	0.00702	30.3		10	10	10	10	10	9	4	10	10	4	87
63	25927	R.O.W. Sciences, Inc.	Potassium dichromate	35.35	Mouse (*Mus musculus*)	1	5	0/3/10/21/92	mg/kg bw/d	N	na	ADL	UX	FD	1	9	w	9	w	JV	M	C	Y	Lab	MOR	MOR	MORT	WO	92.0		Y	0.02684	Y	0.00546	32.5		10	10	10	10	10	9	4	10	10	4	87
64	3029	Gates et al, 1947	Potassium dichromate	100	Rat (*Rattus norvegicus*)	1	4	0/7.2/13.1/25.0	mg/kg bw/d	N	na	ADL	U	DR	2	25	d	NR	NR	JV	B	C	Y	Lab	MOR	MOR	MORT	WO	25.0		Y	0.08	Y	0.0134	25.0		10	5	5	10	10	9	4	10	10	4	77
65	3023	Diaz-Mayans et al., 1986	Sodium chromate	100	Rat (*Rattus norvegicus*)	1	3	0/0.07/0.7	g/L	N	na	ADL	U	DR	1	28	d	NR	NR	SM	M	C	N	Lab	MOR	MOR	MORT	WO	0.70		Y	0.26	Y	0.00942	25.4		10	5	5	10	7	9	4	10	10	4	74
66	3050	Kanojia et al., 1998	Potassium dichromate	100	Rat (*Rattus norvegicus*)	1	4	0/5.57/10.18/13.56	mg/org/d	N	na	NR	U	DR	2	3	mo	50	d	JV	F	C	Y	Lab	MOR	MOR	MORT	WO	5.57	10.2	Y	0.168	N	0.01988	33.2	60.6	10	5	5	10	6	9	10	10	10	4	79
67	3049	Kanojia et al., 1996	Potassium dichromate	100	Rat (*Rattus norvegicus*)	1	4	0/6.44/12.2/15.28	mg/org/d	N	na	NR	U	DR	1	39	d	120	d	GE	F	C	Y	Lab	MOR	MOR	MORT	WO	15.3		Y	0.24002	N	0.02741	63.7		10	5	5	10	6	9	4	10	10	4	73
68	3046	Junaid et al., 1996	Potassium dichromate	100	Mouse (*Mus musculus*)	1	4	0/1.9/3.56/5.23	mg/org/d	N	na	ADL	U	DR	1	20	d	4	mo	SM	F	C	N	Lab	MOR	MOR	MORT	WO	3.56	5.23	Y	0.04338	N	0.005878	82.1	121	10	5	5	10	6	9	10	10	10	4	79
69	3047	Junaid et al., 1996	Potassium dichromate	100	Mouse (*Mus musculus*)	1	4	0/2.0/3.75/5.47	mg/org/d	N	na	ADL	U	DR	1	8	d	NR	NR	GE	F	C	Y	Lab	MOR	MOR	MORT	WO	5.47		Y	0.04179	N	0.005683	131		10	5	5	10	6	9	4	10	10	4	73
70	31	Trivedi et al., 1989	Potassium dichromate	100	Mouse (*Mus musculus*)	1	4	0/1.76/3.6/7.03	mg/org/d	N	na	ADL	U	DR	1	19	d	NR	NR	GE	F	C	N	Lab	MOR	MOR	MORT	WO	7.03		Y	0.043	Y	0.007030	163		10	5	5	10	7	9	4	10	10	4	74
Data Not Used to Derive Wildlife Toxicity Reference Value																																															
71	3085	Schroeder and Mitchener, 1971	Potassium dichromate	100	Mouse (*Mus musculus*)	1	2	0/5	mg/l	N	na	NR	U	DR	1	30	d	19-20	d	JV	M	C	Y	Lab	MOR	MOR	SURV	WO	5.0		Y	0.0206	N	0.003007	0.730		10	5	5	10	6	9	4	1	10	4	64
72	11440	Gribble, 1974	Chromate ion	44.83	Mouse (*Mus musculus*)	1	2	0/400	mg/L	N	na	ADL	U	DR	1	7	d	7	w	JV	F	C	Y	Lab	BIO	CHM	HMGL	BL	400		Y	0.031	Y	0.00095	5.50		10	5	5	10	7	1	4	1	10	4	57
73	3023	Diaz-Mayans et al., 1986	Sodium chromate	100	Rat (*Rattus norvegicus*)	1	3	0/0.07/0.7	g/L	N	na	ADL	U	DR	4	28	d	NR	NR	SM	M	C	N	Lab	BEH	FDB	WCON	WO	0.70		Y	0.26	Y	0.00942	25.4		10	5	5	10	7	4	4	3	10	4	62
74	3098	Zahid et al., 1990	Potassium dichromate	35.35	Mouse (*Mus musculus*)	2	4	0/100/200/400	mg/kg diet	N	na	ADL	U	FD	1	35	d	21	d	JV	M	C	Y	Lab	BEH	FDB	FCNS	WO	400		Y	0.0249	Y	0.0076	43.2		10	10	5	10	7	4	4	1	10	4	65
75	3023	Diaz-Mayans et al., 1986	Sodium chromate	100	Rat (*Rattus norvegicus*)	1	3	0/0.07/0.7	g/L	N	na	ADL	U	DR	2	28	d	NR	NR	SM	M	C	N	Lab	GRO	GRO	BDWT	WO	0.70		Y	0.26	Y	0.00942	79.3		10	5	5	10	7	8	4	1	10	4	64

The abbreviations and definitions used in coding data are provided in Attachment 4-3 of the Eco-SSL Guidance (U.S.EPA, 2003).