Ecological Soil Screening Levels for Antimony

Interim Final

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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 antimony and the documentation for their derivation. This document provides guidance and is designed to communicate national policy on identifying antimony 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 ANTIMONY

Antimony (Sb, stibium) is a semi-metallic element that belongs to group (VA) of the periodic table and shares some chemical properties with lead, arsenic, and bismuth (U.S. EPA, 1992). In nature, antimony is associated with sulfur as stibnite. Antimony also occurs in ores with arsenic, and the two metals share similar chemical and physical properties. Antimony is a common component of lead and copper alloys and is used in the manufacturing of ceramics, textiles, paints, explosives, batteries, and semiconductors. Major sources of environmental contamination are smelters, coal combustion, and incineration of waste and sewage sludge. In the past, antimony compounds have been used therapeutically as an anti-helminthic and anti-protozoic treatment. This practice has been largely discontinued as a result of antimony toxicity.

Antimony exists in valences of 0, -3, +3, +5. The tri- and pentavalent forms are the most stable forms of antimony (U.S. EPA, 1992) and are of the most interest in biological systems. The toxicokinetics and toxicity of the tri- and pentavalent forms vary, with the trivalent form considered to be more toxic.

Ingested antimony is absorbed slowly, and many antimony compounds are reported to be gastrointestinal irritants. Trivalent antimony is absorbed more slowly than the pentavalent form. Approximately 15-39% of trivalent antimony is reported to be absorbed in the gastrointestinal tract of animals (Rossi et al., 1987). The toxic effects of antimony in mammals involve cardiovascular changes. Observed changes include degeneration of the myocardium, arterial hypotension, heart dysfunction, arrhythmia, and altered electrocardiogram patterns (Rossi et al. 1987). The mode of action for antimony-induced cardiotoxicity is unknown.

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

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

Plants	Soil Invertebrates	Wildlife	
		Avian	Mammalian
NA	78	NA	0.27

NA = Not Available. Data were insufficient to derive an Eco-SSL.

Eco-SSL values for antimony were derived for soil invertebrates and mammalian wildlife. Eco-SSL values for antimony could not be derived for plants or avian wildlife. For these receptor groups, data were insufficient to derive soil screening values.

The Eco-SSL value for mammals at 0.27 mg/kg dry weight (dw) is less than the range of reported typical background concentrations in U.S. soils (Figure 2.1).

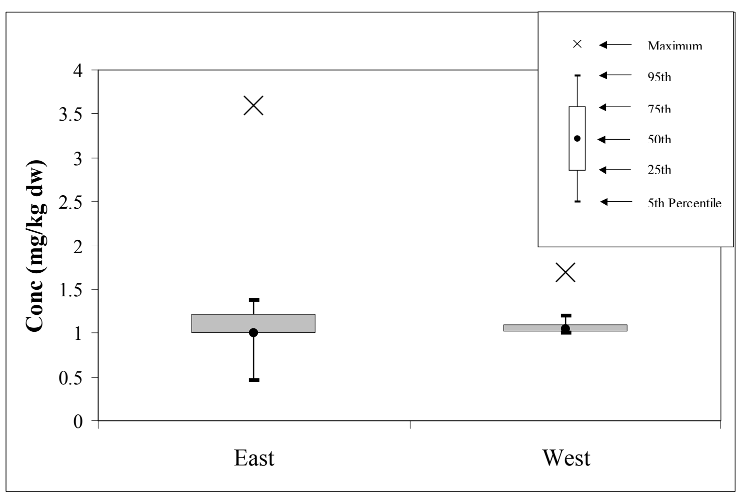


Figure 2.1 Typical Background Concentrations of Antimony in U.S. Soils

The soil invertebrate Eco-SSL at 78 mg/kg dw is well above the reported range of background concentrations for both eastern and western U.S. soils. The reported background concentrations of many metals in the U.S. soils are described in Attachment 1-4 of the Eco-SSL guidance (U.S. EPA, 2003).

3.0 ECO-SSL FOR TERRESTRIAL PLANTS

Of the papers identified from the literature search process, 12 were selected for acquisition for further review. Of those papers acquired, one paper met all 11 Study Acceptance Criteria (U.S. EPA, 2003; Attachment 3-1). Studies in this paper were reviewed and the studies were scored according to the Eco-SSL guidance (U.S. EPA, 2003; Attachment 3-2). There were no studies with an Evaluation Score greater than ten. Thus, an Eco-SSL for plants for antimony could not be derived.

4.0 ECO-SSL FOR SOIL INVERTEBRATES

Of the papers identified from the literature search process, seven were selected for acquisition for further review. Of those papers acquired, three papers met all 11 Study Acceptance Criteria. These papers were reviewed and the studies were scored according to the Eco-SSL guidance (U.S. EPA, 2003; Attachment 4-2). Three studies received an Evaluation Score greater than ten. The data for these studies are listed in Table 4.1.

The studies in Table 4.1 are sorted by bioavailability score and all study results with a bioavailability score of one or two were used to derive the soil invertebrate Eco-SSL for antimony. Three studies are used to derive the soil invertebrate Eco-SSL according to the Eco-SSL guidance (U.S. EPA, 2003). The Eco-SSL is the geometric mean of the EC_{20} values reported for each of three test species under similar test conditions (pH and % organic matter (OM)) and is equal to 78 mg/kg dw.

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 and the TRV (U.S. EPA, 2003).

The literature search completed according to guidance for Eco-SSLs (U.S. EPA, 2003; Attachment 4-2) identified some studies concerning antimony and avian species but all were rejected for use in deriving a wildlife TRV as described in Section 7.5. An avian TRV for antimony could not be derived therefore an Eco-SSL for avian wildlife for antimony was not calculated.

Table 4.1 Soil Invertebrate Toxicity Data - Antimony

Reference	Test Organism		Soil pH	OM %	Bio-availability Score	ERE	Tox Parameter	Tox Value Soil Conc. (mg/kg dw)	Total Eval. Score	Eligible for Eco-SSL Derivation?	Used for Eco-SSL?
Kuperman et al., 2002	Enchytraeid	*Enchytraeus crypticus*	4.08 - 5.29	1.2	2	REP	EC_{20}	194	16	Y	Y
Phillips et al., 2002	Springtail	*Folsomia candida*	4.57 - 5.29	1.2	2	REP	EC_{20}	81	17	Y	Y
Simini et al., 2002	Earthworm	*Eisenia fetida*	4.39 - 5.29	1.2	2	REP	EC_{20}	30	15	Y	Y
							Geometric Mean	78			

EC_{20} = Effective concentration to 20% of the test population
ERE = Ecologically relevant endpoint
OM = Organic matter content
REP = Reproduction
Y= Yes
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)

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 guidance for Eco-SSLs (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 exposure model and the TRV.

6.1 Mammalian TRV

The literature search completed according to the guidance for Eco-SSLs (U.S. EPA, 2003; Attachment 4-1) identified 69 papers with possible toxicity data for antimony for either avian or mammalian species. Of these papers, 58 were rejected for use as described in Section 7.5. The remaining 11 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 6.1. The complete results are provided in Appendix 6-1.

Within the 11 papers, there are 31 results for biochemical (BIO), behavioral (BEH), physiology (PHY), pathology (PTH), reproduction (REP), growth (GRO), and survival (MOR) endpoints with a Data Evaluation Score >65 that can be used to derive the TRV (U.S. EPA, 2003; Attachment 4-4). These data are plotted in Figure 6.1 and correspond directly with the data presented in Table 6.1. 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 growth and reproduction was calculated at 13.3 mg antimony/kg bw/day. However, this value is higher than the lowest bounded LOAEL for effects on reproduction, growth, or survival. Therefore, the TRV is equal to the highest bounded NOAEL below the lowest bounded LOAEL and is equal to 0.059 mg antimony/kg bw/day.

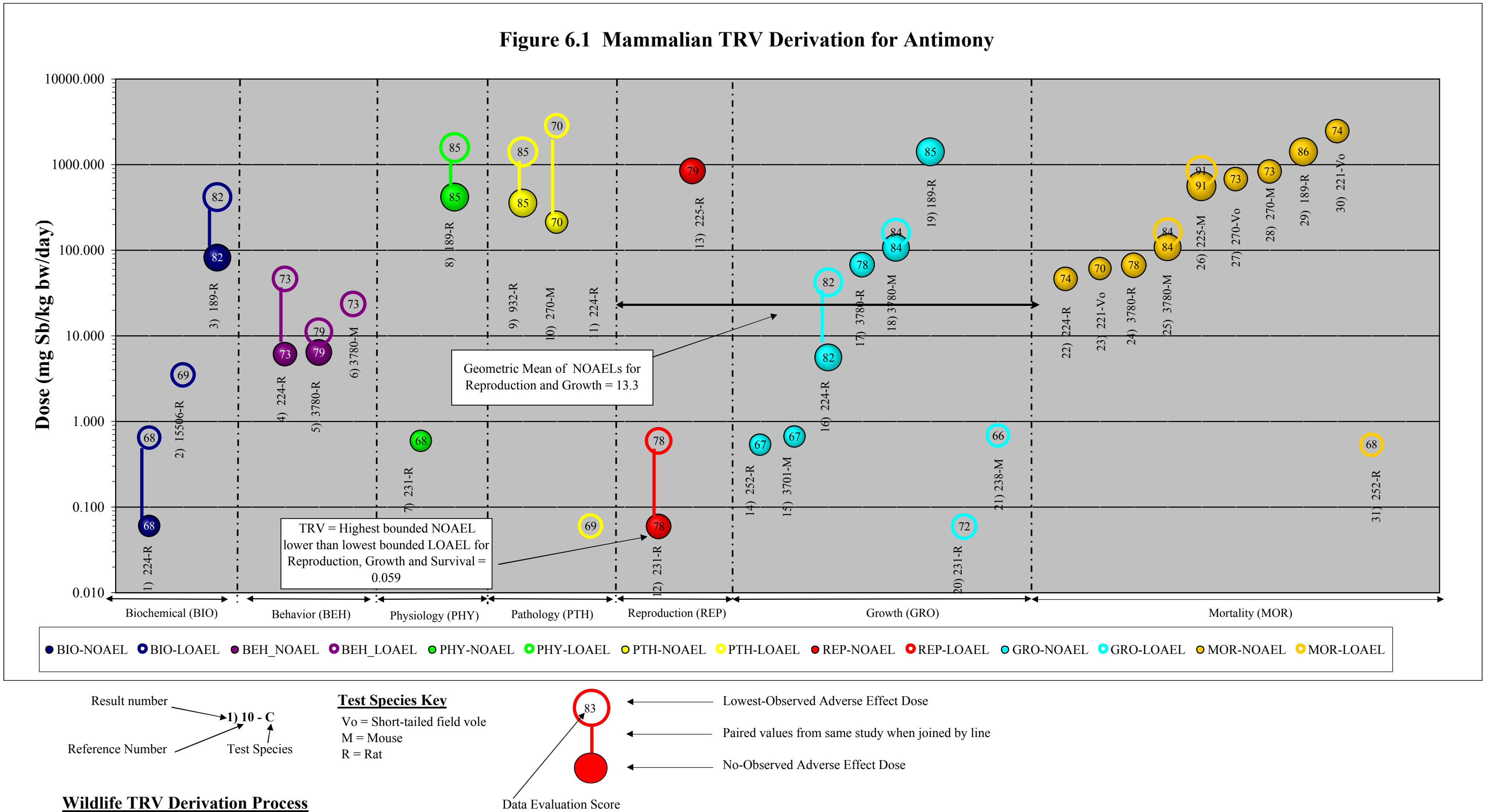
6.2 Estimation of Dose and Calculation of the Eco-SSL

Three separate Eco-SSL values were calculated for mammalian wildlife, one each for three surrogate species representing different trophic groups. The mammalian Eco-SSLs derived for antimony are calculated according to the Eco-SSL guidance (U.S. EPA 2003) and are summarized in Table 6.2.

Table 6.1 Mammalian Toxicity Data Extracted for Wildlife Toxicity Reference Value (TRV)
Antimony

Result #	Reference	Ref No.	Test Organism	# of Conc/ Doses	Method of Analyses	Route of Exposure	Exposure Duration	Duration Units	Age	Age Units	Lifestage	Sex	General Effect Group	Effect Measure	Response Site	NOAEL Dose (mg/kg/day)	LOAEL Dose (mg/kg/day)	Data Evaluation Score
Biochemical																		
1	Poon et al., 1998	224	Rat (*Rattus norvegicus*)	5	UX	DR	13	w	NR	NR	JV	F	BIO	GLUC	WO	0.060	0.640	68
2	Shroeder, 1968	15506	Rat *(Rattus norvegicus)*	2	U	DR	767	d	21	d	JV	B	BIO	CHOL	SR		3.50	69
3	Hext et al., 1999	189	Rat (*Rattus norvegicus*)	4	UX	FD	90	d	NR	NR	AD	F	BIO	ALPH	BL	81.0	413	82
Behavior																		
4	Poon et al., 1998	224	Rat (*Rattus norvegicus*)	5	UX	DR	13	w	NR	NR	JV	F	BEH	WCON	WO	6.10	46.0	73
5	Dieter, 1992	3780	Rat (*Rattus norvegicus*)	6	U	DR	14	d	8	w	NR	F	BEH	WCON	WO	6.35	11.1	79
6	Dieter, 1992	3780	Mouse (*Mus musculus*)	6	U	DR	14	d	8	w	NR	B	BEH	WCON	WO		23.4	73
Physiology																		
7	Rossi et al., 1987	231	Rat (*Rattus norvegicus*)	3	U	DR	38	d	NR	NR	GE	F	PHY	BLPR	WO	0.592		68
8	Hext et al., 1999	189	Rat (*Rattus norvegicus*)	4	UX	FD	90	d	NR	NR	AD	F	PHY	EXCR	WO	413	1570	85
Pathology																		
9	Hext et al., 1999	189	Rat (*Rattus norvegicus*)	4	UX	FD	90	d	NR	NR	AD	M	PTH	ORWT	LI	352	1410	85
10	Ainsworth et al., 1991	270	Mouse *(Mus musculus)*	3	U	FD	18	d	NR	NR	NR	NR	PTH	ORWT	KI	211	2820	70
11	Poon et al., 1998	224	Rat (*Rattus norvegicus*)	5	UX	DR	13	w	NR	NR	JV	F	PTH	GHIS	WO		0.0600	69
Reproduction																		
12	Rossi et al., 1987	231	Rat (*Rattus norvegicus*)	3	U	DR	31	d	NR	NR	GE	F	REP	PRWT	WO	0.0590	0.590	78
13	Gurnani et al., 1993	225	Mouse (*Mus musculus*)	4	U	GV	14	d	8	w	JV	M	REP	SPCV	WO	835		79
Growth																		
14	Shroeder etal., 1970	252	Rat *(Rattus norvegicus)*	2	U	DR	725	d	21	d	JV	M	GRO	BDWT	WO	0.533		67
15	Kanisawa and Shroeder, 1969	3701	Mouse (*Mus musculus*)	2	U	DR	519	d	21	d	JV	B	GRO	BDWT	WO	0.664		67
16	Poon et al., 1998	224	Rat (*Rattus norvegicus*)	5	UX	DR	13	w	7	w	JV	M	GRO	BDWT	WO	5.60	42.0	82
17	Dieter, 1992	3780	Rat (*Rattus norvegicus*)	6	U	DR	14	d	8	w	JV	B	GRO	BDWT	WO	67.0		78
18	Dieter, 1992	3780	Mouse (*Mus musculus*)	6	U	DR	14	d	8	w	JV	F	GRO	BDWT	WO	106	161	84
19	Hext et al., 1999	189	Rat (*Rattus norvegicus*)	4	UX	FD	90	d	NR	NR	AD	M	GRO	BDWT	WO	1410		85
20	Rossi et al., 1987	231	Rat (*Rattus norvegicus*)	3	U	DR	20	d	NR	NR	GE	F	GRO	BDWT	WO		0.0590	72
21	Shroeder et al., 1968	238	Mouse *(Mus musculus)*	2	U	DR	339	d	21	d	JV	F	GRO	BDWT	WO		0.678	66
Survival																		
22	Poon et al., 1998	224	Rat (*Rattus norvegicus*)	5	UX	DR	13	w	NR	NR	IM	F	MOR	MORT	WO	46.0		74
23	Ainsworth et al., 1991	221	Short-tailed vole (*Microtus agrestis*	2	U	FD	60	d	35	d	NR	M	MOR	MORT	WO	60.9		70
24	Dieter, 1992	3780	Rat (*Rattus norvegicus*)	6	U	DR	14	d	8	w	JV	B	MOR	SURV	WO	66.6		78
25	Dieter, 1992	3780	Mouse (*Mus musculus*)	6	U	DR	14	d	8	w	JV	M	MOR	MORT	WO	108	161	84
26	Gurnani et al., 1993	225	Mouse (*Mus musculus*)	4	U	GV	21	d	8	w	JV	M	MOR	MORT	WO	557	835	91
27	Ainsworth et al., 1991	270	Short-tailed vole (*Microtus agrestis*	3	U	FD	21	d	NR	NR	NR	NR	MOR	MORT	WO	673		73
28	Ainsworth et al., 1991	270	Mouse *(Mus musculus)*	3	U	FD	18	d	NR	NR	NR	NR	MOR	MORT	WO	826		73
29	Hext et al., 1999	189	Rat (*Rattus norvegicus*)	4	UX	FD	90	d	NR	NR	AD	M	MOR	MORT	WO	1408		86
30	Ainsworth et al., 1991	221	Short-tailed vole (*Microtus agrestis*	3	U	FD	12	d	35	d	NR	M	MOR	MORT	WO	2440		74
31	Shroeder etal., 1970	252	Rat (*Rattus norvegicus*)	2	U	DR	784	d	21	d	JV	F	MOR	TDTH	WO		0.533	68

ALPH = alkaline phosphatase; AD = adult; B = both; BDWT = body weight changes; BEH = behavior; BIO = biochemical; BL = blood; BLPR = blood pressure; CHOL = cholesterol; d = days; DR = drinking water; EXCR = excretion; F=female; FD = food; FDB = feeding behavior; GE = gestational; GHIS = general histology; GLUC = glucose; GRO = Growth; GV=gavage; HYPL = hyperplasia; IM = immature; JV=juvenile; KI = kidney; kg = kilogram; lf = lifetime; LI = liver; l = liter; LOAEL = lowest-observed adverse effect level; M = measured; M=male; mg = milligram; MOR = mortality; MORT = mortality; N = no; NOAEL = no-observed adverse effect level; NR = not reported; ORWT = organ weight; PHY = physiology; PRWT = progeny weight; PTH = pathology; REP = reproduction; Score = Total Data Evaluation Score as describec in US EPA (2003; Attachment 4-3); SPCV= sperm cell count; SR = serum; SURV = survival; TDTH = time to death; Y = yes; U = unmeasured; UX = reported as measured but data not provided; w = weeks; WCON = water consumption; WO = whole organism.



Wildlife TRV Derivation Process

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 at least three NOAEL results available for calculation of a geometric mean.

3) The geometric mean of the NOAEL values for growth and reproductive effects equals 13.3 mg antimony/kg BW/day but is higher than the lowest bounded LOAEL for reproduction, growth, or mortality effects.

4) The mammalian wildlife TRV for antimony is equal to 0.059 mg antimony/kg BW/day which is the highest bounded NOAEL below the lowest bounded LOAEL for effects on reproduction, growth or survival.

Table 6.2 Calculation of the Mammalian Eco-SSL for Antimony						
Surrogate Receptor Group	**TRV for Antimony (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 Antimony in Biota Type (i)**[2,3] **(B_i) (mg/kg dw)**	**Antimony in Diet of Prey** [4] **(C_{diet})**	**Eco-SSL (mg/kg dw)**[5]
Mammalian herbivore (vole)	0.059	0.0875	0.032	$\ln(B_i) = 0.938 * \ln(Soil_j) - 3.233$ where i = plants	NA	10
Mammalian ground insectivore (shrew)	0.059	0.209	0.030	$B_i = Soil_j * 1.0$ where i = earthworms	NA	0.27
Mammalian carnivore (weasel)	0.059	0.130	0.043	$B_i = C_{diet} * 0.05$ where i = mammals	$C_{diet} = 1 * Soil_j$	4.9

[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] C_{diet} = Concentration in the diet of small mammals consumed by predatory species (weasel).
[5] 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

7.0 REFERENCES

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7.3 References Rejected for Use in Derivation of Plant and Soil Invertebrate Eco-SSLs

These references were reviewed and rejected for use in derivation of the Eco-SSL. The definition of the codes describing the basis for rejection is provided at the end of the reference sections.

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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 6-1

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

February 2005

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

Ref		Exposure															Effects					Conversion to mg/kg bw/day				Result		Data Evaluation Score										
Result #	Ref No.	Chemical Form	MW%		Phase #	# of Conc/ Doses	Conc/ Doses	Conc/Dose Units	Method of Chem Analyses	Route of Exposure	Exposure Duration	Duration Units	Age	Age Units	Lifestage	Sex	Effect Type	Effect Measure	Response Site	Study NOAEL	Study LOAEL	Body Weight Reported	Body Weight (kg)	Ingestion Rate Reported?	Ingestion Rate (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	224	potassium antimony tartrate	100	Rat *(Rattus norvegicus)*	1	5	0/0.06/0.64/6.13/45.69	mg/kg bw/d	UX	DR	13	w	NR	NR	JV	F	CHM	GLUC	WO	0.06	0.64	Y	0.136	N	0.01644	0.0600	0.640	10	5	10	5	7	1	6	10	10	4	68
2	15506	antimony potassium tartrate	100	Rat *(Rattus norvegicus)*	1	2	0/3.5	mg/kg bw/d	U	DR	767	d	21	d	JV	B	CHM	CHOL	SR		3.5	N	0.235	N	0.00269		3.50	10	5	5	5	10	1	4	10	10	4	69
3	189	antimony trioxide	83.53	Rat (*Rattus norvegicus*)	2	4	0/97/494/1879	mg/kg bw/d	UX	FD	90	d	NR	NR	AD	F	ENZ	ALPH	BL	97	494	Y	0.491	N	0.02400	81.0	413	10	10	10	10	7	1	8	10	6	10	82
Behavior																																						
4	224	potassium antimony tartrate	100	Rat (*Rattus norvegicus*)	1	5	0/0.06/0.64/6.13/45.69	mg/kg bw/d	UX	DR	13	w	NR	NR	JV	F	FDB	WCON	WO	6.1	46	Y	0.136	N	0.01644	6.10	46.0	10	5	10	5	7	4	8	10	10	4	73
5	3780	antimony potassium tartrate	39.67	Rat (*Rattus norvegicus*)	1	6	0/16/28/59/94/168	mg/kg bw/d	U	DR	14	d	8	w	NR	F	FDB	WCON	WO	16	28	Y	139	Y	0.01560	6.35	11.1	10	5	5	5	10	4	10	10	10	10	79
6	3780	antimony potassium tartrate	39.67	Mouse (*Mus musculus*)	2	6	0/59/98/174/273/407	mg/kg bw/d	U	DR	14	d	8	w	NR	B	FDB	WCON	WO		59	Y	0.024	Y	0.007600		23.4	10	5	5	5	10	4	4	10	10	10	73
Physiology																																						
7	231	antimony trichloride	53.38	Rat (*Rattus norvegicus*)	1	3	0/1/10	mg/L	U	DR	38	d	NR	NR	GE	F	PHY	BLPR	WO	10		Y	0.323	N	0.03580	0.592		10	5	5	10	6	4	4	10	10	4	68
8	189	antimony trioxide	83.53	Rat (*Rattus norvegicus*)	2	4	0/97/494/1879	mg/kg bw/d	UX	FD	90	d	NR	NR	AD	F	PHY	EXCR	WO	494	1879	Y	0.279	N	0.02400	413	1570	10	10	10	10	7	4	8	10	6	10	85
Pathology																																						
9	189	antimony trioxide	83.53	Rat (*Rattus norvegicus*)	1	4	0/84/421/1686	mg/kg bw/d	UX	FD	90	d	NR	NR	AD	M	ORW	ORWT	LI	421	1686	Y	0.491	N	0.0383	352	1410	10	10	10	10	7	4	8	10	6	10	85
10	270	antimony trioxide	100	Mouse *(Mus musculus)*	2	3	0/500/6700	mg/kg diet	U	FD	18	d	NR	NR	NR	NR	ORW	ORWT	KI	500	6700	N	0.0375	N	0.000016	211	2820	10	10	5	10	5	4	6	10	6	4	70
11	224	potassium antimony tartrate	100	Rat (*Rattus norvegicus*)	1	5	0/0.06/0.64/6.13/45.69	mg/kg bw/d	UX	DR	13	w	NR	NR	JV	F	HIS	GHIS	WO		0.06	Y	0.136	N	0.01644		0.060	10	5	10	5	7	4	4	10	10	4	69
Reproduction																																						
12	231	antimony trichloride	53.38	Rat (*Rattus norvegicus*)	1	3	0/1/10	mg/L	U	DR	31	d	NR	NR	GE	F	REP	PRWT	WO	1.0	10	Y	0.33	N	0.03650	0.0590	0.590	10	5	5	10	6	10	8	10	10	4	78
13	225	antimony trioxide	83.53	Mouse (*Mus musculus*)	1	4	0/400/666.67/1000	mg/kg bw/d	U	GV	14	d	8	w	JV	M	REP	SPCV	WO	1000		Y	0.03	N	0.003847	835		10	8	10	10	10	10	4	3	10	4	79
Growth																																						
14	252	antimony potassium tartrate	100	Rat *(Rattus norvegicus)*	1	2	0/5	mg/L	U	DR	725	d	21	d	JV	M	GRO	BDWT	WO	5		Y	0.475	N	0.0051	0.533		10	5	5	5	6	8	4	10	10	4	67
15	3701	antimony potassium tartrate	100	Mouse (*Mus musculus*)	1	2	0/5	mg/L	U	DR	519	d	21	d	JV	B	GRO	BDWT	WO	5		Y	0.0531	N	0.0071	0.664		10	5	5	5	6	8	4	10	10	4	67
16	224	potassium antimony tartrate	100	Rat (*Rattus norvegicus*)	2	5	0/0.06/0.56/5.58/42.17	mg/kg bw/d	UX	DR	13	w	7	w	JV	M	GRO	BDWT	WO	5.58	42.16	Y	0.375	N	0.04100	5.60	42.00	10	5	10	5	7	8	8	10	10	4	82
17	3780	antimony potassium tartrate	39.67	Rat (*Rattus norvegicus*)	1	6	0/16/28/59/94/168	mg/kg bw/d	U	DR	14	d	8	w	JV	B	GRO	BDWT	WO	168		Y	0.184	Y	0.01190	67.0		10	5	5	5	10	8	4	10	10	10	78
18	3780	antimony potassium tartrate	39.67	Mouse (*Mus musculus*)	2	6	0/59/98/174/273/407	mg/kg bw/d	U	DR	14	d	8	w	JV	F	GRO	BDWT	WO	273	407	Y	0.024	Y	0.002100	106	161	10	5	5	5	10	8	10	10	10	10	84
19	189	antimony trioxide	83.53	Rat (*Rattus norvegicus*)	1	4	0/84/421/1686	mg/kg bw/d	UX	FD	90	d	NR	NR	AD	M	GRO	BDWT	WO	1686		Y	0.491	N	0.03828	1410		10	10	10	10	7	8	4	10	6	10	85
20	231	antimony trichloride	53.38	Rat (*Rattus norvegicus*)	1	3	0/1/10	mg/L	U	DR	20	d	NR	NR	GE	F	GRO	BDWT	WO		1	Y	0.33	N	0.03650		0.0590	10	5	5	10	6	8	4	10	10	4	72
21	238	antimony potassium tartrate	100	Mouse *(Mus musculus)*	1	2	0/5	mg/L	U	DR	339	d	21	d	JV	F	GRO	BDWT	WO		5	Y	0.043	N	0.00058		0.678	10	5	5	5	6	8	4	10	10	4	66
Survival																																						
22	224	potassium antimony tartrate	100	Rat (*Rattus norvegicus*)	1	5	0/0.06/0.64/6.13/45.69	mg/kg bw/d	UX	DR	13	w	NR	NR	IM	F	MOR	MORT	WO	46		Y	0.136	N	0.016436	46.0		10	5	10	5	7	9	4	10	10	4	74
23	221	antimony trioxide	100	Short-tailed vole (*Microtus agrestis*)	1	2	0/500	mg/kg diet	U	FD	60	d	35	d	NR	M	MOR	MORT	WO	500		N	0.04	N	0.004874	60.9		10	10	5	10	5	9	4	10	3	4	70
24	3780	antimony potassium tartrate	39.67	Rat (*Rattus norvegicus*)	1	6	0/16/28/59/94/168	mg/kg bw/d	U	DR	14	d	8	w	JV	B	MOR	SURV	WO	168		N	0.184	Y	0.01190	66.6		10	5	5	5	10	9	4	10	10	10	78
25	3780	antimony potassium tartrate	39.67	Mouse (*Mus musculus*)	2	6	0/59/98/174/273/407	mg/kg bw/d	U	DR	14	d	8	w	JV	M	MOR	MORT	WO	273	407	N	0.0316	Y	0.006000	108	161	10	5	5	5	10	9	10	10	10	10	84
26	225	antimony trioxide	83.53	Mouse (*Mus musculus*)	1	4	0/400/666.67/1000	mg/kg bw/d	U	GV	21	d	8	w	JV	M	MOR	MORT	WO	667	1000	Y	0.03	N	0.003847	557	835	10	8	10	10	10	9	10	10	10	4	91
27	270	antimony trioxide	83.53	Short-tailed vole (*Microtus agrestis*)	2	3	0/500/6700	mg/kg diet	u	FD	21	d	NR	NR	NR	NR	MOR	MORT	WO	6700		N	0.043	N	0.005170	673		10	10	5	10	5	9	4	10	6	4	73
28	270	antimony trioxide	100	Mouse *(Mus musculus)*	2	3	0/500/6700	mg/kg diet	U	FD	18	d	NR	NR	NR	NR	MOR	MORT	WO	6700		N	0.0375	N	0.00462	826		10	10	5	10	5	9	4	10	6	4	73
29	189	antimony trioxide	83.53	Rat (*Rattus norvegicus*)	1	4	0/84/421/1686	mg/kg bw/d	UX	FD	90	d	NR	NR	AD	M	MOR	MORT	WO	1686		Y	0.491	N	0.03828	1410		10	10	10	10	7	9	8	10	6	10	86
30	221	antimony trioxide	100	Short-tailed vole (*Microtus agrestis*)	2	3	0/20000	mg/kg diet	U	FD	12	d	35	d	NR	M	MOR	MORT	WO	20000		Y	0.04	N	0.004874	2440		10	10	5	10	6	9	4	10	6	4	74
31	252	potassium antimony tartrate	100	Rat (*Rattus norvegicus*)	1	2	0/5	mg/L	U	DR	784	d	21	d	JV	F	MOR	TDTH	WO		5	Y	0.475	N	0.005065		0.533	10	5	5	5	6	9	4	10	10	4	68
Data Not Used to Derive a Wildlife Toxicity Reference Value (TRV)																																						
32	238	antimony potassium tartrate	100	Mouse (*Mus musculus*)	1	2	0/5	mg/L	U	DR	548	d	21	d	JV	F	MOR	TDTH	WO	5		Y	0.0517	N	0.000688	0.660		10	5	5	5	6	9	4	1	10	4	59
39	3701	antimony potassium tartrate	100	Mouse (*Mus musculus*)	1	2	0/5	mg/L	U	DR	519	d	21	d	JV	B	HIS	GHIS	LI	5		Y	0.0531	N	0.007051	0.664		10	5	5	5	6	4	4	1	10	4	54
40	3701	antimony potassium tartrate	100	Mouse (*Mus musculus*)	1	2	0/5	mg/L	U	DR	519	d	21	d	JV	B	MOR	TDTH	WO	5		Y	0.0531	N	0.007051	0.664		10	5	5	5	6	9	4	10	1	4	59
41	252	antimony potassium tartrate	100	Rat (*Rattus norvegicus*)	1	2	0/5	mg/L	U	DR	725	d	21	d	JV	M	ORW	SMIX	HE		5	Y	0.46	N	0.04922		0.535	10	5	5	5	6	4	4	10	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).