Ecological Soil Screening Levels for Arsenic

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 group 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 arsenic and the documentation for their derivation. This document provides guidance and is designed to communicate national policy on identifying arsenic 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 ARSENIC

Arsenic is naturally present in rock and soils with concentrations in soils reflecting the geology of the region as well as anthropogenic inputs. Higher concentrations are associated with igneous and sedimentary rocks, particularly with sulfidic ores (API, 1998). Extensive discussions of the sources, concentrations, and chemical species are presented in API (1998) and Cullen and Reimer (1989).

Arsenic is used in multiple manufacturing and industrial processes including the production of wood treating chemicals, herbicides, pesticides, desiccants, metal alloys, glass, pharmaceuticals, and semi-conductors. Elevated arsenic soil concentrations are often associated with mining activities, smelters, pesticide/herbicide manufacturing facilities and agricultural lands (API, 1998).

Arsenic can exist in four oxidation states: +5, +3, 0 and -3. In soil, arsenic is a constituent of numerous minerals and is found frequently associated with sulfur, most commonly as arsenopyrite (FeAsS). Inorganic arsenate can also be bound to iron and aluminum cations, or any other cation that may be present (e.g., calcium, zinc, magnesium, lead) as well as organic matter in soils (API, 1998).

Arsenic occurs in contaminated soils primarily as the inorganic arsenic (V) and arsenic (III) but soil microorganisms can produce organic forms (Cullen and Reimer, 1989; Huang, 1994; CCME, 1996). Transformations among inorganic and organic forms are controlled by the oxidation-reduction, precipitation/adsorption, and biomethylation processes in addition to the biological production and volatilization of the arsines (API, 1998). The availability or solubility of arsenic in soils depends on the source (natural vs. anthropogenic) and the soil's clay content, redox potential, and pH. Generally, factors that tend to increase arsenic availability are anthropogenic sources (e.g., pesticides), low clay content, low redox potential (reducing conditions), and high pH (alkaline conditions) (Cullen and Reimer, 1989, API, 1998).

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

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

Plants	Soil Invertebrates	Wildlife	
		Avian	Mammalian
18	NA	43	46

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

Eco-SSL values for arsenic were derived for plants, avian wildlife, and mammalian wildlife. An Eco-SSL value for arsenic for soil invertebrates could not be derived as data were insufficient. The Eco-SSLs range from 18 mg/kg dry weight (dw) for plants to 46 mg/kg dw for avian wildlife. These concentrations are higher than the reported range of background

soil concentrations in eastern and western U.S. soils (Figure 2.1). Background concentrations of many metals in U.S. soils are described in Attachment 1-4 of the Eco-SSL guidance (U.S. EPA, 2003).

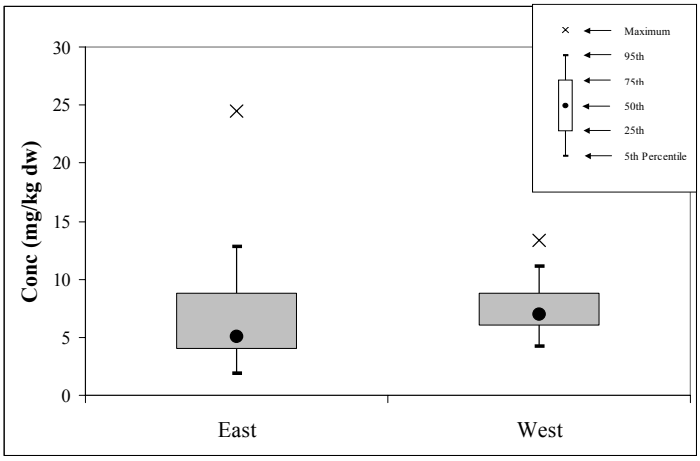


Figure 2.1 Typical Background Concentrations of Arsenic in U.S. Soils.

3.0 ECO-SSL FOR TERRESTRIAL PLANTS

Of the papers identified from the literature search process, 171 were selected for acquisition for further review. Of those papers acquired, 26 met all 11 Study Acceptance Criteria (U.S. EPA 2003; Attachment 3-1). Each of these papers was reviewed and the studies were scored according to the Eco-SSL guidance (U.S. EPA, 2003; Attachment 3-2). Seventeen studies received an Evaluation Score greater than ten. These studies are summarized in Table 3.1.

The data in Table 3.1 are sorted by bioavailability score. There are three study results with a bioavailability score of two used to derive the plant Eco-SSL for arsenic according to the Eco-SSL guidance (U.S. EPA, 2003; Attachment 3-2). The Eco-SSL is the geometric mean of the maximum acceptable toxicant concentration (MATC) values reported for each of three test species under two separate test conditions (pH and % organic matter (OM)) and is equal to 18 mg/kg dw.

4.0 ECO-SSL FOR SOIL INVERTEBRATES

Of the papers identified from the literature search process, 35 were acquired for further review. Of those acquired, one met all 11 Study Acceptance Criteria (U.S. EPA, 2003; Attachment 3-1). There were no studies that received an Evaluation Score greater than 10. A soil invertebrate Eco-SSL could not be derived for arsenic.

Table 3.1 Plant Toxicity Data - Arsenic

Reference	IP Number	Study ID	Test Organism		Soil pH	OM%	Bio-availability Score	ERE	Tox Parameter	Tox Value - Soil Concentration (mg/kg dw)	Total Evaluation Score	Eligible for Eco-SSL Derivation?	Used for Eco-SSL?
Jiang and Singh, 1994	4441	a	Ryegrass	*Lolium perenne*	5.6	0.7	2	GRO	MATC	22	13	Y	Y
Schweizer, 1967	9659	a	Cotton	*Gossypium hirsutum stoneville 7A*	7.9	1.1	2	GRO	MATC	69	16	Y	Y
Schweizer, 1967	9659	b	Rice	*Oryza sativa L. var. Nato*	7.9	1.1	2	GRO	MATC	4	15	Y	Y
									Geometric Mean	18			
Data not Used to Derive Plant Eco-SSL													
Jiang and Singh, 1994	4441	e	Barley	*Hordeum vulgare*	5.6	0.7	2	GRO	LOAEC	2	13	N	N
Jiang and Singh, 1994	4441	g	Barley	*Hordeum vulgare*	5.6	0.7	2	GRO	LOAEC	2	13	N	N
Jiang and Singh, 1994	4441	c	Ryegrass	*Lolium perenne*	5.6	0.7	2	GRO	MATC	22	13	N	N
Woolson and Isensee, 1981	56454	a	Radish	*Raphanus sativus*	5.1	1.5	1	POP	MATC	6	13	N	N
Woolson and Isensee, 1981	56454	b	Soybean	*Glycine Max (L.) Merr.*	5.1	1.5	1	POP	MATC	6	13	N	N
Jacobs et al., 1970	5577	b	Corn	*Zea mays*	5.5	1.2	1	GRO	MATC	40	12	Y	N
Jacobs et al., 1970	5577	c	Snap Bean	*Phaseolus vulgaris*	5.5	1.2	1	GRO	MATC	22	12	Y	N
Jacobs et al., 1970	5577	e	Pea	*Pisum sativum*	5.5	1.2	1	GRO	MATC	40	12	Y	N
Jacobs et al., 1970	5577	a	Potato	*Solanum tuberosum*	5.5	1.2	1	GRO	MATC	97	11	Y	N
Anastasia and Kender, 1973	11144	a	Blueberry	*Vaccinium angustifolium*	4.6	0.17-98.0	0	GRO	MATC	55	13	Y	N
Jiang and Singh, 1994	4441	b	Ryegrass	*Lolium perenne*	4.9	5.3	0	GRO	MATC	22	11	Y	N
Jiang and Singh, 1994	4441	d	Ryegrass	*Lolium perenne*	4.9	5.3	0	GRO	MATC	22	11	N	N
Jiang and Singh, 1994	4441	f	Barley	*Hordeum vulgare*	4.9	5.3	0	GRO	MATC	22	11	Y	N
Jiang and Singh, 1994	4441	h	Barley	*Hordeum vulgare*	4.9	5.3	0	GRO	MATC	22	11	N	N

ERE = Ecologically relevant endpoint
GRO = Growth
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
POP = Population
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)

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).

5.1 Avian TRV

The literature search completed according to the Eco-SSL guidance (U.S. EPA, 2003; Attachment 4-2) identified 1,173 papers with possible toxicity data for either avian or mammalian species. Of these papers, 1,110 were rejected for use as described in Section 7.5. Of the remaining papers, five contained data for avian test species. These papers were reviewed and 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. The complete results are included as Appendix 5-1.

Within the five reviewed papers, there are 16 results for biochemical (BIO), behavioral (BEH), 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 4-5). These data are plotted in Figure 5.1 and correspond directly with the data presented in Table 5.1. The no-observed adverse effect (NOAEL) values for growth and reproduction are used to calculate a geometric mean NOAEL. This result 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 could not be calculated as only two values are available. The TRV is equal to 2.24 mg arsenic/kg bw/day which is the lowest NOAEL value for reproduction, growth, or survival.

5.2 Estimation of Dose and Calculation of the Eco-SSL

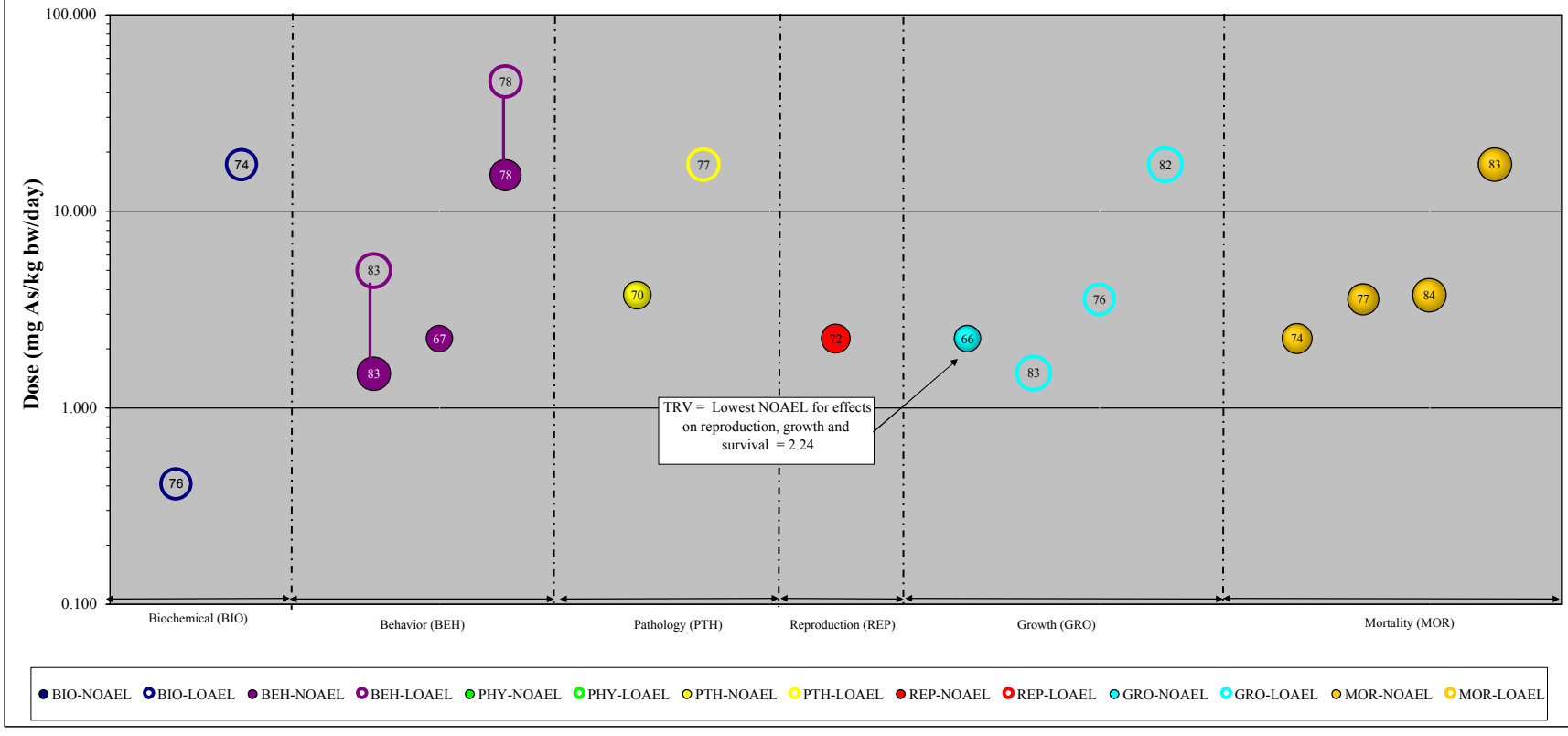
Three separate Eco-SSL values were calculated for avian wildlife, one each for three surrogate species representing different trophic groups. The avian Eco-SSLs for arsenic were calculated according to the Eco-SSL guidance (U.S. EPA, 2003; Attachment 4-5) and are summarized in Table 5.2.

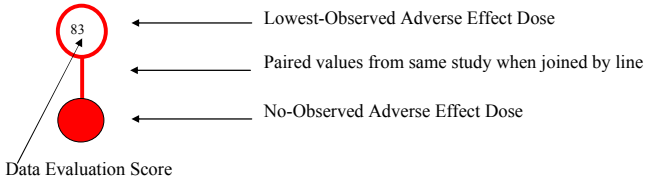
Table 5.1 Avian Toxicity Data Extracted for Wildlife Toxicity Reference Value (TRV)
Arsenic

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 (BIO)																		
1	Camardese et al, 1990	5747	Mallard duck (*Anas platyrhynchos*)	4	UX	FD	10	w	1	d	JV	F	ENZ	ACHE	BR		0.410	76
2	Hoffman et al, 1992	1376	Mallard duck (*Anas platyrhynchos*)	2	UX	FD	4	w	1	d	JV	B	ENZ	GLPX	PL		17.3	74
Behavior (BEH)																		
3	Camardese et al, 1990	5747	Mallard duck (*Anas platyrhynchos*)	4	UX	FD	2	w	1	d	JV	F	FDB	FCNS	WO	1.49	4.98	83
4	Holcman and Stibilj, 1997	5305	Chicken (*Gallus domesticus*)	4	U	FD	19	d	49	w	SM	F	FDB	FCNS	WO	2.24		67
5	Whitworth et al 1991	5690	Mallard duck (*Anas platyrhynchos*)	4	U	FD	9	w	1	d	JV	NR	BEH	ACTV	WO	15.2	45.7	78
Pathology (PTH)																		
6	Camardese et al, 1990	5747	Mallard duck (*Anas platyrhynchos*)	4	UX	FD	10	w	1	d	JV	B	ORW	ORWT	LI	3.72		70
7	Hoffman et al, 1992	1376	Mallard duck (*Anas platyrhynchos*)	2	UX	FD	4	w	1	d	JV	B	ORW	ORWT	LI		17.3	77
Reproduction (REP)																		
8	Holcman and Stibilj, 1997	5305	Chicken (*Gallus domesticus*)	4	U	FD	19	d	49	w	LB	F	REP	PROG	WO	2.24		72
Growth (GRO)																		
9	Holcman and Stibilj, 1997	5305	Chicken (*Gallus domesticus*)	4	U	FD	19	d	49	w	SM	F	GRO	BDWT	WO	2.24		66
10	Camardese et al, 1990	5747	Mallard duck (*Anas platyrhynchos*)	4	UX	FD	2	w	1	d	JV	F	GRO	GGRO	WO		1.49	83
11	Howell and Hill, 1978	1387	Chicken (*Gallus domesticus*)	2	U	FD	21	d	1	d	JV	B	GRO	BDWT	WO		3.55	76
12	Hoffman et al, 1992	1376	Mallard duck (*Anas platyrhynchos*)	2	UX	FD	4	w	1	d	JV	B	GRO	BDWT	WO		17.3	82
Survival (MOR)																		
13	Holcman and Stibilj, 1997	5305	Chicken (*Gallus domesticus*)	4	U	FD	19	d	49	w	SM	F	MOR	MORT	WO	2.24		74
14	Howell and Hill, 1978	1387	Chicken (*Gallus domesticus*)	2	U	FD	21	d	1	d	JV	B	MOR	MORT	WO	3.55		77
15	Camardese et al, 1990	5747	Mallard duck (*Anas platyrhynchos*)	4	UX	FD	10	w	1	d	JV	B	MOR	MORT	WO	3.72		84
16	Hoffman et al, 1992	1376	Mallard duck (*Anas platyrhynchos*)	2	UX	FD	4	w	1	d	JV	B	MOR	SURV	WO	17.3		83

ACHE = acetylcholinesterase; ACTV = general activity levels; B = both; BDWT = body weight changes; BEH = behavior; BR = brain; d = days; ENZ = enzyme changes; F = female; FCNS = food consumption; FD = food; FDB = feeding behavior; GGRO = general growth changes; GRO = growth; GLPX = gluathione peroxidase; JV = juvenile; LB = laying bird; LI = liver; LOAEL = lowest observed adverse effect level; MOR = mortality, MORT = mortality; NOAEL = no observed adverse effect level; NR = Not reported; ORW = organ weight changes; ORWT = organ weight; PL = plasma; PROG = progeny counts; REP = reproduction; SM = sexually mature; SURV = survival; U = unmeasured; UX = measured but results not reported; w = weeks; WO = whole organism

Figure 5.1 Avian TRV Derivation for Arsenic





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 not three NOAEL results available within the growth and reproduction effect groups for calculation of a geometric mean.

3) There are no bounded LOAEL values for comparison.

3) The avian wildlife TRV for arsenic is equal to 2.24 mg arsenic/kg bw/day which is the lowest NOAEL value for effects on reproduction, growth or survival.

Table 5.2 Calculation of the Avian Eco-SSLs for Arsenic					
Surrogate Receptor Group	**TRV for Arsenic (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]**	**Arsenic in Biota Type (i)[2,3] (B_i) (mg/kg dw)**	**Eco-SSL (mg/kg dw)[4]**
Avian herbivore (dove)	2.24	0.190	0.139	$B_i = 0.03752 * Soil_j$ where i = plants	67
Avian ground insectivore (woodcock)	2.24	0.214	0.164	$\ln(B_i) = 0.706 * \ln(Soil_j) - 1.421$ where i = earthworms	43
Avian carnivore (hawk)	2.24	0.0353	0.057	$\ln(B_i) = 0.8188 * \ln(Soil_j) - 4.8471$ where i = mammals	1100

[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 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 1,173 papers with possible toxicity data for arsenic for either avian or mammalian test species. Of these studies, 1,110 were rejected for use as described in Section 7.5. Of the remaining papers, 55 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 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 55 papers there are 138 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 4-3). These data are plotted in Figure 6.1 and correspond directly with the data presented in Table 6.1. The NOAEL values for growth and reproduction are used to calculate a geometric mean NOAEL. This result 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 4-4).

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

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)	Total
Biochemical (BIO)																		
1	Neiger and Osweiler 1989	14583	Dog (*Canis familiaris*)	4	U	FD	8	w	8	mo	JV	F	ENZ	ASAT	SR	1.04	1.66	80
2	Neiger and Osweiler, 1992	15703	Dog (*Canis familiaris*)	4	M	FD	58	d	8	mo	JV	F	CHM	GBCM	UR		0.500	79
3	Wood and Fowler, 1978	15387	Rat (*Rattus norvegicus*)	4	U	DR	6	w	NR	NR	JV	M	ENZ	GENZ	LI		1.20	69
4	Mahaffey et al., 1977	14580	Rat (*Rattus norvegicus*)	2	UX	FD	10	w	NR	NR	AD	M	CHM	RBCE	BL		1.50	68
5	Ghosh et al 1999	15011	Rat (*Rattus norvegicus*)	3	U	GV	28	d	35	d	JV	F	ENZ	GENZ	AR		2.06	73
6	Itoh et al., 1990	14577	Mouse (*Mus musculus*)	3	U	OR	14	d	4	w	JV	M	CHM	TRYP	BR		2.51	77
7	Schroeder, 1968	15506	Rat (*Rattus norvegicus*)	2	U	DR	781	d	21-23	d	JV	B	CHM	CHOL	SR		3.78	69
8	Nagaraja and Desiraju, 1994	15216	Rat (*Rattus norvegicus*)	2	U	GV	20	d	2	d	JV	B	ENZ	ACHE	BR		5.00	77
9	Nagaraja and Desiraju 1993	14546	Rat (*Rattus norvegicus*)	2	U	FD	90	d	90	d	JV	NR	HRM	DOPA	BR		5.00	68
10	Nagaraja and Desiraju 1993	14546	Rat (*Rattus norvegicus*)	2	U	GV	18	d	2	d	JV	B	HRM	DOPA	BR		5.00	77
11	Nagaraja and Desiraju, 1994	15216	Rat (*Rattus norvegicus*)	2	U	FD	90	d	90	d	JV	B	ENZ	ACHE	BR		5.00	74
12	Glattre et. al.,	11361	Rat (*Rattus norvegicus*)	2	U	DR	4	w	NR	NR	JV	M	HRM	TRII	SR		6.36	69
13	Wood and Fowler, 1978	15387	Mouse (*Mus musculus)*	4	U	DR	6	w	NR	NR	JV	M	ENZ	GENZ	LI		6.60	69
14	Morrison and Chavez, 1983	15709	Pig (*Sus scrofa*)	2	U	FD	2	w	21	d	JV	B	ENZ	GLPX	PL		9.44	71
15	Biswas, et al, 2000	25916	Goat (*Ovis aries*)	2	U	OR	3	w	12	mo	AD	F	ENZ	ASAT	BL		14.4	70
16	Biswas et al, 1998	15322	Goat (*Capra hircus*)	2	U	DR	6	w	1	yr	JV	F	CHM	HMGL	BL		14.4	69
17	Garcia-Vargas et al, 1995	15530	Mouse (*Mus musculus*)	2	U	DR	6	w	NR	NR	JV	M	CHM	PORP	UR		24.6	66
18	Tripathi et al 1997	14590	Rat (*Rattus norvegicus*)	2	U	DR	16	w	NR	NR	JV	M	HRM	DOPA	BR		32.0	66
19	Garcia-Vargas et al, 1995	15530	Mouse (*Mus musculus*)	2	U	DR	6	w	NR	NR	JV	M	CHM	PORP	UR		42.1	66
Behavior (BEH)																		
20	Hunder et al, 1999	15007	Guinea pig (*Cavia porcellus*)	4	U	FD	3	w	NR	NR	JV	F	FDB	FCNS	WO	0.844	2.53	79
21	Bencko 1972	15471	Mouse (*Mus musculus*)	3	U	DR	64	d	NR	NR	JV	M	FDB	WCON	WO	0.880	6.00	73
22	Neiger and Osweiler 1989	14583	Dog (*Canis familiaris*)	4	U	FD	1	w	8	mo	JV	F	FDB	FCNS	WO	1.04	1.66	83
23	Franke and Moxon 1937	14508	Rat (*Rattus norvegicus*)	2	U	FD	100	d	28	d	JV	M	FDB	FCNS	WO	1.88		68
24	Fowler and Woods 1979	15358	Mouse (*Mus musculus*)	4	U	DR	6	w	NR	NR	JV	M	FDB	WCON	WO	2.84	5.69	74
25	Franke and Moxon 1937	14508	Rat (*Rattus norvegicus*)	2	U	FD	100	d	28	d	JV	M	FDB	FCNS	WO	3.22		68
26	Morrison and Chavez, 1983	15709	Pig (*Sus scrofa*)	2	U	FD	6	w	21	d	JV	B	FDB	FCNS	WO	3.59		74
27	Hunder et al, 1999	15007	Mouse (*Mus musculus*)	4	U	FD	3	w	NR	NR	JV	F	FDB	FCNS	WO	3.85	7.69	79
28	Benese and Bencko, 1981	15288	Mouse (*Mus musculus*)	4	U	DR	32	d	NR	NR	JV	M	FDB	WCON	WO	6.43	32.4	73
29	Coulson et al, 1935	14603	Rat (*Rattus norvegicus*)	2	M	FD	52	w	33-35	d	JV	B	FDB	FCNS	WO		0.472	79
30	Mahaffey et al., 1977	14580	Rat (*Rattus norvegicus*)	2	UX	FD	10	w	NR	NR	AD	M	FDB	FCNS	WO		1.50	71
31	Itoh et al., 1990	14577	Mouse (*Mus musculus*)	3	U	OR	14	d	4	w	JV	M	BEH	ACTV	WO		2.51	80
32	Brown et al., 1976	4	Rat (*Rattus norvegicus*)	4	U	DR	6	w	NR	NR	JV	M	FDB	WCON	WO		4.70	68
33	Nagaraja and Desiraju, 1994	15216	Rat (*Rattus norvegicus*)	2	U	GV	21	d	2	d	JV	B	FDB	FCNS	WO		5.00	80
34	Nagaraja and Desiraju, 1994	15216	Rat (*Rattus norvegicus*)	2	U	FD	90	d	90	d	JV	B	BEH	ACTP	WO		5.00	73
35	Cabe, et al., 1979	1244	Rat (*Rattus norvegicus*)	2	U	DR	18	w	50	d	JV	M	FDB	WCON	WO		5.81	68
36	Garcia-Vargas et al, 1995	15530	Mouse (*Mus musculus*)	2	U	DR	6	w	NR	NR	JV	M	FDB	WCON	WO		24.6	69
37	Garcia-Vargas et al, 1995	15530	Mouse (*Mus musculus*)	2	U	DR	6	w	NR	NR	JV	M	FDB	WCON	WO		42.1	69
Physiology (PHY)																		
38	Bencko 1972	15471	Mouse (*Mus musculus*)	3	U	DR	32	d	NR	NR	JV	M	PHY	GPHY	LI	0.880	6.00	73
39	Kanisawa and Schroeder, 1969	15061	Rat (*Rattus norvegicus*)	2	U	DR	18	mo	21	d	JV	B	PHY	BLPR	WO		0.569	67
40	Carmignani et al, 1985	15174	Rat (*Rattus norvegicus*)	2	U	DR	18	mo	NR	NR	NR	M	PHY	GPHY	WO		2.55	67
41	Carmignani et al, 1985	15174	Rabbit (*Oryctolagus cuniculus*)	2	U	DR	10	mo	NR	NR	NR	F	PHY	BLPR	WO		2.61	67
42	Carmignani et al, 1985	15174	Rat (*Rattus norvegicus*)	2	U	DR	18	mo	NR	NR	NR	M	PHY	BLPR	WO		3.22	67
43	Morrison and Chavez, 1983	15709	Pig (*Sus scrofa*)	2	U	FD	6	w	21	d	JV	B	PHY	EXCR	WO		3.59	74
44	Brown et al., 1976	4	Rat (*Rattus norvegicus*)	4	U	DR	6	w	NR	NR	JV	M	PHY	RPRT	KI		4.70	68
45	Nagaraja and Desiraju 1993	14546	Rat (*Rattus norvegicus*)	2	U	GV	18	d	2	d	JV	B	PHY	GPHY	HA		5.0	80
46	Carmignani et al 1983	15249	Rat (*Rattus norvegicus*)	2	U	DR	320	d	NR	NR	JV	M	PHY	GPHY	HA		5.65	67
47	Biswas et al, 1998	15322	Goat (*Capra hircus*)	2	U	DR	6	w	1	yr	JV	F	PHY	GPHY	BL		14.4	72
48	Biswas, et al, 2000	25916	Goat (*Ovis aries*)	2	U	OR	9	w	12	mo	AD	F	PHY	RPRT	WO		14.4	73
Pathology (PTH)																		
49	Hughes and Thompson, 1996	15160	Mouse (*Mus musculus*)	3	U	DR	28	d	96	d	SM	F	ORW	ORWT	LI	0.000859	0.0859	67
50	Coulson et al, 1935	14603	Rat (*Rattus norvegicus*)	2	M	FD	52	w	33-35	d	JV	B	HIS	GHIS	LI	0.447		69
51	Kanisawa and Schroeder, 1969	15061	Rat (*Rattus norvegicus*)	2	U	DR	42	mo	21	d	JV	B	HIS	GHIS	KI	0.569		67
52	Nemec et al, 1998	15057	Rabbit (*Oryctolagus cuniculus*)	4	M	GV	7	d	NR	NR	GE	F	GRS	BDWT	WO	0.750	3.0	84
53	Bencko 1972	15471	Mouse (*Mus musculus*)	3	U	DR	64	d	NR	NR	JV	M	ORW	ORWT	SP	0.880	6.00	73
54	Obermeyer et al, 1971	12934	Rat (*Rattus norvegicus*)	2	U	FD	4	w	NR	NR	JV	M	ORW	SMIX	LI	0.913		73
55	Tice et al 1997	14589	Mouse (*Mus musculus*)	4	U	GV	4	d	12	w	JV	M	HIS	USTR	BL	1.44	2.88	86
56	Neiger and Osweiler 1989	14583	Dog (*Canis familiaris*)	4	U	FD	8	w	8	mo	JV	F	ORW	SMIX	LI	1.66		68
57	Fowler et al., 1977	14569	Rat (*Rattus norvegicus*)	4	U	DR	6	w	NR	NR	JV	M	HIS	USTR	LI	2.22	4.43	74
58	Fowler and Woods 1979	15358	Mouse (*Mus musculus*)	4	U	DR	6	w	NR	NR	JV	M	HIS	USTR	LI	2.84	5.69	74

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

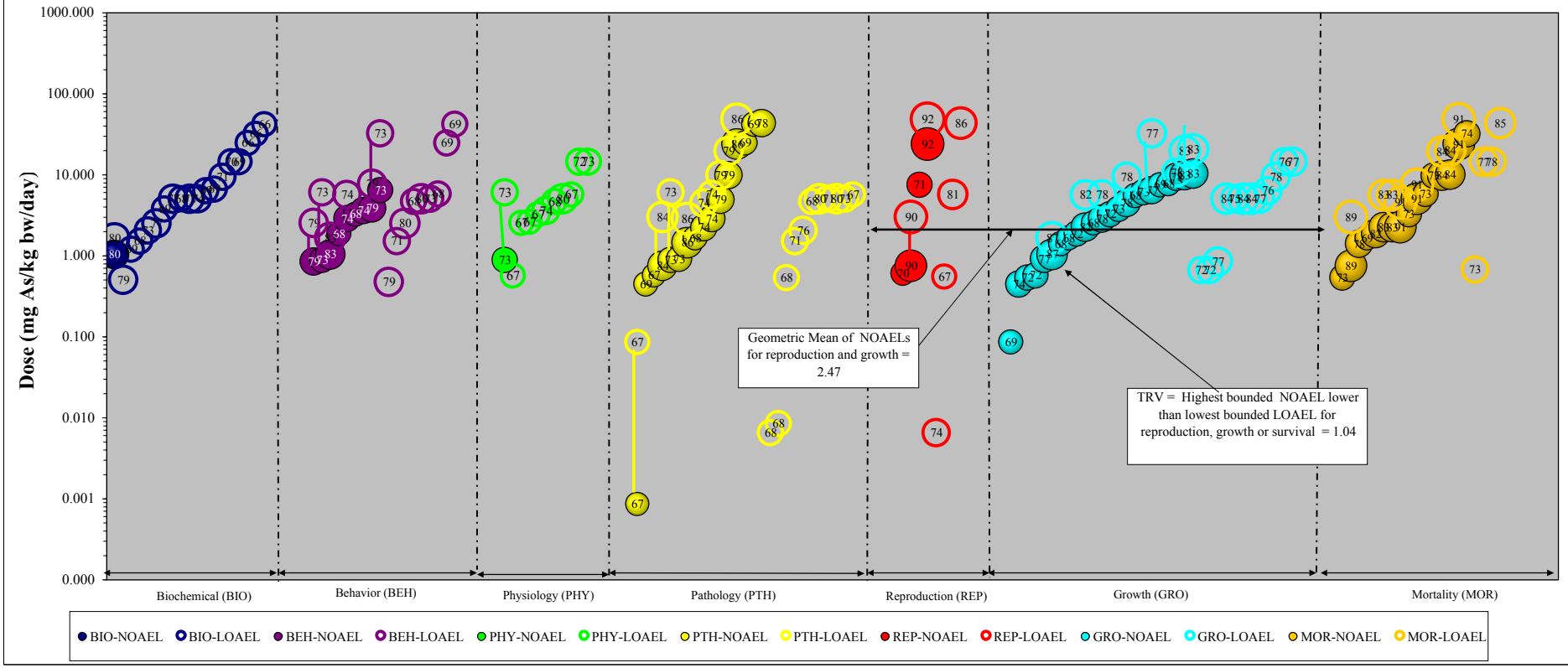
Result #	Reference	Ref No.	Test Organism	# of Conc/ Doses	Method of Analyses	Route of Exposure	Exposure Duration	Duration Units	Age	Age Units	Lifestage	Sex	Effect Type	Effect Measure	Response Site	NOAEL Dose (mg/kg bw/day)	LOAEL Dose (mg/kg bw/day)	Total
59	Byron et al, 1967	2	Rat (*Rattus norvegicus*)	6	U	FD	2	yr	NR	NR	JV	B	HIS	GHIS	LI	4.91	9.81	79
60	Byron et al, 1967	2	Rat (*Rattus norvegicus*)	6	U	FD	2	yr	NR	NR	JV	B	HIS	GHIS	LI	9.84	19.7	79
61	Nemec et al, 1998	15057	Mouse (*Mus musculus*)	4	M	GV	6	d	NR	NR	GE	F	GRS	BDWT	WO	24.0	48.0	86
62	Garcia-Vargas et al, 1995	15530	Mouse (*Mus musculus*)	2	U	DR	6	w	NR	NR	JV	M	ORW	SMIX	LI	24.6		69
63	Garcia-Vargas et al, 1995	15530	Mouse (*Mus musculus*)	2	U	DR	6	w	NR	NR	JV	M	ORW	SMIX	LI	42.1		69
64	Seidenberg et al 1986	113	Mouse (*Mus musculus*)	2	U	GV	5	d	NR	NR	GE	F	GRS	BDWT	WO	43.4		78
65	Healy et al., 1998	14543	Mouse (*Mus musculus*)	3	U	DR	91	d	76	d	JV	M	ORW	ORWT	LI		0.00650	68
66	Healy et al., 1998	14543	Mouse (*Mus musculus*)	3	U	DR	32	d	76	d	JV	M	PTH	ORWT	KI		0.00850	68
67	Schroeder et al, 1968	7	Rat (*Rattus norvegicus*)	2	U	DR	1575	d	21-23	d	JV	M	ORW	SMIX	HE		0.533	68
68	Mahaffey et al., 1977	14580	Rat (*Rattus norvegicus*)	2	UX	FD	10	w	NR	NR	AD	M	GRS	BDWT	WO		1.50	71
69	Ghosh et al 1999	15011	Rat (*Rattus norvegicus*)	3	U	GV	28	d	35	d	JV	F	ORW	SMIX	AR		2.06	76
70	Brown et al., 1976	4	Rat (*Rattus norvegicus*)	4	U	DR	6	w	NR	NR	JV	M	ORW	SMIX	KI		4.70	68
71	Nagaraja and Desiraju, 1994	15216	Rat (*Rattus norvegicus*)	2	U	GV	20	d	2	d	JV	B	ORW	ORWT	BR		5.00	80
72	Nagaraja and Desiraju 1993	14546	Rat (*Rattus norvegicus*)	2	U	FD	90	d	90	d	JV	NR	ORW	ORWT	BR		5.0	71
73	Nagaraja and Desiraju 1993	14546	Rat (*Rattus norvegicus*)	2	U	GV	18	d	2	d	JV	B	ORW	ORWT	BR		5.0	80
74	Nagaraja and Desiraju, 1994	15216	Rat (*Rattus norvegicus*)	2	U	FD	90	d	90	d	JV	B	ORW	ORWT	BR		5.00	73
75	Carmignani et al 1983	15249	Rat (*Rattus norvegicus*)	2	U	DR	320	d	NR	NR	JV	M	HIS	GHIS	KI		5.65	67
Reproduction (REP)																		
76	Savabieasfahani et al, 1998	14556	Cotton rat (*Sigmodon hispidus*)	3	U	DR	6	w	NR	NR	AD	M	REP	TEWT	TE	0.601		70
77	Nemec et al, 1998	15057	Rabbit (*Oryctolagus cuniculus*)	4	M	GV	12	d	NR	NR	GE	F	REP	RSEM	WO	0.750	3.0	90
78	Morris et al, 1938	15125	Rat (*Rattus norvegicus*)	3	U	FD	340	d	26-27	d	JV	M	REP	PRWT	WO	7.47		71
79	Nemec et al, 1998	15057	Mouse (*Mus musculus*)	4	M	GV	9	d	NR	NR	GE	F	REP	PROG	WO	24.0	48.0	92
80	Healy et al., 1998	14543	Mouse (*Mus musculus*)	3	U	DR	91	d	76	d	JV	M	REP	TEWT	TE		0.00650	74
81	Schroeder and Mitchener, 1971	66	Mouse (*Mus musculus*)	2	U	DR	6	mo	21	d	JV	F	REP	PROG	WO		0.548	67
82	Skalnaya et al, 1996	15167	Mouse (*Mus musculus*)	2	U	OR	30	d	NR	NR	GE	F	REP	PRWT	WO		5.66	81
83	Seidenberg et al 1986	113	Mouse (*Mus musculus*)	2	U	GV	5	d	NR	NR	GE	F	REP	PROG	WO		43.4	86
Growth (GRO)																		
84	Hughes and Thompson, 1996	15160	Mouse (*Mus musculus*)	3	U	DR	28	d	96	d	SM	F	GRO	BDWT	WO	0.0859		69
85	Coulson et al, 1935	14603	Rat (*Rattus norvegicus*)	2	M	FD	52	w	33-35	d	JV	B	GRO	BDWT	WO	0.447		74
86	Kanisawa and Schroeder, 1969	3701	Rat (*Rattus norvegicus*)	2	U	DR	519	d	21	d	JV	B	GRO	BDWT	WO	0.533		72
87	Schroeder et al, 1968	7	Rat (*Rattus norvegicus*)	2	U	DR	69	d	21-23	d	JV	B	GRO	BDWT	WO	0.571		72
88	Obermeyer et al, 1971	12934	Rat (*Rattus norvegicus*)	2	U	FD	4	w	NR	NR	JV	NR	GRO	BDWT	WO	0.913		77
89	Neiger and Osweiler 1989	14583	Dog (*Canis familiaris*)	4	U	FD	8	w	8	mo	JV	F	GRO	BDWT	WO	1.04	1.66	87
90	Palmer et al 1983	15262	Rat (*Rattus norvegicus*)	2	U	FD	4	w	NR	NR	JV	M	GRO	BDWT	WO	1.39		68
91	Palmer et al 1983	15262	Rat (*Rattus norvegicus*)	2	U	FD	8	w	NR	NR	JV	M	GRO	BDWT	WO	1.65		68
92	Franke and Moxon 1937	14508	Rat (*Rattus norvegicus*)	2	U	FD	100	d	28	d	JV	M	GRO	BDWT	WO	1.88		72
93	Byron et al, 1967	2	Dog (*Canis familiaris*)	5	U	FD	2	yr	6	mo	JV	B	GRO	BDWT	WO	2.25	5.62	82
94	Schmolke et al 1992	15264	Rat (*Rattus norvegicus*)	3	U	FD	15	w	7	w	JV	F	GRO	BDWT	WO	2.52		68
95	Fowler and Woods 1979	15358	Mouse (*Mus musculus*)	4	U	DR	6	w	NR	NR	JV	M	GRO	BDWT	WO	2.84	5.69	78
96	Franke and Moxon 1937	14508	Rat (*Rattus norvegicus*)	2	U	FD	100	d	28	d	JV	M	GRO	BDWT	WO	3.22		72
97	Ghosh et al 1999	15011	Rat (*Rattus norvegicus*)	3	U	GV	28	d	35	d	JV	F	GRO	BDWT	WO	3.78		73
98	Fowler et al., 1977	14569	Rat (*Rattus norvegicus*)	4	U	DR	6	w	NR	NR	JV	M	GRO	BDWT	WO	4.43	9.42	78
99	Hunder et al, 1999	15007	Rat (*Rattus norvegicus*)	4	U	FD	3	w	NR	NR	JV	F	GRO	BDWT	WO	5.52		68
100	Bencko 1972	15471	Mouse (*Mus musculus*)	3	U	DR	64	d	NR	NR	JV	M	GRO	BDWT	WO	6.00		73
101	Benese and Bencko, 1981	15288	Mouse (*Mus musculus*)	4	U	DR	32	d	NR	NR	JV	M	GRO	BDWT	WO	6.43	32.4	77
102	Morris et al, 1938	15125	Rat (*Rattus norvegicus*)	3	U	FD	340	d	26-27	d	JV	M	GRO	BDWT	WO	7.47		69
103	Hunder et al, 1999	15007	Mouse (*Mus musculus*)	4	U	FD	3	w	NR	NR	JV	F	GRO	BDWT	WO	7.69		68
104	Brown et al., 1976	4	Rat (*Rattus norvegicus*)	4	U	DR	6	w	NR	NR	JV	M	GRO	BDWT	WO	9.40	10.7	78
105	Byron et al, 1967	2	Rat (*Rattus norvegicus*)	6	U	FD	12	w	NR	NR	JV	B	GRO	BDWT	WO	9.84	19.7	83
106	Byron et al, 1967	2	Rat (*Rattus norvegicus*)	6	U	FD	12	w	NR	NR	JV	M	GRO	BDWT	WO	10.3	20.6	83
107	Kanisawa and Schroeder, 1967	20979	Mouse (*Mus musculus*)	2	U	DR	338	d	20-22	d	JV	M	GRO	BDWT	WO		0.663	72
108	Schroeder and Balassa, 1967	3084	Mouse (*Mus musculus*)	2	U	DR	339	d	21	d	JV	B	GRO	BDWT	WO		0.665	72
109	Hunder et al, 1999	15007	Guinea pig (*Cavia porcellus*)	4	U	FD	3	w	NR	NR	JV	F	GRO	BDWT	WO		0.844	77
110	Nagaraja and Desiraju, 1994	15216	Rat (*Rattus norvegicus*)	2	U	GV	20	d	2	d	JV	B	GRO	BDWT	WO		5.00	84
111	Nagaraja and Desiraju 1993	14546	Rat (*Rattus norvegicus*)	2	U	FD	90	d	90	d	JV	NR	GRO	BDWT	WO		5.0	75
112	Nagaraja and Desiraju 1993	14546	Rat (*Rattus norvegicus*)	2	U	GV	18	d	2	d	JV	B	GRO	BDWT	WO		5.0	84
113	Kiyono et al, 1974	15427	Rat (*Rattus norvegicus*)	4	U	GV	10	d	1	d	JV	M	GRO	BDWT	WO		5.0	84
114	Nagaraja and Desiraju, 1994	15216	Rat (*Rattus norvegicus*)	2	U	FD	90	d	90	d	JV	B	GRO	BDWT	WO		5.00	77
115	Glattre et. al.,	11361	Rat (*Rattus norvegicus*)	2	U	DR	4	w	NR	NR	JV	M	GRO	BDWT	WO		6.36	76
116	Morrison and Chavez, 1983	15709	Pig (*Sus scrofa*)	2	U	FD	2	w	21	d	JV	B	GRO	BDWT	WO		9.44	78
117	Biswas et al, 1998	15322	Goat (*Capra hircus*)	2	U	DR	9	w	1	yr	JV	F	GRO	BDWT	WO		14.4	76
118	Biswas, et al, 2000	25916	Goat (*Ovis aries*)	2	U	OR	9	w	12	mo	AD	F	GRO	BDWT	WO		14.4	77

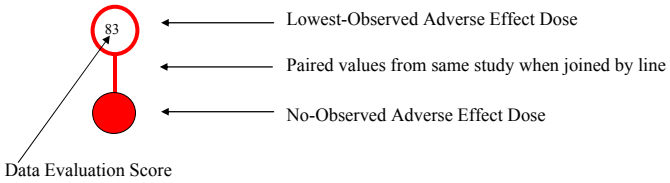
Table 6.1 Mammalian Toxicity Data Extracted for Wildlife Toxicity Reference Value (TRV)
Arsenic
Page 3 of 3

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)	Total
Survival (MOR)																		
119	Schroeder et al, 1968	7	Rat (*Rattus norvegicus*)	2	U	DR	1575	d	21-23	d	JV	B	MOR	SURV	WO	0.533		73
120	Nemec et al, 1998	15057	Rabbit (*Oryctolagus cuniculus*)	4	M	GV	12	d	NR	NR	GE	F	MOR	MORT	WO	0.750	3.00	89
121	Palmer et al 1983	15262	Rat (*Rattus norvegicus*)	2	U	FD	4	w	NR	NR	JV	M	MOR	MORT	WO	1.39		78
122	Palmer et al 1983	15262	Rat (*Rattus norvegicus*)	2	U	FD	8	w	NR	NR	JV	M	MOR	SURV	WO	1.65		69
123	Franke and Moxon 1937	14508	Rat (*Rattus norvegicus*)	2	U	FD	100	d	28	d	JV	M	MOR	MORT	WO	1.88		82
124	Byron et al, 1967	2	Dog (*Canis familiaris*)	5	U	FD	2	yr	6	mo	JV	B	MOR	MORT	WO	2.25	5.62	83
125	Byron et al, 1967	2	Dog (*Canis familiaris*)	5	U	FD	13.5	mo	6	mo	JV	B	MOR	MORT	WO	2.25	5.62	83
126	Nemec et al, 1998	15057	Rabbit (*Oryctolagus cuniculus*)	6	M	GV	12	d	NR	NR	GE	F	MOR	MORT	WO	2.25	4.50	91
127	Franke and Moxon 1937	14508	Rat (*Rattus norvegicus*)	2	U	FD	100	d	28	d	JV	M	MOR	MORT	WO	3.22		73
128	Kiyono et al, 1974	15427	Rat (*Rattus norvegicus*)	4	U	GV	21	d	1	d	JV	M	MOR	MORT	WO	5.0	7.5	91
129	Cabe, et al., 1979	1244	Rat (*Rattus norvegicus*)	2	U	DR	18	w	50	d	JV	M	MOR	MORT	WO	5.81		73
130	Fowler et al., 1977	14569	Rat (*Rattus norvegicus*)	4	U	DR	6	w	NR	NR	JV	M	MOR	MORT	WO	9.63		73
131	Byron et al, 1967	2	Rat (*Rattus norvegicus*)	6	U	FD	78	w	NR	NR	JV	B	MOR	SURV	WO	9.65	19.3	84
132	Byron et al, 1967	2	Rat (*Rattus norvegicus*)	6	U	FD	2	yr	NR	NR	JV	B	MOR	SURV	WO	9.99	20.0	84
133	Nemec et al, 1998	15057	Mouse (*Mus musculus*)	4	M	GV	9	d	NR	NR	GE	F	MOR	MORT	WO	24.0	48.0	91
134	Tripathi et al 1997	14590	Rat (*Rattus norvegicus*)	2	U	DR	16	w	NR	NR	JV	M	MOR	MORT	WO	32.0		74
135	Schroeder and Balassa, 1967	3084	Mouse (*Mus musculus*)	2	U	DR	519	d	21	d	JV	M	MOR	SURV	WO		0.675	73
136	Biswas et al, 1998	15322	Goat (*Capra hircus*)	2	U	DR	78	d	1	yr	JV	F	MOR	MORT	WO		14.4	77
137	Biswas, et al, 2000	25916	Goat (*Ovis aries*)	2	U	OR	12	w	12	mo	AD	F	MOR	MORT	WO		14.4	78
138	Seidenberg et al 1986	113	Mouse (*Mus musculus*)	2	U	GV	5	d	NR	NR	GE	F	MOR	MORT	WO		43.4	85

ACHE = acetylcholinesterase; ACTP = accuracy of learned behavior; ACTV = activity, general; AD = adult; AR = adrenal; ASAT = aspartate aminotransferase; B = both; BDWT = body weight changes; BEH = behavior; BL = blood; BLPR = blood pressure; BR = brain; bw = body weight; CHM = chemical changes; CHOL = cholesterol; d - day; DOPA = dopamine; DR = Drinking water; ENZ = enyzme level changes; EXCR = excretion; F = female; FCNS = food consumption; FD = food; FDB = feeding behavior; GBCM = general biochemical changes; GE = gestation; GENZ = general enzyme changes; GHIS = general histology; GLPX = glutathione peroxidase; GPHY = general pysiology changes; GRO = growth; GRS = gross body weight changes; GV = gavage; HA = hair; HE = heart; HIS = histological changes;HMGL = hemoglobin; HRM = hormone changes; JV = juvenile; kg = kilograms; KI = kidney; L = liter; LI = liver; LOAEL = lowest observed adverse effect level; mo = months; M = male; M = measured; MOR = effects on mortality and survival; MORT = mortality; NOAEL = No Observed Advese Effect Level; NR = Not reported; OR = other oral; ORW = organ weight changes; ORWT = organ weight changes; PHY = physiology; PL = plasma; PORP = porphyrin; PROG = progeny numbers/counts; PRWT = progeny weight; PTH = pathology; RBCE = red blood cell count; REP = reproduction; RPRT = respiratory rate; RSEM = resorbed embryo; SM = sexually mature; SMIX = weight relative to body weight; SP = spleen; SR = serum; SURV = survival; TE = testes; TEWT = testes weight; TRII = tridothyronine; TRYP = tryptophan; U = unmeasured; UR = urine; USTR = ultrastructural changes; UX = measured but values not reported; w = weeks; WCON = water consumption; WO = whole organism; yr = year.

Figure 6.1 Mammalian TRV Derivation for Arsenic





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 three NOAEL results available within the growth and reproduction effect groups for calculation of a geometric mean.
3) The geometric mean is equal to 2.47 mg arsenic /kg bw/d and is lower than the lowest bounded LOAEL for results within the reproduction, growth, and survival (MOR) effect groups.
4) The mammalian wildlife TRV for arsenic is equal to 1.04 mg arsenic/kg bw/day which is the geometric mean of NOAEL values for reproduction and growth.

A geometric mean of the NOAEL values for growth and reproduction was calculated at 2.47 mg arsenic/kg bw/day. However, this value is higher than the lowest bounded LOAEL for reproduction, growth, or survival results. Therefore, the TRV is equal to 1.04 mg arsenic/kg bw/day which is the highest bounded NOAEL lower than the lowest bounded LOAEL for reproduction, growth or survival.

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 for arsenic are calculated according to the Eco-SSL guidance (U.S. EPA, 2003; Attachment 4-5) and are summarized in Table 6.2

Table 6.2 Calculation of the Mammalian Eco-SSLs for Arsenic

Surrogate Receptor Group	TRV for Arsenic (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]	Arsenic in Biota Type (i)[2,3] (B_i) (mg/kg dw)	Eco-SSL (mg/kg dw)[4]
Mammalian herbivore (vole)	1.04	0.0875	0.032	$B_i = 0.03752 * Soil_j$ where i = plants	170
Mammalian ground insectivore (shrew)	1.04	0.209	0.030	$\ln(B_j) = 0.706 * \ln(Soil_j) - 1.421$ where i = earthworms	46
Mammalian carnivore (weasel)	1.04	0.130	0.043	$\ln(B_i) = 0.8188 * \ln(Soil_j) - 4.8471$ where i = mammals	170

[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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7.0 REFERENCES

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7.5 References Rejected for Use in Derivation of Wildlife TRVs

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.

Diss Arsenic: an analytical procedure to determine its total content in biological samples and signs of its deprivation in rats and chicks. *788794 ORDER NO: AAD82-20750*

Diss Characterization and comparison of mitochondrial atpase and adenine nucleotide transport activity in mitochondria from rat liver and neoplastic tissues of different growth rates. *760425 ORDER NO: AAD81-23882*

Diss Characterization, fate and environmental risk assessment of microbial, elemental and toxic components of fractionated broiler litter during storage and reutilization. *01295605 ORDER NO: AAD93-16361*

Diss Crystallographic studies of transport proteins and ligands (thiobacillus ferrooxidans, didelphins virginiana, multiplewavelength anomalous dispersion). *01695894 ORDER NO: AAD99-23629*

Diss Ecology and toxicology of arsenic in contaminated grassland. *0996661 ORDER NO: Not Available from University Microfilms Int'l.*

Diss effects of chronic dietary inorganic arsenic in dogs. *0966997 ORDER NO: AAD87-21915*

Diss effects of stripped oil shale retort water on fishes, birds, and mammals. *01265899 ORDER NO: AAD84-08915*

Diss electrochemical synthesis and structural characterization of zintl anion clusters produced via the cathodic dissolution of telluride electrodes. *01378472 ORDER NO: AAD94-29162*

Diss factors affecting the toxicity and metabolism of organic arsenicals (roxarsone, copper, cysteine). *1003496 ORDER NO: AAD85-02122*

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Chem Meth Zinke-Allmang, M., Feldman, L. C., Patel, J. R., and Tully, J. C. The Morphology of Arsenic Terminated Silicon(111) from Desorption Kinetics. *Surf. Sci. (1988)* 197(1-2): 1-10.

FL Zmudzki, J. and Szkoda, J. Trace Elements Content of Hen Eggs in Poland. *Bromatologia I Chemia Toksykologiczna; 29 (1). 1996. 55-57.*

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) - Arsenic

March 2005

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Appendix 5.1 Avian Toxicity Data Extracted for Wildlife Toxicity Reference Value (TRV)
Arsenic

Ref			Exposure																										Effects						Conversion to mg/kg bw/day				Result		Data Evaluation Score											
Result #	Ref N.	Reference	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	Exposure Duration	Duration Units	Age	Age Units	Lifestage	Sex	Control Type	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/day 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	5747	Camardese et al, 1990	Sodium arsenate	100	Mallard duck (*Anas platyrhynchos*)	1	4	0/30/100/300	mg/kg diet	Y	12.1	ADL	UX	FD	10	w	1	d	JV	F	C	FieldA	5	BIO	ENZ	ACHE	BR		30.0	Y	1.0	Y	0.012		0.410	10	10	10	10	7	1	4	10	10	4	76
2	1376	Hoffman et al, 1992	Sodium arsenate	100	Mallard duck (*Anas platyrhynchos*)	1	2	0/200	mg/kg diet	N	6	ADL	UX	FD	4	w	1	d	JV	B	C	FieldA	4	BIO	ENZ	GLPX	PL		200	N	0.384	N	0.03121		17.3	10	10	10	10	5	1	4	10	10	4	74
Behavior																																																
5	5747	Camardese et al, 1990	Sodium arsenate	100	Mallard duck (*Anas platyrhynchos*)	1	4	0/30/100/300	mg/kg diet	Y	12.1	ADL	UX	FD	2	w	1	d	JV	F	C	FieldA	4	BEH	FDB	FCNS	WO	30.0	100.0	Y	0.160	Y	0.007	1.49	4.98	10	10	10	10	7	4	8	10	10	4	83
3	5305	Holcman and Stibilj, 1997	Arsenic oxide	100	Chicken (*Gallus domesticus*)	1	4	0/7.5/15.0/30.0	mg/kg diet	N	na	NR	U	FD	19	d	49	w	SM	F	C	Lab	1	BEH	FDB	FCNS	WO	30.0		N	1.6	Y	0.1194	2.24		10	10	5	10	6	4	4	8	6	4	67
4	5690	Whitworth et al 1991	Sodium arsenate	100	Mallard duck (*Anas platyrhynchos*)	1	4	0/30/100/300	mg/kg diet	Y	12.1	ADL	U	FD	9	w	1	d	JV	NR	C	Lab	1	BEH	BEH	ACTV	WO	100	300	N	0.092	N	0.01231	15.2	45.7	10	10	5	10	5	4	10	10	10	4	78
Pathology																																																
6	5747	Camardese et al, 1990	Sodium arsenate	100	Mallard duck (*Anas platyrhynchos*)	1	4	0/30/100/300	mg/kg diet	Y	12.1	ADL	UX	FD	10	w	1	d	JV	B	C	FieldA	3	PTH	ORW	ORWT	LI	300		Y	1.10	Y	0.012	3.72		10	10	10	10	7	4	4	1	10	4	70
7	1376	Hoffman et al, 1992	Sodium arsenate	100	Mallard duck (*Anas platyrhynchos*)	1	2	0/200	mg/kg diet	N	6	ADL	UX	FD	4	w	1	d	JV	B	C	FieldA	3	PTH	ORW	ORWT	LI		200	N	0.384	N	0.03121		17.3	10	10	10	10	5	4	4	10	10	4	77
Reproduction																																																
8	5305	Holcman and Stibilj, 1997	Arsenic oxide	100	Chicken (*Gallus domesticus*)	1	4	0/7.5/15.0/30.0	mg/kg diet	N	na	NR	U	FD	19	d	49	w	LB	F	C	Lab	3	REP	REP	PROG	WO	30.0		N	1.6	Y	0.1194	2.24		10	10	5	10	6	10	4	3	10	4	72
Growth																																																
9	5305	Holcman and Stibilj, 1997	Arsenic oxide	100	Chicken (*Gallus domesticus*)	1	4	0/7.5/15.0/30.0	mg/kg diet	N	na	NR	U	FD	19	d	49	w	SM	F	C	Lab	2	GRO	GRO	BDWT	WO	30.0		N	1.6	Y	0.1194	2.24		10	10	5	10	6	8	4	3	6	4	66
10	5747	Camardese et al, 1990	Sodium arsenate	100	Mallard duck (*Anas platyrhynchos*)	1	4	0/30/100/300	mg/kg diet	Y	12.1	ADL	UX	FD	2	w	1	d	JV	F	C	FieldA	2	GRO	GRO	GGRO	WO		30.0	Y	0.160	Y	0.007		1.49	10	10	10	10	7	8	4	10	10	4	83
11	1387	Howell and Hill, 1978	Arsenic trichloride	100	Chicken (*Gallus domesticus*)	1	2	0/50	mg/kg diet	N	na	ADL	U	FD	21	d	1	d	JV	B	C	Lab	1	GRO	GRO	BDWT	WO		50.0	N	0.564	N	0.04009		3.55	10	10	5	10	5	8	4	10	10	4	76
12	1376	Hoffman et al, 1992	Sodium arsenate	100	Mallard duck (*Anas platyrhynchos*)	1	2	0/200	mg/kg diet	N	6	ADL	UX	FD	4	w	1	d	JV	B	C	FieldA	2	GRO	GRO	BDWT	WO		200	Y	0.384	N	0.03121		17.3	10	10	10	10	6	8	4	10	10	4	82
Survival																																																
13	5305	Holcman and Stibilj, 1997	Arsenic oxide	100	Chicken (*Gallus domesticus*)	1	4	0/7.5/15.0/30.0	mg/kg diet	N	na	NR	U	FD	19	d	49	w	SM	F	C	Lab	4	MOR	MOR	MORT	WO	30.0		N	1.6	Y	0.1194	2.24		10	10	5	10	6	9	4	10	6	4	74
14	1387	Howell and Hill, 1978	Arsenic trichloride	100	Chicken (*Gallus domesticus*)	1	2	0/50	mg/kg diet	N	na	ADL	U	FD	21	d	1	d	JV	B	C	Lab	2	MOR	MOR	MORT	WO	50.0		N	0.564	N	0.04009	3.55		10	10	5	10	5	9	4	10	10	4	77
15	5747	Camardese et al, 1990	Sodium arsenate	100	Mallard duck (*Anas platyrhynchos*)	1	4	0/30/100/300	mg/kg diet	Y	12.1	ADL	UX	FD	10	w	1	d	JV	B	C	FieldA	3	MOR	MOR	MORT	WO	300		Y	1.10	Y	0.012	3.72		10	10	10	10	7	9	4	10	10	4	84
16	1376	Hoffman et al, 1992	Sodium arsenate	100	Mallard duck (*Anas platyrhynchos*)	1	2	0/200	mg/kg diet	N	6	ADL	UX	FD	4	w	1	d	JV	B	C	FieldA	1	MOR	MOR	SURV	WO	200		Y	0.384	N	0.03121	17.3		10	10	10	10	6	9	4	10	10	4	83

ailable from 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) - Arsenic

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March 2005

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

Ref			Exposure																								Conversion to mg/kg bw/day					Result		Data Evaluation Score											
Result #	Ref N.	Reference	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	Exposure Duration	Duration Units	Age	Age Units	Lifestage	Sex	Control Type	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	14583	Neiger and Osweiler 1989	Sodium arsenite	57.69	Dog (*Canis familiaris*)	1	4	0.0/0.88/1.80/2.88	mg/kg bw/d	N	na	DLY	U	FD	8	w	8	mo	JV	F	M	Lab	BIO	ENZ	ASAT	SR	1.80	2.88	N	10.1	N	0.4597	1.04	1.66	10	10	5	10	10	1	10	10	10	4	80
2	15703	Neiger and Osweiler, 1992	Sodium arsenite	56.79	Dog (*Canis familiaris*)	1	4	0.0/0.88/1.80/2.88	mg/kg bw/d	N	na	DLY	M	FD	58	d	8	mo	JV	F	C	Lab	BIO	CHM	GBCM	UR		0.880	N	10.1	N	0.4597		0.500	10	10	10	10	10	1	4	10	10	4	79
3	15387	Wood and Fowler, 1978	Sodium arsenate	100	Rat (*Rattus norvegicus*)	1	4	0/1.2/2.2/3.5	mg/kg bw/d	N	na	NR	U	DR	6	w	NR	NR	JV	M	C	Lab	BIO	ENZ	GENZ	LI		1.20	Y	0.2000	N	0.02326		1.20	10	5	5	10	10	1	4	10	10	4	69
4	14580	Mahaffey et al., 1977	Sodium arsenate	100	Rat (*Rattus norvegicus*)	1	2	0/50	mg/kg diet	N	na	ADL	UX	FD	10	w	NR	NR	AD	M	C	Lab	BIO	CHM	RBCE	BL		50.0	N	0.523	Y	0.01568		1.50	10	10	10	10	6	1	4	10	3	4	68
5	15011	Ghosh et al 1999	Sodium arsenite	57.69	Rat (*Rattus norvegicus*)	1	3	0/0.2/0.4	mg/org/d	N	na	DLY	U	GV	28	d	35	d	JV	F	C	Lab	BIO	ENZ	GENZ	AR		0.200	Y	0.056	N	0.006426		2.06	10	8	10	10	6	1	4	10	10	4	73
6	14577	Itoh et al., 1990	Arsenic trioxide	83.53	Mouse (*Mus musculus*)	1	3	0/3/10	mg/kg bw/d	N	na	DLY	U	OR	14	d	4	w	JV	M	C	Lab	BIO	CHM	TRYP	BR		3.0	N	0.022	N	0.002981		2.51	10	8	10	10	10	1	4	10	10	4	77
7	15506	Schroeder, 1968	Sodium arsenite	100	Rat (*Rattus norvegicus*)	1	2	0/3.776	mg/kg bw/d	N	na	ADL	U	DR	781	d	21-23	d	JV	B	C	Lab	BIO	CHM	CHOL	SR		3.78	N	0.2350	N	0.02689		3.78	10	5	5	10	10	1	4	10	10	4	69
8	15216	Nagaraja and Desiraju, 1994	Sodium arsenite	100	Rat (*Rattus norvegicus*)	1	2	0/5	mg/kg bw/d	N	na	DLY	U	GV	20	d	2	d	JV	B	C	Lab	BIO	ENZ	ACHE	BR		5.0	Y	0.050	N	0.005855		5.00	10	8	10	10	10	1	4	10	10	4	77
9	14546	Nagaraja and Desiraju 1993	Arsenic	100	Rat (*Rattus norvegicus*)	2	2	0/5	mg/kg bw/d	N	na	DLY	U	FD	90	d	90	d	JV	NR	C	Lab	BIO	HRM	DOPA	BR		5.0	Y	0.2152	N	0.01943		5.00	10	10	5	4	10	1	4	10	10	4	68
10	14546	Nagaraja and Desiraju 1993	Sodium arsenate	100	Rat (*Rattus norvegicus*)	1	2	0/5	mg/kg bw/d	N	na	DLY	U	GV	18	d	2	d	JV	B	C	Lab	BIO	HRM	DOPA	BR		5.0	Y	0.0313	N	0.003984		5.00	10	8	10	10	10	1	4	10	10	4	77
11	15216	Nagaraja and Desiraju, 1994	Sodium arsenite	100	Rat (*Rattus norvegicus*)	2	2	0/5	mg/kg bw/d	N	na	DLY	U	FD	90	d	90	d	JV	B	C	Lab	BIO	ENZ	ACHE	BR		5.0	Y	0.25	N	0.02198		5.00	10	10	5	10	10	1	4	10	10	4	74
12	11361	Glattre et. al., 1995	Sodium arsenate heptahydrate	100	Rat (*Rattus norvegicus*)	1	2	0/6.36	mg/kg bw/d	N	na	ADL	U	DR	4	w	NR	NR	JV	M	C	Lab	BIO	HRM	TRII	SR		6.36	Y	0.290	N	0.03249		6.36	10	5	5	10	10	1	4	10	10	4	69
13	15387	Wood and Fowler, 1978	Sodium arsenate	100	Mouse (*Mus musculus)*	2	4	0/6.6/11.4/25.1	mg/kg bw/d	N	na	NR	U	DR	6	w	NR	NR	JV	M	C	Lab	BIO	ENZ	GENZ	LI		6.60	Y	0.0300	N	0.004217		6.60	10	5	5	10	10	1	4	10	10	4	69
14	15709	Morrison and Chavez, 1983	Sodium arsenite	100	Pig (*Sus scrofa*)	1	2	0/100	mg/kg diet	N	na	ADL	U	FD	2	w	21	d	JV	B	C	Lab	BIO	ENZ	GLPX	PL		100	Y	5.40	Y	0.5100		9.44	10	10	5	10	7	1	4	10	10	4	71
15	25916	Biswas, et al, 2000	Sodium arsenite	57.69	Goat (*Ovis aries*)	1	2	0/25	mg/kg bw/d	N		DLY	U	OR	3	w	12	mo	AD	F	C	Lab	BIO	ENZ	ASAT	BL		25.0	Y	14.8	N	0.6294		14.4	10	8	10	10	10	1	4	10	3	4	70
16	15322	Biswas et al, 1998	Sodium arsenite	57.69	Goat (*Capra hircus*)	1	2	0/25.0	mg/kg bw/d	N	na	ADL	U	DR	6	w	1	yr	JV	F	C	Lab	BIO	CHM	HMGL	BL		25.0	Y	11.0	N	0.8568		14.4	10	5	5	10	10	1	4	10	10	4	69
17	15530	Garcia-Vargas et al, 1995	Sodium arsenite	100	Mouse (*Mus musculus*)	1	2	0/20	mg/L	Y		ADL	U	DR	2	w	NR	NR	JV	M	C	Lab	BIO	CHM	PORP	UR		20.0	Y	0.030	Y	0.0350		24.6	10	5	5	10	7	1	4	10	10	4	66
18	14590	Tripathi et al 1997	Sodium arsenite	100	Rat (*Rattus norvegicus*)	1	2	0/2.56	mg/org/d	Y	na	ADL	U	DR	16	w	NR	NR	AD	M	C	Lab	BIO	HRM	DOPA	BR		2.56	Y	0.080	N	0.01020		32.0	10	5	5	10	7	1	4	10	10	4	66
19	15530	Garcia-Vargas et al, 1995	Sodium arsenate	100	Mouse (*Mus musculus*)	2	2	0/50	mg/L	Y		ADL	U	DR	2	w	NR	NR	JV	M	C	Lab	BIO	CHM	PORP	UR		50.0	Y	0.0300	Y	0.0240		42.1	10	5	5	10	7	1	4	10	10	4	66
Behavior																																													
20	15007	Hunder et al, 1999	Sodium arsenite	100	Guinea pig (*Cavia porcellus*)	3	4	0/10/30/60	mg/kg diet	N	na	ADL	U	FD	3	w	NR	NR	JV	F	C	Lab	BEH	FDB	FCNS	WO	10.0	30.0	Y	0.315	N	0.02658	0.844	2.53	10	10	5	10	6	4	10	10	10	4	79
21	15471	Bencko 1972	Sodium arsenite	100	Mouse (*Mus musculus*)	1	3	0/0.88/6.0	mg/kg bw/d	N	na	NR	U	DR	64	d	NR	NR	JV	M	C	Lab	BEH	FDB	WCON	WO	0.880	6.00	Y	0.03329	Y	0.005790	0.880	6.00	10	5	5	10	7	4	8	10	10	4	73
22	14583	Neiger and Osweiler 1989	Sodium arsenite	57.69	Dog (*Canis familiaris*)	1	4	0.0/0.88/1.80/2.88	mg/kg bw/d	N	na	DLY	U	FD	1	w	8	mo	JV	F	M	Lab	BEH	FDB	FCNS	WO	1.80	2.88	N	10.1	N	0.4597	1.04	1.66	10	10	5	10	10	4	10	10	10	4	83
23	14508	Franke and Moxon 1937	Sodium arsenate	100	Rat (*Rattus norvegicus*)	1	2	0/1.88	mg/kg bw/d	N	na	DLY	U	FD	100	d	28	d	JV	M	C	Lab	BEH	FDB	FCNS	WO	1.88		Y	0.2874	Y	0.01296	1.88		10	10	5	10	10	4	4	1	10	4	68
24	15358	Fowler and Woods 1979	Sodium arsenate	100	Mouse (*Mus musculus*)	1	4	0/20/40/85	mg/L	N	na	DLY	U	DR	6	w	NR	NR	JV	M	C	Lab	BEH	FDB	WCON	WO	20.0	40.0	Y	0.0267	N	0.003801	2.84	5.69	10	5	5	10	6	4	10	10	10	4	74
25	14508	Franke and Moxon 1937	Sodium arsenate	100	Rat (*Rattus norvegicus*)	2	2	0/3.22	mg/kg bw/d	N	na	DLY	U	FD	100	d	28	d	JV	M	C	Lab	BEH	FDB	FCNS	WO	3.22		Y	0.2635	Y	0.01109	3.22		10	10	5	10	10	4	4	1	10	4	68
26	15709	Morrison and Chavez, 1983	Sodium arsenite	100	Pig (*Sus scrofa*)	1	2	0/100	mg/kg diet	N	na	ADL	U	FD	6	w	21	d	JV	B	C	Lab	BEH	FDB	FCNS	WO	100		Y	14.2	Y	0.5100	3.59		10	10	5	10	7	4	4	10	10	4	74
27	15007	Hunder et al, 1999	Sodium arsenite	100	Mouse (*Mus musculus*)	2	4	0/10/30/60	mg/kg diet	N	na	ADL	U	FD	3	w	NR	NR	JV	F	C	Lab	BEH	FDB	FCNS	WO	30.0	60.0	Y	0.0300	N	0.003847	3.85	7.69	10	10	5	10	6	4	10	10	10	4	79
28	15288	Benese and Bencko, 1981	Sodium arsenite	100	Mouse (*Mus musculus*)	1	4	0/4.945/49.45/249.4	mg/L	N	na	NR	U	DR	32	d	NR	NR	JV	M	C	Lab	BEH	FDB	WCON	WO	49.5	249	Y	0.0325	Y	0.004225	6.43	32.4	10	5	5	10	7	4	8	10	10	4	73
29	14603	Coulson et al, 1935	Arsenic trioxide	100	Rat (*Rattus norvegicus*)	2	2	0/0.21	mg/org/d	N	na	NR	M	FD	52	w	33-35	d	JV	B	C	Lab	BEH	FDB	FCNS	WO		0.21	Y	0.4450	Y	0.01208		0.472	10	10	10	10	7	4	4	10	10	4	79
30	14580	Mahaffey et al., 1977	Sodium arsenate	100	Rat (*Rattus norvegicus*)	1	2	0/50	mg/kg diet	N	na	ADL	UX	FD	10	w	NR	NR	AD	M	C	Lab	BEH	FDB	FCNS	WO		50.0	N	0.523	Y	0.01568		1.50	10	10	10	10	6	4	4	10	3	4	71
31	14577	Itoh et al., 1990	Arsenic trioxide	83.53	Mouse (*Mus musculus*)	1	3	0/3/10	mg/kg bw/d	N	na	DLY	U	OR	14	d	4	w	JV	M	C	Lab	BEH	BEH	ACTV	WO		3.0	Y	0.022	N	0.002981		2.51	10	8	10	10	10	4	4	10	10	4	80
32	4	Brown et al., 1976	sodium arsenate heptahydrate	100	Rat (*Rattus norvegicus*)	1	4	0/4.7/9.4/10.9	mg/kg bw/d	N	na	ADL	U	DR	6	w	NR	NR	JV	M	C	Lab	BEH	FDB	WCON	WO		4.70	Y	0.444	Y	0.01785		4.70	10	5	5	10	10	4	4	10	6	4	68
33	15216	Nagaraja and Desiraju, 1994	Sodium arsenate	100	Rat (*Rattus norvegicus*)	1	2	0/5	mg/kg bw/d	N	na	DLY	U	GV	21	d	2	d	JV	B	C	Lab	BEH	FDB	FCNS	WO		5.0	Y	0.050	N	0.005855		5.0	10	8	10	10	10	4	4	10	10	4	80
34	15216	Nagaraja and Desiraju, 1994	Sodium arsenate	100	Rat (*Rattus norvegicus*)	2	2	0/5	mg/kg bw/d	N	na	DLY	U	FD	90	d	90	d	JV	B	C	Lab	BEH	BEH	ACTP	WO		5.0	Y	0.250	N	0.02198		5.0	10	10	5	10	6	4	4	10	10	4	73
35	1244	Cabe, et al., 1979	Sodium arsenate	100	Rat (*Rattus norvegicus*)	1	2	0/50	mg/L	N	na	ADL	U	DR	18	w	50	d	JV	M	C	Lab	BEH	FDB	WCON	WO		50.0	Y	0.200	N	0.02326		5.81	10	5	5	10	6	4	4	10	10	4	68
36	15530	Garcia-Vargas et al, 1995	Sodium arsenite	100	Mouse (*Mus musculus*)	1	2	0/20	mg/L	Y	na	ADL	U	DR	6	w	NR	NR	JV	M	C	Lab	BEH	FDB	WCON	WO		20.0	Y	0.0300	Y	0.0350		24.6	10	5	5	10	7	4	4	10	10	4	69
37	15530	Garcia-Vargas et al, 1995	Sodium arsenate	100	Mouse (*Mus musculus*)	2	2	0/50	mg/L	Y	na	ADL	U	DR	6	w	NR	NR	JV	M	C	Lab	BEH	FDB	WCON	WO		50.0	Y	0.0300	Y	0.0240		42.1	10	5	5	10	7	4	4	10	10	4	69
Physiology																																													
38	15471	Bencko 1972	Sodium arsenite	100	Mouse (*Mus musculus*)	1	3	0/0.88/6.0	mg/kg bw/d	N	na	NR	U	DR	32	d	NR	NR	JV	M	C	Lab	PHY	PHY	GPHY	LI	0.880	6.00	Y	0.03329	Y	0.005790	0.880	6.00	10	5	5	10	7	4	8	10	10	4	73
39	15061	Kanisawa and Schroeder, 1969	Sodium arsenate	100	Rat (*Rattus norvegicus*)	1	2	0/5	mg/L	N	na	DLY	U	DR	18	mo	21	d	JV	B	C	Lab	PHY	PHY	BLPR	WO		5.0	N	0.248	N	0.02823		0.569	10	5	5	10	5	4	4	10	10	4	67
40	15174	Carmignani et al, 1985	Sodium arsenite	45.71	Rat (*Rattus norvegicus*)	2	2	0/50	mg/L	Y	na	NR	U	DR	18	mo	NR	NR	NR	M	C	Lab	PHY	PHY	GPHY	WO		50	N	0.50	N	0.05305		2.55	10	5	5	10	5	4	4	10	10	4	67
41	15174	Carmignani et al, 1985	Sodium arsenite	57.69	Rabbit (*Oryctolagus cuniculus*)	3	2	0/50	mg/L	Y	na	NR	U	DR	10	mo	NR	NR	NR	F	C	Lab	PHY	PHY	BLPR	WO		50	N	4.10	N	0.3525		2.61	10	5	5	10	5	4	4	10	10	4	67
42	15174	Carmignani et al, 1985	Sodium arsenite	57.69	Rat (*Rattus norvegicus*)	1	2	0/50	mg/L	Y	na	NR	U	DR	18	mo	NR	NR	NR	M	C	Lab	PHY	PHY	BLPR	WO		50	N	0.50	N	0.05305		3.22	10	5	5	10	5	4	4	10	10	4	67
43	15709	Morrison and Chavez, 1983	Sodium arsenite	100	Pig (*Sus scrofa*)	1	2	0/100	mg/kg diet	N	na	ADL	U	FD	6	w	21	d	JV	B	C	Lab	PHY	PHY	EXCR	WO		100	Y	14.2	Y	0.5100		3.59	10	10	5	10	7	4	4	10	10	4	74
44	4	Brown et al., 1976	sodium arsenate heptahydrate	100	Rat (*Rattus norvegicus*)	1	4	0/4.7/9.4/10.9	mg/kg bw/d	N	na	ADL	U	DR	6	w	NR	NR	JV	M	C	Lab	PHY	PHY	RPRT	KI		4.70	Y	0.444	Y	0.01785		4.70	10	5	5	10	10	4	4	10	6	4	68
45	14546	Nagaraja and Desiraju 1993	Sodium arsenate	100	Rat (*Rattus norvegicus*)	1	2	0/5	mg/kg bw/d	N	na	DLY	U	GV	18	d	2	d	JV	B	C	Lab	PHY	PHY	GPHY	HA		5.0	Y	0.0313	N	0.003984		5.0	10	8	10	10	10	4	4	10	10	4	80
46	15249	Carmignani et al 1983	Sodium arsenite	100	Rat (*Rattus norvegicus*)	1	2	0/50	mg/L	N	na	DLY	U	DR	320	d	NR	NR	JV	M	C	Lab	PHY	PHY	GPHY	HA		50.0	N	0.2670	N	0.03016		5.65	10	5	5	10	5	4	4	10	10	4	67
47	15322	Biswas et al, 1998	Sodium arsenite	57.69	Goat (*Capra hircus*)	1	2	0/25.0	mg/kg bw/d	N	na	ADL	U	DR	6	w	1	yr	JV	F	C	Lab	PHY	PHY	GPHY	BL		25.0	Y	11.0	N	0.8568		14.4	10	5	5	10	10	4	4	10	10	4	72
48	25916	Biswas, et al, 2000	Sodium arsenite	57.69	Goat (*Ovis aries*)	1	2	0/25	mg/kg bw/d	N	na	DLY	U	OR	9	w	12	mo	AD	F	C	Lab	PHY	PHY	RPRT	WO		25.0	Y	21.3	N	0.8490		14.4	10	8	10	10	10	4	4	10	3	4	73
Pathology																																													
49	15160	Hughes and Thompson, 1996	Sodium arsenate heptahydrate	100	Mouse (*Mus musculus*)	1	3	0/0.014/1.4	mg/L	N	na	ADL	U	DR	28	d	96	d	SM	F	C	Lab	PTH	ORW	ORWT	LI	0.0140	1.40	Y	0.0799	Y	0.0049	0.000859	0.0859	10	5	5	10	7	4	6	10	6	4	67
50	14603	Coulson et al, 1935	Arsenic trioxide	100	Rat (*Rattus norvegicus*)	2	2	0/0.21	mg/org/d	N	na	NR	M	FD	52	w	33-35	d	JV	B	C	Lab	PTH	HIS	GHIS	LI	0.210		Y	0.4700	Y	0.01168	0.447		10	10	10	10	7	4	4	1	10	4	69
51	15061	Kanisawa and Schroeder, 1969	Sodium arsenate	100	Rat (*Rattus norvegicus*)	1	2	0/5	mg/L	N	na	DLY	U	DR	42	mo	21	d	JV	B	C	Lab	PTH	HIS	GHIS	KI	5.0		N	0.248	N	0.02823	0.569		10	5	5	10	5	4	4	10	10	4	67
52	15057	Nemec et al, 1998	Arsenic acid	100	Rabbit (*Oryctolagus cuniculus*)	3	4	0/0.19/0.75/3.0	mg/kg bw/d	N	na	DLY	M	GV	7	d	NR	NR	GE	F	C	Lab	PTH	GRS	BDWT	WO	0.75	3.0	Y	4.36	N	0.2303	0.750	3.0	10	8	10	10	10	4	8	10	10	4	84
53	15471	Bencko 1972	Sodium arsenite	100	Mouse (*Mus musculus*)	1	3	0/0.88/6.0	mg/kg bw/d	N	na	NR	U	DR	64	d	NR	NR	JV	M	C	Lab	PTH	ORW	ORWT	SP	0.880	6.00	Y	0.03329	Y	0.005790	0.880	6.00	10	5	5	10	7	4	8	10	10	4	73
54	12934	Obermeyer et al, 1971	Sodium arsenite	100	Rat (*Rattus norvegicus*)	1	2	0/10	mg/kg diet	N	na	ADL	U	FD	4	w	NR	NR	JV	M	C	Lab	PTH	ORW	SMIX	LI	10.0		Y	0.202	N	0.01843	0.913		10	10	5	10	6	4	4	10	10	4	73

Appendix 6.1 Mammalian Toxicity Data Extracted for Wildlife Toxicity Reference Value (TRV)
Arsenic
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Ref			Exposure																							Effects					Conversion to mg/kg bw/day					Result		Data Evaluation Score										
Result #	Ref N.	Reference	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	Exposure Duration	Duration Units	Age	Age Units	Lifestage	Sex	Control Type	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
55	14589	Tice et al 1997	Sodium arsenite	57.69	Mouse (*Mus musculus*)	1	4	0/2.5/5.0/10.0	mg/kg bw/d	N	na	DLY	U	GV	4	d	12	w	JV	M	M	Lab	PTH	HIS	USTR	BL	2.5	5.0	N	0.0316	N	0.004015	1.44	2.88	10	8	10	10	10	4	10	10	10	4	86
56	14583	Neiger and Osweiler 1989	Sodium arsenite	57.69	Dog (*Canis familiaris*)	1	4	0.0/0.88/1.80/2.88	mg/kg bw/d	N	na	DLY	U	FD	8	w	8	mo	JV	F	M	Lab	PTH	ORW	SMIX	LI	2.88		N	10.1	N	0.4597	1.66		10	10	5	10	10	4	4	1	10	4	68
57	14569	Fowler et al., 1977	Sodium arsenate	100	Rat (*Rattus norvegicus*)	1	4	0/20/40/85	mg/L	N	na	ADL	U	DR	6	w	NR	NR	JV	M	C	Lab	PTH	HIS	USTR	LI	20.0	40.0	Y	0.325	N	0.03600	2.22	4.43	10	5	5	10	6	4	10	10	10	4	74
58	15358	Fowler and Woods 1979	Sodium arsenate	100	Mouse (*Mus musculus*)	1	4	0/20/40/85	mg/L	N	na	DLY	U	DR	6	w	NR	NR	JV	M	C	Lab	PTH	HIS	USTR	LI	20.0	40.0	Y	0.0267	N	0.003801	2.84	5.69	10	5	5	10	6	4	10	10	10	4	74
59	2	Byron et al, 1967	Sodium arsenite	100	Rat (*Rattus norvegicus*)	1	6	0/15.63/31.25/62.5/125/250	mg/kg diet	N	na	NR	U	FD	2	yr	NR	NR	JV	B	C	Lab	PTH	HIS	GHIS	LI	62.5	125	Y	0.4728	N	0.03711	4.91	9.81	10	10	5	10	6	4	10	10	10	4	79
60	2	Byron et al, 1967	Sodium arsenate heptahydrate	100	Rat (*Rattus norvegicus*)	2	6	0/31.25/62.5/125/250/400	mg/kg diet	N	na	NR	U	FD	2	yr	NR	NR	JV	B	C	Lab	PTH	HIS	GHIS	LI	125	250	Y	0.4652	N	0.03662	9.84	19.7	10	10	5	10	6	4	10	10	10	4	79
61	15057	Nemec et al, 1998	Arsenic acid	100	Mouse (*Mus musculus*)	1	4	0/7.5/24/48	mg/kg bw/d	N	na	DLY	M	GV	6	d	NR	NR	GE	F	C	Lab	PTH	GRS	BDWT	WO	24.0	48.0	Y	0.0527	N	0.006113	24.0	48.0	10	8	10	10	10	4	10	10	10	4	86
62	15530	Garcia-Vargas et al, 1995	Sodium arsenite	100	Mouse (*Mus musculus*)	1	2	0/20	mg/L	Y	na	ADL	U	DR	6	w	NR	NR	JV	M	C	Lab	PTH	ORW	SMIX	LI	20.0		Y	0.0300	Y	0.0350	24.6		10	5	5	10	7	4	4	10	10	4	69
63	15530	Garcia-Vargas et al, 1995	Sodium arsenate	100	Mouse (*Mus musculus*)	2	2	0/50	mg/L	Y		ADL	U	DR	6	w	NR	NR	JV	M	C	Lab	PTH	ORW	SMIX	LI	50.0		Y	0.0300	Y	0.0240	42.1		10	5	5	10	7	4	4	10	10	4	69
64	113	Seidenberg et al 1986	Sodium arsenate	45.71	Mouse (*Mus musculus*)	1	2	0/95	mg/kg bw/d	N		DLY	U	GV	5	d	NR	NR	GE	F	C	Lab	PTH	GRS	BDWT	WO	95.0		Y	0.043	N	0.00517	43.4		10	8	10	10	10	4	4	8	10	4	78
65	14543	Healy et al., 1998	Sodium arsenate heptahydrate	100	Mouse (*Mus musculus*)	2	3	0/6.5/750	ug/kg bw/d	N	na	ADL	U	DR	91	d	76	d	JV	M	C	Lab	PTH	ORW	ORWT	LI		6.50	N	0.0316	Y	na		0.00650	10	5	5	10	6	4	4	10	10	4	68
66	14543	Healy et al., 1998	Sodium arsenate heptahydrate	100	Mouse (*Mus musculus*)	1	3	0/8.5/827	ug/kg bw/d	N	na	ADL	U	DR	32	d	76	d	JV	M	C	Lab	PTH	ORW	ORWT	KI		8.5	N	0.0316	Y	na		0.0085	10	5	5	10	6	4	4	10	10	4	68
67	7	Schroeder et al, 1968	Sodium arsenite	100	Rat (*Rattus norvegicus*)	1	2	0/5	mg/L	N		ADL	U	DR	1575	d	21-23	d	JV	M	C	Lab	PTH	ORW	SMIX	HE		5.0	Y	0.4790	N	0.05104		0.533	10	5	5	10	6	4	4	10	10	4	68
68	14580	Mahaffey et al., 1977	Sodium arsenite	100	Rat (*Rattus norvegicus*)	1	2	0/50	mg/kg diet	N		ADL	UX	FD	10	w	NR	NR	AD	M	C	Lab	PTH	GRS	BDWT	WO		50.0	N	0.523	Y	0.01568		1.50	10	10	10	10	6	4	4	10	3	4	71
69	15011	Ghosh et al 1999	Sodium arsenite	57.69	Rat (*Rattus norvegicus*)	1	3	0/0.2/0.4	mg/org/d	N	na	DLY	U	GV	28	d	35	d	JV	F	C	Lab	PTH	ORW	SMIX	AR		0.200	Y	0.056	N	0.006426		2.06	10	8	10	10	6	4	4	10	10	4	76
70	4	Brown et al., 1976	sodium arsenate heptahydrate	100	Rat (*Rattus norvegicus*)	1	4	0/4.7/9.4/10.9	mg/kg bw/d	N	na	ADL	U	DR	6	w	NR	NR	JV	M	C	Lab	PTH	ORW	SMIX	KI		4.70	N	0.444	Y	0.01785		4.70	10	5	5	10	10	4	4	10	6	4	68
71	15216	Nagaraja and Desiraju, 1994	Sodium arsenate	100	Rat (*Rattus norvegicus*)	1	2	0/5	mg/kg bw/d	N	na	DLY	U	GV	20	d	2	d	JV	B	C	Lab	PTH	ORW	ORWT	BR		5.0	Y	0.050	N	0.005855		5.0	10	8	10	10	10	4	4	10	10	4	80
72	14546	Nagaraja and Desiraju 1993	Arsenic	100	Rat (*Rattus norvegicus*)	2	2	0/5	mg/kg bw/d	N	na	DLY	U	FD	90	d	90	d	JV	NR	C	Lab	PTH	ORW	ORWT	BR		5.0	Y	0.2152	N	0.01943		5.0	10	10	5	4	10	4	4	10	10	4	71
73	14546	Nagaraja and Desiraju 1993	Sodium arsenate	100	Rat (*Rattus norvegicus*)	1	2	0/5	mg/kg bw/d	N	na	DLY	U	GV	18	d	2	d	JV	B	C	Lab	PTH	ORW	ORWT	BR		5.0	Y	0.0313	N	0.003984		5.0	10	8	10	10	10	4	4	10	10	4	80
74	15216	Nagaraja and Desiraju, 1994	Sodium arsenate	100	Rat (*Rattus norvegicus*)	2	2	0/5	mg/kg bw/d	N	na	DLY	U	FD	90	d	90	d	JV	B	C	Lab	PTH	ORW	ORWT	BR		5.0	Y	0.250	N	0.02198		5.0	10	10	5	10	6	4	4	10	10	4	73
75	15249	Carmignani et al 1983	Sodium arsenate	100	Rat (*Rattus norvegicus*)	1	2	0/50	mg/L	N		DLY	U	DR	320	d	NR	NR	JV	M	C	Lab	PTH	HIS	GHIS	KI		50.0	N	0.2670	N	0.03016		5.65	10	5	5	10	5	4	4	10	10	4	67
Reproduction																																															
76	14556	Savabieasfahani et al, 1998	Sodium arsenite	57.69	Cotton rat (*Sigmodon hispidus*)	1	3	0/0.088/0.15	mg/org/d	N		ADL	U	DR	6	w	NR	NR	AD	M	C	Lab	REP	REP	TEWT	TE	0.150		N	0.144	Y	0.01530	0.601		10	5	5	10	6	10	4	10	6	4	70
77	15057	Nemec et al, 1998	Arsenic acid	100	Rabbit (*Oryctolagus cuniculus*)	3	4	0/0.19/0.75/3.0	mg/kg bw/d	N	na	DLY	M	GV	12	d	NR	NR	GE	F	C	Lab	REP	REP	RSEM	WO	0.750	3.0	Y	4.355	N	0.2303	0.750	3.0	10	8	10	10	10	10	10	10	10	4	92
78	15125	Morris et al, 1938	Arsenic trioxide	100	Rat (*Rattus norvegicus*)	1	3	0/450/4100	ug/org/d	N		ADL	U	FD	340	d	26-27	d	JV	M	C	Lab	REP	REP	PRWT	WO	4100		Y	0.549	N	0.01905	7.47		10	10	5	10	7	10	4	1	10	4	71
79	15057	Nemec et al, 1998	Arsenic acid	100	Mouse (*Mus musculus*)	1	4	0/7.5/24/48	mg/kg bw/d	N	na	DLY	M	GV	9	d	NR	NR	GE	F	C	Lab	REP	REP	PROG	WO	24.0	48.0	Y	0.0549	N	0.006322	24.0	48.0	10	8	10	10	10	10	8	10	10	4	92
80	14543	Healy et al., 1998	Sodium arsenate heptahydrate	100	Mouse (*Mus musculus*)	2	3	0/6.5/750	ug/kg bw/d	N	na	ADL	U	DR	91	d	76	d	JV	M	C	Lab	REP	REP	TEWT	TE		6.50	N	0.0316	Y	na		0.00650	10	5	5	10	6	10	4	10	10	4	74
81	66	Schroeder and Mitchener, 1971	Arsenite	75.74	Mouse (*Mus musculus*)	1	2	0/5	mg/L	N		ADL	U	DR	6	mo	21	d	JV	F	C	Lab	REP	REP	PROG	WO		5.0	N	0.0225	N	0.003255		0.548	10	5	5	4	5	10	4	10	10	4	67
82	15167	Skalnaya et al, 1996	Sodium arsenite	56.6	Mouse (*Mus musculus*)	1	2	0/10	mg/kg bw/d	N		DLY	U	OR	30	d	NR	NR	GE	F	C	Lab	REP	REP	PRWT	WO		10.0	N	0.0288	N	0.003715		5.66	10	8	5	10	10	4	10	10	4	81
83	113	Seidenberg et al 1986	Sodium arsenate	45.71	Mouse (*Mus musculus*)	1	2	0/95	mg/kg bw/d	N		DLY	U	GV	5	d	NR	NR	GE	F	C	Lab	REP	REP	PROG	WO		95.0	Y	0.043	N	0.00517		43.4	10	8	10	10	10	10	4	10	10	4	86
Growth																																															
84	15160	Hughes and Thompson, 1996	Sodium arsenate heptahydrate	100	Mouse (*Mus musculus*)	1	3	0/0.014/1.4	mg/L	N		ADL	U	DR	28	d	96	d	SM	F	C	Lab	GRO	GRO	BDWT	WO	1.40		Y	0.0799	Y	0.0049	0.0859		10	5	5	10	7	8	4	10	6	4	69
85	14603	Coulson et al, 1935	Arsenic trioxide	100	Rat (*Rattus norvegicus*)	2	2	0/0.21	mg/org/d	N		NR	M	FD	52	w	33-35	d	JV	B	C	Lab	GRO	GRO	BDWT	WO	0.210		Y	0.4700	Y	0.01168	0.447		10	10	10	10	7	8	4	1	10	4	74
86	3701	Kanisawa and Schroeder, 1969	Sodium arsenite	100	Rat (*Rattus norvegicus*)	1	2	0/5	mg/L	N		ADL	U	DR	519	d	21	d	JV	B	C	Lab	GRO	GRO	BDWT	WO	5.0		Y	0.479	N	0.05104	0.533		10	5	5	10	6	8	4	10	10	4	72
87	7	Schroeder et al, 1968	Sodium arsenite	100	Rat (*Rattus norvegicus*)	1	2	0/5	mg/L	N		ADL	U	DR	69	d	21-23	d	JV	B	C	Lab	GRO	GRO	BDWT	WO	5.0		Y	0.4790	N	0.0280	0.571		10	5	5	10	6	8	4	10	10	4	72
88	12934	Obermeyer et al, 1971	Sodium arsenite	100	Rat (*Rattus norvegicus*)	1	2	0/10	mg/kg diet	N		ADL	U	FD	4	w	NR	NR	JV	NR	C	Lab	GRO	GRO	BDWT	WO	10.0		Y	0.202	N	0.01843	0.913		10	10	5	10	6	8	4	10	10	4	77
89	14583	Neiger and Osweiler 1989	Sodium arsenite	57.69	Dog (*Canis familiaris*)	1	4	0.0/0.88/1.80/2.88	mg/kg bw/d	N	na	DLY	U	FD	8	w	8	mo	JV	F	M	Lab	GRO	GRO	BDWT	WO	1.80	2.88	N	10.1	N	0.4597	1.04	1.66	10	10	5	10	10	8	10	10	10	4	87
90	15262	Palmer et al 1983	Sodium arsenite	100	Rat (*Rattus norvegicus*)	1	2	0/16	ug/g diet	N	na	ADL	U	FD	4	w	NR	NR	JV	M	V	Lab	GRO	GRO	BDWT	WO	16.0		Y	0.2652	N	0.02308	1.39		10	10	5	10	6	8	4	1	10	4	68
91	15262	Palmer et al 1983	Sodium arsenite	100	Rat (*Rattus norvegicus*)	2	2	0/20	ug/g diet	N	na	ADL	U	FD	8	w	NR	NR	JV	M	V	Lab	GRO	GRO	BDWT	WO	20.0		Y	0.3624	N	0.02983	1.65		10	10	5	10	6	8	4	1	10	4	68
92	14508	Franke and Moxon 1937	Sodium arsenate	100	Rat (*Rattus norvegicus*)	1	2	0/1.88	mg/kg bw/d	N		DLY	U	FD	100	d	28	d	JV	M	C	Lab	GRO	GRO	BDWT	WO	1.88		Y	0.2874	Y	0.01296	1.88		10	10	5	10	10	8	4	1	10	4	72
93	2	Byron et al, 1967	Sodium arsenite	100	Dog (*Canis familiaris*)	3	5	0/5/25/50/125	mg/kg diet	N	na	NR	U	FD	2	yr	6	mo	JV	B	C	Lab	GRO	GRO	BDWT	WO	50.0	125	N	10.8	N	0.4858	2.25	5.62	10	10	5	10	5	8	10	10	10	4	82
94	15264	Schmolke et al 1992	Sodium arsenite	100	Rat (*Rattus norvegicus*)	1	3	0/15/30	mg/kg diet	N		DLY	U	FD	15	w	7	w	JV	F	M	Lab	GRO	GRO	BDWT	WO	30.0		Y	0.3250	N	0.02727	2.52		10	10	5	10	6	8	4	1	10	4	68
95	15358	Fowler and Woods 1979	Sodium arsenate	100	Mouse (*Mus musculus*)	1	4	0/20/40/85	mg/L	N		DLY	U	DR	6	w	NR	NR	JV	M	C	Lab	GRO	GRO	BDWT	WO	20.0	40.0	Y	0.0267	N	0.003801	2.84	5.69	10	5	5	10	6	8	10	10	10	4	78
96	14508	Franke and Moxon 1937	Sodium arsenate	100	Rat (*Rattus norvegicus*)	2	2	0/3.22	mg/kg bw/d	N		DLY	U	FD	100	d	28	d	JV	M	C	Lab	GRO	GRO	BDWT	WO	3.22		Y	0.2635	Y	0.01109	3.22		10	10	5	10	10	8	4	1	10	4	72
97	15011	Ghosh et al 1999	Sodium arsenite	57.69	Rat (*Rattus norvegicus*)	1	3	0/0.2/0.4	mg/org/d	N	na	DLY	U	GV	28	d	35	d	JV	F	C	Lab	GRO	GRO	BDWT	WO	0.400		Y	0.061	N	0.006894	3.78		10	8	10	10	6	8	4	3	10	4	73
98	14569	Fowler et al., 1977	Sodium arsenite	100	Rat (*Rattus norvegicus*)	1	4	0/20/40/85	mg/L	N	na	ADL	U	DR	6	w	NR	NR	JV	M	C	Lab	GRO	GRO	BDWT	WO	40.0	85.0	Y	0.325	N	0.03600	4.43	9.42	10	5	5	10	6	8	10	10	10	4	78
99	15007	Hunder et al, 1999	Sodium arsenite	100	Rat (*Rattus norvegicus*)	1	4	0/10/30/60	mg/kg diet	N		ADL	U	FD	3	w	NR	NR	JV	F	C	Lab	GRO	GRO	BDWT	WO	60.0		Y	0.193	N	0.01777	5.52		10	10	5	10	6	8	4	1	10	4	68
100	15471	Bencko 1972	Sodium arsenite	100	Mouse (*Mus musculus*)	1	3	0/0.88/6.0	mg/kg bw/d	N	na	NR	U	DR	64	d	NR	NR	JV	M	C	Lab	GRO	GRO	BDWT	WO	6.000		Y	0.03329	Y	0.005790	6.00		10	5	5	10	7	8	4	10	10	4	73
101	15288	Benese and Bencko, 1981	Sodium arsenite	100	Mouse (*Mus musculus*)	1	4	0/4.945/49.45/249.4	mg/L	N		NR	U	DR	32	d	NR	NR	JV	M	C	Lab	GRO	GRO	BDWT	WO	49.5	249	Y	0.0325	Y	0.004225	6.43	32.4	10	5	5	10	7	8	8	10	10	4	77
102	15125	Morris et al, 1938	Arsenic trioxide	100	Rat (*Rattus norvegicus*)	1	3	0/450/4100	ug/org/d	N		ADL	U	FD	340	d	26-27	d	JV	M	C	Lab	GRO	GRO	BDWT	WO	4100		Y	0.549	N	0.01905	7.47		10	10	5	10	7	8	4	1	10	4	69
103	15007	Hunder et al, 1999	Sodium arsenite	100	Mouse (*Mus musculus*)	2	4	0/10/30/60	mg/kg diet	N		ADL	U	FD	3	w	NR	NR	JV	F	C	Lab	GRO	GRO	BDWT	WO	60.0		Y	0.030	N	0.003847	7.69		10	10	5	10	6	8	4	1	10	4	68
104	4	Brown et al., 1976	sodium arsenate heptahydrate	100	Rat (*Rattus norvegicus*)	1	4	0/4.7/9.4/10.9	mg/kg bw/d	N	na	ADL	U	DR	6	w	NR	NR	JV	M	C	Lab	GRO	GRO	BDWT	WO	9.40	10.7	Y	0.423	Y	0.01785	9.40	10.7	10	5	5	10	10	8	10	10	6	4	78
105	2	Byron et al, 1967	Sodium arsenate heptahydrate	100	Rat (*Rattus norvegicus*)	2	6	0/31.25/62.5/125/250/400	mg/kg diet	N	na	NR	U	FD	12	w	NR	NR	JV	B	C	Lab	GRO	GRO	BDWT	WO	125	250	Y	0.4652	N	0.03662	9.84	19.7	10	10	5	10	6	8	10	10	10	4	83
106	2	Byron et al, 1967	Sodium arsenite	100	Rat (*Rattus norvegicus*)	1	6	0/15.63/31.25/62.5/125/250	mg/kg diet	N	na	NR	U	FD	12	w	NR	NR	JV	M	C	Lab	GRO	GRO	BDWT	WO	125	250	Y	0.358	N	0.02952	10.3	20.6	10	10	5	10	6	8	10	10	10	4	83
107	20979	Kanisawa and Schroeder, 1967	Sodium arsenite	100	Mouse (*Mus musculus*)	1	2	0/5	mg/L	N		NR	U	DR	338	d	20-22	d	JV	M	C	Lab	GRO	GRO	BDWT	WO		5.0	Y	0.0536	N	0.007110		0.663	10	5	5	10	6	8	4	10	10	4	72
108	3084	Schroeder and Balassa, 1967	Sodium arsenite	100	Mouse (*Mus musculus*)	1	2	0/5	mg/L	N		ADL	U	DR	339	d	21	d	JV	B	C	Lab	GRO	GRO	BDWT	WO		5.0	Y	0.052	N	0.069189		0.665	10	5	5	10	6	8	4	10	10	4	72
109	15007	Hunder et al, 1999	Sodium arsenite	100	Guinea pig (*Cavia porcellus*)	3	4	0/10/30/60	mg/kg diet	N		ADL	U	FD	3	w	NR	NR	JV	F	C	Lab	GRO	GRO	BDWT	WO		10.0	Y	0.305	N	0.02589		0.844	10	10	5	10	6	8	4	10	10	4	77
110	15216	Nagaraja and Desiraju, 1994	Sodium arsenate	100	Rat (*Rattus norvegicus*)	1	2	0/5	mg/kg bw/d	N	na	DLY	U	GV	20	d	2	d	JV	B	C	Lab	GRO	GRO	BDWT	WO		5.0	Y	0.050	N	0.005855		5.0	10	8	10	10	10	8	4	10	10	4	84

Appendix 6.1 Mammalian Toxicity Data Extracted for Wildlife Toxicity Reference Value (TRV)
Arsenic
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Ref			Exposure																									Effects					Conversion to mg/kg bw/day					Result		Data Evaluation Score										
Result #	Ref N.	Reference	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	Exposure Duration	Duration Units	Age	Age Units	Lifestage	Sex	Control Type	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
111	14546	Nagaraja and Desiraju 1993	Arsenic	100	Rat (*Rattus norvegicus*)	2	2	0/5	mg/kg bw/d	N	na	DLY	U	FD	90	d	90	d	JV	NR	C	Lab	GRO	GRO	BDWT	WO		5.0	Y	0.2152	N	0.01943		5.0	10	10	5	4	10	8	4	10	10	4	75
112	14546	Nagaraja and Desiraju 1993	Sodium arsenate	100	Rat (*Rattus norvegicus*)	1	2	0/5	mg/kg bw/d	N	na	DLY	U	GV	18	d	2	d	JV	B	C	Lab	GRO	GRO	BDWT	WO		5.0	Y	0.0313	N	0.003984		5.0	10	8	10	10	10	8	4	10	10	4	84
113	15427	Kiyono et al, 1974	Arsenic trioxide	100	Rat (*Rattus norvegicus*)	1	4	0/5.0/7.5/10.0	mg/kg bw/d	N		DLY	U	GV	10	d	1	d	JV	M	C	Lab	GRO	GRO	BDWT	WO		5.0	Y	0.025	N	0.003312		5.0	10	8	10	10	10	8	4	10	10	4	84
114	15216	Nagaraja and Desiraju, 1994	Sodium arsenate	100	Rat (*Rattus norvegicus*)	2	2	0/5	mg/kg bw/d	N	na	DLY	U	FD	90	d	90	d	JV	B	C	Lab	GRO	GRO	BDWT	WO		5.0	Y	0.250	N	0.02198		5.0	10	10	5	10	6	8	4	10	10	4	77
115	11361	Glattre et. al., 1995	Sodium arsenate heptahydrate	100	Rat (*Rattus norvegicus*)	1	2	0/6.36	mg/kg bw/d	N	na	ADL	U	DR	4	w	NR	NR	JV	M	C	Lab	GRO	GRO	BDWT	WO		6.36	Y	0.290	N	0.03249		6.36	10	5	5	10	10	8	4	10	10	4	76
116	15709	Morrison and Chavez, 1983	Sodium arsenite	100	Pig (*Sus scrofa*)	1	2	0/100	mg/kg diet	N	na	ADL	U	FD	2	w	21	d	JV	B	C	Lab	GRO	GRO	BDWT	WO		100	Y	5.40	Y	0.5100		9.44	10	10	5	10	7	8	4	10	10	4	78
117	15322	Biswas et al, 1998	Sodium arsenite	57.69	Goat (*Capra hircus*)	1	2	0/25.0	mg/kg bw/d	N	na	ADL	U	DR	9	w	1	yr	JV	F	C	Lab	GRO	GRO	BDWT	WO		25.0	Y	19.6	N	1.441		14.4	10	5	5	10	10	8	4	10	10	4	76
118	25916	Biswas, et al, 2000	Sodium arsenite	57.69	Goat (*Ovis aries*)	1	2	0/25	mg/kg bw/d	N		DLY	U	OR	9	w	12	mo	AD	F	C	Lab	GRO	GRO	BDWT	WO		25.0	Y	21.3	N	0.8490		14.4	10	8	10	10	10	8	4	10	3	4	77
Survival																																																
119	7	Schroeder et al, 1968	Sodium arsenite	100	Rat (*Rattus norvegicus*)	1	2	0/5	mg/L	N		ADL	U	DR	1575	d	21-23	d	JV	B	C	Lab	MOR	MOR	SURV	WO	5.0		Y	0.4790	N	0.05104	0.533		10	5	5	10	6	9	4	10	10	4	73
120	15057	Nemec et al, 1998	Arsenic acid	100	Rabbit (*Oryctolagus cuniculus*)	3	4	0/0.19/0.75/3.0	mg/kg bw/d	N	na	DLY	M	GV	12	d	NR	NR	GE	F	C	Lab	MOR	MOR	MORT	WO	0.750	3.0	Y	4.36	N	0.2303	0.750	3.00	10	8	10	10	10	9	8	10	10	4	89
121	15262	Palmer et al 1983	Sodium arsenite	100	Rat (*Rattus norvegicus*)	1	2	0/16	ug/g diet	N	na	ADL	U	FD	4	w	NR	NR	JV	M	V	Lab	MOR	MOR	MORT	WO	16.0		Y	0.2652	N	0.02308	1.39		10	10	5	10	6	9	4	10	10	4	78
122	15262	Palmer et al 1983	Sodium arsenite	100	Rat (*Rattus norvegicus*)	2	2	0/20	ug/g diet	N	na	ADL	U	FD	8	w	NR	NR	JV	M	V	Lab	MOR	MOR	SURV	WO	20.0		Y	0.3624	N	0.02983	1.65		10	10	5	10	6	9	4	1	10	4	69
123	14508	Franke and Moxon 1937	Sodium arsenate	100	Rat (*Rattus norvegicus*)	1	2	0/1.88	mg/kg bw/d	N		DLY	U	FD	100	d	28	d	JV	M	C	Lab	MOR	MOR	MORT	WO	1.88		Y	0.2874	Y	0.01296	1.88		10	10	5	10	10	9	4	10	10	4	82
124	2	Byron et al, 1967	Sodium arsenate heptahydrate	100	Dog (*Canis familiaris*)	4	5	0/5/25/50/125	mg/kg diet	N	na	NR	U	FD	13.5	mo	6	mo	JV	B	C	Lab	MOR	MOR	MORT	WO	50.0	125	N	10.8	N	0.4858	2.25	5.62	10	10	5	10	5	9	10	10	10	4	83
125	2	Byron et al, 1967	Sodium arsenite	100	Dog (*Canis familiaris*)	3	5	0/5/25/50/125	mg/kg diet	N	na	NR	U	FD	2	yr	6	mo	JV	B	C	Lab	MOR	MOR	MORT	WO	50.0	125	N	10.8	N	0.4858	2.25	5.62	10	10	5	10	5	9	10	10	10	4	83
126	15057	Nemec et al, 1998	Arsenic acid	100	Rabbit (*Oryctolagus cuniculus*)	2	6	0/0.75/2.25/4.5/6.75/9.0	mg/kg bw/d	N	na	DLY	M	GV	12	d	NR	NR	GE	F	C	Lab	MOR	MOR	MORT	WO	2.25	4.50	N	4.10	N	0.2191	2.25	4.50	10	8	10	10	10	9	10	10	10	4	91
127	14508	Franke and Moxon 1937	Sodium arsenate	100	Rat (*Rattus norvegicus*)	2	2	0/3.22	mg/kg bw/d	N		DLY	U	FD	100	d	28	d	JV	M	C	Lab	MOR	MOR	MORT	WO	3.22		Y	0.2635	Y	0.01109	3.22		10	10	5	10	10	9	4	1	10	4	73
128	15427	Kiyono et al, 1974	Arsenic trioxide	100	Rat (*Rattus norvegicus*)	1	4	0/5.0/7.5/10.0	mg/kg bw/d	N		DLY	U	GV	10	d	1	d	JV	M	C	Lab	MOR	MOR	MORT	WO	5.0	7.5	Y	0.025	N	0.003312	5.00	7.5	10	8	10	10	10	9	10	10	10	4	91
129	1244	Cabe, et al., 1979	Sodium arsenate	100	Rat (*Rattus norvegicus*)	1	2	0/50	mg/L	N		ADL	U	DR	18	w	50	d	JV	M	C	Lab	MOR	MOR	MORT	WO	50.0		Y	0.200	N	0.02326	5.81		10	5	5	10	6	9	4	10	10	4	73
130	14569	Fowler et al., 1977	Sodium arsenate	100	Rat (*Rattus norvegicus*)	1	4	0/20/40/85	mg/L	N	na	ADL	U	DR	6	w	NR	NR	JV	M	C	Lab	MOR	MOR	MORT	WO	85.0		Y	0.260	N	0.02945	9.63		10	5	5	10	6	9	4	10	10	4	73
131	2	Byron et al, 1967	Sodium arsenate heptahydrate	100	Rat (*Rattus norvegicus*)	2	6	0/31.25/62.5/125/250/400	mg/kg diet	N	na	NR	U	FD	78	w	NR	NR	JV	B	C	Lab	MOR	MOR	SURV	WO	125	250	Y	0.5206	N	0.04017	9.65	19.3	10	10	5	10	6	9	10	10	10	4	84
132	2	Byron et al, 1967	Sodium arsenite	100	Rat (*Rattus norvegicus*)	1	6	0/15.63/31.25/62.5/125/250	mg/kg diet	N	na	NR	U	FD	2	yr	NR	NR	JV	B	C	Lab	MOR	MOR	SURV	WO	125	250	Y	0.4279	N	0.03419	9.99	20.0	10	10	5	10	6	9	10	10	10	4	84
133	15057	Nemec et al, 1998	Arsenic acid	100	Mouse (*Mus musculus*)	1	4	0/7.5/24/48	mg/kg bw/d	N	na	DLY	M	GV	9	d	NR	NR	GE	F	C	Lab	MOR	MOR	MORT	WO	24.0	48.0	Y	0.0527	N	0.006113	24.0	48.0	10	8	10	10	10	9	10	10	10	4	91
134	14590	Tripathi et al 1997	Sodium arsenite	100	Rat (*Rattus norvegicus*)	1	2	0/2.56	mg/org/d	N		ADL	U	DR	16	w	NR	NR	JV	M	C	Lab	MOR	MOR	MORT	WO	2.56		Y	0.080	Y	0.01020	32.0		10	5	5	10	7	9	4	10	10	4	74
135	3084	Schroeder and Balassa, 1967	Sodium arsenite	100	Mouse (*Mus musculus*)	1	2	0/5	mg/L	N		ADL	U	DR	519	d	21	d	JV	M	C	Lab	MOR	MOR	SURV	WO		5.0	Y	0.045	N	0.006075		0.675	10	5	5	10	6	9	4	10	10	4	73
136	15322	Biswas et al, 1998	Sodium arsenite	57.69	Goat (*Capra hircus*)	1	2	0/25.0	mg/kg bw/d	N	na	ADL	U	DR	78	d	1	yr	JV	F	C	Lab	MOR	MOR	MORT	WO		25.0	Y	19.6	N	1.441		14.4	10	5	5	10	10	9	4	10	10	4	77
137	25916	Biswas, et al, 2000	Sodium arsenite	57.69	Goat (*Ovis aries*)	1	2	0/25	mg/kg bw/d	N		DLY	U	OR	12	w	12	mo	AD	F	C	Lab	MOR	MOR	MORT	WO		25.0	Y	20.1	N	0.8094		14.4	10	8	10	10	10	9	4	10	3	4	78
138	113	Seidenberg et al 1986	Sodium arsenate	45.71	Mouse (*Mus musculus*)	1	2	0/95	mg/kg bw/d	N		DLY	U	GV	5	d	NR	NR	GE	F	C	Lab	MOR	MOR	MORT	WO		95.0	Y	0.043	N	0.00517		43.4	10	8	10	10	10	9	4	10	10	4	85
Data Not Used to Derive TRV																																																
139	15160	Hughes and Thompson, 1996	Sodium arsenate heptahydrate	100	Mouse (*Mus musculus*)	1	3	0/0.014/1.4	mg/L	N		ADL	U	DR	28	d	96	d	SM	F	C	Lab	BEH	FDB	WCON	WO	1.40		Y	0.0799	Y	0.0049	0.0859		10	5	5	10	7	4	4	10	6	4	65
140	3701	Kanisawa and Schroeder, 1969	Sodium arsenite	100	Rat (*Rattus norvegicus*)	1	2	0/5	mg/L	N		ADL	U	DR	1175	d	21	d	JV	B	C	Lab	MOR	MOR	TDTH	WO	5.0		Y	0.479	N	0.05104	0.533		10	5	5	10	6	9	4	1	10	4	64
141	757	Mercado and Bibby 1973	Arsenic pentoxide	100	Rat (*Rattus norvegicus*)	1	2	0/5	mg/L	N		ADL	U	DR	50	d	23	d	JV	M	C	Lab	PHY	PHY	GPHY	XX	5.0		N	0.2670	N	0.03016	0.565		10	5	5	10	5	4	4	1	10	4	58
142	757	Mercado and Bibby 1973	Arsenic pentoxide	100	Rat (*Rattus norvegicus*)	1	2	0/5	mg/L	N		ADL	U	DR	50	d	23	d	JV	M	C	Lab	GRO	GRO	BDWT	WO	5.0		N	0.2670	N	0.03016	0.565		10	5	5	10	5	8	4	1	10	4	62
143	14556	Savabieasfahani et al, 1998	Sodium arsenite	57.69	Cotton rat (*Sigmodon hispidus*)	1	3	0/0.088/0.15	mg/org/d	N		ADL	U	DR	6	w	NR	NR	AD	M	C	Lab	BIO	CHM	HMGL	BL	0.150		Y	0.144	Y	0.01530	0.601		10	5	5	10	7	1	4	10	6	4	62
144	14556	Savabieasfahani et al, 1998	Sodium arsenite	57.69	Cotton rat (*Sigmodon hispidus*)	1	3	0/0.088/0.15	mg/org/d	N		ADL	U	DR	6	w	NR	NR	AD	M	C	Lab	GRO	GRO	BDWT	WO	0.150		Y	0.144	Y	0.01530	0.601		10	5	5	10	7	8	4	1	6	4	60
145	14556	Savabieasfahani et al, 1998	Sodium arsenite	57.69	Cotton rat (*Sigmodon hispidus*)	1	3	0/0.088/0.15	mg/org/d	N		ADL	U	DR	6	w	NR	NR	AD	M	C	Lab	PTH	ORW	ORWT	LI	0.150		Y	0.144	Y	0.01530	0.601		10	5	5	10	7	4	4	8	6	4	63
146	20979	Kanisawa and Schroeder, 1967	Sodium arsenite	100	Mouse (*Mus musculus*)	1	2	0/5	mg/L	N		NR	U	DR	24	mo	20-22	d	JV	B	C	Lab	MOR	MOR	MORT	WO	5.0		Y	0.0536	N	0.007110	0.663		10	5	5	10	6	9	4	1	10	4	64
147	20979	Kanisawa and Schroeder, 1967	Sodium arsenite	100	Mouse (*Mus musculus*)	1	2	0/5	mg/L	N		NR	U	DR	518	d	20-22	d	JV	B	C	Lab	PTH	HIS	GHIS	MT	5.0		Y	0.0536	N	0.007110	0.672		10	5	5	10	6	4	4	1	10	4	59
148	14543	Healy et al., 1998	Sodium arsenate heptahydrate	100	Mouse (*Mus musculus*)	2	3	0/8.5/827	ug/kg bw/d	N	na	ADL	U	DR	32	d	76	d	JV	M	C	Lab	GRO	GRO	BDWT	WO	750		N	0.0316	Y	na	0.750		10	5	5	10	6	8	4	1	10	4	63
149	14543	Healy et al., 1998	Sodium arsenate heptahydrate	100	Mouse (*Mus musculus*)	1	3	0/8.5/827	ug/kg bw/d	N	na	ADL	U	DR	32	d	76	d	JV	M	C	Lab	BEH	FDB	WCON	WO	827		N	0.0316	Y	na	0.827		10	5	5	10	6	4	4	1	10	4	59
150	14543	Healy et al., 1998	Sodium arsenate heptahydrate	100	Mouse (*Mus musculus*)	1	3	0/8.5/827	ug/kg bw/d	N	na	ADL	U	DR	32	d	76	d	JV	M	C	Lab	GRO	GRO	BDWT	WO	827		N	0.0316	Y	na	0.827		10	5	5	10	6	8	4	1	10	4	63
151	14598	Blakley et al., 1980	sodium arsenite	57.69	Mouse (*Mus musculus*)	1	4	0/0.5/2.0/10.0	mg/L	N	na	NR	U	DR	3	w	6	w	AD	M	C	Lab	BEH	FDB	WCON	WO	10.0		Y	0.02857	Y	0.00437	0.882		10	5	5	10	7	4	4	1	6	4	56
152	14598	Blakley et al., 1980	sodium arsenite	57.69	Mouse (*Mus musculus*)	1	4	0/0.5/2.0/10.0	mg/L	N		NR	U	DR	3	w	6	w	JV	M	C	Lab	GRO	GRO	BDWT	WO	10.0		Y	0.02857	Y	0.00437	0.882		10	5	5	10	7	8	4	6	6	4	65
153	15262	Palmer et al 1983	Sodium arsenite	100	Rat (*Rattus norvegicus*)	1	2	0/16	ug/g diet	N	na	ADL	U	FD	4	w	NR	NR	JV	M	V	Lab	PTH	ORW	ORWT	KI	16.0		Y	0.2652	N	0.02308	1.39		10	10	5	10	6	4	4	1	10	4	64
154	15262	Palmer et al 1983	Sodium arsenite	100	Rat (*Rattus norvegicus*)	2	2	0/20	ug/g diet	N	na	ADL	U	FD	8	w	NR	NR	JV	M	V	Lab	PTH	ORW	ORWT	KI	20.0		Y	0.3624	N	0.02983	1.65		10	10	5	10	6	4	4	1	10	4	64
155	14508	Franke and Moxon 1937	Sodium arsenate	100	Rat (*Rattus norvegicus*)	1	2	0/1.88	mg/kg bw/d	N		DLY	U	FD	100	d	28	d	JV	M	C	Lab	BIO	CHM	HMGL	BL	1.88		Y	0.2874	Y	0.01296	1.88		10	10	5	10	10	1	4	1	10	4	65
156	14414	Morgareidge, 1963	Arsenic trioxide	100	Rat (*Rattus norvegicus*)	2	2	0/16	mg/kg diet	N		DLY	U	FD	4	w	NR	NR	JV	B	C	Lab	BEH	FDB	FCNS	WO	16.0		Y	0.1810	Y	0.02310	2.04		10	10	5	10	7	4	4	1	3	4	58
157	14414	Morgareidge, 1963	Arsenic trioxide	100	Rat (*Rattus norvegicus*)	2	2	0/16	mg/kg diet	N		DLY	U	FD	4	w	NR	NR	JV	B	C	Lab	GRO	GRO	BDWT	WO	16.0		Y	0.1810	Y	0.02310	2.04		10	10	5	10	7	8	4	1	3	4	62
158	15264	Schmolke et al 1992	Sodium arsenite	100	Rat (*Rattus norvegicus*)	1	3	0/15/30	mg/kg diet	N		DLY	U	FD	15	w	7	w	JV	F	M	Lab	BEH	FDB	FCNS	WO	30.0		Y	0.3250	N	0.02727	2.52		10	10	5	10	6	4	4	1	10	4	64
159	14508	Franke and Moxon 1937	Sodium arsenate	100	Rat (*Rattus norvegicus*)	2	2	0/3.22	mg/kg bw/d	N		DLY	U	FD	100	d	28	d	JV	M	C	Lab	BIO	CHM	HMGL	BL	3.22		Y	0.2635	Y	0.01109	3.22		10	10	5	10	10	1	4	1	10	4	65
160	1244	Cabe, et al., 1979	Sodium arsenate	100	Rat (*Rattus norvegicus*)	1	2	0/50	mg/L	N		ADL	U	DR	18	w	50	d	JV	M	C	Lab	GRO	GRO	BDWT	WO	50.0		Y	0.200	N	0.02326	5.81		10	5	5	10	6	8	4	1	10	4	63
161	1244	Cabe, et al., 1979	Sodium arsenate	100	Rat (*Rattus norvegicus*)	1	2	0/50	mg/L	N		ADL	U	DR	18	w	50	d	JV	M	C	Lab	PTH	ITX	INCO	WO	50.0		Y	0.200	N	0.02326	5.81		10	5	5	10	6	4	4	1	10	4	59
162	15125	Morris et al, 1938	Arsenic trioxide	100	Rat (*Rattus norvegicus*)	1	3	0/450/4100	ug/org/d	N		ADL	U	FD	340	d	26-27	d	JV	M	C	Lab	BEH	FDB	FCNS	WO	4100		Y	0.549	N	0.01905	7.47		10	10	5	10	7	4	4	1	10	4	65
163	15125	Morris et al, 1938	Arsenic trioxide	100	Rat (*Rattus norvegicus*)	1	3	0/450/4100	ug/org/d	N		ADL	U	FD	340	d	26-27	d	JV	M	C	Lab	PTH	ORW	ORWT	KI	4100		Y	0.549	N	0.01905	7.47		10	10	5	10	7	4	4	1	10	4	65
164	14590	Tripathi et al 1997	Sodium arsenite	100	Rat (*Rattus norvegicus*)	1	2	0/2.56	mg/org/d	N		ADL	U	DR	16	w	NR	NR	JV	M	C	Lab	BEH	FDB	WCON	WO	2.56		Y	0.080	Y	0.01020	32.0		10	5	5	10	7	4	4	3	10	4	62
165	15288	Benese and Bencko, 1981	Sodium arsenite	100	Mouse (*Mus musculus*)	1	4	0/4.945/49.45/249.4	mg/L	N		NR	U	DR	32	d	NR	NR	JV	M	C	Lab	BIO	CHM	LIPD	LI	249		Y	0.0200	Y	0.004225	32.4		10	5	5	10	7	1	4	1	10	4	57
166	15198	Cobo et al 1995	As_2O_3	37.9	Rat (*Rattus norvegicus*)	1	2	0/0.295	mg/g bw	N		ADL	U	DR	8	w	NR	NR	AD	M	C	Lab	BEH	FDB	WCON	WO	0.295		Y	0.338	N	0.03730	112		10	5	5	10	10	4	4	1	3	4	56

Appendix 6.1 Mammalian Toxicity Data Extracted for Wildlife Toxicity Reference Value (TRV)
Arsenic
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Ref			Exposure																								Effects					Conversion to mg/kg bw/day					Result		Data Evaluation Score											
Result #	Ref N.	Reference	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	Exposure Duration	Duration Units	Age	Age Units	Lifestage	Sex	Control Type	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
167	15160	Hughes and Thompson, 1996	Sodium arsenate heptahydrate	100	Mouse (*Mus musculus*)	1	3	0/0.014/1.4	mg/L	N		ADL	U	DR	28	d	96	d	SM	F	C	Lab	BIO	CHM	TRIG	PL		0.0140	Y	0.0793	Y	0.0049		0.00086	10	5	5	10	7	1	4	10	6	4	62
168	14543	Healy et al., 1998	Sodium arsenate heptahydrate	100	Mouse (*Mus musculus*)	1	3	0/8.5/827	ug/kg bw/d	N	na	ADL	U	DR	32	d	76	d	JV	M	C	Lab	BIO	ENZ	GENZ	TE		8.50	N	0.0316	Y	na		0.00850	10	5	5	10	6	1	4	10	10	4	65
169	14570	Fuentes et al., 1981	Arsenic trioxide	61.01	Rat (*Rattus norvegicus*)	1	3	0/4/12	mg/L	N		ADL	U	DR	3	mo	45	d	JV	F	C	Lab	BIO	ENZ	CCOX	LI		4.0	N	0.204	N	0.02368		0.283	10	5	5	10	5	1	4	10	10	4	64
170	14556	Savabieasfahani et al, 1998	Sodium arsenite	57.69	Cotton rat (*Sigmodon hispidus*)	1	3	0/0.088/0.15	mg/org/d	N	na	ADL	U	DR	4	w	NR	NR	AD	M	C	Lab	BEH	FDB	FCNS	WO		0.0880	Y	0.144	Y	0.01530		0.353	10	5	5	10	7	4	4	10	6	4	65
171	14569	Fowler et al., 1977	Sodium arsenate	100	Rat (*Rattus norvegicus*)	1	4	0/20/40/85	mg/L	N	na	ADL	U	DR	6	w	NR	NR	JV	M	C	Lab	BIO	ENZ	MAOA	LI		20.0	Y	0.340	N	0.03749		2.22	10	5	5	10	6	1	4	10	10	4	65
172	15397	Schiller et al, 1977	Sodium arsonate	100	Rat (*Rattus norvegicus*)	1	4	0/20/40/85	mg/L	N		NR	U	DR	3	w	NR	NR	AD	M	C	Lab	BIO	ENZ	GENZ	LI		20.0	Y	0.2650	N	0.02996		2.26	10	5	5	10	6	1	4	10	6	4	61
173	15358	Fowler and Woods 1979	Sodium arsenate	100	Mouse (*Mus musculus*)	1	4	0/20/40/85	mg/L	N		DLY	U	DR	6	w	NR	NR	JV	M	C	Lab	BIO	ENZ	MAOA	LI		20.0	Y	0.0267	N	0.003801		2.84	10	5	5	10	6	1	4	10	10	4	65
174	15324	Schiller et al 1981	Sodium arsenate	100	Rat (*Rattus norvegicus*)	1	2	0/40	mg/L	N		ADL	U	DR	3	w	NR	NR	AD	M	C	Lab	BIO	ENZ	ALPH	UR		40.0	N	0.510	N	0.05401		4.24	10	5	5	10	5	1	4	10	3	4	57
175	15033	Chaudhuri et al, 1999	Sodium arsenate	100	Rat (*Rattus norvegicus*)	1	2	0/0.05/0.10/0.30/3.0	g/L	Y		DLY	U	DR	40	d	4	w	JV	M	C	Lab	BIO	ENZ	GLRE	BR		0.0500	Y	0.1100	N	0.01358		6.50	10	5	5	10	6	1	4	10	10	4	65
176	14543	Healy et al., 1998	Sodium arsenate heptahydrate	100	Mouse (*Mus musculus*)	2	3	0/8.5/827	ug/kg bw/d	N	na	ADL	U	DR	32	d	76	d	JV	M	C	Lab	BIO	ENZ	GENZ	TE		6.5	N	0.0316	Y	na		6.5	10	5	5	10	6	1	4	10	10	4	65
177	14543	Healy et al., 1998	Sodium arsenate heptahydrate	100	Mouse (*Mus musculus*)	2	3	0/8.5/827	ug/kg bw/d	N	na	ADL	U	DR	32	d	76	d	JV	M	C	Lab	BEH	FDB	WCON	WO		6.5	N	0.0316	Y	na		6.5	10	5	5	10	6	4	4	1	10	4	59
178	14593	Valdonen et al., 1983	Sodium arsenite	100	Rat (*Rattus norvegicus*)	1	2	0/0.1	g/L	N		ADL	U	DR	11	d	3	mo	JV	M	C	Lab	BIO	ENZ	ACHE	NE		0.100	Y	0.313	N	0.03480		11.1	10	5	5	10	6	1	4	10	10	4	65
179	15198	Cobo et al 1995	As_2O_3	37.9	Rat (*Rattus norvegicus*)	1	2	0/0.295	mg/g bw	N		ADL	U	DR	8	w	NR	NR	AD	M	C	Lab	BIO	CHM	GLUC	BL		0.295	Y	0.338	N	0.03730		112	10	5	5	10	10	1	4	10	3	4	62

vailable from Attachment 4-3 of the Eco-SSL *guidance* (U.S. EPA 2003).