Appendix E
Atmospheric Deposition of Metals
Navajo Generating Station

Summary of Analysis by ENVIRON, 2011

E.1 INTRODUCTION

An analysis was conducted of the emissions, environmental transport, transformation, and aquatic impacts of mercury and selenium emissions from the Navajo Generating Station (NGS) (ENVIRON 2011). The analysis provided a general assessment of the potential ecological risks from mercury and selenium emitted from NGS into nearby aquatic environments. The analysis was based on:

- Mathematically modeled atmospheric emissions of mercury and selenium to predict the distribution, transport, and speciation of mercury and selenium in soil, surface water, and sediment in and around the area of the NGS and Lake Powell.
- Comparison of modeled concentrations of mercury (Hg^{2+}), methylmercury (MeHg), and selenium (Se) against available water and sediment screening criteria.
- The potential presence of threatened and endangered species in the vicinity of the site.
- Conservative ecological models used to predict risks to wildlife with an emphasis on aquatic receptors.

E.2 ATMOSPHERIC MODELING

Atmospheric modeling was conducted to estimate the distribution, transport and speciation of mercury and selenium in soil, surface water, and sediment in and around the area of NGS (ENVIRON 2011). Emissions estimates calculated by the Electric Power Research Institute (EPRI) (EPRI 2010) were used for the modeling for the facility. EPRI provided emissions estimates for elemental mercury (Hg^0), divalent gaseous mercury (Hg^{2+}), particulate mercury (Hg^P) and selenium (Se) (Table E-1). The AERMOD modeling system was utilized in the analysis. Existing modeling files for meteorological data, stack parameter data, terrain data and facility data from previous air permitting actions were utilized. Deposition parameters specific to Hg^0, Hg^{2+}, Hg^P, and Se were selected from AERMOD guidance documents in order to allow AERMOD to correctly estimate deposition in the vicinity of the plant. The receptor grid used in the modeling is a Cartesian grid forming a square about the facility of 84 km x 84 km. This is the grid size for which existing meteorological and terrain data were available from recent air permitting actions. The receptors closer to the facility are on a fine grid of 100m x 100m. As the distance from the facility increases, so does the grid spacing, eventually reaching a 2 km x 2 km grid spacing.

Table E-1 Estimated Emissions (kg/year) of Hg and Se from the Navajo Power Plant

	Stack 1	Stack 2	Stack 3
Hg^0	72	83	82
Hg^2	5	6	6
Hg^P	2	2	2
Se	498	573	569

Five years of meteorology data were used representing 2001 through 2005. Both dry and wet deposition were calculated and then summed for each receptor. The average deposition at each receptor over those five years was calculated and applied as the long term deposition flux at that location. On average approximately 4% of the Hg^{2+}, Hg^P, and Se emitted from the facility were deposited within the modeling domain. This is within the expected range shown in other modeling studies (Seigneur et al. 2006).

In order to estimate the impact of the modeled deposition, the domain was divided into 7 drainage areas representing seven different sections of Lake Powell and the Colorado River. Figure E-1 shows the delineation of the drainage areas and the corresponding sections of Lake Powell and the Colorado River. The annual deposition results to each drainage area are shown in Table E-2. For comparison, the measured annual wet deposition flux at the nearest Mercury Deposition Network (MDN) monitoring site (Mesa Verde National Park in southwestern Colorado) was 11.0 $\mu g/m^2$ in 2009. Thus, the annual wet + dry deposition fluxes to each drainage area due to the power plant are typically less than 2% of the annual wet deposition flux due to all sources.

Table E-2 Deposition Results (ug/m^2/year)

	Segment 1	Segment 2	Segment 3	Segment 4	Segment 5	Segment 6	Segment 7
Hg^0	5.0E-02	7.1E-02	5.2E-02	4.1E-02	3.1E-02	1.2E-01	8.3E-02
Hg^2	4.7E-02	6.5E-02	7.0E-02	6.4E-02	5.1E-02	1.4E-01	8.2E-02
Hg^P	7.9E-03	8.4E-03	1.0E-02	9.7E-03	1.0E-02	2.8E-02	1.9E-02
Se	7.9E-01	7.9E-01	7.9E-01	7.9E-01	7.9E-01	7.9E-01	7.9E-01

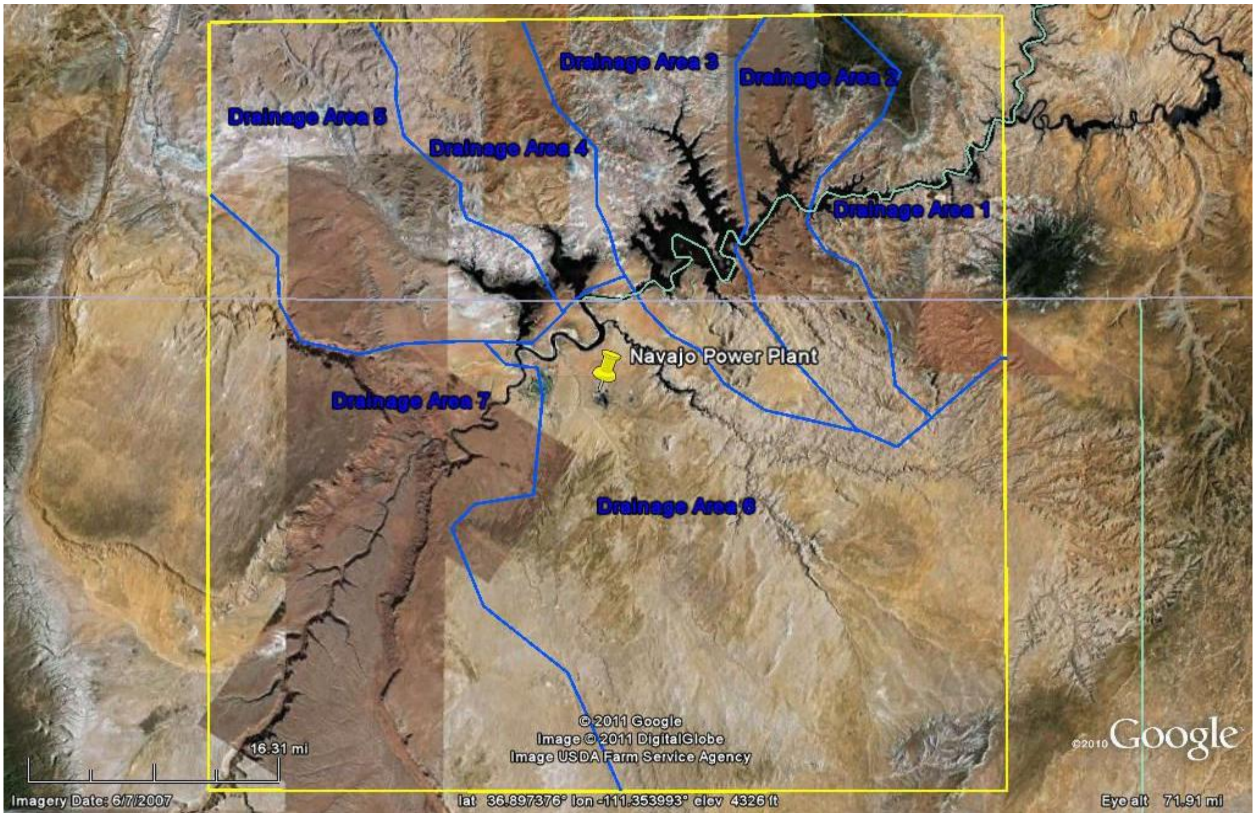

Figure E-1. Drainage Areas in the Modeling Domain

The deposition at each receptor was applied to the drainage area in which it is located. Both the terrestrial and aquatic concentrations were estimated for these seven drainage areas.

In order to calculate the fate of Hg and Se deposited to each drainage area, the U.S. Environmental Protection Agency's (USEPA) Human Health Risk Assessment Protocol (HHRAP) for Hazardous Waste Combustion Facilities (USEPA 2005a) guidance was used. This guidance lists equations appropriate for calculating estimates of metal concentrations in the soil and water in the vicinity of a facility. In many cases, it lists appropriate default values for calculation parameters as well.

The total chemical load (g/year) and the load due to erosion to each waterbody segment were calculated, as was the total concentration of each metal in the waterbody based on USEPA (2005a). Calculations were also performed on the dissipation rate, total concentration of Hg and Se (dissolved phase and associated with suspended solids) in the water column and concentrations in sediment.

For the Hg load to the waterbody, a uniform methylation efficiency of 15% was assumed in the waterbodies which is the recommendation of the HHRAP guidance (USEPA 2005a). The sediment portion was not split into dissolved and adsorbed for this study. Table E-3 provides estimates of the Hg^{2+}, MeHg, and Se concentrations in surface water and sediment in each of the Lake Powell and Colorado River segments.

Table E-3 Estimated Surface Water Concentrations (ng/L) and Sediment Concentrations (ng/g)

	Segment 1	Segment 2	Segment 3	Segment 4	Segment 5	Segment 6	Segment 7
Hg^2 Dissolved	3.2E.04	5.4E.04	5.0E-04	4.0E-04	3.0E-04	7.1E-04	4.4E-04
Hg^2 suspended	3.5E-05	5.8E-05	5.4E-05	4.3E-05	3.2E-05	7.6E-05	1.1E-05
Hg^2 Sediment	3.2E-02	5.4E-02	5.0E-02	4.0E-02	3.0E-02	7.1E-02	4.4E-02
MeHg Dissolved	5.7E-05	9.6E-05	8.9E-05	7.1E-05	5.2E-05	1.3E-04	7.8E-05
MeHg Suspended	3.7E-07	6.2E-07	5.8E-07	4.6E-07	3.4E-07	8.1E-07	1.2E-07
MeHg Sediment	5.7E-03	9.6E-03	8.9E-09	7.1E-03	5.2E-03	1.3E-02	7.7E-03
SE(IV) Dissolved	2.1E-01	2.7E-01	3.5E-01	4.7E-01	3.3E-01	9.1E-01	7.3E-01
SE(IV) Suspended	1.1E-02	1.5E-02	1.9E-02	2.5E-02	1.8E-02	4.9E-02	9.2E-03
SE(IV) Sediment	8.2E-01	1.1E+00	1.4E+00	1.9E+00	1.3E+00	3.6E+00	2.8E+00
SE(VI) Dissolved	1.1E+00	2.0E+00	3.9E+00	5.8E+02	3.3E+02	1.8E+01	2.8E+01
SE(VI) Suspended	1.6E-02	2.7E-02	5.3E-02	7.9E+00	4.6E+00	2.4E-01	8.9E-02
SE(VI) Sediment	4.5E-03	8.0E-03	1.6E-02	2.3E+00	1.3E+00	7.1E-02	1.1E-01

E.3 SELECTION OF ECOLOGICAL RECEPTORS OF INTEREST (ROIs)

Most healthy ecosystems support a large number of individual species representing a variety of feeding guilds. However, it is not feasible to complete risk calculations for all potentially exposed species. Moreover, such an effort would be duplicative because of the similarity of exposure patterns among closely related species and among those with similar feeding guilds. For these reasons, ROIs are selected to represent the different feeding guilds.

ROIs are selected based on six characteristics:

- economic and/or other value to humans;
- ecological relevance;
- potential for high exposure;
- toxicological sensitivity;
- expected presence in the study area; and
- availability of life history information and toxicological data.

Based on the ecological conceptual site model and the above considerations, aquatic and semiaquatic organisms pertinent to the study area are:

- benthic/epibenthic invertebrate community;
- channel catfish (*Ictalurus punctatus*), representing bottom-dwelling fish populations;
- threadfin shad (*Dorosoma petenense*), representing water column dwelling fish populations;
- striped bass (*Morone saxatilis*), representing piscivorous fish populations;
- mink (*Mustela vison*), representing piscivorous mammals;

- great blue heron (*Ardea herodias*); and
- belted kingfisher (*Ceryle alcyon*), representing piscivorous birds.

These ROIs are among the most highly exposed and ecotoxicologically sensitive (i.e., susceptible) of the species likely to inhabit or forage within the study area, so extrapolation of conclusions regarding these ROIs will be protective of other, less susceptible species including endangered species such as razorback sucker and Colorado pikeminnow.

E.4 EFFECTS ASSESSMENT

The effects assessment evaluates the potential for mercury and selenium to cause adverse effects in ROIs and estimates the relationship between the extent of exposure and severity of effects. For measurement endpoints based on direct observations (i.e., benthic invertebrate toxicity, benthic community structure), the effects assessment is the review and selection of toxicity reference values (TRVs) that are used to interpret the potential for adverse effects. TRVs are the literature-derived concentrations or doses, below which adverse effects are unlikely.

E.4.1 Effects Assessment for Aquatic and Sediment Dwelling Invertebrate Community

For the "chemistry" measurement endpoint, concentrations of mercury and selenium in surface water and sediment are compared to appropriate ecological screening benchmarks (ESBs) that are protective of invertebrates. The unitless ratio of the mercury and selenium concentration to the ESB is called a hazard quotient (HQs). A HQ of greater than one indicates that ecological risks may occur.

The surface water concentrations were compared to several ESBs. The USEPA's Criterion Continuous Concentration (CCC) is an estimate of the highest concentration of a constituent in surface water to which an aquatic community can be exposed indefinitely without resulting in an unacceptable effect (USEPA 2011). The State of Arizona also publishes surface water criteria, with a specific criterion for "Aquatic and Wildlife." These criteria are assumed to be protective of invertebrates in the sediment and in the water column, as well as aquatic vertebrates including amphibians, reptiles, and fish. These criteria are listed on Table E-4.

The sediment concentrations were compared to several ESBs. The National Atmospheric and Oceanic Administration (NOAA) developed values through its National Status and Trends program to rank areas that warranted further detailed study on the actual occurrence of adverse effects. The Effects Range Low (ERL) indicates a concentration below which adverse effects rarely occur. The Effects Range Median (ERM) indicates a concentration above which adverse effects frequently occur. These criteria are listed on Table E-5.

E.4.2 Effects Assessment for Fish Populations and Community

The effects assessment for fish relies on two types of effects metrics: surface water ESBs and critical body residues (CBRs) expressed as concentrations of mercury and selenium estimated in whole body invertebrate and fish tissue. Fish tissue-based CBRs are used as the effects metrics for the measurement endpoint of fish tissue chemistry (i.e., concentrations of mercury and selenium in fish tissue in relation to concentrations reported in the literature to be protective of fish). Fish tissue-based CBRs are literature-derived chemical concentrations in the tissue of fish that are protective of fish. Fish tissue-based CBRs integrate exposures across multiple pathways (e.g., gill transfer, sediment ingestions, diet) and reflect the bioavailable fraction of mercury and selenium in the environment. Fish tissue-based CBRs are based on Jarvinen and Ankley (1999), as identified in Table E-6.

E.4.3 Effects Assessment for Bird and Mammal Populations

The effects assessment for wildlife is based on TRVs that relate ingested daily dose to ecotoxicological endpoints. TRVs are literature-derived concentrations or doses, below which adverse effects are unlikely (e.g., ORNL 1996). No observed apparent effect level (NOAEL) TRVs are indicative of doses of constituents that have had no deleterious effects on a wildlife receptor. Lowest observed apparent effect level (LOAEL) TRVs are the minimum doses of constituents where deleterious effects are apparent. The TRVs are summarized in Table E-7.

E.5 RISK CHARACTERIZATION

Risk characterization for the measurement endpoints involves mathematical comparison of exposure and effects estimates for each measurement endpoint. Exposure estimates that are below the relevant effects metric (i.e., surface water quality benchmark, sediment quality benchmark, tissue-based benchmark, or TRV) indicate that adverse effects to a given ROI are unlikely. Exposure estimates that exceed the relevant effects metric indicate that further investigation is warranted to define the potential for adverse effects at the population level, as well as the spatial extent and severity of any such adverse effects (Barnthouse et al. 2008).

E.5.1 Risk Characterization for Aquatic and Sediment Dwelling Invertebrate Communities

The evaluation of chemistry as part of the assessment of risks to aquatic and sediment dwelling invertebrates compares concentrations of mercury and selenium in surface water and sediment to benchmarks (Tables E-4 and E-5, respectively). The risk characterization using chemistry results is based on the HQ, which is the ratio of measured concentrations and ESBs. The surface water and sediment concentrations of Hg and MeHg are far below the surface water and sediment ESBs resulting in HQs well below the threshold value of 1. The same applies for Se with the exception of Se(VI) in Lake Segment 4 where the HQ only slightly exceeds one (HQ = 1.49). Overall, these results indicate that the risk to surface water and sediment organisms from Hg, MeHg and Se is negligible.

E.5.2 Risk Characterization for the Fish Populations and Community

The characterization of risk to fish involves two lines of evidence, surface water chemistry and the evaluation of chemicals in fish tissues relative to CBRs. As seen in the previous section, the "water chemistry" measurement endpoint shows *de minimis* risks to surface water organisms including fish (Table E-4).

The second line of evidence for fish is the comparison of concentrations of chemicals measured in fish tissues to CBRs to generate wildlife HQs, as shown in Table E-8 and illustrated in Figures E-2a and E-2b. The resultant fish HQs range from 9x10-7 to 2x10-2. Generally, the MeHg HQs among higher trophic level receptors are higher than among the lower trophic level receptors, which is consistent with bioaccumulation of Hg up the food chain. Overall, fish HQs are highest for Se, followed by MeHg and then Hg^{2+}.

The two lines of evidence for fish, water chemistry and modeled fish tissue chemistry, both support a conclusion that the modeled concentrations of Se, Hg^{2+} and MeHg do not pose an unacceptable risk to fish populations or the fish community.

E.5.3 Risk Characterization for Bird and Mammal Populations

The characterization of risks for wildlife involves food web modeling using surface water, sediment, soil, and fish tissue chemistry results and comparison to protective TRVs. Food web modeling results are in Table E-9 and a summary of hazard quotients is provided in Table E-8 and illustrated in Figures E-2a and E-2b. As Figure E-2a shows, HQs for each receptor evaluated are well below the threshold of one. In Figure E-2b which provides the same information on a linear scale, the concentrations of inorganic and methylmercury are too small to be visible for most receptors.

While Hg^{2+} and MeHg HQs are very low at the bottom of the food chain, MeHg HQs are three orders of magnitude higher than for Hg^{+2} at the highest trophic level. For MeHg, concentrations are highest in the higher trophic levels. The total daily intake of MeHg is highest among piscivores but similar among the other aquatic receptors. Even combining MeHg and Hg^{2+} HQs results in HQs well below 1. For selenium, HQs were all well below one and very similar regardless of trophic level or feeding guild with HQs lowest for the Great Blue Heron.

To summarize the risk characterization for birds and mammals:

- Se HQs are substantially greater than Hg^{2+} and MeHg HQs.
- MeHg HQs are orders of magnitude greater than Hg^{2+} HQs depending on trophic level.
- MeHg HQs were highest among piscivorous birds (blue heron, kingfisher) which were higher than that of piscivorous mammals (mink).
- All HQs are well below one for each aquatic receptor evaluated.
- Se, Hg^{2+} and MeHg do not pose an unacceptable risk to piscivorous bird and mammal populations.

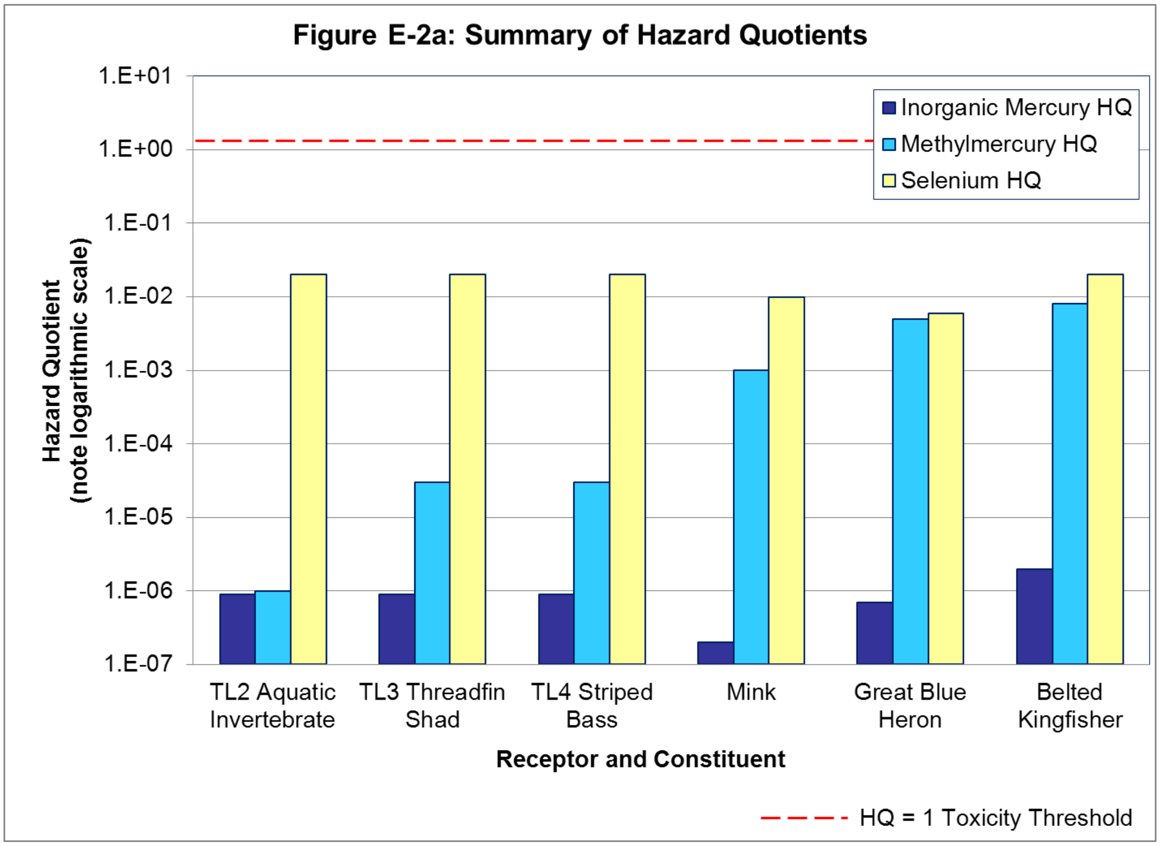
Figure E-2a: Summary of Hazard Quotients
Hazard Quotient
(note logarithmic scale)
1.E+01
1.E+00
1.E-01
1.E-02
1.E-03
1.E-04
1.E-05
1.E-06
1.E-07
Inorganic Mercury HQ
Methylmercury HQ
Selenium HQ
TL2 Aquatic Invertebrate
TL3 Threadfin Shad
TL4 Striped Bass
Mink
Great Blue Heron
Belted Kingfisher
Receptor and Constituent
HQ = 1 Toxicity Threshold

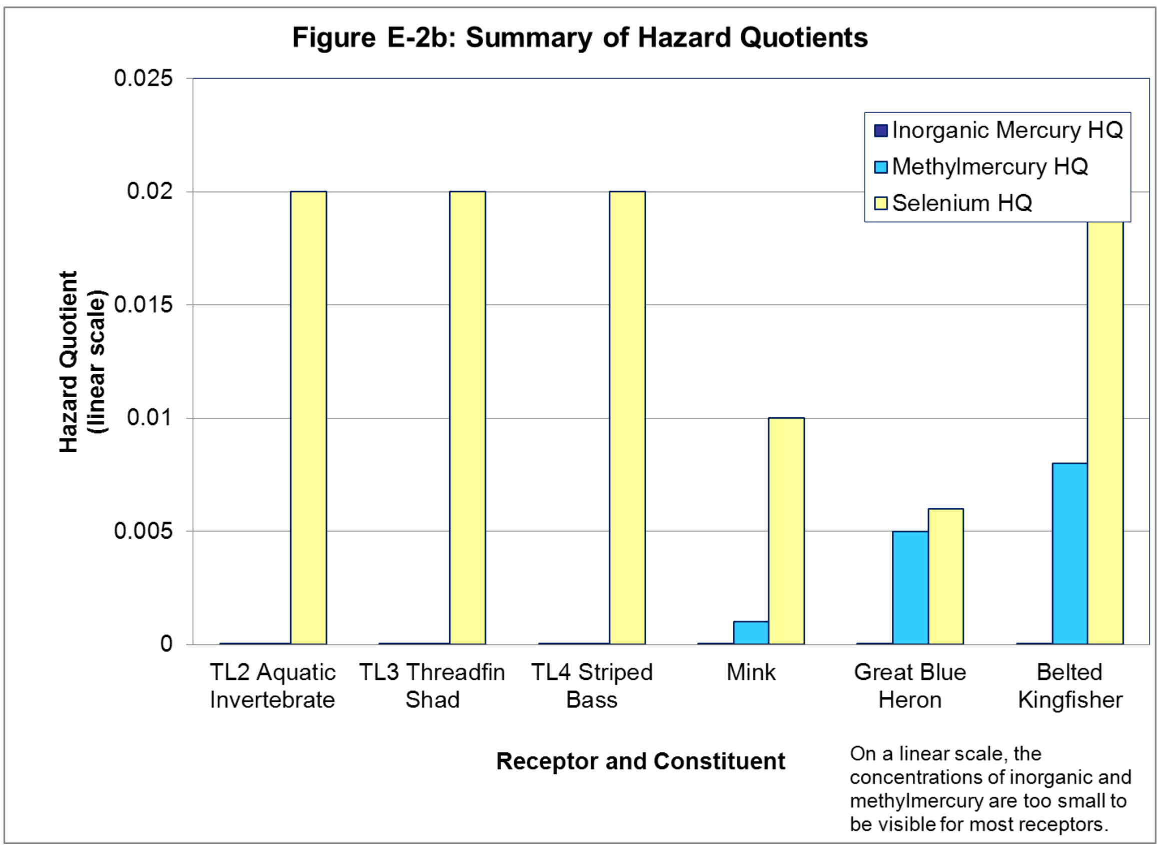
Figure E-2b: Summary of Hazard Quotients
Hazard Quotient
(linear scale)
0.025
0.02
0.015
0.01
0.005
0
Inorganic Mercury HQ
Methylmercury HQ
Selenium HQ
TL2 Aquatic Invertebrate
TL3 Threadfin Shad
TL4 Striped Bass
Mink
Great Blue Heron
Belted Kingfisher
Receptor and Constituent
On a linear scale, the concentrations of inorganic and methylmercury are too small to be visible for most receptors.

E.6 UNCERTAINTIES

Uncertainties can be introduced into ecological risk assessment at every step in the process, as information of varying quality is gathered from diverse sources in order to be integrated into a complex framework. Conservative assumptions are generally employed to compensate for that uncertainty, to ensure the protectiveness of the overall assessment. Varying levels of uncertainty exists with the available information utilized in the chemistry dataset, effects assessment benchmarks, population effects, bioavailability of constituents of potential ecological concerns, receptor organisms and in the risks estimated from surrogate receptors. The conservative assumptions used in the assessment of NGS emissions result in an overestimation of risks (ENVIRON 2011).

E.7 SUMMARY

The purpose of the ecological analysis was to evaluate whether significant risks to aquatic wildlife are occurring due to Hg and Se emissions from NGS. Ecologically significant impacts to wildlife from a regulatory perspective are those that will occur on a scale that could impact populations, communities, and ecosystems of wildlife and the habitat that supports wildlife (USEPA 1994, 1997a, 1998). Special regulatory consideration is given to individual organisms of threatened and endangered species populations since these individuals comprise a greater percentage of the small threatened and endangered populations (USEPA 1997a, 1998).

In larger populations, communities, and ecosystems, *de minimis* impacts can be tolerated without ecologically significant impacts (Suter et al. 1995; USEPA 1994; TNRCC 2000). This means that some impacts can be tolerated without causing adverse (or perhaps even measurable) impacts to the valued ecological entities (i.e., the population, community, and ecosystem). Based on the low modeled concentrations of Hg, MeHg and Se, population, community, and ecosystem level impacts for aquatic species are highly unlikely as a result of NGS emissions. Hazard quotients for Se, Hg and MeHg are well below one representing *de minimis* risk to aquatic receptors.

Overall, the risk to the aquatic and sediment dwelling invertebrate community, fish populations and fish/aquatic invertebrate eating birds and mammals from NGS emissions of mercury and selenium can be summarized as follows:

- Modeled Se, Hg and MeHg concentrations in sediment are below ecological screening levels.
- Modeled Se, Hg and MeHg concentrations in surface water are below ecological screening with the exception of Se(VI) in Lake Segment 4 where concentrations slightly exceeded only the most conservative screening benchmark.
- All calculated critical body residues resulted in HQs well below one suggesting *de minimis* risk to aquatic receptors including fish and piscivorous birds and mammals.

In other words, the analysis of NGS emissions supports a finding that modeled concentrations of Se, Hg^{2+} and MeHg do not pose an unacceptable risk to aquatic receptors in the vicinity of the plant.

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Table E-4 Comparison of Modeled Surface Water Mercury, Methylmercury and Selenium Concentrations against Screening Values

Area	Chemical	Modeled Concentration	Ecological Screening Levels				
			Alberta Env.				CT DEP
			Commercial / Industrial Groundwater Aquatic Life (Coarse)	Commercial / Industrial Groundwater Aquatic Life (Fine)	Residential Groundwater Aquatic Life (Coarse)	Residential Groundwater Aquatic Life (Fine)	Surface-Water Protection Criteria
		ug/L	ug/L	ug/L	ug/L	ug/L	ug/L
Lake Segment 1	Mercury	3.23E-07	--	--	--	--	0.4
	Methyl mercury	5.72E-08	--	--	--	--	--
	Selenium IV	2.05E-04	1	1	1	1	--
	Selenium VI	1.14E-03	1	1	1	1	--
Lake Segment 2	Mercury	5.39E-07	--	--	--	--	0.4
	Methyl mercury	9.55E-08	--	--	--	--	--
	Selenium IV	2.71E-04	1	1	1	1	--
	Selenium VI	2.00E-03	1	1	1	1	--
Lake Segment 3	Mercury	5.02E-07	--	--	--	--	0.4
	Methyl mercury	8.90E-08	--	--	--	--	--
	Selenium IV	3.50E-04	1	1	1	1	--
	Selenium VI	3.90E-03	1	1	1	1	--
Lake Segment 4	Mercury	4.00E-07	--	--	--	--	0.4
	Methyl mercury	7.07E-08	--	--	--	--	--
	Selenium IV	4.67E-04	1	1	1	1	--
	Selenium VI	5.81E-01	1	1	1	1	--
Lake Segment 5	Mercury	2.96E-07	--	--	--	--	0.4
	Methyl mercury	5.23E-08	--	--	--	--	--
	Selenium IV	3.32E-04	1	1	1	1	--
	Selenium VI	3.34E-01	1	1	1	1	--
Lake Segment 6	Mercury	7.06E-07	--	--	--	--	0.4
	Methyl mercury	1.25E-07	--	--	--	--	--
	Selenium IV	9.06E-04	1	1	1	1	--
	Selenium VI	1.78E-02	1	1	1	1	--
Lake Segment 7	Mercury	4.38E-07	--	--	--	--	0.4
	Methyl mercury	7.78E-08	--	--	--	--	--
	Selenium IV	7.31E-04	1	1	1	1	--
	Selenium VI	2.81E-02	1	1	1	1	--

NOTES:
--Screening level not available
ug/L Micrograms per liter
(a) Freshwater and saltwater criteria for metals are expressed in terms of the dissolved metal in the water column. The criterion was calculated by using the previous aquatic life criteria and multiplying it by a conversion factor. (See Reference Document); Freshwater and saltwater criteria for metals are expressed in terms of the dissolved metal in the water column. The criterion was calculated by using the previous aquatic life criteria and multiplying it by a conversion factor. (See Reference Document) ; This recommended water quality criterion was derived from data for inorganic mercury (II), but is applied here to total mercury. If a substantial portion of the mercury in the water column is methylmercury, this criterion will probably be under protective.
(b) Chemical has been designated as a bioaccumulative chemical of concern by the publishing agency.
(c) The recommended water quality criterion is expressed in terms of total recoverable metal in the water column. It is scientifically acceptable to use the conversion factor used in the GLI to convert this to a value that is expressed as dissolved metal
(d) The CMC=1/[(f1/CMC1)=(f2/CMC2)] where f1 and f2 are the fractions of total selenium that are treated as selenite and selenate, respectively, and CMC1 and CMC2 are 185.9 ug/l and 12.83 ug/l, respectively. ; This value was announced (61 FR 58444-58449, November 14, 1996) as a proposed GLI 303(c) aquatic life criterion. EPA is currently working on this criterion and so this value might change substantially in the near future. ; The recommended water quality criterion is expressed in terms of total recoverable metal in the water column. It is scientifically acceptable to use the conversion factor used in the GLI to convert this to a value that is expressed as dissolved metal.
(e) Criterion or value is not available or, as is the case for Csat, not applicable.
(f) Aquatic Life Protection Criteria, Acute; Freshwater {Excluding Pinelands and Class 1 (i.e., maintained in their natural state of quality)}.

Table E-4 (continued)

Area	Chemical	Federal							
		Ambient Water Quality Criteria-Fresh Water--Criteria Continuous Concentration		Ambient Water Quality Criteria-Fresh Water--Criteria Maximum Concentration		Ambient Water Quality Criteria-Salt Water--Criteria Continuous Concentration		Ambient Water Quality Criteria-Salt Water--Criteria Maximum Concentration	
		ug/L		ug/L		ug/L		ug/L	
Lake Segment 1	Mercury	0.77	a	1.4	a	0.94	a	1.8	a
	Methyl mercury	--		--		--		--	
	Selenium IV	5	c	--	d	71	a	290	a
	Selenium VI	5	c	--	d	71	a	290	a
Lake Segment 2	Mercury	0.77	a	1.4	a	0.94	a	1.8	a
	Methyl mercury	--		--		--		--	
	Selenium IV	5	c	--	d	71	a	290	a
	Selenium VI	5	c	--	d	71	a	290	a
Lake Segment 3	Mercury	0.77	a	1.4	a	0.94	a	1.8	a
	Methyl mercury	--		--		--		--	
	Selenium IV	5	c	--	d	71	a	290	a
	Selenium VI	5	c	--	d	71	a	290	a
Lake Segment 4	Mercury	0.77	a	1.4	a	0.94	a	1.8	a
	Methyl mercury	--		--		--		--	
	Selenium IV	5	c	--	d	71	a	290	a
	Selenium VI	5	c	--	d	71	a	290	a
Lake Segment 5	Mercury	0.77	a	1.4	a	0.94	a	1.8	a
	Methyl mercury	--		--		--		--	
	Selenium IV	5	c	--	d	71	a	290	a
	Selenium VI	5	c	--	d	71	a	290	a
Lake Segment 6	Mercury	0.77	a	1.4	a	0.94	a	1.8	a
	Methyl mercury	--		--		--		--	
	Selenium IV	5	c	--	d	71	a	290	a
	Selenium VI	5	c	--	d	71	a	290	a
Lake Segment 7	Mercury	0.77	a	1.4	a	0.94	a	1.8	a
	Methyl mercury	--		--		--		--	
	Selenium IV	5	c	--	d	71	a	290	a
	Selenium VI	5	c	--	d	71	a	290	a

Table E-4 (continued)

Area	Chemical	MI DNRE							
		Ambient Water Quality Criteria-Aquatic Maximum Value for the Protection of Aquatic Life in Ambient Waters		Ambient Water Quality Criteria-Chronic Water Quality Value for Protection of Aquatic Life in Ambient Waters		Ambient Water Quality Criteria-Final Acute Value for Protection of Aquatic Life in Ambient Waters		Ambient Water Quality Criteria-Water Quality Values for Protection of Wildlife	
		ug/L		ug/L		ug/L		ug/L	
Lake Segment 1	Mercury	1.4	b	0.77	b	2.8	b	0.0013	b
	Methyl mercury	--		--		--		--	
	Selenium IV	62		5		120		--	e
	Selenium VI	62		5		120		--	e
Lake Segment 2	Mercury	1.4	b	0.77	b	2.8	b	0.0013	b
	Methyl mercury	--		--		--		--	
	Selenium IV	62		5		120		--	e
	Selenium VI	62		5		120		--	e
Lake Segment 3	Mercury	1.4	b	0.77	b	2.8	b	0.0013	b
	Methyl mercury	--		--		--		--	
	Selenium IV	62		5		120		--	e
	Selenium VI	62		5		120		--	e
Lake Segment 4	Mercury	1.4	b	0.77	b	2.8	b	0.0013	b
	Methyl mercury	--		--		--		--	
	Selenium IV	62		5		120		--	e
	Selenium VI	62		5		120		--	e
Lake Segment 5	Mercury	1.4	b	0.77	b	2.8	b	0.0013	b
	Methyl mercury	--		--		--		--	
	Selenium IV	62		5		120		--	e
	Selenium VI	62		5		120		--	e
Lake Segment 6	Mercury	1.4	b	0.77	b	2.8	b	0.0013	b
	Methyl mercury	--		--		--		--	
	Selenium IV	62		5		120		--	e
	Selenium VI	62		5		120		--	e
Lake Segment 7	Mercury	1.4	b	0.77	b	2.8	b	0.0013	b
	Methyl mercury	--		--		--		--	
	Selenium IV	62		5		120		--	e
	Selenium VI	62		5		120		--	e

Table E-4 (continued)

Area	Chemical	NC DENR		NJDEP		ORNL
		Surface Water Quality Standards-Freshwater Aquatic Life	Surface Water Quality Standards-Saltwater Aquatic Life	Aquatic Life Protection Criteria, Acute; Freshwater (f)	Aquatic Life Protection Criteria, Chronic; Freshwater (f)	Eco PRG
		ug/L	ug/L	ug/L	ug/L	ug/L
Lake Segment 1	Mercury	0.012	0.025	--	--	1.3
	Methyl mercury	--	--	--	--	0.0026
	Selenium IV	5	71	20	5	0.39
	Selenium VI	5	71	20	5	0.39
Lake Segment 2	Mercury	0.012	0.025	--	--	1.3
	Methyl mercury	--	--	--	--	0.0026
	Selenium IV	5	71	20	5	0.39
	Selenium VI	5	71	20	5	0.39
Lake Segment 3	Mercury	0.012	0.025	--	--	1.3
	Methyl mercury	--	--	--	--	0.0026
	Selenium IV	5	71	20	5	0.39
	Selenium VI	5	71	20	5	0.39
Lake Segment 4	Mercury	0.012	0.025	--	--	1.3
	Methyl mercury	--	--	--	--	0.0026
	Selenium IV	5	71	20	5	0.39
	Selenium VI	5	71	20	5	0.39
Lake Segment 5	Mercury	0.012	0.025	--	--	1.3
	Methyl mercury	--	--	--	--	0.0026
	Selenium IV	5	71	20	5	0.39
	Selenium VI	5	71	20	5	0.39
Lake Segment 6	Mercury	0.012	0.025	--	--	1.3
	Methyl mercury	--	--	--	--	0.0026
	Selenium IV	5	71	20	5	0.39
	Selenium VI	5	71	20	5	0.39
Lake Segment 7	Mercury	0.012	0.025	--	--	1.3
	Methyl mercury	--	--	--	--	0.0026
	Selenium IV	5	71	20	5	0.39
	Selenium VI	5	71	20	5	0.39

Table E-4 (continued)

Area	Chemical	USEPA Region 3 Freshwater Screening Benchmarks for Surface Water (ug/L)		USEPA Region 5 Ecological Data Quality Level for Surface Water (ug/L)	AZDEQ Aquatic and wildlife (cold water) (A&Wc) Acute (ug/L)	AZDEQ Aquatic and wildlife (cold water) (A&Wc) Chronic (ug/L)		AZDEQ Aquatic and wildlife (warm water) (A&Ww) Acute (ug/L)		AZDEQ Aquatic and wildlife (warm water) (A&Ww) Chronic (ug/L)		Selected Ecological Screening Level (ESL)	HQ
Lake Segment 1	Mercury	--		0.0013	2.4	0.01		2.4		0.01		0.0013	2.48E-04
	Methyl mercury	0.004	b	0.00246	--	--		--		--		0.00246	2.32E-05
	Selenium IV	--		5	--	2	c	--		2	c	0.39	5.26E-04
	Selenium VI	--		5	--	2	c	--		2	c	0.39	2.93E-03
Lake Segment 2	Mercury	--		0.0013	2.4	0.01		2.4		0.01		0.0013	4.15E-04
	Methyl mercury	0.004	b	0.00246	--	--		--		--		0.00246	3.88E-05
	Selenium IV	--		5	--	2	c	--		2	c	0.39	6.96E-04
	Selenium VI	--		5	--	2	c	--		2	c	0.39	5.13E-03
Lake Segment 3	Mercury	--		0.0013	2.4	0.01		2.4		0.01		0.0013	3.86E-04
	Methyl mercury	0.004	b	0.00246	--	--		--		--		0.00246	3.62E-05
	Selenium IV	--		5	--	2	c	--		2	c	0.39	8.98E-04
	Selenium VI	--		5	--	2	c	--		2	c	0.39	9.99E-03
Lake Segment 4	Mercury	--		0.0013	2.4	0.01		2.4		0.01		0.0013	3.08E-04
	Methyl mercury	0.004	b	0.00246	--	--		--		--		0.00246	2.87E-05
	Selenium IV	--		5	--	2	c	--		2	c	0.39	1.20E-03
	Selenium VI	--		5	--	2	c	--		2	c	0.39	1.49E+00
Lake Segment 5	Mercury	--		0.0013	2.4	0.01		2.4		0.01		0.0013	2.27E-04
	Methyl mercury	0.004	b	0.00246	--	--		--		--		0.00246	2.13E-05
	Selenium IV	--		5	--	2	c	--		2	c	0.39	8.51E-04
	Selenium VI	--		5	--	2	c	--		2	c	0.39	8.58E-01
Lake Segment 6	Mercury	--		0.0013	2.4	0.01		2.4		0.01		0.0013	5.43E-04
	Methyl mercury	0.004	b	0.00246	--	--		--		--		0.00246	5.09E-05
	Selenium IV	--		5	--	2	c	--		2	c	0.39	2.32E-03
	Selenium VI	--		5	--	2	c	--		2	c	0.39	4.57E-02
Lake Segment 7	Mercury	--		0.0013	2.4	0.01		2.4		0.01		0.0013	3.37E-04
	Methyl mercury	0.004	b	0.00246	--	--		--		--		0.00246	3.16E-05
	Selenium IV	--		5	--	2	c	--		2	c	0.39	1.87E-03
	Selenium VI	--		5	--	2	c	--		2	c	0.39	7.21E-02

Table E-5 Comparison of Modeled Surface Water Mercury, Methylmercury and Selenium Concentrations against Ecological Screening Benchmarks

Area	Chemical	Modeled Concentration ug/L	Ecological Screening Benchmark Values: NJDEP/NOAA Effects Range -- Low mg/kg	NJDEP/NOAA Effects Range -- Median mg/kg	ORNL Eco PRG mg/kg	USEPA Region 3 Freshwater Screening Benchmarks for Sediment mg/kg		USEPA Region 4 Sediment Ecological Effect Level mg/kg	USEPA Region 5 Ecological Data Quality Level for Sediment mg/kg	Selected Ecological Screening Level (ESL)	HQ
Lake Segment 1	Mercury	3.23E-05	0.15	0.71	0.7	0.18		0.13	0.174	0.13	2.48E-04
	Methylmercury	5.72E-06	--	--	--	--	a	--	0.00001	0.00001	5.72E-01
	Selenium IV	8.16E-04	--	--	--	2	a	--	--	2	4.08E-04
	Selenium VI	4.55E-06	--	--	--	2	a	--	--	2	2.27E-06
Lake Segment 2	Mercury	5.39E-05	0.15	0.71	0.7	0.18		0.13	0.174	0.13	4.15E-04
	Methylmercury	9.55E-06	--	--	--	--	a	--	0.00001	0.00001	9.55E-01
	Selenium IV	1.08E-03	--	--	--	2	a	--	--	2	5.40E-04
	Selenium VI	7.97E-06	--	--	--	2	a	--	--	2	3.98E-06
Lake Segment 3	Mercury	5.02E-05	0.15	0.71	0.7	0.18		0.13	0.174	0.13	3.86E-04
	Methylmercury	8.90E-06	--	--	--	--	a	--	0.00001	0.00001	8.90E-01
	Selenium IV	1.39E-03	--	--	--	2	a	--	--	2	6.97E-04
	Selenium VI	1.55E-05	--	--	--	2	a	--	--	2	7.75E-06
Lake Segment 4	Mercury	4.00E-05	0.15	0.71	0.7	0.18		0.13	0.174	0.13	3.08E-04
	Methylmercury	7.07E-06	--	--	--	--	a	--	0.00001	0.00001	7.07E-01
	Selenium IV	1.86E-03	--	--	--	2	a	--	--	2	9.30E-04
	Selenium VI	1.55E-05	--	--	--	2	a	--	--	2	7.75E-06
Lake Segment 5	Mercury	2.96E-05	0.15	0.71	0.7	0.18		0.13	0.174	0.13	2.27E-04
	Methylmercury	5.23E-06	--	--	--	--	a	--	0.00001	0.00001	5.23E-01
	Selenium IV	1.32E-03	--	--	--	2	a	--	--	2	6.60E-04
	Selenium VI	1.33E-03	--	--	--	2	a	--	--	2	6.66E-04
Lake Segment 6	Mercury	7.06E-05	0.15	0.71	0.7	0.18		0.13	0.174	0.13	5.43E-04
	Methylmercury	1.25E-05	--	--	--	--	a	--	0.00001	0.00001	1.25E+00
	Selenium IV	3.60E-03	--	--	--	2	a	--	--	2	1.80E-03
	Selenium VI	7.09E-05	--	--	--	2	a	--	--	2	3.55E-05
Lake Segment 7	Mercury	4.38E-05	0.15	0.71	0.7	0.18		0.13	0.174	0.13	3.37E-04
	Methylmercury	7.74E-06	--	--	--	--	a	--	0.00001	0.00001	7.74E-01
	Selenium IV	2.79E-03	--	--	--	2	a	--	--	2	1.40E-03
	Selenium VI	1.11E-04	--	--	--	2	a	--	--	2	5.54E-05

NOTES:

Screening level not available

ug/L Micrograms per liter

mg/kg Milligrams per kilogram

(a) Chemical has been designated as a bioaccumulative chemical of concern by the publishing agency.

Table E-6 Total Daily Intake and Food Web Model

Inorganic Mercury		Lake Segment 1	Lake Segment 2	Lake Segment 3	Lake Segment 4	Lake Segment 5	Lake Segment 6	Lake Segment 7	Min	Average	95th percentile	Max
Concentration in Water (a) (EPC)	mg/L	3.58E-10	5.97E-10	5.56E-10	4.43E-10	3.28E-10	7.82E-10	4.49E-10	3.28E-10	5.02E-10	7.27E-10	7.82E-10
Concentration in TL3 Fish (b)	mg/kg WW	1.26E-06	2.11E-06	1.96E-06	1.56E-06	1.16E-06	2.76E-06	1.59E-06	1.16E-06	1.77E-06	2.56E-06	2.76E-06
Concentration in TL4 Fish (b)	mg/kg WW	1.26E-06	2.11E-06	1.96E-06	1.56E-06	1.16E-06	2.76E-06	1.59E-06	1.16E-06	1.77E-06	2.56E-06	2.76E-06
Total Daily Intake												
Mink	mg/kg BW-d	1.73E-07	2.89E-07	2.69E-07	2.14E-07	1.58E-07	3.78E-07	2.17E-07	1.58E-07	2.43E-07	3.51E-07	3.78E-07
Great Blue Heron	mg/kg BW-d	2.22E-07	3.71E-07	3.45E-07	2.75E-07	2.03E-07	4.85E-07	2.79E-07	2.03E-07	3.11E-07	4.51E-07	4.85E-07
Belted Kingfisher	mg/kg BW-d	6.40E-07	1.07E-06	9.95E-07	7.93E-07	5.86E-07	1.40E-06	8.04E-07	5.86E-07	8.98E-07	1.30E-06	1.40E-06
NOAEL HQ												
Mink	Unitless	2.E-07	3.E-07	3.E-07	2.E-07	2.E-07	4.E-07	2.E-07	2.E-07	2.E-07	4.E-07	4.E-07
Great Blue Heron	Unitless	5.E-07	8.E-07	8.E-07	6.E-07	5.E-07	1.E-06	6.E-07	5.E-07	7.E-07	1.E-06	1.E-06
Belted Kingfisher	Unitless	1.E-06	2.E-06	2.E-06	2.E-06	1.E-06	3.E-06	2.E-06	1.E-06	2.E-06	3.E-06	3.E-06
LOAEL HQ												
Mink	Unitless	2.E-07	3.E-07	3.E-07	2.E-07	2.E-07	4.E-07	2.E-07	2.E-07	2.E-07	4.E-07	4.E-07
Great Blue Heron	Unitless	2.E-07	4.E-07	4.E-07	3.E-07	2.E-07	5.E-07	3.E-07	2.E-07	3.E-07	5.E-07	5.E-07
Belted Kingfisher	Unitless	7.E-07	1.E-06	1.E-06	9.E-07	7.E-07	2.E-06	9.E-07	7.E-07	1.E-06	1.E-06	2.E-06

Methylmercury		Lake Segment 1	Lake Segment 2	Lake Segment 3	Lake Segment 4	Lake Segment 5	Lake Segment 6	Lake Segment 7	Min	Average	95th percentile	Max
Concentration in Water (a) (EPC)	mg/L	5.76E-11	9.61E-11	8.95E-11	7.12E-11	5.26E-11	1.26E-10	7.79E-11	5.26E-11	8.16E-11	1.17E-10	1.26E-10
Concentration in TL3 Fish (b)	mg/kg WW	3.91E-05	6.54E-05	6.09E-05	4.84E-05	3.58E-05	8.56E-05	5.30E-05	3.58E-05	5.55E-05	7.96E-05	8.56E-05
Concentration in TL4 Fish (b)	mg/kg WW	1.55E-04	2.60E-04	2.42E-04	1.92E-04	1.42E-04	3.40E-04	2.10E-04	1.42E-04	2.20E-04	3.16E-04	3.40E-04
Total Daily Intake												
Mink	mg/kg BW-d	1.33E-05	2.23E-05	2.07E-05	1.65E-05	1.22E-05	2.92E-05	1.80E-05	1.22E-05	1.89E-05	2.71E-05	2.92E-05
Great Blue Heron	mg/kg BW-d	2.22E-05	3.71E-05	3.45E-05	2.75E-05	2.03E-05	4.86E-05	3.00E-05	2.03E-05	3.15E-05	4.51E-05	4.86E-05
Belted Kingfisher	mg/kg BW-d	3.46E-05	5.77E-05	5.38E-05	4.27E-05	3.16E-05	7.56E-05	4.68E-05	3.16E-05	4.90E-05	7.03E-05	7.56E-05
NOAEL HQ												
Mink	Unitless	9.E-04	1.E-03	1.E-03	1.E-03	8.E-04	2.E-03	1.E-03	8.E-04	1.E-03	2.E-03	2.E-03
Great Blue Heron	Unitless	4.E-03	6.E-03	6.E-03	5.E-03	3.E-03	8.E-03	5.E-03	3.E-03	5.E-03	8.E-03	8.E-03
Belted Kingfisher	Unitless	6.E-03	1.E-02	9.E-03	7.E-03	5.E-03	1.E-02	8.E-03	5.E-03	8.E-03	1.E-02	1.E-02
LOAEL HQ												
Mink	Unitless	5.E-04	9.E-04	8.E-04	7.E-04	5.E-04	1.E-03	7.E-04	5.E-04	8.E-04	1.E-03	1.E-03
Great Blue Heron	Unitless	3.E-04	6.E-04	5.E-04	4.E-04	3.E-04	8.E-04	5.E-04	3.E-04	5.E-04	7.E-04	8.E-04
Belted Kingfisher	Unitless	5.E-04	9.E-04	8.E-04	7.E-04	5.E-04	1.E-03	7.E-04	5.E-04	8.E-04	1.E-03	1.E-03

NOTES:

(a) Water concentration includes dissolved and suspended mercury and methylmercury and dissolved and suspended selenium. This grossly overestimates the bioavailable/dissolved concentrations of metals in the water.

(b) Fish tissue concentrations were calculated on table 4-2. Water concentration includes dissolved and suspended mercury and methylmercury and dissolved and suspended selenium. This grossly overestimates the bioavailable/dissolved concentrations of metals in the water.

mg/L milligram per liter
mg/kg milligram per kilogram
HQ Hazard Quotient
EPC Exposure point concentration

Table E-6 (continued)

Mercury + Methylmercury		Lake Segment 1	Lake Segment 2	Lake Segment 3	Lake Segment 4	Lake Segment 5	Lake Segment 6	Lake Segment 7	Min	Average	95th percentile	Max
NOAEL HQ												
Mink	Unitless	9.E-04	1.E-03	1.E-03	1.E-03	8.E-04	2.E-03	1.E-03	8.E-04	1.E-03	2.E-03	2.E-03
Great Blue Heron	Unitless	4.E-03	6.E-03	6.E-03	5.E-03	3.E-03	8.E-03	5.E-03	3.E-03	5.E-03	8.E-03	8.E-03
Belted Kingfisher	Unitless	6.E-03	1.E-02	9.E-03	7.E-03	5.E-03	1.E-02	8.E-03	5.E-03	8.E-03	1.E-02	1.E-02
LOAEL HQ												
Mink	Unitless	5.E-04	9.E-04	8.E-04	7.E-04	5.E-04	1.E-03	7.E-04	5.E-04	8.E-04	1.E-03	1.E-03
Great Blue Heron	Unitless	3.E-04	6.E-04	5.E-04	4.E-04	3.E-04	8.E-04	5.E-04	3.E-04	5.E-04	7.E-04	8.E-04
Belted Kingfisher	Unitless	5.E-04	9.E-04	8.E-04	7.E-04	5.E-04	1.E-03	7.E-04	5.E-04	8.E-04	1.E-03	1.E-03

This represents the combined HQ (and is therefore a Hazard Index or HI) for divalent inorganic mercury plus methylmercury.

Selenium		Lake Segment 1	Lake Segment 2	Lake Segment 3	Lake Segment 4	Lake Segment 5	Lake Segment 6	Lake Segment 7	Min	Average	95th percentile	Max
Concentration in Water (a) (EPC)	mg/L	1.16E-06	2.03E-06	3.95E-06	5.89E-04	3.39E-04	1.81E-05	2.82E-05	1.16E-06	1.40E-04	5.14E-04	5.89E-04
Concentration in TL3 Fish (b)	mg/kg WW	1.49E-04	2.62E-04	5.09E-04	7.60E-02	4.37E-02	2.33E-03	3.64E-03	1.49E-04	1.81E-02	6.63E-02	7.60E-02
Concentration in TL4 Fish (b)	mg/kg WW	1.49E-04	2.62E-04	5.09E-04	7.60E-02	4.37E-02	2.33E-03	3.64E-03	1.49E-04	1.81E-02	6.63E-02	7.60E-02
Total Daily Intake												
Mink	mg/kg BW-d	2.06E-05	3.60E-05	7.02E-05	1.05E-02	6.03E-03	3.21E-04	5.02E-04	2.06E-05	2.49E-03	9.13E-03	1.05E-02
Great Blue Heron	mg/kg BW-d	2.63E-05	4.61E-05	8.97E-05	1.34E-02	7.70E-03	4.10E-04	6.41E-04	2.63E-05	3.18E-03	1.17E-02	1.34E-02
Belted Kingfisher	mg/kg BW-d	7.58E-05	1.33E-04	2.59E-04	3.86E-02	2.22E-02	1.18E-03	1.85E-03	7.58E-05	9.18E-03	3.37E-02	3.86E-02
NOAEL HQ												
Mink	Unitless	1.E-04	2.E-04	4.E-04	5.E-02	3.E-02	2.E-03	3.E-03	1.E-04	1.E-02	5.E-02	5.E-02
Great Blue Heron	Unitless	5.E-05	9.E-05	2.E-04	3.E-02	2.E-02	8.E-04	1.E-03	5.E-05	6.E-03	2.E-02	3.E-02
Belted Kingfisher	Unitless	2.E-04	3.E-04	5.E-04	8.E-02	4.E-02	2.E-03	4.E-03	2.E-04	2.E-02	7.E-02	8.E-02
LOAEL HQ												
Mink	Unitless	6.E-05	1.E-04	2.E-04	3.E-02	2.E-02	1.E-03	2.E-03	6.E-05	8.E-03	3.E-02	3.E-02
Great Blue Heron	Unitless	3.E-05	5.E-05	9.E-05	1.E-02	8.E-03	4.E-04	6.E-04	3.E-05	3.E-03	1.E-02	1.E-02
Belted Kingfisher	Unitless	8.E-05	1.E-04	3.E-04	4.E-02	2.E-02	1.E-03	2.E-03	8.E-05	9.E-03	3.E-02	4.E-02

Table E-7 Toxicity Reference Values

Constituent	Toxicity Reference Values (mg/kg-BW/day)				
	Mink		Avians		Note
	NOAEL	LOAEL	NOAEL	LOAEL	
Mercury (mercuric chloride)	1	1	0.45	0.9	(a)
Mercury (methyl mercury)	0.015	0.025	0.006	0.064	(a)
Selenium	0.2	0.33	0.5	1	(a)

NOTES:

(a) Toxicological Benchmarks for Wildlife: 1996 Revision. ES/ER/TM-86/R3 Sample, Opresko, and Suter II. Prepared by the Risk Assessment Program Health Sciences Research Division Oak Ridge, Tennessee 37831. ttp://www.hsrd.ornl.gov/ecorisk/tm86r3.pdf NOAEL data from Table 12

Note: that if a constituent lacked a LOAEL, the NOAEL was used for both TRVs

NOAEL No observable adverse effect level
LOAEL Lowest observable adverse effect level
TRV Toxicity reference value
mg/kg-BW/day milligram per killogram - bodyweight per day

Table E-8 Summary of Average HQs

	Inorganic Mercury HQ	Methylmercury HQ	Selenium HQ
TL2 Aquatic Invertebrate	0.0000009	0.000001	0.02
TL3 Threadfin Shad	0.0000009	0.00003	0.02
TL4 Striped Bass	0.0000009	0.00003	0.02
Mink	0.0000002	0.001	0.01
Great Blue Heron	0.0000007	0.005	0.006
Belted Kingfisher	0.000002	0.008	0.02

NOTES:
The HQs are for average sitewide values for NOAELs or low CBRs.
HQ Hazard Quotient
NOAEL No observable adverse effect level
CBR Critical body residue

Table E-9 Total Daily Intake and Food Web Model

Inorganic Mercury		Lake Segment 1	Lake Segment 2	Lake Segment 3	Lake Segment 4	Lake Segment 5	Lake Segment 6	Lake Segment 7	Min	Average	95th percentile	Max
Concentration in Water (a) (EPC)	mg/L	3.58E-10	5.97E-10	5.56E-10	4.43E-10	3.28E-10	7.82E-10	4.49E-10	3.28E-10	5.02E-10	7.27E-10	7.82E-10
Concentration in TL3 Fish (b)	mg/kg WW	1.26E-06	2.11E-06	1.96E-06	1.56E-06	1.16E-06	2.76E-06	1.59E-06	1.16E-06	1.77E-06	2.56E-06	2.76E-06
Concentration in TL4 Fish (b)	mg/kg WW	1.26E-06	2.11E-06	1.96E-06	1.56E-06	1.16E-06	2.76E-06	1.59E-06	1.16E-06	1.77E-06	2.56E-06	2.76E-06
Total Daily Intake												
Mink	mg/kg BW-d	1.73E-07	2.89E-07	2.69E-07	2.14E-07	1.58E-07	3.78E-07	2.17E-07	1.58E-07	2.43E-07	3.51E-07	3.78E-07
Great Blue Heron	mg/kg BW-d	2.22E-07	3.71E-07	3.45E-07	2.75E-07	2.03E-07	4.85E-07	2.79E-07	2.03E-07	3.11E-07	4.51E-07	4.85E-07
Belted Kingfisher	mg/kg BW-d	6.40E-07	1.07E-06	9.95E-07	7.93E-07	5.86E-07	1.40E-06	8.04E-07	5.86E-07	8.98E-07	1.30E-06	1.40E-06
NOAEL HQ												
Mink	Unitless	2.E-07	3.E-07	3.E-07	2.E-07	2.E-07	4.E-07	2.E-07	2.E-07	2.E-07	4.E-07	4.E-07
Great Blue Heron	Unitless	5.E-07	8.E-07	8.E-07	6.E-07	5.E-07	1.E-06	6.E-07	5.E-07	7.E-07	1.E-06	1.E-06
Belted Kingfisher	Unitless	1.E-06	2.E-06	2.E-06	2.E-06	1.E-06	3.E-06	2.E-06	1.E-06	2.E-06	3.E-06	3.E-06
LOAEL HQ												
Mink	Unitless	2.E-07	3.E-07	3.E-07	2.E-07	2.E-07	4.E-07	2.E-07	2.E-07	2.E-07	4.E-07	4.E-07
Great Blue Heron	Unitless	2.E-07	4.E-07	4.E-07	3.E-07	2.E-07	5.E-07	3.E-07	2.E-07	3.E-07	5.E-07	5.E-07
Belted Kingfisher	Unitless	7.E-07	1.E-06	1.E-06	9.E-07	7.E-07	2.E-06	9.E-07	7.E-07	1.E-06	1.E-06	2.E-06

Methylmercury		Lake Segment 1	Lake Segment 2	Lake Segment 3	Lake Segment 4	Lake Segment 5	Lake Segment 6	Lake Segment 7	Min	Average	95th percentile	Max
Concentration in Water (a) (EPC)	mg/L	5.76E-11	9.61E-11	8.95E-11	7.12E-11	5.26E-11	1.26E-10	7.79E-11	5.26E-11	8.16E-11	1.17E-10	1.26E-10
Concentration in TL3 Fish (b)	mg/kg WW	3.91E-05	6.54E-05	6.09E-05	4.84E-05	3.58E-05	8.56E-05	5.30E-05	3.58E-05	5.55E-05	7.96E-05	8.56E-05
Concentration in TL4 Fish (b)	mg/kg WW	1.55E-04	2.60E-04	2.42E-04	1.92E-04	1.42E-04	3.40E-04	2.10E-04	1.42E-04	2.20E-04	3.16E-04	3.40E-04
Total Daily Intake												
Mink	mg/kg BW-d	1.33E-05	2.23E-05	2.07E-05	1.65E-05	1.22E-05	2.92E-05	1.80E-05	1.22E-05	1.89E-05	2.71E-05	2.92E-05
Great Blue Heron	mg/kg BW-d	2.22E-05	3.71E-05	3.45E-05	2.75E-05	2.03E-05	4.86E-05	3.00E-05	2.03E-05	3.15E-05	4.51E-05	4.86E-05
Belted Kingfisher	mg/kg BW-d	3.46E-05	5.77E-05	5.38E-05	4.27E-05	3.16E-05	7.56E-05	4.68E-05	3.16E-05	4.90E-05	7.03E-05	7.56E-05
NOAEL HQ												
Mink	Unitless	9.E-04	1.E-03	1.E-03	1.E-03	8.E-04	2.E-03	1.E-03	8.E-04	1.E-03	2.E-03	2.E-03
Great Blue Heron	Unitless	4.E-03	6.E-03	6.E-03	5.E-03	3.E-03	8.E-03	5.E-03	3.E-03	5.E-03	8.E-03	8.E-03
Belted Kingfisher	Unitless	6.E-03	1.E-02	9.E-03	7.E-03	5.E-03	1.E-02	8.E-03	5.E-03	8.E-03	1.E-02	1.E-02
LOAEL HQ												
Mink	Unitless	5.E-04	9.E-04	8.E-04	7.E-04	5.E-04	1.E-03	7.E-04	5.E-04	8.E-04	1.E-03	1.E-03
Great Blue Heron	Unitless	3.E-04	6.E-04	5.E-04	4.E-04	3.E-04	8.E-04	5.E-04	3.E-04	5.E-04	7.E-04	8.E-04
Belted Kingfisher	Unitless	5.E-04	9.E-04	8.E-04	7.E-04	5.E-04	1.E-03	7.E-04	5.E-04	8.E-04	1.E-03	1.E-03

NOTES:

(a) Water concentration includes dissolved and suspended mercury and methylmercury and dissolved and suspendid selenium. This grossly overestimates the bioavailable/dissolved concentrations of metals in the water.

(b) Fish tissue concentrations were calculated on table 4-2. Water concentration includes dissolved and suspended mercury and methylmercury and dissolved and suspended selenium. This grossly overestimates the bioavailable/dissolved concentrations of metals in the water.

mg/L milligram per liter
mg/kg milligram per kilogram
HQ Hazard Quotient
EPC Exposure Point Concentration

Table E-9 (continued)

Mercury + Methylmercury		Lake Segment 1	Lake Segment 2	Lake Segment 3	Lake Segment 4	Lake Segment 5	Lake Segment 6	Lake Segment 7	Min	Average	95th percentile	Max
NOAEL HQ												
Mink	Unitless	9.E-04	1.E-03	1.E-03	1.E-03	8.E-04	2.E-03	1.E-03	8.E-04	1.E-03	2.E-03	2.E-03
Great Blue Heron	Unitless	4.E-03	6.E-03	6.E-03	5.E-03	3.E-03	8.E-03	5.E-03	3.E-03	5.E-03	8.E-03	8.E-03
Belted Kingfisher	Unitless	6.E-03	1.E-02	9.E-03	7.E-03	5.E-03	1.E-02	8.E-03	5.E-03	8.E-03	1.E-02	1.E-02
LOAEL HQ												
Mink	Unitless	5.E-04	9.E-04	8.E-04	7.E-04	5.E-04	1.E-03	7.E-04	5.E-04	8.E-04	1.E-03	1.E-03
Great Blue Heron	Unitless	3.E-04	6.E-04	5.E-04	4.E-04	3.E-04	8.E-04	5.E-04	3.E-04	5.E-04	7.E-04	8.E-04
Belted Kingfisher	Unitless	5.E-04	9.E-04	8.E-04	7.E-04	5.E-04	1.E-03	7.E-04	5.E-04	8.E-04	1.E-03	1.E-03

This represents the combined HQ (and is therefore a Hazard Index or HI) for divalent inorganic mercury plus methylmercury.

Selenium		Lake Segment 1	Lake Segment 2	Lake Segment 3	Lake Segment 4	Lake Segment 5	Lake Segment 6	Lake Segment 7	Min	Average	95th percentile	Max
Concentration in Water (a) (EPC)	mg/L	1.16E-06	2.03E-06	3.95E-06	5.89E-04	3.39E-04	1.81E-05	2.82E-05	1.16E-06	1.40E-04	5.14E-04	5.89E-04
Concentration in TL3 Fish (b)	mg/kg WW	1.49E-04	2.62E-04	5.09E-04	7.60E-02	4.37E-02	2.33E-03	3.64E-03	1.49E-04	1.81E-02	6.63E-02	7.60E-02
Concentration in TL4 Fish (b)	mg/kg WW	1.49E-04	2.62E-04	5.09E-04	7.60E-02	4.37E-02	2.33E-03	3.64E-03	1.49E-04	1.81E-02	6.63E-02	7.60E-02
Total Daily Intake												
Mink	mg/kg BW-d	2.06E-05	3.60E-05	7.02E-05	1.05E-02	6.03E-03	3.21E-04	5.02E-04	2.06E-05	2.49E-03	9.13E-03	1.05E-02
Great Blue Heron	mg/kg BW-d	2.63E-05	4.61E-05	8.97E-05	1.34E-02	7.70E-03	4.10E-04	6.41E-04	2.63E-05	3.18E-03	1.17E-02	1.34E-02
Belted Kingfisher	mg/kg BW-d	7.58E-05	1.33E-04	2.59E-04	3.86E-02	2.22E-02	1.18E-03	1.85E-03	7.58E-05	9.18E-03	3.37E-02	3.86E-02
NOAEL HQ												
Mink	Unitless	1.E-04	2.E-04	4.E-04	5.E-02	3.E-02	2.E-03	3.E-03	1.E-04	1.E-02	5.E-02	5.E-02
Great Blue Heron	Unitless	5.E-05	9.E-05	2.E-04	3.E-02	2.E-02	8.E-04	1.E-03	5.E-05	6.E-03	2.E-02	3.E-02
Belted Kingfisher	Unitless	2.E-04	3.E-04	5.E-04	8.E-02	4.E-02	2.E-03	4.E-03	2.E-04	2.E-02	7.E-02	8.E-02
LOAEL HQ												
Mink	Unitless	6.E-05	1.E-04	2.E-04	3.E-02	2.E-02	1.E-03	2.E-03	6.E-05	8.E-03	3.E-02	3.E-02
Great Blue Heron	Unitless	3.E-05	5.E-05	9.E-05	1.E-02	8.E-03	4.E-04	6.E-04	3.E-05	3.E-03	1.E-02	1.E-02
Belted Kingfisher	Unitless	8.E-05	1.E-04	3.E-04	4.E-02	2.E-02	1.E-03	2.E-03	8.E-05	9.E-03	3.E-02	4.E-02

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