Coal Dust Analysis

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Acronyms and Abbreviations

%/w/w	percentage weight/weight
µg/g	microns per gram
µg/kg	microns per kilogram
µg/L	microns per liter
ATSDR	Association for Toxic Substances and Disease Registry
BCFs	bioconcentration factors
BD	below detection
BNSF	BNSF Railway Company
BTAG	Biological Technical Assistance Group
C.F.R	Code of Federal Regulations
EC_{50}	half-maximal effective concentration
Eco-SSL	ecological soil screening level
ERL	effects range-low
g/kg	grams per kilogram
g/m^2	grams per square meter
KOC	soil organic carbon-water partitioning coefficient
lb/gal	pounds per gallon
LC_{50}	lethal concentration 50
LD_{50}	median lethal dose
MCLGs	maximum contaminant level goals
MCLs	maximum contaminant levels
mg element/kg coal dust	milligrams of element to kilograms of coal dust
mg/kg	milligrams per kilogram
mg/L	milligrams per liter
mg/m^2	milligrams per square meter
mg/m^3	milligrams per cubic meter
ml/kg	milliliters per kilogram
MSDS	material safety data sheet
N/A	not applicable

NOEC	no observed effect concentration
OEA	Office of Environmental Analysis
PNEC	predicted no effect concentration
ppm	parts per million
RfD	reference dose
SSL	soil screening level
TSS	total suspended solids
U/kg	unit per kilogram
USEPA	U.S. Environmental Protection Agency

G.1   Introduction

Potential inhalation impacts of particulate matter, including coal dust, are discussed in Chapter 4, *Air Quality*, Chapter 6, *Coal Dust*, and Appendix E, *Air Quality, Emissions, and Modeling Analysis*. Airborne coal dust that deposits into environmental media could pose ingestion risks and hazards to humans and ecological receptors. These ingestion risks are summarized in Chapter 6. This appendix provides the details of the modeling analysis of coal dust ingestion and its impacts on human health and ecological receptors.[1]

G.2   Human Health Ingestion Impacts

The Office of Environmental Analysis (OEA) analyzed human health impacts that could result from ingesting coal dust constituents associated with coal dust emissions from the proposed rail line. OEA used a deposition model combined with a fate and transport model to estimate concentrations of coal dust constituents in soil, water, and sediment, and corresponding concentrations in drinking water and fish. In the absence of information about health impacts from ingesting the coal dust itself, OEA focused on ingestion of the trace elements in coal dust, based on the trace element characteristics of Otter Creek coal.

OEA used conservative assumptions to estimate the concentrations of trace elements from coal dust in soil, water, and sediment and then compared these concentrations to health screening levels specific to each pollutant and intake (ingestion) medium as set by the U.S. Environmental Protection Agency (USEPA), where available. When USEPA screening levels were not available for coal dust constituents, OEA used additional USEPA or other regional guidance levels (U.S. Environmental Protection Agency 2002, 2008, 2009, 2013a, 2014a). OEA used this approach to identify potential human health and ecological impacts (Section G.3, *Ecological Exposure Analysis*) that could be evaluated further in site-specific analyses. OEA found that a site-specific analysis was not warranted for trace elements in coal dust based on the results of the screening-level analysis.

OEA also analyzed health impacts that could result from ingesting the organic compounds in coal topper agents. These agents are used to control dust emissions from rail cars and could be emitted with the coal dust. OEA conducted a screening-level analysis and found that a site-specific analysis was not warranted because the concentrations of the constituents of coal

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[1] This appendix provides supporting information for Chapters 4 and 6 of the *Draft Environmental Impact Statement for the Tongue River Railroad*. This information should not be interpreted as stand-alone information and must be read in combination with the associated chapters.

topper agents in the environment would be well below the concentrations that could result in impacts.

OEA's analysis of potential human health impacts consisted of four parts.

- Analysis of coal composition and topper agent constituents in coal dust.

- Development of the coal dust deposition and fate and transport models.

- Identification of human health screening levels for coal dust constituents, including trace elements and topper agent constituents.

- Evaluation of the potential for human health impacts resulting from ingesting coal dust constituents and topper agent constituents, based on modeling results.

G.2.1   Coal Composition and Trace Constituents in Coal Dust

The Montana Bureau of Mines and Geology supplied data to OEA from composite samples from the Otter Creek coal bed. These coal bed composite data, analyzed in 2004, included mass concentrations of trace elements (e.g., metals) in the coal. The data were presented in two separate data workbooks that did not contain the same set of trace elements, though some elements were in both workbooks (Table G-1). OEA included in the exposure assessment each of the trace elements that had measured values in the composite data. To obtain a single concentration value for each trace element, OEA averaged the concentrations of each chemical in each workbook. Then, if the element was reported in both workbooks, OEA averaged the two averages into an overall average concentration (Table G-1).

For a given trace element included in a given workbook (independent of the other workbook), if all concentrations for that element were below detection level, then OEA did not include that element from that workbook in the overall average. This was true for antimony, cadmium, chlorine, molybdenum, arsenic, selenium, tin, silver, bromine, thallium, and thorium in one workbook.

If the data reported for an element in a workbook included values both above the detection limit and below the detection limit, then OEA calculated the average concentration for that element using all of the reported data by assuming that results below the detection limit were in fact equal to the detection limit. This was the case with antimony, arsenic, bromine, cadmium, chlorine, cobalt, molybdenum, nickel, silver, and tin from one workbook.

Values for molybdenum, thorium, and tin were not reported in one of the workbooks and were below detection for all data points in the other workbook; OEA did not include these trace elements in the coal dust exposure analysis. OEA also found few relevant human health and ecological benchmarks to evaluate molybdenum, thorium, and tin.

Of the trace constituents analyzed, barium and strontium have the largest mass concentrations, respectively accounting for 0.06 and 0.05 percent of Otter Creek coal by

mass, and for 44 and 37 percent of all analyzed trace elements. The concentrations of all other analyzed trace elements were at least five times smaller than that of barium. Mercury was present in the smallest amount, making up 0.000002 percent of Otter Creek coal. Taken together, these analyzed trace elements make up less than 1 percent of coal dust by mass (Table G-1).

Table G-1. Average Trace Element Concentrations in Otter Creek Coal Used in Coal Dust Exposure Analysis

Trace Element	Average Concentration (ppm or µg/g, which are equivalent)			Percent Concentration (%)	Concentration Rank
	Workbook 1	Workbook 2	Final		
Antimony	0.31	BD	0.31	0.000031	19
Arsenic	0.62	BD	0.62	0.000062	17
Barium	690.00	420.00	550.00	0.055403	1
Beryllium	0.29	0.27	0.28	0.000028	20
Boron	N/A	61.00	61.00	0.006127	4
Bromine	13.00	BD	13.00	0.001300	7
Cadmium	0.04	BD	0.04	0.000004	24
Chlorine	86.00	BD	86.00	0.008560	3
Chromium	2.20	4.00	3.10	0.000310	12
Cobalt	0.87	1.07	0.97	0.000097	16
Copper	5.90	5.10	5.50	0.000546	11
Fluorine	4.00	30.00	17.00	0.001682	6
Lead	2.80	2.90	2.90	0.000287	13
Lithium	8.10	8.10	8.10	0.000808	9
Manganese	17.00	20.00	18.00	0.001813	5
Mercury	0.01	0.03	0.02	0.000002	25
Molybdenum	N/A	BD	--	--	--
Nickel	2.20	1.2	1.7	0.000170	15
Selenium	0.28	BD	0.28	0.000028	20
Silver	0.12	BD	0.12	0.000012	22
Strontium	N/A	470.00	470.00	0.046513	2
Thallium	0.05	BD	0.05	0.000005	23
Thorium	N/A	BD	--	--	--
Tin	N/A	BD	--	--	--
Uranium	0.60	0.26	0.43	0.000043	18
Vanadium	4.90	7.40	6.10	0.000613	10
Zinc	3.00	1.50	2.20	0.000223	14
Zirconium	N/A	10.00	10.00	0.001007	8

Notes:

ppm = parts per million; µg/g = microns per gram; N/A = not applicable; element was not analyzed; BD = below detection for most or all samples

Final values reflect rounding.

Source: Montana Department of Natural Resources Conservation 2006

G.2.2   Coal Car Topper Agents

BNSF Railway Company (BNSF) requires that its shippers control coal dust emissions from rail cars originating at coal mines in Montana and Wyoming. Those requirements are met if the shipper applies an approved topper agent in accordance with manufacturer's instructions after the coal has been profiled (shaped) in the railcar (BNSF Railway Company 2013). This section includes a discussion of each of the topper agents, their constituents, and the potential impacts on human health from ingesting topper agent constituents.

G.2.2.1   Topper Constituent Exposure

Table G-2 summarizes the topper agents approved by BNSF, their application rates, and reported chemical constituents as identified in the material safety data sheets (MSDS) for each product (from either SNC Lavalin 2013 or current manufacturer's websites, whichever was more current and complete). The MSDS include wide ranges for the concentrations of some the constituents (e.g., 5 to 50 percent). In other cases, the MSDS identify some constituents as "proprietary" and provide no further information.

OEA conducted a screening-level analysis for topper constituents. With constituent concentration data from the MSDS and toxicity data from other sources, OEA assessed the relative concentration and toxicity of BNSF-approved topper constituents to identify a subset of topper constituents for inclusion in the analysis. Where ranges of topper-constituent concentrations were reported in the MSDS, OEA assessed the highest concentration in the range. Unless otherwise specified, all information in the following discussions on topper agents comes from the topper agent MSDS included in SNC Lavalin (2013).

Summary of Topper Constituent Exposure

Most of the constituents in the topper agents (by percentage) identified in the MSDS have low potential for human health impacts from ingestion based on toxicity information in the MSDS and based on health impacts information, including lethal dose 50 (LD_{50} values), which is the concentration required to cause mortality in 50 percent of a test population of animals (such as mice) in a laboratory setting. Some of the constituents can cause skin and eye irritation with prolonged contact, or irritation of the gastrointestinal tract following ingestion. OEA provides further details below for each topper agent.

Table G-2. Properties of BNSF Acceptable Topper Agents and Application Rates

Topper Agent[a]	Concentrate Applied Per Railcar[b] (gallons)	Total Solution Applied Per Railcar[c] (gallons)	% Solution (Concentrate/ Solution)	Main Product Components (%w/w in topper agent concentrate)
Nalco Dustbind Plus	2	20	10	• Alkyl alcohol (30–60%)
Midwest Soil-Sement	1.25	18.75	6.67	• Acrylic and vinyl acetate polymer (5–50%) • Water (50–95%)
AKJ CTS-100[d]	1.36[e]	15	9	Water (85-98%) Proprietary additive (0.1–2%) • Polyvinyl acetate CAS: 116698-48-7 (2-15%)
AKJ CTS-100C	1.36[e]	15	9	Water (>40%) Proprietary additive (<2%) • Polyvinyl acetate CAS: 116698-48-7 (25–55%)
Rantec Capture 3000	2.5 pounds	20	0.125 lb/gal	Guar gum CAS: 9000-30-0 (40–50%) Soybean oil CAS: 8001-22-7 (40-50%) • Organophillic Clay CAS: 68953-58-2 (1–1.5%) Oleic acid CAS: 112-80-1 (1–1.5%) • Surfactant nonylphenyl CAS: 127087-87-0 (0.8–1%) • Propylene carbonate CAS: 108-32-7 (<0.2%) • (none of the constituents are labeled as hazardous in the MSDS)
MinTech Min Topper S+0150	1.1	20	5.5	• Proprietary: topper constituents are not identified in the MSDS • From MSDS sheet: "This product does not contain a toxic chemical subject to the reporting requirements of Section 313 of the Emergency Planning and Community Right-To-Know Act of 1986 (40 C.F.R. Part 372)."

Notes:
%/w/w = percentage weight/weight; lb/gal = pounds per gallon; MSDS = material safety data sheet; C.F.R. = Code of Federal Regulations
[a] For topper application only
[b] The amount of topper agent concentrate mixed into a solution for each railcar
[c] The amount of topper agent solution applied to each railcar (topper agent concentrate plus dilution water)
[d] Source of main product components for CTS-100: AKJ Industries (2012)
[e] 1.36 gallons of concentrate (CTS-100C) mixed with 13.64 gallons of water
Source unless otherwise noted: SNC Lavalin (2013)

Nalco Dustbind Plus

The only component of Nalco Dustbind Plus listed in the MSDS is alkyl alcohol, and the identity of the chemical is not further specified (e.g., no CAS # or chain length provided). Alkyl alcohols (C6-C13) have oral LD_{50}) values ranging from 2,000 to 3,900 milligrams per kilogram (mg/kg) in Sprague-Dawley and Wistar rats (U.S. Environmental Protection Agency 2006a), an indication of low oral toxicity according to EPA characterization (U.S. Environmental Protection Agency 2008).

Alkyl alcohols have low bioaccumulation potential and range from moderate to high in aquatic toxicity, with 72-hour median effective concentration (EC_{50}, the concentration required to produce half the maximum effect in a test subject) values ranging from 2.6 to 89 milligrams per liter (mg/L) and chronic toxicity ranges from 0.03 to 16.1 mg/L in the three tested trophic levels (U.S. Environmental Protection Agency 2006a). A trophic level is a hierarchy in the aquatic ecosystem and other natural systems, equivalent to levels of the food chain. The alkyl alcohols are less toxic in the terrestrial environment than the aquatic environment, with 14-day lethal concentration 50 (LC_{50}) in earthworms ranging from 128 to 880 mg/kg soil.

Nalco Dustbind Plus mixes in water with partial homogeneity. Approximately 10 to 30 percent is mobile in water, 70 to 90 percent is mobile in soil/sediment, and less than 5 percent is mobile in air. The pH of this agent is not reported, and some constituents of this agent are listed as "proprietary" and are not identified in the MSDS. Physical hazards are described as low (ratings of 1 out of 4 for health and flammability, 0 for instability) and the agent is identified as noncarcinogenic. Based on the MSDS, potential health hazards include eye or skin irritation with prolonged contact, and irritation of lungs or gastrointestinal tract if inhaled or ingested.

According to data from the NALCO Dustbind Plus MSDS, alkyl alcohols released to the environment would likely deposit primarily (70 to 90 percent) in the soil or sediment, with less entering the aquatic environment (10 to 30 percent) or air (less than 5 percent), but this depends on the carbon chain length of the alcohols. Chains of 6 to 10 carbon lengths are more likely to deposit into aquatic environments and chains of 11 to 16 carbon lengths are more likely to deposit in the soil and sediment (U.S. Environmental Protection Agency 2006a:Table 6). Given that the actual chain length is not specified, the environmental fate of this topper agent is uncertain.

Midwest Soil-Sement®

Midwest Soil-Sement® has low ecological toxicity, with an LC_{50} in goldfish of more than 12,500 parts per million (ppm). In the aquatic insect *Daphnia magna*, the 48-hour LC_{50} is 3,482.8 ppm. The chemical constituents of Soil-Sement® are acrylic and polyvinyl acetate polymer, listed on the MSDS as "not hazardous." Acrylic acid has high mobility in soil, is not likely to adsorb to suspended solids or sediment in water, and has low ecological toxicity

as indicated by an LC_{50} in mice of 5,300 mg/m^3 (U.S. Environmental Protection Agency 2013b). Polyvinyl acetate is widely used in wood glues and is insoluble in water. In soil, vinyl acetate is highly mobile (soil organic carbon-water partitioning coefficient [KOC] = 60) and does not tend to adsorb to suspended solids or sediment in water (Hazardous Substances Data Bank 2013). Vinyl acetate has low ecological toxicity as indicated by LC_{50} in mice and rats of 5,456 mg/m^3 and 14,080 mg/m^3, respectively (U.S. Environmental Protection Agency 2013f).

Physical and health hazards for the product are low, with ratings of 0 out of 4 for health, flammability, and reactivity (Midwest Industrial Supply 2013). Soil-Sement® may cause slight eye or skin irritation, headaches, or nausea following inhalation, and irritation to digestive tract with ingestion. Soil-Sement® can be diluted in water and has a pH ranging from 4 to 9.5 depending on formulation, but the MSDS does not describe how the constituents behave in water, soil, or sediment. OEA found limited information on the mobility characteristics of combined acrylic and polyvinyl acetate copolymers. The purpose of Soil-Sement® is to bind to soils, making it likely that the copolymer of acrylic and polyvinyl acetate will preferentially bind to soils, although given the limited information available on the composition of the product and mobility characteristics of the constituents, this is uncertain.

AKJ CTS-100

The MSDS for AKJ CTS-100 does not provide information on ecotoxicity or chronic impacts, although it notes that acute ingestion results in gastrointestinal disturbances and that its health, flammability, and physical hazard ratings are 1-0-0. The primary component of CTS-100 is polyvinyl acetate, which has an LD_{50} of more than 25 mg/kg in both rats and mice by oral exposure (National Library of Medicine 2014) and an $LC_{50,1-hour}$ of 5,656 ppm in rats (AKJ Industries 2012). USEPA (1997) calculated a provisional reference dose (RfD) for vinyl acetate, which is used to make polyvinyl acetate, of 1.0 mg/kg bodyweight per day.

Polyvinyl acetate is insoluble in water but may be hydrolyzed by water to polyvinyl alcohol (Hazardous Substances Data Bank 2013). The Agency for Toxic Substances and Disease Registry (ATSDR) (1992a) reports that aqueous solutions containing polyvinyl acetate can undergo biotransformation by soil fungi. Polyvinyl alcohol in water treatment systems can be degraded by the *Pseudomonas* species of bacteria (Hazardous Substances Data Bank 2013). Metabolism studies using bacterial isolates in soil show that vinyl acetate is metabolized to acetaldehyde (ATSDR 1992a). Acetaldehyde has a LD_{50} value ranging from 560 to 1,930 mg/kg in rats and mice, which is lower than that for vinyl acetate, at 1,613to 2,920 mg/kg (Hazardous Substances Data Bank 2013). Based on these values, both chemicals are considered "slightly toxic" to "practically nontoxic" based on USEPA toxicity categories (U. S. Environmental Protection Agency 2008). AKJ CTS-100 is soluble in water and has a pH ranging from 6 to 8 (AKJ Industries 2012). The MSDS does not describe the environmental mobility of the product in air, water, and soil/sediment, but the MSDS notes that accidentally released product should not be flushed into sewers.

AKJ CTS-100C

AKJ CTS-100C is soluble in water and has a pH ranging from 4 to 6 (AKJ Industries 2011). The MSDS does not describe the environmental mobility of AKJ CTS-100C in air, water, and soil/sediment, nor does it provide information on ecotoxicity. The MSDS identifies the rating as 1, 0, and 0 for health, flammability, and physical hazard, respectively. The MSDS states that acute ingestion may result in gastrointestinal disturbances, but does not provide data on chronic impacts from oral exposure.

The primary component of CTS-100C is polyvinyl acetate, which is described in the above section on AKJ CTS-100.

Rantec Capture 3000

The MSDS for Rantec Capture 3000 describes the physical hazards from the product as low; it is not a carcinogen, not corrosive, not highly toxic, and not a sensitizer, but "may cause skin/eye irritation." No information on ecotoxicity is provided in the MSDS. Rantec Capture 3000 is soluble in water. The MSDS does not list the pH of the product.

Rantec Capture 3000 has several chemical constituents listed in the MSDS, including guar gum, soybean oil, Organophillic clay, oleic acid, nonylphenyl surfactant, and propylene carbonate. Guar gum, which is a nontoxic, food-grade product, has an oral LD_{50} of 9.4 grams per kilogram in the rat (g/kg). Soybean oil is essentially nontoxic, with LD_{50} values of 16,500 mg/kg and 22,100 mg/kg in rats and mice, respectively (National Library of Medicine 2014). Organophillic clay is listed in the MSDS as "moderate" for "other human health priorities," "uncertain" for "inherently toxic to aquatic organisms," and not bioaccumulative or persistent by Environment Canada (2013). Organophillic clay is not irritating to skin or eyes and is not a sensitizer (Hazardous Substances Data Bank 2013).

Oleic acid, which occurs naturally in animal and vegetable fats and oils, is nontoxic with a probable oral human lethal dose of more than 15 g/kg (Hazardous Substances Data Bank 2103). In ecotoxicity assays, oleic acid was not significantly toxic up to 75 mg/L in freshwater fishes and sea urchins (Hazardous Substances Data Bank 2013). An oral LD_{50} value of 74 g/kg is reported for oleic acid in rats (Hazardous Substances Data Bank 2013). If released to soil, oleic acid is not mobile, and in water it tends to adsorb to suspended solids and sediment (KOC = 340,000).

The nonylphenyl surfactant is described by Environment Canada as not persistent or bioaccumulative and not inherently toxic to aquatic organisms (Environment Canada 2013). The National Institutes of Health includes comments that nonylphenyl causes "other liver changes" in acute intraperitoneal injection studies in unspecified nonmammalian species and is an eye irritant, but an LC_{50} is not reported (National Library of Medicine 2014). Other information is not available on this component.

Propylene carbonate exhibits very low toxicity, with an oral LD_{50} of more than 20 milliliters per kilogram (ml/kg) in rabbits (Hazardous Substances Data Bank 2013). Propylene carbonate is listed as not inherently toxic to aquatic organisms and is not bioaccumulative or persistent (Environment Canada 2013). In soil, propylene carbonate is highly mobile and does not adsorb to suspended solids and sediment in water (KOC = 14) (Hazardous Substances Data Bank 2013).

MinTech Min Topper S+0150

The MSDS states that MinTech Min Topper S+0150 "does not contain a toxic chemical subject to the reporting requirements of Section 313 of the Emergency Planning and Community Right-To-Know Act of 1986 (40 C.F.R. Part 372)." No additional information is provided in the MSDS on the chemical components in Min Topper S+0150. MinTech Min Topper S+0150 is dispersible in water and has a pH ranging from 7 to 9. Physical hazards are generally low (1 for health and 0 for flammability and reactivity) as reported in the MSDS, although it may potentially cause eye, skin, and respiratory irritation.

G.2.2.2 Topper Agent Applications

OEA estimated the amount of topper agents that could be emitted from rail cars along with coal dust using a mass balance calculation. First, OEA estimated the amount of topper agent and its primary constituents that would be typically applied to a coal rail car using the following steps.

1. **Topper Agent Application Rate by Volume**

   For a calculation based on the application of Nalco DustBind to a coal rail car, OEA assumed that the application rate is 20 gallons of topper agent solution (containing 2 gallons of topper agent concentrate, or a 10 percent solution) per railcar (SNC Lavalin 2013).

2. **Topper Agent Concentration and Application Rate by Mass**

   Assuming that the topper agent concentrate is 60 percent alkyl alcohol by weight and 9.7 pounds per gallon (lb/gal), based on information from the MSDS, then 20 gallons of 10 percent topper agent solution corresponds to 11.64 pounds of alkyl alcohol applied per railcar.

3. **Railcar Surface Area, Railcar Volume, and Topper Agent Penetration Rate**

   Assuming a railcar is 480 square feet in surface area or 4,603 cubic feet in volume (BNSF Railway Company 2013) and assuming that the topper agent penetrates the top 4 inches of the coal in the railcar, the topper agent would penetrate 160 cubic feet of coal, corresponding to approximately 3.5 percent of the coal in the railcar.

4. **Amount (Mass) of Coal Penetrated by Topper Agent**

A filled railcar would contain approximately 236,000 pounds of coal, of which 3.5 percent would be 8,203 pounds.

5. Concentration of Topper Agent Ingredient in Penetrated Coal Layer

Therefore, 11.64 pounds of alkyl alcohol in 8,203 pounds of coal implies that the alkyl alcohol concentration in the top layer of coal would be approximately 0.14 percent.

Because coal dust blown from a rail car would come from the top layer of coal in the rail car, OEA assumed that the concentration of alkyl alcohol in coal dust would also be 0.14 percent.

6. Apply Similar Calculations to other Topper Agent Ingredients

Using a similar set of calculations for other topper agent constituents, OEA estimated that concentrations of other topper agent constituents in coal dust would range from approximately 0.02 percent to 0.14 percent (Table G-3). Based on the estimated amount of topper agent ingredients that would be emitted from railcars, OEA expects potential levels of human exposure to topper constituents to be well below levels that could lead to irritation of the skin, eyes, or gastrointestinal tract.

Table G-3. Estimated Concentration of Topper Constituents in Coal Dust

Topper Agent	Primary Constituent	Concentration of Primary Constituent[a] (%)	Amount of Topper Agent Applied per Railcar (pounds)	Amount of Topper Agent Constituent per Railcar (pounds)	Estimated Concentration of Constituent in Coal Dust (weight percent)	Oral Toxicity Value - LD_{50} (species)
Nalco Dustbind	Alkyl alcohol	60	19.40	11.64	0.14	2,000–3,900 mg/kg (rat)
Midwest Soil Sement®	Acrylic and vinyl acetate polymer	50	11.99	5.99	0.07	1613–2920 mg/kg (rat & mouse, vinyl acetate)
AKJ CTS-100	Polyvinyl acetate	15	12.47	1.87	0.02	1613–2920 mg/kg (rat & mouse, vinyl acetate)
AKJ CTS-100C	Polyvinyl acetate	55	12.47	6.86	0.08	"no toxic hazards associated with the use of this latex adhesive" (HSDB, 2013)

Notes:
[a] Maximum concentration value identified for the constituent in the MSDS for the topper agent
Source: SNC Lavalin (2013)

Topper agents applied to the coal would be combusted with the coal. For a calculation based on application of Nalco DustBind Plus topper agent to railcars, as an example, 11.64 pounds of alkyl alcohol would be applied to a railcar. Considering the capacity of a railcar is 236,000 pounds of coal, OEA estimates that the amount of topper agent in coal combusted

would be 0.099 pound of alkyl alcohol per ton of coal. A typical 300-megawatt coal-fired power plant would combust 200 tons per hour of coal (the coal contents of approximately 1.7 fully loaded coal railcars per hour) (Briggeman and Gallacher 2014). This rate would correspond to a feed rate to the coal-fired power plant of 20 pounds per hour of the constituent alkyl alcohol. Combustion in a coal-fired power plant boiler is extremely efficient due to the very high temperature and the characteristics of the boiler. Because of the small quantity of topper agent, the efficiency of combustion, and the effective pollutant dispersion afforded by the tall power plant stack, any air quality or ecological impacts from topper combustion would be negligible to nonexistent.

G.2.3   Coal Dust Deposition Modeling

OEA modeled coal dust emissions from the rail cars to evaluate the potential air quality (e.g., inhalation) impacts of coal dust (Appendix E, *Air Quality, Emissions, and Modeling Analysis*), other potential human health impacts (i.e., ingestion), and ecological impacts of coal dust constituents and topper constituents. OEA assumed that the Otter Creek mine would begin producing coal in 2018. The modeling outputs included estimated coal dust deposition rates by month using the USEPA AERMOD air dispersion and deposition model. The estimated coal dust emission rates were based on the maximum estimated train traffic for any scenario to provide a conservative estimate[2] (high production scenario, southern alternatives[3], 26.7 trains per day; the emission rate for the northern alternatives would be about 30 percent lower). Appendix E, *Air Quality, Emissions, and Modeling Data*, provides further detail on the modeling. OEA modeled wet, dry, and total coal dust deposition rates based on estimated rail car coal dust emissions, adjusted for the use of load profiling and topper agents for coal dust emission reduction. OEA estimated deposition rates at 10-meter intervals from the center of the rail line to a distance of 300 meters on each side of the rail line, or 60 locations (receptors). OEA evaluated particle size categories of less than 60 microns in diameter, 60 to 250 microns in diameter, and the sum of the two (i.e., all particles up to 250 microns in diameter).

As discussed in Appendix E, *Air Quality, Emissions, and Modeling Analysis*, OEA did not explicitly model particles of aerodynamic diameter larger than 250 microns because particles of this size would deposit very quickly after being blown from a rail car and would primarily deposit within the right-of-way (Figure G-1). Instead of modeling these large particulates in AERMOD at receptors spaced 10 meters apart, OEA used simplified calculations based on Stokes law to determine settling velocity for these larger particles. OEA estimated the deposition of particles larger than 250 microns based on meteorological data for the Birney monitoring station (Appendix E) and modeling of locations where the track would extend in a southwest to northeast direction. OEA determined that these particles would deposit at a

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[2] The high, medium, and low production scenarios are described in Appendix C, *Coal Production and Markets.* The implications of these scenarios for rail traffic are summarized in Chapter 2, Section 2.3.3, *Rail Traffic.*

[3] The southern alternatives are the Decker Alternatives. The northern alternatives are the Tongue River Alternatives, Colstrip Alternatives, Tongue River Road Alternatives, and Moon Creek Alternatives.

rate of 149 grams per square meter (g/m^2) per month on the southeastern side of the track and at a rate of 105 g/m^2 per month on the northwestern side of the track. Larger particles would deposit mostly within 5 meters of the center of the rail line and would not be likely to deposit outside of the rail right-of-way, even under unusually windy conditions. The coal dust emission rate assumes use of load profiling and topper agents for coal dust emission control.

To provide a conservative analysis, OEA used AERMOD to identify, at each AERMOD receptor location (those inside and outside the rail right-of-way), the largest monthly total deposition rate of all particulates up to 250 microns in diameter (i.e., the sum of the deposition rates of particles smaller than 60 microns and of particles between 60 and 250 microns). Particles larger than 250 microns were not modeled for the human health assessment because it is not realistic to expect people to spend significant amounts of time (across a lifetime) within 5 meters of the rail line. Those very large particles were modeled in watershed calculations as part of the ecological analysis (discussed in Section G.2.3, *Coal Dust Deposition Modeling*) because all particles deposited in the modeling domain could migrate into a local water body. OEA then converted the mass unit deposition rate from grams to milligrams, and divided the monthly deposition rate by the number of days in that month in order to evenly distribute the deposition rate across all days of the month. Figure G-1 shows the average daily deposition rates taken from each location's largest monthly deposition rate. As noted in the figure, the location with the largest deposition rate of particulates smaller than 250 microns (indicated in Figure G-1 as MIR) was 50 meters southeast of the rail line center which is a distance typically within the rail right-of-way.

The method of using the largest monthly deposition rate for coal dust exposure at each receptor is different from (and more conservative than) the methods used in the air quality analysis presented in Appendix E, *Air Quality, Emissions, and Modeling Data*. In the air quality analysis, OEA derived monthly deposition rates by averaging all January deposition rates, averaging all February deposition rates, and so on, for twelve average deposition values per receptor location.

For the evaluation of soil, outdoor dust, and groundwater ingestion exposure for humans, OEA conservatively selected the largest deposition rate of particulates smaller than 250 microns (i.e., 2,168 milligrams per square meter [mg/m^2] per day) at 50 meters southeast of the rail line center (Figure G-1 and Table G-4). This distance would typically be within the right-of-way. The average right-of-way width varies by build alternative, from a minimum average of 367 feet (i.e., 184 feet on either side of the rail line) for the Tongue River East Alternative to a maximum average of 455 feet (i.e., 228 feet on either side of the rail line) for the Decker Alternative, as shown in Figure G-1. Considering together the average right-of-ways of all build alternatives, the collective average right-of-way is 406 feet (i.e., 203 feet on either side of the rail line; not shown in Figure G-1). Therefore, it is unlikely that humans would be exposed to concentrations as high as those used in OEA's calculations. Indeed, most coal dust (about 80 percent) would be deposited within the smallest average right-of-way among the build alternatives.

For this analysis, OEA compared the modeled soil, outdoor dust, and groundwater chemical concentrations for each coal dust constituent to their respective screening levels for human ingestion exposure.

Figure G-1. Daily Total Deposition Rates Used for Ingestion Exposure Analysis
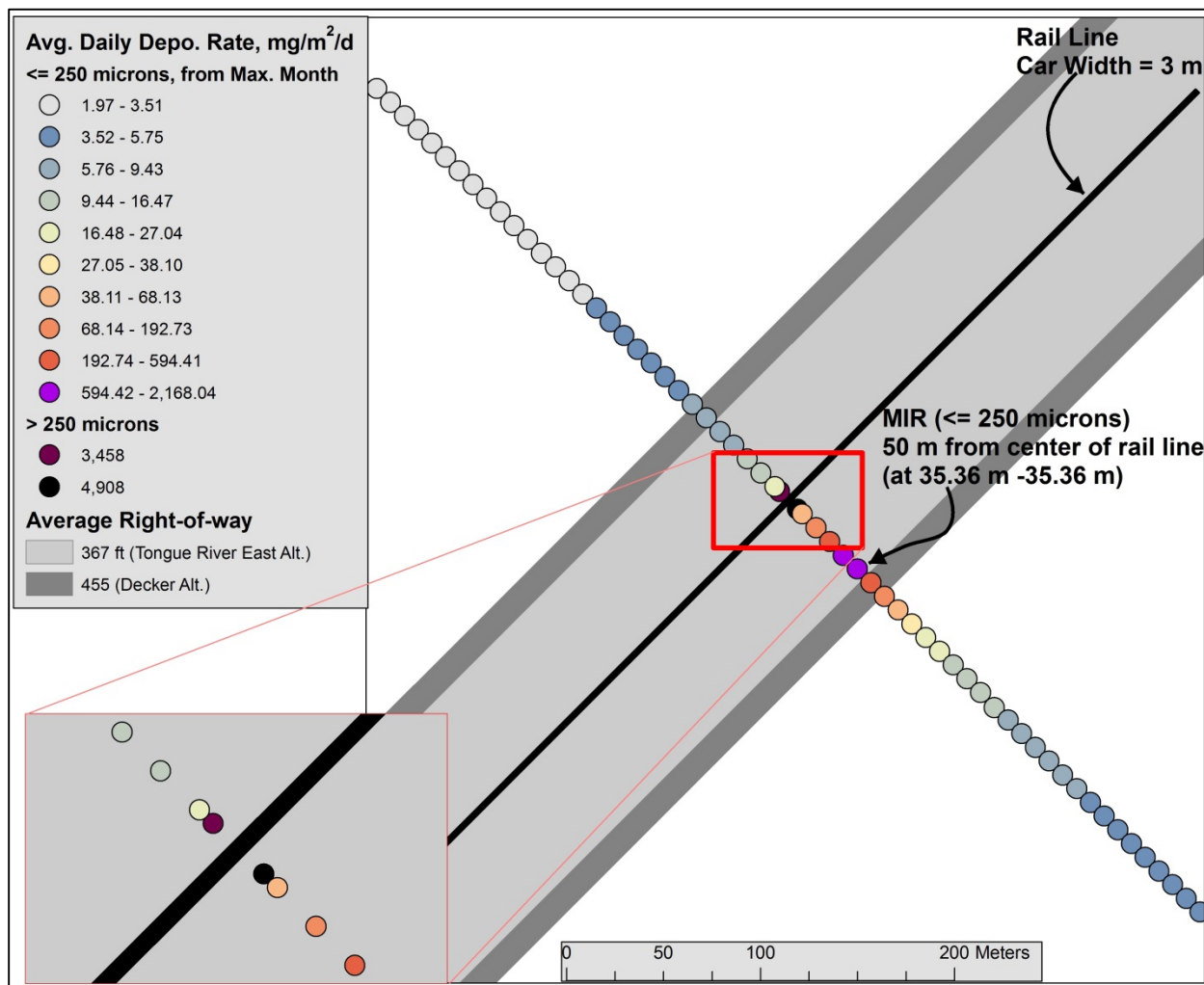
For the evaluation of human ingestion exposure for drinking water, fish, and sediment, OEA simulated the fate and transport of each deposited chemical by modeling a generic landscape comprising a small lake and its surrounding watershed. OEA compared the modeled surface water and sediment chemical concentrations for each coal dust constituent to their respective human drinking water screening levels and fish and sediment ingestion screening levels. OEA used the same area-wide average deposition rate as for plants and land animals. This part of the exposure analysis evaluated deposition both directly to the hypothetical water body and to its watershed. In the model, some of the coal dust deposited onto the watershed is transferred to the water body via modeled runoff and erosion processes. Section G.3.3, *Ecological Exposure: Water*, and Section G.3.4, *Ecological Exposure: Sediment* describes the modeling of surface water and sediment media concentrations.

Table G-4. Average Deposition Rates Used in Coal Dust Exposure Analysis

Coal Dust or Trace Element	Deposition Rate (mg/m^2/d)	
	To Soil, Outdoor Dust	**To Watershed Soil, Surface Water**
Coal dust	2,168	167.9
Antimony	0.00067	0.000052
Arsenic	0.0013	0.000104
Barium	1.2	0.093
Beryllium	0.000603	0.000047
Boron	0.13	0.0103
Bromine	0.028	0.0022
Cadmium	0.000092	0.0000071
Chlorine	0.19	0.014
Chromium	0.0067	0.00052
Cobalt	0.0021	0.00017
Copper	0.012	0.00092
Fluorine	0.036	0.0028
Lead	0.0062	0.00048
Lithium	0.018	0.0014
Manganese	0.039	0.0030
Mercury	0.000045	0.0000035
Nickel	0.0037	0.00029
Selenium	0.00061	0.000047
Silver	0.00025	0.000019
Strontium	1.0084	0.078
Thallium	0.00010	0.0000078
Uranium	0.00093	0.000072
Vanadium	0.013	0.00103
Zinc	0.0048	0.00038
Zirconium	0.022	0.0017

Notes:
mg/m^2/d = milligrams per square meter per day

To provide a conservative estimate of human exposure to settled coal dust and its constituents on a hard outdoor surface, OEA modeled a hypothetical residential outdoor patio-type area. This area was 9 meters square, receiving the largest estimated coal dust deposition rate of particulates smaller than 250 microns (i.e., 2,168 mg/m^2 per day, 50 meters southeast of the rail line center) (Figure G-1 and Table G-4). OEA conservatively assumed that rainfall was the only mechanism to remove the deposited coal dust from the hard outdoor surface, and that each rainfall event removed half the dust for a 0.5 efficiency of removal rate (Batroney et al. 2010). According to the meteorology data used for the AERMOD modeling (Appendix E, *Air Quality, Emissions, and Modeling Analysis*), precipitation events occurred near the study area every 2 days on average. For this analysis, OEA used the 90th percentile time between precipitation events (i.e., approximately 6 days after rounding) as the period of settled coal dust accumulation before partial removal of the dust by precipitation. OEA assumed each precipitation event was in liquid form (as opposed to snow) and did not consider the durations or intensities of precipitation events, in order to provide a conservative assessment.

After approximately eight 6-day periods of this pattern of dust deposition and precipitation removal, the mass of coal dust left on the hard surface equals the amount deposited in a 6-day period. That is, after approximately 48 days, the cycle of coal dust deposition and partial removal reaches a steady state where the mass of coal dust remaining after a precipitation event equals the mass of coal dust deposited over the 6 days prior to the precipitation event. The mass of coal dust settled on the hard surface just prior to a precipitation event equals twice the amount deposited since the last event.

Using the above assumptions, OEA estimated the concentrations of coal dust and trace element and topper agent constituents shown in Table G-5. These concentrations would occur just prior to a precipitation event. In other words, they are the maximum estimated concentrations to which a person could be exposed according to the model framework.

Table G-5. Concentrations Used in Hard Surface Scenario of Coal Dust Exposure Analysis

Coal Dust or Trace Element	Hard Surface Concentration Just Prior to Precipitation Event	
	mg/m^2	mg element/kg coal dust
Coal dust	26,017	--
Antimony	0.0081	0.31
Arsenic	0.016	0.62
Barium	14.4	554
Beryllium	0.0072	0.28
Boron	1.6	61.3
Bromine	0.34	13.0
Cadmium	0.0011	0.043
Chlorine	2.2	85.6
Chromium	0.081	3.1
Cobalt	0.0230.026	0.97
Copper	0.14	5.5

| Coal Dust or Trace Element | Hard Surface Concentration Just Prior to Precipitation Event | |
	mg/m²	mg element/kg coal dust
Fluorine	0.44	16.8
Lead	0.075	2.9
Lithium	0.21	8.08
Manganese	0.47	18.1
Mercury	0.00054	0.021
Nickel	0.044	1.7
Selenium	0.0073	0.28
Silver	0.0030	0.12
Strontium	12.1	465.1
Thallium	0.0012	0.046
Uranium	0.011	0.43
Vanadium	0.16	6.13
Zinc	0.058	2.2
Zirconium	0.26	10.1

Notes:
mg/m² = milligrams per square meter; mg element/kg coal dust = milligrams of element to kilograms of coal dust

G.2.4 Fate and Transport of Coal Dust Constituents

OEA used a simplified environmental fate and transport model to estimate the accumulation of coal constituents in environmental media. OEA then compared the resulting estimated environmental media concentrations to USEPA human health screening levels or other benchmarks.

G.2.4.1 Model Overview

The model simulated the fate and transport of each deposited chemical in a landscape comprising a hypothetical small lake and its surrounding watershed. Although rivers and streams are the predominant types of surface water features in the project area, modeling lakes provides a more conservative estimate of human health impacts because the water does not flow out of the lakes. As discussed in Section G.2.3, *Coal Dust Deposition Modeling*, OEA used the maximum estimated deposition rate to assess potential human health impacts. The model identified three interacting compartments: surface soil, lake surface water, and lake sediment. The three compartments were allowed to interact with adjacent compartments, such as subsurface soil compartments, which were modeled implicitly as sinks. The model also accounted for chemical transformation or degradation processes. OEA modeled the concentrations of coal dust trace elements and topper constituents in lake fish based on estimated water column concentrations and bioconcentration factors derived from the literature, where available. Finally, OEA evaluated the constituents of coal dust on a hard outdoor surface by considering cumulative deposition and partial removal by precipitation.

G.2.4.2 Model Media Relationships

OEA estimated the movement of chemical mass across different compartments by explicitly defining intermedia relationships and their governing transport and transformation processes in terms of mathematical equations. Each medium was represented as a compartment. The chemical content of each compartment was defined using the following inputs and outputs of chemical mass.

- Surface Soil Compartment
    - Input
        - Deposition from air
    - Outputs
        - Percolation to sub-surface
        - Colloidal transport to sub-surface
        - Erosion
        - Runoff
        - Degradation
- Lake Surface Water Compartment
    - Inputs
        - Deposition from air
        - Runoff from surface soil
        - Erosion from surface soil
    - Outputs
        - Flush rate
        - Deposition to sediment
- Lake Sediment Compartment
    - Input
        - Deposition from surface water column
    - Output
        - Burial to lower sediment layer

G.2.4.3 Deposition Inputs

OEA estimated coal dust deposition inputs based on AERMOD modeling (Section G.2.3, *Coal Dust Deposition Modeling*). The AERMOD model provided estimates of the average

deposition rate over the entire modeled watershed as well as an estimate of the peak or maximum deposition rate. Maximum deposition rates occurred over a very small area of the modeled watershed; it would have been excessively conservative to assume that these high rates prevailed over the entire watershed. In estimating potential health impacts, however, it is possible to conceive of an exposure location exactly at the zone of maximum deposition. The fate and transport model therefore used the watershed average deposition rate to compute lake and sediment concentrations but used maximum deposition rates to compute the exposure-point soil concentrations. OEA obtained chemical-specific deposition rates by multiplying the coal dust mass deposition rate by the chemical concentration of coal constituents and topper constituents in the coal dust.

G.2.4.4 Model Mechanics and Parameterization

OEA's environmental fate and transfer model dynamically estimated the mass in each compartment for each day of the simulation period. Starting with an initial chemical content of zero in each compartment, the model estimated the difference between input and output chemical mass on each day to compute daily updated chemical content estimates for each compartment. Because the environmental compartments are interconnected, chemical output from one compartment serves as chemical input into another. The model used mathematical equations to estimate the chemical mass transferred between the modeled environmental compartments through the various input and output processes. Specifically, the model described each physical or chemical input and output process (such as erosion, runoff, sedimentation, or flushing) in terms of a first-order first-degree differential equation. In mathematical terms, the resulting multiple interrelated equations formed a system of differential equations, which were solved numerically by approximation to a system of difference equations. The equations depended on a number of parameters that characterized either the physical landscape or a property of the chemical. OEA based these parameters values largely on those used in USEPA's TRIM.FaTE (U.S. Environmental Protection Agency 2014c, Appendix 4) and MIRC models that support the USEPA Office of Air Quality and Standard's Risk and Technology Review Risk and Technology Review program.

G.2.4.5 Model Outputs

OEA used the fate and transport model to estimate deposition to soil for the soil exposure scenario, surface water, sediment, and groundwater. For each chemical, model outputs included the following values.

- Dry soil chemical concentrations (mg/kg) for the soil exposure area based on maximum deposition rates.

- Bulk lake surface water chemical concentrations (mg/L) based on average deposition over the watershed.

- Dry sediment chemical concentrations (mg/kg) based on average deposition over the watershed.

- Fish tissue chemical concentrations (mg/kg) based on surface water concentrations and bioconcentration factors.

- Incremental suspended solids impact based on erosion/runoff and settling velocity assumptions.

- Hard surface deposition on a modeled patio to estimate residential dust ingestion exposure.

Model estimates were determined for a period of 50 years after the start of deposition because environmental concentrations are likely to have reached steady-state values by that time. A simulation period of 50 years is also used in regulatory environmental fate and transport modeling applications such as in USEPA Office of Air Quality and Standard's Risk and Technology Review program.

G.2.4.6   Model Uncertainties

The fate and transport model estimates are subject to uncertainty. One source of uncertainty is the use of a generic landscape for the project area rather than site-specific conditions for each of the build alternatives. Another is the corresponding use of national default parameter inputs to the model for the generic landscape parameters. In addition, characterization of the modeled fate and transport processes by first-order mathematical equations is subject to uncertainty.

Because of the uncertainty, OEA made conservative assumptions in the analysis. For example, OEA applied a bioavailability factor of 1.0 (i.e., 100 percent bioavailable, the highest possible value) to all chemicals in coal dust to provide a conservative estimate of impacts (Section G.2.4.7, *Bioavailability of Coal Dust Constituents*). For estimation of fish concentrations, bioaccumulation factors were not available so OEA used bioconcentration factors. As noted previously, OEA used maximum deposition rates to assess soil concentrations. OEA also made conservative assumptions for the speciation of mercury, with all mercury assumed to exist as methyl mercury, the form of mercury having the highest toxicity and the highest bioavailability.

G.2.4.7   Bioavailability of Coal Dust Constituents

The behavior and bioavailability in soil of trace elements from coal dust deposition depends on the association of those elements with various soil components and the forms in which the elements are found (Kabala and Singh 2001; Stepniewska et al. 2010). Bioavailability of coal dust constituents is strongly dependent on environmental conditions, such as the pH of soil where the coal dust is deposited, the amount of sulfur present in the coal dust as pyrite, and the relative presence of sulfur-reducing bacteria in the soil (John and Leventhal 1995; Fraser Surrey Docks 2013). Few of these factors have a quantitative boundary that is readily applicable to a modeling scenario outside of a site-specific assessment. In acidic soils that

are well aerated, many metals are more mobile and bioavailable, whereas metals are much less bioavailable in soils that are poorly aerated or alkaline (Buccolieri et al. 2010).

When coal is still in subsurface coal deposits, it is saturated with water, an anoxic and nonreactive environment for the trace elements. This environment is not conducive to leaching, so trace elements are found at low levels in the water of coal seam aquifers. Furthermore, groundwater in the Powder River Basin exhibits low concentrations of dissolved metals (Drever et al. 1977). Once the coal is mined and removed to the surface, constituents on the faces of coal particles, such as pyrite, will oxidize and can become more environmentally mobile. Pyrite and other sulfides are the predominant form of metals in coal, and 12 of the 19 trace elements of concern are found in pyrite and other sulfides (Swaine and Goodarzi 1995). Not all of the pyrite in coal is bioavailable, in part because sulfide minerals may be encapsulated in inert minerals such as quartz (John and Leventhal 1995).

Given the variable environmental factors that influence the bioavailability of coal dust, OEA followed USEPA risk assessment guidance, which recommends that, in the absence of data to the contrary, the bioavailability of a chemical should be set at 1.0, and equal in food, water, and soil (U.S. Environmental Protection Agency 2007a).

G.2.5   Human Health Screening Levels

OEA compared estimated coal dust and topper constituent concentrations in soil, water, and sediment (Section G.2.4, *Fate and Transport of Coal Dust Constituents*) to available screening levels developed by USEPA for human and ecological exposure evaluation. For some trace elements, USEPA screening levels have not been determined, so OEA used other USEPA benchmarks or guidance values for comparison.

USEPA developed several soil screening levels (SSLs) that are risk-based and protective of human health. OEA used these SSLs to evaluate the potential for health impacts from trace elements in coal dust. SSLs exist for various exposure routes, including oral exposure by ingestion and permeation to groundwater drinking exposure. The SSLs and other human health guidance values used in the analysis are described below.

G.2.5.1   USEPA Soil Screening Levels

USEPA bases its generic SSLs on default health-protective assumptions. The SSLs are intended to protect human health for most site conditions. Generic SSLs are derived using default values in standardized equations (U.S. Environmental Protection Agency 1996b). SSLs may be based on oral cancer slope factors and noncancer RfDs, maximum contaminant levels (MCLs), maximum contaminant level goals (MCLGs), or drinking water health-based levels (U.S. Environmental Protection Agency 1996b, 2002).

G.2.5.2 USEPA Protection of Groundwater Soil Screening Levels

USEPA has developed SSLs for migration of contaminants to groundwater from soil. The groundwater SSL values are back-calculated from groundwater concentration limits such as nonzero MCLGs, MCLs, or health-based limits when MCLs are not available. The migration to groundwater SSLs assume an infinite source, uniform distribution from the surface to the vadose zone, no contaminant attenuation in soil or the aquifer, a homogeneous and isotropic aquifer, and a receptor well at the down-gradient edge of the source (U.S. Environmental Protection Agency 1996b).

G.2.5.3 USEPA Reference Doses

The USEPA RfD is an estimate of a daily oral exposure that is likely to be without an "appreciable risk of deleterious effects during a lifetime." The RfD is generally used in noncancer health assessments and includes uncertainty factors that may span up to an order of magnitude. The RfD is protective of sensitive subgroups such as children, the elderly, and women of childbearing age. The RfD may be derived from a no-observed-adverse-effect level, lowest-observed-adverse-effect level, or benchmark dose, and any uncertainty factors are generally applied to reflect limitations of the data used (U.S. Environmental Protection Agency 2014a).

G.2.5.4 USEPA Drinking Water Maximum Contaminant Levels

USEPA MCLs are the maximum permissible levels of contaminants in water delivered to users of a public water system (U.S. Environmental Protection Agency 2009). MCLs exist for many organic and some inorganic compounds. When there is no reliable and feasible method for measuring a contaminant at particularly low concentrations, then a treatment technique is set. This is an enforceable procedure or level of technological performance that public water systems must follow to ensure control of a given contaminant (U.S. Environmental Protection Agency 2009).

G.2.5.5 USEPA Region 3 Fish Consumption Screening Levels

USEPA Region 3 published screening levels for fish consumption generated by the regional screening calculator (U.S. Environmental Protection Agency 2008). USEPA does not set national fish consumption screening levels, but regional offices compile and use the levels for screening-level risk assessments. USEPA used the regional screening calculator to generate fish tissue screening levels consistent with those previously shown on the Region 3 risk-based concentration table (U.S. Environmental Protection Agency 2008). The screening values assume a daily consumption of 54 grams of fish and do not take into account populations such as subsistence fishers, which would require a site-specific evaluation (U.S. Environmental Protection Agency 2008).

G.2.6   Estimated Human Exposure Compared to Screening Levels

OEA compared the estimated coal dust trace element and topper constituent concentrations from the fate and transport modeling to applicable soil and other media-specific screening levels. OEA evaluated human exposure using several screening and benchmark levels, as described in the sections that follow. For the residential soil and groundwater screening levels, OEA used the maximum modeled soil concentration to be conservative. For the surface water and sediment screening, OEA used the average level to estimate the soil concentration carried into the water and sediment. OEA based fish concentrations on water concentrations and bioconcentration factors (BCFs).

G.2.6.1   Oral Exposure: Residential Food Intake

Table G-6 summarizes the estimated maximum concentration in soil (mg/kg) for a residential food exposure by homegrown produce from the model and the generic SSL for human oral exposure to soil from residential homegrown produce intake. As shown, none of the chemical concentrations estimated in soil would be expected to result in values greater than the generic SSL for human ingestion. No existing screening levels account for human exposure via consumption of exposed terrestrial wildlife. Terrestrial wildlife exposures would be expected to be lower than those for fish, ingestion of which is covered by the fish ingestion screening levels discussed in Section G.2.6.5, *Oral Exposure: Fish Ingestion*.

Table G-6. Estimated Maximum Soil Concentrations of Trace Elements and Generic SSLs

Trace Element	Estimated Maximum Soil Concentration (mg/kg)	Generic SSL – Human (mg/kg)
Antimony	0.00033	31[a]
Arsenic	0.00062	0.61[a]
Barium	0.58	15,000[a]
Beryllium	0.00107	160[a]
Boron	0.054	16,000[b]
Bromine	0.060	0.91[b,c]
Cadmium	0.000050	78[a]
Chlorine	0.056	7,500[b]
Chromium	0.56	Cr(III): 78,000; Cr(VI): 390; Cr (Total): 390[a]
Cobalt	0.00099	23[b]
Copper	0.0056	3100[b]
Fluorine	0.024	4700[b]
Lead	0.012	400[a]
Lithium	0.016	160[b]
Manganese	0.021	1,800 (available for nondiet only)[b]
Mercury	0.000022	10[b]
Nickel	0.0019	1500[a]
Selenium	0.00025	390[a]
Silver	0.00011	390[a]
Strontium	0.47	47,000[b]
Thallium	0.000054	0.78[b]
Uranium	0.0011	230[b]
Vanadium	0.028	390[a]
Zinc	0.0025	23[a]
Zirconium	0.12	6.3[b]

Notes:
[a] U.S. Environmental Protection Agency 2002
[b] U.S. Environmental Protection Agency 2013c
[c] Data only available for bromate
mg/kg = milligrams per kilogram; SSL = soil screening level

G.2.6.2   Oral Exposure: Hard Surface Ingestion

Table G-7 shows estimated residential exposure to settled coal dust and its constituents on a hard outdoor surface, compared to the USEPA RfD for each of the trace elements for which an RfD has been derived. For the purposes of the assessment, OEA assumed that a child aged three to six weighing 18.6 kilograms consumed 200 milligrams per day of soil (composed of coal dust mixed to 1 millimeter deep) (U.S. Environmental Protection Agency 2011). These assumptions were based on the largest (nonpica) soil ingestion rate for children. For all trace elements for which an RfD has been derived, the modeled ingestion rates were below the RfD by at least two orders of magnitude.

Table G-7. Human Health Screening Exposure Analysis Results for Hard Surface Scenario

Trace Element	Estimated Mass Ingested Daily, per Unit Body Mass (mg/kg/day)	Human Health RfD (mg/kg/day)[a]	Ratio of Mass Ingested to RfD
Antimony	0.0000034	0.00040	0.0084
Arsenic	0.0000067	0.00030	0.022
Barium	0.0060	0.20	0.030
Beryllium	0.0000030	0.0020	0.0015
Boron	0.00066	N/A	N/A
Bromine	0.00014	N/A	N/A
Cadmium	0.00000046	0.0005 (water); 0.001 (food)	0.00091 (water)
Chlorine	0.00092	N/A	N/A
Chromium	0.000033	0.0030	0.011
Cobalt	0.0000105	N/A	N/A
Copper	0.000059	N/A	N/A
Fluorine	0.00018	N/A	N/A
Lead	0.000031	N/A	N/A
Lithium	0.000087	N/A	N/A
Manganese	0.00019	0.140	0.0014
Mercury	0.00000022	N/A	N/A
Nickel	0.000019	0.020	0.00093
Selenium	0.0000030	0.0050	0.0006
Silver	0.0000012	0.0050	0.00025
Strontium	0.0050	N/A	N/A
Thallium	0.00000050	N/A	N/A
Uranium	0.0000046	0.0030	0.0015
Vanadium	0.000066	0.0090	0.0073
Zinc	0.000024	0.30	0.000080
Zirconium	0.00011	N/A	N/A

Notes:
[a] RfDs from U.S. Environmental Protection Agency 2014b IRIS. Rounding artifacts present.
RfD = reference dose; mg/kg/day = milligrams per kilogram per day; N/A = not applicable**;** RfD not available.

G.2.6.3 Oral Exposure: Groundwater

Table G-8 summarizes the maximum concentration in soil (mg/kg) from the model compared to the generic SSL for protection of groundwater. As discussed in Section G.2.5, *Human Health Screening Levels*, groundwater SSLs were developed by back-calculating soil concentrations based on groundwater concentration limits and health-protective assumptions (U.S. Environmental Protection Agency 1996b). None of the modeled trace element concentrations exceeded the screening thresholds for groundwater. OEA identified a data gap for bromine; therefore, the table provides information for the generic screening levels for bromate. Using these data as a surrogate for comparison, the estimated concentration of bromine in sediment/groundwater approaches, but is still below, the screening level for the protection of groundwater.

Table G-8. Soil/Groundwater Estimated Concentrations of Trace Elements and Screening Levels

Trace Elements	Estimated Maximum Soil Concentration (mg/kg)	Protection of Groundwater SSLs (mg/kg)
Antimony	0.00033	0.27
Arsenic	0.00062	0.0013
Barium	0.58	82
Beryllium	0.00107	3.2
Boron	0.054	9.9
Bromine	0.060	0.077[a]
Cadmium	0.000050	0.38
Chlorine	0.056	0.70
Chromium	0.56	Cr(III): 28,000,000; Cr(VI): 0.00059; Cr (Total): 180,000
Cobalt	0.00099	0.21
Copper	0.0056	22
Fluorine	0.024	140
Lead	0.012	400
Lithium	0.016	9.30
Manganese	0.021	21 (available for nondiet only)
Mercury	0.000022	0.033
Nickel	0.0019	20
Selenium	0.00025	0.26
Silver	0.00011	0.60
Strontium	0.47	330
Thallium	0.000054	0.011
Uranium	0.0011	14
Vanadium	0.028	63
Zinc	0.0025	290
Zirconium	0.12	3.7

Notes:
[a] U.S. Environmental Protection Agency 2002
[b] U.S. Environmental Protection Agency 2013c
[c] Data only available for bromate

G.2.6.4　　　Oral Exposure: Surface Water

Table G-9 summarizes the concentration in water (milligrams per cubic meter [mg/m^3]) estimated by the model compared to USEPA MCLs. All of the estimated values fall below the available USEPA MCLs for drinking water. The Tongue River is not a drinking water source. Any water withdrawn for this purpose would likely be treated by a public water system.

Table G-9. Estimated Surface Water Concentrations of Trace Elements and MCL Values

Trace Elements	Estimated Concentration in a Model Lake (mg/m^3)	USEPA Drinking Water MCLs (mg/m^3)
Antimony	0.006	6.0
Arsenic	0.012	10.0
Barium	10.1	2000.0
Beryllium	0.0011	4.0
Boron	2.6	N/A
Bromine	0.042	N/A
Cadmium	0.00064	5.0
Chlorine	19.1	4000.0
Chromium	0.0027	100.0
Cobalt	0.019	N/A
Copper	0.104	1,300.0[a]
Fluorine	0.19	4000.0
Lead	0.0101	15.0
Lithium	0.062	N/A
Manganese	0.29	50.0
Mercury	0.00035	2.0
Nickel	0.027	N/A
Selenium	0.0094	50.0
Silver	0.0032	100.0[a]
Strontium	8.82	N/A
Thallium	0.0071	2.0
Uranium	0.0025	30.0
Vanadium	0.020	N/A
Zinc	0.036	5,000.0[a]
Zirconium	0.015	N/A

Notes:
[a] Secondary drinking water standard
Source: U.S. Environmental Protection Agency 2009
mg/m^3 = milligrams per cubic meter; USEPA = U.S. Environmental Protection Agency; MCL = maximum contaminant level

G.2.6.5 Oral Exposure: Fish Ingestion

Table G-10 summarizes the concentration in fish estimated by the model compared to USEPA Region 3 fish tissue screening levels. All estimated values fall below identified screening levels. However, the estimated value for thallium is on the same order of magnitude as the USEPA Region 3 fish screening benchmark (U.S. Environmental Protection Agency 1999). Experimental BCF values for thallium range broadly from 11.7 for mussels to 1,430 for juvenile Atlantic salmon (ATSDR 1992b), and OEA chose a value of 15,000 for this analysis. The USEPA Reference Appendix C of the Screening Level Ecological Risk Assessment Protocol was a primary source of information used for gathering BCF values (U.S. Environmental Protection Agency 1999). The 15,000 value OEA chose for this analysis is consistent with the USEPA-recommended screening level value for

aquatic invertebrates from the Screening Level Ecological Risk Assessment Protocol (U.S. Environmental Protection Agency 1999). Fish take up thallium and accumulate the compound in their tissues, but there is uncertainty as to how fish accumulation affects human thallium intake (ATSDR 1992b). ATSDR (1992b) cites a study in the Thallium Toxicological Profile that reports typical concentrations of thallium in food (meat, fish, fat, vegetables) ranging from trace amounts to 0.05 mg/kg, which is greater than the expected fish concentration from the model.

BCF data are not available for several of coal constituents, as indicated in Table G-10. For most of these constituents, OEA used a surrogate BCF value for metals (see table footnote). For the remaining constituents without BCF values, OEA addressed screening qualitatively using available ecotoxicity excerpts (Hazardous Substances Data Bank 2013). For chlorine, there is no potential for bioaccumulation or bioconcentration (Hazardous Substances Data Bank 2013). Similarly, bioconcentration is not reported to be an important fate process for fluorine (Hazardous Substances Data Bank 2013). Uranium falls below the threshold using the surrogate method described above; however, because it is radioactive and does not behave like the other metals, ecotoxicity excerpts were evaluated for this chemical as well. Uranium is reported to decline in concentration with each successive trophic level because it is not efficiently assimilated in higher trophic levels (Hazardous Substances Data Bank 2013). Accumulation in fish species is attributed almost exclusively to accumulation of uranium on gill surfaces, which are not commonly eaten by humans (Hazardous Substances Data Bank 2013).

Table G-10. Estimated Concentrations of Trace Elements in Fish and Screening Levels

Trace Element	Estimated Fish Concentration (mg/kg)	Region 3 Fish Screening Levels (mg/kg)
Antimony	0.00022	0.54
Arsenic	0.0014	0.41
Barium	6.4	270
Beryllium	0.000067	2.7
Boron	0.0071	270
Bromine	NA	5.4
Cadmium	0.00058	1.4
Chlorine	NA	140
Chromium	0.000051	2000
Cobalt	0.000018	41
Copper	0.074	54
Fluorine	NA	81
Lead	0.00000091	0.00014
Lithium	0.055[a]	2.7
Manganese	0.026[a]	190
Mercury	0.0039	14
Nickel	0.0021	15
Selenium	0.0012	6.8
Silver	0.00028	6.8
Strontium	7.94[a]	810
Thallium	0.0107	0.01
Uranium	0.0023[a]	4.1
Vanadium	0.0040	6.8
Zinc	0.074	410
Zirconium	0.014[a]	0.11

Notes:
[a] BCF data not available; surrogate of 0.9 used. The recommended BCF value of 0.9 is the arithmetic average of six recommended values for metals with empirical data (cadmium, chromium, copper, lead, inorganic mercury, and zinc) (U.S. Environmental Protection Agency 1999). The same surrogate BCF value can be applied to lithium, manganese, strontium, uranium, and zirconium.

Source: U.S. Environmental Protection Agency 1999

mg/kg = milligrams per kilogram; BCF = bioconcentration factor

G.3   Ecological Exposure Analysis

OEA evaluated the potential impacts of coal dust on ecological receptors using similar methods as described in Section G.2, *Human Health Ingestion Impacts*. For this analysis, OEA compared soil chemical concentrations to their respective ecological screening levels for plant and land-animal exposure. To evaluate the exposure for plants and land animals near the rail line, OEA used an area-wide average deposition rate (i.e., 168 mg/m^2 per day; Table G-4). The average deposition rate is less conservative than the rate used for evaluating potential human exposure (i.e., the maximum deposition rate). The reasoning behind this is that it is possible for a human to be chronically exposed at the maximum rate, so OEA believes it would be a plausible (although extreme) scenario. For ecological risk, OEA believes it would be too unrealistic to assume that wild, roaming animals would be chronically exposed at the MIR (location with the largest deposition rate), or to assume that an entire watershed had soil concentrations corresponding to the MIR concentration and that all the MIR-level chemical deposited into the hypothetical lake. Nevertheless, the rate used is still conservative because it assumes that all plant and animal exposure in the evaluated area would occur at the deposition rates estimated for the 300 meters closest to the rail line, which is where most of the coal dust would be deposited. This average included the largest deposition rate of particulates smaller than 250 microns at each AERMOD modeling location (Figure G-1) and the estimated average deposition rate of those particulates at the center of the rail line (i.e., the average of the rates at the first receptor on either side of the rail line). It also included the average deposition rate for particulates larger than 250 microns on either side of the rail line—105 g/m^2 per month on the southeastern side of the track and 149 g/m^2 per month on the northeastern side of the track. The estimates assume that the Otter Creek mine will begin producing coal in 2018.

OEA used USEPA ecological soil screening levels (Eco-SSLs), described in Section G.3.1, *Ecological Soil Screening Levels*, to evaluate soil exposure for ecological receptors such as plants, soil invertebrates, avian wildlife, and mammalian wildlife. For many trace elements, there were data gaps for the Eco-SSLs, so OEA reviewed additional ecological toxicity benchmarks for those chemicals without ecological benchmarks. OEA used USEPA Region 3 freshwater screening levels to evaluate concentrations of trace elements in the model lake. OEA also used sediment screening benchmarks from USEPA Region 3 in the analysis. In addition, OEA compared modeled estimates of incremental suspended solids resulting from the deposited coal dust to potential suspended solids targets for the Tongue River, as described in Section G.3.5, *Suspended Solids Analysis*.

G.3.1   Ecological Soil Screening Levels

G.3.1.1   USEPA Ecological Soil Screening Levels (Eco-SSLs)

USEPA developed Eco-SSLs as screening values to identify contaminants of potential concern in soils that may require further evaluation. The Eco-SSLs are useful for evaluating

soil contaminants at a screening, or preliminary, level. In fact, USEPA envisioned that any federal, state, or private environment assessment could use these values to screen soil contaminants and sites to determine if additional ecological site study is warranted (U.S. Environmental Protection Agency 2005). This is how OEA used the values in the current assessment.

G.3.1.2   USEPA Region 3 Freshwater Screening Values

The USEPA Region 3 Biological Technical Assistance Group (BTAG) compiled screening benchmarks to evaluate sampling data at Superfund sites (U.S. Environmental Protection Agency 2013d). These values are compiled from benchmark values developed by various state and federal agencies. Priority is given to values based on direct toxicity (U.S. Environmental Protection Agency 2013d). The Region 3 tables provide a single source for multiple screening values not found in other single references. The values are not based on region-specific information and are useful for evaluating the water concentrations of various chemicals (U.S. Environmental Protection Agency 2013a).

G.3.1.3   USEPA Region 3 Sediment Screening Benchmarks

The sediment screening benchmarks are also from the USEPA Region 3 BTAG, which provides media-specific ecotoxicological benchmarks that can be used in developing screening-level assessments. Priority is given to benchmarks based on chronic direct exposure. USEPA used nonlethal endpoint studies to be protective of sensitive species. The BTAG screening levels provide ecotoxicological benchmarks for screening-level assessment (U.S. Environmental Protection Agency 2006b).

G.3.2   Ecological Exposure: Soil

Table G-11 summarizes the concentration in soil (mg/m^3) estimated by the model compared USEPA Eco-SSLs, where available. For plant screening levels, values were also found in Efroymson et al. (1997). Estimated average soil concentrations are below Eco-SSL values for all types of wildlife, for each of the chemical constituents. There are data gaps for Eco-SSLs for many of the trace elements in coal. Eco-SSLs in all four categories (plants, soil invertebrates, avian wildlife, and mammalian wildlife) were not available for 10 chemicals. OEA investigated any of the chemicals missing data in three or four categories of screening levels individually for information on ecotoxicity and background levels in soil to provide context for the levels observed (Table G-12).

Table G-11. Estimated Soil Concentrations of Trace Elements and Eco-SSLs

Chemical	Estimated Average Soil Concentration (mg/kg)[a]	USEPA Eco-SSL (mg/kg dry weight in soil)[a]			
		Plants	Soil Invertebrates	Avian Wildlife	Mammalian Wildlife
Antimony	0.000026	5.0[b]	78	N/A	0.27
Arsenic	0.000048	10[b]	N/A	43	46
Barium	0.045	500[b]	330	N/A	2000
Beryllium	0.000083	10[b]	40	N/A	21
Boron	0.0042	0.5[b]	N/A	N/A	N/A
Bromine	0.0046	10[b]	N/A	N/A	N/A
Cadmium	0.0000039	4[b]	140	0.77	0.36
Chlorine	0.0043	N/A	N/A	N/A	N/A
Chromium	0.043	1.0[b]	Not enough data	Cr(III): 26 Cr(VI): N/A	Cr(III): 34 Cr(VI): 13
Cobalt	0.000077	13	N/A	120	230
Copper	0.00043	100[b]	80	28	49
Fluorine	0.0019	200[b]	N/A	N/A	N/A
Lead	0.00094	50[b]	1700	11	56
Lithium	0.0013	2.0[b]	N/A	N/A	N/A
Manganese	0.0016	220	450	4300	4000
Mercury	0.0000017	0.30[b]	0.1	N/A	N/A
Nickel	0.00015	300 [b]	280	210	130
Selenium	0.000019	0.52	4.1	1.20	0.63
Silver	0.0000081	2[b]	N/A	4.2	14
Strontium	0.037	N/A	N/A	N/A	N/A
Thallium	0.0000041	1.0[b]	NA	NA	NA
Uranium	0.000086	5.0[b]	N/A	N/A	N/A
Vanadium	0.0022	2.0[b]	N/A	7.8	280
Zinc	0.00019	50[b]	120	46	79
Zirconium	0.0091	N/A	N/A	N/A	N/A

Notes:

[a] All values reported to two significant figures

[b] Values for plants are from Efroymson et al. 1997

USEPA = U. S. Environmental Protection Agency; Eco-SSL = ecological soil screening levels; mg/kg = milligrams per kilograms; N/A = not applicable

Table G-12 presents ecotoxicity data for chemicals with multiple Eco-SSL data gaps. None of the estimated concentrations are greater in magnitude than the ecotoxicity benchmarks that OEA identified, nor are the expected concentrations greater than background levels from the Risk Assessment Information System database (Oak Ridge National Laboratory 2013). The ecotoxicity data are provided as additional information to support the analysis. Some of the ecotoxicity values are reported in aquatic concentration units to provide information on the scale of toxicity in the absence of additional data. Data gaps still exist for lithium and strontium, for which OEA found limited ecological impact data.

Table G-12. Additional Ecotoxicity Data for Chemicals Missing USEPA Eco-SSLs

Chemical	Estimated Average Soil Concentration (mg/kg)[a]	Background Levels (mean range across soil types (mg/kg)[a]	Ecotoxicity Data[a]		
			Toxicity value	Type	Species
Boron	0.0042	20–55	>60 mg/L/4 days	EC$_{50}$	*Lemna minor* (duckweed)
			0.009 to 0.103 mg/L	NOEC	*Oncorhynchus mykiss* (rainbow trout; most sensitive of 5 species tested)
			1.5–2.5 mg/L	NOEC	Long term outdoor pond and field study and laboratory test of 6 trophic stages, respectively
Bromine	0.0046	<0.5–6	1500 µg/L 24 hour	LC$_{50}$	*Daphnia magna* (water flea)
			0.52 ppm 24 hour	LC$_{50}$	*Lepomis macrochirus* (bluegill)
			0.31 ppm for 24 hours	LC$_{50}$	*Oncorhynchus mykiss* (rainbow trout)
Chlorine[b]	0.0043	N/A	304 mg/L 96 hour	NOEC	*Pimephales promelas* (fathead minnow)
			8.3 mg/L 96 hour (chlorine dioxide[c])	LC$_{50}$	*Oncorhynchus mykiss* (rainbow trout)
			0.027 – 208.76 mg/L	LC$_{50}$	Range for *Daphnidae* and *Salmonidae*, respectively (represent min and max LC$_{50}$s for 12 taxonomic families tested)
Fluorine	0.0019	205–465	60000 µg/L 96 hour	LC$_{50}$	*Lemna minor* (duckweed)
			600 µg/kg	ERL	Ecotox threshold (effects range-low)
			2900 µg/kg	N/A	USEPA (1996a) sediment quality threshold
Lithium	0.0013	13–34	Data gap		
Strontium	0.037	120–490	Data gap		
Thallium	0.000004	0.02–2.8	200,000 µg/L (24-hour)	LC$_{50}$	*Caenorhabditis elegans* (nematode)
			110 µg/L 7 days	LC$_{50}$	*Gastrophryne carolinensis* (eastern narrow-mouthed toad)
			170 µg/L 28 days	LC$_{50}$	*Oncorhynchus mykiss* (rainbow trout)
Uranium[d]	0.000086	3.7	250 mg U/kg dry soil	PNEC	Terrestrial plants
			100 mg U/kg dry soil	PNEC	Other soil biota
			0.4 mg/L–23 mg/L (range for very soft to very hard water)	PNEC	Fish

Chemical	Estimated Average Soil Concentration (mg/kg)[a]	Background Levels (mean range across soil types (mg/kg)[a]	Ecotoxicity Data[a]		
			Toxicity value	Type	Species
Zirconium	0.0091	140–330	1.3–-2.5 mg/L	Impact level	Algae
			N/A	Impact level	Bioassays using bacteria and fish (*Salmo giardneri*) showed no toxicity

Notes:

[a] **All values reported to two significant figures**

[b] Chlorine dioxide is rapidly reduced to chlorite in aquatic environments, and it is much more likely that fish will be exposed to chlorite. Ecotox data is for chlorite unless otherwise specified

[c] LC_{50} for chlorite noted to be "48 times lower" than that for chlorine dioxide

[d] Ecotoxicity for uranium is strongly dependent on other environmental factors

Sources: Hazardous Substances Data Bank 2013 (ecotoxicity excerpts); Oak Ridge National Laboratory 2013

USEPA = U.S. Environmental Protection Agency; MCL = maximum contaminant level; Eco-SSL = ecological soil screening level; mg/kg = milligrams per kilogram; mg/L = milligrams per liter; EC_{50} = half-maximal effective concentration; NOEC = no observed effect concentration; µg/L = microns per liter; ppm = parts per million; µg/kg = microns per kilogram; ERL = effects range-low; N/A = not applicable; U/kg = unit per kilogram; PNEC = predicted no effect concentration

G.3.3   Ecological Exposure: Water

The estimated concentrations in water of the coal dust constituents are presented in
Table G-13 (note: units of concentration for coal constituents are shown in mg/m^3, which are
equivalent to micrograms per liter (µg/L) on a per-volume basis). Barium is the only coal
dust constituent analyzed for which OEA's modeled concentration (10.1 micrograms per
liter) would exceed the freshwater screening benchmark of 4.0 micrograms per liter, using
OEA's modeling assumptions. The conservative model assumption of 100 percent
bioavailability (the highest possible value) used in this analysis would likely be unrealistic
for barium, as the chemical is not very mobile in most soil systems (Agency for Toxic
Substances and Disease Registry 2007). OEA therefore considers the 100 percent
bioavailability assumption to be an overestimate. In addition, barium released to water will
readily combine with sulfate ions to form barium sulfate, which precipitates out of solution
because of very limited solubility (Agency for Toxic Substances and Disease Registry 2007).
Therefore, the 100 percent solubility assumption also contributes to an overestimate of the
barium concentration, and OEA concludes that the concentration of barium from coal dust in
freshwaters would be unlikely to exceed the screening benchmark. OEA also notes that
Montana does not have an aquatic life water quality criterion for barium and that barium
concentrations in the Tongue River are typically about 50 micrograms per liter, based on
monitoring during the period from 2001 to 2005 (U.S. Geological Survey 2007). Screening
levels are used to identify situations where a more thorough evaluation of the potential
environmental or health impacts should be undertaken. Screening levels do not represent a
threshold above which impacts will occur, but are rather used as a tool to focus on potential
impacts that warrant further study. Given the conservative assumptions regarding barium
bioavailability and environmental fate, combined with the understanding that barium is
unlikely to exceed the screening benchmark, additional analysis beyond a screening level
assessment is not warranted in this case.

Table G-13. Estimated Water Concentrations of Trace Elements and Screening Levels

Trace Element	Estimated Concentration in a Model Lake (mg/m³)	Freshwater Screening Benchmarks (μg/L)[a]
Antimony	0.0055	30
Arsenic	0.012	As(total): 5; As(III): 55, As(V): 3.1
Barium	10.1	4.0
Beryllium	0.00108	0.66
Boron	2.6	750[b]
Bromine	0.042	N/A
Cadmium	0.00064	0.25
Chlorine	19.1	11[c]
Chromium	0.0027	Cr (III): 74; Cr(VI): 11; Cr(Tot): 85
Cobalt	0.019	23.00
Copper	0.104	9 (hardness=100)
Fluorine	0.19	N/A
Lead	0.0101	2.5
Lithium	0.062	14
Manganese	0.29	120
Mercury	0.00035	0.026
Nickel	0.027	52
Selenium	0.0094	1.0
Silver	0.0032	32
Strontium	8.8	1,500[e]
Thallium	0.00071	0.80
Uranium	0.0025	2.6
Vanadium	0.020	20 or 15 (elemental or pentoxide)
Zinc	0.036	12 (hardness=100)
Zirconium	0.015	17[f]

Notes:
[a] Freshwater screening benchmarks are from USEPA Region 3 unless otherwise specified
[b] USEPA Region 4 chronic surface water screening benchmark
[c] Chronic Ambient water quality criteria for surface water
[d] Secondary drinking standard
[e] Tier II secondary chronic value Surface Water Screening Benchmark
mg/m³ = milligrams per cubic meter; μg/L = microns per liter; N/A = not applicable; USEPA = U.S. Environmental Protection Agency

G.3.4　Ecological Exposure: Sediment

Table G-14 compares the concentration in sediment (mg/m³) estimated by the model with identified and available sediment screening benchmarks (U.S. Environmental Protection Agency 2006b). All estimated values fall below the available sediment screening levels.

Table G-14. Estimated Sediment Concentrations of Trace Elements and Screening Levels

Trace Element	Estimated Sediment Concentration (mg/kg)	Sediment Screening Benchmarks[a] (mg/kg)
Antimony	0.00025	2.0

Trace Element	Estimated Sediment Concentration (mg/kg)	Sediment Screening Benchmarks[a] (mg/kg)
Arsenic	0.00036	9.8
Barium	0.41	200[b]
Beryllium	0.00082	N/A
Boron	0.0078	N/A
Bromine	0.0404	0.65[c]
Cadmium	0.000048	0.99
Chlorine	0.0048	N/A
Chromium	0.052	43.4
Cobalt	0.00065	50
Copper	0.0036	31.6
Fluorine	0.028	0.08
Lead	0.0087	35.8
Lithium	0.018	N/A
Manganese	0.019	460
Mercury	0.000018	0.18
Nickel	0.0018	22.7
Selenium	0.000047	2.0
Silver	0.000027	1.0
Strontium	0.31	N/A
Thallium	0.000050	N/A
Uranium	0.0011	N/A
Vanadium	0.019	57[c]
Zinc	0.0022	121
Zirconium	0.040	N/A

Notes:
[a] Sediment benchmarks are from USEPA (2006b) unless otherwise noted
[b] Ecological screening value for sediment from Friday (1999)
[c] Chronic sediment benchmark (U.S. Environmental Protection Agency 2013e)
Sources: U.S. Environmental Protection Agency 2006b; Friday 1999; National Oceanic and Atmospheric Administration 1999
mg/kg = milligrams per kilogram; N/A = not applicable

G.3.5 Suspended Solids Analysis

Using the transport model described in Section G.2.4, *Fate and Transport of Coal Dust Constituents*, OEA modeled a simulated landscape with three interacting compartments: surface soil, lake surface water, and lake sediment. The lake received coal dust from both direct deposition and erosion/runoff from the surrounding watershed. The model also accounted for chemical transformation or degradation processes. The modeled coal dust in the lake was subject to flushing and deposition to the sediment layer. Using a system of equations, OEA estimated the incremental suspended solids in the modeled lake that could result from the deposited coal dust. Using conservative assumptions, such as the highest erosion/runoff rate per unit area of the watershed in the modeling methodology employed, the deposition model predicted an incremental addition of 0.7 milligrams per liter of suspended solids in the model lake.

The Tongue River is listed on the Montana DEQ/USEPA 303(d) list of impaired waters for solids (suspended sediment/bedload) between the Tongue River Reservoir and the Yellowstone River, as discussed in Chapter 9, Section 9.2, *Surface Water*. However, a suspended solids criterion has not been developed for the river through the total maximum daily load process. A previous study (Montana Department of Environmental Quality 2003) that examined the 303(d) status of the river compared suspended solids concentrations measured for the river to the warm water fisheries protection criteria for Utah and South Dakota, which are set at 90 and 150 milligrams per liter, respectively. The reported data indicate that median suspended solids concentrations generally increase as the river flows from the reservoir to the junction with the Yellowstone River, with a reported median concentration of 46 milligrams per liter downstream of Ashland and 66 milligrams per liter at Miles City, with some reported values exceeding the Utah and/or South Dakota criteria.

Because the modeled suspended solids concentration from coal dust deposition is overstated due to the conservative modeling assumptions and is nevertheless only a small fraction of the suspended solids levels reported for the river, which are typically well below the referenced potential criteria, OEA concludes that coal dust deposition would not be likely to cause adverse ecological impacts.

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