# Review of the Transportation Corridor and Hazardous Material Spill Risks in the Proposed Stibnite Gold Project Supplemental Draft Environmental Impact Statement

Susan C. Lubetkin, PhD

Prepared for Idaho Conservation League and Advocates for the West

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*Analysis of Stibnite Gold Project hazardous materials spill risks*

Photo credit: Chris English, “Ultra Cool Salmon”, August 19, 2007, in Cascade, Idaho
(original cropped by S. Lubetkin)

## Executive Summary

If approved, the Stibnite Gold Project (SGP) will require large quantities of hazardous materials to be transported to and from and used at the mine site during the 15 years of mining operations (Table ES-1) and, to a more limited extent, for as long as water treatment is necessary. In total, more than 3,000 loads of hazardous materials would be transported to or from the mine every year during operations (Table ES-1). The loads would include more than 8,300,000 gallons of flammable materials (diesel, propane, gasoline) as part of more than 9,400,000 gallons of hazardous bulk liquids to be brought to the mine site annually. In addition, more than 46,000 tons of hazardous bulk solids would be transported to or from the mine site (Table ES-1). This includes annual use of 4,000 tons of sodium cyanide, which would be delivered in 167 trips carrying 24 tons each, or roughly one trip every other day.

*Table ES-1. Hazardous materials and mine supplies transported to and from the proposed SGP Project during operations and for water treatment (Tables 2.4-11 and 4.7-1 in USFS 2022 and Perpetua 2021 ModPRO2 Table 3-7).*

| Common name | Annual use | Typical vehicle payload | Estimated number of deliveries each year |
|---|---:|---:|---:|
| *Bulk liquids* | | | |
| Diesel fuel | 5,800,000 gallons | 10,000 gallons | 580 |
| Propane (on-site lime production) | 1,463,000 gallons | 11,000 gallons | 133 |
| Propane (buildings) | 560,000 gallons | 6,000 gallons | 93 |
| Gasoline | 500,000 gallons | 5,000 gallons | 100 |
| Lubricants | 296,000 gallons | 3,000 gallons | 99 |
| Waste oil (50% of lubricant quantity) | 198,000 gallons | 3,000 gallons | 49 |
| Magnesium chloride | 250,000 gallons | 4,500 gallons | 56 |
| Nitric acid | 65,000 gallons | 3,000 gallons | 22 |
| Ferric sulfate | 23,000 gallons | 3,000 gallons | 17 |
| AP 3477 (dialkyl dithiophosphate) | 60,000 gallons | 3,000 gallons | 20 |
| Methyl isobutyl carbonyl | 120,000 gallons | 3,000 gallons | 40 |
| Antifreeze | 40,000 gallons | 3,000 gallons | 13 |
| Antifreeze waste | 40,000 gallons | 3,000 gallons | 13 |
| Hydrogen peroxide | 7,100 gallons | 3,660 gallons | 2 |
| Aerophine 3418A | 10,500 gallons | 200 gallons | 53 |
| Sodium hypochlorite | 2,000 gallons | 1,000 gallons | 2 |
| Sulfuric acid (water treatment) | 12,000 gallons | 3,000 gallons | 5 |
| Solvents | 1,000 gallons | 200 gallons | 5 |
| Waste spent solvents | 1,000 gallons | 200 gallons | 5 |
| Polymer | 1,000 gallons | 200 gallons | 5 |
| Organic sulfide | 1,000 gallons | 200 gallons | 5 |
| Carbon dioxide | 14 tons | 3 tons | 5 |
| *Bulk liquid totals* | 9,400,600 gallons | | 1,322 |

*Table ES-1. (cont'd.)*

| Common name | Annual use | Typical vehicle payload | Estimated number of deliveries each year |
|---|---|---|---|
| *Bulk solids* | | | |
| Antimony concentrate | Up to 17,500 tons | Up to 40 tons | 365-730 |
| Lime | 150 tons | 24 tons | 7 |
| Sodium metabisulfite | 2,000 tons | 22 tons | 91 |
| Grinding media (SAG mill) | 4,449 tons | 24 tons | 186 |
| Grinding media (ball mill) | 3,566 tons | 24 tons | 149 |
| Grinding media (LS ball mill) | 34 tons | 24 tons | 2 |
| Primary crusher liners | 62 tons | 24 tons | 3 |
| Pebble crusher liners | 84 tons | 24 tons | 4 |
| SAG liners | 801 tons | 24 tons | 34 |
| BM liners | 1,424 tons | 24 tons | 60 |
| LS primary crusher liners | 9.16 tons | 24 tons | 1 |
| LS secondary crusher liners | 9.32 tons | 24 tons | 1 |
| LS ball mill liners | 27.8 tons | 24 tons | 2 |
| Lime slaker liners | 3.5 tons | 24 tons | 0.25 |
| Waste from mill liners and crusher liners | 280 tons | 24 tons | 12 |
| Ammonium nitrate | 7,300 tons | 24 tons | 304 |
| Sodium cyanide | 4,000 tons | 24 tons | 167 |
| Copper sulfate | 1,250 tons | 22 tons | 57 |
| Potassium amyl xanthate | 1,350 tons | 20 tons | 68 |
| Lead nitrate | 800 tons | 22 tons | 37 |
| Activated carbon | 500 tons | 22 tons | 23 |
| Sodium carbonate | 430 tons | 24 tons | 18 |
| Flocculant | 300 tons | 22 tons | 14 |
| Sodium hydroxide | 330 tons | 22 tons | 15 |
| Explosives | 100 tons | 5 tons | 20 |
| Microsand | 6.58 tons | | 1 |
| Sodium bisulfite | 0.2 tons | | 1 |
| Scale control reagents | 5,000 pounds | 1,000 pounds | 5 |
| Fertilizer | ~2,500 pounds | | 1 |
| Herbicides | ~1,000 pounds | | 1 |
| Sodium hypochlorite | 2,000 pounds | 1,000 pounds | 2 |
| Pesticides/insecticides | ~250 pounds | | 1 |
| Wastes containing mercury from ore processing (carbon canisters, filter packs, gas condensers) | Not quantified | | |
| *Bulk solids totals* | >46,771 tons | | >1,650 to 2,015 |
| *Bulk liquid and solid total trips/year* | | | >2,977 to 3,337 |

The Supplemental Draft Environmental Impact Statement (SDEIS) acknowledged the spills can be harmful and that a Spill Prevention Control and Countermeasures Plan (SPCC) would be developed for the proposed SGP (USFS 2022). The discussion of spill risk was largely limited to the transportation corridor, specifically from the junction of SH55 with Warm Lake Road to the proposed mine site 70 miles away along two different Action Alternative routes, the Burntlog Route and the Johnson Creek Route. The metrics the SDEIS used for assessing spill risk along the transportation corridor were the quantities of hazardous materials to be transported, used, and stored, and the amount of traffic, as well as descriptions of storage practices and a comparison of the characteristics of the two proposed routes (USFS 2022, p. 4-119). Overall, the assessment of spill risks in the SDEIS suffered from several flaws and presented an incomplete picture of the potential impacts from spills.

First, Perpetua held up their current track record on the mine access roads as an indication that spills will not be an issue in the future. The SDEIS reported that in 288 trips with fuel tankers carrying 4,000 to 4,500 gallons in the last 11 years, there have been no spills (USFS 2022, p. 3-99). Those 288 trips over more than a decade are roughly the same number of trips that would be needed to transport hazardous materials into and out of the mine site each month during 15 years of operations (3,337 trips per year/12 months per year = 278 trips per month).

Second, no quantitative estimates of the numbers of spills that might occur during the lifetime of the SGP were included in the SDEIS, from transportation or from any other causes. Transporting hazardous materials in trucks is a common occurrence in the United States, and there are several governmental agencies that track what is shipped, how far hazardous materials move, and the safety associated with those shipments. In addition, quantitative risk assessment for the transportation of hazardous materials is an active area of study in the operations research branch of applied mathematics. EISs for other mines and resource extraction projects have included calculations for the expected numbers of hazardous materials spills and the probability of at least one spill. The simple model most often used in other EISs is $N = RT$, where

$N$ = the expected number of releases of hazardous materials,

$R$ = the release rate per mile traveled by a truck carrying hazardous materials, and

$T$ = the total number of miles traveled by trucks carrying hazardous materials.

This model has precedent of being used in other mining EISs and is intuitive: The more miles traveled by trucks carrying hazardous materials, the higher the expected number of spills.

Third, the estimated spill rate per truck mile in the SGP SDEIS was 100 times lower than it should have been. The SGP SDEIS calculated (but did not use) their own estimate of $R$ (USFS 2022). The SGP SDEIS misused Federal Motor Carrier Safety Administration (FMSCA) data to estimate hazardous material spill rates of 1.4 x $10^{-9}$ spills per truck-mile in 2013 and 1.9 x $10^{-9}$ spills per truck-mile in 2016. Due to a fundamental math error, these estimates are two orders of magnitude too low. I was able to recreate the math performed in the SGP SDEIS and correct it, arriving at an average spill rate of $R_{spill}$ = 1.814 x $10^{-7}$ spills per truck-mile for the period of 2009-2019 based on data from the FMCSA. Using the same principles and data, I also calculated the rate of accidents for trucks carrying hazardous materials as $R_{accident}$ = 1.34 x $10^{-6}$ accidents per truck-mile. The value of $R_{spill}$ I calculated is closer to rates cited in other EISs, including for Pogo Mine, which used an estimate of 1.9 x $10^{-7}$ spills per truck-mile, and Pebble Mine, which used an estimate of 2.0 x $10^{-7}$ spills per truck-mile for diesel spills >3,000 gallons and 7.8 x $10^{-7}$ spills per truck-mile for ore concentrate. The $R_{spill}$ I estimated is lower than the rate from the Pipeline and Hazardous Materials Safety Administration, which estimated that there were an average 3.2 x $10^{-7}$ spills of hazardous material per truck-mile (Battelle 2001). (Due to underreporting, it is likely that all these estimated rates are too low, perhaps by as much as a factor of ten (PHMSA 2010).)

Fourth, Cascade, Idaho is not a hub of industrial chemical manufacturing and storage. Therefore, the mine supplies would have to come from other locations. I was able to find potential distributor locations nearest to Cascade, Idaho for 22 supplies that would be used at SGP (Table ES-2). Only six supplies (propane, gasoline, nitric acid, sulfuric acid, hydrogen peroxide, and liquid carbon dioxide) were available in the quantities needed for industrial uses within 100 miles of Cascade, Idaho. Diesel fuel was available inside a 250-mile radius. The remaining reagents I was able to find distributors for were only available from cities that were up 500 or 1,000 miles away. Supplies would travel on SH-55 both north and south of Cascade and could potentially impact any of the communities and environments they would pass through.

*Table ES-2. Supplier locations and hazardous materials to be used at the SGP annually. The listed reagents are 56% of the hazardous materials that would be transported to and from the mine site every year for 15 years.*

| City | Substance | Number of annual loads | Quantity per load | Distance to Cascade, Idaho (miles) |
|---|---|---|---|---|
| Boise, Idaho | hydrogen peroxide | 2 | 3,660 gallons | 79 |
| | sulfuric acid | 5 | 3,000 gallons | |
| | nitric acid | 22 | 3,000 gallons | |
| | carbon dioxide | 5 | 3 tons | |
| Caldwell, Idaho | gasoline | 100 | 5,000 gallons | 90 |
| Fortuna, California | scale control reagents | 5 | 1,000 gallons | 724 |
| Gardena, California | lead nitrate | 37 | 22 tons | 923 |
| | potassium amyl xanthate | 68 | 20 tons | |
| Salt Lake City, Utah | antifreeze | 13 | 3,000 gallons | 420 |
| | copper sulfate | 57 | 22 tons | |
| Winnemucca, NV | sodium cyanide | 167 | 24 tons | 326 |
| Greenacres, WA | lime | 7 | 24 tons | 298 |
| McCall, Idaho | propane | 226 | 6,000 gallons or 11,000 gallons | 31 |
| Renton, WA | ferric sulfate | 17 | 3,000 gallons | 499 |
| | sodium carbonate | 18 | 24 tons | |
| | sodium hydroxide | 15 | 22 tons | |
| Seattle, WA | methyl isobutyl carbonyl | 40 | 3,000 gallons | 500 |
| | sodium metabisulfite | 91 | 22 tons | |
| Baker City, Oregon | diesel | 580 | 10,000 gallons | 176 |
| Portland, Oregon | sodium hypochlorite | 2 | 1,000 gallons | 479 |
| Richland, WA | magnesium chloride | 56 | 4,500 gallons | 326 |
| Yakima, WA | activated carbon | 23 | 22 tons | 401 |

Note: All of these materials would then be transported the remaining 70 miles from Cascade, Idaho to the SGP mine site along one of the proposed truck routes.

Instead of only considering the transportation corridor from SH-55 at Cascade to the mine site, the true measure of the communities and environment at risk will extend to the distribution points of the reagents brought to the mine and the destinations of the ore concentrate and wastes taken from it (Table ES-2). The overall exposure will depend on the distances the reagents, products, and wastes need to travel and the number of trips that are necessary for the respective quantities of the hazardous materials. I estimated the total miles per year using an average value for the road miles for the two action Alternatives from Cascade to the mine site and an educated approximation of the minimum distances for sourcing the reagents. For simplicity, I used the distance to Boise, Idaho for all the supplies for which I was unable to find sourcing locations. This set of origin and destination cities is only an example and likely underestimates the total truck-mile exposure per year because both the number of trips and the number of miles to travel used may be lower than the actual values.

Using the total number of heavy vehicles trips with hazardous materials, I found the expected number of spills and crashes along the SH-55 to mine site portion of the transportation corridor (3,503,850 miles over 15 years) and the full distribution points to mine site distance (at least 14,678,325 miles over 15 years) based on the $N = RT$ model and the probabilities of spills and crashes using a Poisson distribution (Table ES-3). Based on that model, there is a 47% chance of at least one spill from a heavy vehicle loaded with hazardous materials between SH55 at Cascade and the SGP mine site, and a 93% chance of at least one such an incident over the full transportation corridor length. Similarly, there are 4-5 accidents involving heavy vehicles laden with hazardous materials expected along the transportation corridor length considered in the SGP SDEIS and 19-20 accidents along the full transportation corridor. The calculations shown here serve as examples of the general process for estimating spill and crash numbers and likely underestimate the risks. Still, these numbers indicate that the impacts that spills and accidents may have on the environment and human safety along the transportation corridor should be seriously and thoroughly considered.

*Table ES-3. Expected numbers and probabilities of at least one hazardous materials-laden trucking accident spill or crash expected in 15 years of mine operations from SH55 at Cascade to the SGP and for the estimated full transportation corridor. based on the N = RT model with $R_{spill} = 1.814 \times 10^{-7}$ spills per truck-mile and $R_{accident} = 1.34 \times 10^{-6}$ accidents per truck mile based on FMCSA data from 2009-2019.*

| | SH55 to SGP (70 miles) | Full corridor |
|---|---|---|
| *T* = miles per trip x number of trips per year x years of operation | 3,503,850 | 14,678,325 |
| Expected number of hazardous materials spills from heavy vehicles | 0.64 | 2.7 |
| Probability of at least one hazardous material spill from a heavy vehicle (Poisson model) | 47.0% | 93.0% |
| Expected number of crashes involving a heavy vehicle loaded with hazardous materials | 4.7 | 19.7 |
| Probability of at least one crash involving a heavy vehicle loaded with hazardous materials (Poisson model) | 99.1% | 100% |

According to Mary Faurot (personal communication), when asked at a December 6, 2022, community meeting why the SDEIS only considered the distance between SH55 and the mine site, "Kevin Knesek (deputy Forest Supervisor) said that the research showed most spills happen on backcountry roads, so that's where they did their 'analysis'." Terminating the consideration of spill risks at the junction of Warm Lake Road and SH55 underestimates the risks of transportation spills in two ways: first, as shown above, it dramatically underestimates the length of the transportation corridor and thus the total number of miles over which hazardous materials would be trucked. Second, the $R_{spill}$ used in the calculations is based on national data, which do not capture the specific hazards associated with different portions of the full transportation corridor. Estimates of spill risk per truck-mile based on data collected nationwide are generalized and miss factors that may be relevant to individual hazardous material transportation scenarios. Some risks are dependent on the route chosen (road grade, number of lanes, weather, etc.) and some are route independent (driver experience level, material type, truck configuration, etc.). SGP would have some significant risks (road grade and quality, avalanche/landslide/rockfall, fires, etc.) that would be expected to increase the spill rate if a detailed model were used. While road improvement and speed limits might help abate some of the risks inherent in the analysis area, it is clear that developing a project-specific spill risk per truck-mile for one or more segments of the transportation corridor would likely result in an estimated rate that is higher than the national average spill rate per truck-mile.

Both the road-specific spill rates and the lengths of the road associated with each rate are important. Consider an analogy: If a pulmonologist knew that a person smoked both a relatively small number of unfiltered cigarettes and a much higher number of filtered cigarettes, the doctor would not base their estimation of whether the person is likely to develop lung (or other) cancer only on the number of unfiltered cigarettes, much less by assessing the number of unfiltered cigarettes as having the same hazard level as filtered cigarettes and ignoring the additional risk posed by the filtered cigarettes. In the case of the SGP SDEIS, the $R_{spill}$ from SH55 to the mine site is likely much too low, and the value for $T$ also underrepresented the true transportation corridor. The risk of hazardous material spills from truck traffic related to the proposed SGP is therefore dramatically underestimated.

The SGP SDEIS described some mitigating procedures to minimize spill risk associated with the transportation of hazardous materials, such as speed limits and having pilot vehicles accompany convoys of heavy trucks (USFS 2022), but questions remain. For example, what would the spacing of vehicles in convoys be? Would there be an upper limit to the number of vehicles in a convoy? If weather or other natural events make the a given route impassable, where and how will vehicles with hazardous materials either wait out the event or temporarily store their cargo?

The SGP SDEIS's rudimentary attempt at describing the risk of hazardous materials spills was constrained to a limited analysis area and a single source (trucks) of potential spills. This narrow consideration of the possible impacts of the transportation corridor and hazardous materials misses other effects related both to the proposed routes and the possibility of spills from other sources. Transportation impacts extend beyond the risk of spills. The physical structure, use, and maintenance of roads may have effects on fish habitats within a 200 m impact zone from the centerline of rural roadways (Kravitz and Blair 2019). Other environmental effects to consider are greenhouse gas emissions and dust generation, which will be dependent on the amount of traffic and application of chemicals to the roadway. Therefore, the conclusions in the SDEIS that construction of and/or use of the roadways will have limited if any impacts on fish and the aquatic environment are not justified. Safety is also a concern with accidents, injuries, and fatalities all possible along the SGP transportation corridor.

Similarly, conclusions that spills will be rare or small are also unjustified. Mine-related spills of hazardous materials can come from many processes besides transportation. The SDEIS did not examine the probability or potential sizes of spills of either tailings or contact water from pipelines or from mining equipment leaks or mechanical failures. Spills from SPCC facilities may be twice as likely as spills from vehicles (Etkin 2006), but the SGP SDEIS did not discuss the possibility of spills from storage facilities. Even if the modeling had been better done, it is likely that the number of spills that would occur would be much higher than the predictions. As shown in a retrospective analysis comparing the spill risks considered in five Alaskan mining EISs and their spill records after years of operations (ADEC 2021), the actual number of spills from trucking accidents is much larger than the $N = RT$ model would predict (Lubetkin 2022). (The five mines studied had shorter transportation corridors than described in the SGP SDEIS. The proposed SGP amounts of ore processed per day, annual trips hauling hazardous materials, years of operations, and total miles traveled with hazardous materials all fell within the bounds of the five mines' characteristics. For example, the SGP would be second only to Fort Knox/True North in its daily ore processing (20,000 to 25,000 tons per day at SGP compared to 36,000 tons per day at Fort Knox/True North.)) Further, the combined 114 spills resulting from truck accidents (rollovers and collisions) are only a small subset of the number of spills attributed to all transportation-related releases, such as leaks, unsecured cargo, overfilling, and human error (1,004 spills). Finally, transportation-related spills are in turn only a small subset of the total number of spills that occur associated with mine operations (8,157 spills recorded across the five mines from 1995-2020) (Table ES-4).

Spills are not only common but can also be quite large. Four of the five large mines studied had at least eight releases of ≥1,000 gallons or ≥1,000 pounds of hazardous materials (Table ES-5). Seventy-five percent of the spill incidents at all five large mines involved non-crude oil, but non-crude oil spills only accounted for 5.2% of the volume spilled (Lubetkin 2022). Most of the spill volume was from releases of hazardous substances (e.g. ore concentrate) and process water, which together represented 94.7% of the volume released, even if they were only 24% of the number of incidents (Lubetkin 2022).

*Table ES-4. A comparison of mine characteristics for five large hardrock mines in Alaska with the characteristics of the proposed SGP and the spills records associated with the operational mines from 1995-2020 based on data from ADEC.*

| Pogo | Kensington | Greens Creek | Fort Knox/ True North | Red Dog | SGP (proposed) |
|---|---|---|---|---|---|
| Mine type | | | | | |
| Underground | Underground | Underground | Open pit | Open pit | Open pit |
| Product | | | | | |
| gold dore/bars | gold ore concentrate | silver and gold; lead and zinc ore concentrate | gold dore/bars | lead and zinc ore concentrate | dore/bars and ore concentrate |
| Total trips per year | | | | | |
| 730 | 2,472 | 17,825 | 1,700 | 9,298 | 3,337 |
| Transportation corridor length considered in the EIS | | | | | |
| 50 miles | 5 miles | 8 miles | 26 miles | 52 miles | 70 miles |
| Years of operations | | | | | |
| 11 | 10 | 28 | 16 | 32 | 15 |
| Total miles traveled with hazardous materials | | | | | |
| 401,500 | 123,600 | 4,077,710 | 707,200 | 15,471,872 | 3,503,325 (mine site to Cascade only);<br>14,678,325 (full transportation corridor) |
| Tons of ore processed per day | | | | | |
| 2,500 to 3,000 | 2,000 | 800 to 2,300 | 36,000 | 3,000 to 10,000 | 20,000 to 25,000 |

*Table ES-4. (Cont'd.)*

<table>
<tr><th>Pogo</th><th>Kensington</th><th>Greens Creek</th><th>Fort Knox/ True North</th><th>Red Dog</th><th>SGP (proposed)</th></tr>
<tr><td colspan="6">Number of expected spills under the $N = RT$ model</td></tr>
<tr><td>0.10</td><td>0.035</td><td>0.76</td><td>0.21</td><td>3.2</td><td>0.64 (mine site to Cascade only);<br>2.7 (full transportation corridor)</td></tr>
<tr><td colspan="6">Probability of at least one spill under the $N = RT$ model (Poisson distribution, as %)</td></tr>
<tr><td>9.7%</td><td>3.4%</td><td>53.2%</td><td>18.9%</td><td>95.8%</td><td>47.0% (mine site to Cascade only);<br>93.0% (full transportation corridor)</td></tr>
<tr><td colspan="6">Hazardous materials spills from truck rollovers or collisions</td></tr>
<tr><td>11</td><td>4</td><td>10</td><td>31</td><td>58</td><td></td></tr>
<tr><td colspan="6">All transportation spills</td></tr>
<tr><td>65</td><td>34</td><td>123</td><td>301</td><td>481</td><td></td></tr>
<tr><td colspan="6">Volume spilled from all transportation spills (gallons)</td></tr>
<tr><td>1,603</td><td>495</td><td>2,396</td><td>11,631</td><td>17,279</td><td></td></tr>
<tr><td colspan="6">Weight spilled from all transportation spills (lbs)</td></tr>
<tr><td>0.5</td><td>2</td><td>0</td><td>10</td><td>1,771,064</td><td></td></tr>
<tr><td></td><td></td><td></td><td></td><td></td><td></td></tr>
<tr><td colspan="6">All spills</td></tr>
<tr><td>1,503</td><td>308</td><td>1,515</td><td>1,949</td><td>2,882</td><td></td></tr>
<tr><td colspan="6">Total volume spilled (gallons)</td></tr>
<tr><td>267,710</td><td>6,272</td><td>111,333</td><td>527,533</td><td>1,450,397</td><td></td></tr>
<tr><td colspan="6">Total weight spilled (lbs)</td></tr>
<tr><td>29.5</td><td>4</td><td>13,899</td><td>5,024</td><td>1,919,563</td><td></td></tr>
</table>

*Table ES-5. Summary of the number and maximum size of large releases from the five mines considered in Lubetkin (2022).*

| Mine | Number of Spills ≥ 1,000 gallons or pounds | Largest release |
|---|---|---|
| Greens Creek | 8 | 72,000 gallons process water |
| Pogo | 17 | 135,000 gallons mine paste backfill |
| Kensington | 0 | 800 gallons process water |
| Fort Knox/True North | 28 | 305,370 gallons process water |
| Red Dog | 128 | 250,000 pounds ore concentrate |

Overall, the analysis of the potential impacts from hazardous materials in the SGP SDEIS is inadequate to make an informed decision because it is incomplete and does not offer a way to compare the Action Alternatives against the No Action Alternative. EISs for other mines include expected spill numbers and probabilities, and the SGP SDEIS did not. EISs for other mines include spill risk rates that are on the order of $2.0 \times 10^{-7}$ spills per truck-mile, but the SGP SDEIS estimated a spill rate ranging from $1.4\text{-}1.9 \times 10^{-9}$ spills per truck-mile, which is two orders of magnitude lower than rates published in multiple sources. The transportation corridor analysis area did not consider any risks beyond Cascade, Idaho. Using a spill risk rate of $1.814 \times 10^{-7}$ spills per truck-mile based on FMCSA data from 2009-2019, I found the probabilities of spills and accidents for the Action Alternatives for the analysis area considered in the SGP SDEIS and the full length of the transportation corridor. The spill rate I used is likely too small as it is an average based on national spill data that may suffer from substantial underreporting and the road characteristics near the proposed SGP would increase spill risks. Without an accurate characterization of the true exposure along the transportation corridor and the spill rate per truck-mile, it is impossible to then make informed statements about spill likelihood and the potential consequences to the environment and to public safety from truck accidents alone, much less any of the other potential sources and causes of spills. Data from five other large operational mines illustrate that hazardous materials spills are frequent, can be sizable, and that transportation spills are only a small fraction of mine-related spills.

In short, a realistic approach to discussing spill risk would

- Include all the hazardous materials being transported (not just diesel or other individual hazardous materials)
- Represent the entire length of the transportation corridor
- Use the correct value(s) for $R_{spill}$, possibly by including specific values for different stretches of road with different characteristics
- Recognize the $N = RT$ model is too simplistic and investigate the many models that are part of the operations research literature about optimizing the transportation of hazardous materials which would better the highlight the trade-offs in choosing between the Burntlog Route or Johnson Creek Route or the No Action Alternative
- Recognize that transportation spills do not just come from truck rollovers and collisions
- Recognize that transportation spills are only a small fraction of the total number of spills at mines; pipelines, storage facilities, and mining equipment can also fail, leak, or otherwise have accidental releases of hazardous materials

- Acknowledge that even if spills at mine sites and elsewhere are contained and cleaned up, that process can also create hazardous waste or other impacts that will then have to be dealt with
- State quantitatively the minimum number and probabilities of expected spills from all mine-related sources, including any "over the fence" infrastructure, as well as explanation of why such an estimate is a lower bound, for the Action Alternatives and the No Action Alternative.

Finally, if the SGP does go forward, in the interest of keeping the communities informed, the USFS should consider requiring that all spills above a certain threshold be recorded in an up-to-date and publicly available database. The Alaska Department of Environmental Conservation statewide oil and hazardous substance spills database would serve as good model.

## Note to the reader

This report draws heavily on the SGP DEIS and the SDEIS, among other documents. I make no assumptions that the reader has access to those references. Therefore, I have made liberal use of extracted blocks of texts to aid comparisons and provide ample context.

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## 1. Introduction

USFS (2022), pp. 2-7, 8:

> Perpetua proposes to develop a mine operation that produces gold and silver doré, and antimony concentrates from ore deposits associated with their mining claims in the SGP area. The estimated recoverable mineral resource consists of:
>
> - 4.2 million ounces of gold
> - 1.7 million ounces of silver
> - 115 million pounds of antimony
>
> Development of the mineral resource would include construction of access and haul roads; construction of supporting infrastructure; open pit mining; ore processing; placement of tailings in a [tailings storage facility] TSF; and placement of development rock. New access to the SGP would be provided by the proposed Burntlog Route, which would be a combination of widening the existing Burnt Log Road (FR 447), Thunder Mountain Road (FR 50375), and Meadow Creek Lookout Road (FR 51290) and constructing new connecting road segments of approximately 15 miles (**Figure 2.4-1**). Development of the Burntlog Route would entail 340.9 acres of new cut and fill activity (including borrow sources) along existing and newly constructed roadways.

This is a reduction in the amounts of mineral resources proposed in the original DEIS (USFS 2020, p. 2-11), which estimated recoverable mineral resource of:

- 4 to 5 million ounces of gold
- 6 to 7 million ounces of silver
- 100 to 200 million pounds of antimony

Mining 75,000-100,000 tons of development rock per day as well as mining and processing 20,000-25,000 tons of ore per day (Midas Gold Idaho, Inc. 2016) would require millions of gallons of bulk liquid reagents and tens of thousands of tons of bulk solid reagents listed as hazardous materials, which would be brought to the mine site using the transportation corridor. Kravitz and Blair (2019) examined the risks to fish posed by the roadway to the proposed Pebble Mine and found that

> [f]our sources of potentially toxic chemicals are related to the transportation corridor: traffic residues, road construction, chemical cargos, and road treatment. During runoff events, traffic residues (metals, oil, grease) can wash into streams and accumulate in sediments or disperse into groundwater (Van Bohemen and Van de Laak 2003). Road construction involves the crushing of minerals for the road fill and bed and the exposure of rock surfaces at road cuts, which leads to leaching of minerals and increased dissolved solids. Chemical reagents used to process ore would be transported by road to the mine site. Truck accidents along the transportation route could spill reagents into wetlands and streams. Roads are treated with salts and other materials to reduce dust and improve winter traction.

This report focuses on the probability of hazardous materials spills along the transportation corridor but will touch on other aspects associated with hazardous materials spills and with roadways. First, it is important to define terms and put the proposed Stibnite Gold Project (SGP) into the larger context of what is already known about transporting hazardous materials in the United States.

## Definition of hazardous materials

By definition, a hazardous material is

> any substance or material capable of causing harm to people, property, and the environment. … The United Nations sorts hazardous materials into nine classes according to their physical, chemical, and nuclear properties: explosives and pyrotechnics; gasses; flammable and combustible liquids; flammable, combustible, and dangerous-when-wet solids; oxidizers and organic peroxides; poisonous and infectious materials; radioactive materials; corrosive materials (acidic or basic); and miscellaneous dangerous goods, such as hazardous wastes (UN, 2001). (Erkut et al. 2007)

Substances which are potentially harmful to human health and/or the environment when released in sufficient quantities are designated as harmful by the Environmental Protection Agency (EPA) (Transportation Research Board 2005). The EPA is required to report releases, and the Department of Transportation (DOT) regulates the transportation of hazardous substances when they are shipped in quantities exceeding specific thresholds (Transportation Research Board 2005).

## Transport of hazardous materials in the United States

The amount of shipping of hazardous materials in the United States is large and growing (Table 1). The number of truck trips carrying hazardous materials has increased from an estimated 250,000-500,000 shipments per day in 1998 (Erkut and Verter 1998) to more than 1,000,000 trips per day by 2010 (Inanloo et al. 2015), moving billions of tons (Table 1). Material quantities can vary from a few ounces to, as is often the case for mines, thousands of gallons or tons of materials, which can be moved through areas with huge potential risks for loss of human life or for environmental damage (Gerard 2005).

Erkut et al. (2007), p. 539.

> According to the US Department of Transportation (US DOT), a hazardous material is defined as any substance or material capable of causing harm to people, property, and the environment. … There are thousands of different hazardous materials in use today (US DOT, 2004b). The United Nations sorts hazardous materials into nine classes according to their physical, chemical, and nuclear properties: explosives and pyrotechnics; gasses; flammable and combustible liquids; flammable, combustible, and dangerous-when-wet solids; oxidizers and organic peroxides; poisonous and infectious materials; radioactive materials; corrosive materials (acidic or basic); and miscellaneous dangerous goods, such as hazardous wastes (UN, 2001).

Craft (2004)

> Types of hazardous materials range from relatively innocuous products, such as hair spray and perfumes, to bulk shipments of gasoline by highway cargo tanks, to transportation of poisonous, explosive, and radioactive materials.

Transportation Research Board (2005)

> Hazardous materials regulation has long been focused on acute hazards, such as flammability, which pose a risk to the public when hazardous materials are accidentally released. This focus, however, has diminished over time as concern over other nonacute risks to human health and the environment has grown. During the 1970s, Congress called on the U.S. Environmental Protection Agency (EPA) to require the reporting of releases of certain environmental contaminants in specific quantities. DOT was subsequently required to regulate the transportation of these hazardous substances when they are shipped in quantities equal to or exceeding their reportable quantities…. Understanding and managing the full array of public safety, environmental, and security risks associated with the transportation of hazardous materials have become more explicit goals of both government and industry.

Transportation Research Board (2005)

> EPA designates certain materials as hazardous substances that are potentially harmful to human health and the environment if they are released in specific quantities. These designated substances are regulated by DOT in transportation. EPA also requires generators of hazardous wastes to keep track of shipments of these wastes by maintaining detailed manifests of their movements from origin to disposal.

Barilla et al. (2009)

> The transport of HazMat is an important, complex, socially and environmentally sensitive problem; involving a plethora of parameters: economic, social and environmental… Generally HazMats have to be transported from a point of origin to one or more destination points. The origin points are fixed facilities where the HazMats are produced, or stored. The HazMats are then transported from a production facility to storage, distribution, or another facility where the HazMat is required. Typically, the transporter will wish to use the minimum cost route. It is also being required that the route(s) taken are to be chosen so as to minimize exposure to hazard in the event of an accident.

Gerard (2005)

> There are over 800,000 daily shipments of hazardous materials moving by plane, train, truck, or vessel in quantities varying from several ounces to many thousands of gallons. These shipments move through densely populated or sensitive areas where the consequences of an incident could be loss of life or serious environmental damage.

*Table 1. Estimates of quantities and distances hazardous materials are shipped in daily and annually in the United States. Unless otherwise specified, shipments may be transported by train, pipeline, truck, and/or airplane.*

| Source<br>• Summary statistic | Internal reference (if any) |
|---|---|
| Erkut and Verter 1998 | |
| • 250,000-500,000 shipments per day | |
| • 1.5-4 billion tons per year | |
| Battelle 2001 | |
| • 74,410 million ton-miles in 1993 | 1993 Commodity Flow Survey |
| • 74,939 million ton-miles in 1997 | 1997 Commodity Flow Survey |
| • 7,763,282,762 vehicle miles in 1997 | |
| • 1.4 billion tons/year | |
| • 5% of all commodity shipment miles | |
| In 1996, 7.2 percent of all trucks surveyed carried HM. | Star Mountain Inc., 1997 |
| • 769,000 hazardous truck shipments per day | US DOT, 1998 |
| • 314,000 petroleum product shipments per day by truck | |
| • 445,000 chemicals and allied products shipped per day by truck | |
| • 1.4 billion tons in hazardous shipments by truck per year | |
| • 1.04 billion tons petroleum per year by truck | |
| • 43% of all HazMat tonnage is transported by truck | |
| Craft 2004 | |
| • >800,000 truck shipments/day | |
| • 7.2% of trucks carry enough HazMat to warrant displaying a warning placard | Office of Motor Carriers 1996 fleet survey |
| Gerard 2005 | |
| • >800,000 shipments per day | |
| • >3 billion tons per year | |
| Transportation Research Board 2005 | |
| • 817,000 shipments per day | 1997 Census Bureau |
| • almost 3 million shipments per year | |
| • 5.4 million tons per day | |
| • 2 billion tons per year | |
| • 768,907 truck shipments per day | |
| • 205 million tons-miles per day by truck | |
| • average shipment weight by truck = 4.82 tons | |

| | |
|---|---|
| • 94% of daily shipments are by truck<br>• 69% of tonnage shipped is by truck<br>• 34% of ton-miles are by truck<br>• 41% of truck shipments are petroleum products; 59% are mostly chemical and allied products | |
| Erkut et al. 2007<br>• 800,000 shipments/day<br>• 9 million tons/day | US DOT, 2000 |
| Inanloo et al. 2015<br>• >15,000 incidents reported to the Pipeline and Hazardous Materials Safety Administration (PHMSA) | |
| • > 1,000,000 daily shipments of hazardous materials by truck | PHMSA, 2010 |

## Definition of an incident

Erkut and Verter (1998) note that "although accident probabilities are quite low for any given trip, the sheer volume of hazmat shipments almost guarantees that there will be some accidents over a sufficiently long period of time." The terminology surrounding "accidents" and "incidents" varies slightly between those who study transportation networks and legal definitions. For those who study the shipping of hazardous materials to model transportation networks and choose optimal routes, an accident resulting in a release of hazardous materials is called an incident (Erkut et al. 2007). Legally, "federal law has defined a hazardous materials transportation incident as an unintentional release of a hazardous material from its package during transportation, which includes periods of loading and unloading and storage incidental to transportation" (Transportation Research Board 2005). Those incidents are events in which there is "an unanticipated cost to the shipper, carrier or any other party", including hazardous material accidents with and without releases, releases related to loading and unloading, and enroute leaks, and reserve the term "accident" for vehicular collisions (Battelle 2001). Incidents that are sufficiently large or have severe enough consequences are considered "serious":

> The definition of "serious" incidents used by PHMSA's Office of Hazardous Materials Safety (OHMS) for hazardous materials releases from road and railway transportation includes additional criteria. Since 2002, PHMSA/OHMS has defined "serious incidents" as incidents that involve either:
>
> - a fatality or major injury caused by the release of a hazardous material,
> - the evacuation of 25 or more persons as a result of release of a hazardous material or exposure to fire,
> - a release or exposure to fire which results in the closure of a major transportation artery,
> - the alteration of an aircraft flight plan or operation,
> - the release of radioactive materials from Type B packaging,
> - the release of over 11.9 gallons or 88.2 pounds of a severe marine pollutant, or
> - the release of a bulk quantity (over 119 gallons or 882 pounds) of a hazardous material.

> The number of “serious” incidents presented in the tables of this section for road and railway includes only incidents meeting the first of these criteria (incidents with fatality or injury caused by the release of a hazardous material), and no other incidents meeting the other criteria. For transmission pipelines, all serious incidents are included. (PHMSA 2010)

PHMSA 2010, p. 10

> PHMSA defines significant incidents as those incidents reported by pipeline operators when any of the following conditions are met:
>
> 1. fatality or injury requiring in-patient hospitalization
> 2. $50,000 or more in total costs, measured in 1984 dollars
> 3. highly volatile liquid releases of 5 barrels or more or other liquid releases of 50 barrels or more
> 4. liquid releases resulting in an unintentional fire or explosion

PHMSA defines a serious pipeline incident as an event involving a fatality or injury requiring in-patient hospitalization. Note that serious incidents are a subset of significant incidents, including only incidents with consequences to human health and safety (fatalities and injuries only).

PHMSA 2010, p. 21

> Questions were raised in 2009 Congressional hearings about the completeness of reporting of (non-pipeline) hazardous materials incidents. One estimate quoted was that 60-90% of all such incidents were unreported. If these estimates apply equally to serious incidents, then the number of serious road and railway hazardous material incidents presented in this section could be too low by a factor of 10 (some cases were cited of non-pipeline incidents involving fatalities or injuries that went unreported).

## Overview of this report

Section 2. The SGP is not the first proposed project that would require the use and transportation of hazardous materials or have risks of spills. In this section I review how the potential risks and impacts of spills are characterized in previous environmental impact statements (EISs) released by the Bureau of Land Management (BLM), the Environmental Protection Agency (EPA), the US forest Service (USFS), and the US Army Corps of Engineers (USACE).

Section 3. This is a summary of the description of the transportation corridor, amount of traffic that would be due to the mine, and how environmental and other risks associated with mine traffic and hazardous materials are addressed over the various stages of the project for different Alternatives.

Section 4. The SGP SDEIS lists more than 50 hazardous materials that would be transported to and from the proposed project. The hazards from the various chemical reagents are not disclosed.

Section 5. The transportation corridor needs clearly defined endpoints. The analysis area for the SGP SDEIS artificially truncates the transportation corridor to only consider the road from SH-55 to the mine site. The length of the corridor will vary by the substance/supply required by the mine. Example distribution points of many mine reagents are shown.

Section 6. The annual probability of a spill of a specific hazardous material will be based on the total transportation corridor length from the distribution point to the mine site and the number of truck trips required per year. The cumulative spill probability is based on the total distance reagents are transported to the mine from their respective distribution locations over the life of the mining project. The individual and combined exposure variables for hazardous materials transportation are calculated in this section.

Section 7. The SGP SDEIS cited Federal Motor Carrier Safety Administration (FMCSA) data to calculate a constant spill probability that is two orders of magnitude smaller than rates used in peer-reviewed studies and other EISs. I went to the original data cited in the FMSCA reports for several years to both recreate the rates cited in the SGP SDEIS and show how to correct those calculations. I then compare the rates I computed with previously cited rates.

Section 8. Models for spill probability range from very simple to very specialized and detailed. The simplest model of spill probability uses a single, constant spill rate for all types of roadway. A more detailed model could incorporate location-specific factors that increase and decrease the estimated rate for segments of the transportation corridor. This section reviews other factors that could affect calculations of spill probabilities per mile of exposure in general and for the SGP specifically.

Section 9. Using the total number of truck-miles from Section 7 with the spill rate per truck-mile I estimated in Section 8, I calculated expected numbers of spills and probability of at least one spill of hazardous materials along the portion of the transportation corridor from SH-55/Warm Lake Road and along my best estimate of the entire transportation corridor from the individual regent distribution locations. Not all accidents result in spill incidents. Very similar math can also be used to find the expected number of accidents of loaded and unloaded heavy vehicles along the transportation corridor for just the vehicles transporting hazardous materials and for all heavy vehicles using the roadway.

Section 10. This section provides an overview of quantitative risk assessments as a well-established field of study in operations research. Risk models in the peer-reviewed literature vary in how they incorporate consequences into the math, depending on the priorities of the specific application. Ignoring that, an estimate of spill probability is an essential first step.

Section 11. This critique only scratches the surface of potential impacts related to hazardous materials and transportation. Mine-related spills of hazardous materials can come from many processes besides transportation. Transportation impacts extend beyond the risk of spills. Finally, to compare theoretical calculations to observed incidents, I collected data about spills from Pogo Mine and found the probability of spills estimated in the EIS was vastly lower than the actual number of incidents.

Section 12. This section offers my conclusions about the adequacy of the presentation of the potential risks posed by hazardous materials along the transportation corridor in the SGP SDEIS.

## 2. Quantitative spill risks and probability assessments from other EISs

The probabilities and potential impacts of spills have been treated as important considerations in other EISs, albeit often with mathematical flaws in the estimations and presented in ways that downplay the cumulative risk exposure (Lubetkin 2020). Here are several treatments of spill risks as presented in EISs written from 1984 to the present. These examples show that 1. there are probability ranges defining when potential impacts need to be thoroughly addressed in an EIS and 2. that it is often possible to estimate the number of spills and the probability of spill occurrence based on spill rates from existing data and the exposure specific to a proposed project. The nine examples here are from EISs with the EPA, the BLM, the USFS, and the USACE as the lead agencies and are presented in chronological order. The spill histories of the mines are compared to the predictions in the EISs for five mines that have had a sufficiently long record of production in Section 11.

As will be seen below, most of the mines only attempted to model spills associated with transportation, usually due to truck accidents (rollovers and collisions) that result in a spill. Total exposure to truck-related incidents is usually based on the number of truck-miles traveled in a given period, which is a function of the number of annual trips for each hazardous substance multiplied by the length of the trip and the number of years. If the number of trips were constant over the production life of the mine, then

$$\text{Truck miles} = \text{road length x total number of trucks/year x years of production}$$

In practice, the number of trucks per year varies with production level and by the substance being transported (ore concentrate, reagents, fuel, etc.). The total number of truck-miles can be used with a spill rate per truck mile to estimate the number of expected spills ($E(N)$) and the probability of there being at least one spill from a truck over different time frames ($P(N \geq 1)$). Harwood and Russell (1990) estimated that $1.9 \times 10^{-7}$ spills occur per truck mile for rural two-lane roads. Using this estimated spill rate, the expected number of spills ($E(N)$) associated with the mine over a given time period is

$$E(N) = \text{spill rate per mile x total miles traveled} = RT$$

where $R = 1.9 \times 10^{-7}$ spills per truck mile and the total miles traveled, $T$, depends on which years of production and operation are considered.

## Spill risks as described in previous EISs from large mines

I examined the descriptions of spill risks from the permitting documents seven large proposed and operating mines, presented in the chronological order of their initial permitting documents: Greens Creek (USFS 1983), Fort Knox/True North (CH2M Hill 1993), Pogo (EPA 2003), Kensington (USFS 2004), Red Dog (EPA 1984, 2009), Donlin (USACE 2018), and Pebble Mine (USACE 2020).

### USFS (1983): Greens Creek acknowledged spill risks but did no modeling

Greens Creek Mine is an underground mine that produces silver and gold, as well as lead and zinc concentrates. Greens Creek is located on Admiralty Island, about 18 miles southwest of Juneau. The ore body was described as “small, but richly mineralized”, and containing silver, gold, lead, zinc, and copper (USFS 1983). In the initial EIS the estimated life of the mine based on the ore reserves known at the time was 11 years and the life of operations was 15-17 years for planning purposes (USFS 1983), but Greens Creek Mine is still in production today.

Greens Creek Mine has a complicated history of ownership and expansion, resulting in the production of multiple EISs and environmental assessments. The first EIS for Greens Creek Mine was completed in 1983 (USFS 1983). Subsequent changes in mine ownership and plans required the production of an environmental assessment in 1988. Ore production began in 1989, and a second environmental assessment was prepared in 1992 for expansion of waste rock disposal. Ore production was halted from 1993-1996 due to low metal prices. After production resumed, a second EIS was completed in 2003 for an extension of the tailings disposal facility. A third EIS was produced in 2013 to modify the plan of operations and expand the tailings disposal facility to allow for 30-50 years of additional storage capacity. The resulting ROD from the Forest Service approved a 10-year extension of the tailings disposal facility.

The initial EIS for Greens Creek (USFS 1983) acknowledged the risks of spills of hazardous substances:

> Potential pollutants would include chemicals used in the milling process such as sodium cyanide, copper sulphate, and other inorganic and organic salts. Fuel, hydraulic fluid, cement, and other materials would be used and stored in the mine and mine service area. Although those materials would be carefully transported, stored, and used, the potential for spillage exists.

but stated that the chances of spills reaching streams and causing environmental damage was low. Neither the EIS nor the later supplemental EIS (USFS 1983, 2013) included estimates of expected spill frequencies. When the EIS for the tailings disposal facility expansion came out in 2013 (USFS 2013a), the spill risk of a chemical or mining product spill having an impact on aquatic resources under Alternative D (the chosen Alternative) was described as similar to Alternative A ("Low, due to [best management practices] and Spill Prevention, Control and Countermeasure Plan requirements"), except that the area of potential spills would expand to include Fowler Creek Drainage and would extend for 30-50 years, rather than to 2019. The Forest Supervisor selected Alternative D in his Record of Decision with the primary modification to "delete construction of a second tailings facility in the Fowler Creek watershed" and "authorize[d] the Greens Creek Mine to expand the existing tailings disposal facility by about 18 acres, further south into the Admiralty Island National Monument" (USFS 2013b).

### CH2M Hill (1993): Fort Knox/True North acknowledged spill risks but did no modeling

Fort Knox Mine is a conventional open-pit gold mine 26 miles northeast of Fairbanks, Alaska. Fort Knox's initial major components were the mine site, the development rock and overburden stockpiles, the mill site, the tailings impoundment, and the water and power supplies (CH2M Hill 1993). After permitting in 1994, Fort Knox's construction began in 1995, and gold has been produced there since 1996 (SRK Consulting 2019). True North was a satellite deposit 12.5 miles away from Fort Knox, with the ore mined at True North hauled to Fort Knox for processing. The first ore from True North was processed at Fort Knox in March 2001 (Fairbanks Gold Mining, Inc., 2001), and True North Mine was closed in 2012 (SRK Consulting 2012). The Walter Creek Valley Heap Leach Facility (WCVHLF) at Fort Knox was authorized in 2007, with ore placement and leaching beginning in 2009 (SRK Consulting 2019).

Since the 1997, the average milling rate at Fort Knox has been above 36,000 tons per day, with a nominal milling rate of 36,287 tons per day (Sims 2015). Fort Knox has an operating capacity of 35,000 to 50,000 tons of ore per day to produce approximately 300,000 ounces of gold each year.

Within the environmental assessment (CH2M Hill 1993), the possibility of accidental releases was acknowledged in the context of medical training and response, but there were no prospective estimates of the number of spills that might be associated with Fort Knox Mine, either at the mine and milling site or along the transportation corridor.

### EPA (2003): Pogo Mine spill rates and probabilities for fuel and reagents

Pogo Mine is a gold mine approximately 38 miles northeast of Delta Junction in the interior of Alaska, predicted in its EIS to process 2,500 to 3,500 tons of ore per day (tpd). In this section I highlight how the transportation corridor spill risks were characterized. Pogo Mine has been in operation long enough to compare the estimates of spill probabilities and numbers predicted in the EIS with the observed spill records available through the Alaska Department of Environmental Conservation online database (ADEC 2020). I will contrast the observed spills with the predictions in Section 11.

EPA (2003), p. 4-20

> The following metrics have been applied [for accidental or unplanned releases of fuel or chemicals]:
>
> - *No or low impact*: No planned release or low likelihood of occurrence; if an accidental release or spill occurred, the potential for impacts to environment or public interests would be negligible.
> - *Moderate impact*: There is a risk of accidental release, or a release has a low likelihood of occurrence but the impacts could be high.

- *High impact*: A high potential for accidental release exists, and the severity of the release would be high.

*Table 2. The Pogo Mine EIS included estimates of the probability of diesel spills under different alternatives using a "probability of truck accidents and release was reported as 1.9 x$10^{-7}$ spills per mile of travel for rural two-lane roads (Harwood and Russell, 1990)", an 11-year project life, and a 49-mile transportation corridor (EPA 2003).*

| Scenario | Amount (in gallons) | Truck loads | Probability of ≥1 spill |
|---|---|---|---|
| without on-site power generation | 786,000 gallons per year | 100 tanker trucks (8,000 gallons each) each year | 1% |
| with on-site power generation | an additional 4.2 million gallons of diesel fuel per year | an additional 525 tanker trucks (8,000 gallons each), for a total of 625 fuel trucks each year | ~6% |

The number of tanker loads of diesel per year and miles to travel were used to calculate diesel spill probabilities, which depended on the specifics of the project options and were estimated to be 1 or 6% (Table 2). Spill risk probabilities for individual reagents or the cumulative number of reagent truck-miles were not calculated, but it was noted that fuel spills near a wetland could have an impact, that a major diesel spill near a creek could result in a high impact in a large area of the watershed, and that a substantial release of cyanide into surface water would have a high impact (EPA 2003).

### USFS (2004): Kensington calculated risks for diesel spills from trucks and tailings slurry spills from pipelines

Kensington Gold Mine is an underground gold mine roughly 45 miles north-northwest of Juneau, Alaska (USFS 2004). Kensington had a complicated permitting history and the 2004 Final Supplemental EIS (SEIS) is the third time that the mine underwent NEPA review (USFS 2004), with prior EISs in 1992 and 1997.

Kensington Mine's EIS contained discussions about the potential impacts of spills on many aspects of the environment, including groundwater, surface water, the marine environment, marine mammals, and fish for each Alternative considered (USFS 2004). Kensington Mine's EIS specifically calculated the number of vehicle trips for that might result in accidents, injuries, fatalities, or fuel spills. The fuel spill risks for all Alternatives were based on the Harwood and Russell (1990) spill rate per mile. The risks were estimated both for a single year and over the life of the project. Kensington's EIS also included quantitative risks associated with the tailings slurry pipeline, although no rate per mile (or other exposure variable) was stated.

Spill risks in the mill site were presumed to be of minimal concern environmentally:

> Within the mill, the concrete floor would be sloped to sumps so that any spillage could be recovered and returned to the processing circuit. Required processing reagents would be prepared and stored in the building. Therefore, any spillage of reagents in the mill building would likely be very small and easily recovered by the sumps. (USFS 2004)

### EPA (1984, 2009): Red Dog uses a mine-specific spill rate for ore concentrate

Red Dog Mine is an open pit lead and zinc mine, roughly 82 miles north of Kotzebue and 47 miles inland from the coast of the Chukchi Sea (EPA 1984, 2009). Red Dog has a current annual output of 1,000,000 pounds of zinc concentrate. While many of the mine components (mine, mill, tailings pond, housing, and water supply facilities) are on private land owned by the NANA Regional Corporation, the transportation corridor goes through Cape Krusenstern National Monument (EPA 1984, 2009). Red Dog Mine began ore processing 1989 (EPA 2009), followed by an expansion into the Aqqaluk ore deposit. The initial estimates of the ore deposit were that >85 million tons of ore were present (EPA 1984). The expected life of the mine was at least 40 years but is now expected to last until 2031 or longer.

The Delong Mountain Transportation System (DMTS) includes a 30-foot wide gravel industrial haul road that is 52 miles long and port infrastructure. The road has nine bridges for crossing creeks. Pipelines to transport ore slurry, tailings impoundment water, and diesel to or from the port were considered but never built.

The expected initial ore concentrate production amounts were 479,000 tons/yr in the first five years and 754,000 tons/year in years six and later (EPA 1984). Production has since increased to 1.5 million tons of ore concentrate shipped from the port site annually (EPA 2009).

Based on production levels estimated for initial production (1989-1993), expanded production (1994-2002) and current production (2003-2020), the number of annual trips with hazardous materials (ore concentrate, reagents, diesel, and ammonium nitrate) increased from ~3,700/year, to ~5,600/year, to ~14,000/year.

The supplemental EIS stated that "Traffic statistics using accident and spill data will be used to assess the effects of changes in transportation among the alternatives" (EPA 2009). The EPA (2009) estimated that 0.6 ore concentrate spills per year could be expected along the road from the mine to the port but did not then calculate the number of expected spills over the remaining life of the project or estimate spill rates for any other hazardous materials. Note a rate of 0.6 concentrate spills per year is based the number of years (exposure variable = time) rather than total miles traveled (exposure variable = truck miles).

### USACE (2018): Donlin Mine qualitative relative rates by spill size class

Donlin Mine is an open pit gold mine in Alaska. Although the Donlin Mine EIS was released 15 years later than the Pogo Mine EIS, it has a less quantitative approach to spill risk assessment, largely borrowed from EISs related to proposed fossil fuel development. The language used by the USACE for spill risks for the Donlin Mine (USACE 2018, p. 3.24-11, emphasis added):

> This section describes, by alternative, the expected relative rate of occurrence and estimated volumes of spills from the proposed project. *The likelihood of a spill is a qualitative assessment based on the rate or frequency of occurrence*. The rate of occurrence is a function of several factors, including operating procedures, personnel training and awareness, maintenance, and human error. *The relative rates listed below are based on the experience of several personnel with spill background, peer-reviewed and "gray" literature, and reports as referenced. The assessment is a subjective evaluation and the categories are relative to each other in the context of area operations*.

is very similar to language used by the BLM (2004, p. 379) to describe spill risks related to oil and gas extraction in the Alpine Satellite Development Plan (emphasis added):

> *The qualitative assessment of potential rate of occurrence is provided …. The relative ranks are based on: the experience of several personnel with extensive oil spill background with spills, peer-reviewed and "gray" literature, USCG spill reports; the reports incorporated by reference earlier,* and other spill reports for North Slope incidents. *The assessment is a subjective evaluation and the categories are relative to each other* in the context of North Slope oil field operations.

The Donlin Mine EIS (USACE 2018, p. 3.24-12) also borrowed the spill size classes and relative risk rate terminology from BLM (2004) (reproduced in Table 3). Unfortunately, "relative", "subjective", and "qualitative" rankings of spill risk are not very informative. While recognizing that larger spills are both less frequent and more damaging is important, this description is insufficient for making decisions, especially if cumulative effects from frequent small spills from many different hazardous materials are to be evaluated.

*Table 3. Reproduction of Table 3.24-1: Expected Relative Rate of Occurrence for Diesel Fuel Spills from Main Project Sources for Donlin Mine. "Note: Probability of Spill: Very high has a probability approaching one, very low has a probability approaching zero" (USACE 2018).*

| Source | Spill Size (US gallons) | | | | |
|---|---|---|---|---|---|
| | Very Small | Small | Medium | Large | Very Large |
| | <10 | 10–99.9 | 100-999.9 | 1,000–100,000 | >100,000 |
| Storage tanks/Tank farms | High | Medium | Low | Very Low | Very Low |
| Vessels (Barges) | High | Medium | Low | Very Low | Very Low |
| Tanker trucks | Very High | Medium | Very Low | Very Low | Would not occur |
| Pipeline | Very High | High | Low | Very Low | Very Low |

The Donlin Mine EIS specifically addresses risks of spills of diesel and cyanide from vehicles along the roadway and acknowledges previous spills of those substances in Alaska and internationally (USACE 2018). The discussion of diesel spill risks includes the number and size of the truckloads that would be required for the project but did not show any measure of road length or total truck-miles or a spill rate per truck-mile. According to the EIS, most diesel spills are expected to be less than 100 gallons but could be as large as the entire volume transported.

USACE (2018), p. 3.24-14

> A fleet of ten 13,500-gallon capacity B-train tanker trucks (with two tanks of approximately 6,750 gallons each) would be used to transport diesel from Angyaruaq (Jungjuk) Port to the Mine Site. There would be an average of 2,424 round trips per year during the shipping season of the Operations Phase, (approximately 22 per day). Research has been conducted into the probability of accidents on a number of different types of roads, but no research has been identified that examines accident rates on controlled access, private industrial roads such as the proposed mine access road (ARCADIS 2013a). Most potential spills would likely be small or very small. It is possible for a medium to large spill (up to 13,500 gallons) to occur in the unlikely event of a rollover or collision that results in a cargo tank being breached and the contents released to the surrounding environment. The risk of a release would be reduced to some degree with provisions made for driver safety through the continued use of [best management practices] BMPs such as travelling at safe speeds. There would be no transport of fuel during winter and trucking would be curtailed during extreme weather events, such as high wind, during the shipping season. The tanker trucks would be equipped with spill response kits, and the drivers would be trained to minimize and contain low-volume spills.

The discussion of potential sodium cyanide spills emphasizes safety, the low probability of a spill, and the expectation that spills can be cleaned up properly (USACE 2018, p. 3.24-24):

> The sodium cyanide containers would be offloaded at the port terminal and trucked to the mine throughout the barging season. NICNAS (2010) found that incidences of spilled cyanide internationally from 1984 to 2010 were rare, relative to the amount of sodium cyanide that is annually transported. The spill risk during truck transportation is very low to non-existent due to the safeguards at the Donlin Gold access road (design for industrial traffic, dedicated use and low speed limits), and the appropriate containment to prevent a spill if an accident occurred. The sodium cyanide would be transported as dry solid briquettes that would be stored in watertight tank-tainers. Potential spills could occur in the unlikely event of an accident or wildlife collision that results in the tank-tainer rupturing. This event could result in either the dry sodium briquettes being spilled on dry ground or the contents could be spilled on wet ground or surface waters. If solid sodium cyanide is spilled on dry ground, it does not present a danger to people or the environment as long as the sodium cyanide remains dry and is swept up and properly contained for disposal. Spill residues would be properly disposed. Sodium cyanide that comes in contact with water poses immediate toxic and acute health dangers.

Overall, the Donlin Mine EIS is an example of a poorly executed spill risk analysis

## USACE (2020): Pebble Mine Project spill risk rates along a mine transportation corridor

The proposed Pebble Mine would extract copper, gold, and molybdenum upstream from Bristol Bay, Alaska. The transportation corridor for the Pebble Mine varies by Alternative and may include marine barges, trucks, a lake ferry, pipelines, and lightering barges, as well as storage facilities along the route and transfers between transport types. The Pebble Mine EIS only developed quantitative spill risk estimates for five transportation corridor spill scenarios: 1. Spills of >300,000 gallons of diesel from marine barges, 2. Spills of >300,000 diesel from the lake ferry, 3. Spills of >3,000 gallons of diesel from tanker trucks, 4. Spills of 80,000 pounds of ore concentrate from trucks, and 5. Spills of 54,000 pounds of ore concentrate slurry from a pipeline. USACE (2020, p. 4.27-1) notes that "The substances analyzed do not include all of the hazardous materials that would be used for the project" and "Substances analyzed in this section were selected based on their spill potential (probability) and potential impacts (consequences)." The diesel and ore concentrate spill scenarios from trucks are most relevant to the SGP DEIS and discussed further below.

Pebble Mine may require 16,000,000 gallons of diesel every year. Depending on the Alternative, the road length would vary from 53 to 82 miles, with trucks hauling triple trailers with a combined payload of 19,050 gallons making 840 trips per year. Pebble Mine expects to produce 876,000 wet tons of copper-gold ore concentrate per year, which would require 7,684 trips per year with each truck hauling 114 tons of ore concentrate. Different spill rates per truck-mile were used for diesel and ore concentrate based on two different roads in Alaska. For diesel, the spill risk per mile was

> [b]ased on interpretation of the available Dalton Highway data, [and] the potential annual spill rate for a 3,000-gallon spill was calculated to be 2.0x10$^{-7}$ spills per truck-mile traveled, or 0.011 spill per year over 66 miles of road transport (55,433 truck-miles traveled per year). (Note that miles of road transport varies by alternative from 53 to 82 …. The original calculation used for the Alternative 1 road corridor was 66 miles.) This equates to a probability of a 3,000-gallon spill of 1 percent in any given year; 20 percent in 20 years; 55 percent in 78 years; or an average of one 3,000-gallon spill every 90 years (AECOM 2019a). Although these estimates are based on limited historical data, the calculated spill rate of 2.0x10$^{-7}$ per truck-mile is essentially identical to the 1.9x10$^{-7}$ rate identified in a separate analysis by the EPA Watershed Assessment (EPA 2014). (USACE 2020, p. 4.27-18, 19)

For ore concentrate, USACE (2020) based the spill rates on observed spill from another Alaska Mine (USACE 2020, p. 4.27-59, 60),

> The Red Dog zinc and lead mine in northwestern Alaska is an appropriate data analog for the Pebble mine, based on similar transport of ore concentrate from the mine site by truck/trailer to a port. Red Dog concentrate spills data are therefore used in determining spill probabilities for the project. … As of 2005, haul trucks at Red Dog mine hauled 85 tons of concentrate in two side-dump trailers (AECOM 2019a).

USACE (2020), p. 4.27-64, 65

> No studies have been identified that analyze trucking-related spill rates on private, controlled-access industrial roads, such as the project access roads (ARCADIS 2013). The probability of this scenario is therefore based on available historic spill data from transport of ore concentrate along the 52-mile haul road used by Red Dog Mine (as discussed above), the most relevant concentrate transport analog in Alaska. Based on the [Alaska Department of Environmental Conservation] ADEC record of spills at Red Dog Mine, the estimated spill rate per mile for a trucking-related concentrate spill in the project was calculated to be 0.78 x$10^{-6}$, which equates to an average of 0.4 trucking-related concentrate spills per year for 66 miles of road transport. Note that miles of road transport vary by alternative from 53 to 82 miles (Table 4.27-1). Sixty-six miles was used in the original calculation for the Alternative 1 road corridor. This equates to a 33 percent probability of such a spill in any given year, and a 100 percent probability in 10 years or more (i.e., 100 percent probability during the proposed 20-year project); or an average of one spill every 2.5 years (AECOM 2019a). (Note that in the expanded mine scenario, concentrate would be transported by pipeline, not by truck.)

Note that the location-specific spill rates per mile vary by substance, with the risks of diesel spills $\geq$3,000 gallon being 2.0 x $10^{-7}$ spills per truck-mile and an ore concentrate spills rate of 7.8 x $10^{-7}$ spill per truck-mile, and that the estimates were compared to the 1.9 x $10^{-7}$ spills per truck-mile rate that the EPA (2014) cited for context.

*Table 4. Reported expected spill numbers and probabilities for diesel and ore concentrate from trucks based on the 66-mile road corridor Alternative for Pebble Mine and different project lifetimes. Numbers in bold were not explicitly included in the EIS. The percent probability for diesel spills for the 78-year project life does not match the text because the one cited in USACE (2020) mistakenly used a 72-year Project life for that calculation.*

| | Expected number of spills | | | Percent probability of $\geq$1 spill | | |
|---|---|---|---|---|---|---|
| Number of years | 1 | 20 | 78 | 1 | 20 | 78 |
| Spill of $\geq$3,000 gallons of diesel; road length = 66 miles; 840 trips per year | | | | | | |
| spill rate = 2.0 x $10^{-7}$ per truck-mile | 0.011 | **0.22** | **0.86** | 1.09% | 19.7% | 57.9% |
| Spill of 80,000 pounds of ore concentrate; road length = 66 miles; 7,684 trips per year | | | | | | |
| spill rate = 0.78 x $10^{-6}$ per truck-mile | 0.396 | **7.91** | **30.85** | 32.7% | **100%** | **100%** |

## Spill risks as described in EISs from oil and gas

Spill risks are not only associated with mining projects. Offshore and onshore oil and gas development also have descriptions of spill risks as components of their EISs. The two that are highlighted here illustrate that it is possible to put bounds on relative probability descriptors and that data from similar projects can be used to inform estimates of the risks associated with future ones.

### USACE (2012): Point Thomson Project spill probability impact categories

The Point Thomson Project is also in Alaska and would produce hydrocarbon liquids. The USACE has developed a semi-quantitative description of spill likelihood for consideration in EISs (USACE 2012). In the Point Thomson Project Final EIS, Table 5.24-4 lists the impact criteria for spills (USACE 2012, p. 5-692, 693). Within that table, the potential for impacts to occur are defined as

- Probable: highly likely to occur (likelihood would approach 1.0)
- Possible: moderately likely to occur (likelihood in the range of 0.4)
- Unlikely: not likely to occur (likelihood less than 0.1)
- Highly unlikely: very unlikely to occur (likelihood would be essentially zero).

Because USACE (2012) did not specify exact numeric ranges for the potential for impacts to occur, I assigned values to each category (Table 5). I will use these ranges and intensity types to characterize later spill and accident probability estimates for the SGP.

*Table 5. Suggested numerical ranges for the spill probability categories listed and described in USACE (2012).*

| Intensity type | Quantitative description from USACE (2012) | Assigned numeric range | Reasoning |
|---|---|---|---|
| Probable | likelihood would approach 1.0 | 0.7 to 1.0 | Extends from the upper bound for “possible” spills to 100% |
| Possible | likelihood in the range of 0.4 | 0.1 to 0.69 | Bottom of range extends to the upper bound for “unlikely” spills; symmetric around 0.4 |
| Unlikely | likelihood less than 0.1 | 0.01 to 0.09 | |
| Highly unlikely | likelihood would be essentially zero | <0.01 | |

For example, if we apply the spill probability ranges from USACE (2012) (Table 5) to the Pebble Mine truck spill risks (Table 4), we find that in any given year, diesel spills of ≥3,000 gallons are “unlikely” and spills of ore concentrate are “possible”, and that for the 20- and 78- year timespans, diesel spills ≥3,000 gallons are “possible” and ore concentrate spills are “probable”.

### BLM (2020): National Petroleum Reserve - Alaska expected numbers of spills by substance and size category

An example of estimating the number of spills comes from the National Petroleum Reserve – Alaska (NPR-A) Final EIS (FEIS). The expected number of spills can be calculated based on a spill rate from historical spill occurrences. In this case the exposure variable was not based on distances traveled and number of trips but instead on the total volume of oil to be produced (spills per billion barrels of oil (BBO)). This FEIS found spill rates for crude oil, refined oil, produced water, and other hazardous materials. The historical spill data were grouped into specific substance and size classes to estimate the rate of occurrence for each category. That is, how frequent is a spill of <2,100 gallons of refined oil? Of 2,101 to 36,036 gallons of hazardous materials? These frequencies vary by substance and size. For example, the spill rates for three size categories and four substance classes were found on the North Slope for the NPR-A using Alaska Department of Environmental Conservation data from 2000-2018 (BLM 2020, Table I-1 reproduced here as Table 6).

*Table 6. North Slope spill rates by substance and size per billion barrels of oil (BBO) produced (2000-2018). (BLM 2020, Appendix I, Table I-1.)*

| Substance | Spill size range (in gallons) | | | Total |
|---|---|---|---|---|
| | 0-2,100 | 2,101-36,036 | >36,036 | |
| Crude oil | 129.53 | 2.63 | 0.20 | 132.36 |
| Refined oil | 563.37 | 1.41 | 0.00 | 564.79 |
| Seawater and produced water | 94.57 | 8.08 | 1.41 | 104.07 |
| Other hazardous materials | 386.16 | 3.23 | 0.20 | 389.59 |
| Total | 1,173.62 | 15.36 | 1.82 | 1,190.80 |

The estimated spill frequency rates can then be used with Alternative-specific exposure variables to estimate the number of spills. For example, BLM (2020) then used a variety of oil production values from several Alternatives to compute specific number of spills that would be expected if 1.35, 1.48, 1.98, or 2.64 billion barrels of oil were produced (BLM 2020, Appendix I, Tables I-3 to I-7), one of which is reproduced here (Table 7).

*Table 7. Projected spills count for Alternative E of the NPR-A (expected production of 2.64 billion barrels of oil) (BLM 2020, Appendix I, Table I-6.) BLM (2020) did not include the bottom total row.*

| Substance | Spill size range (in gallons) | | | Total |
|---|---|---|---|---|
| | 0-2,100 | 2,101-36,036 | >36,036 | |
| Crude oil | 341.95 | 6.94 | 0.53 | 349.42 |
| Refined oil | 1,487.30 | 3.73 | 0.00 | 1,491.04 |
| Seawater and produced water | 249.66 | 21.34 | 3.73 | 274.73 |
| Other hazardous materials | 1,019.45 | 8.54 | 0.53 | 1,028.52 |
| Total | 3,098.36 | 40.55 | 4.79 | 3,143.71 |

While this was not shown in the NPR-A FEIS, the expected number of spills can be used to calculate the probabilities that at least one such spill in each specified category would occur over the lifetime of the proposed project. Thus, the spill rates from Table 6 can be used to calculate expected numbers of spills (Table 7), which can in turn be used to calculate spill probabilities (Table 8). In this example, using the terminology from USACE (2012) (Table 5), we can see that several substances and size classes that are expected to have a 100% probability of occurrence in the NPR-A, falling into the "probable" range of potential impacts. Only spills larger than 36,036 gallons of crude oil and of other hazardous materials fall in the *unlikely* category, and only refined oil spills larger than 36,036 gallons are in *the highly unlikely* category. The impacts will vary depending on their size and their frequency, which could run into the thousands for small spills (Table 6). The NPR-A FEIS has an explicit statement of the total number of spills for each class of hazardous materials for each Alternative. One important aspect of the relationship between estimated numbers of spills and spill probabilities becomes clear in examining Tables 7 and 8: Spill probability cannot exceed 100% and does not give a direct indication of the expected number of spills. Both the expected number of spills and the probability should be considered. Often small spills are dismissed in EISs as having little to no impact as individual events. However, if hundreds or thousands of such spills were to occur, particularly in a limited area, it is harder to downplay their potential harmful effects when they are considered cumulatively.

*Table 8. Probability of having at least one spill in each substance and size class based on the spill rates calculated per billion barrels of oil (BBO) produced and predicted production volume of 2.64 BBO at the NPR-A and assuming spills follow a Poisson distribution. Probability of at least 1 spill = 1 – exp(-N) where N is the expected number of spills for that category from Table 7.*

| Substance | Probability of at least one spills in a size range (in gallons) | | | All sizes |
|---|---|---|---|---|
| | 0-2,100 | 2,101-36,036 | >36,036 | |
| Crude oil | 100% | 99.9% | 41.1% | 100% |
| Refined oil | 100% | 97.6% | 0% | 100% |
| Seawater and produced water | 100% | 100% | 97.6% | 100% |
| Other hazardous materials | 100% | 100% | 41.1% | 100% |
| Total | 100% | 100% | 99.2% | 100% |

## Summary

Environmental impact statements for other mines and resource extraction projects have included spill risk calculations for numbers of hazardous materials spilled and the probability of at least one spill. The presentations vary by project but show several ways to quantify spill risk. No such project specific risk was found in the SGP SDEIS.

## 3. Summary of transportation, risks, and potential impacts as presented in the SGP SDEIS

The transportation corridor for the SGP will rely mostly on truck transport (USFS 2022). The road system, traffic, materials, and hazards are described throughout the SDEIS. I have consolidated and summarized the descriptions of the transportation corridor from Chapter 2: Alternatives Including the Proposed Action, Chapter 3: Affected Environment, and Chapter 4: Environmental Consequences. Within Chapters 3 and 4, I focused mostly but not exclusively on the portions relating to Hazardous Materials (chapter sections 3.7 and 4.7), Access and Transportation (chapter sections 3.16 and 4.16), and Public Health and Safety (chapter sections 3.18 and 4.18). I also reviewed DEIS Appendix E: Geologic Resources and Geotechnical Hazards, which included figures showing where various geohazards are mapped along the one of the proposed routes (Appendix E-1) and the results of a desktop study of geohazards along the two proposed routes (Appendix E-2).

USFS (2022), pp. 3-92, 93

> Hazardous materials are substances which may pose a risk to human health, wildlife, or the environment. Hazardous materials that would be used and/or transported for the proposed mining activities include diesel fuel, gasoline, lubricants, antifreeze, process reagents, antimony concentrate, mercury containing residuals, lime, explosives, and other substances.
>
> When not properly managed, hazardous materials can represent potential risks to human health, the environment, and wildlife. Spills or accidental releases of hazardous materials can impact air, surface water, groundwater, soil, vegetation, wildlife, fish and other aquatic resources, and public health and safety; they can occur during transportation to and from a site, during storage and use activities, or through improper disposal of waste materials.

Although the SDEIS acknowledges that spills may occur during activities other than transporting hazardous materials, the only attempt at calculating a spill rate was for spills from heavy trucks.

The SGP SDEIS defines the area for assessing hazardous materials impacts risks as

USFS (2022), p. 3-93:

> The components of the analysis area for hazardous materials … include the Operations Area Boundary (including all operational areas and haul roads); the proposed off-site facilities: [Stibnite Gold Logistics Facility] SGLF and the Maintenance Facility locations; and the access roads including the Warm Lake Road (CR 10-579), from SH 55 in Cascade past the SGLF, continuing to Landmark; the Burntlog Route: Burnt Log Road (FR 447), new road segments, and segments of Meadow Creek Lookout (FR 51290) and Thunder Mountain (FR 50375) roads; and the Johnson Creek Route: Johnson Creek Road (CR 10-413) and the Stibnite Road portion of the McCall-Stibnite Road (Stibnite Road; CR 50-412), from the village of Yellow Pine to the Operations Area Boundary.

This area description is narrower than the one in the DEIS, which also included tributaries of the East Fork South Fork Salmon River and South Fork of the Salmon River (**bolded** below).

USFS (2020), p. 3-7.1

> - The proposed mine site (including all operational areas and haul roads);
> - Proposed off-site facilities: Stibnite Gold Logistics Facility and the Maintenance Facility locations. The proposed Stibnite Gold Logistics Facility would be used as a central depot for consolidating loads and deliveries;
> - Access roads: Warm Lake Road (County Road [CR] 10-579), from Cascade past the Stibnite Gold Logistics Facility, continuing to Landmark and northeast to the mine site via the proposed Burntlog Route; and the Yellow Pine Route: Johnson Creek Road (CR 10-413) and the Stibnite Road portion of the McCall-Stibnite Road (Stibnite Road; CR 50-412), from the village of Yellow Pine to the mine site; and
> - **Watershed tributaries of the East Fork South Fork Salmon River (Sugar Creek, Meadow Creek, Johnson Creek, Riordan Creek, Burntlog Creek, and Trout Creek); and tributary streams to the South Fork of the Salmon River (Cabin Creek and Warm Lake Creek)**.

That specification did not extend beyond the access roads, even though “national highways would be used to transport materials to the SGP area as far as Cascade, Idaho” (USFS 2022, p. 4-136).

The SGP SDEIS only quantifies the miles of roadway and numbers of trips for various reagents but did not include calculations of total numbers of truck trips or truck-miles with hazardous materials, expected numbers of spills, or the probability of spills for the transportation corridor or other potential spill sites.

USFS (2022), p. 4.7-120:

> The following analysis of effects associated with hazardous materials is considered in the overall context of direct impacts caused by accidental releases or spills to localized areas, as well as potential impacts to outlying areas associated with releases to groundwater or nearby drainages/streams/surface waters. Elements of this context include:
>
> - Amount, type, and location of storage, use, or disposal of hazardous materials and the potential for release to the environment;
> - Transportation of hazardous materials to or from the mine site, and the potential for accidental release to the environment; and
> - Fate and transport (i.e., where the hazardous material may go in the environment) of hazardous materials that have entered the environment.
>
> Impacts associated with the storage, use, and disposal of hazardous materials are measured quantitatively by the amount, type, and location of use. Impacts to the environment in the event of an accidental release are assessed qualitatively, based on the type and amount of hazardous material, handling techniques, location of use and contingency plans, risk of accidental release, and exposure pathway to potential sensitive receptors.

No formal definition of spill size classes was given, but we can infer that 25 gallons may be the threshold between small and large spills:

USFS (2022), p. 4.7-120:

> A release event could range from a minor spill of up to a few gallons (for which on-site cleanup would be readily available) to a large, reportable spill (e.g., over 25 gallons of fuel). Some hazardous chemicals could have immediate adverse impact on soils and vegetation, and potentially degrade aquatic resources and water quality if they enter surface water. Spills of hazardous materials also could potentially seep into the ground and contaminate the groundwater system over the long term. The risk and potential transport to the environment exists for all hazardous materials.

The SGP SDEIS includes three Alternatives (USFS 2022, p. 2-1). Two alternatives are identical except for construction of construction of a different access route. The third alternative is the No Action Alternative.

All mine traffic would be routed through the SGLF, which has a proposed location of approximately seven miles east of SH-55 on Warm Lake Road (USGS 2022, p. 2-38). “Perpetua would require supply truck drivers to check in at the SGLF and direct them to either proceed to the mine site or unload at the warehouse for temporary storage and consolidation of their load" (USGS 2022, p. 2-40).

There are two general routes that could be used for reaching the mine site from the SGLF: the existing Johnson Creek Route (formerly known as the Yellow Pine Route) and the proposed Burntlog Route. The Johnson Creek Route would have improvements to the road corridor (USFS 2020, p. 2-5). The Burntlog Route would require constructing 15 miles of new road to connect the terminus of the existing Burntlog Road to Meadow Creek Lookout Road (USFS 2020, p. 2-21). The Johnson Creek Route would be used during the anticipated two years required to construct the Burntlog Route (USFS 2020, p. 2-20).

Expected traffic to the mine varies by project phase (construction, operations, and closure and reclamation) (Table 9). The number of trips by heavy vehicles and total vehicle trips per year in Table 9 are underestimates of the actual traffic during mining and operations because not all mine transportation needs are listed. Table 9 shows the export of 365 truckloads of ore concentrate from the mine, as well as removal of trash and recyclables, demolished and dismantled items, and tailings storage facility residuals. The totals shown do not account for the range of 365-730 annual truck trips hauling antimony concentrate, the 148,000 gallons of waste oil (50% of the lubricants brought to the mine site), or an unspecified number of trips for wastes containing mercury from ore processing leaving the mine site (USFS 2020, Table 4.7-1). Based on the predicted mine traffic, heavy vehicles will account for 69.2% of mine traffic from the SGLF to the SGP during construction, 66% during mine operations, and 55.6% during closure and reclamation.

*Table 9. Expected round trips by operations phase. Operations phase durations from USFS (2022), p. 2-8. Data for AADT vehicle traffic: Tables 2.4-2, USFS (2022). Number of roundtrips per year = (AADT x 365 days per year)/2.*

| Mine Phase | Construction | Ore Mining and Processing Operations | Closure and Reclamation |
|---|---|---|---|
| Number of years | 3 | 15 | 25 |
| SH 55 to SGLF | | | |
| Heavy vehicles | | | |
| AADT | 30 | 25 | |
| Roundtrips per year | 5,475.0 | 4,562.5 | |
| Light vehicles | | | |
| AADT | 169 | 131 | |
| Roundtrips per year | 30,842.5 | 23,907.5 | |
| **All vehicles** | | | |
| AADT | 199 | 156 | |
| Roundtrips per year | 36,317.5 | 28,470.0 | |
| SGLF to SGP | | | |
| Heavy vehicles | | | |
| AADT | 45 | 33 | 15 |
| Roundtrips per year | 8,212.5 | 6,022.5 | 2,737.5 |
| Light vehicles | | | |
| AADT | 20 | 17 | 12 |
| Roundtrips per year | 3,650.0 | 3,102.5 | 2,190.0 |
| **All vehicles** | | | |
| AADT | 65 | 50 | 27 |
| Roundtrips per year | 11,862.5 | 9,125.0 | 4,927.5 |

The SGP SDEIS acknowledges that the mine would increase traffic on an existing road system that is already hazardous, particularly in winter.

USFS (2022), p. 3-435:

> Vehicle travel on FRs and CRs in the analysis area presents health and safety risks associated with traffic incidents. The analysis area experiences harsh weather conditions that pose potential travel hazards, especially during winter, when roads become snow-covered or icy. During winter, Valley County maintains only one route from Cascade to the analysis area, which follows Warm Lake Road (CR 10-579) to the intersection with SFSR Road (FR 474), then to the East Fork Stibnite Road portion of the McCall-Stibnite Road (CR 50-412) to the village of Yellow Pine. Perpetua maintains Stibnite Road (CR

> 50-412) for access from the village of Yellow Pine to the SGP. All other existing routes to the mine site are not maintained (plowed or sanded) when snow-covered roads become impassable to vehicles. Currently, Warm Lake Road (CR 10-579) has the highest incident rate (eight vehicle accidents per year) out of the FRs, CRs, and state highway in the Project vicinity.

USFS (2022), p. 3-415

> Vehicle accident data for full-size vehicles, motorcycles, and OHVs from 2000 through 2021 was obtained from Valley County Sheriff's Department records for the six roads associated with the three existing primary access routes to the Operations Area Boundary. Warm Lake Road experienced an average of seven accidents per year from 2000 through 2021, followed by SFSR Road with an average of two accidents per year, Lick Creek Road with two accidents per year, Johnson Creek Road with one accident per year, and Stibnite Road and East Fork Road with no accidents on average per year (Ulberg 2017, VCSD 2022).
>
> According to the Valley County Sheriff's traffic incident records from 2000 through 2021, the causes of most accidents on the existing roadways fall under the general categories of driver error, vehicle mechanical issues, and environmental factors (Ulberg 2017, VCSD 2022).

## Logistics facility description

USFS (2022) p. 2-38

> ***Stibnite Gold Logistics Facility***
>
> The SGLF would be located along Warm Lake Road on private land (approximately 7 miles northeast of Cascade), with access to SH 55 (**Figure 2.4-1**). The SGLF would require approximately 25 acres of disturbance to accommodate employee parking, an assay laboratory building, a core sampling logging storage facility, warehouses, laydown yards, equipment inspection areas, a truck scale, and an administration building for Perpetua personnel (**Figure 2.4-7**). The facility would be surrounded by a security fence. One point of ingress/egress would access office parking and the mine personnel card-entry gate, while another ingress/egress would access the truck yard via a guard shack. The parking and assembly area would accommodate approximately 250 light vehicles for employees using bus or van pooling to the SGP. Perpetua would mandate the use of busing and vans for employee and contractor transportation to the SGP.

USFS (2022) p. 2-40

> Perpetua would require supply truck drivers to check in at the SGLF and direct them to either proceed to the SGP or unload at the warehouse for temporary storage and consolidation of their load. A truck scale would be located at the SGLF to verify loads

> going into or out of the warehouse area. The check-in process would include general safety and road readiness inspection of incoming trucks and equipment being transported to SGP. Heavy equipment transport vehicles would be inspected for items such as presence of weeds, excessive soil on earth moving equipment, safety equipment, installed and maintained engine brake muffling systems, and general safety checks of equipment.

Both Action Alternatives have variations on the mine access routes and mine site haul roads, which will lead to differing road lengths, grades, and risks. Sections 7 and 9 of this report address the mine access routes and potential hazards along them.

### On-site lime generation

USFS (2022), p. 2-48:

> ***On-site Lime Generation***
>
> Ground limestone and lime are needed for pH adjustment in the SGP ore processing plant. Rather than trucking these materials to site from an off-site source, a limestone bed in the West End pit is of suitable quality and quantity to satisfy the life-of-mine SGP requirements for lime. Over the life of the mine, approximately 130,000 to 318,000 tons of limestone would be mined annually, averaging approximately 240,000 tons per year. Approximately 25 to 30 percent of the limestone mined annually would be crushed and run through an on-site lime kiln to produce metallurgical lime powder, with the remainder (70 to 75 percent) would be crushed and stockpiled for direct use as limestone. Both ore and limestone would be temporarily stored at the run-of-mine stockpile area.
>
> The on-site lime generation would require additional equipment, which would be placed within the ore processing area. This equipment would include: limestone crusher and conveyor, propane-fired kiln (200 tons per day output capacity), kiln combustion air system including preheat heat exchanger, propane storage tank plus vaporizer, air compressor, receivers, and dryers for plant air and instrument air at kiln area, roll crusher for kiln product discharge, conveyors for moving feed and product materials, off-gas fume filter for kiln discharge, dust collector kiln feed bin, storage bin for kiln feed material; and storage bin for lime products. The limestone crusher, screens, conveyors, and feed bins would not be enclosed. Dust would be controlled in a similar manner to the ore crushing and conveying process through the use of water sprays and/or bag house dust collectors.

The lime plant would require 1,463,000 gallons of propane each year. The propane would be delivered in 11,000-gallon quantities in an average of 133 deliveries per year (USFS 2022, p. 2-77). (This is in addition to the 560,000 gallons used in buildings annually, which would be delivered in tankers carrying 6,000 gallons in 93 deliveries each year (USFS 2022, p. 2-77).)

## Water treatment plant

There are significant changes to the scope of water treatment between the DEIS and SDEIS. The section only addresses how those changes affect the spill risks related to the associated changes in reagent transportation. The water treatment plant was initially described as part of Alternative 2 in the DEIS (USFS 2020, p. 2-8).

USFS (2020), p. 2-110 and 2-111

> • A Centralized WTP would be constructed to handle peak monthly flows exceeding 1,000 gpm, expected in year 7 and beyond. The Centralized WTP would treat up to 4,000 gpm using iron coprecipitation to remove arsenic, antimony, and mercury. If needed, an additional step to precipitate mercury using organic sulfide precipitant would be employed.
>
> The Centralized WTP would be a permanent facility. The facility is currently proposed to be located on NFS land. Midas Gold would investiage (*sic*) moving the system to private land before construction in order to avoid a permanent feature on NFS land. The Centralized WTP would treat contact water, including pit dewatering water, and also could be used to treat process water, if needed. A separate facility would be maintained at the worker housing facility for treatment of domestic wastewater.

USFS (2022), p. 4-187

> Water Management and Water Treatment
>
> According to the 2021 MMP (Perpetua 2021a) three water types would require management over the life of the Project: contact water from mine facilities, which includes dewatering water (construction through closure); consolidation water from the TSF (construction through closure which includes process water); and sanitary wastewater (construction through early closure). Figure 4.9-1 is flow diagram showing the main process water components.

> Specific sources of mining impacted water that could be expected to require treatment during operations include:
>
> > • Contact water from the dewatering of the Hangar Flats, Yellow Pine, and West End pits.
> >
> > • Contact stormwater runoff from the pits, TSF buttress, Bradley Tailings, SODA, Hecla Heap, ore stockpiles, truck shop, and ore processing facility.
> >
> > • Toe seepage and pop-out seepage from the TSF buttress and ore stockpiles.
> >
> > • Sanitary wastewater from the worker housing facility, truck shop, ore processing facility, administrative buildings, and offsite facilities.
>
> After mine closure and final reclamation of the TSF Buttress and pit backfill surfaces which incorporate geosynthetic liners to inhibit interaction between water resources and mined materials, contact water treatment would no longer be required; but process water treatment for the TSF would continue longer, through approximately year 40 to account primarily for consolidation water from the TSF which would exhibit a diminishing flow rate over that period.

The DEIS stated that the water treatment plant would require several chemicals and reagents annually during mine operations, during restoration efforts, and in perpetuity post-closure. The DEIS was inconsistent in the reagents listed and their quantities needed during operations and post-closure in Chapter 2 (USFS 2020, p. 2-111 and Table 2.4-4 on p. 2-115) and Chapter 4 (USFS 2020, p. 4.7-14) (Table 10). The list of reagents and their annual usages in the DEIS also differs from the list of reagents and quantities designated as for water treatment in the SDEIS (USFS 2022, Table 2.4-11, p. 2-79). The SDEIS also expects that 25 years of water treatment will be necessary after operations cease, rather than continuing throughout perpetuity, because the tailings storage facility is expected to be covered in mine year 23.

The feasibility study had more detail about the water treatment under ModPRO2 (M3 2021, pp. 18-39 to 18-41):

> **Water Treatment and Disposal**
>
> Three water types will require treatment over the life of the Project: contact water from mine facilities, which includes dewatering water (construction through closure); process water from the TSF (closure); and sanitary wastewater (construction through early closure.
>
> …

Site-specific discharge standards may be negotiated with regulators as part of discharge permitting (Idaho Pollutant Discharge Elimination System, or IPDES). Should site-specific standards, more in line with baseline or background water quality, be established, water treatment costs and duration may be reduced.

### Contact Water

Water quality permitting discussions are ongoing, but it is likely that the Project will need to adhere to stringent surface water quality standards for arsenic and antimony. Thus, coupled with the timing of water treatment needs with respect to the mining sequence and dewatering excess, treatment methods and capacity will be phased. During construction and early in operations, a modular, mobile, rented iron coprecipitation system is planned. Early in operations, this system would be replaced by a two-train iron coprecipitation system located at the ore processing facility. Sludge from the clarifiers during construction would be stored in a small impoundment in the TSF footprint or on previously disturbed land at SODA. During operations, the sludge would be stored on-site in the TSF.

…

After mine closure and final reclamation of the TSF Buttress and pit backfill surfaces, contact water treatment will no longer be required; process water treatment for the TSF (Section 18.8.5.2) will continue longer, through approximately year 40.

### Process Water

There are no plans to treat process water for discharge during normal mine operations. Ore processing is a significant consumer of water due to evaporation inside of the process plant, and at the TSF from the tailings and supernatant pool surfaces and, most significantly, burial of entrained water with the tailings.

…

At closure, remaining water inventory on the TSF would be eliminated by a combination of mechanical evaporation and active water treatment. Under EPA regulations, the maximum annual process water treatment volume is limited to the net of annual precipitation and evaporation. Cover would be placed on the facility as surface conditions allow use of equipment.

The post-closure period begins after the placement of the cover material and the restoration of Meadow Creek to a lined floodplain corridor in the center of the TSF (Section 20). In post-closure, active water treatment would continue until water quality standards can be met either without treatment or with passive treatment methods, but the treatment plant will be relocated to private land on the TSF Buttress to minimize pipeline length and head, and flow equalization would be provided by shallow water storage basins on the TSF on either side of the Meadow Creek corridor. Treatment is predicted to be necessary until approximately year 40 (approximately 25 years after closure) when consolidation water inflow to the cover is predicted to be minimal. Once this threshold has been achieved the remaining diversions on the perimeter of the facility will be removed, and hillside runoff would be routed over the cover.

> **Sanitary Wastewater**
>
> Early in construction, the currently permitted membrane bioreactor (MBR) plant at the existing exploration camp would be used, and treated effluent reused for flushing toilets and urinals or discharged to the existing permitted drain field, while the worker housing facility and its associated treatment plant is under construction. During operations and closure, sanitary wastewater from the worker housing facility, ore processing facility, and administration buildings would be treated at a new MBR or similar plant located at the worker housing facility and discharged to the EFSFSR via a permitted IDPES outfall. Vaults or portable toilets would be utilized at offsite facilities and remote locations onsite (TSF, pits, maintenance facility etc.), and serviced as needed using vacuum trucks. Treatment residuals would be hauled offsite to a permitted sanitary landfill. Vault/portable toilet wastewater would be hauled to a public / municipal wastewater treatment plant.

The SDEIS does not distinguish between the amounts of reagents to be used during operations and post closure (USFS 2022). Several of the reagent quantities are lower in the SDEIS than in the DEIS, specifically the amounts of sodium hypochlorite, ferric sulfate, and polymer (during operations). The amount of sulfuric acid to be used annually for water treatment increased from 1,700 to 2,400 gallons per year for operations and 870 gallons annually for post-closure in the DEIS to 12,000 gallons annually in the SDEIS (Table 10). The SDEIS also included sodium carbonate (430 tons per year), carbon dioxide (14 tons per year), and microsand (6.58 tons per year), which are reagents not previously mentioned in the DEIS.

*Table 10. A comparison of the reagents listed for water treatment under Alternative 2 in various parts of the DEIS (USFS 2020) and the SDEIS (USFS 2022). Quantities shown are for annual use.*

| | DEIS location | | | | | SDEIS location | Units, annual trips |
|---|---|---|---|---|---|---|---|
| | p. 2-111 | Table 2.4-4, p. 2-115 | | Table 4.7-2, p. 4.7-14 | | Table 2.4-11, p. 2-79 | |
| Project Phase | Oper-ations | Oper-ations | Post-closure | Oper-ations | Post-closure | | |
| Sodium hypochlorite | 15,000 | 5,000 | 2,600 | 5,500 | 2,600 | 2,000<br>2 | gallons,<br>trips |
| Ferric sulfate | 125,000 | 65,000 | 44,800 | 65,000 | 44,800 | 23,000<br>17 | gallons,<br>trips |
| Hydrated lime | 250 | 130 | 90 | Not listed | | | tons,<br>trips |
| Lime | | | | | | 150<br>7 | tons,<br>trips |
| Organic flocculant (polymer) | 1,900 | 1,300 | 670 | Not listed | | 1,000<br>5 | gallons,<br>trips |
| Sulfuric acid | 2,400 | 1,700 | 870 | 1,700 | 870 | 12,000<br>5 | gallons,<br>trips |
| Sodium bisulfite | 2,000 | 1,400 | 690 | Not listed | | <br>0.2<br>1 | gallons<br>tons<br>trips |
| Organic sulfide precipitant (if needed) | TBD | TBD | TBD | Not listed | | 1,000*<br>5 | gallons,<br>trips |
| Sodium carbonate | | | | | | 430<br>18 | tons,<br>trips |
| Carbon dioxide | | | | | | 14<br>5 | tons,<br>trips |
| Microsand | | | | | | 6.58<br>1 | tons,<br>trips |

In the DEIS, it was estimated that "[t]ransport of these chemicals and reagents would add approximately 40 round trips for delivery to the operational [annual average daily traffic] AADT presented in Table 2.4-3" (USFS 2020, p. 2-111). Presumably, that is an additional 40 trips annually and not daily, as USFS (2020) p. 4.7-13 states

> Alternative 2 also would require water treatment chemicals at the Centralized water treatment plant. Water treatment during operations would require hazardous chemicals as listed in Table 4.7-2 in addition to those listed [for ore processing]. Water treatment chemical transport would require approximately 40 trips annually. Water treatment could result in sludges which would be transported to the tailings storage facility for disposal with tailings during operations.
>
> Water treatment at the water treatment plant would continue post closure and would require ongoing transport of chemicals to the site. The expected amount of chemicals needed post closure are listed on Table 4.7-2. In addition, an unknown number of trips would be required to transport any residual treatment sludges and wastes from the site, since these wastes would no longer be able to be disposed of in the TSF.
>
> The in-perpetuity treatment would result in approximately 20 truck trips annually to delivery water treatment chemicals and an unknown number of trips to haul sludges and wastes from the treatment plant off-site for disposal. Transport would occur during the spring through fall with chemicals stockpiled in the fall to avoid winter transport.

USFS (2020), p 4.4-17:

> Alternative 2 also would include the addition of a Centralized Water Treatment Plant (WTP) near the Ore Processing Facility as part of a Water Quality Management Plan. The Centralized WTP would require approximately 40 additional annual truck trips during operations for water treatment-related chemical deliveries. Post-closure, the Centralized WTP would continue to operate in perpetuity (with approximately 34 annual truck trips for chemical deliveries and removal of residuals). Operation of the Centralized WTP in perpetuity also would require continued operation of the new transmission line.

The total number of annual trips for transporting hazardous materials related to water treatment in the SDEIS (USFS 2022) was higher (66 annual trips) than the numbers given in the DEIS (USFS 2020). Importantly, the duration of the water treatment under the SDEIS is not described as continued permanently. Instead, post-closure water treatment is only slated for 25 years, from mine years 16 through 40 (USFS 2022, p. 2-11, Figure 2.4-3).

## Road corridor differences by Alternative

### Existing routes to the proposed project

Within the DEIS, three existing primary routes from Cascade or McCall Idaho to the mine site were described: the Yellow Pine Route, the Lick Creek Route, and the South Fork Salmon River Route (USFS 2020, pp. 3.16-11 and 3.16-12). Within the SDEIS, the same three existing routes are described, but the Yellow Pine Route from the DEIS is called the Johnson Creek Route in the SDEIS (USFS 2022, p. 3-412).

USFS 2020, p. 3-16.11 (paragraph break added to better mirror the USFS 2022 version; bold text matches across the DEIS and SDEIS):

> Yellow Pine Route
>
> **During non-winter conditions (roads clear of snow), the** mine site **can be accessed from the City of Cascade by traveling northeast on Warm Lake Road** (CR 10-579) **for about 34 miles to Landmark, then north on Johnson Creek Road** (CR 10-413) **for approximately 25 miles to the village of Yellow Pine, and approximately 14 miles east on the Stibnite Road portion of McCall-Stibnite Road** (CR 50-412**) (Stibnite Road).** The Yellow Pine Route, **which only includes Johnson Creek Road** (CR 10-413) **and the Stibnite Road portion of** CR 50-412, **is currently used to access the** mine site **during the summer**.
>
> **During the winter, Valley County plows approximately 10 miles of Johnson Creek Road from Yellow Pine to Wapiti Meadow Ranch and Midas Gold (under agreement with Valley County) plows along Stibnite Road**. **Valley County grooms the remaining 17 miles of Johnson Creek Road from Wapiti Meadow Ranch to Warm Lake Road** (CR 10-579) **at Landmark for OSV use. Valley County does not plow Warm Lake Road from Warm Lake to Landmark. This section is a designated groomed OSV route**.

USFS 2022, p. 3-412 (bold text matches across the DEIS and SDEIS, see Figure 1):

> Johnson Creek Route
>
> **During non-winter conditions (roads clear of snow), the** Operations Area Boundary **can be accessed from the City of Cascade by traveling northeast on Warm Lake Road for about 34 miles to Landmark, then north on Johnson Creek Road for**

> **approximately 25 miles to the village of Yellow Pine, and approximately 14 miles east on the Stibnite Road portion of McCall-Stibnite Road (Stibnite Road).** The Johnson Creek Route, **which only includes Johnson Creek Road and the Stibnite Road portion of McCall-Stibnite Road, is currently used to access the** Operations Area Boundary **during the summer**.
>
> The Johnson Creek Road is a county maintained, native surface road that is open to vehicles with seasonal restrictions due to snow. **During the winter, Valley County plows approximately 10 miles of Johnson Creek Road from Yellow Pine to Wapiti Meadow Ranch and Perpetua (under agreement with Valley County) plows along Stibnite Road. Valley County grooms the remaining 17 miles of Johnson Creek Road from Wapiti Meadow Ranch to Warm Lake Road at Landmark for OSV use. Valley County does not plow Warm Lake Road from Warm Lake to Landmark. This section is a designated groomed OSV route.**
>
> The Stibnite Road portion of the route is also a county-maintained native surface road, open to all vehicles with seasonal restrictions due to snow. This road is plowed in the winter by Perpetua through an agreement with Valley County. Stibnite Road connects to Thunder Mountain Road on the southeastern portion of the Stibnite site and currently provides public access through the site.

### Proposed route

Perpetua has proposed of a new route, the Burntlog Route, to be constructed and used in place of the Johnson Creek Route (USFS 2022).

USFS (2022), pp. 2-17, 18; see Figure 2

> Burntlog Route
>
> The Burntlog Route would connect the eastern end of Warm Lake Road (at Landmark) to the SGP (to the northeast) by widening and improving approximately 23 miles of existing roads, including the full length of the existing Burnt Log Road (FR 447) and segments of Meadow Creek Lookout Road (FR 51290) and Thunder Mountain Road (FR 50375). The three road segments would be connected with two new road segments totaling approximately 15 miles. Burnt Log Road is currently a native surface road that is open year-round to all vehicles with seasonal restrictions due to snow. The last 0.25 to 0.5 mile of the existing road is closed and motorized traffic prohibited. Meadow Creek Lookout Road is a native surface road, open year-round to all vehicles. The Burntlog Route is primarily situated topographically on mid-slopes and ridgeline.
>
> Improvements on the existing roads that comprise the Burntlog Route include:
>
> - Straightening tight corners to allow for improved safety and traffic visibility;

- Maintaining grades of less than 10 percent in all practicable locations;
- Placing sub-base material and surfacing with gravel;
- Application of a road binding agent in localized segments to suppress dust, increase stability, and reduce sediment runoff;
- Widening the existing road surface (currently approximately12 feet wide) to a 21-foot-wide travel way (approximately 26 feet including shoulders); and
- Installing side-ditching, culverts, guardrails, and bridges, where necessary, with design features to provide fish passage and limit potential sediment delivery to streams.

Figure 2.4-5 shows the proposed Burntlog Route, which includes the proposed new road construction. A segment of new road construction for the Burntlog Route would be located on the south side of the Riordan Creek drainage and cross Riordan Creek north of Black Lake. The approximately 5.3-mile road segment would have 12 stream crossings, three of which cross perennial streams. The elevation of this road segment is approximately 8,000 to 8,600 feet and the average grade of this road segment would be 5 to 6 percent. After construction is completed, public use would be allowed on Burntlog Route when other public access roads are blocked by mine operations.

The connection segment between the end of Burnt Log Road and Meadow Creek Lookout Road is approximately 11 miles and would cross Trapper Creek 0.5 miles east of the intersection of Trapper Creek Road (FR 440) and FR 440A and continue northeast towards Black Lake and on to the Meadow Creek Lookout Road. The second connector between the Meadow Creek Lookout Road and Thunder Mountain Road would be approximately 4 miles and links up with Thunder Mountain Road approximately 2 miles south of the SGP. Minor surface improvements (e.g., blading) would occur on the portions of the existing Thunder Mountain Road and Meadow Creek Lookout Road that would not become part of the Burntlog Route to provide a safe road surface for transportation of construction equipment required to build the Burntlog Route. There would be no road alignment modification or widening of the portions of the existing roads that are not part of the Burntlog Route.

Primary SGP access would shift from the Johnson Creek Route to the Burntlog Route near the end of the construction phase. The Burntlog Route would be compliant with all related usage and approval requirements included in 36 CFR Section 228, Part A. The Burntlog Route would avoid environmental and human health and safety risks associated with the Johnson Creek Route which passes through identified areas for avalanches, landslides, and floods. This route would provide another route for SGP ingress/egress, would decrease SGP and public traffic interaction with Yellow Pine and Johnson Creek area residents; and would decrease the potential for spill risk adjacent to fish-bearing streams. Upon completion, the Burntlog Route would serve as an alternative public access route to the Thunder Mountain area for the life of the mine until it is decommissioned following mine reclamation and closure.

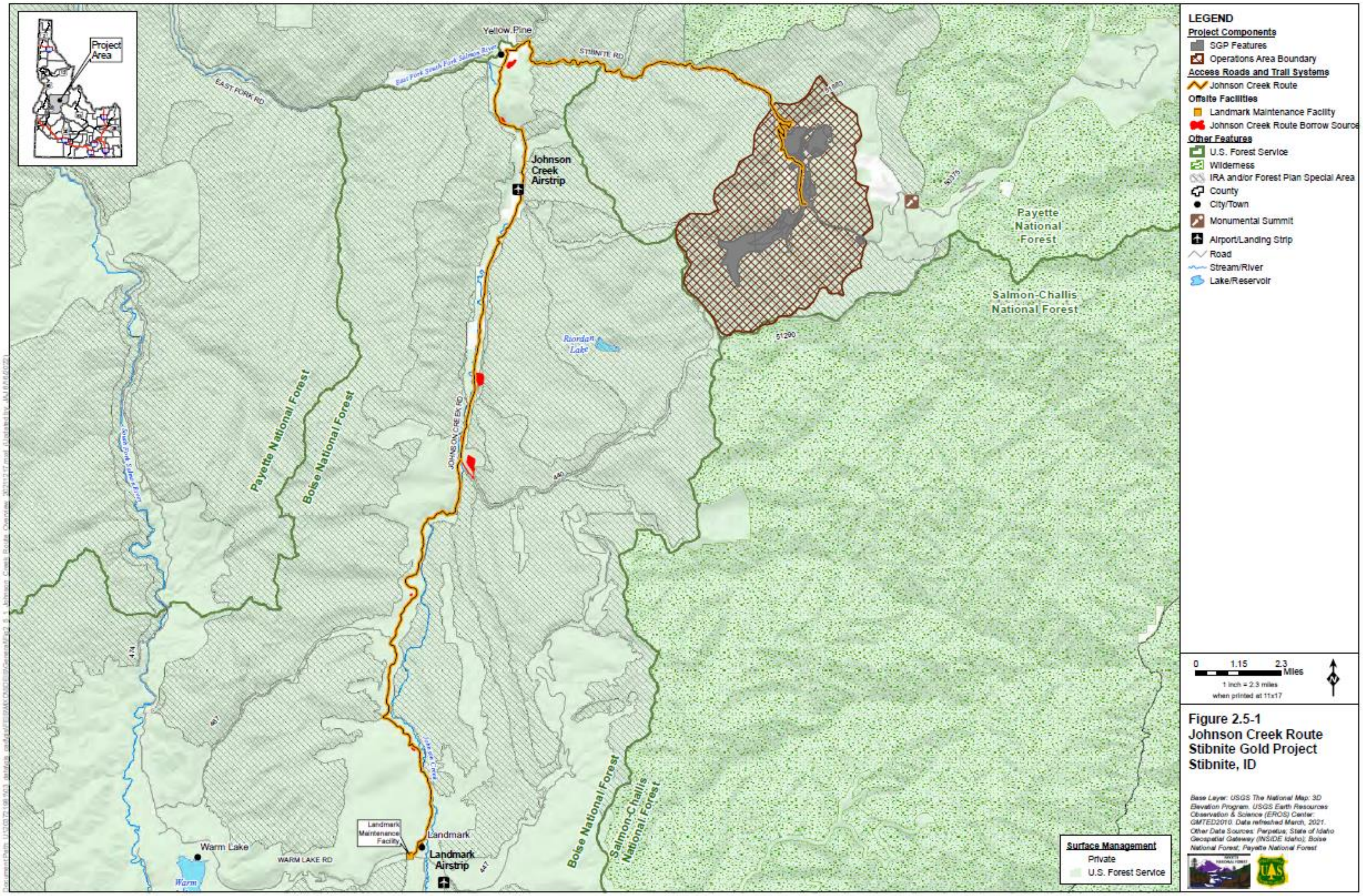


*Figure 1. Johnson Creek Route (former Yellow Pine Route), reproduced from USFS (2022).*

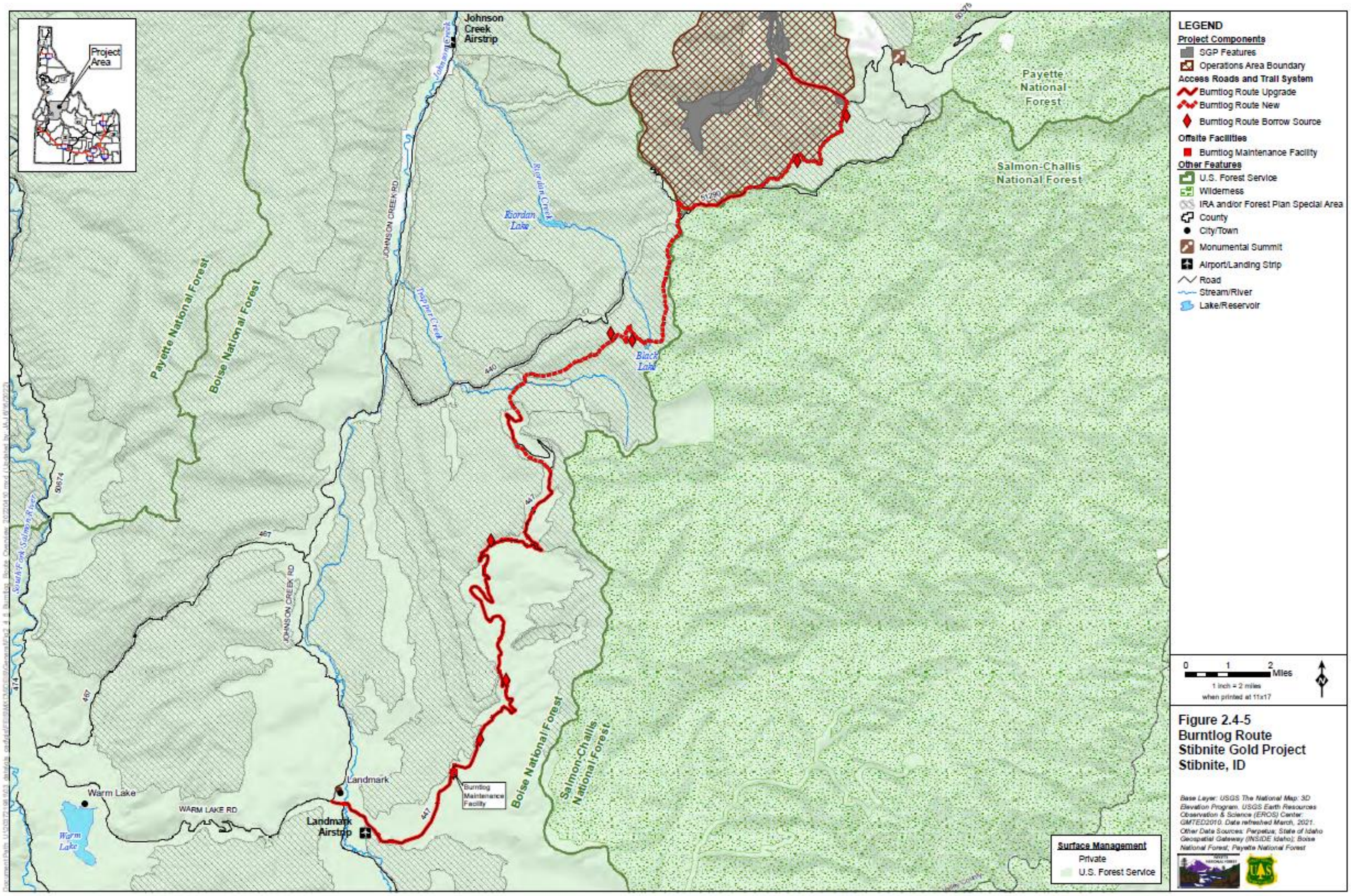


*Figure 2. Burntlog Route, reproduced from USFS (2022).*

The section of the SDEIS that summarized the impacts of public services and infrastructure on public health noted the traffic increases that would occur if the SGP is approved but characterized the Burntlog Route as a positive change that would result from the mine (USFS 2022, p. 4-525):

> The 2021 MMP would add traffic volumes to various roadways in the analysis area during construction, operation, reclamation, and closure. During construction, Warm Lake (CR 10-579), Johnson Creek (CR 10-413), and the Stibnite segment of the McCall-Stibnite (CR 50-412) roads would be affected during the first 3 years of the SGP by construction activities until the Burntlog Route is completed. Once Burntlog Route is completed, the substantial increase in traffic volume would shift to exclusively Warm Lake and Burnt Log (FR 447) roads as they are parts of the Burntlog Route.
>
> Existing traffic volumes on Warm Lake Road are at least 15 times greater than the other access roads. Mine-related traffic on Warm Lake Road would increase by approximately 5 percent during construction and operation activities, and traffic volume on Burntlog Route would more than triple during the operation phase (Access and Transportation Specialist Report, Forest Service 2022k). While increases in traffic volume are expected due to SGP-related activities, overall traffic volume on these access roads would still be low due to the remote location and low-density population in the area. While the potential for accidents could increase due to the increased SGP-related traffic volume, the predicted 5 percent increase in traffic volume due to SGP activities on Warm Lake Road is minimal.
>
> Upon completion of the Burntlog Route, the public could access Thunder Mountain Road (FR 50375) using the Burntlog Route as an alternative to access from Stibnite Road (CR 50-412). This could provide improved access to remote recreational areas and better access for emergency responders, which could result in positive impacts to public health and safety. Thus, the magnitude of impact of the Burntlog Route shown on Table 4.18-3 [for improved access to remote area for first responders] is “medium” and positive and the possibility is rated as “high,” with an overall public health rating of “moderate” positive. Public health and safety impacts related to improved access would be localized, long term, and moderate.

The final sentence in the last paragraph above neglects to examine other public health effects that would be associated with the SGP that are also in Table 4.18-3 (USFS (2022). The magnitude of the impact of the Burntlog Route shown in Table 4.18-3 for increased potential for hazardous waste spills and increased potential for traffic accidents are negative, with high magnitudes of impact, and medium possibility of impact, resulting in a net designation of major public health and safety impacts (USFS 2022, p. 4-521).

## Road corridor impacts addressed in the DEIS and SDEIS: spills

Hazardous materials spills, changes in drainage, traffic residues, and application of road treatment chemicals are four ways in which roadways may be damaging to nearby aquatic environments (Kravitz and Blair 2019). The SGP DEIS included measures of increased traffic from mine vehicles, the amount of fish habitat and number of streams potentially impacted by their proximity to roadways used for mine-related transportation (Table 11) and acknowledged the transportation corridor can potentially affect water quality by spills of fuels and other hazardous materials, and fugitive dust from vehicles driving on the haul roads and SGP access roads (USFS 2020, p. 4.9-1).

USFS (2020), p. 4.7-1, 2

> Spills of hazardous materials could adversely affect soils, vegetation, water quality, wildlife and fish, including lower trophic level aquatic organisms (e.g., bacteria and algae). Impacts could include degraded soil and water quality, fish and wildlife habitat contamination, and toxicity, injury or mortality to fish and other aquatic organisms, depending on the type and volume of material released, location, proximity to streams, timing, spill response, etc.
>
> Impacts could occur at the mine site, off-site facilities, along access routes, or in downstream watersheds. The geographic extent of any impacts would depend on the location and size of the spill and the effectiveness of the response. For most spills the extent would likely be limited to the immediate vicinity of the spill due to the response and cleanup measures that would be in place, but if a spill were to occur into a stream, impacts could extend downstream.
>
> The potential for impacts would perist (*sic*) for the life of the mine.

USFS (2020), p. 4.12-22

> Both Routes would use the Warm Lake Road (CR 10-579) from its intersection with State Highway 55 to its intersection with Johnson Creek Road (CR 10-413). The risk of spills would be lower on Warm Lake Road because it is a paved and generally wider with lower grades (except near Warm Lake area). …The transport of fuel and other materials (e.g., antimony concentrate) along both these routes put fish in these adjacent streams at risk from impacts of a spill.

USFS (2020), p. 4.12-19, 20

> ***Spill Risk***
> Hazardous material spills at the mine site could injure or kill individual fish through direct contact with contaminants. …
>
> Spills of hazardous materials could negatively affect fish and fish habitat. Strict regulatory controls and SGP emergency response procedures would be expected to limit the extent of any incidents. However, the duration of spill risk, and the potential to negatively impact fish and fish habitat, would be long-term because it would exist throughout the life of the SGP. The effect would generally be localized, though spills to flowing water could spread contaminants downstream of the spill site quickly if containment of the spill is delayed or the spill cannot be contained because of the fast-moving nature of the stream/river. Some materials that are highly toxic (e.g., diesel fuel) could result in greater impacts to a localized area. The type of impact could range from habitat loss through displacement from contaminated habitat to direct mortality from a spill. Spills occurring in the winter may be easier to contain because spilled material may not penetrate frozen ground as readily as unfrozen ground, and snow would absorb some spilled material; however, winter conditions also may slow the rate of the response.

USFS (2022), p. 4-267, 2-268 (Section 4.9.2.2)

> Fuels and Hazardous Chemicals
>
> There is the potential for spills to occur along access roads as fuel and other materials are trucked to and from the SGP. If a spill were to occur at a stream crossing or near a stream, surface water could be impacted. Discussion of very low probability scenarios for a large release (tanker truck or concentrate truck rollover), and more probable scenarios involving small releases, is provided in Forest Service 2021k. Overall, regulatory and Forest Plan requirements required by the Forest Service, EDFs proposed by Perpetua, and permit stipulations and regulatory requirements from state and federal agencies (including use of USDOT-certified containers and USDOT-registered transporters) would reduce the risk of spills and ensure that effective response is provided should a spill occur.
>
> The combination of the proposed environmental protection practices and committed design measures would minimize the risk of accidental releases during the transportation, storage, management, and use of hazardous materials. Spills of fuels, oil or chemicals at the SGP would be retained in the secondary containment areas and cleaned up without release to the environment. At the SGP the most likely releases to the environment would be rare, small-scale spills of fuel or hydraulic oil from mobile mining equipment that would be quickly contained and cleaned up by SGP personnel leaving de minimis residuals. Spills from transportation of fuel, oil or chemicals along the proposed transportation routes beyond the SGLF (Burntlog or Johnson Creek roads) would be unlikely due to the receiving operations for chemicals at the SGLF and traffic controls exerted along the access roads for fuel to mitigate risks associated with travel on unpaved roads with steep grades. It would be more likely that spills of bulk liquids transported to the SGP (fuel, oil, acids) could be the result of accidents on the public highways. Perpetua is

> coordinating with local communities to address their potential needs for responding to accidents involving fuels and hazardous materials.
>
> The overall environmental impacts from the reasonably foreseeable releases of hazardous materials under the 2021 MMP are considered to be localized, temporary, and minor to moderate depending on the type of material releases and the location of the spill.

USFS (2022), p. 4-332, 4-333 (Section 4.12.2.2)

> Spill Risk
>
> There is the potential for spills to occur along access roads as fuel and other materials are trucked to and from the SGP during construction of the access roads and mine facilities (see also **Section 4.7.2.2**). If a spill were to occur at a stream crossing or near a stream, surface water could be impacted. Although not all waterbodies crossed via culvert are fish-bearing, spills into any waterway could travel downstream to fish-bearing waters.
>
> Overall, design features (**Section 2.4.9**) and permit stipulations and regulatory requirements from state and federal agencies would reduce the risk of spills and ensure that effective response is provided should a spill occur.
>
> Mine transport begins on Warm Lake Road (CR 10-579) where the risk of spills would be lower, as it is paved and maintained by Valley County and has overall gentler grades. At the intersection of Warm Lake Road and Johnson Creek Road (CR 10-413) the two mine access routes begin, with the Johnson Creek Route north along Johnson Creek Road (CR 10-413) and the Burntlog Route east onto Burnt Log Road (FR 447). The location of the spill risk would change as the SGP progresses under the 2021 MMP. Johnson Creek and the portion of the East Fork SFSR between the village of Yellow Pine and the Operations Area Boundary would be at risk of any significant spills of hazardous materials during the first 1 to 2 years of the SGP when the Johnson Creek Route would be used as the access route during the Burntlog Route construction. For the remainder of the mine life, the waterbodies along the Burntlog Route would be at risk from any significant spills.
>
> The combination of the proposed monitoring, planning, and control practices described in the preceding narrative for transport and handling of fuels and hazardous materials and committed EDFs would minimize the risk of accidental releases during the transportation, storage, management, and use of hazardous materials. Nevertheless, the proximity of the access roads to surface water resources increases the potential for a release to enter water which could result in major impacts.
>
> It is expected that the risk of a spill large enough to negatively affect fish or aquatic habitat would be low, but the risk occurs throughout the period of the operations. The effects of the SGP on fish and aquatic habitat from contaminants from a spill are expected to be minor, long-term, and localized.

Table 12: Alternative 2 from the DEIS is the Burntlog Route proposed in the SDEIS. Alternative 4 in the DEIS is the Yellow Pine Route (aka the Johnson Creek Route in the SDEIS).

*Table 11. Summary of indicators used to assess how the SGP may affect fish species by degrading water quality in waterways adjacent to access roads and through hazardous material spills at the mine site or along access roads and how the SGP may affect public safety on the roads used by mine vehicles during construction, operations, and closure and reclamation activities. Sources: Table 2.9-1, Table 4.7-3, Table 4.9-13, 4.9-20, Table 4.9-25, Table 4.12-3 in USFS (2020). Alternatives 2 and 4 (shaded columns) are the Burntlog and Johnson Creek routes proposed in the SDEIS, respectively.*

| | Alternative | | | |
|---|---|---|---|---|
| Indicator | 1 | 2 (Burntlog) | 3 | 4 (Johnson Creek) |
| Mine road miles used | | | | |
| Yellow Pine Route | 70 | 70 | 70 | 70 |
| Burntlog Route | 73 | 71 | 75 | - |
| Change in AADT over baseline (all mine traffic; heavy vehicle traffic) | | | | |
| Construction | 65; 45 | 65; 45 | 65; 45 | 65; 45 |
| Operations | 68; 49 | 50; 33 | 68; 49 | 68; 49 |
| Reclamation | 25; 13 | 25; 13 | 25; 13 | 25; 13 |
| Post-closure | 6; 0 | 6+; 0 | 6; 0 | 6; 0 |
| Mine-related vehicles per hour (Yellow Pine Route; Burntlog Route) | | | | |
| Construction | 5, - | 5, - | 5, - | 5, - |
| Operations | -, 5 | -, 4 | -, 5 | 5, - |
| Reclamation | -, 2 | -, 2 | -, 2 | 2, - |
| Kilometers of Chinook intrinsic potential (IP) habitat within 91 m (100 yards) of roadway centerline | | | | |
| Yellow Pine Route | 36 | 36 | 36 | 36 |
| Burntlog Route | 7.3 | 5.91 | 4.83 | 0 |
| Warm Lake Road | 9.2 | 9.2 | 9.2 | 9.2 |
| Kilometers of IP habitat within 91 m (100 yards) of roadway centerline (steelhead; bull trout) | | | | |
| Yellow Pine Route | 32.3, 33.7 | 32.3, 33.7 | 32.3, 33.7 | 32.3, 33.7 |
| Burntlog Route | 1.62, 8.87 | 1.23, 7.67 | 1.23, 5.74 | 0, 0 |
| Warm Lake Road | 4.06, 9.05 | 4.06, 9.05 | 4.06, 9.05 | 4.06, 9.05 |
| Miles of route within 0.5 miles of streams (DEIS p. 4.7-13) | | | | |
| Yellow Pine Route | 27 | 27 | 27 | 27 |
| Burntlog Route | 9 | 9 | 9 | - |
| Access road stream crossings | | | | |
| Warm Lake Road | 16 | 16 | 16 | 16 |
| Johnson Creek Road | 16 | - | 16 | 16 |
| McCall-Stibnite Road | 11 | 11 | 11 | 11 |
| Burnt Log Road | 21 | 19 | 21 | - |
| Cabin Creek Groomed OSV Route | 7 | 7 | 7 | 7 |

*Table 12. Summary of indicators used to assess how the SGP may affect fish species by degrading water quality in waterways adjacent to access roads and through hazardous material spills at the mine site or along access roads and how the SGP may affect public safety on the roads used by mine vehicles during construction, operations, and closure and reclamation activities. Sources: Table 2.8-1, Table 4.9-22, and Table 4.9-25 in USFS (2022).*

| Indicator | Alternative | |
|---|---|---|
| | Burntlog Route | Johnson Creek Route |
| Mine road miles used | | |
| Johnson Creek (formerly Yellow Pine) Route | 70 | 70 |
| Burntlog Route | 71 | 0 |
| Change in AADT over baseline (all mine traffic; heavy vehicle traffic) | | |
| Construction | 65; 45 | 65; 45 |
| Operations | 50; 33 | 50; 33 |
| Closure and Reclamation | 25; 13 | 25; 13 |
| Post-closure | 6; 0 | 6; 0 |
| Mine-related vehicles per hour | | |
| Construction (p. 4-489) | 5 | 5 |
| Operations (p. 4-491) | 4 | 4 |
| Reclamation (p. 4-493) | 2 | 2 |
| Kilometers of Chinook intrinsic potential (IP) habitat within 91 m (100 yards) of roadway centerline (DEIS Tables 4.12-3, 4.12-26 and 4.12-64) | | |
| Johnson Creek Route | 35.99 | 35.99 |
| Burntlog Route | 7.67 | |
| Warm Lake Road | 9.17 | 9.17 |
| Kilometers of IP habitat within 91 m (100 yards) of roadway centerline (steelhead; bull trout) (DEIS Table 4.12-3, 4.12-26, and 4.12-64) | | |
| Johnson Creek Route | 32.30; 33.74 | 32.30; 33.74 |
| Burntlog Route | 1.62; 8.87 | |
| Warm Lake Road | 4.06; 9.05 | 4.06; 9.05 |
| Miles of route within 0.5 miles of streams (SDEIS, p. 4-139) | | |
| Johnson Creek Route | 27 | 27 |
| Burntlog Route | 9 | |
| Access road stream crossings | | |
| Warm Lake Road | 16 | 16 |
| Johnson Creek Road | 21 | 16 |
| McCall-Stibnite Road | | 11 |
| Burnt Log Road | not listed; DEIS indicates 19 | |

USFS 2022, p. 4-139 (Section 4.7)

> Close proximity of access roads to surface water resources increases the potential for spilled material on the roadways to enter water, thus increasing the potential consequences of a spill. The Burntlog Route crosses 37 streams and includes 9 miles of road that are within 0.5 mile of surface water resources. The Johnson Creek Route crosses 43 different streams and includes 27 miles of road that are within 0.5 mile of surface water resources, including several miles that parallel the fish-bearing East Fork SFSR and Johnson Creek waterways. Though the Burntlog Route includes a greater number of stream crossings, the Johnson Creek Route includes significantly greater proximity to water resources. The potential consequences from trucking spills would thus be greater along the Johnson Creek Route that would be utilized during construction of the Burntlog Route.

While the SGP DEIS uses a 91 m (100 yard) distance from the centerline of the roadway (Table 11) to measure the lengths of streams potentially affected by road effects, especially spills, Kravitz and Blair (2019) recommend a 200 m distance to define the stream areas inside the effect zone of rural roadways.

USFS (2020), p. 4.12-21

> To evaluate the risk of spills during the transportation and handling of hazardous materials, several factors were assessed, including: past fuel hauling accidents…, length of roads traveled within 91 meters (300 feet) from road centerline of important fish habitat, number and timing of hazardous material trips, and mitigation measures. …
>
> Most of the streams that occur within 91 meters (i.e., the area in which potential impacts to fish habitat from a spill may reasonably occur) of the Yellow Pine and Burntlog routes support Chinook salmon, steelhead trout, bull trout, and cutthroat trout. **…** the location of the spill risk would transition from the Yellow Pine Route to the Burntlog Route as the SGP progresses, which has less critical habitat for bull trout, steelhead, and intrinsic potential habit for Chinook salmon. Johnson Creek and the portion of the EFSFSR between Landmark and the mine site would be at risk during the first 1 to 2 years of the SGP when the Yellow Pine Route would be used as the access route. For the remainder of the SGP, until mine site closure and reclamation activities are complete and the Burntlog Route is reclaimed, the waterbodies adjacent to the Burntlog Route would be at greater risk.

The comparison of intrinsic potential habitat for Chinook, steelhead, and bull trout involved summing the lengths for the three species:

USFS (2020), p. 4.12-22

> **[T]**he amount of important fish habitat that would be at risk along the Yellow Pine Route is higher (102 km) compared to the Burntlog Route (17.8 km). The Yellow Pine Route includes approximately 24.8 km more bull trout critical habitat, 30.7 km more steelhead trout critical habitat, and 28.7 km more Chinook salmon IP habitat than the Burntlog Route. A spill on the Yellow Pine Route could affect a much higher number of fish compared to a spill along the Burntlog Route.

but that may not be a valid measure if they have overlapping ranges in the streams. Furthermore, the assertion that the Yellow Pine Route could affect a higher number of fish should be tied to the fish populations in each stream, as well as to the likelihood that a spill would reach a stream from that route. (See Section 5 of this report for consequence modeling.)

USFS (2020), p. 4.12-23

> As an example, schools of adult Chinook salmon (20 to 100 individuals) have been seen in the EFSFSR and Johnson Creek. Thus, a large spill could potentially kill a substantial number of adult salmon depending on various factors (NMFS 1995). A spill in the fall could kill all the 1-year old juveniles and zero age eggs/alevins, thus eliminating 2 years of Chinook salmon progeny. Diesel from a spill could mix with spawning gravels and sand and be retained in the stream substrate for a year or more, and thereby negatively affect salmon eggs, alevins, and juveniles for several years (Korn and Rice 1981; Moles et al. 1981).

Chemical contaminants are expected to change the baseline watershed condition indicators [WCI] and functional index [FI] because "[a]n increase in traffic and activity increases the potential for spills of deleterious substances. Accidental spills in the soil or directly into waterbodies are likely to decrease the FI, from large-scale spills or an accumulation from small, incidental spills. Furthermore, reaches downstream of the mine site could be exposed to contaminant inputs from the mine site itself. A decline in FI is anticipated." The baseline functional index for Johnson Creek, Upper EFSFSR and Upper South Fork Salmon River are all FR (Functioning at Risk)" (USFS 2020, p. 4.12-57).

The SDEIS (USFS 2022) did not address the length of streams within 91 m of the centerline of either proposed access routes.

## Other road corridor environmental impacts: Greenhouse gas emissions, dust and road surface treatments, road corridor safety

### Greenhouse gas emissions

USFS (2020), p 4.4-17:

> Alternative 2 includes a limestone kiln, which would increase GHG emissions through propane fuel combustion and release of $CO_2$ by reactions during the limestone calcining process (i.e., heating to a high temperature). The added GHG emissions for the limestone kiln operation are quantified for Alternative 2 below.

USFS (2020), p 4.4-17:

> Although the Centralized WTP would require additional truck trips, there would be an overall net reduction of operational truck activity under Alternative 2 due to the on-site generation of lime. However, the reduced GHG emissions for the net reduction in delivery truck activity would largely be offset by off-highway mining haul truck traffic bringing limestone to the lime generation process, at approximately two trucks per day. These trucks are much larger, and while they travel a short distance, they carry much larger volumes of materiel (400 tons per load) and burn 100 gallons of fuel per hour of operation. Assuming each truck operates one hour per day, five days per week, that is 200 gallons of diesel per day. At 19.4 pounds/gallon $CO_2$ emissions, over 260 days per year, that is approximately 500 tons of $CO_2$ per year from limestone hauling.

### Dust and road surface treatments

Kravitz and Blair (2019)

> To estimate the amount of dust generated from the transportation corridor we used an Iowa Highway Research Board project (Hoover et al. 1973) that quantified dust sources and emissions created by traffic on unpaved roads. According to that study, one vehicle, traveling 1 mile of unpaved road once a day every day for 1 year, would result in the deposition of 1 ton of dust within a 1000-foot corridor centered on the road (i.e., traffic would annually deposit 1 ton of dust per mile per vehicle).

Kravitz and Blair (2019)

> Roads are treated with salts and other materials to reduce dust and improve winter traction. In Alaska, calcium chloride is commonly used for dust control and is mixed with sand for winter application. Compounds used to control ice and dust (Hoover 1981) have been shown to cause toxic effects when they run off and enter surface waters.

## Road corridor safety

USFS (2020), p. 3.18-9:

> Increased mine related trucking traffic on roads could increase potential for spills of hazardous substances, as well as increase the potential for traffic accidents, which could have injury impacts as well as well-being and psychosocial impacts.

USFS (2020), p. 4.12-22

> The risk of spills would be lower on Warm Lake Road because it is a paved and generally wider with lower grades (except near Warm Lake area).

USFS (2020), p. 3.16-14

> **Vehicle Accidents**
> Vehicle accident data for full-size vehicles and OHVs from 2000 through 2016 was obtained from Valley County Sheriff Department records for the six roads associated with the three existing primary access routes to the mine site. Warm Lake Road (CR 10-579) experienced an average of eight accidents per year from 2000 through 2016, followed by South Fork Salmon River Road (FR 50674/FR 474) with an average of three accidents per year, Lick Creek Road (CR 50-412) with two accidents per year, Johnson Creek Road (CR 10-413) with two accidents per year, and Stibnite Road (CR 50-412) with one accident per year (DJ&A, PC 2017).
>
> According to the Valley County sheriff's traffic incident records from 2000 through 2016, the causes of most accidents on the existing roadways fall under the general categories of driver error, vehicle mechanical issues, and environmental factors (DJ&A, PC 2017). Examples of driver error include speeding, following another vehicle too closely, inattentiveness, fatigue, gear shift issues, failure to share road, inexperience as a driver, and impairment. Examples of mechanical issues include brake and engine failure and tire-related problems including the misuse or lack of use of chains during ice or snow conditions. Environmental factors that affected traffic incidents include weather-related (e.g., snow, ice, flooding, and other conditions that contributed to poor visibility), poor road conditions (e.g., soft shoulders), and wildlife crossings.

> It is likely that Warm Lake Road (CR 10-579) experiences the most accidents due to the higher traffic volumes and higher speeds observed. No OHV or motorcycle-related crashes were noted in the Valley County Sheriff's Department records; however, it is likely that not all crashes are reported (DJ&A, PC 2017).

USFS (2020), p. 4.7-4

> Statistics for haul truck accidents on county roads and/or in mountainous terrain are very limited. Transportation on local access roads would be at lower speeds and with less traffic than highways, and would likely be safer than highway travel.

## Summary

The SGP SDEIS quantified the risks from spills by measuring road lengths, number of trips, and distances to streams but did not include calculations of spill probabilities. In the DEIS, assessments of fish habitat impacts are based on measuring the amount of stream that is a 91 m distance from the roadway centerline, which is less than half the published distance for a 200 m road-effect zone around rural roadways, but there was no mention of that in the SDEIS for either Action Alternative. There is no measure of how many km of streams or fish habitat are within 200m of roadway. Other environmental effects to consider are greenhouse gas emissions and dust generation, which, like spill risks, will also be proportional to the amount of traffic, and application of chemicals to the roadway. Safety is also a concern. The SGP SDEIS shows that the largest number of accidents occurs on Warm Lake Road but then contrarily posits that it would have the lowest spill probability.

# 4. Hazardous material list: substances, quantities used annually, hazardous waste, and other potential spill sites

Hazardous materials would be transported to and from the mine site in millions of gallons of bulk liquids and tens of thousands of tons of bulk solids (Tables 13 and 14).

Transportation Research Board (2005)

> Carriers specializing in the transportation of hazardous materials often move what are defined by DOT as "bulk packaged" shipments, which are single packagings exceeding 119 gallons for liquids, 882 pounds for solids, and 1,000 pounds for gases. Tank trucks, railroad tank cars, barge tankers, and intermodal tanks are forms of bulk packaging. Tank trucks typically hold between 2,000 and 10,000 gallons… Intermodal tank containers, which are transported on flatbed trucks and flat rail cars, can hold as much as 6,500 gallons. Bulk packaged shipments may also be shipped by truck in van-type trailers, on railroad flatcars, on flat barges, and in other nontank vehicles and containers. Many portable tanks, bins, and drums for transporting hazardous liquids and solids exceed 119 gallons or 1,000 pounds and are thus defined in the regulations as bulk shipments.

## Description of hazardous material transport for mine operations for Alternative 2 in the DEIS

Table 2.3-6 (USFS 2020) shows the materials, quantities, delivery form, onsite storage capacity, and other data for 33 supplies. Table 4.7-1 (USFS 2020) lists 27 hazardous materials, 25 of which appear in Table 2.3-6. (Table 4.7-1 includes antimony concentrate and wastes containing mercury from ore processing, which did not appear in Table 2.3-6.) Eight substances in Table 2.3-6 do not appear in Table 4.7-1: tires, batteries, light ballasts, pesticides/insecticides, herbicides, fertilizer, sulfuric acid, and sodium hypochlorite. Water treatment reagents (USFS 2020, p. 2-111) were listed separately. The combined lists, including the modifications associated with Alternative 2 (on-site lime production and water treatment), are shown in Table 13. In total, more than 9,400,000 gallons and 95,000 tons of hazardous materials would be transported to and from the SGP during operations as described for Alternative 2 in the DEIS, requiring at least 4,640 trips every year.

The mining and ore processing traffic predicted in the DEIS (USFS 2020, Table 2.3-7) indicates that there would be 522 trips for bringing in fuel and miscellaneous supplies, 5,220 trips for ore processing supplies, 730 trips for machine parts and consumables, 365 trips for ore concentrate haulage, and 156 trips for removing trash and recyclables each year, for a total of nearly 7,000 trips annually. The total annual trips for the hazardous materials, including antimony concentrate, grinding metals and liners, and waste oil, listed in the DEIS was between 4,640 and 5,006 trips each year (Table 13). This is a large discrepancy between the estimate of annual trips used for traffic studies and for estimating transportation spills.

*Table 13. Hazardous materials transported to and from the proposed SGP Project during operations. Compiled from Tables 2.3-6, 4.7-1, 4.7-2 (USFS 2020), including the supplies needed for Alternative 2 (p. 2-111). Sulfuric acid to be used at the mine process area (shaded row) did not appear in the list of materials for the SDEIS (Table 14). * Materials that are listed as bulk liquids and as bulk solids in different locations.*

| Common name | Annual use | Typical vehicle payload | Estimated number of deliveries each year |
|---|---:|---:|---:|
| *Bulk liquids* | | | |
| Diesel fuel | 5,800,000 gallons | 10,000 gallons | 580 |
| Propane (buildings) | 1,463,000 gallons | 11,000 gallons | 133 |
| Propane (lime production) | 560,000 gallons | 6,000 gallons | 93 |
| Gasoline | 500,000 gallons | 5,000 gallons | 100 |
| Lubricants | 296,000 gallons | 3,000 gallons | 99 |
| Waste oil (50% of lubricant quantity) | 148,000 gallons | 3,000 gallons? | 49 |
| Magnesium chloride | 250,000 gallons | 4,500 gallons | 56 |
| Nitric acid | 115,000 gallons | 3,000 gallons | 38 |
| Ferric sulfate | 65,000-125,000 gallons | 3,000 gallons? | ≥22 |
| Sulfuric acid (mine process area) | 60,000 gallons | 3,000 gallons | 20 |
| Methyl isobutyl carbonyl | 55,000 gallons | 3,000 gallons | 18 |
| Antifreeze | 40,000 gallons | 3,000 gallons | 13 |
| Hydrogen peroxide | 30,000 gallons | 4,000 gallons | 8 |
| Aerophine 3418A | 10,000 gallons | 200 gallons | 50 |
| Sodium hypochlorite* | 5,000-15,000 gallons | | 5 |
| Scale control reagents* | 5,000 gallons | 500 gallons | 10 |
| Sodium bisulfite* | 2,000 gallons | | |
| Sulfuric acid (water treatment) | 1,700-2,400 gallons | | 1 |
| Solvents | 1,000 gallons | 200 gallons | 5 |
| *Alternative 2 bulk liquid totals* | 9,406,700 to 9,477,400 gallons | | ≥1,300 |

*Table 13. (con't.)*

| Common name | Annual use | Typical vehicle payload | Estimated number of deliveries each year |
|---|---|---|---|
| *Bulk solids and containers* | | | |
| Antimony concentrate | Up to 29,200 tons | Up to 40 tons | 365-730 |
| Lime | 21,240 tons | 24 tons | 885 |
| Sodium metabisulfite | 14,000 tons | 24 tons | 583 |
| Grinding metals (steel balls for mill) | 10,000 tons | 24 tons | 417 |
| Ammonium nitrate | 7,300 tons | 24 tons | 304 |
| Sodium cyanide | 3,900 tons | 24 tons | 163 |
| Crusher and grinding liners | 3,200 tons | 24 tons | 133 |
| Copper sulfate | 2,500 tons | 15 tons | 167 |
| Potassium amyl xanthate | 1,700 tons | 15 tons | 113 |
| Lead nitrate | 700 tons | 10 tons | 70 |
| Flocculant | 600 tons | 15 tons | 40 |
| Activated carbon | 470 tons | 10 tons | 47 |
| Sodium hydroxide | 300 tons | 10 tons | 30 |
| Explosives | 100 tons | 5 tons | 20 |
| Fertilizer | ~2,500 pounds | | 1 |
| Herbicides | ~1,000 pounds | | 1 |
| Sodium hypochlorite* | 1,000 pounds | 1,000 pounds | 1 |
| Pesticides/insecticides | ~250 pounds | | 1 |
| Wastes containing mercury from ore processing (carbon canisters, filter packs, gas condensers) | Not quantified | | |
| *Alternative 2 solids totals* | 95,212 tons | | >3,341 to 3,706 |
| *Alternative 2 bulk liquid and solid total trips/year* | | | >4,641 to 5,006 |

## Description of hazardous material transport for mine operations in the SDEIS

The hazardous materials and other mine supplies to be transported during mine operations were listed in Table 3-7 of ModPRO2 (Perpetua 2021), and Tables 2.4-11 and 4.7-1 of the SDEIS (USFS 2022) and have been compiled in Table 14. Roughly 9,400,000 gallons and more than 46,700 tons of hazardous materials would be transported annually during operations, requiring approximately 3,000 to 3,400 annual trips.

*Table 14. Hazardous materials and mine supplies transported to and from the proposed SGP Project during operations and for water treatment (Tables 2.4-11 and 4.7-1 in USFS 2022 and Perpetua 2021 ModPRO2 Table 3-7). Shaded rows indicate materials not listed in Table 13. Quantities in **bold** differ from the corresponding values given in the DEIS. * Materials that are listed as bulk liquids and as bulk solids in different locations.*

| Common name | Annual use | Typical vehicle payload | Estimated number of deliveries each year |
|---|---|---|---|
| *Bulk liquids* | | | |
| Diesel fuel | 5,800,000 gallons | 10,000 gallons | 580 |
| Propane (on-site lime production) | 1,463,000 gallons | 11,000 gallons | 133 |
| Propane (buildings) | 560,000 gallons | 6,000 gallons | 93 |
| Gasoline | 500,000 gallons | 5,000 gallons | 100 |
| Lubricants | 296,000 gallons | 3,000 gallons | 99 |
| Waste oil (50% of lubricant quantity) | 198,000 gallons | 3,000 gallons | 49 |
| Magnesium chloride | 250,000 gallons | 4,500 gallons | 56 |
| Nitric acid | **65,000 gallons** | 3,000 gallons | **22** |
| Ferric sulfate | **23,000 gallons** | **3,000 gallons** | **17** |
| AP 3477 (dialkyl dithiophosphate) | 60,000 gallons | 3,000 gallons | 20 |
| Methyl isobutyl carbonyl | **120,000 gallons** | 3,000 gallons | **40** |
| Antifreeze | 40,000 gallons | 3,000 gallons | 13 |
| Antifreeze waste | 40,000 gallons | 3,000 gallons | 13 |
| Hydrogen peroxide | **7,100 gallons** | **3,660 gallons** | **2** |
| Aerophine 3418A | **10,500 gallons** | 200 gallons | **53** |
| Sodium hypochlorite* | **2,000 gallons** | **1,000 gallons** | **2** |
| Sulfuric acid (water treatment) | **12,000 gallons** | **3,000 gallons** | **5** |
| Solvents | 1,000 gallons | 200 gallons | 5 |
| Waste spent solvents | 1,000 gallons | 200 gallons | 5 |
| Polymer | 1,000 gallons | 200 gallons | 5 |
| Organic sulfide | 1,000 gallons | 200 gallons | 5 |
| Carbon dioxide | 14 tons | 3 tons | 5 |
| *Bulk liquid totals* | 9,400,600 gallons | | 1,322 |

*Table 14. (cont'd.)*

| Common name | Annual use | Typical vehicle payload | Estimated number of deliveries each year |
|---|---|---|---|
| *Bulk solids and containers* | | | |
| Antimony concentrate | **Up to 17,500 tons** | Up to 40 tons | 365-730 |
| Lime | **150 tons** | 24 tons | **7** |
| Sodium metabisulfite | **2,000 tons** | 22 tons | **91** |
| Grinding media (SAG mill) | **4,449 tons** | 24 tons | **186** |
| Grinding media (ball mill) | **3,566 tons** | 24 tons | **149** |
| Grinding media (LS ball mill) | **34 tons** | 24 tons | **2** |
| Primary crusher liners | **62 tons** | 24 tons | **3** |
| Pebble crusher liners | **84 tons** | 24 tons | **4** |
| SAG liners | **801 tons** | 24 tons | **34** |
| BM liners | **1,424 tons** | 24 tons | **60** |
| LS primary crusher liners | **9.16 tons** | 24 tons | **1** |
| LS secondary crusher liners | **9.32 tons** | 24 tons | **1** |
| LS ball mill liners | **27.8 tons** | 24 tons | **2** |
| Lime slaker liners | **3.5 tons** | 24 tons | **0.25** |
| Waste from mill liners and crusher liners | 280 tons | 24 tons | 12 |
| Ammonium nitrate | 7,300 tons | 24 tons | 304 |
| Sodium cyanide | **4,000 tons** | 24 tons | 167 |
| Copper sulfate | **1,250 tons** | **22 tons** | **57** |
| Potassium amyl xanthate | **1,350 tons** | **20 tons** | **68** |
| Lead nitrate | **800 tons** | **22 tons** | **37** |
| Activated carbon | **500 tons** | **22 tons** | **23** |
| Sodium carbonate | 430 tons | 24 tons | 18 |
| Flocculant | **300 tons** | **22 tons** | **14** |
| Sodium hydroxide | **330 tons** | **22 tons** | **15** |
| Explosives | 100 tons | 5 tons | 20 |
| Microsand | 6.58 tons | | 1 |
| Sodium bisulfite* | 0.2 tons | | 1 |
| Scale control reagents* | 5,000 pounds | 1,000 pounds | 5 |
| Fertilizer | ~2,500 pounds | | 1 |
| Herbicides | ~1,000 pounds | | 1 |
| Pesticides/insecticides | ~250 pounds | | 1 |
| Wastes containing mercury from ore processing (carbon canisters, filter packs, gas condensers) | Not quantified | | |
| *Bulk solids totals* | >46,771 tons | | >1,650 to 2,015 |
| *Bulk liquid and solid total trips/year* | | | >2,972 to 3,337 |

## Differences between hazardous materials transport in the DEIS and SDEIS

According to Perpetua (2021, p. 3-59),

> The ModPRO2 represents no change to the materials, supplies, and chemical reagents versus that detailed in the DEIS for all alternatives, other than greater LOM totals due to extending ore processing an additional 2.25 years, and the use of on-site limestone sources (as in Alternative 2).

Table 15 shows the differences in listed bulk liquid and solid materials and associated number of trips each year. The total quantity bulk liquids and number of associated trips required remained largely unchanged between Alternative 2 of the DEIS and the SDEIS (Tables 13 and 14). Nonetheless, there were still differences across 13 bulk liquids (Table 15). The SDEIS included six bulk liquid materials that were not included in the DEIS (AP 3477, antifreeze waste, waste spent solvents, polymer, organic sulfide, and liquid carbon dioxide). Sulfuric acid had been listed for use at the mine process area (60,000 gallons annually) and for water treatment (1,700 to 2,400 gallons annually) in the DEIS but is only shown for water treatment (12,000 gallons annually) in the SDEIS. The SDEIS had reductions in the amounts of nitric acid, ferric sulfate, hydrogen peroxide, and sodium hypochlorite and increases in the amounts of methyl isobutyl carbonyl and Aerophine 3418A compared to Alternative 2 in the DEIS.

Under Alternative 2 from the DEIS, approximately 95,000 tons of hazardous materials would be delivered to or from the mine in 3,300 to 3,700 annual trips. In the SDEIS, those values drop to ~46,700 tons in ~1,800 trips each year. The expected amount of antimony concentrate produced each year drops by 40% from a maximum of 29,200 tons each year to 17,500 tons each year. The largest decreases in annual use seen in the SDEIS relative to the DEIS Alternative 2 were in lime and sodium metabisulfite. Even with the inclusion of a lime kiln for on-site lime production, Alternative 2 in the DEIS was expected to transport 21,240 tons of lime in 885 loads each year (Table 16). In the SDEIS that was reduced to 150 tons in 7 trips each year. Sodium metabisulfite use dropped from an expected 14,000 tons (583 trips) to 2,000 tons (91 trips) annually. There were also decreases in the amounts of copper sulfate, potassium amyl xanthate, and flocculant expected to be used each year. The SDEIS included three solid bulk materials not listed in the DEIS (waste from mill liners and crushers, sodium carbonate, and microsand). Finally, some of the bulk solids are projected to be delivered in larger quantities, which lead to fewer trips per year. for some reagents (lead nitrate, activated carbon, and sodium hydroxide) the expected annual use increased but the number of annual trips decreased because of the increase in load size per trip.

*Table 15. Differences between the bulk liquid materials listed for transportation annually in the DEIS and SDEIS.*

| Material | DEIS description | SDEIS description | Difference (SDEIS – DEIS) |
|---|---|---|---|
| Sulfuric acid (mine process area) | 60,000 gal<br>20 trips | not listed | -60,000 gal<br>-20 trips |
| AP 3477 | not listed | 60,000 gal<br>20 trips | 60,000 gal<br>20 trips |
| Antifreeze waste | not listed | 40,000 gal<br>13 trips | 40,000 gal<br>13 trips |
| Waste spent solvents | not listed | 1,000 gal<br>5 trips | 1,000 gal<br>5 trips |
| Polymer | not listed | 1,000 gal<br>5 trips | 1,000 gal<br>5 trips |
| Organic sulfide | not listed | 1,000 gal<br>5 trips | 1,000 gal<br>5 trips |
| Carbon dioxide | not listed | 14 tons<br>5 trips | 14 tons<br>5 trips |
| Nitric acid | 115,000 gal<br>38 trips | 65,000 gal<br>22 trips | -50,000 gal<br>-16 trips |
| Ferric sulfate | 65,000 to 125,000 gal<br>22 to 42 trips | 23,000 gal<br>17 trips | -32,000 to -102,000 gal<br>-5 to -25 trips |
| Methyl isobutyl carbonyl | 55,000 gal<br>18 trips | 120,000 gal<br>40 trips | 65,000 gal<br>22 trips |
| Hydrogen peroxide | 30,000 gal<br>8 trips | 7,100 gal<br>2 trips | -22,900 gal<br>-6 trips |
| Aerophine 3418A | 10,000 gal<br>50 trips | 10,500 gal<br>53 trips | 500 gal<br>3 trips |
| Sodium hypochlorite | 5,000 to 15,000 gal | 2,000 gal<br>2 trips | -3,000 to -13,000 gal |
| Sulfuric acid (water treatment) | 1,700 to 2,400 gal | 12,000 gal<br>5 trips | 9,600 to 10,300 gal |

*Table 16. Differences between the bulk solid materials listed for transportation annually in the DEIS and SDEIS.*

| Material | DEIS description | SDEIS description | Difference (SDEIS – DEIS) |
|---|---|---|---|
| Waste from mill liners and crusher liners | not listed | 280 tons<br>12 trips | 280 tons<br>12 trips |
| Sodium carbonate | not listed | 430 tons<br>18 trips | 430 tons<br>18 trips |
| Microsand | not listed | 6.58 tons<br>1 trip | 6.58 tons<br>1 trip |
| Antimony concentrate | ≤ 29,200 tons<br>365 to 730 trips | ≤17,500 tons<br>365 to 730 trips | -11,700 tons |
| Lime | 21,240 tons<br>885 trips | 150 tons<br>7 trips | -21,090 tons<br>-878 trips |
| Sodium metabisulfite | 14,000 tons<br>583 trips | 2,000 tons<br>91 trips | -12,000 tons<br>-492 trips |
| Grinding media and liners | 13,200 tons<br>550 trips | 10,750 tons<br>454 trips | -2,450 tons<br>-96 trips |
| Sodium cyanide | 3,900 tons<br>163 trips | 4,000 tons<br>167 trips | 100 tons<br>4 trips |
| Copper sulfate | 2,500 tons<br>167 trips | 1,250 tons<br>57 trips | -1,250 tons<br>-110 trips |
| Potassium amyl xanthate | 1,700 tons<br>113 trips | 1,350 tons<br>68 trips | -350 tons<br>-45 trips |
| Lead nitrate | 700 tons<br>70 trips | 800 tons<br>37 trips | 100 tons<br>-33 trips |
| Flocculant | 600 tons<br>40 trips | 300 tons<br>14 trips | -300 tons<br>-26 trips |
| Activated carbon | 470 tons<br>47 trips | 500 tons<br>23 trips | 30 tons<br>-24 trips |
| Sodium hydroxide | 300 tons<br>30 trips | 430 tons<br>18 trips | 130 tons<br>-12 trips |

## Bulk liquids

Transportation Research Board (2005)

> A fairly small number of commodities constitute the vast majority of hazardous materials moved in bulk in terms of weight. Gasoline, diesel, and home heating fuel are the most common hazardous cargoes moved in tank trucks. About 125 commodities account for 90 percent of shipments moved by railroad tank car, but 6 of these—liquefied petroleum gas, caustic soda, sulfuric acid, anhydrous ammonia, chlorine, and fuel oil—account for more than half of tank car shipments (AAR 2002).

In both Alternative 2 of the DEIS and in the SDEIS, diesel, propane, and gasoline use totaled to 8.323 million gallons each year. According to the Transportation Research Board (2005), "[a]bout 41% of the truck shipments of hazardous materials are petroleum products, and most of the remaining 59% are chemical and allied products." For the proposed SGP, the combined number of trips for diesel, propane, gasoline, lubricants, and waste oil represented 21% of the number of trips for Alternative 2 (1,054 of 5,006 annual deliveries), but that has shifted to 35% in the SDEIS (1,054 of 2,977).

USFS (2022), p. 2-75

> **Diesel Fuel, Gasoline, and Propane**
>
> Aboveground storage tanks at the SGP would be used for fuels and other fluids, including gasoline, diesel fuel, lubricants, coolants, hydraulic fluids, and propane. Approximately 200,000 gallons of diesel fuel, 10,000 gallons of gasoline, and 30,000 gallons of propane would be stored at the SGP in addition to a variety of materials, supplies, and reagents …. The storage tank facility for gasoline, diesel fuel, and propane would be located near the maintenance workshop with additional propane storage at the ore processing facility area, the underground portal area, and the worker housing facility.

The storage quantities listed above for diesel, gasoline and propane for storage at the mine site represent 3.4%, 2%, and 1.5% of the annual ore processing needs, respectively. With relatively limited storage capacity at the mine site, either deliveries of these petroleum products will have to continue year-round, regardless of weather and road conditions, or other storage facilities will be needed. From 1980-2003, 27.88% of the oil spills of at least 50 gallons that reached US navigable waters within EPA Region 10, which includes Alaska, Idaho, Oregon and Washington, were from vehicles, and 57.09% were from spill prevention, control, and countermeasure (SPCC) facilities (Table 9 in Etkin 2006), rather than other sources such as pipelines, vessels, railways, etc., so truck transport and storage combined accounted for nearly 85% of the spills that reached streams.

The descriptions of how a release of hazardous materials, both for small releases and larger ones have shifted between the DEIS (USFS 2020) and the SDEIS (USFS 2022), as shown below. The newer text limits itself to consideration of small spills to fuel from the vehicles themselves. Larger spills of liquid petroleum or other hazardous materials and considered low probability, although the cause has shifted from " the complete failure of a bulk tanker truck or truck rollover or accident" to " the puncture of the bulk tanker in the accident".

USFS (2020), p. 4.7-10, 11 and USFS (2022, p. 4-138); *italicized* text was present in USFS (2020) but removed in USFS (2022) and text in **bold** is new in USFS (2022)

> The most probable release scenario associated with truck transport would be relatively small *(for example, less than 25 gallons of fuel)* **amounts of fuel spilled from vehicles themselves** and attributed to mechanical failure or human error. Under this scenario, immediate cleanup actions would typically include deployment of containment and spill recovery materials, and removal of impacted *roadbed material* **soil**. *Material* **Fuel** spilled to soils/roadbed could *likely* be **readily** contained and recovered, while *material* **fuel** which enters waterways **via roadside drainages** may be difficult or impossible to fully recover **and there would be potential for migration beyond the immediate spill area**. **Spill response materials on the vehicles and pre-positioned along the access routes and in SGP response vehicle would include materials to contain and recover floating oil.** Response actions would include notification to the appropriate regulatory agencies.
>
> *Most* small volume release scenarios would be temporary due to prompt response and cleanup actions; however, higher volume/lower probability spill scenarios could result in longer-term remedial actions and impacts. The risk of spills would last throughout the life of the SGP (long-term). Effects would generally be local and in close proximity to the release source in most scenarios; however, if surface or groundwater were to be impacted with fuels or other hazardous materials, the potential for migration beyond the local area could occur.
>
> A low probability *fuel release of up to 10,000 gallons or large spill of concentrate* **release of liquid petroleum or hazardous material from a bulk truckload** could potentially occur assuming *the complete failure of a bulk tanker truck or truck rollover or accident* **the puncture of the bulk tanker in the accident**. Under this scenario, spilled material would be released to the immediate roadbed area*, and potentially to nearby surface water* **and**

> **potentially impact physical resources and ecological receptors (e.g., vegetation or wildlife) and nearby surface water** depending on the topography and location. Spill response and recovery measures such as containment, deployment of absorbent materials, removal of impacted roadbed material and vegetation, and deployment of water-based spill recovery equipment (as needed) *may* **would** help to limit impacts. *Impacts to physical resources and ecological receptors (e.g., vegetation or wildlife) could be greater depending on the location of the spill.*
>
> **A release of large quantities of solid hazardous materials such as cyanide or antimony concentrate would also be unlikely. Breaches of the shipping containers for these materials in the case of an accident could release the solid materials to the ground where it would reside until response actions are taken to mechanically clean it up, along with any contaminated soil. Migration of these solid materials from the immediate release site would be less likely than for liquid materials but could be possible in wet weather or snowmelt conditions. Again, spill response and recovery measures would help to limit impacts.**

While Tables 3-9 and 3-11 and 2.3-7 (Perpetua 2021 Mod PRO2) show 522 pilot vehicles to accompany 522 fuel and hazardous materials trips during construction and operations, the number of pilot vehicles is less than the number of trips required to bring bulk liquid and solid hazardous materials to the mine site each year during operations. USFS (2022, p. 2-76) states under “Miscellaneous consumables”, which include sulfuric acid and nitric acid, that

> [l]iquids would be shipped to the SGP in tank trucks designed for spill prevention and escorted to the mine site by pilot cars manned and equipped to handle spills. All reagents would be transported and stored in suitable containers in designated reagent storage areas.

USFS (2022), p. 2-75

> **Miscellaneous Oils, Solvents, and Lubricants**
>
> Various oils including motor oils, lubricants, antifreeze, and solvents would be shipped to the SGP on trucks. These would be stored in approved containers located within, or directly adjacent to, the maintenance shop and contained within secondary containments to prevent spills into the environment. All used petroleum products, waste antifreeze, and used solvents would be collected in approved containers, transported off site, and disposed or recycled.

## Bulk solids

There are two reagents transported as bulk solids that would be brought to the mine in quantities requiring at least 100 truck deliveries per year (excluding grinding metals and crusher and grinding liners). They are ammonium nitrate and sodium cyanide. Overall, these two supplies total to 11,300 tons to be transported annually and 471 trips of heavy vehicles transporting 15 to 24 tons of hazardous solids each.

USFS (2022), p. 2-75

> **Explosives Storage**
>
> Ammonium nitrate prill would be received in bulk in tanker trucks and transferred into storage silos. Other blasting supplies used for mine blasting operations would include blasting emulsion products, detonating cord, cast primers, and blasting caps. These products would be delivered in boxes or other approved containers on trucks. The explosives storage facility would include two silos containing ammonium nitrate on a concrete pad and two buildings, one for explosives and one for detonators. Components of bulk explosive material would be stored in separate and isolated containers, sized, and designed to meet Bureau of Alcohol, Tobacco, Firearms, and Explosives and MSHA requirements. The explosives storage facility would be fenced and securely gated. An explosives contractor would provide the products and manage the explosives storage facility.

USFS (2020), p. 2-62

> **Miscellaneous Consumables**
>
> Sodium cyanide would be transported as dry cyanide briquettes to the SGP. Nitric and sulfuric acid would be transported in tanks designed to prevent spills even in the event of rollovers. Nitric and sulfuric acids would be stored in specialized non-corrosive, polyethylene-lined tanks located within the ore processing facility and would have secondary containment.

## Safety data about some of the most transported reagents and antimony concentrate

I compiled information from the safety data sheets for the reagents from two commercial suppliers (IXOM Safety Data Sheets (https://www.ixom.com/sds-search) and EChemi Safety Data Sheets (http://www.echemi.com)), as well as a few other commercial sources (Appendix A). Reagents and other materials are listed in the same order in Appendix A as they are in Table 13, first by those transported in liquid forms and then those as bulk solids, in order of decreasing quantities to be used annually. Information about each reagent may include chemical classification, hazard and precautionary statements, chemical and physical properties, including stability and reactivity, and information about toxicity to humans and ecological effects, if known. A few details are given for seven reagents and for antimony concentrate below, but this is far from a complete description of the dangers these reagents may pose if there are accidental releases individually or in combination.

### *Diesel*

USFS (2020), p. 4.12-22

> Past accident records indicate that of all the substances to be transported, diesel fuel may pose the highest risk to fish and fish habitat. This is because large quantities of diesel fuel are transported in each load, numerous trips are made each year, and the substance is a liquid that rapidly flows down gradient toward nearby streams.
>
> The intensity of the impact of a hazardous materials spill on fish and fish habitat could be high; as a large diesel spill could kill 100 percent of the Chinook salmon juveniles, adults, alevins, and eggs for a considerable distance (several miles) downstream of the accident (National Marine Fisheries Service [NMFS] 1995). In terms of toxicity to water-column organisms, diesel is one of the most acutely toxic oil types. Fish, invertebrates, and aquatic vegetation that come in direct contact with a diesel spill may be killed (U.S. Environmental Protection Agency [EPA] 2019). The severity of the impact would depend on the timing, size, and location of the spill. Small spills in deep open waters are expected to rapidly dilute; however, fish kills have been reported for small spills in confined, shallow water (EPA 2019).

Diesel is a flammable liquid, may be fatal if swallowed, and is acutely and chronically toxic to aquatic life. (See Appendix A.)

### *Propane*

Propane is an extremely flammable gas and an asphyxiant. It can react violently with chlorine and with nitric acid, is incompatible with oxidizing agents, and produces carbon dioxide when it decomposes. (See Appendix A.)

### *Gasoline*

Gasoline is also extremely flammable and harmful or fatal if swallowed. It contains benzene, which is a known human carcinogen. Gasoline is incompatible with strong oxidizers and will form nitrocresols if it comes in contact with nitric or sulfuric acids. (See Appendix A.)

### *Ammonium nitrate*

One of the supplies needed in substantial quantities every year is ammonium nitrate, which would be used in combination with diesel fuel oil for blasting. The annual usage of ammonium nitrate proposed for SGP is 7,300 tons, with 200 tons stored at the mine site at a time (USFS 2020, Table 2.3-6 on p. 2-60). Following the correct storage protocols for ammonium nitrate is critical for safety. On August 4, 2020, 2,750 tons of ammonium nitrate that had been stored at a port in Beirut, Lebanon since November 2013 exploded and a two-mile radius around the blast was flattened (*New York Times*). Domestic explosions of ammonium nitrate have also occurred. The *New York Times* described the explosion of 540,000 pounds (270 short tons) ammonium nitrate at a fertilizer storage plant in West, Texas on April 17, 2013, which registered as a 2.1 earthquake on the Richter scale. In that case the ammonium nitrate was stored on site with 110,000 pounds (55 short tons) of anhydrous ammonia. (See also Appendix A.)

### *Sodium cyanide*

Sodium cyanide is corrosive to metals and acutely toxic to humans and to aquatic organisms. It can have long term effects on aquatic life. Contact with water or acids liberates toxic gas. (See Appendix A.)

It is worth noting that the use of cyanide at SGP could potentially be eliminated. According to the M3 (2021) Feasibility report, p. 24-8:

> PYRITE CONCENTRATE SALES
>
> A preliminary market study for gold concentrate sales was completed by an independent leading industry participant. The participant's name has been withheld for confidentiality. In the study, the assumption was that the gold flotation concentrate would be shipped offsite to a regional processing facility located in Nevada where several autoclave and roaster plants are located. The direct sale of gold concentrate is not included in the economic cases presented in this report but rather, it is an opportunity for the project that would:
>
> - Simplify the mineral processing done on-site by eliminating the POX and potentially eliminating cyanide leach circuits;
> - Potentially eliminate the use of cyanide on-site; and
> - Significantly decrease capital costs.
>
> However, these benefits would be offset by reduced payability and significant transportation costs. In addition, there would less gold produced and loss of revenue due to the inability to produce gold from oxide ores present in all three deposits. It also is unlikely and contrary to industry practice for toll operations to agree to life-of-mine concentrate sales contracts covering the duration of an operation the size of the SGP, leaving the operation vulnerable to disruptions by its concentrate processor.
>
> Treatment facilities in Nevada and elsewhere are capable of processing gold concentrate that could be produced at the SGP. This option would only require a milling and concentration circuit on-site and would eliminate all downstream processing facilities such as the POX plant, oxygen plant, cyanide-leaching facilities, cyanide destruction plant, and other associated operations. Significant CAPEX savings on the order of $200 million to $250 million would be possible.
>
> The elimination of cyanide use on-site may reduce the complexity of the tailings storage facility liner system design and eliminate the need and complexity for some permits (e.g. IDEQ Cyanidation Permit).
>
> On May 9, 2018, Barrick Gold, which owns and operates (through the Nevada Gold Mines joint venture with Newmont) several roasters and autoclaves in Nevada, was granted a right of first refusal regardiing purchase of gold concentrates as part of a financing arrangement were such concentrates to be shipped off-site. If Barrick maintains a minimum of 10% ownership in Midas Gold, Barrick will maintain its right of first refusal regarding purchase of gold concentrates were Midas Gold to ship such off-site. As of August 26, 2020, Barrick owns ~11% of the issued and outstanding shares of the Corporation, and the right of first refusal is still in force at the time of this Technical Report.

*Copper sulfate*

Copper sulfate is very toxic to aquatic life with long lasting effects. (See Appendix A.)

*Potassium amyl xanthate*

Potassium amyl xanthate is toxic, self-heating in large quantities, and can potentially spontaneously combust. It reacts exothermically with water, is incompatible with oxidizing agents, acids, and water, and can have hazardous decomposition products. (See Appendix A.)

*Antimony concentrate*

USFS (2020), p. 2-31; differences from the SDEIS in italics

> **ANTIMONY CONCENTRATE TRANSPORT**
> The antimony concentrate would contain approximately 55 to 60 percent antimony by weight. The remaining balance, 40 to 45 percent by weight, of the concentrate includes *common rock forming* minerals with trace amounts of gold, silver, and mercury. *The concentrate would be in 1 to 2 ton super sacks and transported on flatbed trailers from the mine site for off-site smelting and refining.* An estimated one to two truckloads of antimony concentrate, *containing up to 20 supersacks per truckload*, would be hauled off site each day. *The antimony concentrate would be transported via Burntlog Route to State Highway 55, and then to a commercial barge or truck loading facility depending upon the refinery location*. It is assumed that the concentrate, when sold, would be shipped to facilities outside of the U.S. for smelting and refining because there are currently no smelters in the U.S. with capacity for refining the antimony concentrate.

USFS (2022), p. 2-50; differences from the DEIS in italics

> Antimony Concentrate Transport
>
> The antimony concentrate would contain approximately 55 to 60 percent antimony by weight. The remaining balance, 40 to 45 percent by weight, of the concentrate includes *sulfur and common* minerals with trace amounts of gold, silver, and mercury. *As described in the Transportation Management Plan (Perpetua 2021e) for transportation of antimony concentrate, Perpetua would load the sealed 2-ton super sacks containing the concentrate into a shipping container at the processing facility. Perpetua would load the concentrate by forklift and hooked lifting racks to safely move the super sacks, which are equipped with lifting straps, into fully enclosed shipping containers for the full course of their transport from the SGP site to their final destination. The supersacks and shipping container would provide primary and secondary containment for the antimony concentrate (Perpetua 2021e). The concentrate would be trucked via SH 55 to a*

> *commercial truck, train, barge, ship loading facility depending on the refinery location.* An estimated one to two truckloads of antimony concentrate would be hauled off site each day. It is assumed that the concentrate, when sold, would be shipped to facilities outside of the U.S. for smelting and refining because there are currently no smelters in the U.S. with capacity for refining the antimony concentrate.

The DEIS acknowledged that releases of antimony concentrate among other toxic chemicals may impact fish (USFS (2020), p. 4.12-40):

> Numerous studies have shown how exposure to toxic contaminants in surface waters can impact fish olfaction which is used in mating, locating prey, and avoiding predators (Tierney et al. 2010).

but the same point was not included in the SDEIS. Both the DEIS and the SDEIS noted that "Antimony does not have a specified NMFS or USFWS standard and is based on EPA's human health chronic criterion for consumption of water and organisms is 0.0056 mg/L" (USFS 2020, 2022).

## Questions that remain about the reagent quantities, truckloads, and storage

How does the storage capacity at mine compare to the usage needs in the event driving may be hazardous/delayed over winter months; how does that compare to storage capacity at SGLF?

Will HazMats get consolidated on trucks if they arrive to the SGLF in small enough quantities?

What are the chances of HazMat spills of multiple substances either due to consolidation of multiple reagents in a single truck or due to multiple vehicle accidents if there are convoys of trucks loaded with a variety of hazardous materials following pilot vehicles?

## Total mine related traffic

Using the more detailed list of annual trips needed for each reagent gave a more complete picture of the number of heavy vehicles that would travel to the mine site. Table 17 is more detailed version of Table 9 in which hazardous materials are a combined total of fuel and miscellaneous supplies, ore processing supplies, water treatment chemicals, and ore concentrate haulage. Based on Table 17, at least 65.5% of mine traffic on the selected route would be heavy vehicles, with the percentage increasing is there are two loads of ore concentrate each day rather than one. Based on the expected number heavy vehicles and the number of trips required to bring hazardous materials into and out of the mine site in the SDEIS, at least 57.7% of heavy vehicles on the transportation corridor described in the SDEIS would be for bringing hazardous materials to or from the mine site. (Such vehicles would likely only be carrying hazardous materials on one leg of a round trip.)

*Table 17. Heavy vehicles vs. light vehicles during mine operations using HazMat trips from Table 2.3-6 and other traffic from Tables 2.3-7 and 2.4-3 (USFS 2020) and Perpetua (2021). This assumes 365 trips with antimony ore concentrate each year.*

| | DEIS Alternative 2 | SDEIS |
|---|---|---|
| *Light vehicles* | | |
| Crew personal vehicles | 651 | 652 |
| Salaried employees | 417 | 417 |
| Pilot vehicle (fuel and hazardous materials) | 522 | 522 |
| Equipment and supply representatives | 522 | 522 |
| Miscellaneous traffic | 1,044 | 1,044 |
| Total annual light vehicles (% of total) | 3,156 (30.5%) | 3,157 (34.5%) |
| | | |
| *Heavy vehicles* | | |
| Hazardous materials, incl. ore concentrate* | 4,653 | 3,456 |
| Crew bus/van transport to site | 287 | 287 |
| Salaried employees bus/van transport to site | 104 | 104 |
| Machine parts and consumables | 730 | 730 |
| Food delivery | 522 | 522 |
| Trash and recyclables | 156 | 156 |
| Road maintenance | 730 | 730 |
| Total annual heavy vehicles (% of total) | 7,182 (69.5%) | 5,985 (65.5%) |
| | | |
| Total annual vehicles | 10,338 | 9,142 |

**655 loads of fuel and miscellaneous supplies, 2,436 loads of ore processing supplies, and 365 loads of ore concentrate haulage for the SDEIS.*

The general descriptions of waste management in the DEIS and the SDEIS are fundamentally identical.

USFS 2022, p. 3-96:

> Perpetua has developed a solid waste management plan to assist with the storage, handling, and disposal of solid, special, and hazardous waste streams (HDR 2017d). This plan was developed in accordance with state and federal regulations pertinent to waste, although the existing exploration activities are currently considered a Very Small Quantity Generator under RCRA (40 CFR262.14). The solid waste management plan establishes procedures to identify hazardous waste and provides protocols to track, collect, and dispose of hazardous materials in accordance with state and federal regulations. The plan also outlines methods to minimize the generation of hazardous waste (e.g., using industrial soaps in place of solvents wherever possible).

## Hazardous waste

There are further details in the fourth chapter of the SDEIS (USFS 2022, p. 4-130; italicized text is subject to analysis below).

> Hazardous Waste Management
>
> *Material the meets the classification of hazardous waste would be collected and stored* according to Idaho regulations implementing federal RCRA regulations on hazardous waste management. *Such wastes would be accumulated in approved containers at designated collection locations in the facilities. These containers would be transferred to a 90-day storage site at the facilities prior to shipping to an offsite, permitted hazardous waste disposal facility.*
>
> The handling of hazardous waste, from generation through off-site disposal, would be done in concert with written procedures to comply with all applicable parts of the Idaho hazardous waste regulations. This would include written contingency plans identifying response and notifications actions in the event of a spill of hazardous waste at the SGP. *The largest quantity of hazardous waste routinely produced by gold mines is laboratory assay wastes containing lead*. These materials are solids like slag, cupels, crucibles, and the like. These wastes are contained in steel bins that are sealed at the mine site before being shipped off site to permitted hazardous waste disposal facilities. In the unlikely event of a spill of these materials the spilled material could be readily recovered with mechanical means appropriate to the spill event placing the material and any contaminated soil in a suitable container by a person equipped with appropriate personal protection equipment. The recovered material would be replaced into the accumulation bins.
>
> *Autoclave refractory liner bricks are typically non-hazardous when new. They can become contaminated with metals during use at mine sites such that they must be handled as hazardous wastes when removed during maintenance relining of an autoclave*. This would be determined at the SGP through operational experience during maintenance activities when the autoclave liner was rebuilt. Spent refractory material would be properly managed and disposed based on its characteristics when the waste was generated.
>
> *Smaller quantities of hazardous waste typically consist of waste maintenance materials such as solvents, paints, batteries, lamps, and electrical equipment. These materials would be accumulated in steel drums positioned near the points of generation of these materials. Any drums of liquid hazardous waste would be placed in secondary containment. Any spills would immediately be contained and remediated according to the site contingency plans*.

Several details from the description above raise further questions.

1. *Material the meets the classification of hazardous waste would be collected and stored… Such wastes would be accumulated in approved containers at designated collection locations in the facilities. These containers would be transferred to a 90-day storage site at the facilities prior to shipping to an offsite, permitted hazardous waste disposal facility.*

This is vague and qualitative. Further specific description of the amounts and types of the anticipated hazardous wastes would be helpful. If three months' worth of wastes need to be stored, what quantity (by volume or weight or both) is that? Do different types of hazardous waste need to be stored separately, and thus require multiple locations?

2. *The largest quantity of hazardous waste routinely produced by gold mines is laboratory assay wastes containing lead*.

This begs the question of comparing how much waste would be associated with the extraction of <4.2 million ounces of gold (as dore) compared to <115 million pounds of antimony ( as a component of antimony concentrate)?

3. *Autoclave refractory liner bricks are typically non-hazardous when new. They can become contaminated with metals during use at mine sites such that they must be handled as hazardous wastes when removed during maintenance relining of an autoclave*.

How frequent is autoclave maintenance? How big is the autoclave? What quantities of liner bricks would be expected annually or over the course of mine operations? The liner bricks are not the only source of hazardous waste from the autoclave and oxygen plant (USFS 2022, p. 2-51):

> The autoclave system would be housed in a steel frame building set on concrete foundations, with interior curbing to provide secondary containment. Air emissions from the pressure oxidation facility would be captured in a series of air pollution controls, and the material collected would be disposed of as a solid waste or a hazardous waste depending on the waste characterization.

*4. Smaller quantities of hazardous waste typically consist of waste maintenance materials such as solvents, paints, batteries, lamps, and electrical equipment. These materials would be accumulated in steel drums positioned near the points of generation of these materials. Any drums of liquid hazardous waste would be placed in secondary containment. Any spills would immediately be contained and remediated according to the site contingency plans.*

Are there specific chemicals (not listed as reagents) for the mine process that would be on hand in case of spills? If so, how would they be stored and in what quantities? Does cleaning up spills create a form of hazardous waste? Does that depend on the spill size, source, substance, and location?

Perpetua 2021 (ModPRO2), p. 3-65

> 3.12.6 Hazardous Waste Handling
>
> This represents no change to hazardous waste handling from what is detailed in the DEIS for Alternatives 1 through 4.
>
> Material that meets the classification of a "hazardous waste" will be collected and stored, per the project Waste Management Plan at specially designed and operated secured satellite collection sites and a main storage site prior to shipment to a Resource Conservation and Recovery Act certified hazardous waste disposal facility.

**USFS 2022**, p. 2-52 (***Gold and Silver Leaching and Carbon Adsorption)***

> The acid solution used during carbon stripping would be reused until it loses its effectiveness. The solution would be neutralized and sent to the tailings thickener for pumping to the TSF. Air emissions from the leaching facility would be captured in a series of air pollution controls, and the material collected would be disposed of as a solid waste or a hazardous waste depending on characterization of the waste.

**USFS 2022, p. 4-132**

> Mercury and Mercury Containing Materials
>
> In the gold and silver leaching process, small amounts of mercury would also be dissolved from the ore and follow the gold and silver through the rest of the process. During the carbon stripping process, a small amount of mercury may not desorb from the activated carbon. This residual mercury would volatilize in the carbon reactivation kiln

> and be controlled with a venturi scrubber and sulfur-impregnated carbon columns in the kiln off-gas stream. Solid waste from this process (i.e., the carbon canisters and filter packs) would be disposed offsite in a permitted solid waste or hazardous waste disposal facility depending on the mercury characteristics of the wastes.

Perpetua 2021 (ModPRO2), p. 3-64

> 3.12.5 Solid Waste
>
> Solid waste management for the ModPRO2 differs from all preceding DEIS alternatives in that no on-site landfill will be constructed or maintained.
>
> All municipal waste and construction and demolition waste generated at the SGP will be hauled off-site for disposal; a landfill will not be constructed or maintained at the SGP. Concrete foundations would be broken or fractured as required to prevent excessive water retention and covered in-place with a minimum of 2 feet of a combination of 1.5 feet of backfill and 0.5 feet of growth media or would be broken up and buried in the TSF Buttress or pit backfill prior to installation of a geomembrane barrier cover. Solid waste from the worker housing facility, shops, and other work areas that cannot be composted or recycled would be collected in wildlife-resistant receptacles and hauled off-site for disposal in a municipal waste landfill.

## Petroleum-contaminated soil landfarm

The DEIS had proposed to have a landfarm for treating petroleum contaminated soil (USFS 2020), but that is not a part of the plan in the SDEIS (Perpetua 2021). Given that the landfarm was initially proposed as a 2-3 acre area, how much petroleum-contaminated soil would that have been effective at treating? The proposed use of petroleum products has not changed from the DEIS to the SDEIS, so whatever quantity was anticipated to be addressed at the landfarm in the DEIS could reasonably be expected to still be part of the environmental impacts that would be part of the SGP in the SDEIS.

USFS 2020, p. 2-55

> On-site Landfarm
>
> A landfarm (i.e., a biological waste treatment process for treating hydrocarbon contaminated soils via spreading and tilling/aerating) would be maintained on approximately 2 to 3 acres of private land. The landfarm and materials to be added would be sampled, characterized, constructed, operated, and monitored in accordance with all applicable local, state, and federal regulatory requirements.

USFS 2020 p. 7-21

> **Landfarm** – Landfarming is a biological waste treatment process wherein contaminated soils or sediments are spread and incorporated into the upper soil zone and periodically tilled to aerate the mixture, using equipment typically seen in agriculture. In this way, natural microbial action breaks down contaminants, particularly hydrocarbons.

Perpetua 2021 (ModPRO2), p. 3-64

> 3.12.4 Landfarm
>
> A landfarm (i.e., a biological waste treatment process for treating hydrocarbon contaminated soils via spreading and tilling/aerating) will not be constructed or maintained on site. This represents a change to what is described in the DEIS for Alternatives 1 through 4.

Perpetua 2021 (ModPRO2), p. 3-64

> 3.12.1 Recycling
>
> All applicable waste materials that may be recycled, to the extent practical, or disposed of in accordance with applicable regulations. Some of the wastes anticipated to be generated

at the mine site include municipal waste, fluorescent bulbs, batteries, empty aerosol containers, and hazardous wastes, which would be managed in accordance with the appropriate regulatory standards.

Used petroleum products would be stored on site in approved containers. Used petroleum products would be transported off site for recycling or disposal in an approved facility.

Other legacy materials may be encountered during construction and operations. If encountered, these materials would be characterized to determine potential for reprocessing, reuse, or off-site disposal.

## Other infrastructure: autoclave and oxygen plant

Two other components of mine infrastructure are the autoclave and oxygen plant. Spills and hazards associated with the autoclave and oxygen plant are not addressed in the SDEIS, although it is clear that both are part of the mine infrastructure (even if the oxygen plant is "over the fence").

USFS 2022, p. 2-51

> An autoclave system would be used to oxidize the sulfide minerals comprising the gold and silver concentrate to liberate the gold and silver for subsequent leaching. Before the gold concentrate is pumped into the autoclave, it would be mixed with appropriate amounts of ground limestone to maintain a constant free acid level of approximately 10 grams per liter in the autoclave. This value was established through bench and pilot-scale metallurgical testing to promote the formation of stable, crystalline arsenic compounds in the autoclave. Oxygen would be injected into the autoclave to promote the oxidation reaction, and the temperature in the autoclave would be maintained at approximately 220 degrees Celsius. Water would be injected into the autoclave as needed to control the temperature. After pressure oxidation, the acidic slurry containing gold and silver would be neutralized using slurried lime and other chemicals and cooled in two forced draft cooling towers. The neutralized slurry would then be sent to the leach circuit for recovery of gold and silver from the slurry.
>
> When increasing arsenic levels are observed, the oxidized slurry would be treated with hot arsenic cure (HAC) prior to neutralization. Metallurgical tests showed that this process promotes formation of the stable crystalline form of the arsenic precipitate enhancing environmental stability of arsenic.
>
> The autoclave system would be housed in a steel frame building set on concrete foundations, with interior curbing to provide secondary containment. Air emissions from the pressure oxidation facility would be captured in a series of air pollution controls, and the material collected would be disposed of as a solid waste or a hazardous waste depending on the waste characterization.

M3 2021 Feasibility report, p. 1-17

> **Oxygen Plant** – An oxygen plant producing 607 t/d of gas at 95 percent oxygen and a gauge pressure of 40 bars is planned. The oxygen would be from a vendor-owned oxygen plant located near the autoclave building providing the autoclave with an "over the fence" supply.

M3 2021 Feasibility report, p. 17-19

> The oxygen plant would be vendor supplied and vendor operated. Appropriate operating characteristics and alarms would be transmitted to the mill control room through the Ethernet.

M3 2021 Feasibility report, p. 18-1

> Existing infrastructure relevant to the development and operation of the Stibnite Gold Project was presented in Section 5. This section summarizes the infrastructure upgrades and infrastructure additions that would be required to support the mining and mineral processing activities that were discussed in Sections 16 and 17, respectively. The Project infrastructure needs that are discussed in this section include:
>
> …
>
> Onsite Infrastructure – systems, facilities, and structures contributing to the entire operation including truck shop, oxygen plant, limestone crushing, lime calcining, freshwater system, reclaim and process water system, and water treatment plant for treating excess water to discharge standards.

M3 2021 Feasibility report, p. 18-6

> The 138-kV line would be routed to the Project site's main electrical substation where transformers would step the voltage down to the distribution voltage of 34.5 kV. The main substations would have redundant dual 138 to 34.5 kV transformers to prevent loss of power due to failure. The current Project design entails oxygen being supplied by a third party through a Sale-of-Gas (**SOG**) contract; therefore, a metered 34.5 kV line would be provided for the operator of the oxygen plant.

M3 2021 Feasibility report, p. 18-18

> ONSITE INFRASTRUCTURE
>
> Infrastructure in the plant area includes a network of roads, power distribution, surface water diversions, and water pipelines. The contributing processes of oxygen supply, limestone crushing, lime calcining, truck servicing, and water treatment for discharge are also included as infrastructure. The roads that provide access to plant buildings and facilities connect to the access road before it reaches the haul road, facilitating deliveries of equipment, materials, and supplies without conflict with mine traffic. The main roads parallel the EFSFSR and have gentle grades, contributing to safety, even in winter months. Power distribution through most of the site is underground in duct banks or above ground in cable trays, contributing to safety and reduction of conflict with mobile cranes used for maintenance. Powerlines enter the site from the west side into the Main Substation and distributed underground to the Oxygen Plant substation and throughout the process area. Overhead power lines distribute power to the north and south of the plant area for water management, truck maintenance, and water reclamation from the TSF. Water from supply wells in the Meadow Creek valley is directed to a collection tank and pumped to the fresh/fire water tank, which is located along the access road at an elevation of approximately 6,800 feet amsl to provide make-up water and water for fire

> suppression by gravity. The pipelines to and from the fresh/fire water tank, as well as yard piping in the plant area, are buried to protect the lines from freezing.
>
> …
>
> 18.7.1 Oxygen Supply
>
> A cryogenic air separation unit (ASU) is planned to provide the supply of oxygen required in the pressure oxidation process (Figure 18-8). The plant would be supplied and managed by an oxygen supply vendor in an "over-the-fence" agreement. Site grading, concrete, and construction support would be provided by the EPCM contractors. Oxygen would be piped directly from the oxygen plant to the autoclave building. The oxygen plant would have its own electrical power substation adjacent to the plant.

M3 2021 Feasibility report, p. 21-2

> The oxygen plant is accounted for as an "over-the-fence" supply contract. Capital costs have been included for building a dedicated substation for the oxygen plant. Midas Gold will supply power and other utilities to the oxygen plant during operations as well as provide beds at the operations camp for its workers.

## Summary

More than 50 different hazardous materials will be brought to and from the mine site if the SGP is approved. Those hazardous materials include fuels, explosives, acids, and toxic materials, but the dangers posed by the reagents are not discussed. Under ModPRO2 (Perpetua 2021), more than 9.4 million gallons of bulk liquid hazardous materials in at least 1,300 truckloads and more than 46,000 tons of bulk solid hazardous materials in at least 1,650 truckloads will be moved along the transportation corridor annually. Spills from SPCC facilities may be twice as likely as spills from vehicles (Etkin 2006); the SGP SDEIS did not discuss the possibility of spills from storage facilities other than to assume that secondary containment would be SPCC plans would be sufficient.

## 5. Potential transportation corridor endpoints

Cascade, Idaho is not currently a hub for the manufacturing, storage, or distribution of many industrial reagents used in mining. Therefore, although the analysis area for hazardous materials only includes the mine site and haul roads on it, the SGLF, access roads from Cascade to the mine site, and associated streams that might be impacted, the USFS (2020, p. 4.7-4) notes that "national highways would be used to transport materials to the SGP area as far as Cascade, Idaho." There was no attempt in the DEIS or SDEIS to characterize points of origin for the reagents that will be needed or destinations for the mine products, either those for sale or waste materials.

The goal of this section is to find the nearest distribution point for each of the reagents and supplies listed in Section 4 to determine minimum exposures for the number of truck-miles that hazardous materials will be transported for the SGP. In a simple analysis of spill probability that does not assign different spill likelihoods to different route segments, shorter route distances lead to lower spill frequencies. Estimates of spill risk based on the sources and destinations closest to Cascade, Idaho will underestimate the actual risk to the extent that the distances used in the model underestimate the actual distance hazardous materials are transported.

Transportation Research Board (2005)

> According to the U.S. Department of Commerce's Commodity Flow Survey, more than 14,000 establishments in the country are engaged in the manufacture of hazardous materials (Census Bureau 2003; RSPA 2003). DOT estimates that about 45,000 firms regularly ship significant quantities of hazardous materials and that another 30,000 are occasional shippers (RSPA 2003). These estimates do not take into account the multiple business locations of many shippers, which can result in many more shipping points. Shippers of large quantities of hazardous materials include oil refiners chemical manufacturers, and gasoline distributors. … Between the time a hazardous materials shipment leaves its place of origin and arrives at its final destination, it may pass through several modes of transportation and transfer point.

Erkut et al. (2007)

> Hazmat transport incidents can occur at the origin or destination (when loading and unloading) or *en-route*. Incidents involving hazmat cargo can lead to severe consequences characterized by fatalities, injuries, evacuation, property damage, environmental degradation, and traffic disruption. In 2003, there were 488 serious

> incidents (among a total of 15,178 incidents) resulting in 15 deaths, 17 major and 18 minor injuries, and a total property damage of $37.75 million (US DOT, 2004c). About 90% of hazmat incidents occur on highways. As far as causes go, human error seems to be the single greatest factor (see Figure 2) in all hazardous materials incidents (minor and serious incidents).

I searched for the chemical reagents listed in Table 14 on

https://www.thomasnet.com/products/mining-chemicals-13860325-1.html#register

to find the suppliers who sold them in the quantities needed for industrial uses within specified radii of Cascade, Idaho (ZIP code 83611). The radius distance choices I checked were <100 miles, <250 miles, <500 miles, and <1,000 miles. The distance categories were inclusive, so the number of distributors inside the 100-mile radius was part of the total number of suppliers in each of the larger radii (Table 18). I used Google maps to find the distance between a distributor in the shortest radius category and Cascade, Idaho. These are example distances; the actual supply chain sourcing used by the Applicant may vary from this (and over time) if the permit is approved.

Table 18 does not include mine reagents and supplies that were listed generically (solvents, lubricants, flocculent, fertilizers, explosives, herbicides, and pesticides/herbicides), grinding and crushing materials, hazardous materials being transported from the mine during operations (e.g., antimony concentrate, wastes containing mercury), or AP 3477 or Aerophine 3418A. Later modeling will use Boise, Idaho as the assumed distribution point for these substances as a reasonable general minimum distance from Cascade, Idaho for computing the total miles hazardous materials travel. (See Sections 7 and 10.)

Based on the example distributor locations in Table 18, I looked at the expected proportions of hazardous materials that would travel north or south on SH-55 to Cascade, Idaho (Table 19). The assumption in the DEIS is that "[a]pproximately two-thirds of all mine-related traffic would originate south of Warm Lake Road and would use State Highway 55 through Cascade and other communities along State Highway 55 south of Cascade including Banks and Horseshoe Bend. Approximately one-third of all mine-related traffic originating north of Warm Lake Road would use State Highway 55 through the communities of Donnelly, Lake Fork, and McCall" (USFS 2020, p. 2-63). It was not possible to determine exactly how many hazardous materials trips would be using SH-55 north or south of Cascade because the distribution points shown are example origins or destinations, some distribution points west of Cascade could travel north or south on SH-55 depending on the route chosen (US-95 through Weiser, Idaho and I-84 though Ontario, Idaho have similar distances and travel times), and I was unable to determine sources for several reagents and supplies. Under Alternative 1, if lime is sourced from a distributor in Greenacres, Washington at least 55.9% of hazardous materials traffic will travel on SH-55 north of Cascade, Idaho (Table 19). The reduction of lime transportation in Alternative 2 drops that to 37.7%, even if propane's distribution point is north of Cascade. Under Alternative 1, a minimum of 15.4% to a maximum of 45.1% of hazardous materials would travel on SH-55 south of Cascade, well less than the approximately two-thirds stated for mine traffic overall. Under Alternative 2, a minimum of 21.9% to a maximum of 62.3% of hazardous materials would travel on SH-55 south of Cascade; the maximum value nears the approximately two-thirds fraction stated in the DEIS for all mine traffic.

*Table 18. Hazardous materials to be transported to the proposed SGP Project during operations. Supplier list, distance ranges, and locations from Thomasnet.com, accessed September 21, 2020, and December 8, 2022. Distance from location listed to Cascade, Idaho 83611 from Google maps.*

| Common name | Number of commercial suppliers listed within *x* miles of 83611 (Cascade, Idaho) | | | | Potential nearest distributor location | Distance to nearest distributor from 83611 (miles) |
|---|---|---|---|---|---|---|
| | 100 | 250 | 500 | 1,000 | | |
| *Bulk liquids* | | | | | | |
| Diesel fuel | 0 | 4 | 43 | 115 | Baker City, OR | 176 |
| Propane | 3 | 12 | 58 | 128 | McCall, ID | 31 |
| Gasoline | 2 | 18 | 111 | 279 | Caldwell, ID | 90 |
| Magnesium chloride | 0 | 0 | 7 | 15 | Richland, WA | 326 |
| Nitric acid | 1 | 2 | 5 | 14 | Boise, ID | 79 |
| Ferric sulfate | 0 | 0 | 1 | 3 | Renton, WA | 499 |
| Sulfuric acid | 1 | 1 | 6 | 15 | Boise, ID | 79 |
| Methyl isobutyl carbonyl (MIBK) | 0 | 0 | 1 | 2 | Seattle, WA | 500 |
| Antifreeze | 0 | 0 | 5 | 11 | Salt Lake City, UT | 420 |
| Hydrogen peroxide | 1 | 2 | 14 | 44 | Boise, ID | 79 |
| Sodium hypochlorite | 0 | 0 | 5 | 12 | Portland, OR | 479 |
| Scale control reagents | 0 | 0 | 0 | 4 | Fortuna, CA | 724 |
| Carbon dioxide | 2 | 4 | 12 | 20 | Boise, ID | 79 |
| *Bulk solids and containers* | | | | | | |
| Lime | 0 | 0 | 7 | 10 | Greenacres, WA | 298 |
| Sodium metabisulfite | 0 | 0 | 2 | 7 | Seattle, WA | 500 |
| Ammonium nitrate | 0 | 0 | 0 | 6 | Suisin City, CA | 665 |
| Sodium cyanide | 0 | 0 | 2 | 5 | Winnemucca, NV | 326 |
| Copper sulfate | 0 | 0 | 5 | 13 | Salt Lake City, UT | 420 |
| Potassium amyl xanthate | 0 | 0 | 0 | 2 | Gardena, CA | 923 |
| Lead nitrate | 0 | 0 | 0 | 1 | Gardena, CA | 923 |
| Activated carbon | 0 | 0 | 29 | 70 | Yakima, WA | 401 |
| Sodium carbonate | 0 | 0 | 7 | 15 | Renton, WA | 499 |
| Sodium hydroxide | 0 | 0 | 6 | 17 | Renton, WA | 499 |

*Lubricants, Aerophine 3418A, AP 3477, solvents, organic sulfide, grinding metals, crusher and grinding liners, flocculant, explosives, sodium bisulfite, microsand, fertilizer, herbicides, pesticides/insecticides would also be brought to the mine site. Antimony concentrate, waste oil, waste spent solvents, wastes from mill liners and crusher liners, wastes containing mercury, and water treatment plant sludges and wastes would be transported away from the mine site.*

*Table 19. Percentage breakdown of hazardous material travel on SH-55 north and south of Cascade, Idaho using potential nearest distributor locations from Table 18.*

| Origin/destination city | Substance | Number of annual trips |
|---|---|---|
| *Origin/destination cities with trucks traveling north to/south from Cascade, Idaho* | | |
| Boise, Idaho | hydrogen peroxide | 2 |
| Boise, Idaho | sulfuric acid | 5 |
| Boise, Idaho | nitric acid | 22 |
| Boise, Idaho | carbon dioxide | 5 |
| Caldwell, Idaho | gasoline | 100 |
| Fortuna, California | scale control reagents | 5 |
| Gardena, California | lead nitrate | 37 |
| Gardena, California | potassium amyl xanthate | 68 |
| Salt Lake City, Utah | antifreeze | 13 |
| Salt Lake City, Utah | copper sulfate | 57 |
| Suisin, California | ammonium nitrate | 304 |
| Winnemucca, NV | sodium cyanide | 167 |
| Total trips (% of 3,337 HazMat truck trips) | | 785 (23.5%) |
| *Origin/destination cities with trucks traveling south to/north from Cascade, Idaho* | | |
| Greenacres, Washington | lime | 7 |
| McCall, Idaho | propane | 226 |
| Renton, Washington | ferric sulfate | 17 |
| Renton, Washington | sodium carbonate | 18 |
| Renton, Washington | sodium hydroxide | 15 |
| Seattle, Washington | methyl isobutyl carbonyl (MIBK) | 40 |
| Seattle, Washington | sodium metabisulfite | 91 |
| Total trips (% of 3,337 HazMat truck trips) | | 414 (12.4%) |
| *Origin/destination cities with trucks traveling either north or south to/from Cascade, Idaho* | | |
| Baker City, Oregon | diesel | 580 |
| Portland, Oregon | sodium hypochlorite | 2 |
| Richland, Washington | magnesium chloride | 56 |
| Yakima, Washington | activated carbon | 23 |
| Total trips (% of 3,337 HazMat truck trips) | | 661 (19.8%) |

*Table 19. (Cont'd.)*

| Origin/destination city | Substance | Number of annual trips |
|---|---|---|
| *Origin/destination city assumed to be Boise, Idaho for exposure miles modeling* | | |
| | fertilizer | 1 |
| | herbicide | 1 |
| | pesticide/insecticide | 1 |
| | solvents | 5 |
| | waste spent solvents | 5 |
| | explosives | 20 |
| | flocculent | 14 |
| | Aerophine 3418A | 53 |
| | AP 3477 | 20 |
| | lubricants | 99 |
| | waste oil from lubricants | 49 |
| | organic sulfide | 5 |
| | antifreeze waste | 13 |
| | sodium bisulfite | 1 |
| | polymer | 5 |
| | microsand | 1 |
| | antimony concentrate | 730 |
| | crusher and grinding liners | 105 |
| | grinding metals | 337 |
| | waste from mill liners and crushers | 12 |
| Total trips (% of 3,337 HazMat truck trips) | | 1,477 (44.3%) |

## Summary

I was able to find potential distributor locations nearest to Cascade, Idaho for 23 supplies that would be used at SGP. Only six supplies (propane, gasoline, nitric acid, sulfuric acid, hydrogen peroxide, and liquid carbon dioxide) were explicitly available within 100 miles of Cascade, Idaho in the quantities needed for industrial uses. Diesel fuel was available inside a 250-mile radius. The remaining reagents I was able to find distributors for were only available from cities that were up to 500 or 1,000 miles away. Supplies would travel on SH-55 both north and south of Cascade. The percentage of heavy vehicles carrying hazardous materials on SH-55 north or south of Cascade depends on how accurate the assignment of Boise, Idaho is as the source/destination city to estimate the travel direction for all the materials that I was unable to find distribution points for.

## 6. Transportation corridor lengths and exposure

In this section I calculate exposure variables (e.g. number of truck-miles per year and for the project lifetime) based on supply endpoints and quantities to be moved. First, I compared the lengths of routes from Cascade, Idaho to the proposed mine site. The distances shown are from Table 3.16-1: Existing Primary Roads in the Analysis Area (USFS 202, pp. 3-409 to 3-411). Roads in *italics* are categorized in the Forest Service Handbook as maintenance level 3 or lower. (Higher ratings indicate roads designed more for passenger vehicles use and comfort.)

Johnson Creek Route (formerly known as the Yellow Pine Route)

To State Highway 55, just north of Cascade, Idaho

| | |
|---|---|
| Warm Lake Road (county road 10-579) | 34 miles |
| Johnson Creek Road (county road 10-413) to Yellow Pine | 25 miles |
| McCall-Stibnite Road (county road 50-412) to the mine site | 14 miles |
| Total distance | distance to Cascade + 73 miles |

Burntlog Route

To State Highway 55, just north of Cascade, Idaho

| | |
|---|---|
| Warm Lake Road (county road 10-579) | 34 miles |
| *Burntlog Road (existing)* | *20 miles* |
| Burntlog Road (proposed new construction, joining to Thunder Mountain Road) | 15 miles |
| Total distance | distance to Cascade + 69 Miles |

These lengths are similar to the length to those reported in USFS (2022), p. 2-155:

ModPRO2: Johnson Creek Route = 70 miles; Burntlog Route = 71 miles.
Johnson Creek Route = 70 miles

For simplicity, I used 70 miles as the approximate length of the road corridor from SH 55 in Cascade to the mine site for all Alternatives. I combined that 70-mile segment with the distances in Table 18 from the distribution point locations to Cascade and the number of expected truck trips per year for each substance to calculate the minimum number of truck-miles for vehicles carrying hazardous materials for the SH-55 to mine site and for the example full transportation corridor (Table 20).

*Table 20. Total annual truck-mile exposures for mine supplies and other hazardous materials based on nearest sourcing points and number of annual trips. Total distance to mine site adds 70 miles from Cascade to the mine site.*

| Material | Distance to Cascade, Idaho | Total distance to mine site | Number of annual trips | Miles per year to Cascade, Idaho | Miles per year to SGP mine site |
|---|---|---|---|---|---|
| *Bulk liquids* | | | | | |
| Diesel | 176 | 246 | 580 | 102,080 | 142,680 |
| Propane | 31 | 101 | 226 | 7,006 | 22,826 |
| Gasoline | 90 | 160 | 100 | 9,000 | 16,000 |
| Magnesium chloride | 326 | 396 | 56 | 18,256 | 22,176 |
| Nitric acid | 79 | 149 | 22 | 1,738 | 3,278 |
| Ferric sulfate | 499 | 569 | 17 | 8,483 | 9,673 |
| Sulfuric acid | 79 | 149 | 5 | 395 | 745 |
| Methyl isobutyl carbonyl | 500 | 570 | 40 | 20,000 | 22,800 |
| Antifreeze | 420 | 490 | 13 | 5,460 | 6,370 |
| Hydrogen peroxide | 79 | 149 | 2 | 158 | 298 |
| Sodium hypochlorite | 479 | 549 | 2 | 958 | 1,098 |
| Scale control reagents | 724 | 794 | 5 | 3,620 | 3,970 |
| Carbon dioxide | 79 | 149 | 5 | 395 | 745 |
| Total miles per year by bulk liquids from known distributor locations | | | | 177,549 | 252,659 |
| | | | | | |
| *Bulk solids* | | | | | |
| Lime | 298 | 368 | 7 | 2,086 | 2,576 |
| Sodium metabisulfite | 500 | 570 | 91 | 45,500 | 51,870 |
| Ammonium nitrate | 665 | 735 | 304 | 202,160 | 223,440 |
| Sodium cyanide | 326 | 396 | 167 | 54,442 | 66,132 |
| Copper sulfate | 420 | 490 | 57 | 23,940 | 27,930 |
| Potassium amyl xanthate | 923 | 993 | 68 | 62,764 | 67,524 |
| Lead nitrate | 923 | 993 | 37 | 34,151 | 36,741 |
| Activated carbon | 401 | 471 | 23 | 9,223 | 10,833 |
| Sodium carbonate | 499 | 569 | 18 | 8,982 | 10,242 |
| Sodium hydroxide | 499 | 569 | 15 | 7,485 | 8,535 |
| Total miles per year by bulk solids from known distributor locations | | | | 450,733 | 505,823 |

*Table 20. (Cont'd.)*

| Material | Distance to Cascade, Idaho | Total distance to mine site | Number of annual trips | Miles per year to Cascade, Idaho | Miles per year to SGP mine site |
|---|---|---|---|---|---|
| *Other materials transported to and from the mine site – assume Boise, Idaho as source/destination* | | | | | |
| Lubricants | 79 | 149 | 99 | 7,821 | 14,751 |
| Waste oil (50% of lubricants) | 79 | 149 | 49 | 3,871 | 7,301 |
| Aerophine 3418A | 79 | 149 | 53 | 4,187 | 7,897 |
| AP 3477 | 79 | 149 | 20 | 1,580 | 2,980 |
| Solvents | 79 | 149 | 5 | 395 | 745 |
| Waste spent solvents | 79 | 149 | 5 | 395 | 745 |
| Polymer | 79 | 149 | 5 | 395 | 745 |
| Organic sulfide | 79 | 149 | 5 | 395 | 745 |
| Sodium bisulfite | 79 | 149 | 1 | 79 | 149 |
| Waste antifreeze | 79 | 149 | 13 | 1,027 | 1,937 |
| Grinding metals | 79 | 149 | 337 | 26,623 | 50,213 |
| Crusher and grinding liners | 79 | 149 | 105 | 8,295 | 15,645 |
| Waste from mill liners and crusher liners | 79 | 149 | 12 | 948 | 1,788 |
| Flocculent | 79 | 149 | 14 | 1,106 | 2,086 |
| Explosives | 79 | 149 | 20 | 1,580 | 2,980 |
| Fertilizer | 79 | 149 | 1 | 79 | 149 |
| Herbicides | 79 | 149 | 1 | 79 | 149 |
| Pesticides/insecticides | 79 | 149 | 1 | 79 | 149 |
| Microsand | 79 | 149 | 1 | 79 | 149 |
| Antimony concentrate | 79 | 149 | 730 | 59,250 | 111,750 |
| Total miles per year estimated for materials with unknown endpoints | | | | 116,683 | 220,073 |
| | | | | | |
| Total of estimated annual truck-miles with haz. mat. | | | | 744,965 | 978,555 |

## Summary

Instead of only considering the transportation corridor from SH-55 at Cascade to the mine site, the true measure of the communities and environment at risk will extend to the distribution points of the reagents brought to the mine and the destinations of the ore concentrate and wastes taken from it. The overall exposure will depend on the distances the reagents, products, and wastes need to travel and the number of trips that are necessary for the respective quantities of the hazardous materials. The total estimated miles per year in Table 20 uses an educated approximation of the minimum distances for sourcing the reagents. This set of origin and destination cities is only an example and likely underestimates the total truck-mile exposure per year because both the number of trips and the number of miles to travel used may be lower than the actual values.

## 7. Risk per truck-mile from the Federal Motor Carrier Safety Administration

Spill frequency may be estimated using local, regional or national data, depending on which is most appropriate, reliable, and/or available.

Kazantzi et al. (2011)

> [T]here is a number of papers that have pointed out the uncertainties and pitfalls in assessing accident and release rates as well as characterizing consequential risk incidents because of the significant gap in available data. Harwood et al (1993) described a general procedure in estimating truck accident rates as a function of road and area type (urban/rural) from state data on highway geometrics, traffic volume, and accidents. Release probabilities in accidents were also derived by using combined federal and state truck accident data. However, the study also underlined some issues in combining data from different states, where estimates relate to different local factors that may need to be used as parameters in this kind of models.

Calculating the probability of a hazardous material spill requires knowing the number of trips, the trip lengths to find the exposure a specific project or route entails, and the risk of a spill over a given road length based on previously collected data. The first two of these are described in Sections 4, 5, and 6 of this report. The SGP DEIS and SDEIS (USFS 2020, 2022) characterized the third, the rate of hazardous materials spills per truck-mile, as very low.

First, Perpetua tried to hold up their current track record on the mine access roads as an indication that spills will not be an issue in the future. The SDEIS reported that in 288 trips with fuel tankers carrying 4,000 to 4,500 gallons in the last 11 years, there have been no spills (SDEIS, p. 3-99):

> Fuels are transported to the site via tanker truck; the transportation of these fluids presents the greatest existing risk for spills and releases to the environment. Exploration-related fuel transportation to the site by Perpetua has been occurring since 2011 and, through 2021, has consisted of deliveries by 288 fuel tankers, each with a capacity between 4,000 and 4,500 gallons. This work was performed under the fuel transportation Standard Operating Procedure protocol ESOP_004 Fuel Transportation (Midas Gold 2022). There have been no reported spills or releases associated with the transport of this fuel.

That 288 trips over the last decade are fewer trips than would be needed to transport hazardous materials into and out of the mine site each month during 15 years of operations.

Second, USFS (2020, 2022) used national spill data about heavy vehicles transporting hazardous materials to estimate a risk rate per truck-mile.

USFS (2022), p. 4-135

> To evaluate the potential impact of the transport of hazardous materials to and from the mine site, the risk of a transportation accident resulting in the release of hazardous materials was estimated. *Accident and incident rates were derived from national statistics for truck accidents that involve hazardous materials as published by the Federal Motor Carrier Safety Administration (2018).* Records show that the number of large trucks (gross vehicle weight of more than 10,000 pounds) on national highways from 2013 to 2016 ranged from over 10.59 million to 11.49 million; with large trucks traveling between 275.01 billion miles to 287.89 billion miles annually. Over that same time frame, large truck crashes involving hazardous materials cargo (with no release) ranged from 2,420 to 2,475, while large truck accidents with release of hazardous materials cargo ranged from 385 to 552. *The statistical rate of large-truck accidents involving hazardous cargo for miles traveled ranged from approximately 1 accident for every 714 million miles traveled in 2013 to approximately 1 accident for every 522 million miles traveled in 2016.* Therefore, statistically, the rate of accidents on the nation's highways involving crashes or spills of hazardous material cargo by large trucks is very low (Federal Motor Carrier Safety Administration 2018).

The risk rates cited in the DEIS (1 spill in 714 million truck-miles in 2013 and 1 spill in 522 million truck-miles in 2016, based on national statistics) are off by two orders of magnitude. In the remainder of this section, I will show that I can recreate the rates cited in the SGP SDEIS from the Federal Motor Carrier Safety Administration (FMCSA) data, why those calculations are incorrect, what the actual spill rates are based on the data, and how those rates compare with other estimates of hazardous spill risk rates.

The *Pocket Guide to Large Truck and Bus Statistics* is published annually by the FMCSA. The data presented in each guide cited here (FMCSA 2014, 2015, 2018, 2020, 2021) cover a four-year time frame, with the most recent twenty-two months in each guide considered preliminary data. I concatenated data from the guides to assess the number of large trucks registered in the United States (Table 1-1 from FMCSA 2014, 2015, 2018, 2020, 2021), the number of vehicle miles traveled by large trucks in the United States (Table 1-2 from FMCSA 2014, 2015, 2018, 2020, 2021), the total number of crashes by vehicle type (Table 4-1 from FMCSA 2014, 2015, 2018, 2020, 2021), fatal crashes by vehicle type (Table 4-2 from FMCSA 2014, 2015, 2018, 2020, 2021), injury crashes (Table 4-3 from FMCSA 2014, 2015, 2018, 2020, 2021), and crashes involving trucks with hazardous material placards, both with and without known releases (Table 4-15 from FMCSA 2014, 2015, 2018, 2020, 2021). Collectively, the data span from 2009-2019, but the data from 2018 and 2019 were considered provisional when the most recent guide (FMCSA 2021) was published. I used the most recently published for each year in Table 21, which may supersede a value from a previous Pocket Guide. For example, FMCSA (2018) lists 522 large truck crashes with known releases in 2016, which is the number cited in the DEIS and SDEIS (USFS 2020, 2022). The most recent guide (FMCSA 2021) had updated that to 553 large truck crashes with releases of hazardous materials in 2016, which is the value shown in Table 21and used in later calculations.

*Table 21. Data extracted from Pocket Guides to Large Truck and Bus Statistics (FMSCA 2014, 2015, 2018, 2020, 2021) for large trucks from 2009-2019. Data cited in USFS (2020, 2022) are in the shaded rows. Column letters are used in Table 22 to show how the rate calculations were performed.*

| Year | Large trucks registered | Millions of vehicle miles traveled by large trucks (VMT) | Crashes | Fatal crashes | Hazardous materials crashes | Hazardous materials crashes with known releases | Hazardous materials crashes with known possible releases |
|---|---|---|---|---|---|---|---|
| | A | B | C | D | E | F | G |
| 2009 | 10,973,610 | 288,306 | 286,000 | 2,983 | 2,462 | 270 | 772 |
| 2010 | 10,770,054 | 286,527 | 266,000 | 3,271 | 2,579 | 279 | 763 |
| 2011 | 10,270,693 | 267,594 | 273,000 | 3,365 | 2,892 | 312 | 881 |
| 2012 | 10,659,380 | 269,207 | 317,000 | 3,464 | 2,775 | 358 | 812 |
| 2013 | 10,597,356 | 275,018 | 327,000 | 3,554 | 3,244 | 385 | 824 |
| 2014 | 10,905,956 | 279,131 | 411,000 | 3,429 | 3,619 | 434 | 1,161 |
| 2015 | 11,203,184 | 279,843 | 415,000 | 3,622 | 3,728 | 483 | 1,064 |
| 2016 | 11,498,561 | 287,895 | 434,000 | 4,177 | 3,577 | 553 | 1,077 |
| 2017 | 12,229,216 | 297,592 | 450,000 | 4,367 | 3,894 | 605 | 1,101 |
| 2018 | 13,233,910 | 304,865 | 499,000 | 4,461 | 4,119 | 664 | 1,165 |
| 2019 | 13,085,643 | 300,051 | 510,000 | 4,479 | 3,690 | 625 | 998 |
| 2009-2019 | | 3,136,029 | 4,188,000 | 41,172 | 36,579 | 4,968 | 10,618 |

Based on the data, I was able to recreate how the DEIS and SDEIS (USFS 2020, 2022) arrived at the estimated rate of hazardous materials crashes (Table 22). USFS (2020, 2022) assumed that the hazardous materials crash rate could be computed by dividing the number of large truck crashes that released hazardous materials by the total large truck vehicle miles traveled in a given year:

$$\mathit{Hazardous\ material\ crash\ rate}\ (\mathit{crashes\ with\ spills\ per\ truck\ mile\ traveled}) = \frac{\mathit{Large\ truck\ crashes\ involving\ hazardous\ material\ releases}}{\mathit{Large\ truck\ miles\ traveled}}$$

which was reported in its inverse form in USFS (2020, 2022) as

$$\begin{aligned}&Hazardous\ material\ crash\ rate\ (truck\ miles\ traveled\ per\ crash\ with\ a\ spill)\\&\quad= \frac{Large\ truck\ miles\ traveled}{Large\ truck\ crashes\ involving\ hazardous\ materials\ releases}\end{aligned}$$

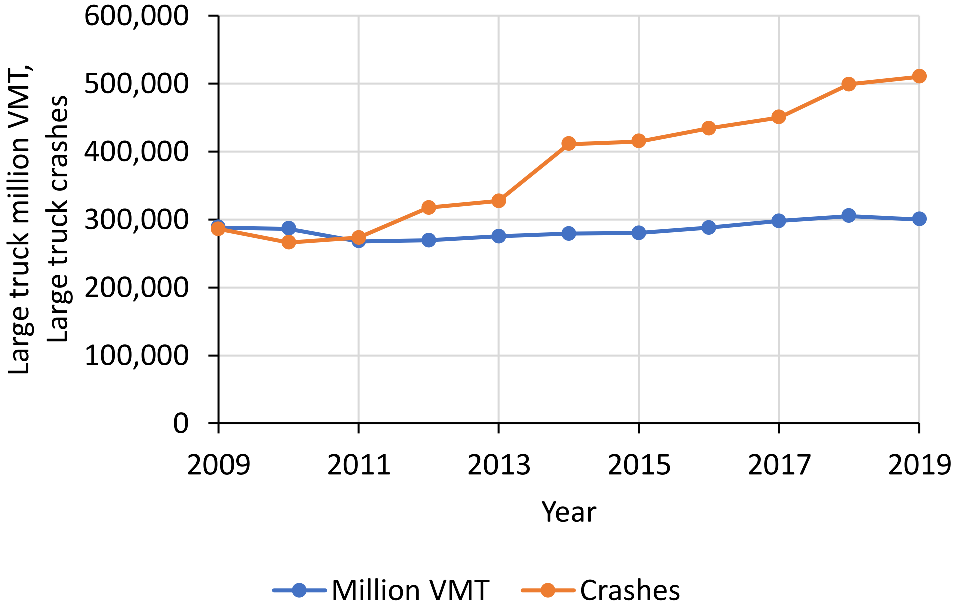
USFS (2020, 2022) calculated that hazardous material spills occurred once every 714 million miles in 2013 and once every 522 million miles in 2016. Inverting those values yields estimated spill rates of $1.4 \times 10^{-9}$ spills per vehicle mile traveled (VMT) in 2013 and $1.91 \times 10^{-9}$ spills per VMT in 2016 (Table 22, shaded columns and rows). The rates cited in USFS (2020, 2022) are incorrect because not all large trucks carry hazardous materials. (The percent of all large truck crashes involving trucks with hazardous materials placards has ranged from 0.82 to 1.06% of all large truck crashes from 2009-2017 (Table 21, columns C and E).)

Ideally, the rate of hazardous materials releases would be calculated based on the number of vehicle miles that large trucks transported hazardous materials, but those data are unavailable. Instead, I will assume that the rate of crashes per million VMT for large trucks carrying hazardous materials is the same as a crash rate per million VMT for all large trucks (Figure 3).

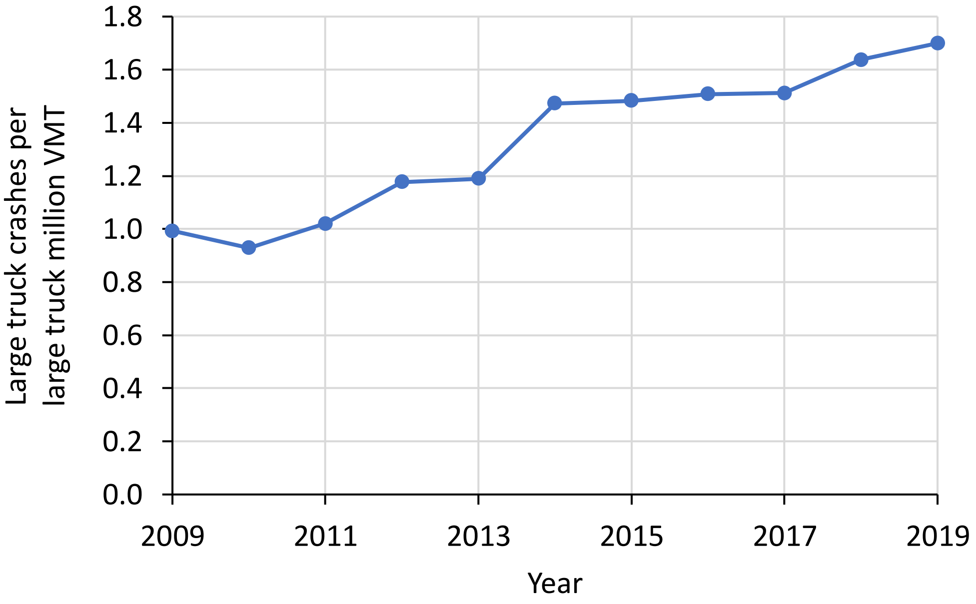
The annual number of truck-miles amassed by heavy vehicles remained relatively constant from 2009-2019, but the number of heavy vehicle crashes generally increased over that period (Figure 3a), leading to an increase in the estimated number of crashes per truck-mile traveled by heavy vehicles (Figure 3b). Not all crashes involving large trucks with hazardous materials placards result in spills. The rate of spills per million VMT is found by taking the large truck crash rate per million VMT and multiplying it by the proportion of crashes that results in spills. I will refer to the number of crashes with known releases and unknown hazardous material release status as possible spills. The number of known spills has generally been less than half of the number of possible spills (Figure 4a). From 2009-2019, the rate of possible spills from heavy vehicles has remained near 30% of crashes and the number of known spills has been between 10-16% of crashes annually and showing a slight upward trend (Figure 4b). (With only 11 years of data, I did not check if this trend was statistically significant.) The percent of crashes involving large trucks with hazardous materials placards that may have had releases ranged from 25.4-32.1% from 2009-2019

(Figure 4b). The percent of potential releases is consistent with other estimates. For trucks that were involved in fatal crashes from 1991-2000, Craft (2004) found that and average of 31.2% of those carrying hazardous materials had releases, compared to 20.9% of the trucks carrying non-hazardous materials.

Based on the crash rate per million VMT and proportion of crashes that resulted in known spills of hazardous materials, the rate of hazardous materials spills per VMT by large trucks ranged from 1.00 x $10^{-7}$ spills per mile traveled in 2010 to 2.88 x $10^{-7}$ spills per mile traveled in 2019 (Table 22 and Figure 5). The known spill rate per number of miles traveled by heavy vehicles increased from 2009-2019, with all rates based on data from an individual year falling between 0.10-0.29 spills per million VMT, and had an average value of 1.814 x $10^{-7}$ per vehicle mile, which is approximately 100 times higher than the rates cited in the SGP DEIS and SDEIS (USFS 2020, 2022), which were 1.4 x $10^{-9}$ hazardous materials crashes per VMT in 2013 and 1.9 x $10^{-9}$ hazardous materials crashes per VMT in 2016. For comparison, recall that when estimating the risks of spills of hazardous materials from trucks for the Pogo and Pebble Mines, EPA (2003, 2014) used a risk rate per mile of 1.9 x $10^{-7}$ spills per truck-mile, citing statistics from Harwood and Russell (1990).

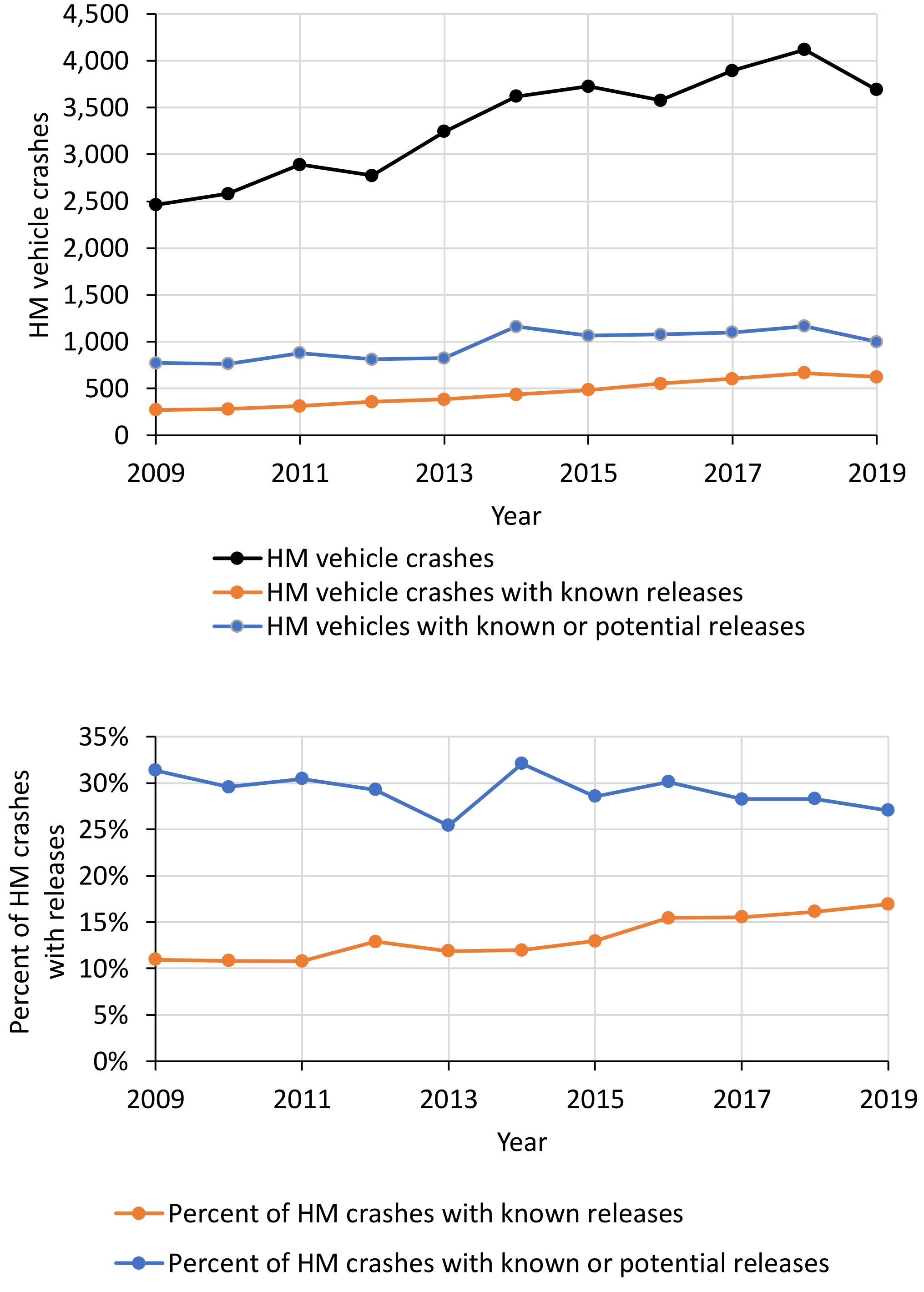


*a.*



*b.*

*Figure 3. a. Millions of vehicle miles traveled by large trucks (blue line) and number of large truck crashes (orange line) from 2009-2019; b. Number of large truck crashes per million vehicle miles traveled from 2009-2019. Data from FMCSA (2014, 2015, 2018, 2020, 2021).*



*a.*

*b.*

*Figure 4. a. Crashes involving large trucks with hazardous materials placards (black line) and the number of known releases of hazardous materials in those crashes (orange line) and known and potential releases of hazardous materials (blue line) from 2009-2019; b. Percent of crashes from large trucks with hazardous materials with known releases (orange line) and percent of crashes from large trucks with hazardous materials with known or potential releases (blue line) from 2009-2019. Data from FMCSA (2014, 2015, 2018, 2020, 2021).*

*Table 22. Rates of crashes and hazardous materials releases from large trucks per year from 2009-2019 based on FMCSA (2014, 2015, 2018, 2020, 2021). The rate calculation method used in USFS (2020, 2022) is in the shaded columns. The minimum spill rate of hazardous materials per million VMT is in the boxed column. See appropriate columns in Table 21 for data used to calculate each rate.*

| Year | Crash rate per million VMT | Fatal crash rate per million VMT | Hazardous material crashes per million VMT | Hazardous material crashes with releases per million VMT (USFS 2020, 2022) | Miles per hazardous material crashes with release (USFS 2020, 2022) | Percent of hazardous materials crashes with known releases | Hazardous materials crashes with known releases per million VMT | Percent of hazardous materials crashes with possible releases | Hazardous material crashes with possible releases per million VMT |
|---|---|---|---|---|---|---|---|---|---|
| | C/B | D/B | E/B | F/B | $(B/F) \times 10^6$ | F/E | (C/B) x (F/E) | G/E | (C/B) x (G/E) |
| 2009 | 0.992 | 0.0103 | 0.0085 | 0.00094 | 1,067,800,000 | 11.0% | 0.1088 | 31.4% | 0.3111 |
| 2010 | 0.928 | 0.0114 | 0.0090 | 0.00097 | 1,026,978,495 | 10.8% | 0.1004 | 29.6% | 0.2747 |
| 2011 | 1.020 | 0.0126 | 0.0108 | 0.00117 | 857,673,077 | 10.8% | 0.1101 | 30.5% | 0.3108 |
| 2012 | 1.178 | 0.0129 | 0.0103 | 0.00133 | 751,974,860 | 12.9% | 0.1519 | 29.3% | 0.3446 |
| 2013 | 1.189 | 0.0129 | 0.0118 | 0.00140 | 714,332,468 | 11.9% | 0.1411 | 25.4% | 0.3020 |
| 2014 | 1.472 | 0.0123 | 0.0130 | 0.00155 | 643,158,986 | 12.0% | 0.1766 | 32.1% | 0.4724 |
| 2015 | 1.483 | 0.0129 | 0.0133 | 0.00173 | 579,385,093 | 13.0% | 0.1921 | 28.5% | 0.4233 |
| 2016 | 1.507 | 0.0145 | 0.0124 | 0.00192 | 520,605,787 | 15.5% | 0.2331 | 30.1% | 0.4539 |
| 2017 | 1.512 | 0.0147 | 0.0131 | 0.00203 | 491,887,603 | 15.5% | 0.2349 | 28.3% | 0.4275 |
| 2018 | 1.617 | 0.0146 | 0.0135 | 0.00218 | 459,134,036 | 16.1% | 0.2639 | 28.3% | 0.4629 |
| 2019 | 1.700 | 0.0149 | 0.0123 | 0.00208 | 480,081,600 | 16.9% | 0.2879 | 27.0% | 0.4597 |
| 2009-2019 | 1.335 | 0.0131 | 0.0117 | 0.00158 | 631,245,773 | 13.6% | 0.1814 | 29.0% | 0.3876 |

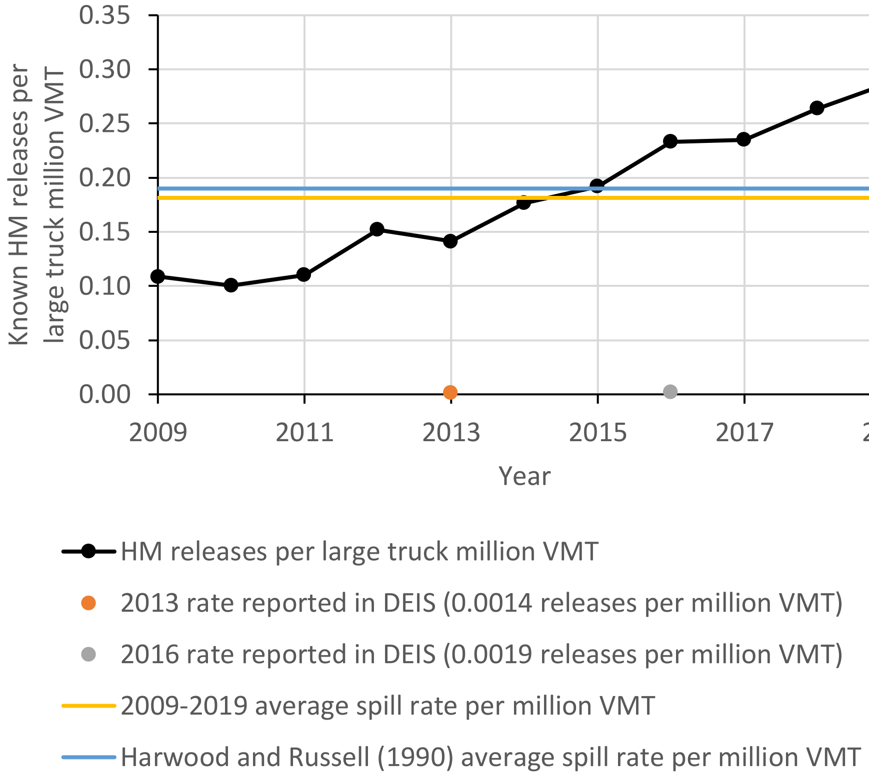


*Figure 5. Estimated rate of known hazardous materials releases per million vehicles miles traveled by large trucks with hazardous materials placards from 2009-2019. Data from FMCSA (2014, 2015, 2018, 2020, 2021). The rates reported in the DEIS and SDEIS (USFS 2020, 2022) from data from 2013 and 2016 are shown for comparison.*

For more context and specificity about hazardous material spill rates from vehicles, we can look to Battelle (2001) for both information about releases due to accidents and those due to leaks for 11 categories of hazardous materials. Battelle (2001) found that the average hazardous material accident rate of 3.2 x $10^{-7}$ spill per vehicle mile, based on estimated mileage figures from the 1997 Commodity Flow Survey. The rate varies by hazardous material class:

Battelle (2001), p. 4.13

> Risk of an accident per mile ranges from 1.3E-07 for Division 2.2 [non-flammable gases] to 7.2E-07 for Class 9 [miscellaneous dangerous goods]. The average accident rate for HM is 3.2E-07. If enroute incidents are included, as shown in Table 25, the risk increases to an average risk of 5.0E-07. Thus, without including enroute incidents, the accident/incident rate for accidents on the road declines by about 37 percent.

Combining leaks and accidents with releases yields the total spills per mile for the various hazardous materials classes. Non-flammable gases have the lowest spill rate of 0.32 x $10^{-7}$ per mile, while toxic materials and miscellaneous dangerous goods have spill rates of 6.4 x $10^{-7}$ and 6.2 x $10^{-7}$ per truck-mile, respectively. (Sodium cyanide was listed as a miscellaneous consumable in the SGP SDEIS, but that may not match its classification in Table 23.) This still does not describe all vehicle spills because "[t]he accidental releases of hazardous materials occur not only during transport, but also at fixed locations during loading and unloading activities (US DOT 2010)" (Inanloo et al 2015).

*Table 23. Spill probabilities (given an accident) may vary by substance type. See Battelle (2001).*

| Hazardous material classes and divisions, with descriptions | HazMat Miles | Total HazMat Accidents | Leaks *en route* | Accidents per mile | Leaks per mile | Fraction of accidents with releases | Accidents with releases per mile | Leaks and accidents with releases per mile |
|---|---|---|---|---|---|---|---|---|
| 1.1, 1.2, and 1.3: Explosives with the potential for mass detonation | 23,000,000 | 14.2 | 1 | 6.2 x $10^{-7}$ | 0.43 x $10^{-7}$ | 0.155 | 0.96 x $10^{-7}$ | 1.4 x $10^{-7}$ |
| 1.4, 1.5, and 1.6: Explosives with characteristics making mass detonation extremely unlikely | 46,000,000 | 32.101 | 3 | 7.0 x $10^{-7}$ | 0.65 x $10^{-7}$ | 0.284 | 2.0 x $10^{-7}$ | 2.6 x $10^{-7}$ |
| 2.1: Flammable gases | 805,000,000 | 276 | 15 | 3.4 x $10^{-7}$ | 0.19 x $10^{-7}$ | 0.170 | 0.58 x $10^{-7}$ | 0.77 x $10^{-7}$ |
| 2.2: Non-flammable gases | 1,400,000,000 | 178 | 19 | 1.3 x $10^{-7}$ | 0.14 x $10^{-7}$ | 0.146 | 0.19 x $10^{-7}$ | 0.32 x $10^{-7}$ |
| 2.3: Poisonous gases | 50,000,000 | 12.02 | 5 | 2.4 x $10^{-7}$ | 1.0 x $10^{-7}$ | - | - | $\geq$1.0 x $10^{-7}$ |
| 3: Flammable liquids and combustible liquids | 2,800,000,000 | 1,379.021 | 587 | 4.9 x $10^{-7}$ | 2.1 x $10^{-7}$ | 0.355 | 1.7 x $10^{-7}$ | 3.8 x $10^{-7}$ |
| 4.1, 4.2, and 4.3: Flammable solids; spontaneously combustible materials and dangerous when wet materials | 48,000,000 | 33 | 13 | 6.9 x $10^{-7}$ | 2.7 x $10^{-7}$ | 0.242 | 1.7 x $10^{-7}$ | 4.4 x $10^{-7}$ |
| 5.1, 5.2: Oxidizers and organic peroxides | 201,000,000 | 61 | 50 | 3.0 x $10^{-7}$ | 2.5 x $10^{-7}$ | 0.475 | 1.4 x $10^{-7}$ | 3.9 x $10^{-7}$ |
| 6.1, 6.2: Toxic (poison) materials and infectious substances | 218,000,000 | 50 | 125 | 2.3 x $10^{-7}$ | 5.7 x $10^{-7}$ | 0.300 | 0.69 x $10^{-7}$ | 6.4 x $10^{-7}$ |
| 7: Radioactive materials | 30,000,000 | 12.001 | 4 | 4.0 x $10^{-7}$ | 1.3 x $10^{-7}$ | - | - | $\geq$1.3 x $10^{-7}$ |
| 8: Corrosive materials | 1,900,000,000 | 257 | 539 | 1.4 x $10^{-7}$ | 2.8 x $10^{-7}$ | 0.284 | 0.38 x $10^{-7}$ | 3.2 x $10^{-7}$ |
| 9: Miscellaneous dangerous goods | 250,000,000 | 179.3 | 94 | 7.2 x $10^{-7}$ | 3.8 x $10^{-7}$ | 0.336 | 2.4 x $10^{-7}$ | 6.2 x $10^{-7}$ |

These risk calculations likely underestimate the actual risk due to underreporting of spills. Not only does the national database of hazardous materials spills, Hazardous Material Information System, not record accidents occurring on intrastate roads and accidents not resulting in a spill (Qiao et al. 2009), but one estimate prepared for a Congressional hearing on PHMSA's effectiveness suggested that spill estimates based on national data could be up to an order of magnitude too small.

PHMSA 2010, p. 21

> Questions were raised in 2009 Congressional hearings about the completeness of reporting of (non-pipeline) hazardous materials incidents. One estimate quoted was that 60-90% of all such incidents were unreported. If these estimates apply equally to serious incidents, then the number of serious road and railway hazardous material incidents presented in this section could be too low by a factor of 10 (some cases were cited of non-pipeline incidents involving fatalities or injuries that went unreported).

## Summary

The SGP DEIS and SDEIS (USFS 2020, 2022) used FMCSA data to estimate hazardous material spill rates of $1.4 \times 10^{-9}$ spills per truck-mile in 2013 and $1.9 \times 10^{-9}$ spills per truck-mile in 2016. These estimates are two orders of magnitude lower than rates cited in other EISs, including for Pogo Mine, which used an estimate of $1.9 \times 10^{-7}$ spills per truck-mile, and Pebble Mine, which used an estimate of $2.0 \times 10^{-7}$ spills per truck-mile for diesel spills >3,000 gallons and $7.8 \times 10^{-7}$ spills per truck-mile for ore concentrate. I was able to recreate the math performed in the SGP DEIS and SDEIS and correct it, arriving at an average spill rate of $1.81 \times 10^{-7}$ spills per truck-mile for the period of 2009-2019. This rate is closer to the rates cited in other EISs but lower than rates from PHMSA, which estimated that there were an average $3.2 \times 10^{-7}$ spills of hazardous material per truck-mile and found the rate varied by class of hazardous material. Due to underreporting, it is likely that all these estimated rates are too low, perhaps by as much as a factor of ten.

## 8. Location specific road hazards

The hazardous spill risk rates in Section 7 are based on national data. The average the rates given do not reflect the variability and localization of spill probabilities, a fact which is acknowledged by both EPA and PHMSA.

EPA (2003)

> The probability of truck accidents and release was reported as 1.9 x$10^{-7}$ spills per mile of travel for rural two-lane roads (Harwood and Russell, 1990). … This frequency provides an order-of-magnitude estimate because the conditions on the Pogo mine road would be different from those for which the statistics were developed (more difficult driving and road conditions).

PHMSA (2010), p. 24

> The rate of serious incidents per mile in a specific location in any specific community may vary considerably, based on the specific characteristics of the transportation infrastructure at the location (pipeline, roadway, and railway) and characteristics of the surrounding community. The expected rate of incidents involving different hazardous material transportation modes in a specific community will depend on the degree of exposure to each mode, namely, the number of miles of road, railway, and pipeline. The higher the pipeline, road, and railway mileage in a community, the higher is the community's level of exposure to potential incidents. However, the characteristics of the area (e.g., rural versus urban; density, pattern, and type of structures; topography) could decrease or increase the risk to the area surrounding the transportation infrastructure.

While in an ideal world (from a statistical standpoint) there would sufficient data to characterize each region specifically, with up-to-date, accurate, and detailed records of accidents, spills, and truck-miles, the reality is that hazardous spill rates are low and data are often collected in different formats by different agencies around the country, incomplete, or inaccurate.

Kazantzi et al. (2011)

> There are two main difficulties in assessing the risk; one can observe that probabilities of incident occurrences in HazMat transportation are very low and reported incident data are very scarce (Erkut and Gzara, 2008). This lack of consistent and sufficient data and the difficulty of obtaining accurate parameter values lead to high degrees of uncertainties associated with incident rates and consequence measurements for dangerous goods

> transportation. There are many critical variables that need to be taken into account in assessing the actual risk in Hazmat transportations (material type, mode of transportation, container type, meteorological and weather conditions, geographical location, season, time of the day, road conditions), as well as variables that depend on the human component and management of the transportation process (such as age, training and condition of the driver, management system, operations performed, equipment used etc). Based on a huge number of possible HazMat transportation alternative combinations, one can conclude that this is a very case-dependent problem...

Erkut et al. (2007)

> QRA relies heavily on empirical accident/incident probabilities. However past data [are] not very reliable. …. What makes matters worse is that there is no agreement on general truck accident probabilities and conflicting numbers are reported by different researchers. Furthermore, applying national data uniformly on all road segments of similar type is quite problematic since it ignores hot spots such as road intersections, highway ramps, and bridges. Researchers need to have access to high quality accident probability data and empirical or theoretical research that leads to improvements in the quality of such data would be welcome.

Erkut and Verter (1998)

> Furthermore, the probability of an incident occurring depends on the substance carried and the road type. Clearly, the risk associated with transporting a hazardous material depends not only on the substance being transported but also on the road network characteristics, such as road type and population, along the chosen route.

## Factors that may affect hazardous material spill rates per truck-mile

Detailed models of spill probability per mile can incorporate area-specific risks that more generalized ones do not. The general procedure is to first find the base (average) accident frequency by dividing the number of accidents by the number of miles traveled, as in Section 7, and then modifying it based on factors that make a significant change to the rate for the specified scenario (Qiao 2009). Potential factors that can affect the accident rate have been studied in mathematical modeling contexts (Qiao et al 2009, Kazantzi et al., 2011), in governmental guidelines (AASHTO 2018), and suggested by examination of specific road corridors (USGS 2020) (Table 24). Factors may be important singly or have compounding effects (Kazantzi et al. 2011).

Erkut et al. (2007)

> [T]he occurrence of an accident may be influenced by intrinsic factors such as tunnels, rail bridges, road geometry, weather conditions, and human factors, as well as other factors correlated to traffic conditions, such as traffic volume and frequency of hazmat shipment. Consequently, some locations are more vulnerable to accidents than others. Therefore, a careful analysis should be done prior to the use of historical data. The rarity of hazmat accidents may result in insufficient information to determine whether historical figures are relevant to the circumstances of concern, particularly regarding rare catastrophic accidents.

Kazantzi et al. (2011)

> There is a considerable variance in estimating these [release] probabilities as reported by various researchers (Pet-Armacost et al.1999, Button and Reilly, 2000, Erkut and Verter, 1998, Saccomanno and Haastrup, 2002), because data are scarce and values depend on methodology and data sources used, as well as assumptions made.

Kravitz and Blair (2019)

> Because conditions on the mine road would be different from those for which the statistics were developed (e.g., more difficult driving and road conditions), this calculation provides an order of magnitude estimate. The reasonableness of these estimates is suggested by an assessment of the Cowal Gold Project in Australia, which estimated that a truck wreck would occur every 1 to 2 years, resulting in a spill every 3 to 6 years (NICNAS 2000).

Recall that in Section 2, some these same factors were mentioned in discussion of hazardous materials spill rates on the roadways to Pogo and Pebble Mines.

*Table 24. Some potential factors that may affect spill probabilities for trucks carrying hazardous materials.*

| Reference | Factors that may affect spill risk |
|---|---|
| Erkut and Verter 1998 | substance being transported<br>road network characteristics, such as road type and population, along the chosen route |
| Erkut et al. 2007 | hot spots such as road intersections, highway ramps, and bridges<br>intrinsic factors such as tunnels, rail bridges, road geometry, weather conditions, and human factors<br>factors correlated to traffic conditions, such as traffic volume and frequency of hazmat shipment |
| Qiao et al. 2009 | nature of the roads, characteristics of the trucks, environmental factors, and driver conditions<br>urban versus rural and divided versus undivided highway<br>location specific conditions, such as vehicle speed limit, topographical conditions, excessive grade, obstructions to vision, poorly designed intersections<br>weather conditions, such as rain, fog, storms, icing, wind, or tornado conditions<br>driver training programs, fleet maintenance, speed monitoring, driver stress level, driver drinking-habits |
| Kazantzi et al. 2011 | material type, mode of transportation, container type, meteorological and weather conditions, geographical location, season, time of the day, road conditions, management of the transportation, age, training and condition of the driver, operations performed, and equipment used |
| AASHTO 2018 | type of terrain (level, rolling, mountainous); straight or winding<br>grade, cross slope, width, medians, number of lanes, speed, rural vs. urban, traffic volumes, sight distances, lighting, drainage |
| USFS 2020 | road surface or substrate; landslide, rockfall and avalanche risk; fires; flash floods; earthquakes; road condition and maintenance level; previous disturbances to the area |

## Incorporation of potential spill risk modifying factors in the SGP DEIS and SDEIS

SGP would have some significant risks (road grade and quality, avalanche/landslide risk, fires, etc.) that would be expected to increase the spill rate if a detailed model were used. It is beyond the scope of this report to model these for different segments of the proposed transportation corridor, for either the ~70-mile section from SH-55 at Cascade to the mine site or the multiple cities that are sources and destinations of hazardous materials. Instead, in the extracted sections of the SDEIS shown, I show that there is sufficient reason to believe that the transportation corridor for the proposed SGP would be more prone to accidents and spills than would be predicted using rates based on national data. Factors making driving on the roads near SGP more difficult include the steep, narrow, rocky roads, harsh winters, debris, and geohazards such as landslides, rockfalls, avalanches and slumps (Table 25).

### Existing road conditions and weather

USFS (2022), p. 3-408, italicized emphasis added

> **Existing Road Transportation Network**
>
> The Stibnite Mining District has been explored and mined since the early 1900s and included activities such as road construction and exploration. *Many of the forest roads in the area were originally built to access mining claims or other remote sites and tend to be very steep, rocky, and winding* (Forest Service 2019d).
>
> The transportation network in the analysis area includes SH 55, Valley County roads, and NFS roads. Valley County maintains Warm Lake Road, Johnson Creek Road, and McCall-Stibnite Road on NFS lands through easements issued under the FRTA (Figure 3.16-1). For the purposes of this section, McCall-Stibnite Road is presented as three segments to provide a more location-specific discussion of existing conditions. These three segments include: Lick Creek Road (from SH 55 east to SFSR Road), East Fork Road (from SFSR Road east to the village of Yellow Pine), and Stibnite Road (from the village of Yellow Pine east to the Operations Area Boundary). There are approximately 130 miles of state roads, approximately 278 miles of Valley County roads, and approximately 1,557 miles of NFS roads in the analysis area.
>
> … The road width of SH 55 generally spans from 20 to 24 feet and the average posted speed limit is 55 miles per hour. Valley County road surface widths range from 14 to 26 feet and general speed limits range from 20 to 50 miles per hour (Valley County 2008b). NFS road surfaces in the SGP area range from 10 to 16 feet wide and most NFS roads do not have posted speed limits, but generally have a design speed limit of 5 to 15 miles per

> hour. *Most roads in the PNF and BNF are single-lane, native surfaced roads with high rock fragment content from the rocky terrain and include pullouts for passing vehicles.* General maintenance during snow-free months consists of grading and re-compacting the road surface, intermittent dust control, and periodic cleaning of drainage culverts and ditches.

USFS (2020), p. 3.18-15, emphasis added

> *The analysis area is dominated by unpaved roads, one state highway, and county roads* **…** The road segment of highest safety and traffic concern from the access and transportation risk analysis was found to be the Warm Lake Road (CR 10-579), with an average of 8 vehicle accidents per year from 2000 to 2016 ....
>
> …
>
> *The analysis area experiences harsh weather conditions that pose potential travel hazards, especially during winter, when roads become snow-covered or icy. During winter, Valley County maintains only one route from Cascade to the analysis area*, which follows Warm Lake Road (CR 10-579) to the intersection with South Fork Salmon River Road (National Forest System Road 474), then to the East Fork Stibnite Road portion of the McCall-Stibnite Road (CR 50-412) to the village of Yellow Pine. Midas Gold maintains Stibnite Road (CR 50-412) for access from the village of Yellow Pine to the mine site. All other routes to the mine site are not maintained (plowed or sanded) when snow-covered roads become impassable to vehicles.

USFS (2020), p. 4.7-11, 12, emphasis added

> All access routes could present occasionally adverse road conditions that are common on remote mountain roads, especially due to ice and snow conditions during winter months. *Road conditions on high mountain passes such as Warm Lake, Landmark and and (*sic*) Big Creek Summit may be particularly challenging in the winter. Both the Burntlog and Yellow Pine routes have segments with steep grades (above 6 percent), and no emergency truck ramps are present or planned on the routes. Switchbanks (*sic*) and reduced turning radius also may be a challenge for large trucks operating on these roads*. Any additional transport of hazardous materials under the action alternatives would increase the spill risk compared to the No Action Alternative.

USFS (2020), p. 3.16-14; the text in **bold** was not part of the USFS (2022) and includes a list of environmental factors that have a history of contributing to accidents in the area.

> According to the Valley County sheriff's traffic incident records from 2000 through 2016, the causes of most accidents on the existing roadways fall under the general

> categories of driver error, vehicle mechanical issues, and environmental factors (**DJ&A, PC 2017**). **Examples of driver error include speeding, following another vehicle too closely, inattentiveness, fatigue, gear shift issues, failure to share road, inexperience as a driver, and impairment. Examples of mechanical issues include brake and engine failure and tire-related problems including the misuse or lack of use of chains during ice or snow conditions. Environmental factors that affected traffic incidents include weather-related (e.g., snow, ice, flooding, and other conditions that contributed to poor visibility), poor road conditions (e.g., soft shoulders), and wildlife crossings.**

The SDEIS notes that the SGP access roads have several hazards (USFS 2022, p. 4-136):

> [T]he use of the SGP access roads do present additional hazards to vehicles such as: mountainous terrain, curves, rockfalls, reduced road widths, reduced sight distances, presence of wildlife, snow accumulations, avalanches, rock falls, falling trees, etc. These conditions could result in accidents related to vehicles encountering these other hazards. Perpetua would monitor conditions along the access roads and control transport of fuels and hazardous materials beyond the SGLF to reduce the effects of these other potential hazards.
>
> Such accidents could cause spills of fuels or hazardous materials the environmental effects of which would depend upon the size of the spill, the material spilled, and proximity to flowing water. Perpetua has proposed spill control and countermeasures to reduce the effects of spills through responses with trained SGP personnel, equipment, and readily available spill response materials.

### Avalanches and landslides

USFS (2020), p. 3.18.-13, emphasis added

> **EXISTING TERRAIN AND FEATURES**
>
> As described in the Public Health and Safety Baseline Study (HDR 2017b), the rugged, mountainous terrain in the analysis area includes many potential hazards to public health and safety that could result in severe injuries or fatalities to users. Common hazards related to terrain include extremely steep slopes, rock cliffs, uneven terrain, and fallen trees. Avalanches, rock falls and debris flows also present a potential hazard for travelers, recreationists, and Forest Service and Midas Gold employees. They can cause severe injury or death and can block access to homes, cabins, and recreation sites. As described in the Recreation Baseline Study (HDR 2017c), the analysis area is a popular destination for winter recreation activities, including snowmobiling, snowshoeing, and cross-country skiing. Recreationists participating in these activities are at risk for causing or encountering avalanches in the analysis area.

> Also described in the Public Health and Safety Baseline Study (HDR 2017b), the entire analysis area presents potential flash flood and debris-flow hazards that also can cause severe injury or death, and can block access to homes, cabins, and recreation sites. In addition, areas that were not traditionally flood-prone are at risk due to changes to the landscape caused by wildfires.
>
> Similar to flash-flooding and debris flows, portions of the analysis area are susceptible to landslides and avalanches due to factors such as geology, landscape, climate, and soil, as was experienced in 2014, 2017 and 2019 along the South Fork of the Salmon River Road (National Forest System Road 474/50674) and the Stibnite portion of the McCall-Stibnite Road (County Road [CR] 50-412).

USFS (2020), p. 4.2-2, emphasis added

> The following analysis of effects associated with geologic resources and geotechnical hazards is considered within the overall context of the local and regional geology. Elements of this context include:
>
> > • A majority of the analysis area is on National Forest System lands within the Salmon River Mountains, a high-relief mountainous physiographic province of central Idaho with the presence of steep slopes that are subject to landslides and avalanches.
> >
> > …
> >
> > • The analysis area is within the seismically active Centennial Tectonic Belt and it is anticipated to be subjected to earthquake ground shaking (URS Corporation 2013).
> >
> > • The mine site includes disturbed areas as a result of previous mining activities, resulting in the presence of legacy mine features with associated slope stability and seismic stability considerations.

USFS (2022), p. 4-14, emphasis added

> Avalanches
>
> Several areas of the Operations Area Boundary are within avalanche hazard zones based on information from DAC (2018) (**Section 3.2.4.7**). Avalanche hazards are already present in the analysis area. Avalanche occurrence is largely a result of a combination of three factors: weather, snowpack, and terrain. The SGP would not substantially alter these factors, but components of the SGP in the paths of avalanches could be impacted. *The most significant concern for avalanche impacts to the 2021 MMP would be along the access routes where avalanches could directly impact vehicles and personnel who were in the path of the avalanches when they occurred (**Figure 3.2-6**). Such accidents could harm the involved persons, damage impacted vehicles, or even potentially cause the vehicles to upend or leave the road. The later situations could then lead to secondary environmental effects from spills of fuel, coolant, or cargoes*.

> A more likely impact would be cases where an avalanche deposited snow and forest debris on the affected roadway which would then require response by plows or other equipment to clear the road and reopen access to the Operations Area Boundary. The effects of these cases would depend on the relative size of the avalanche, described by DAC (2021) in the project areas as potentially size D1 through D4. Size D1 and D2 avalanches would involve displacement of 10 to 100 tonnes of snow respectively, would be more common than larger avalanches, and could cause an accident or stop traffic until the road was cleared. However, even these smaller avalanches could present a severe safety hazard to persons on foot in the avalanche paths. Less likely, but larger D3 avalanches would displace 1,000 tonnes and could bury or destroy a car and damage a truck. The largest potential avalanche path found by DAC (2021) in the analysis area are size D4 avalanches which would displace 10,000 tonnes of snow and have the potential to destroy even large trucks as well as a substantial amount of forest.
>
> Avalanche hazard areas also are present in proximity to the proposed mine support facilities and infrastructure (**Figure 3.2-5**). These existing avalanche hazards would be addressed in the siting and design of proposed facilities at the mine site, but the increased number of personnel present at the mine facilities, and increased value of facilities and equipment at the mine as a result of the 2021 MMP would increase the potential risk of damage, injury, and loss of life from the existing avalanche hazards. Blasting associated with mine operations could trigger avalanches in the vicinity of the mine operations.

USFS (2020), p. 4.7-11, 12, emphasis added

> *Both the Burntlog and Yellow Pine access routes have segments that are susceptible to geohazards, including avalanches, landslides and rockfalls*. See Sections 3.2 and 4.2, Geologic Resources and Geotechnical Hazards, for additional information on geohazards relevant to the SGP. *These geohazards present along the road corridors could increase the potential for truck accidents resulting in spills of hazardous materials*.
> *No geologic hazard assessment, including field reconnaissance, has been conducted to date for the Yellow Pine Route*. Therefore, as part of preparation of the Environmental Impact Statement and to enable a general comparison of identified hazards between the Yellow Pine and Burntlog routes, *a desktop study of both corridors was conducted … the desktop study focused on larger avalanches (Class 3 and above) that could be capable of burying or overturning a vehicle.* Smaller avalanches (Class 1 or 2) could result in temporary road closures, but would be unlikely to increase the risk of a truck accident.
>
> - Along the Burntlog Route, the desktop study identified 6 landslides and 20 rockfalls. No avalanche paths were identified along the Burntlog Route, although the existing Burnt Log Road (National Forest System Road [FR] 447) is known to experience small avalanches. The Burntlog Route is closer to avalanche "starting zones" such that it may have frequent but small avalanches (Class 1 or 2) that would be unlikely to impact vehicles.
> - Along the Yellow Pine Route, 26 landslides, 19 rockfalls, and 12 avalanche paths were identified. Stibnite Road in particular is at the base of several large

> > avalanche paths, and the route is known to have significant avalanches that disrupt traffic periodically.
>
> *Avalanches also can happen outside of existing avalanche paths, especially along road cuts and in areas that have undergone burning*.
>
> The Yellow Pine Route has increased potential for trucking accidents and greater spill risk from these geohazards compared to the Burntlog Route. See Section 3.2.3.7.2, Access Roads for the complete background information on geohazards across the two access routes.
>
> Road conditions for transport routes beyond Landmark also would include occasionally adverse road conditions as noted above, as well as avalanche hazards at Warm Springs (see **Figure 3.2-6**). Occasional "slides" on Big Creek Summit in the last 20 years have caused temporary road closures, and Warm Lake Summit often has avalanche debris areas (Valley County Road Department 2020). These conditions are generally associated with road cuts. *Road hazards past Landmark could increase spill risk for all action alternatives compared to the No Action Alternative*.

Appendix E – Geologic Resources and Geotechnical Hazards (44 pp.)

> A desktop study of geohazards was conducted for the Burntlog Route transportation corridor and Yellow Pine Route transportation corridor (which includes Johnson Creek Road [County Road (CR) 10-413] and the Stibnite Road segment of McCall-Stibnite Road [CR 50-412]) to provide a general comparison of identified geohazards along both corridors.
>
> **2.0 Methods**
> Imagery from Google Earth (2020) was examined using the following criteria to identify probable landslides, rockfalls, and avalanche paths along the two transportation corridors…
>
> …
>
> An important difference in types of avalanche hazards between Stibnite Road and Burntlog Route relates to the types of avalanche regimes. *Stibnite Road is at the base of large avalanche paths that may have a 5-year return interval with associated impacts. The Burntlog Route is closer to the avalanche starting zone and may contain more frequent, but smaller-size avalanches as compared to Stibnite Road* (personal communication, T. Leeds, USFS via email May 5, 2020 [Forest Service 2020]).
>
> In addition to the two corridors described above, the U.S. Forest Service notes an avalanche path along Warm Lake Road (CR 10-579) that would be part of the transportation corridor common to both the Burntlog and Yellow Pine routes. This feature was observed in Google Earth during the desktop study…

*Table 25. There are recognized geohazards along all the road segments that would be part of the transportation corridor for hazardous materials. Sources: USFS (2020) Appendix E, Tables 1, 2, 3, 4, 5, 6, and 7.*

| Road segment | Geohazard type | | | |
|---|---|---|---|---|
| | Rockfall | Landslide | Avalanche Paths | Slumps |
| Landmark to Burntlog Saddle | 3 | | | |
| Burntlog Saddle to connection with Thunder Mountain Road | 15 | 4 | | |
| Thunder Mountain Road to mine site | 2 | 2 | | |
| Burntlog Route | | | 1 | |
| Johnson Creek Road | 8 | 11 | | 2 |
| Stibnite Road | 11 | 15 | 12 | |

### Wildfires

USFS (2020), p. 3.18.-14, emphasis added

> *Wildfires are another potential hazard in the analysis area that can cause severe injury or death* for travelers, recreationists, and Forest Service and Midas Gold employees, as well as damage to homes and property. They can spread unpredictably and rapidly and are highly dependent on changing weather patterns. Past wildfires have presented health and safety risks to the public. Much of the analysis area was burned by major wildfires in 2000, 2006, and 2007, as detailed in the Vegetation Baseline Study (HDR 2017d), as well as more recently in 2019. The danger of wildfires in the analysis area remains. The dense stands of snags and dead material left behind on the forest floor by those fires could be sources of fuel for future fires.

The impact rankings (negligible, minor, moderate, and major) from SGP DEIS Section 4.18 shown below refer to the public health rating matrix shown in Table 27 in Section 10 of this report.

## Mitigations suggested in the SGP DEIS

USFS (2020), p. 4.7-18, 19

> In general, the potential for a release of hazardous material from a truck accident can be reduced for both the Burntlog and Yellow Pine Routes with the use of appropriate management practices such as pilot vehicles, speed restrictions and requiring appropriate spill kits in trucks hauling hazardous materials and in pilot vehicles.

USFS (2020), pp. 2-20, 21, emphasis added

> **BURNTLOG ROUTE**
>
> During the first 2 years of construction, Midas Gold would widen and improve the existing Burnt Log Road (FR 447) and construct 15 miles of new road connecting with Meadow Creek Lookout Road (FR 51290). Improvements on the existing Burnt Log Road (FR 447) include:
>
> - Straightening tight corners to allow for improved safety and traffic visibility;
> - *Maintaining grades of less than 10 percent in all practicable locations*;
> - Placing sub-base material and surfacing with gravel;
> - Widening the existing road surface to a 20-foot-wide travel way (approximately 26 feet including shoulders); and
> - Installing side-ditching, culverts, guardrails, and bridges, where necessary with design features to provide fish passage.

## Summary

Estimates of spill risk per truck-mile based on data collected nationwide are generalized and miss factors that may be relevant to individual hazardous material transportation scenarios. Some risks are dependent on the route chosen (road grade, number of lanes, weather, etc.) and some are route independent (driver experience level, material type, truck configuration, etc.) The SGP would have some significant risks (road grade and quality, avalanche/landslide/rockfall, fires, etc.) that would be expected to increase the spill rate if a detailed model were used. While road improvement and speed limits might help abate some of the risks inherent in the analysis area, it is clear that developing a project-specific spill risk per truck-mile for one or more segments of the transportation corridor would likely result in an estimated rate that is higher than the national average spill rate per truck-mile.

## 9. Transportation corridor spill (incident) calculations

The SGP DEIS acknowledges that "[i]ncreased mine related trucking traffic on roads could increase potential for spills of hazardous substances, as well as increase the potential for traffic accidents, which could have injury impacts as well as well-being and psychosocial impacts" (USFS 2020, p. 3.18-9). In this section I use the exposure variables (total truck-miles) from Section 7 for the hazardous mine reagents, products, and wastes (Section 4) with estimated spill and crash rates (Section 8) to calculate the expected numbers and probabilities of spills and accidents along the transportation corridor defined in the SGP DEIS and a more complete corridor that begins and ends at substance-specific cities (Section 6). I performed the computations for Alternatives 1, 3, and 4 as a group and for Alternative 2 individually.

The simplest method of finding the number of expected spills or accidents is the model $N = RT$, where T is the total miles traveled by trucks carrying hazardous materials. $R$ can either be $R_{spill}$, the spill rate per vehicle mile traveled, or $R_{accident}$, the accident rate per vehicle traveled. To find the probability of at least one spill in each size class or for a spill of any size, I followed the common practice of assuming that the spill rates followed a Poisson distribution. In that case, $P(\geq 1$ spill) is the probability of at least one spill, which can be found by subtracting the probability of there being no spills, $P$(0 spills), from the total probability (100% by definition). The probability of zero spills under a Poisson distribution is $e^{-N_{spill}}$, where $N_{spill}$ is the expected number of spills for the total number of miles traveled. Thus,

$$P(\geq 1\ spill) = \ 1 - P(0\ spills) = 1 - e^{-Nspill}$$

Similarly, we can find the probability of at least one accident as

$$P(\geq 1\ accident) = \ 1 - P(0\ accidents) = 1 - e^{-Naccident}$$

The risk rates I used in the examples are:

- 2009-2019 average: $R_{spill} = 1.81 \times 10^{-7}$ spills per truck-mile (Table 22)
- 2019 rate: $R_{spill} = 2.88 \times 10^{-7}$ spills per truck-mile (Table 22)
- 2009-2019 average: $R_{accident} = 1.34 \times 10^{-6}$ accidents per truck mile (Table 22)
- 2019 rate: $R_{accident} = 1.7 \times 10^{-6}$ accidents per truck mile (Table 22)

These rates are based on national data cited in the SGP DEIS and SDEIS (USFS 2020, 2022). This is the simplest possible model and likely underestimates the risk rate per truck-mile for both accidents and releases. (See sections 8 and 9.)

The reagents and products from the mine travel farther than just the distance from the SH-55 turn-off near Cascade to the mine. The combined distance from origin city to Cascade, Idaho, and then from Cascade to the mine site (rounded to 70 miles) was the total exposure length in miles per one-way (loaded) trip. (See Sections 6 and 7.) The total exposure to hazardous materials spills from trucks per year for the SH-55 to the mine site segment and longer, material-specific transportation corridor can be used with the spill risk rate per truck-mile to find expected numbers and probabilities of spills and with the accident rate per truck mile to find expected numbers and probabilities of accidents (Table 26).

Even using the lower spill rate (based on data from 2009-2019), the probability of a spill along the SH-55 to the mine site is above 45% and well into the possible range during the 15-year Project life (Table 25, Figure 6b). The greater distances included with the full transportation corridor mean a greater exposure to environmental and human safety risks, and between two and five spills of hazardous substances are expected in 15 years, depending on the estimate of $R_{spill}$. In that time frame, there is a 93-99% chance that at least one hazardous material spill occurs at some point along the combined transportation corridor (Table 26, Figure 6).

Accidents are more common than spills, and at least four accidents involving heavy vehicles carrying hazardous materials between SH55 and the mine site would be predicted by this model, even using the lower $R_{accident}$ based on data from 2009-2019. Once the whole transportation corridor is considered, the number of expected accidents involving heavy vehicles carrying hazardous materials is between 19 and 25 over the course of operations, depending on the value of $R_{accident}$ used. The number of accidents related to mine traffic of all types will be higher than the number of accidents related to heavy vehicles laden with hazardous materials. Unless the hazardous materials trucks can arrive at the mine site with a load of reagent and leave with a load of ore concentrate or wastes, the heavy vehicles will have half their miles in the mine site area loaded with hazardous materials and half unloaded, leading to a larger number of miles for each truck. Furthermore, not all heavy vehicles carry hazardous materials, as some are used to transport crew, food, recyclables, and other supplies to or from the mine. This combination of factors means that accidents involving heavy vehicles associated with SGP would be more frequent than predicted here, because this only modeled heavy vehicles with loads of hazardous materials. If lighter vehicles are also included, the number of potentially involved vehicles and the exposure variable (miles driven) increase again, as would the expected numbers of accidents.

*Table 26. Total truck-miles and spill incidents of all sizes for HazMat spills for each Alternative for the SH-55 to mine site and full transportation corridor for 1 year and 12- and 15-year mine operating lifetimes. The rate of 1.81 x $10^{-7}$ spills per truck-mile is the average from 2009-2019 and is lower than the rate cited in EPA (2014) or the 2019 rate (Figure 5).*

| Distance considered | SH-55 to mine site | | Full transportation corridor | |
|---|---|---|---|---|
| Data used in rate calculations | 2009-2019 | 2019 | 2009-2019 | 2019 |
| Road miles (one-way) | 70 | 70 | Varies by substance | |
| Number of trips/year | 3,337 | 3,337 | 3,337 | 3,337 |
| Truck-miles/year | 233,590 | 233,590 | 978,555 | 978,555 |
| | | | | |
| Spill incident rate per truck-mile = $R_{spill}$ | 1.81 x $10^{-7}$ | 2.88 x $10^{-7}$ | 1.81 x $10^{-7}$ | 2.88 x $10^{-7}$ |
| Accident rate per truck-mile = $R_{accident}$ | 1.34 x $10^{-6}$ | 1.70 x $10^{-6}$ | 1.34 x $10^{-6}$ | 1.70 x $10^{-6}$ |
| | | | | |
| *Project life = 1 year* | | | | |
| Number of truck-miles | 233,590 | 233,590 | 978,555 | 978,555 |
| Number of spill incidents | 0.04 | 0.07 | 0.18 | 0.28 |
| Probability of ≥ 1 spill | 4.1% | 6.5% | 16.3% | 24.6% |
| Number of accidents | 0.31 | 0.40 | 1.31 | 1.66 |
| Probability of ≥1 accident | 26.9% | 32.8% | 73.1% | 81.1% |
| | | | | |
| *Project life = 15 years* | | | | |
| Number of truck-miles | 3,503,850 | 3,503,850 | 14,678,325 | 14,678,325 |
| Number of spill incidents | 0.64 | 1.01 | 2.66 | 4.23 |
| Probability of ≥ 1 spill | 47.0% | 63.5% | 93.0% | 98.5% |
| Number of accidents | 4.71 | 5.96 | 19.67 | 24.95 |
| Probability of ≥1 accident | 99.1% | 99.7% | 100% | 100% |

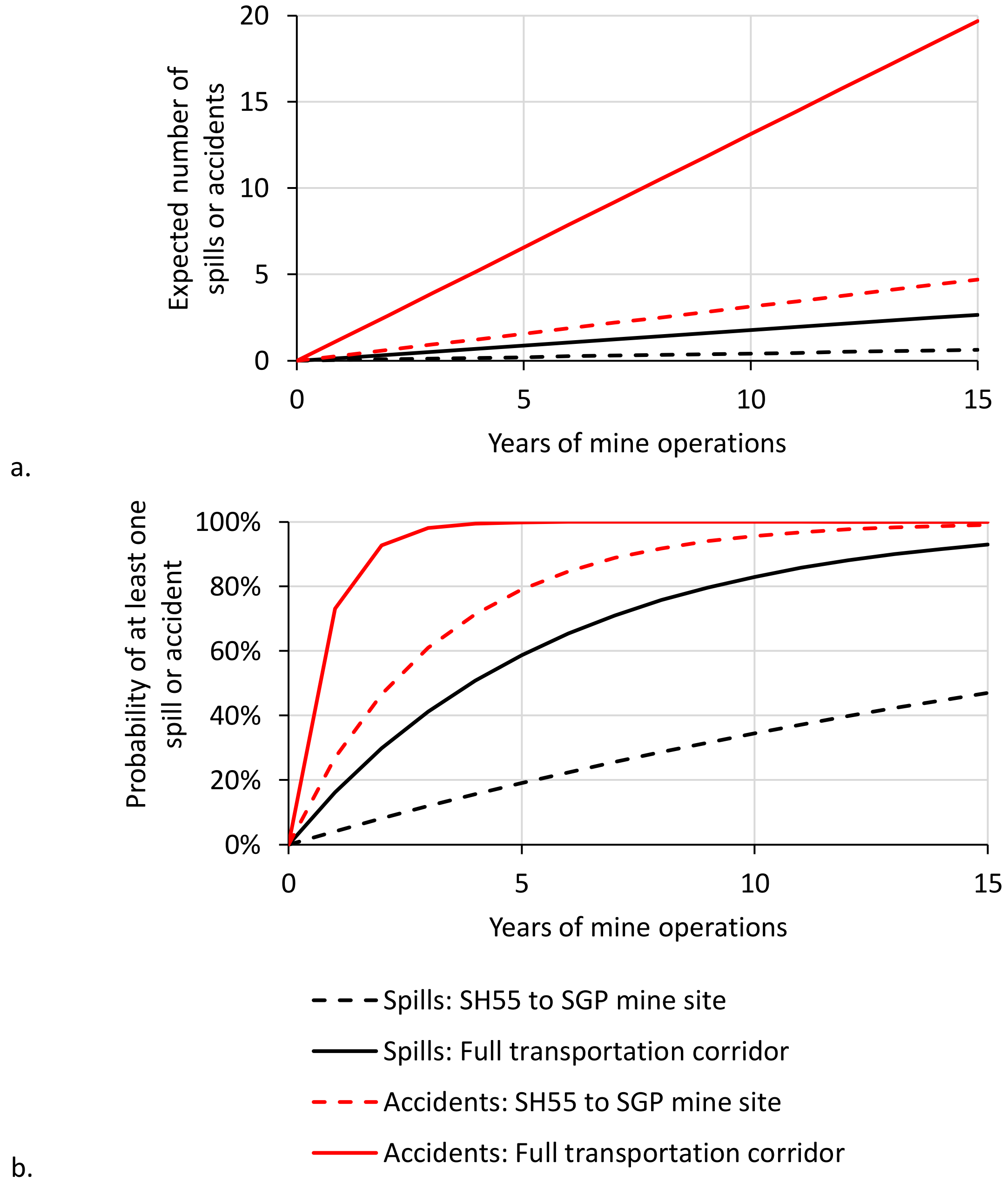


*Figure 6. Comparison of a. expected numbers of accidents (red lines) involving and spills (black lines) from loaded hazardous material trucks from the ~70 roadway from SH-55 to the proposed mine site (dashed lines) and the full transportation corridor (solid lines) estimated using the reagent origins from Table 18, including the ~70 miles from SH-55 to the mine site and b. probabilities of at least one such accident or spill. The calculations use the 2009-2019 average heavy truck accident rate per truck-mile (Table 22).*

## Bias and uncertainty in the calculations

There are biases and uncertainties associated with all the values used to calculate the expected numbers of spills and their probabilities.

- The number of trips to transport hazardous materials to and from the mine site is underestimated because it does not include trips for wastes containing mercury.
- The sample origin/destination cities for the reagents and mine products were chosen to minimize the distance hazardous materials would have to travel to and from Cascade, Idaho. To the extent that the selected group of cities is incorrect, the calculations of truck-miles beyond SH-55 at Cascade will also be wrong.
- The risk rate per truck-mile based on FMCSA data from 2009-2019 is slightly lower than estimates used in other EISs from multiple lead agencies and in peer-reviewed journals and governmental reports.
- Those national rates are also like underestimates due to underreporting of accidents and spills.
- The risks per truck-mile used in Table 22 and Figure 6 do not factor in important location-specific variables that could increase the spill rate per truck-mile for the SGP over the national average.

In short, the calculations in this section show the simplest possible method for estimating spill and accidents with rates that are highly uncertain and biased downwards. A more thorough approach should address these concerns explicitly and present not only quantitative estimates of the risks but also the uncertainties around those estimates. Only then can the impacts associated with spills and crashes be assessed to the appropriate degree, and stakeholders and decision-makers be properly informed.

## Summary

Using the total number of heavy vehicles trips, with and without hazardous materials, I found the expected number of crashes and spills along the SH-55 to mine site portion of the transportation corridor and the full distribution point to mine site distance and the probabilities of spills and crashes (Table 26). Overall, spills and crashes involving heavy vehicles are near certain to occur for all Alternatives when the entire transportation corridor is considered. The calculations shown here serve as an example of the general process for estimating spill and crash numbers and likely underestimate the risks. Still, these numbers indicate that the impacts that spills and accidents may have on the environment and human safety along the transportation corridor should be seriously and thoroughly considered.

# 10. Hazardous materials risk modeling peer-reviewed literature and models

The $N = RT$ model has several positive attributes. It is intuitive, with larger estimated numbers of spills arising when the number of miles traveled increases. It is straightforward to calculate when given the appropriate information about the number of loads transported and length of roads traveled. It has precedent in several EISs and other governmental impact assessments of environmental risks. Finally, there is a ready estimate of $R$ to use from Harwood and Russell (1990) that has been cited in several of those precedent documents. This section explores what other methods for calculating transportation accident risk are in the peer reviewed literature.

There are decades of study and peer-reviewed models in the field of operations research for quantifying the risks of transporting hazardous materials because it “is an important decision problem that is of interest to hazmat producers and consumers, hazmat carriers, local governments, insurance companies, and the people exposed to the risks from the shipments” and a complicated problem that is mathematically interesting (Erkut and Verter 1998). Other transportation problems differ from hazardous materials routing because of the element of risk (Erkut et al. 2007) associated with the cargo and because it is “an important, complex, socially and environmentally sensitive problem; involving a plethora of parameters: economic, social and environmental” (Barilla et al. 2009). Unlike other transportation problems, where the main objective is to minimize the costs or time associated with shipping, hazardous materials transportation requires minimization of hazards exposures from accidents (Erkut and Verter 1998, Barilla et al. 2009), which is an important consideration for not just researchers, but also for government bodies, regulatory authorities, and

## Definition of risk

Risk models in the peer-reviewed literature are nearly always a function that represents both the probability of an incident, like a spill, occurring and the consequences of such an event. The idea that risk is a product of two elements is found in the public health rating matrix shown in Section 4.18 (USFS 2022, p. 4.515, Table 4.18-2), reproduced as Table 27. No quantitative ranges were cited for what constitutes unlikely, sometimes likely, and often likely occurrences, but it would be possible to assign such ranges, which may be context-dependent, in a fashion similar to Table 5.

*Table 27. Public health rating matrix (USFS 2022).*

| Magnitude of Health Impact | Low possibility of health impact occurrence (unlikely to occur) | Medium possibility of health impact occurrence (likely to occur sometimes) | High possibility of health impact occurrence (likely to occur often) |
|---|---|---|---|
| None | negligible | negligible | negligible |
| Low | negligible | minor | moderate |
| Medium | minor | moderate | major |
| High | moderate | major | major |

There are many ways to model risk, as explained by Erkut and Verter (1998), italicized emphasis added

> [T]here is no agreement among researchers on the proper representation of the associated transport risks… Although risk is a popular term in the media, and a popular topic with many authors, there is no universally accepted definition of risk. Most people would agree that risk has to do with the probability and the consequence of an undesirable event. Although some authors define risk as only one of these terms (i.e., probability or consequence), *it is more common to define risk as the product of both the probability of and the consequence of the undesirable event (Covello and Merkhofer 1993). Note that this is an "expected consequence" definition, and it is the definition that we refer to as "traditional risk" in this paper (primarily for the reason that it is the definition used in the U.S. Department of Transportation 1989 guidelines for transporting hazmats, which have influenced many researchers in this area).* We emphasize that, depending on the circumstances, it might make sense to use other definitions of risk.

In various forms, probability, frequency, and consequences of accidents are all components of measuring risk. For example, Etkin (2006) stated, italicized emphasis in the original

> Risk assessment incorporates an evaluation of both the *probability* and *consequences* of particular events. Wtih (*sic*) oil spills, risk assessment requires looking at the *frequency* of spill incidents from historical spill rates, as well as measuring the *consequences* or *potential impacts* (costs and damages) of spill incidents. Impacts vary with oil type, spill magnitude, and a variety of location-related factors (*e.g.*, sensitive natural and socioeconomic resources, waterway type).

Similarly, Qiao et al.'s (2009) definition of risk was "a combination of two parameters: frequency and the magnitude of the consequence" and Barilla et al.'s (2009) was "the expected consequences associated with a given activity." As an example, consider the possibility of trying to stand on one leg for an extended period. In theory, on a flat surface with no wind or other factors that might influence a person to lose their balance, the probability of falling over should not depend on where a person was attempting to stand. If attempt is indoors on carpet in the middle a room with no objects to hit if the attempter fell, the consequences of losing balance would be minimal. On the other hand, if the attempt is near the edge of a long vertical drop, the consequences of losing balances could be grave. This example is silly in many ways but serves to illustrate that just knowing the probability of an event is insufficient to assess its risk. A 10% chance of falling over may seem trivial when there's a soft place to land; a 10% chance of falling over may be completely unacceptable when the potential consequences are much greater.

## Goals of quantitative risk analysis

Risk assessment can be qualitative, dealing with identifying possible accident scenarios and attempting to estimate the resulting impacts and consequences (Erkut et al. 2007), and there are frequent examples of such qualitative assessments in the EISs and EAs for other mines (see later in this section for examples), as well as the SDEIS for SGP. Quantitative risk assessment (QRA), on the other hand, "results in a numerical assessment of risks involved, for example, an expected number of individuals impacted per year" (Erkut et al. 2007). QRA has three component steps: 1. Estimation of the probability (and frequency) of an incident; 2. Identifying the hazard impacts associated with an incident and the relative levels of exposure (to people or the environment) along various route segments; and 3. Modeling the magnitude of the consequences (Erkut et al. 2007, Kazantzi et al. 2011). Particularly in EISs which include several options for transportation corridors, QRA allows for objective measurement and comparison of potential impacts from spills of hazardous materials.

Erkut et al. (2007)

> The language of QRA is one of *frequencies* and *consequences*, and unlike in qualitative risk analysis, QRA results in a numerical assessment of risks involved, for example, an expected number of individuals impacted per year.

## Impacts and consequences to consider and model

Fatalities are an obvious harm to avoid in transporting hazardous materials, and so population density measures around routes are important measures to have (Erkut and Verter 1998). Additional costs and risks to minimize include travel distance, population exposure, societal risk, traditional risk, accident probability, and incident probability (Erkut and Verter 1998). Other potential consequences include health effects, such as death, injury, or long-term exposure effects, property loss, environmental effects, or interruptions in routines such as population evacuations or traffic stoppages along the route (Erkut et al. 2007). Not all spills are created equal, and the "[i]mpacts of hazardous material releases during transport depend on the characteristics of the cargo, incident location and time, weather conditions (i.e., wind direction and speed), and land use" (Inanloo et al. 2015).

Erkut and Verter (1998)

> One can argue that lower incident probabilities should be preferred to higher ones, and lower population exposures should be preferred to higher ones. Thus, we can view the risk minimization problem as a bicriterion optimization problem: one of minimizing incident probability and population exposure.

Erkut and Verter (1998)

> [R]oute evaluation and selection models… are network optimization models, where roads are represented as edges of the network. In the context of hazmat routing it is desirable for an edge to be relatively uniform in its two important attributes: incident probability and population density around the roads.

Erkut and Verter (1998)

> Risk modeling objectives can include minimizing one or more of the following:
>
> 1. Shortest travel distance,
> 2. Minimum population exposure,
> 3. Minimum societal risk,
> 4. Minimum DoT risk,
> 5. Minimum accident probability, and
> 6. Minimum incident probability.

Barilla et al. (2009) demonstrated how to consider several risk measures to minimize (travel time, travel distance, risk for the population, risk for the urban environment, and risk related to a natural hazard) coupled with a matrix describing the relative weight each of those metrics. Barilla et al. (2009) note that "The objectives are not fixed; they reflect the interests of stakeholders in the decision-making process."

Erkut and Verter (1998)

> Although there can be many undesirable consequences of an incident (such as damage to wildlife, economic losses, and injuries), almost all the literature in this area is concerned with fatalities. Hence, it is common to assume that the undesirable consequence is proportional to the size of the population in the neighborhood of the incident, where the size of the neighborhood depends on the substance carried.

Inanloo et al. (2015)

> Impacts of hazardous material releases during transport depend on the characteristics of the cargo, incident location and time, weather conditions (i.e., wind direction and speed), and land use.

Erkut et al. (2007)

> Risk is the primary ingredient that separates hazmat transportation problems from other transportation problems. … In the context of hazmat transport, risk is a measure of the probability and severity of harm to an exposed receptor due to potential undesired events involving a hazmat (Alp, 1995). The exposed receptor can be a person, the environment, or properties in the vicinity. The undesired event in this context is the release of a hazmat due to a transport accident. The consequence of a hazmat release can be a health effect (death, injury, or long-term effects due to exposure), property loss, an environmental effect (such as soil contamination or health impacts on flora and fauna), an evacuation of nearby population in anticipation of imminent danger, or stoppage of traffic along the impacted route. Risk assessment can be qualitative or quantitative. Qualitative risk assessment deals with the identification of possible accident scenarios and attempts to estimate the undesirable consequences.

## Frequency analysis

Deriving an estimate of spill probability (or frequency) is an essential first step. Models for spill probability range from very simple to very specialized and detailed. As we have seen with the $N = RT$ model, simple (and therefore popular) models may only take a few factors into consideration, but other factors such as different types of roads, truck configurations, operating conditions, environmental factors, and road conditions (Qiao et al. 2009) add to the list of parameters to consider individually and in combination.

Erkut et al. (2007)

> The frequency analysis involves (a) determining the probability of an undesirable event; (b) determining the level of potential receptor exposure, given the nature of the event; and (c) estimating the degree of severity, given the level of exposure (Ang and Briscoe,

> 1989). Each stage of this assessment requires the calculation of a probability distribution, with stage (b) and (c) involving conditional distributions.

Qiao et al. (2009)

> [A]ccident frequency estimation is essential for risk analysis.

Qiao et al. (2009)

> Currently, the most popular data cited for accident frequency takes only a few factors into consideration. This paper presents a methodology to estimate the accident frequency for different types of roads by incorporating the effects of a larger number of parameters, including the nature of truck configurations, operating conditions, environmental factors, and road conditions.

Qiao et al. (2009)

> Accident frequency can be defined as the number of accidents per unit of road (mile, kilometer, etc.). The frequency can be computed by dividing the number of accidents by the number of vehicle miles, which is the corresponding exposure measure of opportunities for an accident to occur. There are three basic options to assess accident frequency with reasonable accuracy. The first is to obtain at least one database and analyze both accident data and travel data for the specific conditions under investigation (assuming that the dataset is structured to support distinctions between the desired variables). The second option is to access state databases for specific routes. Frequently, states have accident data and travel data for major state highways. A third option is to use an existing limited analysis of databases and apply the results to a specific route of interest.

Kazantzi et al. (2011)

> There is a double-centered arena of HazMat transportation problems; one considered with optimal transportation routing and the other with risk probabilities evaluation of HazMat transportation.

Not all accidents result in spills, not all trucks carry the same types of hazardous materials in the same load sizes, and not all spills release the same amounts of hazardous substances. Therefore, a more detailed frequency analysis requires more data which can be used to not only determine the probability of an undesirable event but also assess how severe the events are and how such events affect their surroundings (Erkut et al. 2007).

## Models of risk

Models vary in how they incorporate consequences into the math, depending on the priorities of the specific application. Erkut and Verter (1998) identified five models for quantifying risk along different potential routes that hazardous materials might travel: traditional risk, population exposure, incident probability, perceived risk, and conditional risk. Erkut et al. (2007) expanded the list to nine models by adding maximum population exposure, expected disutility, mean-variance, and demand satisfaction models. Only one of these formulations, the population exposure model, did not include some form of *p*, the probability of an incident along a route segment (Table 28).

*Table 28. Various models of path risk shown in Erkut et al. (2007). In these models $p_i$ is the probability of an incident along segment i, and $c_i$ is a measure of the consequence (e.g., population size that would be affected) along segment i for path segments 1 to n.*

| Model | Approximation formula | Notes |
|---|---|---|
| Traditional risk | $\sum_{i=1}^{n} p_i c_i$ | Used by the Department of Transportation |
| Population exposure | $\sum_{i=1}^{n} c_i$ | Measures the total consequence along the entire route |
| Incident probability | $\sum_{i=1}^{n} p_i$ | Measures the total probability along the entire route |
| Perceived risk | $\sum_{i=1}^{n} p_i c_i{}^{\alpha}$ | $\alpha > 0$; allows the modeler to increase the importance of the consequence as it gets larger |
| Conditional risk | $\frac{\sum_{i=1}^{n} p_i c_i}{\sum_{i=1}^{n} p_i}$ | Addresses the size of the consequence if it known that an event will occur |
| Maximum population exposure | $\max e_i \in pc_i$ | Finds the largest consequence along the route |
| Expected disutility | $\sum_{i=1}^{n} p_i\,(\exp\,(\alpha c_i) - 1)$ | $\alpha > 0$; "incorporates the risk aversion of the society toward hazmat incidents, especially incidents with very large consequences" |
| Mean-variance | $\sum_{i=1}^{n} (p_i c_i + \beta p_i c_i{}^2)^4$ | $\beta > 0$; "identifies the least expected length path subject to the constraint that the variance of the path length is within a pre-specified threshold" |
| Demand satisfaction | $\sum_{i=1}^{n} (1 - \exp(-p_i)) c_i \prod_{j=1}^{n} \exp(p_i)$ | Considers that additional shipments will be necessary following an incident to fill the demand that went unmet due to the event |

Erkut et al. (2007) categorized hazardous materials transportation models in the peer reviewed literature from 1973-2004 in four general classes: 1. risk assessment; 2) routing; 3) combined facility location and routing; and 4) network design, but also noted that many problems intersect multiple classes. See Table 2a (Erkut et al. 2007) for a list of peer-reviewed papers on the topic of risk assessment for hazardous materials transportation and Table 2b (Erkut et al. 2007) for hazardous materials transportation routing models for transport by road, rail, marine, and/or air.

Choosing a risk model is not straightforward and using different criteria can lead to defining different routes as optimal. For example, when Erkut and Verter (1998) compared five different models of risk, they:

> searched for answers to the following two questions: "How similar are the paths found by different objectives for a given origin-destination pair?" and "How does the optimal solution for one objective perform under the other objectives?" Our analysis was performed using a professional decision-support system for hazmat route selection. … We found that the optimal paths with respect to the three fundamental risk models—namely, minimizing the traditional definition of risk, minimizing total incident probability, and minimizing total population exposed—do not exhibit strong similarities…. Based on our analysis, we conclude that considerable attention should be paid to the modeling of risk for hazmat transport since the different objectives that are suggested in the literature cannot be used interchangeably. Different models result in different paths, and the models do not tolerate one another very well. (Erkut and Verter 1998)

Fortunately, it is not necessary to force those optimization criteria into agreement. Barilla et al. (2009) demonstrated how to consider several risk measures to minimize (travel time, travel distance, risk for the population, risk for the urban environment, and risk related to a natural hazard) coupled with a matrix describing the relative weight each of those metrics. Barilla et al. (2009) note that "The objectives are not fixed; they reflect the interests of stakeholders in the decision-making process." Considering many types of impacts for specific spill substances and circumstances is complicated, but oversimplified models can miss important differences in spill impacts. As described by Inanloo et al. (2015) from a modeling exercise with two chemicals and different atmospheric conditions:

Inanloo et al. (2015)

> The health risks were calculated for the two chemicals and under different atmosphere stability scenarios. Two approaches were taken into account in order to estimate the risk, which are based on the size of the impact area and the population under risk. The size of the area impacted after a chemical release depends on the characteristics of the chemical along with the meteorological and atmospheric conditions. However, the magnitude of the population exposed depends on the population density in the surrounding area. In this regard, a similar an accidental release in two different locations would affect similar square miles but different number of people depending of the populations density (i.e., rural, urban).

Inanloo et al. (2015)

> The analyses showed that the impact zones can be significantly different for different types of hazardous cargo. …. The overlay of the toxic threat zone plots over the GIS map of the accident location provided an effective tool to visualize the geographical domain affected by the release (number of people exposed, age distribution of the exposed population, potential secondary exposure routes such as water and soil). …. The health risks estimated based on the area and population at risk showed the significance of the consequences of the accidental releases. The analyses showed that the risk which is quantified for a specific consequence can be different from the risk quantified based upon another type of consequence (e.g., impacted area vs. population). … Therefore, a great consideration should be focused on the selecting of the consequences of accidents. The results vary depending on the released chemical, atmospheric condition, location, traffic volume, and crash rate data. … Considering uncertainties and lack of data, risk assessments similar to the proposed approach can help to decrease the accidental release risks of hazardous chemicals during transport by avoiding densely populated areas or segments with high crash rates, as well as selecting specific paths or road segments based on their level of accident risks. The multilevel analysis of impacts after hazardous material releases during transport (i.e., type of material, geographical data, dispersion profile, meteorological information, population density, and traffic data) can be used for planning and implementing appropriate response and mitigation measures for hazardous cargo releases to atmosphere. The insights provided by this research can aid decision makers for routing and scheduling of hazardous material cargos and developing strategies which avoid high-risk and vulnerable regions for transporting hazardous materials.

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> consequence (e.g., impacted area vs. population). … Therefore, a great consideration should be focused on the selecting of the consequences of accidents. The results vary depending on the released chemical, atmospheric condition, location, traffic volume, and crash rate data. … Considering uncertainties and lack of data, risk assessments similar to the proposed approach can help to decrease the accidental release risks of hazardous chemicals during transport by avoiding densely populated areas or segments with high crash rates, as well as selecting specific paths or road segments based on their level of accident risks. The multilevel analysis of impacts after hazardous material releases during transport (i.e., type of material, geographical data, dispersion profile, meteorological information, population density, and traffic data) can be used for planning and implementing appropriate response and mitigation measures for hazardous cargo releases to atmosphere. The insights provided by this research can aid decision makers for routing and scheduling of hazardous material cargos and developing strategies which avoid high-risk and vulnerable regions for transporting hazardous materials.

## Summary

Even though the spill probability for a single trip with hazardous materials is low, spills can be extremely harmful to human health and the environment, and the full measure of risks and impacts need "to be assessed and characterized even in the absence of sufficient data for the quantification of all parameters involved" (Kazantzi et al. 2011). Spills of hazardous materials can have undesirable consequences ranging from economic losses from loss of product, cleanup costs, and property damage, injuries, traffic delays, evacuations, environmental pollution, damage to wildlife, and fatalities (Batelle 2001, Erkut et al. 2007). Quantitative measures of risk, singly or in combination, can be used in an absolute sense to inform stakeholders or comparatively to select an optimal route, including one associated with a No Action Alternative in an EIS (Barilla et al. 2009, Kazantzi et al. 2011). Although formulations for risk vary and can incorporate a range of consequences (safety, environmental harm, etc.), having a measure of the spill frequency over the entire transportation corridor is an essential component of the analysis.

# 11. Other concerns related to the transportation corridor or spills

The bulk of this analysis has focused on quantifying the likelihood of hazardous materials spills along the SGP transportation corridor. While spills from trucks are important to model, they comprise only one aspect of several larger questions.

- What could the impacts to fish and aquatic habitats be?
- What are the public health risks are associated with mine traffic?
- What other effects could roadways have?
- What about spills from other sources, such as the tailings and contact water pipelines or the reagent storage facilities?
- Finally, how good are spill predictions when they are compared to observations, and what might that tell us about how to view the predictions made thus far?

## Impacts to fish and aquatic habitats

The assessment of hazardous spill risk on fish and aquatic habitats contains several problematic statements, some of which are in italics in the extract shown:

USFS (2022), p. 4.347, 4-348; text in **bold** was present in the DEIS (USFS 2020) but not in the SDEIS (USFS 2022) and *italicized* text is new in the SDEIS.

I will address the underlined sentences in order.

> It is expected the risk associated with a spill large enough to negatively affect fish or aquatic habitat would generally be low *but possible*. **This varies depending on the substance that is spilled but considers typical substances that would be transported**. An exception may be when materials are transported during inclement weather conditions, this could increase the risk to moderate. Spills during the winter would be easier to contain because spilled material would not penetrate frozen ground as readily as unfrozen ground, and snow could absorb the spilled material *in addition to the visual contrast between snow and fuel could aid in cleanup*. However, areas that are harder to access **(e.g., remote or in a canyon)** may increase the time it takes to access and cleanup a spill, creating the potential for fish or **fish** *aquatic* habitat to be in contact with a hazardous material longer and could impact more fish or fish habitat.

> **The duration of spill risks would extend throughout the SGP. The geographic extent of impacts would depend on the location and size of the spill and the effectiveness of the response. <u>The extent of the spill risk was limited to streams within 91 meters of the access roads - and downstream of spill locations.</u>**
>
> While the likelihood of a spill is **low** *negligible* to moderate, the magnitude of impacts could be ***high*** *major* to individuals exposed to harmful concentrations of hazardous materials *making impacts of spills moderate, temporary, and localized depending on the type of material releases, the location of the spill, and the presence of fish and aquatic species in the affected area.* **<u>The duration of the risk of impacts would extend throughout the SGP.</u>**

*1. It is expected the risk associated with a spill large enough to negatively affect fish or aquatic habitat would generally be low but possible.*

Section 9 of this report shows that there is a 47-64% chance of at least one hazardous material spill during the 15-year operating life of the Project within the analysis area as defined in the SGP SDEIS, a probability that grows to 93-99% when the larger extent of the true transportation corridor is considered. This report has not included any information on spill size distribution, so I cannot speculate on how many spills would qualify as serious as defined by PHMSA or meet a biologically significant threshold.

*2. This varies depending on the substance that is spilled but considers typical substances that would be transported*.

This sentence was not present in the SDEIS. The reagents that would be transported to the mine most often and could be considered "typical substances" include diesel, propane, gasoline, lubricants, waste oil, antimony concentrate, lime, sodium metabisulfite, ammonium nitrate, sodium cyanide, copper sulfate, and potassium amyl xanthate. For details about their specific properties, see Appendix A.

*3. The extent of the spill risk was limited to streams within 91 meters of the access roads - and downstream of spill locations.*

There was no threshold distance specified to define the extent of impacts from roadways, including potential spills. For the Pebble Mine, a 200 m road effect zone was used to assess roadway impacts (Kravitz and Blair 2019). The Burntlog Route has 9 miles of roadway within 0.5 miles of streams and the Johnson Creek Route has 27 miles of roadway within 0.5 miles of streams (Table). In addition, Warm Lake Road includes 4.1 km of steelhead IP habitat and 9.1 km of bull trout IP habitat within 100 yards of the roadway centerline (Table 12).

*4. The duration of the risk of impacts would extend throughout the SGP.*

This sentence was not present in the SDEIS. The duration of the spill risk extends throughout the 15-year operations period of the mine and, to a lesser extent, throughout the 25-year post closure and water treatment phase, but this is not explicitly stated in the SDEIS the way it was in the DEIS.

## Public health risks associated with mine traffic

The impact rankings (negligible, minor, moderate, and major) in the section below from SGP DEIS and SDEIS Section 4.18 refer to the public health rating matrix shown in Table 27 in Section 10 of this report.

The SDEIS (USFS 2022, p. 4-521) shows that public health impacts due to the increased traffic associated with the SGP would be direct and negative, with high impact. Those impacts were described as having “medium” possibility of occurrence. Section 9 of this report shows that there is a 99-100% chance of at least one crash involving a heavy vehicle carrying hazardous material during the 15-year operating life of the Project within the analysis area as defined in the SGP SDEIS, and that 4.7 to 6.0 such accidents are expected. Once the geographical scope reflects the true transportation corridor length, 20-25 accidents involving heavy vehicles laden with hazardous chemicals are predicted. The high probability I calculated reinforces the designation of heavy vehicles having a major public health impact.

As noted in the DEIS, (USFS 2020, p. 4.18-34), even under baseline conditions,

> The entire SGP area presents potential flash-flood and debris-flow hazards that also can cause severe injury or death, or block access. Some portions of the mine site also are conducive to landslides and avalanches. Fires can cause severe injury or death for travelers, recreationists, and Forest Service and Midas Gold employees, as well as damage to property.

and the action alternatives increase the risk of exposing people to natural hazards like avalanche and landslides (USFS 2020, p. 4.18-34):

> The SGP would increase the risk of damage, injury, or loss of life by allowing the increase in people traveling through the area to the mine site and construction and/or use of roads would increase the risk of damage, injury, or loss of life from such hazards by allowing additional people and facilities into avalanche susceptible areas.

## Other roadway impacts

Other roadway impacts not related to hazardous material transport include dust, application of chemicals, and changes to the drainage that result from new or modified roadways.

Kravitz and Blair (2019)

> Dust results from traffic operating on unpaved roads in dry weather, grinding and breaking down road materials into fine particles (Reid and Dunne 1984). The amount of dust derived from a road surface is a function of many variables, including composition and moisture state of the surface, amount and type of vehicle traffic, and speed. Dust particles are either transported aerially in the dry season or mobilized by water in the wet season. These fines may also include trace contaminants, including deicing salts, hydrocarbons, and metals. Following initial suspension by vehicle traffic, aerial transport by wind spreads dust over long distances, so that it can reach surface waters that are

> otherwise buffered from sediment delivery via aqueous overland flow. Dust control agents such as calcium chloride have been shown to reduce the generation of road dust by 50–70% (Bader 1997), but these agents may cause toxic effects when they run off and enter surface waters.

Kravitz and Blair (2019)

> To estimate the amount of dust generated from the transportation corridor we used an Iowa Highway Research Board project (Hoover et al. 1973) that quantified dust sources and emissions created by traffic on unpaved roads. According to that study, one vehicle, traveling 1 mile of unpaved road once a day every day for 1 year, would result in the deposition of 1 ton of dust within a 1000-foot corridor centered on the road (i.e., traffic would annually deposit 1 ton of dust per mile per vehicle).

Kravitz and Blair (2019)

> Roads are treated with salts and other materials to reduce dust and improve winter traction. In Alaska, calcium chloride is commonly used for dust control and is mixed with sand for winter application. Compounds used to control ice and dust (Hoover 1981) have been shown to cause toxic effects when they run off and enter surface waters.

Kravitz and Blair (2019)

> Roads modify natural drainage networks and accelerate erosion processes, which can lead to changes in streamflow regimes, sediment transport and storage, channel bank and bed configurations, substrate composition, and the stability of slopes adjacent to streams (Furniss et al. 1991). These changes may occur long distances from the road, both down- and up-gradient of the road crossing (Richardson et al. 2001). Road construction can increase the frequency of slope failures by orders of magnitude, depending on variables such as soil type, slope steepness, bedrock type and structure, and presence of subsurface water. These slope failures can result in episodic sediment delivery to streams and rivers, potentially for decades after roads are built (Furniss et al. 1991; Trombulak and Frissell 2000). All of these potential changes can have important biological consequences for anadromous and resident fishes by negatively affecting food, refugia, spawning habitat, water quality, and access for upstream and downstream migration (Furniss et al. 1991).

## Pipeline spills: tailings and contact water

Midas Gold, Idaho, Inc. (2016), p. 149

> Tailings are what remain after desired recoverable minerals are removed from ore. Tailings at the Stibnite Gold Project will be comprised of the finely ground rock materials remaining after the minerals stibnite (hosting antimony and some silver) and pyrite (hosting the gold and some silver) and free gold, are extracted and concentrated in the ore processing facility…
>
> To ensure long-term operational integrity, the tailings pipeline will be a 24-inch diameter carbon steel pipe (or equivalent), lined with high-density polyethylene (HDPE). A geosynthetic-lined trench will provide secondary containment of the pipeline and capture any potential release or spillage. The trench will have emergency containment catchment basins at low points along the alignment to collect any leakage, precipitation or runoff collected within the trench. The geosynthetic-lined trench will also house an 18-inch HDPE (or equivalent) reclaim water return pipeline to supply recycled water back to the ore processing facility.

No flow rates or failure likelihoods are given for these pipelines, not are their lengths, making it impossible to assess the expected number or probability of a spill, the duration of a spill, or the potential volume that might be released. Without that analysis, environmental impacts of releases of tailings or contact water cannot be assessed.

## Reagent storage spills

The assessment of hazardous spill risk from storage facilities contains problematic statements, some of which are in italics in the extract shown. The DEIS and SDEIS had similar if not identical language, contrasted below. I will address the italicized sentences in order (language based on the SDEIS when it differs from the DEIS) following the SDEIS text.

USFS (2020), p. 4.7-10; text in **bold** was not included in the corresponding section of the SDEIS; paragraph breaks added to aid in comparison of the text from the DEIS and the SDEIS

> Spills at Mine Site and Off-Site Facilities

> *A large volume release to the environment at the mine site or off-site facilities (SGLF,* ***Landmark*** *Maintenance Facility) is not likely to occur based on the planned infrastructure specifically designed for the storage and management of hazardous materials and use of secondary containment.* **There was a reportable spill at the mine site from a plane crash in February of 2012 that resulted in a diesel spill. There have been no reportable spills since then.**
>
> *In the event a* ***release*** *was to occur, it would be relatively small in volume* ***based on estimated*** *container volumes* and would be promptly addressed by stopping the source of the spill, using absorbent material or barriers to prevent further migration of the spilled material, and removing, characterizing, and properly **disposing of any impacted soil** per implementation of the prescribed SPCC Plan and/or Emergency Response Plan recovery efforts.
>
> The bulk fuel storage facilities would be constructed with **appropriate, redundant, and legally required protection** systems in place. The **fuel** tanks would be aboveground and located within **a concrete-**lined secondary containment facility that would be capable of holding a minimum of 110 percent of the largest tank volume present within the containment **(Midas Gold 2016).**
>
> *For these reasons, possible spill-related impacts to surface water and other physical resources would be low to negligible.* Any effects would be temporary in duration, assuming proper spill response measures, but the low risk of spills would be throughout the life of the SGP (long-term). **Spills would be limited to the immediate area of release and would therefore be local in geographic extent. The effects would be localized, though spills to flowing water could spread contaminants downstream. Some materials that are highly toxic (e.g. cyanide) could result in greater impacts to a localized area**.

USFS (2022), p. 4-137 and 4-138; text in **bold** was not included in the corresponding section of the DEIS

> Spills at Mine Site and Off-Site **SGP** Facilities
>
> *A large volume release to the environment at the mine site or off-site facilities (SGLF,* ***Burntlog*** *Maintenance Facility) is not likely to occur based on the planned infrastructure specifically designed for the storage and management of hazardous materials and use of secondary containment.* **A copy of the SPCC plan would be kept at an appropriate on-site facility. Staff handling fuel or hazardous materials would be trained to successfully implement the SPCC plan. Inspections of the storage and handling areas would be conducted as specified in the SPCC plan and appropriate warning signs would be placed around storage facilities**.
>
> **All contractors and company staff involved in handling oil and other chemicals would be made aware of the SPCC plan, spill kit locations, and appropriate emergency response procedures, and would be required to abide by all applicable**

> **federal, state, and local laws and regulations pertaining to their respective operations. Annual spill awareness/response training would be required for on-site personnel and suppliers/providers.**
>
> *In the event a* ***leak or spill*** *was to occur, it would* ***likely*** *be relatively small in volume* ***compared to the*** *container volumes* and would be promptly addressed by stopping the source of the spill, using absorbent material or barriers to prevent further migration of the spilled material, and removing, characterizing, and **properly handling the cleanup wastes** per implementation of the prescribed SPCC Plan and/or Emergency Response Plan recovery efforts.
>
> The bulk petroleum **and reagent** storage facilities would be constructed with **secondary containment** systems in place. The tanks would be above ground and located within lined secondary containment facilities that would be capable of holding a minimum of 110 percent of the largest tank volume present within the containment. **All process areas that include process liquids in tanks, vessels, or pipes would also include lined spill containment and collection sumps or ponds to retain any leaks or spills of process water or slurries. These materials would be recycled back into the process circuits without discharge to the environment.**
>
> **Spills from transporters or mine equipment outside of secondary equipment at the site would be immediately responded to in order to limit effects to the immediate area of release and would therefore be local in geographic extent. Containment of any such spills to prevent migration of spilled material to flowing surface waters would be a maximum priority. Timely cleanup of any spilled materials and contaminated soils would reduce potential for longer-term contamination of surface water or groundwater.**
>
> **A standard marine-type fuel containment boom (which would be of sufficient length for a worst-case discharge), spill prevention kit, and fire kit would be stored at the re-fueling site and would be readily available during off-loading of fuel from the fuel trucks or during re-fueling operations.**
>
> **For these reasons, the overall direct and indirect effects of hazardous materials and other substances would depend on the location where a spill occurs and the amount and type of material released**. *For these reasons, possible spill-related impacts* ***of fuels or hazardous materials*** *to surface water,* **groundwater,** *and other physical resources* ***from these facilities*** *would be* ***localized and*** *low to negligible.* Any effects would be temporary in duration, **considering** proper spill response measures, but the low risk of spills would be throughout the life of the SGP (long term).

*1. A large volume release to the environment at the mine site or off-site facilities (SGLF,* ***Burntlog*** *Maintenance Facility) is not likely to occur based on the planned infrastructure specifically designed for the storage and management of hazardous materials and use of secondary containment.*

Etkin (2006) studied oil spill incident data for the years 1980 – 2003. She analyzed nearly 52,000 oil spills of at least 50 gallons that had at least 1 gallon reach a navigable waterway in the US. The spills originated from pipelines, vehicles, vessels, rail, and spill prevention, control, and countermeasure (SPCC) facilities, among others. She found that the largest sources of oil spilled (by volume) into inland waterways are pipelines and SPCC facilities, that the largest number of oil spills came from SPCC facilities, and that spills from SPCC facilities have an average size of almost 6,000 gallons (Etkin 2006).

*2. In the event a* ***leak or spill*** *was to occur, it would* ***likely*** *be relatively small in volume* ***compared to the*** *container volumes.*

The SGP SDEIS mentions the total amounts of storage available at the mine site for diesel, gasoline, and propane, but not the number and size of the containers. The storage volumes range from 10,000 to 200,000 gallons.

USFS (2022), p. 2-75

> **Diesel Fuel, Gasoline, and Propane**
>
> Aboveground storage tanks at the SGP would be used for fuels and other fluids, including gasoline, diesel fuel, lubricants, coolants, hydraulic fluids, and propane. Approximately 200,000 gallons of diesel fuel, 10,000 gallons of gasoline, and 30,000 gallons of propane would be stored at the SGP in addition to a variety of materials, supplies, and reagents

*3. For these reasons, possible spill-related impacts* ***of fuels or hazardous materials*** *to surface water,* ***groundwater,*** *and other physical resources* ***from these facilities*** *would be* ***localized and*** *low to negligible.*

See responses to 1 and 2.

## Mine EIS spill risk impacts: predictions vs. reality

One important question to address is how accurately the potential impacts and effects described in an EIS are predicted. We can get a sense from a retrospective analysis done comparing the spill impacts described in the permitting documents for five large, operational hardrock mines in Alaska and their respective spill records from 1995-2020 (Lubetkin 2022). The retrospective analysis reviewed state and federal government records for the five major hardrock mining operations in Alaska (Pogo, Kensington, Greens Creek, Fort Knox/True North, and Red Dog), with the following objectives:

- Assess what spill risks are addressed in the permitting documents
- Use a consistent quantitative model for estimating the number of spills predicted and the probability of at least one trucking accident spill for all hazardous materials
- Compare actual spills to predicted numbers
- Offer model critiques
- Identify data gaps
- Synthesize the findings and make recommendations for the environmental review process for proposed new mines and mine expansions.

Alaska has a long history of mining and with it, a trove of mine permitting documents and environmental records. Hardrock mines are large industrial facilities that generate and use large volumes of hazardous and toxic materials that present a significant environmental and public health risk if spilled into the environment. The permitting process is intended to provide decision-makers and the public with accurate information about the potential risks associated with a proposed mine, including any associated pipelines and access roads.

The retrospective report considered five large, hard rock mines that are currently in production in Alaska: Pogo, Kensington, Greens Creek, Fort Knox/True North, and Red Dog. The five mines are mix of underground mines (Pogo, Kensington, and Greens Creek) and open pit mines (Fort Knox/True North and Red Dog) and extract different ores. Each mine can be viewed as an experiment in which predictions were made about the outcomes and effects of construction and operation in the permitting documents which can then be tested against the actual history. The report focused on spill risks as presented in environmental assessments (EAs), environmental impact statements (EISs), or plans of operation and compares those with the spill records kept by the Alaska Department of Environmental Conservation (ADEC). The goal was to see how accurately spill risks were predicted and described in the permitting stages and see what might need to be done to improve EISs for future mines so that the public and decision-makers have more accurate information about the potential risks.

Based on the descriptions within the permitting documents for each mine, I compiled as complete a record of hazardous materials as was given. The information I searched for included the entire list of processing reagents, water treatment chemicals, diesel, ore concentrate, blasting agents, and other hazardous materials, as well as the annual use quantities, the methods of transport, and the load size per trip. Diesel can be used in blasting, as a reagent, and/or in power generation and may have different quantities proposed in permitting documents, depending on the specifics of the alternatives analyzed.

As with the proposed SGP, the total number of truck-miles can be used with a spill rate per truck mile to estimate the number of expected spills ($E(N)$) and the probability of there being at least one spill from a truck over different time frames ($P(N \geq 1)$). Harwood and Russell (1990) estimated that $1.9 \times 10^{-7}$ spills occur per truck mile for rural two-lane roads. Although this estimate predates some of the EISs, such as the 1984 EIS for Red Dog, it was cited in some of the EISs for the case study mines. For consistency of risk comparison across mines, I used the Harwood and Russell (1990) spill rate for all the large mines considered here. Using this estimated spill rate, the expected number of spills ($E(N)$) associated with the mine over a given time period is

$$E(N) = \text{spill rate per mile x total miles traveled} = RT$$

where $R = 1.9 \times 10^{-7}$ spills per truck mile and the total miles traveled, $T$, depends on which years of production and operation are considered. If we assume that spills follow Poisson distribution (as is commonly done for independent, randomly occurring events that are relatively rare), then the probability of at least one spill during a certain period is

$$P(N \geq 1) = 1 - P(N = 0) = 1 - \exp(-RT)$$

We can estimate the number of truck miles based on data given in the EISs and other documents and compare $E(N)$ with the actual number of spills from trucking accidents in the ADEC database (ADEC 2021).

## ADEC Spill Reporting Requirements and terminology

Alaskan spill reporting requirements can be found at https://dec.alaska.gov/spar/ppr/spill-information/reporting (accessed on July 20, 2021; emphasis in the original):

> Notification requirements
>
> Hazardous Substance Releases
>
> *Any* release of a hazardous substance ***must be reported*** as soon as the person has knowledge of the discharge.
>
> Oil/Petroleum Releases
>
> **To Water:**
>
> • ***Any*** release of oil to water *must be reported* as soon as the person has knowledge of the discharge.
>
> **To Land:**
>
> • ***Any*** release of oil in ***excess of 55 gallons*** must be reported as soon as the person has knowledge of the discharge. Any release of oil in ***excess of 10 gallons but less than 55 gallons*** must be reported within 48 hours after the person has knowledge of the discharge. A person in charge of a facility or operation shall maintain, and provide to the Department on a monthly basis, a written record of discharge of oil from *1 to 10 gallons*.
>
> **To Impermeable Secondary Containment Areas:**
>
> • Any release of oil in ***excess of 55 gallons*** must be reported within 48 hours after the person has knowledge of the discharge.

ADEC collects information related to up to 30 spill incident descriptors. Among them is the spill substance type, which falls into one of six categories: *Crude oil, extremely hazardous substances, hazardous substances, non-crude oil, process water,* and *unknown*, each of which is a subset of the broader category hazardous materials. Within those, there is further clarification for hazardous substance, extremely hazardous substance, and process water (mining operations) (ADEC 2007):

> **Hazardous substance:** means (A) an element or compound that, when it enters into or on the surface or subsurface land or water of the state, presents an imminent and substantial danger to the public health or welfare, or to fish, animals, vegetation, or any part of the natural habitat in which fish, animals, or wildlife may be found; or (B) a

> substance defined as a hazardous substance under 42 U.S.C. 9601-9657 (Comprehensive Environmental Response Compensation, and Liability Act of 1980); "hazardous substance" does not include uncontaminated crude oil or uncontaminated noncrude (refined) oil in an amount of 10 gallons or less.
>
> **Extremely hazardous substance:** Although there is no definition for extremely hazardous, the Senate Report on the Clean Air Act provides criteria EPA may use to determine if a substance is extremely hazardous. The report expressed the intent that the term "extremely hazardous substance" would include any agent "which may or may not be listed or otherwise identified by any Government agency which may as the result of short-term exposures associated with spills to the air cause death, injury or property damage due to its toxicity, reactivity, flammability, volatility, or corrosivity". The term "EHS" otherwise includes substances listed in the appendices to 40 CFR part 355, Emergency Planning and Notification.
>
> **Process water (mining operations):** Process water for mining operations include water taken from tailing ponds for the milling process (reclaim water), water that has been through the water treatment plant but not the sand filter (process water), water that has been through both the water treatment and sand filter (discharge water), water mixed with ground ore materials (slurry), or water used in the milling and product recovery process (process solution water).

I compared the recorded transportation accidents with the number of spills predicted in the permitting documents (if any) and the number of expected spills that can be estimated using the $N = RT$ model shown above for truck accident spills. Within ADEC (2021) "*collision/allision"* and "*rollover/capsize"* are two forms of accidents; *collision* and *rollover* generally refer to trucks, while *allision* and *capsize* are more applicable to marine vessels. The distinction between "collision" and "allision" for marine vessels is that collisions involve two moving vessels and "allision" refers to a vessel impacting a non-moving object. Based on the definition of a transportation incident from federal guidelines and of an accident from ADEC, I included only *collision/allision* and *rollover/capsize* spills in my comparison of projected transportation incidents based on the $N = RT$ model and the actual count of spill incidents for each mine.

It is not always clear from ADEC (2021) if a transportation spill occurred while moving materials around the mine site or transporting them to or from the mine. Some spills incidents list mile markers or have more detail in their spill names, but it is difficult to know with precision where all the transportation spills occurred and how much they may have affected the environment outside the mine. Many spills within the mine site, whether associated with transportation or related to other processes, will still generate some waste or contaminated materials associated with clean-up. The frequency of those spills and the fates of those substances may have impacts on the environment in and around the mine, especially if hazardous wastes are created. The spill data about where on the mine site the spill occurred, what media it impacted, and how it was cleaned up are all necessary for determining the environmental significance of the spills' impacts, individually and collectively.

## Predictions and spill records for five large, operational mines

I now return to the predictions of spills from five of the seven mine EISs presented in Section and compare them to spill records from the Alaska Department of Environmental Conservation from 1995-2020 (ADEC 2021). The mines with sufficiently long operating periods to study their spill records were Greens Creek (USFS 1989), Fort Knox/True North (CH2M Hill 1993), Pogo (EPA 2003), Kensington (USFS 2004), and Red Dog (EPA 1984, 2009). None of the mines had quantitative spill predictions for anything other than transportation spills, and the transportation spill risks calculated were limited to single substances spilled via truck accidents or pipelines. Other forms of transportation spills and composite totals of spill risks were not calculated.

### Greens Creek

The EIS for Greens Creek Mine did not include any quantitative modeling of spill risks along the transportation corridor or from any other potential spill causes. Based on the number of annual trips and the trip lengths, Greens Creek Mine trucks would log more than 145,000 miles per year with environmentally hazardous materials, and each year there would be a 2.7% chance of a spill related to a trucking accident. If the mine had operated at 2,200 to 2,300 tons of ore produced each year for the 28 years it has been in operation, then more than 4,000,000 truck miles have been traveled. With that level of exposure, the Harwood and Russell (1990) spill rate suggests that 0.76 spills from vehicle accidents should have occurred since 1989, and a 53.4% chance of at least one spill related to a truck accident. According ADEC (2021) there were seven *collision/allision* incidents and three *rollover/capsize* incidents at Greens Creek Mine from 1995-2020. There were an additional 113 spills related to transportation from other causes, such as *vehicle leaks, cargo not secured*, and various forms of *equipment failure*, for a total of 123 spills related to transportation at Greens Creek Mine from 1995-2020. Accidents (*collision*/*allision* + *rollover*/*capsize* incidents) made up 8.1% of transportation spills.

The full ADEC (2021) record of spills for Greens Creek Mine listed 1,515 incidents from 1995-2020. Transportation spills from all causes comprised 8.1% of that list, and transportation accident-related spills were 0.66% of the total. The most common type of spill was hydraulic oil, with 1,039 spills releasing 7,196 gallons. The largest single spill listed in ADEC (2021) was a 72,000-gallon *process water* spill from December 2004. Overall, more than 2,000 gallons of *hazardous substances* were spilled in 90 incidents, and more than 19,000 gallons of *non-crude oil* were spilled in just less than 1,400 incidents.

There were nearly 14,000 pounds of *hazardous substances*, including arsenic, lead, zinc and zinc concentrate, tailings, and copper sulfate, spilled in 15 incidents.

ADEC (2021) lists eight spills of >1,000 gallons at Greens Creek Mine. The spills of <1,000 gallons accounted for 99.4% of the incidents, but the remaining 0.6% of the spills represented 84.6% of the volume released. These records do not include some spills listed in spill logs from Greens Creek's most recent Plan of Operations (Hecla Greens Creek Mining Company 2020), which also showed a 2,000,000 to 9,000,000-gallon spill of treated process water in June 2013 among 42 spills listed in Greens Creek Mine records but not ADEC (2021).

### Fort Knox/True North

The permitting documents for Fort Knox/True North did not include estimates of the number of spills that might occur related to mine activities or transport. Based on *a priori* information (CH2M Hill 1993) and one update of reagent use (Golder Associates, Inc. 2004), I estimated the number of trips to Fort Knox Mine with hazardous materials from 1996-2002 and 2003-2020 to find the total number of miles traveled by trucks carrying hazardous materials, the expected number of spills based on Harwood and Russell's (1990) spill rate per truck mile, and the probability of there being at least one spill along the transportation corridor, assuming the spills followed a Poisson distribution. More than 1,000,000 miles of truck travel resulted in an expected value of 0.21 spills between 2003- 2020, and or an 18.7% probability of at least one spill along the transportation route during that time.

Based on records from ADEC (2021), there were 31 *collision*/*allision* and *rollover*/*capsize* spills recorded for Fort Knox and True North Mines, which were 10.3% of the 301 spills related to transportation. More than 11,600 gallons were released due to transportation spills.

In all, there were 1,874 spills associated with Fort Knox and True North Mine and 75 spills associated with Alaska West Express and Lynden Transport along the Steese Highway, Elliot Highway, or in Fairbanks City or Fairbanks North Star Borough. If all the Alaska West Express and Lynden Transport spills are included with the Fort Knox/True North spills, there were a total of 1,949 spills associated with those mines from July 1995-December 2020.

The most frequently spilled substance was hydraulic oil, with 846 recorded incidents (43.5% of the number of incidents) and 42,433 gallons released (8.0% of the total volume). More than 88% of the spills were <100 gallons in size, and 1.5% (28 incidents) were >1,000 gallons. The spills of <100 gallons collectively accounted for 5.9% of the total volume released, and spills >1,000 gallons accounted for 85.3% of the volume. Spills classed as *hazardous substances* and *non-crude oil* had the largest numbers, but the largest volume spills were of *process water*. The largest individual spill was 305,370 gallons of process solution in May 2010.

### Pogo

The Pogo Mine EIS (EPA 2003) used an estimate of $1.9 \times 10^{-7}$ spills per truck-mile for hazardous material spill rates on rural two-lane roads (Harwood and Russell 1990). The number of tanker loads of diesel per year and miles to travel were used to calculate diesel spill probabilities, which depended on the specifics of the project options and were estimated to be 1 or 6% (Table 2) and was noted as “an order-of-magnitude estimate because the conditions on the Pogo mine road would be different than those for which the statistics were developed (more difficult driving and road conditions)” (EPA 2003). While a 1% chance of a diesel spill was not considered to be a high risk, the increased possibility of a spill when on-site power generation required transporting more truckloads (6%), elicited a different response (EPA 2003, p. 5-34):

> On-site generation, however, would require an additional approximately 4.2 million gallons of fuel to be trucked to and stored at the mine site. For five resources (water quality, wetlands, fish, wildlife, and subsistence), the risks of spills from the seven-fold increase in fuel volume that would be trucked to the mine site were considered high.

Spill risk probabilities for individual reagents or the cumulative number of reagent truck-miles were not calculated. Instead, the implication was the risks of associated with spills of lime, cyanide, and sodium metabisulfite as individual supplies being transported to the mine would be less than those associated with fuel transportation because fewer trips would be required to haul them, and thus they were too small to warrant quantitative attention. The aggregated risk from all reagent transportation was not considered explicitly. It was noted that fuel spills near a wetland could have an impact, that a major diesel spill near a creek could result in a high impact in a large area of the watershed, and that a substantial release of cyanide into surface water would have a high impact (EPA 2003).

Based on the $N = RT$ model and using the Harwood and Russell (1990) estimate of $R = 1.9 \times 10^{-7}$ spills/mile, the 2003 EIS (EPA 2003) estimated that there was a 1% chance of spill over the 11-year project life at the 2,500 tpd ore production rate. Once the remaining hazardous materials (propane, explosives, reagents, etc.) are included, the estimate of the expected number of spills along the transportation corridor was 0.057 to 0.068, and the probability of at least one spill was 5.6% for the 2,500 tpd ore production scenario and 6.5% for the 3,500 tpd ore production rate. (In the EIS, EPA (2003) did not consider 1% to be a high risk, but a 6% chance of a spill was considered high.)

Based on data from ADEC (2021) there were 12 spills due to *collision/allision* and *rollover/capsize* incidents attributed to Pogo Mine from 1998-2020, four of which were diesel spills, four which were other forms of *non-crude oil* (gasoline and engine lube oil), and four spills of *hazardous substances* (ethylene glycol, propylene glycol, and “other”). There were an additional 53 transportation-related spills associated with Pogo Mine, for a total of 65 transportation spills.

There were an estimated 1,503 spills related to Pogo Mine from 1995-2020 in ADEC (2021). Spills related to *vehicle* or *heavy equipment* accidents (*collisions/allisions* + *rollover/capsizes*) represent less than 1% of the total incidents. Transportation spills from all causes were estimated to account for 4.3% of the spills associated with Pogo Mine.

Almost 1,300 of the spills at Pogo Mine were of *non-crude oil*. The cumulative volume of all the spills is over 260,000 gallons. The largest spill was 135,000 gallons of mill slurry due to a line failure in May 2015. While more than 95% of the spills were of <100 gallons, the 5% of spills that were >100 gallons accounted for 97.5% of the volume released. There were 17 spills of at least 1,000 gallons. More than 8,600 gallons of *non-crude oil* were spilled at Pogo Mine, including more than 4,000 gallons of hydraulic oil in more than 1,100 incidents. Although *non-crude oil* spills accounted for 86.1% of the number of recorded incidents, accidental releases of *hazardous substances* represented 89.6% of the volume spilled.

The most common causes of the 143 *hazardous substance* spills were *equipment failure* (64 spills), *containment overflow* (21 spills), and *line failure* (15 spills). The 1,291 *non-crude oil* spills were overwhelming attributed to *equipment failure* (971 spills), followed by *line failure* (136 spills) and *leaks* (67 spills). *Process water* spills were most often due to *human error* (20 spills) and *containment overflow* (14 spills).

### Kensington

Kensington’s EIS contained quantitative estimates of spills associated with trucking diesel and with pipeline spills. I estimated the number of truckloads per year for flotation concentrate, diesel, ammonium nitrate, and reagents and other materials for two different daily processing rates at Kensington Mine. I also found the number of annual trips per year for filtered tailings under the amended plan of operations. Based on the number of loads per year, the miles per load, and the years for the two different production scenarios, I calculated the risk of truck accident spills at Kensington Mine. The $N = RT$ model estimate is that from 2006-2020, there was a 3.4% chance of a spill from a trucking accident, and that there is a 5.1% chance of a trucking accident spill in the next 10 years.

The total amount of hazardous materials transportation was estimated as 2,472 loads per year under the scenario described in the 2004 EIS and 17,213 loads per year under the amended plan of operations with expanded production and tailings haulage by truck.

Harwood and Russell's (1990) estimate of $R = 1.87 \times 10^{-7}$ spills per mile was used in the 2004 EIS to estimate the percent chance of diesel spills annually and over the expected project life for six Alternatives considered (USFS 2004). The road length, load size, and number of loads per year varied, but all Alternatives were expected to have a <0.5% chance of at least one diesel spill over the life of the project. Pipeline spill risks were also calculated. Once the hazardous materials to be transported (other than diesel) were included, the probability of at least one spill for Alternative D from 2006-2020 was 3.4% and the probability of at least one spill in the next 10 years under the amended plan of operations was 5.1% using the $N = RT$ model with the same value of $R$.

Based on data from ADEC (2021) there were four *collision/allision* and *rollover/capsize* spills associated with Kensington Mine through the end of 2020. There were an additional 30 spills associated with mine transportation from causes such as *vehicle leaks* and *cargo not being secured*, for a total of 34 transportation spills. Spills from accidents (*collision*/*allision* + *rollover*/*capsize*) were 11.8% of transportation spills.

Overall, ADEC (2021) listed 308 spills of 18 different hazardous materials at Kensington Mine, with a total of 6,272 gallons released. Most of the substances spilled were not mentioned in the permitting documents. The most frequently spilled substance was hydraulic oil (170 spills totaling 1,609 gallons). The greatest percentage (90.6%) of spill incidents involved *non-crude oil* products, mostly diesel fuel and hydraulic oil. *Non-crude oil* products were also 69.4% of the total volume released. Although 95.4% of the spills were <100 gallons, the remaining 4.6% of the spills (those >100 gallons) accounted for 64.1% of the volume released. The largest single spill incident was a release of 800 gallons of *process water* due to a coupler failing at slurry pond 1 on August 4, 2018.

*Hazardous* and *extremely hazardous substances* represented 9.1% of the number of spill incidents and 17.9% of the volume spilled. They were most often caused by *human error* (12 spills), or *line failure* (6 spills). *Non-crude oil* spills were most commonly caused by *line failure* (108 spills), *equipment failure* (52 spills), and *leaks* (40 spills). The number of reported spills per year has been increasing at Kensington Mine, especially for *non-crude oil*.

### Red Dog

The initial EIS left the transportation corridor risks as "undetermined probabilit[ies]" (EPA 1984). The supplemental EIS stated that "Traffic statistics using accident and spill data will be used to assess the effects of changes in transportation among the alternatives" (EPA 2009). The EPA (2009) estimated that 0.6 ore concentrate spills per year could be expected along the road from the mine to the port but did not then calculate the number of expected spills over the remaining life of the project or estimate spill rates for any other hazardous materials.

Based on production levels estimated for initial production (1989-1993), expanded production (1994-2002) and current production (2003-2020), the number of annual trips with hazardous materials (ore concentrate, reagents, diesel, and ammonium nitrate) increased from ~3,700/year, to ~5,600/year, to ~14,000/year. With more than 320,000 truckloads transporting hazardous materials 52 miles, 3.2 spills would have been expected from transportation accidents from 1989-2020 under the $N = RT$ model with Harwood and Russell's (1990) value for $R$ and the probability of at least one such spill would have been 95.8%.

Based on records from ADEC (2021), *collision/allision* and *rollover/capsize* accounted for a combined 58 (12.1%) of the 481 transportation spills associated with Red Dog Mine from 1995-2020. The most common cause subtypes associated with transportation-related spills at Red Dog were *line failure* (114 spills), *leaks* (77 spills), and *cargo not secured* (57 spills). There were 25 spills of zinc or zinc concentrate from transportation-related incidents between 1995 and 2020, with 7 of those between 2012 and 2020.

Based on records from ADEC (2021), there were 2,882 spills attributable to Red Dog Mine from 1995-2020. There were 192 incidents with quantities in pounds, and the remaining 2,690 spill amounts were in gallons. Transportation spills (including all subcauses) were 16.7% of the total spills, with (*collision*/*allision* + *rollover*/*capsize*) spills as 2% of all spills associated with Red Dog. *Non-crude oil* and *hazardous substance* spills accounted for 2,441 out of 2,690 spills listed in gallons, with more than 1,000 spills of hydraulic oil. The *hazardous* and *extremely hazardous substances* spilled included cyanide, sulfuric acid, and glycols, as well as ore concentrates and slurry. While 56% of the spills were less than 10 gallons, the relative infrequency of larger spills was overshadowed by their contribution the overall volume of hazardous materials released. The

10% of the spills that were of 100 gallons or more amassed 98% of the total volume accidentally released. More than 20% of the spills listed by weight were of at least 1,000 pounds; those spills accounted for 99% of the materials released listed by weight. ADEC (2021) shows there were 128 spills of >1,000 gallons or pounds associated with Red Dog Mine from 1995-2020.

There were 1,048 hydraulic oil spills totaling to 11,363 gallons at Red Dog Mine. While those spills represent 39% of the number of spills listed by volume, they only account for 0.8% of the 1,450,397 gallons spilled. *Hazardous substances* (719,118 gallons) and *process water* (699,924 gallons) were 49.6% and 48.3% of the total spills given by volume, respectively.

## Comparison of the operational mines' sizes, spill estimates, and spill records

None of the mines examined in the retrospective report had quantitative spill predictions for anything other than transportation spills, and the transportation spill risks calculated were limited to single substances spilled via truck accidents or pipelines. Other forms of transportation spills and composite totals of spill risks were not calculated.

When I applied the $N = RT$ and Poisson models to the full set of hazardous materials to be transported for each of the five example mines, the calculated spill probability of at least one trucking accident spill varied from 2.3% for Kensington to 94.4% for Red Dog when all hazardous materials described in the EIS/EAs were included. Only two of the EISs, Pogo and Kensington, included quantitative spill probabilities. Pogo estimated 1% risk of a diesel spill if diesel were not trucked in for power generation, but the full set of hazardous materials had a 7.2% chance of a spill based on the estimations from the $N = RT$ model. Kensington's EIS also had an estimate for the probability of a diesel spill, but the <0.4% chance did not capture the full set of hazardous materials, which would have led to an estimate of a 2.3% chance. For both mines, there was a 6 to 7-fold discrepancy between considering just diesel and including all hazardous materials in the trucking accident risk estimates. The supplemental EIS for Red Dog included an annual spill rate estimate for ore concentrate from trucks but did not extend that to either an expected number of spills or a spill probability.

As a comparison with the SGP project, the characteristics of the five Alaskan hard rock mine transportation corridor road lengths, and reagents required are shown (Table 30). Recall that the prediction for Pogo Mine was that there was an estimated 1% chance of a spill associated with moving 786,000 gallons of diesel annually from a truck along its transportation corridor or a 6% chance when 4,200,000 gallons of diesel would be needed (EPA 2003). In practice, there have been four diesel spill incidents from accidents at Pogo between in 11 years of operations. Those four spills were a subset of 80 diesel spills reported to ADEC, with sizes ranging from 0.5 to 1,500 gallons, and totaling to 4,174 gallons. The SGP is estimated to need 5,800,000 gallons of diesel annually for each of its 15 years of operations.

The SGP would be second only to Fort Knox/True North in its daily ore processing (20,000 to 25,000 tons per day at SGP compared to 36,000 tons per day at Fort Knox/True North.) The proposed SGP has a longer transportation corridor than any of the mines in the retrospective analysis, even when only counting the length of road from the mine site to Cascade. The SGP would require transporting hazardous goods more than 3.5 million miles in thousands of trips between Cascade and the mine site over the course of its 15 years of operations, which is a small part of at least 14.7 million miles of transportation once bringing materials along SH55 and other routes is include rather than only considering the last 70 miles to the mine site. These values are close to the miles of exposure for Greens Creek (SH55 to mine site) and Red Dog mines (whole corridor).

The probabilities of truck accident spills ranged from 3.4% for Kensington to 95.8% for Red Dog, and reflected a combination of years of operation, number of truck trips, and transportation corridor length. Kensington and Pogo have been in operation for nearly the same amount of time, but Pogo was expected to have roughly three times as many spills. This difference is because while Pogo's transportation corridor is 10 times longer, Kensington had approximately three times as many loads of hazardous substances because Kensington transports ore concentrate from the mill to the port.

The number of expected truck accident spills depends on many factors, including road length, number of annual trips, and number of years materials are transported. Although Red Dog and Pogo have similar road lengths, the number of annual trips at Red Dog is more than an order of magnitude higher and it has been in production for longer (Table 30). Those two factors mean that Red Dog was predicted to have ~30 times as many truck accident spills as Pogo based on the $N = RT$ model. In practice, Pogo had 11 truck accident spills between 2006-2020 and Red Dog had 58 from 1989-2020. Both mines had more truck accident spills than were predicted. Fort Knox/True North had the second most truck accident spills (31 from 1994-2020) with a transportation corridor half the length of Pogo's or Red Dog's. Greens Creek and Pogo had nearly the same number of truck accidents (10 and 11, respectively) even though Pogo has a 50-mile road and Greens Creek has road lengths of 7.5 and 8.5 miles (depending on what's being transported). In short, while road length alone is not enough to predict the number of spills, it is literally a factor in the equation for determining how many spills are expected.

In practice, the number of truck accidents observed exceeded the predicted number from the $N = RT$ model for all five mines, and the predictions were often orders of magnitude too low (Table 30). Considering the expected number of miles traveled for all five mines through 2020, the $N = RT$ model would have predicted that there would have been four or five truck accidents. Based on the records from ADEC (2021) there were 114 *collision/allision* and *rollover/capsize* accidents, which is 26.5 times as many as would have been predicted. These 114 accidents spilled nearly 6,000 gallons and 1,660,000 pounds of hazardous materials. The truck accident spills only represent 11.4% of all 1,004 transportation-related releases from the five mines considered.

While truck accident and pipeline spills are the only spills with quantitative representation in any of the EIS/EAs examined, they are only a small portion all the transportation spills or of the overall number of spills. The five mines considered in the retrospective report had a combined total of more than 8,150 spill incidents, releasing >2,360,000 gallons and >1,930,000 pounds of *hazardous substances* since July 1995 (Table 30). Fort Knox/True North and Red Dog mines accounted for both the highest numbers of spill incidents and the largest spill quantities by volume. If overall spill were risk were directly proportional to ore production, Fort Knox/True North, which produces 36,000 tons of ore per day, would be expected to have more spills than Red Dog, which has a 10,000 tons of ore per day production rate. In a very general sense, the underground mines (Pogo, Kensington, and Greens Creek) seem to have fewer and smaller spills than the open pit mines (Fort Knox/True North and Red Dog), but several other factors (operating lifetime, scale of production, exported product) could also be at play in those differences.

Seventy-five percent of the spill incidents at all five large mines involved *non-crude oil*, but *non-crude oil* spills only accounted for 5.2% of the volume spilled (Lubetkin 2022). Most of the spill volume was from releases of *hazardous substances* and *process water*, which together represented 94.7% of the volume released, even if they were only 24% of the incidents (Lubetkin 2022). More than 92% of the spills were in quantities <100 gallons and had total volume of almost 75,000 gallons; the remaining 7.8% of the incidents released 2,288,361 gallons (Lubetkin 2022). While diesel was the substance used in modeling spill risks, diesel spills only represented 15.8% of *non-crude oil* spill incidents and 11.9% of all spill incidents given by volume in ADEC (2021) (Lubetkin 2022). Spills of *hazardous* and *extremely hazardous substances* accounted for 19.8% of spill incidents, 41.4% of the volume released (Lubetkin2022), and nearly all of the weight spilled.

At least 49 different hazardous substances were spilled at the five mines studied in the retrospective report (Lubetkin 2022). That number is an undercount due to spills of “other” or “unknown” substances that were not otherwise specified. All five of the mines had recorded spills of more substances than were discussed in their EIS/EAs. Relatively few of the listed substances had recorded spills, but sodium cyanide, sulfuric acid, hydrochloric acid, copper sulfate, ore concentrate, diesel, and gasoline were all mentioned in EIS/EAs and had recorded spill instances. Most (between 80 and 88%) of the substances spilled were not discussed in the EIS/EAs. (The spill frequencies and quantities of the listed and unlisted substances should also be considered.) All five mines at least mentioned the possibilities of tailings spills, which are listed as *process water* in ADEC (2021) and occurred at all five mines in the case studies. Although >49 materials were spilled, quantitative modeling was only attempted for diesel, ore concentrate, and mill slurry.

Many of the unlisted spill substances are *non-crude oil* (hydraulic oil, transmission oil, used oil, etc.), as well as antifreezes such as ethylene glycol, propylene glycol, and other glycols. While these chemicals were not listed among the reagents associated with milling, they are essential to running the heavy equipment at the mines and are used in sufficient quantities to result in more than 5,100 spills and nearly 85,000 gallons released. Of the five mines analyzed, only Kensington Mine has not had a spill of at least 1,000 gallons or pounds recorded (Table 29).

*Table 29. Summary of the number and maximum size of large releases from the five mines considered in Lubetkin (2022).*

| Mine | Number of Spills ≥ 1,000 gallons or pounds | Largest release |
|---|---|---|
| Greens Creek | 8 | 72,000 gallons process water |
| Pogo | 17 | 135,000 gallons mine paste backfill |
| Kensington | 0 | 800 gallons process water |
| Fort Knox/True North | 28 | 305,370 gallons process water |
| Red Dog | 128 | 250,000 pounds ore concentrate |

*Table 30. A comparison of mine characteristics for five large hardrock mines in Alaska with the characteristics of the proposed SGP and the spills records associated with the operational mines from 1995-2020 based on data from ADEC.*

| Pogo | Kensington | Greens Creek | Fort Knox/ True North | Red Dog | SGP (proposed) |
|---|---|---|---|---|---|
| Mine type | | | | | |
| Underground | Underground | Underground | Open pit | Open pit | Open pit |
| Product | | | | | |
| gold dore/bars | gold ore concentrate | silver and gold; lead and zinc ore concentrate | gold dore/bars | lead and zinc ore concentrate | dore/bars and ore concentrate |
| Total trips per year | | | | | |
| 730 | 2,472 | 17,825 | 1,700 | 9,298 | 3,337 |
| Transportation corridor length considered in the EIS | | | | | |
| 50 miles | 5 miles | 8 miles | 26 miles | 52 miles | 70 miles |
| Years of operations | | | | | |
| 11 | 10 | 28 | 16 | 32 | 15 |
| Total miles traveled with hazardous materials | | | | | |
| 401,500 | 123,600 | 4,077,710 | 707,200 | 15,471,872 | 3,503,325 (mine site to Cascade only);<br>14,678,325 (full transportation corridor) |
| Tons of ore processed per day | | | | | |
| 2,500 to 3,000 | 2,000 | 800 to 2,300 | 36,000 | 3,000 to 10,000 | 20,000 to 25,000 |

*Table 30. (Cont'd.)*

| Pogo | Kensington | Greens Creek | Fort Knox/ True North | Red Dog | SGP (proposed) |
|---|---|---|---|---|---|
| Number of expected spills under the $N = RT$ model | | | | | |
| 0.10 | 0.035 | 0.76 | 0.21 | 3.2 | 0.64 (mine site to Cascade only);<br>2.7 (full transportation corridor) |
| Probability of at least one spill under the $N = RT$ model (Poisson distribution, as %) | | | | | |
| 9.7% | 3.4% | 53.2% | 18.9% | 95.8% | 47.0% (mine site to Cascade only);<br>93.0% (full transportation corridor) |
| Hazardous materials spills from truck rollovers or collisions | | | | | |
| 11 | 4 | 10 | 31 | 58 | |
| All transportation spills | | | | | |
| 65 | 34 | 123 | 301 | 481 | |
| Volume spilled from all transportation spills (gallons) | | | | | |
| 1,603 | 495 | 2,396 | 11,631 | 17,279 | |
| Weight spilled from all transportation spills (lbs) | | | | | |
| 0.5 | 2 | 0 | 10 | 1,771,064 | |
| | | | | | |
| All spills | | | | | |
| 1,503 | 308 | 1,515 | 1,949 | 2,882 | |
| Total volume spilled (gallons) | | | | | |
| 267,710 | 6,272 | 111,333 | 527,533 | 1,450,397 | |
| Total weight spilled (lbs) | | | | | |
| 29.5 | 4 | 13,899 | 5,024 | 1,919,563 | |

## Summary

The SGP SDEIS's rudimentary attempt at quantitatively estimating the risk of hazardous materials spills was constrained to a limited analysis area, only considered a single source of potential spills (trucks), and incorrectly calculated an estimate of the spill rate per mile that was two orders of magnitude too low and was not applied to the total number of miles trucks would transport hazardous materials. This narrow consideration of the possible impacts of the transportation corridor and hazardous materials misses other effects related to the SGP. Transportation impacts extend beyond the risk of spills. Mine-related spills of hazardous materials can come from many processes besides transportation. The conclusions in the SDEIS that spills along the roadway will have limited if any impacts on fish and the aquatic environment are not justified. Neither are conclusions that spills from chemical storage will be rare or small. The SDEIS did not examine the probability or potential sizes of spills of either tailings or contact water from pipelines.

Even if the modeling had been better done, it is likely that the number of spills that would occur would be much higher than the predictions. Based on the spill risks and impacts presented in other mining EISs, proposed mines underestimate the number of spills associated with hazardous materials transportation, and transportation spills are a small fraction of the total number of unintentional releases associated with mines. For example, the Pogo Mine, which is roughly 12% as large as the proposed SGP and has a shorter transportation corridor, has had more than 1,500 spills across a wide range of hazardous materials, spill volumes, and spill sources, with spills from vehicles representing less than 5% of that number. Red Dog Mine, an open pit mine that processes up to 10,000 tons per day and transports ore concentrate by truck along a 52 mile road, has had 58 spills from rollovers or collisions; those spills only represent 2% of the number of spill incidents associated with Red Dog, including 128 spills of at least 1,000 pounds of gallons of hazardous materials.

## 12. Conclusions

Overall, the analysis of the potential impacts from hazardous materials in the SGP SDEIS is inadequate to make an informed decision. EISs for other mines include expected spill numbers and probabilities, and the SGP SDEIS did not. The transportation corridor analysis area did not consider any risks beyond Cascade, Idaho. EISs for other mines include spill risk rates that are on the order of $2.0 \times 10^{-7}$ spills per truck-mile, but the SGP SDEIS estimated a spill rate ranging from $1.4\text{-}1.9 \times 10^{-9}$ spills per truck-mile, which is two orders of magnitude lower than rates published in multiple sources. Using a spill risk rate of $1.814 \times 10^{-7}$ spills per truck-mile, I found that probabilities of spills and accidents range from possible to probable (if not certain) for both Action Alternatives for the analysis area considered in the SGP SDEIS and the full length of the transportation corridor. The spill rate I used is likely too small as it is an average based on national spill data that may suffer from substantial underreporting and the road characteristics near the proposed SGP would increase spill risks. Without an accurate characterization of the true exposure along the transportation corridor and the spill rate per truck-mile, it is impossible to then make informed statements about spill likelihood and the potential consequences to the environment and to public safety. Data from the several large, operation hardrock mines in Alaska illustrate that hazardous materials spills are frequent, can be sizable, and that transportation spills are only a small fraction of mine-related spills.

The truck accident spill model of $N = RT$ has some precedent in other environmental permitting for large mines and has used a value of $R = 1.87 \times 10^{-7}$ spills per mile (Harwood and Russell 1990). The $N = RT$ model only applies to trucking accidents, such as *collisions/allisions* and *rollovers/capsizes*. Other types of transportation spills, such as *leaks*, *cargo not being secured*, or *overfilling of tanks*, are not considered in this model. The $N = RT$ model requires an estimate of $T$, the total vehicle miles traveled with hazardous materials.

The SGP SDEIS did not apply the $N = RT$ model or any others to any of the hazardous substances that would be transported to, from, or used at the mine in quantities up to hundreds of tons and millions of gallons each year. Based on that model and recent national statistics, I estimate that 0.64 to 2.7 spills, with associated probabilities of 47.1% and 95.8% for at least one spill, would be expected along the transportation route for the section considered in the SGP SDEIS and for a fuller picture of the transportation corridor, respectively. Accident rates are higher per mile than hazardous material spill rates. The estimated number of accidents that trucks carrying hazardous materials might be involved in ranged from 4.7 to 19.7 accidents, depending on if the length of travel was just from SH55 at Cascade to the mine site or the full transportation corridor.

As in other EISs, the SGP SDEIS only addressed spills qualitatively. Spills of individual substances, such as diesel, from specific sources, such as tanker trailers, and certain events, like accidents, are described as low probability events, but the aggregate, cumulative risks and impacts of all the hazardous material spills from all sources and causes are not addressed. There were more than 50 hazardous materials specified for use at the SGP. The SGP gave only cursory descriptions, if any, of the properties of reagents such as sodium cyanide and sulfuric acid, non-crude oil products and antifreezes that are spilled frequently, ore concentrate, tailings/process water, and other mine wastes.

Although spill probabilities at mines are often characterized as low in permitting documents, especially for individual hazardous materials from specific sources, from July 1995-December 2020, there were 8,157 spill incidents that released 2,363,245 gallons and 1,938,520 pounds of hazardous materials at the five hardrock mines in these case studies (Lubetkin 2022). In short, few EISs quantitatively addressed any spill risks, those that did only considered some of the hazardous materials singly, and the $N = RT$ model was inadequate to predict a subset of spills which comprised 1.4% (114 of 8,157) of all the spills recorded at the five mines.

The $N = RT$ model uses a value of $R$ from Harwood and Russell (1990) based on data from California, Michigan, and Illinois that are now at least 30 years old to estimate hazardous material spill rates per vehicle mile. The more recent estimate of $R$ that I derived based on FMSCA data from 2009-2019 is a national average. The model assumes that every mile has the same spill rate and does not account for any differences that the routes to the SGP has from the national data the estimate of $R$ was based on. It may be difficult to estimate spill risks for new mines on new roads, but site-specific information from roads with similar characteristics can be used to improve risk and impact prediction.

More comprehensive models of hazardous material trucking accident risks are plentiful in the peer-reviewed literature. Even if the trucking accident release rates and probabilities are successfully modeled, spills and releases along the transportation corridor from accidents (i.e., *collisions/allisions* and *rollover/capsizes*) are only a fraction of transportation incidents, and transportation incidents are only small fraction of all spills. Likewise, spills are only a small portion of environmental impacts from mining. It is possible that other impact descriptions in EIS/EAs are as inadequate as those for spill risks.

Based on the analysis from the five mines in the retrospective report, we cannot expect that spills are low probability events or that their total frequency can be accurately predicted based on overly simplistic models that only address two potential spill causes/sources.

Several recommendations arise from this analysis before the SGP SDEIS analysis of spill risk can be considered to be truly informative for the public and decision-makers. The SGP spill impact assessment must

- Include an explicit, complete, and quantitative reagents list, as well as other chemicals for blasting, water treatment, spill mitigation, and materials associated with the mining machinery, such as hydraulic oil and antifreeze, and all hazardous wastes that would be considered hazardous materials being transported to or from the mine or used on-site.
- Include complete descriptions of the transportation methods (trucks, pipelines, etc.), load sizes, and frequency for the hazardous materials listed above, as well as tailings and other hazardous wastes.
- When assessing hazardous material spill risk, consider that the transportation corridor to model is not just defined by the length of the any newly built roads associated with the mine, but instead extends to the origin(s) and destination(s) of the hazardous materials. As noted by Barilla et al. (2009):

  > Generally HazMats have to be transported from a point of origin to one or more destination points. The origin points are fixed facilities where the HazMats are produced or stored. The HazMats are then transported from a production facility to storage, distribution, or another facility where the HazMat is required.

- Include quantitative transportation spill risk estimates for the aggregated total of trips.
- The peer-revied literature for risk analysis of hazardous materials transportation is robust. Consider more detailed transportation spill risk models, with up-to-date risk

rates and location-specific descriptions of the transportation corridor that allow for modification from national or regional average estimates of *R*.

- Acknowledge that accident modeling only describes one potential way hazardous materials are released from vehicles, and that transportation-related releases can have a multitude of causes, many of which are not modeled. Modeling transportation accidents is a necessary step, but not sufficient to model all transportation spills or all the unintentional releases that occur at mines.
- Be explicit about the numbers of expected spills. The two goals of the EIS production process are to clearly state potential consequences of projects and to inform stakeholders and decision makers of those impacts. The current treatment of spill risks in mining EISs does neither.

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# Appendix A. Extracts from material safety data sheets for the materials that would be transported under various Alternatives.

I compiled information from the safety data sheets for the reagents from two commercial suppliers (IXOM Safety Data Sheets (https://www.ixom.com/sds-search) and EChemi Safety Data Sheets (http://www.echemi.com)) and other sources as noted. Reagents and other materials are listed in the same as they are in Table 14, first by those transported in liquid forms and then those as bulk solids.

## Bulk liquids

**Diesel fuel** **5,800,000 gallons/year in 580 deliveries**

Extracts from ixom.com Safety Data Sheet (https://www.ixom.com/sds-search) for fuel oil.

> Classified as Dangerous Goods by the criteria of the Australian Dangerous Goods Code (ADG Code) for Transport by Road and Rail; DANGEROUS GOODS.
>
> This material is hazardous according to Safe Work Australia; HAZARDOUS CHEMICAL.
>
> *Classification of the chemical:*
> Flammable liquids - Category 4
> Aspiration hazard - Category 1
> Skin Irritation - Category 2
> Acute Inhalation Toxicity - Category 4
> Carcinogenicity - Category 2
> Specific target organ toxicity (repeated exposure) - Category 2
> Acute Aquatic Toxicity - Category 2
> Chronic Aquatic Toxicity - Category 2
>
> SIGNAL WORD: DANGER
>
> *Hazard Statement(s):*
>
> H227 Combustible liquid.
> H304 May be fatal if swallowed and enters airways.
> H315 Causes skin irritation.
> H332 Harmful if inhaled.
> H351 Suspected of causing cancer.

H373 May cause damage to organs through prolonged or repeated exposure.
H411 Toxic to aquatic life with long lasting effects.

*Precautionary Statement(s): Prevention:*

P201 Obtain special instructions before use.
P202 Do not handle until all safety precautions have been read and understood.
P210 Keep away from heat, sparks, open flames, hot surfaces. No smoking.
P260 Do not breathe mist, vapours, spray.
P264 Wash hands thoroughly after handling.
P271 Use only outdoors or in a well-ventilated area.
P273 Avoid release to the environment.
P280 Wear protective gloves / protective clothing / eye protection / face protection.

*Accidental release measures*

Emergency procedures/Environmental precautions: Shut off all possible sources of ignition. Clear area of all unprotected personnel. Shut off leak if possible without risk. Work up wind. Use water spray to disperse vapour. Do not allow container or product to get into drains, sewers, streams or ponds. If contamination of sewers or waterways has occurred advise local emergency services.

*Toxicological information*

Ingestion: Swallowing can result in nausea, vomiting and central nervous system depression. If the victim is showing signs of central system depression (like those of drunkeness) there is greater likelihood of the patient breathing in vomit and causing damage to the lungs. Breathing in vomit may lead to aspiration pneumonia (inflammation of the lung).

Eye contact: May be an eye irritant. Overexposure to diesel exhaust fumes may result in eye irritation.

Skin contact: Contact with skin may result in irritation. Will have a degreasing action on the skin. Repeated or prolonged skin contact may lead to irritant contact dermatitis. Repeated exposure may cause skin dryness or cracking.

Inhalation: Breathing in vapour may produce respiratory irritation. Breathing in vapour can result in headaches, dizziness, drowsiness, and possible nausea. Breathing in high concentrations can produce central nervous system depression, which can lead to loss of co-ordination, impaired judgement and if exposure is prolonged, unconsciousness. Overexposure to diesel exhaust fumes may result in headaches, nausea and respiratory irritation.

*Ecological information*

Ecotoxicity Avoid contaminating waterways.

Aquatic toxicity: Toxic to aquatic organisms. May cause long lasting harmful effects to aquatic life. Material floats on water. Films formed on water may affect oxygen transfer between the water and the atmosphere and cause adverse effects on aquatic organisms. Prevent entry of the material into waterways, sewers, basements or confined areas.

**Propane** **2,023,000 gallons/year in 226 deliveries**

Extracts from ixom.com Safety Data Sheet (https://www.ixom.com/sds-search) for propane.

> Classified as Dangerous Goods by the criteria of the Australian Dangerous Goods Code (ADG Code) for Transport by Road and Rail; DANGEROUS GOODS.
>
> This material is hazardous according to Safe Work Australia; HAZARDOUS CHEMICAL.
>
> *Classification of the chemical:*
> Flammable Gases - Category 1
> Gases under pressure - Liquefied Gas
>
> SIGNAL WORD: DANGER
>
> *Hazard Statement(s):*
>
> H220 Extremely flammable gas.
> H280 Contains gas under pressure; may explode if heated.
>
> *Precautionary Statement(s):*
> *Prevention:*
> P210 Keep away from heat, sparks, open flames, hot surfaces. No smoking.
>
> *Response*:
> P377 Leaking gas fire: Do not extinguish, unless leak can be stopped safely.
> P381 Eliminate all ignition sources if safe to do so.
>
> *Storage*:
> P410+P403 Protect from sunlight. Store in a well-ventilated place.
> P403 Store in a well-ventilated place.
>
> *Accidental release measures*
>
> Emergency procedures/Environmental precautions: Shut off all possible sources of ignition. Clear area of all unprotected personnel. Increase ventilation.
>
> Personal precautions/Protective equipment/Methods and materials for containment and cleaning up: If safe to do so, isolate the leak. Small spills are allowed to evaporate provided there is adequate ventilation. Wear protective equipment to prevent skin and eye contact and breathing in vapours. Avoid breathing in vapours. Work up wind or increase ventilation. Contain - prevent run off into drains and waterways. Use absorbent (soil, sand or other inert material). Collect and seal in properly labelled containers or drums for disposal. Use non-sparking tools.

*Exposure controls/personal protection*

Propane: Asphyxiant

Asphyxiant - gases which can lead to reduction of oxygen concentration by displacement or dilution. The minimum oxygen content in air should be 18% by volume under normal atmospheric pressure.

*Stability and reactivity*

Possibility of hazardous reactions: Can react violently with chlorine, pool chlorine, or nitric acid.

Conditions to avoid: Avoid exposure to heat, sources of ignition, and open flame. Avoid exposure to direct sunlight. Avoid exposure to extremes of temperature.

Incompatible materials: Incompatible with strong oxidising agents.

Hazardous decomposition products: Carbon monoxide. Carbon dioxide.

*Toxicological information*

Ingestion: Swallowing can result in nausea, vomiting and central nervous system depression. If the victim is showing signs of central system depression (like those of drunkeness) there is greater likelihood of the patient breathing in vomit and causing damage to the lungs.

Eye contact: Vapour from product may irritate eyes. Liquid splashes or spray may cause freeze burns to the eye.

Skin contact: Contact with skin may result in irritation. Liquid splashes or spray may cause freeze burns.

Inhalation: Vapours may cause drowsiness and dizziness. Intentional misuse by deliberately concentrating and breathing the contents can be harmful or fatal. An asphyxiant; exposure to high concentrations can eventually lead to a lack of oxygen in the blood, which may cause death.

*Ecological information*

Ecotoxicity: Avoid contaminating waterways.

**Gasoline** **500,000 gallons per year in 100 deliveries**

Extracts from Hess Corporation 1 Hess Plaza Woodbridge, NJ 07095-0961; Internet Website www.hess.com

> EMERGENCY OVERVIEW
>
> DANGER!
>
> EXTREMELY FLAMMABLE
> - EYE AND MUCOUS MEMBRANE IRRITANT
> - EFFECTS CENTRAL NERVOUS SYSTEM
> - HARMFUL OR FATAL IF SWALLOWED
> - ASPIRATION HAZARD
>
> High fire hazard. Keep away from heat, spark, open flame, and other ignition sources.
>
> If ingested, do NOT induce vomiting, as this may cause chemical pneumonia (fluid in the lungs). Contact may cause eye, skin and mucous membrane irritation. Harmful if absorbed through the skin. Avoid prolonged breathing of vapors or mists. Inhalation may cause irritation, anesthetic effects (dizziness, nausea, headache, intoxication), and respiratory system effects.
>
> Long-term exposure may cause effects to specific organs, such as to the liver, kidneys, blood, nervous system, and skin. Contains benzene, which can cause blood disease, including anemia and leukemia.
>
> *Hazards Identification*
>
> EYES Moderate irritant. Contact with liquid or vapor may cause irritation. SKIN Practically non-toxic if absorbed following acute (single) exposure. May cause skin irritation with prolonged or repeated contact. Liquid may be absorbed through the skin in toxic amounts if large areas of skin are exposed repeatedly.
>
> INGESTION The major health threat of ingestion occurs from the danger of aspiration (breathing) of liquid drops into the lungs, particularly from vomiting. Aspiration may result in chemical pneumonia (fluid in the lungs), severe lung damage, respiratory failure and even death. Ingestion may cause gastrointestinal disturbances, including irritation, nausea, vomiting and diarrhea, and central nervous system (brain) effects similar to alcohol intoxication. In severe cases, tremors, convulsions, loss of consciousness, coma, respiratory arrest, and death may occur.
>
> INHALATION Excessive exposure may cause irritations to the nose, throat, lungs and respiratory tract. Central nervous system (brain) effects may include headache, dizziness, loss of balance and coordination, unconsciousness, coma, respiratory failure, and death.

WARNING: the burning of any hydrocarbon as a fuel in an area without adequate ventilation may result in hazardous levels of combustion products, including carbon monoxide, and inadequate oxygen levels, which may cause unconsciousness, suffocation, and death.

CHRONIC EFFECTS and CARCINOGENICITY Contains benzene, a regulated human carcinogen. Benzene has the potential to cause anemia and other blood diseases, including leukemia, after repeated and prolonged exposure. Exposure to light hydrocarbons in the same boiling range as this product has been associated in animal studies with systemic toxicity. See also Section 11 - Toxicological Information.

MEDICAL CONDITIONS AGGRAVATED BY EXPOSURE Irritation from skin exposure may aggravate existing open wounds, skin disorders, and dermatitis (rash). Chronic respiratory disease, liver or kidney dysfunction, or pre-existing central nervous system disorders may be aggravated by exposure.

*Fire fighting measures*

FIRE AND EXPLOSION HAZARDS Vapors may be ignited rapidly when exposed to heat, spark, open flame or other source of ignition. Flowing product may be ignited by self-generated static electricity. When mixed with air and exposed to an ignition source, flammable vapors can burn in the open or explode in confined spaces. Being heavier than air, vapors may travel long distances to an ignition source and flash back. Runoff to sewer may cause fire or explosion hazard.

*Stability and reactivity*

CONDITIONS TO AVOID Avoid high temperatures, open flames, sparks, welding, smoking and other ignition sources INCOMPATIBLE MATERIALS Keep away from strong oxidizers. HAZARDOUS DECOMPOSITION PRODUCTS Carbon monoxide, carbon dioxide and non-combusted hydrocarbons (smoke). Contact with nitric and sulfuric acids will form nitrocresols that can decompose violently.

*Toxicological properties*

ACUTE TOXICITY

Acute Dermal LD50 (rabbits): > 5 ml/kg Acute Oral LD50 (rat): 18.75 ml/kg Primary dermal irritation (rabbits): slightly irritating Draize eye irritation (rabbits): non-irritating Guinea pig sensitization: negative

CHRONIC EFFECTS AND CARCINOGENICITY

Carcinogenicity: OSHA: NO IARC: YES - 2B NTP: NO ACGIH: YES (A3) IARC has determined that gasoline and gasoline exhaust are possibly carcinogenic in humans. Inhalation exposure to completely vaporized unleaded gasoline caused kidney cancers in male rats and liver tumors in female mice. The U.S. EPA has determined that the male kidney tumors are species-specific and are irrelevant for human health risk assessment. The significance of the tumors seen in female mice is not known. Exposure to light hydrocarbons in the same boiling range as this product has been associated in animal studies with effects to the central and peripheral nervous systems, liver, and kidneys. The significance of these animal models to predict similar human response to gasoline is uncertain. This product contains benzene. Human health studies indicate that prolonged and/or repeated overexposure to benzene may cause damage to the blood-forming system (particularly bone marrow), and serious blood disorders such as aplastic anemia and leukemia. Benzene is listed as a human carcinogen by the NTP, IARC, OSHA and ACGIH.

This product may contain methyl tertiary butyl ether (MTBE ): animal and human health effects studies indicate that MTBE may cause eye, skin, and respiratory tract irritation, central nervous system depression and neurotoxicity. MTBE is classified as an animal carcinogen (A3) by the ACGIH.

**Magnesium chloride** **250,000 gallons per year in 56 deliveries**

Extracts from ixom.com Safety Data Sheet (https://www.ixom.com/sds-search) for magnesium chloride solution

> *Hazards identification*
>
> Not classified as Dangerous Goods by the criteria of the Australian Dangerous Goods Code (ADG Code) for transport by Road and Rail; NON-DANGEROUS GOODS.
> Based on available information, not classified as hazardous according to Safe Work Australia; NON-HAZARDOUS CHEMICAL.
>
> *Stability and reactivity*
>
> **Incompatible materials:** Incompatible with strong acids.
> **Hazardous decomposition products:** Oxides of magnesium.
>
> *Ecological information*
>
> **Ecotoxicity** Avoid contaminating waterways.

**Nitric acid** **65,000 gallons per year in 22 deliveries**

Extracts from ixom.com Safety Data Sheet (https://www.ixom.com/sds-search) for nitric acid 30% (Data sheets for 1, 30, 40, 40-50, 45, and 60-64% solutions were available.)

*Hazards identification*

Classified as Dangerous Goods by the criteria of the Australian Dangerous Goods Code (ADG Code) for Transport by Road and Rail; DANGEROUS GOODS.

This material is hazardous according to Safe Work Australia; HAZARDOUS CHEMICAL.

*Classification of the chemical:*
Corrosive to Metals - Category 1
Skin Corrosion - Sub-category 1A
Eye Damage - Category 1

SIGNAL WORD: DANGER

*Hazard Statement(s):*
H290 May be corrosive to metals.
H314 Causes severe skin burns and eye damage.

*Precautionary Statement(s):*
*Prevention:*
P234 Keep only in original container.
P260 Do not breathe mist, vapours, spray.
P264 Wash hands thoroughly after handling.
P280 Wear protective gloves / protective clothing / eye protection / face protection.

*Response:*
P301+P330+P331 IF SWALLOWED: Rinse mouth. Do NOT induce vomiting.
P303+P361+P353 IF ON SKIN (or hair): Take off immediately all contaminated clothing. Rinse skin with water/shower.
P363 Wash contaminated clothing before re-use.
P321 Specific treatment (see First Aid Measures on Safety Data Sheet).
P305+P351+P338 IF IN EYES: Rinse cautiously with water for several minutes. Remove contact lenses, if present and easy to do. Continue rinsing.
P310 Immediately call a POISON CENTER or doctor/physician.
P304+P340 IF INHALED: Remove person to fresh air and keep comfortable for breathing.
P390 Absorb spillage to prevent material damage.

*Stability and reactivity*

Reactivity: Reacts with strong alkalis. Corrodes metals.
Chemical stability: Stable under normal ambient and anticipated storage and handling conditions of temperature and pressure.

Possibility of hazardous reactions: Reacts with metals liberating flammable hydrogen gas. May cause fire in contact with organic materials such as wood, cotton or straw, evolving toxic nitrogen oxides gases (brown fumes).

Conditions to avoid: Avoid exposure to light. Avoid contact with foodstuffs.

Incompatible materials: Incompatible with strong alkalis, organic chemicals, reducing agents, carbides, chlorates, metals.

Hazardous decomposition products: Oxides of nitrogen.

*Toxicological information*

Ingestion: Swallowing can result in nausea, vomiting, diarrhoea, abdominal pain and chemical burns to the gastrointestinal tract.

Eye contact: A severe eye irritant. Corrosive to eyes; contact can cause corneal burns. Contamination of eyes can result in permanent injury.

Skin contact: Contact with skin will result in severe irritation. Corrosive to skin - may cause skin burns.

Inhalation: Breathing in mists or aerosols may produce respiratory irritation. Nitric acid may decompose to a toxic brown gas of nitrogen dioxide. Inhalation of the gas may result in chest discomfort, shortness of breath and possible pulmonary oedema, the onset of which may be delayed.

Chronic effects: Chronic overexposure to vapour, fumes or aerosols may produce adverse effects on the lungs and erosion of the teeth.

*Ecological information*

Ecotoxicity Avoid contaminating waterways.

**Ferric sulfate** **23,000 gallons per year in 17 deliveries**

Extracts from ixom.com Safety Data Sheet (https://www.ixom.com/sds-search) for ferric sulphate 70% w/v (40-45% w/w)

> *Hazards identification*
>
> Classified as Dangerous Goods by the criteria of the Australian Dangerous Goods Code (ADG Code) for Transport by Road and Rail; DANGEROUS GOODS.
>
> This material is hazardous according to Safe Work Australia; HAZARDOUS CHEMICAL.
>
> *Classification of the chemical:*
> Corrosive to Metals - Category 1
> Skin Corrosion - Sub-category 1B
> Eye Damage - Category 1
>
> SIGNAL WORD: DANGER
>
> *Hazard Statement(s):*
> H290 May be corrosive to metals.
> H314 Causes severe skin burns and eye damage.
>
> *Precautionary Statement(s):*
> *Prevention:*
> P234 Keep only in original container.
> P260 Do not breathe mist, vapours, spray.
> P264 Wash hands thoroughly after handling.
> P280 Wear protective gloves / protective clothing / eye protection / face protection.
>
> *Response:*
> P301+P330+P331 IF SWALLOWED: Rinse mouth. Do NOT induce vomiting.
> P303+P361+P353 IF ON SKIN (or hair): Take off immediately all contaminated clothing. Rinse skin with water/shower.
> P363 Wash contaminated clothing before re-use.
> P304+P340 IF INHALED: Remove person to fresh air and keep comfortable for breathing.
> P310 Immediately call a POISON CENTER or doctor/physician.
> P321 Specific treatment (see First Aid Measures on Safety Data Sheet).
> P305+P351+P338 IF IN EYES: Rinse cautiously with water for several minutes. Remove contact lenses, if present and easy to do. Continue rinsing.
> P390 Absorb spillage to prevent material damage.
>
> *Storage:*
> P405 Store locked up.
> P406 Store in corrosive resistant container with a resistant inner liner.

*Physical and chemical properties*

Physical state: Liquid
Colour: Dark red-brown-black
Odour: Odourless
Solubility: Miscible with water.
pH: <1

*Stability and Reactivity*

Reactivity: Reacts with alkalis. Corrodes metals.

Chemical stability: Stable under normal conditions of use.

Possibility of hazardous reactions: Mildly corrosive to metals and concrete. Reacts with alkalis. Hazardous polymerisation will not occur.

Conditions to avoid: Avoid contact with metals. Avoid contact with alkalis.

Incompatible materials: Incompatible with alkalis. Mildly corrosive to metals and concrete.

Hazardous decomposition products: Oxides of sulfur. Oxides of iron.

*Toxicological information*

Ingestion: Swallowing can result in nausea, vomiting, diarrhoea, abdominal pain and chemical burns to the gastrointestinal tract.

Eye contact: A severe eye irritant. Corrosive to eyes; contact can cause corneal burns. Contamination of eyes can result in permanent injury.

Skin contact: Contact with skin will result in severe irritation. Corrosive to skin - may cause skin burns.

Inhalation: Breathing in mists or aerosols may produce respiratory irritation.

Acute toxicity: Oral LD50 (rat): >5000 mg/kg for product (1)
(1) Supplier Safety Data Sheet; 04/ 2001.

*Ecological information*

Ecotoxicity Avoid contaminating waterways

*Disposal considerations*

Disposal methods: Refer to Waste Management Authority. Dispose of material through a licensed waste contractor.

Special precautions for landfill or incineration: Decontamination and destruction of containers should be considered.

| **Sulfuric acid** | **12,000 gallons per year in 5 deliveries** |
|---|---|

Extracts from ixom.com Safety Data Sheet (https://www.ixom.com/sds-search) for sulfuric acid 10-51%. (Data sheets for <5, 5-10, 10-51, and >51% solutions were available.)

> *Hazards identification*
>
> Classified as Dangerous Goods by the criteria of the Australian Dangerous Goods Code (ADG Code) for Transport by Road and Rail; DANGEROUS GOODS.
>
> This material is hazardous according to Safe Work Australia; HAZARDOUS CHEMICAL.
>
> Classification of the chemical:
> Skin Corrosion - Sub-category 1A
> Eye Damage - Category 1
> Specific target organ toxicity (single exposure) - Category 3
>
> SIGNAL WORD: DANGER
>
> *Hazard Statement(s):*
> H290 May be corrosive to metals.
> H314 Causes severe skin burns and eye damage.
> H335 May cause respiratory irritation.
>
> *Precautionary Statement(s):*
> *Prevention:*
> P234 Keep only in original container.
> P260 Do not breathe mist, vapours, spray.
> P264 Wash hands thoroughly after handling.
> P271 Use only outdoors or in a well-ventilated area.
> P280 Wear protective gloves / protective clothing / eye protection / face protection.
>
> *Response:*
> P301+P330+P331 IF SWALLOWED: Rinse mouth. Do NOT induce vomiting.
> P303+P361+P353 IF ON SKIN (or hair): Take off immediately all contaminated clothing. Rinse skin with water/shower.
> P321 Specific treatment (see First Aid Measures on Safety Data Sheet).
> P363 Wash contaminated clothing before re-use.
> P304+P340 IF INHALED: Remove person to fresh air and keep comfortable for breathing.
> P312 Call a POISON CENTER or doctor/physician if you feel unwell.
> P305+P351+P338 IF IN EYES: Rinse cautiously with water for several minutes. Remove contact lenses, if present and easy to do. Continue rinsing.
> P310 Immediately call a POISON CENTER or doctor/physician.
> P390 Absorb spillage to prevent material damage.

### *Stability and reactivity*

Reactivity: Reacts with alkalis.

Chemical stability: Stable under normal ambient and anticipated storage and handling conditions of temperature and pressure.

Possibility of hazardous reactions: Corrosive to most metals. Reacts exothermically with water.

Conditions to avoid: Avoid exposure to moisture.

Incompatible materials: Incompatible with many metals, organic chemicals, alkalis.

Hazardous decomposition products: Sulfur dioxide.

### *Toxicological information*

Ingestion: Swallowing can result in nausea, vomiting, diarrhoea, abdominal pain and chemical burns to the gastrointestinal tract.

Eye contact: A severe eye irritant. Corrosive to eyes; contact can cause corneal burns. Contamination of eyes can result in permanent injury.

Skin contact: Contact with skin will result in severe irritation. Corrosive to skin - may cause skin burns.

Inhalation: Breathing in mists or aerosols will produce respiratory irritation.

Acute toxicity: No LD50 data available for the product. For the constituent Sulfuric acid (1):

Oral LD50 (rat): 2140 mg/kg
Inhalation LC50 (rat): 510 mg/m$^3$/2hours

Respiratory or skin sensitisation: No information available.

Chronic effects: No information available for the product.

For the component Sulfuric acid: Repeated overexposure may lead to chronic conjunctivitus, lung damage and dental erosion. The International Agency for Research on Cancer (IARC) have concluded that occupational exposure to strong inorganic acid mists containing sulfuric acid is carcinogenic to humans, causing cancer of the larynx and to a lesser extent, the lung. No direct link has been established with sulfuric acid, itself, and cancer in humans. Exposure to any mist or aerosol during the use of this product should be avoided and exposure should not exceed the exposure standard. (2)

*Ecological information*

Ecotoxicity Avoid contaminating waterways.

(1) `Registry of Toxic Effects of Chemical Substances'. Ed. D. Sweet, US Dept. of Health & Human Services: Cincinnati, 2019.

(2) International Agency for Research on Cancer. In: `IARC Monographs on the Evaluation of Carcinogenic Risk to Humans'. World Health Organisation, 1992.

**Methyl isobutyl carbinyl** **120,000 gallons per year in 40 deliveries**

From USACE 2020, p. 4.27-89:

> [Methyl isobutyl carbinol] is a flammable liquid, with flammable vapor. It is classified as Dangerous Goods by the International Maritime Dangerous Goods Code (IXOM 2017)…
>
> [Methyl isobutyl carbinol] is considered hazardous, can cause eye and respiratory irritation, is a kidney toxin, and a carcinogen (IXOM 2017). The Materials Safety Data Sheet (MSDS) recommends use only outdoors or in a well-ventilated area, and to avoid breathing mist, vapor, or spray (IXOM 2017).

Extracts from ixom.com Safety Data Sheet (https://www.ixom.com/sds-search) for **Methyl isobutyl carbinol**

> Classified as Dangerous Goods by the criteria of the Australian Dangerous Goods Code (ADG Code) for Transport by Road and Rail; DANGEROUS GOODS.
> This material is hazardous according to Safe Work Australia; HAZARDOUS CHEMICAL.
>
> *Classification of the chemical:*
>
> Flammable liquids - Category 3
> Eye Irritation - Category 2A
> Specific target organ toxicity (single exposure) - Category 3
>
> Signal word Warning
>
> *Hazard statement(s)*
>
> H226 Flammable liquid and vapour.
> H319 Causes serious eye irritation.
> H335 May cause respiratory irritation.
>
> *Precautionary statement(s): Prevention*
>
> P210 Keep away from heat, sparks, open flames, hot surfaces. No smoking.
> P233 Keep container tightly closed.
> P240 Ground or bond container and receiving equipment
> P241 Use explosion-proof electrical, ventilating, lighting equipment.
> P242 Use only non-sparking tools.
> P243 Take precautionary measures against static discharge.
> P261 Avoid breathing mist, vapours, spray.

P264 Wash hands thoroughly after handling.
P271 Use only outdoors or in a well-ventilated area.
P280 Wear protective gloves / protective clothing / eye protection / face protection.

*Accidental Release Measures*

Emergency procedures/Environmental precautions: Shut off all possible sources of ignition. Clear area of all unprotected personnel. If contamination of sewers or waterways has occurred advise local emergency services.

Personal precautions/Protective equipment/Methods and materials for containment and cleaning up: Slippery when spilt. Avoid accidents, clean up immediately. Wear protective equipment to prevent skin and eye contact and breathing in vapours. Work up wind or increase ventilation. Contain - prevent run off into drains and waterways. Use absorbent (soil, sand or other inert material). Collect and seal in properly labelled containers or drums for disposal. Use non-sparking tools.

*Toxicological information*

Ingestion: Swallowing can result in nausea, vomiting and central nervous system depression. If the victim is showing signs of central system depression (like those of drunkenness (*sic*)) there is greater likelihood of the patient breathing in vomit and causing damage to the lungs.

Eye contact: An eye irritant.

Skin contact: Contact with skin may result in irritation. Will have a degreasing action on the skin. Repeated or prolonged skin contact may lead to irritant contact dermatitis. Can be absorbed through the skin with resultant adverse effects.

Inhalation: Material is irritant to the mucous membranes of the respiratory tract (airways). Breathing in vapour can result in headaches, dizziness, drowsiness, and possible nausea. Breathing in high concentrations can produce central nervous system depression, which can lead to loss of co-ordination, impaired judgement and if exposure is prolonged, unconsciousness.

*Ecological information*

Ecotoxicity Avoid contaminating waterways.
Persistence/degradability: The material is readily biodegradable.
48hr EC50 (*Daphnia magna*): 337 mg/L (semi-static test)
96hr LC50 (rainbow trout): 359 mg/L (semi-static test)

**Hydrogen peroxide** **7,100 gallons per year in 2 deliveries**

Extracts from ixom.com Safety Data Sheet (https://www.ixom.com/sds-search) for hydrogen peroxide 20-60% solution

*Hazards identification*

Classified as Dangerous Goods by the criteria of the Australian Dangerous Goods Code (ADG Code) for Transport by Road and Rail; DANGEROUS GOODS.

This material is hazardous according to Safe Work Australia; HAZARDOUS CHEMICAL.

*Classification of the chemical:*
Oxidising liquids - Category 2
Skin Corrosion - Sub-category 1B
Eye Damage - Category 1
Acute Oral Toxicity - Category 4
Acute Inhalation Toxicity - Category 4
Specific target organ toxicity (single exposure) - Category 3

SIGNAL WORD: DANGER

*Hazard Statement(s):*
H272 May intensify fire; oxidizer.
H302+H332 Harmful if swallowed or if inhaled.
H314 Causes severe skin burns and eye damage.
H335 May cause respiratory irritation

*Precautionary Statement(s):*
*Prevention:*
P210 Keep away from heat. No smoking.
P220 Keep and store away from clothing, incompatible materials, combustible materials.
P221 Take any precaution to avoid mixing with combustibles / incompatible materials.
P260 Do not breathe mist, vapours, spray.
P264 Wash hands thoroughly after handling.
P270 Do not eat, drink or smoke when using this product.
P271 Use only outdoors or in a well-ventilated area.
P280 Wear protective gloves / protective clothing / eye protection / face protection.

*Response:*
P301+P330+P331 IF SWALLOWED: Rinse mouth. Do NOT induce vomiting.
P301+P312 IF SWALLOWED: Call a POISON CENTER or doctor/physician if you feel unwell.
P303+P361+P353 IF ON SKIN (or hair): Take off immediately all contaminated clothing. Rinse skin with water/shower.
P304+P340 IF INHALED: Remove person to fresh air and keep comfortable for breathing.

P312 Call a POISON CENTER or doctor/physician if you feel unwell.
P305+P351+P338 IF IN EYES: Rinse cautiously with water for several minutes. Remove contact lenses, if present and easy to do. Continue rinsing.
P310 Immediately call a POISON CENTER or doctor/physician.
P321 Specific treatment (see First Aid Measures on Safety Data Sheet).
P363 Wash contaminated clothing before re-use.
P370+P378 In case of fire: Use extinguishing media as outlined in Section 5 of this Safety Data Sheet to extinguish.

*Physical and chemical properties*
pH: 1-4

*Stability and reactivity*
Conditions to avoid: Avoid exposure to heat.

Incompatible materials: Incompatible with acids, reducing agents, alkalis, heavy metals and their salts, dust, enzymes, combustible material, organic chemicals, cyanides, dirt, rust, hexavalent chromium compounds.

Hazardous decomposition products: Oxygen, which will support combustion

*Toxicological information*
Ingestion: Swallowing can result in nausea, vomiting, diarrhoea, abdominal pain and chemical burns to the gastrointestinal tract. Decomposition may occur in the stomach leading to the production of oxygen gas. This may cause distension of the stomach and the possibility of some bleeding. Death may occur if large amounts are ingested.

Eye contact: A severe eye irritant. Corrosive to eyes; contact can cause corneal burns. Contamination of eyes can result in permanent injury.

Skin contact: Contact with skin will result in severe irritation. Corrosive to skin - may cause skin burns.

Inhalation: Breathing in vapour will produce respiratory irritation.

Acute toxicity: Oral LD50 (rat): 841 mg/kg (60% solution)

Respiratory or skin sensitisation: No information available.

Chronic effects: Available evidence from animal studies indicate that repeated or prolonged exposure to this material could result in effects on the lungs.

*Ecological information*
Ecotoxicity Avoid contaminating waterways.

**Sodium hypochlorite (listed as a solid for the DEIS and a liquid for the SDEIS)**
**DEIS: 1,000 pounds per year in 1 delivery and additional 5,000-15,000 gallons per year for Alternative 2**
**SDEIS: 2,000 gallons in 2 deliveries**

Extracts from ixom.com Safety Data Sheet (https://www.ixom.com/sds-search) for sodium hypochlorite solution (10-15% solution)

> *Hazards identification*
>
> Classified as Dangerous Goods by the criteria of the Australian Dangerous Goods Code (ADG Code) for Transport by Road and Rail; DANGEROUS GOODS.
> This material is hazardous according to Safe Work Australia; HAZARDOUS CHEMICAL.
>
> *Classification of the chemical:*
> Skin Corrosion - Sub-category 1B
> Eye Damage - Category 1
> Specific target organ toxicity (single exposure) - Category 3
> The following health/environmental hazard categories fall outside the scope of the Workplace Health and Safety Regulations:
> Acute Aquatic Toxicity - Category 1
> Chronic Aquatic Toxicity – Category 1
>
> SIGNAL WORD: DANGER
>
> *Hazard Statement(s):*
> H314 Causes severe skin burns and eye damage.
> H335 May cause respiratory irritation.
> H410 Very toxic to aquatic life with long lasting effects.
>
> *Precautionary Statement(s):*
> *Prevention:*
> P260 Do not breathe mist, vapours, spray.
> P264 Wash hands thoroughly after handling.
> P271 Use only outdoors or in a well-ventilated area.
> P280 Wear protective gloves / protective clothing / eye protection / face protection.
> P273 Avoid release to the environment.
>
> *Response:*
> P301+P330+P331 IF SWALLOWED: Rinse mouth. Do NOT induce vomiting.
> P303+P361+P353 IF ON SKIN (or hair): Take off immediately all contaminated clothing. Rinse skin with water/shower.
> P321 Specific treatment (see First Aid Measures on Safety Data Sheet).
> P363 Wash contaminated clothing before re-use.
> P304+P340 IF INHALED: Remove person to fresh air and keep comfortable for breathing.

P312 Call a POISON CENTER or doctor/physician if you feel unwell.
P305+P351+P338 IF IN EYES: Rinse cautiously with water for several minutes. Remove contact lenses, if present and easy to do. Continue rinsing.
P310 Immediately call a POISON CENTER or doctor/physician.

*Other Hazards:*
AUH031 Contact with acids liberates toxic gas.

*Physical and chemical properties*
pH: 12.5 (1% w/w)

*Stability and reactivity*
Possibility of hazardous reactions: Hazardous polymerisation will not occur. Reacts exothermically with acids. Reacts with ammonia, amines, or ammonium salts to produce chloramines. Decomposes on heating to produce chlorine gas.

Conditions to avoid: Avoid contact with foodstuffs. Avoid exposure to heat, sources of ignition, and open flame. Avoid exposure to light. Avoid contact with other chemicals. Avoid contact with acids.

Incompatible materials: Incompatible with acids, metals, metal salts, peroxides, reducing agents, ethylene diamine tetra-acetic acid, methanol, aziridine, urea. Incompatible with ammonia and ammonium compounds such as amines and ammonium salts.

Hazardous decomposition products: Chlorine.

*Toxicological information*
Ingestion: Swallowing can result in nausea, vomiting, diarrhoea, abdominal pain and chemical burns to the gastrointestinal tract.

Eye contact: A severe eye irritant. Corrosive to eyes; contact can cause corneal burns.
Contamination of eyes can result in permanent injury.

Skin contact: Contact with skin will result in severe irritation. Corrosive to skin - may cause skin burns.

Inhalation: Breathing in mists or aerosols will produce respiratory irritation. Delayed (up to 48 hours) fluid build up in the lungs may occur.

Acute toxicity: No LD50 data available for the product.

For the constituent SODIUM HYPOCHLORITE:
Oral LD50 (mice): 5800 mg/kg
Serious eye damage/irritation: Moderate irritant (rabbit). Standard Draize test

*Ecological information*
Ecotoxicity: Avoid contaminating waterways.

Persistence/degradability: This material is biodegradable.

Bioaccumulative potential: Does not bioaccumulate.

Mobility in soil: No information available.

Aquatic toxicity: Very toxic to aquatic life with long lasting effects.
96hr LC50 (fish): 0.065 mg/L (for sodium hypochlorite)

**Antifreeze** **40,000 gallons per year in 13 deliveries**

The DEIS did not specify the exact formula; the MSDSs for monoethylene glycol, polyethylene glycol, and propylene glycol are shown here.

### Monoethylene glycol

Extracts from ixom.com Safety Data Sheet (https://www.ixom.com/sds-search) for monoethylene glycol

> Not classified as Dangerous Goods by the criteria of the Australian Dangerous Goods Code (ADG Code) for transport by Road and Rail; NON-DANGEROUS GOODS.
>
> This material is hazardous according to Safe Work Australia; HAZARDOUS CHEMICAL.
>
> *Classification of the chemical:*
> Acute Oral Toxicity - Category 4
> Specific target organ toxicity (single exposure) - Category 3
> Specific target organ toxicity (repeated exposure) - Category 2
>
> SIGNAL WORD: WARNING
>
> *Hazard Statement(s):*
> H302 Harmful if swallowed.
> H335 May cause respiratory irritation.
> H373 May cause damage to organs through prolonged or repeated exposure.
>
> *Precautionary Statement(s):*
> *Prevention*:
> P260 Do not breathe mist, vapours, spray.
> P264 Wash hands thoroughly after handling.
> P270 Do not eat, drink or smoke when using this product.
> P271 Use only outdoors or in a well-ventilated area.
>
> *Response:*
> P301+P312 IF SWALLOWED: Call a POISON CENTER or doctor/physician if you feel unwell.
> P330 Rinse mouth.
> P304+P340 IF INHALED: Remove person to fresh air and keep comfortable for breathing.
> P312 Call a POISON CENTER or doctor/physician if you feel unwell.
> P314 Get medical advice/attention if you feel unwell.
>
> *Toxicological information*

Ingestion: Initial symptoms following a large dose (>100ml) are those of alcohol intoxication progressing to vomiting, headache, stupor, convulsions and unconsciousness. Respiratory system involvement may occur 12 - 24 hours after ingestion. Symptoms may include hyperventilation and rapid shallow breathing. Death may occur from respiratory failure or pulmonary oedema.

Eye contact: A mild eye irritant.

Skin contact: Contact with skin will result in mild irritation. Will have a degreasing action on the skin. Repeated or prolonged skin contact may lead to irritant contact dermatitis. Can be absorbed through the skin. Effects can include those described for 'INGESTION'.

Inhalation: Breathing in vapour will produce respiratory irritation. Breathing in vapour can result in headaches, dizziness, drowsiness, and possible nausea.

Acute toxicity: Oral LD50 (rat): 4700 mg/kg

Skin corrosion/irritation: Mild irritant (rabbit).

Serious eye damage/irritation: Mild irritant (rabbit).

Respiratory or skin sensitisation: No information available.

Chronic effects: Available evidence from animal studies indicate that repeated or prolonged exposure to this material could result in effects on the central nervous system, liver and kidneys.

Aspiration hazard: No information available.

Estimated minimum lethal dose (human) following ingestion of ethylene glycol is thought to be 1.4ml/kg. High doses of ethylene glycol in rats and mice have resulted in reproductive and developmental toxicity following exposure by the oral and inhalation (respirable aerosol) routes. These particular data sets are not considered relevant to normal industrial use but do emphasise the need for care in handling.

*Ecological information*

Ecotoxicity Avoid contaminating waterways.

96hr LC50 (fish): >10,000 mg/L (marine water); 8050 mg/L (fresh water).

## Polyethylene glycol

Extracts from ixom.com Safety Data Sheet (https://www.ixom.com/sds-search) for polyethylene glycol

> Not classified as Dangerous Goods by the criteria of the Australian Dangerous Goods Code (ADG Code) for transport by Road and Rail; NON-DANGEROUS GOODS.
> Based on available information, not classified as hazardous according to Safe Work Australia; NON-HAZARDOUS CHEMICAL.
>
> *Stability and reactivity*
>
> Conditions to avoid: Avoid exposure to heat, sources of ignition, and open flame. Avoid dust generation.
>
> Incompatible materials: Incompatible with strong acids and oxidising agents.
>
> Hazardous decomposition products: Oxides of carbon.
>
> *Ecological information*
>
> Ecotoxicity Avoid contaminating waterways.

## Propylene glycol

Extracts from ixom.com Safety Data Sheet (https://www.ixom.com/sds-search) for propylene glycol

> Not classified as Dangerous Goods by the criteria of the Australian Dangerous Goods Code (ADG Code) for transport by Road and Rail; NON-DANGEROUS GOODS.
>
> Based on available information, not classified as hazardous according to Safe Work Australia; NON-HAZARDOUS CHEMICAL.
>
> *Stability and reactivity*
>
> Conditions to avoid: Avoid exposure to heat, sources of ignition, and open flame. Avoid temperatures above 40°C. Avoid exposure to direct sunlight.
>
> Incompatible materials: Incompatible with strong oxidising agents, strong acids, isocyanates.
>
> Hazardous decomposition products: Oxides of carbon. Aldehydes. Alcohols. Ethers. Organic acids.
>
> *Ecological information*
>
> Ecotoxicity 96hr LC50 (rainbow trout): 40,613 mg/L

**Sodium hypochlorite (listed as a solid for the DEIS and a liquid for the SDEIS)**
**DEIS: 1,000 pounds per year in 1 delivery and additional 5,000-15,000 gallons per year for**
**Alternative 2SDEIS: 2,000 gallons in 2 deliveries**

Extracts from ixom.com Safety Data Sheet (https://www.ixom.com/sds-search) for sodium hypochlorite solution (10-15% available chlorine)

> *Hazards identification*
>
> Classified as Dangerous Goods by the criteria of the Australian Dangerous Goods Code (ADG Code) for Transport by Road and Rail; DANGEROUS GOODS.
> This material is hazardous according to Safe Work Australia; HAZARDOUS CHEMICAL.
>
> *Classification of the chemical:*
> Skin Corrosion - Sub-category 1B
> Eye Damage - Category 1
> Specific target organ toxicity (single exposure) - Category 3
> The following health/environmental hazard categories fall outside the scope of the Workplace Health and Safety Regulations:
> Acute Aquatic Toxicity - Category 1
> Chronic Aquatic Toxicity – Category 1
>
> SIGNAL WORD: DANGER
>
> *Hazard Statement(s):*
> H314 Causes severe skin burns and eye damage.
> H335 May cause respiratory irritation.
> H410 Very toxic to aquatic life with long lasting effects.
>
> *Precautionary Statement(s):*
> *Prevention:*
> P260 Do not breathe mist, vapours, spray.
> P264 Wash hands thoroughly after handling.
> P271 Use only outdoors or in a well-ventilated area.
> P280 Wear protective gloves / protective clothing / eye protection / face protection.
> P273 Avoid release to the environment.
>
> *Response:*
> P301+P330+P331 IF SWALLOWED: Rinse mouth. Do NOT induce vomiting.
> P303+P361+P353 IF ON SKIN (or hair): Take off immediately all contaminated clothing. Rinse skin with water/shower.
> P321 Specific treatment (see First Aid Measures on Safety Data Sheet).
> P363 Wash contaminated clothing before re-use.
> P304+P340 IF INHALED: Remove person to fresh air and keep comfortable for breathing.

P312 Call a POISON CENTER or doctor/physician if you feel unwell.
P305+P351+P338 IF IN EYES: Rinse cautiously with water for several minutes. Remove contact lenses, if present and easy to do. Continue rinsing.
P310 Immediately call a POISON CENTER or doctor/physician.

*Other Hazards:*
AUH031 Contact with acids liberates toxic gas.

*Physical and chemical properties*

pH: 12.5 (1% w/w)

*Stability and reactivity*

Possibility of hazardous reactions: Hazardous polymerisation will not occur. Reacts exothermically with acids. Reacts with ammonia, amines, or ammonium salts to produce chloramines. Decomposes on heating to produce chlorine gas.

Conditions to avoid: Avoid contact with foodstuffs. Avoid exposure to heat, sources of ignition, and open flame. Avoid exposure to light. Avoid contact with other chemicals. Avoid contact with acids.

Incompatible materials: Incompatible with acids, metals, metal salts, peroxides, reducing agents, ethylene diamine tetra-acetic acid, methanol, aziridine, urea. Incompatible with ammonia and ammonium compounds such as amines and ammonium salts.

Hazardous decomposition products: Chlorine.

*Toxicological information*

Ingestion: Swallowing can result in nausea, vomiting, diarrhoea, abdominal pain and chemical burns to the gastrointestinal tract.

Eye contact: A severe eye irritant. Corrosive to eyes; contact can cause corneal burns.
Contamination of eyes can result in permanent injury.

Skin contact: Contact with skin will result in severe irritation. Corrosive to skin - may cause skin burns.

Inhalation: Breathing in mists or aerosols will produce respiratory irritation. Delayed (up to 48 hours) fluid build up in the lungs may occur.

Acute toxicity: No LD50 data available for the product.

For the constituent SODIUM HYPOCHLORITE:

Oral LD50 (mice): 5800 mg/kg
Serious eye damage/irritation: Moderate irritant (rabbit). Standard Draize test

*Ecological information*

Ecotoxicity: Avoid contaminating waterways.

Persistence/degradability: This material is biodegradable.

Bioaccumulative potential: Does not bioaccumulate.

Mobility in soil: No information available.

Aquatic toxicity: Very toxic to aquatic life with long lasting effects.
96hr LC50 (fish): 0.065 mg/L (for sodium hypochlorite)

Extracts from ixom.com Safety Data Sheet (https://www.ixom.com/sds-search) for sodium hypochlorite solution

Not classified as Dangerous Goods by the criteria of the Australian Dangerous Goods Code (ADG Code) for transport
by Road and Rail; NON-DANGEROUS GOODS.
Based on available information, not classified as hazardous according to Safe Work Australia; NON-HAZARDOUS CHEMICAL.

*Stability and reactivity*

Reactivity: No information available.
Chemical stability: Stable under normal ambient and anticipated storage and handling conditions of temperature and pressure.
Possibility of hazardous reactions: May react with strong acids.
Conditions to avoid: Avoid exposure to heat.
Incompatible materials: Incompatible with strong acids .
Hazardous decomposition products: Chlorine

*Toxicological information*

Ingestion: No adverse effects expected, however, large amounts may cause nausea and vomiting.
Eye contact: May be an eye irritant.
Skin contact: Contact with skin may result in irritation.

Inhalation: Breathing in mists or aerosols may produce respiratory irritation.

*Ecological information*

Ecotoxicity: Avoid contaminating waterways.
Persistence/degradability: The material is biodegradable.
Bioaccumulative potential: Does not bioaccumulate

**Sodium bisulfite** **1,400-2,000 gallons per year in the DEIS**
**0.2 tons per year in the SDEIS**

Extracts from ixom.com Safety Data Sheet (https://www.ixom.com/sds-search) for sodium bisulfite solution (15-40%)

> *Hazards identification*
>
> Classified as Dangerous Goods by the criteria of the Australian Dangerous Goods Code (ADG Code) for Transport by Road and Rail; DANGEROUS GOODS.
> This material is hazardous according to Safe Work Australia; HAZARDOUS CHEMICAL.
>
> *Classification of the chemical:*
> Acute Oral Toxicity - Category 4
> Skin Irritation - Category 2
> Eye Irritation - Category 2A
>
> SIGNAL WORD: WARNING
>
> *Hazard Statement(s):*
> H302 Harmful if swallowed.
> H315 Causes skin irritation.
> H319 Causes serious eye irritation.
> Precautionary Statement(s):
> Prevention:
> P264 Wash hands thoroughly after handling.
> P270 Do not eat, drink or smoke when using this product.
> P280 Wear protective gloves / protective clothing / eye protection / face protection.
>
> *Response:*
> P301+P312 IF SWALLOWED: Call a POISON CENTER or doctor/physician if you feel unwell.
> P330 Rinse mouth.
> P302+P352 IF ON SKIN: Wash with plenty of soap and water.
> P321 Specific treatment (see First Aid Measures on Safety Data Sheet).
> P332+P313 If skin irritation occurs: Get medical advice/attention.
> P362 Take off contaminated clothing and wash before reuse.
> P305+P351+P338 IF IN EYES: Rinse cautiously with water for several minutes. Remove contact lenses, if present and easy to do. Continue rinsing.
> P337+P313 If eye irritation persists: Get medical advice/attention.
>
> *Disposal:*
> P501 Dispose of contents and container in accordance with local, regional, national, international regulations.

*Other Hazards:*

AUH031 Contact with acids liberates toxic gas.

*Physical and chemical properties*
Physical state: Liquid
Colour: Pale Yellow
Odour: Pungent , Sulfur – like
Solubility: Soluble in water.
pH: ca. 4-5

*Stability and reactivity*
Reactivity: Contact with acids liberates toxic gas.
Incompatible materials: Incompatible with acids, strong oxidising agents, and materials that react violently with water.

Hazardous decomposition products: Sulfur dioxide.
*Toxicological information*
Ingestion: Swallowing can result in nausea, vomiting, diarrhoea, and gastrointestinal irritation.

Eye contact: An eye irritant.

Skin contact: Contact with skin will result in irritation. May cause skin sensitisation in sensitive individuals. Repeated or prolonged skin contact may lead to allergic contact dermatitis.

Inhalation: Breathing in mists or aerosols may produce respiratory irritation. May cause respiratory sensitisation in sensitive individuals, producing asthma-like symptoms.

Acute toxicity: No LD50 data available for the product.

For the constituent SODIUM BISULFITE:
Oral LD50 (rat): 2000 mg/kg
Skin corrosion/irritation: Irritant.
Serious eye damage/irritation: Irritant.
Respiratory or skin sensitisation: No information available.
Chronic effects: Not a listed carcinogen.
Aspiration hazard: No information available.
Estimated fatal dose in humans is 10 g.
The sodium bisulfite constituent in this product can sensitise the skin and/or respiratory tract of some susceptible individuals.

*Ecological information*
Ecotoxicity Avoid contaminating waterways.

**Carbon dioxide (liquid)** **14 tons in 5 deliveries**

Extracts from ixom.com Safety Data Sheet (https://www.ixom.com/sds-search) for carbon dioxide

Classified as Dangerous Goods by the criteria of the Australian Dangerous Goods Code (ADG Code) for Transport by Road and Rail; DANGEROUS GOODS.
This material is hazardous according to Safe Work Australia; HAZARDOUS CHEMICAL.
Classification of the chemical:
Gases under pressure - Liquefied Gas
SIGNAL WORD: WARNING

Hazard Statement(s): H280 Contains gas under pressure; may explode if heated.
Precautionary Statement(s):
Prevention: P103 Read label before use.
Response: No response statements.
Storage: P410+P403 Protect from sunlight. Store in a well-ventilated place.

*Stability and reactivity*
Reactivity: No information available.
Chemical stability: Stable under normal conditions. Corrosive when moist.
Possibility of hazardous reactions: Dust of aluminium, chrome and manganese ignite and explode when heated in carbon dioxide.
Conditions to avoid: Avoid exposure to moisture.
Incompatible materials: Incompatible with acrylaldehyde, aziridine, metal acetylides, moisture, potassium, sodium, sodium peroxide, mild steel.

*Ecological information*
Ecotoxicity Avoid contaminating waterways.

*Transport information*
**Road and Rail Transport**
Classified as Dangerous Goods by the criteria of the Australian Dangerous Goods Code (ADG Code) for Transport by Road and Rail; DANGEROUS GOODS.
**Marine Transport**
Classified as Dangerous Goods by the criteria of the International Maritime Dangerous Goods Code (IMDG Code) for transport by sea; DANGEROUS GOODS.
**Air Transport**
Classified as Dangerous Goods by the criteria of the International Air Transport Association (IATA) Dangerous Goods
Regulations for transport by air; DANGEROUS GOODS. TRANSPORT PROHIBITED under the International Air Transport Association (IATA) Dangerous Goods Regulations for transport by air in Passenger and Cargo Aircraft; may be transported by Cargo Aircraft Only.

## Bulk solids

**Lime** **150 tons in 7 deliveries**

Extracts from ixom.com Safety Data Sheet (https://www.ixom.com/sds-search) for calcium carbonate

> Not classified as Dangerous Goods by the criteria of the Australian Dangerous Goods Code (ADG Code) for transport by Road and Rail; NON-DANGEROUS GOODS.
> Based on available information, not classified as hazardous according to Safe Work Australia; NON-HAZARDOUS CHEMICAL.
>
> *Stability and reactivity*
> Reactivity: Reacts with acids.
> Chemical stability: Stable under normal ambient and anticipated storage and handling conditions of temperature and pressure.
> Possibility of hazardous reactions: Reacts with acids liberating carbon dioxide.
> Conditions to avoid: Avoid dust generation. Avoid exposure to moisture.
> Incompatible materials: Incompatible with acids, strong oxidising agents, ammonium salts.
> Hazardous decomposition products: Carbon dioxide.
>
> *Ecological information*
> Ecotoxicity Avoid contaminating waterways.

Extracts from echemi.com Safety Data Sheet (http://www.echemi.com/sds/calcium-oxide-pd180727113170.html):

> *Classification of the substance or mixture*
> Flammable liquids, Category 3
> Aspiration hazard, Category 1
> Hazardous to the aquatic environment, long-term (Chronic) - Category Chronic 2
>
> Signal word Danger
>
> *Hazard statement(s)*
>
> H226 Flammable liquid and vapour
> H304 May be fatal if swallowed and enters airways
> H411 Toxic to aquatic life with long lasting effects
>
> *Precautionary statement(s): Prevention*
>
> P210 Keep away from heat, hot surfaces, sparks, open flames and other ignition sources. No smoking.

P233 Keep container tightly closed.
P240 Ground and bond container and receiving equipment.
P241 Use explosion-proof [electrical/ventilating/lighting/...] equipment.
P242 Use non-sparking tools.
P243 Take action to prevent static discharges.
P280 Wear protective gloves/protective clothing/eye protection/face protection/hearing protection/...
P273 Avoid release to the environment.

*Accidental release measures*

Personal precautions, protective equipment and emergency procedures: Avoid dust formation. Avoid breathing mist, gas or vapours. Avoid contacting with skin and eye. Use personal protective equipment. Wear chemical impermeable gloves. Ensure adequate ventilation. Remove all sources of ignition. Evacuate personnel to safe areas. Keep people away from and upwind of spill/leak.

Environmental precautions: Prevent further spillage or leakage if it is safe to do so. Do not let the chemical enter drains. Discharge into the environment must be avoided.

*Ecological information*

Toxicity:

Toxicity to fish: LL50 - *Cyprinus carpio* - 6.8 mg/L - 96 h.

Toxicity to daphnia and other aquatic invertebrates: EL50 - *Daphnia magna* - 5.3 mg/L - 48 h.

Toxicity to algae: EL50 - *Pseudokirchneriella subcapitata* (previous names*: Raphidocelis subcapitata*, *Selenastrum capricornutum*) - 15 mg/L - 72 h.

Toxicity to microorganisms: NOEC - 10 mg/L - 28 d.

**Slaked lime (hydrated lime, milk of lime, calcium hydroxide)**

Extracts from ixom.com Safety Data Sheet (https://www.ixom.com/sds-search) for calcium hydroxide

Not classified as Dangerous Goods by the criteria of the Australian Dangerous Goods Code (ADG Code) for transport by Road and Rail; NON-DANGEROUS GOODS.
This material is hazardous according to Safe Work Australia; HAZARDOUS CHEMICAL.

*Classification of the chemical:*
Skin Irritation - Category 2
Eye Damage - Category 1

Specific target organ toxicity (single exposure) - Category 3

SIGNAL WORD: DANGER

*Hazard Statement(s):*
H315 Causes skin irritation.
H318 Causes serious eye damage.
H335 May cause respiratory irritation.

*Precautionary Statement(s):*
*Prevention:*
P261 Avoid breathing dust / fume / gas / mist / vapours / spray.
P264 Wash hands thoroughly after handling.
P271 Use only outdoors or in a well-ventilated area.
P280 Wear protective gloves / protective clothing / eye protection / face protection.

*Response:*
P302+P352 IF ON SKIN: Wash with plenty of soap and water.
P321 Specific treatment (see First Aid Measures on Safety Data Sheet).
P332+P313 If skin irritation occurs: Get medical advice/attention.
P362 Take off contaminated clothing and wash before reuse.
P304+P340 IF INHALED: Remove person to fresh air and keep comfortable for breathing.
P312 Call a POISON CENTER or doctor/physician if you feel unwell.
P305+P351+P338 IF IN EYES: Rinse cautiously with water for several minutes. Remove contact lenses, if present and easy to do. Continue rinsing.
P310 Immediately call a POISON CENTER or doctor/physician.

*Stability and reactivity*

Reactivity: Reacts with acids.

Chemical stability: Stable under normal ambient and anticipated storage and handling conditions of temperature and pressure. Absorbs carbon dioxide from air. Attacks aluminium, lead and brass in the presence of moisture. Decomposes with loss of water at approximately 580°C to form calcium oxide (quicklime).

Possibility of hazardous reactions: None known.

Conditions to avoid: Avoid exposure to moisture. Avoid exposure to air.

Incompatible materials: Incompatible with acids, nitromethane, nitroethane, nitroparaffins, nitropropane, maleic anhydride.

Hazardous decomposition products: Calcium oxide.

*Toxicological information*

Ingestion: Swallowing can result in nausea, vomiting, diarrhoea, abdominal pain and chemical burns to the gastrointestinal tract.

Eye contact: A severe eye irritant. Contamination of eyes can result in permanent injury.

Skin contact: Contact with skin will result in irritation.

Inhalation: Breathing in dust will result in respiratory irritation.

Acute toxicity: Oral LD50 (rat): 7340 mg/kg.

Skin corrosion/irritation: Irritant (rabbit).

Serious eye damage/irritation: Severe irritant (rabbit).

Respiratory or skin sensitisation: No information available.

Chronic effects:

Mutagenicity: No information available.

Carcinogenicity: Not listed as carcinogenic according to the International Agency for Research on Cancer (IARC).

Reproductive toxicity: No information available.

Specific Target Organ Toxicity (STOT) - single exposure: May cause respiratory irritation.

Aspiration hazard: No information available.

*Ecological information*

Ecotoxicity Avoid contaminating waterways.

Persistence/degradability: Biodegradation is not an applicable endpoint since the product is an inorganic chemical.

Bioaccumulative potential: Does not bioaccumulate.

Mobility in soil: No information available.

48hr EC50 (*Daphnia magna*): 49.1 mg/L
96hr LC50 (fish): 33.9 mg/kg (*Clarias gariepinus*)

| **Sodium metabisulfite** | **2,000 tons in 91 deliveries** |
|---|---|

Extracts from ixom.com Safety Data Sheet (https://www.ixom.com/sds-search) for sodium metabisulfite

Classified as a hazardous chemical in accordance with the criteria of Safe Work Australia - Globally Harmonized System (GHS).

Acute toxicity –

| | |
|---|---|
| Oral | Category 4 |
| Serious eye damage/eye irritation | Category 1 |

Signal word: DANGER

**Hazard statements**

H302 - Harmful if swallowed
H318 - Causes serious eye damage

**Precautionary Statements - Prevention**

Wash eyes thoroughly after handling.
Do not eat, drink or smoke when using this product
Wear eye/face protection
IF IN EYES: Rinse cautiously with water for several minutes. Remove contact lenses, if present and easy to do. Continue rinsing
Immediately call a POISON CENTER or doctor/physician
IF SWALLOWED: Call a POISON CENTER or doctor/physician if you feel unwell
Rinse mouth

**Precautionary Statements - Storage**

No storage statements

**Precautionary Statements - Disposal**

Dispose of contents/container in accordance with local, regional, national, and international regulations as applicable

**Other hazards which do not result in classification**

AUH031 - Contact with acids liberates toxic gas

*Stability and reactivity*

**Reactivity**

Reactivity: Reacts with acids.

**Chemical stability**

Stability: Stable under normal conditions.

**Explosion data**

Sensitivity to mechanical impact: None.
Sensitivity to static discharge: None.

**Possibility of hazardous reactions**
Possibility of hazardous reactions: Contact with acids liberates toxic gas.

**Conditions to avoid**
Conditions to avoid: Heat. Exposure to air. Moisture.

**Incompatible materials**
Incompatible materials: Acids.

**Hazardous decomposition products**
Hazardous decomposition products: Oxides of sulfur.

*Toxicological information*

**Product Information** No adverse health effects expected if the chemical is handled in accordance with this Safety Data Sheet and the chemical label. Symptoms or effects that may arise if the chemical is mishandled and overexposure occurs are:

**Inhalation** Inhalation of dust in high concentration may cause irritation of respiratory system. May cause sensitization in susceptible persons.

**Eye contact** Causes serious eye damage.

**Skin contact** May cause irritation. May cause sensitization in susceptible persons.

**Ingestion** Ingestion may cause gastrointestinal irritation, nausea, vomiting and diarrhoea.

**Symptoms** Irritation/Corrosion. May cause redness and tearing of the eyes.

*Ecological information*

Ecotoxicity

**Ecotoxicity** Keep out of waterways.

Algae/aquatic plants
EC50: = 48mg/L (72h, *Desmodesmus subspicatus*) EC50: = 40mg/L (96h, *Desmodesmus subspicatus*)

Fish LC50: =32mg/L (96h, *Lepomis macrochirus*)

Crustacea EC50: =89mg/L (24h, *Daphnia magna Straus*)

**Ammonium nitrate** **7,300 tons per year in 304 deliveries**

Extracts from ixom.com Safety Data Sheet (https://www.ixom.com/sds-search) for ammonium nitrate

Classified as Dangerous Goods by the criteria of the Australian Dangerous Goods Code (ADG Code) for Transport by Road and Rail; DANGEROUS GOODS.

This material is hazardous according to Safe Work Australia; HAZARDOUS CHEMICAL.

*Classification of the chemical:*
Oxidising solids - Category 3
Eye Irritation - Category 2A

SIGNAL WORD: WARNING

*Hazard Statement(s):*

H272 May intensify fire; oxidizer.
H319 Causes serious eye irritation.

*Precautionary Statement(s): Prevention:*

P210 Keep away from heat, sparks, open flames, hot surfaces. No smoking.
P220 Keep and store away from clothing, incompatible materials, combustible materials.
P221 Take any precaution to avoid mixing with combustibles / incompatible materials.
P264 Wash hands thoroughly after handling.
P280 Wear protective gloves / protective clothing / eye protection / face protection

*Accidental release measures*

Emergency procedures/Environmental precautions: Shut off all possible sources of ignition. Clear area of all unprotected personnel. Do not allow the product to mix with combustible/organic materials. Do not allow container or product to get into drains, sewers, streams or ponds. If contamination of sewers or waterways has occurred advise local emergency services.

Personal precautions/Protective equipment/Methods and materials for containment and cleaning up: Clean up spillages immediately. Contain - prevent run off into drains and waterways. Wear protective equipment to prevent skin and eye contact and breathing in dust. Sweep up, but avoid generating dust. Collect in properly labelled containers, with loose fitting lids, for disposal. (Loose fitting lids). DO NOT return spilled material to original container for re-use. Ensure that contaminated material (clothing, pallets) is thoroughly washed.

### *Physical and chemical properties*

Physical state: Granular Solid / Prills
Colour: White to Off-white
Odour: Negligible
Molecular Formula: $NH_4NO_3$
Solubility: Soluble in water
pH: 4.5 - 5.2 (10% solution @20°C)

### *Toxicological information*

Ingestion: Swallowing can result in nausea, vomiting, diarrhoea, and abdominal pain. Swallowing large amounts may result in headaches, dizziness and a reduction in blood pressure (hypotension).

Eye contact: An eye irritant.

Skin contact: Repeated or prolonged skin contact may lead to irritation. Can be absorbed through cut, broken, or burnt skin with resultant adverse effects. Contact with molten material may cause skin burns. See effects as noted under 'Inhalation'.

Inhalation: Breathing in dust may result in respiratory irritation. Blasting may produce a toxic brown gas of nitrogen dioxide. Inhalation of the gas may result in chest discomfort, shortness of breath and possible pulmonary oedema, the onset of which may be delayed.

Absorption of ammonium nitrate by inhalation, ingestion or through burnt or broken skin may cause dilation of blood vessels by direct smooth muscle relaxation and may also cause methaemoglobinaemia. May cause dizziness, drowsiness, nausea and headache due to central nervous system effects.

### *Ecological information*

Ecotoxicity Avoid contaminating waterways. Ammonium nitrate is a plant nutrient. Large scale contamination may kill vegetation and cause poisoning in livestock and poultry.

Low toxicity to aquatic life. $TL_m$ 96: 10-100 ppm
Ammonia: 48hr LC50 (*Cyprinus carpio*): 1.15-1.72mg un-ionised $NH_3$/L; 95-102 mg total $NH_3$/L
Nitrates: 96hr LC50 (Chinook salmon, rainbow trout, bluegill): 420-1360 mg $NO_3^-$/L

Mobility in soil: The material is water soluble and may disperse in soil.

Aquatic toxicity: Ammonium nitrate was evaluated at 5, 10, 25 and 50 mg $(NH_4^+)$/L. The fertility of *Daphnia magna* was decreased at 50 mg/L. Post embryonic growth of crustacea was impaired at 10, 25 and 50 mg/L.

**Sodium cyanide** **4,000 tons per year in 167 deliveries**

Extracts from ixom.com Safety Data Sheet (https://www.ixom.com/sds-search)

> Classified as Dangerous Goods by the criteria of the Australian Dangerous Goods Code (ADG Code) for Transport by Road and Rail; DANGEROUS GOODS.
>
> This material is hazardous according to Safe Work Australia; HAZARDOUS CHEMICAL.
>
> *Classification of the chemical:*
> Corrosive to Metals - Category 1
> Acute Dermal Toxicity - Category 1
> Acute Inhalation Toxicity - Category 2
> Acute Oral Toxicity - Category 2
> Skin Irritation - Category 2
> Eye Damage - Category 1
> Specific target organ toxicity (repeated exposure) - Category 1 Acute Aquatic Toxicity - Category 1
> Chronic Aquatic Toxicity - Category 1
>
> SIGNAL WORD: DANGER
>
> *Hazard Statement(s):*
> H290 May be corrosive to metals.
> H300+H310+H330 Fatal if swallowed, in contact with skin or if inhaled.
> H315 Causes skin irritation.
> H318 Causes serious eye damage.
> H372 Causes damage to organs through prolonged or repeated exposure.
> H410 Very toxic to aquatic life with long lasting effects.
>
> *Prevention:*
> P234 Keep only in original container.
> P260 Do not breathe mist, vapours, spray.
> P262 Do not get in eyes, on skin, or on clothing.
> P264 Wash hands thoroughly after handling.
> P270 Do not eat, drink or smoke when using this product.
> P271 Use only outdoors or in a well-ventilated area.
> P273 Avoid release to the environment.
> P280 Wear protective gloves / protective clothing / eye protection / face protection.
> P284 Wear respiratory protection.
>
> *Other Hazards:*
> AUH029 Contact with water liberates toxic gas.
> AUH032 Contact with acids liberates very toxic gas.
> AUH070 Toxic by eye contact.

Poisons Schedule (SUSMP): S7 Dangerous Poison

*Accidental release measures*

Emergency procedures/Environmental precautions: Clear area of all unprotected personnel. Isolate spill or leak area immediately. Shut off all possible sources of ignition. Work up wind or increase ventilation. Do not allow container or product to get into drains, sewers, streams or ponds. If contamination of sewers or waterways has occurred advise local emergency services. For large spills notify the Emergency Services.

Personal precautions/Protective equipment/Methods and materials for containment and cleaning up: Avoid breathing in dust. Work up wind or increase ventilation. Wear protective equipment to prevent skin and eye contact and breathing in vapours/dust. DO NOT allow material to get wet. Contain - prevent run off into drains and waterways. Spillage area and contaminated solids can be detoxified by treatment with an excess of dilute sodium hypochlorite, calcium hypochlorite, or ferrous sulfate after the addition of soda ash or lime to raise the pH to greater than 10.5. Allow 1 hour for complete decomposition before washing spillage area down with large quantities of water to ensure maximum dilution. Collect and seal in properly labelled containers or drums for disposal.

*Toxicological information*

Ingestion: Highly toxic. Swallowing can result in nausea, vomiting, diarrhoea, abdominal pain, convulsions and loss of consciousness. May cause cyanosis (blueness of the skin) due to lack of oxygen in the blood. May cause a weak or irregular heart beat, drop in blood pressure or cardiac arrest. Collapse and possible death may occur.

Eye contact: Causes serious eye damage. A severe eye irritant. Contamination of eyes can result in permanent injury.

Skin contact: Contact with skin will result in irritation. Toxic in contact with skin. Can be absorbed through the skin. Effects can include those described for 'INGESTION'.

Inhalation: Breathing in high concentrations may result in the same symptoms described for 'INGESTION'. High inhaled concentrations may lead to a feeling of suffocation and cause difficulty in breathing, headaches, dizziness and loss of consciousness. Can cause suffocation. Material is toxic - inhalation may be fatal.

Chronic effects: Repeated or prolonged skin contact may lead to irritant contact dermatitis - 'cyanide rash' - characterised by itching and skin eruptions. Chronic and subchronic exposure to cyanide is known to induce thyroid effects due to the cyanide metabolite, thiocyanate. Thiocyanate adversely affects the thyroid gland via competitive inhibition of iodide uptake and perturbation of the homeostatic feedback mechanisms that regulate the synthesis and secretion of essential thyroid hormones. Other chronic effects reported include headache, eye irritation, fatigue, shortness of breath and nose bleeds.

*Ecological information*

Ecotoxicity: Avoid contaminating waterways. Avoid release to the environment.

Bioaccumulative potential: Not expected to bioconcentrate or bioaccumulate.

Mobility in soil: Toxic to the soil environment.

Aquatic toxicity: Very toxic to aquatic organisms. May cause long lasting harmful effects to aquatic life.

**Copper sulfate** **1,250 tons per year in 57 deliveries**

Extracts from ixom.com Safety Data Sheet (https://www.ixom.com/sds-search)

Classified as Dangerous Goods by the criteria of the Australian Dangerous Goods Code (ADG Code) for Transport by Road and Rail; DANGEROUS GOODS.

Environmentally Hazardous Substances meeting the descriptions of UN 3077 or UN 3082 are not subject to the provisions of the Australian Code for the Transport of Dangerous Goods by Road and Rail when transported by road or rail in: packagings that do not incorporate a receptacle exceeding 500 kg(L); or IBCs.

This material is hazardous according to Safe Work Australia; HAZARDOUS CHEMICAL.

*Classification of the chemical:*
Acute Oral Toxicity - Category 4
Skin Irritation - Category 2
Eye Irritation - Category 2A
Acute Aquatic Toxicity - Category 1
Chronic Aquatic Toxicity - Category 1

SIGNAL WORD: WARNING

*Hazard Statement(s):*
H302 Harmful if swallowed.
H315 Causes skin irritation.
H319 Causes serious eye irritation.
H410 Very toxic to aquatic life with long lasting effects.

*Precautionary Statement(s):*
*Prevention:*
P264 Wash hands thoroughly after handling.
P270 Do not eat, drink or smoke when using this product.
P273 Avoid release to the environment.
P280 Wear protective gloves / protective clothing / eye protection / face protection.

*Response:*
P301+P312 IF SWALLOWED: Call a POISON CENTER or doctor/physician if you feel unwell.
P330 Rinse mouth.
P302+P352 IF ON SKIN: Wash with plenty of soap and water.
P321 Specific treatment (see First Aid Measures on Safety Data Sheet).
P332+P313 If skin irritation occurs: Get medical advice/attention.
P362 Take off contaminated clothing and wash before reuse.
P305+P351+P338 IF IN EYES: Rinse cautiously with water for several minutes. Remove contact lenses, if present and easy to do. Continue rinsing.

P337+P313 If eye irritation persists: Get medical advice/attention.
P391 Collect spillage.

*Toxicological information*

Ingestion: Swallowing can result in nausea, vomiting, diarrhoea, and gastrointestinal irritation.

Eye contact: An eye irritant.

Skin contact: Contact with skin will result in irritation. May cause skin sensitisation in sensitive individuals. Repeated or prolonged skin contact may lead to allergic contact dermatitis.

Inhalation: Breathing in dust may result in respiratory irritation. Breathing in fumes from heating may produce symptoms of 'metal fume fever'. This condition is characterised by influenza type symptoms occurring a few hours after exposure and lasting up to 48 hours. Symptoms may include chills, fever, headache, tightness of the chest, coughing, weakness, dryness of nose and mouth, muscular pain, nausea, and vomiting.

Acute toxicity:
Oral LD50 (rat): 482 mg/kg (anhydrous)
Dermal LD50 (rat): >2000 mg/kg (anhydrous)

*Ecological information*

Ecotoxicity: Avoid contaminating waterways.
Aquatic toxicity: Very toxic to aquatic organisms. May cause long lasting harmful effects to aquatic life.
48hr EC50 (*Daphnia magna*): 0.024 mg/L

**Potassium amyl xanthate** **1,350 tons per year in 68 deliveries**

Extracts from ixom.com Safety Data Sheet (https://www.ixom.com/sds-search)

Classified as Dangerous Goods by the criteria of the Australian Dangerous Goods Code (ADG Code) for Transport by Road and Rail; DANGEROUS GOODS.

This material is hazardous according to Safe Work Australia; HAZARDOUS CHEMICAL.

*Classification of the chemical:*
Self-heating substances and mixtures - Category 2
Acute Oral Toxicity - Category 4
Acute Dermal Toxicity - Category 4
Skin Irritation - Category 2
Eye Irritation - Category 2A
Specific target organ toxicity (single exposure) - Category 3
Toxic to Reproduction - Category 2
Specific target organ toxicity (repeated exposure) - Category 2

SIGNAL WORD: WARNING

*Hazard Statement(s):*
H252 Self-heating in large quantities; may catch fire.
H302+H312 Harmful if swallowed or in contact with skin.
H315 Causes skin irritation.
H319 Causes serious eye irritation.
H335 May cause respiratory irritation.
H361 Suspected of damaging fertility or the unborn child.
H373 May cause damage to organs through prolonged or repeated exposure.

*Precautionary Statement(s):*
*Prevention:*
P201 Obtain special instructions before use.
P202 Do not handle until all safety precautions have been read and understood.
P235+P410 Keep cool. Protect from sunlight.
P260 Do not breathe dust.
P264 Wash hands thoroughly after handling.
P270 Do not eat, drink or smoke when using this product.
P271 Use only outdoors or in a well-ventilated area.
P280 Wear protective gloves / protective clothing / eye protection / face protection.
P281 Use personal protective equipment as required.

*Response:*
P301+P312 IF SWALLOWED: Call a POISON CENTER or doctor/physician if you feel unwell.

P330 Rinse mouth.
P302+P352 IF ON SKIN: Wash with plenty of soap and water.
P321 Specific treatment (see First Aid Measures on Safety Data Sheet).
P322 Specific measures (see First Aid Measures on Safety Data Sheet).
P362 Take off contaminated clothing and wash before reuse.
P363 Wash contaminated clothing before re-use.
P332+P313 If skin irritation occurs: Get medical advice/attention.
P305+P351+P338 IF IN EYES: Rinse cautiously with water for several minutes. Remove contact lenses, if present and easy to do. Continue rinsing.
P337+P313 If eye irritation persists: Get medical advice/attention.
P304+P340 IF INHALED: Remove person to fresh air and keep comfortable for breathing.
P312 Call a POISON CENTER or doctor/physician if you feel unwell.
P308+P313 IF exposed or concerned: Get medical advice/attention.
P314 Get medical advice/attention if you feel unwell.

*Fire fighting measures*

Specific hazards arising from the chemical:
Substance liable to spontaneous combustion.
Avoid all ignition sources.
In common with many organic chemicals, may form flammable dust clouds in air. For precautions necessary refer to Safety Data Sheet "Dust Explosion Hazards".

Special protective equipment and precautions for fire-fighters:
Heating can cause expansion or decomposition of the material, which can lead to the containers exploding. If safe to do so, remove containers from the path of fire. Decomposes on heating emitting toxic fumes, including those of carbon disulphide.
Fire fighters to wear self-contained breathing apparatus and suitable protective clothing if risk of exposure to products of decomposition.

*Stability and reactivity*

Reactivity: Reacts exothermically on dilution with water. Contact with acids liberates toxic gas.

Chemical stability: Stable under normal conditions of use. Hygroscopic: absorbs moisture or water from surrounding air.

Possibility of hazardous reactions: Hazardous polymerisation will not occur. Can react with water producing carbon disulfide.

Conditions to avoid: Avoid dust generation. Avoid exposure to heat, sources of ignition, and open flame. Avoid exposure to moisture. Avoid exposure to direct sunlight. Avoid electrostatic discharge.

Incompatible materials: Incompatible with oxidising agents, combustible materials, acids, water, phosgene, sulfur chlorides, copper, copper alloy.

Hazardous decomposition products: Carbon disulfide. Hydrogen sulfide. Oxides of sulfur. Oxides of carbon.

*Toxicological information*

Ingestion: Swallowing can result in nausea, vomiting, diarrhoea, abdominal pain, convulsions and loss of consciousness. Death may occur if large amounts are ingested.

Eye contact: An eye irritant.

Skin contact: Contact with skin will result in irritation. Will liberate carbon disulfide upon contact with moist skin. Carbon disulfide can be absorbed through the skin with resultant adverse effects.

Inhalation: Breathing in dust will result in respiratory irritation. Breathing in high concentrations can produce central nervous system depression, which can lead to loss of co-ordination, impaired judgement and if exposure is prolonged, unconsciousness. Breathing in high concentrations may result in an irregular heart beat and prove suddenly fatal.

Acute toxicity: Oral LD50 (rat): 500-2000 mg/kg

Chronic effects:
- Mutagenicity: No information available.
- Carcinogenicity: Not listed as carcinogenic according to the International Agency for Research on Cancer (IARC).

Reproductive toxicity: Suspected of damaging fertility or the unborn child.

Specific Target Organ Toxicity (STOT) - single exposure: May cause respiratory irritation.

Specific Target Organ Toxicity (STOT) - repeated exposure: May cause damage to organs through prolonged or repeated exposure.

*Ecological information*

Ecotoxicity Avoid contaminating waterways

**Lead nitrate** **800 tons per year in 37 deliveries**

From ixom.com Safety Data Sheet (https://www.ixom.com/sds-search)

Classified as Dangerous Goods by the criteria of the Australian Dangerous Goods Code (ADG Code) for Transport by Road and Rail; DANGEROUS GOODS.
This material is hazardous according to Safe Work Australia; HAZARDOUS CHEMICAL.

*Classification of the chemical:*
Oxidising solids - Category 2
Acute Oral Toxicity - Category 4
Acute Inhalation Toxicity - Category 4
Toxic to Reproduction - Category 1A
Mutagenicity - Category 2
Carcinogenicity - Category 2
Specific target organ toxicity (repeated exposure) - Category 2
Acute Aquatic Toxicity - Category 1
Chronic Aquatic Toxicity - Category 1

SIGNAL WORD: DANGER

*Hazard Statement(s):*
H272 May intensify fire; oxidizer.
H302+H332 Harmful if swallowed or if inhaled.
H318 Causes serious eye damage.
H341 Suspected of causing genetic defects.
H351 Suspected of causing cancer.
H360 May damage fertility or the unborn child.
H373 May cause damage to organs through prolonged or repeated exposure.
H410 Very toxic to aquatic life with long lasting effects.

*Precautionary Statement(s):*
*Prevention:*
P201 Obtain special instructions before use.
P202 Do not handle until all safety precautions have been read and understood.
P210 Keep away from heat, sparks, open flames, hot surfaces. No smoking.
P220 Keep and store away from clothing, incompatible materials, combustible materials.
P221 Take any precaution to avoid mixing with combustibles / incompatible materials.
P260 Do not breathe mist, vapours, spray.
P264 Wash hands thoroughly after handling.
P270 Do not eat, drink or smoke when using this product.
P271 Use only outdoors or in a well-ventilated area.
P273 Avoid release to the environment.
P280 Wear protective gloves / protective clothing / eye protection / face protection.

P281 Use personal protective equipment as required.
*Response:*
P301+P312 IF SWALLOWED: Call a POISON CENTER or doctor/physician if you feel unwell.
P312 Call a POISON CENTER or doctor/physician if you feel unwell.
P330 Rinse mouth.
P304+P340 IF INHALED: Remove person to fresh air and keep comfortable for breathing.
P305+P351+P338 IF IN EYES: Rinse cautiously with water for several minutes. Remove contact lenses, if present and easy to do. Continue rinsing.
P310 Immediately call a POISON CENTER or doctor/physician.
P308+P313 IF exposed or concerned: Get medical advice/attention.
P314 Get medical advice/attention if you feel unwell.
P370+P378 In case of fire: Use extinguishing media as outlined in Section 5 of this Safety Data Sheet to extinguish.
P391 Collect spillage.

*Physical state and chemical properties*

pH: 3.0-4.0 (20% aq. solution)

*Stability and reactivity*

Conditions to avoid: Avoid dust generation. Avoid exposure to heat, sources of ignition, and open flame.

Incompatible materials: Incompatible with ammonium thiocyanate, powdered carbon, hydrogen peroxide, lead hypophosphite, combustible materials, organic materials, strong reducingagents, powdered metals.

Hazardous decomposition products: Lead fume. Oxides of nitrogen. Oxides of lead.

*Toxicological information*

Ingestion: Swallowing can result in nausea, vomiting, diarrhoea, and abdominal pain. Swallowing large amounts may result in lethargy, motor weakness, muscle tenderness and inco-ordination. Death may occur if large amounts are ingested.

Eye contact: A severe eye irritant. Contamination of eyes can result in permanent injury.

Skin contact: Contact with skin may result in irritation.

Inhalation: Breathing in dust may result in respiratory irritation.

Acute toxicity: No oral LD50 data available for the product.

Chronic effects: Absorption of lead over a prolonged period of time (by any route) can produce adverse effects on the blood, central and peripheral nervous systems and reproductive systems, and renal injury. Long term exposure to low concentrations of lead (by any route) may result in blood effects, anaemia, central and peripheral nervous system damage, gastrointestinal disturbances, renal injury, foetotoxicity, developmental deficiencies in neonates and children, and testicular damage including decreased sperm count.

Lead compounds, inorganic: Have been classified by the International Agency for Research on Cancer (IARC) as a Group 2A carcinogen. Group 2A - The agent is probably carcinogenic to humans.

Mutagenicity: Suspected of causing genetic defects.

Carcinogenicity: Suspected of causing cancer.

Reproductive toxicity: May damage fertility or the unborn child.

Specific Target Organ Toxicity (STOT) - single exposure: No information available.

Specific Target Organ Toxicity (STOT) - repeated exposure: May cause damage to organs through prolonged or repeated exposure.

*Ecological information*

Ecotoxicity: Avoid contaminating waterways.

Persistence/degradability: No information available.

Bioaccumulative potential: No information available.

Mobility in soil: No information available.

Aquatic toxicity: Very toxic to aquatic organisms. May cause long lasting harmful effects to aquatic life.

48hr EC50 (*Daphnia magna*): 0.5-2.0 mg/L
96hr LC50 (fish): 0.4-1.3 mg/L (Carp)

**Activated carbon** **500 tons per year in 23 deliveries**

Extracts from ixom.com Safety Data Sheet (https://www.ixom.com/sds-search) for activated carbon (not spontaneously combustible)

> Not classified as Dangerous Goods by the criteria of the Australian Dangerous Goods Code (ADG Code) for transport by Road and Rail; NON-DANGEROUS GOODS.
> This product has been tested according to "United Nations Recommendations on the Transport of Dangerous Goods, Manual of Tests and Criteria Part III - 33.3.1.3" and is not classified as a Class 4.2 dangerous good.
> This material is hazardous according to Safe Work Australia; HAZARDOUS CHEMICAL.
>
> *Classification of the chemical:*
> Eye Irritation - Category 2A
> Specific target organ toxicity (single exposure) - Category 3
>
> SIGNAL WORD: WARNING
>
> *Hazard Statement(s):*
> H319 Causes serious eye irritation.
> H335 May cause respiratory irritation.
>
> *Precautionary Statement(s):*
> *Prevention:*
> P261 Avoid breathing dust / fume / gas / mist / vapours / spray.
> P264 Wash hands thoroughly after handling.
> P271 Use only outdoors or in a well-ventilated area.
> P280 Wear protective gloves / protective clothing / eye protection / face protection.
>
> *Response:*
> P305+P351+P338 IF IN EYES: Rinse cautiously with water for several minutes. Remove contact lenses, if present and easy to do. Continue rinsing.
> P337+P313 If eye irritation persists: Get medical advice/attention.
> P304+P340 IF INHALED: Remove person to fresh air and keep comfortable for breathing.
> P312 Call a POISON CENTER or doctor/physician if you feel unwell.
>
> *Stability and reactivity*
>
> Possibility of hazardous reactions: Dust explosion hazard. Hazardous polymerisation will not occur.
>
> Conditions to avoid: Avoid dust generation. Avoid exposure to moisture.

Incompatible materials: Incompatible with strong oxidising agents. Incompatible with hydrocarbons.

Hazardous decomposition products: Oxides of carbon.

*Toxicological information*

Ingestion: No adverse effects expected, however, large amounts may cause nausea and vomiting.

Eye contact: An eye irritant.

Skin contact: Contact with skin may result in irritation.

Inhalation: Breathing in dust will result in respiratory irritation.

*Ecological information*

Ecotoxicity Avoid contaminating waterways.

**Sodium carbonate** **430 tons per year in 18 deliveries**

Extracts from ixom.com Safety Data Sheet (https://www.ixom.com/sds-search) for sodium carbonate

Not classified as Dangerous Goods by the criteria of the Australian Dangerous Goods Code (ADG Code) for transport by Road and Rail; NON-DANGEROUS GOODS.
This material is hazardous according to Safe Work Australia; HAZARDOUS CHEMICAL.

**Classification of the chemical:**
Eye Irritation - Category 2A
Specific target organ toxicity (single exposure) - Category 3
**SIGNAL WORD:** WARNING

**Hazard Statement(s):**
H319 Causes serious eye irritation.
H335 May cause respiratory irritation.
**Precautionary Statement(s):**
**Prevention:**
P261 Avoid breathing dust.
P264 Wash hands thoroughly after handling.
P271 Use only outdoors or in a well-ventilated area.
P280 Wear protective gloves / protective clothing / eye protection / face protection.
**Response:**
P305+P351+P338 IF IN EYES: Rinse cautiously with water for several minutes. Remove contact lenses, if present and easy to do.
Continue rinsing.
P337+P313 If eye irritation persists: Get medical advice/attention.
P304+P340 IF INHALED: Remove person to fresh air and keep comfortable for breathing.
P312 Call a POISON CENTER or doctor/physician if you feel unwell.

**Storage:**
P403+P233 Store in a well-ventilated place. Keep container tightly closed.
P405 Store locked up.
**Disposal:**
P501 Dispose of contents and container in accordance with local, regional, national, international regulations.

*Physical and chemical properties*
**Physical state:** Solid
**Colour:** White
**Odour:** Odourless

**pH:** 11.3 (10 g/L, 25°C)

*Stability and reactivity*

**Reactivity:** Reacts with incompatible materials shown below.

**Chemical stability:** Hygroscopic: absorbs moisture or water from surrounding air. Stable if stored and handled under recommended conditions.

**Possibility of hazardous reactions:** Reacts exothermically with strong acids evolving carbon dioxide.

**Conditions to avoid:** Avoid dust generation. Avoid exposure to moisture. Avoid exposure to heat.

**Incompatible materials:** Incompatible with acids, phosphorus pentoxide, aluminium, lead, magnesium, iron, zinc, fluorine.

**Hazardous decomposition products:** Carbon dioxide.

*Toxicological information*

**Ingestion:** Swallowing can result in nausea, vomiting, diarrhoea, and gastrointestinal irritation.

**Eye contact:** An eye irritant.

**Skin contact:** Contact with skin may result in irritation.

**Inhalation:** Material is irritant to the mucous membranes of the respiratory tract (airways).

**Acute toxicity:**

Oral LD50 (rat): 4090 mg/kg
Dermal LD50 (rabbit): >2000 mg/kg

**Skin corrosion/irritation:** Non-irritant (rabbit).

**Serious eye damage/irritation:** Moderate irritant (rabbit).

*Ecological information*

**Ecotoxicity** Avoid contaminating waterways.

**Persistence/degradability:** Biodegradation is not an applicable endpoint since the product is an inorganic chemical.

*Regulatory information*

**Classification:**

This material is hazardous according to Safe Work Australia; HAZARDOUS CHEMICAL.

**Classification of the chemical:**

Eye Irritation - Category 2A
Specific target organ toxicity (single exposure) - Category 3

**Hazard Statement(s):**

H319 Causes serious eye irritation.
H335 May cause respiratory irritation.

**Sodium hydroxide** **330 tons per year in 15 deliveries**

Extracts from ixom.com Safety Data Sheet (https://www.ixom.com/sds-search) for caustic soda – liquid (46-50%) (Data sheet for 5-45% also available.)

Classified as a Dangerous Good according to NZS 5433:2012 Transport of Dangerous Goods on Land.
Classified as hazardous according to criteria in the Hazardous Substances (Minimum Degrees of Hazard) Notice 2017 and the Hazardous Substances (Classification) Notice 2017.

SIGNAL WORD: DANGER

Subclasses:
Subclass 6.1 Category D - Substances which are acutely toxic.
Subclass 8.1 Category A - Substances that are corrosive to metals.
Subclass 8.2 Category B - Substances that are corrosive to dermal tissue.
Subclass 8.3 Category A - Substances that are corrosive to ocular tissue.
Subclass 9.1 Category D - Substances that are slightly harmful to the aquatic environment or are otherwise designed for biocidal action.

*Hazard Statement(s):*
H290 May be corrosive to metals.
H302 Harmful if swallowed.
H313 May be harmful in contact with skin.
H314 Causes severe skin burns and eye damage.
H402 Harmful to aquatic life.

*Precautionary Statement(s):*
*Prevention:*
P102 Keep out of reach of children.
P103 Read label before use.
P234 Keep only in original container.
P260 Do not breathe mist/vapours/spray.
P264 Wash hands thoroughly after handling.
P270 Do not eat, drink or smoke when using this product.
P273 Avoid release to the environment.
P280 Wear protective gloves/protective clothing/eye protection/face protection.

*Response:*
P301+P330+P331 IF SWALLOWED: Rinse mouth. Do NOT induce vomiting.
P303+P361+P353 IF ON SKIN (or hair): Remove/Take off immediately all contaminated clothing. Rinse skin with water/shower.
P304+P340 IF INHALED: Remove to fresh air and keep at rest in a position comfortable for breathing.

P305+P351+P338 IF IN EYES: Rinse cautiously with water for several minutes. Remove contact lenses, if present and easy to do. Continue rinsing.
P310 Immediately call a POISON CENTER or doctor/physician.
P321 Specific treatment (see First Aid Measures on the Safety Data Sheet).
P363 Wash contaminated clothing before re-use.
P390 Absorb spillage to prevent material damage.

*Physical and chemical properties*

Physical state: Liquid
Colour: Colourless
Odour: Odourless
Solubility: Miscible with water.
Specific Gravity: 1.48-1.52 @20°C
Relative Vapour Density (air=1): Not available
Vapour Pressure (20 °C): 1.34 mm Hg (calculated)
Flash Point (°C): Not applicable
Flammability Limits (%): Not applicable
Autoignition Temperature (°C): Not applicable
Boiling Point/Range (°C): ca. 145 (literature)
pH: 14 (literature)
Freezing Point/Range (°C): ca. 12 (calculated)

*Stability and reactivity*

Reactivity: Reacts violently with acids. Reacts exothermically on dilution with water.
Chemical stability: Stable under normal ambient and anticipated storage and handling conditions of temperature and pressure. Absorbs carbon dioxide from the air.

Possibility of hazardous reactions: Reacts with ammonium salts, evolving ammonia gas. Reacts readily with various reducing sugars (i.e. fructose, galactose, maltose, dry whey solids) to produce carbon monoxide. Take precautions including monitoring the tank atmosphere for carbon monoxide to ensure safety of personnel before vessel entry.

Conditions to avoid: Avoid exposure to moisture. Avoid exposure to direct sunlight.

Incompatible materials: Incompatible with acids, ammonium salts, aluminium, tin, zinc, brass.

*Toxicological information*

Ingestion: Swallowing can result in nausea, vomiting, diarrhoea, abdominal pain andchemical burns to the gastrointestinal tract.

Eye contact: A severe eye irritant. Corrosive to eyes; contact can cause corneal burns.

Contamination of eyes can result in permanent injury. May cause blindness.

Skin contact: Contact with skin will result in severe irritation. Corrosive to skin - may cause skin burns.

Inhalation: Breathing in mists or aerosols may produce respiratory irritation.

Acute toxicity: No LD50 data available for the product.

For the constituent Sodium hydroxide: Skin corrosion/irritation: Severe irritant (rabbit).

Specific Target Organ Toxicity (STOT) - single exposure: May cause respiratory irritation. Serious eye damage/irritation: Severe irritant (rabbit).

*Ecological information*

Ecotoxicity Avoid contaminating waterways.

**Sodium hypochlorite (listed as a solid for the DEIS and a liquid for the SDEIS)**
DEIS: **1,000 pounds per year in 1 delivery and additional 5,000-15,000 gallons per year for Alternative 2**
**SDEIS: 2,000 gallons in 2 deliveries**

| | |
|---|---|
| Sodium hypochlorite (liquid) | 2,000 gallons per year in 2 deliveries |

## Bulk liquids I was unable to find MSDSs for

| | |
|---|---|
| Lubricants | 296,000 gallons per year in 99 deliveries |
| AP 3477 (dialkyl dithiophosphate) | 60,000 gallons per year in 20 deliveries |
| Aerophine 3418A | 10,000 gallons per year in 50 deliveries |
| Solvents | 1,000 gallons per year in 5 deliveries |

## Bulk solids I was unable to find MSDSs for

| | |
|---|---|
| Antimony concentrate | Up to 17,500 tons per year in 365-730 deliveries |
| Grinding metals (Steel balls for mill) | 8,049 tons per year in 337 deliveries |
| Crusher and grinding liners | 2,421 tons per year in 105 deliveries |
| Flocculent | 300 tons per year in 14 deliveries |
| Explosives | 100 tons per year in 20 deliveries |
| Scale control reagents | 5,000 pounds per year in 5 deliveries |
| Fertilizer | 2,500 pounds per year in 1 delivery |
| Herbicide | 1,000 pounds per year in 1 delivery |
| Pesticides/insecticides | 250 pounds per year in 1 delivery |

## Appendix B. Susan Lubetkin statement of qualifications

**Susan C. Lubetkin, PhD**
**922 Nob Hill Ave N, Seattle, Washington 98109 (206) 719-4730**
**susan.c.lubetkin@gmail.com**

### WORK EXPERIENCE

*Independent analyst, principal at Elemental Statistics* June 2015-present
Elemental Statistics is a boutique environmental statistics consulting firm that specializes in third party technical review of environmental permitting documents, often for projects involving fossil fuels or mining.

*Selected reports and analyses for clients*

Technical Review of Section 4.6: Environmental Consequences: Potential Impacts of Oil Spills and Appendix G: Oil Spill Estimates from the 2023-2028 National OCS Oil and Gas Leasing Program Draft Programmatic Environmental Impact Statement (BOEM, July 2022) and OECM Oil Spill Model (Section 1.2.4.2) and Statistical Frequency of Catastrophic Oil Spill (Section 3.3.3) from the Draft Economic Analysis Methodology for the 2023–2028 National Outer Continental Shelf Oil and Gas Leasing Program (BOEM, July 2022). October 2022.

Comments on the Spill Risk Assessment in the Willow Master Development Plan DSEIS (BLM 2022). August 2022.

Declaration clarifying the implications of the return period cited for catastrophic discharge events in the Gulf of Mexico. May 2022.

Alaska Mining Spills: A comparison of the predicted impacts described in permitting documents and spill records from five major operational hardrock mines. 569 pp. Completed in November 2021; released in April 2022.

Critical review of the oil spill risk analysis as presented in the Cook Inlet Planning Area Oil and Gas Lease Sale 258 in Cook Inlet, Alaska Draft Environmental Impact Statement and Oil Spill Risk Analysis: Cook Inlet Planning Area OCS Lease Sale 258 (Revised) OCS Report BOEM 2021-061. 122 pp. December 2021.

Critical review of the oil spill risk analysis as presented in the proposed rule concerning incidental take of walruses and polar bears in the Beaufort Sea and adjacent lands, 2021-2026. 45 pp. July 2021.

Technical review of the offshore oil spill risk analysis in Appendix L of the Texas GulfLink Deepwater Port license application draft environmental impact statement. 38 pp. January 2021.
Review of the transportation corridor risks of hazardous materials spills in the proposed Stibnite Gold Project draft environmental impact statement.197 pp. October 2020.

A review of Pebble Project Final EIS Section 4.24, Fish Values: PHABSIM/HABSYN model estimates of salmonid usable habitat areas in the presence of Pebble Mine are baseless. Co-written with Gordon Reeves, PhD. 216 pp. August 2020.

A review of Pebble Project Final EIS Section 4.27, Spill Risk: current data compilations and consequences of probability analyses. 223 pp. August 2020.

Technical review of the spill risk analyses in the Sea Port Oil Terminal Deepwater Port Project Draft Environmental Impact Statement. 37 pp. March 2020.

*Instructor, University of Washington* January-December 2014

- Nomination for a Distinguished Teaching Award, December 2014, University of Washington
- Quantitative Science (QSci) 482: Statistical Inference in Applied Research I: Hypothesis Testing and Estimation for Ecologists and Resource Managers (Fall 2014, Summers 1999, 2000)
- Quantitative Ecology and Resource Management (QERM) 514: Analysis of Ecological and Environmental Data (Spring 2014)
- QSci 486: Analysis of Designed Experiments (Winter 2014)

## RESEARCH POSITIONS

September 2011- February 2013
University of Washington Seattle, Washington

Post-doctoral research assistantship with Evelyn Lessard (School of Oceanography) using nonparametric multiplicative regression to characterize the environmental variables best for predicting harmful algal blooms of *Pseudo-nitzschia* spp. and the production of domoic acid in the Pacific northwest.

September 2008 – May 2010
University of Washington Seattle, Washington

Post-doctoral research assistantship with Judith Zeh (Department of Statistics) modeling bowhead whale baleen length and body length at age with several canonical growth models. This involved fitting nonlinear models to multivariate data and using bootstrapping procedures to then estimate the ages of whales with known baleen and/or body lengths.

September 1997- June 1998
National Oceanographic and Atmospheric Administration Seattle, Washington

Research assistantship with Sarah Hinckley modeling nutrient-phytoplankton-zooplankton dynamics along the coastal Gulf of Alaska

## EDUCATION

2008 University of Washington Seattle, Washington

Ph.D., Quantitative Ecology and Resource Management (QERM): Using annual cycles of stable carbon isotope ratios with baleen and body length data from bowhead whales (*Balaena mysticetus*) to estimate whale age and explore anomalous years

My dissertation was focused on modeling the growth of bowhead whales, using stable isotope patterns in non-linear mixed effects (NLME) models and nonlinear regression techniques.

1997 University of Washington Seattle, Washington

M.S., QERM: Multi-source mixing models: food web determination using stable isotope tracers

I developed a model to use stable isotopes to estimate primary production and other nutrient flows through estuarine food webs.

1994 Harvey Mudd College Claremont, California

B.S., Biology

## PUBLICATIONS

*Peer reviewed articles and book chapters*

George, J.C., S. C. Lubetkin, J. E. Zeh, J. G. M. Thewissen, D. Wetzel, and G. Givens. 2021. Chapter 21 - Age estimation. Pp. 309-322 in J. C. George and J. G. M. Thewissen, eds., *The Bowhead Whale* Balaena mysticetus: *Biology and Human Interactions*. Academic Press.

Lubetkin, S.C. 2020. The tip of the iceberg: three case studies of spill risk assessments used in environmental impact statements. *Marine Pollution Bulletin.* Available online January 31, 2020. https://doi.org/10.1016/j.marpolbul.2019.110613

Lubetkin, S. C., Zeh, J. E., and George, J. C. 2012. Statistical modeling of baleen and body length at age in bowhead whales (*Balaena mysticetus*). *Canadian Journal of Zoology*. 90: 915-931.

Lubetkin, S. C., Zeh, J. E., Rosa, C., and George, J. C. 2008. Age estimation for young bowhead whales (*Balaena mysticetus*) using annual baleen growth increments. *Canadian Journal of Zoology*. 86: 525-538.

Lubetkin, S. C. and Simenstad, C. A. 2004. Two multi-source mixing models using conservative tracers to estimate food web sources and pathways. *Journal of Applied Ecology 41*: 996-1008.

Schindler, D. E. and Lubetkin, S. C. 2004. Using stable isotopes to quantify material transport through food webs. Pp. 25-42 in Gary A. Polis, Mary E. Power, and Gary R. Huxel, eds., *Food Webs at the Landscape Level*. University of Chicago Press.

Schindler, D.E., Chang, G. C., Lubetkin, S. C., Abella, S. E. B., and Edmondson, W. T. 2002. Rarity and functional importance in a phytoplankton community. Pp. 206-220 in Peter Kareiva and Simon A. Levin, eds., *The Importance of Species*. Princeton University Press.

## MEETING PRESENTATIONS, WORKSHOPS

Lubetkin, S.C. 2020. The tip of the iceberg: three case studies of spill risk assessments used in environmental impact statements. Poster at the Alaska Marine Sciences Symposium, January 27-30, 2020.

September 22-23, 2016, Washington, DC. Science and Tools for Developing Arctic Marine Protected Area Networks: Understanding Connectivity and Identifying Management Tools. Invited participant to the Arctic Council, Protection of the Arctic Marine Environment (PAME) scientific working group.

Lubetkin, S. C., and Lessard, E. J. 2013. Habitat modeling of *Pseudo-nitzschia* distribution and toxicity in the coastal waters of the northwest Pacific using non-parametric multiplicative regression. Poster at the 7th Annual Harmful Algal Bloom Symposium, Sarasota, Florida, October 2013.

Lubetkin, S. C., and Lessard, E. J. 2013. Habitat modeling of *Pseudo-nitzschia* distribution and toxicity in the coastal waters of the northwest Pacific using non-parametric multiplicative regression. Oral presentation at the Association for the Sciences of Limnology and Oceanography meeting, New Orleans, Louisiana, February 2013.

Lubetkin, S. C., and Zeh, J. E. 2006. Deriving age-length relationships for bowhead whales (*Balaena mysticetus*) using a synthesis of age estimation techniques. Paper SC/58/BRG14 presented to the International Whaling Commission Scientific Committee, June 2006.

Lubetkin, S. C., Zeh, J. E., Rosa, C., and George, J. C. 2004. Deriving von Bertalanffy age-length relationships for bowhead whales (*Balaena mysticetus*) using a synthesis of age estimation techniques. Paper SC/56/BRG3 presented to the IWC SC, June 2004.

Lubetkin, S. C. 2000. Bowhead whale age determination: extending estimates from baleen stable isotope signatures. Oral presentation at the 4th Meeting of the Society of Marine Mammalogy Northwest Student Chapter. University of Washington, Seattle, Washington, April 29, 2000.

Lubetkin, S. C. and Simenstad, C. A. 1997. Food web determination using a multiple stable isotope mixing model. Poster at the 14th Biennial Estuarine Research Federation International Conference: The State of Our Estuaries. Providence, Rhode Island, October 12-16, 1997.

November 7-9, 1996, Savannah, Georgia. Land Margin Ecosystems Research Program Workshop. (Participant with Charles Simenstad.)

February 3-6, 1996, Woods Hole, Massachusetts. Land Margin Ecosystems Research Program Workshop. (Participant with Charles Simenstad.)