May 9, 2019
US Army Corps of Engineers
Shane McCoy, Project Manager
http://www.poa.usace.army.mil
(907) 753-2712

Re: Direct and cumulative impacts of road system fugitive dust in the Pebble Project draft EIS

Dear Mr. McCoy:
Please find attached our memo on road system fugitive dust, which lays out our concerns with respect to the lack of analysis of contaminant sources, deposition rates, chemistry, and most importantly the environmental consequences. We believe there is a significant risk of ecotoxic effects from trace metals and hydrocarbons, particularly to aquatic life.

These risks are real and must be addressed and considered in a revised Draft EIS (preferred) or the Final EIS.

Thank you for this opportunity to comment.

Chris Frissell, PhD, Fisheries and aquatic ecology
Frissell & Raven Hyrobiological and Landscape Sciences, LLC

Sarah O'Neal, Fisheries biologist
PhD student, University of Washington

Key comments and actions needed

Our analysis found numerous deficiencies. Details and literature citations are provided in the memo after this initial section; up front we providea summary of key comments, and of actions that need to be performed if a revissed Draft EIS (preferred) or the final EIS is to address and disclose these envitonmental effects with enouvh accuracy to inform a reasoned decision on the proposed project. .

Key Comments

The key comments related to "Sources of Fugitive Dust" are the following:

- There is no real analytical work in the DEIS to determine the extent of dust plumes from road and port traffic based on inputs such as winds and topography. The basis for choosing a 100 m zone of impact around roads is inadequate.
- Sources contributing to dust chemistry, such as vehicle wear and tear, were ignored.
- Material sites were ignored as a source of dust at road and the pipeline corridors.
- Inadequate justification for soil density, percent silt, and threshhold value of tailings particles as inputs in dust plume modeling. Incomplete wind and precipitation data applied.
- The volume of dust from the mine site is estimated but there is no analysis of whether, or under what conditions, contaminats in dust would enter waterways where fish could be exposed.
- Information has not been pulled into the DEIS in any meaningful way that would allow the reader to understand sources, volumes, and chemical make-up of dust.
- Assumptions about the efficiency of dust control are unrealistic.
- Critical data is missing, old, or in RFIs and not in the DEIS chapters.

The key comments related to "Impacts of Fugitive Dust" are the following:

- Fugitive dust chemistry does not include important pollutants originating from road maintenancae and operations including salts and hydrocarbons.
- There is no analysis of contaminant leaching and mobilization from dust deposited on different parts of the landscape under different pH and redox conditions, therefore the fate and effects of contaminants in aquatic ecosystems cannot be accounted for.
- There is no analysis of impacts to wetlands or water bodies, only the number of acres impacted. There is no description of wetlands and water bodies within the likely deposition zones at the road and port.
- There is no baseline soil chemistry for roads and no soil or sediment chemistry near ferry terminals therefore future impacts cannot be assessed. Baseline chemistry needs to include trace elements and salt or petroleum components that could be in chemical dust suppressants.
- There is no ecological analysis that considers the cumulative and potentially cascading physico-chemical effects of fugitive dust and dust-associated pollutants on the environment, especially accounting for potential bioaccumulation, and resulting cumulative impacts on fish and aquatic resources.
- There is no analysis of how road material sites in different Alternatives affect acres or types of vegetation, wetlands, or water bodies impacted.
- Critical assumptions of the dust deposition model are buried in an RFI and not provided in the DEIS.

Deficiencies

The DEIS is deficient in not providing the following relevant to fugitive dust sources and impacts:

- Baseline soil and surface geology chemical analysis for pH, trace elements, and salts at the road system, port areas, and sediment chemistry for Iliamna Lake near the proposed ferry terminals.
- The DEIS needs a full accounting over the life of the project and beyond of contaminants that have a reasonable likelihood of entraining in fugitive dust, such as copper, zinc, mercury and hydrocarbons originating from vehicles and salts from dust suppression actions. This analysis must account for the persistent effects of contaminants released into the environment during the time span of road operations, as well as for the effects of what maintenance and traffic activity will foreseeably occur on the road system after the time frame of operations proposed in this EIS- including both future mining and other transportation uses.

The DEIS is deficient in not providing the following information necessary to assess the environmental effects of fugitive dust from roads and road operations:

- Description of wetlands and water bodies that are in the road dust deposition zone.
- Map of wetlands and water bodies within the deposition zone, including how this changes seasonally. Seasonal changes are expected given that some ponds are fed only by snowmelt or rainwater, and therefore change in size or become completely dry during some periods of the year.
- Baseline turbidity of water bodies within the road dust deposition zone, so that changes caused by dust deposition can be assessed.
- Baseline metals concentration of water and sediment in water bodies within the dust deposition zone.

The DEIS is deficient in:

- Relying on outdated materials, placing critical information in RFIs and memos, and failing to use available meteorological data available; these meterological data are essential to accurately predicting dust dispersion and deposition in the affected environment.

Actions Needed

Below we lay out, by category, actions that in our opinion should be performed and provided in a revised Draft EIS.

<u>Missing data and Contaminants associated with Road Dust</u>

→ Critical model inputs for determining dust deposition rates and accumulated metal concentrations must be supplied in the FEIS.

→ The full likely suite of major chemical components of fugitive dust must be identified and accumulated concentrations determined for the 20-year and 78-year mine scenarios.

→ Baseline soil and sediment data sufficient to determine future impact must be collected and presented.

<u>Inadequate assessment of soil types</u>

- ➔ Provide plume maps for the roads, using relevant, recent data on soils, wind, and topography. Wind and topography are mentioned as contributing to the effects of fugitive dust on wetlands (DEIS Chapter 4.22), but this only considered the mine site, not roads or ports.
- ➔ Provide qualitative information on the potential for wind erosion by type of soil. Provide this information for the mine access road, port access road, Iliamna spur road, and roads in Alternatives. Given the difference in topography and physiography along the route from Kamishak Bay to Iliamna Lake compared with the route from Iliamna Lake to the mine, soil/surficial geology type and ability of material to become windborne will be different netween these road segments, and wer could find no assessment in the DEIS of dust effects from the Lake Iliamna-Kamishak Bay road segment .
- ➔ Provide a map of surficial soils and geology at the material site and quarry locations. Describe how the physical properties of the materials available at the material sites affect the potential for breatkdown of road surface material and the generation of windborne dust. Provide this information for the mine access road, port access road, Iliamna spur road, and roads in Alternatives. Reasonably accurate prediction of dust mobilization requires such a characterization of the breakdown properties of road surface material, including sand applied to roads to mitigate winter ice and snow travel.

<u>Road corridor route</u>

- ➔ Apply site-specific data as inputs in dust deposition models.
- ➔ Account for road material source sites, including quarries, processing pads, waste and storage piles, and traction sand sources and storage sites as dust sources directly associated with the road and pipeline corridor. This neeces to be done for each alternative, given that alternatives include substantial differences in the configuration of the trnansportation corridor.
- ➔ Provide maps of the geographic extent of dust in context with the landscape dust will settle upon, including land and waters downwind of the prevailing wind directions.

<u>Soil density and silt</u>

- ➔ The assumptions for the dust deposition model need to be independently reviewed. Model inputs for soil density and silt content appear to be unrealistically low, which would lead to substantital underestimation of dust transport distances stated in the DEIS to be substantially underpredicted. An independent review should include the recent dustfall jar collection studies conducted at Red Dog Mine, which measure actual current levels of dust from road traffic, and the Denali Park traffic effects study.
- ➔ Actual silt and moisture content of roadbed materials should be gathered, as described in the Ap-42 manual. Model inputs and assumptions that affect results must be disclosed in the .DEIS.

<u>Windspeed and precip</u>

- ➔ All available wind, particulate, precipitation, and other relevant data from meteorological stations should be utilized in fugitive dust modeling. Because meterological conditions are crucial deteminants of dust mobilization and transport, it is critical that the most accurate available data be applied in analysis of dust effects at the mine site and transportation corridor.
- ➔ Explain why precipitation data from all met weather stations in the vicinity of Pebble were not utilized. What information justified the assumption in the DEIS that dust would be greatest in

summer? Based on dust activity at other mines operating and hauling during cold winter conditions, we question this assumption. Traction sand applied in winter is likely to be a major dust source that must be accounted for, especially as it cannot be controlled by water spreading in near- or sub-freezing conditions.

- ➔ Provide information and maps on the likely extent of fugitive dust deposition from the road system before and after mitigation for summer and winter.

Chemical dust suppressants

- ➔ Provide examples of where road systems in similar climates have controlled dust to a high degree through watering alone, including direct support for the DEIS the assumption that dust control is not needed in winter, when water-based dust abatement is not practical.
- ➔ If examples cannot be provided to justify dust control by water spreading only, in the revised DEIS must include analysis of chemical or other alternatives for dust abatement, and analyze and disclose their potential impacts on wetlands, water bodies, vegetation, fish, and wildlife through both airborne dispersion and surface runoff.

Baseline sampling

- ➔ Sample soils and sediment in locations that will be impacted by the road system. The DEIS lacks sufficient baseline information on these ecosystem components necessary to predict and evaluate how they will be affected by road dust and its associated pollutants.

Fugitive dust chemistry

- ➔ Natural soils need to be tested to determine background variation in concentrations of metals and salts at different locations along the road system, particularly at locations where soil and surface geology are already known to change.
- ➔ Samples need to be extracted from road material sites and undergo geochemical testing, and results presented in a revised DEIS in order to determine the potential for road construction and maintenance material to serve as s source of contaminants to soils, vegetation and waterways .
- ➔ The revised DEIS must provide a clear description of modeling inputs and assumptions employed to determine dust deposition areas and rates, and the trace metal and other pollutant concentrations deposited with fugitive dust along the full length of the road system.

Contaminant transfer

- ➔ The revised DEIS must include a cumulative effects analysis to asses on potential effects of pollutants associated with fugitive dust, including known landscapes that dust will affect, pathways by which dust and dust-associated pollutants will directly or scondarily enter waterways, and likely biogeochemical cycling of those pollutants in the receiving environment. This analysis is ncessary to reasonably assess risks of harm to aquatic life, fish, and birds, and mammals dependent on fish. This cumulative effects analysis must focus particularly on persistent pollutants that are prone to bioaccumulation in food webs, including mercury, selenium and polycyclic aromatic and other classes of persistent hydrocarbons known to be delivered in road dust. The DEIS inexplicably lacks any analysis or disclosure of the biological effects of dust contaminants on aquatic ecosystems and wildlife dependent on them.

Toxicity, bioaccumulation, and cumulative effects in ecosystems and biota

- ➔ Impacts to fish and wildlife need to consider the ways in which dust-borne contaminants will exert toxic effects in combination with contaminants from runoff, spills, and other sources. Sub-lethal effects, bioaccumulation, and trophic transfer effects must be considered to assess potential impacts.
- ➔ Cumulative effects analysis of the ecosystem and biological effects of pollutants delivered by road dust, including waters downstream of the roads themselves, must be evaluated in the context of effects of similar pollutants derived from other components of the project, including dust, runoff and water treatment effluent the mine site, ongoing water-borne runoff from haul roads and associated materials source and storage sites, and leakeage and spills from truck haul and lake ferry and marine operations.

Introduction

Fugitive dust refers to particulate matter suspended in air. Fugitive dust originating from disturbed soils, waste piles, and unvegetated surfaces at mine sites construction sites, quarries, and roads is a significant vector for transport of pollutants into the surrounding environment (Cecala et al. 2012). Mining activities originate dust through stripping vegetation, draining or disturbing soils, creating waste piles, and grinding and crushing mineral particles on driving surfaces (Thompson and Visser 2007). Dust is then mobilized and transported by turbulence caused by moving vehicles, and secondarily transported by external contamination of moving vehicles and loads. Once mobilized, dust is further suspended and dispersed by aeolian processes. In open, windblown landscapes, aeolian transport can extend for distances of many kilometers from the point of origin. Some suspended and aeolian transported dust ascends to higher altitudes where it is subject to movement at a global scale (Schepanski 2018).

The environmental impact of fugitive dust extends far beyond the effects of the inert fraction of mineral particles themselves on air quality and water quality in dust dispersion plumes. Dust particles from industrial sites, mines, and roads are virtually always contaminated with metals originating from ore, concentrate, or quarry rock, with a wide variety of toxic and often persistent hydrocarbons originating from equipment and vehicle wear, lubricants, fuels, and exhaust, and with chemicals applied for dust abatement (Jones 2017) or for reduction of snow and ice. Over the lifetime of a project, dust generated along the transportation corridor inevitably becomes laden with metals originating from leached, leaky or spilled loads, and external contamination of vehicles and containers at loading operations (Cecala et al. 2012).

Dust control measures are commonly taken to reduce immediate health hazards to workers and to reduce impairment of visibility that can cause traffic accidents (Cecala et al. 2001, Jones 2017). Because abatement measures are always imperfect, background fugitive dust remains as vector for environmental contamination, especially where mining and transport operations are continuously or frequently occurring over time periods of many years.

Moreover, dust control measures themselves introduce additional sources of chemical contamination of the surrounding environment (Piechota et al. 2004, Irwin et al. 2008). Dust palliatives and their byproducts not transported as a fraction of dust eventually disperse from the site of application via aqueous runoff, thus can affect surrounding soils, vegetation, wetlands, lakes and streams.

Source of fugitive dust

The DEIS recognizes fugitive dust will come from in-pit drilling and blasting, material handling (transport, storage, processing) and the tailings beach (DEIS Chapter 4.14-3). However, there is virtually no discussion about dust from the road system. Additionally, the impact analysis is minimal.

The key comments related to "Sources of Fugitive Dust" are the following:

- There is no real analytical work to determine the extent of dust transport plumes and potential deposition from road and port traffic based on inputs such as winds and topography. The basis for choosing a 100 m zone of impact around roads is inadequate.
- Sources contributing to dust chemistry such as road material source geochemistry, vehicle fuels and exhaust, lubricants, and wear of tires and other components, chronic leakage or spills of hauled material (including ore concentrates and rock and soil for road construction and maintenance), and fugitive dust transported on the exterior of vehicles were ignored.
- Road fill and surface material sites as well as road waste sites were ignored as sources of dust associated with the roads and pipeline.
- Traction sand applied in winter is likely to be a major dust source that must be accounted for, especially as it cannot be controlled by water spreading in near- or sub-freezing conditions.
- The DEIS offers inadequate justification for soil density, percent silt, and threshhold value of tailings particles as inputs in dust plume modeling. Incomplete wind and precipitation data were applied.
- The volume of dust from the mine site is estimated but there is no analysis of whether, or under what conditions, contaminants in dust would enter waterways where fish could be exposed.
- Information has not been pulled from RFIs into the DEIS in any meaningful way that would allow the reader to understand sources, volumes, and chemical make-up of dust.
- Critical data are missing, outdated, or buried in RFIs and not summarized in the DEIS chapters.
- Assumptions in the DEIS about the efficiency of dust control are unjustified and wildly unrealistic. The DEIS and supporting record lacks citation to published literature or analyses supporting the assumed effectiveness and feasibility of the dust abatement measures identified.

Adequacy of analysis of fugitive dust sources

Critical model data missing from DEIS

We incorporate by reference concerns detailed in Zamzow_04202019_Fugitive dust_mine site.Final . with regards to dust deposition modeling missing entirely from Chapter 4.14 Soils. The DEIS chapter provides only a simple equation, for estimating the concentration of metals due to dust (Cs), with no explanation of the actual input data utilized (Chapter 4.14.2.1). Additionally, it appears the analysis was not conducted for the road system; the soils chapter makes no mention whatsoever of fugitive dust from roads, with the Transportation Section saying only:

> *Soils capable of retaining moisture in the project area are generally considered to have a low susceptibility to wind erosion, due to inherent moisture content from periodic precipitation or*

> *snowmelt throughout the year. For this reason, the potential for wind erosion would be greatest during drier periods lasting 1 to 2 months during the summer. If necessary, wind erosion can be mitigated through dust-control watering as needed during the summer.* (DEIS Chapter 4.14)

Analysis of road dust effects needs to consider the suite of factors that affect 1) road dust generation and dispersion – including mineralogy and breakdown under traffic of surface rock particles – landscape factors, wind factors, traffic speed and density factors; 2) road dust contamination, including quarry source material composition, vehicle wear, dust palliatives and ice control agents. Discussion should be provided on the contributions of hydrocarbons from spills and leakage as dust components, citing literature.

There is also no explanation in Chapter 4.14 as to how the deposition rate was determined. To produce meaningful results this analysis would need to incorporate data on particle density and site-specific and seasonal windspeeds,and prevailing wind directions, among other factors (Countess et al. 2001). RFI 009 does partially address windspeeds, but selects only a subset (January 2009-December 2011) of the full meteorological data set available (January 2005- December 2012) (SLR 2013). A single density is chosen for particles regardless of source material, and this information is only found in an RFI (RFI 009), not the DEIS.

The DEIS assumes that dust suppression at the mine site will consist entirely of watering, and will only be needed in the summer. This is counter to all evidence across Alaska and at mine sites. Dust palliatives will certainly be needed. Water spreading is impractical and unsafe means of dust control in near-freezing or sub-freezing winter conditions, when dust is commonly generated from sand applied to improve vehicle traction. If salts, such as $CaCl_2$, are applied, they can incorporate into fugitive dust as they dry (Stehn and Roland 2018). This chemical component of dust and its potential effects (Frissell and Trombulak 2000, Lohnes and Coree 2002, Thompson and Visser 2007, Jones 2017) is not mentioned or analysed in the DEIS.

The DEIS ignores hydrocarbons and vehicle wear as a source contributing to dust chemistry. In particular vehicles shed particles from catalysts (platinum, palladium), brakes (copper, nickel), tires (zinc, cadmium) and engines (iron, manganese, chromium) (Pratt and Lottermoser 2006, Knight et al. 2017). Mercury originating from vehicle emissions and from wear of automoblie components can also contaminate road surfaces, road verges and road dust (Ozaki 2004).

There appears to be no soil chemistry – either baseline metal content or metal leachability studies – for soils along the transportation corridor. . However, 17 soil samples were collected and analyzed from the transportation corridor during baseline sampling in 2004-2008 (SLR 2011 Chapter 10.4.7). Was this data considered? If not, why not? The 17 soil samples by themselves are likely insufficient:

> *Individual elements vary greatly in concentration across sampling locations, and within a given location concentrations vary among elements.* (SLR 2011 p.10.4-4)

No soil samples have been collected around port sites (Kokhanok, Kamishak Bay, Diamond Point port) or along the route from Kokhanok to Kamishak Bay.Without adequate baseline data, there can be no accurate assessment of ecological impacts from road dust, dust palliatives, and metal fines from vehicles.

Despite the lack of modeled road dust dispersion, and an apparent complete lack of baseline soil chemistry from road materials, and no analysis of dust-associated pollutants originating from the road system, there is an entirely unsupported statement in the DEIS that there will be no adverse impacts on soils in the transportation corridor (DEIS Table 4.14-6).

Inadequate assessment of soil types

We incorporate by reference concerns detailed by Zamzow_04202019_Fugitive dust_mine site.Final with regards to outdated and missing baseline soil data. PLP environmental baseline contractors should collect original soil type and chemistry data at material sites and road corridor sites. Without this, there is no way to assess potential impacts in the DEIS, nor will it be possible for mine personnel, regulators, or the public to determine actual impacts from the mining project in the future.

It is useful to contrast the information utilized in the Pebble DEIS and the Donlin DEIS (US Army Corps of Engineers 2015). Importantly, for the primary soil types listed in the Donlin DEIS, the slopes, drainage class, and qualitative assessment of susceptibility to wind or water erosion are also listed as shown in the snapshot of Donlin DEIS Table 3.2-3 below:

Table 3.2-3: Soil Types and Erosion Hazards for Mine Road Alternatives

Soil Map Unit and Major Components	Family or Taxonomic Class	Parent Material Description	Landscape Position	Slope Range (%)	Drainage Class	Erosion Water	Erosion Air
Soil Descriptions Common to Angyaruaq (Jungjuk) and BTC Roads, and Crooked Creek Winter Road							
R30FPA: Yukon-Kuskokwim Highlands, Boreal Floodplains and Terraces							
Boreal forest, gravelly floodplains and similar soils	Fluventic Haplocryepts	Loamy alluvium over sandy and gravelly alluvium	Toeslopes of floodplains on mountains	0 to 2	Moderately well drained; occasional flooding	Slight	Moderate
Boreal forest, loamy floodplains and similar soils	Aquic Cryofluvents	Coarse-loamy alluvium	Floodplains	0 to 5	Moderately well drained; occasional flooding	Slight	Moderate
Boreal scrub, gravelly floodplains and similar soils	Aquic Cryorthents	Sandy and gravelly alluvium	Floodplains	0 to 7	Somewhat poorly drained, occasional flooding	Slight	Moderate
Boreal scrub, silty terraces and similar soils	Typic Cryaquepts	Organic mat over silty alluvium and/or loess over gravelly alluvium	Terraces	0 to 5	Very poorly drained, no flooding	Slight	Slight

In the Pebble DEIS is a much less detailed table, which, it should be noted, also omits footnote descriptions of port access road soil types (IA72 and IA173). The reference to PLP 2018 is also quite vague.

Table 4.14-2: Alternative 1 Road Lengths, Terrain, and Soil Types

Road Segment	Gentle Terrain	Moderate Terrain	Rough Terrain	Approximate Percent Soil Map Unit
Port Access Road	3.9 miles (10%)	9.8 miles (26%)	23.6 miles (63%)	20% (IA72), 80% (IA173)
Mine Access Road	26.7 miles (92%)	2.3 miles (8%)	None (0%)	59% (IA7), 37% (IA94), 4% (HY4)
Iliamna Spur Road	2.9 miles (41%)	4.1 miles (59%)	None (0%)	47% (IA7), 53% (IA9)
Percent Total Access Roads Terrain Type1	46%	22%	32%	

Notes:
[1] Kokhanok airport spur road is not included in the evaluation due to the comparatively short road length and similar conditions to other project access roads.
[2] IA7: Typic Cryandepts – Very gravelly, nearly level to rolling association.
[3] IA17: Dystric Lithic Crandepts – Loamy, hilly to steep association.
[4] IA9: Typic Cryandepts – Very gravelly, hilly to steep association.
[5] HY4: Pergelic Cryofibrists – Nearly level association.
Source: Rieger et al. 1979; PLP 2018

Qualitative assessments, such as in the Donlin DEIS would be a start, but the data should also be utilized to generate more site-specific dust plume models, which in turn should be overlaid on aerial photos and groundtruthed mapping to best determine the type of vegetation, wetlands, and water bodies in the path of the expected depositional plume.

Contaminants Associated with Road Dust

A DEIS supporting document provide tables of analysis of vehicle exhaust and fugitive dust emissions associated with the mine site (RFI 007 Appendix A-2 and A-3) and transportation corridor (RFI 007 Appendix B Tables 5, 6, and 18). Emissions were estimated based on the AP-42 manual numbers, and, with the exception of lead in vehicle exhaust (which was simply assumed to be negligible, without analysis), did not consider contributions of roadbed particles or vehicle wear.

Road dust consists in bulk of relatively inert mineral particles. However these particles are virtually always laden with trace chemical contaminants originating from multiple sources: road surface materials and their breakdown under traffic, vehicle exhaust emissions and the wear and tear of vehicle components, and chemicals used in the maintenance of roads, including deicing and dust abatement treatments, as well as herbicides applied for control of invasive weeds. More than 20 different elements have been detected in road dust with x-ray fluorescence and other methods (e.g., Atiemo et al. 2011). Vehicles will shed particles from catalysts (platinum, palladium), brakes (copper, nickel), tires (zinc, cadmium) and engines (iron, manganese, chromium) (Pratt and Lottermoser 2006). Road dusts in Australia were associated with elevated levels of lead, palladium, platinum, and zinc compared to the ambient environment, and isotopic signature analysis allow the investigators to trace the pathway of these contaminants from a road system to stream and estuarine sediments 10 or more km distant downstream

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(Pratt and Lottermoser 2006). Mercury is a common trace component of road dust; it originates from vehicle exhaust, particulate matter from abrasion sources such as the wearing of the road surface material, tire and brake wear debris, and from particles re-suspended from the road surface (Londonio et al. 2012). Elevated levels of zinc cadmium, and lead were reported from areas affected by fugitive dust from the Red Dog Mine haul road in northwest Alaska, likely originating from leakage and spills of concentrate ores (Neitlich et al. 2017). Accidents and spills both large and small are ceretain to occur on any indistrial haul route (See Lubetkin comments on DEIS for quantitative information and a critique of the DEIS assumptions on spills).

Organic chemicals novel to industrial processes also contaminate dust. Polycyclic aromatic hydrocarbons (PAH's) are one family of hydrocarbon that originates from gasoline and diesel vehicle exhaust, fuel spills and leaks, and wear of tires and other components (Wang et al. 2016) and universally contaminate roadways, road verges, and zones of delivery of dust and runoff from roads to waterways (Trombulak and Frissell 2000, Abdel-Shafy and Mansour 2016, Grung et al. 2016). PAH's are toxic to many or most organisms, but are also highly persistent in the environment and prone to bioaccumulation, such that they may accrue to more toxic concentrations are higher trophic levels (Fisher 1995). PAH's are known to disperse widely within aquatic ecosystems from limited points of delivery—by way of bioaccumulation and biotransport processes (Grung et al. 2016). It is well known that herbicides and their breadown products are frequently aerially transported on dust particles (Tiryaki and Temur 2010).

Geographic extent of dust deposition impacts

The DEIS provides crude estimates of direct dispersion of road dust based on an arbitrary 100-meter boundary placed around roads. This results in impacts to 892 acres of "wetlands and other waters", including 648 acres of wetland, 205 acres of lakes and ponds, and 37 acres of rivers and streams (DEIS Chapter 4.22). An additional 6,100 acres of vegetation would be impacted by road dust (DEIS Chapter 4.26). All in all, including contributions from mine sit dust, 10,000 acres of wetlands, vegetation, and water bodies could be impacted by fugitive dust based on the current dust plume assessments. Much of this area would receive repeated inputs of thousands of tons of dust annually (RFI 007). However, the nature of the impact that this deposited dust might have on aquatic ecosystems is not considered ordisclosed in the DEIS.

Mobilization and deposition distance of dust will vary with material density, size, wind speeds and terrain, as well as with the activity and travel speeds of light trucks in administrative use or heavy trucks hauling supplies, waste rock, ore, and concentrate (Countess et al. 2001, Cecala et al. 2012). The dust dispersion model likely does not fully account for these variables, and in so doing, in our opinion very likely underestimates the area directly impacted. Equally important, secondary transport of dust particles and associated contaminants downstream after initial deposition in soils, vegetation, and aquatic systems is not considered or disclosed in the DEIS.

Road corridor deposition zone

The DEIS applied a 100 m (330 ft) deposition zone around roads and assumed that fugitive road dust would remain within those bounds, with the greatest impact in the first 35 m. Although a figure showing the dust plume for the mine site is provided in DEIS Chapter 4.14, there is no figure illustrating the presumed footprint of the road dust desposition zone, nor any discussion of road dust, nor any further mention of the 100 m zone. Instead, the information on the deposition zone is buried in RFI 009, and mentioned in DEIS Chapter 4.22 (Wetlands) and DEIS Chapter 4.26 (Vegetation), but not in DEIS Chapter 4.18 (Water-Sediment Quality), despite the fact that extensive water bodies are known to fall within the specified 100 m zone (e.g. stream and river crossings and banks, ponds, wetlands, and Iliamna Lake). A reasoned, accurate and defensible description and disclosure of the road dust deposition zone needs to be included in a revised DEIS Chapters 4.14 (Soils) and FEIS Chapter 4.18 (Water-Sediment Quality).

RFI 009 states that a 100 m (330 ft) dust deposition zone should be applied around all roads to determine the acres of vegetation, wetland, and water bodies that could be impacted. The 100 m distance is based on the Donlin Project and Point Thompson EIS's (DEIS Chapter 4.22) and does not take into account known soil types, the prevailing wind direction (which would deposit dust further on one side of the road than another, and would move dust further in open wind-exposed areas), or particle size relevant to roads. The federal AP-42 manual, which is the source of many of the inputs for dust modeling, notes that

> *Particles that are 30 to 100 µm in diameter are likely to … settle within a few hundred feet from the road. Smaller particles… have much slower gravitational settling velocities and are much more likely to have their settling rate retarded by atmospheric turbulence* (AP-42 1995, Section 13.2).

About half of the particulate matter expected from wind erosion during road construction have diameter of 10 µm or less (RFI 007, Appendix A Table 8). Given this and based on the manual cited above and other available information, in our opinion the 100 m assumption for dust dispersion in the DEIS likely seriously underestimates the probable zone of dispersion of dust and dust-borne contaminants. Among other case studies, studies from the haul route of the Red Dog Mine, as cited elsewhere in this document, offer evidence of dispersion of dust and associated contaminants at distances >100m from the haul route.

Missing also from the DEIS is a clear analysis of the contribution of fugitive dust from material sites along the road and pipeline corridors. The impacts from truck traffic and grading are assessed (RFI 007, Tables 5, 6, 18), but there is no mention of material sites (Figure 1). Blasting and transfer of gravel, sand, and rock will produce dust, as will the necessary spur roads to reach many of these sites. Material sites are expected to vary from 241 acres to 717 acres for the roads and from 10 acres to 306 acres for the pipeline corridor, depending on the Alternative.

<u>Soil density and silt</u>

As at Pebble, Donlin attempted to place a 100 m dust deposition zone around the road. This was challenged by a contractor; in particular, they challenged the assumption that particle density of 2.7 g/cm^3 should be applied in modeling the extent of fugitive dust (Cardno 2015). This density is representative of waste rock, and does not reflect the amount of gravel, silt, and clay that would be in the roadbed material, which is critical to determining the ability of material to become airborne and the extent to which it travels.

It appears that the Pebble DEIS utilized a soil density of 2.65 g/cm^3 (RFI 009 and RFI 009 Follow up questions), although Appendix K4.18 (Table K4.18-18) suggests 1.5 g/cm^3 was used in estimating impacts of dust constituents on groundwater. They based the density on "project-specific materials and previously approved values for other Alaska mining projects" (RFI 009), almost certainly referring to project-specific waste rock and to the previously approved Donlin mine.

- Pebble modeled deposition of 0.0027 g/m^2 per day (1 g/m^2 per year) at the mine site boundary and up to 30 g/m^2 per year 0.0822 g/m^2 per day (30 g/m2 per year) at the mine site.
- At Donlin, the same soil density resulted in deposition rate of 0.15 g/m^2 per day within 1 meter of the road.
- More recent studies at Denali National Park (Stehn and Roland 2018), with seasonal use similar to the traffic on the Donlin mine access road (about 150 vehicle trips per day), deposition rates were as high as 2.14 g/m^2 per day (767 g/m^2 per year) within 5 m of the road.

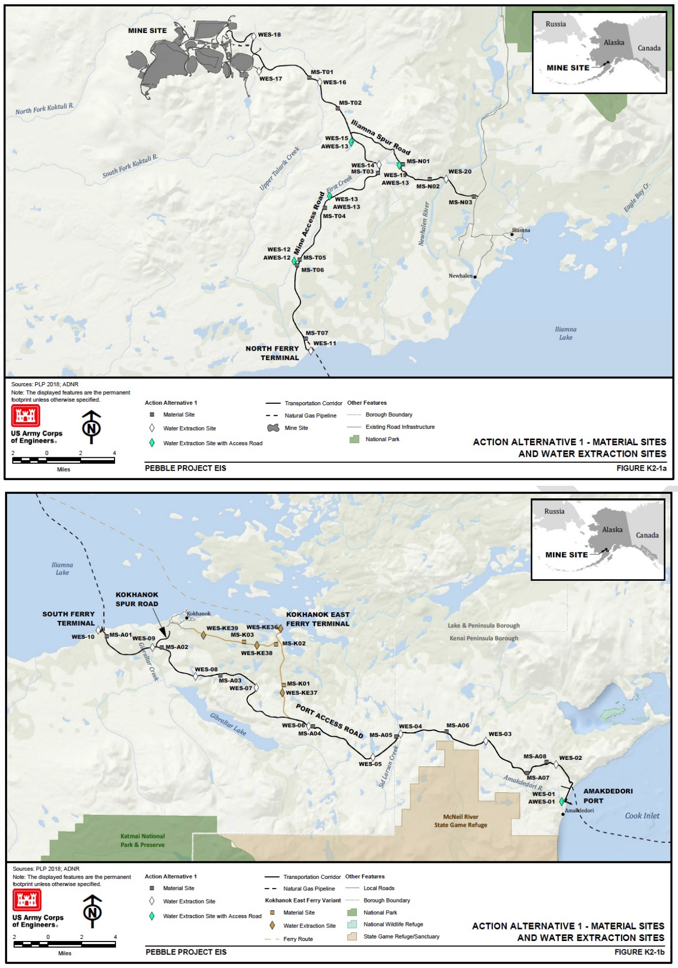

Figure 1. Material sites on the road system. *Source: DEIS Appendix K Figures K2-1a and K2-1b*

The percent of silt in roadbeds also affects dust. The model for dust from road construction used a silt concentration of 3.9%, representative of national “industrial roads” from the AP-42 manual, not site specific data (RFI 007). However, the AP-42 notes that the silt content of unpaved roads can vary by two orders of magnitude:

> *Dust emissions from unpaved roads have been found to vary directly with the fraction of silt (particles smaller than 75 µm in diameter) in the road surface materials.…Table 13.2.2-2 summarizes measured silt values for public unpaved roads. It should be noted that the ranges of silt content* ***vary over two orders of magnitude****. Therefore, the use of data from this table can*

> *potentially introduce considerable error. Use of this data is strongly discouraged when it is feasible to obtain locally gathered data.* (AP-42 2006 Section 13.2.2)

While the AP-42 manual allows for the use of an "appropriate mean" when site data is not available, the manual offers no tables that show a mean as low as the 3.9% used in the dust modeling for the DEIS. Haul roads for coal mines might be the closest category, and these show a mean of 8.4% silt; a freshly-graded haul road has a mean of 24% silt.

Additionally, it is almost inevitable that chemical dust suppressants will be needed on the road. This could increase the amount of small particles:

> *Many chemical unpaved road dust suppressants form a hardened surface that binds particles together. After several applications, a treated road often resembles a paved road except that the surface is not uniformly flat. Because the improved surface results in more grinding of small particles, the silt content of loose material on a highly controlled surface may be substantially higher than when the surface was uncontrolled* (AP-42 2006, Section 13.2.2).

Therefore, when watering alone is applied, the silt-sized fraction will not increase but the road will be expected to dry quickly on days when there is not active precipitation. Chemical suppressants will keep dust down longer, but could increase the silt-fraction which will become windborne with lower windspeeds than gravel or aggregate.

The Denali Park study found that vehicle speed, wind, and precipitation – or the application of dust suppressants – had the most impact on dust deposition (Stehn and Roland 2018).

<u>Windspeed and precipitation</u>
We incorporate concerns regarding the meteorological data applied to the models, as detailed in Zamzow_04202019_Fugitive dust_mine site.Final.. We reiterate concerns that the DEIS may incorrectly assume that the most dust will be generated in the summer, rather than in winter during periods of low humidity and high winds (Teck 2005, Neitlich et al. 2017).

There appears to be no estimate for windborne fugitive emissions along the transportation corridor whatsoever (RFI 007, RFI 009). Landscape features will cause windborne effects to differ along the road system, and these need to be accounted for. Additionally, landscape features and road slopes and gradients will channel road runoff during precipitation events and snowmelt. This will affect the distance over which dust is transported as waterborne particulates and the effective distance over which it may affect vegetation, wetlands, streams, ponds, and lakes.

<u>Volume of dust</u>
RFI 007 appears to have information on volumes of dust potentially generated at roads. Fugitive "emission units" as particulate matter is expected to be over 1,500 tpy for the transportation corridor (RFI 007 Appendix B Table 1.b) during operations and over 5,700 tpy during road construction (RFI 007 Appendix xx Table 1.1 pdf page 279). None of this is mentioned in Chapter 4.14, Environmental Consequences, Soils.

Dust control

We incorporate by reference the material on Dust Control in Zamzow_04202019_Fugitive dust_mine site.Final. We re-state herethat watering alone (DEIS Chapter 4.14) will not work and that other dust control measures will be needed (Cecala et al. 2001, Teck 2005, Teck 2015, Jones et al. 2017). We also re-state that trucks dedicated to dust suppression are not likely to be priorities for repair, potentially leaving roads without any treatment for weeks at a time (personal communication,with Jeff Jewel, Highland Valley mine). This has occurred at the Highland Valley mine which sits right on the road system; it would be reasonable to assume that a mine with 70+ miles of unpaved road network would see this issue multiplied. Similarly, at Denali National Park, watering and application of chemical dust suppressants occurs "when staff resources are available and weather conditions permit" (Neitlich et al. 2017), and the best weather conditions were those without wind. The take-home message from these real-world examples is that even beyond the limited effectiveness of water as a dust abateent measure, perfect execuion of any dust abatement measures is exceedingly unlikely.

<u>Effectiveness of dust suppression</u>

The DEIS fugitive dust impacts model applies a control efficiency of 80% to dust suppression for fugitive dust (RFI 007). This number comes from the federal AP-42 manual. This manual also notes that

> *Control techniques for fugitive dust sources generally involve watering, chemical stabilization, or reduction of surface wind speed with windbreaks or source enclosures. Watering, the most common and, generally, least expensive method, provides only temporary dust control. The use of chemicals to treat exposed surfaces provides longer dust suppression, but may be costly, have adverse effects on plant and animal life, or contaminate the treated material.*
>
> *Unpaved roads have a hard, generally nonporous surface that usually dries quickly after a rainfall or watering, because of traffic-enhanced natural evaporation* (AP-42 2006 Section 13.2.2).

The AP-42 applies an 80% control efficiency – but for unpaved roads with chemical dust suppression (AP-42 1998, Chapter 2). When watering alone was used as the dues abatement menthod – in an area where winds remained below 22 mph – control efficiency was 40-70% for PM10 and 30-60% for total suspended particulates, and in a test under which a section of unpaved road was watered for 30 minutes, watering was about 72% effective for the next 3-4 hours (AP-42 1998, Chapter 4). This strongly indicates that water spreading would be far less effective at dust control than assumed in the modeling used in this DEIS, equations, more dust would result, and from that the volume of dust and potentially concentration of trace elements deposited on the land and water would be much greater than the DEIS predicts.

<u>Chemical dust suppressants</u>

Dust control measures themselves may introduce additional sources of chemical contamination of the surrounding environment (Piechota et al. 2004, Irwin et al. 2008). Dust palliatives and their byproducts not transported as a fraction of dust eventually disperse from the site of application via aqueous runoff, thus can affect surrounding soils, vegetation, wetlands, lakes and streams. The most commonly applied dust abatement measure, frequent spreading of water on the road surface, simply shifts the transport of dust components from airborne delivery to waterborne delivery to the environment (Irwin et al. 2008); runoff from road surfaces inevitably enters waterways at crossing points or where roads are built closely adjacent to of wetlands, streams, rivers, and lakes. These contaminant sources to the environment have not been assessed or disclosed in the DEIS.

The DEIS Mitigation chapter mentions that chemical dust suppressants could be applied, but the DEIS does no analysis of the impacts of this potential dust cotrol mitigation measure. The DEIS should address whether chemical palliatives would be needed and if so during what periods of the year – based on evidence from mines and communities in Alaska. Chemical dust palliatives very widely in their composition, effectivcesness in different environments, and their mobility and toxicity to ecosytems that receive them in the form of dust or runoff (Piechota et al. 2004, Irwin et al. 2008, Stehn and Roland 2018).

Assuming the Final EIS determines there will be a reasonably foreseeable need for chemical suppressants, the environmental consequences of these suppressant chemicals themselves needs to be analyzed. Additionally, there may be conditions under which it would be better to have no dust control. For example, Denali Park uses $CaCl_2$ for dust suppression, but not on steep grades or where the road is adjacent to wetlands. The decision to not apply on steep grades is for safety:

> *$CaCl_2$ in high concentrations can create a slippery road surface, as the dust particles bind into a slurry, and so reports of slippery corners may also affect application sites or rate.* (Stehn and Roland 2018)

Steep slopes can also cause dust abatement salts to accumulate in the surrounding environment further from the road. The National Park Service noted that $CaCl_2$ affected soil chloride 7m from the road moreso than immediately adjacent to the road when applied near steep slopes (Stehn and Roland 2018). Hence specific road locations relative to local slope angle, as well as proximity to receiving waters and swales and natural drainage systems, are fundamental to assessing the imapct of the road system in the DEIS, and how this might vary across alternatives with different transportation designs.

The DEIS needs to analyze the trade-off of risks related to applying or not applying chemical palliatives. It needs to provide maps indicating the extent of wetlands the roads will run through, discuss the potential for dust during periods when watering will be impossible, and discuss the impacts of no dust suppression versus suppression with available chemical palliatives. Impacts will be strongly correlated with the rate of application.

<u>Impacts of fugitive dust</u>

The environmental consequences, including toxicological effects, of fugitive dust once it enters freshwater ecosystems are addressed nowhere in the DEIS.

- Fugitive dust chemistry as reported in the DEIS does not include metals from vehicle wear as a component, therefore environmental consequences to aquatic life cannot be assessed.
- There is no baseline soil chemistry for roads, therefore future impacts cannot be assessed. Baseline chemistry needs to include trace elements and salt or petroleum components that could be in chemical dust suppressants.
- There is no ecological analysis that considers the cascading physico-chemical effects of fugitive dust on the environment, including bioaccumulation of metals and polycyclic aromatic hydrocarobons, and the resulting potential impacts on fish and aquatic resources.
- There is no analysis of how different source sites of construction and maintenance material for roads and other operations required vary across different Alternatives in terms of effects on acres or types of vegetation, wetlands, or water bodies impacted.
- There is no analysis of impacts to wetlands or water bodies, only the number of acres directly impacted by dust deposition according to the grossly inadequate model employed in the DEIS. The transport of dust and associated contaminants away from the site of deposition by water flow and biological processes is completely ignored.
- Critical assumptions underlying the dust deposition model are buried in an RFI and not provided in the DEIS.

Baseline sampling locations

There was baseline soil chemistry sampling at 117 locations, but there is no map of the locations in DEIS Chapters 3.14, 4.14, or Appendix K3.14, therefore there is no way to determine if they were representative either geographically or with respect to soil type. There does not appear to be any assessment of soil chemistry along the road (or pipeline) corridor(s). Seventeen soil samples (with associated sediment and fish tissue samples) were collected in 2004-2008 (SLR et al. 2011) and analyzed for soil chemistry; there is no map in the DEIS to indicate that this work was done, and no discussion of the results in DEIS Chapters 3.14 (Soils) or 3.18 (Water and Sediment Quality), despite the location of the samples along what would be the North Road Alternative (Figure 2). There does not appear to have been any sampling along the pipeline corridor, or at the Kokhanok ferry terminal(s), or along the route from the Kokhanok ferry terminal to the proposed Amakdedori port.

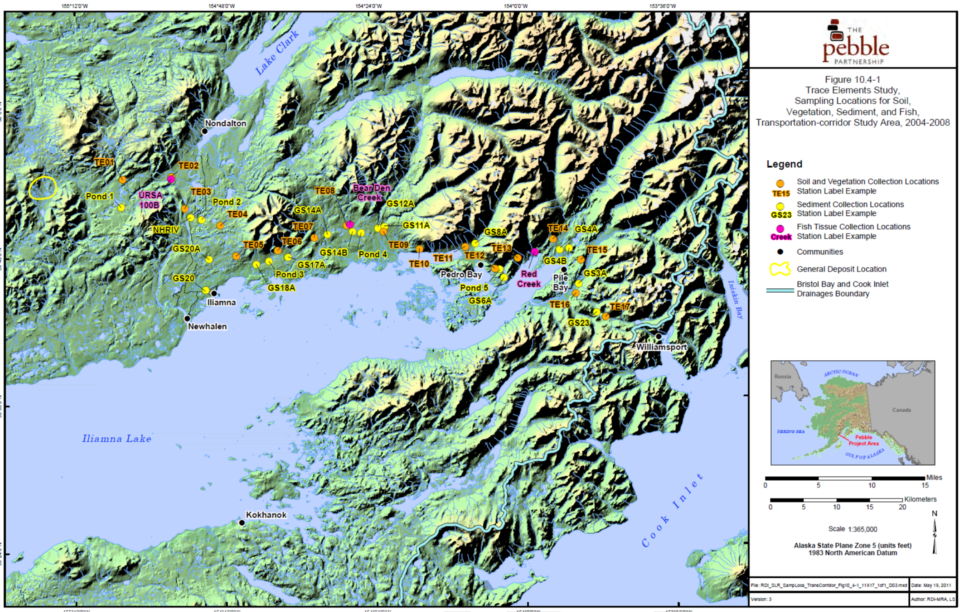

Figure 2. Transportation corridor soil samples, 2004-2008. *Source: EBD Figure 10.4-1*

In addition to baseline data collected in the past, there is soil, sediment, and rock chemistry data collected by the USGS that is publically available and should be included in the baseline (Granitto et al. 2011).[1] This does not release PLP from the obligation to collect baseline sufficient to determine future impacts at the mine site and road, pipeline, and port infrastructures.

Without baseline soil chemistry, the potential environmental impact from roads cannot be assessed. At Red Dog, although the haul trucks are "closed", there were truck spills of concentrate in 2011 and 2014, and monitoring suggests there may be an increase in zinc along the transportation corridor, although whether this is related to the recent spills, historical contamination, or something else was not discussed in the monitoring report (Teck 2015).

There is no analysis of lake sediment, including no analysis of sediment near the proposed ferry docks (DEIS Chapter 3.14, 3.18). Soil samples and soil chemistry were not collected near the proposed ferry docks, although these are areas where reagents and ore concentrate shipping containers will be transferred between trucks and boats, and therefore an area of potential spills and leaks.

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[1] An interactive map of sample sites in the Pebble area, including soil, rock, and sediment chemistry, is available at https://mrdata.usgs.gov/general/map-ak.html#home

Adequacy of analysis of fugitive dust chemistry

Fugitive dust chemical components
We incorporate by reference comments on mine site fugitive dust chemistry as detailed in Zamzow_04202019_Fugitive dust_mine site.Final. Mine site fugitive dust will in many places be added to fugitive dust from the road system. We reiterate that vehicle wear will contribute metals and hydrocarbons as fugitive dust chemical components.

There is no geochemical assessment of metal leaching from representative material sites along the road (or pipeline) corridor(s). Roadbed material itself may be a source of contaminants depending on the mineral and trace metal composition of quarry sites. The transportation corridors are known to have naturally elevated arsenic and selenium in soils (SLR et al. 2011 Table 10.4-2, Appendix Table 10.4-B, Granitto et al. 2011) relative to average crustal abundance (Weast 1984) Non-acid generating waste rock from the mine site which will be used in mine construction is known to leach high concentrations of selenium, but whether selenium or other trace elements will leach when used in road material cannot be known, as no rock material appears to have been collected or tested along the transportation corridor.

Fugitive dust is expected to land in hundreds of acres of wetlands and water bodies, and therefore will be exposed to different pH and redox environments. This has not been considered at all in the assessment of ecological impacts. Without geochemistry, the risks from fugitive dust cannot be assessed.

Particulate and metal accumulation
There is no assessment of the potential for accumulation of metals in fugitive dust along the road corridor. As noted in Zamzow_04202919_Fugitive dust_mine site.DRAFTv2, the assumption of the deposition rate of fugitive dust used in the DEIS, which is for the mine site only, may be reasonably be questioned; these inputs should be critically reviewed when developing road-dust plume maps. Inputs to dust plume models for the mine site and road corridors should be independently reviewed.

Once the dust plume area is determined and overlaid on landscape components, an analysis of particulate and metal accumulation needs to consider the long-term and dynamic nature of the deposition areas. Accumulation of trace elements in dust may form, over time, a growing pool of contaminants within the organic soil horizons or in pond sediment. Analysis should consider that dust will build up in some locations over winter, and deposit the accumulated dust of several months, with its contaminant load, into the underlying environment at snowmelt.

Ecological impacts

Although the DEIS states that traffic on unpaved roads will be a source of fugitive dust, there is virtually no analysis of dust magnitude and dispersion, nor of its ecological impacts, nor the basic factors underpinning dust effects and the mobility and toxicity of dust-associated pollutants, such as water and soil chemistry in the affected environment. Despite the fact that environmental contamination by dust measured at any given time might appear small, over the very long time frame over which the project is proposed to operate persistent or bioaccumulating toxics such as metals and complex hydrocarbons will not only build up in receiving soil and water, but may further disperse and potentially effect connected water bodies and their biota.

For the road system, the fate and transport needs to be assessed based on the expected chemical make-up of fugitive dust and the type of landscape it enters. The impacts are expected to overlap with areas impacted due to dewatering and habitat fragmentation. At the Red Dog mine, changes in ecosystem communities were likely related to the presence of the road itself:

> *These community shifts appear to be, in part, a result of physical and chemical influences of the road and their effect on hydrology, soil chemistry, and plant vitality. Physical and chemical stresses are commonly found associated with gravel roads in tundra environments.* (Exponent 2011).

Some metals and metal species will be more mobile than others; for example, zinc in deposited dust may be more mobile in water than lead (Teck 2005). Sequestration, dilution, accumulation, and transformation of these elements will be different depending on the environment they enter: wetland, oxygenated stream, still pool, rocky hillside, freshwater lake. These affect how bioavailable a trace element will become. Bioaccessibility, trophic transfer, and bioaccumulation then determine the impacts that reverberate through the food chain.

Contaminant Transfer to Aquatic Habitats

Although nearly 7,000 acres of impacted lands and water due to road corridor fugitive dust (and 11,000 acres total including mine site dust) is not trivial, a simple list of the acres and broad categories of landscapes directly affected is insufficient for an analysis of environmental consequences. We incorporate by reference comments on impacts to terrestrial and aquatic vegetation detailed in Zamzow_04202019_Fugitive dust_mine site.Final.

Turbidity. We re-iterate that the inert mineral component of dust can impair water clarity, suppressing primary production and foraging efficiency of fishes, and can settle into substrate interstices, degrading habitat for benthic organisms, eggs, and larvae (Newcombe and McD0nald 1991, Newcombe and Jensen 1996, Trombulak and Frissell 2000, Bash et al. 2001, Henley et al. 2010, Kemp et al. 2011). Decreased primary production associated with increases in sedimentation and turbidity and produce negative cascading effects by way of depleted food availability to zooplankton, insects, freshwater mollusks, and fish. Effects at each trophic level are mortality, reduced physiological function, behavioral avoidance, and decreases in available food; these sublethal effects commonly result in depressed rates of growth, reproduction, and recruitment (Henley et al. 2010). It is also in clear shallow waters that deposited mercury goes through photodemethylates in the long summer days of the arctic (Lehner and St. Louis 2009); increased turbidity could reduce rates of demethylation.

Fugitive dust may also cause early snowmelt, which could result in an increase in soil temperatures, leading to rapid decomposition of organic matter, which in turn could lead to hypoxia – particularly in shallow water bodies and pools in wetlands. If mercury enters these areas – either through fugitive dust or atmospheric deposition from other sources – the extended activity by soil microbes in hypoxic areas would more rapidly methylate mercury. Wetlands that are naturally slightly acidic (e.g. pH 4.5-5.5), or that have slowly become slightly acidic over time may enhance the bioaccumulation of mercury in plankton, and from there through the food chain (Watras and Bloom 1992).

Given that the DEIS very likely underestimates the mobilization and potential deposition of dust in water bodies near the mine site and road, it remains difficult to assess what the magnitude of physical effects of dust-associated turbidity and sedimentation might be on aquatic life in the affected water bodies. The effects of both suspended and deposited sediment originating from dust will compound with those of fine sediment delivered by fluid runoff from road running surfaces, ditches, and verges.

Dust that settles on vegetation of soils is subject to secondary delivery to wetlands, lakes and streams through both windborne and normal rain and snowmelt runoff processes.

Trace metals and hydrocarbons. The toxic trace metals and hydrocarbons associated with dust can enter aquatic food webs through various direct and indirect pathways (Ritter et al. 2002). Contaminants can be disassociated from dust particles in in the water column, where they can affect gill function and cause oxidative stress harmful to fishes (Sevcikova et al 2011), but commonly the more persistent forms of metals and PAHs remain adhered to inorganic dust particles. Organisms are then exposed to these contaminants via uptake from sediments by aquatic microbes, plants and benthic-living and filter-feeding invertebrates, from which they can be subsequently passed upward in food webs (Poteat and Buchwalter 2013).

In the case of persistent contaminants such as some metals and PAHs, they can secondarily enter streams and wetlands after first being taken up by terrestrial vegetation (Ritter et al. 2002), followed by subsequent deposition and breakdown of vegetation in waterways--both by physical transport processes and by herbivores.

<u>Toxicity and Bioaccumulation Risks of Dust-borne Contaminants</u>

The DEIS entirely lacks any discussion of the biological impacts of exposure to contaminants from fugitive dust through inhalation, direct ingestion, or consumption of prey, but these effects must be analyzed because the project will release known toxins into the environment via road dust and other vectors (other vectors include mine site discharges, accidents, leaks and spills during transport, road runoff, and potential tailings dam failures). Exposure of fish and aquatic life to trace elements from fugitive dust is downplayed in the DEIS, there is no discussion of effects on invertebrates, amophibians, reptiles, birds and mammals, and there is no analysis of exposure as elements bioaccumulate through the food chain (DEIS Chapter 4.24).

The section above notes some potential ways that mercury and selenium could enter the landscape on fugitive dust and become bioavailable. These are two of the HAPs assessed as components of fugitive dust (DEIS Table 4.14-1), but the assessment did not consider potential entry into and bioaccumulation through the food chain. Small concentrations of these elements in dust, transferred then to water and sediment, can result in tissue concentrations that are toxic in fish and birds (Chapman et al. 2009).

Once they enter aquatic ecosystems, metal and organic contaminants of dust can kill or impair aquatic organisms and food webs. As mentioned above, dust is only one vector by which these contaminants reach aquatic systems; dust-associated contaminants will exert toxic effects in combination from contaminants originating from road and industrial site runoff and direct delivery from accidents and spills, vehicle exhaust, and road maintenance actions.

Road dust on mine haul routes with heavy traffic or traffic continuing over many years inevitably becomes contaminated by mine concentrates via leakage of containers, external contamination of vehicles, and accidents leading to spills that can rarely be completely recovered, as discussed above. Therefore, dust contaminated by major constituents of mine concentrates, such as copper, can co-accumulate with copper delivered from other sources like vehicle wear, which could lead to outright toxicity to aquatic invertebrates and fishes. Toxic effects of copper, for example, include both direct lethal effects, and sublethal effects that may adversely affect survival and reproduction, including salmon and trout olefactory sensory systems that are critical to reproductive homing behavior (Baldwin et al. 2003; and see O'Neal comments on the DEIS). Many trace metals with potential toxicity accumulate in the tissues of aquatic macrophytes (Outridge and Noller 1991), and elevated copper concentrations are widely observed in aquatic systems affected by mine runoff (e.g., Siaki et al. 1995). We incorporate by reference additional discussion of copper impacts as detailed in Zamzow_04202019_Fugitive dust_mine site.Final..

More insidious impacts can be a caused by toxins that do not outright kill organisms at all trophic levels, but are prone to bioaccumulation (Fisher 1995). Metals like mercury, cadmium and selenium, and certain persistent hydrocarbons such as PAHs (Grung et al. 2016), are acquired and stored within tissues by plants and other organisms to concentrations well beyond the ambient environmental concentration, then can be passed to herbivores (D'Adamo et al. 1997, Henley et al. 2000) and subsequently to carnivores (Tillit et al. 1992) in food webs via dietary intake (Fisher 1995).

Long-term chronic contamination of the ecosystem by road dust and other sources, extended over the many years of the proposed mine project, could lead to eventual toxicity that is expressed at higher trophic levels of the food web, in particular among the largest and longest-lived predator species. In this regard, bioaccumulating toxics are of greatest concern precisely because they do not kill organisms near the base of the food web, but instead are concentrated in body tissues and passed upward in food webs at ever higher concentrations, and at the same time potentially transported out of the immediate area of direct discharge of contaminants by mobile fishes, and migrating birds and mammals that prey on fishes. Relatively pristine natural ecosystems such as Bristol Bay lakes, rivers and estuaries are especially vulnerable to the effects of bioaccumulation because their food webs include abundant, long-lived, upper-level carnivores that over time can bioaccumulate dietary toxics at high concentrations. Examples include predacious fishes such as trout, and salmon, northern pike, and Iliamna Lake seals. Because humans consume these species, humans also could be at risk from bioaccumulated toxins originating from the proposed road system and other mine-related sources.

Contaminants such as copper, mercury, selenium, cadmium, and PAHs all have different rates of accumulation and excretion, and different conditions for mobilization and immobilization. The DEIS must consider what toxic substances are likely to be associated with the proposed mine site and transportation corridor dust, and how they are likely to be dispersed into and subsequently affect the Bristol Bay environment--not just by physical means, but by biological means as well, including the bioaccumulation processes. Unique trophic aspects of the Bristol Bay ecosystem that influence the propensity for bioaccumulation of toxins (see Frissell draft report on cumulative effects of bioaccumulation) must be explicitly analyzed. These include the pervasive presence of long-lived, large-bodied predators at the upper echelons of food webs, and the potential mobility of predatory species (fish, birds, and mammals) that can bioaccumulate toxics near the area of initial emission, but move their body burdens many kilometers as they migrate.

This type of analysis needs to be conducted for both the 20-year mine and the extended 78-year mine scenarios, as the environmental consequences and cmulative effects will be determined in part by the span of years that dust-generating activities are sustained. Currently, a very terse summary of cumulative impacts on wetlands simply assumes that the same ratio of shrub and herbaceous wetlands will be impacted, although the acres of impact from all mine activities would increase from 4,000 to over 21,000 acres (DEIS Chapter 4.22). This was not broken down to show the increase in impacts from fugitive dust, spills, herbicide applications, and other contaminant build-up in the environment.

The USEPA's Bristol Bay Assessment

The Bristol Bay Assessment by USEPA (2014) identified the potential significance most aspects of dust pollution from the the road system associated with Pebble Mine proposals that are elaborated in these comments. Hence it is espcially puzzling why road dust pollution concerns are grossly inadequate and mostly absent in the DEIS. In fact road dust concerns are of greatly elevated serious ness in the DEIS than in the earlier tranporstation scenario addressed in USEPA (2014) and in the recent article by Kravitz and Blair (2019) because the DEIS proposse exensive, eyear-round, 24-hour use of the road for heavy haul of concentrates, rather than by s;urty pipeline ads in erarlier scenarios.

Specifically, USEPA (2014) covered dust generation from vehicle traffic and its role in contaminating waterways and their biota, including fishes (p. 6-41, 10-44, and 14-14), the potential effects of road salts used in dust control and deicing (p. 10-33), the potential toxicity of road salts used in dust control and deicing (p. 10-34 to 10-35), the process of fust formation, mobilization and transport in the presence of road traffic (p. 10-38 through 10-39), the potential spatial dispersion of road dust into the surrounding aquatic and terrestrial environment (p. 10-39 and 10-44),

The need for a revised DEIS

The topics raised here are important ones that deserve public review and comment. The only mechanism to achieve that is through providing the public with a revised DEIS. Release of a final EIS would remove the ability of the public to review and comment on the many new issues brought up in this memo and other substantive comments.

Summary and Conclusion

Fugitive dust is recognized as a potential impact of the Pebble mine operations in the DEIS. However, the treatment of the potential distribution and associated environmental risks of fugitive dust in the DEIS is grossly inadequate, and as a consequence misleading. It is disjointed, fragmented, seriously incomplete, and relies on outdated and inaccurate assumptions.

The extent and volume of fugitive dust is likely to be enormous. An estimated 8,300 tons of fugitive dust per year from the mine site and 1,500 tpy from the road corridor annually (as well as 5,700 tpy during road construction) are anticipated to impact over 1,500 acres of wetlands, 250 acres of lakes and ponds, and nearly 50 acres of rivers and streams. Over 9,000 acres of vegetation could be impacted. This is nearly 10,000 tons of fugitive dust anticipated to impact a vast landscape annually for a minimum of 20 years.

Despite this, dust is likely to extend further than has been modeled, and the impacts of fugitive dust on wetlands, water bodies, and aquatic life are very likely more extensive than has been stated in the DEIS. There are substantial gaps in the information that make an actual analysis impossible. Importantly, the DEIS lacks any analysis of the likely dispersion in the environment of dust originating from the haul and service roads, and no analysis of disclosure of the trace metal and hydrocarbon content of an estimated 1,500 tpy of road dust and how those contaminants will affect the Bristol Bay environment.

Road dust is of great importance in this context because as proposed the relatively long transportation system in the DEIS constitutes a far flung but direct source of industrial pollutants to numerous waterways it crosses or parallels, including Iliamna Lake. The environmental effects of dust abatement measures themselves, including sourcing, transport and spread of large quantities of water, and potential chemical palliatives, are entirely ignored in the DEIS. Considering the broad spectrum and extensive spatial distribution of likely impacts, the DEIS either underestimates or fails entirely to disclose the likely immediate and cumulative ecological and toxic effects of fugitive dust caused by the proposed project on fish and aquatic life.

The distance of dust dispersion is likely underestimated through application of high soil density, low silt content, and ignoring local windspeeds (means and maximums) and topography. The assessment for impacted areas on the road corridor applied none of these inputs. Available site-specific information has been ignored in development of mine area and road corridor dust plumes.

The chemical impact of dust is underestimated, as it does not include vehicle wear, chemical palliatives, or herbicides as a component of fugitive dust and there is no understanding of the potential chemistry of roadbed materials or the leachability of components in dust. The volume of dust may be underestimated in that material sites are not considered as a source for road construction and maintenance.

The DEIS does not describe the impacts of fugitive dust in the context of the depositional landscape. It does not consider the dynamic cycling and bioaccumulation of trace elements that enter wetlands and waters, nor the biological impacts of these processes.

The DEIS should provide an independent third party review of the road corridor dust plume model inputs. This should lead to an estimate of accumulation of metals and salts in fugitive dust from the road network.

Finally, an ecological risk assessment should be conducted to assess and disclose the potential biological impacts of dust deposition. Because the mine is certain to expand from a 20-year mine to a 78-year mine, the cumulative effects of both the quantity of dust on vegetation, wetlands, and water bodies needs to be assessed, the cumulative effects of increased concentration of metals in the dust as they leach out into underlying vegetation, wetlands, and water bodies, as well as the increasing physical effects (e.g. early snowmelt, increased soil temperatures) as they link to biogeochemical cycling and biological impacts. The impact of 10,000 tons of fugitive dust over the landscape annually, with 1,500 tons of that along a 70-mile long corridor, may not follow a linear pattern, but have multiplier effects.

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