Health Impact Assessment for Proposed Coal Mine at Wishbone Hill, Matanuska-Susitna Borough Alaska

Prepared For:

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LIST OF ACRONYMS

ADEC	Alaska Department of Environmental Conservation
ADF&G	Alaska Fish and Game
ADHSS	Alaska Department of Health and Social Services
ADNR	Alaska Division of Natural Resources
AFN	Alaska Federation of Natives
Al	Aluminum
AN EpiCenter	Alaska Native Epidemiology Center
ANMC	Alaska Native Medical Center
ANTHC	Alaska Native Tribal Health Consortium
APIA	Aleutian Pribilofs Islands Association
ASNA	Arctic Slope Native Association
ATR	Alaska Trauma Registry
ATSDR	Agency for Toxic Substances and Disease Registry
BBAHC	Bristol Bay Area Health Corporation
BRFSS	Behavioral Risk Factor Surveillance System
Cd	Cadmium
CDC	Center for Disease Control and Prevention
CI	Confidence interval
CIRI	Cook Inlet Region Inc.
CIS	Community Information Summaries
COMEAP	Committee on the Medical Effects of Air Pollutants
COPCs	Chemical(s) of potential concern
COPD	Chronic obstructive pulmonary disease
CSM	Conceptual site model
CT	Chlamydia trachomatis
Cu	Copper
CVD	Cardiovascular disease
CWP	Coal workers' pneumoconiosis
DEE	Diesel engine exhaust
DEP	Diesel exhaust particles
DHHS	Department of Health and Human Services
DNR	Alaska Department of Natural Resources
DPM	Diesel particulate matter
EC	Electrical conductivity-elemental carbon
EPA	U.S. Environmental Protection Agency
EU	Emissions unit
FAS	Fetal Alcohol Syndrome
FCS	Food Cost Survey
Fe	Iron
GMU	Game Management Unit
HEC	Health Effects Category
HIA	Health Impact Assessment
HMP	Health Management Plan
HRQOL	Health-related quality of life
IARC	International Agency for Research on Cancer
ICCM	International Council on Mining and Metals

IFC	International Finance Corporation
IPIECA	International Petroleum Industry Environmental Conservation Association
IRIS	Integrated Risk Information System
ISER	Institute of Social and Economic Research
KGB	Knik-Goose Bay
KPIs	key performance indicators
m	Meter
Mat-Su	Matanuska – Susitna
mg/dL	Milligrams per deciliter
Mn	Manganese
MTM	Mountaintop mining
NAAQS	National Ambient Air Quality Standard
NCD	Non-Communicable Diseases
NEPA	National Environmental Protection Act
Ni	Nickel
P.S.D.	Prevention of Significant Deterioration
PAC	Potentially affected community
PACs	Potentially affected communities
PAHs	Polycyclic aromatic hydrocarbons
Pb	Lead
PID	Pelvic inflammatory disease
PM	Particulate matter
PSD	Particle size distribution
PTE	Potential to emit
RTA	Road traffic accidents
RfC	Reference concentration
RR	Rate ratio
SCMPA	Surface coal mining permit application
SDH	Social Determinants of Health
Si	Silica
STIs	Sexually Transmitted Infections
SVOCs	Semi-volatile organic compounds
TANF	Temporary Assistance for Needy Families
TEO	Toxic equivalency
Ti	Titanium
TPY	Tons per year
TRI	Toxics Release Inventory
UAF	University of Alaska Fairbanks
UCM	Usibelli Coal Mine
UK	United Kingdom
US	United States
USGS	U.S. Geological Survey
V	Vanadium
VOCs	Volatile organic compounds
WATSAN	Water and Sanitation
WHM	Wishbone Hill Mine Project
Workforce Information	Alaska Department of Labor and Workforce Development, Research and Analysis Chapter, Alaska Local & Regional Information

WHO	World Health Organization
Zn	Zinc

EXECUTIVE SUMMARY

Background

Wishbone Hill Mine Health Impact Assessment (HIA)

The ADHSS HIA Program developed an HIA for the proposed Wishbone Hill Mine (WHM). This HIA provides decision makers with a review of potential positive and negative human health impacts related to the WHM. The WHM HIA was developed using the strategies and methodologies described in the Alaska HIA Toolkit. The HIA is not required for permitting, and the project proponent is not legally required to comply with any of the stated recommendations.

The proposed project area is located in the Matanuska-Susitna (Mat-Su) Valley near Sutton, Alaska and is 8 miles east of Palmer, near Buffalo Mine road and the community of Buffalo Soapstone. Usibelli Coal Mine, Inc. (UCM) holds an active permit for the proposed WHM area. Idemitsu Alaska obtained the original permit for the area in 1991, but the permit was transferred to UCM in 1997. UCM satisfied the 5-year permit renewal requirements in 2001 and 2006, and is currently seeking to complete another renewal. Because the mine will involve a coal production and processing plant, the renewal of the mining permit also depends on obtaining an air quality permit. The proposed development focuses on a 6 million ton coal reserve identified in Mine Areas 1 and 2. UCM estimates that Mine Areas 1 and 2 could produce 500,000 tons of coal annually for approximately 12 years.

Health Impact Assessment

Health impact assessment (HIA) is a combination of procedures, methods and tools by which a policy, program, or project may be judged as to its potential effects on the health of a population, and the distribution of those effects within the population.

An HIA will:

- Provide a formal mechanism to engage the relevant stakeholders and key regulatory decision makers
- Review proposed project specifics
- Review the physical and general environmental setting of the proposed project;
- Identify potentially affected communities (PACs)
- Analyze the sufficiency of baseline health
- Select key health impacts using both a set of defined health effects categories (HECs) and input from stakeholder meetings
- Conduct qualitative impact rating and ranking analysis
- Propose a series of recommendations tied to potential impacts

Scoping Process

HIA uses a process known as “scoping” to obtain enough data and stakeholder input to identify the most important potential health impacts related to a project. Scoping can retrieve data through formal public health surveillance reports, census reports, socioeconomic studies, and cultural reports. The scoping process also includes the input of local residents who will experience the impacts of a potential project.

Stakeholder Engagement

The HIA program gathered input through a series of focus groups and invited written comments. The focus group meetings were held in a variety of settings. The meetings started with a brief introduction to the purpose and process of conducting an HIA, and were followed by a questions and comments period. This stakeholder engagement process resulted in a wide-ranging list of perceived impacts which are discussed at length in Chapter 3 of the HIA.

Baseline Data Collection

The HIA Program also reviewed baseline data from a variety of sources (e.g., Alaska Native Regional Health Status Reports, Alaska Behavioral Risk Factor Surveillance Survey, and the U.S. Census) and organized the information into eight health effect categories (HEC). The baseline health summary in Chapter 4 creates a point of reference regarding the health status of the potentially affected communities prior to development of the proposed WHM; it also describes an overall health profile for the area. Decision-makers can use their knowledge about the features of the proposed WHM and the health profile of the region to better consider health in their deliberations.

Coal Literature Review

The WHM HIA summarizes key studies pertaining to the impacts of coal mining on community health in Chapter 5 of the HIA. These studies demonstrate inconsistent results, but provide additional context for decision-makers, particularly when considering the potential impacts of particulate matter (which is commonly produced by coal combustion) on human health.

Identification of Health Impacts

The ultimate goal of an HIA is to identify the potential health impacts of the proposed project or policy and use this information to maximize benefits and minimize adverse consequences to the public's health. Health impacts include positive and negative changes in specific health outcomes (e.g., asthma rates, gonorrhea rates, motor vehicle fatality rates) and health determinants (e.g., access to health care, air and water quality, household income).

The table below displays a list of the important potential health impacts (both positive [+] and negative [-]) identified in the HIA for the WHM, and the rating of each impact on an ordinal scale (i.e., low, medium, high, or very high).

Health Impacts Rated by Health Effect Category		
Social Determinants of Health		
Health Impact	**+/-**	**Rating**
Change in morbidity and mortality data related to psychosocial distress such as depression, anxiety, substance abuse, and changes to family structure.	**(-)**	Medium
Change in median household income	**(+)**	Medium
Change in unemployment	**(+)**	Medium
Change in the percentage of households living below poverty line	**(+)**	Medium
Change in educational attainment data	**(+)**	Medium
Accidents and Injuries		

Health Impact	+/-	Rating
Change in morbidity and mortality data related to commercial motor vehicle (CMV) traffic on roadways related to the project and coal transport.	**(-)**	Medium
Change in morbidity and mortality data related to non-commercial motor vehicle crashes.	**(-)**	Medium
Exposure to potentially Hazardous Materials		
Health Impact	**+/-**	**Rating**
Change in morbidity and mortality data from poor air quality events (exceedances) through exacerbation of chronic obstructive pulmonary disease (COPD), asthma, cerebrovascular diseases, and cardiovascular diseases.	**(-)**	Medium
Food, Nutrition and Subsistence		
Health Impact	**+/-**	**Rating**
Change in regional food costs expressed as a % of median household income	**(+)**	Low
Infectious Diseases including STIs		
Health Impact	**+/-**	**Rating**
Change in the rates of STI such as gonorrhea, chlamydia, Hepatitis C, and HIV.	**(-)**	Low
Change in the rates of respiratory diseases such as influenza and pneumonia	**(-)**	Low
Chronic Non-Communicable Diseases		
Health Impact	**+/-**	**Rating**
Change in morbidity and mortality for chronic diseases including cancer	**(-)**	Low
Water and Sanitation		
Health Impact	**+/-**	**Rating**
Change in % of households served with water and sanitation services	(-)	Low
Health Infrastructure and Capacity		
Health Impact	**+/-**	**Rating**
Change in ratio of people to health care providers	(+)	Low
Change in time needed for emergency response for health issues	(+)	Low

Summary of Recommendations

Recommendations were provided for the HECs with health impacts that received a medium or higher rating. Action steps and monitoring approaches were developed for each of these HECs and summarized in the table below. The action steps and monitoring approaches are provided as recommendations to key decision makers, based on the predicted health impacts. Stakeholders are encouraged to review the potential impacts and consider ways to use this information to maximize benefits and minimize harms to persons living in the PACs.

Recommendations by Health Effect Category

Health Effect Category	Action Steps	Monitoring Approaches
Social Determinants of Health	• Follow the best practices strategies developed by the International Council on Mining and Metals and the World Bank Group for engaging with PACs and indigenous communities.[175 176 177] In other contexts around the world, this often includes community-based participatory monitoring for a suite of measurable and objective key performance indicators (KPIs). • Perform formal community engagement and conflict mediation practices to increase understanding between stakeholders and reduce psychosocial distress in PACs.	• Perform regular community engagement meetings to stay abreast of (and appropriately respond to) community concerns.
Accidents and Injuries	• Assure that drivers are well trained and that transportation equipment is in excellent working order. • Follow routine approaches to transportation safety such as having a written safety plan, driver training programs, safety meetings, equipment checks, drug and alcohol testing for drivers, fatigue management planning, and accident investigation and driver retraining procedures. • Utilize free consultation and training services available at Alaska Occupational Safety and Health (AKOSH) to review existing transportation and safety plans and journey management plans. • Review traffic information so that traffic volumes and road conditions are well understood for both commercial vehicles and commuters. An emphasis on locations where UCM transport logistics may intersect local populations is critical (i.e., schools, school bus pick-up locations, etc.). • Develop and implement medical emergency response plans and drills for off-site accidents, injuries, or hazardous material release events. • Coordinate and review emergency response plans with established local emergency response services.	• Review the Alaska Department of Transportation (ADOT) data on commercial and non-commercial motor vehicle crashes (accident information can be obtained for specific sections of each road). • Review statewide ADOT reports that include data on fatal and nonfatal motor vehicle accidents.
Exposure to Potentially Hazardous Materials	• Minimize road dust in the mining area through frequent application of water to the mine's roadways. This can also be accomplished through synthetic surfactants, soil cements, and polymers. • Cover or enclose coal stockpiles or use synthetic agents to bind coal particles and minimize dust generation. • Cover or enclose coal transfer points and processing facilities to minimize dust production. • Minimize coal dust during off-site coal transport by covering trucks and rail cars or using synthetic binders. • Refrain from blasting activities on high-wind days.	• Regularly review air monitoring stations in Palmer and Eagle River. • Regularly review water quality monitoring stations. • Use publicly available air quality alert systems such as www.airnow.gov to monitor air quality and health risk information.

1.0 INTRODUCTION AND OVERVIEW

1.1 Project Overview

This HIA provides decision makers with a review of potential positive and negative human health impacts related to the proposed Wishbone Hill Mine (WHM). The proposed project area is located in the Matanuska-Susitna (Mat-Su) Valley near Sutton, Alaska.

Miners have extracted an estimated 7 million tons of coal from 18 different mines in the Matanuska-Susitna Valley since the early 1900's. Several mining companies have conducted extensive exploration activities within coal reserve areas since 1917, but these groups have not actively mined the Wishbone Hill area since 1983. Usibelli Coal Mine, Inc. (UCM) holds an active permit for the proposed WHM area (Permit Numbers 01-89-796 & 02-89-796), which is 8 miles east of Palmer, near Buffalo Mine road and the community of Buffalo Soapstone (Map 1, Appendix A). Idemitsu Alaska obtained the original permit for the area in 1991, but the permit was transferred to Usibelli Coal Mine (UCM) in 1997. UCM satisfied 5-year permit renewal requirements in 2001 and 2006 and is currently seeking to complete the next renewal. Because the mine will involve a coal production and processing plant, the renewal of the mining permit depends on obtaining an air quality permit as well. This is discussed in detail in section 5.

The proposed development focuses on a 6 million ton coal reserve identified in Mine Areas 1 and 2. (Map 2, Appendix B). UCM estimates that Mine Areas 1 and 2 could produce 500,000 tons of coal annually for approximately 12 years.

Since 2010, UCM has undertaken a feasibility study that examines development of Mine Area 1 and 2. Feasibility work included an exploration trail to facilitate confirmation drilling for geology and coal quality. The feasibility study analyzes transportation options (including a proposed test shipment from Point MacKenzie), permit updates, and additional environmental data collection. UCM plans to extract coal from the mining areas using conventional truck and excavator mining techniques.

1.2 Legal, Administrative and Legislative Requirements for Health Impact Assessment (HIA)

The State of Alaska does not require a formal HIA, but has developed a specific resource document entitled "Technical Guidance for Health Impact Assessment (HIA) in Alaska".[1] The WHM HIA utilizes the overall strategies and methodologies described in the Alaska HIA technical guidance.

1.3 Project Requirement for HIA

As a "best practices" approach to responsible natural resources development, the Alaska Department of Natural Resources (DNR) consulted with the Alaska Department of Health and Social Services (ADHSS) HIA Program. The ADHSS HIA program has developed this HIA for the WHM. The HIA is not required for permitting. The HIA does not have statutory power to (i) require additional data collection or (ii) write permit stipulations.

1.4 HIA Framework and Methodology

1.4.1 HIA Definition

Health impact assessment is a combination of procedures, methods and tools by which a policy, program, or project may be judged as to its potential effects on the health of a population, and the distribution of those effects within the population.

1.4.2 HIA Methods

As presented in the July 2011 Alaska "Technical Guidance for Health Impact Assessment,"[1] the WHM HIA will:

- Provide a formal mechanism to engage the relevant stakeholders and key regulatory decision makers;
- Review proposed project specifics;
- Review the physical and general environmental setting of the proposed project;
- Identify potentially affected communities (PACs);
- Analyze the sufficiency of baseline health;
- Select key health impacts using both a set of defined health effects categories (HECs) and input from stakeholder meetings;
- Conduct qualitative impact rating and ranking analysis; and,
- Propose a series of recommendations tied to potential impacts.

1.4.3 HIA Type

An HIA can be a short desktop exercise that takes an expert practitioner less than 2 weeks to prepare, a rapid assessment that takes several months, or a comprehensive report that requires a year or more to complete (see below). Each type involves different approaches to baseline data collection and stakeholder engagement. The type of HIA chosen by the practitioner depends on a variety of factors including the type of project, the timeframe available for HIA completion, and the resources available for performing the HIA.

1.4.3.1 Desktop HIA

The desktop HIA is a qualitative assessment and is most appropriate for projects with few anticipated health impacts. The HIA team often does not pursue extensive stakeholder engagement although some involvement is usually required. The desktop HIA is useful for determining whether a more detailed review is needed. From a State of Alaska perspective, a desktop HIA doubles as a screening exercise and it can reveal the need for further work.

1.4.3.2 Rapid Appraisal HIA

A rapid appraisal HIA is considered to be a site-specific HIA that uses available health information *without* conducting new field survey work. Data sources may include peer-reviewed scientific literature, health department databases and tribal health service data sources. A rapid appraisal HIA may evolve into a comprehensive HIA.

1.4.3.3 Comprehensive HIA

The hallmark of the comprehensive HIA is collection of new data, to address important data gaps identified during the scoping process. A comprehensive HIA also pursues extensive stakeholder engagement. A comprehensive HIA may be appropriate for projects that involve:

- Resettlement of existing communities;
- Significant population influx;
- Major disruption of subsistence practices;
- Major impacts to key social determinants of health; and,
- Information gaps related to a well-known aspect of a project.

The WHM HIA utilizes a rapid appraisal strategy. WHM is a renewal of an existing permitted mining lease and the HIA was performed within a restricted time frame, which precluded extensive field study. This HIA identifies potential project impacts, positive or negative, in a timely fashion for decision makers and stakeholders. The rapid appraisal HIA strategy is fully capable of identifying potentially critical impacts and data gaps. Data gaps may be informational, temporal, spatial or related to the quality of existing information. The identification of a “data gap” does not automatically imply that fieldwork is either recommended or must be performed.

A major goal of this HIA is to accurately inform decision makers and stakeholders regarding potential impacts based on the current set of available data. The HIA identifies the areas where additional data, including field investigation, would enhance the analysis.

1.4.4 HIA Scope

This HIA reviews the proposed WHM based on the following information:

- Permit application materials submitted by the project proponent, Usibelli Coal Mine (UCM);
    - 2014 Alaska Department of Environmental Conservation (DEC) review and technical analysis of the UCM Minor Air Permit application
    - 2014 Alaska DNR regulatory and data review of WHM ground water and surface water information conducted for UCM
- Comments and issues raised during focus groups and public consultation meetings held by the relevant State of Alaska agencies including, ADNR, Alaska Department of Environmental Conservation (ADEC), and ADHSS; and,
- General parameters developed by the July 2011 “Alaska Technical Guidance for Health Impact Assessment”.

1.4.4.1 Areas outside the scope of the HIA

The study does not address classic occupational health concerns (e.g., physical hazards or environmental hazards encountered by workers), which are referred to as ‘inside the fence’ and are addressed by federally mandated health and safety protocols enforced by the Occupational Safety and Health Administration (OSHA) and the Mining Safety and Health Administration (MSHA).

This study cannot fully address features of the project that are not clearly defined by UCM or the permitting documents, such as potential coal transport via the rail belt and the use of ports for coal shipment, even though these are discussed briefly in the HIA.

1.4.5 Health Effect Categories (HECs)

The Alaska HECs, shown below in Table 1, are a standard set of effects categories that have been developed and discussed in the July 2011, "Technical Guidance for Health Impact Assessment (HIA) in Alaska."[1]

Table 1 Health Effects Categories

Health Effects Category	Pathway Description
Social Determinants of Health (SDH)	The SDH are the conditions in which people are born, grow, live, work and age. These circumstances are shaped by the distribution of money, power, access, and resources at global, national, state, regional, and local levels. The SDH are mostly responsible for health inequities -- the unfair and avoidable differences in health status seen within and between countries. This category reviews outcomes and determinants related to mental health, maternal and child health, substance use, social exclusion, psychosocial distress, historical trauma, family dynamics, economic status, educational status, social support systems, and employment status.
Accidents and Injuries	This category contains health outcomes and determinants related to accidents and injuries. The key outcomes considered are increases and decreases in intentional and unintentional injuries with fatal and nonfatal results. The key determinants in this category include items such as the presence of law enforcement, traffic patterns, alcohol involvement, distance to emergency services, and the presence of prevention programs.
Exposure to potentially hazardous materials	This category contains health outcomes and determinants that may arise from exposure to hazardous materials. The key health outcomes considered are increases and decreases in documented illnesses or exacerbation of illnesses commonly associated with pollutants of potential concern. These may be mediated through inhalation, ingestion, or physical contact.
Food, Nutrition, and Subsistence Activity	This category includes health outcomes and determinants related to food security, dietary choices, and the consumption of subsistence foods. The key health outcomes considered are nutrient levels, malnutrition

	or improvements in nutrient intake, and the subsequent increases or decreases in related diseases. The key determinants include diet composition, food security, and the consumption of subsistence foods.
Infectious Disease	This category includes health outcomes and determinants that result from infectious diseases. The key health outcomes include rates of increase or decrease for a range of infectious diseases, such as sexually transmitted infections (STI), respiratory illness, or skin infections. Important health determinants may include immunization rates, and the presence of infectious disease prevention efforts.
Water and Sanitation	This category includes changes to access, quantity, and quality of water supplies. Key determinants reviewed may include distance to clean water, water fluoridation, indoor plumbing, water treatment facilities, adequate volume of water resources, and the existence of community facilities, such as a washeteria and/or community.
Non-communicable and Chronic Diseases	This category includes health outcomes and determinants related to chronic disease. Important outcomes include increases or decreases in mortality and morbidity rates of cancer, cardiovascular and cerebrovascular diseases, diabetes, respiratory diseases, and mental health disorders. Key determinants for chronic diseases may include smoking rates, rates of alcohol and drug abuse, physical activity levels, presence of recreation centers, as well as cancer screening rates.
Health Services Infrastructure and Capacity	This category considers health outcomes and determinants related to health care access and health care infrastructure. Important outcomes include the increase or decrease in the number of medical evacuations, clinics or hospital visit trends, health expenditures, and medication usage. Health determinants may include distance to health facilities, medevac facilities/aircraft, the presence of community health aides, and the frequency of physician visits to the area.

HECs have been developed to identify the full spectrum of possible health impacts related to a specific project. The HEC approach includes all of the biomedical and social concerns originally developed by key international health and development agencies, i.e., the World Health Organization (WHO) and the World Bank Group. In general, while each HEC may not be relevant for a given project, it is still important to systematically analyze the potential for project related impacts (positive, negative or neutral) by careful consideration of each HEC.

1.5 Stakeholder Engagement

The ADHSS HIA program organized and participated in multiple community listening sessions for WHM. The HIA team has reviewed the written notes associated with community meetings held by the relevant State of Alaska agencies. Written comments submitted by the public and reviewed by state agencies (e.g., ADEC air permit regulators) have also been reviewed. A separate section (Section 3.0) details and categorizes the available stakeholder comments regarding human health concerns and the WHM.

2.0 PLACE, PERSONS, PROJECT

2.1 The Place-Proposed Wishbone Hill Project Location and Environs

2.1.1 Coal History in the Matanuska

Coal lands in the Matanuska area were opened by the Federal government for lease in 1916. Access into the Matanuska Coal Fields was completed in 1917, but the route ascending Moose Creek was not finished for another 6 years. The Wishbone Hill area was the focus of intensive coal mining activity in the years following 1917. The legacy of this activity was apparent as late as 1981 in the form of structures and heavy equipment associated with several coal mines in the project area. Three mines operated there: Premier (Alaska Heritage Resource Survey site number ANC-475), Buffalo (ANC-439) and Baxter (ANC-476). The Baxter Mine was one of the earliest in the area, with the commencement of coal shipments in 1917. Coal was mined predominantly in the winter months so that it could be sledded to the main Matanuska Branch of the Alaska Railroad. A narrow-gauge spur ascending Moose Creek reached this operation in October of 1923[2]. The first mining operation at the Premier Mine began in 1922. There has been no active, full-scale mining in the Wishbone Hill area since 1983.[3]

2.1.2 Physical Features

The proposed Permit Area is located in Cook Inlet Basin, which covers approximately 38,000 square miles in south-central Alaska. Technically, Cook Inlet Basin belongs to the subarctic climate category, but the actual climate zones range from maritime to continental near WHM.

The Project area experiences weather similar to communities in the Cook Inlet area. Data from the Alaska Climate Research Center for 1971-2000 indicates an annual mean temperature of 36°F with an average of 62.9 inches of snowfall and 15.8 inches of accumulated precipitation annually. The air quality section below discusses wind patterns near WHM.

The WHM area is a topographic upland within the lower Matanuska Valley, and a broad valley drained by tributaries of Moose and Eska Creeks separates WHM from the Talkeetna Mountains. The northern boundary features a sharp drop-off from maximum elevation of 1,050 feet to the bed of Moose Creek at 920 feet at the northeast edge of the property and 820 feet at the northwest corner. The southern portion is flanked by a broad sand and gravel glacial outwash approximately 700 to 800 feet in altitude. The main Wishbone Hill upland is underlain by gravelly, sandy loam glacial till. Buffalo Creek is the main drainage way on the upland and is narrow and generally without bordering lowland areas. Farther south out to the Glenn Highway the topography is complex including a sinuous system of high eskers and dry basins or kettles.[3]

2.1.3 Flora and Fauna

The project area supports a mixed upland forest interspersed with previously disturbed lands. Large trees include birch, poplar, aspen, and cottonwood mixed with conifers, mainly spruces. Paper birch and quaking aspen mark the dry eskers and kames. Ground cover in the parklands and mixed forest consists predominantly of fireweed, cow parsnip, high bush cranberry, blueberry and grasses. Well-drained hillocks and ridges often possess smaller berry-producing plants, such as low bush cranberry, bunchberry, and crowberry. Poorly drained zones include numerous sedges, grasses, and cotton grass.

At least 134 species of birds, fourteen species of fish and twenty-eight species of mammals are presently known to inhabit the general vicinity.[4] The most important mammal species in the project area include moose, black bear, and some fur bearers. Fish known to be present in Moose Creek include Chinook salmon, Coho salmon, Dolly Varden and Rainbow trout. The bird species most commonly taken for food include the three species of ptarmigan and spruce grouse. The most important subsistence food resources obtained from this region over time have been moose and salmon.

2.1.4 Soil

Detailed discussion is presented in section 4.5.1.

2.1.5 Water Bodies in the Project Area

The proposed Permit Area occupies approximately 2.5 square miles in the southern portion of the Moose Creek watershed. The study area includes the entirety of Buffalo Creek. Detailed discussion is presented in Chapter 4.

2.1.5.1 Water Use

Some surface waters in the Cook Inlet Basin currently provide a salmon fishery resource, and are suitable for recreation. Surface water also provides a drinking and irrigation water source for single family homes and small farms. There are 8 existing water permits in the project area (4 springs and 4 drilled wells). The water rights search area contains no known water supply intakes. No supply intakes for current users of surface water were found.

Groundwater resources in and near the proposed Permit Area are limited. Minor quantities of groundwater exist in sedimentary, igneous and metamorphic bedrock underlying the area, but potential well yields from bedrock are expected to be less than 10 gallons per minute except in areas where the bedrock permeability is enhanced by fracturing or faulting. Groundwater also exists in saturated glacial sediments overlying bedrock. These sediments are highly variable in permeability but are generally expected to yield less than 10 gallons per minute. Glacial sediments often provide adequate well yields for domestic use. Detailed discussion regarding hydrology is presented in Chapter 4.

2.1.5.2 Water Quality

Detailed discussion is presented in Chapter 4.

2.1.6 Air Quality

The Mat-Su Borough is classified by the Alaska Department of Environmental Conservation (ADEC) as a Class II P.S.D (Prevention of Significant Deterioration) area, which is considered to be clean air.[5] Few significant sources of air pollution exist in the area. Naturally occurring blowing dust occurs as "Matanuska Winds" pick up glacial sediment from the Matanuska and Knik River floodplains. Dust may occur in any season, especially when high winds correspond with a lack of snow cover. Typically, several air quality alerts are issued per year by ADEC because of wind-blown dust events. Detailed discussion of air quality is presented in Chapters 4 and 5.

2.1.7 Land Use in the Project Area

Private residences exist within ¼ mile of the permit boundary. Additional residential units exist within ½ to 1 mile from the final footprint of active mining in Mine Area 1. Local residents utilize portions of the Wishbone Hill area for commercial and personal use timber harvesting, commercial firewood sales, and Christmas tree cutting. The Division of Forestry regulates these activities and has previously constructed a series of roads and trails to transport forest products from the area. In addition to mining and forest management, the public also uses the Wishbone Hill area for recreation. Popular activities include target shooting, four-wheeling, snowmobiling, large and small game hunting, dog sledding, hiking, biking, and skiing. On some of the private holdings west of the Wishbone Hill area, the land has been subdivided and used for either recreational summer cabins or residential dwellings. Local residents also use the area for harvesting subsistence resources and maintaining cultural traditions.

2.2 Potentially Affected Communities

The Alaska HIA Toolkit defines a potentially affected community (PAC) as an area, community, or village where project-related health impacts may reasonably be expected to occur.[1] This study refers to four zones created while considering distance from mine operations and movement of materials. (See Maps 5 and 6 and Table 2):

- Zone 1 -communities within 5km (3 miles) of mine site 1;
- Zone 2- communities approximately 5-10km (3-6 miles) from the mine;
- Zone 3- communities along the transportation route (e.g., path of the coal trucks); and,
- Zone 4 communities within 5km (3 miles) of Point MacKenzie.

Table 2 Zones for Wishbone Hill Coal Mine Project PACs

Community	Zone
Buffalo/Soapstone Community	1
Sutton-Alpine[a]	2
Farm Loop	2
Fishhook	2
Palmer	3
Wasilla	3
Knik-Fairview	4
Point MacKenzie	4

[a]Includes the Chickaloon Traditional Village residential area (see section 2.5.1.1 below)

2.3 Community Profiles

Community profile information was obtained from the Alaska Division of Community and Regional Affairs: Alaska Community Database, Custom Data Queries and Alaska Community Database Community Information Summaries (CIS); and the Alaska Department of Labor and Workforce Development, Research and Analysis Chapter, Alaska Local & Regional Information (Workforce Information).

2.3.1 Matanuska-Susitna Borough

The Matanuska-Susitna (Mat-Su) Borough encompasses 24,681.5 square miles of land and 578.3 square miles of water. Ahtna and Dena'ina Athabascans have lived in this region for centuries. Athabascans were traditionally nomadic in nature and were known as hunters and gatherers, living on moose and caribou, plants, berries, and fish. The population of the region boomed in the 1920s with the boom on coal production in the area. Coal development in Chickaloon was halted in 1925, and the land reverted to public domain. Homesteaders, who led an agricultural lifestyle, settled the Matanuska Valley in the 1930s. Construction of the statewide road system and the productive farmlands fueled early population growth.

Although the borough covers 24,681.5 square miles of land, 90% of its residents live in "the Valley," a small corridor between the communities of Sutton on the Glenn Highway and Willow on the Parks Highway. Incorporated communities located within the borough include Houston, Palmer, and Wasilla. Unincorporated communities include: Big Lake, Buffalo Soapstone, Butte, Chase, Chickaloon, Farm Loop, Fishhook, Gateway, Glacier View, Knik River, Knik-Fairview, Lake Louise, Lakes, Lazy Mountain, Meadow Lakes, Petersville, Point MacKenzie, Skwentna, Susitna, Sutton-Alpine, Talkeetna, Tanaina, Trapper Creek, and Willow.

2.3.2 Mat-Su Demographics

According to Census 2010, 88,995 people reside in the Mat-Su Borough, an increase of 50% compared with the 2000 US Census and over 100% compared with the 1990 census. The increase reported for the Mat-Su between the 2000 and 2010 was the largest population gain in the state.

The Mat-Su hosts a less diverse population than the rest of the state.

Table 3 Racial Composition of the Mat-Su Population

Race	Percentage of Total Population (%)
White	84.9
Native American or Alaska Native	5.5
Hispanic	3.7
Asian	1.2
African-American	1.0
Pacific Islander	0.2%

Source: US Census, 2010

Over 6% of the local residents had multi-racial backgrounds. The percentage of Alaska Natives in the borough is much lower than the state as a whole (Table 4). The median age of the Mat-Su area's population is 34.8 years, one year older than the statewide median age and nearly four years older than the area's median age in 1999. The age breakdown of its population is similar to the state average, as is the ratio of males to females.

Table 4 Primary Place of Work and Wages, Matanuska-Susitna Borough Residents, 2008

Work Location	Number of workers living in the Mat-Su Borough[a]	Percent of workers from the Mat-Su Borough (%)	Wages
Matanuska-Susitna Borough	20,665	55	$543,926,149
Anchorage Municipality	12,192	32	$553,470,946
North Slope Borough	2,858	8	$222,468,891

Source: Alaska Department of Labor and Workforce Development, Research and Analysis Section (as presented in Alaska Economic Trends December, 2010
[a]Excludes uniformed military, federal, and self-employed workers, 2008

2.3.3 Housing

The 2010 Census reports a total of 41,329 housing units in the borough, 31,824 of which were occupied. The raw vacancy rate appears high because 6,823 of the 9,505 vacant units are seasonal, recreational, or occasional use homes. When these housing units are removed from the analysis, the true vacancy rate is 3.3%. The State Department of Labor and Workforce Development (DLWD) describes the Mat-Su

Borough as a bedroom community - a place where people live while working elsewhere.[6] According to DLWD data (which exclude federal, uniformed military, and self-employed workers), nearly one third of the Mat-Su Borough's residents work in Anchorage. In both 2000 and 2008, 45% of Mat-Su residents commuted beyond borough boundaries. However, DLWD notes that between 2005 and 2008 workers began taking jobs farther from their home of record. For example, the number of commuters that worked on the North Slope doubled between 2005 and 2008, which reflects the Mat-Su area's role as home to a large share of the state's oil industry workforce. In fact, the borough supplies the second-largest group of oil industry workers to the North Slope, after Anchorage. Commuters favor the borough because it offers a competitive housing market and the state's largest labor market (Anchorage) is within reasonable driving distance for most residents.

According to Alaska Economic Trends, in 2010, the average sale price of a single-family home in the area was $239,572, three-quarters of the price of an average priced single-family home in Anchorage ($318,896), and below the statewide average price of $277,941. This price difference attracts those who desire close proximity to Anchorage at a lower cost.

2.3.4 Employment and Income (see Table 13)

Mat-Su supports a diverse economy that employs residents in a variety of retail, professional, and government occupations. Top employers are Mat-Su schools, Valley Hospital, Wal-Mart, Carrs/Safeway, and Fred Meyer. There are 44 schools located in the borough, attended by 17,079 students. In 2010, 300 borough residents held commercial fish permits. The eastern portion of the Mat-Su Borough has a long history of mining and mining related activities.

The average annual salary in the Mat-Su area in 2009 was $36,492, nearly $13,000 less than in Anchorage. Workers can earn higher wages on the North Slope and elsewhere in Alaska. The Mat-Su Borough's wages tend to be lower due to the prevalence of retail and service jobs. Higher paying jobs in the valley include health care, construction, and information technology occupations. Lower paying jobs include retail trade, leisure and hospitality jobs. In 2008, Mat-Su residents earned more of their wages in Anchorage than they did at home, i.e., 61% of all earnings came from outside the borough. About 8.6% of all residents had incomes below the poverty level. The 2009 poverty guideline for a single person living in Alaska was $13,530.

2.4 Zone 1- 5 Km (3 miles) from the WHM

2.4.1 Buffalo Soapstone

The Buffalo Soapstone community is located on Buffalo Mine Road and Soapstone Road, directly north of Palmer and Farm Loop, west of the Glenn Highway and northwest of the proposed Wishbone Hill Coal Mine. According to the 2010 US Census, 855 people lived in Buffalo Soapstone. Its population was predominantly white and older than the state as a whole (Table 5). This area was not separately counted in the 1990 census but reported almost 700 people in the 2000 census. Census 2010 reports that there were 375 housing units in the community, 314 of which were occupied. About three-quarters of households have individual wells and septic systems. There are no schools or medical facilities and few businesses in Buffalo/Soapstone as most residents commute to Palmer, Wasilla, or Anchorage for these services. Detailed economic data for this community is available in Chapter 4.

2.5 Zone 2- approximately 5-10 Km (3-6 miles) from the WHM

2.5.1 Sutton-Alpine

Sutton-Alpine lies between mile markers 52 and 72 of the Glenn Highway, 11 miles northeast of Palmer and contains the site of the mine access road to the Glenn Highway. The area is accessed by Chickaloon Way and Jonesville Road and the Glenn Highway. There is a public gravel airstrip at the Jonesville Mine.

Sutton was founded around 1918 as a station on the Matanuska branch of the Alaska Railroad for coal export purposes. The railroad passed through Sutton to reach the Chickaloon Mine. The Sutton Coal Washery operated from 1920 to 1922. Sutton also served as the base camp for Glenn Highway road construction from 1941 to 1945. Coal from the privately owned Evan Jones, Jonesville, and Eska mines fueled the Sutton and Palmer economies until 1968, when the military bases in Anchorage converted their power systems to oil, and coal mining ceased.

During the 1980s, several large tracts of land were subdivided, fueling growth in and around the community. The 2010 US Census reported that 1,447 people lived in Sutton Alpine. Its population was 16.8% American Indian or Alaska Native and 69.8% white. The Chickaloon Native Village is included in the Sutton Alpine census counts because the majority of their residential area, Tribal offices, and community facilities are located in the community. Almost 68% of the Sutton Alpine community is male, significantly higher than the 52% in the borough and the state as a whole (Table 5).

2.5.1.1 The Chickaloon Village Traditional Council

Ahtna and Dena'ina Athabascans have lived in this region for the past 10,000 years. Athabascans were traditionally nomadic in nature and were known as hunters and gatherers, living on moose and caribou, plants, berries, and fish. Chickaloon Native Village is an Ahtna Athabascan tribe located in Sutton. Chickaloon Native Village has been impacted by natural resource development since the 1900s. The Tribe's lands have been impacted by mining, logging, and the construction of the Glenn Highway and the railroad. Impacts from this development, in addition to the introduction of new diseases and the mandatory boarding school educational system in the 1930s-1950s, have threatened the Tribe and their cultural and spiritual traditions. The Chickaloon Village Traditional Council was re-established in 1973 to reassert the Tribe's identity and cultural traditions.[7]

The Chickaloon Alaska Native Village Statistical Area (ANVSA) includes almost one-third of the Mat-Su Borough, including the communities of Glacier View, Chickaloon, Sutton, Palmer, and Butte along the Matanuska River. The 2010 U.S. Census reported that over 23,000 persons lived in the Chickaloon ANVSA of whom almost 1,400 are either American Indian or Alaska Native. The Chickaloon Village Traditional Council (CVTC) is federally and internationally recognized as a traditional sovereign government with a nine member traditional council that is the governing body for the Tribe, Chickaloon Native Village. The Chickaloon land includes areas within the community of Sutton Alpine, close to the Zone 2 border on the southeast of the proposed mine, and continues 17 miles northeast of Sutton along the Glenn Highway to the town of Chickaloon. The majority of the demographic information about the Chickaloon people who live in the Sutton area (Zone 2) is presented in the Sutton Community Description, above. The town of Chickaloon lies 17 miles northeast of the Permit Area and is not included in any of the zones.

Table 5 Social Determinants of Health of Potentially Affected Communities, Population and Demographics, 2000 and 2010 Census

Community	Total Population 2000	Total Population 2010	Male Population (%)	White Population (%)	Alaska Native Population (%)	Median Age
United States	281,421,906	308,745,538	49.2	72.4	1.7	38.5
Alaska	626,932	710,231	52	66.7	19.5	33.8
Mat-Su Borough	59,322	88,995	51.7	84.9	5.5	34.8
Zone 1						
Buffalo/Soapstone	699	855	52.2	84.1	3.3	37.6
Zone 2						
Sutton-Alpine[a]	1,080	1,447	67.2	69.8	16.8	37.9
Farm Loop	1,067	1,028	49.7	88.8	4.2	40.3
Fishhook	2,030	4,679	51.1	87.5	3.6	34.3
Zone 3						
Palmer	4,533	5,937	49.5	79.1	9.2	30.1
Wasilla	5,469	7,831	49.8	83.4	5.2	32.2
Zone 4						
Knik Fairview	7,049	14,923	51.6	84.3	5.3	31.2
Point MacKenzie	111	529	76.2	67.7	23.3	32.8

Source: US Census 2000, 2010
[a]Includes the Chickaloon Traditional Village residential area

Chickaloon Village Traditional Council maintains offices in Sutton Alpine and employs local residents. The Chickaloon tribally owned school, *Ya Ne Dah Ah* (Ancient Teachings), is a public school that is located in Sutton to the east of Moose Creek and accepts students from all backgrounds. The tribe also owns and operates "*C'eyiits' Hnax*" or "Life House" Health Clinic in Sutton. The local stores, lodges, restaurant, library, post office, and school also provide employment. The Palmer/Wasilla area and Anchorage offer a variety of employment opportunities. The Chickaloon Alpine Historical Park features relics and historic buildings from the coal washery. In 2009, three residents held commercial fishing permits. Detailed economic data for this community is available in Chapter 4.

2.5.2 Farm Loop

Farm Loop is an unincorporated residential area located in the center of the Matanuska Valley, about 42 miles northeast of Anchorage, off the Glenn Highway. It is just north of Palmer, off of Farm Loop Road and Willow-Fishhook Road and northwest of the proposed mine site.

According to Census 2010, there were 1,028 residents of Farm Loop (Table 5). Its population was predominately white and older than the rest of the borough and the state. The census reported 394 housing units in the community; 361 homes were occupied. The majority of homes have individual wells and septic systems. Local hospitals or health clinics include Valley Hospital in Palmer or Anchorage hospitals.

There are several businesses in the Farm Loop area; many residents are employed in Palmer, Wasilla, or Anchorage. Detailed economic data for this community is available in Chapter 4.

2.5.3 Fishhook

Fishhook is northwest of Palmer and north of Lakes and Farm Loop. The George Parks Highway, Glenn Highway, and other local roads connect the area to Anchorage, the remainder of the state, and Canada. There are ten private airstrips in the vicinity.

Fishhook is a relatively large unincorporated area of 4,679 residents (more than double from the 2000 census figure of 2,030), according to the 2010 Census. Its population was predominantly white and approximately the same median age as the borough and the state as a whole (Table 5). According to Census 2010, there were 1,734 housing units in the community, 1,591 of which were reportedly occupied. The majority of homes have individual wells and septic systems. There are some private piped systems. Students are bused to Palmer and Wasilla schools.

While there are several small businesses in the area, many residents are employed in Palmer, Wasilla, or Anchorage in a myriad of retail and other services and city, borough, state, and federal government employment. Independence Mine Historic Park and Hatcher Pass have the highest visitor rate of any destination in the valley. Detailed economic data for this community is available in Chapter 4.

2.6 Zone 3- Transportation Corridor (Map 6)

2.6.1 Palmer

Palmer is an incorporated city located in the center of the Matanuska Valley, 42 miles northeast of Anchorage on the Glenn Highway. The area encompasses 3.8 square miles of land and 0.0 square miles of water. In addition to surface transportation on the Glenn Highway, the Palmer Municipal Airport supports private and chartered services with two paved airstrips. There are several privately owned airstrips in the vicinity.

Palmer has shown steady population growth for the last 20 years and according to Census 2010, there were 5,937 residents in Palmer. Palmer has an unusual history in that in 1935, the Federal Emergency Relief Administration planned an agricultural colony in Alaska. Two hundred and three (203) families, mostly from Michigan, Wisconsin, and Minnesota, were invited to join the colony. Although the failure rate was high, many of their descendants still live in the Mat-Su Valley and the population is predominantly white (79.1%) with 9.2% American Indian or Alaska Native. The median age of the population is lower than the borough and the state (Table 5).

According to the 2010 Census, there were 2,281 housing units in the community, 2,113 of which were reportedly occupied. Water is provided by three deep wells and is treated and stored in a million-gallon reservoir. Sewage is collected by pipe and treated in an aerated lagoon facility. All homes are completely plumbed.

Many residents commute to Anchorage for employment. Palmer's economy is based on a variety of retail and other services and city, borough, state, and federal government. Some light manufacturing occurs. In 2009, 74 residents held commercial fishing permits. The University of Alaska has an Agricultural and Forestry Experiment Station Office and a district Cooperative Extension Service office here. The university's Matanuska Research Farm is also located in Palmer. Detailed economic data for this community is available in Chapter 4.

2.6.2 Wasilla

Wasilla is an incorporated community located midway between the Matanuska and Susitna Valleys on the George Parks Highway. The area encompasses 11.7 sq. miles of land and 0.7 sq. miles of water. The Alaska Railroad serves Wasilla on the Fairbanks-to-Seward route. A city airport, with a paved airstrip, provides scheduled commuter and air taxi services. Float-planes land at Wasilla Lake, Jacobsen Lake, and Lake Lucille. There are numerous additional private airstrips in the vicinity.

The US Census reported that 7,831 people lived in Wasilla in 2010. Its population was predominately white (83.4%) with 5.2% American Indian or Alaska Native. Residents of Wasilla are also slightly younger than the borough and the state as a whole (Table 5). According to Census 2010, there were 3,277 housing units in the community, 2,962 of which were occupied. The majority of homes use individual water wells and septic systems, although the city operates a piped water and sewer system. Water is provided by 3 wells; there is a 2.3 million gallon storage capacity. There are 20 schools located in Wasilla, attended by 10,250 students. Local hospitals include the Mat-Su Valley Regional Hospital Emergency Services have limited highway marine coastal floatplane and helicopter access and are within 30 minutes of a higher-level satellite health care facility.

Approximately 30% of the Wasilla workforce commutes to Anchorage. The local economy is diverse, and residents are employed in a variety of government, retail, and professional service positions. Tourism, agriculture, wood products, and steel and concrete products are part of the economy. In 2010, 177 area residents held commercial fishing permits. Wasilla is the home of the Iditarod Trail Committee and Iron Dog Race. Detailed economic data for this community is available in Chapter 4.

2.7 Zone 4- Communities within 5 km of Point Mackenzie (Port)

2.7.1 Knik-Fairview

Knik-Fairview, an unincorporated community, is located on the northwest bank of the Knik Arm of Cook Inlet, 37 road miles northwest of Anchorage in the Mat-Su Borough. It lies south of Wasilla, Big Lake, and Meadow Lakes, off of Knik-Goose Bay (KGB) Road and Fairview Loop Road on the route to Port Point Mackenzie. KGB Road connects to the Parks Highway and provides road access to Wasilla and Anchorage. There are several private airstrips in the area.

According to the US 2010 Census, 14,923 people lived in Knik-Fairview, more than double the population reported in the 2000 census (7,049), which was significantly larger than the population reported in the 1990 census of 272 people. Its population was 5.3% American Indian or Alaska Native and 84.3% white. The Knik Tribe, a federally recognized tribe, is located in the community. There are more males in the community than females. The median age of community residents was 31.2 year.

According to Census 2010, there were 5,535 housing units in the community and 5,040 were occupied Low housing costs, the semi-rural lifestyle, and a tolerable commute to Anchorage have all supported growth in the area. Most households use individual water wells and septic systems and are fully plumbed. There are several privately-operated piped systems. There are 3 schools located in the community, attended by 1,280 students. High-school students are bused to Wasilla. Local hospitals or health clinics include Valley Hospital in Palmer or Anchorage hospitals. Emergency Services have highway coastal and helicopter access and are within 30 minutes of a higher-level satellite health care facility. Emergency service is provided by volunteers. Auxiliary health care is provided by Valley Hospital in Palmer or Anchorage hospitals.

Most residents are employed in Palmer, Wasilla, or Anchorage in a variety of retail, services, city, borough, state, or federal government positions. Knik is a check-point for the Iditarod Sled Dog Race and is called the "Dog Mushing Center of the World."

2.7.2 Point MacKenzie

Point MacKenzie is located between the south shore of Knik Arm of Cook Inlet and the Little Susitna River on Point MacKenzie Road. Point MacKenzie Road is accessible from Knik Road and the George Parks Highway. A variety of transportation means are available from Wasilla, Palmer, and Anchorage. A private airstrip is located in the area. The Point MacKenzie Industrial Port is a deep-draft port, which may be used to transport the coal to market.

According to Census 2010, 529 people lived in Point MacKenzie. Its population was 23.3 % American Indian or Alaska Native and 67.7% white. There were significantly more males in the community than females and a low ratio of workers to non-workers (dependency ratio) (Table 5).

The census also reported 257 housing units in the community, 112 of which were occupied. Most year-round homes have individual water wells and septic systems, with complete plumbing. Others haul water and use outhouses. There are no schools in Point Mackenzie; students are bused to schools in Wasilla. Local hospitals or health clinics include Valley Hospital in Palmer or Anchorage hospitals. Auxiliary health care is provided by Mat-Su Borough Fire/EMS Valley Hospital in Palmer or Anchorage hospitals.

Many residents are employed in Palmer, Wasilla, or Anchorage. The Port MacKenzie dock is currently being used to ship 5-star energy-rated modular homes constructed by Alaska Manufacturing Contractors LLC to rural villages. Detailed economic data for this community is available in Chapter 4.

2.8 Environmental Justice

On February 11, 1994, President Clinton issued Executive Order 12898, *Federal Actions to Address Environmental Justice in Minority and Low-Income Populations.* The purpose of the order is to avoid the disproportionate placement of adverse environmental, economic, social, or health effects from federal actions and policies on minority and low-income populations. The first step in analyzing this issue is to identify minority and low-income populations that might be affected by implementation of the proposed action or alternatives. Demographic information on ethnicity, race, and economic status is provided in this chapter as the baseline against which potential effects can be identified and analyzed.

2.9 Identification of Minority and Low Income Populations

The Council on Environmental Quality (CEQ)[8] identifies groups as low income or minority populations when either (1) the minority or low-income population of the affected area exceeds 50% or (2) the minority or low-income population percentage in the affected area is meaningfully greater than the minority population percentage in the general population or appropriate unit of geographical analysis. In order to be classified meaningfully greater, a formula describes an environmental justice threshold of 10% above the State of Alaska percentage of for local minority and low-income persons. For purposes of this Chapter, minority and low-income populations are defined as follows:

- *Minority populations* are persons of Hispanic or Latino origin of any race, Blacks or African Americans, American Indians or Alaska Natives, Asians, and Native Hawaiian and other Pacific Islanders as reported in the 2010 US Census
- *Low-income populations* are persons living below the poverty level as reported by the American Community Survey for 2009.

Estimates of these two populations were developed to determine if environmental justice populations exist in the PAC, as presented below (Table 6).

Table 6 Environmental Justice Status of Potentially Affected Communities

Community	Total Population 2010	Percent Minority Population 2010 (%)	Percent of People below Poverty Limit 2009 (%)
State of Alaska	710,231	35.9	9.6
Zone 1			
Buffalo/Soapstone	855	16.3	2.2
Zone 2			
Sutton-Alpine[a]	1,447	32.2	14.6
Farm Loop	1,028	11.9	8.0
Fishhook	4,679	14.0	4.3
Zone 3			
Palmer	5,937	23.6	14.4
Wasilla	7,831	18.7	14.2
Zone 4			
Knik Fairview	14,923	19.8	7.9
Point MacKenzie	529	34.4	0.0

Source: US Census for Alaska, 2010
2009 American Community Survey 2005-2009 5-year estimates
[a]Includes the Chickaloon Traditional Village residential area

Overall, none of the potentially affected communities meet either of the criteria. That is, none of these communities have minority or low-income populations that make up 50% of the population and none of the communities have a minority or low-income population percentage that is at least 10% higher than the percentage of these populations in the State of Alaska.

2.10 Project Description

The proposed WHM is a surface coal mine and is a part of the Wishbone Hill Coal District (Maps 1-3 Appendices A-C), which is one of the four coal districts of the Matanuska Coal Field. UCM has submitted two surface coal mining permit renewal requests to the DNR, Division of Mining, Land & Water for the proposed mine, and ancillary facilities near the reserve area. UCM states:

> "Although all of the mining components are encompassed in one logical permit area, two application forms have been submitted to facilitate agency review of the coastal zone management requirements. Permit Application No. 01-89-796 includes those portions of the project lying in Township 19 North, Range 2 East, while Permit Application No. 02-89-796 addresses the initial segment of the project access road that lies in Section 1, Township 18 North, Range 2 East (Map 2 and 2011 Renewal Applications for Permit Numbers 01-89-796 & 02-89-796[3]).

The Alaska Surface Coal Mining Control and Reclamation Act requires that all surface coal mining and reclamation operations that will disturb more than two acres obtain a Surface Mining Permit from the Department of Natural Resources (DNR) prior to initiation of the operation. DNR states:

> "The purpose of the permit is to assure that the mining operation and reclamation practices are consistent with the performance standards set forth in the Act and its regulations; that the rights of surface owners and others with an interest in the property are protected; that appropriate procedures for incorporating public participation are provided; and that a proper balance exists between the protection of the environment and the development of the State's coals resources."[3]

The WHM has been permitted since 1992 following exploration that began in 1983. UCM has renewed the mining permits every 5 years. UCM last renewed these permits in 2006 and the permits are set to expire on November 27, 2011. Landowners in the permitted area include the State of Alaska Mental Health Trust, and Cook Inlet Region Inc. (CIRI). The access road from the mine site to the Glenn Highway is located on lands owned by the Mat-Su Borough. The majority of the proposed WHM is comprised of two coal leases (i.e., rental agreements) UCM purchased from the state in 1997. In other words the proposed WHM includes land leased by UCM from the State of Alaska, the Mat-Su Borough, as well as from private landowners. UCM owns 2 parcels (150 and 8.5 acres) that have no developments or improvements.

The Wishbone Hill Coal District is approximately 2 miles wide and 8 miles long and takes its name from the prominent rock capped hill that occupies its central part. This district has the greatest coal development potential of the four districts because of its relatively simple structure, good coal quality, close location to existing infrastructure, and surface mineable reserves. The Wishbone Hill District has produced more coal than all the other districts combined as a result of these attributes. It has a resource of 40-50 million tons of low-sulfur bituminous coal (~25 million tons proven). Multiple potential mining operations exist within the district. The existing permits held by UCM in the district

(01-89-796 and 02-89-796) cover 7334 acres and allow for a mining rate up to 1.5 million tons per year but the current plan is to mine approximately 500,000 tons per year.

To date, UCM has drilled/excavated approximately 330 exploration and development holes in the project areas 1 and 2. Through this work, a surface mineable reserve of high quality bituminous coal has been defined.

Coal will be mined from two surface mining areas using conventional truck-shovel mining techniques. The basic sequence of mining will be as follows:

1. Timber salvage and clearing
2. Topsoil removal and stockpiling
3. Overburden removal
4. Coal removal
5. Backfilling with overburden
6. Topsoil replacement
7. Revegetation

2.11 Infrastructure and Linear Features

The proposed WHM is planned as a surface mine at the western boundary of the Wishbone Hill coal district on the southwestern extent of Wishbone Hill. Wishbone Hill is a synclinal structure (i.e., a fold in rocks in which the rock layers dip inward from both sides toward the axis) bisected by several major transverse and low angle thrust faults.

The initial project activity will be construction of the mine access road. Because this property is owned by Mat-Su borough, UCM has received permission to begin construction and as of the writing of this document, road construction is underway. Once the access road is complete and if the final permit renewal is granted, construction of mine facilities could begin.

Topsoil and overburden removal operations will begin in Mine Area 1 with the removal of vegetative cover followed by topsoil removal using dozers, scrapers, or trucks. Once all topsoil has been salvaged from an area, overburden removal activities will begin. Initial overburden removal is not expected to require blasting; however, blasting will be required to remove the lower overburden units. Coal removal will occur following blasting of the coal seam. UCM will transport coal from the pit area to the wash plant for stockpiling or direct feed into the wash plant. After the coal has been excavated, UCM will backfill the pits concurrently with mining operations.

UCM estimates that the Life of Mine is 15 years for Mine Area 1 and Mine Area 2, which includes:

- 18 months: construction of mine facilities to service Mine Areas 1 and 2
- 8-10 years: Operation
    - 4-5 years: Mine Area 1, working from east to west
    - 4-5 years: Mine Area 2, working from west to east
- Closure and contemporaneous reclamation, which is planned within 1 year following the end of mining to dismantle the facilities and a 10 year monitoring period.

2.12 Mine Facilities

UCM reports the mine facilities to include a wash station, overburden and top soil mounds, sediment ponds and a slurry pond. They plan to divert drainage from all disturbed areas to seven sediment basins (ponds) located throughout the permitted mine area. UCM states that the sediment basins will primarily make use of the numerous natural depressions present on site and suggests these basins will not substantially change the surface water runoff patterns existing prior to mining. In addition, UCM reports that a slurry pond will be constructed in a natural depression adjacent to and south of the plant site for disposal of the fine coal refuse. The slurry pond will be designed with 759 acre feet of available storage. Slurry from the plant will be piped to the slurry pond. UCM will also locate a wash down water recycle pond adjacent to the facilities area sediment pond, northwest of the plant site. The wash down water recycle pond will collect equipment-washing water from the maintenance area. As described by UCM in the permit renewal applications, the wash down water will first be collected in a sump in the maintenance building where a skimmer will be used to remove oil, grease and solvents from the water. The water will then be piped to the wash down water recycle pond. UCM states that the wash down water recycle pond will be lined with 60 mil HDPE liner to prevent seepage of the wash down water into the underlying gravels and allow recycling of the water. In addition, they plan to place a one-foot thick layer of compacted native soils over the liner for protection from winter conditions.[3]

DNR requires all coal mine operators to submit a reclamation bond (i.e., debt security) before initiating mining in order to ensure that reclamation is accomplished. The bond must be large enough to allow the state to reclaim the site themselves should an operator fail to do so. UCM has already posted a bond in the amount of $29,910 to cover the predevelopment work that was completed in 2010. They have submitted a new reclamation cost estimate for the first five years of mining using current rates and price quotes with their renewal application (see Table 7).

Table 7 Bond Amounts by Year

Year	Amount
0 (Predevelopment)	$29,910
1	$7,707,780
2	$7,813,811
3	$11,140,449
4	$38,198,209
5	$55,332,611

Upon satisfaction of bond obligations, the state of Alaska will grant final bond release for Mine Area 1 in year 15 to 20 and in year 20 to 25 for Mine Area 2. According to the Wishbone Hill ASMCRA permit (Part D, Operation and Reclamation Plan, 2011), reclamation will be designed to reestablish moose habitat and strengthen multiple use (recreation) on the Moose Range.

2.12.1 Blasting

UCM estimates up to 360 controlled blasts per year. The Division of Mining and Water Management has detailed guidance regarding blasting. According to 11 AAC 90.375 PUBLIC NOTICE OF BLASTING, section (d), the operator shall conduct blasting operations at times approved by the commissioner and announced in the blasting schedule. The commissioner will, in the commissioner's discretion, based on the need to protect the public, limit blasting by hours per day, times per day, number of blasts per day, or specific areas.

Alaska Fish and Game (ADF&G) standards limit blast strength to avoid impact to nearby fish populations. In Part D of the permit, UCM outlines a specific blasting plan to minimize impacts to nearby residents that includes, (i) pre-blast notification; (ii) no charge pre-blast surveys (if requested) for homeowners and (iii) restricted work hours, i.e., UCM will not normally work at night. Rob Brown, UCM (oral communication August 22, 2011) stated that the local geology and geography will produce significant natural noise attenuation.

2.12.2 Land Transportation Corridor

The Mat-Su Borough has approved construction of an access road to the mine facilities. The access road enters the Glenn Highway at approximately mile marker 55.5. The Chickaloon Traditional Village has a school at mile marker 56 on the Glenn Highway. The access road is downhill and 1,200 feet west of the school. Trucks will travel on the Glenn Highway and use the Parks Highway interchange to arrive in in Wasilla. Coal trucks will then turn left on the Knik Goose Bay Road and travel to Point MacKenzie to offload coal at the port. As stipulated by the UCM land lease issued by the Mat-Su Borough in 2010, all trucks will be covered/tarped before they leave the site and wheel hubs and tires will be washed just before entering the Glenn Highway.

UCM will contract 12 highway-legal tandem trucks that will travel exclusively on federal and state highways (Figure 1). Each truck will, on average, make 3 round trips per day (36 round trips) from the mine area to the port at Point MacKenzie during a 12-hour nighttime shift (Table 8), 6 days a week for 50 weeks per year. Each truckload will carry 45 tons of coal.

Figure 1 Tandem Truck Example

2.12.3 Hours of Operation

UCM plans to operate the mine 5 days a week year round utilizing two 8-hour shifts. At present they do not plan to operate a midnight (grave yard) shift; however, UCM acknowledges that demand may alter operational plans. All submitted permit materials are based on continuous operations (see Chapter 7). UCM estimates that the mine will employ 75-125 people from the local community. Employment/shift levels at various phases of the mine are outlined in Table 8 below.

Table 8 Employment/Shift Levels of Mine Phases

	Number of 8 Hour Shifts	Number of Workers
Construction	2	20-40 contract workers
Operation		
Mine Area 1	2	40-50 miners
Mine Area 2	2	80-90 miners

Source: UCM, Oral Communication, August 22, 2011

According to UCM, predominantly local staff from Sutton/Palmer area will be hired. Perhaps 8 to 10 skilled technical and managerial staff may be hired from other locations in Alaska. UCM does not anticipate influx of non-resident workers for mine employment.

3.0 STAKEHOLDER ENGAGEMENT

3.1 Scoping Overview: Public Issues and Concerns

HIA uses a process known as “scoping” to obtain enough data and stakeholder input to identify the most important potential health impacts related to a project. Scoping can retrieve data through formal public health surveillance reports, census reports, socioeconomic studies, and cultural reports. The scoping process also includes the input of local residents who will experience the impacts of a potential project. Depending on the regulatory and geographical context, stakeholder input may be gathered by a variety of acceptable methods that include formal public scoping meetings, submission of written comments, or more informally in a small focus group format. In some cases, the HIA will employ all of these methods in a variety of formats.

Because the WHM HIA was completed within a limited timeframe, the HIA program gathered input through a series of focus groups and invited written comments (Table 9). This process generated a lengthy list of potential benefits and concerns from stakeholders who are both opposed to and in favor of the mine (Table 10).

The ADNR provided the HIA Program a list of the community council leaders in the areas surrounding the proposed project. The HIA program initiated contact through a phone call and/or an email and requested community council leaders to assemble a small group (<10 people) of community members to give their input about the proposed mine. The HIA program responded to requests from other groups to hold meetings not already planned for the project and encouraged community leaders and advocacy groups to notify their constituents of the opportunity to meet or send written comments.

The focus group meetings were held in a variety of settings and used an open format with a brief introduction to the purpose and process of conducting an HIA, followed by a session for questions and comments. Comments in writing were also accepted after the meetings. Community council members were encouraged to notify their constituents of the HIA program’s email address and website and the HIA program welcomed their health concerns and responded as promptly as possible. New issues from each meeting and from emails were added to Table 10 below. A list of health issues was also accepted from the Chickaloon Village Traditional Council that expresses their concerns (Table 11, cover letter in Appendix C).

Table 9 Focus Group Meetings: Locations, Dates, and Times

Date	Time	Meeting	Location
August 3, 2011	4:00pm-6:00pm	Dr. Prevost/Dr. Benedetti	Palmer, AK
August 3, 2011	6:00pm-8:00pm	Buffalo/Soapstone Focus Group	Home of Dr. Prevost and Dr. Benedetti, Buffalo Mine Road
August 3, 2011	10:00am-12:00pm	Chickaloon Focus Group	Home of Warren Keogh, Chickaloon
August 3, 2011[a]	1:00pm-3:00pm	Members of Castle Mountain Coalition	Chickaloon Tribal Council Building, Sutton
August 10, 2011[a]	11:00am-4:00pm	Chickaloon Village Traditional Council-HIA Introductory Meeting	Chickaloon Tribal Council Building, Sutton
August 10, 2011[a]	6:00pm-8:30pm	Sutton Focus Group	Alpine Inn, Sutton
September 15, 2011	1:00pm-3:00pm	Chickaloon Village Traditional Council-Elders luncheon	Chickaloon Tribal Council Building, Sutton

[a]Meetings were recorded

Table 10 provides a record of the scoping activities for the HIA identification of potential health impacts. Public issues and concerns are summarized by the health effect categories (HECs) described in the HIA Toolkit[1].

Table 10 Public Issues and Concerns Identified in Scoping Meetings and Internet Search

Health Effects Category	Health Concern	Contact
Social Determinants of Health (SDH)	Emotional distress from destruction of natural setting and rural way of life	Chickaloon Focus Group
	Severe mental despair and depression from thinking about the potential impacts of the mine	Chickaloon Focus Group
	Psychological distress from worrying about increased contaminants and poisons in the water	Chickaloon Focus Group
	Psychological distress over potential loss of natural habitat for subsistence species (i.e., moose and salmon)	Chickaloon Focus Group
	Psychological distress that causes lack of sleep, and a sense of “no control”	Chickaloon Focus Group
	Psychological distress over the potential for increased traffic accidents and poor highway conditions during due to coal trucks	Chickaloon Focus Group
	Psychological distress over fears that cumulative developments will facilitate increased vandalism, vagrancy, and trespassing on private property	Chickaloon Focus Group
	Psychological distress from fears that the political process will continue to marginalize local concerns	Chickaloon Focus Group
	Severe emotional distress about possibly being displaced (having to move) if the mine permit is granted, loss of financial equity, and the loss of a place to live	Chickaloon Focus Group
	Psychological distress over fears that coal trucks will degrade the experience of those who travel the Glenn Highway, which is a National Scenic Byway, which would harm tourism	Castle Mountain Coalition
	Psychosocial distress and conflict due to community polarization over the mine	Castle Mountain Coalition
	Concern over outmigration of professionals and	Castle Mountain Coalition

	highly educated community members who are opposed to the mine	
	People with PTSD, particularly in the prison, will experience worsened illness due to blasting events at the mine	Castle Mountain Coalition
	Anxiety that the mine will affect the quality and quantity of subsistence resources	Chickaloon Focus Group
	Stress of being displaced; and the ensuing loss of social support and community networks; will also create loss of the individual to the community	Castle Mountain Coalition
	Psychological distress because of fear over decreased property values for homes adjacent to a coal mine and the inability to sell property if forced to move	Buffalo Mine/Soapstone Focus Group
	Psychological distress from blasting and living near industrial noise	Buffalo Mine/Soapstone Focus Group
	Psychological stress of having windows blown out from blasting	Prevost/Benedetti
	Psychological distress that of the mine will affect the well being of cancer survivors who need to avoid stress to remain healthy	Buffalo Mine/Soapstone Focus Group
	Psychological distress from fears that residents will be exposed to unacceptable noise levels for a rural community	Prevost/Benedetti
	Psychological distress from fears that noise from the mine will cause difficulty sleeping	Buffalo Mine/Soapstone Focus Group
	Anxiety over the loss of the lands, rivers, and streams that surround Wishbone Hill and are sacred to the Chickaloon people. Anxiety over threats to potlatch ceremonies and spiritual lives. Need for recognition of religious and spiritual connections to land and its resources.	Chickaloon Village Traditional Council (in complaint filed with the Organization for Economic Cooperation and Development)
	Psychological distress from fears that open pit mining would contaminate local drinking water sources as well as rivers, streams, and groundwater that support salmon, moose, and other animals and plants vital for subsistence, religious and cultural practices	Chickaloon Village Traditional Council (in complaint filed with the UN Independent Expert on Human Rights)
	Lost income leads to an increase in health problems because of high stress levels and decreased access to	Sutton Focus Group

	health insurance	
	The community is now very polarized and cannot properly function (breakdown in community cohesion)	Sutton Focus Group
	The coal mine helped build a volunteer fire department, a community center, etc. If the coal mine is not permitted the community would lose the opportunity for positive development of the community	Sutton Focus Group
	Permitting the mine would be beneficial because the community had a sense of pride when there was coal mining	Sutton Focus Group
	Permitting the coal mine would bring back a sense of social connectedness for the community of Sutton	Sutton Focus Group
	Permitting the coal mine would allow local employers to hire more people	Sutton Focus Group
	Permitting the mine would increase employment and reduce the number of people facing food shortages due to financial constraints. (If more people are employed, less people will go without meals)	Sutton Focus Group
	Permitting the coal mine would benefit the community's economy, employment levels, and educational resources for children	Sutton Focus Group
	Permitting the mine would bring more teachers and students to the school and the school would thrive	Sutton Focus Group
	Permitting the mine would strengthen the sense of community and if the community is strengthened, there will be productive things for children to do	Sutton Focus Group
	Psychological distress from the loss of benefits if the mine is not permitted. Significant stress that the mine might not go through	Sutton Focus Group
	Psychological distress that if the mine does not go through, people will lose their homes	Sutton Focus Group
	Social benefits from the belief that if there are jobs in the community, parents can stay home to raise their families and live a more fulfilling life (i.e., not commuting)	Sutton Focus Group

	Entire families will see benefits from there being a source of income and stability in the community	Sutton Focus Group
	The potential of earning an income gives people something to strive for and decreases apathy	Sutton Focus Group
	People will have money to buy things and won't have to steal it (Reduced crime)	Sutton Focus Group
	Everyone will be able to get a job that wants one (Reduced unemployment)	Sutton Focus Group
	Stress and fatigue from commuting would be relieved if employed closer to home (decreased exposure to long commute times and hazards)	Sutton Focus Group
	Family stress would be lessened if employment was closer to home and income was stable (Increased family stability)	Sutton Focus Group
	The job base has dried up and the mine would bring opportunities back (increased employment)	Sutton Focus Group
	Many people have had to move from area or are considering moving and the mine would enable people to remain in the community (Increase in community cohesion)	Sutton Focus Group
Accidents and Injuries	Increased accidents and injuries on the roadway for residents, motorcyclists, commuters, and tourists	Chickaloon Focus Group
	The highway is already too narrow for semi trucks, adding more will increase the amount of accidents	Chickaloon Focus Group
	There will be more opportunity for intrusions; increased risk of injuries due to conflicts over personal property	Chickaloon Focus Group
	Debris from crushing and washing will be carried into the residential area by high winds	Prevost/Benedetti
	Blasting will cause property damage	Prevost/Benedetti
	Dust will interfere with airplanes at the Palmer Airport	Buffalo Mine/Soapstone Focus Group
	If a coal seam fire or a coal pile fire were to occur, it	Buffalo Mine/Soapstone

	could reach neighborhoods and cause injury, property damage	Focus Group
	Mine and mine access would be close to residences.	Groundtruth Trekking
	Mine haul road is 100 yards from the traditional council's tribal school, Ya Ne Dah Ah School, prompting safety concerns for students	Chickaloon Village Traditional Council (in complaint filed with the Organization for Economic Cooperation and Development)
	There will be fewer highway accidents/deaths of community members if people are employed closer to home	Sutton Focus Group
Exposure to Potentially Hazardous Materials	Concern that baseline levels of contaminants will become higher	Chickaloon Focus Group
	Coal dust is dirty and seeps in everywhere causing many opportunities for exposure	Chickaloon Focus Group
	Southern prevailing winds may bring coal dust to Chickaloon	Chickaloon Focus Group
	If coal is handed out for home heating, there will be more people exposed to coal	Castle Mountain Coalition
	Acid drainage may contaminate local water sources; hydrology information is needed	Castle Mountain Coalition
	Slurry ponds will contaminate the watershed	Castle Mountain Coalition
	If the watershed is contaminated, residents may not know that their drinking water has excess levels of contaminants until they have already been exposed	Prevost/Benedetti
	In the event of an earthquake, or other cause of pond failure, heavy metals from the slurry ponds will be released into the watershed	Buffalo Mine/Soapstone Focus Group
	Global use of coal will cause pollution of fish and large animals in Alaska and the more that Alaska exports coal, the more Alaska will see those effects	Castle Mountain Coalition
	Those in prisons will have forced exposure to local hazards because they are a captive population	Castle Mountain Coalition

	Those attending youth/Bible camps will have unwitting exposure to local hazards due to the coal mine	Castle Mountain Coalition
	High winds will bring fugitive coal dust from the mine site to the residential area and other surrounding communities	Buffalo Mine/Soapstone Focus Group
	The mine will increase levels of $PM_{2.5}$ via fugitive dust, which is of particular concern for respiratory and cardiovascular health	Prevost/Benedetti
	Lead, mercury, and chemicals used to clean the coal will be brought into the community via fugitive dust and leaching into the watershed	Prevost/Benedetti
	The mine will not be able to control high levels of dust and other toxins from the coal or mining process, which could affect the entire surrounding communities	Prevost/Benedetti
	Trucks and ancillary mine equipment will generate significant amounts of air pollution from dust and diesel fuel/exhaust	Prevost/Benedetti
	Dust would clog domestic air filter systems	Buffalo Mine/Soapstone Focus Group
	Coal fires, in underground seams or in the stockpiles, would be a source of air pollution	Buffalo Mine/Soapstone Focus Group
	Coal dust is a fine powder form of coal, which is created by the crushing, grinding, or pulverizing of coal. Because of the brittle nature of coal, coal dust can be created during mining, transportation, or by mechanically handling coal. Particulate Matter, the vast majority of dust from mining consists of course particulate matter that can be breathed in. Chronic inhalation of coal dust is associated with pulmonary disease, bronchitis, decreased pulmonary function, and	Alaska Coal
	Emphysema. Inhalation of coal dust can permanently damage lung tissue. Children, people with chronic illnesses, and the elderly are particularly vulnerable, according to Alaska Community Action on Toxics.	
	Coal mining of any kind can release large amounts of methane from coal seams. Coal mining can	Groundtruth Trekking

	contribute to acid mine drainage	
	Coal dust with its associated negative effects will be impossible to control in the Mat Valley winds	Castle Mountain Coalition
	Water and air will be returned cleaner than it was before mine	Sutton Focus Group
Food, Nutrition, and Subsistence Activity	There will be a negative change in the quality of subsistence foods	Chickaloon Focus Group
	There will be changes to competition of resources as hunters/berry pickers are displaced and move up the valley	Chickaloon Focus Group
	Access to local food sources (organic/CSAs) will be limited because their crops will be tainted	Chickaloon Focus Group
	Salmon will disappear from the streams due to loss of critical habitat	Chickaloon Focus Group
	There will be a loss of habitat for the moose in the area	Chickaloon Focus Group
	There will be a decrease in available subsistence foods because more hunters/gatherers will have to use a smaller area	Chickaloon Focus Group
	Coal combustion in Asia is having a major impact on Alaska's wild fisheries in the form of mercury pollution and ocean acidification	Castle Mountain Coalition
	Mine will threaten the recently restored King salmon run on Moose Creek.	Castle Mountain Coalition
	Open pit mining would contaminate local drinking water sources as well as rivers, streams, and groundwater that support salmon, moose, and other animals and plants vital for subsistence, religious and cultural practices	Chickaloon Village Traditional Council (in complaint filed with the UN Independent Expert on Human Rights)
	There will be increased food security if more people are employed as a result of the mine	Sutton Focus Group
	More moose will die because of additional vehicles on the mine access road and the highway	Chickaloon Village Traditional Council
	Moose will migrate away from the region due to	Chickaloon Village

	blasting, vehicle traffic, and additional noise	Traditional Council
	Blasting will negatively affect salmon eggs and juvenile salmon	Chickaloon Village Traditional Council
Infectious Disease	There will be an influx of pests and disease vectors not seen in the arctic due to coal induced climate change	Castle Mountain Coalition
Water and Sanitation	The watershed will be contaminated from the slurry ponds	Prevost/Benedetti
	Arsenic levels 10,000 times the EPA action level are anticipated based on research in other coal mining areas of the nation	Prevost/Benedetti
	Watershed/Aquifers will be significantly changed and people may not be able to have access to water due to decreased availability	Prevost/Benedetti
	The streams will become contaminated	Chickaloon Focus Group
	Blasting and ground surface removal would create ground water impacts	Alaska Center for the Environment
	Blasting will cause contaminated or failed wells	Michele Prevost
	Open pit mining would contaminate local drinking water sources as well as rivers, streams, and groundwater that support salmon, moose, and other animals and plants vital for subsistence, religious and cultural practices	Chickaloon Village Traditional Council (in complaint filed with the UN Independent Expert on Human Rights)
	Water from mine will be returned to the streams cleaner than it was before the mine	Sutton Focus Group
	Unlined settling ponds mean that toxic water is leaving the mine site. This will cause water quality contamination of surface and ground water.	Chickaloon Village Traditional Council
	The chemical composition of the coal will likely lead to an alkaline water quality in settling ponds, which causes leaching of arsenic into the water.	Chickaloon Village Traditional Council
	Residential wells and Palmer Correctional Center wells will be contaminated by toxic water leaching	Chickaloon Village Traditional Council

	out of unlined slurry ponds.	
Non-communicable and Chronic Diseases	Childhood asthma will be increased for those who grow up near the mine	Castle Mountain Coalition
	Birth defects will be increased due to coal mining	Castle Mountain Coalition
	If coal is handed out for home heating, there will be an increased risk of respiratory disease	Castle Mountain Coalition
	Chronic bronchitis is already prevalent	Buffalo Mine/Soapstone Focus Group
	Exposure to coal dust will affect cardiovascular health	Buffalo Mine/Soapstone Focus Group
	Living near a coal mine markedly increases heart, lung, kidney disease and the death rate for adjacent communities	Michele Prevost
	Coal and coal mining related toxins are associated with cancer and other chronic illnesses	Michele Prevost
Health Services Infrastructure and Capacity	Access to medical care in the Mat-Su borough will be impacted because medical professionals will leave the area, which would decrease available resources.	Prevost/Benedetti
	Mines create jobs, which will allow more people to have access to health insurance and more people can seek medical care	Sutton Focus Group

Table 11 Health Issues and Concerns Identified by Chickaloon Village Traditional Council

Health Effects Category	Health Concern	Contact
Social Determinants of Health (SDH)	Distress and fear of being attacked verbally or physically due to racism/racial discrimination over opposition of coal mine.	Chickaloon Village Traditional Council
	Anxiety over the loss of the lands, rivers, and streams that surround Wishbone Hill and are sacred to the Chickaloon people. Anxiety over threats to potlatch ceremonies and spiritual lives. Need for recognition of religious and spiritual connections to land and its resources.	Chickaloon Village Traditional Council (in complaint filed with the Organization for Economic Cooperation and Development)
	Psychological distress from fears that open pit mining would contaminate local drinking water sources as well as rivers, streams, and groundwater that support salmon, moose, and other animals and plants vital for subsistence, religious and cultural practices	Chickaloon Village Traditional Council (in complaint filed with the UN Independent Expert on Human Rights)
	Psychological distress related to the proposed coal mine permitting process and proposed mining activities will cause a lack of productivity at work. It also leads to illness, which may result in a loss of income. The loss in income results in a decrease in health status. Lowering one's income has a direct impact on their health status.	Chickaloon Village Traditional Council
	The community is now very polarized and Tribal citizens and staff are being subjected to ongoing prejudice and racism in the community while attempting to access local businesses or public facilities.	Chickaloon Village Traditional Council
	Changes in community due to polarization is distressing and negatively impacting families and family structures (husbands disagreeing with wives, fathers disagreeing with sons and daughters, etc.)	Chickaloon Village Traditional Council
	The coal mine will result in a loss of experienced fire/rescue/and EMT volunteers, as several volunteers will likely move if the mine goes in. The result will be an increase in distress for community members regarding the lack of emergency services. Additionally the reduction in trained personnel will result in increased cost to the Mat-Su	Chickaloon Village Traditional Council

	Borough to train and recruit new volunteers.	
	Permitting the coal mine and later mining will lead to community challenges attracting innovative entrepreneurs and young couples to Sutton as there will be a negative stigma on the community. It will be compared to other impoverished coal communities like those in Virginia, Tennessee, and Pennsylvania.	Chickaloon Village Traditional Council
	Permitting the coal mine and later mining would create a social disconnect as many members of the community, will move away to protect the health of their families.	Chickaloon Village Traditional Council
	Permitting the coal mine and later mining would deter eco-friendly businesses from locating in the community resulting in no new hire of sustainable jobs.	Chickaloon Village Traditional Council
	The jobs affiliated with the mine will be hazardous to the health of the workers and their families. The community health status will decrease as workers of the mine get sick and bring an increased medical burden into the community.	Chickaloon Village Traditional Council
	Increase medical burden in coal mining families will lead to increased familial distress as families cope with illness. (Loss of income/negative coping strategies [alcohol/substance use]/domestic violence/sexual abuse/child abuse/ etc.)	Chickaloon Village Traditional Council
	Permitting the coal mine and later mining will result in the reduction of social programs in the community providing food and services to Elders.	Chickaloon Village Traditional Council
	Permitting the coal mine and later mining will risk our children's ability to learn about their environment and the cultural and spiritual connection to the areas near their school.	Chickaloon Village Traditional Council
	Permitting the coal mine and later mining would decrease the number of qualified teachers who would want to work in or near a coal mining town, or move to a coal mining town, resulting in a lower quality education for our children.	Chickaloon Village Traditional Council
	This coal mine permit process and potential mine is exacerbating generational post-traumatic stress disorder in our community.	Chickaloon Village Traditional Council

This coal mine permit process and potential mine is exacerbating anxiety and other mood disorders in our community.	Chickaloon Village Traditional Council
The proposed blasting will increase instances of post-traumatic stress disorder.	Chickaloon Village Traditional Council
This coal mine permit process and potential mine is exacerbating diagnosable depression in our community.	Chickaloon Village Traditional Council
The coal mine permit process and potential mine is increasing the rate of alcohol consumption and substance abuse in our community.	Chickaloon Village Traditional Council
This coal mine permit process and potential mine is increasing the rate of diagnosable obsessive-compulsive disorders in our community.	Chickaloon Village Traditional Council
There has been noted psychological distress due to the fact that if the mine does go through, people will be forced to move to protect their families and yet also lose their ancestral homes.	Chickaloon Village Traditional Council
The sense of instability in the community is growing. There is a loss of faith and confidence in state and local government and a marginalization happening, which is negatively affecting one ethnic group disproportionately.	Chickaloon Village Traditional Council
Permitting the coal mine and later mining will result in increased driving anxiety for all; however, the youth and elderly will be most negatively impacted.	Chickaloon Village Traditional Council
As with other noted coal communities, the proposed coal industry will increase alcohol and substance abuse rates in the community, which will ultimately result in an increase in crime/theft/domestic violence/sexual abuse/child abuse/etc.	Chickaloon Village Traditional Council
Increased incidents of stress, fatigue, and road rage will occur as a result of having to traverse the Glenn Highway and alternate routes with the increased traffic flow and slow-moving coal trucks.	Chickaloon Village Traditional Council
The proposed coal mine will negatively impact the second largest employer in the area resulting in a loss of services to the community.	Chickaloon Village Traditional Council

	Palmer Correctional Center inmates are in close proximity to the mine site and do not have the option to move away from the mine. This will result in undue stress on inmates and prison staff.	Chickaloon Village Traditional Council
	The mine site and mine access routes are close to Tribal low income housing, again negatively affecting one ethnic group disproportionately.	Chickaloon Village Traditional Council
	Stress regarding the potential mine footprint getting larger, increased likelihood that adjacent mines will initiate operations, and potential taking of private lands that have coal underneath. This could be the private lands on Wishbone Hill - where Tribal Citizens own land, as well as across Moose Creek	Chickaloon Village Traditional Council
Accidents and Injuries	Increased accidents and injuries on the roadway for Emergency Medical/Rescue/Fire Services to respond to timely.	Chickaloon Village Traditional Council
	Increased risk for Emergency Medical/Rescue/Fire Service personnel responding to road accidents and local fires.	Chickaloon Village Traditional Council
	Increased risk for accidents due to higher probability of earthquakes caused by mining activities on the Castle Mountain Fault.	Chickaloon Village Traditional Council
	The proposed mine haul road is 100 yards from the traditional council's Tribal school, the Ya Ne Dah Ah School, prompting safety concerns for students and staff commuting to school from Palmer.	Chickaloon Village Traditional Council (in complaint filed with the Organization for Economic Cooperation and Development)
Exposure to Potentially Hazardous Materials	Water from washing tires of trucks (as mandated by the Mat-Su Borough) will deplete the water table and enter into the aquifers introducing toxins into Moose Creek, the Matanuska River, as well as contaminating local wells.	Chickaloon Village Traditional Council
	The proposed mine will require the transportation of large quantities of hazardous materials such as diesel fuel and oils for their equipment. Spills and leaks will expose the	Chickaloon Village Traditional Council

	community to health hazards.	
Food, Nutrition, and Subsistence Activity	Subsistence foods like Deniigi (Moose) will abort/desert their young and migrate away from distress due to blasting activities. Luk'ae (Salmon) eggs will be destroyed and Luk'ae adults will be displaced by blasting as well.	Chickaloon Village Traditional Council
	Open pit mining would contaminate local drinking water sources as well as rivers, streams, and groundwater that support salmon, moose, and other animals and plants vital for subsistence, religious and cultural practices.	Chickaloon Village Traditional Council (in complaint filed with the UN Independent Expert on Human Rights)
	There will be decreased food security and increased pressure on families due to the lack of subsistence foods.	Chickaloon Village Traditional Council
	Open pit mining would contaminate local drinking water sources as well as rivers, streams, and groundwater that support salmon, moose, and other animals and plants vital for subsistence, religious and cultural practices	Chickaloon Village Traditional Council (in complaint filed with the UN Independent Expert on Human Rights)
Non-communicable and Chronic Diseases	Diabetes rates will increase due to dietary changes from not having access to subsistence foods.	Chickaloon Village Traditional Council
	High blood pressure, stroke, and rates of heart disease will increase due to increases in stress and other environmental exposures.	Chickaloon Village Traditional Council
	Coal mining and coal transportation will increase respiratory distress and disease in the community for children and adults.	Chickaloon Village Traditional Council
Health Services Infrastructure and Capacity	The only community health center between Wasilla to Glennallen may be in jeopardy of closing if the proposed mine goes in due to staff relocation.	Chickaloon Village Traditional Council

	The increase in road traffic will make it more difficult to get to Mat-Su Regional Hospital, as the community health clinic hours are only Mon-Fri (8:00 – 4:00).	Chickaloon Village Traditional Council

3.2 Summary

The WHM HIA stakeholder engagement process yielded a broad spectrum of concerns, comments, and viewpoints. It is important to distinguish the stakeholder engagement process from a formal comment and response process. The HIA stakeholder engagement process occurs before there is a completed HIA document to determine the perceived health impacts of the proposed project from the community's perspective.

Formal comment and response periods, on the other hand, occur after a draft document has been prepared and released to the public. The goal of formal comment and response periods is to adequately address individual concerns about a document or proposal that has been released for public review.

The following sections are an attempt to summarize the feedback from the stakeholder engagement process according to health effect category (HEC).

3.3 Social Determinants of Health

A large number of stakeholder comments focused on issues that belong to the social determinants of health category. Many stakeholders expressed their experience of psychological distress (e.g., anxiety, fear, and uncertainty) regarding a wide variety of current and anticipated negative changes to their economic, social, cultural, and spiritual environment if the proposed mine was developed. Other stakeholders also expressed their experience of continued psychological distress if the mine was not permitted and the concurrent loss of the economic and social opportunities from development. This category received the largest number of comments and occupied a major portion of each meeting.

3.4 Accidents and Injuries

A large number of stakeholder concerns focused on issues in the accidents and injuries health effect category. By far, the most prominent concern related to increased injuries/fatalities from truck traffic related accidents during coal transport. Some stakeholders articulated that commuter traffic would be reduced if they could work closer to home and this could reduce commuting related accidents due to fatigue while driving.

3.5 Exposure to Hazardous Materials

A large number of stakeholder concerns related to issues in the Exposure to Hazardous Materials category. Stakeholders repeatedly raised a wide spectrum of concerns that focused on the potential for public exposure to coal dust, coal tailings, grey water, and other sources of mine toxicants through air, water, soil, and deposition. Stakeholders frequently cited extremely high winds in the region ("Matanuska Winds") that heightened these concerns, as well as uncertainty about wastewater management in the area (i.e., unlined settling ponds, pit-lakes, etc.). Noise and flyrock from blasting, noise from mining machinery as well as light from project facilities were also common concerns.

3.6 Food, Nutrition, and Subsistence

Stakeholders raised concerns about how the proposed mine might affect issues that belong to the Food, Nutrition, and Subsistence category. Most comments can be summarized as concerns about how the proposed mining activities could negatively affect the quantity and quality of subsistence wildlife and plant life through possible negative changes to local habitat. Stakeholders identified subsistence resources as an important food source, cultural component, and spiritual entity.

3.7 Infectious Diseases

Few stakeholders raised concerns related to the infectious disease health effect category. Some were concerned that Wishbone Hill coal would be mined, then transported to Asia, where it would be burned, and produce greenhouse gasses that would contribute to warmer temperatures in the Arctic. Warmer temperatures could then result in the northern migration of arthropod vectors for vector borne diseases (e.g., West Nile virus and Lyme disease) in Alaska.

3.8 Chronic Diseases

There were a handful of written comments related to the chronic diseases health effect category that were derived from concerns related to other categories. Most comments focused on concerns about exacerbation of chronic respiratory diseases from coal dust, the chronic health effects of psychosocial distress, potential decreases in air and water quality, and changes in the availability of subsistence foods.

3.9 Water and Sanitation

There were also a few comments related to the water and sanitation health effect category and these focused on concerns over changes in water quantity (e.g., the sustainability of private wells) and changes in water quality from contamination events previously raised in the hazardous materials category.

3.10 Health Services Infrastructure and Capacity

Comments related to the Health Services Infrastructure and Capacity category focused on concerns over staff shortfalls (e.g., from professional outmigration) and possible challenges to health care access due to increases in roadway traffic from commercial vehicles related to the mine. Some indicated that new jobs would allow increased access to health care for the 70-100 individuals employed at the mine and their families.

4.0 BASELINE CONDITIONS

4.1 Introduction and Background

Baseline health conditions form a fundamental context for the overall health impact assessment (HIA) process. The baseline health summary creates a point of reference for the health status of a community prior to development of a proposed project and also describes an overall health profile for an area. The health profile can inform decision makers about health vulnerabilities in a region as well as positive health traits present in a population. Decision-makers can use their knowledge about the features of a project and the health profile of a region to better consider health in their deliberations.

For Alaska, baseline health information resides in public health surveillance systems maintained by the State of Alaska, the Alaska Native Tribal Health Consortium (ANTHC) and occasionally local borough and tribal entities. This chapter focuses on a review of existing public health surveillance data. The WHM HIA reports all personal health information (PHI) according to the requirements of the Health Insurance Portability and Privacy Act of 1996 (HIPPA). The HIA program approach to PHI is detailed in the HIA Toolkit, Chapter 6.[1]

Alaska public health agencies routinely report public health surveillance data at the statewide or regional level. These agencies do not report village or community-level data to avoid privacy violations (e.g., stigmatization) and problems with statistical analysis when case numbers are small. In general, the State of Alaska does not release disaggregated results for small numbers (e.g., <6). As a result, the information in this baseline summary represents the entire Mat-Su borough and does not report community level data.

Many rural Alaskan communities contain a high percentage of Alaska Natives and these communities may occasionally track health information in a centralized computerized database. Permission from tribal communities is required to access these records. Personal Health Information (PHI) is strictly protected by HIPPA. The Anchorage Service Unit of the Southcentral Foundation serves the Chickaloon Traditional Village; specific health data, as presented below, is taken from the Alaska Native Health Status Report 2009, Alaska Native Epidemiology Center, Alaska Native Tribal Health Consortium.[9]

4.2 Sources of Information

- Alaska Native Regional Health Status Reports (ANTHC)
- State of Alaska Department of Labor (AK DOL)
- 2000 and 2010 U.S. Census
- U.S. Census Bureau, American Community Surveys 2005-2009
- Alaska Bureau of Vital Statistics (ABVS)
- Alaska Behavioral Risk Factor Surveillance Survey (BRFSS)
- Alaska Department of Health and Social Services, Section of Epidemiology
- Alaska Trauma Registry (ATR)
- Alaska Department of Health and Social Services, Cancer Registry

- County Health Rankings (University of Wisconsin)

This report utilizes demographic data as reported by the Alaska Division of Community and Regional Affairs: Alaska Community Database, Custom Data Queries and Alaska Community Database Community Information Summaries (CIS); the Alaska Department of Labor and Workforce Development, Research and Analysis Section, Alaska Local & Regional Information (Workforce Information); and the 2010 U.S. Census.

4.3 HEC 1: Social Determinants of Health

The HIA team uses both health outcome data and health determinant data to describe the social determinants and establish baseline health information for this health effect category. An outcome is a health event that has actually occurred, while a determinant is a “setting” or context that strongly influences health status. For example, for outcomes, maternal and child health, suicide rates, substance abuse rates, and other serious illness and death rate parameters are reported as general indicators of physical and social well-being. For health determinants general demographics, family structure, economic status, and educational attainment are included. These regional parameters are compared to all Alaska Natives, all Alaskans and occasionally to the U.S. population, where possible.

4.3.1 Maternal and Child Health

Maternal and child health outcomes (e.g., low birth-weight) can introduce current or future challenges (or improvements) to human health. This HIA reports components of maternal and child health including initiation of prenatal care, initiation of prenatal care visits, maternal and infant mortality, low-birth weight, child-abuse, oral health, and teen-birth rates.

General prenatal care can identify women at risk for complications during delivery. It is also important for the screening and treatment of medical conditions that may arise during pregnancy, such as preeclampsia and eclampsia. Some of these may be life threatening, as many as one in four maternal deaths occur during pregnancy. Prenatal appointments further allow for interventions involving behavioral risk factors associated with poor birth outcomes, such as smoking.[10] Adequate prenatal care is generally thought to increase the likelihood of a healthy pregnancy, although data on pregnancy outcomes are equivocal due to multiple confounding variables.[11]

Initiation of prenatal care during the first trimester may serve as a marker of improved infant health outcomes.[12] According to the Alaska Bureau of Vital Statistics, in 2009 78.3% of pregnant women in the Mat-Su Borough made their initial prenatal visit during the first trimester compared with 80% of all pregnant women in Alaska.[13]

Infant mortality is another health outcome that can be used to approximate baseline health conditions in a region (AMAP 2009). According to the Alaska Bureau of Vital Statistics (2007-2009), the Mat-Su Borough experienced a decreased infant mortality rate of 3.9 per 1,000 live births compared with 6.3 per 1,000 in Alaska (Table 12). In 2009, the infant mortality rate for the United States was 6.9 per 1,000 live births.[13]

Table 12 Infant Deaths and Infant Mortality Rates for Mat-Su Borough and Alaska, All Races, 2007 - 2009[13]

	Mat-Su Borough		State of Alaska
Infant Deaths	**Number of deaths**	**Rate per 1,000 live births**	**Rate per 1,000 live births**[a]
Neonatal (infants less than 28 days of age)[b]	6	1.6[d]	2.6
Postneonatal (infants 28 days to 1 year of age)[c]	15	3.9[d]	3.6
Total Infant Deaths	21	5.5	6.3

[a] Rates are the number of infant deaths per 1,000 live births
[b] Deaths to infants less than 28 days of age
[c] Deaths to infants 28 days to 1 year of age.
[d] Rates based on fewer than 20 occurrences are statistically unreliable and should be used with caution

Low weight at birth (< 2500 g, 5.5 lbs[9]) is multi-factorial and can also be related to the health of the mother.[14] Low birth weight is associated with an increased risk of disability and death in infants.[15] Low birth weight is therefore both an indicator of the health of the maternal population and a determinant of the health of the infant. According to the Alaska Bureau of Vital Statistics in 2009, 5.8% of all births in the Mat-Su Borough were classified as low birth-weight babies compared to 5.9% in the State of Alaska. Alaska Native babies had a smaller tendency to be low birth weight than white babies (3.4%). One source indicates that in 2008, the percent of all births that were low birth weight in the United States was 8.2%.

Substance use during pregnancy refers to the consumption of alcohol, tobacco, and/or drugs during the partum period. Substance use is dangerous for both the mother and the fetus, and can lead to premature detachment of the placenta, sudden infant death syndrome (SIDS), and developmental problems in childhood.[10] In 2009, 1.4% of all mothers in the Mat-Su Borough reported drinking during pregnancy compared to 3.1% of all Alaska mothers. Over 15% of all mothers in the Mat-Su Borough reported smoking during pregnancy compared to 15.6% of all Alaska mothers. Almost 23% of Alaska Native mothers in the Mat-Su Borough reported smoking during pregnancy.[13]

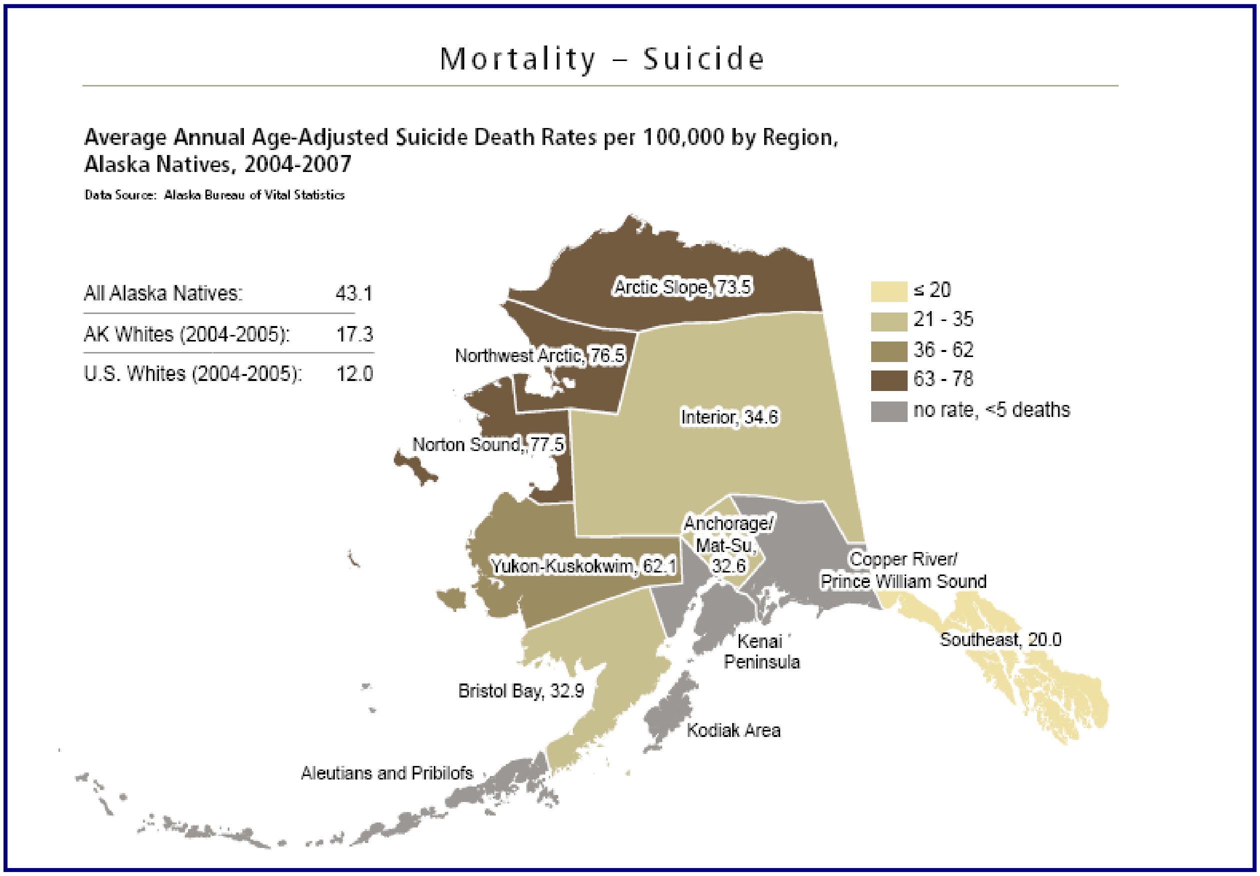
According to the Centers for Disease Control (CDC) fetal alcohol syndrome (FAS) is a condition that can occur in a person whose mother drank alcohol during pregnancy. These effects can include a mixture of physiological and behavioral challenges that may severely limit growth, development and socialization of the child.[16] The rate of FAS births among Native populations in Alaska for those born between 1996 and 2002, and diagnosed by 2008 (age 6), dropped from about 20 per 10,000 births in Alaska to 13.5, reflecting a steady decline through the years.[17] No data is available for the same years for the U.S., but the CDC estimates that between 2 and 20 cases of FAS occur for every 10,000 live births in the United States.[16] Infants born to teen mothers (aged 15 to 19 years) are at increased risk of preterm birth, low birth weight births, and death during infancy. They are more likely to have health problems as children, to drop out of school, to be incarcerated during adolescence, to give birth as a teenager, and to be unemployed as a young adult.[18] Teenaged mothers are less likely to receive a high school diploma[19], which may negatively impact their future health. In 2009, 10.7% of all babies were born to 15 to 19 year olds in the Mat-Su Borough, which was slightly higher than for all Alaskans (9.8%). In 2009, the percentage of Alaska Native teen-aged mothers in the Mat-Su Borough was 17.8 %, which was higher than the percentage for all Mat-Su Borough residents (10.7%) and for Alaska Natives statewide (15.4%).[20] The statewide teen pregnancy rate for all races was 9.8%.

4.3.2 Suicide

Suicide can function as one indicator of mental health wellness in a population. From 2007- 2009, there were 53 suicides in the Mat-Su Borough with an age-adjusted rate of 23.2 deaths per 100,000 people, the same rate experienced state-wide (22.8 deaths per 100,000 persons) among all races.[21]

In general, Alaskan Natives experience a higher suicide death rate than Alaskans or U.S. whites.[9] From 2004-2007, the suicide death prevalence for Alaska Natives living in the Mat-Su Borough was 32.6 deaths per 100,000 people, lower than the prevalence for all Alaska Natives (43.1 per 100,000 people) but higher than the borough, state, and the U.S. rates (Figure 2).

Figure 2 Suicide Death Rates by Region



Source: Alaska Native Epidemiology Center 2009.

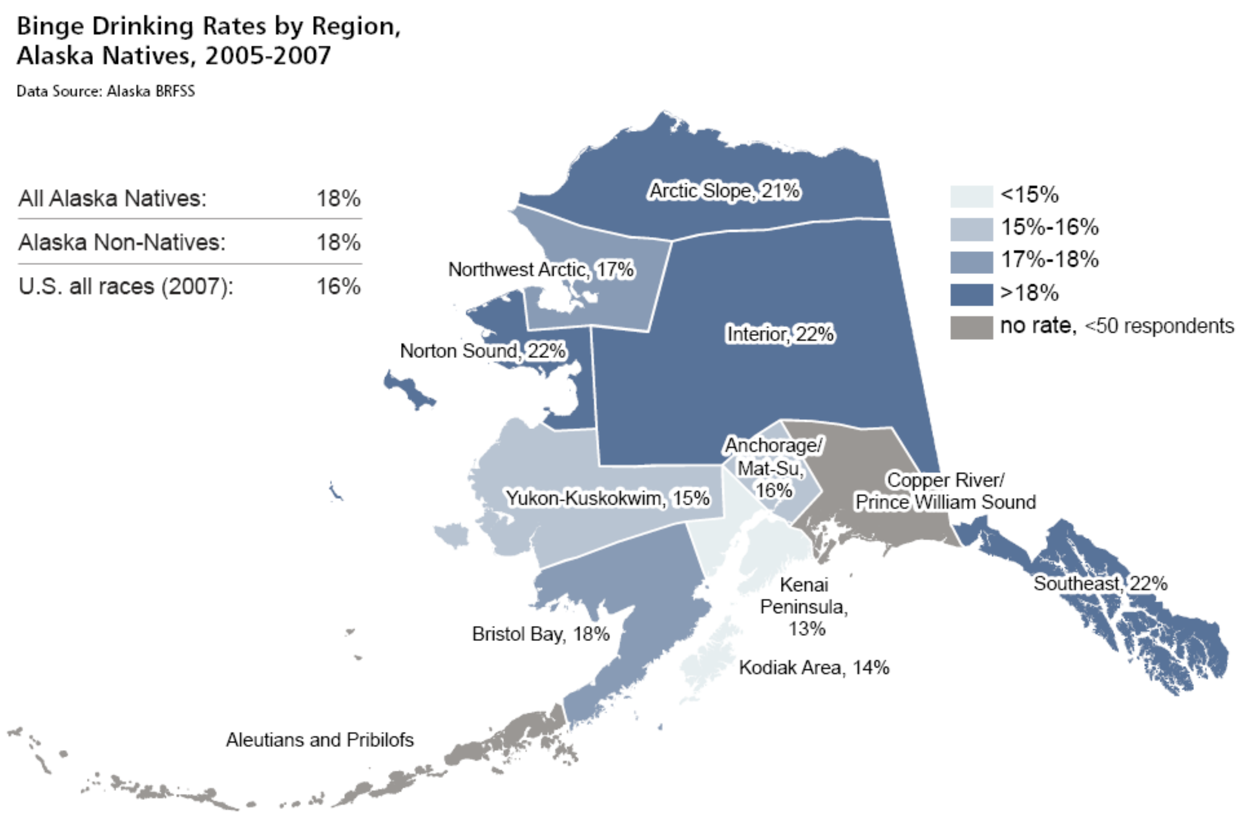
4.3.3 Substance Abuse

Substance abuse influences many health outcomes such as accidents and injuries. Substance abuse includes illegal drugs (e.g., marijuana, cocaine), alcohol addiction, and binge drinking. According to the Alaska Native Epidemiology Center, substance abuse for adolescents is defined as having used alcohol, marijuana or cocaine in the past 30 days. Binge drinking is defined as having 5 or more drinks on one or more occasion in the past 30 days. The excessive drinking measure reflects the percent of the adult population that reports either binge drinking, defined as consuming more than 4 (women) or 5 (men) alcoholic beverages on a single occasion in the past 30 days, or heavy drinking, defined as drinking more than 1 (women) or 2 (men) drinks per day on average.[9]

The County Health Rankings report reveals that 16% of the residents of the Mat-Su Borough report participation in 'excessive drinking' as binge and heavy drinkers, lower than the 19% reported for all Alaskans but twice the national benchmark of 8%.[22]

Overall Alaska Native regional data from the state's Behavioral Risk Factor Surveillance System (BRFSS) for 2004–2007 are shown in Figure 3. The self-reported percentages of binge drinking are lower for the Anchorage/Mat-Su Region Alaska Natives (16%) than the binge drinking percentages for all Alaska Natives, all Alaskans and all races in the U.S.

Figure 3 Binge Drinking Rates by Region



Source: Alaska Native Epidemiology Center 2009

4.3.4 Economic Indicators

Economic status may create a powerful context for human health and improved income is generally thought to be associated with improved community health outcomes. While there are many indicators used to assess economic status, the HIA reports median household income, employment, and the percentage of households living below poverty levels.

4.3.4.1 Median Household Income

Median household income is one important measure of economic well-being and a key determinant of human health.[23] Median means that half of the households have higher income and half of the households have lower income. In Alaska, income includes all monetary sources of income including wages, the Permanent Fund Dividend, Corporation Dividends and Public Assistance. Income does not include subsistence resources. For 2009, the estimated median household income in the Mat-Su Borough was $66,052; for Alaska it was $66,953, and for the U.S. it was $49,777 (Table 13).

Table 13 Potentially Affected Communities – Economic Indicators

Zone/Community	Median Household Income (2009) ($)	Per Capita Income (2009) ($)	Percent of People below Poverty Limit (2009)	Unemployment Rate (%)	
				12/2010	6/2011
United States	51,425	27,041	13.5	9.1	9.3
State of Alaska	64,635	29,382	9.6	8.2	7.9
Mat-Su Borough	66,052	24,906	10.3	9.3	9.0
Zone 1					
Buffalo Soapstone	66,406	35,126	2.2	-	-
Zone 2					
Sutton-Alpine[a]	61,111	18,479	14.6	-	-
Farm Loop	83,750	27,989	8.0	-	-
Fishhook	85,273	26,239	4.3	-	-
Zone 3					
Palmer	60,000	21,105	14.4	-	-
Wasilla	53,977	24,221	14.2	-	-
Zone 4					
Knik Fairview	69,604	22,214	7.9	-	-
Point MacKenzie	106,250	27,671	0.0	-	-

Sources: U.S. Bureau of Labor Statistics. Not seasonally adjusted
2009 American Community Survey 2005-2009 5-year estimates
AK Dept of Labor and Workforce Development
[a] Includes Chickaloon Traditional Village residential area

4.3.4.2 Employment

Employment is another key demographic factor that influences health.[9] According to the Alaska Native Epidemiology Center, unemployment includes anyone who has made an active attempt to find work in the four-week period up to and including the week that includes the 12th of the referenced month. Due to the scarcity of employment opportunities in some parts of Alaska, many individuals do not meet the official definition of unemployment because they are not conducting active job searches. In June 2011, unemployment stood at 9% for the entire Mat-Su Borough, above the statewide unemployment level of 7.9 %, but below the nation-wide level of 9.2 % (Table 13).

4.3.4.3 Percentage of Households Living Below Poverty Line

Poverty is a powerful determinant of human health.[23] The U.S. Census defines poverty in a complex way that does not account for the higher cost of living in Alaska. The Alaska Department of Health and

Human Services (ADHHS) adjusts poverty guidelines for entitlement programs such as Women, Infants and Children (WIC), and Temporary Assistance for Needy Families (TANF) for local factors. For a single person, the 2009 DHHS poverty level for Alaska for one person was $13,000 and for a four-person household it was $26,500. In 2009, 10% of Mat-Su Borough residents lived below the poverty line, which is slightly higher than Alaska as a whole (9%) but lower than the U.S. population (13.5%; Table 6). The percentage of residents living below the poverty line in Palmer (14.4%), Wasilla (14.2%), and Sutton-Alpine (14.6%) was slightly higher than the U.S. population (13.5%; Table 6).

4.3.4.4 Property Values

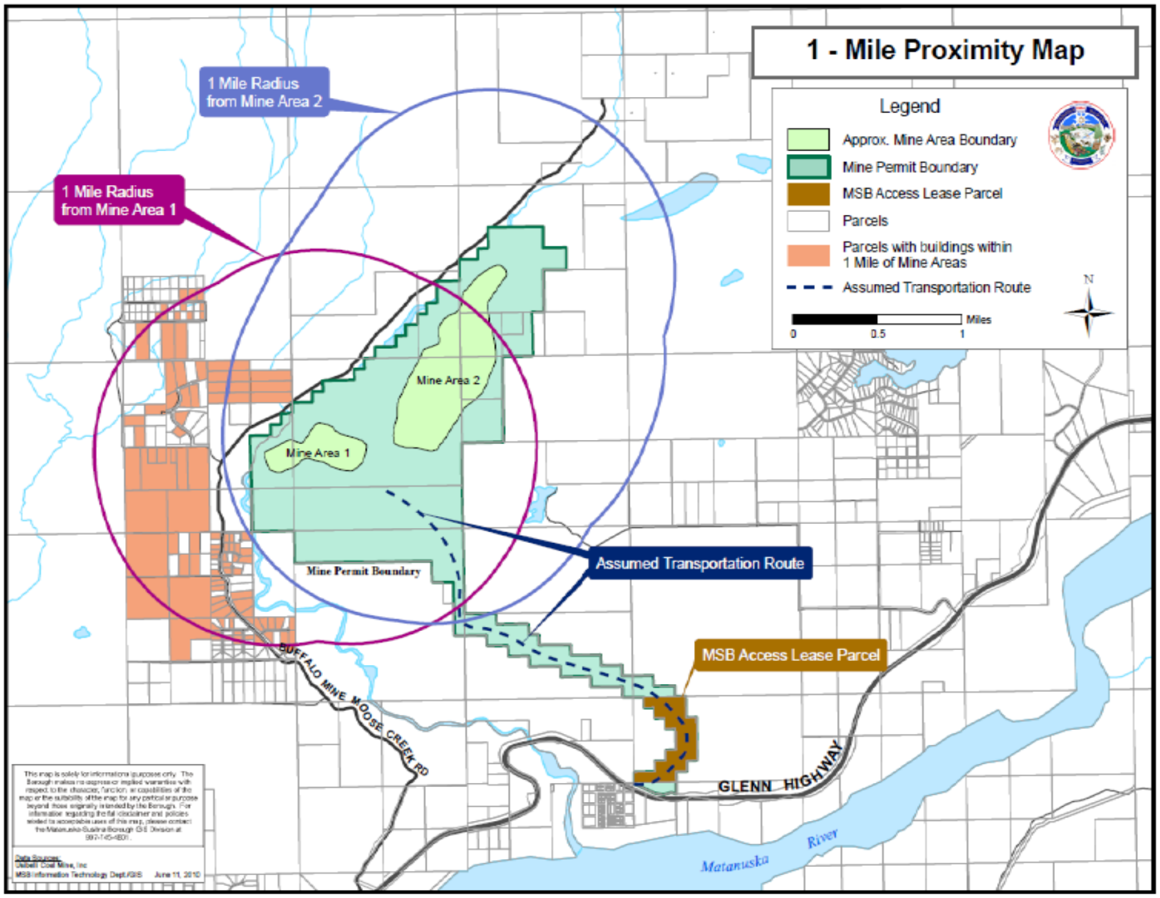
Local residents express concern over the potential loss of property values if mine development proceeds. At the request of the Mat-Su Borough, the Institute of Social and Economic Research (ISER) University of Alaska Anchorage studied the potential socioeconomic impacts of the mine.[24] Many residents opposed to the mine have commented that they doubt the validity of this study, but this HIA relies on the conclusions of the ISER report in the absence of other rigorous studies of the area.

ISER assumed a 16-year period of startup and mine production using two known deposits that are currently permitted by the State of Alaska for mineral exploration. “Mine Area 1” would be mined during years 2-7 and “Mine Area 2” would be mined during years 8-16. Mining would only take place at one of these areas during any given time. For purposes of the analysis the report considered properties within 1 mile of mining area 1 and, separately, properties within 1 mile of mining area 2 (Figure 4).

According to assessed value data ISER obtained from the Mat-Su Borough, 98 parcels exist within 1 mile of Mine Area 1. The total property value (land + buildings) of these parcels is $11.6 million. Roughly 30% (29 parcels) have buildings with an assessed value greater than $100,000; 15% have buildings with an assessed value of between $50,000 and $100,000 and 55% of the parcels have buildings with assessed value less than $50,000.

There are 8 parcels with structures within 1 mile of Mine Area 2. The total property value of these parcels is $500,000. Only one of these 8 parcels has buildings assessed at more than $100,000; the other 7 parcels have buildings assessed at less than $50,000.

Figure 4 Properties within 1 mile of Mine Site



Source: Institute of Social and Economic Research, University of Alaska, 2010

ISER used the above values to consider the magnitude of possible changes in property values as a result of coal mining. In theory, property market values could go up or down depending on a host of factors. Negative factors might include the extent and nature of possible noise, dust, traffic, or visual impacts. Positive factors might include the demand for housing by mine workers and additional economic activity in the area.

The ISER report concludes by noting that it is important to remember that the market value may differ from the subjective value of the property to its current owner. According to ISER:

> "When considering changes in property values, it is important to remember that the market value may differ from the subjective value of the property to its current owner. In theory, it is possible for a property owner to suffer a loss of subjective value at the same time that the market value of the property is stable or increasing."

This HIA team does not attempt to forecast property values in this document.

4.3.4.5 Educational Attainment

The level of educational attainment in a household can influence community health. In one study, high school graduates have been found to live an average of six to nine years longer than high school dropouts.[25] Adults with low educational attainment were more likely to die from cardiovascular disease, cancer, and lung disease.[26] Multiple possible mechanisms have been proposed to account for this trend. Education positively impacts lifestyle choices and health-related decisions. Better-educated people are also less likely to be employed in dangerous jobs.[27]

Table 14 compares Mat-Su Borough residents with the State of Alaska and the U.S., based on 2009 US Census data, American Communities Survey. The percent of residents over 25 in the State of Alaska and in the Mat-Su Borough and the Zone 1 community who have graduated from high school is over 90%. Point MacKenzie has the highest graduation levels (100%). Palmer and Sutton have the lowest number of high school graduates but are still at or close to the borough and the state averages. Point MacKenzie has the highest percentage (32%) of residents over 25 who have a Bachelor's Degree or higher.

4.3.5 Family Structure

Family stability refers to families where parents are healthy and employed; where members experience infrequent housing changes; and family members experience infrequent divorce and remarriage, or few separations due to immigration and job-seeking.

Family stability has been shown to provide numerous benefits to children such as, more effective child supervision and parental monitoring, less family conflict, and more family cohesion. Good parental monitoring, in particular, results in better child physical and mental health.[28]

Families in the Mat-Su Borough appear to be stable compared to families in the State of Alaska and the U.S. (Table 15). Many of the communities in the Mat-Su Borough have high percentages of families with both parents in the household; only Palmer, Sutton-Alpine, and Wasilla have a higher percentage of female heads of household than the Mat-Su average.

Table 14 Potentially Affected Communities – Education Indicators

Zone/Community	Educational attainment persons 25 years and older: High School Grads or more (%)	Educational attainment persons 25 years and older: Bachelor's degree or higher (%)	High School Drop-out rate	Community Literacy Rate
United States	84.6	27.5	4.1	85.5
State of Alaska	90.8	26.6	7.3	91.0
Mat-Su Borough	90.4	19.9	-	92.0[a]
Zone 1				
Buffalo Soapstone	95.4	17.7	-	-
Zone 2				
Sutton-Alpine*	90.4	9.4	-	-
Farm Loop	97.6	28.2	-	-
Fishhook	92.4	22.1	-	-
Zone 3				
Palmer	91.6	20.2	-	-
Wasilla	90.6	20.2	-	-
Zone 4				
Knik Fairview	88.6	19.2		
Point MacKenzie	100.0	32.0	-	-

Sources: 2009 American Community Survey 1-Year Estimates

National Center for Education Statistics, Public School Graduates and Dropouts 2007-2008, 2009 American Community Survey 3-Year Estimates: Table 4 (first two columns)

[a] 2003 National Assessment of Adult Literacy

Table 15 Potentially Affected Communities – Household Characteristics

Zone/Community	Number of Households	Average Household size	Percent of Family Households	Female Households, No Husband Present (Percent of Family Households)	Two- Parent Households with own Children Present under 18 Years (Percent of Family Households)
United States	116,716,292	2.6	66.4	19.7	30.4
State of Alaska	258,058	2.7	66.2	16.2	34.3
Mat-Su Borough	31,824	2.8	70.9	12.3	36.9
Zone 1					
Buffalo Soapstone	314	2.7	71.7	10.2	36.4
Zone 2					
Sutton-Alpine[a]	393	2.5	63.6	13.2	29.2
Farm Loop	361	2.8	77.8	9.6	33.8
Fishhook	1591	2.9	77.2	8.6	41.9
Zone 3					
Palmer	2,113	2.6	63.3	22.4	37.9
Wasilla	2,962	2.6	64.7	18.1	33.9
Zone 4					
Knik Fairview	5,040	3.0	75.2	11.3	41.6
Point MacKenzie	112	3.6	54.5	4.9	39.3

Sources: US Census 2010 (http://live.laborstats.alaska.gov/cen/dparea.cfm)
http://factfinder2.census.gov/faces/tableservices/jsf/pages/productview.xhtml?fpt=table
[a] Includes Chickaloon Traditional Village

4.3.6 Cultural Indicators

In Alaska, subsistence practices are a component of cultural identification and community cohesion. The Alaska Federation of Natives (AFN) describes subsistence as “the hunting, fishing, and gathering activities, which traditionally constituted the economic base of life for Alaska's Native peoples and which continue to flourish in many areas of the state today. Subsistence, being integral to our worldview and among the strongest remaining ties to our ancient cultures, is as much spiritual and cultural, as it is physical[29].”

Subsistence practices anchor the customs and traditions of many cultural groups in Alaska. These customs and traditions encompass sharing and distribution networks, cooperative hunting, fishing, and ceremonial activities. Participation in subsistence activities promotes transmission of traditional knowledge from generation to generation and serves to maintain people’s connection to the physical and biological environment. The Chickaloon Traditional Village Council values the preservation of cultural knowledge and has operated a public school (Ya Ne Dah Ah "Ancient Teachings”) in Sutton, near the mine entrance road, which offers a variety of cultural classes to its students since 1992. It is important to note that the Mat-Su region has been designated as a non-subsistence area by ADF&G. This designation is discussed in detail below (section 4.6).

4.3.6.1 Data Gaps Analysis

During large federal project review cycles, communities typically share their views and practices during in person interviews conducted by experts in Traditional Knowledge (TK). Household level TK survey data for the PACs are not available for the proposed Wishbone Hill project.

4.4 HEC 2: Accidents and Injuries

4.4.1 Fatal Injuries

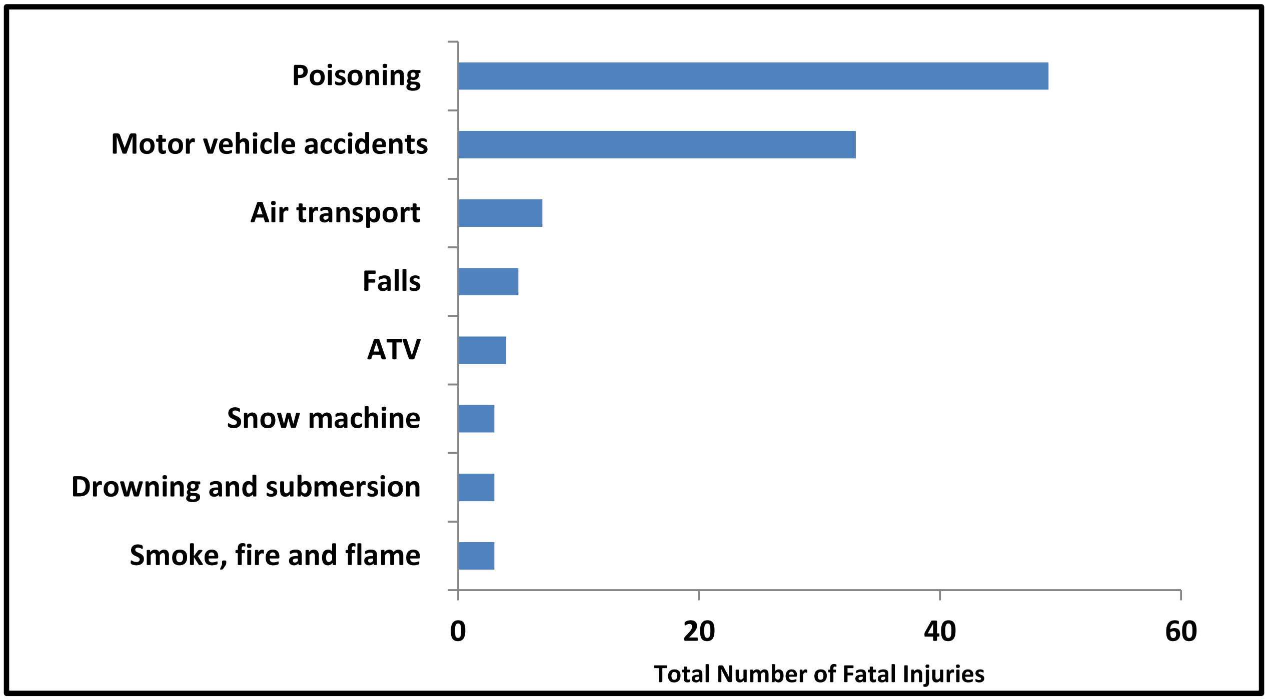
During 2007-2009, there were 117 unintentional fatal injuries in the Mat-Su Borough (Table 16). The leading cause of non-transportation related fatalities was poisoning (20.0/100,000) and the leading cause of transportation related fatalities was motor vehicle accidents (13.7/100,000) (Table 16, Figure 5). Unintentional poisoning is often related to alcohol overdose. The Mat-Su Borough has a higher rate of poisoning deaths than the State as a whole (20.0 vs. 16.9/100,000) and a similar rate of fatal motor vehicle fatalities as compared to State of Alaska as a whole (13.7 vs. 13.2/100,000).[30]

Table 16 Major Causes of Unintentional Injury Deaths, Mat-Su Borough and State of Alaska, 2007 – 2009[30]

	Mat-Su Borough		State of Alaska	
Cause of Death	**Deaths**	**Age-Adjusted Rate**[a]	**Deaths**	**Age-Adjusted Rate**[a]
Unintentional Injuries	117	50.4	1,024	55.2
Transport accidents	41	16.8	308	15.4
Motor vehicle accidents	33	13.7	262	13.2
Snow machine[b]	3	**	48	2.5
ATV[c]	4	**	21	1.0
Water transport	0	0.0	15	7[d]
Air transport	7	2.8	27	1.3
Other transport accidents	1	**	4	**
Non-transport accidents	76	33.6	716	39.8
Falls	5	**	73	5.6
Accidental discharge of firearms	0	0.0	6	3[d]
Drowning and submersion	3	**	74	3.6
Smoke, fire and flame	3	**	39	1.9
Poisoning	49	20.0	348	16.9

[a] Age-Adjusted rates are per 100,000 U.S. year 2000 standard population
[b] Deaths to an operator or passenger related to the use of a snow machine
[c] Deaths to an operator or passenger related to the use of an ATV
[d] Rates based on fewer than 20 occurrences are statistically unreliable and should be used with caution
** Rates based on fewer than 6 occurrences are not reported

Figure 1 Number of Fatal Injuries in the Matanuska Susitna Borough, 2007-2009 (N=117)



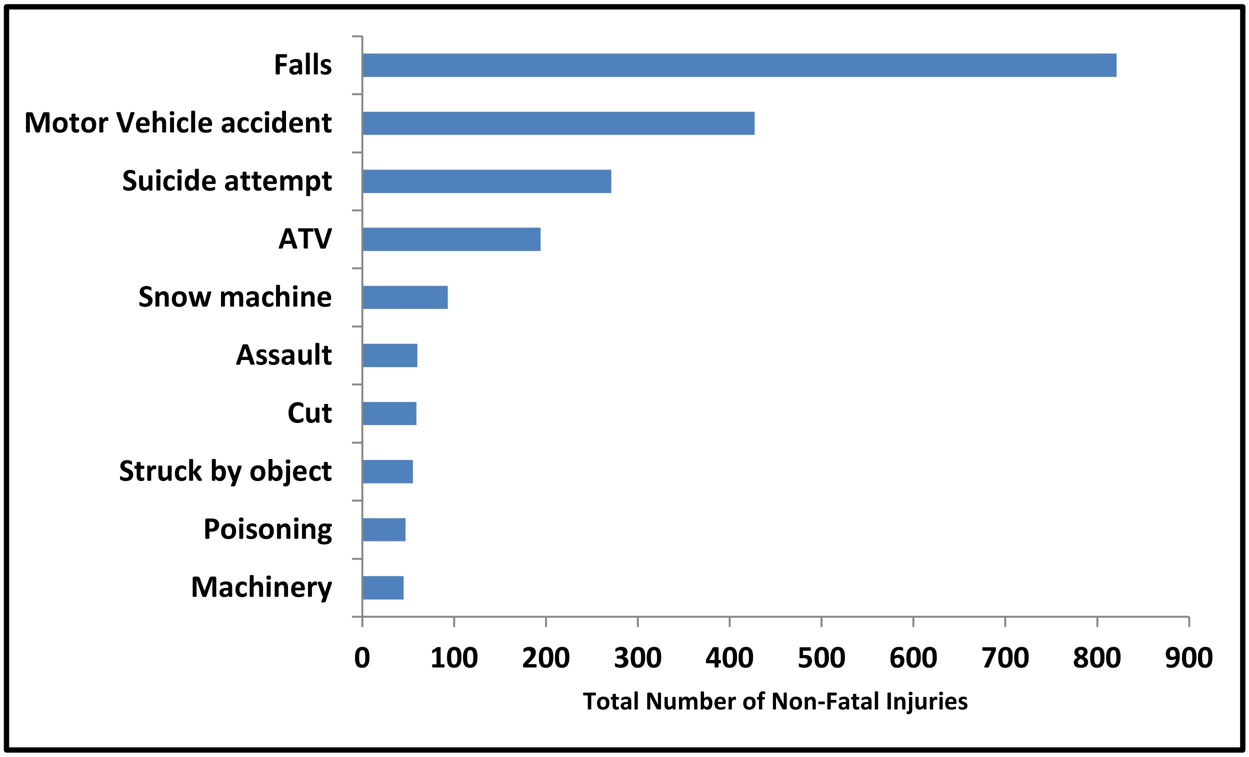
Source: Alaska Bureau of Vital Statistics 2011

4.4.2 Non-fatal Injury

The Alaska Trauma Registry (ATR) records non-fatal injuries that are serious enough to require admission to a health care facility. From 2004-2008, the ATR recorded 2,530 non-fatal accidents and injuries in the Mat-Su Borough with an average of 500 injuries per year. Males accounted for almost 60% of these injuries. Individuals between 15-24 years of age were the most commonly injured and accounted for 18% of all injuries for this period.

The most common cause of non-fatal injury requiring hospitalization in the Mat-Su Borough area was falls (32%), followed by motor vehicle accidents (17%), and suicide attempts (11%). These three causes of injury alone accounted for 60% of all non-fatal injuries during this period. Figure 6 below lists the 10 most common non-fatal injuries in this region for the period 2004-2008.

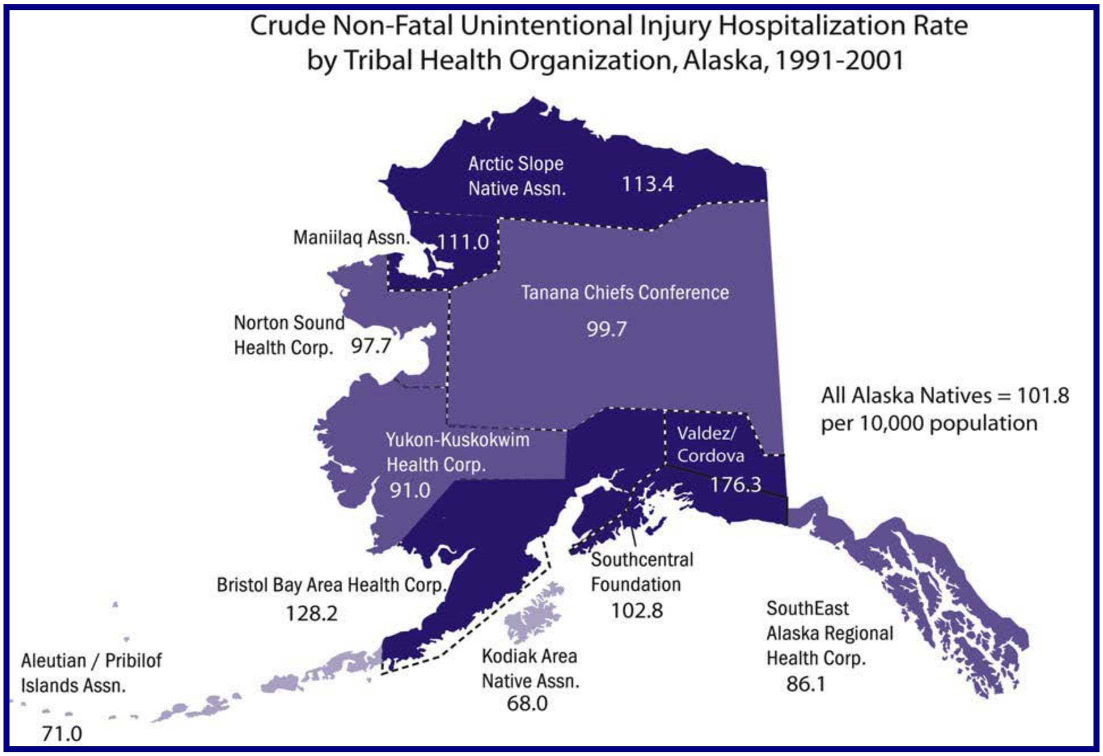
Figure 6 Leading Causes of Non-Fatal Injury in the Matanuska Susitna Borough, 2004 –2008 (N=2,530)



Source: Alaska Trauma Registry 2011

Figure 7 indicates that between 1991 and 2001, the crude rate of unintentional Injury Hospitalization for Alaska Native residents cared for by the Southcentral Foundation was 102.8/10,000.

Figure 7 Crude Non-Fatal Unintentional Injury Hospitalization Rate by Tribal Health Organization, Alaska, 1991-2001



Source: Alaska Native Epidemiology Center 2009

4.4.3 Traffic and Accidents

The Mat-Su Valley is served by the state and borough highway systems. The Glenn Highway comes into the borough from Anchorage in the south and continues east through Palmer and Sutton to Glennallen. The Glenn Highway splits at the north end of the Knik Arm and the Parks Highway goes west into Wasilla and on to Fairbanks.

Table 17 below presents the 2008 annual average daily traffic counts for the proposed route of the coal trucks entering the Glenn Highway at Mile Post 55.5 and continuing to the port at Point Mackenzie.

Table 17 Annual Average Daily Traffic by Road Segment, 2008

Road Segment	Annual Average Daily Traffic (AADT) (2008)
Glenn Highway between Farm Loop and Jonesville Rd (includes mine entrance)	2,562
Glenn Highway to Farm Loop	4,100
Glenn Highway between Fishhook Rd and Scott Rd	8,790
Glenn Highway from Scott Rd to Palmer Wasilla Highway	12,080
Glenn Highway from Palmer-Wasilla Highway to Spring Loop	13,840
Glenn Highway from Spring Loop to Parks Highway	10,924
Parks Highway Junction to Trunk Rd	23,839
Parks Highway from Trunk Rd to Old Matanuska Willow Rd	28,543
Knik Goose Bay Rd	26,458
Knik Goose Bay Rd to Edlund Rd	17,312
Knik Goose Bay Rd from Edlund to Vine	13,101
Knik Goose Bay Rd from Vine to Settlers Bay Dr.	7,820

Source: Alaska Department of Transportation and Public Facilities

4.4.4 Accident Data from the Alaska Trauma Registry

According to the ATR, there were 590 accidents between 2001 and 2008 on the Glenn Highway between Palmer and Jonesville Road (Table 18 and Table 19).

Table 18 Traffic Accidents by Mile Post between Palmer and Sutton, 2001-2008

General Location by Mile Point/Mile Post/Name	Total Number of Accidents (2001-2008)
West of Palmer to Fishhook Road	316
Fishhook Road to Buffalo Mine Road	142
Buffalo Mine Road to Chickaloon School	55
Mile Post 57 to Sutton (Mile Post 60)	54
Sutton to Jonesville Mine Road	23
Total	**590**

Source: Alaska Trauma Registry 2011

In summary between 2001 and 2008:

- A total of 590 crashes were documented from 2001 thru 2008
- Most crashes occurred on a Friday, Saturday or Monday
- 30% of the crashes are between MP 38-41
- 30% of the crashes included injuries; 10 (<2%) fatalities were documented
- 59% of the crashes were property damage only
- Nearly 60% occurred during daylight hours
- 15% involved moose; 50% involved impacting another vehicle (angle, rear-end; <3% were head-on)

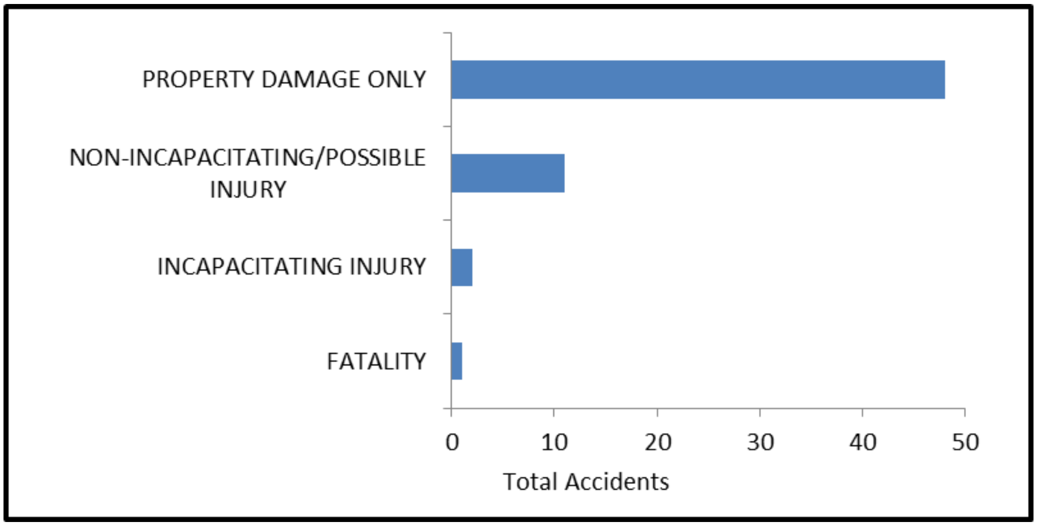
Table 19 Number of Non-fatal Motor Vehicle Accidents Requiring Hospitalization Per Year, 2001-2008, Glenn Highway between Palmer and Jonesville Road

	Year							
Total	**2001**	**2002**	**2003**	**2004**	**2005**	**2006**	**2007**	**2008**
590	80	62	79	90	65	80	72	62

Source: Alaska Trauma Registry 2011

Property damage was the most likely outcome of the accidents in 2008 (Figure 8); one fatality and two incapacitating injuries were recorded for this stretch of the Glenn Highway (Table 19).

Figure 8 Accident Severity for Transportation Accidents on Glenn Highway, 2008.

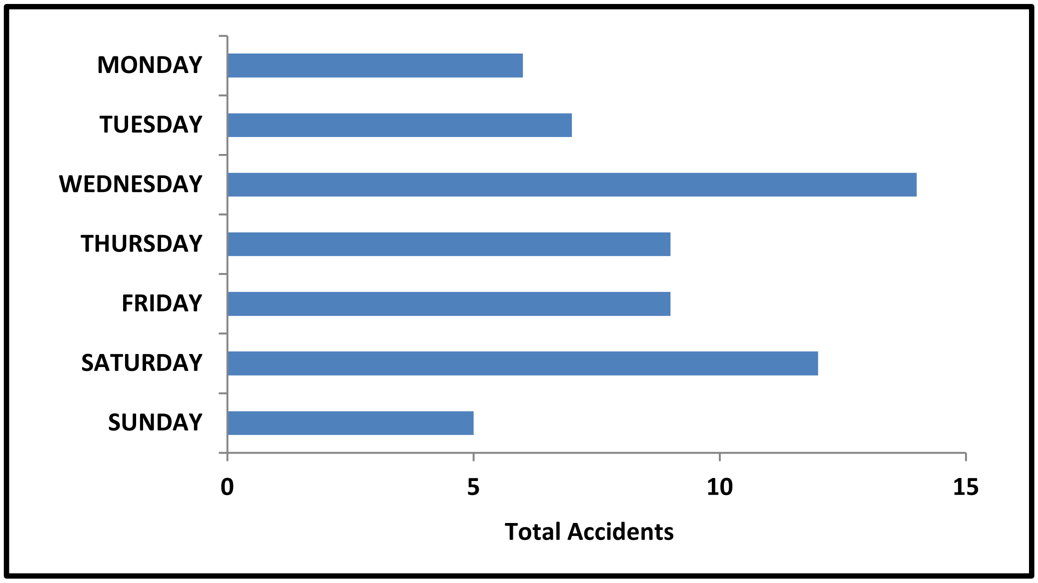


Source: Alaska Trauma Registry 2011

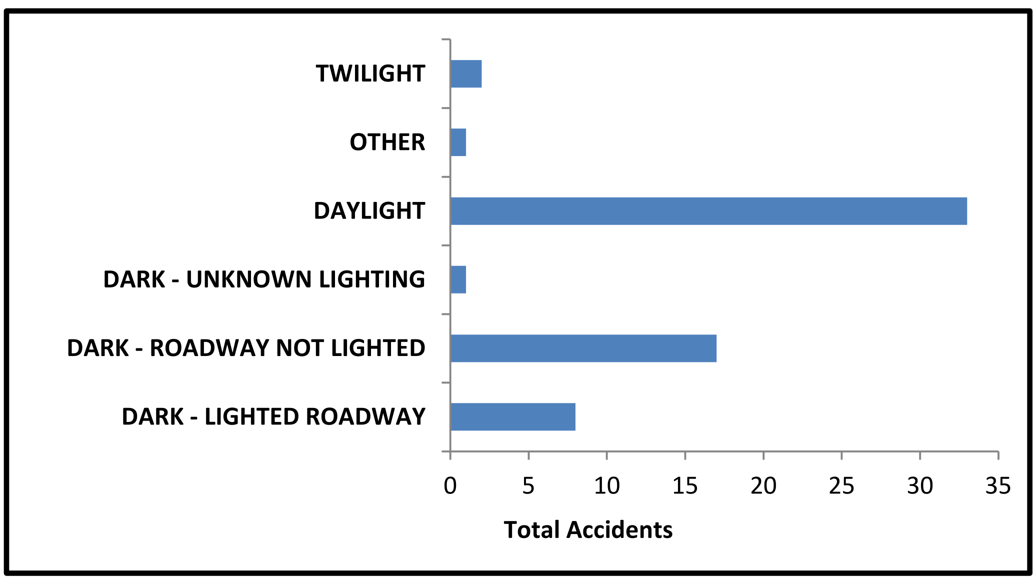
For 2008, most of the accidents occurred on Wednesday and Saturday during daylight hours (Figures 9a and 9b).

Figure 9 (a) Accidents by Day of the Week and (b) Time of Day on Glenn Highway, 2008.

(a)



(b)



Source: Alaska Trauma Registry 2011

4.4.5 Traffic Accident Fatalities

The Alaska Department of Transportation and Public Facilities (ADOT) compiles statistics on the number of fatalities in Alaska each year based on the resident population and the number of vehicle miles of travelled (VMT). Between 1997 and 2007, 938 people died in traffic accidents in Alaska yielding a fatality rate of 13.24 deaths per 100,000 people or 1.57 deaths per 100 million VMT.[31] According to the

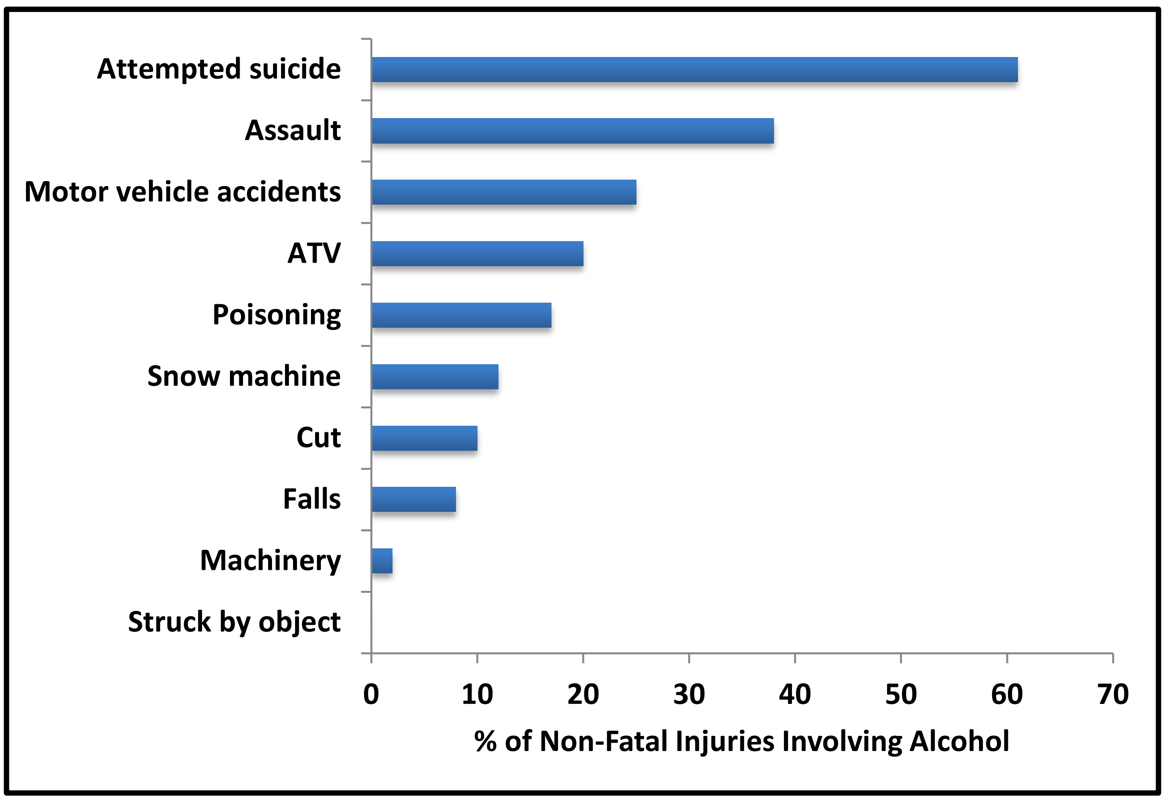
ADOT[32], there were 13 fatal accidents on the Glenn Highway between MP 49 to MP 118 between 2001 and 2007. The state reports that 2 people died on roads in the Study Area in 2011; in January two people died in a traffic accident on Knik-Goose Bay Road.[33]

4.4.6 Alcohol Related Accidents and Injuries

Alcohol consumption and injury death are strongly related. In 1997, Landen[34] reported that in Alaskan injury fatality cases where blood alcohol was actually recorded, more than 65% had a blood alcohol level of ≥80 mg/dL.

For non-fatal injury, ATR records reveal that alcohol use was documented over in 20.6% of all non-fatal injury cases. See Figure 10 for a ranking of the top 10 causes of non-fatal injury by percentage involving alcohol.

Figure 10 Non-fatal injuries by Percentage Involving Alcohol: 2004-2008 Matanuska Susitna Borough, Alaska



Source: Alaska Trauma Registry 2011

4.4.7 Law Enforcement

The Wishbone Hill Coal mine is in an unincorporated area of the Mat-Su Borough. It is served by the Palmer Station of the Alaska State Troopers. Palmer and Wasilla provide police services within their municipalities. The Palmer and Wasilla police departments have 15 and 24 (in 2010) full-time sworn patrol officers respectively. According to the Department of justice, in the US in 2008 there were 251 full time sworn officers per 100,000 population (i.e., officers who can make arrests) and in Alaska there were 189 full time sworn officers per 100,000 population.[35]

4.4.8 Dry/Wet/Moist Community

Alaska Native village policies have been enacted that designate a community as dry (alcohol sale and consumption prohibited), damp (sale of alcohol illegal, but possession allowed), and wet (sale and possession allowed). Chickaloon does not have a "local option law" in place that regulates alcohol.[36] There are liquor stores and bars throughout the area.

4.4.9 Potential Data Gaps

- Year 2009, 2010, and 2011 accident and injury data from the Alaska Trauma Registry.

4.5 HEC 3: Exposure to Potentially Hazardous Materials

When gathering data on exposure to potentially hazardous materials, the HIA team attempts to report on mortality from illnesses that may result from exposures to hazardous materials. These outcomes are reported in the HEC: Chronic non-communicable diseases below. The HIA team also reports information on health determinants, such as soil conditions, water quality, and air quality to understand the types and quantities of contamination that might be present. ADHSS routinely monitors two heavy metal toxins: methyl mercury, through hair samples of pregnant women, and lead (a reportable condition in Alaska). However, for the WHM, these two metals are not considered to be significant potential contaminants of concern as there is no onsite thermal processing of the coal ore and therefore, exposure to methyl mercury and lead is not expected.

The HIA team has performed a careful review of (i) the relevant sections of the 2011 Wishbone Hill Coal Mining Permit Application Parts A-E, (ii) (a) Alaska Department of Environmental Conservation (ADEC) Technical Analysis Report- for Air Quality Control Minor Permit AQ1227MSS04 (June 10, 2014), (b ADEC June 2014 "Response To Comments (RTC); (iii) June 2013, UCM Application for an Air Quality Control Minor Permit' and (iv) ADEC Final Air Quality Control Minor Permit AQ1227MSS04 for UCM 'Wishbone Hill Coal Mining and Processing Operation" (June 10, 2014). The "Permit Application Parts A-E" materials are detailed technical submissions covering, air, water (hydrology and surface water), soils, fish/aquatics, vegetation, wildlife, subsistence resources, etc. These materials largely, but not exclusively, contain background information that was obtained over a 1988-1991 timeframe. There are post-2008 data collections for a few specific areas including, groundwater monitoring, and aquatics.

4.5.1 Soils

According to the permit, soils data analysis is based on a June 1988 survey that covered the entire permit area. The basic objective of the field investigation was to map and sample the soils of the Wishbone Hill proposed permit area in sufficient detail to characterize their physical and chemical properties and depths to which they may be salvaged as a source of topsoil for mine reclamation purposes. Laboratory results indicate that Wishbone Hill soils are very low in salts (electrical conductivity-elemental carbon [EC] and sodium), generally low in calcium and magnesium, and have a low pH, which is characteristic of many Alaskan soils. Most soils contain spodic horizons, which are accumulation zones of illuviated organic matter, aluminum, and iron. All soils have an acidic surface organic layer. Results are considered to be typical for Mat-Su Valley soils. Other than aluminum and iron, results for other metals (e.g., lead, arsenic, cadmium, and mercury) were not presented. However, there is no reason to believe that metal concentrations found in Wishbone soils would be different than other Mat-Su Valley soils.

4.5.2 Groundwater

Groundwater flow mirrors surface topography with flow from high areas towards Moose Creek. Quarterly groundwater sampling and head pressure data were collected from 1988 through December 1990. In 1988, Idemitsu (original lease holder) installed seventeen monitoring wells in alluvial/glacial sediments and bedrock. Monitoring wells were sampled in November 1988, and February, May/June, and July 1989. According to the permit filed by Usibelli, in October 2008, the ground water monitoring programs were reinitiated in order to expand the Project's site database.

The important components of the monitoring program are as follows:

- Six monitoring wells installed in bedrock to obtain representative water samples and water levels. At least one well was installed in each of the major coal groups including the Burning Bed, Eska, Premier and Jonesville.
- Two of the monitoring wells in bedrock were of sufficient diameter to conduct pump tests for the purpose of determining large-scale hydrogeologic characteristics in bedrock. The drawdown during the pump testing was monitored in the pumped well and surrounding piezometers. A piezometer is designed to measure underground pressures.
- Eleven monitoring wells were completed in the uppermost aquifer (i.e., glacial and alluvial sediments) for the purpose of measuring water levels and obtaining water samples. These monitoring wells were located up-gradient and down-gradient of the proposed open pits, around the proposed slurry northwestern portion of the proposed Permit Area.
- One of the monitoring wells in the alluvial sediments was of sufficient diameter to conduct a pump test for the purpose of determining large-scale hydrogeologic characteristics in alluvium adjacent to Moose Creek.
- Two monitoring wells were installed in the area of the old Premier underground mine to evaluate groundwater conditions and quality in the old workings. One of these wells was of sufficient diameter to conduct a pump test.
- Thirty seven piezometers in thirteen drill holes were installed at suitable depths and locations to determine the potentiometric conditions in bedrock in the areas of the proposed open pit mine. Piezometers were also located to provide monitoring during two pump tests that were conducted in bedrock.

4.5.3 Key Findings - Groundwater/Hydrology

- The uppermost aquifer in the proposed Permit Area is located in the glacial and alluvial sediments. Based on water levels measured in the uppermost aquifer, there is a major groundwater flow divide running east-west through the proposed Permit Area corresponding to a topographic divide. Groundwater flows north and south from this major divide. Groundwater in the glacial sediments is probably recharging the bedrock system over most of the site.

- Recharge to the glacial/alluvial sediments aquifer originates from precipitation falling on the proposed Permit Area. Recharge appears to be occurring over most of the proposed Permit Area. Discharge from the glacial/alluvial sediments aquifer occurs by horizontal flow into Moose and possibly Buffalo Creeks and by vertical leakage into the underlying bedrock.
- Groundwater quality monitoring completed to date indicates that the ground waters in the proposed Permit Area are variable but generally of moderate to high quality and generally meet Federal Primary Drinking Water Standards with the exception of the groundwater from the glacial alluvial materials, which exceeds Federal Secondary Drinking Water Standards for iron and manganese while groundwater from the bedrock units exceeds drinking water standards for other various parameters.
- Past investigations indicate that no significant water quality problems were identified in groundwater of the Moose Creek watershed; with the exception that groundwater possessing high sodium adsorption ratios is not suitable for irrigation supply. Concentrations of trace constituents, primarily metals, were generally quite low. Most trace constituents were near or below their detection limits. Nutrient levels in groundwater were variable.
- According to the February 2014 MWH Consultants "Technical Memo," "Based on review of available information, it appears that the existing data, network of surface water monitoring locations, groundwater monitoring wells, and piezometers are sufficient to characterize background conditions at the Wishbone Hill site. Comparative analyses of available background data indicate that 2008 data are generally within the range established by data collected in 1988-90 and earlier." "…the analysis of central tendency and variation indicates that the original baseline data (1988-1990) is comparable to the 2008 data."[36]

4.5.4 Potential Issues

According to the "Decision and Findings of Compliance Related to Surface Mining Permits" (Idemitsu Alaska Incorporated; Wishbone Hill Mine); ADNR Division of Mining (August 2, 1991) concluded:

- Due to the possibility that some degradation of the groundwater could occur, the uses of the groundwater must be considered. The applicant listed users of the surface water and groundwater within one mile of the proposed Permit Area.
- Although the risk of degradation of public water supplies is not great, adequate monitoring of the mine operations should be provided to ensure compliance.
- The hydrogeology in the vicinity of the sediment control ponds and slurry pond was only minimally characterized.

The MWH Technical Memo addressed these points and stated that "it appears that the existing data, network of surface water monitoring locations, groundwater monitoring wells, and piezometers are sufficient to characterize background conditions at the Wishbone Hill site".[36]

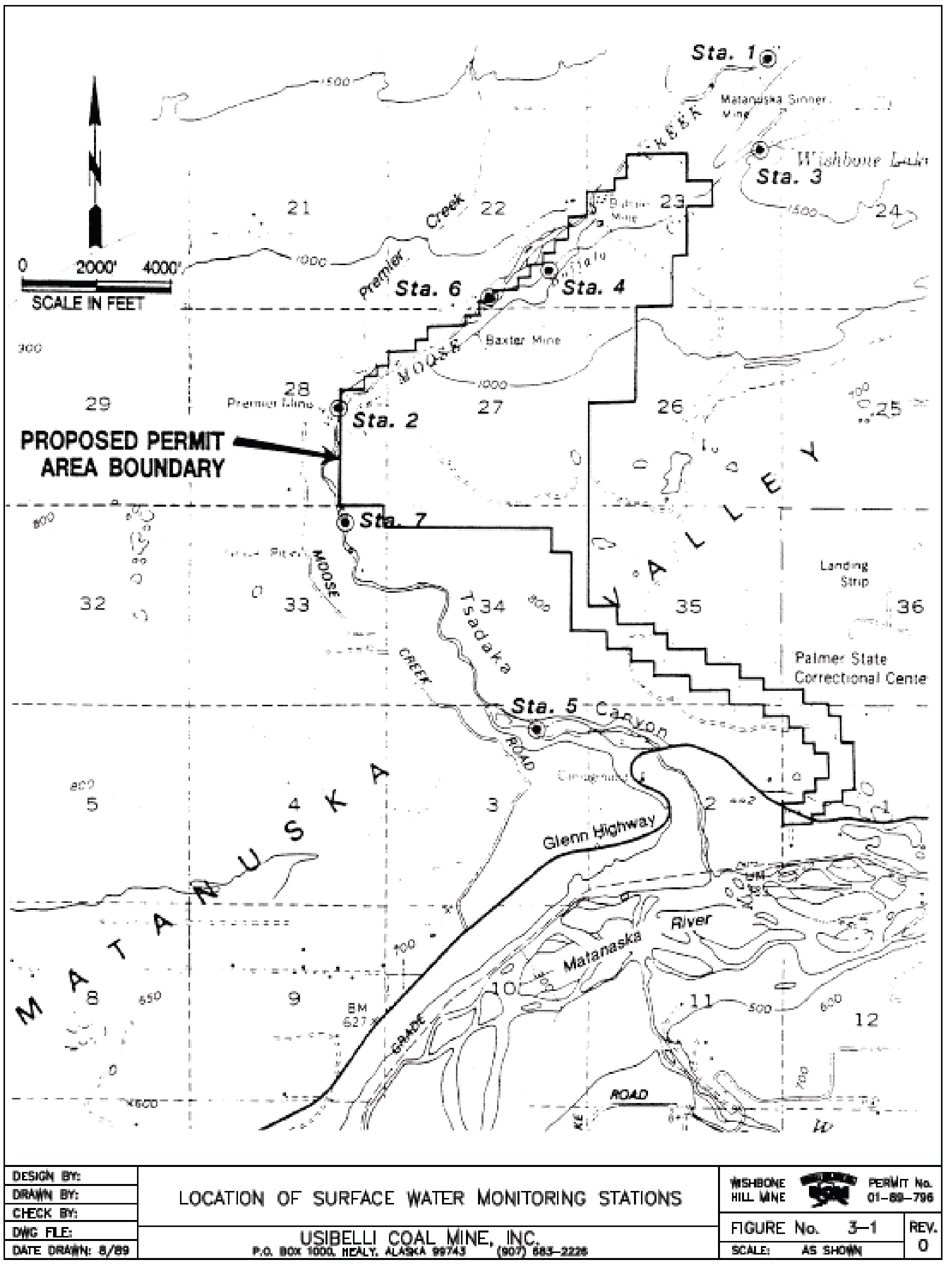
4.5.5 Surface Water

The proposed Permit Area occupies approximately 2.5 square miles in the southern portion of the Moose Creek watershed. Moose Creek drains approximately 49.6 square miles and flows into the Matanuska River about 3 miles downstream of the site. The streambed of Moose Creek is comprised of large boulders, cobbles and gravels typical of a high energy environment.

Typical stream flow in this region is generated from precipitation, snowmelt and glacial melt waters. Flows vary seasonally, with peak flows occurring in spring and early summer due to snowmelt and breakup, and in late summer and early autumn due to rain storms. Periods of lowest flow occur in winter when precipitation falls as snow, and when little surface runoff occurs

The surface drainage pattern in the proposed Permit area has been significantly affected by glaciation. Much of the area is characterized by closed depressions, which have no surface drainage outlet. Seven water quality sampling stations were established to monitor surface water quality in and near the proposed Permit Area (Figure 11).

Figure 11 Location of Surface Water Monitoring Stations



Source: Usibelli Coal Mine 2011 Renewal Applications for Permit Numbers 01-89-796 & 02-89-796

Four sampling stations were located on Moose Creek, two on Buffalo Creek and one on Premier Creek. Three stations at which both water quality and sediment sampling were conducted coincide with the stream flow monitoring stations discussed above (Stations 1, 4 and 5). Two additional stations for water quality and sediment sampling were established, one on Premier Creek near its confluence with Moose Creek (Station 2) and one on Buffalo Creek near the outlet of Wishbone Lake (Station 3). Finally, two additional stations at which only field parameters and sediment samples were taken, were established on Moose Creek near potential locations for pond outfalls (Stations 6 and 7).

4.5.6 Field Measurements

Field measurements and laboratory analyses of surface water samples collected from July, 1988 through June, 1989, indicate that Moose, Buffalo, and Premier Creeks all have good water quality (i.e., acceptable for all or most uses such as drinking, agriculture, or fisheries). The waters have near neutral pH, low hardness (15 to 59 mg/l), moderate alkalinity (11-113 mg/l), and almost no acidity. Surface waters meet State and Federal standards for drinking water quality. There is currently no evidence of physical or biological pollution in the surface waters. Acidity and pH values show no remaining adverse effects from previous mining activities. Concentrations of all dissolved priority pollutant metals are below detection limits. Sediment concentrations are generally low.

Field observations, surveys and measurements indicate potential interaction between surface streams and the groundwater contained in shallow alluvial deposits in and around the stream channels. It is possible that a small fraction of the water entering the alluvial materials may recharge the groundwater system in glacial sediments and bedrock, where hydraulic gradients permit. Based on the stream flow measurements taken to date and hydrogeological data, it is unlikely that large quantities of water are leaving Moose Creek into the groundwater system in the vicinity of the mine permit boundary.

The 2014 MWH Consultants “Technical Memo” also addressed surface water data in terms of characterizing the existing background conditions prior to mine development. In addition, MWH reviewed the 1989 Golder Associates groundwater-surface water physical model. Overall, MWH concluded, “Underlying assumptions used in the model remain unchanged, and there is no indication that it insufficiently characterizes pit inflows or potential impacts from excavations. Mine excavations are not expected to induce groundwater flows from shallow alluvium, or cause losses of surface water from Moose Creek.”[36]

4.5.6.1 Potential Issues

According to the “Decision and Findings of Compliance Related to Surface Mining Permits” (Idemitsu Alaska Incorporated; Wishbone Hill Mine); ADNR Division of Mining (August 2, 1991) concluded**:**

- The mining areas are located adjacent to Moose Creek. In most of this area, the groundwater discharges to the stream (i.e., the stream is gaining). Therefore, mining operations that affect the quality of the groundwater could ultimately affect the quality of the stream water, as well as the quality of the regional groundwater.
- Moose Creek may represent a groundwater discharge boundary or the bedrock flow regime may pass under the creek, particularly along the western edge of the site.

The MWH Technical Memo addressed these points and stated that "the conclusions that mine excavations are not expected to induce groundwater flows from shallow alluvium, or cause losses of surface water from Moose Creek, appear valid."[36]

4.5.7 Fish and Aquatics

During the summer and early fall of 1988, an independent consulting firm (Dames & Moore) conducted an aquatic baseline survey of Moose and Buffalo creeks. The purpose of this survey was to develop a data baseline, which could be used for evaluating potential impacts from the construction and operation of the Wishbone Hill Coal Development Project. Baseline data, (identified as necessary by the ADF&G), were collected concerning fish habitat, water quality, juvenile fish distribution and abundance, spawner escapement, and benthic invertebrates.

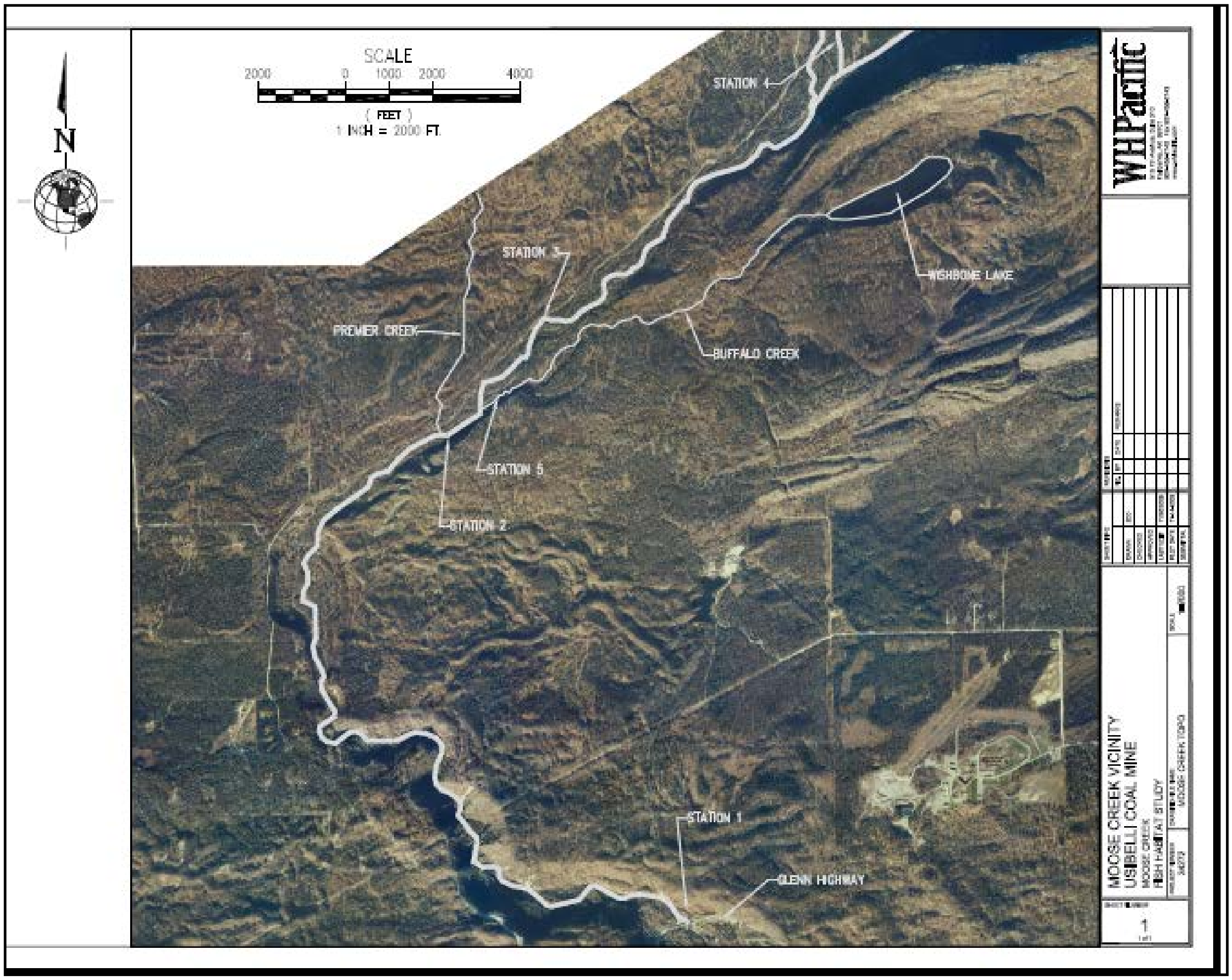
In late September and early October 2008, a consulting firm, WHPacific, conducted another aquatic biological resources study on Moose and Buffalo creeks. This study attempted to replicate the surveys and protocols that were implemented in 1988 and were conducted to provide comparative long term monitoring data. Specific monitoring stations are shown in Figure 12 below.

The 2008 fisheries sampling and monitoring effort demonstrated many changes over the last 20 years, including expanded salmon access and habitat utilization, which has greatly expanded throughout the study reach above the waterfall at river mile 3.2. This is not surprising as in the in the last 3 years there have been significant restoration and habitat improvement efforts by the Chickaloon Village Traditional Council. These efforts have produced greater habitat access and availability to salmon, trout, Dolly Varden and other resident fish. In 2008, water quality in Moose creek was considered to be very good to excellent.

4.5.7.1 Data Gaps

- Temporal: Fish and aquatics data set (2008) may not fully capture all of the recent restoration efforts.

Figure 12 Aquatic Resources Monitoring Stations (2008)



Source: Usibelli Coal Mine. 2011 Renewal Applications for Permit Numbers 01-89-796 & 02-89-796
Station 1 Moose Creek from USGS gauging station upstream 270 ft.
Station 2 Moose Creek from the premier Creek confluence upstream 270 ft.
Station 3 MC at approximately RM 4.9 upstream 300 ft. Station is located immediately below Buffalo Mine Road
Station 4 MC on the left fork immediately upstream of fork confluence and old railroad bridge.
Station 5 Buffalo Creek from 25 feet upstream of confluence with MC to an endpoint 240 ft upstream

4.5.8 Air Quality

The Permit (Part C Chapter VII) presents TSP, PM_{10} and surface meteorological data that were initially collected from October 12, 1988 through June 30, 1989. To further assess baseline conditions, the collection of data from the on-site monitoring station continued through October 31, 1991. Air quality data were collected from October 12, 1988 through October 31, 1990; the collection of meteorological data continued for a full 3-year period that started on October 23, 1988 and ended October 31, 1991. The air quality data are a combination of 24-hour mean values, annual averages and peak concentrations. Regulatory analysis is based on 24- hour mean and annual average data; however, short-term peak concentration data can be important toxicologically and medically.[37]

The wind direction data indicated the predominant winds were from the east-southeast during the winter period. This suggests that local topography within the project area likely influences the wind direction since winter winds in Palmer and at the Department of Natural Resources Wishbone Lake weather station tend to be from the northeast or north-northeast per the orientation of the Matanuska River Valley. In April, the predominating wind direction switched from the east-southeast winter condition to a more westerly orientation, which is typical of summer conditions. Wind readings were generally light in the spring months.

Nevertheless, according to permit analysis, wind direction and velocity are highly variable depending on local topography. Strong northeast winds exceeding 60 mph periodically blow down the Matanuska River Valley in the fall through spring months. These winds occur as often as 32 times per year, but seldom occur in the summer, according to the data.

Although the mining area is affected by the Matanuska wind phenomenon, maximum wind speed appears to be substantially less than is the case for Palmer and other areas closer to the Matanuska River.

The short-term information that was collected suggests that significant differences in temperature and precipitation occur between Palmer and Sutton, near the project area.

A comparison of the PM_{10} data to the TSP data is presented in Table 20. These peak and mean values illustrate that the majority of the mass concentration are contributed to particulates greater than 10 microns in size, consistent with glacial silt being the primary source. During the measurement period, there was not a major thermal combustion source located within the project area. Thermal combustion, e.g., vehicles, generators, large machinery, etc., produces fine particulates, typically smaller than 10 microns. Home heating (e.g., wood burning) is another potential source of fine particulate emissions.

Table 20 Wishbone Hill Particulate Data 10/12/88 – 10/31/90

	PM_{10} (µg/m^3)	TSP (µg/m^3)
Highest Observed	197	623
Second Highest Observed	107	324
Mean Value	12.9	30.0
Standard Deviation	19.9	58.2

Source: Usibelli Coal Mine 2011[3]

These data can be put into context by comparing them to more current (1998-2008) annual mean PM_{10} data and 24-hour PM_{10} data (4th max to 1st max) from Anchorage, Fairbanks, Juneau and Mat-Su Borough (Table 21 and Table 22). Regulatory agencies (e.g., US EPA) report particulate matter as 1st Max, 2nd Max, 3rd Max, 4th Max. These values are the four highest 24-hour values of the year, in micrograms per cubic meter.

Table 21 Annual Mean PM_{10} Values (µg/m^3)

Year	Anchorage Municipality	Fairbanks North Star Borough	Juneau City and Borough	Matanuska-Susitna Borough
1998	20.25	19	11	21
1999	20.17	20	7	16
2000	19.2	17	8	12
2001	23.25	-	7	14
2002	22.5	-	8	9
2003	23.25	-	10	21
2004	20.75	-	9	29
2005	24.75	-	11	23
2006	21	-	9	14
2007	21.25	-	7	11
2008	18.5	-	7	18

Source: US EPA: http://www.epa.gov/air/data/monvals.html?st~AK~Alaska

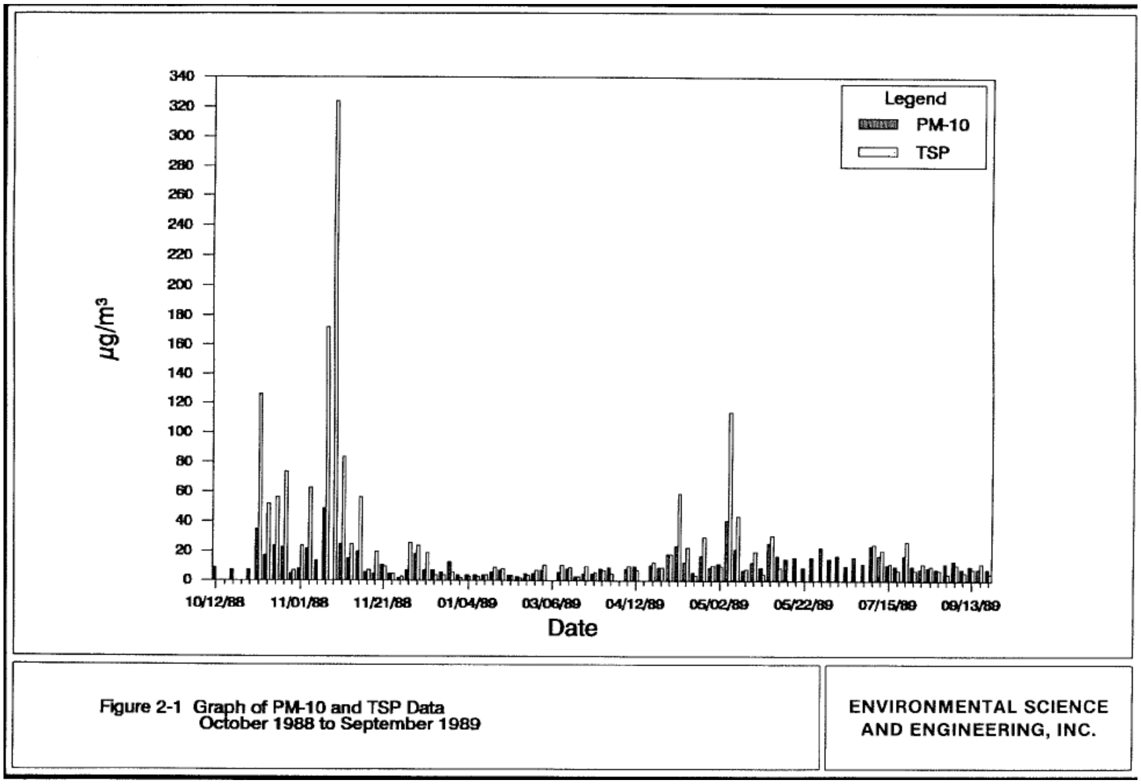
Table 22 Range of Maximum 24-Hour PM_{10} Values (µg/m^3)

	Anchorage Municipality		Fairbanks North Star Borough		Juneau City and Borough		Matanuska-Susitna Borough	
Year	4th Max	1st Max	4th Max	1st Max	4th Max	1st Max	4th Max	1st Max
1998	35	115	35	44	30	48	87	282
1999	26	94	46	82	18	28	95	161
2000	13	111	26	54	23	33	38	184
2001	48	150	-	-	24	28	63	121
2002	33	105	-	-	19	29	30	37
2003	37	187	-	-	21	26	72	265
2004	35	97	-	-	28	34	40	605
2005	40	145	-	-	34	42	52	176
2006	17	108	-	-	25	33	43	84
2007	36	223	-	-	20	45	22	168
2008	26	106	-	-	18	28	22	233

Source: US EPA: Http://www.epa.gov/air/data/monvals.html?st~AK~Alaska

There is marked annual variability, and a correspondingly large standard deviation, in the data. The Wishbone Hill mean PM_{10} value of 12.9 µg/m^3, with a standard deviation of 19.9, is consistent with the Mat-Su Borough annual average PM_{10} data, which ranges from 9-29 µg/m^3. The 1998-2008 Mat-Su 24-hour PM_{10} data (4th max to 1st max) shows similar variability and is consistent with the pattern at Wishbone Hill (October 1988 to September 1989; Figure 13). The site-specific Wishbone Hill data illustrates that there are multiple days where elevated particulate concentrations are observed. According to the permit application, these high particulate days were associated with elevated wind speeds. Only PM_{10} data are available, as $PM_{2.5}$ was not measured.

Figure 13 Graph of PM_{10} and TSP Data October 1988 to September 1989



Source: Usibelli Coal Mine[3].

4.5.8.1 Alaska Department of Environmental Conservation Air Permit Analysis

As part of the HIA process, 2013-2014 Wishbone Mine air permit documentation publically released by ADEC was reviewed. The HIA utilizes materials in the air permit to help facilitate potential health impact analysis. The State of Alaska HIA Program does not have regulatory authority and does not opine on the technical processes and procedures of the ADEC permitting process. The permit materials considered included:

- AQ1227MSS04 Application 062313- "Application for an Air Quality Control Minor Permit;" prepared by SLR for Usibelli Coal Mine (June 2013);
- AQ1227MSS04 Final Permit 061014- "Department of Environmental Conservation Air Quality Control Minor Permit" Final-June 10,2014;
- AQ1227MS04 Final TAR 061014- "Technical Analysis Report For Air Quality Control Minor Permit AQ1227MSS04;" prepared by ADEC; Final June 10,2014;
- AQ1227MSS04 RTC 061014; "Response to Comments for Minor Permit" prepared by ADEC June 10, 2014;
- AQ1227MSS04 Final Trans 061014; "Final Decision to Approve Minor Permit Application for Usibelli Coal Mine, Inc.'s Air Quality Control Minor Permit AQ1227MSS04;" prepared by ADEC, June 10, 2014

Specific technical analyses performed for the HIA included:

- Reviewing the emissions inventory analysis performed by ADEC
    - Source, classification and quantification of emission units (EUs)
    - Definition of coal preparation and processing plant as it pertains to issuance of a minor air permit

- Reviewing the potential chemicals of concern (PCOCs) considered by ADEC
    - CO (carbon monoxide)
    - SO_2 (sulfur dioxide)
    - VOCs (volatile organic compounds)
    - PM_{10} (particulate matter with an aerodynamic diameter of less than 10 microns)
    - $PM_{2.5}$ (particulate matter with an aerodynamic diameter of less than 2.5 microns)
    - NO_x (oxides of nitrogen)

- Reviewing the air modeling analysis
    - Selection of POCs for air modeling
    - Potential exposure concentrations
    - Uncertainties of the modeling exercise

Background and Analysis

The ADEC air permit documents are detailed and complex. In order to better understand and follow the ADEC TAR, several regulatory and technical terms are defined below.

Glossary
Key terms are explained using authoritative regulatory sources:
- ADEC 2012 Publication "Assessable Emission Policy Update, Plain Language Guide,"
- ADEC 18 AAC 50 "Air Quality Control Definitions" (2012),
- California Air Resources Board (http://www.arb.ca.gov/bact/docs/definitions.htm)
- USEPA (http://www.epa.gov/NSR/psd.html; http://www.epa.gov/air/criteria.html; http://www.epa.gov/nsr/; http://www.epa.gov/region9/air/permit/defn.html.

- ***Assessable emission***- the quantity of each air pollutant for which emission fees are assessed. User fees are assessed upon stationary sources with permits under State Air Quality Control (AQC) Permit Programs. ADEC assesses fees per ton of emissions.
    - ADEC assesses fees on each regulated air pollutant if the assessable emission estimate for that pollutant is 10 tons or greater.
        - Fugitive emissions to the extent they are quantifiable, count toward assessable emissions. For example, coal receiving and bunkering activities at a coal power plant have assessable emissions.
        - Non-road engine emissions do not count toward assessable emissions. For example, tracked construction equipment on-site have no assessable emissions.
- ***Emissions Unit-*** Emissions Units include all individual pieces of equipment that emit air pollutants at a stationary source. EPA regulations define an emissions unit as any part of a

stationary source which emits or would have the potential to emit any pollutant subject to regulation under the Clean Air Act.

- ***Fugitive emissions-*** Emissions that cannot reasonably pass through a stack, chimney, vent or equivalent opening. The deciding factor is not whether the emissions do pass through an opening but whether they could pass through an opening. <40 CFR51.166 (b)(20)>.
- ***Hazardous Air Pollutant (HAP***)- A federal term for toxic air pollutants which generally do not have safe exposure levels. An initial list of such pollutants is in Section 112(b)(1) of the federal Clean Air Act. Other compounds are added or deleted to this list as time proceeds.
- ***Major source-*** Under the Clean Air Act, a stationary source that emits or has the potential to emit more than 10 tons or more per year of a single hazardous air pollutant (HAP) or 25 or more tons per year of all HAPs.
- ***Minor permit-*** A permit issued under 18 AAC 50.502 – 18 AAC 50.560; Minor permits must conditionally assess their fugitive emissions for the purposes of permit classification in accordance with the federal rules adopted under 18 AAC 50.502(i). See section 2.0 Permit Conditions TAR for Minor Permit AQ1227MSS04.
- ***Mobile Source-*** Moving objects that release pollution. They are categorized as on-highway vehicles or as non-road engines. Mobile sources include self-propelled cars, trucks, buses, planes, train locomotives, vessels, motorcycles and construction equipment.
- ***National Ambient Air Quality Standards (NAAQS)-*** National Ambient Air Quality Standards are federal standards for the minimum ambient air quality needed to protect public health and welfare. EPA has set National Ambient Air Quality Standards for six principal pollutants, which are called "criteria" pollutants: CO (carbon monoxide), Pb (lead), NO_2 (nitrogen dioxide), O_3 (ozone), Particle Pollution (PM_{10} and $PM_{2.5}$) and SO_2 (sulfur dioxide).
  - *The Clean Air Act* identifies two types of national ambient air quality standards.
    - *Primary standards* provide public health protection, including protecting the health of "sensitive" populations such as asthmatics, children, and the elderly.
    - *Secondary standards* provide public welfare protection, including protection against decreased visibility and damage to animals, crops, vegetation, and buildings.
- ***New Source Review (NSR)***: New major stationary sources of air pollution and major modifications to major stationary sources are required by the Clean Air Act to obtain an air pollution permit before commencing construction. This process is called new source review (NSR); NSR is required regardless of whether the major source or modification is planned for an area where the national ambient air quality standards (NAAQS) are exceeded (nonattainment areas) or if an area where air quality is acceptable (attainment and unclassifiable areas). Permits for sources in attainment areas are referred to as prevention of significant air quality deterioration (PSD) permits; while permits for sources located in nonattainment areas are referred to as nonattainment (NAA) permits. The entire program, including both PSD and NAA permit reviews, is referred to as the NSR program.
- ***Point Sources-*** A single, identifiable source of air pollutant emissions characterized as being elevated or at ground level.
- ***Potential to Emit (PTE)-*** The maximum capacity of a stationary source to emit, after emission controls, operational limits and emission limits are considered. PTE is the total potential emissions of any regulated pollutant, which could result from operating under a

"worst case operating scenario," running 24-hours a day (with no pollution control equipment), 365 days a year at full capacity.

- ***Potential Contaminant of Concern (PCOC)-*** Any contaminant that might be expected to occur at a site
- ***Prevention of Significant Deterioration (PSD***): A federal preconstruction permitting program that applies to areas that are not violating a National Ambient Air Quality Standard. PSD applies to new major sources or major modifications at existing sources for pollutants where the area the source is located is in attainment or unclassifiable. The program applies pollutant-by- pollutant. That is, an air quality jurisdiction can be nonattainment for one pollutant and attainment or unclassified for another pollutant. The area will fall under the PSD Program for those pollutants that are attainment or unclassified.
    - PSD does not prevent sources from increasing emissions. Instead, PSD is designed to:

      1. Protect public health and welfare;

      2. Preserve, protect, and enhance the air quality in national parks, national wilderness areas, national monuments, national seashores, and other areas of special national or regional natural, recreational, scenic, or historic value;

      3. Insure that economic growth will occur in a manner consistent with the preservation of existing clean air resources; and

      4. Assure that any decision to permit increased air pollution in any area to which this section applies is made only after careful evaluation of all the consequences of such a decision and after adequate procedural opportunities for informed public participation in the decision making process.
- ***Significant Emissions Rates (SER)-*** EPA's air permitting programs use significant emission rate levels to determine when NSR requirements apply to existing facilities. Significant emission rates are used to evaluate whether a proposed project at an existing facility is considered a major modification and therefore requires the facility to obtain permits and also determines which pollutants must be analyzed for major sources.

  This rule sets the significant emissions rate for direct $PM_{2.5}$ and precursor pollutants as follows:
    - Direct $PM_{2.5}$ emissions at 10 tpy
    - SO_2 emissions at 40 tpy
    - NO_x emissions at 40 tpy
    - VOC emissions (if regulated) 40 tpy unless the state demonstrates that a lower rate is appropriate.
- ***Stationary Source***- A source includes most of the emitting activities on properties under common control and related to a general industry group type. The activities include fugitive emissions and exhaust stack emissions but exclude mobile sources. Source properties are contiguous or adjacent, but not necessarily touching. They may be separated by roadways, rivers, or other properties. The governing principle whether nearby properties are part of a single source is whether the activities function together as a single plant.

- ***Surface Mining Control and Reclamation Act (SCMCRA)***- Regulatory requirements for coal mines are different than for other types of mines. Spurred by major environmental impacts from coal mining in the 1960's and 1970's, the U.S. Congress passed the Surface Mining Control and Reclamation Act in1977. This act completely restructured the way coal mining was regulated nationwide and greatly increased environmental oversight.

  The federal act also allowed individual states to develop coal regulatory program consistent with the federal legislation, and assume primacy over the federal program. Alaska chose to develop its own program, and enacted the Alaska Surface Coal Mining Control and Reclamation Act on May 2, 1983.

Key Historical Timeline

(*adapted from* http://www.usibelli.com/Coal-Wishbone-Hill.php)

- 1991 Idemitsu Alaska, Inc. receives Wishbone Hill Alaska SCMCRA permit.
- 1995 Wishbone Hill Mine Alaska SCMCRA permit transferred from Idemitsu Alaska, Inc. to Cook Inlet Region Inc. (CIRI) (North Pacific Mining Corporation).
- 1996 Wishbone Hill Alaska SCMCRA permit renewed.
- 2001 & 2006 Wishbone Hill Alaska SCMCRA permit renewed.
- 2010 Usibelli notifies the State Department of Natural Resources of its intention to renew the Alaska SCMCRA permit.
- Minor Air permitting process initiated by UCM for coal preparation and processing plant (various submissions, revisions, modifications, reapplications, etc., to ADEC, 2009-2014)

Air Permit

Emission Analysis

According to the TAR, UCM proposed to establish a new Wishbone Hill stationary source with the main purpose of coal extraction and processing. The underlying Alaska SCMCRA permit is still valid. For the new source, UCM requested:

1. Install a new 900 hp backup diesel electric generator, listed as EU ID 1;
2. Install space heaters up to, and including, a maximum of 10 MMBtu/hr total, listed as EU ID 2;
3. Install a coal preparation and processing plant consisting of related coal conveying, crushing, and cleaning, listed as EU IDs 9–23, and 25–28. Use centrifuge for drying the coal and not use thermal dryers in the preparation of the coal. Not using thermal dryers in preparation of the coal allows the source to avoid being classified as one of the 100 tpy special category sources under 40 CFR 52.21(b)(1)(iii);
4. Install emission units associated with surface coal mining, listed as EU IDs 3 through 8, 24, and 29 through 36;
5. Maintain adherence to the Public Access Control Plan;
6. Maintain adherence to the Fugitive Dust Control Plan; and
7. Characterize the stationary source fugitive emissions and their impact on ambient air quality.

A summary of the named EUs (1-36) and their “potential to emit” (PTE) in tons per year (tpy) is shown as Table 23 below.

Table 23 Emissions Unit Inventory and Calculations

ID	Unit ID/ Description	Expected Operation	NO_X		CO		SO_2		VOC		PM-10	
			Emission factor	PTE TPY	Emission factor	PTE TPY	Emission factor	PTE TPY	Emission factor	PTE TPY	Emission Factor (In lb/ton unless otherwise noted)	PTE TPY
1	Power Generation - Diesel-fired Engine	8,760 hr/yr	14.0 lb/hr	61.3	1.77 lb/hr	7.8	0.75 % S	10.0	0.14 lb/hr	0.6	0.18 lb/hr	0.8
2	Diesel-fired Heaters	8,760 hr/yr	20 lb/10^3 gal	6.5	0.036 lb/MMBtu	1.6	0.75 % S	17.2	0.002 lb/MMBtu	0.1	2 lb/10^3 gal	0.6
3	Topsoil removal and storage	2,660 hr/yr	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	32.0 lb/hr	21.28
4	Overburden blasting	240 blast/yr	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	11.32 lb/blast	1.3584
5	Coal blasting	120 blast/yr	N/A	27	N/A	N/A	N/A	N/A	N/A	N/A	11.32 lb/blast	0.6792
6	Overburden truck loading	4,234,000 tpy	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	0.00013	0.285
7	Overburden dumping	4,234,000 tpy	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	0.00013	0.285
8	Coal removal	1,815,000 tpy	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	0.01779	16.148
9	Coal dumping –Crusher feeder	1,815,000 tpy	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	0.01779	16.148
10	Coal dumping from run of mine pile	605,000 tpy	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	0.01779	5.383
11	Coal Reclaim from run of mine pile	605,000 tpy	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	0.01779	5.383
12	Crusher	350 tph	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	0.0024	3.679
13	Transfer-Crusher to conveyor	1,815,000 tpy	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	0.00020	0.183
14	Transfer-Conveyor 1 to raw stockpile	1,815,000 tpy	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	0.00020	0.183
15	Transfer-Raw stockpile to conveyor 2	1,815,000 tpy	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	0.00020	0.183
16	Transfer-Conveyor 2 to Jig Plant	1,815,000 tpy	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	0.00020	0.183
17	Transfer-Jig Plant to Conveyor 3	815,000 tpy	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	0.00013	0.055
18	Transfer-Conveyor 3 to reject stockpile	815,000 tpy	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	0.00013	0.055
19	Transfer- Jig plant to conveyor 4	1,000,000 tpy	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	0.00013	0.067
20	Transfer-Conveyor 4 to clean stockpile	1,000,000 tpy	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	0.00013	0.067
21	Transfer-Clean stockpile to conveyor 5	1,000,000 tpy	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	0.00013	0.067
22	Transfer-Conveyor 5 to loadout bin	1,000,000 tpy	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	0.00013	0.067
23	Transfer- loadout bin to truck	1,000,000 tpy	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	0.00013	0.067
24	Wind erosion- mine area	168 acres	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	52.4 g/m^2/yr	41.017
25	Wind erosion - run-of-mine coal stockpile	4 acres	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	52.4 g/m^2/yr	0.977
26	Wind erosion- raw coal stockpile	1.5 acres	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	52.4 g/m^2/yr	0.366
27	Wind Erosion – clean coal stockpile	1.5 acres	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	124.8 g/m^2/yr	0.835
28	Wind Erosion –reject stockpile	0.1 acres	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	52.4 g/m^2/yr	0.024
29	Mobile Equipment – grader operations	13,122 VMT/yr	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	0.765 lb/VMT	2.51
30	Mobile Equipment – overburden hauling - backfill	19,340 VMT/yr	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	4.46 lb/VMT	8.626
31	Mobile Equipment – overburden hauling - stockpile	137,413 VMT/yr	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	4.46 lb/VMT	61.286
32	Mobile Equipment – coal hauling within mine	14,103 VMT/yr	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A		
33	Mobile Equipment – miscellaneous mine traffic	50,000 VMT/yr	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	0.874 lb/VMT	26.274
34	Mobile Equipment – other vehicle traffic	236,520 VMT/yr	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A		
35	Mobile Equipment – coal truck haul – loop road	4,410 VMT/yr	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	2.42 lb/VMT	1.067
36	Off Source – coal truck haul – access road	101,430 VMT/yr	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	2.42 lb/VMT	24.546

Source: ADEC (2014), TAR; Appendix A

As noted by ADEC, the majority of the emissions identified in the analysis (EUs 1-36), are particulate matter (PM) fugitive dust emissions (Table 2 below). Other pollutant emissions (CO, SO_2, and VOCs) are associated with EUs 1 & 2. NO_2 emissions are associated with EUs 1, 2 and 3 (blasting). The HIA analysis considers all of the PCOCs. “Coal dust” is not a statutory priority pollutant subject to a NAAQS. Coal dust is considered in the toxicology section of the HIA, but is not analyzed as a separate chemical entity in the permit process. However, coal dust is captured in the overall quantitative emission analysis of particulate matter.

In Table 24, point sources are EUs 1 & 2. “Total coal prep plant fugitive” (35 PTE tpy) and “total coal mine fugitive” (239 PTE tpy) are discussed below in detail. Nitrogen dioxide (NO_2) emissions are captured in the “total point source”(EUs 1 &2-power generation and heaters) and “total coal mine fugitive” (EU 3 – Blasting) categories. CO, SO_2 and VOCs are tied to point sources (EUs 1 &2). “Assessable emissions” are used to calculate potential emission fees, as per ADEC regulations previously defined (See Glossary).

Table 24 Summary Emissions Calculations

ID	Unit ID/ Description	Expected Operation	NO_X		CO		SO_2		VOC		PM-10	
			Emission factor	PTE TPY	Emission factor	PTE TPY	Emission factor	PTE TPY	Emission factor	PTE TPY	Emission Factor (In lb/ton unless otherwise noted)	PTE TPY
	Total Point Sources			67.8		9.4		27.1		0.7		1.4
	Total Coal Prep. Plant Fugitive											35
	Total Coal Mine Fugitive			27								239
	Total Assessable Emissions	361										

Source: ADEC (2014), TAR; Appendix A

According to ADEC, based on (i) the definition of coal preparation and processing plant, and (ii) EPA guidance addressing fugitive emissions, ADEC determined that specific Wishbone Hill emission units (Table 25 below) and activities be included as part of the coal preparation and processing plant.

Table 25 Coal Preparation and Processing Plan Emission Units

EU ID	Description
9	Coal Dumping—Crusher Feeder
10	Coal Dumping—Run-of-Mine Pile
11	Coal Reclaim—Run-of Mine Pile
12	Crusher
13	Transfer—Crusher to Conveyor 2
14	Transfer—Conveyor to Raw Stockpile
15	Transfer—Raw Stockpile to Conveyor 2
16	Transfer—Conveyor 2 to Jig Plant
17	Transfer—Jig Plant to Conveyor 3
18	Transfer—Conveyor 3 to Reject Stockpile
19	Transfer—Jig Plant to Conveyor 4
20	Transfer—Conveyor 4 to Clean Coal Stockpile
21	Transfer—Clean Coal Stock Pile to Conveyor 5
22	Transfer—Conveyor 5 to Loadout Bin
23	Transfer—Loadout Bin to Truck
25	Wind Erosion—Run-of-Mine Coal Stockpile
26	Wind Erosion—Raw Coal Stockpile
27	Wind Erosion—Clean Coal Stockpile
28	Wind Erosion—Reject Stockpile

Table 25 EUs "are included for the purposes of determining PSD applicability and minor air quality permit classification. Since surface coal mines are not among the listed stationary source categories (and are considered within Alaska SCMRA), the fugitive emissions associated with the surface coal mine, i.e., those emissions not associated with the *primary activity* of the listed stationary source, are not included for the purposes of permit classification (ADEC, TAR)."

- *Primary activities* associated with a coal preparation and processing plant include coal processing and conveying equipment (including breakers and crushers), coal storage systems, transfer and loading systems, and open storage piles.
- *Permit classification* per ADEC

Table 26 presents the emissions for the EUs listed in Table 25. As seen in Table 26, the coal preparation and processing plan EUs do not have CO, NO_2, SO_2 and VOC emissions.

Table 26 Coal Preparation and Processing Plan Emission Units, PTE-TPY

ID	Description	NO_x	CO	SO_2	VOC	PM_{10}
9	Coal Dumping-Crusher Feeder	N/A	N/A	N/A	N/A	16.148
10	Coal Dumping-Run of Mine Pile	N/A	N/A	N/A	N/A	5.383
11	Coal Reclaim-Run of Mine Pile	N/A	N/A	N/A	N/A	5.383
12	Crusher	N/A	N/A	N/A	N/A	3.679
13	Transfer- Crusher to Conveyor 1	N/A	N/A	N/A	N/A	0.183
14	Transfer- Conveyor to Raw Stockpile	N/A	N/A	N/A	N/A	0.183
15	Transfer- Raw Stockpile to Conveyor 2	N/A	N/A	N/A	N/A	0.183
16	Transfer-Conveyor 2 to Jig Plant	N/A	N/A	N/A	N/A	0.183
17	Transfer-Jig Plant to Conveyor 3	N/A	N/A	N/A	N/A	0.055
18	Transfer- Conveyor 3 to Reject Stockpile	N/A	N/A	N/A	N/A	0.055
19	Transfer-Jig Plant to Conveyor 4	N/A	N/A	N/A	N/A	0.067
20	Transfer-Conveyor 4 to Clean Stockpile	N/A	N/A	N/A	N/A	0.067
21	Transfer-Clean Stockpile to Conveyor 5	N/A	N/A	N/A	N/A	0.067
22	Transfer-Conveyor 5 to Loadout Bin	N/A	N/A	N/A	N/A	0.067
23	Transfer-Loadout Bin to truck	N/A	N/A	N/A	N/A	0.067
25	Wind Erosion-Run of Mine Coal Stockpile	N/A	N/A	N/A	N/A	0.977
26	Wind Erosion-Raw Coal Stockpile	N/A	N/A	N/A	N/A	0.366
27	Wind Erosion-Clean Coal Stockpile	N/A	N/A	N/A	N/A	0.835
28	Wind Erosion- Reject Stockpile	N/A	N/A	N/A	N/A	0.024
Total		N/A	N/A	N/A	N/A	**33.973**

N/A = Not Applicable

According to ADEC, in addition to point source emissions (EU IDs 1 and 2), fugitive particulate emissions from the coal preparation and processing plant (Table 26 above which includes EU IDs 9–23, and 25–28) are included for the purposes of determining PSD and minor air quality permit classification. The summary table for minor permit applicability is shown below (Table 27).

Table 27 Minor Permit Applicability (tpy)

Parameter	NO_x (TPY)	CO (TPY)	SO_2 (TPY)	PM-10 (TPY)	PM-2.5 (TPY)	VOC (TPY)	Total[3] (TPY)
900 hp diesel fired engine	61.3	7.8	10.0	0.8	0.8	0.6	361
10 MMBtu/hr diesel fired heater	6.5	1.6	17.2	0.6	0.14	0.1	
Fugitive dust emissions from the coal preparation and processing plant[1]	-	-	-	33.97	6.61	-	
PTE for Permit Applicability	67.8	9.4	27.2	35.36	7.55	0.7	
Minor Permit 18 AAC 50.502(c)(1) threshold (tpy)	40	100[4]	40	15	10	N/A	
Minor Permit Triggered?	Yes	N/A	No	Yes	N/A	No	
PSD Permit Thresholds (tpy)	250	250	250	250	250	250	
PSD Permit Triggered?	No	No	No	No	No	No	
Operating Permit Threshold (tpy)	100	100	100	100	100	100	
Operating Permit Triggered?	No	No	No	No	No	No	
Fugitive Emissions	27			239			
Assessable Emissions[2]	95	NA	27	239	NA	NA	

Table Notes
1. Fugitive emissions included in the applicability determination pursuant to 18 AAC 50.502(i). (see Section 1.3).
2. NA means not applicable. The potential to emit is less than 10 tons per year for CO, SO_2, PM-2.5, and VOC and these pollutant emissions are not included in the Total column or in the Assessable Emissions row. Additionally, PM-2.5 is a sub-set of PM-10 emissions and, to avoid double-counting of particulate emissions, PM-2.5 is not included in the Total column or in the Assessable Emissions row.
3. Reflects Total Assessable Emissions.
4. Applicable only if the source is located within 10 kilometers of a CO nonattainment area.

As shown in Table 27, the PM_{10} fugitive dust total (33.97 tpy) matches the quantity shown in Table 26. The 35 tpy PM_{10} value is based on the EU values in Table 3 (33.97) plus EU 1 & 2 (1.4 tpy), or approximately 35 tpy. According to the ADEC analysis, for minor permit purposes, only the PTE tpy for NO_x and PM_{10} triggered further assessment (PM_{10} >15 PTE tpy; NO_2 > 40 PTE tpy).

$PM_{2.5}$ Emissions

$PM_{2.5}$ emissions created by secondary formation from precursor emissions (i.e., SO_2, NO_x, VOCs and ammonia (NH3)) is a separate and more involved scientific/regulatory issue. The USEPA recently presented "guidance on demonstrating compliance with the fine particulate matter ($PM_{2.5}$) National Ambient Air Quality Standards (NAAQS) and Prevention of Significant Deterioration (PSD) increments, especially with regard to considerations of the secondarily formed component of $PM_{2.5}$. This document reflects the EPA's recommendations for how a *major stationary source seeking a PSD permit* [emphasis added] may demonstrate that it will not cause or contribute to a violation of the NAAQS and PSD increments for $PM_{2.5}$, as required under section 165(a)(3) of the Clean Air Act (CAA) and 40 CFR Sections 51.166(k) and 52.21 (k). According to the 2014 EPA guidance, "the EPA is recommending four different assessment cases shown in Table 28 that define which air quality analyses, if any, a permit applicant should conduct to demonstrate compliance with the $PM_{2.5}$ NAAQS and PSD increments".[38]

Table 28: Recommended Assessment Cases that Define Needed Air Quality Analyses of Source Impacts[3]

Assessment Case	Description of Assessment Case	Assess Primary Impacts of Direct $PM_{2.5}$ Emissions?	Assess Secondary Impacts of Precursor Emissions of NO_x and/or SO_2?
Case 1: No Air Quality Analysis	Direct PM2.5 emissions < 10 tpy SER NOx and SO2 emissions < 40 tpy SER	NO	NO
Case 2: Primary Air Quality Impacts Only	Direct PM2.5 emissions ≥ 10 tpy SER NOx and SO2 emissions < 40 tpy SER	YES	NO
Case 3: Primary and Secondary Air Quality Impacts	Direct PM2.5 emissions ≥ 10 tpy SER NOx and SO2 emissions ≥ 40 tpy SER	YES	YES
Case 4: Secondary Air Quality Impacts Only	Direct PM2.5 emissions < 10 tpy SER NOx and SO2 emissions ≥ 40 tpy SER	NO	YES

For Case 4, "Secondary Air Quality Impacts Only" ($PM_{2.5}$<10 tpy SER and NO_x and/or SO_2 emissions> 40 tpy SER), EPA states,

"For "Case 4—Secondary Air Quality Impacts Only," if the direct $PM_{2.5}$ emissions are less than the SER of 10 tpy, but the NO_x and/or SO_2 precursor emissions are greater than or equal to the respective SERs of 40 tpy, then a modeled $PM_{2.5}$ compliance demonstration for the direct $PM_{2.5}$ emissions is not required, but the permit applicant should assess the potential impact of the significant precursor emissions from the project source. Similar to "Case 3," the accounting of the precursor emissions impact on secondary $PM_{2.5}$ formation may be: a) qualitative in nature; b) based on a hybrid of qualitative and quantitative assessments utilizing existing technical work; or c) a full quantitative photochemical grid modeling exercise. Again, the EPA anticipates that only a limited number of situations would require explicit photochemical grid modeling."

$PM_{2.5}$ primary and/or secondary analysis is complex and is further clarified in the ADEC Response To Comments (AQ1227MSSS04 RTC 061014), see specifically ADEC response 3.a.

$PM_{2.5}$ Analysis

The quantity of $PM_{2.5}$ shown in Table 27 is based on an individual EU assessment of converting potential PM_{10} emissions to potential $PM_{2.5}$ emissions. This conversion is accomplished using published emission factors per EU. ADEC provided this analysis (Shown below as Table 29) in their "Response To Comment (RTC)" AQ1227MSS04 RTC 061014, response 8.i (pg. 41 of 59). As shown in Tables 27& 29, the ADEC compared calculated PTE tpy emissions for the various pollutants against (i) minor permit and (ii) PSD permit thresholds. It is important to note that fugitive and mobile sources were not part of permit applicability and were therefore not quantified in the permit. Therefore, EUs 3-8 (approximately 40 tpy) and EUs 24 (41 tpy) and 29-36 (124 tpy) are not considered in these specific permit particulate matter threshold calculations, i.e., PM_{10} to $PM_{2.5}$ conversion is performed for these EUs. The total potential

PM_{10} tpy from EUs 3-8, 24 and 29-36 is 205 tpy. The conversion PM_{10} to $PM_{2.5}$ would depend on the conversion factor used which would typically be 10-15% with a range from 1-40.[39] Depending upon the conversion ratio utilized the $PM_{2.5}$ would likely be between 20 tpy (using 10%) to 31 tpy (15%).

The $PM_{2.5}$ emission threshold for a minor permit is 10 tpy. The 10 tpy threshold is based on EPA modeling work that is discussed in "Implementation of the New Source Review (NSR) Program for Particulate Matter Less Than 2.5 Micrometers ($PM_{2.5}$)" [**Federal Register** / Vol. 73, No. 96 / Friday, May 16, 2008 / Rules and Regulations]. EPA based their analysis "on determining the size of a source of direct $PM_{2.5}$ emissions that would be expected to have an ambient impact of 4 percent or more of the NAAQS. This relationship holds true regardless of the origin of the particles that make up the ambient $PM_{2.5}$."

The $PM_{2.5}$ annual NAAQS for $PM_{2.5}$ is 12 $\mu g/m^3$. The EPA determination indicates that a 10 tpy $PM_{2.5}$ would have an annual incremental impact of less than 0.5 $\mu g/m^3$. In this Federal Register rule, the EPA does not discuss whether this is a linearly scalable function, i.e., a 20 tpy increase would be an approximately 1 $\mu g/m^3$ increment added to annual baseline. Potential daily changes are not addressed; however, the incremental increase over background is likely to be extremely small. In the toxicology section of the HIA, the concentration-response relationship between changes in particulate matter (either PM_{10} or $PM_{2.5}$) is discussed.

Table 29 Potential $PM_{2.5}$ Emissions

ID	Description	Basis for Emission Factor	Potential PM-10 Emissions (tpy)	PM-2.5/ PM-10 Ratio	Potential PM-2.5 Emissions (tpy)
1	Diesel-fired Engine	Vendor Data	0.8	ND[1]	0.80
2	Diesel-fired Heaters	AP-42 Tables 1.3-1, 1.3-6	0.6	0.240	0.14
9	Coal Dumping - Crusher Feeder	AP-42 Table 11.9-1	16.1	0.144	2.32
10	Coal Dumping - Run-of-Mine Pile	AP-42 Table 11.9-1	5.4	0.144	0.78
11	Coal Reclaim from Run-of-Mine Pile	AP-42 Table 11.9-1	5.4	0.144	0.78
12	Coal Crusher	AP-42 Table 11.19.2-2	2.2	ND[2]	2.20
13	Transfer - Crusher to Conveyor 1	AP-42 Section 13.2.4, Eq. 1	0.2	0.151	0.03
14	Transfer - Conveyor 1 to Raw Stockpile	AP-42 Section 13.2.4, Eq. 1	0.2	0.151	0.03
15	Transfer - Raw Stockpile to Conveyor 2	AP-42 Section 13.2.4, Eq. 1	0.2	0.151	0.03
16	Transfer - Conveyor 2 to Jig Plant	AP-42 Section 13.2.4, Eq. 1	0.2	0.151	0.03
17	Transfer - Jig Plant to Conveyor 3	AP-42 Section 13.2.4, Eq. 1	0.1	0.151	0.02
18	Transfer - Conveyor 3 to Reject Stockpile	AP-42 Section 13.2.4, Eq. 1	0.1	0.151	0.02
19	Transfer - Jig Plant to Conveyor 4	AP-42 Section 13.2.4, Eq. 1	0.1	0.151	0.02
20	Transfer - Conveyor 4 to Clean Stockpile	AP-42 Section 13.2.4, Eq. 1	0.1	0.151	0.02
21	Transfer - Clean Stockpile to Conveyor 5	AP-42 Section 13.2.4, Eq. 1	0.1	0.151	0.02
22	Transfer - Conveyor 5 to Loadout Bin	AP-42 Section 13.2.4, Eq. 1	0.1	0.151	0.02
23	Transfer – Loadout Bin to Truck	AP-42 Section 13.2.4, Eq. 1	0.1	0.151	0.02
25	Run-of-Mine Coal Stockpile	AP-42 Section 13.2.5, Eq. 2 & 3	0.9	0.150	0.14
26	Raw Coal Stockpile	AP-42 Section 13.2.5, Eq. 2 & 3	0.4	0.150	0.06
27	Clean Coal Stockpile	AP-42 Section 13.2.5, Eq. 2 & 3	0.7	0.150	0.11
28	Reject Stockpile	AP-42 Section 13.2.5, Eq. 2 & 3	0.02	0.150	0.00
Total PTE from All Point Emission Units			1.4		0.94
Total PTE from Coal Preparation and Processing Plant Fugitive Emission Units			32.6		6.61
Total PTE from All Emission Units for Permit Applicability Determinations			34.0		**7.55**
PSD Permit Applicability Threshold for Coal Preparation and Processing Plant			100		100
PSD Applicable			No		No
Minor Air Quality Permit Applicability Threshold (18 AAC 50.501(c)(1)(A))			15		10
Minor Permit Applicable under 18 AAC 50.502(c)(1)(A)			Yes		No

Notes: [1] No vendor data on PM-2.5 available; assume PM-2.5 = PM-10 as worst-case
[2] No uncontrolled crusher PM-2.5 data available; assume PM-2.5 = PM-10 as worst-case

Additionally, the *Background Document for Revisions to Fine Fraction Ratios used for AP-42 Fugitive Dust Emission Factors* *(AP-42, Chapter 13.2.2) states "PM-2.5 / PM-10 ratios for fugitive dust should be in the range of 0.1 to 0.15. Currently, the fine fraction ratios in AP-42 range from 0.15 to 0.4 for most fugitive dust sources." Based on the PM-2.5 / PM-10 ratios provided above, the Background Document suggests that the PM-2.5 PTE calculations are within an acceptable range.*

HAPs

Hazardous air pollutants (HAPs) were also considered. HAPs include the VOCs. Total HAP emissions, as tpy, were estimated at less than 1.0, a level well below regulatory thresholds that would require additional analysis (see Table 27).

PCOC Analysis

As assessed by ADEC, only two PCOCs, PM_{10} and NO_2, exceeded defined permit thresholds. The project required an ambient NO_2 and PM_{10} analysis per 18 AAC 50.540(c)(2)(A), because the NO_2 emissions from the new source are predicted to be greater than 40 tons per year and PM_{10} emissions are predicted to be greater than 15 tons per year (see Table 27). An ambient analysis is not required by ADEC for other project pollutants since they are emitted at less than applicable thresholds (see Table 27); hence, there are no modeled exposure point concentrations for CO, SO_2, VOCs, and $PM_{2.5}$. Secondary $PM_{2.5}$ air quality issues, including precursor effects are discussed in earlier sections of this analysis.

Modeled Air Concentrations

ADEC presented modeled air concentration data for PM_{10} and NO_2. The PM_{10} concentration calculation considered total emissions from all EUs, i.e., #1-36. Similarly all NO_2 EUs were considered in the concentration modeling analysis. The results of the air modeling concentration are shown in Table 30.

Table 30 Maximum Total Impacts Compared to NAAQS

Maximum Total Impacts Compared to the AAAQS

Air Pollutant	Avg. Period	Maximum Modeled Conc [1] (µg/m³)	Bkgd Conc (µg/m³)	TOTAL IMPACT: Max conc plus bkgd (µg/m³)	AAAQS (µg/m³)
NO_2	1-hr	147.4[2]	37.6	**185**	188
	Annual	43.2[2]	18.8	**62**	100
PM-10	24-hr	79.4[3]	28.5	**108**	150

1. The maximum modeled concentration reflects the high second-high 24-hour PM-10 concentration; the maximum annual NO_2 concentration; and the 98th percentile of the maximum daily 1-hour NO_2 concentrations.
2. The NO_2 modeling results include the following changes:
   a. Enviroplan's revision to the 12-hour daily blast "window" and the correction to the NOx emission rate for EU 2, as described in Appendix B;
   b. The inclusion of tailpipe emissions; and
   c. The additional receptors summarized in Section 1.5 of this TAR.
3. The PM-10 modeling results include the following changes:
   a. A 50-percent rather than 80-percent control efficiency for EU 3 and 29;
   b. Conveyor belt emissions; and
   c. The additional receptors summarized in Section 1.5 of this TAR.

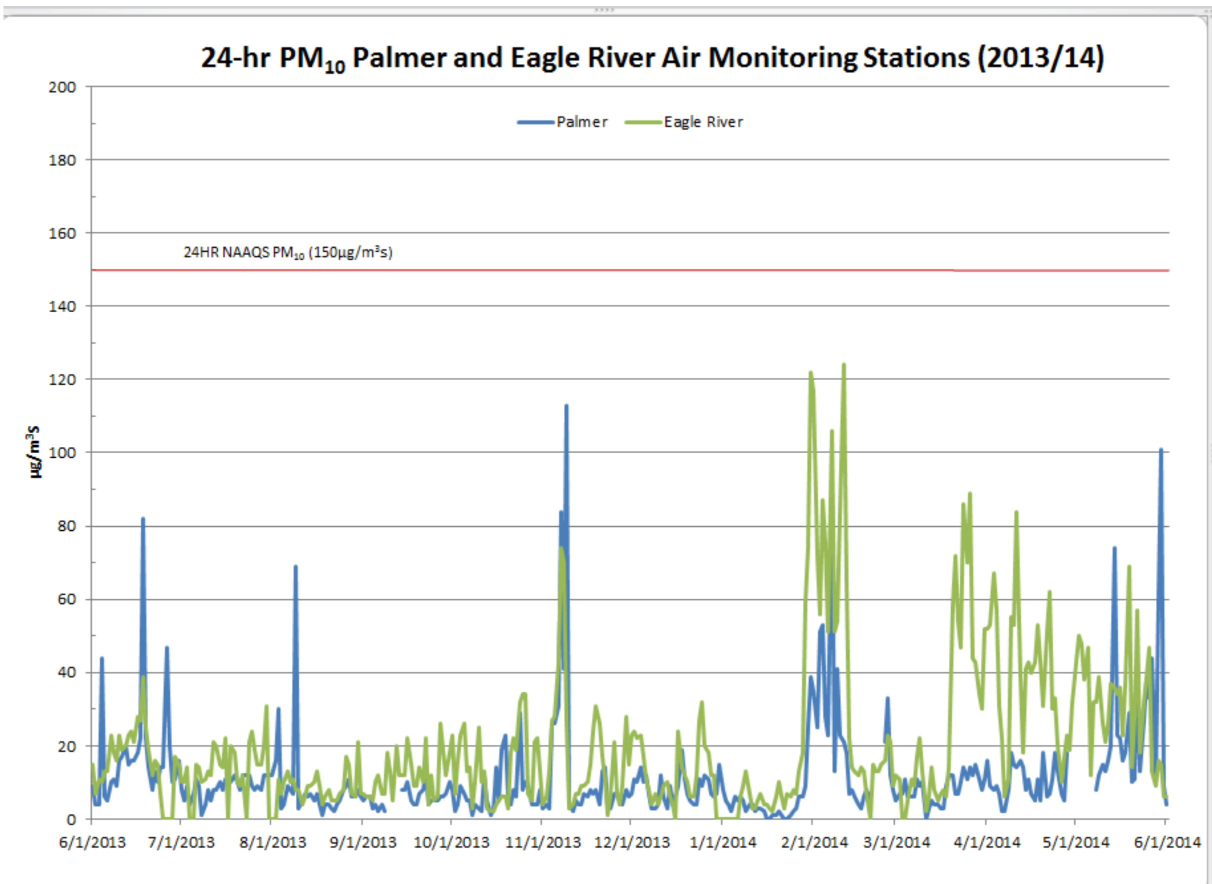
As illustrated in Table 30 the critical increments are 79.4 µg/m^3 for PM_{10} (24-hr) and 147.4 µg/m^3 for NO_2 (1-hr). According to ADEC, "the background concentration represents impacts from sources not included in the modeling analysis. Typical examples include natural, area-wide, and long-range transport sources. The background concentration must be evaluated on a case-by-case basis for each ambient analysis. Once the background concentration is determined, it is added to the modeled concentration to estimate the total ambient concentration." The choice and decisions for background air monitoring stations and time frames are presented in the ADEC TAR. Occasionally, natural events such as dust storms or forest fires pose short term increases in background concentrations. US EPA has established exceptional event rules for analyzing natural event triggered exceedances of the NAAQS.[40]

The modeled concentrations will vary with distance and direction from each EU. ADEC states, "Lower impacts would occur in all other areas of the modeling domain and beyond. The maximum 24-hour PM_{10} impact occurs along the access road and the western perimeter of the mine near the location of the open pit source."

The maximum 1-hr NO_2 and annual impacts are predicted to occur along the western perimeter of the mine, a location in close proximity to the location of a blast. The 1-hr NO_2 (98th percentile) calculation assumes that the instantaneous blast emission rate is constant over an entire hour and occurs at the same location all year long. ADEC states that these are highly conservative (if not artifactual) assumptions.

The HIA reviewed background air concentrations for available PCOCs. The most current 12- month background PM_{10} and $PM_{2.5}$ air quality data for Eagle River and Palmer air stations are shown below (similar NO_x data are not available). These data represent the June 2013 –June 2014 time period.

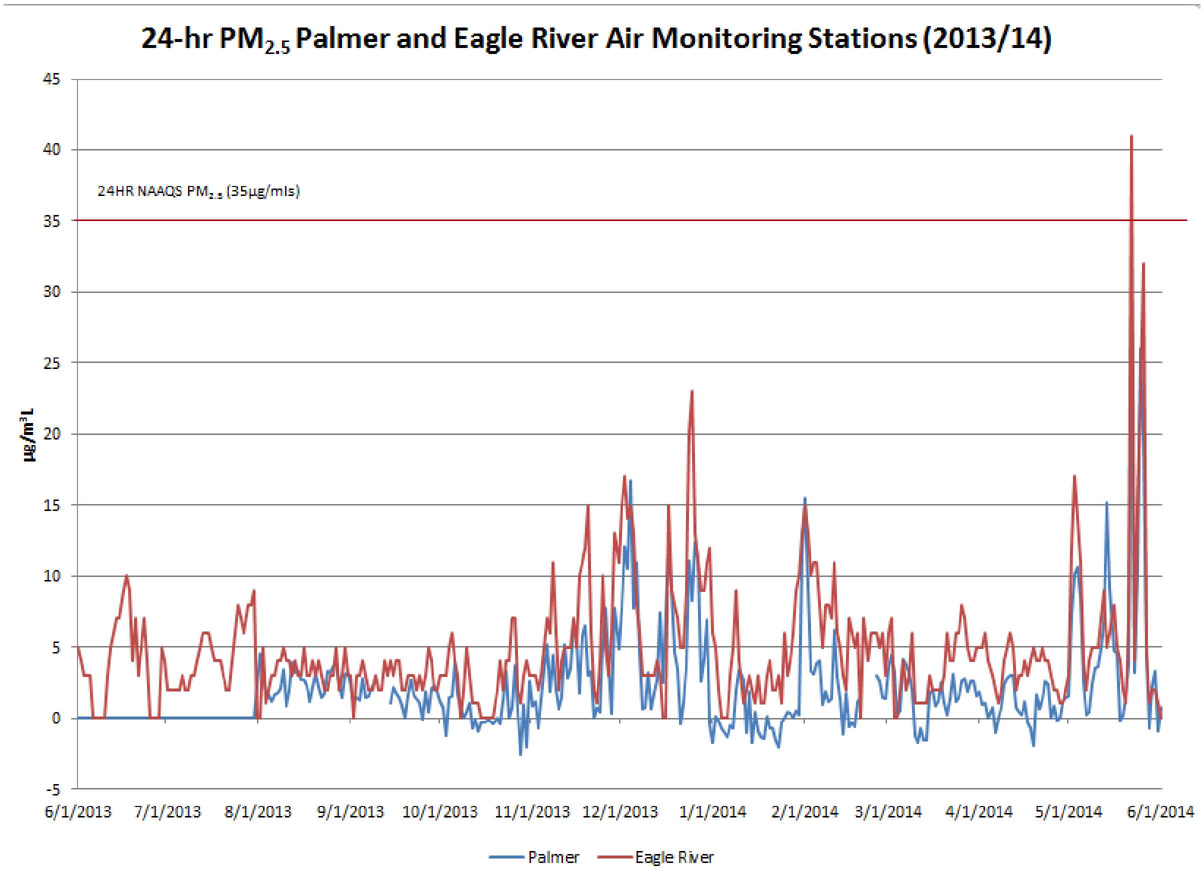
Figure 14 24-hr PM_{10} Palmer and Eagle River Monitoring Stations (June 2013-June2014)



As illustrated in Figure 1, the Palmer and Eagle River time sequence data is generally coherent although there are differences in the magnitude of concentration peaks. Wishbone air modeling concentration isopleths are presented in the AQ1227MSS04 Application 062313- "Application for an Air Quality Control Minor Permit;" prepared by SLR for Usibelli Coal Mine (June 2013). Whether the total PM_{10} concentration would approach or exceed NAAQS for 24-hr PM_{10} is strongly dependent upon the location, ambient background conditions and potential incremental from the Wishbone Coal Mine.

A similar situation exists for $PM_{2.5}$ as shown in Figure 15. The extremely high background $PM_{2.5}$ level shown in June 2014 is related to a large forest fire. Again, whether the total $PM_{2.5}$ concentration would approach or exceed NAAQS for 24-hr PM_{10} is strongly dependent upon the location, ambient background conditions and potential incremental from the Wishbone Coal Mine. $PM_{2.5}$ isopleths are not available as per previous discussion in this overall analysis.

Figure 15 24-hr $PM_{2.5}$ Palmer and Eagle River Monitoring Stations (June 2013-June2014)



The potential health impacts of the modeled air contaminants are discussed in both the toxicology analysis (Section 5.0) and the overall impact sections (Section 7.0) of the HIA.

4.5.9 Physical Exposures- Noise and Visual Effects

Two important physical effects for potentially affected communities are noise and visual effects (night illumination). Both issues were raised in stakeholder comments.

In November 2008 a noise consultant, Mullins Acoustics, performed baseline noise measurements. According to their study:

> "The background noise levels in some locations were quite low, since this is a very rural area. We saw average levels as low as 26 dBA for nighttime hours on a calm night. Noise levels were considerably higher when the wind began blowing through this area, which occurred starting at 3 am on Saturday. Hourly sound levels increased from 35 dBA when calm, to as high as 55 dBA, with the only difference being the wind noise. Wind is a common occurrence in the Matanuska valley.
>
> "Many home sites are fairly far from the Glenn Highway, and are further sheltered by terrain. The highway is located mostly in the river canyon, whereas most of the homes are up on ridges and plateaus. In these more remote areas, the primary noise events are local traffic coming to and from the neighborhoods, wind noise, and general aviation aircraft flyovers."

In summary,

- The potential incremental noise addition from the proposed project to background is unknown.
- There are no visual effects studies available for review.

4.6 HEC 4: Food, Nutrition, and Subsistence Activity

The Alaska Federation of Natives (AFN) describes subsistence as "the hunting, fishing, and gathering activities which traditionally constituted the economic base of life for Alaska's Native peoples and which continue to flourish in many areas of the state today."[29]

Subsistence is part of a rural economic system, called a "mixed, subsistence-market" economy, wherein families invest money into small-scale, efficient technologies to harvest wild foods. Fishing and hunting for subsistence resources provide a reliable economic base for many rural regions. Subsistence is focused toward meeting the self-limiting needs of families and small communities.[41] Participants in this mixed economy in rural Alaska augment their subsistence production by cash employment. Cash (from commercial fishing, trapping, and/or wages from public sector employment, construction, fire fighting, oil and gas industry, or other services) provide the means to purchase the equipment, supplies, and gas used in subsistence activities. The combination of subsistence and commercial-wage activities provides the economic basis for the way of life so highly valued in rural communities.[41]

The State of Alaska confirms that subsistence fishing and hunting are important sources of employment and nutrition in almost all rural communities.[29] Subsistence is a source of nutrition for residents in areas of Alaska where food prices are high. While some people earn income from employment, these and other residents rely on subsistence to supplement their diets throughout the year. Furthermore, subsistence activities support a healthy diet and contribute to residents' overall wellbeing. Subsistence is a central aspect of life for many tribes, including Chickaloon Native Village, and is rooted in the Tribe's traditional ties to their environment. In addition to providing nutritional resources, subsistence practices also strengthen community and family ties, build cultural identity, and support a traditional worldview.

Based on materials (believed to represent opinions and data circa 1991) prepared in the "Permit," the Project area is wholly within Game Management Unit (GMU) 14A, which has been designated a non-rural area by the joint Alaska Boards of Fisheries and Game.[3] Anyone living within Game Management Unit 14A is not eligible for subsistence use status. However, there may be individuals living outside GMU 14A in rural areas who qualify to use subsistence resources within the area because they have customarily and traditionally done so. The State of Alaska has established criteria for determining if customary and traditional use of subsistence resources pertains in specific instances (Alaska Game Regulations, No. 25, p. 66).

According to the permit materials (Part C Chapter XIII), these criteria were applied to the hunting of moose in GMU 14A by individuals living outside the unit, and it was determined by the Alaska Board of Game that there was no customary and traditional hunting of moose in GMU 14A. Inhabitants of the closest Native community outside of GMU 14A, those individuals living in the portion of Chickaloon located to the east of the Chickaloon River, do not appear to have traditionally conducted extensive harvests of subsistence species as far west as Wishbone Hill, as is indicated by the decision of the Board.

Permit opinions and conclusions state that:

- Though moose occur in the project area, limited runs of salmon are found in Moose Creek, and other subsistence species may be present in the near vicinity, the project area does not appear to possess enough resource potential to have been the focus of intensive subsistence species harvest activities in the past or in more recent times.

- There is no indication in the ethnographic literature that the project area was particularly important to Native people for subsistence use purposes during the historic period.
- There does not appear to be any legal foundation for subsistence use today of natural resources by Native Alaskans living within GMU 14A, which encompasses the project area.
- Because there was no customary and traditional hunting of moose or use of other subsistence species in GMU 14A, subsistence use of natural resources there by Native Alaskans living outside GMU 14A is not permitted under current regulations.
- The few households with Alaskan Native members in Chickaloon, the nearest community of any size, do not appear to conduct subsistence species harvest activities as far west as Wishbone Hill.
- While some use of natural resources does take place today in the project area, the harvest appears to be neither substantial nor of particular importance to an identifiable subsistence resource user group.

Additionally, it is important to note that there have been significant and successful attempts to upgrade and restore salmon habitat in Moose Creek since 2008 (see Fish/Aquatics section 4.5.7 above).

4.6.1 Contribution of Subsistence Activities

Chickaloon was the only community surveyed by the ADF&G; the most recent harvest data for Chickaloon was collected in 1982.[42] That report indicates that almost 90% of the residents of Chickaloon (estimated at 70 persons in 1982) participated in subsistence harvesting. The survey estimates that the annual wild food harvest in the Chickaloon area in 1982 was approximately 15,650 pounds in useable weight for the entire community, an average of 223 pounds per person. Almost 78% of the harvesters reported gathering fish, including salmon, grayling, and rainbow trout. Almost 45% of those surveyed reported harvesting moose and 55.6 % reported harvesting upland birds. In the last 10 years, the Chickaloon Village Traditional Council has undertaken efforts to restore the fish passage and salmon populations on Moose Creek.

Two-thirds of Chickaloon households surveyed in the 1982 ADF&G picked berries for a mean household harvest of 30 quarts, among the highest berry harvests reported in the study. Blueberries, cranberries, currants, and raspberries were popular. Slightly less than one-third of the households collected wild plants, with mushrooms being the most commonly harvested plant resource. Overall, 49% of the mean household harvest of wild resources by Chickaloon households was composed of big game and 37% was fish. Berries and plants made up 8% of the harvest, and small game the remaining 7%. Chickaloon households harvested an average of 7.4 resources, in the lower third among surveyed communities.

Specific information for use of the project area indicate the three resource use areas are the lower Moose Creek valley for freshwater fish, most of the Moose Creek drainage for furbearers, and the entire project area for moose (Alaska Habitat Management Guide Reference Maps, Alaska Department of Fish and Game 1985) for the Southcentral region (Volume III).[3] The Matanuska Valley Moose Range Management Plan[4] estimates that 500-1000 angler days effort per year are expended in fishing for rainbow and Dolly Varden in Moose Creek. Moose Creek has been an important salmon stream for the Chickaloon Native Village. Moose Creek was rerouted several times as part of railroad construction for the coal mining industry from the 1920s to the 1980s. This construction impeded salmon from traveling up the stream. The Chickaloon Village Traditional Council began restoring Moose Creek in 2005. Restoration efforts were successful and Moose Creek is again a location for subsistence activities.[43]

In addition to a relatively unquantified subsistence contribution, the Mat-Su Valley has been a productive agricultural area with farms, dairies and gardens since it was settled in the 1930s. The area has grown not only in population but also in retail services, including grocery stores. The County Health Ranking systems states that "Access to healthy foods is measured as the percent of zip codes in a county with a healthy food outlet, defined as a grocery store or produce stand/farmers' market."[44] In 2011, the measure was based on the percent of residential zip codes in a county with a healthy food outlet, defined as grocery stores or produce stands/farmers' markets." According to the rankings 100% of the households in the Mat-Su Borough have access to healthy foods, compared to 56% of all Alaskan households and 92% of all American households.[44]

4.6.2 Food Security

Food security means having enough food to fully meet basic needs at all times. According to the Food and Agricultural Organization of the United Nations, "Food security is a situation that exists when all people, at all times, have physical, social and economic access to sufficient, safe and nutritious food that meets their dietary needs and food preferences for an active and healthy life".[45] At present, there are no known acute shortages of major dietary components (e.g., proteins, carbohydrates, grains, fruits, or vegetables) in any of the potentially affected communities. While many residents in the communities engage in subsistence hunting, fishing, and gathering as a part of their diets, it is not known what percent of their food supply currently comes from subsistence activities.

4.6.3 Food costs

The University of Alaska Fairbanks (UAF), Cooperative Extension Service, performs a Food Cost Survey (FCS) every quarter. Information on the specific vegetables, fruits, grains, carbohydrates and proteins included as well as quarterly results for the last 10 years is available online.[46]

The UAF CFS reports that in March 2012 (the last quarter available) it cost a family of 4, $157.71 to purchase the 104 items in the market basket at a grocery store in Palmer-Wasilla, $11 more than the same products cost in Anchorage. This weekly cost equates to almost $8,200 for food over the course of a year or 12% of the annual median family income for Mat-Su Borough residents (see Table 13). This same market basket, purchased in the Palmer-Wasilla area would equate to 13% of total household income for residents of Sutton. The same basket purchased in Sutton is expected to cost slightly more due to increased food prices in the smaller communities.

4.6.4 Micronutrient Deficiencies

There are no reported deaths by malnutrition or other nutritional disorders in the Mat-Su Borough. Information on clinical visits for these conditions is not available at this time, but incidence is generally low and not likely related to involuntary nutritional limitations.

4.6.4.1 Potential Issues

- There is no Traditional and Local Knowledge survey

- Subsistence data and analysis does not appear to have been updated for two decades

4.7 HEC 5: Infectious Diseases including STIs

Reportable infectious diseases are an important performance indicator and were the cause of 34 deaths in the Mat-Su Borough from 2007 to 2009 (Table 31). Pneumonia, septicemia and viral hepatitis were the major contributors in terms of number of deaths. No influenza deaths were reported during the same time period. Age adjusted rates were similar to those experienced in the State of Alaska.

Table 31 Infectious and Parasitic Disease Caused Deaths, Matanuska – Susitna Borough and State of Alaska, 2007 – 2009[30]

	Mat-Su Borough		State of Alaska	
Cause of Death	**Deaths**	**Age-Adjusted Rate**[a]	**Deaths**	**Age- Adjusted Rate**[a]
Infectious and Parasitic Disease	22	11.6	218	14.1
Tuberculosis	1	**	9	6[b]
Septicemia	8	6.3[b]	80	6.3
Viral hepatitis	8	2.7[b]	63	2.9
HIV disease	2	**	25	1.2
All other infectious disease	3	**	41	3.1
Influenza and Pneumonia	12	10.4[b]	148	12.5
Influenza	0	0.0	11	7[b]
Pneumonia	12	10.4[b]	137	11.8

[a]Age-adjusted rates are per 100,000 U.S. year 2000 standard population
[b]Rates based on fewer than 20 occurrences are statistically unreliable and should be used with caution
**Rates based on fewer than 6 occurrences are not reported

The Bureau of Vital Statistics does not report infectious disease data by race; data from the Alaska Native Epidemiology Center is used to discuss the data for Alaska Natives. Overall reportable infectious disease cases for all Alaska Natives January 2007-October 2008 are shown in Table 32.

Table 32 Reportable Infectious Disease Cases, Alaska Natives, January 1, 2007-October 3, 2008

Infectious Disease	Cases	Percent of Total
Chlamydia	4,103	79.3
Gonorrhea	476	9.2
Hepatitis C	198	3.8
Pneumococcal invasive	135	2.6
Tuberculosis, Pulmonary	52	1.0
Chlamydia, PID	37	0.7
Pertussis	32	0.6
Salmonella	25	0.5
GAS invasive disease	24	0.5
GBS invasive disease	18	0.3
Chicken Pox	15	0.3
Botulism, Foodborne	13	0.3
Campylobacter	12	0.2
Gonorrhea, PID	9	0.2
Invasive H Flu, Not Meningitis	7	0.1
Giardia	5	0.1
Hepatitis B	3	0.1
Meningitis, Haemophilus	3	0.1
Other Infectious Diseases	10	0.2
Total	5,177	100.0

Source: Alaska Native Epidemiology Center 2009

Alaska had the highest Chlamydia trachomatis (CT) infection rate in the nation in 2010, and has consistently had the first or second highest rate in the nation since 2000. CT is a bacterium that can cause pelvic inflammatory disease (PID), ectopic pregnancy, infertility, and preterm labor. Infants born to infected women are at risk for neonatal conjunctivitis and pneumonia. Untreated CT infections in men can cause epididymitis, Reiter syndrome, and infertility.

A total of 6,026 cases of urogenital CT infection were reported to State Office of Epidemiology in 2010; Alaska's CT case rate was 849 per 100,000 persons. This represents a 13% increase compared to 2009 and is more than twice the 2010 US rate of 417 per 100,000 persons. Alaskan women (66%), adolescents and young adults (68% were under 25 years of age), and Alaska Natives (47%) are disproportionally impacted by CT. The 2010 increase in co-infection with Neisseria gonorrhoeae is likely associated with the recent statewide increase in gonococcal infection.[47]

The CT rates were highest in the Northern region (2250 cases per 100,000 persons), followed by the Southwest (1803 cases per 100,000 persons), the Interior (816 cases per 100,000 persons), Anchorage/Mat-Su (806 cases per 100,000 persons), and Southeast (601 cases per 100,000 persons).

Sexually Transmitted Infections (STIs) comprised 89.4% of all Alaska Native reportable infectious disease cases. Chlamydia was by far the most commonly reported infectious disease, accounting for 80% of all reported infectious diseases. Gonorrhea is an STI caused by the bacterium Neisseria Gonorrhea. The Chlamydia rate reported for Alaska Native men is about 4 times greater than is reported for Alaska White men. The Chlamydia rate reported for Alaska Native women is about 7 times greater than is reported for Alaska White women.

HEC 6: Chronic Non-communicable Disease

4.7.1 Cardiovascular Diseases

Cardiovascular disease is a category of disorder affecting the heart and blood vessels, and includes coronary heart disease, other diseases of the heart, arteriosclerosis, hypertension and cerebrovascular disease.

Table 33 presents data regarding the number and age-adjusted rates of death caused by major cardiovascular diseases between 2007 and 2009 in the Mat-Su Borough and the State of Alaska. Diseases of the heart were the second most common cause of deaths in the Mat-Su Borough in 2009 (149.6 deaths per 100,000 people). Cardiovascular diseases rates are lower in the Mat-Su Borough than the state as a whole.

Table 33 Major Cardiovascular Disease Deaths, Matanuska -Susitna Borough and the State of Alaska, 2007 – 2009[30]

	Mat-Su Borough		State of Alaska	
Cause of Death	Deaths	Age- Adjusted Rate[a]	Deaths	Age- Adjusted Rate[a]
Major Cardiovascular Diseases	**306**	**219.4**	**2567**	**204.9**
Heart disease	233	163.2	1945	151.2
Ischemic heart disease	132	89.4	1152	87.6
Acute myocardial infarction	29	18.1	232	19.2
Atherosclerotic cardiovascular disease	41	20.7	484	31.0
All other ischemic heart disease	62	50.7	436	37.5
All other heart disease	101	73.8	793	63.5
Cerebrovascular disease	49	40.1	488	43.1
All other cardiovascular diseases	24	16.2	134	10.7

[a]Age-Adjusted rates are per 100,000 U.S. year 2000 standard population

4.7.2 Cerebrovascular Diseases

The age-adjusted death rate in the Mat-Su Borough for all races caused by cerebrovascular diseases between 2007 and 2009 was 40.1 deaths per 100,000 people lower than the state rate of 43.1 deaths per 100,000 people (Table 33).

The Alaska Department of Health and Social Services (ADHSS), Division of Public Health gathers information on the percentage of adults of all races over 18 years of age who self-reported via the Behavioral Risk Factor Surveillance System (BRFSS). In response to the question: “Has a doctor, nurse, or other health professional EVER told you had a stroke?” 3.2% of Mat-Su Borough said “Yes” while a mean of 2.4% of all Alaskans said “Yes” during the 2008–2010 survey period.[48] No incidence data are available. The Alaska HIA Program also reviewed hospital discharge data from 2001-2007 for hospital visits in the Mat-Su Borough related to cardiovascular and cerebrovascular conditions. Hospital visits with an ICD-9 code related to respiratory disease were categorized by health condition group (Table 34).

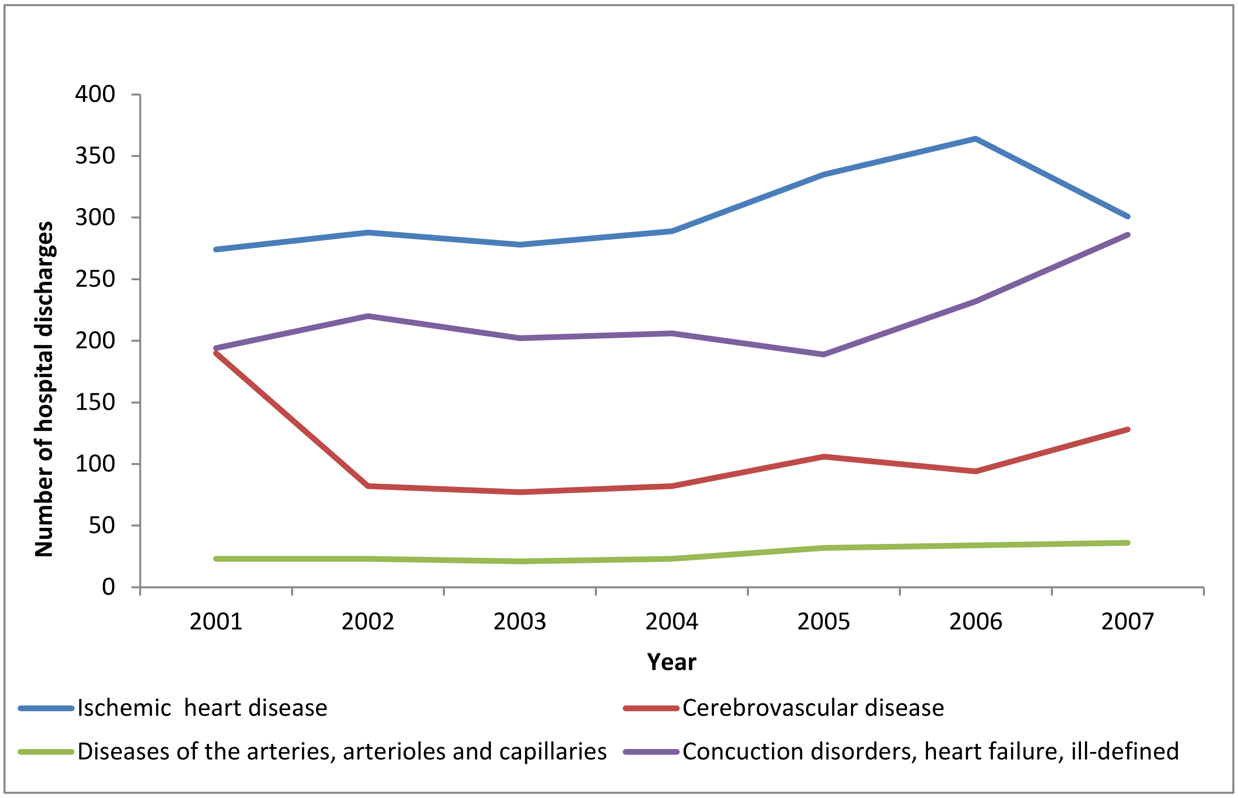
Table 34 Number of hospital discharges by ICD-9 code grouping, top cardiovascular conditions, 2001-2007

ICD-9 Code	Health Condition Group	N*
410-414	Ischemic heart disease	2129
426-429	Conduction disorders, cardiac dysrythmias, heart failure, ill-defined descriptions of heart disease	1529
430-438	Cerebrovascular disease	759
440-448	Diseases of the arteries, arterioles, and capillaries	192

*Number of hospital visits

The leading cardiovascular-related health condition groups of interest were ischemic heart disease (40.1%), cerebrovascular disease (16.5%), diseases of the arteries, arterioles and capillaries (3.6%), and other conditions, which includes conduction disorders, cardiac dysrythmias, heart failure, and ill-defined descriptions of heart disease (28.8%) (Figure 16).

Figure 16 The annual number hospital discharges coded under asthma for residents of the Matanuska-Susitna Borough, 2001-2007.



4.7.3 Asthma

Chronic lower respiratory diseases, including asthma, chronic obstructive pulmonary disease, bronchitis, and emphysema, were among the top five leading causes of death in the Mat-Su Borough in 2009, accounting for 22 deaths.

In terms of lung-related health conditions, the ADHSS, Division of Public Health[48] indicated that 16.9% of adults over the age of 18 answered yes to the following question: "Have you ever been told by a doctor, nurse, or other health professional that you had asthma?" The mean response for all Alaskans was 14.2%. The self-reported rate has increased since the question was tabulated in 2000–2002 when the mean Alaska response was 11.4% Yes and the Yes response for residents of the Mat-Su Borough was 12.1%.[48]

In addition to reviewing self-reported asthma rates, the Alaska HIA Program reviewed hospital discharge data from 2001-2007 for asthma-related hospital visits in the Mat-Su Borough. Hospital visits with an ICD-9 code related to respiratory disease were categorized by health condition group (Table 35).

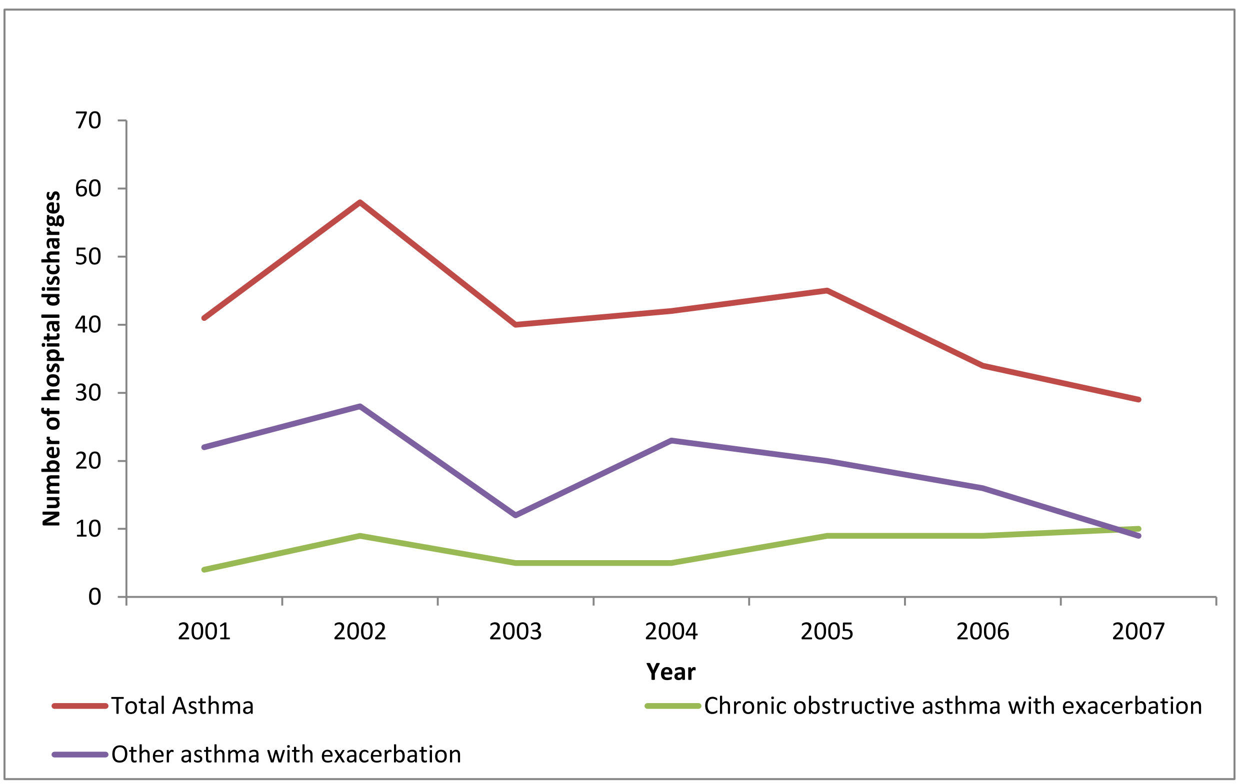
Table 35 Number of hospital discharges by ICD-9 code grouping, top respiratory conditions, 2001-2007

ICD-9 Code	Health Condition Group	N*
464-466	Respiratory tract infections	190
480-487	Pneumonia, influenza	1099
490-492	Bronchitis, emphysema	359
493	Asthma	289

*Number of hospital visits

The number of discharges coded under asthma remained relatively stable in the period from 2001 to 2007 (Figure 17). In fact, the number of asthma-related hospital discharges for Mat-Su residents decreased slightly from 2005 to 2007. Asthma exacerbations also remained relatively stable from 2001 to 2007.

Figure 17 The annual number hospital discharges coded under asthma for residents of the Matanuska-Susitna Borough, 2001-2007.



4.7.4 Mental Health Disorders

Mental health, or behavioral health, is considered a critical component of overall health and is linked to physical health and well-being for persons of all ages. Mental health includes reactions to stress and depression and problems with emotions. According to the State's BRFSS data base[48], from 2008 to 2010, Mat-Su Borough residents self-reported three days in the past 30 days in which their mental health was not good; 8.3% reported having periods of frequent mental distress (defined as 14 or more days of poor mental health). These numbers were similar to the mean of all Alaska residents who self-reported 2.8 days in which their mental health was not good and 8.0% reported having periods of frequent mental distress.

4.7.5 Cancer

10.8% of Mat-Su Borough adults have been told that they had cancer.[49] The state's cancer registry[49] breaks down cancer data by organ location. Table 36 presents cancer death data for Mat-Su versus the State of Alaska.

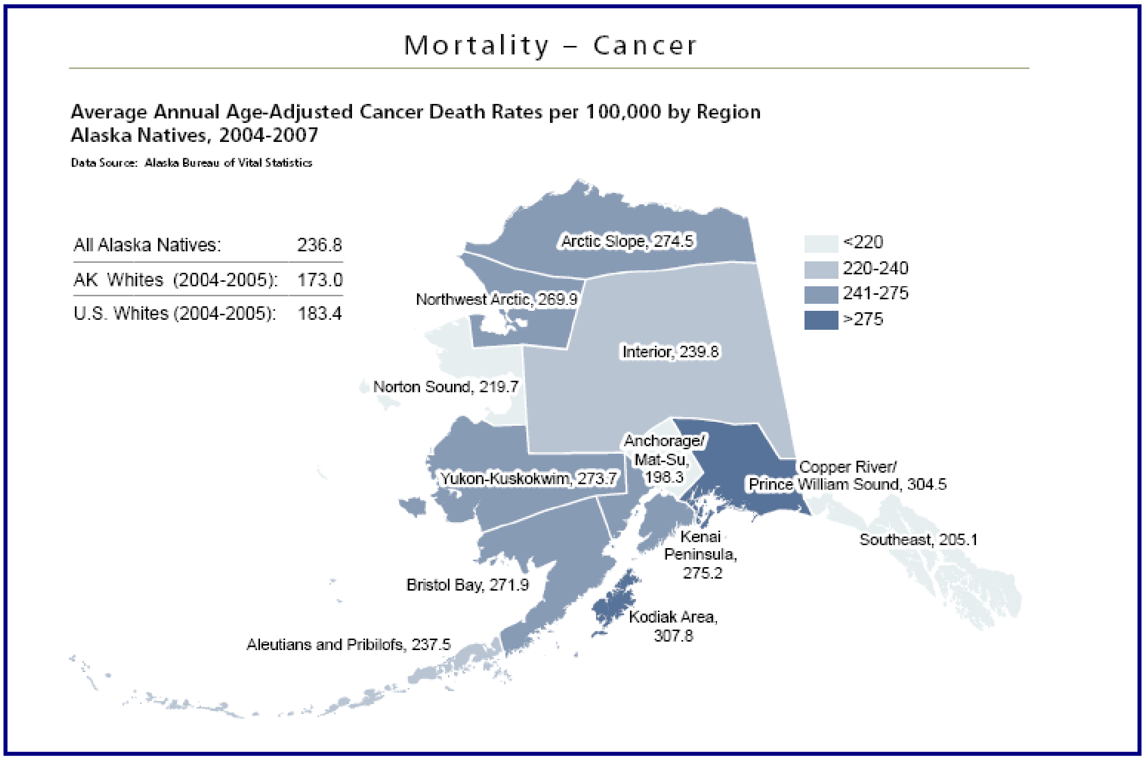
Table 36 Cancer Deaths by Type, Matanuska-Susitna Borough and the State of Alaska, 2007 – 2009[30]

Cause of Death	Mat-Su Borough Deaths	Mat-Su Borough Age- Adjusted Rate[a]	State of Alaska Deaths	State of Alaska Age- Adjusted Rate[a]
Malignant Neoplasms	**301**	**175.3**	**2583**	**182.8**
Colon, rectum and anus	25	13.6	236	17.5
Liver and intrahepatic bile ducts	8	4.2[c]	94	5.7
Lung	82	47.8	770	55.0
Breast [b]	20	22.5	187	24.0
Prostate [b]	14	24.2[c]	104	21.0
Lymphoid & hematopoietic	27	13.6	209	15.5
Non-hodgkin's lymphoma	8	3.4[c]	83	6.3
Leukemia	14	8.1[c]	88	6.4
All other lymphoid & hematopoietic	5	**	38	2.8
All other malignant neoplasms	125	73.9	983	67.6

[a]Age-Adjusted rates are per 100,000 U.S. year 2000 standard population
[b]Breast cancer rates are for females only and prostate cancer rates are for males only
[c]Rates based on fewer than 20 occurrences are statistically unreliable and should be used with caution
**Rates based on fewer than 6 occurrences are not reported

The Alaska Native cancer rates are shown in Figure 18. Although there appears to be a difference between the regions, only the Anchorage/Mat-Su Region has a statistically significant lower rate than all other regions.

Figure 18 Alaska Native Age-Adjusted Cancer Death Rates



Source: Alaska Native Epidemiology Center 2009

The lung/bronchus cancer rates are strongly related to the extremely high tobacco usage that occurs in Alaska Native populations. Smoking rates in Alaska Natives are elevated versus US White populations. Colon/rectal cancer is also a leading cause of cancer death.

4.7.6 Physical Activity Levels

Consistent physical activity is an important indicator of future non-communicable diseases risk, particularly cardiovascular disease risk. Moderate physical activity is defined as some activity that causes an increase in breathing or heart rate (30 or more minutes a day, 5 or more days per week). Vigorous physical activity is defined as some activity that causes a large increase in breathing or heart rate (20 or more minutes a day, 3 times or more a week).[9] In the BRFSS 2008 to 2010 data, 79.0% of Alaskans and 76.7% of residents of the Mat-Su Borough self-reported that they participate in leisure time physical activities.[48] In 2009, 78.1% of Mat-Su adults met the 2008 physical activity recommendations, compared to 74.4% for the state as a whole.

4.7.7 Tobacco Use

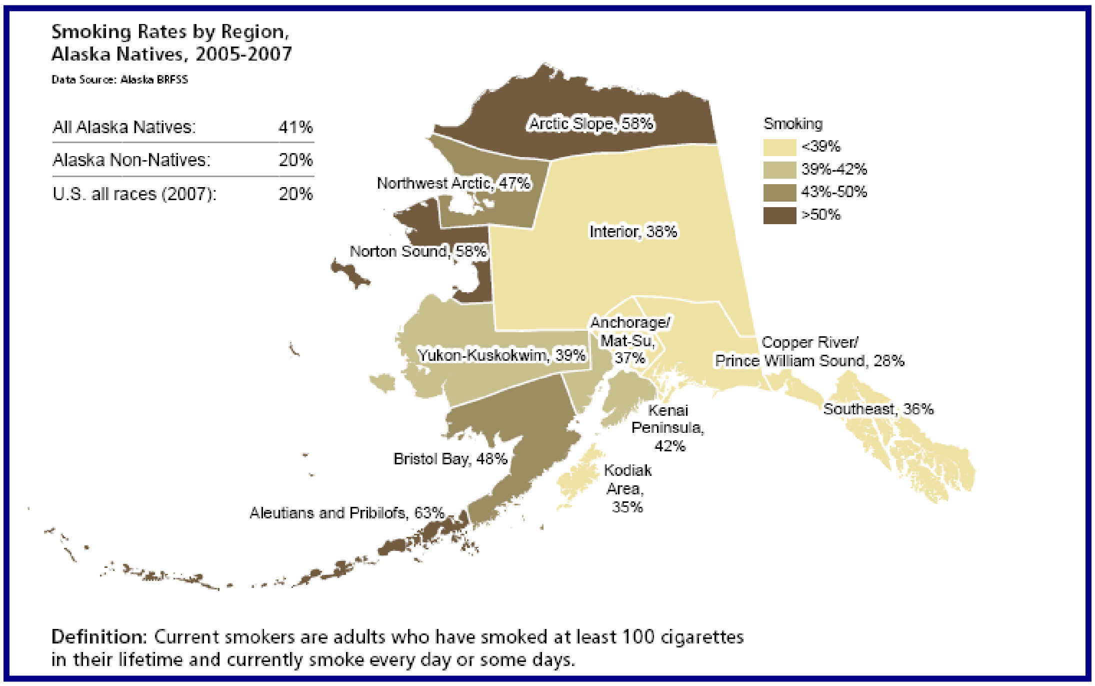
The County Health Rankings define smokers as the percentage of the adult population that currently smokes every day or most days and has smoked at least 100 cigarettes in their lifetime.[44] Twenty-eight percent (28%) of all adults in the Mat-Su Borough are smokers. This is the same percentage as all Alaskans but higher than the United States at 15%.

The BRFSS report asks questions on the use of smokeless tobacco products such as chewing tobacco, snuff, Iq-mik or Blackbull. According to the 2008 to 2010 BRFSS data, almost 5% of Mat-Su Borough adults self-reported that they had used such products, very similar to the use of smokeless tobacco products by all Alaska adults.[48]

BRFSS also asks questions about people smoking cigarette, cigar, or pipes within their homes. Over 13% of Mat-Su adults self-reported that they or someone else had smoked in their homes compared with just 8% of all Alaska adults.[48]

Overall regional smoking rate data for Alaska Natives is shown in Figure 19. The smoking prevalence between 2005 and 2007 for Alaska Natives in the Anchorage/Mat-Su Region (37%), which is less than the rate for all Alaska Natives (41%) but twice the rate of Alaska non-Natives and all races in the United States.

Figure 19 Tobacco Use



Source: Alaska Native Epidemiology Center 2009

4.8 HEC 7: Water and Sanitation

Adequate provision of water and sanitation services is a critical public health infrastructure. In rural Alaska, lack of adequate water service is linked to the high rates of lower respiratory infections observed in some regions, and to invasive skin infections.

4.8.1 Households with Water and Sewer

According to the Alaska Department of Community and Regional Affairs Community Information Services, a housing unit is considered to have water and sewer service if it has water/sewer pipes or closed haul services.

According to the Alaska Department of Community and Regional Affair's Community Information Services, residents of the smaller communities such as Buffalo/Soapstone, Chickaloon, Farm Loop, Fishhook, Sutton Alpine, and Knik Fairview primarily use individual wells and septic systems. Most houses in these communities are fully plumbed. In Point MacKenzie, some houses have individual wells and septic systems, but many residents haul water and use outhouses to dispose of sanitary wastes

Table 37 presents information about the percentage of Alaska Native houses statewide that have indoor plumbing. Alaska Natives in the Mat-Su Borough are part of the Southcentral Foundation, which has a regional rate of 89% with water and sewer service. Both the City of Palmer and the City of Wasilla provide water and wastewater service through their wastewater utilities and most homes are fully plumbed.

Table 37 Water and Sanitation Service Rates by Regional Health Corporation, 2008

Regional Health Corporation	2008 Housing Units with Pipes or Close Haul	2008 Total Housing Units	Percent Served
Aleutian Pribilofs Islands Association (APIA)	271	324	84%
Artic Slope Native Association (ASNA)	462	491	94%
Bristol Bay Area Health Corporation (BBAHC)	1364	1572	87%
Chugachmuit	179	189	95%
Copper River Native Association	343	397	86%
Eastern Aleutian Tribes	507	541	94%
Kodiak Area Native Association	349	356	98%
Maniilaq Association	865	1140	76%
Norton Sound Health Corporation	970	1509	64%
Southcentral Foundation	212	238	89%
Southeast Alaska Regional Health Consortium	2288	2329	98%
Tanana Chiefs Conference	1150	1930	60%
Yukon-Kuskokwim Health Corporation	2753	4760	58%
Independent	1437	1556	92%
Total	**13150**	**17332**	**76%**

Source: Alaska Native Epidemiology Center 2009

Residents of the smaller communities obtain untreated water primarily from deep aquifers, which is not treated before use. The City of Palmer reports that it has a clean water source.[50] Water is disinfected with a chlorine solution, and fluoride is added to assist in preventing dental diseases. After treatment the water is either directly discharged into the distribution system or pumped to one of the four storage tanks. In 2010, as in years past, Palmer's tap water met all U.S. Environmental Protection Agency (EPA) and state drinking water health standards; the system has not violated a maximum contaminant level or any other water quality standard.[50]

The City of Wasilla operates two water systems--Wasilla and Lacy Laine. The City provides drinking water through three primary groundwater wells and four 1-million gallon above-ground steel reservoirs. The water in both systems is treated with chlorine to maintain minimal residual levels in the distribution system; no fluoride is added. In 2009, as in years past, both the Wasilla and Lacy Laine systems' tap water met all U.S. EPA and state drinking water health standards; neither system has violated a maximum contaminant level or any other water quality standard.[51]

4.8.2 Data Gaps Analysis

- Water and sanitation data sets do not include 2011 information.

4.9 HEC 8: Health Services Infrastructure and Capacity

Lack of health insurance coverage is a significant barrier to accessing needed health care. Examining insurance rates among non-elderly adults, or those ages 18-64 years, is a commonly used indicator because Medicare covers the preponderance of adults aged 65 years and older in this country. In the Mat-Su Borough, 1 in 4 (26%) non-elderly adults lack health insurance.[44] For Alaska as a whole, 22% of non-elderly adults lack health insurance, as do only 13% of all US residents. Alaska Natives can receive health care at Southcentral Foundation facilities, as described below.

Having access to care requires not only having financial coverage but also access to providers. Primary care providers include practicing physicians specializing in general practice medicine, family medicine, internal medicine, pediatrics, and obstetrics and gynecology. The measure represents the number of people per one provider (Table 38).

Table 38 Ratio of People to Providers[22]

Location	Number of People Per One Primary Care Provider
United States	631 to 1
Alaska	731 to 1
Matanuska-Susitna Borough	1,293 to 1

The Alaska Department of Labor and Workforce Development notes that the health care industry is growing rapidly in the Mat-Su Borough; even with expected population growth, it is possible that the ratio of primary care providers will more closely match that of the state in the future.[52]

4.9.1 Health Service Providers

In the Mat-Su Borough, health services are provided by both private and public organizations for both Alaska Natives and non-natives by hospitals, clinics, and individual providers throughout the borough. Health statistics for borough residents are collected and analyzed by the Department of Health and Social Services and include Alaska Natives and non-natives in their totals. The Alaska Native Epidemiology Center maintains health statistics on the Southcentral/Aleutians area that are used in this report with the understanding that those statistics are dominated by the Anchorage urban population.

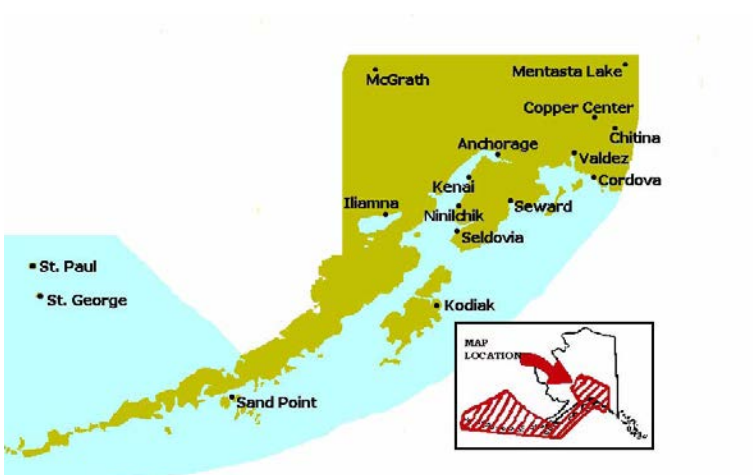
The Mat-Su Regional Medical Center is located mid-way between Palmer and Wasilla with 74 licensed beds, a total staff of 660, of which 92 are physicians. Services include emergency, surgical, intensive care, medical, dental, laboratory, and pharmacy.[53]

Providence Health & Services Alaska has family medicine, behavioral health and laboratory services available in a new building on the Parks Highway. The clinic has 10 physicians on staff.

The Cook Inlet Region, Inc. (CIRI) is the Alaska Native Corporation that organizes and manages services to Alaska Natives within the Study Area. Health services are provided via the Southcentral Foundation to the Anchorage Service Unit (Figure 20). The Foundation recently broke ground on the Southcentral Valley Native Primary Care Center at the junction of Knik Goose Bay Road and the Palmer Wasilla Highway. This new facility will replace a clinic in Wasilla.

The Alaska Native Medical Center (ANMC), in Anchorage, is owned and managed by the CIRI Southcentral Foundation and the Alaska Native Tribal Health Consortium (ANTHC). The medical center is the state-wide referral center and gatekeeper for specialty care for Alaska Natives.

Figure 20 The Anchorage Service Unit



No clinics exist in the smaller communities in the study area, except for "C'eyiits' Hnax or ""Life House "" Health Clinic in Sutton run by the Chickaloon Village Traditional Council. Highway access is available at the 3 major medical facilities; and helicopter access is available to the Mat-Su Regional Medical Center.

Emergency Services in the Mat-Su Borough have highway and air access and are within 30 minutes of a higher-level satellite health care facility. Emergency service is provided by 911 Telephone Service and volunteers. Auxiliary health care is provided by the Mat-Su Borough Fire/EMS and by volunteer Fire/EMS/Ambulance services in some of the smaller communities.

4.9.2 Data Gaps Analysis

- No significant data gaps noted.

5.0 EXPOSURE AND TOXICITY ASSESSMENT

5.1 Introduction

As described in the Technical Guidance for Health Impact Assessment (HIA) in Alaska,[1] health regulatory agencies throughout the world have agreed on a conceptual framework and investigative methodology to evaluate community exposure to potentially hazardous materials. This framework is described in many standard textbooks of occupational/environmental medicine and toxicology [54] [55], and integrated into international regulatory guidance documents published by (among many others) the National Research Council[56] [57] (NRC), Environmental Protection Agency[58] [59] (EPA), the World Health Organization[60] [61] (WHO), the Agency for Toxic Substances and Disease Registry[62] (ATSDR), the American Society for Testing and Materials[63] [64] (ASTM), and the Alaska Department of Environmental Conservation[65] [66] (ADEC).

According to this consensus approach, a scientifically defensible conclusion that exposure to one or more chemicals of potential concern (COPCs) can cause a given adverse health effect, or that any individual or group is at significantly increased risk of adverse effects from a certain chemical exposure, requires rigorous elucidation of each element of the logical sequence: COPCs are defined as chemicals that are associated with a site and/or its operations, and present in environmental media at concentrations higher than background levels or conservative risk-based screening levels.[58]

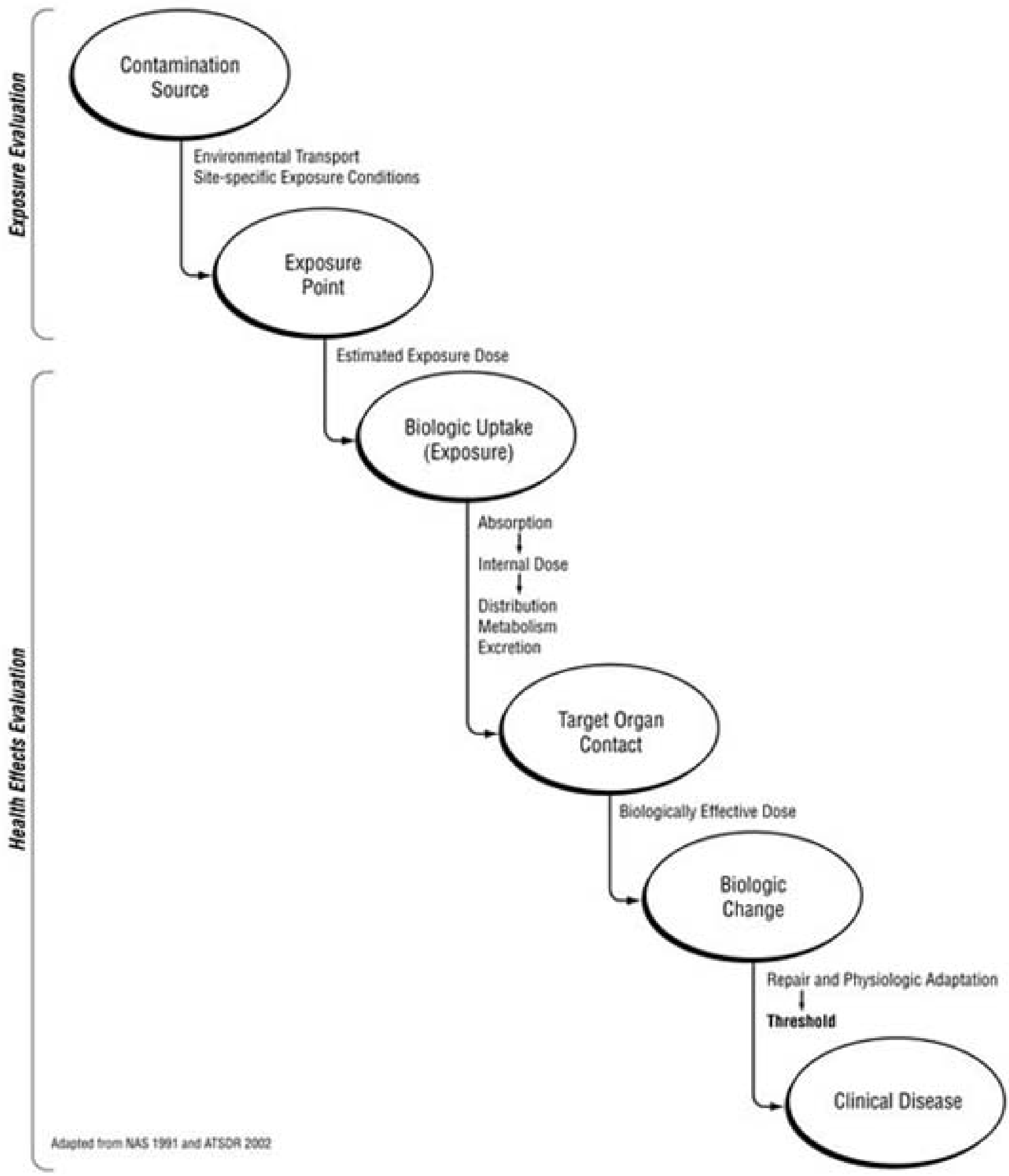
Source → Exposure → Dose → Health Effect(s)

This evaluation requires the following steps:

- Establish the presence of a complete exposure pathway linking a chemical source(s) to the human receptor. A pathway is defined as “the course a chemical or physical agent takes from a source to an exposed organism.” A complete exposure pathway includes a source or release from a source, an environmental transport/exposure medium (or media), an exposure point (location of potential contact between a receptor and a chemical or physical agent), and an exposure route (i.e., ingestion, inhalation, dermal contact).[58]
- Measure or calculate via modeling the concentration(s) of any chemical(s) of potential concern (COPCs) at logical exposure points (locations where receptors [people, animals, plants] could be present).
- Measure or calculate via modeling the dose received by receptors at the exposure point.
- Evaluate the potential health effects of the chemical(s) under investigation based upon the route of exposure and chemical-specific dose-response relationship(s).

This logical sequence is the basis for health impact assessment, as illustrated in Figure 21.

Figure 21 Factors Affecting Whether Environmental Contamination May Result in Harmful Effects[62]



These basic principles underlie the process of quantitative human health risk assessment that has been developed by regulatory authorities such as EPA, ATSDR, and ADEC. The risk assessment process consists of three basic elements:

- Exposure Assessment: Determination of the extent of human exposure based on potentially complete pathways is summarized in the exposure pathway conceptual site model (CSM).
- Toxicity Assessment: Identification of the type(s) of adverse health effects associated with COPCs, and determination of the relationship between exposure (dose) to a COPC and the probability of occurrence of these adverse health effects (response).
- Risk Characterization: Synthesis of exposure and toxicity information to determine the nature and magnitude of potential health risks at a site, including attendant uncertainties.

The following sections present relevant information on the first two risk assessment elements, exposure assessment and toxicity assessment.

5.2 Exposure Assessment

As discussed in previous sections, Usibelli Coal Mine, Inc. (UCM) has submitted a surface coal mining permit application (SCMPA) dated May 11, 2011 to the Alaska Department of Natural Resources Division of Mining, Land, and Water.[3] The project includes installation of a coal preparation plant to grind and wash the coal before transport to Point MacKenzie via truck and rail (pending completion of the proposed Point MacKenzie rail extension[67]) for shipment to market. Suburban residential development has occurred in the mine vicinity since the first permit was issued in 1991. There are houses within one-quarter of a mile of the northwest mine boundary, and the haul trucks will pass through towns on the Glenn Highway on their way to Point MacKenzie (Map 6). These activities have the potential to expose off-site residents to site-related COPCs.

Developing an exposure pathway conceptual site model (CSM) is a critical step in evaluating potential human exposures to chemicals. The CSM comprehensively represents current site conditions. It characterizes the distribution of contaminant concentrations across the site and identifies all potential exposure pathways, migration routes, and potential receptors for further analysis. As such, the CSM guides data gathering efforts. According to ADEC guidance[65], the CSM should distinguish between complete and incomplete exposure pathways. Exposure pathways consist of four elements:

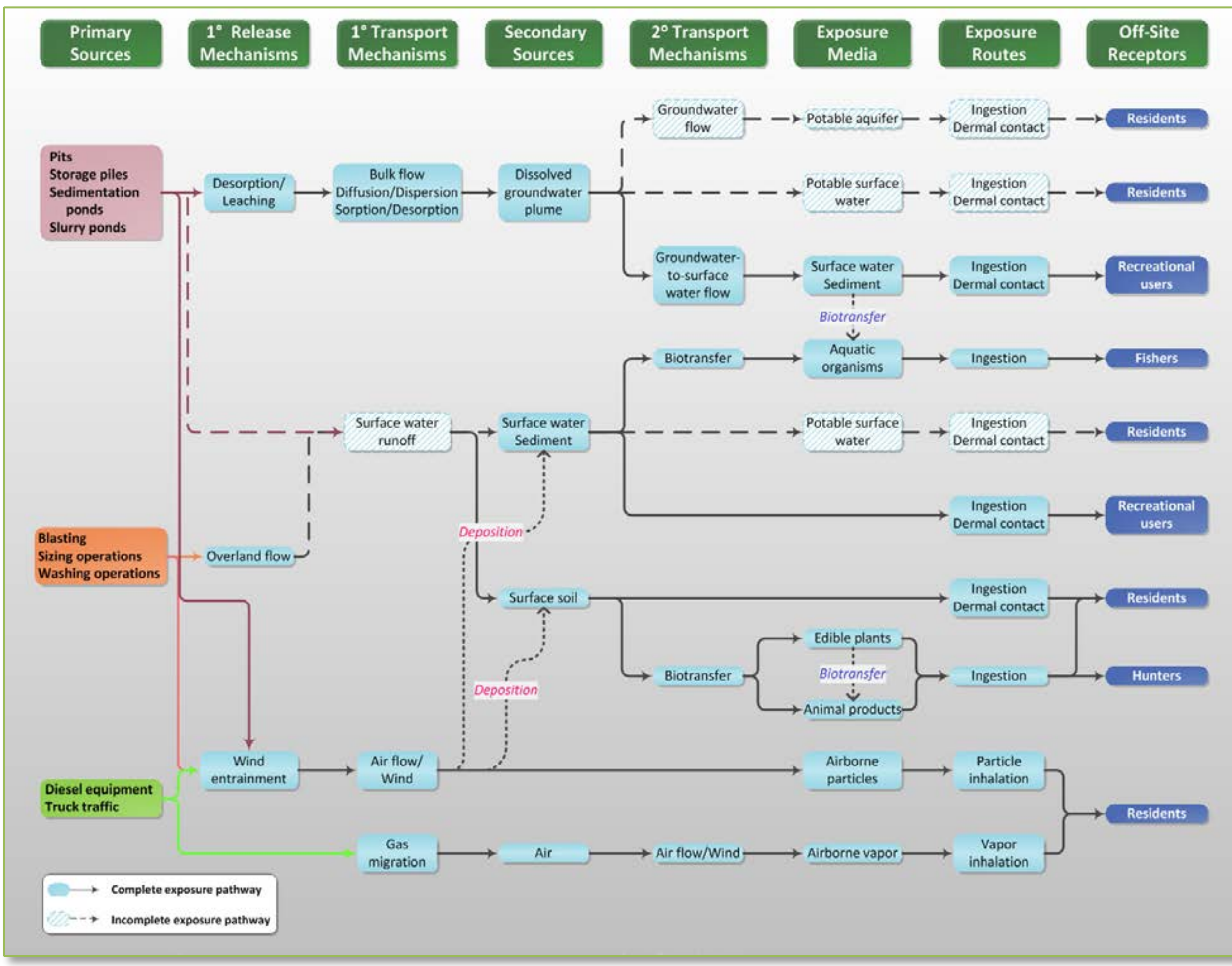
- A source and mechanism(s) of analyte release to the environment
- An environmental transport medium for the released analyte
- A point of potential human contact with the affected medium
- A route of entry into humans (inhalation, ingestion, or dermal contact with the affected medium)

If any of these components is missing, then the pathway is incomplete and does not contribute to receptor exposure. Complete pathways should include both currently complete pathways and any that may be complete in the future based on changes in operations, COPC migration, or changes in land use. *It is important to understand that identifying a pathway as complete does not automatically mean there is actual harm or risk to humans or the environment*. Rather, it means that exposure across the pathway needs further evaluation to determine if it presents a risk.

As shown in Figure 22, the CSM includes:

- Known or potential sources of COPCs
- Environmental media that may contain COPCs, including surface soil, subsurface soil, mined material, groundwater, air, and vegetation
- Primary and secondary release mechanisms that may be associated with each affected medium
- Potential exposure pathways for defined receptors, based on collected data or expected pathways
- Potential human receptor populations

Figure 22 Preliminary Exposure Pathway Conceptual Site Model for the Wishbone Hill Project



A brief discussion of the components of and rationale for the preliminary CSM for the Wishbone Hill Coal Mining and Processing Operation is presented in the following sections.

5.2.1 Sources

Surface coal mining typically involves removal of vegetation and soil and rock overburden, blasting, mucking, loading, hauling, and dumping. In addition to the coal being mined, overlying materials within and adjacent to the deposit are removed. These activities (including day-to-day operations, disposal practices, and accidental releases) are potential sources of particulate matter (PM) consisting of crustal material, coal dust, and exhaust from engines and associated COPCs to air, soil, surface water, and groundwater. As discussed in Part C, Chapter VII (Climatological and Air Quality Information) of the SCMPA[3], there are few significant point sources of air pollution present in the area. However, a variety of other potential dust emission sources do exist, including agricultural activities, and paved and unpaved roads. In addition, Matanuska winds pick up glacial sediment from the Matanuska and Knik River floodplains. Dust occurs most often in the spring and fall when high winds combine with a lack of snow cover. In addition, several area residents have reported winter wind patterns when snow has been blown off of exposed areas. More widespread or regional conditions will also affect the occurrence of wind-blown dust on and around the Site.

While the quantity of rock and topsoil waste generated by surface coal mining operations is relatively large, much of the waste poses little direct risk of toxicity. That is, typical mining waste is relatively benign in terms of the standard hazardous waste characteristics. Limited data are presently available concerning specific chemicals of potential concern (COPCs) for UCM. The following categories of sources may impact soil, air and water quality:

Rock and topsoil

- Extraction processes – removal of overburden material (soil, waste rock, and vegetation)
    - Explosives/blasting
    - Earth moving
- Coal sizing operations
- Coal washing operations
- Tailings from coal preparation processes
- Heavy diesel equipment and heaters on-Site
- Traffic on haul roads

Potential air quality impacts include diesel engine exhaust (DEE) from diesel-powered heavy equipment and heaters and respirable dust from sizing operations and traffic on haul roads. Potential surface water impacts include runoff, discharges from coal washing, and groundwater-to-surface water transport. Groundwater could be impacted by infiltration and leaching of substances from the surface.

5.2.2 Identification of Chemicals of Potential Concern Associated with Surface Mining Activities

According to EPA Toxics Release Inventory (TRI) data for 2012, the top ten chemicals released by U.S. surface coal mining operations (NAICS 2121) were (in descending order) barium compounds, ammonia, manganese compounds, lead compounds, vanadium compounds, lead, zinc compounds, chromium compounds, copper compounds, and arsenic compounds.[68] The TRI data represents materials that are generated by the site, reduced or disposed of on site, recycled, or transported off site.

Results of analyses of pilot plant makeup ("fresh") water and coal slurry water (described as clarified process water from thickener overflow) were reported in Part C, Chapter III of the SCMPA ("Overburden and Interburden Assessment") submitted by UCM. According to the study, concentrations of arsenic, barium, chloride, iron, potassium, magnesium, manganese, sodium, and sulfate were higher in process than fresh water. No information on organic constituents was provided. The contribution of these and/or other soil and coal constituents to water and PM that may be transported off-Site is unknown.

There are no active air quality control permits for the Wishbone coal mine project. UCM submitted a new permit application in 2013, which included modelling for PM_{10} and NO_2. The ADEC reviewed the submitted materials and issued a minor air permit. As discussed in Section 4.5.8, there are no current measured or modeled concentrations of fine respirable particles. Based on conditions at similar mining sites around the world, the most likely COPCs are (1) PM_{10}, $PM_{2.5}$, and ultrafine PM, and (2) DEE, which contains PM of various sizes as well as VOCs, and inorganic combustion products such as NO_x and SO_x. Unidentified inorganic and/or organic constituents in water infiltrating to groundwater from slurry and sedimentation ponds could potentially be COPCs if there is a completed exposure pathway to offsite receptors. It is important to note that permitted off-site emission levels are expected to be below regulatory health standards (protective of human health), as described in the applicable permits.

5.2.3 Potential Migration Pathways

The concentration and distribution of Site-related COPCs in environmental media on and in the vicinity of the Site could be affected by one or more of the following general mechanisms:

- Suspension and dispersion of overburden soil particles in air in the vicinity of the Site
- Suspension and dispersion of coal dust in air during on-Site sizing operations and from stock piles
- Suspension and dispersion of coal dust in air during transport from the Site to Point MacKenzie, and from stock piles in Point MacKenzie
- Airborne dispersion of DEE from diesel-fueled heavy equipment engines and heaters
- Deposition of airborne soil and coal particles on soil and surface water
- Suspension and dispersion of soil and coal particles in surface water runoff
- Desorption of COPCs from overburden soil and coal and leaching into underlying groundwater
- Migration of dissolved COPCs in groundwater
- Uptake of COPCs into edible plants
- Biotransfer of COPCs into tissues of aquatic animals used as human food
- Biotransfer of COPCs into tissues of terrestrial domestic, game, and subsistence species used as human food
- Biological or chemical transformation of COPCs

5.2.4 Potential Receptor Populations

Residential land use exists in the vicinity of the Site and in Point MacKenzie. According to Part C, Chapters IX and XIII on the SCMPA, recreational uses include hiking and hunting in the Moose Range and salmon fishing in Moose Creek. The residential scenario represents adults and children living full-time in the off-Site area. As the residential scenario involves the greatest potential exposure, it is considered protective of off-Site occupational exposure scenarios. Although subsistence use of resources appears to be unlikely in the area, consumption of recreationally caught fish in Moose Creek and local game as well as domestic livestock and products (milk, meat, eggs) and garden vegetables should also be considered.

5.2.5 Potentially Complete Exposure Pathways

The rationale for selection of potentially complete exposure pathways is discussed in the following sections.

5.2.5.1 Exposure to Particulate Matter and Associated COPCs

PM emitted during mining operations may migrate off the Site and be (1) inhaled by local residents, and (2) deposited on vegetation, buildings and other objects, surface soil, and surface water. Potential exposures via inadvertent ingestion of and dermal contact with deposited material cannot be evaluated in the absence of information on particle composition, although these exposure pathways are likely to be complete. Potentially complete indirect exposure pathways include biotransfer of chemicals associated with PM into edible plants and tissues of game and/or domestic animals maintained in the vicinity. Again, permitted off-site emission levels are expected to be below regulatory health standards (protective of human health), as described in the applicable permits.

5.2.5.2 Exposure to Gases and Vapors

DEE is also a source of gas and vapor emissions (VOCs and oxides of nitrogen and sulfur). Gases and vapors that migrate beyond Site boundaries could be inhaled by local residents.

5.2.5.3 Exposure to COPCs in Groundwater

The majority of residents in the vicinity of the Site obtain potable water from private wells. Baseline groundwater monitoring data collected in the late 1980s and presented in the SCMPA (Part C, Chapter IV, “Hydrogeology”) indicated variable but generally moderate to high quality with respect to federal drinking water standards (Section 4.5.2). Recharge to the water table aquifer is from local precipitation. Discharge is primarily to Moose Creek, with some discharge into Buffalo Creek.

According to Part D of the SCMPA (“Operation and Reclamation Plan”), drainage from disturbed areas will be diverted to sediment basins located throughout the mine area. While sediment will be retained in these basins, the runoff water will be allowed to infiltrate into the surrounding glacial gravels. This could provide a complete pathway of COPCs to groundwater underlying these structures. The SCMPA indicates that the potentially affected aquifer is not currently used as a potable water source. Therefore, human exposure to COPCs in groundwater could occur via direct contact (ingestion and dermal contact during bathing) is assumed to be unlikely. However, flow of affected groundwater into surface water bodies could provide complete exposure pathways.

5.2.5.4 Exposure to COPCs in Surface Water

Surface water bodies in the Site vicinity include Wishbone Lake, Elk's Lake, and several unnamed lakes and ponds (Section 4.5.5). Moose Creek bounds the Site to the north and west, and is the major surface stream in the area. It flows into the Matanuska River. Buffalo Creek flows across the Site from Wishbone Lake to Moose Creek. Premier Creek flows into Moose Creek from the north and does not cross the Site.

Water quality data presented in the SCMPA (Part C, Chapter V, "Surface Water Hydrology") indicate that the surface waters of the Moose Creek watershed are of high quality when compared to most water quality standards, and there is no evidence of physical or biological pollution in the surface waters. According to the SCMPS (Part C, Chapter VI, "Surface Water and Groundwater Rights and Uses"), local surface water is not used as a source of potable water in the area. However, these water bodies may be used by local residents for camping, hunting, and fishing. As noted in Section 4.2.5.3, surface drainage from disturbed areas will be controlled and routed to sedimentation basins and control ponds designed to prevent discharge to existing surface waters. However, the runoff water will be allowed infiltrate into the surrounding glacial gravels, thereby providing a potentially complete pathway of COPCs to surface water via groundwater-to-surface water flow. In addition, PM could be deposited on surface water bodies. COPCs associated with surface water and sediment could be contacted by recreational users, and taken up by organisms consumed by humans, though permitted emissions are expected to result in off-site levels that are below regulatory health standards (protective of human health).

5.3 Toxicity Assessment

The purpose of the toxicity assessment is to weigh available evidence regarding the potential for COPCs to cause adverse effects in exposed individuals. It relies upon toxicity criteria developed by EPA and other authoritative bodies. These toxicity criteria are based on information developed through both toxicological studies investigating the effects of known doses on experimental animal species, and epidemiological studies investigating the effects of chemical exposures on human populations. As discussed in the preceding section and 4.5.8, the only COPCs that can be quantitatively evaluated based on existing information are PM_{10} (including coarse particles in DEE) and NO_2.

5.3.1 General Principles

Toxicology is the field of science that investigates and describes whether and how exposure to environmental factors causes adverse (toxic) effects in organisms, including humans. The central tenet of toxicology is that the effect of any chemical in a biological system is determined by the magnitude and timing of exposure (dose rate). This concept was famously articulated in the 16th century by the physician Paracelsus:[69]

> "What is there that is not poison? All things are poison, and nothing is without poison: the dose alone makes a thing not poison."

Simply put, the toxic effects of a given chemical depend on dose (how much), frequency of exposure (how often), duration of exposure (how long), and the route by which the chemical enters the body (ingestion, inhalation, dermal absorption) – not simply by the fact of exposure itself.

Accordingly, estimation of the health risks that result from exposure to a chemical requires knowledge of (1) the intrinsic hazard posed by a chemical, and (2) the dose or concentration that people are exposed to, as well as the frequency and duration of exposure. It is important to clearly distinguish between the concepts of "hazard" and "risk" in this context. The term "hazard" refers to the effect(s) potentially caused by a chemical, without regard to the dose or exposure. "Risk" refers to the likelihood that an adverse health effect will occur under defined exposure conditions. For example, pure vitamin D is highly toxic, but a small amount is required daily for good health. Thus, hazard is not synonymous with risk, but is rather a component of risk whose importance is strictly determined by exposure.

Epidemiology is the study of how disease is distributed in populations, and the factors that influence or determine this distribution. Although epidemiological studies are superior to animal toxicity studies in that they focus on human beings, it is important to recognize that epidemiological studies alone can rarely prove that a chemical exposure causes a human disease. As defined by the EPA:[70]

> "Cause" is a significant, effectual relationship between an agent and an effect on health or public welfare. "Association" is the statistical dependence among events, characteristics, or other variables. An association is prima facie evidence for causation; alone, however, it is insufficient proof of a causal relationship between exposure and disease or health effect.

There are several types of epidemiological study design, including experimental studies and observational studies. Experimental studies investigate the role of some factor or agent (usually a drug) in the prevention or treatment of a disease. In this type of study, the investigator controls drug recipients and drug dosage. Because of the detailed information available concerning individual characteristics, doses, and responses experimental epidemiological studies are considered to provide the most scientifically rigorous data of all the designs. However, because experimental studies are often impractical or impossible because of difficulty identifying subjects, high costs, and obvious ethical issues, most epidemiological studies are observational.

Observational studies vary in the time required, cost involved, and the conclusions that can be responsibly drawn from the information in the study. The characteristics and interpretation of observational epidemiological studies are briefly summarized below. None of these study designs can "prove" causation, although some of them give stronger support than others to the case that an exposure causes disease. A useful set of nine "viewpoints" regarding the relationship between exposure and disease identified by Sir Austin Bradford Hill in connection with his studies on the strong relationship between tobacco smoking and lung cancer are the most widely cited criteria for evaluating causation.[71] While not definitive in themselves, these criteria provide a rational and consistent framework for evaluating epidemiological information.

"Hill Criteria"

- Is there a temporal relationship (did the exposure precede the disease)?
- How strong is the association between the exposure and the disease?
- Is there a dose-response relationship (does disease incidence or severity increase with exposure)?
- Have the results been replicated?
- Is the association between exposure and disease biologically plausible?
- Have alternative explanations been considered?
- What is the effect of ceasing exposure?
- Does the association exhibit specificity?
- Are the findings consistent with other relevant knowledge?

Measurements of exposure may be absent or highly uncertain in epidemiological studies (Table 39), which greatly limits their interpretation. The NRC[72] has established a hierarchy of seven types of exposure data or surrogates that ranges from "best" to "poorest" with respect to approximation of actual exposure (Table 40).

Table 39 Characteristics of Observational Epidemiological Studies

Type	Characteristics	Purpose	Measurement of Risk	Causality Inference	Advantages	Limitations
Case report/series	Describes unusual features of a single case or series of cases	Hypothesis generation	None	Cannot be determined	Quick, low cost Early evidence of association between exposures and diseases	Lacks controls
Cross-sectional	Examines relationship between exposure and disease prevalence in a defined group at a single point in time	Hypothesis generation	Prevalence association	Cannot be determined	Quick, low cost	Cannot determine temporal sequence Selection bias Not suitable for rare conditions
Ecological	Examines relationship between exposure and disease with population-level rather than individual-level data	Hypothesis generation	Correlation	Cannot be determined	Quick, low cost Ability to include contextual effects on health	Ecological fallacy Lack of information on key variables
Case-control	Examines disease in context of exposure; subjects defined as cases and controls, and exposure histories compared	Hypothesis testing	Odds ratio	Suggestive	Quick, low cost Useful for studying rare diseases	Recall and selection bias Not suitable for rare exposures
Cohort	Examines health effects of an exposure; subjects defined according to estimated exposure and followed for disease occurrence over time	Hypothesis testing	Relative risk, attributable risk	Suggestive, possibly definitive	Clear temporal sequence	Expensive, time-consuming Loss of subjects Not suitable for rare diseases

Table 40 Hierarchy of Exposure Data or Surrogates[72]

	Types of Data	Approximation to Actual Exposure
1	Quantified personal measurements	**Best**
2	Quantified area or ambient measurements in the vicinity of the residence or other sites of activity	
3	Quantified surrogates of exposure	
4	Distance from site and duration of residence	
5	Distance or duration of residence	
6	Residence or employment in geographic area in reasonable proximity to site where exposure can be assumed	
7	Residence or employment in defined geographical area	**Poorest**

[a] From Table 3-4

Because of the use of ecological study design in evaluating the relationship between coal mining and community health in Appalachia (Section 5.3.4.1), this type of study design is discussed in detail.

Ecologic comparison studies assess the correlation between potential environmental exposures (e.g., living near a coal mine) and disease rates (e.g., lung diseases) among different populations during a defined time period. Ecological studies compare a population that has a suspected exposure (e.g., living in a city) to a population without the suspected exposure (e.g., people living in rural areas) to discover potential differences in disease rates that could be explained by the exposure in question. In ecological studies, the investigator knows the overall number of exposed persons in the population (e.g., people living in a county of known exposure) and the overall rate of a disease in the population. What the investigator does not know is the level of individual exposure among persons with the disease. This can lead an investigator to falsely assume that because a diseased person lives in an area of exposure that their disease must be due to the exposure and not some other factor.

This false assumption is a classic mistake in epidemiology and is called the "ecological fallacy". The ecological fallacy makes the assumption that group attributes (an apparent association between population exposure and disease) represent individual attributes (an individual's disease must be caused by the exposure). In other words, an association that appears to exist on a group level does not necessarily exist at an individual level. The reason for this is that ecological studies are vulnerable to confounding factors (other risk factors that could cause the disease) because investigators know very little about the detailed health risks of individuals in the population.

In epidemiology, "confounding" is the mixing of effects that occurs when a factor that is associated with (but not due to) the exposure of interest is also a cause of the health effect of interest. Confounding factors may be known or unknown. A classic example of confounding cited by Rothman[73] is the relationship between increasing birth order and Down's syndrome. Birth order is a surrogate for the more important risk factor for Down's syndrome, maternal age. A mother's age will increase as birth order of children increases and so both age and birth order could be the risk factor for Down's syndrome. Thus, the apparent effect of birth order on risk of Down's syndrome is confounded by maternal age. On account of these shortcomings, ecological studies cannot be used to determine causation or quantify risk. As stated by Gordis:[74]

> "[Ecological epidemiological studies] can suggest avenues of research that may be promising in casting light on etiologic [causal] relationships. In and of themselves, however, they do not demonstrate conclusively that a causal association exists".

In summary, causality determinations are based on the evaluation of evidence from across scientific disciplines. A conclusion that exposure to a chemical causes a disease in humans (as opposed to merely being present at the same time) requires evidence that the occurrence of the disease is significantly increased in a group with well-documented chemical exposure. This group must be compared with an otherwise similar non-exposed control group, with the weight of evidence confirming that differences between the groups are not due to chance, bias, or confounding. Because few studies provide such findings, determination of causation must rely on consideration of all available data, with appropriate weighting for quality.

5.3.2 Health Effects of Particulate Matter

PM is one of six principal (or criteria) pollutants for which EPA has established National Ambient Air Quality Standards (NAAQS). Airborne PM is a complex mixture of organic and inorganic, solid and liquid, primary and secondary particles that can vary greatly in composition and concentration depending on source, geographic location, season, weather conditions, and time of day. Major sources of PM and its precursor pollutants include fugitive dust, biomass burning, agriculture, wind erosion, and fossil fuel combustion.

High levels of PM have long been recognized as harmful to human health. More recently, acute (short-term) and chronic (long-term) exposures to much lower levels have been consistently associated with increased human mortality and morbidity, especially from cardiopulmonary diseases, including lung cancer.[75] [76] The principal sources of these results have been ecologic or semi-ecologic epidemiological studies in which health effects in the population within a geographic area are related to average measurements of PM and related air quality indices at fixed monitoring locations in the area. However, these results are generally supported by controlled human exposure and toxicological studies.

Available evidence indicates that the relationship between airborne pollutants and short- and long-term health effects is a highly complex and variable function of many factors that are not clearly understood. Effects reported in association with increased levels of PM and the EPA's judgment of causal evidence are indicated in Table 41.

Table 41 Summary of EPA's Causality Determinations for Particulate Matter Health Effects by Particle Size and Exposure Duration[75]

Size Fraction	Exposure Duration	Health Endpoint	Causality Determination
$PM_{2.5}$	Short-term	Cardiovascular	Causal
		Respiratory	Likely to be causal
		Central nervous system	Inadequate
		Mortality	Causal
	Long-term	Cardiovascular	Causal
		Respiratory	Likely to be causal
		Mortality	Causal
		Reproductive and developmental	Suggestive
		Cancer, mutagenicity, genotoxicity	Suggestive
$PM_{10-2.5}$	Short-term	Cardiovascular	Suggestive
		Respiratory	Suggestive
		Central nervous system	Inadequate
		Mortality	Suggestive
	Long-term	Cardiovascular	Inadequate
		Respiratory	Inadequate
		Mortality	Inadequate
		Reproductive and developmental	Inadequate
		Cancer, mutagenicity, genotoxicity	Inadequate

[a] Modified from Table 2-6

5.3.2.1 Determinants of PM Toxicity

<u>PM Size and Composition</u>

The size of suspended PM in the atmosphere varies over four orders of magnitude, from a few nanometers (billionths of a meter) to tens of micrometers (millionths of a meter). PM comes in many different shapes, and can be made up of hundreds of different chemicals. The aerodynamic properties of PM determine how it is transported in air. Individual particles have irregular shapes, so their aerodynamic behavior is expressed in terms of the diameter of an idealized sphere, or aerodynamic diameter, which is usually simply referred to as "particle size." These properties determine the likelihoods of both inhalation and deposition in the respiratory tract, and are also associated with the chemical composition and sources of particles. That is, certain size modes tend to contain certain chemical components.

Atmospheric particles usually occur in specific size groupings that also differ in their origins and properties (Figure 23 and Table 42). Characterizing particle size is important because different size particles penetrate to different regions of the human respiratory tract. Because of their ability to penetrate the lung, particles with aerodynamic diameters of (1) less than 10 µm (PM_{10}), and (2) less than

2.5 µm ($PM_{2.5}$) are routinely assessed in air monitoring, and are the basis for PM NAAQS (Section 5.3.2.3).

Figure 23 Particulate Matter Size Categories

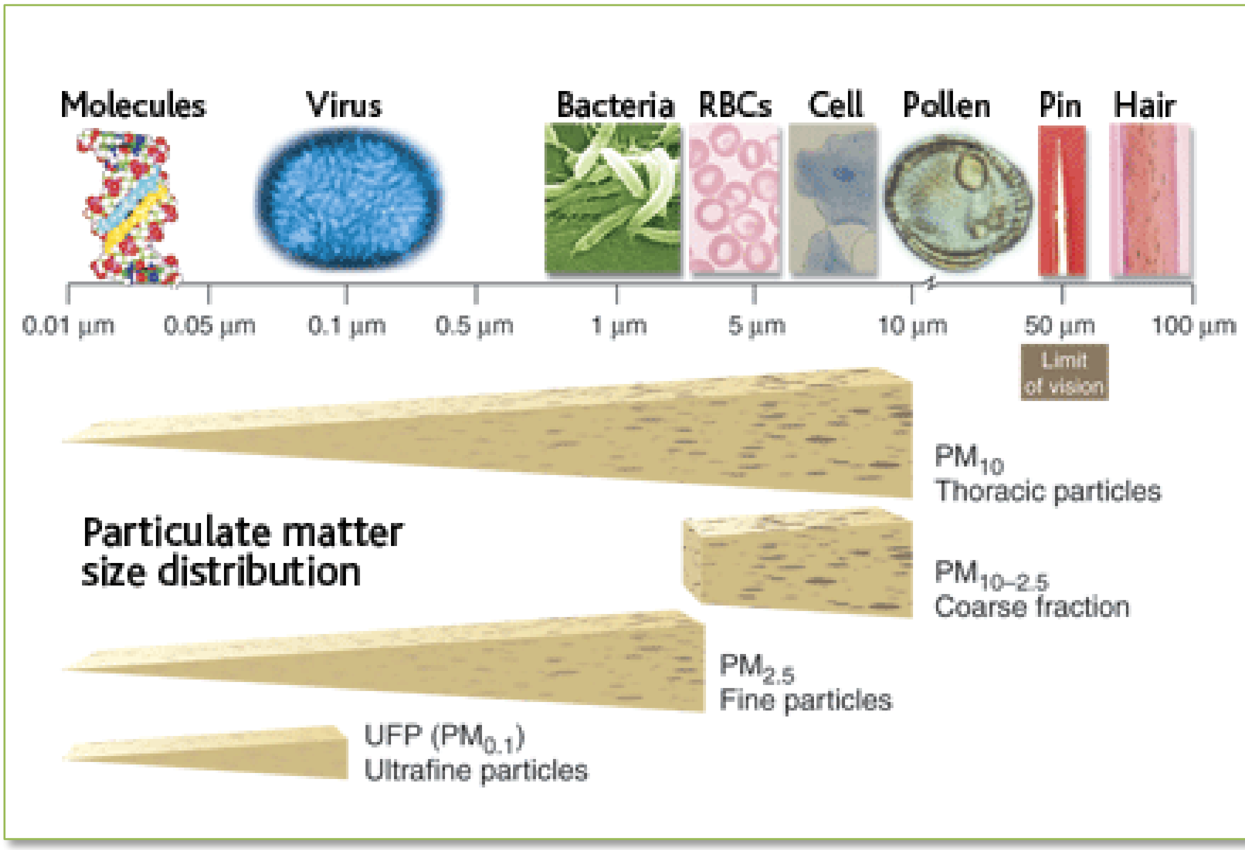


Table 42 Particle Characteristics[75]

	Particle Size	
	Fine	**Coarse**
Sources	Combustion of fossil and biomass fuels High-temperature industrial processes, smelters¸ refineries¸ steel mills, etc. Atmospheric oxidation of NO_2, SO_2, and organic compounds, including biogenic organic species (e.g., terpenes)	Resuspension of particles deposited onto roads Tire, brake pad, and road wear debris Suspension from disturbed soil (e.g., farming, mining, unpaved roads) Construction and demolition Fly ash from uncontrolled combustion of coal, oil, and wood Ocean spray
Formation processes	Combustion, high-temperature processes, and atmospheric reactions	Break-up of large solids/droplets
Formed by	Condensation of gases Coagulation of smaller particles Reactions of gases in or on particles Evaporation of fog and cloud droplets in which gases have dissolved and reacted	Mechanical disruption (crushing, grinding, abrasion of surfaces) Evaporation of sprays Suspension of dusts Reactions of gases in or on particles
Chemical composition	Sulfate, nitrate, ammonium, hydrogen ions Elemental carbon Large variety of organic compounds Compounds of Pb, Cd, V, Ni, Cu, Zn, Mn, Fe, etc. Particle-bound water Bacteria, viruses	Nitrates/chlorides/sulfates from reactions with coarse particles Oxides of crustal elements (Si, Al, Ti, Fe) Salts Bacteria, pollen, mold, fungal spores, plant and animal debris
Atmospheric deposition	Forms cloud droplets and rains out Dry deposition	Dry deposition by fallout Scavenging by falling rain drops
Travel distance	Hundreds to thousands of kilometers	Less than one to tens of kilometers (much further in dust storms)

[a] Modified from Table 3-1

PM_{10} includes fine and ultrafine particles as well as the “coarse” or “thoracic” particles between 2.5 and 10 µm. Thus, PM_{10} is inhalable and can penetrate beyond the larynx to the conducting airways and alveolar regions of the lungs.[77] Coarse PM is usually produced by the mechanical break-up of larger solid particles via grinding, wind, or erosion, and includes dust from roads, agricultural processes, uncovered soil or mining operations, non-combustible materials released when burning fossil fuels, sea spray, pollen grains, mold spores, and plant and insect parts. Because coarse particles are relatively large, they settle out of the atmosphere in a more rapidly than smaller particles. Their chemical composition reflects their sources, and hence it is predominantly inorganic such as sand and sea salt, although significant amounts of organic compounds may be associated with them. Because the sources, composition, and environmental fate of coarse PM are different from those of the finer particles, their occurrence tends to be only weakly associated.[75 76 78]

$PM_{2.5}$, referred to as “fine” or “respirable” PM, can penetrate deeper into the lung and reach the smaller conducting airways and alveoli. Fine PM is largely formed from condensation of low-volatility vapors). Particles in this nucleation range or mode subsequently grow by coagulation (the combination of two or more particles to form a larger particle) or by condensation of gas or vapor molecules on the surface of existing particles. Because of the nature of their sources, fine particles generally contain more organics than the coarse particles (other than biologically derived coarse particles), as well as soluble inorganic ions such as ammonium, nitrate, and sulfate.[75 76 78]

Ultrafine particles (UFPs) or nanoparticles are the fraction of ambient particulates with an aerodynamic diameter smaller than 0.1 µm ($PM_{0.1}$). UFPs are the most abundant class of PM in urban and industrial areas, being principally derived from anthropogenic sources such as internal combustion engines, power plants, incinerators and other combustion sources. Road vehicles are the dominant anthropogenic source of UFPs in polluted urban environments, contributing as much as 90% of total particle number concentrations.[79] Because they can penetrate deeply into the lung, UFPs are able to traverse the respiratory epithelium by various transport mechanisms and enter the circulation, resulting in distribution throughout the body, and they have very large surface areas per unit mass. The relative toxicity of UFPs is suspected to be high[80 81], but adequate data for concentration-response analysis are currently lacking.[82]

Inhaled PM can exert adverse effects on the pulmonary, cardiovascular, hematopoietic, nervous, and other systems. Several mechanisms for these effects have been identified or proposed, including effects on the cytotoxicity through oxidative stress, oxygen free radical-generating activity, DNA oxidative damage, mutagenicity, and stimulation of pro-inflammatory factors[75 83 84 85] PM toxicity has been linked to adhered organic compounds[86 87 88], biological components (*i.e.*, bacterial endotoxins)[89 90 91], and soluble (but not insoluble) transition metal content.[92 93 94 95 96 97 98] This toxicity is thought to result from the ability of these metals to catalyze cyclic redox reactions (Haber-Weiss reactions) that generate reactive oxygen species such as hydrogen peroxide, superoxide radical, and hydroxyl radical. PM characteristics associated with greater toxicity are as follows:

- Small size
    - Higher surface area
    - Greater numbers
    - Smaller, combustion-related particles more potent
- Composition
    - High oxidative stress potential
    - High soot content
    - High concentrations of bioavailable transition metals

Cohort, time-series, panel, and toxicological studies conducted in the U.S. and Europe consistently show the strongest associations between PM derived from traffic-related or coal combustion sources and health effects.[99] [100] [101] [102] [103] [104] [105] [106] [107] [108] [109] (Lippmann 2014). Diesel PM is discussed in Section 5.3.2.4.

Individual Susceptibility and Vulnerability

The adverse health effects of air pollution are known to vary widely across subpopulations, depending on demographics, behavior patterns, income, access to health care, and other factors. As a result, research efforts throughout the world have sought to identify the characteristics of susceptible (possessing innate or acquired characteristics increasing likelihood of adverse effects) and vulnerable (groups tending to have greater exposure and/or reduced access to health care) populations. The collective evidence from epidemiological, controlled human exposure, and toxicological studies indicates that preexisting cardiovascular and respiratory diseases, diabetes, obesity, socioeconomic status, life stage, and certain genetic polymorphisms area associated with increased susceptibility to PM-related health effects.[110] [111] [112] [113]

What determines human susceptibility to PM?

- Health status
  - Pregnancy
  - Nutritional status
  - Cardiovascular disease (coronary artery disease)
  - Respiratory disease (asthma, chronic obstruction pulmonary disease)
  - Diabetes
  - Obesity
- Age
  - Infants/children
  - Elderly
- Genetic factors
- Lower socioeconomic status

5.3.2.2 Concentration-Response Relationships

Concentration-response (C-R) relationships have been developed for criteria pollutants, particularly for fine ($PM_{2.5}$) and coarse (PM_{10}) particulate matter. Over the last 20 years, the scientific focus has been concentrated on the fine PM fraction, although there is a large body of older PM_{10} epidemiological studies. Extensive and voluminous USEPA scientific assessments and reviews on fine PM have been published.[82] In turn, the large EPA reviews and assessments reference hundreds of peer-reviewed epidemiological and toxicological studies on particulate matter and potential human impacts. In general, C-R functions (CRF) are used to calculate the increment of disease incidence per increment of exposure concentration.

As noted, there are limitations to the available air station and modeled concentration data. From a health perspective, fine particulate matter is more determinate of adverse human health impacts than coarse PM. In addition, defining (1) the true exposed population and its demographics and (2) critical key mortality and morbidity endpoints for the exposed population is a significant and complex undertaking in the current setting. Nevertheless, the HIA Team conducted screening risk assessments, which involve using the modeled incremental changes in PM_{10} concentrations from the ADEC TAR (range: 5–80 ug/m^3), to model the likely health consequences using standard C-R functions for PM_{10} (Appendix D). The results of the screening assessment indicate that the predicted human health impacts of PM_{10} increments due to mining operations are likely to be small under most conditions.

Per ADEC Minor Permit regulations, the ADEC TAR did not include similar quantitative $PM_{2.5}$ air modeling because the estimated $PM_{2.5}$ annual emissions quantity was below threshold levels that would trigger air modeling (see section 4.5.8). As such, the HIA Team was unable to perform parallel screening risk assessments for $PM_{2.5}$ based on actual air modeling results. However, because changes in $PM_{2.5}$ concentrations are known to be the most important determinants of adverse health consequences due to particulate matter exposure, the HIA Team calculated change estimates for annual $PM_{2.5}$ concentrations based on the ADEC TAR $PM_{2.5}$ estimate of 7.55 tons per year (Table 27) and the EPA $PM_{2.5}$ modeling methodology explained in the “Implementation of the New Source Review (NSR) Program for Particulate Matter Less Than 2.5 Micrometers ($PM_{2.5}$)” [Federal Register/Vol. 73, No. 96/Friday, May 16, 2008/Rules and Regulations] (see section 4.5.8). While these estimates indicate that the incremental increase in $PM_{2.5}$ concentrations due to mining operations is highly unlikely to result in substantial clinically-observable adverse consequences to human health in surrounding communities, there are many uncertainties inherent to the analysis that preclude the HIA Team’s ability to provide definitive quantitative data to substantiate this. However, given the ADEC TAR’s forecasted low emission rates of $PM_{2.5}$, a detailed quantitative C-R risk assessment for $PM_{2.5}$ does not appear to be indicated. That said, if underlying ambient conditions dramatically change due to a combination of events (e.g., forest fires, wind, or temperature changes), the incremental addition of $PM_{2.5}$ from the Wishbone Hill Coal Mine could be more significant from a health perspective, particularly over short-term (24-hour) time frames. As discussed in section 4.5.8, exceptional event rules (e.g., forest fires) are established by EPA and followed by ADEC.[40]

5.3.2.3 Regulatory Criteria

The EPA’s current NAAQS for PM_{10} and $PM_{2.5}$ are based on specific, defined exposure durations (Table 43).[114] Both monitoring and epidemiological/toxicological data are currently insufficient to develop standards for the coarse fraction between 2.5 and 10 µm alone.[82] As discussed previously, individual variation in human responses to air pollutants indicates that some sensitive subgroups are at increased risk for the detrimental effects of PM and other air pollutants. Recognizing this, the NAAQS are intended to provide an adequate margin of safety for both general populations and sensitive subgroups.

Table 43 National Ambient Air Quality Standards for Primary Particulate Matter, 2012[114]

Size Fraction	Averaging Time	NAAQS ($\mu g.m^3$)	Criteria
PM_{10}	24-hour	150	Not to be exceeded more than once per year on average over 3 years
$PM_{2.5}$	Annual	12.0	3-year average of the weighted annual mean $PM_{2.5}$ concentrations from single or multiple community-oriented monitors must not exceed 12.0 $\mu g/m^3$
	24-hour	35	3-year average of the 98th percentile of 24-hour concentrations at each population-oriented monitor within an area must not exceed 35 $\mu g/m^3$

5.3.2.4 Characteristics of PM at Surface Coal Mining Sites

The levels of composition of PM generated by surface mining is determined by local geology and influenced by local topography, mining operations, and weather conditions. Reynolds et al.[115] observed that coal dust from opencast mining differs from that generated in underground mines due to the fact that underground mining cuts the coal itself, while surface mining generates more dust from overburden. Pless-Mulloli et al.[116] reported that PM samples collected at the boundary on opencast mines contained higher concentrations of shale.

Aneja et al.[117] measured PM_{10} collected near roads frequented by coal trucks in Virginia. The authors' assumption that all of the collected material was coal dust is unlikely to be accurate. Inorganic analysis revealed the presence of antimony, arsenic, beryllium, cadmium, chromium, cobalt, lead, manganese, mercury, nickel, and selenium. Knuckles et al.[118] collected PM at two locations within a mile of an active mountaintop mine in West Virginia. Compositional analysis of the PM indicated that it was of predominantly crustal origin. Kurth et al.[119] compared PM size distribution and concentration in repeated samples from two mountaintop mining communities versus a non-mining area. They reported that particle number concentrations were significantly greater in the mining area samples, indicating greater potential deep lung deposition. Both of these groups attempted to link their results with reported greater morbidity and mortality in Appalachian coal mining areas, discussed further in Section 5.4.1.

In a study of PM collected near an opencast coal mine in Wales, Jones et al.[120] reported that the mass of dust within the pit was approximately twice that outside the pit, chiefly due to large, non-respirable particles, as expected in proximity to the source. Vehicle exhaust was the largest source in terms of particle numbers (over 95%). Coal dust was a minor component, averaging between 10 and 20%. The relative toxicities of a surrogate dust mixture with the same particle size distribution was compared with (1) a similar mixture with 50% diesel exhaust particles (DEP) by weight added, (2) DEP, and (3) quartz upon instillation into the lungs of rats.[115] Animals were sacrificed one, six, and 11 weeks after treatment, and evaluated for lung-to-body weight ratios, presence of protein in lung lavage (indicative of lung permeability), and total free cells (indicative of inflammation). The surrogate mixture with and without addition of DEP had little effect on increasing lung permeability and inflammation, similar to that of DEP alone. In contrast, quartz caused early and persistent increases in permeability and inflammation. The authors concluded that opencast dust caused only "insignificant" effects in rat lungs, and was no more toxic than DEP. The relevance of the endpoints examined in this study to human exposures and responses in unclear, and the fact that the dust examined was a surrogate based on particle size rather than composition limits interpretation of these results. However, the results are compatible with those of the Pless-Mulloli epidemiological study, which observed that PM in opencast communities in northeast England did not appear to differ in toxicity from that in control communities (Section 5.4.3).[116]

5.3.3 Nitrogen Dioxide

5.3.3.1 Sources

"Nitrogen oxides" (NO_x) are a complex mixture of oxidized nitrogen compounds, including NO, NO_2, and all other oxidized *N*-containing compounds. For purposes of NAAQS development, NO_2 is the component of greatest interest and the indicator for the larger group of NO_x. Ambient levels of NO_2 are the product of both direct NO_2 emissions and emissions of other NO_x, which can be converted to NO_2.[121] NO_2 is ubiquitous due to the widespread occurrence of both natural and anthropogenic sources. Anthropogenic sources account for approximately 87% of total NO_x emissions, and on-road, and to a lesser extent, off-road mobile sources account for about 60% of total anthropogenic emissions.[121] Diesel and gasoline engines each contribute about half of mobile source emissions. There are also natural sources of NO_x, including microbial activity in soils, lightning, wildfires, and volcanism.[121] Substantial indoor NO_2 exposure may also result from common household sources such as tobacco smoke, wood stoves, oil stoves, candles, and the use of gas-fired appliances. Indoor concentrations may exceed those outdoors, especially in buildings where unvented combustion appliances are used.[122]

5.3.3.2 Toxicity

NO_2 is a strong respiratory irritant. Having low to moderate water solubility in water, it reaches deep into the respiratory tract and primarily affects the bronchotracheal and alveolar regions. Three kinds of studies have assessed the health effects of NO_2: (1) epidemiology studies (largely ecological in design), (2) human clinical studies, and (3) animal toxicology studies. Animal studies are difficult to extrapolate to human environmental exposures due to the relatively very high exposure levels used. The NO_2 epidemiology remains inconsistent and uncertain due to the potential for exposure misclassification, residual confounding, and co-pollutant effects, whereas animal toxicology findings using high levels of NO_2 exposure require extrapolation to humans exposed at low ambient NO_2 levels. Interpretation of epidemiological data is complicated by the fact that exposure to NO_2 only does not occur. Rather, it is one component of a mixture of air pollutants that often display similar temporal courses and spatial distributions. However, EPA has concluded that epidemiological data provide a sufficient basis for causal determination.[121] EPA's interpretation of the causal role of NO_2 in producing short- and long-term health effects is summarized in Table 44.

Table 44 Summary of EPA's Causality Determinations for Health Effects Associated with Short- and Long-Term Exposure to Nitrogen Dioxide

Exposure Duration	Health Endpoint	Causality Determination
Short-term	Respiratory morbidity	Likely to be causal
	Cardiovascular morbidity	Inadequate
	Mortality	Suggestive
Long-term	Respiratory morbidity	Suggestive
	Other morbidity	Inadequate
	Mortality	Inadequate

[a] Modified from Table 5.3-1 (EPA 2008)

5.3.3.3 Regulatory Criteria

The EPA's current NAAQS for NO_2 are based on specific, defined exposure durations (Table 45). Because some sensitive subgroups are at increased risk for the detrimental effects of NO_2 and other air pollutants the NAAQS are intended to provide an adequate margin of safety for both general populations and sensitive subgroups.

Table 45 National Ambient Air Quality Standards for Nitrogen Dioxide[123]

Averaging Time	Primary/ Secondary	NAAQS (ppb)	Criteria
1-hour	primary	100	98^{th} percentile averaged over 3 years
Annual	primary and secondary	53	Annual mean

5.3.4 Diesel Engine Exhaust

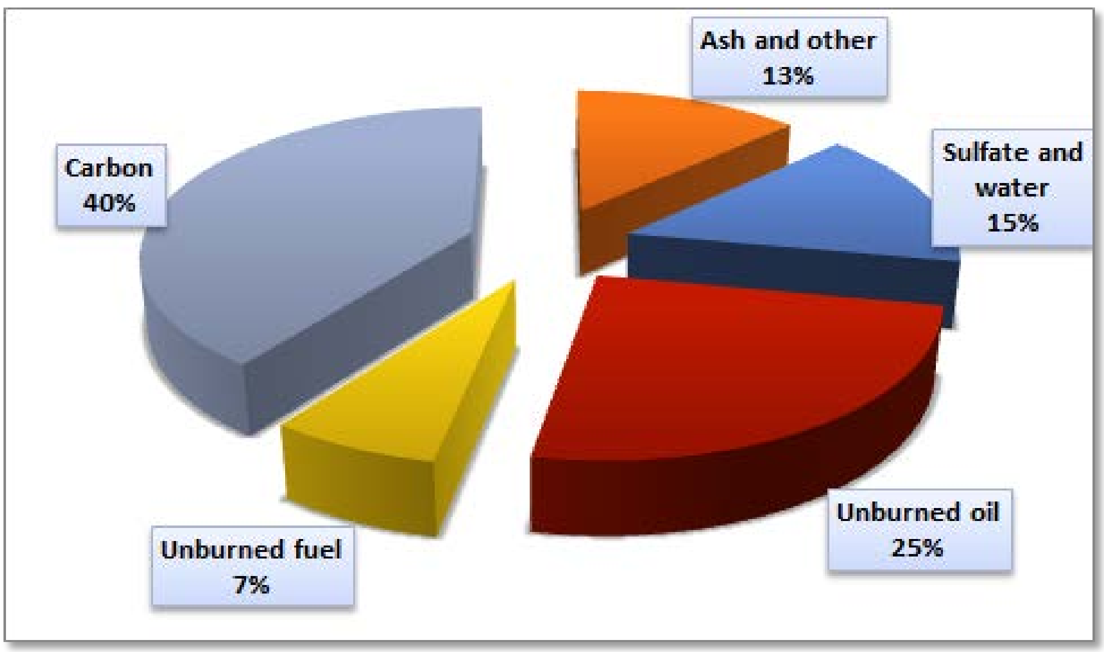
The diesel portion of petroleum distillate consists of a complex mixture of hydrocarbons with chain length C8 to C25. Aromatic compounds such as benzene and PAHs are also present. The primary products of complete combustion of diesel fuels are carbon dioxide, water, and nitrogen. Most of the components of the complex mixture of gases, vapors, and particles that make up DEE result from incomplete combustion and pyrosynthesis. The composition of DEE varies by engine type and condition, fuel, operating conditions, environmental conditions, and exhaust after treatment such as particle traps and catalysts. In particular, new technology DEE is markedly different from traditional DEE.[124] [125] [126]

5.3.4.1 Particle-Phase Emissions

Diesel particulate matter (DPM) comprises a small fraction (typically less than 1%) of the mass of typical DEE. DPM is a highly complex and variable mixture, encompassing a range of sizes and morphologies, and having numerous inorganic and organic chemical components that depend upon engine characteristics, operations, and fuels. The major constituents of traditional DPM are carbonaceous agglomerates (mainly elemental carbon [EC]), organic carbon (OC), sulfates, and ash (Figure 24). New technology diesel engines emit much less DPM, of different composition (Figure 25).[125 127]

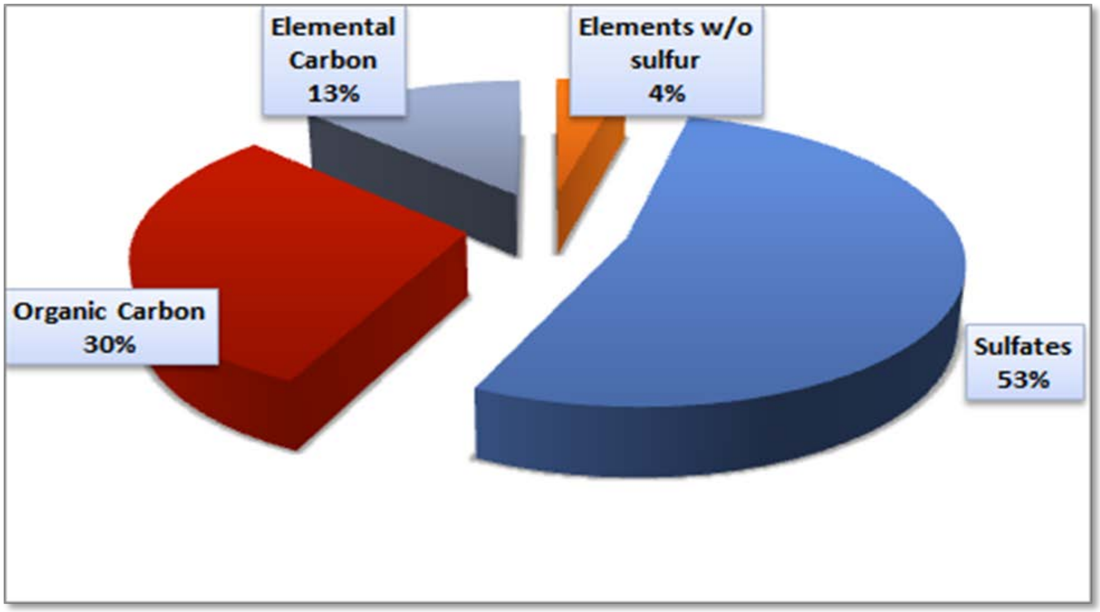
As discussed previously, the size distribution of PM is directly relevant to potential health risks, as size is one of the key determinants of depth of penetration into the lung. The size distribution of diesel particles differs from engine to engine, among fuels, and with operating conditions in the same engine, such as engine load and exhaust dilution. Like most combustion-generated aerosols, diesel particles are relatively fine. Most of the particles emitted by engines are in the sub-micrometer diameter range, in two principal size modes: (1) a nuclei mode in the 3 to 30 nm diameter range, containing more than 90% of the particle number but less than 1% of the particle mass, and (2) an accumulation mode in the 30 to 500 nm range, containing most of the particle mass (Figure 26).

Figure 24 Chemical Composition of DPM from a Traditional Heavy-Duty Diesel Engine



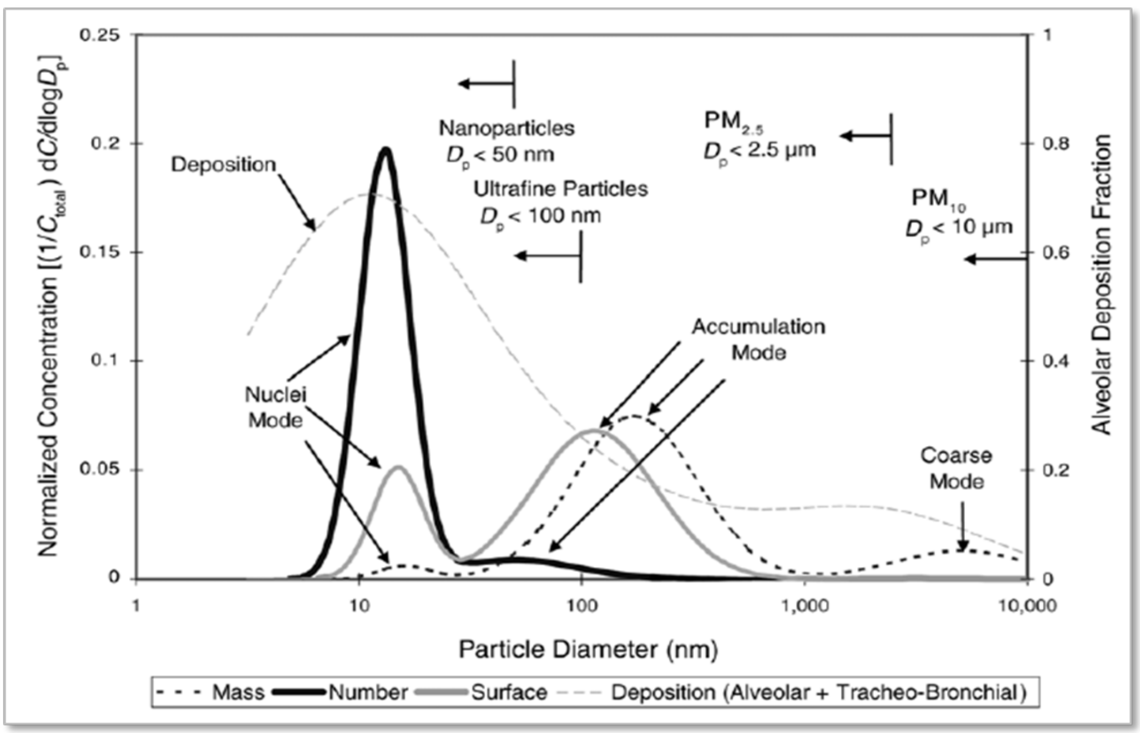
Source: Holgate ST et al.[130]

Figure 25 Chemical Composition of DPM from a New Technology Heavy-Duty Diesel Engine



Source: From Hesterberg TW et al.[125]

Figure 26 Typical Diesel Engine Exhaust Particle Size Distribution



Source: Holgate ST et al.[130]

Nuclei mode particles consist primarily of volatile or semivolatile organic matter condensed on sulfate nuclei. Solid metallic ash particles may also be present in this mode. The majority of accumulation mode particles consist of soot. The EC core of soot particles serves as a nucleus for condensation of organic compounds such as polycyclic aromatic hydrocarbons (PAHs), PAH derivatives (nitro-PAHs and oxidized PAHs), and inorganic compounds such as including sulfate. [126]

In a 2001 review, direct emissions of PM from diesel engines in urban areas were reported to represent about 10% of the mass of ambient particles; secondary particles (primarily nitrates and sulfates) from diesel engines can contribute another 5%. At roadside locations near high diesel traffic, diesel contributions to ambient PM can be even greater.[128] However, it is important to note that meeting the stringent emission standards for engines built for 2007 and beyond will probably require use of exhaust filters. These filters are very effective at removing solid particles, so very little EC or ash is likely to be emitted. [59 126 127 129]

5.3.4.2 Gas and Vapor Phase Emissions

The vast majority of the mass of DEE consists of gases and vapors, primarily carbon dioxide, water vapor, carbon monoxide, nitrates, sulfate, and hydrocarbon-based gases and vapors. Organic gases and vapors are emitted as unburned and partially burned fuel, and to a lesser extent, lubrication oil. The compositional profile reflects the chemical composition of the diesel fuel. Organics include both lighter volatile organic compounds (VOCs) and heavier semi-volatile organic compounds (SVOCs). Gas-phase aldehydes are largely formaldehyde, but include acetaldehyde and higher molecular weight aldehydes. Lighter PAHs such as naphthalene are also found in the gas phase and are dominant, by mass, over the PAHs in the DPM.[130] Chlorinated dioxins and furans may also be emitted as a result of incomplete combustion. The current inventory value used by the EPA to approximate the dioxin/furan emissions from diesel engines is 172 picograms (pg) (one trillionth of a gram) toxic equivalency (TEQ) per kilometer.[131] However, recent emission factor results from a modern diesel engine equipped with catalyzed emission control systems suggest a one to four orders-of-magnitude reduction in dioxin/furan emissions, indicating that modern diesel engines are a minor contributor to the U.S. dioxin/furan inventory.[132]

5.3.4.3 DEE Toxicity

The relationship between diesel exhaust exposure and risk of lung cancer has been a public health concern for several decades. More recently, there has been concern that exposure to diesel exhaust also may enhance allergic sensitization and cause or exacerbate asthma. [110 126 130 133]

The carcinogenicity of traditional diesel exhaust has been investigated over the last several decades using both epidemiologic and toxicologic approaches. Inhaled diesel exhaust has been shown to induce lung tumors in rats, but these findings do not appear to be relevant to humans, because the doses used in the rat studies were at levels associated with the “lung overload” phenomenon, in which clearance mechanisms are overwhelmed, leading to particle accumulation. Accumulation of particles that are considered to be non-carcinogenic can cause lung cancer in rats with potency similar to that of DEE, so the carcinogenicity may be a consequence of the species-specific phenomenon of lung overload. Analysis of rat study results indicated a threshold for lung cancer well above ambient environmental levels. Also, DEE was not carcinogenic in chronic studies conducted with mice and Syrian hamsters.[126 129 130 133 134 135 136] As stated by Mauderly and Garshick:[126]

> "Although some agencies view the rat tumor response as supporting the plausibility of a cancer hazard, it has become a consensus view among inhalation toxicologists and inhalation hazard assessment experts that the rat study results cannot be extrapolated to human unit cancer risks."

Because of these uncertainties in the animal evidence, epidemiologic studies of occupationally exposed groups have been the principal source of data on the lung cancer risk to humans posed by DEE. Numerous studies of workers in various industries have been conducted using case control or cohort designs have found a slight (20% to 40%) increase in lung cancer risk for exposed workers. Low relative risks, inadequate control of smoking and other potential confounders, lack of sufficient follow-up, and lack of direct information regarding exposure limit the use of currently available epidemiological studies for quantitative risk estimation.[126] [129] [130] It is also important to note that, as mentioned previously, changes in fuel composition and exhaust treatment have resulted in significant changes in DEE. As stated by Mauderly and Garshick:[126]

> "…[T]here are no data from either animals or humans from which to estimate carcinogenic hazards or risks from exhaust from the most recent fuel, engine, or after-treatment technologies."

DEE has been shown to increase acute and chronic non-cancer health effects in experimentally exposed rodents and humans, including allergic responses such as asthma, inflammation, oxidative stress, susceptibility to infection, respiratory symptoms, and cardiovascular responses. Both human and animal data indicate that DPM is capable of enhancing (but not inducing) an allergic response**.** [130] [133] [137] [138] However, the experimental models used exposure levels much higher than those encountered by the general population. Further, the majority of studies have been conducted with old technology DEE. In one of the few studies to compare old and new diesel technologies, McDonald et al.[139] compared respiratory health responses in mice exposed to the same dilution of DEE from the same engine fueled with (1) conventional diesel, and (2) low-sulfur diesel plus a particle trap. While all indicators were significantly changed in the conventional exposure group, there were no significant differences from control in the new technology group.

5.3.4.4 Regulatory Criteria

Several international and national health agencies have reviewed relevant epidemiologic and experimental studies of diesel engine exhaust and human cancer based on the literature available at the time. The IARC classified DEE as "probably carcinogenic to humans" (Group 2A) in 1989. The California EPA identified DPM as a lung carcinogen in 1998.[140] The EPA classified DEE as "likely to be carcinogenic to humans by inhalation from environmental exposures" in 2002. The U.S. National Toxicology Program first listed DPM as "reasonably anticipated to be a human carcinogen" in 2000 in its ninth Report on Carcinogens (ROC), and reaffirmed this finding in its tenth, eleventh, and twelfth ROCs.[141] [142] [143] [144] Thus, there appears to be a consensus among regulatory agencies that DEE, most probably DPM, poses some risk of human lung cancer at high levels of exposure. The EPA has also developed a non-cancer reference concentration (RfC) for DEE of 5 $\mu g/m^3$ based on inflammatory and histopathological changes in the lungs of rats exposed to high concentrations. An RfC is considered to represent an exposure level to which humans may be exposed throughout their lifetime without being at appreciable risk of adverse health effects.

Cancer and non-cancer toxicological criteria for DEE (specifically, DPM) are presented in Table 43 National Ambient Air Quality Standards for Primary Particulate Matter, 2012. As mentioned previously, it is important to recognize that all of these evaluations are based on data from studies involving exposures to old diesel technology, and thus do not represent potential risks associated with new-technology DEE.

5.3.5 Review of Studies Pertaining to Impacts of Coal Mining on Community Health

It is well known that coal miners can be exposed to high concentrations of airborne coal dust, and that high exposures over prolonged periods of time can lead to coal workers' pneumoconiosis (CWP) and other respiratory diseases, particularly in underground mines.[145] [146] [147] Results of epidemiological studies of cancer risk in miners have been inconsistent, and animal studies negative.[148] [149] As a result, the International Agency for Research on Cancer (IARC) has designated coal dust as Group 3 (cannot be classified as to its carcinogenicity to humans).

Much less is known about the potential health impacts of coal mining on communities surrounding coal mines. Relevant studies conducted in the U.S. and U.K. are briefly reviewed in the following sections.

5.3.5.1 Studies Conducted in Appalachia

Appalachia is a region of the eastern U.S. from the Southern Tier of New York to northern Alabama, Mississippi, and Georgia, and includes all counties in West Virginia. Appalachia has long lagged behind the rest of the U.S. in most economic and health indicators. It is well known that a complex of social, economic, and behavioral risk factors put many Appalachians at high risk for obesity and diabetes, both of which are major risk factors for cardiovascular diseases and certain cancers.[150] [151] Obesity has also been consistently higher in West Virginia than nationally.[152] West Virginia has consistently ranked among the highest diabetes prevalence and diabetes-related mortality of all the United States. In the most recent CDC Chronic Disease Indicators, West Virginia ranked first in both age-adjusted adult diabetes mortality rate and diabetes prevalence. In contrast, Alaska ranked last in diabetes prevalence and 43rd in diabetes mortality. According to the 2008 Behavioral Risk Factor Surveillance System (BRFSS) data, West Virginia also has the nation's highest smoking rate, the most important risk factor for lung cancer and other chronic cardiopulmonary diseases.

Michael Hendryx, a psychologist at West Virginia University, and colleagues have published a series of ecological epidemiological studies examining the association between county coal production or proximity to coal mining facilities and early mortality, a range of major chronic diseases, as well as low birth weight and poor educational performance in Appalachia (especially West Virginia).[153] [154] [155] [156] [157] [158] [159] [160] [161] [162] [163] Hendryx and colleagues have consistently found that people living in Appalachian coal mining areas experience slightly higher morbidity and mortality rates from certain chronic diseases (lung cancer, cardiovascular, respiratory, and kidney disease) than those in the rest of Appalachia and the nation. All of their studies use similar ecological assessment methods. As discussed in Section 5.3.1, ecological studies do not satisfy the Hill criteria for determining causation. They are considered suitable for hypothesis generation, but not hypothesis testing (Table 39). Further, Hendryx and colleagues' studies rely on geographic location as a measure of exposure–the least reliable indicator for this critical parameter (Table 40). Therefore, these studies cannot support conclusive evidence regarding the causation of the various health impacts they consider, and as such, have been subject to criticism .[164] [165]

It is noteworthy that the health effects observed in Appalachian coal-mining communities do not seem to occur in mining areas outside of Appalachia. Hendryx[156] found that age-adjusted mortality rates in 1999 – 2004 were elevated in Appalachian mining counties, but not in coal-mining counties elsewhere in the nation:

> "That effects were found for Appalachian coal mining areas but not coal mining areas elsewhere may reflect the unique relationship of mining activity to topography and population centers characteristic of Appalachia."

Hendryx[157] reported compared mortality from heart, respiratory, and kidney disease in Appalachian coal-mining and non-coal-mining counties and non-Appalachian coal-mining counties with non-coal-mining counties across the nation. All rate ratios were very small, but he again found no increased chronic disease mortality in non-Appalachian coal-mining counties. In fact, the rate ratio (RR) for male age-adjusted chronic heart disease mortality was significantly reduced in non-Appalachian coal-mining counties (RR = 0.96, 95% confidence interval [CI] = 0.94 – 0.98). The fact that mortality from acute heart and respiratory causes was significantly decreased in high-production Appalachian counties appears inconsistent with Hendryx's hypothesis, but was not discussed by the author. Acknowledged limitations included "imprecisely measured" smoking rates and lack of information on diabetes and hypertension.

Hendryx and Zullig[161] reported that while odds ratios for coronary heart disease and heart attack morbidity were significantly increased in Appalachia, particularly in coal-mining counties, odds ratios for "any CVD" and heart attack were significantly lower in men residing in unspecified coal mining counties outside of Appalachia. Non-Appalachian mining counties also reported lower rates of current smoking (17.9% vs. 24.6% in Appalachian mining counties), obesity (26% vs. 30.5% in Appalachian mining counties), and diabetes (9.4% vs. 12.1% in Appalachian mining counties). The authors speculated that "this might reflect a 'healthy worker' effect or other unique demographic or behavioral characteristics of men who live in mining areas outside Appalachia."

Zullig and Hendryx[163] assessed self-reported health in mining and non-mining counties in and out of Appalachia using the 2006 BRFSS survey. Although the abstract of this article stated that residents of both Appalachian and non-Appalachian coal-mining counties suffered from poorer health, the data indicate only a modest and inconsistent effect in non-Appalachian coal-mining counties. The authors did not include potentially relevant chronic health indicator data included in the BRFSS (e.g., asthma, diabetes). As in other studies, the magnitude of the adjusted odds ratios for fair/poor health were very small.

Hendryx and colleagues have focused on mountaintop removal mining in Appalachia in subsequent publications. Esch and Hendryx[154] examined age-adjusted chronic cardiovascular disease mortality from 1999 to 2006 in counties in the four Appalachian states where mountaintop mining is practiced (Kentucky, Tennessee, Virginia, and West Virginia), divided according to mining type (mountaintop mining, non-mountaintop mining, and non-mining). "Exposure" was represented by contemporaneous county-level coal production data. After adjustment with county-level information on covariates (including rates of smoking, adult obesity, diabetes, poverty and number of physicians per 1,000 population), mortality was reported to be significantly increased only in the mountaintop mining counties. The authors stated,

> "In non-MTM [mountaintop mining] mining zones, increased mortality risk appeared to be the result of adverse socioeconomic and behavioral conditions that drive poor health."

> "Specifically, the current study demonstrates that higher adjusted chronic CVD mortality rates are concentrated in MTM areas relative to non-MTM and nonmining areas."

Zullig and Hendryx[163] evaluated individual-level self-reported health and quality of life in 120 central Appalachian counties dividing by mining type (mountaintop mining, other mining, and non-mining) based on the 2006 BRFSS. After adjustment for covariates (including smoking, BMI, alcohol consumption, age, gender, race/ethnicity, income, and education), significantly reduced self-rated health was observed only in mountaintop mining counties. As noted by the authors, "…HRQOL impairment in other coal mining counties begin to appear more similar in HRQOL to the referent nonmining counties…." They concluded,

> "Results indicate that previously documented HRQOL [health-related quality of life] disparities in Appalachia's coal mining areas are concentrated in MTM [mountaintop mining] zones in the central part of the region."

A similarly designed study reported that after adjustment for covariates (including mother's age, race, education, prenatal care, alcohol consumption, smoking, and diabetes comorbidity, and infant sex), the relationship between mountaintop mining in central Appalachia and seven categories of anomalies remained significant, while a weaker relationship in two categories was observed in "other mining areas".[153]

More recently, Hendryx and colleagues have sought to attribute ill health in Appalachia to PM. Knuckles et al.[118] characterized the toxicity of PM collected within one mile of an active mountaintop mining site in West Virginia. As noted previously, this PM was predominantly crustal in origin, but may also have contained coal dust. Extracted PM resulted in increased arteriolar reactivity in rats both *in vivo* and *in vitro*. In the absence of comparative studies with other sources of PM, the authors' conclusion that the microvascular toxicity of mountaintop mine PM "…may account or contribute to the known cardiovascular health disparities frequently observed in this unique population" is not supported. Kurth et al.[119] sought to characterize PM in two mountaintop mining communities compared to PM in a non-mining community. While the two mountaintop mining sampling sites are located in air-trapping valleys surrounded by mountains, the non-mining site is in an open area. Once a month for a year, particle size distributions in the 0.5- to 20-µm size range were measured in 10-minute samples, and number concentration for particles 0.01- to 0.4 µm were measured in 2-minute and 15-second sessions. Results were combined for the two mountaintop mining sites. The authors' conclusion that the significantly higher number concentration and estimated respiratory deposition of ultrafine particles in mountain mining areas were correlated with differences in mortality, cardiovascular disease, birth defect, and cancer ventures far beyond the power of their data.

Hendryx and colleagues have clearly acknowledged the limitations of their ecological study design, the imprecision of their attempts to adjust for important covariables, and the absence of objective exposure data. However, these limitations do not in themselves refute these authors' hypothesis that proximity to mountaintop removal coal mining in Appalachia influences health in surrounding communities. For people living in mining areas outside of West Virginia and Appalachia, it is relevant to ask, do similar associations exist? Recognizing all the uncertainties in this research mentioned previously, the answer from Hendryx and colleagues' work appears to be no.

5.3.5.2 Studies Conducted in Merseyside

A cross-sectional study was conducted to compare the respiratory health of "exposed" schoolchildren aged five to 11 years attending school in the Bootle dock area of north Liverpool, Merseyside with that of otherwise similar children in two control areas (n = 1,872) over a three-month period in 1991.[166] Stockpiled steam coal was mentioned as a source, but dust composition was not evaluated. Respiratory symptoms were assessed via questionnaire. Dust deposit gauges indicated significantly higher dust burden in the exposed area. The children were similar in age and physical characteristics, and had a similar prevalence of parental asthma. However, there was higher unemployment, more rented housing, and higher parental smoking rates in the exposed area. After adjusting for these differences and confounding variables, respiratory symptoms, but not hospitalization for respiratory symptoms, were increased. The questionnaire response rate was very high, but as noted by the authors, results may have been biased by the high degree of public and press awareness of the issue in the exposed area. Also as noted by the authors, a cross-sectional study cannot attribute the observed differences to any specific cause.

In a subsequent study based on these data, respiratory symptoms (excess cough, wheezing, breathlessness, school absenteeism, and doctor-diagnosed asthma) were examined as a function of dust levels measured in multiple outdoor locations as well as inside houses where there had been complaints of coal dust nuisance.[167] Allergies and parental asthma were the most important risk factors for all endpoints; proximity to the Bootle dock area was approximately as influential as passive smoking with respect to all symptoms except doctor-diagnosed asthma. Reported hospital admissions for respiratory symptoms did not differ between exposed and control areas, suggesting that increased dust did not cause acute or severe exacerbations of respiratory conditions. Logistic regression analysis of the data (adjusted for family history of asthma, allergies, dampness in the home, and socioeconomic characteristics) indicated a significant association between dust level in the vicinity of a child's home and excess cough, but not wheezing, suggesting a lack of association of dust with asthma.

Rizwan et al.[168] examined trends in asthma prevalence among children and parents in the Bootle dock area based on three cross-sectional respiratory health surveys (parental questionnaires) conducted between 1991 and 1998. According to these authors, the dust exposure in this area had been greatly reduced by 1998. The prevalence of doctor-diagnosed asthma in both children and mothers increased significantly between 1991 and 1998, although the prevalence of the symptom triad of cough, wheeze, and breathlessness did not increase. Residing in the dust-exposed area was associated with increased prevalence of the symptom triad, but not with prevalence of doctor-diagnosed asthma. An additional cross-sectional health survey in this area in 2006 indicated a significant decrease in doctor-diagnosed asthma and symptoms among children, but an increase in asthma prevalence among parents between 1998 and 2006.[169] Dust exposure was not mentioned by these authors.

Overall, these studies indicate an association between elevated levels of dust and respiratory symptoms in school children living in a socioeconomically deprived area, but do not establish a causal relationship.

5.3.5.3 Studies Conducted in Northeast England

Community concerns about possible health impacts of PM associated with opencast coal mining in non-urban Northeast England prompted a large-scale nationally funded study of children's respiratory health conducted by Pless-Mulloli and colleagues at the University of Newcastle upon Tyne. Unlike the work in

Appalachia, these studies included both objective exposure measurements for PM_{10} and individual-specific health data for an endpoint known to be relevant (respiratory health) in a potentially susceptible population (children aged 1 to 11 years).

The acute and chronic respiratory health of children from five communities located within a mile of active opencast coal mining and five control communities in the same administrative area (matched for socioeconomic characteristics, urban/rural mix, and distance from the coast) was examined via daily diaries completed by parents and medical records during the PM_{10} sampling periods. Thus, the potential for confounding by socioeconomic status was reduced. The children's exposure to PM_{10} was evaluated over a six-week period using continuous real-time monitors at representative sites in four matched pairs of communities, and a 24-week period in one pair. PM_{10} was also measured at the site boundaries. A unique aspect of this study was the concurrent qualitative evaluation of the health and environmental risk perceptions of parents. The results of the study did not support and generally assuaged parents' concerns about children's health ("it wasn't the plague we expected").[170]

Levels of PM_{10} were slightly (14%) higher in opencast than control communities (geometric mean of 17.0 μg/m^3 vs. 14.9 μg/m^3), and both were similar to readings from nearby urban network stations, suggesting a strong regional component of PM_{10} levels.[171] Although the proportion of shale particles (indicative of geological disturbance) was higher in PM_{10} in opencast communities, no correlation with permitted working hours or wind direction from the sites was observed.

Information on family circumstances and children's respiratory health history was initially collected via a postal questionnaire. There was no apparent association between living in an opencast community and lifetime prevalence of wheeze, asthma, or bronchitis.[172] Children's consultations with their general practitioners were evaluated over both the six-week PM_{10} monitoring period and the preceding year.[173] While consultation rates for all conditions did not differ between opencast and control communities during the six-week period, consultations were slightly but significantly (40%) higher in four of the five opencast communities for respiratory, skin, and eye conditions (odds ratio = 1.4; 95% confidence interval = 1.0 – 1.7). However, a significant difference in consultations for these conditions over the preceding year was seen in only one community pair. The absence of PM_{10} monitoring data over this longer period prevents further analysis of this inconsistency.

Respiratory morbidity was also evaluated by means of daily diaries kept by the children's parents. While the association between PM_{10} levels and the prevalence and incidence of respiratory morbidity was generally positive, there were no consistent differences between communities as would be expected if the PM_{10} in opencast communities were more toxic than background PM_{10}.[172] That is, the associations between health effects and PM_{10} in opencast communities would be expected to be stronger than those in control communities if the opencast community PM_{10} were more toxic than that in control communities.

The recommended policy response to the epidemiological findings was to increase monitoring to within a one-kilometer radius of opencast sites with a nearby population. The United Kingdom Committee on the Medical Effects of Air Pollutants (COMEAP) is a British body of independent scientific and medical experts (in air quality science, atmospheric chemistry, toxicology, physiology, epidemiology, statistics, pediatrics, respiratory medicine, cardiology, environmental health and public health) that provides advice to government departments and agencies on matters concerning the effects of air pollutants on health. COMEAP considered the Pless-Mulloli study to be of high quality.[174] The COMEAP concurred with the recommended policy response, and reached the following conclusions relevant to the UCM:[174]

> "Overall, the number of consultations made to general practitioners was similar for children who lived close to open cast sites compared to those who did not. However, there was a small increase in consultations for respiratory, skin and eye conditions in those living close to open cast sites in four of the five pairs of communities studied. Though the increase was statistically significant, the average difference in the number of consultations between the communities close to and distant from open cast sites was small. In the absence of other evidence of effects it is not possible to be certain that these differences were due to open cast operations."

6.0 DATA GAPS

The proposed WHM requires a renewal of an existing permit and there is no requirement under State of Alaska or federal regulations for a comprehensive set of environmental and social impact assessments. For many natural resources projects, particularly those performed under the federal National Environmental Protection Act (NEPA), the HIA is part of a suite of impact assessments that covers (i) detailed environmental and social analyses and (ii) consideration of alternatives, including a "no action" option. As previously discussed (Chapter 1.0), performance of an HIA for the WHM is discretionary, and is being performed by the Alaska HIA Program in collaboration with the Alaska Department of Natural Resources (ADNR).

While this HIA does not have access to comprehensive environmental and social impact assessments, a substantial body of environmental and social information has been developed as part of the original permit process. In addition, permit information has been updated and in some instances, e.g., fish/aquatics and groundwater monitoring, new data have been collected (Chapter 4.0). The HIA draws upon numerous data sources for information above and beyond the original permit and its request for modification. Nevertheless, the HIA process has uncovered additional technical data gaps. This is normal even during the federal NEPA process. For the proposed WHM, many of the data gaps exist because the requirements of a modification to an existing permit generate a specific set of technical data that is not fully matched to those used by the HIA, which holistically considers potential impacts to community health. A standard step in any HIA (for both regulatory decision makers and stakeholders) is the data gaps analysis. The key data gaps for health are listed below in Table 46 by health effect category.

Table 46 Key Data Gaps by Health Effect Category

HEC 1 Social Determinants of Health (SDH)	Current household level survey data for the PACs is not available. Data sets do not include years 2009-2011.
HEC 2: Accidents and Injuries	Data sets do not include data from the ATR for years 2009-2011.
HEC 3 Exposure to potentially Hazardous Materials	No offsite residential monitoring well data are available for review. Fish/Aquatics data set may not fully capture all of the recent restoration efforts. There are no site specific $PM_{2.5}$ data. There is no analysis of potential dust/diesel emissions in Point MacKenzie or along a proposed transportation corridor Visual effects analysis is not available. Complex off-Site terrain noise modeling has not been performed.
HEC 4 Food, Nutrition and Subsistence	There is no Traditional and Local Knowledge survey. Subsistence data and analysis does not appear to have been updated for two decades.
HEC 5 Infectious Diseases including STIs	No critical data gaps
HEC 6 Chronic Non-Communicable Diseases (NCDs)	No critical data gaps
HEC 7 Water and Sanitation (WATSAN)	No critical data gaps
HEC 8 Health Infrastructure and Capacity	No critical data gaps

While environmental fate-transport considerations dominate the data gaps analysis, there are other health-relevant data gaps that would typically be reported by a social impact analysis. The social analysis informs the HIA, and provides both qualitative and quantitative information:

- Equity effects and environmental justice analysis
- Household level core welfare indicators survey
- Economic impact analysis
- Systematic key informant interviews and/or surveys. Stakeholder meetings have inherent “selection bias” problems and can be dominated by vocal minorities or interest groups who may or may not be representative of the wider community
- Community dynamics and power relationship analysis

Closure of these data gaps would allow for the development of a comprehensive HIA. Given the limitations of available information, the current HIA is a rapid appraisal that can only make broad qualitative priority assessments for potential impacts.

7.0 PRIORITIZING HEALTH IMPACTS

7.1 Introduction

The ultimate goal of an HIA is to identify whether there are potential health impacts and communicate these impacts to decision makers during the planning and permitting process. This section of the HIA synthesizes the previous sections of the HIA and identifies a group of the most important key health impacts related to the proposed WHM. The approach for rating and ranking health impacts is taken from Section 8 of the Alaska HIA Toolkit.[1]

A health impact is a positive or negative change in a specific health outcome or health determinant. Health impacts are:

- Changes in health outcomes or determinants, not general changes in environmental conditions
- Specific health outcomes or determinants, not general statements about health status
- Quantifiable, whenever possible

Each health effect category (HEC) contains health impacts that fit the criteria above. The following table (Table 47) displays a list of the most important health impacts (positive and negative) that have been identified for each HEC.

Table 47 Key Health Impacts by Health Effect Category

Social Determinants of Health (see section 4.3)	• Change in morbidity and mortality data related to psychosocial distress such as depression, anxiety, substance abuse, and changes to family structure. • Change in median household income • Change in unemployment • Change in the percentage of households living below poverty line • Change in educational attainment
Accidents and Injuries (see section 4.4)	• Change in morbidity and mortality data related to commercial motor vehicle (CMV) traffic on roadways related to the project and coal transport. • Change in morbidity and mortality data related to non-commercial motor vehicle crashes.
Exposure to potentially Hazardous Materials (see section 4.5)	• Change in morbidity and mortality data from poor air quality events (exceedances) through exacerbation of chronic obstructive pulmonary disease (COPD), asthma, cerebrovascular diseases, or cardiovascular diseases.
Food, Nutrition and Subsistence (see section 4.6)	• Change in regional food cost expressed as a % of median household income
Infectious Diseases including STIs (see section 4.7)	• Change in the rates of STI such as gonorrhea, chlamydia, Hepatitis C, and HIV. • Change in the rates of respiratory diseases such as influenza and pneumonia
Chronic Non-Communicable Diseases (see section 4.8)	• Change in mortality and morbidity data due to cancer
Water and Sanitation (see section 4.9)	• Change in % of households served with water and sanitation services
Health Infrastructure and Capacity (see section 4.10)	• Change in ratio of people to health care providers • Change in time needed for emergency response

Given this list of potential health impacts, the next step is to establish which impacts are most important for decision makers to address. This is determined by attempting to assign a score that describes the intensity of the impact and the likelihood that the impact could occur. The table below (Table 48) describes the first step in the method for assigning intensity to the four dimensions of each impact. Each dimension is reviewed and given a rating of low, medium, high, or very high.

Table 48 Impact Dimensions

Step 1				
	Impact Dimensions			
Impact Level (score)	A – Health Effect (+/-)	B- Duration	C-Magnitude	D- Extent
Low (0)	Effect is not perceptible	Less than 1 month	Minor intensity	Individual cases
Medium (1)	(+/-) minor benefits or risks to injury or illness patterns (no intervention needed)	Short-term: 1-12 months	Those impacted will 1.)be able to adapt to the impact with ease and maintain pre-impact level of health, 2.) see noticeable but limited and localized improvements to health conditions	Local: small limited impact to households
High (2)	(+/-) moderate benefits or risks to illness or injury patterns (Intervention needed)	Medium-term: 1 to 6 years	Those impacted will: 1.) be able to adapt to the health impact with some difficulty and will maintain pre-impact level of health with support, or 2.) experience beneficial impacts to health for specific population some maintenance may still be required	Entire Potentially Affected Communities (PACs); village level
Very high (3)	(+/-) severe benefits or risks: marked change in mortality and morbidity patterns (intervention needed, if negative)	Long-term: more than 6 years/life of project and beyond	Those impacted will 1.) not be able to adapt to the health impact or to maintain pre-impact level of health 2.)see noticeable major improvements in health and overall quality of life	Extends beyond PACs; regional and state-wide levels

After the intensity level is determined, steps 2 and 3 allow the likelihood of the event to be evaluated and a final rating is assigned to the potential impact using the table below (Table 49). The final result in step 4 is that each impact then receives an overall rating of low, medium, high, or very high.

Table 49 Likelihood Rating

Step 2	**Step 3**						
Impact Level	**Likelihood Rating**						
(Use Score from Step 1 to choose low, medium, high or very high)	**Extremely Unlikely (<1%)**	**Very Unlikely (1-10%)**	**Unlikely (11-33%)**	**About as likely as Not (33-66%)**	**Likely (66-90%)**	**Very Likely (90-99%)**	**Virtually Certain (>99%)**
Low (1-3)	*	*	*	*	**	**	**
Medium (4-6)	*	*	*	**	**	**	***
High (7-9)	**	**	**	***	***	***	****
Very High (10-12)	***	***	***	****	****	****	****
Step 4	**Impact Rating**						
	Low = * Medium = ** High = * Very High = ******						

7.2 Rating and Ranking Health Impacts—what do the ratings mean?

As previously stated, there is a broad spectrum of health impacts that could be imagined for any particular project. The goal of an HIA, however, is to survey this spectrum of impacts and evaluate a handful of the most important health impacts related to the project.

<u>The ratings assigned to health impacts are not statements of health risks or heath benefits.</u> Rather, the rating of a health impact (very high, high, medium, low) tells decision makers the importance of one particular health impact in relationship to the others. The ratings also allow decision makers to consider what approach they could take towards action steps and monitoring efforts for particular health impacts.

The table below (Table 50) suggests an approach to the health impact ratings in this section.

Table 50 Suggested Approach to Health Impact Ratings

	Action Steps	Monitoring
Low (*)	None	Standard health surveillance
Medium (**)	Described	Standard health surveillance
High (***)	Recommended	Impact specific monitoring
Very High (****)	Strongly recommend	Impact specific monitoring

For impacts rated as low, no action steps are needed and any monitoring of health impacts can be completed by standard public health surveillance methods already in effect. The HIA program will describe action steps for impacts rated as medium and these impacts may also be monitored using standard public health surveillance systems already in place. For impacts rated as high, the HIA will describe action steps and make recommendations about how decision makers implement them. Impacts rated high will also benefit from periodic active surveillance of the health data to monitor for change. If an impact were rated as very high, the HIA would describe appropriate action steps and strongly recommend that decision makers take action to promote benefits or prevent negative impacts to health. Periodic impact-specific monitoring will also be valuable in these cases. Action steps and monitoring approaches for the key impacts associated with WHM will be explained in Section 8, below.

The following sections briefly explain the rating decisions for selected health impacts from each HEC. Those impacts receiving a low rating will be discussed in general terms, while those that have a medium or higher rating will be explained in more detail.

7.2.1 Social Determinants of Health (SDH)

SDH describes how living conditions and social situations provide a context for the health of individuals and communities. The following sections describe the ratings assigned for each health impact in the HEC table above.

7.2.1.1 Change in morbidity and mortality data related to psychosocial distress such as depression, anxiety, substance abuse, and changes to family structure.

Psychosocial distress is an important contributor to a host of human health behaviors. Persons who are distressed for prolonged periods are at increased risk for anxiety and depression, and other adverse health consequences such as substance abuse, relational problems, and occupational dysfunction. Unfortunately, the health outcomes related to psychosocial distress will be difficult to quantify because mental health conditions are not reportable to state health officials and many people experiencing such distress will not seek medical care. That said, a variety of information sources (e.g., stakeholder comments, media stories, and public signage) have already clearly demonstrated psychosocial distress experienced by some proponents and opponents of the proposed WHM. As such,

- the *health effect* to the community are expected to be medium;
- the *duration* of the impact will last for the life of the project (very high);
- the *magnitude* is expected to be medium, since it may be difficult for some people to fully cope with the outcome of the permitting decision, though it is difficult to determine whether overall levels of health for an individual (versus the larger overall population) are adversely impacted; and
- the *extent* is expected to be medium since this impact will be limited to local households near the mine area.
- *Overall,* this impact receives a rating of medium because it is "likely" (66-90%) that some stakeholders will be distressed by the development of the mine.

7.2.1.2 Change in median household income

Economic status is a well-known health determinant that influences health and median household income is a common metric used to evaluate economic status. In general, changes to median household income in the region may be quite small, but for some individuals, the proposed WHM mine would be an economic opportunity. The proposed mine would provide year round employment for between 75-120 individuals.

Overall, the impact to median household income numbers should be positive because of the increased economic activity from the proposed mine. As such,

- The *health effect* to the community is expected to be medium because some minor/modest benefits to health will likely occur;
- the *duration* will be for the length of the project (very high);
- the *magnitude* of the impact is expected to be medium since some benefits will be noticeable in localized areas; and
- the *extent* of the impact is expected to be medium since a limited proportion of households will benefit from employment at the mine.
- *Overall*, this positive impact receives a rating of medium because it is "very likely" (90-99%).

7.2.1.3 Change in unemployment

Employment is an important determinant of health status. As stated above, employment numbers at the mine are predicted to be 75-125 people.

In general, this should result in a positive impact for a small number of people, as it could produce minor improvements in unemployment numbers for the region. The overall health effects of this change in unemployment would confer some benefits. As such,

- the *health effect* to the community is expected to be medium;
- the *duration* will be for the length of the project (very high);
- the *magnitude* of the impact is expected to be medium**,** since there would be a noticeable, but limited, impact to households where someone is employed; and

- the *extent* is expected to be medium since a limited proportion of households will benefit from employment at the mine.
- *Overall*, this positive impact received a rating of medium because it is "very likely" (90-99%).

7.2.1.4 Change in number of households living below the poverty line

Living below the poverty line is also an important determinant of health status. Poverty can be associated with decreased access to health care and increased disparities in health outcomes. In general, the mine would produce a positive impact on poverty status for a small number of people employed at the WHM site. Like other social determinants of health, the overall health effects of this small change in unemployment would confer some health benefits. As such,

- the *health effect* to the community is expected to be low;
- the *duration* will be for the length of the project (very high);
- the *magnitude* of the impact is expected to be medium, since impacts would be localized; and
- the *extent* is expected to be medium since a limited proportion of households will directly benefit from employment at the mine.
- O*verall*, this positive impact receives a rating of medium because it is "about as likely as not" (33-66%).

7.2.1.5 Change in educational attainment

Higher levels of educational attainment are associated with positive health outcomes such longer lifespans and decreased risk for cardiovascular disease, cancer, and lung disease. In general, the WHM is expected to exert a positive change to this health impact. Economic influx into the area will likely draw families that can support local schools. As such,

- the *health effect* to the community is expected to be low, since these effects will likely be minor overall;
- the *duration* would be long term (very high);
- the *magnitude* of the positive change is expected to be medium because this health impact could be noticeable through initiation of new educational programs, and it would be localized; and
- the *extent* is expected to be medium since a limited proportion of households will directly benefit from employment at the mine.
- O*verall*, this impact is positive and receives a rating of medium because it is "about as likely as not" (33-66%) to occur.

7.2.2 Accidents and Injuries

The accidents and injuries health effect category describes changes to fatal and non-fatal injury statistics that can be either intentional (e.g., suicide, homicide, assault, and self-harm) or unintentional (e.g., motor vehicle crashes and falls).

7.2.2.1 Change in morbidity and mortality data related to commercial motor vehicle traffic on roadways related to the project and coal transport

The proposed project would increase the number of commercial motor vehicles (e.g., coal trucks and other vehicles) on the Glenn Highway, which could potentially produce a small increase in accidents and injuries in the region. In general, changes in this health impact are expected to be negative, resulting in an increase in morbidity and mortality outcome data. As such,

- the *health effect* to the community is expected to be low;
- the *duration* of the impact is for the life of the mine (very high);
- the *magnitude* of the impact is expected to be low; and
- the *extent* of the impact is expected to be low since it would likely be limited to rare individual cases.
- O*verall*, this impact receives a rating of medium because increases in accidents and injuries from CMV traffic are expected to occur during development projects; the likelihood of this impact in relation to WHM is "very likely" (90-99%).

7.2.2.2 Change in morbidity and mortality data related to non-commercial motor vehicle crashes

Motor vehicle crashes are a leading cause of fatal and non-fatal injury in the Mat-Su Borough (see section 4.4). The number of motor vehicle crashes could be influenced by increases in non-commercial commuter and other traffic to and from the mine site. While employment at WHM will decrease the commute time to work for some persons, employment at WHM will increase the commute time for others (e.g., employees living in Anchorage will need to travel the Glenn Highway to get to and from the mine site). The impact to the number of motor vehicle crashes on the Glenn Highway will likely be negative (i.e., a very small increase in crashes). The change is likely to be imperceptible since the vehicle trips added by the mine will be small relative to the large volume of traffic on the roadway. As such,

- the *health effect* to the community is expect to be low;
- the *duration* of the impact is for the life of the mine (very high);
- the *magnitude* of the impact is expected to be low; and
- the *extent* of the impact is expected to be low because a small number of individuals would be affected by the impact (low).
- O*verall*, this impact receives a rating of medium because it is commonly seen with most resource development projects using road transport and so, while small, negative changes to this impact are "very likely" (90-99%).

7.2.3 Exposure to Hazardous Materials

Exposure to hazardous materials from the proposed WHM would primarily occur through changes in air quality and changes in water quality. Both air and water exposure routes are carefully reviewed in chapters 4 and 5. Regulatory permitting standards for air and water quality are in place to minimize changes that may occur and to establish air and water quality monitoring during mining operations.

7.2.3.1 Change in morbidity and mortality data for exacerbation of chronic respiratory disease (COPD), asthma, cardiovascular disease, and cerebrovascular disease because of poor air quality events (exceedances)

Air quality is an important factor for impacts related to cardiovascular, cerebrovascular (i.e., stroke), and pulmonary disease (e.g., COPD, asthma). Individuals who live in the Mat-Su Valley are familiar with poor air quality days related to local winds and glacial geology (glacial dust). Exposure to small dust particles

<2.5 micrometers ($PM_{2.5}$) can cause worsening of chronic respiratory disease, cardiovascular disease, and cerebrovascular diseases.

Any mining activity at WHM will generate some particulate matter that becomes suspended in the air (dust); however, based on the ADEC TAR, the incremental change in air quality is likely to be small (see sections 4.5.8 and 5.3.2.2). As noted in previous discussions on concentration-response functions, there is an established relationship between incremental changes in PM (particularly $PM_{2.5}$) and adverse health outcomes. The published concentration-response literature on PM and adverse health outcomes is typically based on (i) extremely large populations (morbidity and mortality rate changes are usually reported per 100,000), and (ii) detailed objective air quality monitoring.

As previously discussed in section 5.3.2.2, the results of the screening assessment indicate that the predicted human health impacts of PM_{10} increments due to mining operations are likely to be small under most conditions, and the predicted human health impacts of $PM_{2.5}$ are highly unlikely to result in substantial clinically-observable adverse consequences to human health in surrounding communities. Therefore, this constitutes a negative impact that would be difficult to detect at the community-level under most circumstances, but could be detectable during exceptional events (e.g., forest fires). As such,

- the *health effect* to the community is expected to be low;
- the *duration* of the impact is for the life of the mine (very high);
- the *magnitude* is expected to be medium, since those affected will likely be able to maintain their previous level of health; and
- the *extent* is expected to be low since this impact will likely be experienced by a small subset of persons.
- O*verall*, this impact receives a rating of medium because it is “about as likely as not” (33-66%) that there could be a small change in morbidity and mortality data for chronic diseases related to sporadic poor air-quality events (exceedances).

7.2.4 Food, Nutrition and Subsistence Activity

Food security, nutritional status, and subsistence activities can all be influenced by development projects. The area of the WHM is designated as a non-subsistence area and impacts to subsistence usage due to the mine are likely to be small. The changes to traditional use of the WHM area by the Chickaloon Native Village community are discussed under the social determinants of health (section 7.2.1). Overall, this impact receives a rating of low.

7.2.4.1 Change in regional food costs expressed as a % of median household income

Food costs are an important determinant for adequate nutrition. High food costs can adversely affect food choices by predisposing individuals to purchase calorie dense foods with low nutritional value. Resource development projects can bring income into an area and make healthy foods more affordable for residents since they have more money to spend on food.

This impact would be positive, since some persons in the region would experience a small increase in median household income. As such,

- The *health effect* of this impact is expected to be low;

- the *duration* of the impact is for the life of the mine (very high);
- the *magnitude* is expected to be low since the changes in income or cost of foods would be small; and
- the *extent* of the impact is expected to be medium, limited to households that have a family member who obtains new employment.
- O*verall*, this impact receives a rating of low because it is "unlikely" (11-33%) that regional food costs will change as a result of the WHM.

7.2.5 Infectious Diseases

The two impacts (see Table 47) in this HEC can result from the influx of a large and uncontained workforce. Because the workforce is local and small (≤125 workers), and because environmental changes will be limited to on-site infrastructure and the immediate area, changes in infectious disease rates are expected to be small. As such,

- the *health effect* to the community is expected to be low;
- the *duration* of the impact is for the life of the mine (very high);
- the *magnitude* of the impact is expected to be medium since the impacted individuals would be readily able to adapt and maintain good health via available medical therapies; and
- the *extent* of the impact is expected to be low and limited to individual cases.
- O*verall*, this impact receives a rating of low because the likelihood of this impact is "very unlikely" (1-10%) due to the small size of the workforce.

7.2.6 Chronic Non-communicable Diseases

The proposed project could produce behavioral changes at the household level such as alcohol use, smoking, or dietary changes that may contribute to a rise in non-communicable disease (NCD) outcomes. These are discussed under SDH. Cancer is also a NCD. As discussed in the toxicology review (Chapter 5), observable changes in cancer incidence rates characteristically result from long-term, substantial, offsite releases to local residents at concentration levels that are highly unlikely to be produced by WHM mining operations. The extensive toxicologic literature related to population-level effects of coal mining operations was reviewed in Chapter 5. The WHM is a small project and is not expected to result in significant changes in cancer incidence in surrounding communities. As a result, this parameter receives a rating of low.

7.2.7 Water and Sanitation

Development projects typically influence water and sanitation by increasing or decreasing access to water and sanitation services for communities. The Mat-Su Borough has excellent availability of sanitation services and the impacts of the mine are likely to be minimal.

In sections 4.5.2 through 4.5.5, the quality of ground water and surface water quality are discussed. Monitoring wells were installed near the mine site and studies of water quality were conducted. Past investigations indicate that no substantial water quality problems were identified in the Moose Creek watershed. Concentrations of trace constituents, primarily metals, were generally low. Surface waters met Federal standards for drinking water quality. To guard against degradation of the water supply, the

ADNR Division of Mining Land and Water reviewed the hydrology studies from 1988-89 and made a series of recommendations for the use of water quality data (section 4.5).

Monitoring plans included in the Wishbone Hill Coal Mining Permit Application and the in-place monitoring wells will help characterize the impacts of the mine on ground and surface waters; however, based environmental data supplied in application materials, a small negative change in water quality could occur. As such, this impact receives a low rating.

7.2.8 Health Services Infrastructure and Capacity

Access to health care and health care capacity is often influenced by natural resources development projects. The WHM could produce a small beneficial impact in this HEC to the region. The Mat-Su Borough currently has a ratio of people to medical providers that is much lower than the average for the United States and the rest of Alaska (Table 38). While some medical providers may leave the area if the mine is developed, there are others who may relocate to the area (e.g., to provide occupational or environmental health services generated by the mine). Emergency response times could be slightly less due to increased presence in the mine area and the existence of trained first responders in the work force. Both impacts in this category received a rating of low.

7.3 Overall Prioritization of Health Effect Categories

Table 51 displays the priority level for the health impacts organized by HEC. Again Table 51 does not describe health risks, but provides decision makers with information that explains which impacts require the highest priority attention in their decisions and why.

Table 51 Health Impacts Rated by Health Effect Category

Health Impact	+/-	Effect	Durat'n	Mag	Ext	Total	Likelihood	Rating
Social Determinants of Health (see section 4.3)								
Health Impact	**+/-**	**Effect**	**Durat'n**	**Mag**	**Ext**	**Total**	**Likelihood**	**Rating**
Change in morbidity and mortality data related to psychosocial distress such as depression, anxiety, substance abuse, and changes to family structure.	(-)	Medium (1)	Very high (3)	Med (1)	Med (1)	6	66-90%	Medium **
Change in median household income	(+)	Medium (1)	Very high (3)	Med (1)	Med (1)	6	90-99%	Medium **
Change in unemployment	(+)	Medium (1)	Very high (3)	Med (1)	Med (1)	6	90-99%	Medium **
Change in the percentage of households living below poverty line	(+)	Low (1=0)	Very high (3)	Med (1)	Med (1)	5	33-66%	Medium **
Change in educational attainment data	(+)	Low (0)	Very high (3)	Med (1)	Med (1)	5	33-66%	Medium *
Accidents and Injuries (see section 4.4)								
Health Impact	**+/-**	**Effect**	**Durat'n**	**Mag**	**Ext**	**Total**	**Likelihood**	**Rating**
Change in morbidity and mortality data related to commercial motor vehicle (CMV) traffic on roadways related to the project and coal transport.	(-)	Low (0)	Very high (3)	Low (0)	Low (0)	3	90-99%	Medium **
Change in morbidity and mortality data related to non-commercial motor vehicle crashes.	(-)	Low (0)	Very high (3)	Low (0)	Low (0)	3	90-99%	Medium **
Exposure to potentially Hazardous Materials (see section 4.5)								
Health Impact	**+/-**	**Effect**	**Durat'n**	**Mag**	**Ext**	**Total**	**Likelihood**	**Rating**
Change in morbidity and mortality data from poor air quality events (exceedances) through exacerbation of chronic obstructive pulmonary disease (COPD), asthma, cerebrovascular diseases, and cardiovascular diseases.	(-)	Low (0)	Very high (3)	Med (1)	Low (0)	4	33-66%	Medium **
Food, Nutrition and Subsistence (see section 4.6)								
Health Impact	**+/-**	**Effect**	**Durat'n**	**Mag**	**Ext**	**Total**	**Likelihood**	**Rating**
Change in regional food costs expressed as a % of median	(+)	Low (0)	Very High (3)	Low (0)	Med (1)	4	11-33%	Low *

household income								
Infectious Diseases including STIs (see section 4.7)								
Health Impact	**+/-**	**Effect**	**Durat'n**	**Mag**	**Ext**	**Total**	**Likelihood**	**Rating**
Change in the rates of STI such as gonorrhea, chlamydia, Hepatitis C, and HIV.	**(-)**	Low (0)	Very High (3)	Med (1)	Low (0)	4	1-10%	Low *
Change in the rates of respiratory diseases such as influenza and pneumonia	**(-)**	Low (0)	Very High (3)	Med (1)	Low (0)	4	1-10%	Low *
Chronic Non-Communicable Diseases (see section 4.8)								
Health Impact	**+/-**	**Effect**	**Durat'n**	**Mag**	**Ext**	**Total**	**Likelihood**	**Rating**
Change in morbidity and mortality for chronic diseases including cancer	**(-)**	Low (0)	Very High (3)	Low (0)	Low (0)	3	<1%	Low *
Water and Sanitation (see section 4.9)								
Health Impact	**+/-**	**Effect**	**Durat'n**	**Mag**	**Ext**	**Total**	**Likelihood**	**Rating**
Change in % of households served with water and sanitation services	(-)	Low (0)	Very High (3)	Low (0)	Med (1)	4	1-10%	Low *
Health Infrastructure and Capacity (see section 4.10)								
Health Impact	**+/-**	**Effect**	**Durat'n**	**Mag**	**Ext**	**Total**	**Likelihood**	**Rating**
Change in ratio of people to health care providers	(+)	Low (0)	Very High (3)	Low (0)	High (2)	5	1-10%	Low *
Change in time needed for emergency response for health issues	(+)	Low (0)	Very High (3)	Low (0)	High (2)	5	1-10%	Low *

8.0 RECOMMENDATIONS

8.1 Introduction

Recommendations in this section are based on the impact ratings from chapter 7. It is important to re-state that an HIA does not create legal stipulations, as it is not a regulatory document. The action steps and monitoring approaches discussed in this section are provided as recommendations to key decision makers, based on the predicted health impacts. Stakeholders are encouraged to review the potential impacts and consider ways to use this information to maximize benefits and minimize harms to persons living in the PACs.

8.1.1 Social Determinants of Health (SDH)

Five health impacts were identified for this health effect category. One potential health impact related to psychosocial distress was negative and four health impacts were positive. All impacts in this HEC were rated medium; action steps and standardized monitoring approaches are discussed below.

Controversial projects and community polarization are not unknown situations for companies in the extractive industries. There is substantial experience in the United States and other countries in dealing with this problem, for example, a series of "best practice" documents have been developed by industry trade associations, and multi-lateral development agencies.[175] [176] [177] According to the International Finance Corporation (IFC, a member of the World Bank Group):

> "Companies need to be prepared for the fact that they are entering into a pre-existing yet dynamic context, with established histories and cultures, and often complex political, social, and economic relations between groups that can be thrown into flux by the advent of a project and the development process that accompanies it."

A project can become politicized and complicated, leading to or exacerbating underlying community tensions. Adverse health outcomes, particularly psychosocial effects, can follow from this situation. The HIA recommendations are to (i) manage the process proactively and collaboratively, and (ii) consider some of the established good practice approaches and principles that have been developed over decades of worldwide experience in similar situations.

8.1.1.1 Action Steps

- Follow the best practices strategies developed by the International Council on Mining and Metals and the World Bank Group for engaging with PACs and indigenous communities.[175] [176] [177] In other contexts around the world, this often includes community-based participatory monitoring for a suite of measurable and objective key performance indicators (KPIs).
- Perform formal community engagement and conflict mediation practices to increase understanding between stakeholders and reduce psychosocial distress in PACs.

8.1.1.2 Monitoring

- Perform regular community engagement meetings to stay abreast of (and appropriately respond to) community concerns.

8.1.2 Accidents and Injuries

Two negative health impacts were rated as medium in this HEC. One impact relates to commercial vehicle traffic accidents and the other addresses motor vehicle crashes in general. The calculated number of trips and predicted accidents is small, but an important health impact over the life of the project. The goal of the action steps below is to make commercial vehicle and commuter traffic as safe as possible in order to minimize the potential adverse health impacts of increased use of the Glenn Highway and other roadways.

8.1.2.1 Action Steps

- Assure that drivers are well trained and that transportation equipment is in excellent working order.
- Follow routine approaches to transportation safety such as having a written safety plan, driver training programs, safety meetings, equipment checks, drug and alcohol testing for drivers, fatigue management planning, and accident investigation and driver retraining procedures.
- Utilize free consultation and training services available at Alaska Occupational Safety and Health (AKOSH) to review existing transportation and safety plans and journey management plans.
- Review traffic information so that traffic volumes and road conditions are well understood for both commercial vehicles and commuters. An emphasis on locations where UCM transport logistics may intersect local populations is critical (i.e., schools, school bus pick-up locations, etc.).
- Develop and implement medical emergency response plans and drills for off-site accidents, injuries, or hazardous material release events.
- Coordinate and review emergency response plans with established local emergency response services.

8.1.2.1 Monitoring

- Review the Alaska Department of Transportation (ADOT) data on commercial and non-commercial motor vehicle crashes (accident information can be obtained for specific sections of each road).
- Review statewide ADOT reports that include data on fatal and nonfatal motor vehicle accidents.

8.1.3 Exposure to Potentially Hazardous Materials

The HIA presented a detailed conceptual site model (CSM) for potential exposure to hazardous materials. Based on the CSM, there are a number of theoretically complete exposure pathways via air, surfacewater, and groundwater. In general, these pathways are unlikely to result in substantial adverse health consequences in PACs.

The most important impact identified in this HEC relates to air quality and the potential for exacerbation of respiratory, cardiovascular, and cerebrovascular diseases (medium rating). In general, air quality in the region is affected by high winds, and occasionally there will be days when the air quality is poor due to natural conditions. Coal dust and other emissions and dust from the WHM will inevitably impact the air quality in PACs to some degree. Action steps to reduce the impact of WHM on air quality are described below.

8.1.3.1 Action Steps

There are a variety of engineering controls that are widely used to minimize fugitive dust during coal production and processing. Most of the dust generated during mining activities is produced by truck traffic on unpaved roads. Other key sources of dust are i) exposed stockpiles, and ii) points where coal is transferred from a vehicle to a processing area or from processing to storage.

- Minimize road dust in the mining area through frequent application of water to the mine's roadways. This can also be accomplished through synthetic surfactants, soil cements, and polymers.
- Cover or enclose coal stockpiles or use synthetic agents to bind coal particles and minimize dust generation.
- Cover or enclose coal transfer points and processing facilities to minimize dust production.
- Minimize coal dust during off-site coal transport by covering trucks and rail cars or using synthetic binders.
- Refrain from blasting activities on high-wind days.

8.1.3.2 Monitoring

- Regularly review air monitoring stations in Palmer and Eagle River.
- Regularly review water quality monitoring stations.
- Use publicly available air quality alert systems such as www.airnow.gov to monitor air quality and health risk information.

8.1.4 Remaining Health Impacts (HEC)

The remaining health impacts from the other health effect categories received a rating of low, which means they are unlikely to occur, and if they did occur, the health effects would be difficult to perceive. No action steps are suggested for these impacts; they can be monitored using standard surveillance systems already in-place in Alaska.

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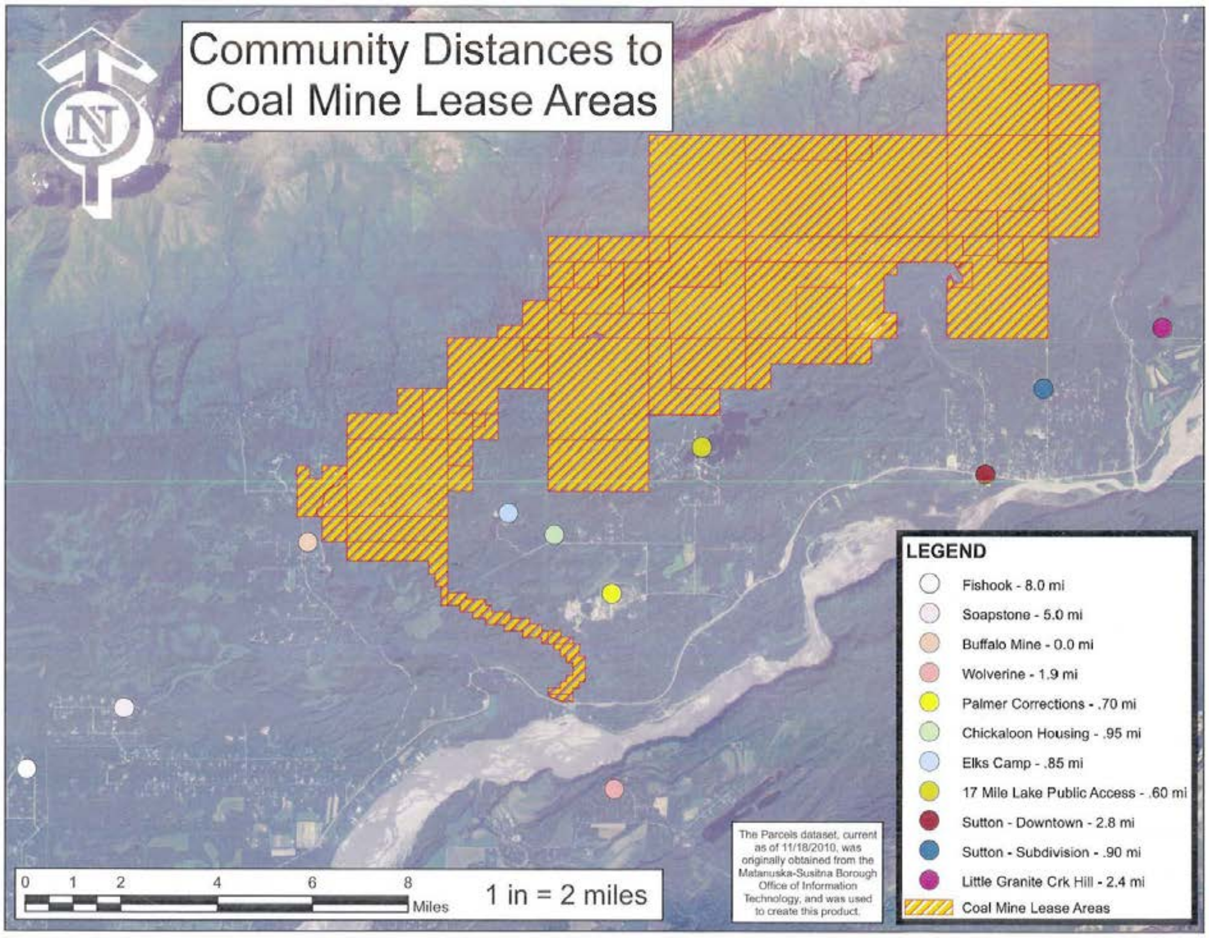
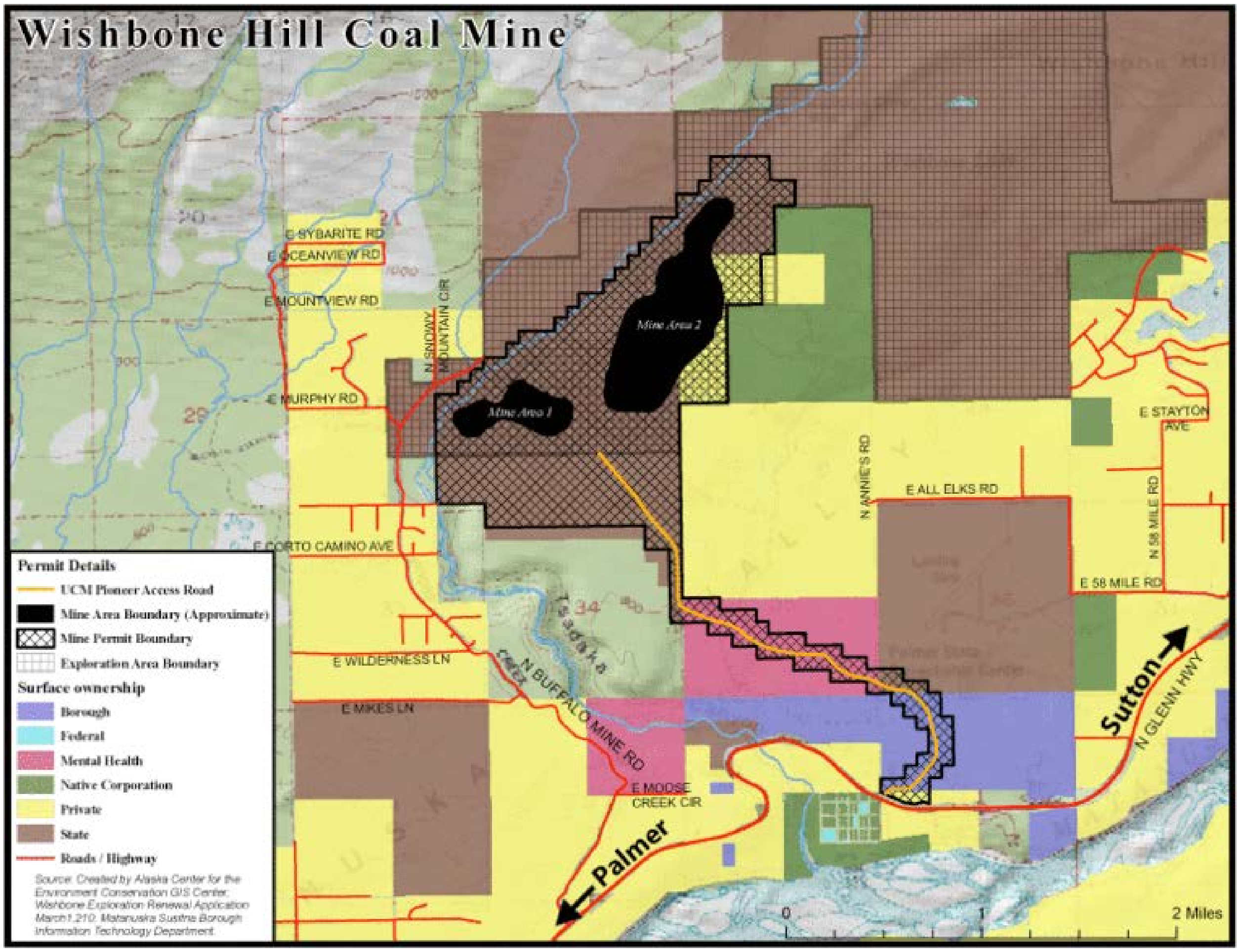
Appendix A: Map 1



Appendix B: Map 2



Appendix C: Cover Letter from Chickaloon Village Traditional Council

NAY'DINI'AA NA'
(CHICKALOON VILLAGE)
TRADITIONAL COUNCIL

September 21, 2011

Paul Anderson M.D., M.P.H.
Health Impact Assessment (HIA) Program Manager
State of Alaska
Department of Health and Social Services
Division of Public Health
Section of Epidemiology
3601 C Street, Suite 540
Anchorage, Alaska 99503

Re: Rapid Health Impact Assessment of the proposed Wishbone Hill Coal Mine

Dear Dr. Anderson,

Attached are some of the identified health concerns provided by a few Chickaloon Native Village Tribal citizens. We are sending them to you for inclusion in the Wishbone Hill Rapid Health Impact Assessment (HIA). The following are some general comments regarding the proposed project and the HIA process that we would also like to see included in your published report.

We strongly believe that this project warrants a comprehensive Health Impact Assessment (HIA) due to the potential for serious impacts to the health and quality of life for Chickaloon Native Village Tribal citizens, other Alaska Native/American Indian peoples, and other community members (e.g. increased traffic, reduced air and water quality, negative impact on health services, out-migration of qualified and educated community members, reduction in overall health status to the community, etc.). Performing a "Rapid" HIA on a rushed timeline has limited the contributions of many Tribal citizens and the amount of valuable qualitative data which could have been gathered given an adequate amount of time to complete a comprehensive HIA. More public input is warranted on this process to strengthen the recommendations of the HIA and to help tailor the process to work for the Chickaloon Tribal community.

The social determinants of health and environmental health are intricately linked to the physical health of Chickaloon Native Village Tribal citizens and to the village as a whole. To try to exclude the social and environmental impacts minimizes the potential health risks for Tribal citizens. We view health holistically including the dimensions of mental, physical, spiritual and emotional wellness.

This project is already disproportionately affecting Chickaloon Native Village Tribal citizens and other Alaska Native/American Indian peoples residing in the affected communities of Wasilla, Palmer, Sutton, Chickaloon, and Glacier View. Issues and disorders related to generational trauma are resurfacing at alarming rates. The Tribe has been negatively impacted in the past by transient coal mine activities and specifically with the introduction of alcohol, disease, and racism. Micro-aggressions, ongoing in the community, are becoming overt such as the news story published on September 8, 2011 in the *Anchorage Daily News* which elicited a racist rant in the comments section that ran for at least one day before the newspaper pulled it.

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"Chickaloon and Sutton now owe their existence to federal tax money that is given to the 'Chickaloon Indians' who, for the most part are less Indian than my dog, and who want nothing more than to leech off of the rest of us... This is about a few deciding on the basis of emotionalism and feelings about something that they perceive as a problem without bothering to find out what steps are required to mitigate the problem. We do need the jobs. The needs of the many outweigh the idiocy of the few."

The extremely limited amount of health statistics on the community of Sutton will not give a clear health status picture regarding past mining impacts on this community. To garner a true picture of the health status of the community will require qualitative research to supplement missing quantitative data. To do this we will need more community input.

We would ask that his process be extended and that the Tribal consultation be a part of the process going forward. To schedule a future meeting, please contact Lisa Wade at (907) 745-0704.

May Creator Guide Our Footsteps,

Jennifer D. Hansen

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Appendix D: Concentration-Response Calculations

The standard formula for calculating almost all of the disease outcomes follows the formula shown in Equation 1:

Equation 1:

$$\Delta Incidence = -[y_o * (\exp(-\beta \Delta C_{exposure}) - 1] * population$$

Where:

y_o = the baseline prevalence of illness per year;

β = the coefficient of the concentration change (natural logarithm (ln) of the relative risk ***divided*** by the change in mean/median exposure), and

ΔC = change in daily average PM_{10} or $PM_{2.5}$ concentration

Population = the number of people exposed.

There is a different C-R functional form (shown as Equation 2) for certain types of respiratory outcomes/symptoms (e.g., acute/chronic bronchitis, asthma, lower/upper respiratory symptoms, shortness of breath, etc.)

Equation 2:

$$\Delta\_\_\_\_\mathrm{Re}\,spiratorySymtoms = -\left[\frac{y_0}{(1-y_0)\cdot e^{\Delta PM_x \cdot \beta} + y_0} - y_0\right]\cdot pop$$

The C-R functions use ambient air quality data from fixed-site, population-oriented monitors; therefore, according to USEPA (2010), the appropriate application of these functions in a PM risk assessment similarly requires the use of ambient air quality data at fixed-site, population-oriented monitors. For the Wishbone Hill Project, there are:

- Offsite fixed station air monitoring stations at Palmer and Eagle River (see section 4 air permit analysis for 2013/14 PM data);
- Modeled air concentration isopleths for PM_{10} and NO_2: and
- No modeled $PM_{2.5}$, CO, VOC, SO_2 concentration isopleths (see section 4)

The HIA team extensively reviewed the critical priority pollutant C-R functions, potential key performance indicators (e.g., various mortality and morbidity endpoints) and potential exposed population demographics (see list of key studies, below). In addition, the USEPA model, BenMAP was also considered.

BenMAP is a computer program that is primarily intended as a tool for estimating the health impacts, (and associated economic values), associated with changes in ambient air pollution. It accomplishes this by running health impact (C-R) functions, which relate a change in the concentration of a pollutant with a change in the incidence of a health endpoint. Inputs to health impact functions typically include:

- The change in ambient air pollution level,
- Health effect estimate,
- The baseline incidence rate of the health endpoint, and
- The exposed population.

BenMAP essentially layers the previously discussed (equations 1 & 2) C-R functions over base maps. The necessity of accurately knowing key C-R variables is not eliminated by the BenMAP program.

Key studies used for calculating concentration-response functions:

Abt Associates Inc. Environmental Benefits Mapping and Analysis Program (BenMAP), User's Manual. 2003. [Online] http://www.epa.gov/ttnnaaqs/standards/pm/data/jly3amd.pdf.

Bell ML, Ebisu K, Peng RD, Walker J, Samet JM, Zeger SL, Dominici F. Seasonal and regional short-term effects of fine particles on hospital emssions in 202 US countries, 1999-2005. *Am J Epidemiol.* 2008;168(11):1301-1310.

Bell ML, Dominici F. Effect modification by community characteristics on the short-term effects of ozone exposure and mortality in 98 US communities. *Am J Epidemiol.* 2008;167(8):986-997.

Bell ML, Ebisu K, Peng RD, Samet JM, Dominici F. Hospital admissions and chemical composition of fine particulate air pollution. *Am J Respir Crit Care Med.* 2009;179(12):1115-1120.

Krewski D, Burnett RT, Goldberg MS, Hoover K, Siemiatycki J, Jerrett M, Abrahamowicz M, White WH. Reanalysis of the Harvard Six Cities study and the American Cancer Society study of particulate air pollution and mortality. 2000. HEI Research Report, 140, Health Effects Institute, Boston, MA.

Krewski D, Jerrett M, Burnett RT, Ma R, Hughes E, Shi Y, Turner MC, Pope CA, Thurston G. Extended follow-up and spatial analysis of the American Cancer Society study linking particulate air pollution and mortality. 2009. HEI Research Report, 140, Health Effects Institute, Boston, MA.

Moolgavkar S. Air pollution and daily deaths and hospital admissions in Los Angeles and Cook counties. 2003. In: Health Effects Institute Special Report, Revised Analysis of Time-Series Studies of Air Pollution and Health. Health Effects Institute, Cambridge, MA.

Tolbert PE, Klein M, Peel JL, Sarnat JA. Multipollutant modeling issues in a study of ambiet air quality and emergency department visits in Atlanta. *J Expo Sci Environ Epidemiol.* 2007;17:S29-S35.

U.S. Environmental Protection Agency. Office of Air and Radiation. *Quantitative Health Risk Assessment for Particulate Matter.* Office of Air Quality Planning and Standards; EPA/452/R-10-005. 2010.

Zanobetti A, Schwartz J. The effect of fine and coarse particulate air pollution on mortality: A national analysis. *Envrion Health Perspect.* 2009;117(6):898-903.