3.22 HUMAN HEALTH

SYNOPSIS

This section describes current human health conditions and evaluates potential project impacts on human health within the EIS Analysis Area from the proposed action and alternatives. Human health data for the EIS Analysis Area are generally available at broad scales, rather than at a community level. Where differences are able to be distinguished at a component level, these are discussed. However, as with socioeconomic data, the impacts are more typically evaluated by phase for the Donlin Gold Project as a whole. Impacts were evaluated using Alaska Department of Health and Social Services (ADHSS) methodology (ADHSS 2011, 2015), and therefore the impact terminology and ratings differ from other sections in the EIS.

The evaluation of impacts on human health is a required component of the National Environmental Policy Act (NEPA) as it pertains to negative and beneficial consequences of a proposed project on potentially affected communities. There are laws and regulations, such as the Clean Water Act (CWA), Clean Air Act (CAA), and various Alaska statutes that have been enacted to ensure protection of human health by protecting natural resources like water and air that are consumed by humans. Additional discussions can be found in Section 3.7 Water Quality and Section 3.8 Air Quality. Compliance with health laws and regulations are taken into consideration in the evaluation of health impacts.

The preparation of a Health Impact Assessment (HIA) to support a NEPA evaluation and the use of ADHSS guidelines to do so are not mandatory in Alaska, but are decisions that are made on a project-specific basis (ADHSS 2015). However, once the decision to prepare an HIA under ADHSS leadership is made, it is useful to draw upon the HIA as a primary resource for the health evaluation that is required under NEPA. As mentioned above, Section 3.22 for the Donlin Gold Project EIS was developed to be consistent with the ADHSS HIA methodology, which provides a comprehensive overview of health categories that are generally applicable to the evaluation of impacts related to a proposed program, project, policy, or plan under consideration by decision-makers. The HIA developed under ADHSS leadership (Newfields 2015, 2016) was used as one of the primary resources for this section of the EIS. Although the HIA and Section 3.22, Human Health, describe the broad health effects categories (HECs) included in the ADHSS guidelines, emphasis is focused on assessing key issues and potential impacts identified during scoping (as required by NEPA) as well as health-related issues identified or expressed during public/stakeholder engagement. In accordance with NEPA practice, the scope of the human health section is limited to “outside of the fence.” Consistent with ADHSS (2015), this assessment does not include a direct evaluation of the anticipated workforce safety and health issues (i.e., “inside the fence”) because the Donlin Gold Project is governed by the regulations of the Occupational Safety and Health Administration (OSHA) and the Mining Safety and Health Administration (MSHA). However, the HIA does consider “crossover issues” where workforce behaviors result in interactions/overlap with the local communities.

For the purposes of this document, health is defined by ADHSS not merely as the absence of disease, but as “the reduction in mortality, morbidity, and disability due to detectable disease or disorder, and an increase in the perceived level of health” (ADHSS

2011, 2015). Thus, it represents an integrated state of physical, social, and mental well-being. Health is affected by environmental, social, cultural, and genetic factors often called "determinants of health." Community health in Alaska, with its environmental and social setting and complex blend of health determinants, is in many ways different from national health trends in the United States (ADHSS 2011, 2015).

Large projects such as mining activities can often affect the health of nearby communities in complex ways. The impacts may be both positive and negative. The Donlin Gold Project is a large and complex mining project which is expected to affect the socioeconomic and health aspects of a very large area (see Chapter 2, Alternatives, for project description). The health assessment for this project is intended to document baseline health status in the EIS Analysis Area so that project-related negative health consequences may be identified and ranked as to their severity and likelihood, and mitigation measures may be recommended to minimize potential negative impacts that could occur due to the project, during the Construction, Operation and Closure/post-Closure phases.

The ADHSS contracted the collection of baseline health data and evaluation of potential health impacts (Newfields 2015, 2016) for the eventual development of a complete HIA. The HIA developed under the leadership of ADHSS (Newfields 2015, 2016) was used as one of the primary resources for the Human Health section (Section 3.22) of this EIS. For the purposes of this EIS, baseline information was categorized within the context of the three project components (Mine Site, Transportation Corridor, and Pipeline) and with a functional classification of potentially affected communities as Mine Site, river, and pipeline-related communities. The baseline information has been condensed and summarized for this EIS. Where available, additional data have also been incorporated from publicly available sources (e.g., national demographic data from the United States Census Bureau).

The terminology used for descriptions and rankings of health impacts in this section generally correspond to the terms used in the ADHSS HIA guidance (ADHSS 2015). A characteristic of this guidance is that the individual dimensions of health impacts (i.e., nature of health effect, duration, magnitude, extent, and likelihood) are each given their own descriptive terms for the estimated relative degree of occurrence, but a final consolidated health impact rating for each health metric or HEC is only numerical (Category 1 through 4). The guidance suggests that impact ratings of 2 or higher may markedly increase or decrease illness and injury rates and may warrant interventions, if negative (ADHSS 2015).

A focused risk analysis (FRA), including details from a quantitative human health risk assessment (HHRA; ERM 2017), was conducted to evaluate the potential risks and hazards of exposure to project-related hazardous chemicals, and is included in Appendix AB. The ERM HHRA document is not included as a component of the EIS; however, the findings are detailed in the FRA (Appendix AB) and are relied on for the evaluation of impacts related to exposures to potentially hazardous constituents. The FRA evaluates potential exposure to chemicals released to air, soil, groundwater, surface water, sediment, and biota (i.e., uptake of bioaccumulated chemicals into subsistence foods, including fish, waterfowl, wildlife, and plants), to the extent possible, based on the available data in the EIS. The FRA does not evaluate human health impacts from potential spills/failures; the potential health impacts from exposure to chemicals due to a spill or failure are unanticipated and are typically short-term, acute exposures. The standard risk assessment methodology is not designed to evaluate these kinds of short-

term exposures. Section 3.24, Spill Risk, includes information regarding how health concerns and potential impacts would be addressed in the unlikely event that a spill or failure were to occur (e.g., containment, monitoring, public outreach and information). At this time, there are no standard methods to evaluate health risks in relation to climate change and the typical source-to-receptor risk assessment methodology is not appropriate for evaluation of climate change. Additional information pertaining to climate change has been incorporated into Sections 3.22.3.7 and 3.22.4.2.9. Section 3.22.4.2.9 discusses the increased risk of potential chemical exposure due to climate change (e.g., permafrost affecting the structural stability of project features).

EXISTING CONDITION SUMMARY

The EIS Analysis Area for human health includes communities within the Bethel Census Area, Yukon-Kuskokwim Health Corporation (YKHC) Service Area, eight Central Kuskokwim River communities near the Mine Site, Tyonek, and Dutch Harbor. Much of the region is classified as medically underserved or has a shortage of health care professionals; the more urbanized communities are serviced by a more extensive network of healthcare facilities. The Yukon-Kuskokwim (Y-K) region typically fares worse than the state average in aspects of physical, mental, and social health. Examples of this include high rates of suicide, sexually transmitted infections, and poor access to water and sanitation services. Important health strengths include high rates of childhood immunizations in the YKHC service area, no clear signs of nutritional deficiencies in the Bethel Census Area, and residents reporting high rates of participation in subsistence and leisure time physical activities. Rates of low birth weight infants and alcohol use by pregnant mothers and divorce rates were lower than state averages.

POTENTIAL EFFECTS SUMMARY

The potential consequences to human health were evaluated using criteria outlined in Alaska's HIA guidance (ADHSS 2011, 2015). While different from the terminology in other sections, the analysis and impact ratings for human health are consistent with the principles of analysis required by NEPA.

The impact ratings for human health take into consideration two components:

1) Severity of impacts, and considers four impact dimensions: severity of potential health effects (which can be positive or negative and considers the need for intervention, if the impact is negative), magnitude, duration, and extent of the impact (see Table 3.22-15); and

2) Likelihood of each impact occurring.

The findings of these two components are used to develop an overall significance impact rating of category of 1, 2, 3, or 4. Recommended actions for negative impacts are listed by category below:

Category 1: Actions to reduce negative impacts are not needed.

Category 2: Recommend that decision-makers assess whether actions to reduce negative impacts would be helpful for negative impacts.

Category 3: Recommend that decision-makers develop and implement actions to reduce negative impacts.

Category 4: Strongly recommend that decision-makers develop and implement actions to reduce negative impacts.

Alternative 1 - No Action

This alternative would have both beneficial and negative effects to human health, largely maintaining current baseline levels of health. Some negative impacts related to psychosocial stress, food insecurity, and access to healthcare services may result from the loss of income and employment to specific households, related to termination of Donlin Gold's exploration activities in the area. Other current health conditions and trends would continue in the EIS Analysis Area. For context, the August 2017 unemployment rate (not seasonally adjusted) for Bethel Census Area was 14.9 percent, Kenai Peninsula Borough was 6.8 percent, and Matanuska-Susitna Borough was 7.8 percent compared to the state of Alaska at 6.3 percent (Alaska Department of Labor and Workforce Development available online at: http://laborstats.alaska.gov/).

Alternative 2 - Donlin Gold's Proposed Action

Impacts to human health would be both beneficial and adverse (positive and negative). The magnitude of impacts would generally be assigned a score of 1. Eight HECs provide a framework for discussion of potential impacts and are discussed below. Overall, potential benefits could include increases in household income, employment and education attainment, and improved health and well-being due to increased food security (due to increased income). Some potential adverse impacts could include increases in accidents and injuries (particularly during Construction), increases in exposure to potentially hazardous chemicals released into the environment, increases in rates of communicable diseases (due to workforce rotation and use of labor from outside local communities) and non-communicable diseases, and overwhelming local and regional healthcare capacities under emergency situations.

Social Determinants of Health: Category 3 beneficial effects could include increases in household income, employment and educational attainment, and reductions in substance abuse rates, family stress and instability. Category 1 impacts to psychosocial stress could be positive or negative because it is uncertain as to how the impact may be experienced in different populations, households, or by individuals.

Accidents and Injuries: Category 2 level adverse effects could include the potential for accidents and unintentional injury, particularly during the Construction Phase.

Exposure to Potentially Hazardous Materials: Adverse impacts from exposure to potentially hazardous materials are generally rated Category 1.

Food, Nutrition, and Subsistence Activity: Potential Category 2 level health benefits would be due to decreased regional food costs and increased food security (resulting from potential increases in median household incomes). Category 1 level adverse impacts could include a potential for decreased access to and/or quantity of subsistence resources.

Infectious Diseases: Adverse impacts due to increased rates of infectious diseases are rated Category 1 to 2. Increases in infectious disease rates could occur due to employment of workers from outside the region and/or the rotation of the workforce during the project phases but may be minimized or avoided by proactive public health programs.

Water and Sanitation: Adverse effects due to the availability and quality of water and sanitation facilities are rated Category 1; it is very unlikely (1-10 percent) that water and sanitation services of communities located near the Donlin Gold Project would be affected.

Non-communicable and chronic diseases: Increased rates of cancer, respiratory disease, and cardiovascular morbidity and mortality are considered very unlikely (1-10 percent), with a summary impact rating of Category 1.

Health Services Infrastructure and Capacity: Under routine conditions, the potential for decreased access to healthcare services is rated Category 1. Under emergency situations, the potential to overwhelm regional health care capacities is rated Category 2 the event is considered very unlikely (1-10 percent), with a summary impact rating of Category 2.

OTHER ALTERNATIVES – This section discusses differences of note between Alternative 2 and other action alternatives, but does not include a comprehensive discussion of each alternative's impacts if they are the same as or similar to Alternative 2 impacts.

Alternative 3A - LNG Powered Trucks

This alternative would decrease the total number of project-related barge round trips per season from 122 in Alternative 2 to 83 during Operations, resulting in a decreased potential for accidents and reduced impacts to fish resources and subsistence fishing. Additionally, the reduced diesel emissions would reduce exposure to hazardous constituents in the air, water, and aquatic biota at the Mine Site and along the transportation corridor. These actions are considered to slightly reduce health impacts, compared to Alternative 2.

Alternative 3B - Diesel Pipeline

This alternative would decrease the total number of project-related barge round trips per season from 122 in Alternative 2 to 64 during Operations, resulting in a decreased potential for accidents and reduced impacts to subsistence fishing. There would be fewer impacts to air quality, water quality, and biota along the Kuskokwim River, associated with the decrease in barging. These actions are considered to slightly reduce health impacts, compared to Alternative 2.

Alternative 4 - Birch Tree Crossing (BTC) Port

This alternative would result in an increased potential for surface transport accidents. The additional surface transport has the potential for increased displacement of terrestrial subsistence resources. The shortened round trip barge trip would result in reduced potential for impact to subsistence fisheries, especially for the upriver communities. These actions are considered to slightly reduce health impacts, compared to Alternative 2.

3.22.1 REGULATORY ENVIRONMENT, ASSUMPTIONS AND LIMITATIONS

The primary guidance used for the health component is the *Technical Guidance for Health Impact Assessment (HIA) in Alaska*. 2015 Version 2.0, published by the Alaska Department of Health and

Social Services (ADHSS). This document uses the principles of HIA guidance developed by the International Finance Corporation (IFC 2009) to provide a comprehensive framework and tools for addressing health in a manner that is relevant to Alaskan conditions and was developed in consultation with local and regional agencies, and community stakeholders. As described by ADHSS (2015), "HIA is a structured planning and decision-making process for analyzing the potential positive and negative impacts of programs, projects, and policies on public health."

Among the types of HIA that can be performed (Desktop, Rapid Appraisal and Comprehensive), the Donlin Gold HIA (i.e., the analysis provided in this Section 3.22 and Appendix AB) is a Rapid Appraisal and Comprehensive HIA. It presents a comprehensive assessment of potential health impacts based on extensive stakeholder engagement during the scoping process and some new data collection.

In accordance with NEPA practice, the scope of the discussion in Section 3.22 below is limited to "outside of the fence." Consistent with ADHSS (2015), this assessment does not include a direct evaluation of the anticipated workforce safety and health issues (i.e., "inside the fence") because the Donlin Gold Project is governed by the regulations of OSHA and MSHA. However, the discussion to follow does consider "crossover issues" where workforce behaviors result in interactions/overlap with the local communities. For example, some baseline data (e.g., traffic accidents) may not differentiate between workers and non-worker (i.e., workers not involved in the Donlin Gold Project) populations and may indirectly evaluate worker populations. Similarly, some impacts to workers (e.g., a catastrophic event) may affect available community health or public safety resources and indirectly affect the health of local communities.

The health and safety of worker and contractor populations are expected to be adequately addressed by compliance with site health and safety plans and occupational health and safety regulations, including use of onsite potable water wells that will be located south of Omega Gulch, near Crooked Creek (see Section 2.3.2, Description of Alternatives, Alternative 2). For additional information pertaining to Mine worker safety "inside the fence," including use of groundwater as potable water and planned health and safety measures at the Mine and mine camps, see Table 3.6-1 (Applicable Regulations under Groundwater Hydrology), Sections 2.3.2 (Description of Alternatives, Alternative 2), 3.6.1.5.1 (Groundwater Hydrology, Affected Environment, Groundwater Use, Mine Site and Pipeline), 3.6.2.2.1 (Groundwater Hydrology, Environmental Consequences, Alternative 2, Mine Site), 3.6.2.2.2 (Groundwater Hydrology, Environmental Consequences, Alternative 2, Transportation Corridor), 3.7.1.1 (Water Quality, Regulatory Framework), 3.7.2.1 (Water Quality, Affected Environment, Surface Water Quality), 3.7.3.2.3 (Water Quality, Environmental Consequences, Alternative 2, Groundwater Quality), and 5.0 (Impact Avoidance, Minimization, and Mitigation).

Other limitations are inherent to HIA and HIA methodology. Since health is a multi-dimensional concept, the prediction of any "reduction in mortality, morbidity, and disability due to detectable disease or disorder, and an increase in the perceived level of health" is subject to high uncertainty. While baseline conditions and project characteristics are used to develop qualitative or semi-quantitative projections of impact severity and likelihood, there may be considerable uncertainty in both the accuracy and precision of the predicted impacts. This is particularly true of health impacts related to Social Determinants of Health, Food, Nutrition and Subsistence Activity, Infectious Diseases and Non-communicable Diseases. The availability of baseline health information for the affected communities typically varies in age, completeness, quality and level of detail. Conditions such as psychosocial stress (e.g., depression, rates of

suicide) are affected by cultural, social, economic, behavioral and genetic risk factors. To definitively attribute significant changes in psychosocial stress to any single proposed project is typically neither realistic nor provable.

There may also be health impacts related to projects that are simultaneously beneficial and negative. For example, increased economic benefits may decrease the number of food-insecure households, but may also lead to increases in consumption of nutritionally poor, processed foods. Influx of worker populations may lead to increased potential for the spread of infectious diseases, but may also be minimized or avoided with pro-active public health measures such as vaccinations. The assessment of health consequences related to exposure to hazardous chemicals is subject to the uncertainties inherent in the models that are used to predict chemical concentrations in air, water and fish at a point 27 years into the future, which represents the cumulative potential environmental impacts from Mine Site operations (i.e., the timeframe when potential project-related releases would likely occur due to the project); however, the health impact evaluation considers duration of impacts for all project phases, including Construction, Operations, and Closure. Overall, both overestimation and underestimation of health impacts are possible, although the methodology may intentionally tend towards overestimation of impacts. The objective of the HIA is not to present value judgements on these consequences but only to document the possible occurrence of both consequences and recommend measures to enhance positive health benefits and mitigate negative impacts, as appropriate. These uncertainties are described further in Section 3.22.4. Overall, an HIA can be a valuable tool to evaluate community health consequences in a balanced, comprehensive, multi-disciplinary manner, and to form a basis for the development of recommendations for actions that would serve to reduce negative impacts or enhance positive benefits, as long as there is a clear understanding of the limitations and uncertainties.

The HIA developed under ADHSS leadership (Newfields 2015, 2016) was used as one of the primary resources for Section 3.22 of this EIS and was supplemented, where available, with data obtained from other publicly available sources. While baseline data were readily available at the state and national level, local (small) and regional community data were generally lacking for some of the key health data indicators and, where available, at times were outdated (e.g., greater than five years old). Impact ratings were developed using professional judgment, to the extent possible, considering baseline data gaps and available information pertaining project design and planned mitigation measures.

The preparation of the Donlin Gold HIA is consistent with ADHSS (2011 and 2015) and other guidelines that include the following:

- **Screening:** The initial phase where the need for a HIA is evaluated. The Donlin Gold Project EIS will include an HIA.
- **Scoping:** The phase that develops the scope of the HIA and key issues to be addressed based on consideration of project description, surrounding environment, stakeholder concerns, and other factors. Personnel from ADHSS, their contractor, and Yukon-Kuskokwim Health Corporation (YKHC) held meetings with community stakeholders to identify issues of health concern to be addressed in the EIS (Newfields 2015, 2016). ADHSS staff also attended the EIS scoping meetings to document comments and concerns related to health.

- **Health Risk/Impact Assessment:** The phase that includes the Community Health Baseline and Risk/Impact Assessment.

ADHSS (2011, 2015) identifies eight HECs which are particularly relevant to Alaskan conditions to be included in this assessment. A HEC contains a routine set of health issues and concerns that are commonly grouped together, such as accidents and injuries. Past HIA experience in Alaska has demonstrated that the HEC framework is useful for analyzing, rating, and ranking potential impacts, both positive and negative. Table 3.22-1 summarizes these HECs and health impact issues within each of the HECs. The health impact issues presented are those that may be particularly relevant to the Donlin Gold Project.

Table 3.22-1: Health Effects Categories (HECs) and Health Impact Issues

Category	Health Impact Issues	Summary Table Numbers
HEC 1. Social determinants of health	• Household incomes, employment and education • Psychosocial stress • Physical stress (noise, vibration, and light) • Substance abuse (including drug and alcohol) • Family stress/stability	Table 3.22-4
HEC 2. Accidents and injuries	• Unintentional accidents and injuries morbidity and mortality rates due to air transportation • Unintentional accidents and injuries morbidity and mortality rates due to surface transportation • Unintentional accident and injury morbidity and mortality rates due to water transport • Intentional injury: suicide rate	Table 3.22-5 Table 3.22-5.
HEC 3. Exposure to potentially hazardous materials	• Air quality (mercury, PM, and VOCs) • Surface water quality • Groundwater quality • Soil quality • Bioaccumulation of chemicals into fish • Bioaccumulation of chemicals into waterfowl and wildlife	Table 3.22-6
HEC 4. Food, nutrition, and subsistence activity	• Region food costs (expressed as a percent of median household income) • Access to and quantity of subsistence resources • Diet composition and food security	Table 3.22-8
HEC 5. Infectious diseases	• Sexually transmitted infection rates (including gonorrhea, chlamydia, Hepatitis C, and HIV) • Infectious (respiratory) disease morbidity and mortality rates (e.g., influenza and pneumonia) • Rates of foodborne illness and zoonotic diseases	Table 3.22-9
HEC 6. Water and sanitation	• Morbidity and mortality rates due to the availability and quality of water and sanitation facilities	None

Table 3.22-1: Health Effects Categories (HECs) and Health Impact Issues

Category	Health Impact Issues	Summary Table Numbers
HEC 8. Health services infrastructure and capacity	• Access to routine healthcare • Access to healthcare due to emergency situations and overwhelming local and regional healthcare capacities	Figure 3.22-3

3.22.2 APPROACH

The majority of the information presented for the scoping and baseline assessment of health is drawn from the two sources listed below:

- Newfields 2015, 2016. Draft Health Impact Assessment, Baseline Community Health Data Assessment, Donlin Gold Project. Prepared for ADHSS Health Impact Assessment Program.
- Alaska Department of Health and Social Services (ADHSS). 2013. Donlin Hair Mercury Summary for Eight Communities. Draft Report.

The baseline information developed by Newfields (2015, 2016) is extensive and covers a wide range of indicators within each HEC. The date of the most recent information varies from 2007 to 2011, depending on HEC; and in many cases, older data are also examined. The discussion that follows presents a summary of the information for the HECs from Newfields (2015, 2016). In some cases, the information presented in Newfields (2015, 2016) was updated or supplemented by reference to other publicly available sources.

Potential exposure to mercury (associated with mining activities) is a particular health concern that was frequently expressed by stakeholders. Therefore, baseline data on current levels of mercury in the potentially affected community (as expressed by mercury in hair samples) provide valuable baseline information. Data from a study undertaken by the ADHSS HIA Program in the eight communities near the Mine Site are also included as part of the baseline health section.

The organization of the summary of baseline health conditions is as follows:

- The general affected environment is presented, based on the three project components: Mine Site, Transportation Corridor, and Pipeline.
- Discussions of the general baseline community health conditions by HECs are presented. The term "rate" is commonly used to describe the incidence of the health metrics normalized to a population of a certain size. For example, infant mortality rates are expressed on a basis of 1000 births, binge drinking on a percentage basis. These rates refer to the level of occurrence or incidence of a particular health metric or outcome with respect to a population of a certain size and should not be confused with the term "rate" as used for time-based occurrence of physical phenomena (e.g., flow rate of water).
- For a project of this size, complexity and duration, all of the eight health effects categories mentioned in the ADHSS guidance were relevant to some degree. Those

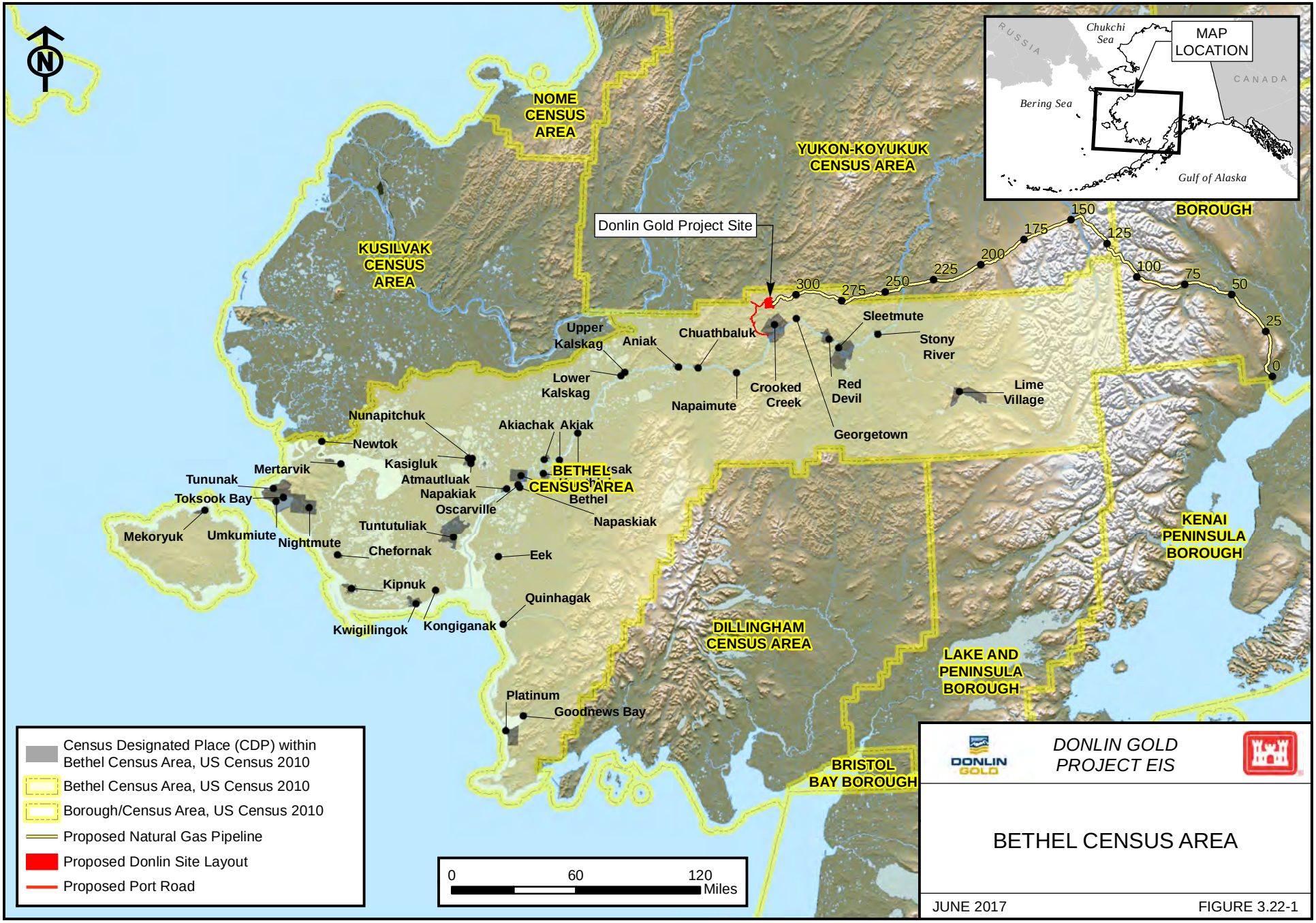
health impact issues that appeared to be most relevant or appropriate to the project description and the affected communities' concerns were included in the baseline and carried forward for the impact assessment with the greatest level of detailed evaluation. These included social determinants of health, accidents and injuries, exposure to potentially hazardous materials, and food nutrition and subsistence activity.

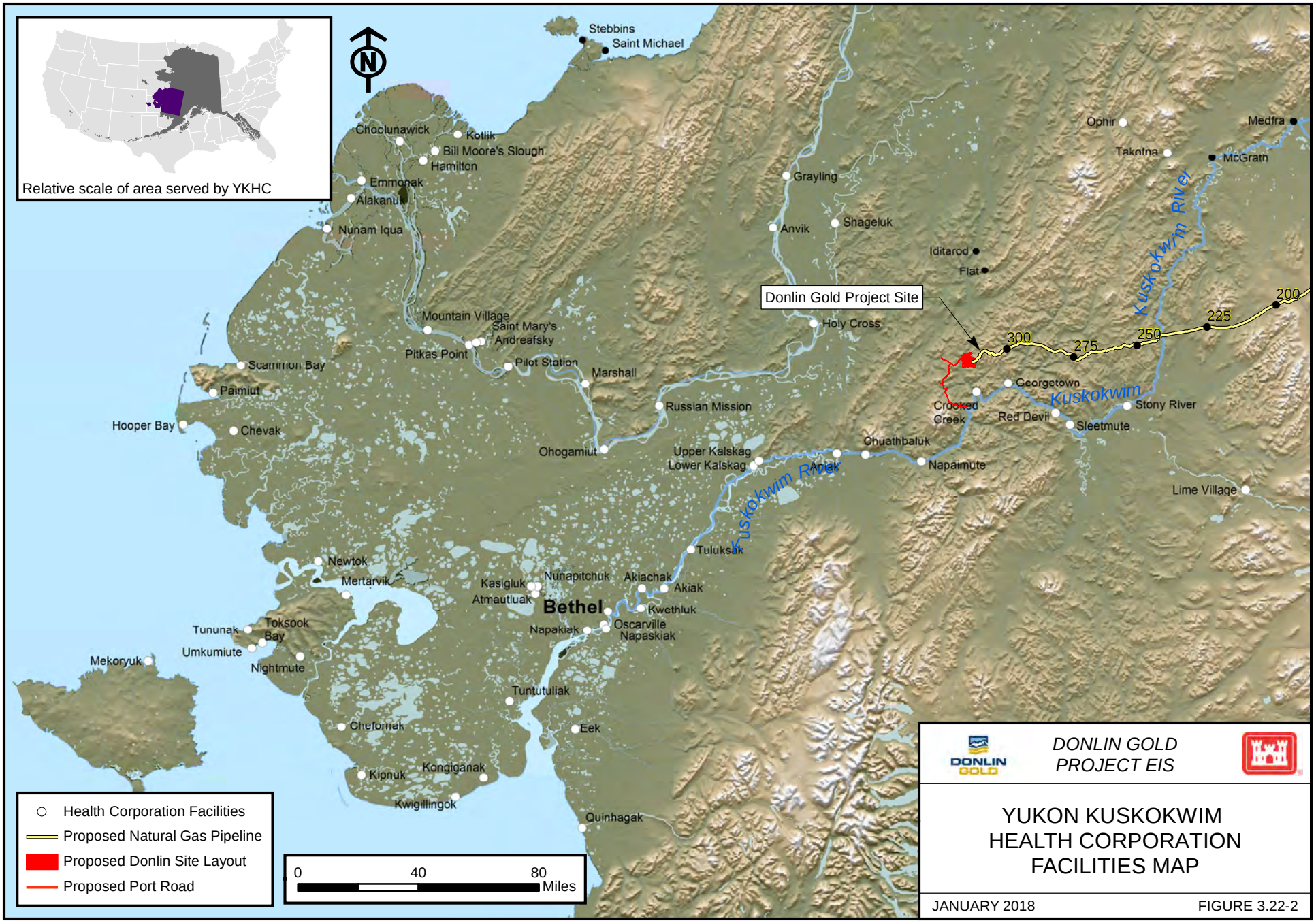
- Other health impact issues that were also relevant for a project of this size and extent but required less detailed evaluation included infectious diseases, water and sanitation, non-communicable and chronic diseases, and health services infrastructure and capacity.
- As needed, HECs with multiple health impact issues will have a summary table listing the values used in the HEC discussion.
- As appropriate, applicable worker protection programs are mentioned.

3.22.3 AFFECTED ENVIRONMENT

Identifying Potentially Affected Communities: The potentially affected communities are identified in relation to the three components of the Donlin Gold Project and then by the regions and smaller communities potentially affected by each component. The reach of the project components is largely based on geographic location and proximity. The limitation to this approach is that some effects may not be directly related to the length of distance between the community and the project component. Examples of such instances would be employment opportunities, and the significance of the changes caused by the project. Although the direct economic effects are discussed in Section 3.18, Socioeconomics, the relationship between income and health cannot be overstated. The substantial distances (including terrain) and the planned onsite housing camps, makes traditional commute times irrelevant and therefore the communities that would contribute to the workforce may include more than those closest to the site. Also not directly related to distance would be changes within a community such as the city of Bethel where a new dock at the Bethel Port would be a connected action. Any actions that would occur at Dutch Harbor or the Port of Bethel at the Bethel Yard Dock are not part of the proposed action, and are considered connected actions (see Section 1.2.1, Connected Actions, in Chapter 1, Project Introduction and Purpose and Need). These factors that are not dependent on distance also warrant consideration along with the communities generally located close to the project components.

The Donlin Gold Project covers a relatively large geographical distance (for example, the pipeline extends over 300 miles in length) and considers effects to broad rural areas. Health data are not always available at the community or regional level for many of the potentially affected communities. These limitations are typical of health data, due to privacy concerns and very small community sizes. These are not considered to be severe limitations for the purposes of the Donlin Gold Project EIS. For the Donlin Gold Project EIS, these limitations are addressed by using two broad regional data sources: Bethel Census Area (Figure 3.22-1) and The Kuskokwim Corporation (TKC) (which is part of the YKHC) (Figure 3.22-2) for overall coverage. The smaller, relatively nearby communities (some with only 20 occupied housing units) are discussed when data were available. These represent the small communities along the Central Kuskokwim River which are relatively close to project components and may be more directly impacted both positively and negatively than communities further away.


NOME CENSUS AREA
YUKON-KOYUKUK CENSUS AREA
KUSILVAK CENSUS AREA
Donlin Gold Project Site
BOROUGH
150
175
125
200
100
225
75
300
275
250
50
25
0
Upper Kalskag
Aniak
Chuathbaluk
Sleetmute
Stony River
Lower Kalskag
Napaimute
Crooked Creek
Red Devil
Lime Village
Georgetown
Nunapitchuk
Akiachak
Akiak
Newtok
Kasigluk
Mertarvik
Tununak
Atmautluak
BETHEL CENSUS AREA
Napakiak
Toksook Bay
Oscarville
Bethel
Napaskiak
Mekoryuk
Umkumiute
Nightmute
Tuntutuliak
Chefornak
Eek
Kipnuk
Quinhagak
Kwigillingok
Kongiganak
DILLINGHAM CENSUS AREA
KENAI PENINSULA BOROUGH
LAKE AND PENINSULA BOROUGH
Platinum
Goodnews Bay
BRISTOL BAY BOROUGH
MAP LOCATION
Chukchi Sea
RUSSIA
CANADA
Bering Sea
Gulf of Alaska
Census Designated Place (CDP) within Bethel Census Area, US Census 2010
Bethel Census Area, US Census 2010
Borough/Census Area, US Census 2010
Proposed Natural Gas Pipeline
Proposed Donlin Site Layout
Proposed Port Road
0
60
120
Miles
DONLIN GOLD
DONLIN GOLD PROJECT EIS
BETHEL CENSUS AREA
JUNE 2017
FIGURE 3.22-1


Relative scale of area served by YKHC
N
Stebbins
Saint Michael
Choolunawick
Kotlik
Bill Moore's Slough
Hamilton
Emmonak
Alakanuk
Nunam Iqua
Mountain Village
Saint Mary's
Andreafsky
Pitkas Point
Pilot Station
Marshall
Scammon Bay
Paimiut
Hooper Bay
Chevak
Russian Mission
Ohogamiut
Upper Kalskag
Lower Kalskag
Aniak
Chuathbaluk
Napaimute
Crooked Creek
Red Devil
Sleetmute
Georgetown
Stony River
Lime Village
Kuskokwim River
Kuskokwim
Donlin Gold Project Site
Holy Cross
Grayling
Anvik
Shageluk
Iditarod
Flat
Ophir
Takotna
McGrath
Medfra
300
275
250
225
200
Tuluksak
Newtok
Mertarvik
Nunapitchuk
Akiachak
Akiak
Kasigluk
Atmautluak
Bethel
Kwethluk
Napakiak
Oscarville
Napaskiak
Tununak
Toksook Bay
Umkumiute
Nightmute
Mekoryuk
Tuntutuliak
Chefornak
Eek
Kipnuk
Kongiganak
Kwigillingok
Quinhagak
Health Corporation Facilities
Proposed Natural Gas Pipeline
Proposed Donlin Site Layout
Proposed Port Road
0
40
80
Miles
DONLIN GOLD
DONLIN GOLD PROJECT EIS
YUKON KUSKOKWIM HEALTH CORPORATION FACILITIES MAP
JANUARY 2018
FIGURE 3.22-2

Mine Site. The Mine Site would include many structures such as a planned airstrip, new roads, and the buildings and factories to support the mining operations (see Figure 2.3-6). Currently, there are no direct public roads from the Mine Site area to nearby communities. The nearest community to the Mine Site is located 10 miles south at the Middle Kuskokwim River village of Crooked Creek (about 280 miles northwest of Anchorage). Potentially affected regions and communities are:

- Bethel Census Area (population of 17,746 [2012] and an area of 40,570 sq. mi. and density of 0.4 persons per sq. mi. [USCB 2013d])
- YKHC service area (covers an area approximately a quarter of the state) also includes the Yukon-Kuskokwim (Y-K) region. The Y-K region includes the Bethel Census and Kusilvak Census areas, but excludes the city of Bethel.
- Eight small Central Kuskokwim River communities: Aniak, Chuathbaluk, Crooked Creek (closest community at approximately 10 miles from the Mine Site), Upper Kalskag, Red Devil, Sleetmute, Stony River, and Lower Kalskag (furthest community at approximately 80 miles from the Mine Site).

Transportation Corridor. The Transportation Corridor component encompasses the pathway of the supply chain for the Mine Site infrastructure and processes. The planned route has sea vessels leaving Canadian and Pacific northwestern US ports and traveling to Dutch Harbor port and then into the Kuskokwim Bay, up-river to Bethel, transferring cargo from sea vessels to river barges, and along the Kuskokwim River to the docks at Angyaruaq (Jungjuk) Port site near the Mine Site.

Overall, potentially affected regions and communities for the Transportation Corridor component are divided into three functional categories as follows:

Mine Site and Riverbank Communities

- Bethel Census Area;
- YKHC Service Area; and
- Small Central Kuskokwim River communities listed under the Mine Site (Aniak, Chuathbaluk, Crooked Creek, Lower Kalskag, Red Devil, Sleetmute, Stony River, and Upper Kalskag) along with the downriver communities of Napaimute, Tuluksak, Akiak, Akiachak, Kwethluk, Oscarville, Napaskiak, and Napakiak.

Ocean to River Barge Transfer / Storage Location

- City of Bethel

Ocean Port Location

- Dutch Harbor (City of Unalaska in the Aleutian West Census Area)

Health data coverage is derived from regional sources for the numerous small communities that may be affected by the transportation component. The regional sources include data for the Y-K region and for the Bethel Census Area.

There is considerable overlap in communities affected by the Mine Site and the Transportation Corridor (Bethel Census Area, YKHC Service Area, and Central Kuskokwim River communities). The Y-K region is comprised of approximately 50 small villages and there may

be an additional 30 small communities from Stony River to Platinum (Calista Corporation 2014b).

The Bethel Census Area covers the communities and cities listed in the HIA (Newfields 2016), such as the communities down river (e.g., Napaimute, Tuluksak, Akiak, Akiachak, Kwethluk, Oscarville, Napaskiak, and Napakiak), the city of Bethel, and Dutch Harbor. Limited information is available at the community level for the baseline data; therefore the Central Kuskokwim River communities, Bethel and Dutch Harbor, would be mostly covered by the Bethel Census Area information. The Central Kuskokwim River communities share similar characteristics and are comprised predominantly of Alaska Natives, as noted in Section 3.19, Environmental Justice (USCB 2013c, d). The city of Bethel is a hub in the Y-K region, with approximately one-fifth of the region's population (USCB 2013e). The demographic and socioeconomic profiles for the city of Bethel are slightly more diverse in comparison to the smaller communities in the region, but generally more aligned with the region than state averages (USCB 2013c, d). Dutch Harbor is a major sea port for Alaska.

Pipeline. The 14-inch steel pipeline would be 316 miles long, originating near Beluga and terminating at the Donlin Gold Mine Site (Figure 2.3-14). It would be buried for the majority of its length and would be located within an approximately 50-foot wide easement within State of Alaska and Bureau of Land Management (BLM) lands and is generally remote from communities and settlements. As apparent from the figure, potentially affected regions and communities include:

- Kenai Peninsula Borough (KPB) communities of Beluga and Tyonek (communities closest to the eastern terminal of the pipeline);
- the Matanuska-Susitna Borough (MSB) communities of Susitna and Skwentna (region near the eastern terminal of the pipeline);
- the Yukon-Koyukuk Census Area communities of McGrath, Nikolai, and Takotna (small communities approximately 50 miles north of the pipeline); and the
- Bethel Census Area communities of Crooked Creek, Red Devil, Sleetmute, and Stony River (small communities approximately 25 miles from the pipeline and are overlapping communities from Mine Site infrastructure and processes).

3.22.3.1 DEMOGRAPHIC SUMMARY OF POTENTIALLY AFFECTED COMMUNITIES

Demographic and socioeconomic profiles of the affected communities are presented in Section 3.18, Socioeconomics, and Section 3.19, Environmental Justice, and the information is not repeated in detail here. Section 3.18, Socioeconomics, contains tables of information for potentially affected communities, including Table 3.18-2 of population and age statistics, Table 3.18-3 of education statistics, and Table 3.18-5 of income and unemployment statistics. To provide context for the human health analysis, a summary of the demographic data is presented in Table 3.22-2. The Y-K region had a total population of 19,345, Bethel Census Area had a population of 17,013 (88 percent of Y-K region), and Kuskokwim River communities had a population of 9,140 (5 percent of Y-K region). The ethnicity for the Y-K region was predominantly comprised of Alaska Natives (79 to 97 percent), in comparison with the statewide estimate of 19.1 percent and 1.2 percent nationwide. These areas had younger

populations (median age 26.2 years [Bethel Census Area] to 24.1 years [Y-K region]) compared to the state median of 33.8 years and national median of 37.2 years. They also had lower educational levels; an estimated 14 to 18 percent did not complete high school compared to 7 percent in the state and 12 percent in the nation; 7 to 13 percent earned college degrees compared to 28 percent of residents in the state and 42 percent nationally. The region also had lower median annual incomes ($21,992 to $32,108), and higher unemployment rates (15.0 to 20.7 percent) in comparison to state and national averages for median annual income ($45,665 and $53,339, respectively) and unemployment (7.6 percent and 4.7 percent, respectively). Statistics for the city of Bethel (population 6,080) are more diverse than for the smaller communities, but are generally similar (USCB 2013c, d; ADOL 2013c, d). National data was obtained from the United States Census Bureau (USCB 2013d).

Table 3.22-2: Demographic Summary

Subject	Percent Alaska Native Population (2000)	Percent White Population (2000)	Median Age (2010)	Did Not Complete High School (2007 to 2015	Earned College Degrees (2007 to 2015	Median Annual Income (2007 to 2015	Unemployment Rate (2016)
Community Bethel Census Area	79% to 97%	--	26.2 years	14% to 18%	7% to 13%	$21,992 to $32,108	15.0% to 20.7%
Community KPB	--	83%	40.6 years	6%	23%	$41,772	9.40%
Community MSB	--	83%	34.8 years	6%	21%	$41,905	8.80%
Regional (Y-K region or as noted)	79% to 97%	22% (Yukon-Koyukuk Census Area)	24.1 years	14% to 18%	7% to 13%	$21,992 to $32,108	15.0% to 20.7%
Alaska	19.1	61.10%	33.8 years	7%	28%	$45,665	7.60%
National	1.2% (American Indian or Alaska Native	61.60%	37.2 years	12%	42%	$53,339	4.70%

Notes:

-- = Not Available and/or Not Used
KPB = Kenai Peninsula Borough MSB = Mat-Su Borough

The Y-K region includes the Bethel Census and Kusilvak Census areas, but excludes the city of Bethel.

See Section 3.18, Socioeconomics for additional discussion and details.

The KPB and MSB are predominantly white (82.8 percent for both) in comparison with the statewide estimate of 64.1 percent white. The median age in these areas is older (40.6 years [KPB] to 34.8 years [MSB]) than the state median age of 33.8 years. Educational levels are similar to or slightly lower than state averages for high school and college completion. For both KPB and MSB, 6 percent did not complete high school and 23 percent earned higher degrees in the KPB and 21 percent for MSB. Median incomes ($41,772 KPB and $41,905 MSB) were slightly

lower than the state median income ($45,665), and unemployment rates (9.4 percent KPB and 8.8 percent MSB) were slightly higher than the state average (7.6 percent Alaska). Dutch Harbor (city of Unalaska, population 4,376) is a diverse city with a mixture of white, Hawaiian Islander, African-American, Alaska Native, and other groups, with a higher median age (40.7 years), lower median income ($30,334), and lower unemployment rate (3.1 percent) when compared to the state averages (USCB 2013c, d; ADOL 2013c, d). Dutch Harbor demographics are shown in Table 3.22-3.

Table 3.22-3: Dutch Harbor Demographics

Subject	Community Dutch Harbor	Alaska
Median Age (2010)	40.7 years	33.8
Median Income (2011 to 2015)	$30,334	$45,665
Unemployment Rate (2016)	3.1%	7.6%

See Section 3.18 for additional discussion and details.

3.22.3.2 STAKEHOLDER CONCERNS ABOUT HEALTH

Identifying and addressing stakeholder concerns about health are key aspects of the scoping phase of the health impact assessment process. Personnel from ADHSS, Newfields, and representatives from community organizations undertook a variety of activities to elicit information on stakeholder concerns about health for the Donlin Gold Project (Newfields 2015, 2016). They included public and community meetings.

Stakeholder concerns were more commonly expressed in the area for four HECs: social stresses and benefits, accidents and injuries, exposure to hazardous chemicals, and changes to subsistence patterns. There were fewer concerns regarding communicable and non-communicable diseases, water and sanitation, and health services infrastructure. Stakeholders' expectations of positive health benefits included the potential for improvements in social and mental health related to increased employment and income and better transportation access to healthcare facilities. Concerns about negative health impacts included possible increases in alcohol and drug use with increasing disposable income, family and marital stress related to employment schedules, changes to traditional ways of life and impacts on subsistence activities and nutrition, increases in accidents and injuries related to barge traffic, and potential exposure to hazardous chemicals associated with mining operations (e.g., arsenic, cyanide, mercury). Local residents stressed the need for the health impact assessment process to encompass all aspects of their lives, as highlighted during the Akiak Scoping Meeting:

> in terms of human health, we have to make sure that we do an assessment on health impacts or health status of the community, alcohol, physical health, emotional health, spiritual health, and make sure that we have that data, and to make sure that it doesn't have an impact in diminishing the status of our health, but to increase the status, health status of our people physically, emotionally, mentally, et cetera. (URS 2013b)

3.22.3.3 BASELINE COMMUNITY HEALTH CONDITIONS: HEALTH EFFECTS CATEGORIES

Information for the potentially affected communities is presented and compared to other local and regional data as warranted and also compared to state or U.S. data. Primary data sources listed in Newfields (2015 and 2016) and in this section include the World Health Organization (WHO), U.S. Census Bureau (USCB), U.S. Centers for Disease Control and Prevention (CDC), Alaska Bureau of Vital Statistics (BVS), ADHSS sources, Alaska Department of Environmental Conservation (ADEC), Alaska Department of Fish and Game (ADF&G), Alaska Office of Children's Services (OCS), Alaska Native Regional Health Status Reports produced by the Alaska Native Tribal Health Consortium (ANTHC), Alaska State Troopers (AST), Regional Health Profile for YKHC, and other government and academic sources. Although statewide data offers some context, the HEC discussions in this EIS Section 3.22 are limited to health endpoints which have relevant and current (within the last five years) regional and local data available. Although current data are generally preferred, older data are presented as warranted or if current data were not available. In most cases, local data are neither reported nor available due to small size or privacy concerns. In addition, in some instances, available local data were representative of very small populations. Comparisons of statewide rates with local rates that are projected from very small populations should be interpreted with caution due to the statistical uncertainty associated with small populations.

3.22.3.4 MINE SITE

The Mine Site includes the open pit mine, overburden stockpile, WRF, ore processing facilities, TSF, and power plant, utilities, services and infrastructure. The Mine Site activities are sequenced into the Construction, Operations, and Closure phases. Chapter 2, Alternatives, presents project description details, and a summary of the potentially affected communities for this component was presented above.

3.22.3.4.1 HEC 1: SOCIAL DETERMINANTS OF HEALTH (SDH)

The following social health determinants represent a comprehensive and regionally relevant baseline. In most cases, the Yukon-Koyukuk and Bethel census areas were compared to state or U.S. data. For cases where regional data are not available, data for Alaska Natives are viewed as an indicator for the affected communities as they are the majority of the population of the Y-K region and Bethel Census Area (USCB 2013d). The ADHSS 2011 Technical Guide suggests a broad list of SDHs for consideration, of which many are discussed in this section. SDHs such as isolation and cultural change were not included due to the lack of meaningful available data on these topics at the level of community health. However, these topics are also addressed in larger context in Section 3.20, Cultural Resources, and Section 3.21, Subsistence.

Life Expectancy. Life expectancy is a standard metric of community health status. According to the Alaska Native Epidemiology Center (ANTHC 2013), data for 2004 to 2008 show Alaska Native population life expectancy (at birth) to be notably lower at 70.5 years as compared to Alaska white population and U.S. white population at 77.7 years and 78.3 years, respectively. The ANTHC data (2013) show that for the same time period amongst Alaska Natives, the life expectancy range was narrow and equivalent to the statewide Alaska Native population life expectancy of 70.5 years, with the range being between 67.6 years (Arctic Slope region) and 72.6

years (Southeast region), and the Y-K region falling in the middle at 70.0 years. Since 1980, overall life expectancy rates have climbed at a similar rate for all study groups across regions, ethnicities, and races (ANTHC 2013).

Maternal and Child Health. Maternal and child health are important indicators of a community's wellness and access to healthcare since they are influenced by many factors. The key indicators compared between Bethel Census Area and the state were infant mortality, adequacy of prenatal care, low birth weight, substance use during pregnancy, and teen pregnancy. The Bethel Census Area infant mortality rate of 7.5 (per 1,000 births) was based on only 10 counts from 2010 to 2012, but was higher than both state (4.3) and U.S. (6.75) rates (ADHSS 2014, as cited in Newfields 2016). The adequacy of prenatal care utilization (APNCU) index compares the number of prenatal visits with the expected number of visits for the period when care began and the delivery date.

To classify the adequacy of received services, the number of prenatal visits is compared to the expected number of visits for the period between when care began and the delivery date. The expected number of visits is based on the American College of Obstetricians and Gynecologists prenatal care standards for uncomplicated pregnancies and is adjusted for the gestational age when care began and for the gestational age at delivery. A ratio of observed to expected visits is calculated and grouped into four categories— Inadequate (received less than 50 percent of expected visits), Intermediate (50–79 percent), Adequate (80–109 percent), and Adequate Plus (110 percent) (BVS 2009). "Adequate prenatal care" is defined as care that begins in the first trimester and includes nine visits throughout the pregnancy. "Inadequate prenatal care" is defined as beginning in the third trimester and includes no more than four visits (BVS 2009).

In 2012, the Bethel Census Area had a higher percentage of inadequate prenatal care at 29.3 percent than the state (17.3 percent) with Alaska Native mothers faring worse than white mothers across all reported metrics (ADHSS 2014, as cited in Newfields 2016). During the period of 2010 to 2012,the Bethel Census Area recorded a higher percentage of infants born from mothers who smoked, which increases the chance of low birth weights, as compared to the state and the nation (22.3 percent compared to 14.5 percent and 8.4 percent, respectively) (ADHSS 2014, as cited in Newfields 2015). In 2009, there was little difference between Bethel Census Area and the state in terms of low birth weight (5.1 percent compared to 5.9 percent, respectively) (ADHSS 2011, as cited in Newfields 2015, 2016). During the period of 2010 to 2012, alcohol use by pregnant women within the Bethel Census Area was 2.1 percent compared to 2.9 percent for the state (ADHSS 2014, as cited in Newfields 2015, 2016). In 2012, for Alaska Native teen pregnancies (under 20 years old), prevalence amongst Alaska Natives and the state were also similar (12.4 percent compared to 12.7 percent, respectively) (ADHSS 2014, as cited in Newfields 2015, 2016). National teen pregnancy prevalence for all races was 24.2 percent (CDC 2016).

Abuse and Sexual Violence. Abuse and violence are linked to physical, social, and mental health. There are limited local data available for child abuse and only associations could be made for the Bethel Census Area based on the regional grouping by OCS. In 2010, the Western Region of Alaska (includes the Bethel Census Area), when compared to the other five regions, had the highest rates for both substantiated allegations of child abuse (450 per 10,000 children) and child abuse victims (216 per 10,000 children) (OCS 2011, as cited in Newfields 2015, 2016). In 2010, he sexual violence rate in Alaska is 2.3 times higher than the U.S. rate (2010 Alaska Victimization Survey, as cited in Newfields 2015, 2016). In 2010, for the State of Alaska, the

lifetime prevalence of intimate partner violence for Alaska Native women was 31 percent compared to all races at 22.4 percent (2010 Alaska Victimization Survey, as cited in Newfields 2015, 2016). In 2012, the prevalence of reported intimate partner violence in rural areas (26 percent) was higher than urban locations such as Anchorage (23 percent) and Fairbanks (19 percent) (ADHSS 2012, as cited in Newfields 2016).

Oral Health. General oral health covers oral and pharyngeal cancer**,** gingivitis, periodontal disease, cavities which are directly related to access to dental care, fluoridation of drinking water, and education. In 2008, 20 percent of Alaska Natives visited the dentist as compared to the national percentage of 65.1 percent for all races (AN EpiCenter 2009; U.S. Dept. of Health and Human Services 2000, as cited in Newfields 2015, 2016). The low percentage affects oral health education and prevention, early detection of lesions or tumors, and overall lack of dental care. High tobacco and soda use and low rates of drinking water fluoridation amongst Alaska Natives and remote regions are also contributing factors for oral health concerns. For example, children without fluoridated water have up to 3 times the amount of cavities, decay, and other dental problems than children in villages with fluoridated water (CDC 2011, as cited in Newfields 2015, 2016).

Suicide. Suicide rates are an indicator of mental health wellness within communities. For the Bethel Census Area, suicide ranked fourth in leading causes of death. Suicide was sixth in leading causes of death in the state of Alaska from 2007 to 2009. For Alaska Natives ages 5 to 14, suicide ranked third in leading causes of death; for ages 15 to 34 suicide ranked second in leading causes of death; and for ages 35 to 44 suicide ranked third in leading causes of death. The age-adjusted rate of suicide deaths per 100,000 U.S. Year 2000 standard population was 61.6 for the Bethel Census Area and 22.7 for the state of Alaska (BVS 2011, as cited in Newfields 2015, 2016). The national rate was 12.6 (CDC 2017b).

Substance Abuse. Substance abuse refers to the consumption of mind and behavior altering substances (Newfields 2015, 2016). During the period of 2003 to 2009, the prevalence of excessive drinking, which includes both binge-drinking and heavy drinking for the Bethel Census Area were 17 percent, which was lower than the state at 19 percent (AN EpiCenter 2007, as cited in Newfields 2015, 2016). The prevalence of male adult binge drinking was double that of females among YKHC service area residents. The prevalence of male adult binge drinking was also higher than those for females in the Bethel Census Area (Institute of Health Metrics and Evaluation 2015), the state or nationally (CDC 2017a). Alaska Natives between 25 to 34 years of age had the highest self-reported prevalence of binge drinking (18 percent) of all age groups (University of Wisconsin 2011, as cited in Newfields 2015, 2016).

In 2009, Alaska Native high school students typically report higher percentages of marijuana use (32 percent) than Alaska non-native high school students (17 percent); the percentage for Alaska Native students is similar to the percentage for 10th graders nationally (National Institute on Drug Abuse 2016). However, the prevalence of alcohol, marijuana, and cocaine usage are comparable among these two groups. It is inferred that these trends would be similar in the current Mine Site communities (AN EpiCenter 2009, as cited in Newfields 2015, 2016).

Economic Indicators. Section 3.18, Socioeconomics, and Section 3.21, Subsistence, discuss the relevant factors for the project description and the potentially affected communities. Section 3.22.3.1, Human Health, summarizes median household income for the region. It should be noted that these income metrics do not include any dollar equivalent of subsistence resources which are vital resources for this region and especially the small rural communities (

3.18, Socioeconomics). Section 3.21.1, Subsistence, discusses the monetary value equivalence for subsistence activity. Positive linkages have been acknowledged between diets based on a subsistence lifestyle (e.g., consumption of fish and caribou) and the generally positive health benefits associated with such diets (ADHSS 2011).

Accurate employment data are difficult to ascertain due to strict reporting requirements that preclude some of the population, the remoteness of the region, and the seasonal aspect of local job opportunities. There is generally a lack of local employment opportunities for the region, especially at the small Kuskokwim River communities (Martin et al. 2008). Section 3.22.3.1, Human Health, presents a summary of employment data for the communities and the region as compared to the state. Section 3.18, Socioeconomics, presents the socioeconomics subjects in more detail.

Educational Attainment. The positive relationship between educational attainment and health has been well-documented (Cutler and Llera-Muney 2007; Hernandez-Murillo and Martinek 2011). Section 3.22.3.1, Human Health, presents general education data for the region. For the period of 2005 to 2009, the percentage of adults who were high school graduates varies considerably among the eight Central Kuskokwim River communities, from a low of 33 percent in Stony River to a high of 100 percent in Red Devil. Only Red Devil had higher education percentage than the state high school graduation percentage of 67 percent (ADOL&WD, ACS 2009; UCB 2000, both as cited in Newfields 2015, 2016).

Family Stability. Family stability can be a determinant of social and mental health, particularly for children. The prevalence of divorce for the nation was twice as high and the state was almost 7 times higher than for the Bethel Census Area in 2009 (CDC 2017a; ADHSS undated, as cited in Newfields 2015, 2016). Bethel Census Area (14.0 percent) also had equivalent percentages of women-head-of-household (no father) as the state (16.2 percent). For the small Kuskokwim River communities, the range of women-head-of-households had a much larger disparity from 17.5 percent (Aniak) to 50 percent (Crooked Creek) as compared to the state having 16.2 percent (ADOL&WD, ACS [2005-2009], as cited in Newfields 2015, 2016) and the nation having 40.4 percent (Pew Research Center 2013). Social determinants of health are shown in Table 3.22-4.

Table 3.22-4: Social Determinants of Health

Social Determinants of Health (Date Period; Source)	Community (Bethel Census Area or as noted)	Regional (Y-K region or as noted)	Alaska	National
Life Expectancy in years (2004 to 2008; ANTHC 2013)	NA	70.5 (AN)	77.7 (White)	78.3 (White)
Infant Mortality (rate per 1,000 births) (2010 to 2012; ADHSS 2014)	7.5	15.2 (Y-K AN) [2006 to 2010]	4.3	6.75
Inadequate Prenatal Care by percent for all races (2012; ADHSS 2014)	29.3%	--	17.3%	--
Inadequate Prenatal Care by percent for AN and White (2012; ADHSS 2014)	29.9% (AN) 19.4% (White)	--	24.4% (AN) 13.4% (White)	--

Table 3.22-4: Social Determinants of Health

Social Determinants of Health (Date Period; Source)	Community (Bethel Census Area or as noted)	Regional (Y-K region or as noted)	Alaska	National
Low Birth Weight by percent (2009; ADHSS 2011, CDC 2011)	5.1%	--	5.9%	8.16%
Births from Pregnant Mothers Who Smoked by percent (2010 to 2012; ADHSS 2014)	22.3%	6.8%	14.5%	8.4%
Births from Pregnant Mothers with Alcohol Use by percent (2010 to 2012; ADHSS 2014)	2.1%	--	2.9%	10.2%
AN Teen Pregnancy by percent (2012; ADHSS 2014)	12.4%	--	12.7%	24.2%
Allegations of Child Abuse by region in rate per 10,000 children 2010; OCS 2011)	--	**450 (Western)** 178 (Anchorage) 292 (Northern) 243 (Southcentral) 192 (Southeastern)	--	--
Victims of Child Abuse by region in rate per 10,000 children (2010; OCS 2011)	--	**216 (Western)** 106 (Anchorage) 139 (Northern) 101 (Southcentral) 71 (Southeastern)	--	--
Intimate Partner Violence Prevalence Lifetime percent by surveyed period noted; Alaska Victimization Surveys)	27.2% (2006 to 2012)	44.6% (2012)	47.6%	31% (AI / AN) (2010) 22.4% (all races) (2010))
Intimate Partner Violence Prevalence Lifetime (percent surveyed by region (2012; (Alaska Victimization Survey)	--	23% (Anchorage / Mat-Su) 19% (Interior) 26% (Southwest)	--	--
Visited the Dentist by percent of noted population (2008; AN EpiCenter 2009)	--	--	20% AN	25.0% (AI & AN) 65.1% (all races)
Suicide rate per 100,000 (2007 to 2009; BVS 2011, CDC 2017b)	61.6	62.1	22.7	12.6
Reported Excessive Drinking by percent surveyed (2003 to 2009; University of Wisconsin 2011, CDC 2017a)	17%	--	19%	23.4%
Binge Drinking by percent surveyed by gender 2003 to 2009; University of Wisconsin 2011, CDC 2017a)	22% (male) 14% (female)	16% (male) 8% (female)	23.8% (male) 14.9% (female)	29.6% (male) 17.8% (female)

Table 3.22-4: Social Determinants of Health

Social Determinants of Health (Date Period; Source)	Community (Bethel Census Area or as noted)	Regional (Y-K region or as noted)	Alaska	National
Binge Drinking by (percent surveyed by age group (2003 to 2009; University of Wisconsin 2011, CDC 2017a)	--	18% (AN 25-34)	--	28.5% (18-24) 33.2% (25-44)
High School Student Marijuana Use by percent (2009; AN EpiCenter 2009)	--	36%	32% (AN) 17% (non-AN)	35.6% (10th graders) 23.9% (12th graders)
Unemployment by percent (Five-year average, 2011-2015; and 2016: see Section 3.18-5 for additional context)	11.3%	--	5.9%	4.7%
High School Diploma or Higher by percent of population (2007 through 2015; see Section 3.18-3 for additional context)	79.1%	64% (AN)	90%	88%
Divorce (rate per 1,000) marriages (2009; CDC 2017a; ADHSS 2011)	1.7 (male) 1.3 (female)	--	7.3 (male) 7.9 (female)	3.2
Female Head of Household by percent of family households (2005 to 2009; ACS 2009)	14.0%	--	16.2%	40.4%

Notes:

Bold used to specify region of interest
AI = American Indian
AN = Alaska Native
-- = Not Available and/or Not Used
yrs = years
The Y-K region includes the Bethel Census and Kusilvak Census areas, but excludes the city of Bethel.
Sources are as listed or as cited by Newfields 2015 and 2016 (see Section 3.22.3.4.1).

3.22.3.4.2 HEC 2: ACCIDENTS AND INJURIES

Accidents and injuries include both fatal and non-fatal incidents that are primarily unintentional and affect the mortality and morbidity rates of a community. Intentional incidents include suicide and homicide.

Fatal Injuries. The data, rates, and statistics for injuries are based on relatively low counts (for example there were 39 fatal injuries over three years [2007-2009] in the Bethel Census Area) and therefore calculated rates per given population should be weighed carefully. For the Bethel Census Area, the leading cause of fatal injury is alcohol overdose (grouped under "poisoning" by Alaska BVS [2007-2009]) showing an age-adjusted rate 1.5 times higher than the state. Alcohol abuse is also associated with the other leading causes which were motor vehicle accidents (the majority are snow machine accidents) and drowning. Suicide, as noted by the Alaska Trauma Registry (ATR), while not unintentional, was the most common cause of fatal injuries in the Bethel Census Area (ADHSS undated; ATR 2011, both as cited in Newfields 2015, 2016).

Non-fatal Injuries. During 2004 to 2008 for the Y-K region, the most common cause of non-fatal injury requiring hospitalization was attempted suicide (23 percent of all non-fatal injuries), followed by falls (22 percent), and assault (10 percent). These three causes of injury alone accounted for 55 percent of all non-fatal injuries during this period (ATR 2011, as cited in Newfields 2015, 2016). The prevalence of attempted suicide was much lower in the state (5 percent) (ADHSS 2016) and the nation (<1 percent) (CDC 2013). Falls were a higher proportion of non-fatal injuries in the state (54 percent) (ADHSS 2016) though the Y-K region and the national prevalence were similar (25 percent) (CDC 2013). The prevalence of assault in the Y-K region was similar to that of the state (10 percent) (ADHSS 2016) and higher than the national prevalence (4 percent) (CDC 2013).

Law Enforcement. There are police stations in Bethel and Aniak. The city of Bethel has its own police department and also staffs 12 Alaska State Troopers (ASTs) and uses air taxis to service the nearby villages; the community of Aniak staffs 4 AST and 2 Village Public Safety Officers (VPSOs) and services 14 nearby village communities (AST 2010, as cited in Newfields 2015, 2016). Law enforcement response times to incidents in nearby villages can be prolonged; even with travel via air taxi, responses can have delays of greater than one hour.

Dry/Wet/Damp Community. The role of alcohol in accidents and injuries is well-known (Landen et al., 1997 as cited in Newfields 2015, 2016). Alaska Native villages have enacted policies that designate a community as dry (no sale or consumption), damp (no sale, but possession allowed), and wet (sale, importation, and possession allowed). During a study comparing 97 Alaskan communities, it was found that injury death rates were generally lower in damp or dry communities than in wet communities, (Berman et al. 2000). As of June 2011, three Central Kuskokwim River communities have adopted "local option laws" to prohibit alcohol: Lower Kalskag (dry), Upper Kalskag (damp), and Red Devil (damp). Alcohol is permitted in the remaining five Central Kuskokwim River communities (wet) (ADPS, ABC Board 2011, as cited in Newfields 2015, 2016).

Transportation-related Accidents. Section 3.23, Transportation, discusses marine and riverine incidents, such as accidents and spills, with Table 3.23-2 giving information on U.S. Coast Guard incident investigation reports for the Kuskokwim River and Kuskokwim Bay. The table lists nine incidents occurring between 2002 and 2009. All but two of the incidents involved groundings (the remaining two incidents were a collision that damaged a vessel and a fatal onboard fishing vessel accident). An additional incident occurred June 4, 2015, where a barge was grounded near Kuskokwim Bay carrying an estimated 68,000 gallons of fuel. The U.S. Coast Guard found no damage to the tanks or hull, and identified no pollution resulting from the incident (Alaska Dispatch News 2015b).

The Bethel Harbor had an average of 111.8 inbound and outbound trips by self-propelled vessels between 2007 and 2011. Table 3.23-3 in Section 3.23, Transportation, has complete data for commercial vessel trips in the Bethel Harbor. Between 2007 and 2011, an average of 405 commercial vessel trips was logged annually on the Kuskokwim River, with 187 trips being self-propelled vessels. Tables 3.23-4, 3.23-5, 3.23-6, 3.23-7, and 3.23-8 in Section 3.23, Transportation, contain information about Kuskokwim River vessel traffic.

At Dutch Harbor, the Unalaska Department of Ports and Harbors manages six marine facilities. Section 3.23, Transportation, describes these facilities and notes Unalaska Island marine traffic included 1,423 total domestic trips in 2009 (Northern Economics, Inc. 2009). Accidents and injuries are shown in Table 3.22-5.

Table 3.22-5: Accidents and Injuries

Type of Accident or Injury (Date Period; Reference)	Community (Bethel Census Area or as noted)	Regional (Y-K region or as noted)	Alaska	National
Fatal Injury: Poisoning (rate per 100,000 people) (2007 to 2009; Alaska BVS)	24.1	--	16.9	12.3
Attempted Suicide (percent of all nonfatal injuries) (2004 to 2008; ATR 2011)	--	23%	5%	<1%
Nonfatal Falls (percent) (2004 to 2008; ATR 2011)	--	22%	54%	25%
Nonfatal Assault (percent) (2004 to 2008; ATR 2011)	--	10%	9%	4%

Notes:
-- = Not Available and/or Not Used
The Y-K region includes the Bethel Census and Kusilvak Census areas, but excludes the city of Bethel.
Alaska and national data from ADHSS 2016 and CDC 2013, respectively
Sources are as listed or as cited by Newfields 2015 and 2016 (see Section 3.22.3.4.2).

3.22.3.4.3 HEC 3: EXPOSURE TO POTENTIALLY HAZARDOUS MATERIALS

Environmental exposure to chemicals or physical hazards through the air, land, or water is also considered a health determinant. Baseline data may be qualitative in terms of proximity to known contamination sources, or quantitative through analytical data collection and monitoring such as the ADHSS methylmercury testing of hair samples from pregnant women (Newfields 2015, 2016).

Physical Hazards. There are no specific data on physical hazards (Newfields 2015, 2016), but it should be recognized that the rural and remote regions in Alaska carry exposure risk to the elements and wildlife.

Air Quality. The role of poor air quality on community health, particularly with regard to respiratory disorders, has been well-documented (WHO 2011). There were no specific data available on air quality for the EIS Analysis Area (Newfields 2015, 2016). Local practices of burning trash, generating power using diesel generators, and heating of some homes using wood stoves could contribute to poor air quality outdoors. The lack of paved roads may circulate pollutants in dust which affects air quality and may also settle on food sources. There are also indoor air quality issues with the use of old wood burning stoves, which may be made worse by spending a lot of time in airtight homes (Newfields 2015, 2016).

Water Quality. "The State of Alaska has some of the highest levels (up to 10,000 µg/liter) of naturally occurring arsenic in drinking water in the U.S." (Harrington et al. 1978, as cited in Newfields 2015, 2016). In 2005, out of the 60 regulated public water systems in the Y-K basin, 19 exceeded arsenic screening levels (ADEC 2010, as cited in Newfields 2015, 2016) and additional discussion of existing water quality is provided in the Water Quality section (Section 3.7). Due to historic mining at Red Devil mine, lengths of the middle Kuskokwim River exceed screening levels for mercury, arsenic, and antimony, which affect water quality and forces fish advisories

(ADHSS 2010, as cited in Newfields 2015, 2016). While no water bodies in the EIS Analysis Area are listed as impaired under Section 303(d) of the federal Clean Water Act, the Kuskokwim River is listed as a Category 5 impaired water body under state water quality standards at the outflow of Red Devil Creek. The designation extends 100 feet upriver to 900 feet downriver from the confluence of Red Devil Creek and the Kuskokwim River. Category 5 refers to pollutant-caused impairments requiring a Total Maximum Daily Load (TMDL) technical analysis that calculates the reduction in pollutants necessary for the impaired water body to again meet water quality standards.

Potentially Hazardous Materials. ADHSS maintains a hair mercury biomonitoring program. Mercury is a naturally occurring metal that may be released into the environment from mining processes (ATSDR 1999, as cited in Newfields 2015, 2016). Since 2002, the ADHSS state-wide Hair Mercury Biomonitoring Program has been testing the hair of pregnant women and women of child-bearing age for methylmercury (Newfields 2015, 2016).

ADHSS Mercury Biomonitoring (2002-2010)

From 2002 to 2010, ADHSS tested 308 pregnant women and 505 women of childbearing age throughout Alaska (113 communities). The southwest region of Alaska, which includes the YKHC service area and the Bethel Census Area, showed a median hair methylmercury concentration of 0.78 parts per million (ppm) with a maximum of 7.82 ppm. Both levels (median and maximum) were below the Agency for Toxic Substances and Disease Registry (ATSDR) No Observed Adverse Effect Level (NOAEL) of 15.3 ppm for methylmercury in hair (ADHSS 2010, as cited in Newfields 2015, 2016). The median hair mercury level (0.78 ppm) was below, but the maximum hair mercury level (7.82 ppm) slightly exceeded the ADHSS Environmental Public Health Program follow-up level of 5 ppm (ADHSS 2013). Similarly, a comparison of the hair mercury levels showed the median hair methylmercury concentration of 0.78 ppm was below, but the maximum hair mercury level (7.82 ppm) exceeded the hair mercury level of 1 ppm (which corresponds to the EPA's oral reference dose).

ADHSS (2014) strives to balance the risks of methylmercury exposure with the known benefits of fish consumption, and therefore considers the ATSDR's NOAEL (15.3 ppm) for methyl mercury in hair to support risk management decisions. However, ADHSS indicates that in cases where methylmercury risks are evaluated as a result of known pollutant sources, for example, industrial releases of mercury into the environment, that the recommended toxicity metric is the mercury level in hair (i.e., 1 ppm) that corresponds to exposure to the EPA's oral reference dose for methylmercury as discussed in NRC (2000). It is important to note that although hair analysis has some potential advantages over some biological sampling approaches, there are potential limitations including the fact that hair analysis results typically cannot distinguish substances that have been deposited onto hair (i.e., internal versus external sources of exposures) and sometimes do not correlate with blood or urine concentrations (ATSDR 2003; Nuttall 2006).

ADHSS Hair Mercury Monitoring (2012) in Potentially Affected Communities

ADHSS conducted fieldwork in the summer and fall of 2012 in Aniak, Upper Kalskag, Lower Kalskag, Crooked Creek, Sleetmute, Chuathbaluk, Stony River, and Red Devil. One hundred and eighty six hair samples from eight communities were collected for the study. The median hair mercury level for the study population was 0.510 ppm, with a range of 0.030-3.707 ppm

(Table 3.22-6). Every study participant had a hair mercury level that was below the ATSDR NOAEL (15.3 ppm) for methylmercury in hair, as well as the ADHSS Environmental Public Health Program methylmercury in hair cut-off for follow-up (5 ppm) (ADHSS 2013). The median hair mercury level was below 1 ppm (which corresponds to the EPA's oral reference dose); however, some study participant levels exceeded 1 ppm.

The ADHSS 5 ppm hair mercury level cut-off for follow-up was developed for women of child-bearing age, who are an at-risk population because of the potential for adverse health effects to fetuses through maternal exposure. ADHSS conducts follow-up evaluations for all hair mercury levels reported at or above 5 ppm. The inclusion of men and women outside of child-bearing age indicate a baseline level of exposure to potentially affected communities. Uncertainties are discussed further in Appendix AB, Focused Risk Analysis.

Table 3.22-6: Summary of Data Collected by Gender, Donlin Gold, 2012

Population	Number of Samples	Mean Age (years)	Age Range (years)	Median Hg (ppm)	Range Hg (ppm)
Total	186	44	15-74	0.510	0.030-3.707
Male	41	50	22-74	0.768	0.126-3.640
Female	145	43	15-74	0.557	0.033-3.707

Males had a median hair mercury level that was 0.211 ppm higher than females, though this difference was not statistically significant (p-value=0.203). The hair mercury concentrations were weakly but positively correlated with age (Pearson Correlation=0.28, p-value=0.00). Age accounted for 7.9 percent of the variance of hair mercury concentrations. For every year increase in age, hair mercury concentrations increased by 0.012 ppm (p-value=0.00, 95 percent CI=0.006-0.019) (ADHSS 2013).

The median hair mercury level found in this study (0.510 ppm) was similar to the state median level (0.46 ppm), and was lower than the median levels observed in the Southwest Region (0.78 ppm) (ADHSS 2010, as cited in Newfields 2015, 2016). Additionally, the communities that were downriver and closest to the former Red Devil Mine (Red Devil, Crooked Creek, and Chuathbaluk) had some of the lowest levels of the sampled communities. Observed hair mercury levels are shown in Table 3.22-7.

Proximity to known contamination sources can be a qualitative indicator of baseline exposure to potentially hazardous materials. There are a total of 15 open ADEC regulated contaminated sites, 4 U.S. Environmental Protection Agency (EPA) Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA) sites, and 1 Formerly Used Defense site in the communities of Aniak, Lower Kalskag, Red Devil, Sleetmute, and Stony River (ADEC 2011, as cited in Newfields 2016). Contaminants of concern from these sites include: arsenic, antimony, mercury, diesel range organics (DROs), gasoline range organics (GROs), polycyclic aromatic hydrocarbons (PAHs), benzene, toluene, ethylbenzene, and xylenes (Newfields 2016). All these sites are under active oversight by government agencies, and agency directives are expected to control or prevent exposure to the general public. Therefore, the proximity of these sites is not expected to contribute to the baseline exposure to hazardous materials.

Table 3.22-7: Observed Levels of Mercury and Lead in Alaska and National Populations, 2012

Subject	Gender	Community (Bethel Census Area or as noted)	Regional (Y-K region or as noted)	Alaska	National
Hair Mercury Median for Tested Riverbank Communities (ppm) (Environmental Public Health Program methylmercury in hair cut-off - 5 ppm	Both	0.510	--	0.46	--
	Male	0.768	--	--	--
	Female	0.557	--	--	--
Hair Mercury Range for Tested Riverbank Communities (ppm) (Environmental Public Health Program methylmercury in hair cut-off - 5 ppm)	Both	0.030-3.707	--	--	--
	Male	0.126-3.640	--	--	--
	Female	0.033-3.707	--	--	--
Children Elevated **Blood Lead Level Case Rate** (i.e., <5 micrograms per deciliter) (per 100,000)	Both	23	64 (Yukon-Koyukuk Census Area)	96	565

Notes:

Ppm = parts per million

-- = Not Available and/or Not Used

The Y-K region includes the Bethel Census and Kusilvak Census areas, but excludes the city of Bethel.

Data for mercury are from 2012 (ADHSS 2014, as cited in Newfields 2015, 2016))

Data for lead are from 2012 (ADHSS 2014, as cited in Newfields 2015, 2016)

Pre-existing Environmental Hazardous Materials. Based on 2012 data, Newfields (2015 and 2016) reported that blood lead levels in Alaskan children (less than 6 years old) had a lower rate (cases per 100,000) then the national rate of blood lead levels exceeding the CDC threshold of 5 micrograms per deciliter (μg/dL), which were 23 compared to 565 (out of 100,000 persons), respectively (ADHSS 2014, as cited in Newfields 2015, 2016). The Y-K area and the state also had lower rates than the nation at 64 and 96, respectively (ADHSS 2014). Observed blood lead levels are shown in Table 3.22-7.

3.22.3.4.4 HEC 4: FOOD, NUTRITION, AND SUBSISTENCE ACTIVITY

It should be noted that subsistence activity is vital in the region, especially for small Central Kuskokwim River communities, which is not represented in household income data and related food supply information. Refer to Section 3.21, Subsistence, for more information on subsistence activity.

Micronutrients Deficiencies. There are no clear signs of nutritional deficiencies in the Bethel Census area such as reports of scurvy or other nutritional disorders. Limited market data show a supermarket in Aniak and small stores throughout other communities stocked with basic food options (Newfields 2015, 2016). Subsistence foods are widely used (Section 3.21, Subsistence) and are widely recognized as healthier than market food options.

Food Security. Food Security is defined by the WHO as "existing when all people at all times have access to sufficient, safe, nutritious food to maintain a healthy and active life" (WHO

2011). Based on U.S. Department of Agriculture definitions, many of the small Central Kuskokwim River communities are below total food security with some as low as 52 percent (Lower Kalskag) and all (except Aniak at 89 percent) were between 52 percent to 82 percent which were below the state and U.S. percentage of 87 percent (ADF&G 2011, as cited in Newfields 2015). The small Central Kuskokwim River communities also had worse percentages for residents experiencing "low" (excluding Aniak [6 percent], ranging from 10 percent to 25 percent) and "very low" (0 to 22 percent) food security with some like Lower Kalskag (22 percent) being four times or more of the state (low food security of 8 percent and very low food security of 5 percent) and U.S. (low food security of 8 percent and very low food security of 5 percent) percentages (Brown et al. 2012, as cited in Newfields 2015, 2016). Food security data, as collected by ADF&G, do include subsistence foods as well as store-bought foods. A more detailed discussion about current subsistence activities is in Section 3.21.5. This section notes variability and long term changes in subsistence harvests due to changes in regulations, accessibility, and employment seasons. While subsistence activities remain an important food source with most houses reporting using and harvesting a subsistence resource, it is difficult to determine how the effect of variability in subsistence activities would influence food security. Though multiple communities reported lack of a specific resource, often moose or salmon, many of the communities generally reported getting enough subsistence resources. Section 3.18.1 also discusses how subsistence activities continue to contribute to the economy of the region. Subsistence activities remain the basis of many local economies and are important for food security due to the low availability of jobs and high cost of grocery food in the region.

Food Costs. A metric for comparing relative food costs is to compare the percent of the median household income to purchase the same food products annually. Using data from 2005 to 2011, this comparison shows that, to get the same food, 9.2 percent of the household median income for Anchorage or 11 percent of the median household income for the nation is equivalent to 24.0 percent of the median household income for the Bethel Census Area. At the community level, Bethel was 14.7 percent and rose to 53.6 percent for Upper Kalskag, and as high as 125.0 percent for Stony River (USCB 2000; ADOL&WD, ACS [2005-2009]; University of Fairbanks 2011, all as cited in Newfields 2015, 2016). Though food costs were much higher in Stony River due to a lower median income than other communities, the total food security for the community was similar to that of other communities. Stony River also harvested 1,686 pounds of wild food per household, while other communities harvested up to 988 pounds of wild food per household (Newfield 2016). The additional wild foods may bolster food security in the community, and food basket costs may not be an accurate metric of food costs for Stony River. Statistics on food security and costs are shown in Table 3.22-8.

Table 3.22-8: Food Security and Costs, 2009

Subject	Community (Bethel Census Area or as noted)			Regional (Y-K region or as noted)	Alaska	National
	Lower Kalskag	Aniak	Other Central Kuskokwim River Communities			
Total Food Security 2 or fewer food access problems or limitations per week (percent)	52%	89%	range from 69% to 82%	--	87%	87%
Low Food Security reduced quality, variety, or desirability of their diet (percent)	25%	6%	range from 10% to 22%	--	8%	8%
Very low food Security - multiple instances of disrupted eating patterns and reduced food intake (percent)	22%	5%	range from 0% to 13%	--	5%	5%
Food basket Costs (percent of income)	Bethel Census Area: 24.0% Bethel: 14.7% Upper Kalskag: 53.6% Stony River: 125.0%			Anchorage: 9.2%	--	11%

Notes:

-- = Not Available and/or Not Used

The Y-K region includes the Bethel Census and Kusilvak Census areas, but excludes the city of Bethel.

Source: Brown et al., 2013, as reported by Newfields 2016

3.22.3.4.5 HEC 5: INFECTIOUS DISEASES

The role of infectious diseases in the mortality and morbidity rates of a population is well known. Reportable infectious diseases (e.g., tuberculosis, septicemia, viral hepatitis, HIV, and sexually transmitted infections [STIs], influenza, and pneumonia) were the fifth leading cause of death to all races in the Bethel Census Area, but it should be noted that this was based on a low count of 16 infectious disease-related deaths from 2010 to 2012. More noteworthy are the conditions that promote the spread of disease such as unsafe water, poor personal hygiene, and unsanitary conditions which may be more common in rural regions (ADHSS undated; WHO 1999, both as cited in Newfields 2015, 2016).

STIs. During the period of 2007 to 2008, among Alaska Natives, *chlamydia trachomatis* was 10 times more common than gonorrhea, which was the second-leading STI in the state (University of Wisconsin 2011; ADHSS 2011, both as cited in Newfields 2015, 2016). In 2011, the chlamydia rate in the Bethel Census Area was 2,321 cases per 100,000 population compared to the state rate of 711 cases per 100,000 population with both rates increasing from previous years (University of Wisconsin 2011, as cited in Newfields 2015, 2016). The regional rate (2,183 per 100,000 population) was similar to that of Bethel Census area, and both were greater than the national

rate of 478.8 per 100,000 population (ANTHC 2007). Alaska Native men and women had higher rates, 4 and 7 times higher, respectively, than Alaska white men and women. In 2005, the gonorrhea rate for Alaska Natives within the YKHC service area (116 cases per 100,000 population) is higher than the state gonorrhea rate for all races (92 cases per 100,000 population), but is nearly equivalent to the national gonorrhea rate of 115.6 cases per 100,000 population (AN EpiCenter 2007, as cited in Newfields 2015, 2016).

Immunization. There are mixed findings showing immunization rates. For Alaskan children in 2009, immunization percentages were low at 56.6 percent which ranked 48th among all states; yet in the YKHC area, the percentages in 2007 showed 90 percent had received their childhood immunizations which was higher than the national percentage of 78.0 percent reported for the Indian health Service (ADHSS 2011; AN EpiCenter 2007, both as cited in Newfields 2015, 2016). Infectious diseases are shown in Table 3.22-9 below.

Table 3.22-9: Infectious Diseases

Infectious Disease Indicators (Period; sources)	Community (Bethel Census Area or as noted)	Regional (Y-K region or as noted)	Alaska	National
Ranking of Top Types of Reported Infectious Disease (percent) (2007-2008; EpiCenter 2009)	STIs (89.4%) Hepatitis B &C (3.9%) Pneumococcal Invasive (2.6%) Tuberculosis, Pulmonary (1.0%)	--	--	--
Chlamydia Cases (rate per 100,000 population) (2007-2008; EpiCenter 2009)	2,321	2,183 (AN)	711	478.8
Gonorrhea Cases (rate per 100,000 population) (2007-2008; EpiCenter 2009)	--	116 (AN)	92 (all races)	115.6 (all races)
Immunization Rate for Alaskan Children (percent) (period noted; ADHSS 2011; EpiCenter 2007)	--	90% (2007)	56.6% (2009)	78.0% (Indian Health Service) (2007)

Notes:

AN = Alaska Native
-- = Not Available and/or Not Used
The Y-K region includes the Bethel Census and Kusilvak Census areas, but excludes the city of Bethel.
Sources are as listed or as cited by Newfields 2015 and 2016 (see Section 3.22.3.4.5).

3.22.3.4.6 HEC 6: WATER AND SANITATION

The lack of a safe water supply (i.e., running water) and suitable sewage disposal are leading causes of preventable diseases in rural Alaska (Newfields 2015, 2016). ADEC studies found that a lack of water is associated with higher incidence of respiratory tract and skin infections among rural Alaska natives. These infections include pneumonia, meningitis, and antibiotic resistant skin infections (Hennessy et. al. 2008). As a solution,

> the Alaska Department of Environmental Conservation has initiated a project to spur worldwide research to develop innovative and cost effective water and sewer systems

> for homes in remote Alaska villages. The project, called the Alaska Water and Sewer Challenge, focuses on decentralized water and wastewater treatment, recycling, and water minimization. These approaches have a high potential for use in individual homes and housing clusters. Our goal is to significantly reduce the capital and operating costs of in-home running water and sewer in rural Alaska homes.
>
> The project is currently in the third phase, called Development and Testing of Pilot Systems. Three pilot systems are in operation in locations around the state, and final results will be evaluated this summer. The next phase, expected to begin early next year (2018), will focus on field system development. As stated in the ADEC website available at: https://dec.alaska.gov/water/watersewerchallenge/index.html.

It has been acknowledged that, "Lack of water and sanitation infrastructure is a major public health and community development problem encountered throughout the [Yukon-Kuskokwim area]" (Indian Health Services). As of 2008, the YKHC had water and sanitation service for 58 percent of their communities which was the fewest of the 14 regional health corporations. Although the YKHC was the largest corporation by far, with 4,760 housing units (the next highest had 2,329 units), their service coverage was well below the 76 percent overall served for all corporations (AN EpiCenter 2009, as cited in Newfields 2015, 2016). Based on the 2017 ADEC Village Safe Water Program (available online at: http://watersewerchallenge.alaska.gov/ruralCommunities.html), of the eight small Central Kuskokwim River communities, Crooked Creek, and Stony River were classified as "unserved Rural Alaska Communities" which is defined where 45 percent or more homes have not been served either via pipes, septic tank and well, or covered haul systems. The other communities are served by central wells and a mix of central sewage plumbing, septic systems, honey buckets, and outhouses. Smaller towns have community washeterias for laundry and bathing (Newfields 2015, 2016).

3.22.3.4.7 HEC 7: NON-COMMUNICABLE AND CHRONIC DISEASES

Non-communicable and chronic diseases consume a large part of healthcare resources and affect the overall health status of a population. Overall, the relative small population of the Bethel Census Area makes calculating rates (per 100,000 people) for causes of death and disease unreliable and difficult to compare to state rates.

Cancer. In the Bethel Census Area, cancer accounts for 21.6 percent of all deaths and has been the leading cause of death for the previous decade and as recent as the 2007 to 2009 period. For this period, the leading causes of cancer deaths amongst Alaska Natives were lung cancer at 27 percent and then colon and rectum cancer at 13 percent. All others were 6 percent or less (AN EpiCenter 2009, as cited in Newfields 2015, 2016).

For the period of 2010 to 2012, the total number of cancer deaths for the Bethel Census Area was 67 resulting in an age-adjusted rate of 235 (per 100,000) which was a higher rate than the state with a count of 2,736 and a rate of 169.9. During this period, lung cancer deaths led all other cancers with 19 occurrences (rate of 73 [age-adjusted rate per 100,000]), followed by 16 counts (rate of 45) of colon cancer deaths, and all others were 5 or less. For counts less than 20 occurrences, the calculated rates are not reliable, but age-adjusted rates for both would be higher than the state (lung [count of 763 and rate of 49.0] and colon [count of 249 and rate of

15.2]) (BVS 2014, as cited in Newfields 2015, 2016). Nationally, the two leading causes of cancer death were lung (rate of 43.3) and female breast cancer (20.7) (CDC 2017a).

Cardiovascular, Stroke and Respiratory Diseases. Cardiovascular disease and chronic lower respiratory disease are noted leading causes of death for Alaska Natives. Tentatively calculated age-adjusted rates of death caused by major cardiovascular diseases (number of deaths per 100,000 U.S. year 2000 standard population) for the Bethel Census Area from 2010 to 2012 are higher than statewide or national rates, with the Bethel Census Area having an age-adjusted rate of 277.2, Alaska having an age-adjusted rate of 196.4, and the nation having an age-adjusted rate of 192.7 (Newfields 2015, 2016; ADHSS as cited in Newfields 2015, 2016; CDC 2017a).

Chronic obstructive pulmonary disease (COPD) mortality data from 2008 to 2011 show Alaska Natives in the Y-K region had a COPD rate of 67.0 (count of 31) as compared to all Alaska Natives with a rate of 73.5 (count of 174). Both rates are higher than those reported for both Alaska Non-Natives (38.7) and U.S. whites (45.6) (AN EpiCenter 2014, as cited in Newfields 2015, 2016).

Cerebrovascular disease or stroke deaths for the Bethel Census Area show a rate of 59.2 deaths per 100,000 people which is higher than the state rate of 40.6 (ADHSS 2007-2014, as cited in Newfields 2015, 2016) or the national rate of 41.7 (CDC 2017a). The Alaska Native rate for stroke cases has steadily increased since 1992 whereas the rate for the state has steadily decreased (AN EpiCenter 2007, as cited in Newfields 2015, 2016).

Liver Disease. Chronic liver disease and cirrhosis are noted leading causes of death for the state but there were only five counts in 2010 to 2012 from the Bethel Census Area (BVS 2014, as cited in Newfields 2015, 2016).

Mental Health. Based on 2008 to 2010 self-reported Behavioral Risk Factor Surveillance System (BRFSS) data, the Bethel Census Area had fewer self-reported days of poor mental health than state and national averages (2.3 days compared to 2.8 days and 3.7 days), and lower prevalence of mental distress (5.9 percent compared to 8.0 percent) (ADHSS 2011, as cited in Newfields 2015; CDC 2017a). The prevalence of poor mental health may be more common than reported, as evidenced by the high suicide rates for both the Bethel Census Area and the Yukon Koyukuk Census Area (Section 3.22.3.6.1, Human Health).

Dietary Diseases. BRFSS and CDC data from 2004 to 2011 show Bethel Census Area with an obesity prevalence of 32 percent. Regional and state obesity prevalence for the period of 2005 to 2007 show the Alaska Natives of the Y-K region to be 26 percent, statewide Alaska Natives to be 31 percent, statewide Non-Natives to be 25 percent, and US all races to be 28 percent (ADHSS 2009; AN EpiCenter 2009, CDC 2008, as cited in Newfields 2015, 2016).

Based on self-reported BRFSS data from 2008 to 2010, Bethel Census Area had 3.7 percent of adults with diabetes which is less than the state prevalence of 6.8 percent (ADHSS 2009 as cited in Newfields 2015, 2016).

Tobacco Use. In the Bethel Census Area, 34 percent of adults smoke, which is higher than the state percentage of 23 percent (University of Wisconsin 2011, as cited in Newfields 2015, 2016) and the national percentage of 15.1 percent (CDC 2017a). Alaska Native adults and adolescents are twice as likely to smoke as non-Natives with Alaska Native young men having the highest percentages (AN EpiCenter 2007, as cited in Newfields 2015, 2016).

Data from periods 2005 to 2007 and 2008 to 2010 show relatively high smokeless tobacco use in the Bethel Census Area with rates being five times higher than state rates, and Alaska Natives in the YKHC three times higher than Alaska Natives statewide. Similar trends are noted amongst Alaska Native high school students when compared to non-Native students (AN EpiCenter 2007; ADHSS 2009, both as cited in Newfields 2015, 2016). Non-communicable and chronic diseases are shown in Table 3.22-10.

Table 3.22-10: Non-Communicable and Chronic Diseases

Disease Type and Metric (period; sources)	Community (Bethel Census Area or as noted)	Regional (Y-K region or as noted)	Alaska	National
Leading Types of Cancer Deaths (count & rate per 100,000 population) (2010 to 2012; EpiCenter 2009)	Lung (count of 19 and rate of 73.4)	--	Lung (count of 763 and rate of 49.0)	Lung (Rate of 43.4)
2nd Leading Types of Cancer Deaths (count & rate per 100,000 population) (2010 to 2012; EpiCenter 2009)	Colon (count of 16 and rate of 44.8)	'--	Colon (count of 249 and rate of 15.2)	Female Breast (Rate of 20.7)
Cardiovascular Disease Deaths (count & rate per 100,000 population) (2010 to 2012; ADHSS, CDC 2017a)	Count of 64 and rate of 277.2	Count of 82 and rate of 190.9	Count of 2,841 and rate of 196.4	Count of 614,348 and rate of 192.7
Chronic obstructive pulmonary disease (COPD) Mortality (rate per 100,000 population) (2008 to 2011; EpiCenter 2014)	--	AN: 67.0	AN: 73.5 Alaska Non-Natives: 38.7	White: 45.6
Cerebrovascular Mortality (rate per 100,000 population) (2007-2014; ADHSS, CDC2017a)	59.2	57.4	40.6	41.7
Health Factors				
Poor Mental Health Days per Month (self-reported) (2008 to 2010; ADHSS 2011, CDC2017a)	2.3 days	--	2.8 days	3.7 days
Prevalence of Obesity (percent self-reported) (period noted; ADHSS, EpiCenter 2009, CDC 2008)	32% (all races) (2004 to 2011)	26% (AN) (2005 to 2007)	31% (AN) 25% (Non-Native) (2005 to 2007)	28% (all races) (2005 to 2007)
Smokers (percent) (2011; University of Wisconsin 2011, CDC 2017a)	34%	46%	23%	15.1%

Notes:

AN = Alaska Native
-- = Not Available and/or Not Used
Rates per 100,000 in age-adjusted population
The Y-K region includes the Bethel Census and Kusilvak Census areas, but excludes the city of Bethel.
Sources are as listed or as cited by Newfields 2015 and 2016 (see Section 3.22.3.4.7).

3.22.3.4.8 HEC 8: HEALTH SERVICES INFRASTRUCTURE AND CAPACITY

An important measure of the health-related resilience and support structure of a community is the quality and quantity of healthcare that is available to the residents.

Health Services. The YKHC manages a comprehensive healthcare system on behalf of 58 federally recognized tribes for 50 rural communities in southwest Alaska (Newfields 2015, 2016). The Alaska Native Medical Center (ANMC) is the statewide referral center for specialty care for Alaska Natives. Yukon-Kuskokwim Delta Regional Hospital (YKDRH) is a 50-bed hospital located in Bethel that provides dental and optical services, mental health services, substance abuse counseling and treatment, health promotion and disease prevention programs, and environmental health service. The ANMC and YKDRH support a system of small local clinics throughout the region (YKHC undated, as cited in Newfields 2015, 2016). These five sub-regional clinics are in the following locations: Aniak, Emmonak, Hooper Bay, St. Mary's, and Tooksook Bay.

Due to the remote region and terrain, air travel is the primary mode of large distance transportation, especially for medical issues. Flight times from the small Central Kuskokwim River communities to the city of Bethel medical facilities range from 39 minutes (from Lower Kalskag) to about 1.5 hours (from Stony River) (YKHC 2014).

Hospitalizations. Based on regional hospital data in Bethel, the leading causes of hospital discharges were childbirth, pneumonia, psychoses, alcohol abuse, bronchitis/emphysema, infected skin, and accidents/injuries (ANTHC 2007). Based on regional hospital data in Bethel, the leading causes of inpatient days were alcohol abuse, psychoses, pneumonia, and childbirth. The primary reasons for outpatient visits included upper respiratory problems, hospital medical/surgical follow-up visits, and pregnancy, childbirth, and puerperium (a period of six weeks after childbirth) (AN EpiCenter 2007, as cited in Newfields, 2015, 2016).

Health impact issues for the adequacy of health services for areas are Health Professional Shortage Area (HPSA) or a Medically Underserved Area/Population (MUA/P). These designations take into account the availability of medical care by population size and whether the care is over-utilized, excessively distant or otherwise inaccessible.

Primary Care HPSAs are based on a physician to population ratio of 1:3,500. In other words, when there are 3,500 or more people per primary care physician, an area is eligible to be designated as a primary care HPSA. Dental HPSAs are based on a dentist to population ratio of 1:5,000. Mental Health HPSAs are based on a psychiatrist to population ratio of 1:30,000. MUAs may be a whole county or a group of contiguous counties, a group of county or civil divisions or a group of urban census tracts in which residents have a shortage of personal health services. Medically Underserved Populations (MUPs) may include groups of persons who face economic, cultural or linguistic barriers to health care (HRSA 2015).

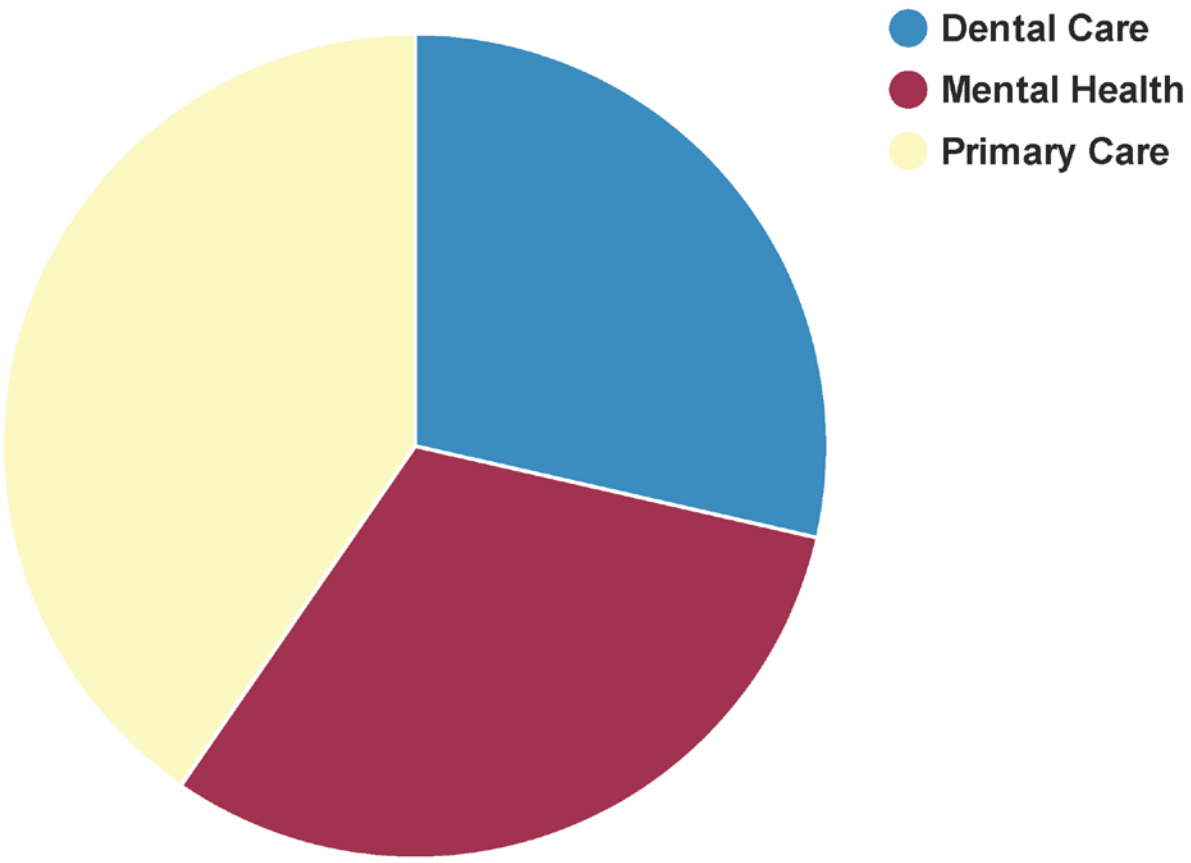
HPSAs may be designated as having a shortage of primary medical care, dental or mental health providers. They may be urban or rural areas, population groups, or medical or other public facilities (HRSA 2015).

It should be noted that these designations are most directly comparable when the populations are similar; otherwise, a relatively low population area such as the Y-K census area may appear to have less "need" than a densely populated area when the difference may be more due to the population disparity than actual "need." Also comparing a community to a larger region or

state would not be meaningful since the region or state value represents a sum total that includes the community.

The Bethel Census Area is designated as MUA and the HPSA rating is 11. Figure 3.22-3 indicates health professional shortages by discipline in Alaska.

Figure 3.22-3: Health Professional Shortage Areas by Discipline in Alaska



3.22.3.5 TRANSPORTATION CORRIDOR

The communities affected by the Transportation Corridor component are found along the route for the supply chain for the Mine Site. Baseline health conditions for these communities have already been described in Section 3.22.3.4, Human Health, since they overlap with the Mine Site component. Key project activities with potential health effects to the affected communities are Bethel Port (including the dock and fuel storage improvements), Kuskokwim River barge traffic, and the Angyaruaq (Jungjuk) Port site. Details on the project descriptions are presented in Chapter 2, Alternatives, and a summary of the potentially affected communities was presented above in Section 3.22.3, Human Health. Section 3.22.3.3, Human Health, presents the baseline data for the Bethel Census Area, YKHC Service area, and the small Kuskokwim River communities (as available) for all HECs.

3.22.3.6 PIPELINE

The Pipeline includes rights-of-way (ROWs), above ground facilities (fault crossings, a compressor station, pig launcher and receiver station, and main line valves), and temporary work areas outside the ROW over mostly remote and rural regions except for the communities near the eastern terminal end which includes the KPB and MSB. Details are presented in the project description in Chapter 2, Alternatives, and a summary of the potentially affected communities was presented in Section 3.22.3, Human Health.

Although the Y-K region is included under the potentially affected communities of the Pipeline component, that data are generally not repeated here (except for context as applicable) since it has been covered under the Mine Site component. The KPB and MSB are the potentially affected communities primarily covered in this section, as well as Alaska Natives in general, since they are a functional classification representing the small Central Kuskokwim River communities.

3.22.3.6.1 HEC 1: SOCIAL DETERMINANTS OF HEALTH (SDH)

Minimal data specific to KPB and MSB were available for intimate partner violence, oral health, or family structure. Subsistence information is presented in Section 3.21, Subsistence, and additional data specific to Alaska Native populations are presented in Section 3.22.3.4.1, Human Health.

Life Expectancy. For the Kenai region, the life expectancy of Alaska Native males and females in the period of 2000 to 2008 is 70.7 years and 71.5 years, respectively (ANTHC 2012). For the Anchorage and Mat-Su region, the life expectancy for Alaska Native males and females in the period of 2000 to 2008 are 66.6 years and 73.3 years, respectively (ANTHC 2011).

Maternal and Child Health. Approximately 37 percent fewer Alaska Native mothers received adequate prenatal care than white mothers in Alaska (ADHSS 2007-2014, as cited in Newfields 2015, 2016).

Infant mortality rates (per 1,000 live births) for the period of 2010 to 2012 in the KPB were 3.2, and in the MSB were 1.9. (BVS 2014, as cited in Newfields 2015, 2016); relatively low as compared to the U.S. (6.75) (CDC 2010).

The percentage of babies born with low birth weight from 2010 to 2012 in the KPB (4.7 percent) and MSB (5.8 percent) is relatively low compared to the U.S. (8.0 percent [2012]) (CDC 2014). Statistics for Alaska Native babies were slightly lower percentage of low birth weights in the KPB (7.8 percent) and in the MSB (6.6 percent). During the period of 2010 to 2012, teen birth rates for all races were 6.3 percent for the KPB and 7.9 percent with higher rates for Alaska Natives (12.2 percent and 13.5 percent, respectively) than Whites (5.4 percent and 7.1 percent, respectively). During the period of 2010 to 2012, although equivalent between KPB and MSB, the percentage of mothers who smoked during pregnancy in the KPB was 13.7 percent and in the MSB was 12.8 with Alaska Native mothers (25.7 percent and 23.4 percent, respectively) almost double than White mothers (11.9 percent and 11.5 percent, respectively) (BVS 2014, as cited in Newfields 2015, 2016).

Child abuse rates are not available specifically for the KPB and MSB. OCS groups the state into four vast regions which generally show rural locations have higher rates of child abuse than Anchorage or the Southeastern region in 2010 (OCS 2010, as cited in Newfields 2015, 2016).

Suicide. The suicide rate per 100,000 population, for the period of 2010 to 2012 for the KPB was 23.8 based on 46 deaths, the MSB was 15.2 based on 46 deaths, the Yukon-Koyukuk Census Area was 60.2 based on a low count of 14 deaths, and the Bethel Census Area was 17.6 based on 22 deaths. Based upon ranking for leading cause of death, Yukon-Koyukuk and Bethel Census Areas both ranked suicide as fourth, and KPB and MSB did not rank suicide in the top five (BVS 2014, as cited in Newfields 2015, 2016).

Median Household Income. Section 3.22.3.1, Human Health, summarizes income data for the region during the period of 2008 to 2012. At the community level, amongst the high group were Beluga ($66,090) and McGrath ($66,111) and amongst the low group were Stony River ($6,667) and Crooked Creek ($10,391) (USCB 2012b, as cited in Newfields 2015, 2016).

Employment. Section 3.22.3.1, Human Health, summarizes employment data for the region during the period of 2008 to 2012. At the community level, unemployment was highest at Nikolai at 24.2 percent, followed by Crooked Creek at 20.0 percent, and then Sleetmute at 11.8 percent (USCB 2012b, as cited in Newfields 2015, 2016).

Educational Attainment and Workforce Development. The high school dropout percentage for the 2009-2010 school year based on NCES (2014) was higher than the U.S. percentage (7 percent) for the communities of Beluga (25 percent), Tyonek (25 percent), Susitna (9.2 percent), and Sleetmute (28.57). In contrast, the KPB and MSB had overall lower percentages of 4.58 percent and 5.19 percent, respectively. Notably, Nikolai, McGrath, Takotna, and Stony River had a 0 percent dropout rate. Literacy percentage were high (86 percent or better) for all reported regions (ADOL&WD, ACS, as cited in Newfields 2015, 2016). Relatively higher education percentage (Bachelor's degree or higher) are recorded for Beluga (100 percent) and Susitna (72.7 percent) with Borough level percentage for KPB (20.7 percent) and MSB (19.9 percent) near 20 percent for both (ADOL&WD, ACS 2009, as cited by Newfields 2015, 2016). Social determinants of health are shown in Table 3.22-11.

Table 3.22-11: Social Determinants of Health

Social Determinants of Health **(period; sources)**	**Community**	**Regional**	**Alaska**	**National**
Life Expectancy (years) Regional:(2000 to 2008; ANTHC 2012) Alaska:(2007; Kulkarni et al, 2011 as cited in Newfields 2016)	--	Kenai region: 70.7 (AN male) 71.5 (AN female)	75.9 (male) 80.5 (female)	75.6 (male) 80.8 (female)
	'--	Anchorage & Mat-Su: 66.6 (AN male) 73.3 (AN female)		
Infant Mortality (rate per 1,000 births) (2010 to 2012; BVS 2014, CDC 2010)	--	KPB: 3.2	4.3	6.75
	'--	MSB: 1.9		
Low Birth Weight (percent of births) Regional & National: (2010 to 2012; CDC 2014) Alaska: (2009; ABVS 2011, as cited in Newfields 2016)	--	KPB: 4.7% (all races) 7.8% (AN)	5.9	8.0% (all races)
	'--	MSB: 5.8% (all races) 6.6% (AN)		

Table 3.22-11: Social Determinants of Health

Social Determinants of Health **(period; sources)**	**Community**	**Regional**	**Alaska**	**National**
Prevalence of Teen Birth (percent of all births) Regional: (2010 to 2012; BVS 2014) Alaska: (2012; BVS 2014, as cited in Newfield 2016)	--	KPB: 6.3% (all races) 12.2% (AN) 5.4% (White)	7.5 (all races) 12.7% (AN)	--
	'--	MSB: 7.9% (all races) 13.5% (AN) 7.1 (White)		
Pregnant Mothers Who Smoked (percent of births) (2010 to 2012; BVS 2014)	--	KPB: 13.7% (all races) 25.7% (AN) 11.9% (White)	15.5% (all races) 30% (AN) 10% (White)	--
	'--	MSB: 12.8% (all races) 23.4% (AN) 11.5 (White)		
Suicide Rate (per 100,000 population) Regional: (2010 to 2012; BVS 2014) Alaska: (2007-2009; BVS 2011, as cited in Newfields 2016)	--	KPB: 23.8	22.7	--
	'--	MSB: 15.2		
	'--	Y-K CA: 60.2		
	'--	Bethel CA: 17.6		
Median Household Income (2008 to 2012; USCB 2012b)	Beluga: $66,090	KPB: $70,728	$69,917	--
	McGrath: $66,111			
	Stony River: $5,667	MSB: $59,421		
	Crooked Creek:$10,391			
Unemployment (percent) (2008 to 2012; USCB 2012B)	Nikolai: 24.2%	KPB: 5.6%	5.8%	--
	Crooked Creek: 20.0%	MSB: 6.8%		
	Sleetmute: 11.8%			
High School Dropout Percentages Regional and National: (2009-2010 school year; NCES 2014)	Beluga: 25%	KPB: 4.58%	6.9%	7%
	Tyonek: 25%			
	Susitna: 9.2%			
	Sleetmute: 28.57%			
	Nikolai: 0%	MSB: 5.19%		
	McGrath: 0%			
	Takotna: 0%			
	Stony River: 0%			

Table 3.22-11: Social Determinants of Health

Social Determinants of Health **(period; sources)**	**Community**	**Regional**	**Alaska**	**National**
Higher Education Community and Regional: (ADOL&WD, ACS 2009) Alaska: (2009; ACS 2009, as cited in Newfields 2016)	Beluga: 100% Susitna: 72.7%	KPB: 20.7% MSB: 19.9%	26.6%	--

Notes:
AN = Alaska Native
CA = census area
KPB = Kenai Peninsula Borough
MSB = Mat-Su Borough
-- = Not Available and/or Not Used
yrs = years
Sources are as listed or as cited by Newfields 2015 and 2016 (see Section 3.22.3.6.1)

3.22.3.6.2 HEC 2: ACCIDENTS AND INJURIES

Fatal Injuries. Age-adjusted rate per 100,000 population accidental death rates from 2010 to 2012 for KPB (49.5), MSB (57.3), Y-K Census Area (176.0), and Bethel Census Area (82.1) were all higher than the state (49.2). Motor vehicle accidents and poisoning (includes alcohol poisoning) were noteworthy causes, but low regional population and low counts increased uncertainty (BVS 2014, as cited in Newfields 2015, 2016). Accidents and injuries are shown in Table 3.22-12.

Non-fatal Injuries. Available data for 2010 indicate crude rates of non-fatal accidents per 10,000 population of Alaska Natives, to be lower in KPB and MSB (102.8, collectively), and Yukon-Koyukuk Census Area (99.7) to be lower than Alaska Native rates statewide (108.1) (Alaska Trauma Registry 2010, as cited in Newfields 2015, 2016).

Dry/Wet/Damp Community. Nikolai is a "dry" community and Red Devil is a "damp" community; the others allow sale and possession (AST 2012, as cited in Newfields 2015, 2016).

Table 3.22-12: Accidents and Injuries

Accident Rates (per 10,000 population) (period; sources)	**Regional**	**Alaska**	**National**
Death Rate from Accidents (2010 to 2012; BVS 2014)	KPB: 49.5 MSB: 57.3 Y-K CA: 176.0 Bethel CA: 82.1	49.2	42.7
Non-Fatal Accidents (2010; Alaska Trauma Registry 2010)	KPB & MSB: 102.8 (AN) Y-K Census Area: 99.7 (AN	108.1 (AN)	--

Notes:
AN = Alaska Native
KPB = Kenai Peninsula Borough
MSB = Mat-Su Borough
- = Not Available
Sources are as listed or as cited by Newfields 2015 and 2016 (see Section 3.22.3.6.2)

3.22.3.6.3 HEC 3: EXPOSURE TO POTENTIALLY HAZARDOUS MATERIALS

Existing Contaminated Sites. Within Tyonek, there are 18 open contaminated sites (mostly by oil and gas industries). At Skwentna there are four sites, and at McGrath there are 22, plus two large landfills, and an old sewer system (Newfields 2015, 2016).

3.22.3.6.4 HEC4: FOOD, NUTRITION, AND SUBSISTENCE ACTIVITY

It should be noted that subsistence activity is vital in the region, especially for the small rural communities, which is not represented in household income data and related food supply information. Refer to Section 3.21, Subsistence, for subsistence activity.

3.22.3.6.5 HEC 5: INFECTIOUS DISEASES

Infectious Diseases. The low counts make rates for infectious and parasitic disease caused deaths uncertain. For the period of 2010 to 2012, the KPB the age-adjusted rate per 100,000 population was 16.3 with the leading cause being septicemia (8.7) followed by viral hepatitis (2.7). For the MSB the rate was 10.7 with the leading cause being viral hepatitis (3.1) followed by septicemia (2.3). For pneumonia caused deaths, the rates for KPB and MSB were 10.4 and 10.1, respectively), compared to the state rate of 11.5 (BVS 2014, as cited in Newfields 2015, 2016 and the national rate of 15.9 (CDC 2017a).

In 2010, the *chlamydia trachomatis* rates (per 100,000 population) for all Alaskans in the KPB were 281, and in the MSB were 317, as compared to the state and US rates of 711 and 83 cases, respectively (BVS 2014, as cited in Newfields 2015, 2016). Infectious diseases are shown in Table 3.22-13.

Table 3.22-13: Infectious Diseases

Health Outcome Rate per 100,000 (period; sources)	**Kenai Peninsula Borough**	**Mat-Su Borough**	**Alaska**	**National**
Pneumonia Caused Deaths (2010 to 2012; BVS 2014, CDC 2017a)	10.4	10.1	11.5	15.9
Chlamydia trachomatis (2010; BVS 2014)	281	317	711	83

Notes:
Sources are as listed or as cited by Newfields 2015 and 2016 (see Section 3.22.3.6.5)

3.22.3.6.6 HEC 6: WATER AND SANITATION

There are many part-time occupied houses (recreational and seasonal purposes) within the potentially affected communities. Some communities have less than 10 percent of all housing structures occupied full-time (i.e., Susitna, Skwentna). Most have individual wells, either outhouses or septic sewage systems, and either burn refuge or use local landfills; only McGrath has formal garbage service. Tyonek and McGrath have the most full-time occupied homes and facilities with 70 and 147, respectively; and most are fully plumbed with sewer service. Nikolai and Sleetmute have almost 40 full-time households. Beluga, Susitna, Skwentna, Takotna, and

Stony River have about 20 full-time households or less with mixed well or surface water sources and mixed outhouse or septic systems (Newfields 2015, 2016).

3.22.3.6.7 HEC 7: NON-COMMUNICABLE AND CHRONIC DISEASES

During the period of 2005 to 2007, Anchorage and Mat-Su percentage of adults who smoked was 37 percent and the KPB was 42 percent (EpiCenter 2009 as cited in Newfields 2016). Substance abuse data are not readily available specifically for the KPB and MSB. Discussion on smoking and substance abuse data for Alaska Natives are presented in Section 3.22.3.4.7, Human Health.

Cancer. Cancer was the leading cause of death in 2012 for all regions, with the KPB rate per 100,000 population of 143.5 slightly lower, and the MSB rate of 177.5 per 100,000 population slightly higher than the state rate of 163.3 per 100,000 population (age-adjusted). The national rate per 100,000 population was higher than the state rate at 185.6 (CDC 2017a). The leading prevalent cancer types for the period of 2010 to 2012 were lung, breast, and then prostate. The KPB (lung [49.6], breast [24.7], and prostate [24.4]) and MSB (lung [54.8], breast [21.0], and prostate [23.0]) rates for these three cancer types were similar to the state (lung [49], breast [19.9], and prostate [20.2]) (BVS 2014, as cited in Newfields 2015, 2016).

Heart Disease. From 2007 to 2009, heart disease ranked as the second most prevalent cause of death statewide (age adjusted rate per 100,000 population of 155.9) as well as for the KPB (228.5) and the MSB (149.6) (ADHSS undated, as cited in Newfields 2015, 2016). The national rate per 100,000 population was 192.7 (CDC 2017a).

Diabetes. In 2009, the diabetes-related death rates per 100,000 population were similar between the KPB (65.3), MSB (73.7), and the state (62.8) with KPB having slightly fewer deaths; the national rate per 100,000 population was lower at 24 (CDC 2017a). Historically, the prevalence of diabetes has been growing through all regions within the state; and from 1990 to 2006; the Alaska Native rate increased 114 percent (ADHSS undated, as cited in Newfields 2015, 2016).

Chronic Lower Respiratory Disease. The KPB had 16 and the MSB had 22 deaths from chronic lower respiratory disease in 2012 which results in an age-adjusted rate per 100,000 population similar to the state (25.4 and 54.6, respectively). In comparison, the COPD rate for the state was 40.1 in 2012 (BVS 2014, as cited in Newfields 2015, 2016) and 46.1 in the nation (CDC 2017a).

Cerebrovascular Diseases. In 2012, both KPB (32.1) and MSB (33.6) had lower rates per 100,000 population of stroke caused deaths than the state rate per 100,000 population of 40.6 or the national rate per 100,000 population of 41.7 (CDC 2017a). It should be noted that the rate per 100,000 population for KPB was based on a low count of 15 deaths (ADHSS undated, as cited in Newfields 2015, 2016).

Chronic Liver Disease and Cirrhosis. In 2012, the KPB had higher lower chronic liver disease and cirrhosis death rate per 100,000 population of 14.8 as compared to the state rate per 100,000 population of 12.4 and the national rate per 100,000 population of 12 (CDC 2017a), while the MSB had equivalent lower rate per 100,000 population of 8.1 (BVS 2014, as cited in Newfields 2015, 2016).

Mental Health Disorders. Based on self-surveyed reporting from 2008 to 2010, the KPB and MSB both recorded equivalent days of poor mental health compared to state (approximately 3 days per month) averages. The KPB (3.3 days) showed a slightly higher rate of frequent mental

distress than both the MSB Borough (3.0 days) and the state (2.8 days) (BRFSS 2011, as cited in Newfields 2015, 2016). These were all lower than the national rate of 3.7 days (CDC 2017a).

Physical Activity. Based on self-surveyed reporting from 2008 to 2010, the KPB (76.7 percent) and MSB (64.2 percent) reported similar percentages of physical activity as the state (79.0 percent) (BRFSS 2011, as cited in Newfields 2015, 2016). A 2009 study showed similar findings across the region and a general observation that Alaska Natives showed a greater percentage of those meeting physical activity recommendations than the U.S. percentage (49 percent) (AN EpiCenter 2009, as cited in Newfields 2015, 2016).

Obesity and Overweight. In 2010, the KPB (30 percent) and MSB (28 percent) were reported as having an equivalent percent of obesity as the state and the nation (both 28 percent) (University of Wisconsin 2011, as cited in Newfields 2015, 2016). Non-communicable and chronic diseases are shown in Table 3.22-14.

3.22.3.6.8 HEC 8: HEALTH SERVICES INFRASTRUCTURE AND CAPACITY

The Fairbanks Memorial Hospital (110 workers) serves 35 villages of the interior including Nikolai, McGrath, and Takotna. Services include pharmaceutical, patient education, medical records, nutrition services, and social outreach services. The McGrath Health Center is a sub-regional Emergency Care Center clinic and supports the 50 Community Health Aides and Practitioners in the area. Central Kenai Peninsula Hospital and the Dena'ina Health Clinic serve the KPB. There is a lack of medical services for Beluga, Susitna, Skwentna, and Red Devil (Newfields 2015, 2016).

The KPB and MSB are designated as MUA with the KPB with a HPSA rating of 15 and the MSB with a HPSA rating of 14. Figure 3.22-3 displays health professional shortage areas by discipline in Alaska (HRSA 2015).

3.22.3.7 CLIMATE CHANGE

Climate change effects on the atmosphere, water resources, permafrost, vegetation, wildlife, and subsistence may have ramifications for several health determinants in the EIS Analysis Area. Section 3.26 discusses the potential effects of climate change. The most likely impacts on human health would be associated with changes in biological resources and subsistence activities (Section 3.26). Climate change has likely contributed to recent declines in moose in GMU 19A and Chinook salmon populations in the Kuskokwim River, as discussed in Section 3.21.5.12. These declines threaten food security and nutrition, particularly in rural communities where subsistence harvests are important to the local food supply. Different hydrology patterns may affect drinking water quantity or quality, and different vegetative communities and bloom timing could increase allergens. Combined with warmer winters and less snow cover, large-scale stream flow changes may impact barge schedules as well as other resources within the Project Area. Predicted increases in average precipitation may also cause changes in stream flow (Section 3.26). Fire smoke pollution from more intense summer wildfires could also lower air quality seasonally. Permafrost stability or anticipated changes to existing permafrost conditions may influence design and construction considerations for the Donlin Gold Project associated with settlement and ground stability issues (Section 3.26). Indirectly, erosion or ground subsidence induced by permafrost melt may damage community sanitation facilities, which could spread infectious diseases or have other adverse health impacts. Stress caused by

worries and adaptations for climate change may also indirectly have an adverse impact on the incidence of non-communicable and chronic health conditions and psychosocial stress.

Table 3.22-14: Non-Communicable and Chronic Diseases

Health and Disease Factors (period; sources)	Regional	Alaska	National
Cancer Rates (per 100,000 population)			
All Types Cancer Death (2012; CDC 2017a)	KPB: 143.5 MSB: 177.5	163.3	185.6
Lung Cancer Prevalence (2010 to 2012; BVS 2014)	KPB: 49.6 MSB: 54.8	49	59.4
Breast Cancer Prevalence (2010 to 2012; BVS 2014)	KPB: 24.7 MSB: 21.0	19.9	123.7
Prostate Cancer Prevalence (2010 to 2012; BVS 2014)	KPB: 24.4 MSB: 23.0	20.2	101.6
Non-cancer Disease Rates (per 100,000 population unless noted otherwise)			
Heart Disease (2007 to 2009, ADHSS, CDC 2017a)	KPB: 228.5 MSB: 149.6	155.9	192.7
Diabetes Deaths (2009; ADHSS, CDC 2017a)	KPB: 65.3 MSB: 73.7	62.8	24
Diabetes Prevalence Increase by Percentage (1990 to 2006; ADHSS)	Anchorage Area: 76% (AN)	114% (AN)	86%
Chronic Lower Respiratory Disease Deaths (2012; BVS 2014, CDC 2017a)	KPB: 25.4 MSB: 54.6	40.1	46.1
Cerebrovascular Disease Deaths (2012; ADHSS, CDC 2017a)	KPB: 32.1 MSB: 33.6	40.6	41.7
Chronic Liver Disease and Cirrhosis Deaths (2012; BVS 2014, CDC 2017a)	KPB: 14.8 MSB: 8.1	12.4	12
Health Factors			
Mental Health Disorders (reported days per month) (2008 to 2010; BRFSS 2011)	KPB: 3.3 MSB: 3.0	2.8	3.7 days
Physical Activity (percent of residents) (2008 to 2010; BRFSS 2011)	KPB: 76.7% MSB: 64.2%	79.0%	49.0%
Obesity (percent of residents) (2010; University of Wisconsin 2011	KPB: 30% MSB: 28%	28%	28%

Notes:
KPB = Kenai Peninsula Borough
MSB = Mat-Su Borough
Sources are as listed or as cited by Newfields 2015 and 2016 (see Section 3.22.3.6.7)

Health categories, including food safety, air quality, and community water, are categories monitored in the ANTHC Local Environmental Observer Network. In 2014, observations were recorded for early willow budding in Bethel and transportation safety concerns related to thin ice on the Kuskokwim River. Accidents and injuries could result from potential increased dangers of winter travel over frozen waterways.

3.22.3.8 SUMMARY

The potentially affected communities of the EIS Analysis Area range in size from villages as small as 20 homes to relatively large population centers such as Bethel and the MSB. The ethnic composition and demography of the EIS Analysis Area also varies, ranging from majority Alaska Native to majority white populations. Given the broad population in the EIS Analysis Area, the baseline health status also varies across the different geographies and ranges from worse than the state average to equivalent with the state average. While the communities potentially affected by the Mine Site of the Y-K region and Bethel Census Area typically fare worse than the state average in many aspects of physical, mental, and social health, there are also important health strengths. There are high rates of childhood immunizations in the YKHC service area, no clear signs of nutritional deficiencies in the Bethel Census Area, and residents report leisure time participation in physical activities. Rates of low birth weight infants, alcohol use by pregnant mothers, and divorce rates were lower than state averages. Dutch Harbor has lower rates of unemployment than the state average. While much of the region is classified as medically underserved or has a shortage of health care professionals, the larger communities, such as Bethel, the MSB, and the KPB, are serviced by a more extensive network of healthcare facilities.

3.22.4 ENVIRONMENTAL CONSEQUENCES

The potential consequences to human health were evaluated using criteria outlined in Alaska's HIA guidance (ADHSS 2011, 2015). While different from the terminology in other sections, the analysis and impact ratings for human health are consistent with the principles of analysis required by NEPA. The first step is to determine the impact score, which takes into consideration four impact dimensions: severity of potential health effects (which can be positive or negative and considers the need for intervention, if the impact is negative), magnitude, duration, and extent of the impact (Table 3.22-15). Each component of the impact dimension is assigned a score of 0, 1, 2, or 3 to derive the overall impact rating score.

The next step is to evaluate the severity and likelihood of each type of impact and develop an overall significance impact rating category of 1, 2, 3, or 4. Recommended actions for negative impacts are listed by category below:

> Category 1: Actions to reduce negative impacts are not needed.
>
> Category 2: Recommend that decision-makers assess whether actions to reduce negative impacts would be helpful for negative impacts.
>
> Category 3: Recommend that decision-makers develop and implement actions to reduce negative impacts.
>
> Category 4: Strongly recommend that decision-makers develop and implement actions to reduce negative impacts.

While the framework used for the evaluation of health impacts is generally consistent with ADHSS guidance, it is important to note that any assessment of potential impacts is subject to several types of uncertainty as summarized below. The data are considered sufficient for analysis in the Donlin Gold Project EIS.

- Baseline data used to describe current health status and conditions varies along the spatial and temporal scales; the reported data may range from current to several years since data were collected; some data are available at the level of individual communities while others are regional or state-level in scale. Therefore, not all health conditions are described or evaluated at the same level of precision and timeliness. This uncertainty is described for each type of cited data.
- While the presentation of baseline health conditions may be based on data of varying levels of completeness and quality, the evaluation of health impacts is generally more qualitative. The evaluation of social determinants of health is particularly subject to uncertainty since many of the choices that affect social and mental health and behavioral risk factors are actually made at the level of the individual. Two individuals exposed to the same situation may make very different behavioral choices. Thus, there is uncertainty in trying to predict the aggregate of individual choices at a community level in terms of overall severity, likelihood and impact rating. The evaluation uses published literature, where feasible, to provide context for this type of uncertainty.
- Health consequences related to changes in environmental conditions, e.g., air quality, water quality, bioaccumulation in foods, are subject to modeling uncertainties. While the concentrations of chemicals under baseline conditions may be known, future concentrations (e.g., as related to end-of-mine life and Closure) are estimated by using intentionally conservative modeling approaches. This approach (as presented in Appendix AB and the HHRA (ERM 2017) is likely to overestimate the consequences of potential exposure to hazardous substances and generally follows accepted regulatory approaches to evaluate chemical exposures at existing contaminated sites with known exposure concentrations (e.g., Comprehensive Environmental Response, Compensation and Liability Act [CERCLA]), with modifications to be more in line with the NEPA framework (see Section AB.1-2 in Appendix AB for further details). Given that the general approach used in the FRA is applied to assessing potential contaminants for a proposed project and future estimated concentrations that are based on conservative modeling (i.e., assumptions that would overestimate the potential for impacts), the conservatism of this approach should be considered in the interpretation of the findings. Although NEPA case law and current Council on Environmental Quality (CEQ) regulations do not require the use of a worst-case scenario in considering environmental impacts, a conservative approach was considered useful to approximate the potential health consequences related to potential change in exposures to environmental conditions due to the Donlin Gold Project.
- Some potential health consequences, by their very nature, are complex, and not easily quantifiable. For example, effects related to communicable and non-communicable diseases typically cannot be quantified since their prevalence depends on numerous environmental, behavioral, and genetic factors. The potential for these indirect health effects to occur is included in the assessment based on reports of their occurrence at

other projects and sites, but the severity and likelihood of their occurrence in relation to the project cannot be precisely estimated.

- Where quantifiable evaluations are not possible, qualitative evaluations strive for transparency in professional judgement. To this end, the components of the severity ranking system and the likelihood ranking system follow the gradations described in the ADHSS guidance, and the final impact ratings are based on a combination of severity and likelihood considerations. This allows the reader to clearly understand the basis of the ratings for project-related health consequences.
- A particular source of uncertainty is the rating system for "likelihood" of impacts that is employed by the ADHSS guidance (Figure 8.2, ADHSS 2015). A range of likelihoods, from extremely unlikely (<1 percent) to virtually certain (>99 percent), based on the "informed judgement of the rater" are recommended for the HIA practitioner to use in the second step of impact level evaluation. Uncertainties regarding the reliability of impact ratings and the methodology have been pointed out by several authors (Thomson 2008; Petticrew et al 2007). Uncertainty in estimating likelihood is easier to describe and quantify for certain types of health impacts such as exposure to potentially hazardous materials and more difficult for other kinds of impacts such as social determinants of health, or diseases (both infectious and non-communicable). For this health assessment, estimation of likelihood is based on a general understanding of baseline health status and trends, project description including proposed programs and measures to avoid or minimize health impacts, the detailed evaluation of certain types of impacts in other sections of the EIS (e.g., air quality, water quality, socio-economics, subsistence, transportation) and publicly available literature regarding these impacts on other, similar projects. The actual likelihood of the impacts may vary from the estimated level.

Table 3.22-15: Impact Dimensions

Step 1				
Impact Dimensions				
Impact Rating Score	**A – Health Effect (+/-)**	**B- Duration**	**C-Magnitude**	**D- Extent**
0	Effect is not perceptible	Less than 1 month	Minor	Individual cases
1	(+/-) minor benefits or risks to injury or illness patterns (no intervention needed)	Short-team: 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
2	(+/-) moderate benefits or risks to illness or injury patterns (intervention needed, if negative)	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	Entire Potentially Affected Communities; village level

Table 3.22-15: Impact Dimensions

Step 1				
Impact Dimensions				
Impact Rating Score	**A – Health Effect (+/-)**	**B- Duration**	**C-Magnitude**	**D- Extent**
			support, or 2.) experience beneficial impacts to health for specific population some maintenance may still be required	
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 Potentially Affected Communities; regional and state-wide levels

Source: ADHSS 2015.

Table 3.22-16: Likelihood Rating and Overall Impact Rating

Step 2	**Step 3**						
Impact Level (Use Score from Step 1 to choose range)	**Likelihood Rating**						
	Extremely Unlikely (<1%)	**Very Unlikely (1-10%)**	**Unlikely (10-33%)**	**About as likely as Not (33-66%)**	**Likely (66-90%)**	**Very Likely (90-99%)**	**Virtually Certain (>99%)**
1-3	♦	♦	♦	♦	♦♦	♦♦	♦♦
4-6	♦	♦	♦	♦♦	♦♦	♦♦	♦♦♦
7-9	♦♦	♦♦	♦♦	♦♦♦	♦♦♦	♦♦♦	♦♦♦♦
10-12	♦♦♦	♦♦♦	♦♦♦	♦♦♦♦	♦♦♦♦	♦♦♦♦	♦♦♦♦
Step 4	**Impact Rating**						
	Category 1 = ♦ Category 2 = ♦♦ Category 3 = ♦♦♦ Category 4 = ♦♦♦♦						

Source: ADHSS 2011, 2015.

The ADHSS (2015) defines health as "the reduction in mortality, morbidity and disability due to detectable disease or disorder and an increase in the perceived level of health." Since health is a multi-dimensional concept with physical, mental, and social aspects, the Donlin Gold Project may affect aspects of health at a localized or individual level, a community level, a regional level, or a state-wide level.

For each alternative, the consequences of the project activities are described with regard to relevant issues and concerns associated with the eight HECs described in the HIA guidance (ADHSS 2015). The consequences to human health are considered for all project phases (Construction, Operations, and Closure). While all components were considered (Mine Site, Transportation Corridor, and Pipeline), at times the Donlin Gold Project was analyzed as a whole because effects could not be attributed to a single component. Finally, the health consequences are summarized by HEC and for the alternative as a whole and expressed as

Category 1, 2, 3, or 4. ADHSS does not provide narrative descriptions for these numeric impact category rankings and only suggests that they be used to propose recommendations for actions.

As previously mentioned, the HIA developed under the leadership of ADHSS (Newfields 2015, 2016) was used as one of the primary resources for the Human Health section (Section 3.22) of the EIS.

3.22.4.1 ALTERNATIVE 1 – NO ACTION

For the health component, it is difficult to project the No Action health status 27 years into the future due to the many factors and variables that could impact the health of communities in the EIS area in the future; therefore, current (i.e., baseline) is assumed as a reasonable proxy to qualitative evaluate the future No Action alternative. As result, no quantitative discussion (i.e., rating) is presented for the No Action alternative. However, the probability of termination of existing healthcare funding, employment and income related to Donlin Gold's exploration activities during the recent past (as described in Section 3.18.2.1 - Socioeconomics) is considered.

Under the No Action Alternative, the Donlin Gold Project would not occur. Donlin Gold would not develop a Mine Site, Transportation Corridor, or Pipeline. Exploration activities would likely cease under Alternative 1, but there would not be a complete removal of infrastructure. The camp and airstrip are expected to remain in place. Socioeconomic impacts from Donlin Gold exploration activities, which were realized in the Y-K region over the previous decade, would cease. The direct benefits of employment and income related to the exploration activities are local in scale; the activities also contribute partially to the dividend that Calista Corporation provides to its 12,000 shareholders, including some funding for local healthcare services (Section 3.18.2.1). There may also be some changes in population size and subsistence activities. As noted in Section 3.21.6.1.3 and 3.21.6.2 (Subsistence), the loss of exploration-related income may contribute further to the ongoing trends of declining populations in the communities of the Upper and Central Kuskokwim River. The remaining populations may shift towards an age-structure that is more heavily weighted towards older adults and health issues that are associated with older age groups. Subsistence activities and subsistence-level nutrition may experience a slight increase under the No Action Scenario since those undeveloped areas would be available for hunting, fishing, and foraging uses.

Thus, human health impacts associated with the loss of jobs and decrease in household income would be expected to result in minor changes relative to baseline, with potential increases or decreases in social determinants of health, such as income, psychosocial stress, substance abuse, and family stability. Other health factors would be similar to current conditions (baseline), such as potential rates of accidents and injuries, communicable and non-communicable diseases, exposure to hazardous constituents, and access to healthcare services.

Overall, health impacts would be negligible to minor, primarily with effects that are not perceptible and requiring medical intervention. The duration would be assumed to be 27 years in the future (comparable to Mine Site duration). The magnitude would be limited, with those affected able to adapt and maintain baseline levels of health. Overall, the extent would be primarily local, with impacts limited to households affected by exploration employment.

Therefore, Alternative 1 would have minor direct or indirect effects, largely similar to baseline levels of health. There would be no contribution to cumulative effects on human health. Current health conditions and trends, as described in Affected Environment (Section 3.22.3, Human

Health), would continue in the EIS Analysis Area. Alternative 1 would have no effect on climate change as related to human health in the EIS Analysis Area. Existing trends in climate change, as described in Section 3.26, Climate Change, would continue.

3.22.4.2 ALTERNATIVE 2 – DONLIN GOLD'S PROPOSED ACTION

The communities potentially affected by the Donlin Gold Project range from small, remote, rural communities to larger regional and urban centers. The closest community is Crooked Creek, located approximately 10 miles southeast of the Mine Site. The communities within the Y-K region, including the Bethel Census Area and the Kusilvak Census Area, would be most closely affected by the Mine Site and the Pipeline components, with Bethel and the Kuskokwim River communities also experiencing effects from the Transportation Corridor component. Some regional centers, such as the KPB and MSB, would be primarily affected by the Pipeline component. Anchorage would be potentially affected by all components of the project (Tables 3.18-1 and 3.18-2, in Section 3.18, Socioeconomics).

The consequences (described below) for all project components are expected to be more noticeable in the smaller communities and Bethel, and less perceptible in the larger communities of, Unalaska, the MSB, and the Municipality of Anchorage.

Based on comments on the Draft EIS from agencies and the public, one route option has been included in Alternative 2 to address concerns due to pipeline crossings of the Iditarod National Historic Trail (INHT):

- **North Option:** The MP 84.8 to 112 North Option would realign this segment of the natural gas pipeline crossing to the north of the INHT before the Happy River crossing and remain on the north side of the Happy River Valley before rejoining the alignment near MP-112 where it enters the Three Mile Valley. The North Option alignment would be 26.5 miles in length, compared to the 27.2 mile length of the mainline Alternative 2 alignment it would replace, with one crossing of the INHT and only 0.1 mile that would be physically located in the INHT ROW. The average separation distance from the INHT would be 1 mile.

3.22.4.2.1 HEC 1: SOCIAL DETERMINANTS OF HEALTH

The following subsections present the evaluation of potential health impacts, both beneficial (positive) and adverse (negative), that are often correlated with social health determinants, including household incomes, employment and education attainment, psychosocial stress and mental health, substance abuse (including drugs, tobacco use, and alcohol), and family stress and instability. Table 3.22-17 summarizes the potential impact levels for the social determinants of health, including the health effect consequence, magnitude, duration, and geographic extent of the impact, and likelihood of the impact occurring.

Household Incomes, Employment, and Education Attainment

Increases in household incomes, employment rates, and education attainment would likely result in an improvement to the overall health and well-being of residents living in the communities from which the workforce for the Mine Site, Transportation Corridor, and Pipeline would be employed. As noted in Section 3.18.2.2, Socioeconomics, the project is expected to result in employment for about 1,600-1,900 people from among the local potentially affected

communities during the Construction Phase, about 500-600 people during the Operations Phase, and 20-100 people during Closure.

The benefits (positive impacts) of these employment opportunities would be felt most in the households of those employees, but the ancillary sales and taxes would benefit the communities as a whole. However, it cannot be assumed that all of the increased income and ancillary sales and taxes would be directed towards increased healthcare spending or community healthcare facilities development. Therefore, although the economic benefit to the region may be major, the associated health benefits are rated as Category 3. The benefits are also expected to be more apparent in the small, remote, Kuskokwim River communities, where even small changes in their economies could have a measurable impact on their overall health and well-being. Most of the Kuskokwim River communities' economies are based on subsistence and have limited opportunities for long-term, stable employment (Section 3.18, Socioeconomics). The potentially affected communities also have high minority (Alaska Natives) and low-income populations (Section 3.22.3.1, Human Health). It is estimated that about 14-18 percent of the residents living in the potentially affected communities do not have a high school diploma (Section 3.22.3.1, Human Health). Several studies have documented positive correlations between increased education and improved health outcomes; that is, persons with more years of education tend to have better health and well-being and healthier behaviors (Feinstein et al. 2006; VCU 2015 Zimmerman et al. 2015). The potential health benefits of increased economic opportunities due to the Donlin Gold Project could extend beyond the direct operating workforce because Alaska firms based in Anchorage would likely provide goods and services during the Construction and Operations phases of the Donlin Gold Project (Section 3.18, Socioeconomics). While there would be employees from outside the region, Donlin Gold is committed to local hire.

The summary impact to human health due to increased household incomes, employment rates, and education attainment for the potentially affected communities would be Category 3 (beneficial) for all three phases (i.e., Construction, Operations, and Closure). Section 3.18, Socioeconomics discusses the economic impacts of household incomes, employment rates, and education attainment.

For all project phases, the health effect is assigned a score of 1 (i.e., effect is perceptible), and the magnitude of effect is assigned a score of 2 (beneficial impacts to specific population) since the benefits may be noticeable in terms of increased access and utilization of healthcare (e.g., more visits to healthcare providers, increased use of treatment options). The geographic extent of this potential benefit is assigned a score of 2 because it would be realized by households and communities throughout the EIS Analysis Area that would benefit from project-related economic opportunities, which may range from 20 to 1,900 households (households associated with the expected employment opportunities) in the EIS Analysis Area, during the various project phases. These households are expected to be drawn from the potentially affected communities described in Section 3.22.3, Human Health, primarily the communities of the Bethel Census Area, YKHC Service Area, and the small communities along the Kuskokwim River. However, the health benefits may extend to a state-wide level, depending on the overall distribution of economic benefits due to mine activities. The duration of this benefit would correlate with the duration of the three project phases; therefore, the Construction Phase (3-4 years) is assigned a score of 2, and the Operations (27 years), and Closure (> 50 years) phases are assigned a score of 3. The likelihood of this benefit occurring is considered likely (66-90 percent) because Donlin Gold has established an in-region, Calista and TKC shareholder hiring preference and has committed to maintaining this hiring preference through the project phases.

Psychosocial Stress

As defined by ADHSS (2015), the term psychosocial refers "to social situations that produce psychological distress or psychological relief." Adverse health behaviors may be adopted by persons to cope with psychological stress, and likewise beneficial health behaviors may be fostered during times of perceived optimism and hopefulness (e.g., change in economic and education status; increased food security, improved infrastructure, and access to healthcare services). Poverty, lack of employment, rural and urban isolation, cultural change, family instability, and outward and inward migration are some of the social factors that may impact psychological stress. An example would be a community's fear that a proposed project would likely impact their natural resources. Increased stress could also occur due to increased exposure to physical stressors such as noise, vibration, and light.

Noise related to airplane and road traffic could be increased near the Mine Site, particularly during the Construction and Operations phases. Similarly, vibration and light could be increased during the Construction Phase of the Mine Site. The nearest sensitive receptor to the Mine Site is Crooked Creek (14.83 miles away from the airstrip), with a corresponding existing ambient noise level of 39 dBA Day Night Sound Level (L_{DN}) (adapted from Table 3.9-2 for Rural Residential) and LEQ estimated at 33 dBA (Section 3.9.4.3.2, Noise). The existing ambient noise level at the airstrip is estimated at 35 dBA LDN (adapted from Table 3.9-2 for Wilderness Ambient; also see Table 3.9-7) and Equivalent Sound Level (L_{eq}) estimated at 29 dBA. For the aircraft flights, considering the size of the airstrip, it is assumed that only one aircraft would be taking off or landing at the runway at any one time (Section 3.9.4.3.2, Noise). The noise from the airstrip is expected to result in an increase of 3-4 dBA L_{DN} above ambient levels of 40 dBa L_{DN} for the closest receptors who would be located at Crooked Creek, about 15 miles away from the airstrip (Table 3.9-27, Noise). Overall, noise impacts are expected to be intermittent, slightly detectable and comparable to natural sounds.

Some potential health outcomes due to psychosocial stress may include substance abuse, depression, and suicide. It is important to note this type of multi-dimensional behavioral and social impact is not readily predictable or quantifiable.

There may be both decreases and increases in psychosocial stress, with different potential causes and effects in different segments of the community. The potential for decreases in psychosocial stress could occur due to improved economic opportunities. The available baseline data suggest rates of poor mental health for the potentially affected communities are low (ADHSS 2009, as cited in Newfields 2015, 2016). However, the prevalence of poor mental health may be more common than indicated, based on the high suicide rates for the Bethel Census Area and Yukon-Koyukuk Census Area (Section 3.22.3.6.1, Human Health). The potential impacts of existing psychosocial stressors in the potentially affected communities such as high unemployment, low income, low education attainment, outward population migration, and rural isolation could be lessened by the perceived potential for increased economic opportunities. The improved economic status of residents in the potentially affected communities could result in improved mental health, but the positive effects may not be immediately discernable and possibly may be difficult to quantify.

There is also the potential for increases in psychosocial stress in the potentially affected communities, related to fear of changes in lifestyle and cultural practices, land encroachment, impact to natural resources (e.g., soil, air, groundwater, and surface water), and food security and quality. The addition of new stressors to the populations in the EIS Analysis Area could

potentially worsen existing mental health conditions, primarily for those individuals that are susceptible and who are not benefiting from increased economic security related to the Donlin Gold Project or accessory economic development. Community members in attendance at Donlin Gold Project public meetings had concern for potential impacts on mental health (Newfields 2015, 2016).

As noted in Section 3.22.3.4.8, the affected communities' area currently includes shortages of mental health professionals as a contributing factor to its MUA and MPSA designations. Any substantial increases in mental health disorders would further strain an already underserved system. While it is difficult to predict changes in the direction and magnitude of psychosocial stresses, it is considered that both positive benefits and negative impacts may occur in the area of psychosocial stress, family stress and family instability and that both types of changes are relatively unlikely since they are influenced by complex, multi-dimensional contributing factors.

The summary impact to human health due to changes in psychosocial stress for the potentially affected communities is rated as Category 1 (beneficial and adverse) for all three phases (i.e., Construction, Operations, and Closure). The health effect is assigned a score of 1, with beneficial and adverse effects. No intervention would be required for beneficial effects, and adverse effects could be considered minor injury that may not require intervention. The magnitude of the impact is assigned a score of 1 (those impacted would be able to adapt easily). The geographic extent of this potential benefit would be scored 1 with effects realized by households within the communities throughout the EIS Analysis Area, primarily those reaping economic benefits and security.

The duration of impacts (adverse and beneficial) is a assigned a score of 2 for the Construction Phase (3-4 years) and 3 for the Operations (27 years) and Closure (> 50 years) phases. The likelihood of effects is considered unlikely (10-33 percent) during the Construction and Operations phases, but very unlikely (1-10 percent) during Closure. Because the same household and/or individual may be impacted by both positive and negative factors resulting from the Donlin Gold Project, it is uncertain how the impact may be experienced in different populations and, as a result, makes it difficult to predict potential likelihoods for the project phases. The Construction and Operations phases are assigned a slightly higher likelihood than the Closure Phase because it would be expected that individuals in the potentially affect communities would be more reactive (positive or negative) to the initial phases of the project. For example, it is uncertain whether increased and/or stable incomes would promote positive behaviors in a substantial portion of the populations in the EIS Analysis Area; likewise, it is possible that stakeholders in the region would not display anxiety or stress due to the project. The Construction and Operation phases are assigned a slightly higher likelihood than the Closure Phase because it would be expected that individuals in the potentially affect communities would be more reactive (positive or negative) to the initial phases of the project.

Rates of Substance Abuse

As with psychosocial stress, there may be both decreases and increases in rates of substance abuse, with different potential causes and effects in different segments of the community. Increases in substance abuse (drug, tobacco, and alcohol consumption) rates could result in negative health impacts such as alcohol poisoning, alcohol-related accidents and injuries, and drug and tobacco addiction. Baseline data suggest high rates of substance abuse (especially

binge drinking amongst males), alcohol poisoning, and alcohol related-accidents and injuries (University of Wisconsin 2011, as cited in Newfields 2015, 2016). Data from periods 2005 to 2007 and 2008 to 2010 show relatively high smokeless tobacco use in the Bethel Census Area, with rates being five times higher than state rates, and Alaska Natives in the YKHC three times higher than Alaska Natives statewide (AN EpiCenter 2007; ADHSS 2009, both as cited in Newfields 2016). From 2004 to 2008, alcohol use was documented in 34.8 percent of all non-fatal injury cases in the Y-K region (Newfields 2015, 2016).

Alcohol abuse is also associated with the other leading causes of death (e.g., motor vehicle accidents, suicide, assault, and drowning) (Newfields 2015, 2016). In other places where a number of people have been employed at past and present mine sites, the increase in disposable income led to noticeable increases in drug and alcohol use and gambling in the local communities in other regions (Diavik 1999; UBC 2014). Community members brought concerns to Donlin Gold Project stakeholder meetings for potential increases in alcoholism with increased income and many anecdotal and personal concerns were expressed by numerous stakeholders during the scoping meetings. The ADHSS/HIA Chuathbaluk Tribal Council mentioned that this trend has been observed with other increases in income like the Permanent Fund Dividend (PFD) or 1-2 week jobs that fund an alcohol binge (Newfields 2015, 2016). There were also community member concerns for drug use, particularly marijuana, and potential population influxes could influence problems related to drug and alcohol use (Newfields 2015, 2016). In addition to employee training programs, Donlin Gold is a drug- and alcohol-free workplace, and there is a zero tolerance policy for drug and alcohol use at any project site. Drug tests are administered prior to employment, randomly, post-accident/incident and upon reasonable suspicion. These policies are intended to discourage substance abuse by employees and typically raise awareness of substance abuse issues in local communities (including employee families and friends) outside of the project boundaries

Potential decreases in rates of substance abuse could also occur, due to the increase in jobs available in the region. Some village and regional leaders have asserted the new jobs and increased income would likely increase family stability and decrease rates of substance abuse. Proportions of adverse and beneficial effects cannot be predicted, as the causes and effects would vary among different portions of the population.

> *I think it [employment] could be positive or negative. Certainly, if you have more money in your home and you are using it wisely you are in way better shape and a lot of those bad effects don't necessarily happen. As Evelyn Thomas up in Crooked Creek always pushes, when they had money a lot of the problems went away. Certainly a lot of problems can suddenly occur when you have money too. I don't know. That is one that would have to be carefully measured. I don't know which way it will go. But certainly improving the economic conditions out here would have to be a major benefit. The one that I hadn't anticipated which has been mentioned is that because the men were gone for long periods of time, they claim that divorce rates went way up. That might not be measurable because I have a feeling, that doesn't necessarily mean divorce. I think that also means there is a lot of people who aren't married out here but have a stable relationship. I have a feeling there are just a lot of men who moved on elsewhere. That is really bad for those left behind. On the behavioral health side that is a real problem.* (Joseph Klejka, M.D., Medical Director YKHC, Bethel, AECOM Forthcoming).

The health effect, both beneficial and adverse, is assigned a score of 2 (moderate benefits or injury that may require intervention) and the magnitude of the impact is assigned a score of 1

(those impacted would be able to adapt and maintain pre-impact level of health). The geographic extent of this potential impact is assigned a score of 1 because a limited number of households would be affected (i.e., not every individual or every household within the affected area communities would be expected to exhibit the behavior). The duration of this impact is assigned a score of 2 for the Construction Phase (3-4 years) and 3 for the Operations (27 years) and Closure (> 50 years) phases. The likelihood of this impact occurring is considered unlikely (10-33 percent) for all phases. Although some stakeholders have indicated a trend in the communities of increase in alcohol binge drinking with increases in household incomes, it would be expected that negative behaviors would be strongly deterred with the implementation of Donlin Gold's drug- and alcohol-free workplace policy and drug and alcohol testing programs. The summary impact to human health due to increased substance abuse rates is rated as Category 2 (beneficial and adverse) for all project phases.

Family Stress and Instability

As with psychosocial stress and rates of substance abuse, there may be both decreases and increases in family stress and instability, with different potential causes and effects in different segments of the community. Increases in family stress and instability could occur due to fly-in, fly-out work rotations. Community interviews for other mine projects suggest that long-term fly-in, fly-out work rotations can contribute to stress and instability in families. Rotational work schedules can also affect relationships, and may increase feelings of fatigue, anxiety, worry, and jealousy, contributing to domestic violence, extra-marital affairs, and unwanted sexual harassment particularly of women (UBC 2014; Diavik 1999). Women reported an increase in spousal assaults as a result of mine employment and long-distance commuting, as well as noticeable strains on marriages and relationships (Diavik 1999). Some women reported excessive drinking and anger in some spouses when they returned from their mine rotation (UBC 2014). The rotation schedules and long absences also led to more disruptive behavior in children and reported difficulties in managing older children when the a parent was away (Diavik 1999). In several communities, additional stress was noted for extended family members (such as grandparents) who provided child care while a parent was away working at the mines (UBC 2014; Diavik 1999). Community members attending scoping meetings for the Donlin Gold Project indicated concerns for potential increases in marital problems, divorce, and family disruption because of long stays at the work camp and isolation with a rotational work schedule (Newfields 2015, 2016).

Potential increases in family stability could also occur, due to the increase in jobs available in the region. As noted in the discussion of rates of substance abuse, village and regional leaders have asserted the new jobs and increased income could improve family stability. Proportions of adverse and beneficial effects cannot be predicted, as the causes and effects would vary among different portions of the population.

The health effect is assigned a score of 2 (moderate benefit or injury that may require intervention since) and the magnitude of the impact is assigned a score of 1 (those impacted would be able to adapt and maintain pre-impact level of health). The geographic extent of this potential impact is assigned a score of 1 (i.e., only a limited number of individuals within the affected communities would be likely to exhibit such behavior with corresponding effects on their households). The duration of this impact is assigned a score of 2 for the Construction Phase (3-4 years) and 3 for the Operations (27 years) and Closure (> 50 years) phases. The likelihood of effects occurring is considered unlikely (10-33 percent) during the Construction

and Operations phases, but very unlikely (1-10 percent) during the Closure Phase. Because the same household and/or individual may be impacted by both positive and negative factors related to the project; it is uncertain how the impact may be experienced by households or an individual and, as a result, makes it difficult to predict potential likelihoods for the project phases. The Construction and Operation phases are assigned a slightly higher likelihood than the Closure Phase because it would be expected that individuals in the potentially affect communities would be more reactive (positive or negative) to the initial phases of the project. The summary impact to human health due to increased family stress for the potentially affected communities is rated as Category 1 (beneficial and adverse) for all project phases.

Alternative 2, HEC 1 Impact Summary: Social Determinants of Health

For the social determinants of health, both beneficial and adverse (positive and negative) health impacts were evaluated within the framework of the HIA guidance that health means "the reduction in mortality, morbidity and disability due to detectable disease or disorder and an increase in the perceived level of health" (ADHSS 2015). As noted in Section 3.22.1 and in the range of conflicting concerns and comments expressed by stakeholders in the affected communities, it is quite likely that both beneficial and negative impacts could occur to the same individual, family or community, and could be partially attributed to Alternative 2. The exact likelihood of occurrence of such benefits or negative impacts is impossible to predict accurately and reliance is placed on studies done for similar situations and informed judgement.

There could be potential beneficial increases in economic opportunities, reductions in psychosocial stress, reductions in substance abuse, and improved family stability. Adverse health impacts could include potential increases in psychosocial stress, substance abuse rates, and family instability. The overall impact for HEC 1: Social Determinants of Health is rated Category 2, as shown in Table 3.22-17, with both beneficial and adverse impacts under Alternative 2, acknowledging a lower level of estimated impact associated with potential beneficial and address effects on psychosocial stress and family stability.

Table 3.22-17: Summary of HEC 1 Impacts: Social Determinants of Health

Potential Impact	Project Component	Project Phase	Negative/ Positive	Health Effect	Magnitude	Duration	Geographic Extent	Severity Ranking	Likelihood Rating	Impact Rating	Impact Category
Increase in household incomes, employment, and education attainment	All components: Mine Site, Transportation Corridor, Pipeline	Construction	+	1, minor	2, beneficial impacts to health for specific population	2, medium-term	2, limited to households that benefit from economic opportunities through the Y-K region	**7**	66-90%	***	**3**
		Operations		1, minor	2, beneficial impacts to health for specific population	3, long-term	2, limited to households that benefit from economic opportunities through the Y-K region	**8**	66-90%	***	**3**
		Closure		1, minor	2, beneficial impacts to health for specific population	3, long-term	1, limited to households that benefit from economic opportunities	**7**	66-90%	***	**3**
Psychosocial stress	All components: Mine Site, Transportation Corridor, Pipeline	Construction	+/-	1,minor	1, adaptable and able to maintain pre-impact levels of health	2, medium-term	1, limited number of households	**5**	10-33%	*	**1**
		Operations		1, minor	1 ,adaptable and able to maintain pre-impact levels of health	3, long-term	1, limited number of households	**6**	10-33%	*	**1**
		Closure		1, minor	1, adaptable and able to maintain pre-impact levels of health	3, long-term	1, limited number of households	**6**	1-10%	*	**1**
Substance abuse (including drug, tobacco, and alcohol)	All components: Mine Site, Transportation Corridor, Pipeline	Construction	+/-	2, moderate	1 ,adaptable and able to maintain pre-impact levels of health	2, medium-term	1, limited number of households	**6**	10-33%	**	**2**
		Operations		2, moderate	1, adaptable and able to maintain pre-impact levels of health	3, long-term	1, limited number of households	**7**	10-33%	**	**2**
		Closure		2, moderate	1, adaptable and able to maintain pre-impact levels of health	3, long-term	1, limited number of households	**7**	10-33%	**	**2**
Family stress and stability	All components: Mine Site, Transportation Corridor, Pipeline	Construction	+/-	1, minor	1, adaptable and able to maintain pre-impact levels of health	2, medium-term	1, limited number of households	**5**	10-33%	*	**1**
		Operations		1, minor	1, adaptable and able to maintain pre-impact levels of health	3, long-term	1, limited number of households	**6**	10-33%	*	**1**
		Closure		1, minor	1, adaptable and able to maintain pre-impact levels of health	3, long-term	1, limited number of households	**6**	1-10%	*	**1**

3.22.4.2.2 HEC 2: ACCIDENTS AND INJURIES

Accidents (e.g., motor vehicle crashes, falls, and fires) can result in unintentional injuries. Intentional injuries include homicide and suicide. Non-fatal and fatal intentional and unintentional injuries can place a substantial burden on available healthcare resources (such as hospitals, clinics, and ambulances). The following subsections present the evaluation of potential impacts due to increases in unintentional accidents (air, surface, and water transportation) and intentional injuries (poisonings and suicides). Table 3.22-18 summarizes the potential impact levels for accidents and injuries, including the potential health effect consequence, magnitude, duration, and geographic extent of the impact, and likelihood of the impact occurring.

It is important to note Donlin Gold would provide safety training (as required by the Occupational Health and Safety Act and Mining Safety and Health Act) for all employees, health and safety plans would be developed and implemented, and public access would be prohibited in industrial facilities (Donlin Gold 2016e):

> *As a matter of company policy and to comply with extensive laws and regulations related to worker health and safety, Donlin Gold will continue to implement a rigorous health and safety program to prevent accidents and injuries from occurring. The expectation of success is based on the fact that Donlin Gold has not had a lost-time incident for more than 10 years (over 2 million hours worked). All safety incidents and near misses are reported and assessed by management to avoid future occurrences. Not only will this approach minimize the risk of accidents and injuries associate with project activities, workers will continue to bring Donlin Gold's safety first culture back to their villages. We believe strongly this will encourage safe practices in residents' daily lives. Finally, Donlin Gold has undertaken long-term initiatives to promote health and safety throughout the Y-K region. For example, the river-wide distribution of life vests has been extraordinarily successful in changing attitudes towards boating safety. We intend to continue and expand on these initiatives as Mine construction and operations move forward."*

Therefore, it is assumed that the project workforce would adhere to Donlin Gold's safety procedures when travelling or operating in the public domain and promote the safety culture outside of standard work operations as well (i.e., "outside the fence"). The accidents and injuries discussed in this section are generally considered to be events with low probability of occurrence, but high consequence if they did occur.

Unintentional Accidents and Injuries Morbidity and Mortality Rates due to Air Transportation

Increases in accidents and injuries (mortality and morbidity rates) due to air transportation could occur because the primary mode of transportation for employees, time-sensitive supplies, and equipment for the project would be via air. Air transportation is also the primary mode of transporting mail and important goods, healthcare access, and residents' routine travel within the region. Although air travel accidents occur very rarely, they have a high consequence, resulting in loss of life or severe health injuries.

Mine Site employees would use a fly-in/fly-out work arrangement, with Donlin Gold organizing and paying for transportation between point of hire locations (such as Anchorage

and Bethel) and the various project work sites. Local air traffic would increase by 5,148 annual operations during the Construction Phase, but would be reduced for the Operations Phase (1,716 annual operations), and further reduced for the Closure Phase. Even though the project would result in an increase in air travel in the region, the Donlin Gold Mine Site airstrip would not be routinely used by the general public (except for emergencies) and, as such, would not directly impact air travel for residents living in the EIS Analysis Area. However, the increase in frequency of air travel due to the project, particularly for the Construction Phase, could affect the magnitude of travel for the workforce (e.g., fly-in/fly-out rotations) and the potential for air travel accidents, indirectly affecting residents living in the EIS Analysis Area.

The workforce for the Pipeline component would also be transported via air. Pipeline construction would require temporary airfields that would be reclaimed after the Construction Phase as well as use of existing public airports. Air traffic related to the Pipeline component would be greatest during Construction, with intermittent monitoring flights throughout Operations.

For all project phases, the health effect is assigned a score of 3 (severe) due to the potential for serious health injury and loss of life if an accident were to occur. The magnitude of the effect is assigned a score of 2 because those impacted would not be able to adapt to the health impact or maintain pre-impact levels of health. The geographic extent of this potential impact is assigned a score of 0 because impacts would be limited to individual cases, although the personnel affected may be from any of the affected communities in the EIS Analysis Area. The duration of this impact is assigned a score of 2 for the Construction Phase (3-4 years) and 3 for the Operations (27 years) and Closure (> 50 years) phases. The potential for accidents and injuries due to air transportation is very low because it is not a leading cause of accidents and injuries in the region; therefore, the likelihood of this impact occurring is considered extremely unlikely (<1 percent). The summary impact to human health due to air transportation is rated Category 2 for all phases.

Unintentional Accidents and Injuries Morbidity and Mortality Rates due to Surface Transportation

Increases in surface transportation accidents and injuries (mortality and morbidity rates) could occur during any of the project phases related to transportation of goods, materials, and supplies and due to workforce travel to and from the project work sites. Between 2010 and 2012, motor vehicle accidents were reported as the leading cause of unintentional injury fatality in the Bethel Census Area, with the majority occurring from snow machine travel (BVS 2014, as cited in Newfields 2015, 2016). The communities closest to the Mine Site are not connected by roads. Surface travel occurs via foot, all terrain-vehicles, and snow machines (Section 3.23.2.2.1, Transportation). The few existing primitive trails in the vicinity of the Mine Site would be closed throughout all project phases to limit public access for safety considerations.

The new access road between the Angyaruaq (Jungjuk) Port site and the Mine Site would be used seasonally to transport fuel and cargo. This road would be located in an area that is remote, and not pass near existing settlements or communities, nor would it connect with an existing road system. Public access would not be authorized during the operational life of the mine; traffic on this road would be limited to vehicles associated with the Donlin Gold Project (2,917 annual trips made by tractor-trailers). Due to the access control and lack of connection with existing roads, there would be no effect on existing surface transportation from Angyaruaq

(Jungjuk) Port site to the Mine Site. Travel related to the construction and operations of the transportation facilities in Bethel is expected to cause a slight increase in daily traffic in the community. In addition, if construction of additional fuel storage were to occur at Dutch Harbor, minimal traffic would be added to local roads. The additional traffic from trips by construction workers and suppliers to the two ports (i.e., Bethel and Dutch Harbor) would not noticeably alter local traffic patterns, and would be easily accommodated by the existing road network (Section 3.23.2.2.2, Transportation).

Public access to the pipeline ROW by way of surface transportation would be limited over the majority of the pipeline due to the remoteness of the route. Temporary access roads would be required during Construction, including a winter corridor (ice road) and gravel temporary and shoofly roads. All roads would be reclaimed after the construction of the pipeline. After construction of the pipeline, a site would be developed in the Beluga area to stage and store materials used for operations and maintenance. It is anticipated that there would be a slight increase in the use of this facility during the Operations Phase, which could be noticeable in the vicinity of Beluga. However, given the current low levels of use by local Beluga residents and other business operations, there would be minimal impact to surface transportation resources (Section 3.23.2.2.3, Transportation).

Similar to air transportation, the health effect is assigned a score of 3 (severe) due to the potential for serious health injury and loss of life if an accident were to occur. The magnitude and geographic extent of the effect are assigned a score of 0 due to the low levels of surface transportation, with low speeds of travel, and having limited nexus with public surface transportation systems. The duration of this impact is assigned a score of 2 for the Construction Phase (3-4 years) and 3 for the Operations (27 years) and Closure (> 50 years) phases. The likelihood of increases in surface transportation accidents and injuries in Bethel, Dutch Harbor, and Beluga is considered unlikely (10-33 percent), as public access would be restricted from the industrial sites. The summary impact to human health due to surface transportation is rated Category 2 for all phases.

Unintentional Accidents and Injuries, Morbidity and Mortality Rates due to Water Transportation

The project would include shipping cargo from marine terminals in Seattle and Vancouver via ocean barges up the Kuskokwim River to a cargo terminal in Bethel. At Bethel, cargo would be transferred from ocean barges to river barges for towing up the Kuskokwim River to the Angyaruaq (Jungjuk) Port. Cargo would then be transported by truck from the Angyaruaq (Jungjuk) Port to the Mine Site. Heavy barge traffic upriver of Bethel is not unprecedented. Between calendar years 2007 and 2011, an average of 405 commercial vessel trips per year was logged on the Kuskokwim River. Based on interviews with Kuskokwim River barge operators conducted in November and December of 2013, approximately 68 freight and fuel barge tows per year serve the villages upriver of Bethel (Ausdahl 2013; Clevenger 2013; Faulkner 2013; Jansen and Stauffer 2014; Leary 2013; Myers 2013). Any actions that would occur at Dutch Harbor or the Port of Bethel at the Bethel Yard Dock are not part of the proposed action, and are considered connected actions (see Section 1.2.1, Connected Actions, in Chapter 1, Project Introduction and Purpose and Need).

During the Construction Phase, it is estimated that about 89 barge round trips per year would be required to transport cargo and fuel from Bethel to the Angyaruaq (Jungjuk) Port; the

additional barge traffic during the Construction Phase would represent a modest increase in river traffic relative to baseline. During the Operations Phase, the project would require about 122 cargo and fuel barge tows round trip per season from Bethel to the Angyaruaq (Jungjuk) Port, which would represent a notable increase in river traffic along this segment. The elevated traffic during the Operations Phase could result in congestion, particularly along narrow channel segments. After closure of the mine, the Angyaruaq (Jungjuk) Port would be removed and reclaimed, with only a small barge landing remaining to support monitoring (Section 3.23.2.2, Transportation). It is expected that during the Closure Phase, water transportation would be substantially reduced possibly returning to near baseline levels.

During pipeline construction, pipe and other heavy construction materials would be shipped by ocean barge from Seattle and/or Vancouver to the Port of Anchorage for temporary storage and then to the Beluga barge landing. The Port of Anchorage and Beluga Port would experience a temporary and slight increase in water transport shipments. Other materials used for pipeline construction would be barged on the Kuskokwim River from Bethel to the Angyaruaq (Jungjuk) Port and Kuskokwim Landings, near Devil's Elbow at the point where the pipeline crosses the Kuskokwim River. At project closure, decommissioned pipeline materials (e.g., above-ground pipeline facilities) that can be salvaged or recycled would be transported to Anchorage by barge from the Beluga barge landing to the Port of Anchorage where they would be dismantled, salvaged, recycled, and disposed of as appropriate. The increase in barge traffic at the Beluga Port and Port of Anchorage as a result of these activities would be minimal relative to other port traffic (Section 3.23.2.2.3, Transportation).

The potential for accidents and injuries due to water transportation would be primarily associated with transportation on the Kuskokwim River because it is the principal water body in the region that supports local and commercial vessel traffic and commercial and subsistence fishing. Guided fishing trips are also provided commercially for non-local fishermen on some Kuskokwim River tributaries. In addition, hunting for moose, bear, caribou, marine mammals, and waterfowl, and gathering berries and firewood are often associated with travel by boat to access these resources. Many stakeholders have expressed concern about the potential for accidents and related spills due to increased project-related barge traffic. Barge strandings could occur, but are not likely to cause a human health risk; reported industrial accidents associated with barge traffic in the EIS Analysis Area are very low (Section 3.23.2.2.2, Transportation).

Similar to air and water transportation, the health effect is assigned a score of 3 (severe) due to the potential for serious health injury and loss of life. The magnitude of the effect is assigned a score of 2 because those affected may require medical intervention to maintain pre-impact level of health. The geographic extent of this potential impact is assigned a score of 0 because impacts would be limited to individual cases although the individuals may come from any of the communities in the EIS Analysis Area. The duration of this impact is assigned a score of 2 for the Construction Phase (3-4 years) and 3 for the Operations (27 years) and Closure (> 50 years) phases. The likelihood of a water transport accident occurring is considered very unlikely (1-10 percent). The summary impact to human health due to water transportation is rated Category 2 for all phases.

Intentional Injury: Suicide Rate

Increases in suicide rates could occur due to psychosocial stress and family instability from anxiety, fear, poor mental health, and depression. Similarly, decreases in suicide rates could also

occur due to feelings of optimism and hopefulness due to change in socio-economic status. Suicide is noted by the Alaska Trauma Registry (ATR) as the most common cause of fatal injuries in the Bethel Census Area (ADHSS undated; ATR 2011, both as cited in Newfields 2015, 2016). During 2004 to 2008, the most common cause of non-fatal injury requiring hospitalization for the Y-K region was attempted suicide (23 percent of all non-fatal injuries) (ATR 2011, as cited in Newfields 2015, 2016). Expectations regarding suicide rates should be treated with caution since the causes of suicide are complex and unpredictable and may be easily overestimated or underestimated.

For all project phases, the health effect would be very high due to the potential for serious health injury and loss of life. The magnitude of the effect is assigned a score of 2 because those affected would not maintain pre-impact level of health. The geographic extent of this potential impact is assigned a score of 0 because impacts would be limited to individual cases in the EIS Analysis Area. The duration of this impact is assigned a score of 2 for the Construction Phase (3-4 years) and 3 for the Operations (27 years) and Closure (>50 years) phases. The likelihood of this impact occurring is considered as very unlikely on a large scale (1-10 percent) because both beneficial and adverse effects could occur due to the project. The summary impact to human health due to increases in suicide rates would be Category 2 for all project phases.

Alternative 2, HEC 2 Impact Summary: Accidents and Injuries

For accidents and injuries, potential impacts due to unintentional accidents (air, surface and water transportation) and intentional injuries (suicide) were evaluated. The summary impact level (considering the combined ratings for the three phases) is rated Category 2, acknowledging a lower level of estimated impact associated with surface transportation. Expectations regarding suicide rates should be treated with caution since the causes of suicide are complex and unpredictable and may be easily overestimated or underestimated. The accidents and injuries discussed in this section are generally considered to be events with very low probability of occurrence, but high consequence if they did occur.

Table 3.22-18: Summary of HEC 2 Impacts: Accidents and Injuries

Potential Impact	Project Component	Project Phase	Negative/ Positive	Health Effect	Magnitude	Duration	Geographic Extent	Severity Ranking	Likelihood Rating	Impact Rating	Impact Level
Increase in unintentional accidents and injuries morbidity and mortality rates due to air transportation	All components: Mine Site, Transportation Corridor, Pipeline	Construction	–	3, severe	3, unable to maintain pre-impact level of health	2, medium-term	0, individual cases	**8**	<1%	**	**2**
		Operations		3, severe	3, unable to maintain pre-impact level of health	3, long-term	0, individual cases	**9**	<1%	**	**2**
		Closure		3, severe	3, unable to maintain pre-impact level of health	3, long-term	0, individual cases	**9**	<1%	**	**2**
Increase in unintentional accidents and injuries morbidity and mortality rates due to surface transportation	All components: Mine Site, Transportation Corridor, Pipeline	Construction	–	3, severe	0, minor	2, medium-term	0, individual cases	**5**	10-33%	*	**1**
		Operations		3, severe	0, minor	3, long-term	0, individual cases	**6**	10-33%	*	**1**
		Closure		3, severe	0, minor	3, long-term	0, individual cases	**6**	10-33%	*	**1**
Increase in unintentional accidents and injuries morbidity and mortality rates due to water transportation	All components: Mine Site, Transportation Corridor, Pipeline	Construction	–	3, severe	2, able to maintain pre-impact level of health with medical intervention	2, medium-term	0, individual cases	**7**	1-10%	**	**2**
		Operations		3, severe	2, able to maintain pre-impact level of health with medical intervention	3, long-term	0, individual cases	**8**	1-10%	**	**2**
		Closure		3, severe	2, able to maintain pre-impact level of health with medical intervention	3, long-term	0, individual cases	**8**	1-10%	**	**2**
Increase in intentional injury: suicide rate	All components: Mine Site, Transportation Corridor, Pipeline	Construction	+/_	3, severe	3, unable to maintain pre-impact level of health	2, medium-term	0, individual cases	**8**	1-10%	**	**2**
		Operations		3, severe	3, unable to maintain pre-impact level of health	3, long-term	0, individual cases	**9**	1-10%	**	**2**
		Closure		3, severe	3, unable to maintain pre-impact level of health	3, long-term	0, individual cases	**9**	1-10%	**	**2**

3.22.4.2.3 HEC 3: EXPOSURE TO POTENTIALLY HAZARDOUS MATERIALS

The potential for adverse health effects associated with exposure to hazardous materials (chemicals) that may be released to the environment due to the Donlin Gold Project is a concern frequently expressed by communities in the EIS Analysis Area. Overall, the health concerns expressed by community members pertain to how hazardous constituents would be stored, handled, and used at the Mine Site, emissions and releases would be controlled and managed, and accidental spills and releases related to the Transportation and Pipeline components would be minimized to prevent unacceptable exposures to on-site workers or off-site communities.

As described in Newfields (2015, 2016), a summary of specific health concerns that were raised during scoping meetings and other project meetings were as follows:

- Release of mercury and dust emissions to air from point and fugitive sources;
- Release of mercury and other metals to surface water and groundwater;
- Uptake of mercury and other chemicals into vegetation, fish, waterfowl, wildlife, and large game;
- Handling and use of mercury and worker exposure to mercury;
- Release of acid rock drainage (ARD) to the environment;
- Usage and release of cyanide to the environment and uptake by fish and wildlife;
- Increased exposure to arsenic; and
- Accidental releases of diesel, fuel oil, and explosives associated with barge, air, and truck traffic.

In addition, numerous comments on the Draft EIS also expressed concerns about the potential risk to human health associated with potential exposures to project-related hazardous chemicals. Most of the concerns were associated with consumption of chemicals in food (fish, wildlife, vegetation) and inhalation of chemicals in air. Other concerns included exposure to chemicals in surface water, sediment, groundwater, and soil. While exposure to mercury was the dominant chemical of potential concern (COPC), there were concerns about other chemicals, including antimony, arsenic, cyanide, selenium, lead, potassium amyl xanthate, nitric acid, sodium cyanide, calcium oxide, copper sulfate, sulfur, and diesel exhaust. Some stakeholders also expressed concerns about exposures to "volatile airborne emissions," "carcinogens," "teratogens," "hazardous chemicals," "heavy metals," "toxic chemicals," "dust and vapors," "stack emissions," "acid," "waste water treatment," "groundwater as drinking water," "spills to river," failures, and leaks.

In December 2016, a focused "Mercury Workshop" for the project was held to review concerns and comments on potential project-related mercury impacts. At the December 2016 Mercury Workshop, commenters expressed a preference to assess all the health concerns related to chemical exposures in a single section in the EIS, rather than dispersed through multiple chapters. Accordingly, a FRA, including a quantitative HHRA, was conducted to evaluate the potential risks and hazards of exposure to project-related hazardous chemicals and is included in Appendix AB. The quantitative HHRA was conducted by Environmental Resources Management, Inc. (ERM 2017). The ERM HHRA document (ERM 2017) is not provided as a

component of the EIS because it is a non-NEPA document; however, the HHRA in its entirety has been reviewed by the applicable federal and state agencies. The findings of the ERM HHRA (2017) are summarized in the FRA (Appendix AB) and are relied on for the evaluation of health impacts related to exposures to potentially hazardous chemicals. This Human Health Section focuses on summarizing the significant findings of the FRA. Citations are included in this section that refer the reader to pertinent sections of the FRA, which includes more detailed information.

Consistent with the EIS and NEPA practice, the FRA evaluates potential exposure pathways for chemicals that may be used and released from project activities to air, soil, groundwater, surface water, and sediment, and bioaccumulated in biota (e.g., subsistence foods, including fish, waterfowl, wildlife, and plant foods) to the extent possible (i.e., based on the available data in the EIS) by presenting baseline exposure, combined baseline and predicted project-related exposure, and incremental exposure (e.g., percent increase from baseline). Specifically, the FRA focuses on evaluation of exposures via ingestion, dermal, and inhalation to hazardous chemicals due to potential project-related impacts to abiotic media and potential bioaccumulation in biota, and also summarizes how these predicted project-related exposures relate to baseline exposures. The FRA does not evaluate human health impacts from potential spills/failures; the potential health impacts from exposure to chemicals due to a spill or failure are unanticipated and are typically short-term, acute exposures. The standard risk assessment approach used in the FRA is not designed to evaluate these types of short-term exposures. Section 3.24, Spill Risk, includes information regarding how health concerns and potential impacts would be addressed (e.g., containment, monitoring, public outreach and information) in the unlikely event that a spill or failure were to occur.

As outlined in Appendix AB, the FRA is comprised of a three step process as follows:

- Step 1 (Exposure Pathway Analysis): This step includes the identification of the primary project-related sources of contamination, COPCs, and determination of complete exposure pathways. Primary project sources of contamination included anticipated project sources and COPCs (e.g., Mine Site air emissions, Mine Site and Transportation Corridor fugitive dust). Only pathways that are complete warrant additional risk analysis. If a pathway is incomplete and there is no exposure, then there is no associated risk.
- Step 2 (Screening-Level Assessment, Single Media): Step 2 includes a comparison of background (baseline) concentrations with predicted concentrations (based on reasonable maximum exposure [RME] and comparable arithmetic mean [CAM]) and a comparison of background and predicted media concentrations to applicable Alaska Department of Environmental Conservation (ADEC) and USEPA media-specific screening criteria for potentially complete exposure pathways (including insignificant and potentially significant). The goal of Step 2 is to identify: 1) constituents that do not exceed the environmental (abiotic or non-tissue) screening levels (i.e., they are unlikely to pose a threat to human health in an exposure medium such as soil, sediment, groundwater or surface water) and are not considered bioaccumulative; 2) constituents that do not exceed the abiotic screening levels and do not exceed background, regardless of bioaccumulative potential; 3) constituents that would be carried forward to Step 3, which include constituents that were not screened out from further evaluation for each abiotic medium; and 4) constituents that have the potential for bioaccumulation in tissue

for evaluation for the subsistence dietary pathway. Consistent with the EIS, baseline concentrations and risk represent current conditions (i.e., the No Action Alternative). The baseline concentrations were obtained from the relevant media sections (e.g., air, groundwater, surface water, and sediment) of the EIS.

- For the FRA, the screening levels selected were the promulgated human health-protective values from the sources presented in the media screening-level evaluation sections (see Appendix AB, Sections AB.5.1 and AB.5.3). For non-carcinogenic screening values, the individual-chemical promulgated values were selected (i.e., hazard quotient [HQ] = 1) to be consistent with the approach used in the EIS (Section 3.2, Soils, Section 3.7, Water Quality, and Section 3.8, Air Quality), for identification of individual metals elevated in baseline data, and to identify those chemicals that are more likely to have potential human health impacts to be consistent with NEPA practice (i.e., disclosure of likely impacts). Carcinogenic screening values were selected as promulgated (i.e., excess lifetime cancer risk [ELCR] = 1x10-5 for ADEC and 1x10-6 for EPA values). The ELCR values represent the probability of an exposed individual developing cancer, expressed as one in one hundred thousand (1x10-5) or one in a million (1x10-6).Step 3 (Quantitative HHRA, Multimedia): This step includes the quantitative risk evaluation of complete (insignificant and potentially significant) pathways and associated chemicals relative to baseline conditions. The quantitative HHRA estimated risks and hazards for COPCs (i.e., mercury, arsenic, and antimony) individually and for multiple chemicals, media and exposure pathways. Step 3 also includes incremental evaluation that quantifies the added exposure and associated incremental risk above baseline due to predicted future concentrations of the COPCs in abiotic media and biota tissue, as well as inhalation associated with air emissions. As stated previously, the quantitative ERM HHRA (ERM 2017) is not included in the EIS, but the findings are summarized in the FRA (Appendix AB).

Since the objective of the quantitative HHRA (ERM 2017) was to evaluate the potential incremental hazard and risk of human exposure resulting from the project relative to baseline, the relevant comparison was the incremental change in non-carcinogenic hazards for all three COPCs and cancer probability estimates for arsenic (the only carcinogen of the three COPCs). For the purposes of the HHRA, incremental changes in hazard and risk were considered substantial, (i.e., warrant further risk management discussion) if:

- Non-cancer hazards (i.e., Hazard quotient [HQ] or hazard index [HI]) changed from a baseline less than 1 to future estimated hazard greater than 1; or
- Cancer estimates increased in the future estimated risk assessment by 10-fold or more (e.g., if baseline cancer risks are $1x10^{-6}$ and future cancer risks are $1x10^{-5}$ or greater).
- Overall, the approach used in the FRA generally follows the methodology used to evaluate existing contaminated sites under ADEC and EPA guidance (ADEC 2015, 2016a; EPA 1989, 1991, 2002b, 2016), with modifications to be more in line with the NEPA framework (see Appendix AB, Section AB.1-2 for further details). Given that the general approach used in the FRA is applied to assessing potential contaminants for a proposed project and future estimated concentrations that are based on conservative modeling (i.e., assumptions that would overestimate exposures), the conservatism of this approach should be considered in the interpretation of the findings. Although NEPA case law and current CEQ regulations do not require the use of a worst-case

scenario in considering environmental impacts, a conservative approach was considered useful to approximate the potential health consequences related to potential change in exposures to environmental conditions due to the Donlin Gold Project.

Uncertainties are inherent in the risk assessment process, ranging from uncertainties related to estimating media concentrations, selection of exposure parameters (i.e., exposure assessment) and toxicity values (i.e., toxicity assessment), to the assumptions used for risk estimation. In general, conservative exposure assumptions were incorporated into the HHRA to prevent Type II errors (i.e., erroneous elimination or false-negative conclusion).

The FRA includes a detailed exposure pathway analysis, including a discussion of fate and transport pathways, conceptual site models (CSMs), and complete and incomplete exposure pathways (see Appendix AB, Section AB.4). A schematic representation of complete and incomplete exposure pathways for a site is typically referred to as an exposure-based CSM. The purpose of the CSM is to conceptualize the relationship between contaminant sources and potential receptors based on consideration of reasonable anticipated or actual migration (fate and transport) and exposure pathways. Based on the project description, planned project controls and measures planned for handling and management of emissions, discharges, and waste, and an understanding of the distribution of affected communities and land uses in the area, CSMs were developed for each of the Donlin Gold Project components. Because of the similarity among alternatives in relation to exposure pathways, the models are considered representative of all of the action alternatives. The exposure-based CSMs included in the FRA illustrate the potentially complete and incomplete pathways (Appendix AB, Figures AB.4-1 to AB.4-3).

In the FRA, potentially affected communities are identified in relation to the three components of the Donlin Gold Project, as described in Section 3.22.3 and illustrated in their respective CSMs (Appendix AB, Figures AB.4-1 to AB.4-3). Potential human receptors for all three components include residents in villages near the project area (e.g., Crooked Creek is the nearest village, 10 miles from the Mine Site), recreationalists, and subsistence consumers (e.g., foragers, hunters, and fishers). For the Transportation Corridor, commercial/industrial workers not related to the Donlin Gold Project (e.g., other workers at the Transportation Corridor ports) are considered potential receptors, and referred to as non-project commercial/industrial workers. The HHRA evaluated risk to child and adult subsistence residents from direct exposure to abiotic media (soil, sediment, and air) and dietary exposure to representative biota (berries, northern pike, beaver, and mallard duck). In addition, the HHRA included a comparison of northern pike estimated exposure concentrations to the Alaska fish consumption advisory levels and a qualitative evaluation for migratory fish (e.g., salmon and evaluation of the ADHSS mercury hair study).

Consistent with the EIS HIA and NEPA practice, Donlin Gold Project employee health is covered by Donlin Gold's Plan of Operations, which includes an occupational health and safety plan and monitoring, and is governed by OSHA and MSHA regulations. Therefore, consistent with ADHSS (2015), a direct evaluation of the anticipated project workforce safety and health issues (i.e., "inside the fence") is not considered in the FRA because the health and safety of project worker and contractor populations are expected to be adequately addressed by compliance with project health and safety plans and occupational health and safety regulations (see Section 3.22.1). Workers and employees typically have training and monitoring precautions to ensure their health and safety. Workers who are housed in enclave workforce camps at the

Mine Site would be prohibited from engaging in fishing and hunting activities in the vicinity of the Mine Site, as described in Section 3.21, Subsistence. For additional information pertaining to Mine Site worker safety "inside the fence," including use of groundwater as potable water and planned health and safety measures at the Mine Site and at Mine Site camps, see Table 3.6-1 (Applicable Regulations under Groundwater Hydrology), Sections 2.3.2 (Description of Alternatives, Alternative 2), 3.6.1.5.1 (Groundwater Hydrology, Affected Environment, Groundwater Use, Mine Site and Pipeline), 3.6.2.2.1 (Groundwater Hydrology, Environmental Consequences, Alternative 2, Mine Site), 3.6.2.2.2 (Groundwater Hydrology, Environmental Consequences, Alternative 2, Transportation Corridor), 3.7.1.1 (Water Quality, Regulatory Framework), 3.7.2.1 (Water Quality, Affected Environment, Surface Water Quality), 3.7.3.2.3 (Water Quality, Environmental Consequences, Alternative 2, Groundwater Quality), and 5.0 (Impact Avoidance, Minimization, and Mitigation).

Although exposure could potentially be complete for human receptors, if an accidental spill, leak, or release were to occur, the FRA did not qualitatively or quantitatively evaluate health impacts because these are unanticipated and highly variable, typically short-term, acute exposures and project procedures would be in place to minimize the potential for spills to occur. In addition, the standard risk assessment methodology used in the FRA is not designed to evaluate unanticipated and short-term, acute exposures such as accidental spills. Spill risk is discussed in Section 3.24, Spill Risk, including possible spill scenarios involving fuels (e.g., diesel and liquefied natural gas [LNG]), mercury, cyanide, and tailings, potential effects on drinking water supplies at Crooked Creek village in the event of a partial dam failure, along with an extensive discussion of the planned spill prevention control measures, and health responses (e.g., containment, monitoring, public outreach and information) in the unlikely event that a spill or failure were to occur.

Materials that could act as sources of contamination would be tested prior to stockpiling and use for road construction. If materials could act as sources of contamination, they would not be stockpiled or used as road construction material (e.g., only non-acid generating [NAG] waste rock that does not indicate leaching potential would be used for road construction) and other materials would be used. For further discussions on waste rock characteristics and testing, see Sections 3.7 (Water Quality) and 3.2.3.2.4 (Soils) (also see Appendix AB, Section AB.5.3). In addition, BMP measures (e.g., water truck) would be used to help control roadway dust emissions (see Appendix AB, Section AB.5.2). The following subsections present the predicted health consequences for exposures to potentially hazardous chemicals due to project-related impacts to air, soil, groundwater, surface water, sediment, and bioaccumulation into fish, waterfowl, wildlife, and plant foods. Table 3.22-20 summarizes the potential project-related impacts to human health due to increased exposure to potentially hazardous chemicals, either directly (e.g., inhalation of chemicals in air) or indirectly (i.e., consumption of subsistence foods). As shown in Table 3.22-20, impacts to human health due to increased exposure to potentially hazardous chemicals is rated Category 1 for all project components and phases.

Increased Risk of Exposure to Potentially Hazardous Chemicals in Air

Air emissions related to the project may originate from three types of sources: stationary (e.g., emissions from power plant stack, boiler, and generators), mobile (e.g., exhaust from transport and construction equipment, vehicles, and vessels) and fugitive (e.g., emissions from wind erosion, roads, drilling, blasting, crushing, material/ore handling, and waste handling). The emissions may consist of chemicals that are in the vapor or particulate phase. The direct air

exposure pathways are evaluated in this section, while indirect exposure due to potential chemical constituent air deposition is evaluated separately for bioaccumulative chemicals in fish tissue, waterfowl, wildlife, and plant foods (see section below pertaining to Increased Risk of Exposure to Bioaccumulated Chemicals in Fish, Waterfowl, Wildlife, and Plant Foods).

Based on the CSMs for each project component (Appendix AB, Figures AB.4-1 to AB.4-3), the following are the complete or potentially complete (insignificant and significant) exposure scenarios for inhalation of potentially hazardous air constituents:

- Mine Site (all phases): Inhalation of emissions and/or fugitive dust by residents (including recreational receptor) and subsistence consumers (hunter, fisher, or forager).
- Transportation Corridor (all phases): Inhalation of fugitive dust and/or vehicle/vessel exhaust by residents (including recreational receptor), subsistence consumers, and non-project commercial/industrial workers (e.g., workers not associated with the project at ports and harbors).
- Pipeline (all phases): Inhalation of emissions by residents (including recreational receptor) and subsistence consumers.

The results of the air screening-level evaluation (Appendix AB, Section AB5.1) indicate the following:

- Inhalation exposure to air emissions or dust from the Mine Site is expected to be insignificant relative to background exposures and below air quality standards/guidelines for residents (including recreational receptor) and not expected to result in substantial incremental changes in hazard and risk relative to baseline for subsistence consumers (based on the HHRA).
- Inhalation exposures to fugitive dust and/or vehicle or vessel exhaust along the Transportation Corridor is expected to meet regulatory standards (see Sections 3.8.1.3.8 and 3.8.3.3.2, Air Quality) and are not expected to adversely impact potentially exposed human receptors (residents, subsistence consumers, and non-project commercial/workers).
- Inhalation exposure to emissions related to the Pipeline component is expected to be insignificant relative to background exposures and below air quality standards/guidelines for residents (including recreational receptor), and subsistence consumers.

Based on the findings of the FRA, the Donlin Gold Project is not expected to pose a health concern for all project components and phases for increased risk of exposure to potentially hazardous project-related chemicals in air because potential exposure would be either insignificant relative to background exposures or not expected to result in substantial incremental changes in non-cancer hazard and cancer risk relative to baseline (based on the HHRA). In addition, mitigation measures and BMPs would be implemented to further minimize exposure of potentially hazardous chemicals in air for the potential affected communities.

For the Mine Site (all phases), the health effect is assigned a score of 1 (minor risk of health injury, no intervention required) because potential exposure is not expected to result in substantial incremental changes in non-cancer hazard and cancer risk relative to baseline (based

on the HHRA). For the Transportation Corridor and Pipeline components (all phases), the health effect is assigned a score of 0 (not noticeable) because potential exposures would be insignificant relative to background exposures. For all project components and phases, the magnitude of the impact is assigned a score of 0 (minor) because predicted exposure concentrations are not expected to pose a health concern. The duration of this impact would correlate with the duration of the three project phases; therefore, the Construction Phase (3-4 years) is assigned a score of 2, and the Operations (27 years) and Closure (>50 years) phases are assigned a score of 3. The geographic extent of this impact is assigned a score of 2 because the communities within the vicinity of the project components could be potentially affected.

The likelihood of potential health impacts due to increased risk of exposure to hazardous air pollutants is considered very unlikely (1-10 percent) for the Mine Site because potential exposure is not expected to result in substantial incremental changes in non-cancer hazard and cancer risk relative to baseline (based on the HHRA). For the Transportation Corridor and Pipeline components, the likelihood of potential health impacts due to increased risk of exposure to hazardous air pollutants is considered extremely unlikely (<1 percent) because potential exposures would be insignificant relative background exposures. The potential impact of increases in exposure to potentially hazardous chemicals in air for the potentially affected communities is rated Category 1 for all phases and components.

Increased Risk of Exposure to Potentially Hazardous Chemicals in Soil

As noted in Section 3.2.3.2.4, Soils, no pre-existing contaminated conditions of environmental concern were identified at the Mine Site; thus, effects from exposure of existing contaminated soils during Construction, Operations, or Closure are not expected to occur. Although metals are naturally occurring minerals, mining activities may sometimes result in metal concentrations in soil that are elevated above levels that may be of health concern. Soil quality could be impacted by fugitive dust settling on soil, or gaseous mercury emissions that wash out of the atmosphere as wet or dry deposition. Fugitive dust generated during Mine Site Construction (pre-production) and Operations could potentially result in elevated concentrations of metals in soils surrounding the Mine Site over time through dust deposition. The dust particulates would reflect the minerals in the source material. Gaseous mercury would be emitted from the mill facility, WRF, and TSF. As discussed in the FRA (Appendix AB, Section AB4.2.4), exposure to COPCs in soil is expected to be complete for subsistence consumers and complete, but insignificant relative to background exposures for residents (including recreationalists) for the Mine Site.

For the Transportation Corridor component, as discussed in Appendix AB, Section AB4.2.4, exposure to COPCs in soil is expected to be complete, but insignificant compared to background exposures for residents because the footprint of the Transportation components would not be located in residential areas; however, it is possible residential recreationalists may occasionally venture within the footprint of the Transportation Corridor. Exposure to COPCs in soil is expected to be incomplete for non-project commercial/industrial workers (e.g., at port locations). As presented in Section 3.2.3.2.4, along the Kuskokwim River Corridor and at various transportation infrastructure facilities, the primary sources of potential soil quality impacts are from possible spreading of pre-existing contamination due to disturbance caused by project-related activities. Although multiple existing contaminated sites are present in close proximity to the project Transportation Corridor, only one open contaminated site is within potential project infrastructure at Bethel Port and one open contaminated site at Dutch Harbor

Port. Any actions that would occur at Dutch Harbor or the Port of Bethel at the Bethel Yard Dock are not part of the proposed action, and are considered connected actions (see Section 1.2.1, Connected Actions, in Chapter 1, Project Introduction and Purpose and Need). The site at Bethel Port is related to a petroleum release, has an ADEC "cleanup complete" status, has been redeveloped, and little to no impacts are expected since project-related activities are not expected to disturb this site. The Dutch Harbor Port contaminated site could be impacted by third party fuel tank expansion, but BMPs, Storm Water Pollution Prevention Plan (SWPPP) compliance, and likely required remediation by the third party would be expected to effectively control impacts on the project and protect human health.

For the Pipeline component, as discussed in Section 3.2.3.2.4 and Appendix AB, Section AB4.2.4, potential impacts to soil from fugitive dust during pipeline ROW construction are considered negligible compared to background conditions because BMPs and design measures would be implemented to minimize soil quality impacts, and public exposure is considered incomplete during Construction. As discussed in Section 3.2.3.2.4, no pre-existing contaminated conditions of environmental concern have been identified along the Pipeline ROW. Although there are open contaminated sites at the Beluga camp and storage yard and the Farewell airstrip, the construction activities at the Beluga camp and storage yard would not involve cuts or subsurface excavations and there is third-party responsibility for mitigation of potential soil impacts at Farewell if grading activities disturb existing petroleum-contaminated soils. Therefore, the potential soil exposure pathway for disturbing and releasing pre-existing contamination is considered incomplete for all receptors.

The direct soil exposure pathways are evaluated in this section, while indirect exposure due to uptake of potential chemical constituents from soil into biota is evaluated separately for bioaccumulative chemicals in fish tissue, waterfowl, wildlife, and plant foods (see section below pertaining Increased Risk of Exposure to Bioaccumulated Chemicals in Fish, Waterfowl, Wildlife, and Plant Foods). Based on the CSMs for the Mine Site and Transportation Corridor components (Appendix AB, Figures AB.4-1 and AB.4-2), the following summarizes the complete or potentially complete direct soil exposure pathways:

- Mine Site (all phases): Resident (including recreationalists), and subsistence consumer exposure to soil potentially impacted by Mine Site air emissions and fugitive dust.
- Transportation Corridor (all phases): Resident (including recreationalists) and subsistence consumer exposure to soil along transportation roadway potentially impacted by fugitive dust (i.e., erosion via wind) and overland flow with entrained soil/rock particles (i.e., erosion via water).

A screening-level evaluation was conducted for potential impacts to soil quality for the Mine and Transportation components and is presented in Appendix AB, Section AB5.2. Estimated soil concentrations were compared to baseline soil data, the ADEC Soil Clean-up Levels, and EPA Soil Residential RSLs. Based on the results of the FRA (Appendix AB) and the quantitative HHRA:

- For the Mine Site, residential and recreational exposures to potentially impacted soils due to Mine Site activities are expected to be insignificant compared to background exposures. While subsistence consumer soil exposure from Mine Site activities may be complete, project related impacts are generally within the natural variation of

background, and predicted soil concentrations of applicable COPCs would be below soil quality guidelines.

- For the Transportation Corridor component, soil exposure for residential and recreational exposure is insignificant compared to background concentrations; subsistence consumer exposure is complete, but likewise negligible compared to baseline concentrations for applicable COPCs.

Based on the findings of the FRA, the project is not expected to pose a health concern for all project components and phases due to increased risk of exposures to potentially hazardous chemicals in soil because potential exposures would be either incomplete or not expected to result in substantial incremental changes in non-cancer hazard and cancer risk relative to baseline (based on the HHRA). In addition, mitigation measures and required BMPs would be implemented to further minimize exposure of potentially hazardous chemicals in soil to receptors in the potential affected communities.

For the Mine Site and Transportation Corridor components (all phases), the health effect is assigned a score of 1 (minor risk of health injury, no intervention required) because exposure is not expected to result in substantial incremental changes in non-cancer hazard and cancer risk relative to baseline (based on the HHRA). Since the soil exposure pathway would be incomplete for the Pipeline component, the health effect is assigned a score of 0 (not noticeable). For all project components and phases, the magnitude of the impact is assigned a score of 0 (minor) because predicted exposure concentrations are not expected to pose a health concern. The duration of the impact is assigned a score of 2 for the Construction Phase (3-4 years) and 3 for the Operations (27 years) and Closure (>50 years) phases. The geographic extent of this impact is assigned a score of 2 because the communities within the vicinity of the project components could be potentially affected. The likelihood of potential health impacts due to increased risk of exposure to hazardous chemicals in soil is considered very unlikely (-1-10 percent) for the mine and transportation component because exposure is not expected to result in substantial incremental changes in non-cancer hazard and cancer risk relative to baseline (based on the HHRA). The likelihood of potential health impacts due to increased risk of exposure to hazardous chemicals in soil due the Pipeline component is considered extremely unlikely (<1 percent) because this pathway would be incomplete. For all components and phases, the potential impact of increases in exposure to potentially hazardous chemicals in soils for the potentially affected communities is rated Category 1.

Increased Risk of Exposure to Potentially Hazardous Chemicals in Groundwater

Since many of the rural communities lack municipal water and sanitation systems, water for potable use is drawn from wells and the Kuskokwim River. There may be groundwater sources (wells or springs) that are in use associated with residences or public camps (e.g., subsistence or recreational). In many areas near streams, groundwater is shallow enough to be accessed with small-diameter driven point wells that would be unlikely to be registered in public databases. A community water supply well is located in the village of Crooked Creek, about 10 miles downstream of the Mine Site and ½-mile southwest of the confluence with the Kuskokwim River. The drinking water source protection area identified by ADEC (2013c) for these groundwater supplies extends across the mouth of Crooked Creek (Section 3.6.1.5.1, Groundwater Hydrology). See Sections 3.7.1.1 (Water Quality, Regulatory Framework), 3.7.2.1 (Water Quality, Affected Environment, Surface Water Quality), and 3.7.2.2 (Water Quality,

Affected Environment, Groundwater Quality) for further details on water quality regulations and programs that are in place that prevent further degradation of surface water quality. The typical depth from which groundwater is drawn in the wells is unknown. Any effects to human health related to groundwater quality would only occur if project-related contamination were to migrate "outside the fence" and to where groundwater usage may be occurring. As previously stated, consistent with NEPA practice, Mine Site workers are not assessed in this document for potential human health impacts, with the exception of cross-over exposures. Mine Site worker safety is covered by Donlin Gold's Health and Safety Plans, which are governed by OSHA and MSHA.

For the Mine Site, as discussed in Section 3.7.3.2.3, Water Quality, and Appendix AB, impacted shallow groundwater would be contained "inside the fence," any impacted deep bedrock groundwater (> 600 feet) immediately "outside the fence" after Closure is expected to meet water quality regulatory limits, and future development of groundwater wells in this area is not reasonably anticipated, especially not deep bedrock groundwater wells. Therefore, exposure pathways for groundwater are incomplete for all human receptors "outside the fence."

For the Transportation Corridor component, all phases, exposure to COPCs in groundwater (as potable water) is incomplete for all receptors because the transport of COPCs to groundwater is not expected to result in any measurable changes from air deposition to soil or from the NAG waste rock used for construction since it would be tested prior to use and only non-leaching NAG rock would be used (Appendix AB). As discussed in Section 3.7.2.2.3 (Water Quality), for the Pipeline component, potential impacts to groundwater quality are expected to be minimal due to changes in groundwater flow and small groundwater general chemistry composition changes (SRK 2013b). For the areas along the pipeline route where groundwater depth may fall within the pipeline burial depths, mitigation measures would prevent the potential for COPC contamination of groundwater (Section 3.6.2.2.3, Groundwater Hydrology). During Closure, the pipeline would be abandoned in place and no additional impacts to groundwater quality would be expected, except perhaps for the production and mobilization of minor corrosion products from the steel pipe sections. As outlined in the FRA (Appendix AB, Section AB4.2.4), throughout all phases, groundwater quality impacts would be minor (i.e., general chemistry parameters). Therefore, the groundwater exposure pathway is considered incomplete.

Since the groundwater exposure pathway would be incomplete "outside the fence" for all project components and phases, the health effect is assigned a score of 0 (not noticeable) and the magnitude of the impact is assigned a score of 0. The duration of the impact is assigned a score of 2 for the Construction Phase (3-4 years) and 3 for the Operations (27 years) and Closure (>50 years) phases. The geographic extent of this impact is assigned a score of 1 because the impact would be limited to households. The likelihood for potential health impacts due to increased risk of exposure to hazardous chemicals in groundwater for all components (and all phases) is considered extremely unlikely (<1 percent) because this pathway is incomplete. For all components and phases, the impact of increases in exposure to potentially hazardous chemicals in groundwater for the potentially affected communities is rated Category 1.

Increased Risk of Exposure to Potentially Hazardous Chemicals in Surface Water and Sediment

Consistent with Section 3.7, Water Quality, a watershed approach was used for evaluating human health exposure to surface water "outside the fence" that could be potentially impacted

by project-related activities. Sections 3.7.1.1 (Water Quality, Regulatory Framework) and Section 3.7.2.1 (Water Quality, Affected Environment, Surface Water Quality) describe the anti-degradation surface water regulations and programs in place that prevent further degradation of surface water quality. Although, none of the surface water bodies in the vicinity of the Mine Site are known to be used for potable water supply purposes, including Crooked Creek, they could be used as potable water sources by subsistence consumers or other multi-day outdoor recreationalists. The closest known use of surface water for potable water purposes is at the Kuskokwim River, which is generally protected for all uses (including drinking water) downstream from its confluence with Crooked Creek, eight miles downstream of the Mine Site (see Section 3.7.2.1, Water Quality, and Section 3.5 (Surface Water Hydrology). This watershed approach is conservative because dilution within creeks (from upstream inputs) and at the confluence with the Kuskokwim River would occur.

The direct surface water and sediment exposure pathways are evaluated in this section, while indirect exposure due to potential uptake of chemical constituents from surface water and sediment are evaluated separately for bioaccumulative chemicals in fish tissue, waterfowl, and wildlife (see section below pertaining Increased Risk of Exposure to Bioaccumulated Chemicals in Fish, Waterfowl, Wildlife, and Plant Foods). Based on the surface water and sediment quality exposure assessment (Appendix AB, Section AB4.24), no potentially complete surface water and sediment exposure pathways were identified for the Pipeline component for all project phases and potential receptors (see Appendix AB, Section AB4.2.4 for further details). As discussed in Sections 3.7.2.2.2 and 3.7.3.2.2 (Water Quality), during Construction, discharges of the small amounts of pipeline hydrostatic test water would be required to meet the applicable Alaska Pollutant Discharge Elimination System (APDES) General Permit requirements based on the EPA's Ambient Water Quality Criteria (AWQC)/Alaska's Water Quality Standards (AWQS). During Construction and Operation phases, erosion and sedimentation control (ESC) measures and monitoring would be used to control erosion and overland flow. At Closure, if the pipeline is not abandoned in place, any identified impacts caused by removal of the pipeline would be avoided or mitigated.

Based on the CSMs for the Mine Site and Transportation Corridor components (Figures AB.4-1 and AB.4-2), the following are the complete (insignificant and significant) exposure scenarios for surface water and sediment:

- Mine Site (all phases): Ingestion of and dermal contact with potentially impacted surface water and sediment by residents (including recreationalist) and subsistence receptors (hunter, fisher, and forager).
- Transportation Corridor (all phases): Ingestion of and dermal contact with potentially impacted surface water and sediment by residents (including recreationalist) and subsistence receptors (hunter, fisher, and forager). Note that surface water and sediment exposures are incomplete for the commercial/industrial non-Mine Site worker (e.g., workers at the Transportation Corridor ports not associated with the Donlin Gold Project) for this component (see Appendix AB, Figure AB.4-2).

A screening-level evaluation was conducted to evaluate the potential impacts on surface water and sediment during all phases of the mine and transportation components (see Appendix AB, Section AB5.3). Predicted concentrations of mercury in surface water and sediment were estimated, as well as predicted concentrations of treated Water Treatment Plant (WTP) effluent for numerous metals, including arsenic, cyanide, and mercury; however, of these project-related

hazardous chemicals, only mercury and arsenic are reported as also naturally occurring in surface waters in Alaska. Cyanide has not been reported as naturally-occurring in surface waters in Alaska. Unlike elemental constituents of surface waters (such as arsenic and mercury), cyanides can be destroyed by oxidation reactions, which predominantly yield less-toxic cyanate as a reaction product that can be subsequently hydrolyzed, ultimately yielding ammonium and bicarbonate ions (see Section 3.7.2.1.1, Water Quality for further details). As discussed earlier in the baseline conditions section, some of the highest levels (up to 10,000 µg/liter) of naturally occurring arsenic in drinking water have been reported in Alaska (Harrington et al. 1978, as cited in Newfields 2015, 2016). Due to historic mining at the Red Devil Mine, lengths of the middle Kuskokwim River exceed screening levels for mercury, arsenic, and antimony, which affect water quality and drives fish advisories (ADHSS 2010 as cited in Newfields 2015, 2016). The existence of surface water mercury contamination associated with the Red Devil Mine does not justify any potential contamination to the watershed due to the Donlin Gold Project. While no water bodies in the EIS Analysis Area are listed as impaired under Section 303(d) of the federal Clean Water Act, the Kuskokwim River is listed as a Category 5 impaired water body under state water quality standards at the outflow of Red Devil Creek. The designation extends 100 feet upriver to 900 feet downriver from the confluence of Red Devil Creek and the Kuskokwim River. This designation requires a Total Maximum Daily Load technical analysis to calculate pollution reductions. See Section 3.7, Water Quality, for additional information on this topic.

Baseline and modeled surface water and sediment concentrations from the project activities were compared to Alaska's WQS and EPA's WQC. The human-health-based WQC values are intended to be protective of long-term water consumption and, therefore, even if short-term exceedances of the water quality criteria were to occur, adverse health effects would not necessarily occur. The results of the surface water screening-level evaluation (see Appendix AB, Section AB5.3) indicate exposures to potentially impacted surface water due to the Mine Site and Transportation Corridor components are estimated to be insignificant compared to baseline concentrations.

For all components and phases, the health effect is assigned a score of 0 (not noticeable) and the magnitude of the impact is assigned a score of 0 because predicted surface water impacts are estimated to be either negligible or insignificant compared to baseline concentrations. The duration of the impact is assigned a score of 2 for the Construction Phase (3-4 years) and 3 for the Operations (27 years) and Closure (>50 years) phases. The geographic extent of this impact is assigned a score of 2 because the communities within the vicinity of the project components could be potentially affected. For all components, the likelihood of potential health impacts due to increased risk of exposure to hazardous chemicals in surface water and sediment is considered extremely unlikely (<1 percent) because these pathways are insignificant (compared to background) for the Mine Site and Transportation Corridor components, or incomplete for the Pipeline component. For all components and phases, the impact of increased exposure to potentially hazardous chemicals in surface water and sediment for the potentially affected communities is rated Category 1.

Increased Risk of Exposure to Bioaccumulated Chemicals in Fish, Waterfowl, Wildlife, and Plant Foods

The consumption of local subsistence foods (fish, waterfowl, small and large mammalian wildlife, and fruits and berries) is an important part of the diet of the potentially affected

communities. Deposition on and uptake (bioaccumulation) of project-related contaminants by these natural resources may potentially occur due to project impacts to the aquatic and terrestrial environments. Stakeholders expressed concerns regarding the potential bioaccumulation of project-related contaminants, such as mercury, into food items that would be consumed by subsistence consumers and recreational harvesters.

As evaluated in the FRA (Appendix AB), fish may be directly exposed to potentially impacted surface water and sediment, as well as through their diet (e.g., ingestion of aquatic prey that has taken up project-related contamination). The primary bioaccumulative project-related COPCs (e.g., arsenic and mercury) may accumulate in fish and subsequently be consumed by subsistence populations.

As discussed in Appendix AB, Section AB.5.4, waterfowl and wildlife may bioaccumulate project-related COPCs through inhalation of potentially impacted air, direct contact with and/or ingestion of potentially impacted media (soil, water, and sediment), or through diet (vegetation and/or prey that has taken up project-related contamination). However, large terrestrial mammalian wildlife species that are of interest to subsistence hunters in the EIS Analysis Area (e.g., moose, caribou, black bear) are generally not a concern for bioaccumulation of chemicals from soils and vegetation. As described in Section 3.12.2.2.1 (Wildlife), moose and caribou are herbivorous and the black bear has a diet comprised primarily of new plant growth in spring, berries during summer, and spawning salmon during summer and fall (Johnson 2008). These game mammals typically have large foraging areas, and therefore, feeding on vegetation from the vicinity of the Mine Site would represent a minor portion of their home range. Therefore, there is low likelihood that consumption of large subsistence game (e.g., moose, caribou, black bear) would result in human health impacts from the Donlin Gold Project that would be distinguishable from baseline levels. Unlike large terrestrial mammals, small mammals, such as the beaver, have foraging ranges less than the Mine Site area and may be harvested and consumed; therefore, they could potentially be exposed to bioaccumulative project-related contaminants (e.g., arsenic, mercury) at levels that could potentially pose a concern to subsistence consumers.

As noted in Section 3.12.3 (Wildlife), standing water bodies would have varying levels of inorganic constituents, with the TSF likely to have higher concentrations of antimony, arsenic, and selenium than the pit lake. The TSF would be characterized by on-going mining activity during the Operations Phase, and would be unlikely to support growth of vegetation or invertebrates that might serve as quality food sources for waterfowl. Without quality food sources, it is unlikely waterfowl would stay long in the TSF. Similarly, migratory waterfowl are not expected to be at risk from ingestion of contaminated water, food or sediment at the Mine Site water storage features. However, emissions and fugitive dust could be deposited and/or transported into other surface water bodies within the vicinity of the Mine Site and Transportation Corridor, and subsequently taken up by aquatic biota.

Fugitive dust could be deposited directly onto fruits (berries) and roots could take up metals from soils impacted by emissions and fugitive dust in the vicinity of the Mine Site and Transportation Corridor. Although a majority of the berries picked by the residents of Crooked Creek likely occur in areas away from the Mine Site and Transportation Corridor, where deposition modeling shows that dust levels are expected to be negligible (see Sections 3.2, 3.10, and 3.21), this exposure pathway was retained for further quantitative evaluation in the HHRA.

For the Pipeline component, since the soil, surface water, and sediment exposure pathways are incomplete, then uptake for these media into biota would also be incomplete. Since the air exposure pathway is insignificant for the Pipeline component and soil impacts from dust deposition would be negligible and within naturally occurring baseline ranges, biota would not be expected to uptake COPCs from air emissions in measurable concentrations above baseline.

Based on the CSMs for Mine and Transportation components (Appendix AB, Figures AB.4-1 and AB.4-2), the following are the complete or potentially complete (insignificant and significant) exposure scenarios:

- Mine Site (all phases): Exposures to residents (including recreational receptor) and subsistence consumers due to bioaccumulation of project-related COPCs into biota (fish, waterfowl, wildlife and plant foods).
- Transportation Corridor (all phases): Exposures to residents (including recreational receptor) and subsistence consumers due to bioaccumulation of project-related COPCs into biota (fish, waterfowl, wildlife and plant foods). Note that bioaccumulation into biota is incomplete for the commercial/industrial non-worker for this component (see Appendix AB, Figure AB.4-2).

The tissue screening-level evaluation (Appendix AB, Section AB5.4) concluded that arsenic and mercury have the potential to bioaccumulate in berries, small mammals, fish, and waterfowl that may be consumed by residents and subsistence populations and required further evaluation in the quantitative HHRA. In addition, since the screening-level assessment represents a single-media, individual-chemical evaluation, representative chemicals (i.e., mercury, arsenic, and antimony) that are anticipated to contribute the most to future media increases, were retained for further evaluation in HHRA in order to assess potential human health impacts for multiple chemicals, media and exposure pathways.

The results of the HHRA (ERM 2017) are summarized in Appendix AB. A summary of the HHRA findings is provided below:

- Non-cancer risk estimates (HQs and HIs) were all at or less than 1 for both baseline and future risks for potential receptors, indicating that non-cancer effects are unlikely.
- Baseline risk estimates for mercury are consistent with a mercury hair study completed by the ADHSS in 2012, whose results indicate that baseline exposure to mercury in communities studied is below levels of public health concern. The ADHSS tested methylmercury in hair samples from pregnant women in selected communities, including the Upper Kuskokwim River region communities. The hair mercury level for every study participant was below both the ATSDR NOAEL (15.3 ppm) and the ADHSS Environmental Public Health Program level for follow-up (5 ppm) (ADHSS 2013). The median hair mercury level was below 1 ppm (which corresponds to the EPA's oral reference dose); however, some study participant levels exceeded 1 ppm. Note that the EPA's oral reference dose was used in the quantitative HHRA to evaluate non-cancer hazards for methylmercury (ERM 2017); the ATSDR NOAEL was evaluated in a weight of evidence context.
- For arsenic, the cancer risk estimates, both baseline and future risk estimates ranged between $2x10^{-5}$ and $5x10^{-5}$, which is within the EPA's risk management range of $1x10^{-4}$ to

$1x10^{-6}$. Future estimates of cancer risks were similar to baseline, indicating no unacceptable change in risk.

- The HHRA evaluated risks due to northern pike fish consumption because, as a large, relatively long-lived resident fish, they are expected to be a more conservative fish for risk estimation due to the relatively greater exposure period compared to migratory fish such as salmonids. As top-level predators, they would also be expected to bioaccumulate mercury to a greater degree than lower-trophic level fish species. The results indicate estimated baseline and future HQs and incremental cancer risks below those considered substantial (i.e., HQs at or less than 1 and incremental cancer risk less than 1×10^{-6}).

Overall, the findings of the quantitative HHRA indicated that the small increases in constituent concentrations estimated to occur outside of the Mine Site due to project-related activities are unlikely to result in unacceptable risks to human populations who would have the highest exposure (i.e., subsistence populations). Based on these findings, other human populations, such as residents in the region, would not be expected to be exposed to unacceptable risk due to exposure to project-related concentrations of mercury, arsenic, or antimony.

For the Mine Site and Transportation Corridor components (all phases), the health effect is assigned a score of 1 (minor risk of health injury, no intervention required) because potential project-related exposure is not expected to result in substantial incremental changes in non-cancer hazard and cancer risk relative to baseline (based on the HHRA). Since bioaccumulation into biota would be incomplete for the Pipeline component, the health effect is assigned a score of 0 (not noticeable). For all project components and phases, the magnitude of the impact is assigned a score of 0 (minor) because predicted exposure is not expected to pose a health concern. The duration of the impact is assigned a score of 2 for the Construction Phase (3-4 years) and 3 for the Operations (27 years) and Closure (>50 years) phases. The geographic extent of this impact is assigned a score of 2 because the communities within the vicinity of the project components could be potentially affected.

The likelihood of potential health impacts due to increased risk of exposure to hazardous chemicals into biota is considered very unlikely (-1-10 percent) for the Mine Site and Transportation Corridor components because potential project-related exposure is not expected to result in substantial incremental changes in non-cancer hazard and cancer risk relative to baseline (based on the HHRA). For the Pipeline component, the likelihood of potential health impacts due to increased risk of exposure to potentially hazardous chemicals due to bioaccumulation into biota is considered extremely unlikely (<1 percent) because this pathway is incomplete. For all components and phases, the potential impact of increases in exposure to potentially hazardous chemicals due to bioaccumulation into biota (fish, waterfowl, wildlife, and plant foods) for the potentially affected communities is rated Category 1.

Alternative 2, HEC 3 Impact Summary: Exposure to Potentially Hazardous Materials

For exposure to potentially hazardous materials, potential impacts were evaluated due to increased direct exposure to potentially hazardous project-related chemicals released to air, groundwater, surface water and sediment, as well as increased indirect exposure due to the potential uptake (bioaccumulation) of project-related chemicals into biota (including fish, waterfowl, wildlife, and plant foods). To support the evaluation of potential health impacts for exposure to potentially hazardous materials, a FRA (Appendix AB), including information from

a quantitative HHRA (ERM 2017), was conducted, and the findings of the FRA were used as the basis to estimate the potential consequences to human health due to exposures to potentially hazardous materials as a result of the Donlin Gold Project. Consistent with NEPA practice, the FRA (Appendix AB) evaluated baseline, combined baseline and predicted project-related, and incremental (e.g., percent increase from baseline) exposures in the evaluation of potential health impacts. The evaluation focused on potential for health consequences "outside of the fence" and emphasis was placed on evaluation of potentially complete and significant exposures relative to baseline conditions. As noted previously, this section does not evaluate human health impacts for Mine Site workers because the protection of employees and workers involved in the handling and use of hazardous constituents is covered in the Donlin Gold Project health and safety plans and is not within the scope of the health consequence evaluation. In addition, health impacts due to potential spills/failures are not evaluated in this section; see Section 3.24, Spill Risk, for further details.

The summary impact level for exposure to potentially hazardous materials is rated Category 1 for direct and indirect exposures, considering all project components and project phases. Table 3.22-20 presents the summary of HEC 3 Impacts: Exposure to Potentially Hazardous Materials.

3.22.4.2.4 HEC 4: FOOD, NUTRITION, AND SUBSISTENCE ACTIVITY

The following subsections evaluate potential benefits due to decreases in regional food costs and increases in food security that could occur due to increased economic opportunities for the potentially affected communities. The potential impact due to decreases in access to and/or quantity of subsistence resources is also evaluated. Table 3.22-20: Summary of HEC 4 Impacts summarizes the potential impact levels for food, nutrition, and subsistence activity, including the potential health effect consequence, magnitude, duration, and geographic extent of the impact, and likelihood of the impact occurring.

Decrease in Food Costs Relative to Income

Increases in economic opportunities could result in increases in the median household incomes of the populations located in the potentially affected communities, which could result in decrease in food cost relative to income (i.e., the percent of median household income spent on food) A metric for comparing relative food costs is to compare the percent of the median household income to purchase the same food products annually. This comparison shows that to get the same food, 9.2 percent of the household median income for Anchorage is equivalent to 24 percent of the median household income for the Bethel Census Area. The rate rises to 14.7 percent for Bethel, 53.6 percent for Upper Kalskag, and as high as 125.0 percent for Stony River (USCB 2000; ADOL 2005; UAF 2011, all as cited in Newfields 2015, 2016). Therefore, the Donlin Gold Project could provide opportunities for decreased food costs relative to income for households in the EIS Analysis Area. However, there is also the probability that food costs could increase marginally due to higher food demand as a result of worker influx into the region because of the project.

Table 3.22-19: Summary of HEC 3 Impacts: Exposure to Potentially Hazardous Materials

Potential Impact	Project Component	Project Phase	Negative/ Positive	Health Effect	Magnitude	Duration	Geographic Extent	Severity Ranking	Likelihood Rating	Impact Rating	Impact Category
Increased risk of exposure to potentially hazardous chemicals in air (mercury, PM, and VOCs)	Mine Site	Construction	–	1, minor	0, minor	2, medium-term	2, potentially affected community	**5**	1-10%	*	**1**
		Operations		1, minor	0, minor	3, long-term	2, potentially affected community	**6**	1-10%	*	**1**
		Closure		1, minor	0, minor	3, long-term	2, potentially affected community	**6**	1-10%	*	**1**
	Transportation Corridor Pipeline	Construction	–	0, not noticeable	0, minor	2, medium-term	2, potentially affected community	**4**	<1%	*	**1**
		Operations		0, not noticeable	0, minor	3, long-term	2, potentially affected community	**5**	<1%	*	**1**
		Closure		0, not noticeable	0, minor	3, long-term	2, potentially affected community	**5**	<1-%	*	**1**
Increased risk exposure to potentially hazardous chemicals in surface water and sediment	Mine Site and Transportation Corridor	Construction	–	0, not noticeable	0, minor	2, medium-term	2, potentially affected community	**4**	<1%	*	**1**
		Operations		0, not noticeable	0, minor	3, long-term	2, potentially affected community	**5**	<1%	*	**1**
		Closure		0, not noticeable	0, minor	3, long-term	2, potentially affected community	**5**	<1%	*	**1**
	Pipeline	Construction	–	0, not noticeable	0, minor	2, medium-term	2, potentially affected community	**4**	<1%	*	**1**
		Operations		0, not noticeable	0, minor	3, long-term	2, potentially affected community	**5**	<1%	*	**1**
		Closure		0, not noticeable	0, minor	3, long-term	2, potentially affected community	**5**	<1%	*	**1**
Increased risk of exposure to potentially hazardous chemicals in groundwater	All components: Mine Site, Transportation Corridor, Pipeline	Construction	–	0, not noticeable	0, minor	2, medium-term	1, local	**3**	<1%	*	**1**
		Operations		0, not noticeable	0, minor	3, long-term	1, local	**4**	<1%	*	**1**
		Closure		0, not noticeable	0, minor	3, long-term	1, local	**4**	<1%	*	**1**
Increased risk of exposure to potentially hazardous chemicals in soil	Mine Site, Transportation Corridor	Construction	–	1, minor	0, minor	2, medium-term	2, potentially affected community	**5**	1-10%	*	**1**
		Operations		1, minor	0, minor	3, long-term	2, potentially affected community	**6**	1-10%	*	**1**
		Closure		1, minor	0, minor	3, long-term	2, potentially affected community	**6**	1-10%	*	**1**
	Pipeline	Construction	–	0, not noticeable	0, minor	2, medium-term	2, potentially affected community	**4**	<1%	*	**1**
		Operations		0, not noticeable	0, minor	3, long-term	2, potentially affected community	**5**	<1%	*	**1**
		Closure		0, not noticeable	0, minor	3, long-term	2, potentially affected community	**5**	<1%	*	**1**
Increased risk of exposure to bioaccumulated chemicals in Fish, Waterfowl, Wildlife, and Plant Foods	Mine Site, Transportation Corridor	Construction	–	1, minor	0, minor	2, medium-term	2, potentially affected community	**5**	1-10%	*	**1**
		Operations		1, minor	0, minor	3, long-term	2, potentially affected community	**6**	1-10%	*	**1**
		Closure		1, minor	0, minor	3, long-term	2, potentially affected community	**6**	1-10%	*	**1**
	Pipeline	Construction	–	0, not noticeable	0, minor	2, medium-term	2, potentially affected community	**4**	<1%	*	**1**
		Operations		0, not noticeable	0, minor	3, long-term	2, potentially affected community	**5**	<1%	*	**1**
		Closure		0, not noticeable	0, minor	3, long-term	2, potentially affected community	**5**	<1%	*	**1**

Notes:
>1 % = Extremely unlikely
1-10 % = Very unlikely
10-33% = Unlikely

The potential impact (beneficial) to human health due to decrease in food cost relative to median household income spent on food for the EIS Analysis Area is rated Category 2 for all phases. Increases in household income or employment rates could influence the affordability of goods and services (including food). The health effect is assigned a score of 1 (minor) for the Construction and Operations phases and 0 (not noticeable) for the Closure Phase. The magnitude of this benefit is assigned a score of 1 (measureable/noticeable change) for the Construction and Operations phases, and 0 (minor) for the Closure Phase. The geographic extent of this potential benefit is assigned a score of 1 because it would be limited to households that would benefit from project-related economic opportunities. The duration of this benefit would correlate with the duration of the three project phases; therefore, the Construction Phase (3-4 years) is assigned a score of 2, and the Operations (27 years) and Closure (>50 years) phases are assigned a score of 3. The likelihood that food cost will decrease is considered likely (66-90 percent) due to the expected improved economic opportunities, including increases in household incomes and employment rates.

Increases in Diet Composition and Food Security

Increases in economic opportunities could result in an increase in the median household incomes of the populations located in the EIS Analysis Area, resulting in an increase in food security. Based on U.S. Department of Agriculture definitions for food security, many of the small communities are below food security (ADF&G 2011, as cited in Newfields 2015, 2016). The percentage of low and very low food secure-households in the EIS Analysis Area ranges from 5 to 25 percent of the communities in the Bethel Census Area (Table 3.22-8). Although there would be some uncertainty in assuming that increased incomes due to employment or ancillary sales and taxes would be channeled directly to food-insecure households, it is likely that at least some portion of the economic benefits would improve food security. While not all of the increased income may be spent on food, at least some portion would likely be spent on food, especially in the food-insecure households. As discussed in Section 3.21.6.3.5, there is a potential that increased income may lead to increased participation in seasonal subsistence activities, which could lead to greater food security. It is also possible that with increased income some residents could consume unhealthier food choices and rely less on traditional subsistence resources.

The potential benefit of increased food security for communities in the EIS Analysis Area is rated Category 3 for Construction and Operations phases and Category 2 for the Closure phase. Increases in household incomes or employment rates are likely to improve food security. For the Construction and Operations phases, the health effect is assigned a score 3 (severe benefit), and 0 (not noticeable) for the Closure Phase. The magnitude of this benefit is assigned a score of 1 (measureable/noticeable change) for the Construction and Operation phases, and 0 (minor) for the Closure Phase. The geographic extent of this potential benefit is assigned a score of 1 because it would be most evident in food-insecure households that would benefit from project-related economic opportunities. The duration of this benefit is assigned a score of 2 for the Construction Phase (3-4 years) and 3 for the Operations (27 years) and Closure (>50 years) phases. The likelihood of increases in food security in the EIS Analysis Area is considered likely (66-90 percent) due to the expected improved economic opportunities, including increases in household incomes, and employment rates.

Access to and Quantity of Subsistence Resources

Changes in access to and/or quantity of subsistence resources (possibly a scarcity of subsistence food options) in the region could occur as a result of changes in employment (population outward migration), the fly-in, fly-out work rotations of the workforce, and overlap of subsistence resources and subsistence uses in the vicinity of project components. Subsistence activity is vital in the region, especially for the small Kuskokwim River communities, where unemployment rates are high, household incomes are low, and food cost is high. Subsistence foods are commonly used and are widely recognized as healthier than market food options. Input from scoping meetings and tribal cooperating agencies stated the importance of the subsistence way of life and Alaska Native cultural traditions (Section 3.21, Subsistence).

Fear of contamination of subsistence resources could also influence the food choice decisions of local residents. ERM's HHRA (ERM 2017) evaluated human health risks due to northern pike fish consumption. As top predators, northern pike fish would be expected to bioaccumulate mercury to a greater degree than lower-trophic level fish species. The HHRA estimated baseline and future HQs and incremental cancer risks below those considered substantial (i.e., HQs at or less than 1 and incremental cancer risk less than 1×10^{-6}). The findings of the HHRA indicated that the small increases in constituent concentrations estimated to occur outside of the Mine Site due to project-related activities are unlikely to result in unacceptable hazards and/or risks to human populations who would have the highest exposure (i.e., subsistence populations).

Subsistence and commercial fishing and other uses of the river could potentially be affected by project-related barge traffic. Project-related barge traffic along the Kuskokwim River may accelerate bank erosion and create riverbed scour, particularly in narrow and shallow segments of the river during the Construction and Operations phases. In combination with existing boat traffic, this could degrade habitat and disturb or destroy fish eggs, larvae, or juveniles (see Section 3.13, Fish and Aquatic Resources). Barge interference with placement and maintenance of fish nets and alterations in large mammal behavior could also cause them to move away from the Kuskokwim River corridor, which is a readily accessible hunting area. Levels of disturbance from river and ocean barge traffic that would affect fish, marine mammals, and terrestrial mammals would generally be limited; however, greater effects could occur in the narrow and shallow segments of the Kuskokwim River, such as near Aniak, Birch Tree Crossing, and the Oskawalik River, where subsistence fishing and moose hunting along the bank could be intermittently disturbed (see Section 3.21, Subsistence). Outside confined areas, overall reduction in harvest success is expected to be limited. Additional information on the potential effects to fish populations is discussed in Section 3.13, and the potential effects to subsistence activities are discussed in Section 3.21.

As discussed in the FRA (Appendix AB, Section AB4.2.4), the Pipeline component is expected to have a negligible impact on subsistence resources because potential surface water and sediment exposure pathways are incomplete and would not represent a pathway for constituent uptake into biota. Additionally, since the Pipeline component air exposure pathway is insignificant and soil impacts from dust deposition would be negligible and within naturally occurring baseline ranges, biota would not be expected to uptake project-related constituents in measurable concentrations above baseline. The effect of the Donlin Gold Project on subsistence activities suggests that net positive benefits may be realized since increased incomes would make procurement of hunting and fishing equipment more affordable and the estimated area of impact related to project activities is expected to be marginal within the context of availability of

much larger areas of natural resources in the EIS area. By maintaining their connections to subsistence activities, both the social and dietary health benefits of subsistence lifestyles would be realized.

The potential impact of decreased access to and/or quantity of subsistence resources for the potentially affected communities is rated Category 1 for the project phases. Residents living in the Central Kuskokwim River communities closest to the mine, particularly Crooked Creek, could be impacted by reduced access to subsistence resources near the Mine Site that would be closed to public use for safety purposes. Subsistence users may perceive that waterfowl potentially accessing the tailings pond and the pit lake could be contaminated, but this is not expected to be a health concern (Section 3.22.3.4.3, Human Health). Therefore, the health effect is assigned a score of 0 (effects not perceptible).

The magnitude of the impact is assigned a score of 0 (minor) because the residents of Crooked Creek historically have relied only in small part upon subsistence resources from the Mine Site. A similar magnitude of effect would also be anticipated for residents that rely on migratory waterfowl that may pass through the Mine Site (based on residents' perception that waterfowl may be contaminated and may avoid consumption). The Pipeline corridor overlaps with portions of the subsistence use areas of Crooked Creek, Stony River, McGrath, Nikolai, Skwentna, and Tyonek. Displacement of subsistence access would be greater during Construction and very limited during Operations and Closure. Increased access for fly-in hunters and trappers at the Farewell Airstrip and along the cleared ROW north and west of the Alaska Range could result in an increase in competition, affecting the residents of McGrath and Nikolai, since their subsistence use areas for large mammals, furbearers, vegetation, and birds overlap with the ROW (see Section 3.21). However, ROW affects small portions of these subsistence use areas, and alternative areas would be available at low additional cost and effort, to achieve similar harvest levels (see Section 3.21, Subsistence). Therefore, a similar magnitude of impact (score of 0) would also be anticipated for potential exposure to the region and minor increased access for airborne hunters and trappers at Farewell Airstrip.

The geographic extent of this potential impact is assigned a score of 1 because a limited number of households would be affected, primarily among the Kuskokwim River communities. The duration of this impact is assigned a score of 2 for the Construction Phase (3-4 years) and 3 for the Operations (27 years) and Closure (>50 years) phases.

The likelihood of this impact occurring is considered unlikely (10-33 percent) for all phases. The overlap of the Mine Site with local subsistence resources is small and the potential for contamination of migratory waterfowl is low. Water transportation along the Kuskokwim River and activities in the vicinity of the pipeline would be similar to or near baseline during the Closure Phase.

Alternative 2, HEC 4 Impact Summary: Food, Nutrition, and Subsistence Activity

Alternative 2 is rated Category 2 for potential health benefits due to decreased regional food costs, and Category 3 for increased food security (resulting from potential increases in median household incomes). This alternative is rated Category 1 for negative impacts (adverse) due to a potential for decreased access to and/or quantity of subsistence resources. Table 3.22-21 is a summary of HEC 4 Impacts: Food, Nutrition, and Subsistence Activity

Table 3.22-20: Summary of HEC 4 Impacts: Food, Nutrition, and Subsistence Activity

Potential Impact	Project Component	Project Phase	Negative/ Positive	Health Effect	Magnitude	Duration	Geographic Extent	Severity Ranking	Likelihood Rating	Impact Rating	Impact Category
Decrease in food cost relative to income (expressed as percent of median household income spent on food	All components: Mine Site, Transportation Corridor, Pipeline	Construction	+	1,minor	1, noticeable, but limited and localized	2, medium-term	1, limited to households that benefit from economic opportunities	**5**	66-90%	**	**2**
		Operations		1, minor	1, noticeable, but limited and localized	3, long-term		**6**	66-90%	**	**2**
		Closure		0, not noticeable	0, minor	3, long-term		**4**	66-90%	**	**2**
Increase in diet composition and food security	All components: Mine Site, Transportation Corridor, Pipeline	Construction	+	3, severe	1, noticeable, but limited and localized	2, medium-term	1, limited to households that benefit from economic opportunities	**7**	66-90%	***	**2**
		Operations		3, severe	1, noticeable, but limited and localized	3, long-term		**8**	66-90%	***	**2**
		Closure		2, moderate	0, minor	3, long-term		**6**	66-90%	**	**2**
Access to and quantity of subsistence resources	All components: Mine Site, Transportation Corridor, Pipeline	Construction	–	0, not noticeable	0, minor	2, medium-term	1, limited number of households	**3**	10-33%	*	**1**
		Operations		0, not noticeable	0 ,minor	3, long-term		**4**	10-33%	*	**1**
		Closure		0, not noticeable	0, minor	3, long-term		**4**	10-33%	*	**1**

3.22.4.2.5 HEC 5: INFECTIOUS DISEASES

The following subsections present the evaluation of the potential impacts of increases in rates of infectious diseases, including sexually transmitted infections (STIs) (e.g., gonorrhea, chlamydia, Hepatitis C, and HIV), respiratory diseases (e.g., influenza and pneumonia), foodborne illness (e.g., salmonella and E. Coli), and zoonotic diseases (disease that is passed between animals and humans). Table 3.22-22 summarizes the potential impact levels for infectious diseases, including the potential health effect consequence, magnitude, duration, and geographic extent of the impact, and likelihood of the impact occurring.

As described in Section 2.3.2.1 of the EIS, the construction camp at the Mine Site would be near the process plant site (see Section 3.2 for a description of the permanent accommodation camp). The main building would include 14, 3-story dormitories designed to accommodate shift workers during construction of the mine. Each of the 14 dormitories would be designed as three-story wings with double-occupancy bedrooms and a common wash module on each floor containing toilets, showers, and personnel laundry facilities. Building modules would be transported by barge to the Angyaruaq (Jungjuk) Port facility and then transported via truck to the construction camp site. Construction camp modules would be disassembled and removed after construction is complete. The construction camp would occupy approximately 15 acres and would support a workforce of 2,560 people.

The permanent accommodations camp would be located at a different location than the construction camp, along the mine access road approximately 2.4 miles from the Mine Site. It would initially house 434 workers and be expanded to house a maximum of 638 workers during mine operations. The camp would include six, three-story dormitory wings and a single-story core services facility. Dormitory wings would be attached to the core services building via heated utility tunnels (Section 2.3). Each dormitory would be designed with bedrooms to accommodate two single-occupancy employees, one on site and one off site, with every two rooms sharing a toilet-shower room.

For the pipeline, mobile and stationary construction camps would be used in locations along the pipeline ROW where construction and facility crews would require temporary housing during Construction. Construction camps would be moved as construction progresses. Of the seven proposed 300-person camps, only four would be active at any given time, to support an active construction spread (Section 2.3.2.3.4). The main campsites would be supplemented by fly-in camps without temporary road access along the ROW, to reduce travel time and commute distance. Camps would be relocated at the end of each construction season in preparation for future construction. As pipeline construction nears completion, the pipeline construction camps would be demobilized along with the pipeline construction equipment.

Donlin Gold plans to conduct worker code of conduct training and implement a closed work camp and workforce health education programs that would promote awareness of infectious diseases and preventive measures. Donlin Gold's health policies also promote a healthy workplace where workers who have infectious diseases (of any kind) could be diagnosed and treated, and measures taken to avoid transmittal of diseases to others.

Increases in Sexually Transmitted Infection Rates

Increases in STI rates could occur due to employment of workers from outside the region and/or the rotation of the workforce during the project phases, particularly the Construction Phase. Residents living in the vicinity of the project base camps would typically be the most vulnerable receptors to increases in STIs due to their proximity. However, because the Mine Site base camp would be located in a remote area, the probability of worker interactions with the residents living in local communities would be lower relative to the base camps that would be provided for construction of the Transportation Corridor and Pipeline.

STI rates are reported as high for the populations in the EIS Analysis Area, and account for 89.4 percent of reported infectious disease cases from 2007 to 2008 for Alaska Natives (University of Wisconsin 2011; ADHSS 2011, both as cited in Newfields 2015, 2016). Chlamydia trachomatis was reported as 10 times more common than the next STI (gonorrhea) (University of Wisconsin 2011; ADHSS 2011, both as cited in Newfields 2015, 2016). In 2011, the chlamydia rate in the Bethel Census Area was 2,321 cases per 100,000 population compared to the state rate of 711 cases per 100,000 population, with both rates increasing from previous years (University of Wisconsin 2011, as cited in Newfields 2015, 2016). Hepatitis C may be transmitted as an STI but also through other means such as blood transfusions.

For all components and project phases, the health effect is assigned a score of 1 (minor risk of health injury). The magnitude of this impact is assigned a score of 1 because those affected would be expected to adapt to this impact by obtaining medical care and may avoid such impacts in the first place, if the proposed educational and screening programs are effective. The geographic extent of this impact is assigned a score of 1 because this impact would be limited to infected individuals and their immediate partners.

The duration of this impact would correlate with the duration of the three project phases; therefore, the Construction Phase (3-4 years) is assigned a score of 2, and the Operations (27 years) and Closure (>50 years) phases are assigned a score of 3. Because the project would use individuals primarily from the region for the workforce (i.e., there would not be a major influx of workers from outside the region) and statewide STI rates are lower than for communities located in the EIS Analysis Area, it is expected that STI rates would not show a discernable change. Hence, the likelihood of increased STI rates is considered as likely as not (33-66 percent) for the construction of the transportation corridor and pipeline due to the larger workforce (including those that already have STIs and may transmit to others) that would be housed in base camps near local communities, but unlikely (10-33 percent) for the construction of the Mine Site due to expected remote location of base camp, and Operations and Closure phases due to the smaller workforce required for these phases. Further, the educational, preventive and treatment programs to be instituted as part of the project may also serve to prevent increases or possibly reduce the incidence of STIs.

The potential impact of increases in STI rates for the potentially affected communities is rated Category 1 for all phases and components, except for the Construction Phase for the Transportation Corridor and Pipeline, which is rated Category 2.

Increases in Infectious Diseases

Increases in infectious disease rates could occur due to employment of workers from outside the region and/or the rotation of the workforce during the project phases. Pneumonia, septicemia

and viral hepatitis were the top three causes of death due to infectious diseases (ADHSS 2007-2014, as cited in Newfields, 2015, 2016). No influenza deaths were reported during the same time period (ADHSS 2007-2014, as cited in Newfields 2015, 2016). Age-adjusted rates of death from communicable diseases have been consistently higher than those experienced in the state of Alaska since 2000 (ADHSS 2007-2014, as cited in Newfields 2015, 2016).

Impacts to human health due to increases in infectious disease rates would be the same as discussed for sexually transmitted diseases. In addition, workforce health education programs and screening and treatment would promote awareness of infectious diseases and preventive measures (such vaccinations for influenza, chickenpox, and measles). The potential impact of increases in infectious (respiratory) diseases rates for the potentially affected communities is rated Category 1 for all phases and components, except for the Construction Phase for the Transportation Corridor and Pipeline, which is rated Category 2.

Increases in Rates of Foodborne Illnesses and Zoonotic Diseases

Increases in rates of foodborne illnesses and zoonotic diseases could occur due to improper food handling/catering services and food disposal (harboring wildlife) at the base camps during the project phases. Food-borne illnesses could occur at the base camps and be transmitted to the local communities via rotating staff. Similarly, improper food disposal practices, such as harboring and feeding of wildlife near base camps, could encourage spread of zoonotic diseases within the base camp and be transferred to outside the camp due to rotation of staff from the local communities. The potential for increased rates of foodborne illnesses and zoonotic diseases due to improper food handling/catering services and food disposal (harboring wildlife) would be expected to impact primarily the local communities located near the project components. This scenario is considered unlikely if Donlin Gold adheres to and enforces food services regulations (such as 18 AAA 31) at the base camps or workforce housing.

The potential for increases in rates of foodborne illnesses and zoonotic diseases is greatest in base camps or workforce housing, which would occur at the Mine Site component and in the Construction Phase for other components. For all project phases, the health effect is assigned a score of 1 (minor risk of health injury). The magnitude of this impact is assigned a score of 1 because those affected would be expected to easily adapt to this impact. The geographic extent of this impact is assigned a score of 0 because this impact would be limited to individual cases. The duration of this impact is assigned as a score of 2 for the Construction Phase (3-4 years) and 3 for the Operations (27 years) and Closure (>50 years) phases. The likelihood of this impact occurring is very unlikely (1-10 percent) because the base camps would have safe food handling and disposal protocols in place to manage the food handling and catering services that would be provided for the project workforce. Inert, general Mine Site refuse (e.g., packaging, non-recyclable empty containers, non-putrescible refuse) would be placed directly into permitted on-site landfill trenches, and solid waste that contains organic matter (e.g., food scraps, paper, cardboard and wood scraps) would be incinerated in a burn pit or incinerator. The potential impact of increases in rates of foodborne illnesses and zoonotic diseases is rated Category 1 for all project phases.

Alternative 2, HEC 5 Impact Summary: Infectious Diseases

The summary impact for increases in rates of infectious (communicable) diseases (e.g., STIs, influenza, pneumonia, and foodborne illnesses) is rated Category 1 for Alternative 2,

acknowledging a potential Category 2 rating for the Construction Phase for the Transportation Corridor and Pipeline components (Table 3.22-21).

3.22.4.2.6 HEC 6: WATER AND SANITATION

The section presents the evaluation of the potential impacts of increases in morbidity and mortality rates due to the availability and quality of water and sanitation services. Table 3.22-23 summarizes the potential impact levels, including the potential health effect consequence, magnitude, duration, and geographic extent of the impact, and likelihood of the impact occurring.

Increases in Morbidity and Mortality Rates due to the Availability and Quality of Water and Sanitation Services

Increases in mortality and morbidity rates could occur due to overwhelming the availability and quality of water and sanitation services. The lack of a safe water supply (i.e., running water) and suitable sewage disposal are leading causes of preventable diseases in rural Alaska (Newfields 2015, 2016). Respiratory, gastrointestinal, and skin diseases are common in areas without safe water supplies (Newfields 2016). As of 2008, the YKHC had water and sanitation service for 58 percent of their communities. Based on the 2017 ADEC Village Safe Water Program (available online at: http://watersewerchallenge.alaska.gov/ruralCommunities.html), of the eight small Central Kuskokwim River communities, Crooked Creek, and Stony River were classified as "unserved Rural Alaska Communities" which is defined where 45 percent or more homes have not been served either via pipes, septic tank and well, or covered haul systems. The other communities are served by central wells and a mix of central sewage plumbing, septic systems, honey buckets, and outhouses; smaller towns have community washeterias for laundry and bathing (Newfields 2015, 2016). As reported in Newfields (2016), approximately 95 percent of the homes in Crooked Creek community lack plumbing; residents haul water and use honeybuckets. The Donlin Gold Project may bring financial resources to the Y-K Region that could be used (at the discretion of community leaders) to invest in necessary improvements to existing village water and sanitation systems.

Table 3.22-21: Summary of HEC 5 Impacts: Infectious Diseases

Potential Impact	Project Component	Project Phase	Negative/ Positive	Health Effect	Magnitude	Duration	Geographic Extent	Severity Ranking	Likelihood Rating	Impact Rating	Impact Category
Increase in sexually transmitted infection rates (including gonorrhea, chlamydia, Hepatitis C, and HIV)	All components: Mine Site, Transportation Corridor, Pipeline	Construction	–	1, minor	1 noticeable, but limited and localized	2, medium-term	1, limited to infected individuals and their partners	**5**	33-66% (T, P) 10-33% (M)	****** *****	**2** **1**
		Operations		1, minor	1, noticeable, but limited and localized	3, long-term	1, limited to infected individuals and their partners	**6**	10-33%	*	**1**
		Closure		1, minor	1, noticeable, but limited and localized	3, long-term	1, limited to infected individuals and their partners	**6**	10-33%	*****	**1**
Increase in infectious (respiratory) disease morbidity and mortality rates (e.g., influenza and pneumonia)	All components: Mine Site, Transportation Corridor, Pipeline	Construction	–	1, minor	1, noticeable, but limited and localized	2, medium-term	1, limited to infected individuals and their households/ neighbors	**5**	33-66% (T, P) 10-33% (M)	******	**2** **1**
		Operations		1, minor	1, noticeable, but limited and localized	3, long-term	1, limited to infected individuals and their households/ neighbors	**6**	10-33%	*	**1**
		Closure		1, minor	1, noticeable, but limited and localized	3, long-term	1, limited to infected individuals and their households/ neighbors	**6**	10-33%	*****	**1**
Increase in rates of foodborne illness and zoonotic diseases	All components: Mine Site, Transportation Corridor, Pipeline	Construction	–	1, minor	1, noticeable, but limited and localized	2, medium-term	0, limited to individual cases	**4**	1-10%	*****	**1**
		Operations		1, minor	1, noticeable, but limited and localized	3, long-term	0, limited to individual cases	**5**	1-10%	*****	**1**
		Closure		1, minor	1, noticeable, but limited and localized	3, long-term	0, limited to individual cases	**5**	1-10%	*****	**1**

Notes:
M = Mine Site
T = Transportation Corridor
P = Pipeline

Table 3.22-22: Summary of HEC 6 Impacts: Water and Sanitation

Potential Impact	Project Component	Project Phase	Negative/ Positive	Health Effect	Magnitude	Duration	Geographic Extent	Severity Ranking	Likelihood Rating	Impact Rating	Impact Category
Increase in morbidity and mortality rates due to the availability and quality of water and sanitation facilities	All components: Mine Site, Transportation Corridor, Pipeline	Construction	–	1, minor	1, adaptable and able to maintain pre-impact levels of health	2, medium-term	0, limited to individual cases	**4**	1-10%	*	**1**
		Operations		1, minor	1, adaptable and able to maintain pre-impact levels of health	3, long-term	0, limited to individual cases	**5**	1-10%	*	**1**
		Closure		1, minor	1, adaptable and able to maintain pre-impact levels of health	3, long-term	0, limited to individual cases	**5**	1-10%	*	**1**

Water and sanitation services would be associated with base camps or workforce housing, which would occur at the Mine Site component and in the Construction Phase for other components. For all project phases, the health effect is assigned a score of 1 (minor). The magnitude of this impact is assigned a score of 1 because those affected would be expected to easily adapt to this impact. The geographic extent of this impact is assigned a score of 0 because this impact would be limited to individual cases. The duration of this impact is assigned a score of 2 for the Construction Phase (3-4 years) and 3 for the Operations (27 years) and Closure (>50 years) phases. Donlin Gold would provide water and sanitation services at the base camps for the workforce for the three project phases (Section 2.3.2.1.7, Descriptions of Alternatives). Although it is projected that the Donlin Gold Project would not directly affect access to water and sanitation services in the local communities, it is possible that project-induced inward migration of workers could increase the number of local community users that would be serviced by existing water and sanitation resources. However, it is also probable that improvements to water and sanitation services could occur through government taxes and borough services due to the economic benefits of the project (Section 3.18.2.2.3, Socioeconomics). Therefore, the likelihood of increasing mortality and morbidity rates due to change in the availability and quality of water and sanitation services of communities located near the Donlin Gold Project is considered very unlikely (1-10 percent). The potential impact of increases in mortality and morbidity rates due to change in the availability and quality of water and sanitation services is rated Category 1 for the potentially affected communities for all project phases.

Alternative 2, HEC 6 Impact Summary: Water and Sanitation

The summary impact level for increases in morbidity and mortality rates due to changes in the availability and quality of water and sanitation services is rated Category 1 for Alternative 2. It is very unlikely that water and sanitation services of communities located near the Donlin Gold Project would be affected (Table 3.22-22).

3.22.4.2.7 HEC 7: NON-COMMUNICABLE AND CHRONIC DISEASE

This section presents the evaluation of the potential impacts of increases in non-communicable and chronic (such as cancer, respiratory, and cardiovascular) morbidity and mortality rates in the potentially affected communities. Although several factors (such as obesity, diabetes, and hyperlipidemia) can contribute to increases in non-communicable and chronic morbidity and mortality rates, the evaluation of potential impacts focused on factors that could be directly attributed to the project. Table 3.22-24 summarizes the potential impact levels for non-communicable and chronic disease morbidity and mortality rates, including the potential health effect consequence, magnitude, duration, and geographic extent of the impact, and likelihood of the impact occurring.

Increases in Cancer, Respiratory, and Cardiovascular Morbidity and Mortality Rates

Increases in exposure to potentially hazardous chemicals could occur during Construction, Operation, and Closure for all components that could result in increases in non-communicable and chronic (such as cancer, respiratory, and cardiovascular) morbidity and mortality rates in the potential affected communities. For example, there is reported correlation between increased exposure to hazardous air constituents and increases in the morbidity and mortality

rates for cancer (IARC 2013; Hystad et al. 2013; Kota et al. 2011; Turner et al. 2011), chronic lower respiratory diseases (CLRD) (Koren 1995; Schwela 2000; Chen 2008; Kota et al. 2011), and cardiovascular diseases (Atkinson et al. 2013; Gan et al. 2010, 2011; Yorifuji et al. 2010).

Extensive media-specific modeling and evaluations were performed for a variety of constituents and source types (stationary and mobile) for components and phases for the project. In addition, a FRA (Appendix AB), and a quantitative HHRA (ERM 2017), was conducted to evaluate the potential impacts of increased exposure to potentially hazardous chemicals in air, surface water, sediment, soil, groundwater, and biota (fish, waterfowl, wildlife, and plant food items) as a result of the Donlin Gold Project. Based on the findings of the FRA, the project is not expected to pose a health concern because potential exposure would be either insignificant or not expected to result in substantial incremental changes in non-cancer hazard and cancer risk relative to baseline (based on the HHRA).In addition, mitigation measures and required best management practices would be implemented to further minimize potential exposures of hazardous chemicals to receptors in the potential affected communities.

For the three components and project phases, the health effect is assigned a score of 0 (not noticeable). The magnitude of the impact is assigned a score of 0 (minor) because potential exposure is not expected to pose a health concern based on the findings of the FRA (Appendix AB) and quantitative HHRA (ERM 2017). The geographic extent of this impact is assigned a score of 2 because the communities within the vicinity of the Project Area could be potentially affected. The duration of this impact is assigned a score of 2 for the Construction Phase (3-4 years) and 3 for the Operations (27 years) and Closure (>50 years) phases. The likelihood of increased cancer, respiratory, and cardiovascular morbidity and mortality rates due to increased exposure to potentially hazardous chemicals is considered very unlikely (1-10 percent) because potential exposures are not expected to pose a health concern based on the findings of the FRA (Appendix AB) and quantitative HHRA (ERM 2017). The summary impact level for increased morbidity and mortality rates for cancer, respiratory, and cardiovascular diseases for the potentially affected communities is rated Category 1 for Alternative 2.

Table 3.22-23: Summary of HEC 7 Impacts: Non-communicable and Chronic Diseases

Potential Impact	Project Component	Project Phase	Negative/ Positive	Health Effect	Magnitude	Duration	Geographic Extent	Severity Ranking	Likelihood Rating	Impact Rating	Impact Category
Increase in cancer, respiratory, and cardiovascular morbidity and mortality rates	All components: Mine Site, Transportation Corridor, Pipeline	Construction	–	0, not noticeable	0, minor	2, medium-term	2, potentially affected community	**4**	1-10%	*	**1**
		Operations		0, not noticeable	0, minor	3, long-term	2, potentially affected community	**5**	1-10%	*	**1**
		Closure		0, not noticeable	0, minor	3, long-term	2, potentially affected community	**5**	1-10%	*	**1**

Table 3.22-24: Summary of HEC 8 Impacts: Health Services Infrastructure and Capacity

Potential Impact	Project Component	Project Phase	Negative/ Positive	Health Effect	Magnitude	Duration	Geographic Extent	Severity Ranking	Likelihood Rating	Impact Rating	Impact Category
Access to routine healthcare	All components: Mine Site, Transportation Corridor, Pipeline	Construction	–	1, minor	1, adaptable and able to maintain pre-impact levels of health	2, medium-term	1, limited number of households	**5**	10-33%	*	**1**
		Operations		1, minor	1, adaptable and able to maintain pre-impact levels of health	3, long-term	1, limited number of households	**6**	10-33%	*	**1**
		Closure		1, minor	1, adaptable and able to maintain pre-impact levels of health	3, long-term	1, limited number of households	**6**	10-33%	*	**1**
Access to healthcare due to emergency situations and overwhelming local and regional healthcare capacities	All components: Mine Site, Transportation Corridor, Pipeline	Construction	–	2, moderate	1, adaptable and able to maintain pre-impact levels of health	2, medium-term	2, potentially affected community	**7**	1-10%	**	**2**
		Operations		2, moderate	1, adaptable and able to maintain pre-impact levels of health	3, long-term	2, potentially affected community	**8**	1-10%	**	**2**
		Closure		2, moderate	1, adaptable and able to maintain pre-impact levels of health	3, long-term	2, potentially affected community	**8**	1-10%	**	**2**

3.22.4.2.8 HEC 8: HEALTH SERVICES INFRASTRUCTURE AND CAPACITY

Access to health services is important for achieving health equity and increasing the quality of life for all individuals. The level of access to health services can impact life expectancy, mortality, and morbidity rates; early detection and treatment of health conditions, and control of infectious diseases (access to vaccines). The following subsections present the evaluation of the potential impacts due to decreased access to healthcare under routine conditions and emergency situations that could overwhelm local and regional healthcare capacities. Table 3.22-25 summarizes the potential impact levels for health services infrastructure and capacity, including the potential health effect consequence, magnitude, duration, and geographic extent of the impact, and likelihood of the impact occurring.

Access to Routine Healthcare

The workforce estimated for Alternative 2 has the potential to impact access to routine healthcare. Several entities provide healthcare services in the EIS Analysis Area. As noted in Section 2.3.2.1.11, Descriptions of Alternatives, on-site mine rescue and medical emergencies would be handled by a mine rescue team. The team would include advanced first aid and emergency medical technician trained personnel. Medical evacuation would be available by fixed-wing aircraft or helicopter to fly injured workers to medical facilities. All industrial camps would also include first-aid units. The workforce employed at transportation facilities located near the Mine Site (such as the airstrip and mine access road) would have access to medical services that would be available at the base camps. Workforce employed at other transportation facilities may obtain routine healthcare from the primary healthcare facility in Bethel and/or Dutch Harbor.

For all project phases, the health effect is assigned a score of 1 (minor). The magnitude of the effect is assigned a score of 1 (residents living in the local communities would be able to easily adapt to the impact). The residents that routinely use the small clinics, such as those in the Kuskokwim River communities that are in close proximity to the Mine Site, could potentially be affected; therefore, the geographic extent of the impact is assigned a score of 1 because a limited number of households would be potentially affected. The duration of this impact is assigned a score of 2 for the Construction Phase (3-4 years) and 3 for the Operations (27 years) and Closure (>50 years) phases. Given that Donlin Gold would provide base camps equipped with on-site medical facilities for routine use (e.g., vaccinations) by the workforce, it is unlikely (10-33 percent) that employees would routinely use off-site community healthcare resources. Therefore, a noticeable effect on access to routine healthcare services is not expected for residents living in the EIS Analysis Area, including the communities near the Mine Site. The potential impact of decreased access to routine healthcare in the EIS Analysis Area would be low for all components and project phases.

Access to Healthcare due to Large Scale Emergency Situations and Overwhelming Local and Regional Healthcare Capacities

There is the potential to impact access to healthcare services and overwhelm local and regional capacities due to emergency situations that could occur during implementation of the Donlin Gold Project. However, while this scenario is possible, the probability of occurrence of emergency scenarios is expected to be rare. While much of the region is classified as medically

underserved or has a shortage of health care professionals, the more urbanized communities such as Bethel, the MSB, and KPB, are serviced by a more extensive network of healthcare facilities including the YKDRH in Bethel, Fairbanks Memorial Hospital, McGrath Health Center, Central Kenai Peninsula Hospital, and the Dena'ina Health Clinic. Potential serious/life-threating emergency scenarios associated with the Donlin Gold Project would be most likely handled by the more advanced healthcare facilities in Anchorage.

There is only one primary hospital (in Bethel) available for residents near the Mine Site that can handle emergency situations. Due to the remote region and terrain, air travel is the primary mode of large distance transportation, especially for medical issues. The industrial facility medical resources may not have the qualified or appropriate staff or equipment to handle life-threating health conditions or multiple injured personnel in an emergency situation. Also, availability and response time for air flight resources to provide travel to Bethel or Anchorage could be a limiting factor for quick access to healthcare if multiple individuals require emergency care.

For all project phases, the health effect is assigned a score of 2 (moderate injury that may require intervention). The magnitude of this impact is assigned a score of 1 because those potentially affected are estimated to be able to adapt to the impact and maintain pre-impact levels of health. The geographic extent of this impact is assigned a score of 2 because the potentially affected communities in the region could be affected. The duration of this impact is assigned a score of 2for the Construction Phase (3-4 years) and 3 for the Operations (27 years) and Closure (>50 years) phases. While this scenario is possible, the probability of occurrence of emergency scenarios is expected to be rare due to industrial safety protocols that would be employed. Therefore, this impact is considered very unlikely (1-10 percent) to occur.

Alternative 2, HEC 8 Impact Summary: Health Services Infrastructure and Capacity

Under routine conditions, decreased access to healthcare services is rated Category 1. Under emergency situations, the summary impact is rated Category 2 with potential to overwhelm health care capacities. Emergency situations are generally considered to be events with low probability of occurrence.

3.22.4.2.9 CLIMATE CHANGE

The Donlin Gold Project would contribute to climate change as discussed in Section 3.8, Air Quality, and Section 3.26, Climate Change, through production of greenhouse gasses. The level of greenhouse gas emissions generated by implementation of Alternative 2 is not likely to create climate change effects to human health. In general, impacts to and from permafrost due to climate change would range from scenarios in which there would be little noticeable additional ground settlement from climate change, to scenarios in which design and BMPs at major Mine Site structures and along the Pipeline would be effective in controlling permafrost hazards, differential settlement, and thermal erosion (see Section 3.26, Climate Change). Wildlife habitat could be impacted by vegetation and wetland changes due to climate change, causing impacts to wildlife and bird species; these changes in biological resources could translate into changes in the quantity and quality of subsistence resources available to area residents. If current climate change trends persist, impacts to human health and use would likely be similar to those discussed in Section 3.22.3.7.

3.22.4.2.10 SUMMARY OF IMPACTS FOR ALTERNATIVE 2

Table 3.22-26 shows impact ratings for the HECs under Alternative 2. Impacts to human health would be the same under Alternative 2 - North Option. Human health impacts resulting from Alternative 2 would be unique in context because they would affect primarily low income and minority communities, as discussed in Section 3.19, Environmental Justice. However, it is noted that much of the affected community area would qualify as having majority populations of low income and minority communities.

Project-related economic benefits are rated Category 3 and are expected to result in benefits to many aspects of human health, including increased income, employment and educational opportunities as well as increased diet composition and food security. Economic benefits are also likely to have positive effects on affordability of healthcare services and improving mental health, including suicide rates. No negative impacts at a rating of Category 3 were identified.

Other benefits that are rated as Category 2 include reduced food costs and improved social well-being for both positive and negative effects (i.e., psychosocial stress and substance abuse). Negative health consequences rated as Category 2 may be related to potential accidents and injuries for all phases (due to accidents by air, water, or suicide), decreased access to healthcare due to emergency situations, and increased infectious (communicable) diseases rates during the Construction phase.

Potential impacts that were classified as Category 1 include both positive and negative effects related to family stress and stability, accidents by surface transportation, reduced access to water and sanitation, reduced access to subsistence resources, increased risk of exposure to potentially hazardous chemicals, reduced access to routine healthcare, and increases in infectious and non-communicable diseases rates that are subject to control and mitigation based on the Donlin Gold Project plans.

Overall, the economic and health benefits of improvements in economic status are considered to be substantial for the residents of the affected communities. Many of the other potential impacts were generally assigned a score of 1, and adaptable in magnitude, except for potential increases in accidents and injuries where the magnitude of the impact is assigned a score of 3 and may require medical intervention. The duration of the impacts are generally assigned a score of 2 or 3 based on the duration of the project phases. In general, the geographic extent of the impacts would range from 0 to 1, with the exception of the potential for increased rates of non-communicable and chronic diseases and access to healthcare due to emergency situations potentially overwhelming local and regional healthcare capacities. As noted in the discussion of emergency situations, these are considered to be low probability events.

Table 3.22-25: Alternative 2 Impact Levels by HEC

Health Effects Categories[1]	Summary Impact Category	Adverse or Beneficial Rating
HEC 1: Social Determinants of Health		
Household incomes, employment, and education attainment	3	+
Psychosocial stress	2	+/-
Substance abuse (including drug and alcohol)	2	+/-
Family stress and instability	1	+/-
HEC 2: Accidents and Injuries		
Unintentional accidents and injuries morbidity and mortality rates due to air transportation	2	-
Unintentional accidents and injuries morbidity and mortality rates due to surface transportation	1	-
Unintentional accidents and injuries morbidity and mortality rates due to water transportation	2	-
Intentional injury: suicide rate	2	-
HEC 3: Exposure to Potentially Hazardous Materials		
Mercury impacts to air quality	1	-
Surface water impacts	1	-
Groundwater impacts	1	-
Air quality impacts due to PM and VOCs	1	-
Bioaccumulated chemicals in fish	1	-
Bioaccumulated chemicals in waterfowl and wildlife	1	-
HEC 4: Food, Nutrition, and Subsistence Activity		
Region food costs (expressed as a percent of median household income)	2	+
Diet composition and food security	3	+
Access to and quantity of subsistence resources	1	-
HEC 5: Infectious Disease		
Rates of STI such as gonorrhea, chlamydia, and HIV	1-2	-
Rates of respiratory diseases such as influenza and pneumonia	1-2	-
Foodborne illness and zoonotic disease	1	-
HEC 6: Water and Sanitation		
Access to water and sanitation facilities	1	-
HEC 7: Non-communicable and Chronic Disease		
Cancer, respiratory, and cardiovascular morbidity and mortality rates	1	-
HEC 8: Healthcare Services Infrastructure and Capacity		
Access to routine healthcare	1	-
Access to healthcare due to large scale emergency situations	2	-

Notes:

1 The impact level assessment rating accounts for impact reducing design features proposed by Donlin Gold and Standard Permit Conditions and BMPs that would be required. It does not account for additional mitigation measures being considered.
The ratings presented in this table are based on the ADHSS (2011, 2015) methodology. The terms differ from terms used in other sections of the EIS. See Section 3.22.3 and Tables 3.22-15 and 3.22-16 for overview of methodology.

Table 3.22-26: Summary of Health Impact Reducing Design Features, Permit Conditions, and Best Management Practices

Potential Impact/Benefit	Design Features	Standard Permit Conditions	Best Management Practices
HEC 1: Social Determinants of Health Potential economic benefit	Donlin Gold would provide health coverage for employees, which would provide access to healthcare for their families as well. These potential benefits may be noticeable in terms of increased access and utilization of healthcare (e.g., more visits to healthcare providers and increased use of treatment options because they would be more affordable under employee-provider health coverage).	Not applicable	Not applicable
HEC 1: Social Determinants of Health Increased rates of substance abuse, stress and family instability	Donlin Gold would develop and implement a drug and alcohol abuse prevention program for employees as well as programs regarding workplace behavior, sexual harassment, healthy eating and wellness, and cultural sensitivity. These prevention programs are intended to discourage negative behaviors by employees; however, these programs typically raise general awareness of these issues in local communities (including employee families and friends) outside of the project boundaries. The benefits of a drug- and alcohol-free workplace and zero tolerance drug and alcohol policy will realize positive benefits (such as increased family stability, reduced divorce rates, domestic violence, child abuse, intentional accidents and injuries, and sexual harassment) within the local communities.	Not applicable	Not applicable
HEC 2: Impacts: Accidents and Injuries Increase in unintentional accidents and injuries morbidity and mortality rates	Donlin Gold would develop an Operations and Maintenance Plan/Manual; Health, Safety, and Environment Plan (including a Safety Plan/Program), Pipeline Surveillance and Monitoring Plan, and other plans that would outline safety measures that would be implemented during the life of the project.	Not applicable	Not applicable
HEC 3: Exposure to Potentially Hazardous Materials Increased risk of exposure to air, soil, groundwater, surface water, and sediment, and bioaccumulated in biota	Donlin Gold will monitor physical, chemical (water quality) and biological (fish, waterfowl, wetlands) resources during all project phases (Construction, Operations, Closure) in Crooked Creek.	Developing spill prevention and response type plans as required by federal and state requirements. The plan(s) would prescribe effective processes and procedures to prevent the spill of fuel or hazardous substances and include procedures to respond to accidental releases	Developing an Erosion and Sediment Control Plan and Storm Water Pollution Prevention Plans prior to the commencement of ground disturbance activities.

Table 3.22-26: Summary of Health Impact Reducing Design Features, Permit Conditions, and Best Management Practices

Potential Impact/Benefit	Design Features	Standard Permit Conditions	Best Management Practices
HEC 3: Exposure to Potentially Hazardous Materials Increased risk of exposure to air, soil, groundwater, surface water, and sediment, and bioaccumulated into biota	At the TSF dry beach the project design includes installing silt fences, removing snow from active placement areas only, and using polymer dust suppressant.	Not applicable	Developing an Erosion and Sediment Control Plan and Storm Water Pollution Prevention Plans prior to the commencement of ground disturbance activities.
HEC 5: Infectious Diseases Increase in rates of sexually transmitted infection rates	Donlin Gold would develop a program that includes work place education, prevention, screening, treatment, and prevention of transmission of infectious diseases. This program would promote awareness of infectious diseases and preventive measures and promote a healthy workplace, where workers who have infectious diseases could be diagnosed and treated expeditiously, and measures would be taken to avoid transmittal of diseases to other workers as well as residents in the local communities.	Not applicable	Not applicable
HEC 8: Health Services Infrastructure and Capacity Access to Healthcare Services Infrastructure and Capacity due to routine care required by workforce or due to large scale emergency situations that could overwhelming local and regional healthcare capacities.	Donlin Gold would develop an Operations and Maintenance Plan/Manual; Health, Safety, and Environment Plan (including a Safety Plan/Program), Pipeline Surveillance and Monitoring Plan, and other plans that would outline safety measures that would be implemented during Operations.	Not applicable	Not applicable

3.22.4.2.11 MITIGATION AND MONITORING FOR ALTERNATIVE 2

Effects determinations take into account impact reducing design features (Table 5.2-1 in Chapter 5, Impact Avoidance, Minimization, and Mitigation) proposed by Donlin Gold and also the Standard Permit Conditions and BMPs (Section 5.3) that would be implemented. Several examples of these are presented below (also see Table 3.22-27 for further details).

Design features important for reducing impacts to human health include:

- Where practicable, construction and maintenance schedules would seek to minimize impacts on subsistence hunting and fishing, with the understanding that some construction activities must also take advantage of seasonal and environmental conditions;
- Donlin Gold would implement a no hunting/fishing policy for employees at work sites to minimize competition from employees for local resources;
- Shareholder preference in hiring maximizes economic benefit to local communities (minority and low income); along with enclave work place, this minimizes risk of influx of non-local workers into nearby communities;
- The project design includes shift work schedules to maximize opportunities for employees to remain active in subsistence harvest efforts during Construction and Operations phases;
- Donlin Gold would develop and implement a drug and alcohol abuse prevention program for employees during all phases of the project. Donlin Gold would develop and apply employee sensitivity training for issues such as cultural respect, racial bias, and sexual harassment. They would provide counselors; and discuss the dangers and history of alcoholism and drug abuse;
- Donlin Gold would develop an Operations and Maintenance Plan/Manual; Health, Safety, and Environment Plan (including a Safety Plan/Program); Pipeline Surveillance and Monitoring Plan; and other plans that would outline safety measures that would be implemented during Operations;
- Cyanide and mercury spill response planning would be components of Donlin Gold's hazardous materials management and spill plans. The applicable training, inspection, reporting, preparedness, spill prevention, contingency planning, and emergency procedures required by RCRA and ADEC Division of Spill Prevention and Response would be implemented. Emergency response information would be provided and maintained according to Title 49 CFR 172;
- A detailed Mercury Management Plan would be developed that describes mercury control systems, storage areas, inspections, training, hazard communication, and procedures for off-site transport and disposal (Donlin Gold 2015d). Implementation of this plan would minimize the potential for release of mercury to the environment through normal ancillary activities;
- A Fugitive Dust Control Plan and air quality permit requirements would be followed that describe BACTs and source testing for PM emissions, BMPs for controlling dust

from site activities (including roads) and wind erosion, and training and performance assessment procedures (ADEC 2017i);

- Design features for cyanide include cyanide detoxification of the leach tailings and cyanide handling, storage, and transport in compliance with the International Cyanide Management Code (ICMC);
- Special ISO-approved water tight tank-tainers would be used for the transport of cyanide and the containers would be tracked during shipment. Design features for cyanide also include cyanide handling, storage, and transport in compliance with the ICMC;
- The project design includes special flasks and metric ton containers for mercury transport;
- To reduce impacts on existing river traffic and potential for groundings and accidents, Donlin would establish navigational aids and develop procedures for queuing in narrow channels. Donlin Gold vessels would use state-of-the-art navigation and communication equipment; and
- The project design includes new, dedicated transportation equipment and infrastructure (such as the new port at Angyaruaq (Jungjuk), the Mine Site airstrip, and the double-hulled barges) that would minimize impacts to existing regional transportation facilities and activities.

Standard Permit Conditions and BMPs important for reducing impacts to human health include:

- Implementation of Storm Water Pollution Prevention Plans (SWPPPs) and Erosion and Sediment Control Plans (ESCPs);
- Development and maintenance of Oil Discharge Prevention and Contingency Plans (ODPCPs), Spill Prevention, Control, and Countermeasure (SPCC) Plans, and Facility Response (FRP) Plans;
- Use of BMPs such as revegetation planning, watering and use of dust suppressants to control fugitive dust;
- Preparation and implementation of a Wildlife Avoidance and Human Encounter/Interaction Plan; and
- Compliance with Alaska Ambient Air Quality Standards (AAAQS), National Ambient Air Quality Standards (NAAQS), and Prevention of Significant Deterioration (PSD) increments.

Additional measures are being considered by the Corps and cooperating agencies to further minimize project impacts, as reasonable and practicable, and are further assessed in Chapter 5, Impact Avoidance, Minimization, and Mitigation (Section 5.5 and Section 5.7). Examples of additional measures being considered that are applicable to this resource include:

- To control dust, reclaim the dry stack tailings incrementally rather than wait until Closure (Alternative 5A), to the extent practicable;

- Make the Emergency Action Plan for the tailings dam available to the public to review. Require a communication and alert system to be in place that is sufficient to warn people in Crooked Creek and boaters on the Kuskokwim near Crooked Creek of the potential need to move out of the area; and
- Place mercury monitors at locations in the workplace where mercury vapor is collected to ensure that workers are not exposed by inhalation.

3.22.4.3 ALTERNATIVE 3A – REDUCED DIESEL BARGING: LNG-POWERED HAUL TRUCKS

Alternative 3A would use liquefied natural gas (LNG) instead of diesel to power the large trucks that would move waste rock and ore from the open pits. Alternative 3A would result in a reduction of total river barge traffic from 122 in Alternative 2 to 83 by reducing the amount of diesel fuel that would be barged. The primary differences between this alternative and Alternative 2 are the addition of the LNG plant and storage tanks near the process plant, reduced consumption of diesel, reduced barge trips, reduced on-site diesel storage, and increased natural gas consumption.

Overall, the positive and negative health consequences related to Alternative 3A would be similar to Alternative 2 for most of the HECs for the all components. The HECs for which consequences may be different from Alternative 2 are as follows:

3.22.4.3.1 HEC 2: MORTALITY AND MORBIDITY ASSOCIATED WITH ACCIDENTS RELATED TO WATER TRANSPORT

Under Alternative 3A, the increase in barge traffic for both ocean and river barges under Alternative 3A (relative to baseline), though less than Alternative 2, would still result in noticeable disturbance and limited displacement of other uses at the Bethel Port facilities and in narrow reaches of the river.

3.22.4.3.2 HEC 3: EXPOSURE TO HAZARDOUS CONSTITUENTS

This alternative would decrease emission loads and thereby reducing the overall quantity of hazardous contaminants in the air at the Mine Site and along the transportation corridors during the Operations Phase. The health effect improvement would be localized and limited to the Construction and Operations phases. Since diesel engines would still be used at other project components and phases, there would be no change to the list of hazardous contaminants, exposure pathways or receptors. The potential health impact from exposure to media contaminated by a spill or leak of diesel fuel would be reduced.

Overall, the consequences related to hazardous constituents for this alternative are related to the Transportation Corridor component. There may be less exposure to hazardous constituents in air and in surface water in the Kuskokwim River, but constituents in air would be less than the applicable air quality standards and permitting thresholds for both alternatives 2 and 3A. Impacts to water quality may be seen as lower concentrations of chemicals in water and aquatic biota, in comparison to Alternative 2, thus resulting in lower exposures. Impacts to human health related to air quality, surface water quality, and consumption of fish from the

Kuskokwim River, as associated with Alternative 3A, are rated Category 1; the same as for Alternative 2.

3.22.4.3.3 HEC 4: ACCESS TO AND QUANTITY OF SUBSISTENCE RESOURCES

The reduction in river barge traffic would reduce the magnitude of impacts to fish and subsistence fishing in narrow reaches of the river, relative to Alternative 2. Effects on subsistence uses from changes in subsistence resources and access to subsistence resources in the vicinity of the Mine Site and along the pipeline route would be the same as in Alternative 2. The summary impact of Alternative 3A would be the same as Alternative 2 (Category 1).

3.22.4.3.4 SUMMARY FOR ALTERNATIVE 3A

Overall, the health consequences for Alternative 3A are similar to Alternative 2. The health consequences related to Alternative 3A that were considered to be different from Alternative 2 were reduced rates of accidents and injuries related to water transport; reduced exposures to hazardous constituents in air, water and aquatic biota; and greater access to and quantity of subsistence resources. While the reduction in these consequences relative to Alternative 2 would be considered beneficial to health, these health effects are rated Category 2, the same as Alternative 2. Impacts associated with climate change would also be the same as discussed for Alternative 2. The effects determinations take into account applicable impact reducing design features and monitoring, as discussed in Alternative 2.

3.22.4.4 ALTERNATIVE 3B – REDUCED DIESEL BARGING: DIESEL PIPELINE

Under Alternative 3B, an 18-inch diameter diesel pipeline would be constructed from Cook Inlet to the Mine Site to eliminate diesel barging on the Kuskokwim River. Alternative 3B would eliminate the 58 fuel barge tow round trips per year required under Alternative 2. Total annual barging would be reduced from 122 under Alternative 2 to 64, as cargo barging would still occur on the Kuskokwim River, as proposed in Alternative 2. The natural gas pipeline proposed in Alternative 2 would not be constructed. The diesel pipeline would be located in the same corridor proposed for the natural gas pipeline under Alternative 2, with an additional 18-mile segment from the proposed terminus of the natural gas pipeline, south to Tyonek or to Port MacKenzie. This additional segment would cross the Beluga River or the Susitna and Little Susitna Rivers.

Two options to Alternative 3B have been added based on Draft EIS comments from agencies and the public:

- **Port MacKenzie Option:** The Port MacKenzie Option would utilize the existing Port MacKenzie facility to receive and unload diesel tankers instead of the Tyonek facility considered under Alternative 3B. A pumping station and tank farm of similar size to the Tyonek conceptual design would be provided at Port MacKenzie. A pipeline would extend northwest from Port MacKenzie, route around the Susitna Flats State Game Refuge, cross the Little Susitna and Susitna rivers, and connect with the Alternative 3B alignment at approximately MP 28. In this option, there would be no improvements to the existing Tyonek dock; a pumping station and tank farm would not be constructed near Tyonek; and the pipeline from the Tyonek tank farm considered under Alternative 3B to MP 28 would not be constructed.

- **Collocated Natural Gas and Diesel Pipeline Option**: The Collocated Natural Gas and Diesel Pipeline Option (Collocated Pipeline Option) would add the 14-inch-diameter natural gas pipeline proposed under Alternative 2 to Alternative 3B. Under this option, the power plant would operate primarily on natural gas instead of diesel as proposed under Alternative 3B. The diesel pipeline would deliver the diesel that would be supplied using river barges under Alternative 2 and because it would not be supplying the power plant, could be reduced to an 8-inch-diameter pipeline. The two pipelines would be constructed in a single trench that would be slightly wider than proposed under either Alternative 2 or Alternative 3B and the work space would be five feet wider. The permanent pipeline ROW would be approximately two feet wider. This option could be configured with either the Tyonek or Port MacKenzie dock options.

This alternative would require either construction of a new dock or dock expansion in Tyonek or utilization of the Port MacKenzie facility. A new tanker berth system would be needed at Tyonek to accommodate the tide, ice, and seismic conditions and provide adequate depth for continuous 24-hour operation. A barge landing at Tyonek sufficient for most tidal stages would be required to support the construction and operation of the facilities. Tanks sufficient for storing one month's fuel consumption, approximately 10-million gallons, would be installed at each end of the pipeline. There would be no change in the location of the Mine Site under Alternative 3B; however, diesel fuel would be used instead of natural gas.

The positive and negative health consequences related to Alternative 3B would be similar to Alternative 2 for most of the Health Effects Categories for all Options. The HECs for which consequences may be different from Alternative 2 are as follows:

3.22.4.4.1 HEC 2: MORTALITY AND MORBIDITY ASSOCIATED WITH ACCIDENTS AND INJURIES

The potential human health impact would be similar to Alternative 2, noting a potential reduction in accidents and injuries with a decrease in barge traffic along the Kuskokwim River during the Operations Phase; however, there would be increased barge traffic at Tyonek, primarily during the Construction Phase. Other impact ratings would remain the same. The summary impact is rated Category 2.

3.22.4.4.2 HEC 3: EXPOSURE TO HAZARDOUS CONSTITUENTS

Under normal operations, this alternative would not change the hazardous contaminants, exposure pathways, or receptors. Relative to Alternative 2, this alternative would have less negative impacts on air quality, water quality, and biota in the Kuskokwim River due to the reduction in barge traffic. The reduction in barge volume under Alternative 3B would dramatically reduce the spill risks associated with diesel fuel transport using river barge, tank farm storage, and tanker trucks. However, this alternative introduces additional spill risks associated with the transportation of fuel along the pipeline corridor. Under Alternative 3B, there is the possibility for diesel spills to occur in remote areas. As noted in Section 3.24.2.1 (Spill Risk), there are regulations that require spill prevention and response planning for companies that store or transport diesel. As these companies operate in remote areas, response gear is prepositioned, as appropriate (e.g., carried on each tank barge, stationed at storage and transfer facilities), that would be used by initial responders in the event of a spill. This response

equipment typically includes sorbents, containers, deflective or sorbent booms, pumps, skimmers, and/or skiffs. In some areas, companies collaborate to share equipment and responders in order to maximize their ability to respond quickly, while keeping costs down (see Section 3.24.1, Spill Risk for additional information). The summary impact rating is Category 1; the same as for Alternative 2.

3.22.4.4.3 HEC 4: HEALTH EFFECTS ASSOCIATED WITH ACCESS TO AND QUANTITY OF SUBSISTENCE RESOURCES

Negative health impacts related to subsistence activity would be reduced under Alternative 3B, with a decrease in river barge traffic, resulting in decreased disturbance in the Kuskokwim River could accommodate greater access to and quantity of subsistence resources. However, during the construction of the dock in Tyonek, increased subsistence disturbance could occur. Construction activities have the potential to cause marine mammals in the vicinity to be behaviorally disturbed and may temporarily displace marine life from routine hunting areas; it is expected that animals would likely return after cessation of construction activities. Construction activities and barge traffic could also potentially interfere with placement and maintenance of fish nets in Tyonek. The diesel tanker traffic to the modified Tyonek North Forelands Facility would increase the potential for disturbance or collisions, but the occurrence of marine mammals in that area is low (Section 3.12, Wildlife). As a result, low level impacts are estimated to marine mammal subsistence hunting by Tyonek residents (Section 3.21.6.5, Subsistence). The construction of the new dock in Tyonek would likely increase household incomes (primarily during Construction), which could decrease food cost. The presence of the new Tyonek dock could also lower food transportation costs for goods transported to the area due to increased flow of water transport to Tyonek. The summary impact rating is rated Category 1 for Alternative 3B, which is the same as Alternative 2.

3.22.4.4.4 SUMMARY FOR ALTERNATIVE 3B

The human health impacts for Alternative 3B are similar to Alternative 2. The health consequences related to Alternative 3B that were considered to be different from Alternative 2 were reduced rates of accidents and injuries related to water transport; reduced exposures to hazardous constituents in air, water and aquatic biota; and possible greater access to and quantity of subsistence resources. The reduction in these consequences relative to Alternative 2 would be considered beneficial to health. Impacts associated with climate change would also be the same as discussed for Alternative 2. The effects determinations take into account applicable impact-reducing design features and monitoring, as discussed in Alternative 2.

3.22.4.5 ALTERNATIVE 4 – BIRCH TREE CROSSING (BTC) PORT

Alternative 4 would move the upriver port site from Angyaruaq (Jungjuk) (under Alternative 2) to Birch Tree Crossing, located about 124 river miles upriver from Bethel. This would reduce the barge distance for freight and diesel out of Bethel bound for the Mine Site by 75 miles. The same volume of cargo and diesel fuel would be transported by barge as in Alternative 2. The BTC mine access road would be 76 miles long, versus 30 miles for the mine access road from Angyaruaq (Jungjuk) Port, an increase of 46 miles. The shorter barge distance would eliminate impacts from barging to communities where the Kuskokwim River narrows upriver of the BTC, including Aniak, Chuathbaluk, and Napaimute.

HECs for which consequences may be different from Alternative 2 are as follows:

3.22.4.5.1 HEC 2: MORTALITY AND MORBIDITY ASSOCIATED WITH ACCIDENTS RELATED TO WATER AND SURFACE TRANSPORT

The reduced barging distance would result in shorter round trip barge transportation times from Bethel to the BTC Port; however, the same number of tows would be required as Alternative 2. Alternative 4 would have fewer days of traffic than Alternative 2, but would remain a large increase in traffic relative to the baseline conditions. Since the number of barge trips would be the same as under Alternative 2, the potential for accidents and injuries is expected to remain the same, although it may be limited to a smaller section of the river.

The human health impacts would be increased for potential surface transport accidents and injuries relative to Alternative 2 since the road could be accessible from communities in the vicinity. The potential health impact for accidents and injury would be similar to Alternative 2, except for small reductions in the geographic extent of potential mortality and morbidity related to vessel transport.

3.22.4.5.2 HEC 3: EXPOSURE TO HAZARDOUS CONSTITUENTS

Alternative 4 would not change the hazardous contaminants, exposure pathways, or receptors. The potential health impact from exposure to media contaminated by a spill or leak of diesel fuel in the river would be reduced in geographic extent. Impacts to air quality may increase in the vicinity of the additional section of surface roadway in a localized manner; however, exposures to the roadway would be limited due to access restrictions. For exposure to hazardous constituents, impacts would be similar to Alternative 2.

3.22.4.5.3 HEC 4: HEALTH EFFECTS ASSOCIATED WITH ACCESS TO AND QUANTITY OF SUBSISTENCE RESOURCES

As noted in Section 3.21.6.6, Subsistence, subsistence resources impacts would be reduced for subsistence fisheries under Alternative 4 since a smaller portion of the Kuskokwim River would have barge traffic, relative to Alternative 2. However, a larger area of terrestrial subsistence resources, such as moose, may be affected due to the longer stretch of BTC roadway during the Construction and Operations phases that may be utilized for subsistence than the area used by Crooked Creek harvesters near the Angyaruaq (Jungjuk) Port site road. Impacts to human health would be similar to Alternative 2, except for lower magnitude of effects to subsistence fishery resources and greater magnitude from the mine access road to habitat for terrestrial subsistence resources.

3.22.4.5.4 SUMMARY FOR ALTERNATIVE 4

Alternative 4 is rated Category 2, the same as those under Alternative 2, noting a reduction in the potential for vessel accidents and injuries, an increase in potential surface transport accidents and injuries, a reduction in potential subsistence fisheries impacts, and a potential increase in the displacement of wildlife used by subsistence hunters. Impacts associated with climate change would also be the same as discussed for Alternative 2. The effects

determinations take into account applicable impact reducing design features and monitoring, as discussed in Alternative 2.

3.22.4.6 ALTERNATIVE 5A – DRY STACK TAILINGS

Alternative 5A would use a "dry stack" process to reduce the potential of tailings water leaving the tailings storage facility. Direct and indirect impacts for the transportation facilities and pipeline components would be the same as under Alternative 2. For the Mine Site, the probability for exposure to potentially hazardous materials (HEC 3) would be reduced, but the summary impact rating, the same as Alternative 2.

The direct and indirect human health impacts of Alternative 5A would be similar to those under Alternative 2. Impacts associated with climate change would be the same as discussed for Alternative 2. The effects determinations take into account applicable impact reducing design features (such as installing silt fences, removing snow from active placement areas only, and using polymer dust suppressant) and monitoring, as discussed in Alternative 2. This alternative is also discussed in Section 3.8.3.7. This alternative would include measures to mitigate fugitive emissions. Stationary source emissions are expected to be similar to Alternative 2.

3.22.4.7 ALTERNATIVE 6A – MODIFIED NATURAL GAS PIPELINE ALIGNMENT: DALZELL GORGE ROUTE

Under Alternative 6A, the pipeline route would be west of the alignment described under Alternative 2 between MP 106.5 and 152.7, and would traverse the Dalzell Gorge. The Mine Site and transportation facilities would remain the same as described under Alternative 2 and effects would be very similar to Alternative 2.

Alternative 6A would require larger workforce and higher expenditures due to more horizontal directional drilling than Alternative 2, which could increase the socioeconomic benefits to communities within the EIS Analysis Area. Under normal operations, this alternative would not change the hazardous contaminants, exposure pathways or receptors. This area would be outside of the subsistence use area of Skwentna, the closest community to the alignment variation, so there would be no change to the subsistence impacts identified under Alternative 2. Impacts associated with climate change would be the same as discussed for Alternative 2. The effects determinations take into account applicable impact reducing design features and monitoring, as discussed in Alternative 2.

3.22.4.8 ALTERNATIVES IMPACT COMPARISON

A comparison of the impacts to human health by alternative is presented in Table 3.22-27.

Table 3.22-27: Comparison of Impacts by Alternative* for Human Health

Impact- causing Project Component	Alternative 2 – Proposed Action	Alternative 3A – LNG-Powered Haul Trucks	Alternative 3B – Diesel Pipeline	Alternative 4 – BTC Port	Alternative 5A – Dry Stack Tailings	Alternative 6A – Dalzell Gorge Route
HEC 1: Social Determinants of Health:	Increases in household incomes, employment rates, and education attainment could result in an improvement to the overall health and well-being of residents. The potential impacts of psychosocial stressors, such as high unemployment, low income, low education attainment, outward population migration, and rural isolation could be lessened by the potential for increased economic opportunities. There is also the potential for increases in psychosocial stress, related to fear of changes in lifestyle and cultural practices, impact to natural resources (e.g., soil, air, groundwater, and surface water), and food security and quality. Increases or decreases in substance abuse (drug and alcohol consumption) rates could occur. The overall impact for HEC 1: Social Determinants of Health is rated Category 2.	Same as Alternative 2.	Same as Alternative 2.	Same as Alternative 2.	Same as Alternative 2.	Same as Alternative 2.
HEC 2: Accidents and Injuries:	The summary impact of accidents and injuries is rated Category 2. The accidents and injuries discussed in this section are generally considered to be events with low probability of occurrence, but high consequence if they did occur. The summary impact level (considering the combined ratings for the three phases) is rated Category 2, acknowledging a lower level of estimated impact associated with surface transportation.	Decreased potential for water transport accidents.	Decreased potential for water transport accidents	Potential for accidents and injuries decreased for water transport, but same as Alternative 2 for surface transport.	Same as Alternative 2.	Same as Alternative 2.
HEC 3: Exposure to Potentially Hazardous Materials:	Effects to human health related to groundwater quality would occur only if project-related contamination were to migrate out to where groundwater usage may be occurring. The principal mechanisms responsible for effects to groundwater quality at the Mine Site would be inputs of seepage from the WRF and TSF to shallow groundwater resources underneath and immediately adjacent to the WRF, and the discharge of water from the pit to the surrounding deep bedrock groundwater. Groundwater that could potentially be contaminated by inputs of WRF seepage would flow towards the pit, and the spatial extent of the impacts would be limited because the contaminated groundwater would	Decreased emission loads, reducing the overall quantity of hazardous contaminants in the air, and surface water.	Decreased impacts on air quality, water quality and biota in the Kuskokwim River, due to the reduction in barge traffic.	Impacts to air quality may increase in the vicinity of the additional section of surface roadway, but would	Same as Alternative 2.	Same as Alternative 2.

Table 3.22-27: Comparison of Impacts by Alternative* for Human Health

Impact- causing Project Component	Alternative 2 – Proposed Action	Alternative 3A – LNG-Powered Haul Trucks	Alternative 3B – Diesel Pipeline	Alternative 4 – BTC Port	Alternative 5A – Dry Stack Tailings	Alternative 6A – Dalzell Gorge Route
	be intercepted by the pit and the pit dewatering system. Similarly, seepage and leakage from the TSF would be captured, contained, and treated, and impacts to groundwater would be minimized. Fugitive dust generated during Mine Site Construction (pre-production) and Operations could potentially result in elevated concentrations of metals in soils surrounding the Mine Site over time through dust deposition. Given the low predicted overall increase in mercury content in soil and sediment and lack of large change anticipated for methylmercury production rates, potential changes in mercury concentrations in plants, fish, and wildlife as result of the Donlin Gold Project were predicted to be small. The summary impact level for exposure to potentially hazardous materials is rated Category 1 for all project components and all project phases.			remain low.		
HEC 4: Food, Nutrition, and Subsistence Activity:	Impacts would result from increases in economic opportunities, increase in the median household incomes, decreases in regional food costs, and an increase in food security. Low levels of adverse impacts could result from changes in access to and/or quantity of subsistence resources in the region could occur as a result of changes in employment (population outward migration), the fly-in, fly-out work rotations of the workforce, and overlap of subsistence resources and uses in the vicinity of project components. Alternative 2 is rated Category 2 for potential health benefits due to decreased regional food costs, and Category 3 for increased food security (resulting from potential increases in median household incomes). This alternative is rated Category 1 for impacts (adverse) due to a potential for decreased access to and/or quantity of subsistence resources.	Reduced impacts to fish and subsistence fishing due to reduced barging.	Reduced impacts to fish and subsistence fishing due to reduced barging.	Impacts to subsistence fisheries reduced, increased potential for displacement of terrestrial wildlife.	Same as Alternative 2.	Same as Alternative 2.
HEC 5: Infectious Diseases:	Increases in infectious disease rates could occur due to employment of workers from outside the region and/or the rotation of the workforce.	Same as Alternative 2.	Same as Alternative 2.	Same as Alternative 2.	Same as Alternative 2.	Same as Alternative 2.

Table 3.22-27: Comparison of Impacts by Alternative* for Human Health

Impact- causing Project Component	Alternative 2 – Proposed Action	Alternative 3A – LNG-Powered Haul Trucks	Alternative 3B – Diesel Pipeline	Alternative 4 – BTC Port	Alternative 5A – Dry Stack Tailings	Alternative 6A – Dalzell Gorge Route
	The summary impact for increases in rates of infectious (communicable) diseases (e.g., STIs, influenza, pneumonia, and foodborne illnesses) is rated Category 1 for Alternative 2, acknowledging a potential Category 2 rating for the Construction Phase for the transportation and pipeline components.					
HEC 6: Water and Sanitation:	Impacts to the availability and quality of water and sanitation services of the potentially affected communities are considered unlikely. The summary impact level for increases in morbidity and mortality rates due to changes in the availability and quality of water and sanitation services is rated Category 1 for Alternative 2. It is very unlikely that water and sanitation services of communities located near the Donlin Gold Project would be affected.	Same as Alternative 2.	Same as Alternative 2.	Same as Alternative 2.	Same as Alternative 2.	Same as Alternative 2.
HEC 7: Non-communicable and chronic diseases:	Increased cancer, respiratory, and cardiovascular morbidity and mortality rates due to increased exposure to hazardous air pollutants is considered unlikely. The summary impact level for increased morbidity and mortality rates for cancer, respiratory, and cardiovascular diseases is rated Category 1 for Alternative 2.	Same as Alternative 2.	Same as Alternative 2.	Same as Alternative 2.	Same as Alternative 2.	Same as Alternative 2.
HEC 8: Health Services Infrastructure and Capacity:	Under routine conditions, decreased access to healthcare services is rated Category 1. Under emergency situations, the summary impact is rated Category 2 with potential to overwhelm health care capacities. Alternative 2 is rated Category 2for overwhelming regional healthcare capacities under emergency situations. The emergency situations are generally considered to be events with low probability of occurrence.	Same as Alternative 2.	Same as Alternative 2.	Same as Alternative 2.	Same as Alternative 2.	Same as Alternative 2.

Notes:

*The No Action Alternative would have low direct or indirect effects to human health, largely returning to pre-impact levels.