Phase II Field Sampling and Analysis Plan for the DMTS Fugitive Dust Risk Assessment

Prepared for

Teck Cominco Alaska Incorporated
Anchorage, Alaska

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Acronyms and Abbreviations

CAS	Columbia Analytical Services
COC/SAR	chain-of-custody/sample analysis request form
CoPC	chemical of potential concern
CSB	concentrate storage building
DMTS	DeLong Mountain Regional Transportation System
DRCV	drive rod check valve
FSP	field sampling plan
GPS	global positioning system
HSP	health and safety plan
QA/QC	quality assurance and quality control
QAPP	quality assurance project plan
SOP	standard operating procedure
Teck Cominco	Teck Cominco Alaska Incorporated

1 Introduction

The purpose of the DeLong Mountain Regional Transportation System (DMTS) fugitive dust risk assessment is to estimate risks to humans and other receptors posed by current and future exposure to metals in soil, water, sediments, and biota surrounding the DMTS, and to determine what additional measures may be needed to reduce those risks. This field sampling plan (FSP) has been prepared in support of the DMTS risk assessment, which is being conducted under the oversight of the Alaska Department of Environmental Conservation.

Two phases were planned for the risk assessment field sampling program. The Phase I sampling event (which occurred during the summer of 2003) included collection of surface sediment, surface water, soil, tundra soil,[1] and moss. Data collected in the first phase were used to address data gaps for additional analytes in the primary environmental media. Using the data collected in Phase I, a detailed screening of chemicals of potential concern (CoPCs) for potential effects to human and ecological receptors was performed. The results of this screening were provided in the risk assessment work plan for the site (Exponent 2004), along with a summary of data collection needs. A copy of the data needs summary from the work plan is provided in Table 1. The Phase II sampling event (planned for summer 2004 and described herein) includes the collection of biota (e.g., small mammals, ptarmigan, terrestrial invertebrates, aquatic invertebrates, fishes) and additional plants (e.g., willow, sedges, lichen) as needed.

The study area for the Phase II fieldwork is the DMTS transportation corridor extending from the Red Dog Mine to the port, including the road, the port facilities, and outlying tundra areas, including those outside of the solid waste permit boundary at the mine (Figure 1).

1.1 Setting

The Red Dog Mine is located approximately 50 miles east of the Chukchi Sea, in the western end of the Brooks Range of northern Alaska (Figure 1). Base metal mineralization occurs naturally throughout much of the western Brooks Range, and strongly elevated zinc, lead, and silver concentrations have been identified in many areas (Exponent 2002b). The mine is located on land owned by the NANA Regional Corporation.

The Red Dog Mine operations began in 1989. Ore containing lead sulfide and zinc sulfide is mined and milled to produce lead and zinc concentrates in a powder form. These concentrates are hauled year-round from the mine via the DMTS road to concentrate storage buildings (CSBs) at the port, where they are stored for later loading onto ships during the summer months. The storage capacity allows mine operations to proceed year-round. During the shipping season, the concentrates from the storage buildings are loaded into an enclosed conveyor system and transferred to the shiploader, and then into barges. The barges have built-in and enclosed conveyors that are used to transfer the concentrates to the holds of deepwater ships.

[1] Note that "soil" refers to inorganic soil, principally found on the road and facility areas. "Tundra soil" refers to the peaty organic material immediately beneath the live tundra mat.

1.2 Existing Data

A moss study performed in 2000 by the National Park Service (Ford and Hasselbach 2001) found elevated concentrations of metals in tundra along the DMTS road and near the port, apparently resulting from fugitive dust from these facilities. A fugitive dust study completed by Teck Cominco in 2001 (Exponent 2002a) provided an initial characterization of the nature and extent of fugitive dust releases from the DMTS corridor and provided baseline data from which to monitor the performance of new transport and handling equipment and dust management practices. Additional characterization was completed by Teck Cominco at the port site in 2002 (Exponent 2003c; Teck Cominco 2003). The Phase I sampling program, designed to support the risk assessment, was conducted in 2003 to obtain data for additional analytes in multiple environments and media (Exponent 2004).

Surface water metals data are available for rivers and creeks in the vicinity of the DMTS road, coastal lagoons, and marine water at the port site. Surface soil samples have been collected from transects along the DMTS road and at the port site. Sediment metals data are currently available for coastal lagoons and the nearshore marine environment, and for streambeds in Cape Krusenstern National Monument (Brabets 2003, pers. comm.). Analytical results are available for vegetation samples (moss, lichen, willow) collected from transects along the DMTS road and locations at the port site. Metals concentrations are also available for fish sampled in rivers and creeks near the DMTS road. In addition, subsistence food sampling results, including data for berries, sourdock, and caribou, are available.

Table 2 summarizes the available sources of analytical data that may be used in the DMTS fugitive dust risk assessment. Data sets listed in Table 2 include results from investigations led by Teck Cominco Alaska Incorporated (Teck Cominco) and state and federal agencies initiated in 1978, before mining operations began, and continuing to the present. The previous data are described in detail in Exponent (2003b, 2004). Table 3 provides a summary of analytical data that were used to screen CoPCs for the risk assessment work plan. A detailed discussion of the data in Table 3 is provided in that document (Exponent 2004).

1.3 Data Gap Review

As described in the previous sections, the sources, transport mechanisms, and distribution of metals from DMTS fugitive dust are fairly well known at present. However, while data are available for CoPCs in many media, analytical results for biota samples (i.e., ecological prey species and food items) are limited to a few of the CoPCs (primarily lead, zinc, and cadmium) for a few of the needed items. As a result, the primary objective for the Phase II field program is to address this data gap by obtaining analytical results for various biota (i.e., small mammals, ptarmigan, terrestrial and aquatic invertebrates, fishes, and vegetation), and in the primary environmental media (i.e., tundra soil[2] and sediment) associated with the biota. Table 1 summarizes the data needs for the ecological risk assessment in relation to each environment, assessment endpoint, receptor, and associated food item (Exponent 2004).

[2] As described previously, "tundra soil" refers to the peaty organic material immediately beneath the live tundra mat.

A secondary objective of the Phase II field program is to collect additional data from the marine environment near the shiploader at the port facility. Substantial improvements to the shiploader and lightering barges were completed early in the 2003 shipping season, which resulted in significantly better containment of concentrate dust. Sediment data collected during the 2003 shipping season several months after the shiploader improvements were completed showed a significant decrease in concentrations (Exponent 2003b; Appendix A). Two additional sampling events will be conducted in 2004 (pre-shipping [June] and during shipping activities [late August to early September]) to characterize current marine sediment concentrations near the port facility.

1.4 Document Overview

The sampling methods presented in this FSP are designed to address data needs for the exposure pathways and receptors described in the risk assessment work plan (Exponent 2004). An overview of the field study design is provided in Section 2. Field sampling locations and procedures are described in Section 3, and sample identifiers are described in Section 4. Field quality control sampling procedures are provided in Section 5. Sample handling, field custody procedures, and sample packaging and shipping requirements are discussed in Section 6. Field reporting procedures are discussed in Section 7. An overview of the chemical analyses to be performed for this study is provided in Section 8. The proposed schedule for the sampling event is provided in Section 9.

Descriptions of laboratory analytical methods and procedures for data management, analysis, and reporting are presented in the quality assurance project plan (QAPP), provided as Appendix A. To ensure that the data collected under the specifications of this FSP achieve an acceptable level of quality, rigorous quality assurance and quality control (QA/QC) procedures will be followed at all stages of sample collection and analysis. Standard operating procedures (SOPs) for field activities are provided in Appendix B. Depending on field conditions, procedures specified in the referenced SOPs may be modified in the field if necessary. Any such modifications will be noted in the field logbook. Example field data forms are provided in Appendix C.

Site-specific health and safety issues are presented in the health and safety plan (HSP), provided as Appendix D. The site-specific HSP establishes procedures and practices to protect Exponent employees from potential hazards posed by field activities at the site. The HSP provides measures to minimize potential exposure, accidents, and physical injuries that may occur during daily onsite activities and to minimize the hazards of adverse conditions. Contingency arrangements are also provided in the HSP for emergency situations.

2 Field Study Design

This field study consists of four major elements intended to provide additional information to assess risk to the environment and human health from the DMTS. These elements are a terrestrial assessment, a freshwater aquatic (i.e., streams and tundra ponds) assessment, a coastal lagoon assessment, and a marine assessment. This Phase II assessment is primarily focused on addressing data gaps by evaluating concentrations of CoPCs (Table 4) in biota in each environment: small mammals, ptarmigan, terrestrial and aquatic invertebrates, lagoon fishes, and vegetation, as well as in the primary media that these biota come into contact with: tundra soil and sediment.

Detailed procedures for sample collection are provided in Sections 3, 4, and 5 of this FSP. Procedures for sample handling and shipping are described in Section 6 of this FSP. An overview of each of the major components of this field program is presented below and in Tables 4 and 5. Table 4 provides details of the Phase II sampling matrix for each of the sampling media. Table 5 shows the number of samples to be collected by media and by sample type. The data needs for the ecological risk assessment in relation to each environment, assessment endpoint, receptor, and associated food item are provided in Table 1, which originates from the data needs summary presented in Exponent (2004), which also identified antimony, barium, cadmium, lead, thallium, and zinc in ptarmigan as data needs for the human health risk assessment.

2.1 Terrestrial Assessment

The terrestrial assessment will evaluate the CoPC concentrations in small mammals, soil invertebrates, vegetation, and tundra soils collected on five transects extending to the north/west (downwind) side of the DMTS road and from one transect extending to the north/west (downwind) side of the mine's solid waste permit boundary. A schematic of the typical terrestrial station sampling layout is provided in Figure 2. The proposed locations of the terrestrial transects are shown on Figures 3 and 4. In addition, ptarmigan will be collected at locations near the DMTS road.

The station locations for the terrestrial assessment are designed to allow evaluation of gradients of CoPC concentrations in relation to sources. Five of the terrestrial transects begin at the edge of the road with a road shoulder sample, and run out into the tundra toward the downwind (north/west) side of the road (see Figure 3). The first transect (i.e., TT5) is located on the downwind side of the road at the port site, near the CSBs. This transect location is intended to represent tundra habitat that has been the most affected by fugitive dust deposition. The second transect (i.e., TT2) was sampled during the Phase I event and is located near the concentrate storage buildings at road station 10, where road surface concentrations were elevated in 2001. The third transect (i.e., TT8) is located in the middle portion of the road, just north of Cape Krusenstern National Monument at road station 20, representing conditions on the downwind side of the largest portion of road. The fourth transect (i.e., TT3) was sampled during Phase I and is also located in the middle portion of the road, and also represents conditions on the

downwind side of the largest portion of road. The fifth transect (i.e., TT6) is located toward the north end of the road, closer to the mine. The final transect (i.e., TT7) is located downwind of the mine's solid waste permit boundary.

Reference site samples of small mammals, ptarmigan, soil invertebrates, vegetation, and tundra soil will be collected. Reference sample stations will be located in the terrestrial reference area shown in Figure 3. The reference area was selected because it is near the DMTS, but far enough away in the prevailing upwind direction (south of the DMTS) that it is expected to be unaffected by fugitive dust. In addition, the geology and topography prevalent at the reference area are similar to the study area.

The number and type of samples to be collected during the Phase II sampling event for the terrestrial assessment are summarized below and in Table 4. Table 4 also identifies the analytes for each sample type:

- **Small Mammal Samples—**Small mammal tissue will be used to evaluate risks to terrestrial avian and mammalian carnivores, represented in the ecological risk assessment by the snowy owl (*Nyctea scandiaca*) and the arctic fox (*Alopex lagopus*), respectively. Samples of small mammals (target species of either tundra vole [*Microtus oeconomus*] or brown lemming [*Lemmus trimucronatus*], depending on availability, with attempts made to collect the same species at all sampling locations) will be collected for chemical analysis of tissue. The small mammals will be collected at 15 stations near the DMTS road or mine. Stations located at the edge of the tundra immediately next to the DMTS road will be centered at 20 m from the road to avoid the grid overlapping the road and to minimize possible noise disturbance in the trapping zone from traffic moving along the road. Small mammals will not be collected at the 2,000-m stations located on transects near the mine (i.e., TT6 and TT7) because their location is distant from possible airborne dust contamination from the DMTS road.

  Small mammals will also be collected from one station at the terrestrial reference area to evaluate background risk to terrestrial carnivores. The small mammal traps will be placed in close proximity to the tundra soil stations (see Figure 2). It is anticipated that five individual small mammal samples will be collected at each station on each terrestrial transect and five individual small mammal samples will be collected at the reference area. Chemical analyses will be conducted on whole body tissue to evaluate potential ecological risks to terrestrial receptors. Each individual small mammal will be analyzed as a single, whole body sample.

- **Ptarmigan Samples—**Ptarmigan tissue will be used to evaluate potential risks to human health. Adult ptarmigan (either willow ptarmigan [*Lagopus lagopus*] or rock ptarmigan [*Lagopus mutus*], depending on availability, with attempts made to collect the same species at all sampling locations) will be collected for chemical analysis of tissue. Five ptarmigan samples will be collected (if possible) for chemical analysis from near the DMTS road and

five ptarmigan samples will be collected in the terrestrial reference area. Each ptarmigan sample will consist of one individual adult bird. Chemical analyses will be conducted on breast, liver, and kidney tissue from each bird to evaluate potential bioaccumulation of metals and risks to human receptors. In addition, the testing laboratory will retain specific feathers (as specified in the QAPP [Appendix A of this document]) for age determinations of the ptarmigan collected for analysis.

- **Soil Invertebrate Samples—**Aboveground soil invertebrates will be collected from the tundra to evaluate risks to terrestrial avian and mammalian invertivores, represented in the ecological risk assessment by the Lapland longspur (*Calcarius lapponicus*) and the tundra shrew (*Sorex arcticus tundrensis*), respectively. Soil invertebrates will also be collected as a surrogate for pond invertebrates to evaluate risks to avian invertivores that forage on wet tundra, represented in the ecological risk assessment by the common snipe (*Gallinago gallinago*). The soil invertebrates will be collected at seven tundra soil stations near the port facility and DMTS road (four on transect TT5 and three on transect TT2)[3]. Soil invertebrates will also be collected from one station at the terrestrial reference area. The soil invertebrates will be collected in close proximity to the tundra soil stations (see Figure 2). Chemical analyses will be conducted on whole body tissue. All soil invertebrates collected at a given station will be combined into a single tissue sample and weighed (wet weight). Soil invertebrates in the samples will be documented to the lowest possible taxonomic level in the field and the weights of each taxonomic group within the sample will be measured (if possible).

- **Vegetation Samples—**Vegetation samples will be collected to provide tissue data for use in food web models to evaluate risks to terrestrial avian and mammalian herbivores, represented in the ecological risk assessment by the willow ptarmigan, tundra vole, caribou (*Rangifer tarandus*), and moose (*Alces alces*). Target species for collection are willows (*Salix* sp.), sedge (*Carex* sp.), and lichen (*Peltigera* sp.). Vegetation samples for chemical analysis will be collected at 20 stations near the DMTS road or mine and also at three stations at the terrestrial reference area. The vegetation samples will be collected in close proximity to the tundra soil stations (see Figure 2).

  Young willow leaves and new growth shoots, whole lichens, and sedge plants (blades only; no root material) will be sampled to represent the aboveground plant material that herbivores would eat while grazing or browsing in the tundra. Avian herbivores also feed upon the seeds of the sedge plant. If seeds are available during the sampling event, then a sample of sedge seeds will be collected at each station. The seed samples will be archived for possible future analysis.

[3] If invertebrate sampling is successful at these locations on transects TT5 and TT2, then additional sampling of terrestrial invertebrates may be conducted at 10 m and 100 m stations on transect TT3 to provide data that represents the middle portion of the road.

In addition, the community structure of the vegetation at fourteen site terrestrial stations and three reference area stations will be evaluated (Figures 3 and4) to assess changes in plant community. On one of the transects (Transect TT3), the community structure of vegetation will be assessed at two additional stations to better document any possible gradient in plant community structure versus distance from the DMTS (Figure 4). The exact location of these two additional stations will be determined in the field. An attempt will be made to place these stations at locations where there is a visible transition in the appearance or structure of the plant community along Transect TT3. If no such transitions are obvious to the field crew, then these stations will be placed at 50 and 250 m. The pH of the tundra soil associated with each of the vegetation plots will also be measured.

- **Tundra Soil Samples—**Tundra soil, as defined and sampled historically, is the decayed or decaying peaty organic material just beneath the live tundra mat. Tundra soil samples (0–2 cm from beneath the live tundra mat, which is approximately 5 to 15 cm [2–6 in.] thick depending on location) will be collected from five transects extending to the north/west of the DMTS road and from one transect extending to the north/west of the mine's solid waste permit boundary. Five of the transects will be located on the prevailing downwind side of the DMTS road and the sixth transect will be located downwind of the mine's solid waste permit boundary. All of the transects will be oriented in the general downwind direction, and generally perpendicular to the road or solid waste permit boundary at each respective location. The exact station placement will be determined in the field based on the location of target plant species in the immediate area of the transect. Depending on the transect's location (see Figures 3 and 4), the transect will include three or four sampling stations at various distances from the toe of the road embankment: at approximately 10 m (the exact distance will be measured in the field), and at 100, 1,000, and 2,000 m. In addition, a tundra soil sample will also be collected at each of the two additional plant community stations on Transect TT3. One sample will be collected at each terrestrial station; a total of 26 tundra soil samples from the site. Tundra soil will also be collected from three stations at the terrestrial reference area (Figures 3 and 4).

2.2 Freshwater Aquatic Assessment

The structure of the aquatic invertebrate community in freshwater streams along the DMTS between the port and the mine and the CoPC concentrations in willows and sedges near these streams will be evaluated for the freshwater aquatic assessment. A schematic of the typical stream station sampling layout is provided in Figure 5. The freshwater aquatic assessment will also evaluate CoPC concentrations in sedges and tundra soil at the edges of tundra ponds located between the port and the mine.

2.2.1 Streams

Aquatic invertebrates, willow leaves and new growth shoots, sedges, and tundra soil will be collected from or near three streams that cross the DMTS (Aufeis Creek, Omikviorok River, and Anxiety Ridge Creek), as shown in Figure 6. These three streams were selected to represent varying conditions over the length of the road, and to match Phase II sampling stations with stations where sampling has been previously conducted (Exponent 2002a, 2004; Morris and Ott 2001). Aufeis Creek is nearest to the port, Omikviorok River represents conditions in the middle portion of the road, and Anxiety Ridge Creek represents conditions nearer to the mine. Stations will coincide with stations at which Teck Cominco regularly collects water samples (Exponent 2002a) and where surface sediment was collected during the Phase I sampling event.

Aquatic invertebrates, willow leaves and new growth shoots, sedges, and tundra soil will also be collected from the freshwater aquatic reference area (see Figure 6). The reference area stations will coincide with stations sampled during the Phase I sampling event. The reference area was selected because it is near the DMTS, but far enough away in the prevailing upwind direction (south of the DMTS) that it is expected to be unaffected by fugitive dust. In addition, the geology and topography at the reference area are similar to the study area.

The number and type of samples to be collected from freshwater streams during the Phase II sampling event are summarized below and in Table 4. Table 4 also identifies the analytes for each sample type:

- **Aquatic Invertebrate Samples—**To determine the characteristics of aquatic invertebrate communities in the freshwater streams near the DMTS road, five replicate samples of aquatic invertebrates will be collected from each of the following four locations: Aufeis Creek, Omikviorok River, Anxiety Ridge Creek, and a reference area stream (Figure 6).

- **Vegetation Samples—**Young willow leaves and new growth shoots as well as sedge will be collected at stations on three streams crossing the DMTS road and at three reference area stream stations. Willow is an important food item for the moose, a terrestrial receptor in the ecological risk assessment that frequently browses in riparian areas. The willow samples will be collected as near as possible to the aquatic invertebrate stations. In addition, sedge samples will be collected in or near the stream channels to evaluate risks to freshwater avian and mammalian herbivores, represented in the ecological risk assessment by the green-winged teal (*Anas crecca*) and the muskrat (*Ondatra zibethicus*). The whole sedge plant (blades and roots) will be collected to include the above- and below-ground plant material that herbivorous receptors might eat, particularly the muskrat, which is known to feed upon the roots and stems of aquatic plants. Muskrat also feed upon the seeds of the sedge plant. If seeds are available during the sampling event, then a sample of sedge seeds will be collected at each station. The seed samples will be archived for possible future analysis.

- **Tundra Soil Samples—**To provide plant and media CoPC data near the stream stations, tundra soil samples (0–2 cm from beneath the live tundra

mat, which is approximately 5 to 15 cm [2–6 in.] thick depending on location) will be collected adjacent to the immediate area of the streams where willow and sedge samples are collected, at all stream stations.

- **Water Quality Measurements**—Water quality parameters (e.g., pH, dissolved oxygen, temperature, conductivity, and salinity) will be measured at each stream station.

2.2.2 Tundra Ponds

Sedges and tundra soil from the edges of five tundra ponds will be sampled during the Phase II field event. Two of the five tundra pond stations will be located at the tundra ponds that were sampled during the Phase I sampling event (i.e., TP1-0100 and TP1-1000; see Figure 6). These ponds are located within the port facility boundary and on the downwind (north/west) side of the road and will provide the most conservative estimate of possible effects on the tundra from the port facility. The remaining three tundra ponds will be located 100–500 m from the road and at varying distances between the mine and the port site (i.e., near the mine, middle of the road, and toward the port). These tundra pond stations will be used to evaluate gradients of CoPC concentrations in relation to sources (see Figure 6). The exact locations of these three tundra pond stations will be determined in the field based on locations of tundra ponds at the time of sampling. All tundra pond stations will be located on the downwind (north/west) side of the road. As a result, all of the tundra pond data will be conservative with respect to concentrations in water bodies located upwind (south/east) of the road.

Sedges and tundra soil will also be collected from the freshwater aquatic reference area (see Figure 6). The reference area stations will coincide with stations sampled during the Phase I sampling event. The reference area was selected because it is near the DMTS, but far enough away in the prevailing upwind direction (south of the DMTS) that it is expected to be unaffected by fugitive dust. In addition, the geology and topography prevalent at the reference area are similar to the study area.

The number and type of samples to be collected from tundra ponds during the Phase II sampling event are summarized below and in Table 4. Table 4 also identifies the analytes for each sample type:

- **Vegetation Samples—**Sedge samples will be collected at the edges of tundra ponds to evaluate risks to freshwater avian and mammalian herbivores, represented in the ecological risk assessment by the green-winged teal and the muskrat. Sedge samples will be collected in close proximity to the tundra soil stations. Sedge samples will be collected from five tundra ponds near the port facility and along the DMTS road and from three stations near the reference area tundra ponds (Figure 6). The whole sedge plant (blades and roots) will be collected to include the above- and below-ground plant material that herbivorous receptors might eat, particularly the muskrat, which is known to feed upon the roots and stems of aquatic plants. Muskrat also feed upon the seeds of the sedge plant. If seeds are available during the sampling

event, then a sample of sedge seeds will be collected at each station. The seed samples will be archived for possible future analysis.

- **Tundra Soil Samples—**Five samples of the 0–2 cm interval of tundra soil will be collected: one from each station at the edge of five tundra ponds located near the DMTS port facility and near the DMTS road and from three tundra ponds at the reference area (Figure 6). One grab sample will be collected at the edge of each tundra pond. The tundra soil samples will be collected in close proximity to the sedge samples.

- **Water Quality Measurements**—Water quality parameters (e.g., pH, dissolved oxygen, temperature, conductivity, and salinity) will be measured at each tundra pond station.

2.3 Coastal Lagoon Assessment

The coastal lagoon assessment will evaluate the CoPC concentrations in aquatic invertebrates, fishes, sedges, surface sediments, and tundra soil at stations in or adjacent to the coastal lagoons to the north and west (prevailing downwind) of the port facilities. Historically, the lagoons to the north of the port have had higher metals concentrations than those to the south. The station locations (see Figure 7) are selected to allow evaluation of risk in locations with the highest-measured CoPC concentrations in lagoon media, as well as to provide a gradient of concentrations away from port site facilities. The stations have all been sampled historically as part of periodic monitoring conducted at the port site (RWJ 1997; Exponent 2003c) and were sampled in Phase I of the fugitive dust risk assessment.

Aquatic invertebrates, fishes, sedges, surface sediment, and tundra soil samples will also be collected from three reference stations in lagoons located to the southeast (in the prevailing upwind direction) of the port site facilities. Because it is important to match similar invertebrate habitats and communities between the site lagoon stations and the reference lagoon stations, the exact location of the reference lagoon stations will be determined in the field. The site lagoon stations and the reference lagoon stations must have similar physical and chemical characteristics (as indicated by grain size distribution, visual content of organic material, and salinity) to allow a valid comparison of the aquatic invertebrate communities collected from both locations. Therefore, the locations of the reference lagoon stations will be based on grain size tests, visual inspections of organic content, and salinity determinations conducted by the field crew.

In addition, vegetation community surveys will be conducted near three site lagoon stations and three reference lagoon stations to compare vegetation communities and evaluate whether there are any effects on site lagoon vegetation.

The number and type of samples to be collected during the Phase II sampling event for the coastal lagoon assessment are summarized below and in Table 4. Table 4 also identifies the analytes for each sample type:

- **Aquatic Invertebrate Samples—**Benthic macroinvertebrates will be collected from the coastal lagoons: 1) to evaluate community structure, and 2) to provide data for food web modeling. To evaluate community structure, invertebrate samples will be collected at three stations in the coastal lagoons near the DMTS port facility spanning a CoPC gradient in sediment, and at three stations in reference lagoons southeast of the DMTS port facility (Figure 7). The aquatic invertebrates will be collected in close proximity to the sediment stations. Five replicate samples will be collected at each station for community analysis (i.e., based on taxonomic composition).

  To evaluate risks to avian invertivores, representative samples of aquatic macroinvertebrates (multiple species and multiple individuals in each sample) will be collected for chemical analysis of tissue at each of the three stations in the coastal lagoons near the DMTS port facility and at one station in a reference lagoon southeast of the DMTS port facility. Chemical analyses will be conducted on whole body tissue. All aquatic macroinvertebrates collected at a given station will be combined into a single tissue sample and weighed (wet weight). Aquatic macroinvertebrates in the samples will be documented to the lowest possible taxonomic level in the field and the weights of each taxonomic group within the sample will be measured (if possible).

- **Fishes**—Fishes will be collected from the coastal lagoons to evaluate risks to coastal avian piscivores, represented in the ecological risk assessment by the red throated loon (*Gavia stellata*). Individual fish will be collected from two coastal lagoons near the port facility (i.e., Port Lagoon North and North Lagoon) and from one reference lagoon southeast of the DMTS port facility. Chemical analyses will be conducted on whole body tissue. Each individual fish will be analyzed as a single, whole body sample, unless the mass of the individual fish is less than the required mass for the chemical analyses, in which case the fish collected at a given lagoon will be combined to form up to five composite tissue samples per station, and then weighed (wet weight). Fish in the samples will be documented to the lowest possible taxonomic level in the field, and the weights of each taxonomic group within the sample will be measured (if possible). Attempts will be made to collect the same species at all stations, if possible. If multiple species are collected, an attempt will be made to collect some of each species at one of the site stations to provide "bridge data" between the species.

- **Vegetation Samples—**Sedge samples will be collected at the edges of the coastal lagoons to evaluate risks to avian herbivores, represented in the ecological risk assessment by the brant (*Branta bernicla*). Sedge samples will be collected in close proximity to the sediment stations. Sedge samples will be collected from three stations in the coastal lagoons near the DMTS port facility and at three stations in reference lagoons southeast of the DMTS port facility (Figure 7). The whole sedge plant (blades and roots) will be collected to include above- and below-ground material that a brant or other

avian herbivore might pull from the sediment and eat. A brant or other avian herbivore might also eat sedge seeds. Therefore, if seeds are available during the sampling event, then a sample of sedge seeds will be collected at each station. The seed samples will be archived for possible future analysis.

The community structure of the vegetation fringing the lagoons will be evaluated near the three site lagoon stations and near the three reference area lagoon stations. The exact location of these community surveys will be determined in the field based on vegetation present at a given station.

- **Sediment Samples—**A sample of the 0–2 cm sediment interval will be collected from three stations in the coastal lagoons near the DMTS port facility and from three stations in reference area lagoons southeast of the DMTS port facility (Figure 7). Stations will correspond with locations where samples are collected for benthic community analysis. One grab sample will be collected at each station.

  If field sampling indicates that benthic macroinvertebrates are scarce or absent in the coastal lagoons, then additional surface sediment (0–2 cm) will be collected for toxicity testing using the estuarine amphipod *Leptocheirus plumulosus* as an alternate means of evaluating effects on benthic invertebrates. If sediment is required to perform toxicity testing, it will be collected at three stations in the coastal lagoons near the DMTS port facility and at one station in a reference area lagoon southeast of the DMTS port facility (Figure 7). Any sediment collected for toxicity testing will be collected from the same sediment samples from which sediment is collected for chemical analysis.

- **Tundra Soil Samples—**Tundra soil samples (0–2 cm from beneath the live tundra mat, which is approximately 5 to 15 cm [2–6 in.] thick depending on location) will be collected at the three site and three reference lagoon stations where vegetation community survey plots are located.

- **Water Quality Measurements**—Water quality parameters (e.g., pH, dissolved oxygen, temperature, conductivity, and salinity) will be measured at each lagoon sampling station.

2.4 Marine Assessment

The marine assessment will evaluate current CoPC concentrations in surface sediments at stations in the Chukchi Sea in the vicinity of the shiploader, one year after major shiploader and lightering barge improvements were made to further control fugitive concentrate dust. The station locations are selected primarily on the basis of historical evaluations (RWJ 1997; Exponent 2003d) and offshore current patterns (prevailing current is northward), and are designed to allow evaluation of gradients of CoPC concentrations in relation to sources, as well as temporal changes in CoPC concentrations (i.e., by resampling stations from previous studies).

Sediment samples will be collected in two events, the first being conducted prior to 2004 shipping activities at the port site (June), and the second to be conducted during the shipping

season (August/September). These two events will help to evaluate possible seasonal variability in exposures in the marine environment.

The stations planned for sampling (see Figure 8) are located on a grid that has been sampled historically in the vicinity of the port site (RWJ 1997; Exponent 2003c,d). Chemicals that show exceedances of the marine screening benchmarks and that are higher than reference concentrations in 2003 (cadmium, copper, lead, mercury, silver, and zinc) will be analyzed at a subset of 7 of the 26 grid stations (see Figure 8). Lead, zinc, and cadmium analyses will be conducted at all of the remaining grid stations. The subset of seven locations (NMD, NMGZ, NML, NMM, NMN, NMO, and NMAA) includes the 4 stations where these chemicals exceeded benchmarks in 2003 (i.e., NMD, NMGZ, NML, and NMM), and also represents a range of concentrations observed historically, based on data collected previously (RWJ 1997; Exponent 2003d). Extra sediment volume will be collected at these locations for possible toxicity testing. Quick-turnaround laboratory analyses will be conducted on samples from the subset of 7 site stations, and the following assessment will be made with that data:

1. If there are no exceedances of screening benchmarks (i.e., ERLs), then no further analyses will be conducted (i.e., no toxicity testing).

2. If there are exceedances of screening benchmarks, then a comparison will be made between data collected in 2004 with that collected in 2003, to assess whether there has been a significant decrease in concentrations.

3. In comparing 2004 data with 2003 data, one or more methods may be used, such as graphical comparison (box and whisker plots), calculation of percent differences, and statistical comparison (e.g., Wilcoxon rank-sum non-parametric test, with a significance level of 0.1). The data will be reviewed for the subset of 4 stations where exceedances occurred in 2003, and for the larger subset of 7 stations where quick-turnaround results are available. Analytical results will be shared with DEC to facilitate discussion of the comparison approach to be used.

4. If concentrations in 2004 have not decreased in comparison with the 2003 concentrations, then toxicity tests will be run using the extra sediment volume collected at 7 site stations and 3 reference stations (see below).

5. Toxicity testing, if conducted as described above, will only be conducted for one event. If conditions in the pre-shipping event warrant conducting the toxicity tests, as described above, then the testing will be conducted using those samples. If not, then the evaluation will be made again in the during-shipping event.

Reference site samples will be collected from three stations at an area approximately 4 km south (upcurrent) of the port site facilities (see Figure 5). The three reference locations selected (NM-REF-1, NM-REF-2, and NM-REF-3) have similar grain size composition to the on-site stations. Extra sediment volume will be collected from the reference stations for possible toxicity testing. If toxicity tests are conducted for site samples, they will also be conducted for the reference samples.

3 Field Sampling

Detailed procedures for sample collection are described in this section.

3.1 Vehicle, Helicopter, and Vessel Operation

A sampling vehicle with an enclosed cargo bed (i.e., an SUV) will be provided by Teck Cominco to transport the field team and the necessary sampling equipment and supplies to transect points that are near the DMTS road. A helicopter and a pilot, also provided by Teck Cominco, will be used to transport the field team and the necessary sampling equipment and supplies to transect points that are distant from the DMTS road (e.g., transect stations at 1,000 and 2,000 m from the road, coastal lagoons, reference areas). If a helicopter is used, it should land at a sufficient distance from the proposed sampling location so that any dust blown into the air by the helicopter's rotors does not become re-deposited on the media that are to be sampled.

Teck Cominco will provide the sampling vessel used for the marine assessment, and the onsite environmental personnel to conduct the marine sampling. The vessel operator or Teck Cominco personnel onboard the sampling vessel should be thoroughly familiar with accurate deployment and retrieval of the sampling gear (i.e., grab sampler) from this vessel. Teck Cominco will also provide an inflatable boat to assist the sampling team with sample collection activities at the lagoon stations, if needed.

3.2 Station Locations

Sampling stations will be located on terrestrial transects extending out from the DMTS, in freshwater streams and tundra ponds located near the DMTS, in the coastal lagoons near the port facility, and at the reference areas. Sampling locations have been chosen to provide representative coverage of the surrounding area, as well as areas with the highest known concentrations of CoPCs from previous sampling. A total of 78 stations will be sampled during this investigation, as follows:

- 29 terrestrial stations (including 3 reference)
- 6 stream stations (including 3 reference)
- 8 tundra pond stations (including 3 reference)
- 6 lagoon stations (including 3 reference)
- 29 marine sediment stations (including 3 reference).

The proposed locations of the sampling stations and transects are shown in Figures 3, 4, 6, 7, and 8. The kinds of samples to be collected at each station are summarized in Table 5.

Designated sampling locations will be found in the field using standard global positioning system (GPS) equipment that will be provided by Teck Cominco. Exponent's field team leader will determine the exact locations of the stations and transects depending on the conditions encountered in the field. For example, the location of willows and tundra ponds in the field will determine the exact location of terrestrial transect stations and tundra pond stations, respectively.

Photographs will be taken that are representative of various kinds of sample stations, and representative photographs will be taken of each sample type or medium.

3.3 Sampling Procedures

In this section, procedures are described for collecting samples during the field event.

3.3.1 Small Mammal Collection

The preferred species of small mammal collection is the tundra vole, which is the default indicator species chosen by DEC for ecological risk assessments conducted in the northwest ecoregion (DEC, no date). Brown lemmings, which are prey species for the artic fox and red fox (*Vulpes fulva*) and snowy owls, may be collected as alternative specie, depending on availability (with attempts made to collect the same species at all sampling locations). It is anticipated that five individual small mammal samples will be collected at each station on each terrestrial transect and five individual small mammal samples will be collected at the reference area.

Procedures for small mammal trapping are provided in SOP BI-15, *Small Mammal Trapping Procedure*. A 30×30-m (100×100-ft) square will be measured out at each station and the four corners will be flagged. The four sides of the square will be marked every 10 ft and a flag will be placed every 20 ft, forming a grid pattern. Figure 2 provides a schematic layout of a typical terrestrial station. After the sampling grid is in place, Sherman live traps will be placed at each flag location and covered with vegetation to protect any captured small mammals from heat and stress. Rolled oats with peanut butter will be used as bait. Baited snap traps will also be placed throughout the trapping grid between the Sherman live traps. The traps will be checked at least once a day.

Once a small mammal is trapped in the Sherman live traps, if it is one of the target species (i.e., tundra vole or brown lemming), it will be humanely euthanized by thoracic compression, placed in a bag, and processed.

The following information will be recorded as soon as possible after collection of each small mammal sample:

- Date collected
- Method of collection

- Species identification
- Total length
- Total weight
- Visible presence of gross abnormalities
- Age, sex, and reproductive state, if possible.

Small mammals of equivalent size will be used for chemical analyses, within the constraints imposed by small mammal availability. After length and weight have been measured, the whole small mammal will be double-bagged in two plastic Ziploc® bags containing a sample identification label. The whole body will be analyzed by the testing laboratory. The whole small mammal will be sent to the testing laboratory where the sample will be prepared for analysis. All the small mammals will be stored in the field at 4±2°C. Because of the remote location of the study area, tissue samples must be held more than 24 hours prior to shipping. Therefore, the samples will be frozen prior to shipping and will be shipped whole on ice (4±2°C) to the analytical laboratory by express delivery.

3.3.2 Ptarmigan Sample Collection

Ptarmigan tissue (breast muscle tissue [with the skin on], liver, and kidneys) will be used to evaluate bioaccumulation of CoPCs and risks to human health. Ptarmigans were selected because they have a relatively small home range compared to other animals used for food by people in the area and because they are known to spend time on and ingest soil from the DMTS road. Ptarmigans (either willow ptarmigan or rock ptarmigan depending on availability, with attempts made to collect the same species at all sampling locations) will be shot (using steel shot) and collected by local hunters. The local hunters will be supervised by Teck Cominco personnel. Five individual ptarmigan samples will be collected near the DMTS road and five individual ptarmigan samples will be collected in or near the reference area. Each ptarmigan sample will be one individual adult bird. The following information will be recorded by Teck Cominco's oversight person as soon as possible after collection of each ptarmigan sample:

- Date collected
- Method of collection
- Relative location and approximate distance from the road
- GPS coordinates (if available)
- Species identification
- Body length (do not include tail feathers in length measurement)
- Total weight

- Visible presence of gross abnormalities
- Age, sex, and reproductive state, if possible.

Ptarmigan of equivalent size will be used for chemical analyses, within the constraints imposed by ptarmigan availability. The smallest ptarmigan collected should be no less than 80 percent of the size of the largest ptarmigan collected. After length and weight have been measured, whole ptarmigan will be double-bagged in two plastic Ziploc® bags containing a sample identification label. Breast muscle tissue, with the skin on, liver, and kidneys will be analyzed separately. There will be no de-feathering, de-boning, or disemboweling of the ptarmigan in the field. The whole ptarmigan will be sent to the testing laboratory where the sample will be prepared for analysis of the breast, liver, and kidneys. In addition, the testing laboratory will retain specific feathers (as specified in the QAPP [Appendix A of this document]) for age determinations of the ptarmigan collected for analysis. All the ptarmigans will be stored in the field at 4±2°C. Because of the remote location of the study area, tissue samples must be held more than 24 hours prior to shipping. Therefore, the samples will be frozen prior to shipping and will be shipped whole on ice (4±2°C) to the analytical laboratory by express delivery.

3.3.3 Soil Invertebrate Collection

The terrestrial invertebrate samples will be collected as close as possible to the locations where the tundra soil samples were collected (see below). Figure 2 provides a schematic layout of a typical terrestrial station. Procedures for soil invertebrate sampling are provided in SOP BI-14, *Terrestrial Invertebrate Sampling*.

A combination of pitfall and pan traps will be used to obtain the terrestrial invertebrates. The pitfall traps used for this study will be simple containers that are of relatively small diameter (i.e., the diameter will be less than the depth of the trap). The pan traps will be shallow pans approximately 0.6 m^2 (2 ft^2). At each terrestrial transect station, 15 pitfall traps and 5 pan traps will be sunk into the ground (i.e., the lip of the trap will be placed flush with the tundra surface). A barrier (e.g., raised plastic sheeting) will be placed outside the trap area to "herd" terrestrial invertebrates into the traps. A moist paper towel will be placed in the bottom of the pitfall trap to keep any captured terrestrial invertebrates alive until the traps are checked. The pan traps will contain water with a surfactant, which is added to the pan to keep the invertebrates within the pan. The traps will be unbaited and partially covered to minimize bird predation and other scavengers.

Sample collection and handling will be performed using powderless latex or Nitrile gloves and forceps. Terrestrial invertebrates will be collected and rinsed with distilled water to remove any large pieces of tundra soil present on the invertebrates. All soil invertebrates collected at a given station will be combined into a single tissue sample and weighed (wet weight). Soil invertebrates in the samples will be documented to the lowest possible taxonomic level in the field and the weights of each taxonomic group within the sample will be measured (if possible). Collection at each location will continue until the minimum mass requirement for tissue analyses (i.e., 2–4 g) is obtained at each location, or until a reasonable effort has been expended to obtain the sample. The length of time spent at each location to collect terrestrial invertebrate

tissue for chemical analysis will vary according to the abundance of organisms in the tundra. The pitfall and pan traps will be left in place for 2 days and then will be checked. The pitfall and pan traps will be left at a sampling station for a maximum of 4 days.

All terrestrial invertebrates will be collected at a given station and will be combined into a single tissue sample. The terrestrial invertebrates will be placed in precleaned containers and stored in the field at 4±2°C. Because of the remote location of the study area, tissue samples must be held more than 24 hours prior to shipping. Therefore, the samples will be frozen prior to shipping and will be shipped whole on ice (4±2°C) to the analytical laboratory by express delivery.

3.3.4 Vegetation Sample Collection

Three kinds of vegetation will be sampled during the Phase II field investigation: willows (*Salix* spp.), sedge (*Carex* spp.), and lichen (*Peltigera* spp.). Figure 2 provides a schematic layout of a typical terrestrial station. Procedures for vegetation sampling are provided in SOP BI-13, *Vegetation Sampling*. Sample collection techniques for each plant type are provided in the following sections. Unless otherwise noted, vegetation samples will be collected and analyzed unwashed, along with any dust present on the plant samples. For consistency with previous vegetation sampling conducted at the site (i.e., willow and lichen sampling), collection methods used for previous studies will be followed in this sampling effort.

The following information will be recorded as soon as possible after sample collection:

- Confirmatory identification to lowest possible taxon
- Total wet weight
- Degree of surficial dust, if possible
- Presence of parasites or anomalies.

All vegetation samples will be collected from near the tundra soil sample locations. If sufficient vegetation of a given type (i.e., willows, sedges, or lichens) is not found, the two-person sampling team will separate and walk away from the designated sampling location in opposite directions perpendicular to the original transect, but at the same distance from the DMTS road or solid waste permit boundary as the original location. For example, if no sample can be found at a transect point 100 m (330 ft) from the DMTS road, the team members should walk, in both directions, along a strip perpendicular with the original transect lying 100 m (330 ft) from the DMTS road. If, after walking for a pre-determined search time, such as 15–20 minutes, the team members have not found a sufficient vegetation sample, they should move 5–10 m (18–33 ft) further from the road and walk a second strip back toward the original sampling location while still searching for vegetation samples. Samples found as close as possible to the originally designated sampling location should be collected for analysis, and a GPS reading should be taken at the alternate location and noted in the field logbook. If no sample can be located along either the outbound or inbound search strip, then vegetation collection will not be performed at that location and shall be so noted in the field logbook.

3.3.4.1 Willow Sample Collection

One willow (leaves and new growth shoots only) sample will be collected at stations on the terrestrial transects near the DMTS road and near the mine's solid waste permit boundary, and at each stream station. Willow samples (leaves and new growth shoots only) will also be collected at three stations at the terrestrial reference area and at three streams in the reference area. At each station, samples will be collected from three willow plants. Only young willow leaves and new growth shoots will be collected. If, after searching the above-specified grid, it is determined that willows are not present at or near a specific transect, then birch or other suitable shrub species will be the alternate species collected. If an alternate species is sampled at stations where willow cannot be located, then a sample of young willow leaves and new growth shoots, and young leaves and new growth shoots of that alternate species will be collected at one of the site stations to provide "bridge data" between the species. The location of the willow (or birch) sampled will be documented with GPS.

Sample collection and handling will be performed using powderless latex or Nitrile gloves and decontaminated forceps or scissors. Samples will be picked clean of debris (either in the field or at the field laboratory) and will be double-bagged in two plastic Ziploc® bags containing a sample identification label. The willow samples will be stored at 4±2°C and shipped on ice to the analytical laboratory by express delivery.

3.3.4.2 Sedge Sample Collection

A single representative sample of sedge or another herbaceous kind of vegetation, depending on availability, will be collected at each sampling location. Sedges will be collected by hand from the terrestrial transect stations and from along shorelines of the freshwater streams, tundra ponds, and coastal lagoons. At each station, a minimum of three sedge plants will be collected. The sedge plants selected for sampling will be collected at approximately 15-cm intervals. At the freshwater streams, tundra ponds, and coastal lagoon stations, every effort will be made to obtain sedges from in or as close as possible to the open water. The sedge samples will be collected in close proximity to where the tundra soil sample or the coastal lagoon sediment sample was collected (depending on assessment type).

Sample collection and handling will be performed using powderless latex or Nitrile gloves. For samples from the terrestrial environments, unwashed sedge blades will be removed from the root materials by cutting the blades with decontaminated scissors. For sedge samples from the aquatic environments (i.e., freshwater streams, tundra ponds, and coastal lagoons), the plants will be pulled up roots and all, and the root portion will be rinsed clean of sediment or tundra soil, leaving the blades unwashed, and the entire plant will be retained as the sample. In addition, if seeds are available during the sampling event, then a separate sample of sedge seeds will be collected at each station. The seed samples will be archived for possible future analysis. After the weight measurement has been made, the sedge samples will be double-bagged in two plastic Ziploc® bags containing a sample identification label. Immediately after the sample bags are filled, they will be placed in a cooler on ice. Samples will be stored at 4±2°C and shipped on ice to the analytical laboratory by express delivery.

3.3.4.3 Lichen Sample Collection

One lichen sample (i.e., *Peltigera* sp. or other lichen, depending on availability) will be collected at stations on the terrestrial transects and at the three reference area stations. The exact location of the lichen sampled will be documented with GPS.

Sample collection and handling will be performed using powderless latex or Nitrile gloves and forceps. Samples will be picked clean of large debris and will be double-bagged in two plastic Ziploc® bags containing a sample identification label. The lichen samples will be stored at 4±2°C and shipped on ice to the analytical laboratory by express delivery.

3.3.4.4 Plant Community Analysis

The general health and vitality of vegetation and species richness, dominance, and distribution will be assessed at thirteen terrestrial transect stations, at three coastal lagoon stations, at three terrestrial reference area stations, and at three reference lagoon stations during the Phase II field investigation.

The general health and vitality of vegetation will be assessed qualitatively. The assessment will be conducted through field observations and photographs. Field team members will document the overall appearance of plants, estimate the amount of foliage cover on shrubs, note whether species are flowering or senescing, and record any signs of disease, infestation, or herbivory. Photographs of the vegetation plot and surrounding area will be taken to document sampling conditions and plant communities.

Plant richness, dominance, and distribution will be assessed quantitatively by identifying each plant species (to the lowest possible taxon), estimating its canopy coverage, and calculating the frequency with which each species occurs within the vegetation plot. Canopy cover is defined as "the percentage of ground covered when a polygon drawn about the extremities of the undisturbed canopy of each plant is projected upon the ground, and all such projections on a given area are summed" (Daubenmire 1959). It is a "two-dimensional estimate of that part of space over which a plant exerts its influence" (Daubenmire 1959). Frequency is a measure of how often a species occurs, or how common it is, rather than how much space it occupies. The calculation method for frequency is described below.

- Consistent with methods applied in previous vegetation monitoring events at the site, canopy cover and percent frequency will be evaluated in ten 1-m^2 microplots established within the 100-m^2 vegetation plot at the stations (a schematic layout of a typical station is provided in Figure 2). Four microplots will be arranged on the east and west sides of the vegetation plot and an additional microplot will be established in the middle of the north and south sides of the vegetation plot.

At each of the 10 microplots, a field botanist will identify shrub, forb, sedge, and grass species to the species level, if possible, using taxonomic classifications in Eric Hultén's *Flora of Alaska and Neighboring Territories* (Hultén 1968) or other appropriate botanical reference. A 1-m^2 frame or other appropriate tool will be used to delineate the boundaries of the microplot.

Voucher specimens of each plant species will be collected and retained until species' identities are confirmed. Microplot vegetation will be documented in photographs.

The canopy cover of vascular plant species will be estimated for each microplot using cover classes, or ranges of percent cover, modified from Daubenmire (1959; Table 6). These broad cover classes are used rather than precise percentages in order to minimize observer bias in plant cover estimates (ENSR 1993; Daubenmire 1959) and to be consistent with earlier vegetation monitoring (ENSR 1993, 1994; RWJ 1998). Percent covers of moss, lichen, rocks, and bare ground in each microplot will also be estimated. Cover classes at each microplot will be recorded in the field on the canopy cover field data form (Appendix C). Plant species that occur in a microplot at trace levels but do not provide measurable canopy cover will be assigned a cover class of "+" (Table 6).

Average percent cover values will be obtained from four 150-ft transects extending away from the corners of the vegetation plot at a 90° angle, parallel to the DMTS road (as shown in Figure 9). Average percent cover values will be obtained by summing the distances intercepted by particular species and dividing those species-specific total distances by 150 ft (total transect length).

The following information will be recorded during the plant community survey:

- Date and time of sampling
- Personnel conducting the activity
- Weather conditions
- Vegetation plot code
- Location of vegetation plot (e.g., GPS coordinates, distance from the mine)
- Vegetation community type
- Microplot number
- Qualitative description of the general health and vitality of microplot vegetation
- Plant voucher information
- Digital photograph number or conventional film frame and a description of the photograph (e.g., microplot, bearing, reference points)
- Account of any deviation from the protocol (as applicable).

3.3.5 Tundra Soil Collection

Tundra soil, as defined and sampled historically, is the decayed or decaying peaty organic material just beneath the live tundra mat. Tundra soils are usually covered by vegetation

(e.g., sedges, mosses, or lichens). The tundra soil under the vegetation is peat or coarse, decaying organic material. Figure 2 provides a schematic layout of a typical terrestrial station.

At the terrestrial transect stations, a 2-cm interval of tundra soil will be collected immediately below the live vegetation mat, which is typically from 5 to 15 cm (2 to 6 in.) deep. At stations where small mammals are to be collected, the tundra soil will be collected from the center and four corners of the small mammal trapping grid (as illustrated in Figure 2) and composited into a single sample. At terrestrial assessment stations where small mammals are not targeted for collection, five subsamples of tundra soil sample will be collected and combined into a single sample in a similar pattern. Prior to sample collection, the overlying vegetation will be removed and any tundra soil that is present will be shaken off. The soil samples will be collected by hand using a new, clean pair of latex gloves for each sample. A stainless-steel ruler will be used to ensure that the sampling criterion for adequate penetration depth is met and that the correct amount of soil has been removed. The soil will be mixed in the sample collection bag to achieve a uniform texture and color before the soil is transferred to precleaned containers.

Tundra soil pH will be determined in the field at each of the vegetation community survey stations. A slurry of tundra soil will be prepared in the field and the pH of the slurry will be tested using the procedures provided in SOP SL-15, *Field Laboratory Measurement of Soil Slurry pH and Conductivity*.

At tundra ponds, tundra soil samples (0–2 cm) will be collected from edges of tundra pond stations using a stainless-steel trowel. Before sampling begins at a station, the stainless-steel trowel will be scrubbed with Alconox® or Liquinox® and rinsed with distilled water. If there is a significant lapse of time between decontamination of the stainless-steel trowel and collection of the sample, then the decontaminated stainless-steel trowel will be covered with foil to protect it from possible contamination. The tundra soil will be mixed in a sample collection bag to achieve a uniform texture and color before the tundra soil is transferred to precleaned containers.

Water quality parameters (e.g., pH, dissolved oxygen, temperature, conductivity, and salinity) will be measured at all of the tundra ponds where tundra soil is collected.

A description of the tundra soil collected at each station will be recorded in the field logbook. Documentation procedures are provided in SOP SL-09, *Field Classification of Soil*, and transferred to precleaned containers. Immediately after sample containers are filled, they will be placed in a cooler on ice. Samples will be stored at 4±2°C and shipped on ice to the analytical laboratory by express delivery.

3.3.6 Aquatic Invertebrate Collection

Aquatic invertebrates will be collected from freshwater streams and coastal lagoons. At the freshwater stream stations, aquatic invertebrates will be collected only for community analysis (i.e., based on taxonomic composition). At the coastal lagoon stations, two kinds of analyses will be performed on the aquatic invertebrates: chemical analysis of their tissue and community analysis. Water quality parameters (e.g., pH, dissolved oxygen, temperature, conductivity, and

salinity) will be measured at all of the freshwater streams and coastal lagoons where aquatic invertebrates are collected.

3.3.6.1 Streams

Aquatic invertebrates in the freshwater streams' riffle and pool habitats will be collected using the rapid bioassessment techniques developed by the U.S. Environmental Protection Agency (Barbour et al. 1997), and as modified by Alaska Department of Fish and Game for aquatic monitoring at Red Dog Mine in 2000 (Scannell and Ott 2001). Drift nets will be used to collect aquatic invertebrates for community analysis. Figure 5 provides a schematic layout of a typical stream station. After sample collection, any aquatic invertebrates retained on the drift net will be processed immediately in the field. Care will be taken to avoid damaging fragile or soft-bodied organisms. Using gentle streams of water, the nets will be washed off into a U.S. Standard No. 30 sieve (600 μm). Five drift nets will be placed in each freshwater stream for approximately 1 hour. Each replicate will consist of the invertebrates collected from each individual drift net. Multiple sieves will be available so that more than one sample can be processed simultaneously.

All material retained in the sieve will be rinsed into one or more polypropylene bottles, and a sufficient quantity of 10 percent buffered formalin will be added to each sample. Sample containers will be labeled using both internal and external labels, and lids will be sealed with plastic PVC tape to prevent loosening or leakage. The sample bottles will be inverted and swirled or agitated gently to ensure exposure of all organisms to the formalin. The drift nets and sieves will be thoroughly rinsed with site water following collection of each sample.

3.3.6.2 Coastal Lagoons

Aquatic invertebrates (i.e., benthic macroinvertebrates) in surface sediments in coastal lagoons will be collected for community analysis using either an Ekman grab sampler or a modified petite-Ponar sampler. Aquatic macroinvertebrates for chemical analysis may also be collected with a shovel, or a drive rod check valve (DRCV) corer. Although the penetration depth of the sampler may vary depending on sediment type, the consistency of penetration depth will be evaluated, and a sample will be discarded if it is distinctly different from previous samples collected at a station. Procedures for using Ekman grab sampler, Ponar grab sampler, and DRCV corer are provided in SOP SD-05, *Surface Sediment Sampling Using an Ekman Grab Sampler*, SOP SD-06 *Surface Sediment Sampling Using a Ponar Grab Sampler*, and SOP SD-10, *Sediment Coring Using a Drive Rod Check Valve Corer*, respectively. Detailed sampling procedures for collecting and processing macroinvertebrate tissues are provided in SOP BI-12, *Benthic Macroinvertebrate Sampling Using a Grab Sampler*.

After sample collection, the sediment and overlying water will be sieved immediately in the field. Using gentle streams of water, the content of the sampling apparatus will be screened through a U.S. Standard No. 30 sieve (600 μm). Care will be taken to avoid damaging fragile or soft-bodied organisms. Multiple sieves will be available so that more than one sample can be processed simultaneously.

Chemical Analysis—For chemical analysis of the benthic macroinvertebrate tissue, all aquatic macroinvertebrates collected at a given station will be combined into a single tissue sample and weighed (wet weight). Macroinvertebrates in the samples will be documented to the lowest possible taxonomic level in the field and the weights of each taxonomic group within the sample will be measured (if possible).

Before sampling begins at a station, the grab sampler will be scrubbed with Alconox® or Liquinox® and rinsed with site water. Sample collection and handling will be performed using powderless latex or Nitrile gloves and forceps. The aquatic macroinvertebrates will be placed in precleaned containers. The aquatic macroinvertebrates will be stored in the field at 4±2°C. Because of the remote location of the study area, tissue samples must be held more than 24 hours prior to shipping. Therefore, the samples will be frozen prior to shipping and will be shipped whole on ice (4±2°C) to the analytical laboratory by express delivery.

The number of sediment samples required to collect macroinvertebrate tissue for chemical analysis will vary at each location according to the abundance of organisms in the sediment. Sediment collection at each location will continue until the minimum mass requirement for tissue analyses (i.e., 2 to 4 g) is obtained at each location, or until a reasonable effort has been expended to obtain the sample (i.e., 3 hours at each station). If after the 3 hours, sufficient sample mass has not been attained to warrant continued effort at the station, the effort will be discontinued and the Exponent project manager will be notified.

Community Analysis—For community analysis of benthic macroinvertebrates in coastal lagoons, five replicate sediment grabs or cores will be collected in each habitat and at each station. All material retained on the sieve will be rinsed into one or more polypropylene bottles, and a sufficient quantity of 10 percent buffered formalin will be added to each sample. Sample containers will be labeled using both internal and external labels, and lids will be sealed with plastic PVC tape to prevent loosening or leakage. The sample bottles will be inverted and swirled or agitated gently to ensure exposure of all organisms to the formalin. The grab sampler and sieves will be thoroughly rinsed with site water following collection of each sample.

3.3.7 Fish Collection

Fishes will be collected from the coastal lagoons to evaluate risks to coastal avian piscivores, represented in the ecological risk assessment by the red throated loon. It is anticipated that five individual fish samples will be collected at each of two coastal lagoons near the port facility (Port Lagoon North and North Lagoon) and five individual fish samples will be collected at one reference area lagoon.

Chemical analyses will be conducted on whole body tissue to evaluate ecological risks to piscivorous avian receptors. Each individual fish will be analyzed as a single, whole body sample, unless the mass of the individual fish is less than the required mass for the chemical analyses, in which case the fish collected at a given lagoon will be combined to form up to five composite tissue samples per station, and then weighed (wet weight). Compositing will be performed only if necessary to obtain sufficient tissue mass to perform chemical analyses. If possible, the smallest fish collected should be no less than 80 percent of the size of the largest fish collected. Fish in the samples will be documented to the lowest possible taxonomic level in

the field, and the weights of each taxonomic group within the sample will be measured (if possible). Attempts will be made to collect the same species at all stations, if possible. If multiple species are collected, an attempt will be made to collect some of each species at one of the site stations to provide "bridge data" between the species.

It is anticipated that the fish will be collected using a beach seine net. If, however, this method is unsuccessful, then baited minnow traps will be placed in the coastal lagoons. Procedures for fish collection are provided in SOP BI-05, *Fish Collection Procedures Using a Seine Net* and SOP BI-07, *Fish Collection Procedures Using Fish Traps.* The procedures for taking measurements of individual fish are provided in SOP BI-08, *Fish Processing Procedures.*

The following information will be recorded as soon as possible after collection of each fish sample:

- Date collected
- Method of collection
- Species identification
- Total length
- Total weight
- Visible presence of gross abnormalities.

After length and weight have been measured, the whole fish will be double-bagged in two plastic Ziploc® bags containing a sample identification label. The whole fish will be sent to the testing laboratory where the sample will be prepared for analysis. All the fish will be stored in the field at 4±2°C. Because of the remote location of the study area, tissue samples must be held more than 24 hours prior to shipping. Therefore, the samples will be frozen prior to shipping and will be shipped whole on ice (4±2°C) to the analytical laboratory by express delivery. The whole body will be analyzed by the testing laboratory.

3.3.8 Surface Sediment Collection

Surface sediment samples (0–2 cm) will be collected from coastal lagoon stations using either a stainless-steel Ekman grab sampler, modified petite-Ponar grab sampler, or a drive rod check valve (DRCV) corer. Procedures for using an Ekman grab sampler are provided in SOP SD-05, *Surface Sediment Sampling Using an Ekman Grab Sampler*. Procedures for using a modified petite-Ponar grab sampler are provided in SOP SD-06, *Surface Sediment Sampling Using a Ponar Grab Sampler*. Procedures for using a DRCV are provided in SOP SD-10, *Sediment Coring Using a Drive Rod Check Valve Corer*. If field sampling indicates that benthic macroinvertebrates are scarce or absent in the coastal lagoons, then additional surface sediment (0–2 cm) will be collected for toxicity testing using the estuarine amphipod *Leptocheirus plumulosus* as an alternate means of evaluating effects on benthic invertebrates.

Surface sediment samples (0–2 cm) will be collected from the marine stations using a modified Ponar grab sampler in accordance with standard methods used by U.S. EPA (1986). If necessary, surface sediment may also be collected with the assistance of divers. Procedures for using a modified Ponar grab sampler are provided in SOP SD-06, *Surface Sediment Sampling Using a Ponar Grab Sampler*. Extra sediment volume will be collected at a subset of 7 of the 26 marine grid stations (NMD, NMGZ, NML, NMM, NMN, NMO, and NMAA), and at 3 reference stations (NM-REF-1, NM-REF-2, and NM-REF-3) for possible use in toxicity testing. Station locations are shown on Figure 8.

Before sampling begins at a station, the grab sampler will be scrubbed with Alconox® or Liquinox® and rinsed with site water. Decontamination procedures are provided in SOP SD-01, *Decontamination of Equipment—Sediments*. Equipment used for collecting the sediment samples (i.e., stainless-steel bowls and spoons) will follow the same basic decontamination sequence except that the final rinse will be with distilled water. If there is a significant lapse of time between decontamination of the stainless-steel spoons and bowls and collection of the sample, then the decontaminated stainless-steel spoons and bowls will be covered with foil to protect them from possible contamination.

After a sediment sample is retrieved and judged to be acceptable for chemical analyses (see discussion below), the overlying water will be siphoned off and the upper layer of sediment will be collected in accordance with U.S. EPA (1986) guidelines. Stainless-steel spatulas or spoons will be used to collect the sediment. A stainless-steel ruler will be used to ensure that the sampling criterion for adequate penetration depth is met and that the correct amount (e.g., 2 cm) of sediment has been removed. Sediment touching the sides of the grab sampler will not be collected.

Material collected in the sampler will be evaluated for acceptability according to whether the following criteria are met:

- The sampler is not overfilled
- Overlying water is present
- The overlying water is not excessively turbid
- The sediment surface is relatively undisturbed
- The minimum penetration depth is attained.

If additional sediment is required to perform toxicity testing, it will be collected using the same procedures provided above. Any sediment collected for toxicity testing will be collected from the same sediment samples from which sediment is collected for chemical analysis. Sediment for chemical analysis and toxicity testing will be combined in a stainless-steel bowl into a single sample. After the sediment has been stirred with a stainless-steel spoon to achieve a uniform texture and color, then subsamples will be taken from the bowl for each analysis.

Exponent's field team leader will evaluate all samples collected. If a sample fails to meet the above criteria, it will be rejected and discarded away from the station. A description of all

sediment that meets the criteria and that is collected at each station will be recorded in the field logbook. Documentation procedures are provided in SOP SD-19, *Field Classification of Sediment*.

Sediment in the bowl will then be mixed using a large stainless-steel spoon to achieve a uniform texture and color before subsamples are taken and transferred to precleaned containers. Immediately after sample containers are filled, they will be placed in a cooler on ice. Samples will be stored at 4±2°C and shipped on ice to the analytical laboratory by express delivery.

4 Sample Identifiers

Sample identifiers will be established before field sampling begins and will be assigned to each sample as it is collected. Sample identifiers consist of codes designed to fulfill two purposes: 1) to obscure the relationships between samples so that laboratory analysis will be unbiased by presumptive similarities between samples, and 2) to track individual sample containers to ensure that the laboratory receives all of the material associated with a single sample. To accomplish these purposes, each container is assigned a sample number and a tag number. These codes and their uses are described below:

- **Sample Number**—The sample number is an arbitrary number assigned to each sample collected. All subsamples of a field sample will have the same sample number. Each field duplicate of a given type will have a different sample number, and the sample numbers of related field duplicates will not necessarily have any shared content. The sample number appears on the sample containers and the chain-of-custody and sample analysis request (COC/SAR) forms. Sample numbers will begin with two letters to differentiate the kind of sample being collected (i.e., SM = small mammal; PT=ptarmigan; SI = soil invertebrates; WI = willow; SE = sedge; LI = lichen; TS = tundra soil; BI = benthic invertebrates; FI = fishes; SD = sediment). After the media code, all sample numbers will be followed by four digits.

- **Tag Number**—A different sample tag number is attached to each sample container. If the amount of material (i.e., everything associated with a single sample number) is too large for a single container, each container will have the same sample number and a different sample tag. A sample will also be split between containers if a different preservation technique is used for each container (i.e., because different analyses will be conducted). The sample tag number will appear on the COC/SAR forms. Tag numbers are used by laboratories only to confirm that they have received all of the containers that were filled and shipped. Data are reported by sample number.

Sample numbers will be assigned sequentially in the field; sample tags will be preprinted with tag numbers.

5 Field Quality Control Sample Procedures

The following quality control samples will be collected in the field and analyzed by the chemical analytical laboratory with the natural samples:

- **Field Duplicates/Replicates—**Field duplicate tundra soil and sediment samples will be collected and analyzed to assess the variability of chemical concentrations at a location. Field duplicates will be collected from the homogenized media (i.e., tundra soils and sediments) and a subsample will be collected for the field duplicate. Field replicates will be collected for each of the vegetation sample types (willow, sedge, lichen). Five field replicates will be collected for the community survey of aquatic invertebrates in the freshwater streams and coastal lagoons. The field duplicate and field replicate will be assigned a separate sample number from the test sample.

  Field duplicates and replicates provide a measure of the total analytical bias (field and laboratory variance), including bias resulting from the heterogeneity of the duplicate sample set itself. Field duplicates and replicates will be collected at a minimum frequency of 1 per 20 samples. The exact number of field duplicates and replicates will be determined in the field and will be based on how many samples are actually collected for chemical analysis. No field duplicate or replicate samples will be collected for the small mammals, ptarmigan, soil invertebrates, or fish.

- **Equipment Rinsate Blanks—**Equipment rinsate blanks will be collected to help identify possible contamination from the sampling environment or from the sampling equipment (e.g., trowels and sediment samplers, bowls, spoons). Equipment rinsate blanks will consist of running distilled/deionized water over the sampling equipment after decontamination. One equipment rinsate blank will be collected for each type of sampling equipment used during the sampling event. The equipment rinsate blanks will be collected after equipment has been decontaminated.

6 Sample Handling

All sample containers will be provided by the laboratory and prepared in accordance with U.S. EPA (1986) guidelines prior to field operations. Sample containers will be kept closed and in a cooler until use. As they are collected, samples will be fully labeled, recorded in the field logbook along with other pertinent collection data, and returned to coolers as soon as possible. Immediately after they are filled, all sample containers will be placed on ice in a cooler at 4±2°C. All samples will be stored in a secure place, where containers are not susceptible to breakage.

Because of the remote location of the study area, tissue samples must be held more than 24 hours prior to shipping. Therefore, the tissue samples will be frozen prior to shipping. All samples for chemical analysis will be shipped on ice (4°C) to the testing laboratories and will be stored at the testing laboratory at the appropriate temperature until after analysis and final disposition of the samples. All field samples will be analyzed as soon as possible after receipt at the laboratories. Maximum sample holding times are stipulated in Table 7. All sample containers will be placed in an outer plastic bag to avoid cross contamination should breakage occur. All tissue samples will be double bagged.

COC/SAR forms will be completed and signed at the end of the day and shipped with the samples to the analytical laboratories. Samples will be shipped by express delivery to arrive at the participating laboratories as soon as possible after sample collection.

Samples shipped in glass containers will be packed in bubble-wrap plastic to prevent breakage. All sample coolers will have chain-of-custody seals placed across the cooler lids. Chain-of-custody forms will be enclosed in the coolers with the samples and will be signed at the laboratory upon receipt. A copy of the signed form will be returned to the field sampling contractor and filed in the project file. Sample custody requirements are described in SOP GEN-02, *Sample Custody*. Sample packaging and shipping requirements are described in SOP GEN-03, *Sample Packaging and Shipping*.

Teck Cominco personnel will be responsible for shipping and handling of all samples collected at the end of the Phase II sampling event.

7 Documentation

The integrity of each sample from the time of collection to the point of data reporting must be maintained throughout the study. Proper record-keeping and chain-of-custody procedures will be implemented to allow samples to be traced from collection to final disposition. The various logs, forms, and labels required to adequately identify and catalogue sampling locations and sample information include the following:

- **Field Logbook—**A bound, waterproof field logbook with consecutively numbered pages will be used. All daily field activities will be documented in indelible ink in this logbook; all entries will be signed and dated, and no erasures will be made. If an incorrect entry is made, the information will be crossed out with a single strike mark that is signed and dated by the sampler. Field logbooks will be stored in a secure manner when not in use. The field team leader will record the following information daily in the field logbook:
  - Project name, project location, and project number
  - Project start date and end date
  - Date and time of entry (24-hour clock)
  - Time and duration of daily sampling activities
  - Weather conditions
  - Name of person making entries and other field personnel
  - Onsite visitors, if any
  - GPS coordinates of each station and transect location recorded at the time of sampling
  - Sketches relative to existing features as appropriate
  - Water depth at each sediment station recorded at the time of sampling
  - Specific information on each type of sampling activity
  - Sample number and tag number for each sample
  - The number of photographs taken at the sampling location, if any
  - Variations, if any, from specified sampling protocols or sampling plan, and reasons for the deviation.
- **Sample Label**—A sample label will be completed for each sample (example provided in Appendix B). A sample label will be placed on the outside of all sample containers. An internal label on waterproof paper will also be placed inside each invertebrate sample for community analysis and vegetation sample container. All sample label entries will be made with indelible ink. Sample containers will be labeled at the time of sampling with the following

information: sample number, site name, sampling date and time, sampling personnel, preservative (if appropriate), and tag number.

- **Chain-of-Custody/Sample Analysis Request Form**—The sample numbers and tag numbers of each sample container will be recorded on a COC/SAR form (example provided in Appendix B). The signed COC/SAR form will be secured to the inside top of each cooler, or package containing samples, identifying the sample collection date and time, the type of sample, the project, and the field personnel. The COC/SAR form will also identify the preservative or other sample pretreatment applied and the analyses to be conducted, by referencing a list of specific analytes or the statement of work for the laboratory. The COC/SAR form will be sent to the laboratory along with the sample. The chain-of-custody forms will be completed in triplicate, with one copy retained by the field team leader.

- **Custody Seal**—Two custody seals (example provided in Appendix B) will also be placed across the lid of the cooler or the package containing samples (front right and back left) prior to shipping.

At the end of each day and prior to shipping or storage, chain-of-custody entries will be made for all samples. Finally, information on the labels and tags will be checked against field logbook entries, and samples will be recounted.

The field team leader (or this person's delegate) is responsible for properly completing all logbooks and forms. COC/SAR forms will be completed and signed before the end of each sampling day and before the samples pass from the control of the field team leader. COC/SAR forms will be signed at each additional point of sample transfer between the field and the chemical testing laboratories, and within each laboratory.

Field documentation procedures that are to be used for this study are provided in SOP GEN-01, *Field Documentation*. In addition, a sampling location map will be updated during sampling and will be maintained throughout the sampling event. Station and sample logs must be completed at the time the observations are made.

8 Laboratory Analyses

Chemical analysis of and small mammal tissue, ptarmigan tissue, terrestrial and aquatic invertebrate tissue, fishes, vegetation, tundra soil, and sediment will be performed on samples collected during the Phase II sampling event. In addition, the composition of the aquatic invertebrate communities present in the streams and coastal lagoons will be characterized during the Phase II sampling event. If sampling of coastal lagoons indicates that benthic macroinvertebrates are scarce or absent, then toxicity testing will also be performed. If sampling of marine sediment indicates no decline in concentrations compared with 2003 concentrations, then sediment toxicity testing will be performed on marine sediment samples (see discussion in Section 2.4).

The procedures and requirements described in the QAPP (Appendix A) will apply to all phases of project quality assurance management; sample collection, handling, and analysis; data validation and management; and data interpretation for the study described in this FSP.

8.1 Chemical Analyses

Chemical analysis of small mammals, terrestrial and aquatic invertebrates, fishes, vegetation, ptarmigan tissue, tundra soil, and sediment will be completed by Columbia Analytical Services (CAS), located in Kelso, Washington. The samples will be analyzed for the analytes listed in Table 4.

Sample preservation and handling information and the holding-time requirements for the samples are provided in Table 7. The testing laboratory will use the methods and data quality objectives provided in the QAPP (Appendix A). All analytical and testing procedures will be completed in accordance with requirements specified in the selected methods. Analyses and associated QA/QC procedures will be completed as described in the QAPP (Appendix A). Also, as discussed in the QAPP, method reporting limits and method detection limits were established such that they are low enough to allow comparison of the analytical results with human health and ecological risk-based screening benchmarks.

Small mammals, aquatic and terrestrial invertebrates, fishes, and ptarmigan will be sent whole to the laboratory. The whole body (with skin and fur on) of the small mammal will be homogenized into a single sample prior to analysis. CAS will pluck the feathers from the ptarmigan and remove the breast muscle (with skin on), liver, and kidneys from the ptarmigan for analysis. Specific feathers (as specified in the QAPP [Appendix A of this document]) will be retained by CAS for age determinations of the ptarmigan collected for analysis. The tissue from each ptarmigan sample will be homogenized prior to analysis and will be stored frozen (-20°C) at the laboratory. The measurement quality objectives provided in the QAPP, including holding times, will apply to the biota samples. Any unused portions will be stored frozen (-20°C) at the laboratory.

Plant samples will be homogenized at the laboratory using a blender. If necessary, the samples will be chopped with a stainless-steel knife prior to homogenization to reduce the length of fibers. Samples for analysis of metals will be air-dried at 60°C prior to homogenization. The measurement quality objectives provided in the QAPP, including holding times, will also apply to the plant samples. The plant samples will be stored at 4°C at the laboratory until they are processed for analysis. Any unused portions will be stored at 4°C at the laboratory.

For wet tundra soil samples and sediment samples, the laboratory shall assume that the entire sample submitted for analysis is representative material. To avoid substance losses, any overlying water in wet tundra soil samples and sediment samples received from the field will be mixed into the sample before removing a subsample for analysis. The measurement quality objectives provided in the QAPP, including holding times, will apply to the tundra soil and sediment samples. Any unused portions will be stored frozen (–20°C) at the laboratory.

8.2 Aquatic Invertebrate Community Analyses

The composition of the aquatic invertebrate communities present in the streams and coastal lagoons will be characterized by taxonomist Steve Peek of Fairbanks, Alaska, who has previously conducted taxonomic analysis for the Alaska Department of Fish and Game in their monitoring programs at Red Dog.

Each invertebrate community sample from a freshwater stream station will consist of the material retained on a drift net. Each invertebrate community sample from a coastal lagoon station will be collected from the sediment in the grab sampler. The aquatic invertebrates will be washed from the sediment sample while still in the field. The aquatic invertebrates that are retained on a 600-μm sieve from a single station will be transferred to an appropriate container, preserved with 10 percent formalin. Prior to enumeration and identification at the laboratory, samples will be transferred (under proper ventilation) from the formalin fixative to 95 percent ethyl alcohol or isopropyl alcohol.

Each sample will be sorted, and then organisms will be identified to the lowest taxonomic level possible; the target being species level. For incomplete specimens, only the anterior or posterior ends shall be enumerated, depending upon the taxon. All identifications shall be made using binocular-dissecting or compound microscopes. If possible, at least two pieces of literature should be used for each species identification.

At the taxonomic laboratory, samples will be stored in an upright position at a cool temperature and away from direct sunlight. Samples will be stored in a secure place, where containers are not susceptible to breakage, and samples will be checked periodically to ensure that adequate levels of preservative are maintained.

8.3 Sediment Toxicity Testing

In the coastal lagoons, if field sampling indicates that benthic macroinvertebrates are scarce or absent, then sediment toxicity testing will be performed using the amphipod *Leptocheirus*

plumulosus as an alternate means of evaluating effects on benthic invertebrates. In the marine environment, if criteria are met in the evaluation described in Section 2.4, then marine sediment toxicity tests will be performed using the amphipod *Leptocheirus plumulosus.*

If toxicity testing is required, the tests will be performed by Northwest Aquatic Sciences of Newport, Oregon using the amphipod *Leptocheirus plumulosus.* This 10-day test measures mortality in sub-adult amphipods exposed for 10 days to test sediment. Protocols and QA/QC performance standards are described in U.S. EPA (1994).

Amphipods will be cultured in the laboratory and acclimated to the test water temperature and salinity for 3–4 days prior to testing. For each toxicity test replicate, 20 amphipods will be exposed to a 2-cm layer of bedded test sediment in a 1-L chamber filled with clean seawater. Five replicate analysis will be conducted for each sample. After the 10-day exposure period, the surviving amphipods in each test chamber will be sieved from the sediment and counted. Percent mortality will be determined relative to the total of 20 individuals added to each chamber at the beginning of the test. The survivors will then be exposed to clean control sediment, and the number that fail to rebury will be determined. Percent nonreburial will be determined relative to the number of survivors in each test chamber.

9 Schedule

Marine sediment sampling will be conducted during two field events (pre-shipping [June] and during shipping activities [late August to early September]). The Phase II ecological risk assessment sampling will occur in mid-June to mid-July 2004. The marine sediment sampling events are estimated to require approximately 4 days for each event. The Phase II ecological risk assessment sampling event is estimated to require approximately 20–30 days. The sequence of sample collection will be arranged to maximize efficiency while minimizing potential cross-sample contamination. The actual sequence in which the stations will be visited will be determined in the field by Teck Cominco's field team leader (for the marine sediment sampling) or by Exponent's field team leader (for the ecological risk assessment sampling) in coordination with Teck Cominco site personnel.

Laboratory analyses are expected to be completed approximately 8 weeks following completion of the fieldwork, with the exception of the aquatic invertebrate taxonomy, which will take up to 4 months to complete.

Data validation and preparation of a data report are expected to be completed approximately 10 weeks following receipt of all of the laboratory data by Exponent.

It should be noted that no weather days or holidays were included in the schedule.

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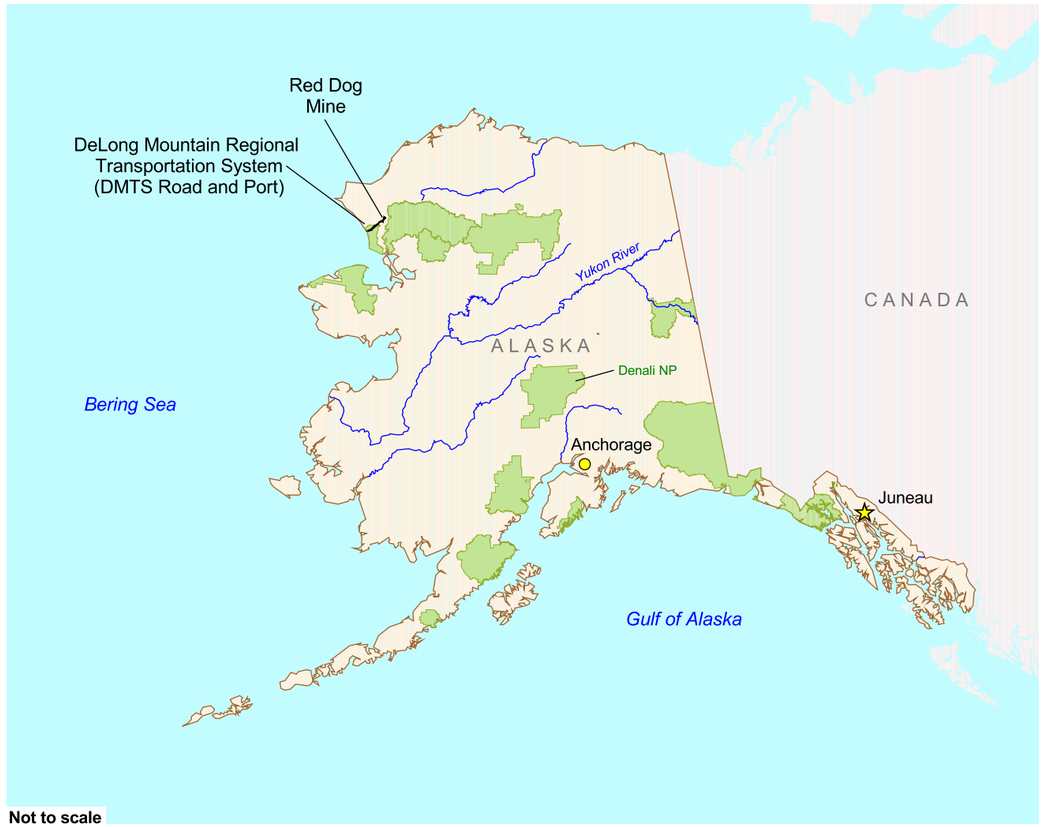
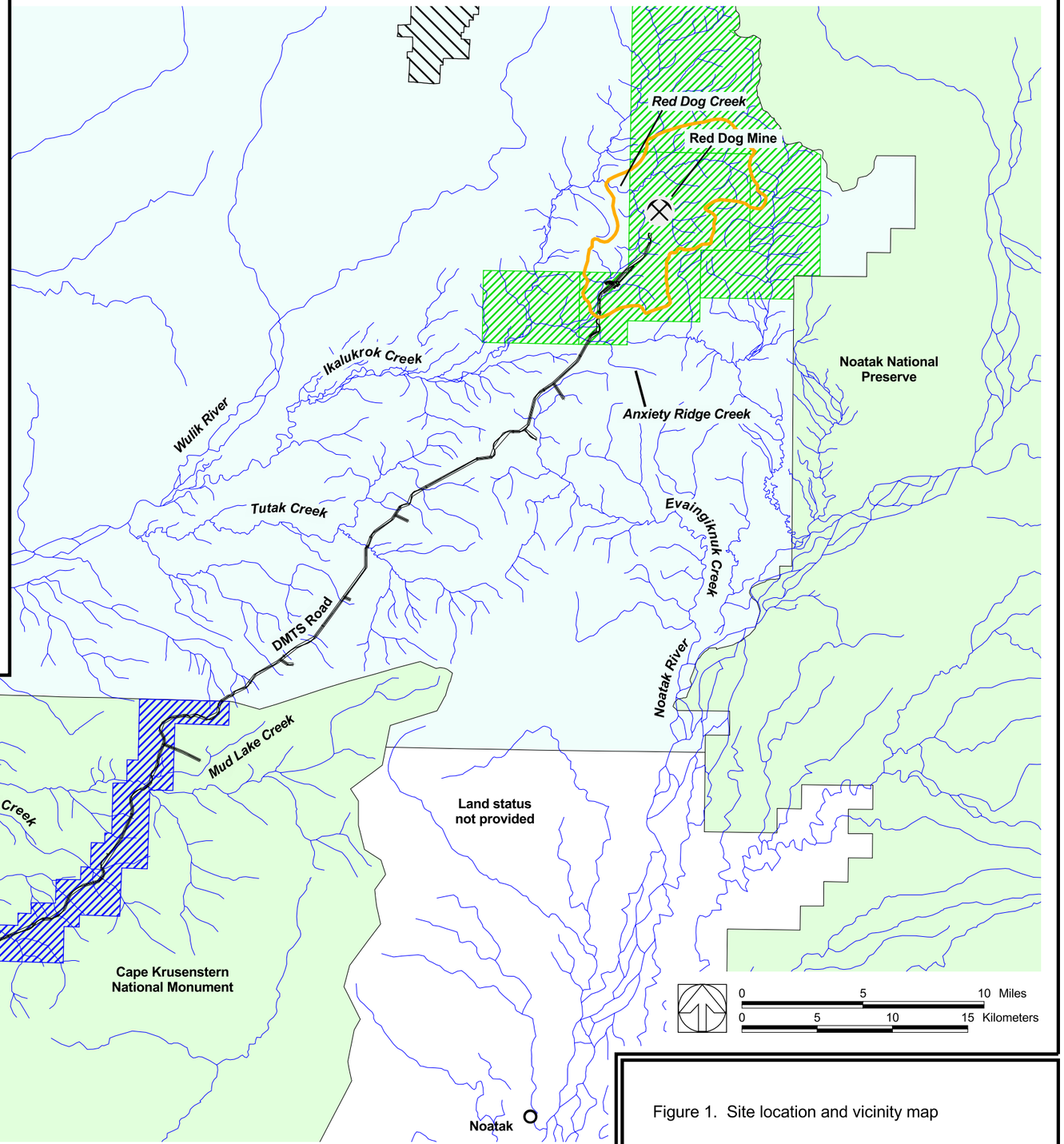
Figures

Figures





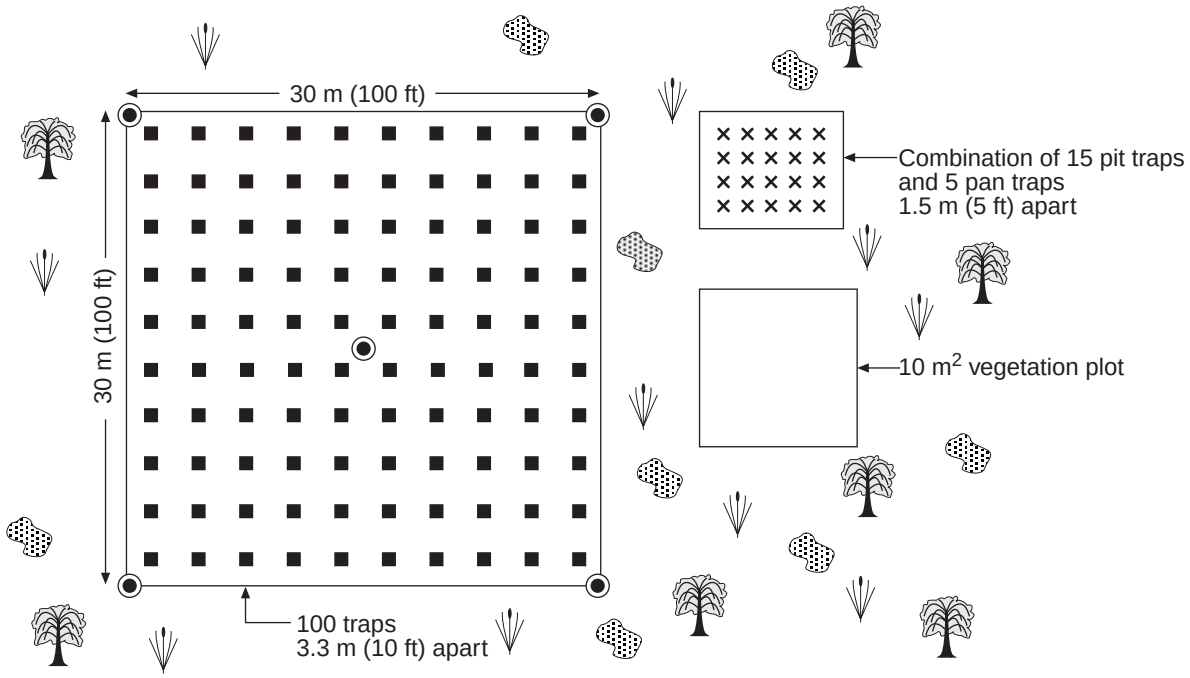
LEGEND

- DeLong Mountain Regional Transportation System road
- Port site ambient air boundary and mine site ambient air/solid waste permit boundary
- BLM land
- NANA land
- NANA easement
- State land

Note: * Hoefler (2000)

Exponent®

Figure 1. Site location and vicinity map



LEGEND

- Tundra soil sampling location
- Sedges
- Lichen
- Willow
- ■ Traps for small mammals
- × Pit traps for soil invertebrates

Figure 2. Schematic layout of typical terrestrial station

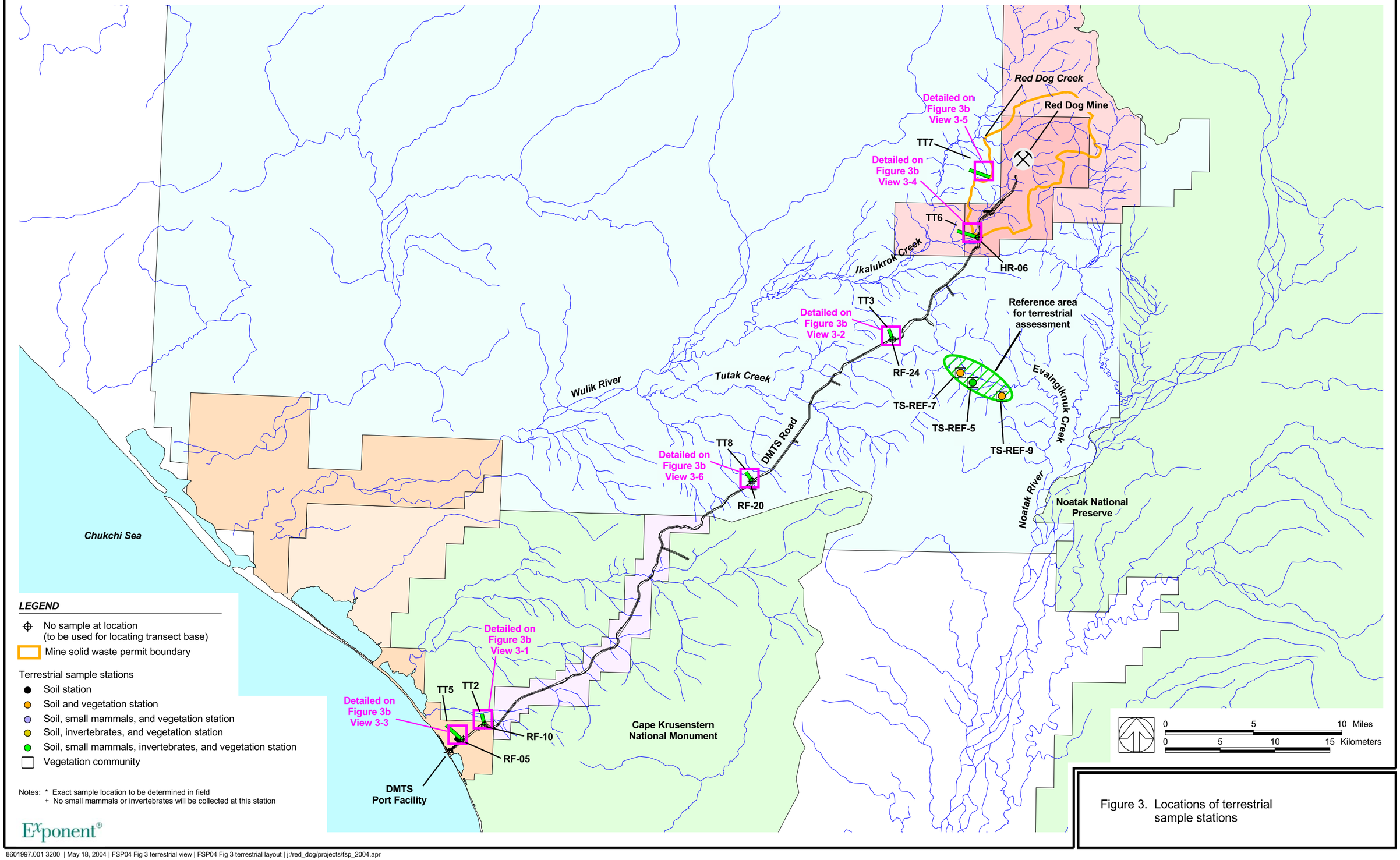
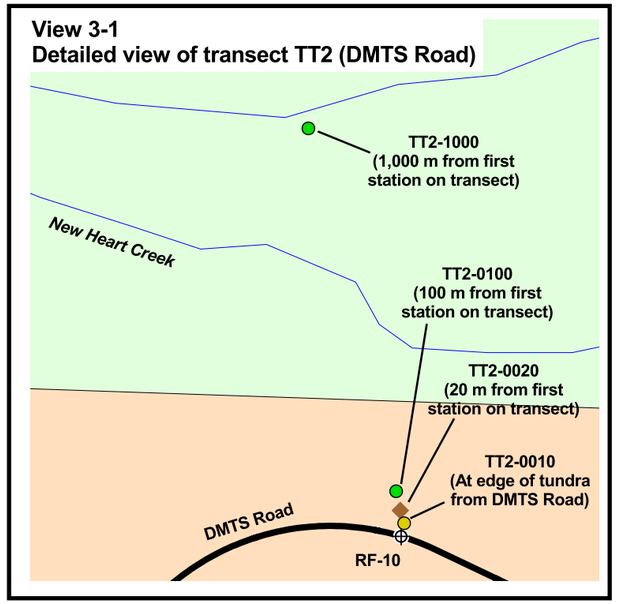
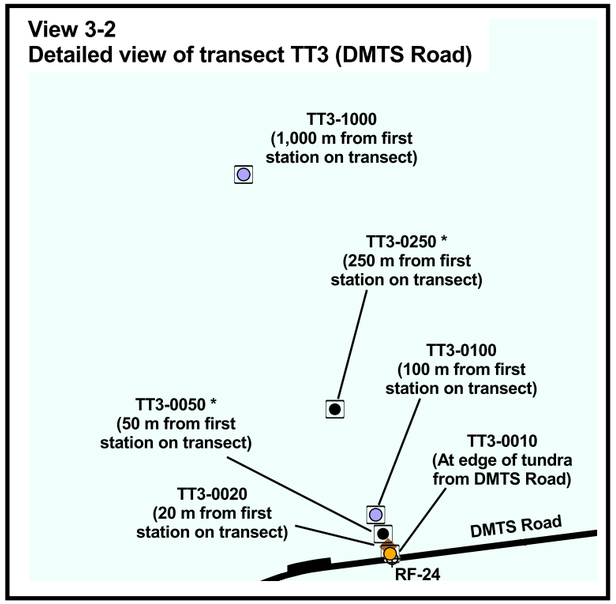
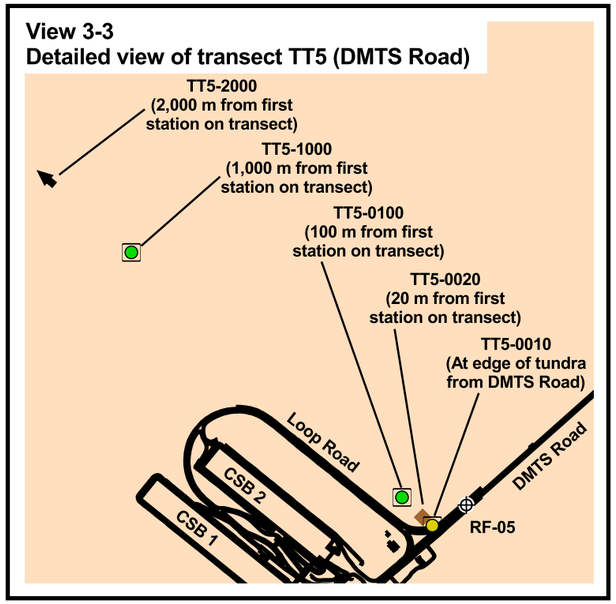
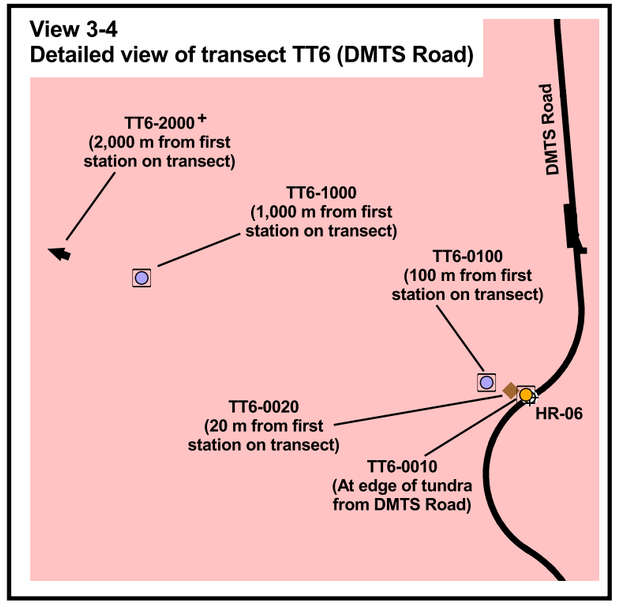


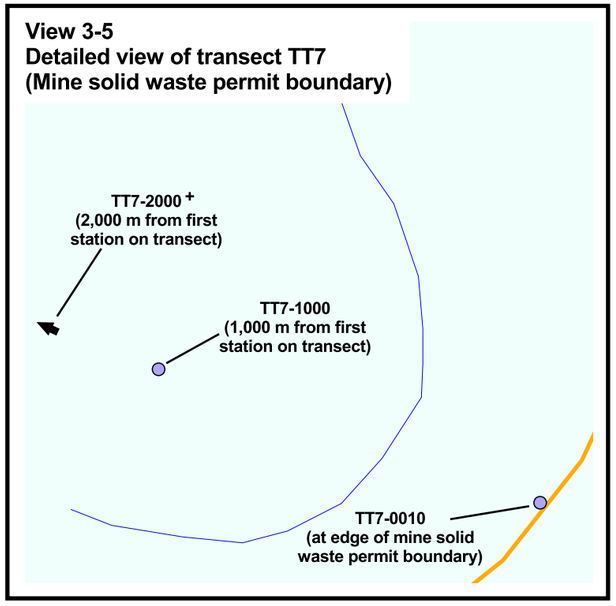
Figure 3. Locations of terrestrial sample stations

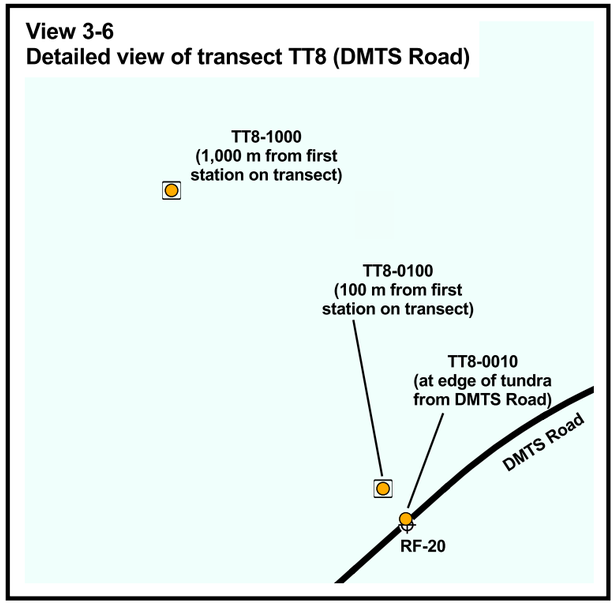












LEGEND

- No sample at location (to be used for locating transect base)
- Mine solid waste permit boundary

Terrestrial sample stations

- Soil station
- Soil and vegetation station
- Soil, small mammals, and vegetation station
- Soil, invertebrates, and vegetation station
- Soil, small mammals, invertebrates, and vegetation station
- Small mammals
- Vegetation community

Notes: * Exact sample location to be determined in field
\+ No small mammals or invertebrates will be collected at this station

0 1000 2000 3000 Feet
0 500 1000 Meters

Figure 4. Detailed views of locations of terrestrial sample stations

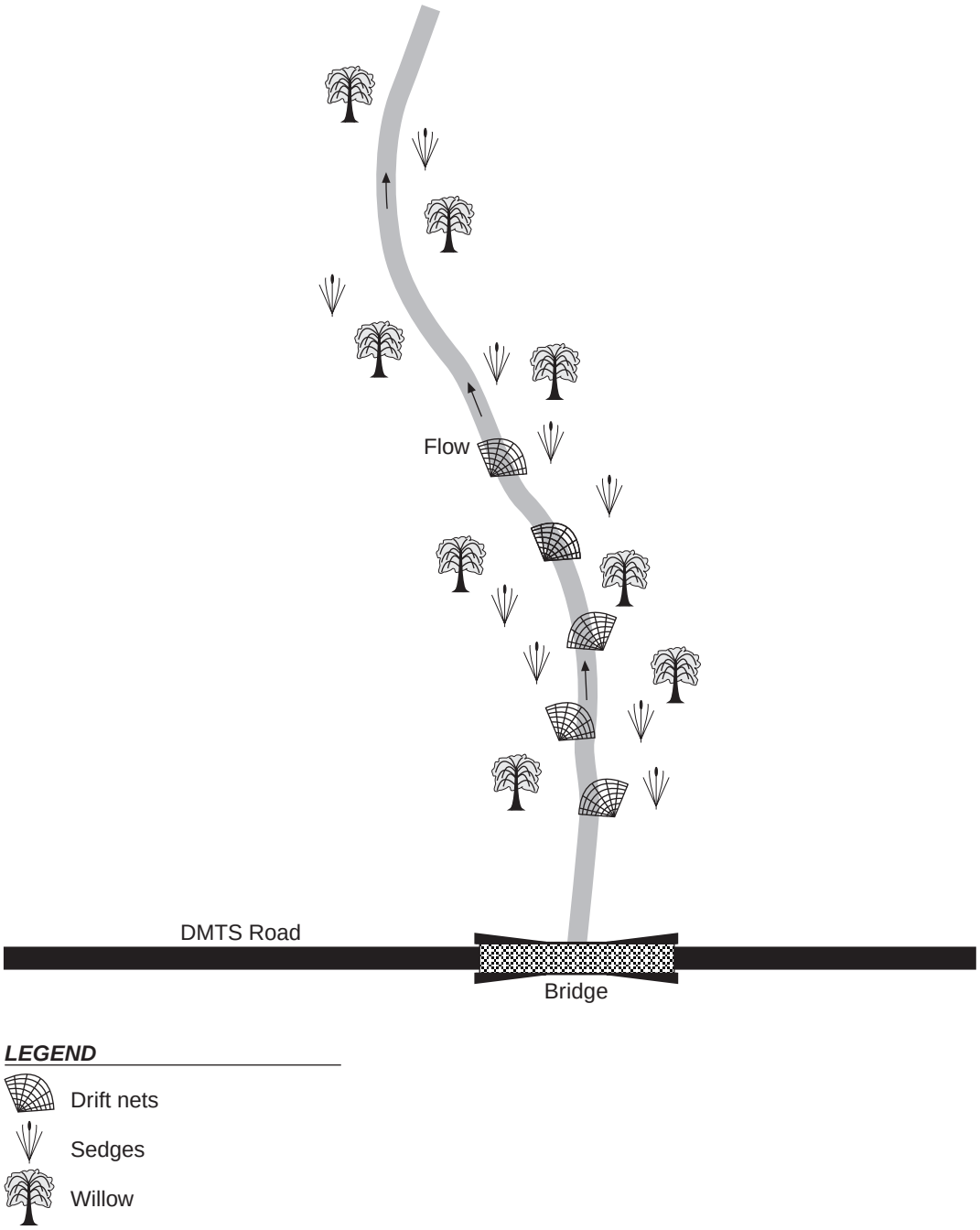
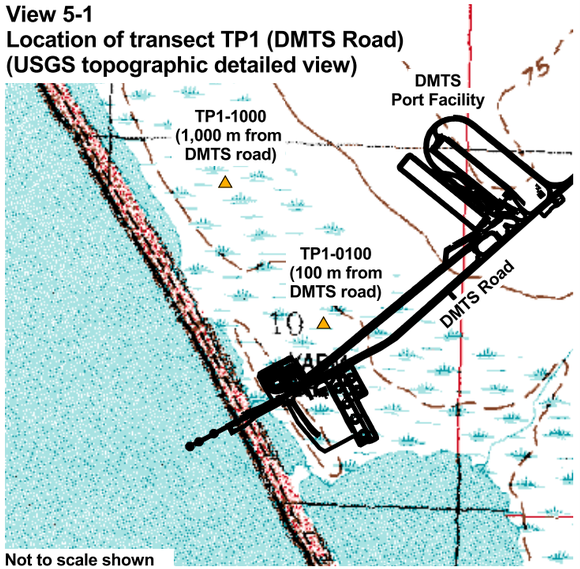


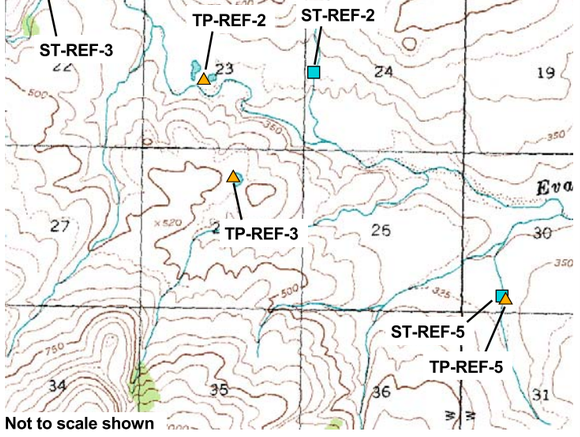
Figure 5. Schematic layout of typical stream station

View 5-1
Location of transect TP1 (DMTS Road)
(USGS topographic detailed view)

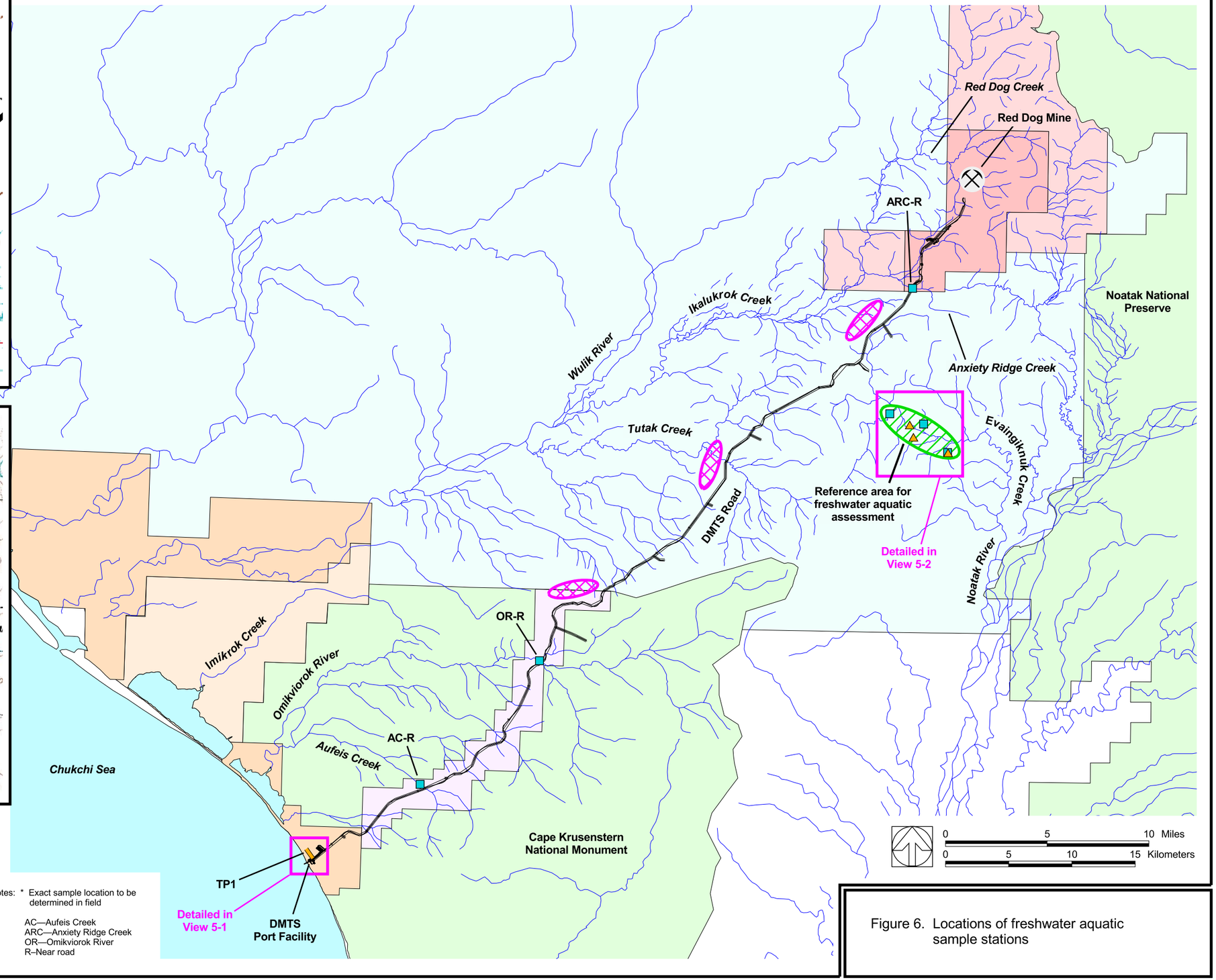


Not to scale shown

View 5-2
Location of reference stations
(USGS topographic detailed view)



Not to scale shown



LEGEND

- Proposed tundra pond sample location *

Sample types
- ○ Vegetation
- △ Tundra soil and vegetation
- □ Aquatic invertebrates (community analysis), and vegetation

Station locations
- Tundra pond station
- Stream station*

Notes: * Exact sample location to be determined in field

AC—Aufeis Creek
ARC—Anxiety Ridge Creek
OR—Omikviorok River
R–Near road

Figure 6. Locations of freshwater aquatic sample stations

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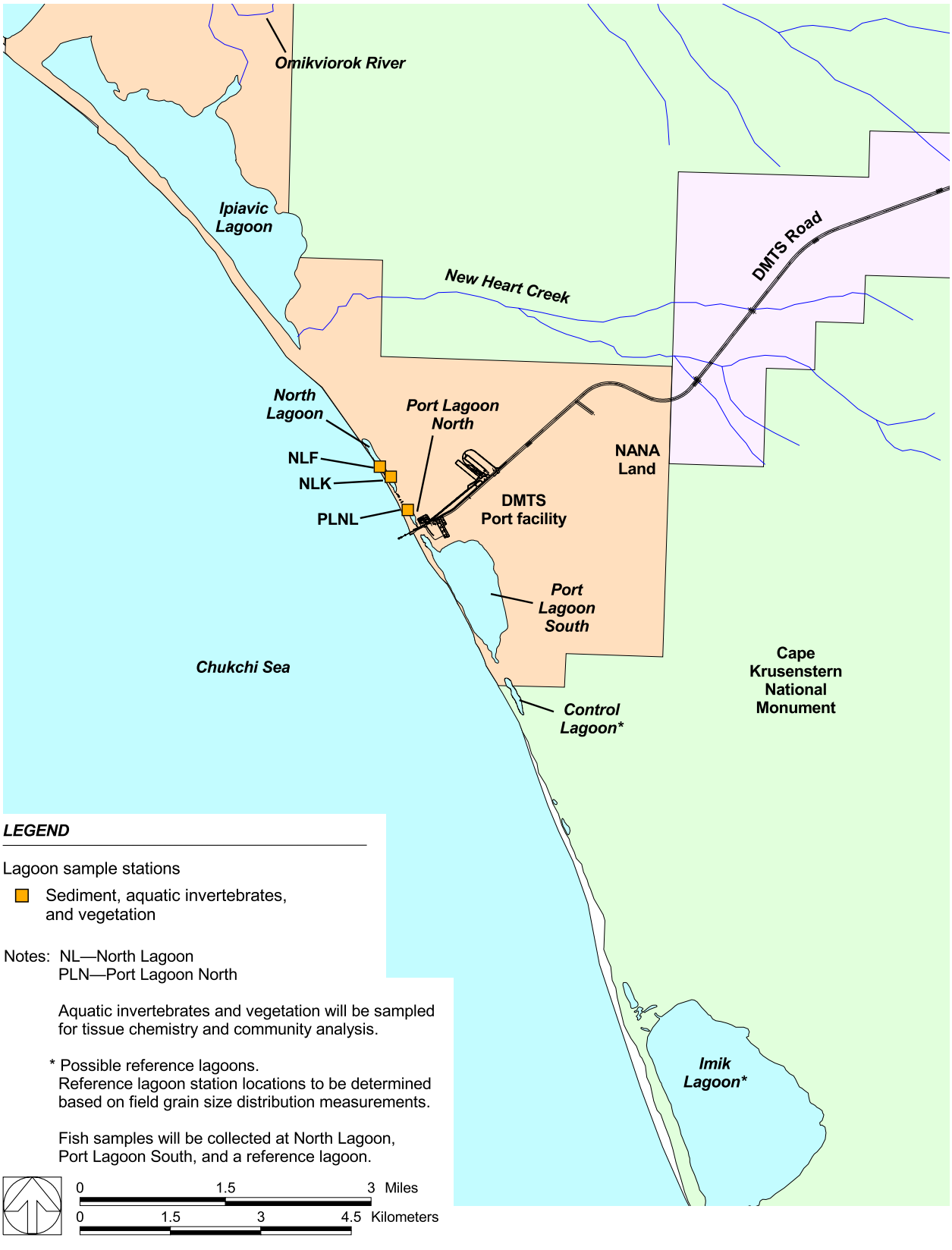


Figure 7. Locations of coastal lagoon sample stations

Exponent®

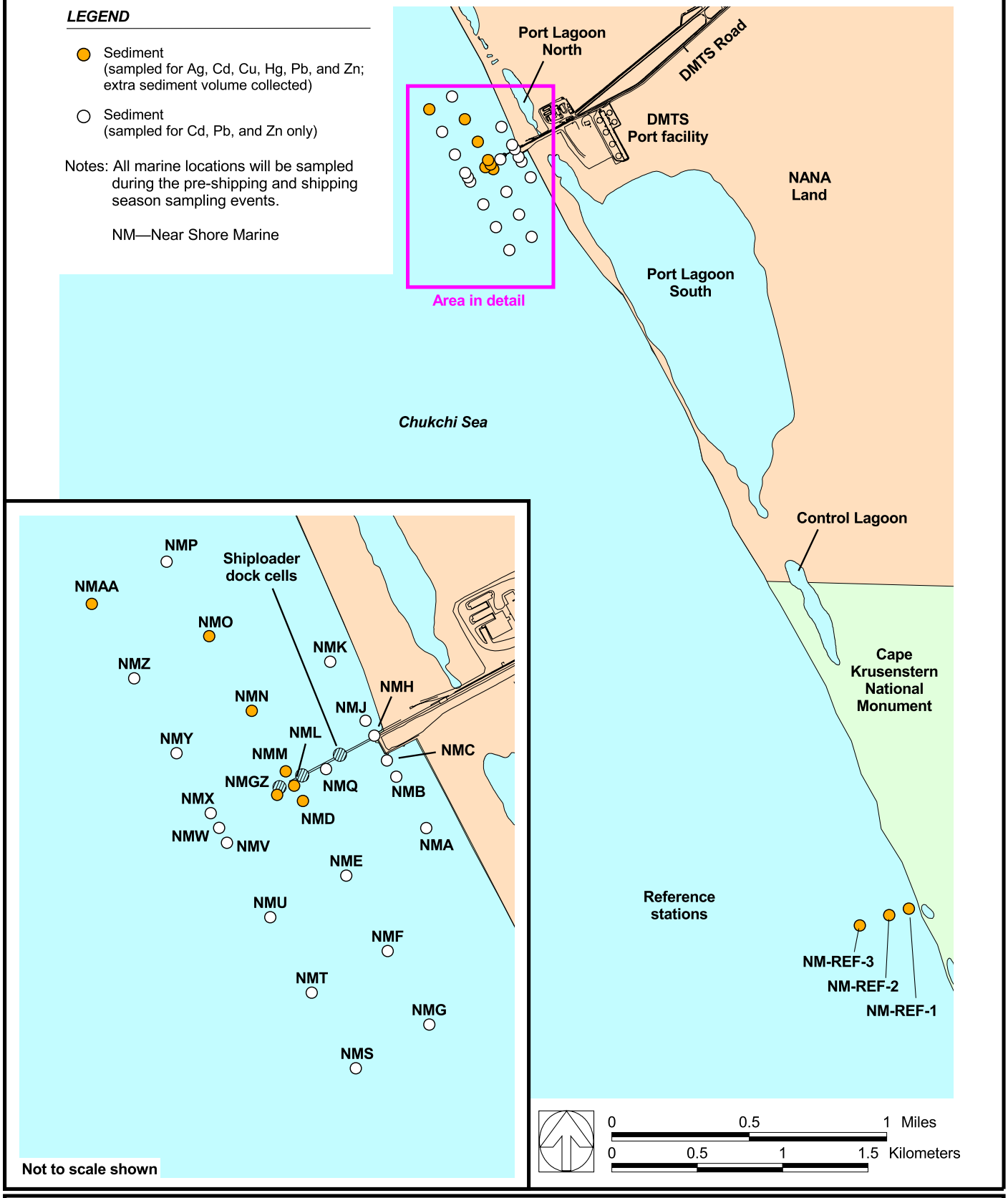
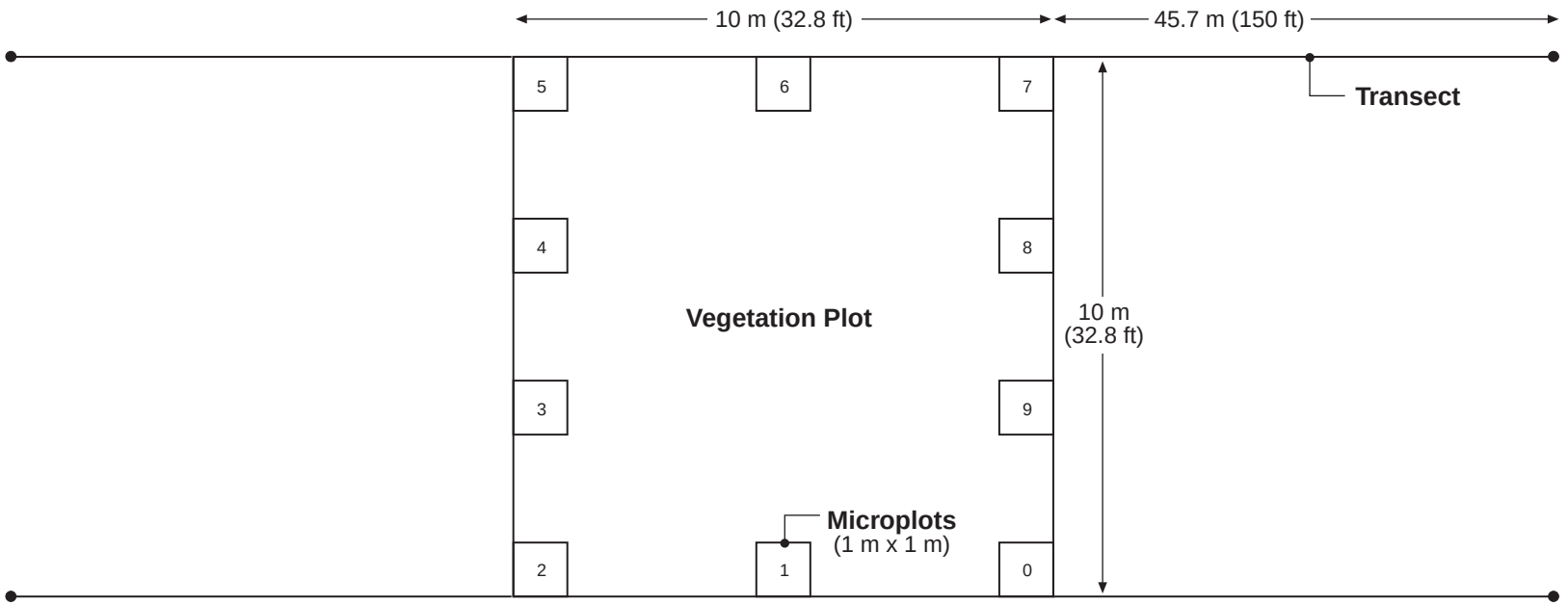


Figure 8. Proposed locations of marine sediment sample stations

Exponent®



Note: Vegetation plots and transects located nearest the DMTS road will be oriented parallel to the road

Not to scale

Figure 9. Typical vegetation plot for plant community analysis

Tables

Table 1. Data needs for the ecological risk assessment

Environment	Assessment Endpoint	Representative Receptor	Food Item	Data Need
Tundra	Structure and function of terrestrial plant communities	Terrestrial plant communities	NA	Tundra plant community surveys
Tundra	Structure and function of tundra soil fauna communities	Tundra soil fauna communities	NA	None. Not directly assessed; evaluated through terrestrial plant community analysis
Tundra	Survival, growth, and reproduction of terrestrial avian herbivore populations	Willow ptarmigan	Terrestrial plants (willow and sedge)	CoPCs in terrestrial plants[a]
Tundra	Survival, growth, and reproduction of terrestrial mammalian herbivore populations	Tundra vole; caribou; moose	Terrestrial plants (willow, sedge, and/or lichen)	CoPCs in terrestrial plants[a]
Tundra	Survival, growth, and reproduction of terrestrial avian invertivore populations	Lapland longspur	Terrestrial invertebrates	CoPCs in terrestrial invertebrates[a]
Tundra	Survival, growth, and reproduction of terrestrial mammalian invertivore populations	Tundra shrew	Terrestrial invertebrates	CoPCs in terrestrial invertebrates[a]
Tundra	Survival, growth, and reproduction of terrestrial avian carnivore populations	Snowy owl	Small mammals (voles or lemmings)	CoPCs in small mammals[a]
Tundra	Survival, growth, and reproduction of terrestrial mammalian carnivore populations	Arctic fox	Small mammals (voles or lemmings)	CoPCs in small mammals[a]
Streams	Structure and function of stream aquatic and wetland plant communities	Stream aquatic and wetland plant communities	NA	CoPCs in stream aquatic/wetland plants (arsenic, cadmium, lead, nickel, and zinc)
Streams	Structure and function of stream aquatic invertebrate communities	Stream aquatic invertebrate communities	NA	Stream aquatic invertebrate community surveys
Streams	Survival, growth, and reproduction of stream avian herbivore populations	Green-winged teal	Aquatic/wetland plants (sedge)	CoPCs in stream aquatic/wetland plants[a]
Streams	Survival, growth, and reproduction of stream mammalian herbivore populations	Muskrat	Aquatic/wetland plants (sedge)	CoPCs in stream aquatic/wetland plants[a]
Streams	Survival, growth, and reproduction of stream avian invertivore populations	Common snipe	Aquatic invertebrates	CoPCs in stream invertebrates (cadmium, lead, mercury, and zinc)[b]

Table 1. (cont.)

Environment	Assessment Endpoint	Representative Receptor	Food Item	Data Need
Tundra ponds	Structure and function of tundra pond aquatic and wetland plant communities	Tundra pond aquatic and wetland plant communities	NA	Tundra pond and wetland plant community surveys[c]
Tundra ponds	Structure and function of tundra pond aquatic invertebrate communities	Tundra pond aquatic invertebrate communities	NA	Tundra pond aquatic invertebrate community surveys[b]
Tundra ponds	Survival, growth, and reproduction of tundra pond avian herbivore populations	Green-winged teal	Aquatic/wetland plants (sedge)	CoPCs in tundra pond aquatic/wetland plants[a]
Tundra ponds	Survival, growth, and reproduction of tundra pond mammalian herbivore populations	Muskrat	Aquatic/wetland plants (sedge)	CoPCs in tundra pond aquatic/wetland plants[a]
Tundra ponds	Survival, growth, and reproduction of tundra pond avian invertivore populations	Common snipe	Aquatic invertebrates	CoPCs in tundra pond aquatic invertebrates (arsenic, barium, cadmium, lead, mercury, thallium, and zinc)[b]
Coastal lagoons	Structure and function of coastal lagoon aquatic and wetland plant communities	Coastal lagoon aquatic and wetland plant communities	NA	Coastal lagoon aquatic and wetland plant community surveys
Coastal lagoons	Structure and function of coastal lagoon aquatic invertebrate communities	Coastal lagoon aquatic invertebrate communities	NA	Coastal lagoon aquatic invertebrate community surveys
Coastal lagoons	Structure and function of coast lagoon fish communities	Coastal lagoon fish	NA	CoPCs in coastal lagoon fish[d]
Coastal lagoons	Survival, growth, and reproduction of coastal lagoon avian herbivore populations	Brant	Aquatic/wetland plants (sedge)	CoPCs in coastal lagoon aquatic/ wetland plants[a]
Coastal lagoons	Survival, growth, and reproduction of coastal lagoon avian invertivore populations	Black-bellied plover	Aquatic invertebrates	CoPCs in coastal lagoon aquatic invertebrates (cadmium, lead and zinc)
Coastal lagoons	Survival, growth, and reproduction of coastal lagoon avian piscivore populations	Red-throated loon	Fish	CoPCs in coastal lagoon fish[a]

Footnotes on following page.

Table 1. (cont.)

Note: CoPC - chemical of potential concern
NA - not applicable

[a] CoPCs for all herbivores, terrestrial invertivores, terrestrial carnivores, and lagoon piscivores are aluminum, antimony, arsenic, barium, cadmium, chromium, cobalt, lead, mercury, molybdenum, selenium, thallium, vanadium, and zinc.

[b] Data for terrestrial invertebrate samples collected during the Phase II field event will be used to evaluate this assessment endpoint.

[c] Data for terrestrial plant community surveys collected during the Phase II field event will be used to evaluate this assessment endpoint.

[d] CoPCs for coastal lagoon fish are arsenic, cadmium, lead, and zinc.

Table 2. Summary of existing data by media

Lead Organization	Study Type	Citation	Study Dates	Soil	Water	Sediment	Plants	Fish	Caribou
Pre-Mine/Baseline									
Teck Cominco	Environmental baseline study	Dames & Moore (1983)	1981–1983		X			X	
General Crude Oil and Minerals	Environmental baseline study	Ward and Olson (1980)	1978–1979		X			X	
Alaska Department of Environmental Conservation	Aquatic baseline study	EVS and Ott Water (1983)	1982					X	
U.S. Fish and Wildlife Service	Baseline study for Selawik NWR	Mueller et al. (1993)	1987–1988		X	X		X	
Post-Mine									
Teck Cominco	Port site monitoring	ENSR (1990, 1991, 1993, 1996); RWJ (1997)	1990–1996	X	X	X			
	Transportation corridor monitoring	ENSR (1991)	1991–1992	X	X				
	Vegetation and soil monitoring	RWJ (1998)	1992, 1993, 1997	X					
	Fugitive dust study	Exponent (2002a,b)	2001	X	X		X		
	Kivalina drinking water study	RWJ (1997); DHSS (2001); (Kulas 2003, pers. comm.)	1991–2003		X				
	Supplemental road sampling	Exponent (2002c)	2002	X					
	Caribou evaluation	Exponent (2002d)	1996, 2002						X
	Port site characterization	Exponent (2003a)	2002	X	X	X			
Alaska Industrial Development and Export Authority	Sediment quality survey	Cominco et al. (1999)	1998	X		X			
Alaska Department of Environmental Conservation	Subsistence foods investigation	E&E (2002); DHSS (2001)	2001		X		X		
Alaska Department of Fish and Game	NPDES monitoring, expanded scope	Weber-Scannell and Ott (2001)	1994–2001		X			X	
	Juvenile fish tissue study	Morris and Ott (2001); DHSS (2001)	1993, 1998–2001					X	
National Park Service	DMTS road dustfall study	Ford and Hasselbach (2001)	2000	X			X		
		Hasselbach (2003a, pers. comm.)	2003				X		
Kivalina Village	Kivalina drinking water sampling	DHSS (2001)	1995, 1996, 2001		X				
United States Geological Survey	Cape Krusenstern trace elements study	Brabets (2003, pers. comm.)	2002		X	X			
	Willow study	Gough (2003, pers. comm.)	2002				X		
	Soil study	Kelley and Hudson (2003)	2002	X					
Teck Cominco	Fugitive dust study (Phase I risk assessment)	Exponent (2004)	2003	X	X	X	X		

Note: X - analytical data available

Table 3. Analytical data summary for screening chemicals of potential concern

Environment	Medium	Site/ Reference	Survey Name	Numbers of Samples by Analyte[a]																					
				Aluminum	Antimony	Arsenic	Barium	Cadmium	Chromium	Cobalt	Copper	Fluoride	Iron	Lead	Manganese	Mercury	Molybdenum	Nickel	Selenium	Silver	Strontium	Thallium	Tin	Vanadium	Zinc
Terrestrial	Soil	Site	PHASE1RA, PSCHAR, FUGDST01, SUPPRSS, TECK03	51	40	75	40	478	40	40	40	12	51	479	40	12	40	40	30	40	20	12	27	40	479
		Reference	PHASE1RA, FUGDST01	10	5	10	5	10	5	5	5	5	10	10	5	5	5	5	5	5	5	5	5	5	10
	Tundra Soil	Site	PHASE1RA, PSCHAR, ENSR92	31	25	31	25	224	25	25	25	12	31	264	25	12	25	25	25	25	17	12	17	25	264
		Reference	PHASE1RA	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10
Stream	Sediment	Site	PHASE1RA	14	14	14	14	14	14	14	14	14	14	14	14	14	14	14	14	14	14	14	14	14	14
		Reference	PHASE1RA	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5
	Water	Site	TECK03, TECK01, USGS02	230	14	14	14	229	18	14	18	31	230	230	18	14	14	14	29	14	14	29	14	14	230
		Reference	PHASE1RA	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3
Tundra Pond	Sediment	Site	PHASE1RA	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4
		Reference	PHASE1RA	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5
	Water	Site	PHASE1RA	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4
		Reference	PHASE1RA	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3
Lagoon	Sediment	Site	PHASE1RA, PSCHAR	8	8	8	8	34	8	8	8	11	8	26	8	8	8	8	8	8	8	8	11	8	26
		Reference	PHASE1RA, PSCHAR, ENSR91, ENSR92, ENSR95, ENSR96	3	3	3	3	13	3	3	3	3	3	28	3	3	3	3	3	3	3	3	3	3	28
	Water	Site	PHASE1RA, PSCHAR	8	8	8	8	14	8	8	8	8	8	14	8	8	8	8	8	8	8	8	8	8	14
		Reference	PHASE1RA, PSCHAR	3	3	3	3	5	3	3	3	3	3	5	3	3	3	3	3	3	3	3	3	3	5
Marine	Sediment	Site	PHASE1RA, PSCHAR, CORPS00, DMTP98	18	17	69	69	129	69	18	69	16	18	129	18	16	18	18	17	69	17	17	17	41	129
		Reference	PHASE1RA, DMTP98, BASLIN82	15	9	21	21	21	21	9	21	9	15	21	9	9	9	15	15	21	9	9	9	9	21
	Water	Site	PHASE1RA	9	9	9	9	9	9	9	9	9	9	9	9	9	9	9	9	9	9	9	9	9	9
		Reference	PHASE1RA	6	6	6	6	6	6	6	6	6	6	6	6	6	6	6	6	6	6	6	6	6	6

Note: Survey names and citations:

PHASE1RA	Exponent (2003d) and Appendices A, C, and D of Exponent (2004)
PSCHAR	Exponent (2003c)
FUGDST01	Exponent (2002a)
SUPPRSS	Exponent (2002b)
TECK03	Teck Cominco (2003)
TECK01	Exponent (2002a)
ENSR91	ENSR (1992)
ENSR92	ENSR (1993)
ENSR95	ENSR (1996)
ENSR96	RWJ (1997)
DMTP98	Cominco et al. (1999)
CORPS00	Corps (2001)
BASLIN82	Dames & Moore (1983)
USGS02	Brabets (2003, pers. comm.)

[a] The numbers of samples shown are for the data to be used in the assessment, processed according to the data usability criteria listed in Section 3.2 of the risk assessment work plan (Exponent 2004).

Table 4. Phase II sampling matrix

Sample Type	Description	No. of Stations	No. of Field Samples	Kind of Sample	Analytes	Purpose
Terrestrial						
Small mammals	Port - TT5 - points roughly 20 m, 100 m, 1 km, and 2 km north of road	4	20 (5 mammals per location)	Tissue chemistry; whole body; each individual mammal equals one sample	List 1[a]	To collect prey tissue data for use in food web exposure models for the snowy owl and arctic fox
Small mammals	DMTS road transects - TT2, TT3, TT6 - points at 20 m, 100 m and 1 km north of road	9	45 (5 mammals per location)			
Small mammals	Solid waste permit boundary transect - TT7- points at boundary and 1 km downwind of mine	2	10 (5 mammals per location)			
Small mammals	Terrestrial reference area	1	5 (5 mammals per location)			
Ptarmigan	Near the DMTS road	NA	5 individual birds	Tissue chemistry; breast muscle tissue (skin on), liver, and kidneys from each bird analyzed separately	List 2: Antimony, barium, cadmium, lead, thallium, and zinc	To collect subsistence food data to support the human health risk assessment
Ptarmigan	Terrestrial reference area	NA	5 individual birds			
Soil invertebrates	Port - TT5 - points roughly 10 m, 100 m, 1 km, and 2 km north of road	4	4 (1 composite per station)	Tissue chemistry; whole body; composite tissue sample of all soil invertebrates collected at a given station	List 1[a]	To collect prey tissue data for use in food web exposure models for the Lapland longspur, common snipe, and tundra shrew
Soil invertebrates	DMTS road transect - TT2 - points at 10 m, 100 m, and 1 km north of road	3	3 (1 composite per station)			
Soil invertebrates	Terrestrial reference area	1	1 (1 composite per station)			
Willow (birch)	Port - TT5 - points roughly 10 m, 100 m, 1 km, and 2 km north of road	4	4 (1 composite per station)	Tissue chemistry; willow leaves only; unwashed and debris removed in field	List 1[a]	To collect plant tissue data for use in food web exposure models for the willow ptarmigan, caribou, and moose
Willow (birch)	DMTS road transects - TT2, TT3, TT8 - points at 10 m, 100 m, and 1 km north of road	9	9 (1 composite per station)			
Willow (birch)	DMTS road transect - TT6 - points at 10 m, 100 m, 1 km, and 2 km north of road	4	4 (1 composite per station)			
Willow (birch)	Solid waste permit boundary transect - TT7 - points at boundary, 1 km, and 2 km downwind of mine	3	3 (1 composite per station)			
Willow (birch)	Terrestrial reference area	3	3 (1 composite per station)			
Sedge	Port - TT5 - points roughly 10 m, 100 m, 1 km, and 2 km north of road	4	4 (1 composite per station)	Tissue chemistry; minimum 3 plants per station; unwashed sedge blades only	List 1[a]	To collect plant tissue data for use in food web exposure models for the willow ptarmigan, Lapland longspur, tundra vole, caribou, and moose
Sedge	DMTS road transects - TT2, TT3, TT8 - points at 10 m, 100 m, and 1 km north of road	9	9 (1 composite per station)			
Sedge	DMTS road transect - TT6 - points at 10 m, 100 m, 1 km, and 2 km north of road	4	4 (1 composite per station)			
Sedge	Solid waste permit boundary transect - TT7 - points at boundary, 1 km, and 2 km downwind of mine	3	3 (1 composite per station)			
Sedge	Terrestrial reference area	3	3 (1 composite per station)			
Lichen	Port - TT5 - points roughly 10 m, 100 m, 1 km, and 2 km north of road	4	4 (1 composite per station)	Tissue chemistry; minimum 3 lichen plants per station; unwashed and debris removed in field	List 1[a]	To collect plant tissue data for use in food web exposure models for the tundra vole and caribou
Lichen	DMTS road transects - TT2, TT3, TT8 - points at 10 m, 100 m, and 1 km north of road	9	9 (1 composite per station)			
Lichen	DMTS road transect - TT6 - points at 10 m, 100 m, 1 km, and 2 km north of	4	4 (1 composite per station)			
Lichen	Solid waste permit boundary transect - TT7 - points at boundary, 1 km, and 2 km downwind of mine	3	3 (1 composite per station)			
Lichen	Terrestrial reference area	3	3 (1 composite per station)			

Table 4. (cont.)

Sample Type	Description	No. of Stations	No. of Field Samples	Kind of Sample	Analytes	Purpose
Vegetation plots	Port - TT5 - points roughly 10 m, 100 m, 1 km, and 2 km north of road	4	--	Community analysis		To assess the structure and function of tundra plant communities
Vegetation plots	DMTS road transects - TT3 and TT6 - points at 10 m, 100 m and 1 km north of road	6	--	Community analysis		
Vegetation plots	DMTS road transect - TT8 - points at 100 m and 1 km north of road	2				
Vegetation plots	DMTS road transect - TT3 - vegetation transition points	2	--	Community analysis		
Vegetation plots	Terrestrial reference area	3	--	Community analysis		
Tundra soil	Port - TT5 - points roughly 10 m, 100 m, 200 m, 1 km, and 2 km north of road	5	3	Chemistry; 0–2 cm	List 3[b] and pH	To collect tundra soil data to support the tundra plant and soil fauna community assessments
Tundra soil	DMTS road transects - TT2, TT3, and TT6 - points at 10 m, 20 m, 100 m, 1 km north of road, and also at 2 km north of road on TT6	13	13	Chemistry; 0–2 cm	List 3[b] and pH	
Tundra soil	DMTS road transect - TT8 - points at 10 m, 100 m, and 1 km north of road	3	3	Chemistry; 0–2 cm	List 3[b] and pH	
Tundra soil	Solid waste permit boundary transect - TT7 - points at boundary, 1 km, and 2 km downwind of mine	3	3	Chemistry; 0–2 cm	List 3[b] and pH	
Tundra soil	DMTS road transect - TT3 - vegetation transition points	2	2	Chemistry; 0–2 cm	List 3[b] and pH	
Tundra soil	Terrestrial reference area	3	3	Chemistry; 0–2 cm	List 3[b] and pH	
Streams						
Invertebrates	Aufeis Creek, Omikviorok River, Anxiety Ridge Creek	3	15 (5 replicates per station)	Community analysis	--	To assess the structure and function of stream invertebrate communities
Invertebrates	Freshwater aquatic reference area - 3 streams	3	15 (5 replicates per station)	Community analysis	--	
Willow	Aufeis Creek, Omikviorok River, Anxiety Ridge Creek	3	3 (1 composite per station)	Tissue chemistry; willow leaves only; unwashed and debris removed in field	List 1[a]	To collect plant tissue data for use in food web exposure models for the moose
Willow	Freshwater aquatic reference area - 3 streams	3	3 (1 composite per station)			
Sedge	Aufeis Creek, Omikviorok River, Anxiety Ridge Creek	3	3 (1 composite per station)	Tissue chemistry; minimum 3 plants per station; roots and blades; the roots will be rinsed clean of sediment, leaving the blades unwashed, and the entire plant will be sampled	List 1[a]	To collect plant tissue data for use in food web exposure models for the green-winged teal, common snipe, and muskrat
Sedge	Freshwater aquatic reference area - 3 streams	3	3 (1 composite per station)			
Tundra soil	Aufeis Creek, Omikviorok River, Anxiety Ridge Creek	3	3	Chemistry; 0–2 cm	List 3[b]	To collect tundra soil data associated with stream plant tissue data
Tundra soil	Freshwater aquatic reference area - 3 streams	3	3	Chemistry; 0–2 cm	List 3[b]	
Stream water	Aufeis Creek, Omikviorok River, Anxiety Ridge Creek	3	3	Field measurements	Water quality parameters[c]	To collect water quality data to support the stream aquatic invertebrate community assessment
Stream water	Freshwater aquatic reference area - 3 streams	3	3	Field measurements		

Table 4. (cont.)

Sample Type	Description	No. of Stations	No. of Field Samples	Kind of Sample	Analytes	Purpose
Tundra Ponds						
Sedge	Port - TP1-0100 and TP1-1000	2	2 (1 composite per station)	Tissue chemistry; minimum 3 plants per station; roots and blades; the roots will be rinsed clean of sediment, leaving the blades unwashed, and the entire plant will be sampled	List 1[a]	To collect plant tissue data for use in food web exposure models for the green-winged teal, common snipe, and muskrat
Sedge	DMTS road - 3 ponds at 100-500 m north of road - near mine, middle of road, toward port	3	3 (1 composite per station)			
Sedge	Freshwater aquatic reference area - 3 ponds	3	3 (1 composite per station)			
Tundra soil	Port - TP1-0100 and TP1-1000	2	2	Chemistry; 0–2 cm	List 3[b]	To collect tundra pond soil data to support the tundra pond invertebrate community assessment
Tundra soil	DMTS road - 3 ponds at 100-500 m north of road - near mine, middle of road, toward port	3	3	Chemistry; 0–2 cm		
Tundra soil	Freshwater aquatic reference area - 3 ponds	3	3	Chemistry; 0–2 cm		
Tundra pond water	Port - TP1-0100 and TP1-1000	2	2	Field measurements	Water quality parameters[c]	To collect water quality data to support the tundra pond invertebrate community assessment
Tundra pond water	DMTS road - 3 ponds at 100-500 m north of road - near mine, middle of road, toward port	3	3	Field measurements		
Tundra pond water	Freshwater aquatic reference area - 3 ponds	3	3	Field measurements		
Coastal Lagoons						
Invertebrates	3 stations from 2 site lagoons	3	3 (1 composite per station)	Tissue chemistry; composite sample of all invertebrates collected at a station	List 4: Cadmium, lead, and zinc	To collect prey tissue data for use in food web exposure models for the black-bellied plover
Invertebrates	Reference lagoon TBD	1	1 (1 composite per station)			
Invertebrates	3 stations from 2 site lagoons	3	15 (5 replicates per station)	Community analysis		To assess the structure and function of coastal lagoon invertebrate communities
Invertebrates	Reference lagoon TBD	3	15 (5 replicates per station)	Community analysis		
Fish	2 site lagoons	2	10 (5 individuals or composites per lagoon)	Tissue chemistry; whole body; each individual fish or composite equals one sample	List 1[a]	To collect prey tissue data for use in food web models for the red-throated loon
Fish	Reference lagoon TBD	1	5 (individuals or composites)			
Sedge	3 stations from 2 site lagoons	3	3 (1 composite per station)	Tissue chemistry; minimum 3 plants per station; roots and blades; the roots will be rinsed clean of sediment, leaving the blades unwashed, and the entire plant will be sampled	List 1[a]	To collect plant tissue data for use in food web exposure models for the brant
Sedge	Reference lagoon TBD	3	3 (1 composite per station)			

Table 4. (cont.)

Sample Type	Description	No. of Stations	No. of Field Samples	Kind of Sample	Analytes	Purpose
Vegetation plots	3 site stations TBD	3	--	Community analysis	--	To assess the structure and function of coastal lagoon plant communities
	3 reference lagoon stations TBD	3	--	Community analysis	--	
Tundra soil	3 site stations TBD	3	3	Chemistry; 0–2 cm	List 3[b] and pH	To collect tundra soil data to support the coastal lagoon plant community assessment
Tundra soil	3 reference lagoon stations TBD	3	3	Chemistry; 0–2 cm		
Surface sediment	3 stations from 2 site lagoons	3	3 (1 composite per station)	Chemistry; 0–2 cm	List 5: Arsenic, cadmium, lead, zinc; List 6: Grain size and total solids; Leptocheirus survival and growth[d]	To collect sediment data to support the coastal lagoon invertebrate community assessment; to provide sediment for toxicity testing[d]
Surface sediment[d]	3 stations from 2 site lagoons	3	3 (5 lab replicates per station)	Toxicity test; 0–2 cm		
Surface sediment	Reference lagoon TBD	3	3 (1 composite per station)	Chemistry; 0–2 cm		
Surface sediment[d]	Reference lagoon TBD	3	3 (5 lab replicates per station)	Toxicity test; 0–2 cm		
Lagoon water	3 site stations TBD	3	3	Field measurements	Water quality parameters[c]	To collect water quality data to support the lagoon assessment
Lagoon water	3 reference lagoon stations TBD	3	3	Field measurements		
Marine						
Surface sediment	19 stations around the port	19	38 (two events)		List 4: Cadmium, lead, zinc	To assess current conditions in marine sediment, and to provide sediment for possible toxicity testing[e]
Surface sediment[e]	7 port stations - NMD, NMGZ, NML, NMM, NMN, NMO, NMAA	7	14 (two events)		List 7: Cadmium, copper, lead, mercury, silver, zinc; List 6: Grain size, total solids; Leptocheirus survival and growth[e]	
Surface sediment[e]	3 reference stations to the southeast	3	6 (two events)			

Note: CoPC - chemical of potential concern
DMTS - DeLong Mountain Regional Transportation System
NA - not applicable
TBD - to be determined

[a] List 1: Aluminum, antimony, arsenic, barium, cadmium, chromium, cobalt, lead, mercury, molybdenum, selenium, thallium, vanadium, and zinc.

[b] List 3: Antimony, arsenic, barium, cadmium, cobalt, copper, lead, manganese, mercury, molybdenum, selenium, silver, thallium, vanadium, and zinc.

[c] Water quality measurements will be taken in the field (e.g., pH, dissolved oxygen, temperature, conductivity, and salinity).

[d] Toxicity testing of coastal lagoon sediment will be performed only if aquatic invertebrates collected for community analyses are negligible.

[e] Toxicity testing of marine sediment will only be performed if concentrations in marine sediment have not decreased in comparison with 2003 concentrations. Toxicity tests will only be performed for one of the two sampling events.

Table 5. Summary of number of stations and samples

	Terrestrial			Streams			Tundra Ponds			Coastal Lagoons			Marine		
	No. of Stations		No. of	No. of Stations		No. of	No. of Stations		No. of	No. of Stations		No. of	No. of Stations		No. of
Sample Type	Site	Reference	Samples	Site	Reference	Samples	Site	Reference	Samples	Site	Reference	Samples	Site	Reference	Samples
Small mammals	15	1	80[a,b]	--	--	--	--	--	--	--	--	--	--	--	--
Ptarmigan	5	5	30[c,d]	--	--	--	--	--	--	--	--	--	--	--	--
Soil invertebrates															
Tissue chemistry	7	1	8[b]	--	--	--	--	--	--	--	--	--	--	--	--
Vegetation															
Willow	20	3	23[b]	3	3	6[b]	--	--	--	--	--	--	--	--	--
Sedge	20	3	23[b]	3	3	6[b]	5	3	8[b]	3	3	6[b]	--	--	--
Lichen	20	3	23[b]	--	--	--	--	--	--	--	--	--	--	--	--
Vegetation plots	14	3	17	--	--	--	--	--	--	3	3	6	--	--	--
Tundra soil	26	3	29[e]	3	3	6[e]	5	3	8[e]	3	3	6[e]	--	--	--
Aquatic invertebrates															
Tissue chemistry	--	--	--	--	--	--	--	--	--	3	1	4[f]	--	--	--
Community analysis	--	--	--	3	3	30[g]	--	--	--	3	3	30[g]	--	--	--
Fish	--	--	--	--	--	--	--	--	--	2	1	15[b,h]	--	--	--
Sediment															
Chemistry	--	--	--	--	--	--	--	--	--	3	3	6[i,j]	26	3	38[f,k]/20[j,k,l]
Toxicity tests	--	--	--	--	--	--	--	--	--	3	3	6[m]	7	3	10[n]
Water quality parameters	--	--	--	3	3	6	5	3	8	3	3	6	--	--	--

[a] Five small mammals will be collected at each location.

[b] List 1: Aluminum, antimony, arsenic, barium, cadmium, chromium, cobalt, lead, mercury, molybdenum, selenium, thallium, vanadium, and zinc.

[c] Three tissue samples (breast with skin on, liver, and kidneys) will be analyzed for each bird.

[d] List 2: Antimony, barium, cadmium, lead, thallium, and zinc.

[e] List 3: Antimony, arsenic, barium, cadmium, cobalt, copper, lead, manganese, mercury, molybdenum, selenium, silver, thallium, vanadium, and zinc. pH will also be measured in the field.

[f] List 4: Cadmium, lead, and zinc.

[g] Five replicate samples will be collected at each location.

[h] Five individual fish or composites will be collected from two site lagoons and the reference area lagoon.

[i] List 5: Arsenic, cadmium, lead, and zinc.

[j] List 6: Grain size and total solids.

[k] Two sampling events will be conducted, pre-shipping (June) and during-shipping (late August to early September).

[l] List 7: Cadmium, copper, lead, mercury, silver, and zinc.

[m] Toxicity testing of coastal lagoon sediment will be performed only if aquatic invertebrates collected for community analysis are negligible.

[n] Toxicity testing, if conducted, will only be conducted for one of the sampling events.

Table 6. Cover classes for quantifying percent cover of plant species

Cover Class	Range (percent)	Midpoint (percent)
+	Trace	0
1	<5	2.5
2	5–25	15
3	25–50	37.5
4	50–75	62.5
5	75–95	85
6	95–100	97.5

Source: Modified from Daubenmire (1959).

Table 7. Sample preservation, handling procedures, and holding time requirements

Analyte	Approximate Laboratory Subsample[a]	Container	Preservation and Handling	Maximum Holding Time[b]
Sediment/Soil				
Conventional Analytes				
Total solids	10 g	125-mL wide-mouth HDPE jar	Cool (4°C)	180 days
Grain Size	100 g	125-mL wide-mouth HDPE jar	Cool (4°C)	180 days
Toxicity tests				
Leptocheirus survival	2 L	1 L wide mouth glass jar; Teflon-lined lid	Keep in dark; cool (4°C)	14 days
Metals				
Metals	10 g	125-mL wide-mouth HDPE jar	Cool (4°C)	180 days
Mercury	10 g	125-mL wide-mouth HDPE jar	Cool (4°C)	28 days
Tissue				
Conventional Analytes				
Solids	1–2[c] g	Double plastic self-sealing bags; minimize air space[d]	Cool (4°C)	180 days
Metals				
Metals	1–2[c] g	Double plastic self-sealing bags; minimize air space[d]	Cool (4°C)	1 year
Mercury	2–5[c] g	Double plastic self-sealing bags; minimize air space[d]	Cool (4°C)	1 year

Note: HDPE - high density polyethylene

[a] Sample volumes listed are the optimum amounts that should be used to conduct the target analyses to achieve the detection limit goals. However, the sample volume that will be used at the laboratory may vary if a limited amount of sample is collected or if concentrations of target analytes are elevated.

[b] Sample collection to preparation holding time/sample preparation to analysis holding time.

[c] Sample volumes listed are the minimum amounts that should be used to conduct the target analyses to achieve the detection limit goals (due to limited sample size).

[d] Wide-mouth glass jars with Teflon®-lined lids will be used by the laboratory to store tissue samples.