SITE INSPECTION REPORT
FOR THE
NABESNA MINE
NABESNA, ALASKA

CERCLIS ID NO. AK0000333021

Prepared for:

Work Assignment No. 54-17-0JZZ
Contract No. 68-W9-0054
United States Environmental Protection Agency
Region 10
1200 Sixth Avenue
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September 26, 1995

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URS DCN 62760.35.20.1043.45.b1

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APPENDIXES

ABBREVIATIONS AND ACRONYMS

ANILCA	Alaska National Interest Lands Conservation Act of 1980
bgs	below ground surface
CERCLA	Comprehensive Environmental Response, Compensation, and Liability Act of 1980
CFR	Code of Federal Regulations
DQO	data quality objective
EPA	United States Environmental Protection Agency
IDW	investigative-derived waste
MS/MSD	matrix spike/matrix spike duplicate
Nabesna	Nabesna Mine
NRHP	National Register of Historic Places
NPL	National Priorities List
NPS	National Park Service
PCB	polychlorinated biphenyl
QMP	Quality Management Plan
SAM	site assessment manager
SARA	Superfund Amendments and Reauthorization Act of 1986
SI	site inspection
SQL	sample quantitation limit
SVOCs	semivolatile organic compounds
TSOP	Technical Standard Operating Procedures
URS	URS Consultants, Inc.

FIGURES

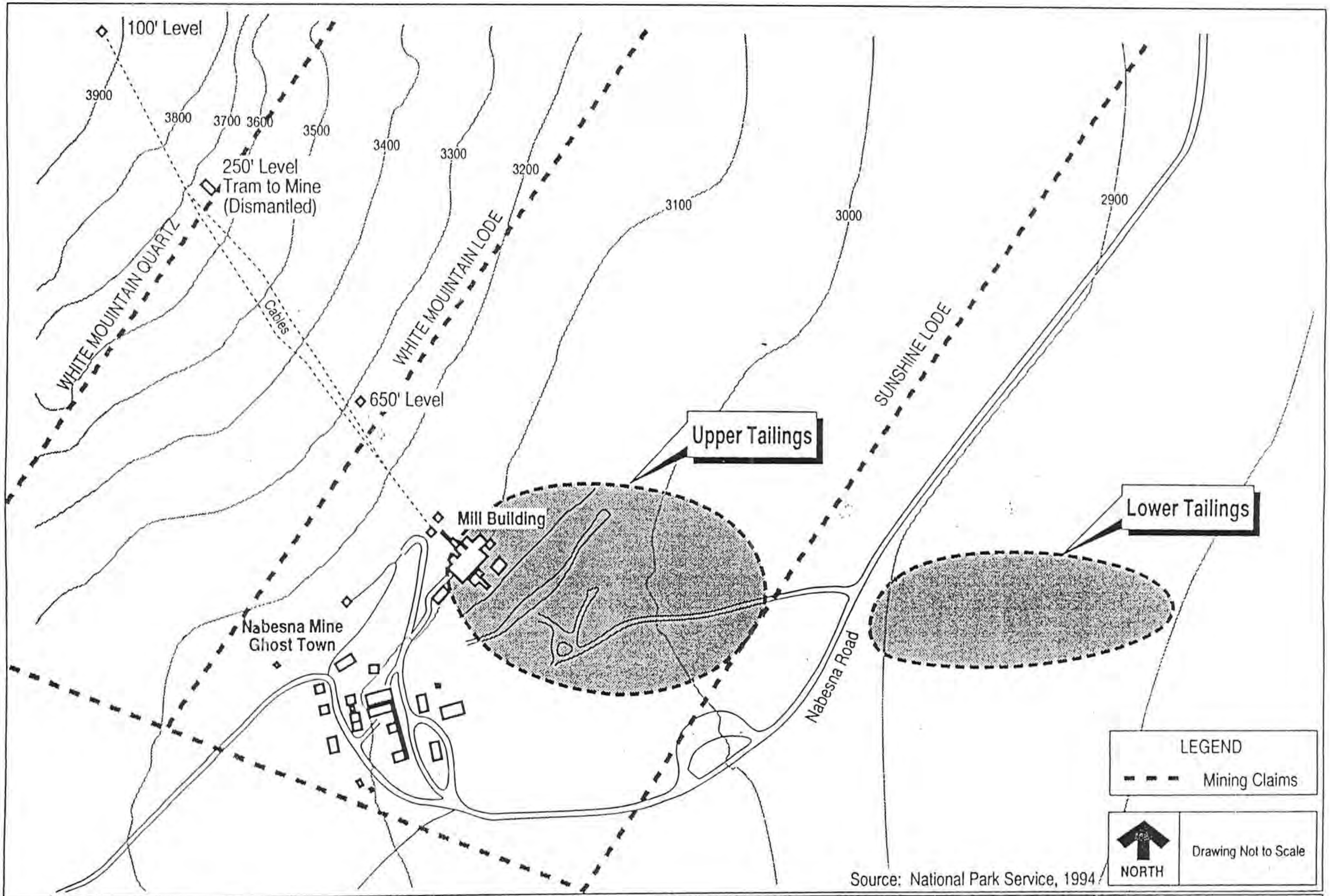
TABLES

1.0 INTRODUCTION

Pursuant to United States Environmental Protection Agency (EPA) Contract No. 68-W9-0054 and Work Assignment No. 54-17-0JZZ, URS Consultants, Inc. (URS) has conducted a site inspection (SI) of the Nabesna Mine (Nabesna) site located at Milepost 46 on the Nabesna/Slana Road, Nabesna, Alaska. This SI was conducted under the authority of the Comprehensive Environmental Response, Compensation, and Liability Act of 1980, as amended by the Superfund Amendments and Reauthorization Act of 1986 (SARA). The SI process is intended to (1) document a threat or potential threat to public health or the environment posed by a site; (2) identify if a potential emergency situation exists that may require an immediate response; (3) document the presence or absence of uncontained or uncontrolled hazardous substances on a site; and (4) confirm site characteristics and area receptor information collected during the preliminary assessment. The SI is intended to collect sufficient data to enable evaluation of the site's potential for inclusion on the National Priorities List (NPL), and, for those sites determined to be NPL candidates, establish priorities for additional action. The SI process and this SI do not include extensive or complete site characterization, contaminant fate determination, or quantitative ecological or human health risk assessment.

Sections of this document present specific information regarding the Nabesna SI:

- Section 1.0: Introduction—provides a description of authority and purpose
- Section 2.0: Site Background—provides a summary of site-related information
- Section 3.0: Environmental Pathways and Potential Targets—includes an evaluation of specific pathways
- Section 4.0: Sampling Program—includes a synopsis of sampling conducted
- Section 5.0: Sample Results and Discussion—provides a discussion of sampling results
- Section 6.0: References—provides a list of references



Source: National Park Service, 1994

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Figure 2-3
Nabesna Mine Site Map

Nabesna Mine
Nabesna, Alaska
SITE INSPECTION

2.0 SITE BACKGROUND

2.1 SITE LOCATION

Site Name: Nabesna Mine

CERCLIS No: AK0000333021

Location: Milepost 46, Nabesna/Slana Road
Nabesna, Alaska

Latitude: 62°22'20.0" North

Longitude: 143°0'17.0" West

Legal Description: Section 21, Township 7 North, Range 13 East

Site Owner: Mr. Kirk Stanley
Ptarmigan Company, Inc.
P.O. Box 200956
Anchorage, Alaska 99520
(907) 333-5639

Site Operator: Site is currently inactive

Site Contact: Mr. Kirk Stanley
(907) 333-5639

2.2 SITE DESCRIPTION

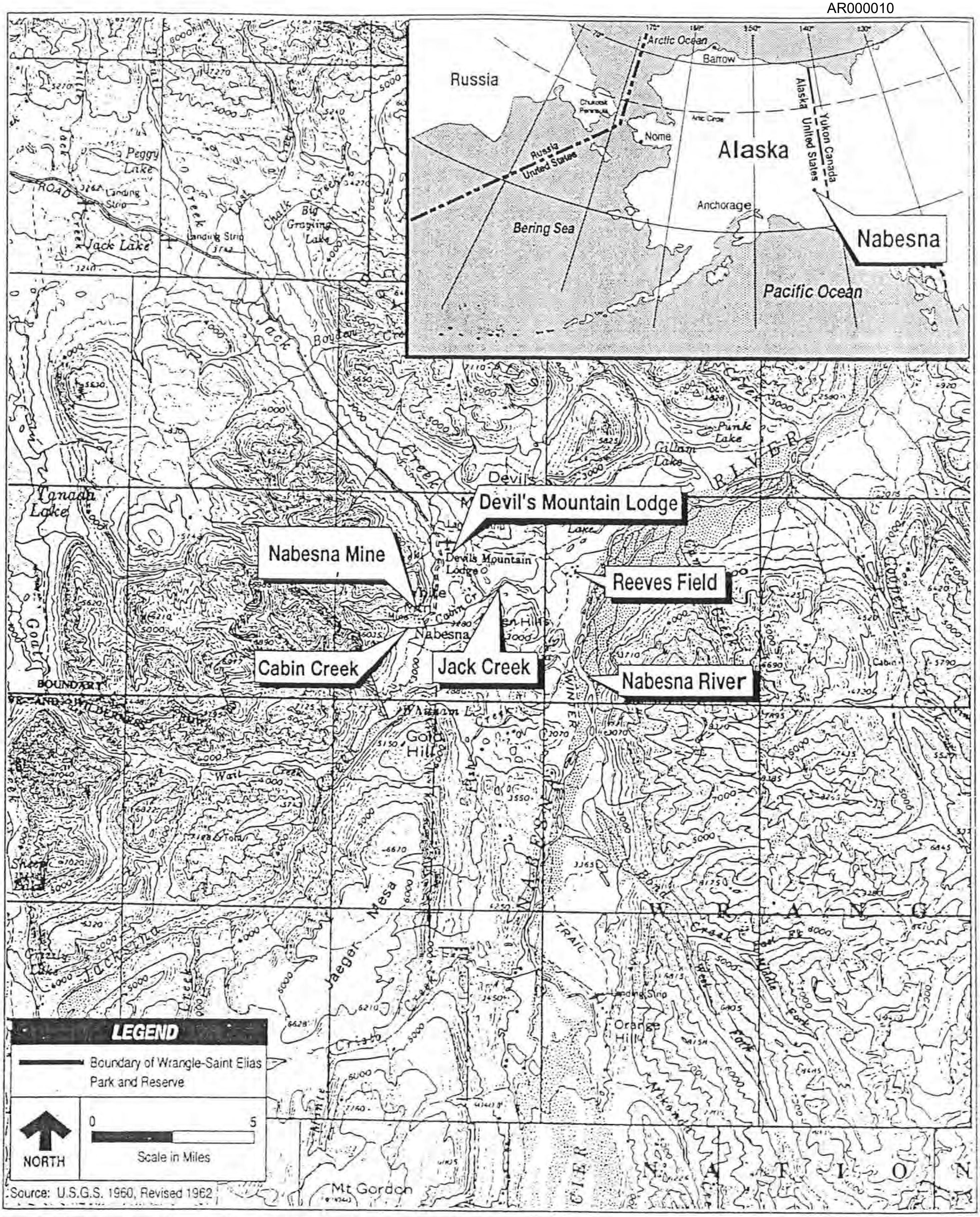
The Nabesna site, which consists of a gold mine, is located in the White Mountains in the northern portion of the Wrangell-Saint Elias National Park and Preserve. This area is located in the southeastern section of Alaska, approximately 300 miles east of Anchorage. Gold mining operations began in the early 1900s and continued until the 1940s. The site is a privately owned, patented mining claim (the Sunshine Lode), which is one of several mining claims in the area owned by the Ptarmigan Company. The mining claims are situated within the Wrangell-Saint Elias National Park and Preserve. The land south of the site is part of the National Park Service (NPS), which was established in 1980 by the Alaska National Interest Lands Conservation Act of 1980 (ANILCA). Figure 2-1 shows the general location of Nabesna and the surrounding area. Appendix A includes a surface water distance map and a photographic log of the site visit and sampling conducted on June 20 and 21, 1995.

The site consists of the mill, on-site tailings, and the surrounding area, which comprises the remaining structures that supported mining activities (i.e., the Nabesna Mine Ghost Town). The assay office, machine shop, boiler house, mess hall, several miners' cottages, the foreman and superintendent houses, the horse barn, and the boardwalks remain on site. The store, dispensary, post office, and tram terminal used during mining activities were in ruins by 1978. The lower tailings that were produced from on-site mining activities are east of the site on an unpatented claim on National Park Service property. The Nabesna gold mine district (including the mill, ghost town, and on-site tailings) is listed on the National Register of Historic Places (NRHP). Figure 2-2 is a copy of an aerial photograph of the area surrounding the mine. Figure 2-3 presents a detailed map of the Nabesna site (USDOI, 1978).

The Nabesna mill building (where the ore was processed) and the upper mine shafts are located at an elevation of 3,100 and 3,800 feet above sea level (ASL), respectively. The land continues to slope and drain into the Nabesna River (elevation 2,500 feet) approximately 5 miles to the east. Cabin Creek is located 0.25 mile southwest of the site. Cabin Creek courses below ground level and re-emerges south of the mill, flows approximately 4 miles, and joins Jack Creek, which flows approximately 5 miles before it merges with the Nabesna River, which is fed from the Nabesna Glacier (Stanley 1995).

2.3 SITE PHYSICAL AND GEOLOGICAL CHARACTERISTICS

The Nabesna mine is located at the base of White Mountain in the Nabesna River valley. The rocks of the White Mountain area include the Nabesna limestone of upper Triassic age, which is underlain by basaltic lavas and some dark shales of possible Permian age and intruded by stocks and dikes of quartz diorite and andesite. These rocks are overlain unconformably by Wrangell lava of Tertiary and Quaternary age. The quaternary period is also represented by fluviatile deposits, lateral moraine, talus, and fan rubble. Nabesna limestone is the host rock of the gold deposits of White Mountain. The three types of mineralization occurring from erosion of the limestone are magnetite with pyrite, calcite, and some gold; veins and masses of pyrrhotite with or without pyrite and gold; and veins of auriferous pyrite with calcite (Wayland 1943). Appendix B includes a map of the geological formation of the area.



Source: U.S.G.S. 1960, Revised 1962

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Figure 2-1
Vicinity Map

Nabesna Mine
Nabesna, Alaska
SITE INSPECTION

The terrain is typical of a glaciated mountainous region, with rugged to precipitous highlands cut by the wide, relatively flat Nabesna River valley. The toe of the Nabesna Glacier, which feeds the river, is located about 13 miles south of the site. The timberline is at an elevation of about 3,500 feet. The main valleys are wooded (spruce and birch), and the mountain slopes are generally bare or tundra-covered. The slopes are typically brushy (willow and alder) at the timberline. The yearly temperature range is approximately -40 degrees to 85 degrees Fahrenheit, and the annual precipitation is approximately 20 inches (WGM Inc. 1981).

2.4 SITE OPERATIONS AND WASTE CHARACTERISTICS

Prospecting for gold in the White Mountain area reportedly began in 1899 when prospectors traveling to the Klondike district panned for gold in the gravel at the foot of the mountain's 1,500-foot limestone cliff (at an altitude of 6,400 feet) (Wayland 1943).

Between 1903 and 1905, A.J. Fjeld and Paul Paulson located 28 claims in the White Mountain area. In 1906, Fjeld and Paulson formed the Royal Development Company. The claims were mined and prospected by the company until 1914 when the claims lapsed. The claims were relocated, worked, and again lapsed by unnamed prospectors between 1914 and 1924 (Wayland 1943).

In 1922, the area near what was to become the Nabesna mine site was first prospected by Mr. Whitham. In 1924, Mr. Whitham relocated the claims associated with the Royal Development Company, and in 1925, the Bear Vein was discovered. It was documented that a bear dug out a gopher in a moss-covered outcrop of White Mountain; Mr. Whitham enlarged the bear's diggings and found the rich gold ore vein. The Bear vein is the principal vein of the present Nabesna mine, which is 1,000 feet northeast of the principal vein of the Royal Development Company. During the next 3 years, Mr. Whitham made a 50-foot cut on the vein, sank a 30-foot shaft in the outcrop, and exposed the vein at what is now the portal of the drift (tunnel) at the 100-foot level (100 feet below the outcrop) (Wayland 1943).

In the fall of 1929, the Nabesna Mining Corporation was formed and funding was available to develop the mine. By 1931, a tram had been built to the mill site at the base of the cliff. The mill site, which began operating that same year, contained a crusher and a Hardinge ball mill (which was later replaced with a Marcy ball mill). Also in 1931, a permanent camp was under construction and work began on the 250-foot level (250 feet below the top of the outcrop). In 1933, work began on the 650-foot level (650 feet below the top of the outcrop) (Wayland 1943). Appendix C contains cross-sectional diagrams of the mine.

The original outcrop of the Bear Vein contained pieces of flinty quartz carrying pyrite. Other vein minerals included fine crystals of pyrite, cerussite, marcasite, and anglesite. The vein was light gray with a dark gray streak near the middle that contained cerussite and anglesite. Gold panning done from the vein indicated considerable free gold. The gold was irregular in shape (not angular) and stained a dark color (Wayland 1943).

2.4.1 Gold Mining

Lode deposits are mined by either underground or open pit methods, depending on factors such as the size and shape of the deposit, the ore grade, the depth of deposit, and the mineralogical characterization of the ore (U.S. EPA 1978). Gold-bearing veins occur in steeply dipping veins and mineralized fault zones and are rarely uniform in value or size. Portions of the veins that contain minable quantities are termed "ore shoots" or "ore bodies." The ore shoots at Nabesna ranged in thickness from a few inches to 35 feet (averaging 5 to 7 feet). Underground mining was necessary to reach the veins. The mines would be developed by horizontal shafts or adits with haulage levels at convenient levels (e.g., 100 feet, 250 feet, and 650 feet). Raises (tunnels) are run in the ore or just beneath it from level to level. Ore is then drilled and blasted from the vein, loaded into ore cars, and taken to the surface or portals. The total workings of the Nabesna mine included six levels (interconnected with manways and ore chutes) and totaled approximately 16,000 linear feet. All the ore was hand trammed to the portals, then lowered 2,000 feet by a gravity system aerial tram to the mill. The gold was recovered by shaker tables, flotation, and cyanide leaching (see Section 2.3.2 for details) (Brooks 1968; WGM Inc. 1981; Spude 1984).

Most of the known veins near the Bear Vein were worked out by 1939. At the beginning of World War II, the Nabesna Mine was closed by U.S. War Production Board Order L-208. This presidential war order decreed that only mining activities directly supporting the war effort would be permitted to continue. In the late 1940s, the U.S. Army-Counter Intelligence organized and operated an underground force in Alaska because of the potential threat of a Russian invasion. The tunnels in the mines were used for storage of supplies and arms. A drift from the Royal Development Company mines was used between 1947 and 1949. In 1949 the arms and supplies were removed from the nearby mine and access was restricted by a locked door to the entrance of the drift, with a No Trespassing by order of the U.S. Government sign (Stanley 1995). The mine reopened briefly after the war. However, with the death of Mr. Whitham in 1947 and the depletion of high-grade ore, the mine closed (WGM Inc. 1981; Spude 1984).

After the mine closed, the Ptarmigan Company, which acquired the property in the early 1960s, attempted to recover gold from the old tailings. In 1980, Minex-Alaska, Inc., the predecessor of Nabesna Corp. Limited, also attempted to recover gold from the upper and lower tailings. The first attempt consisted of a crude cyanide leaching process, while the second attempt consisted of a sluicing operation. Neither attempt was successful (WGM Inc. 1981; Stanley 1995). The site tailings have been assessed and analyzed periodically since the 1980s to determine the feasibility and profitability of recovering gold from them. Currently, no mining is occurring on site. The mine is occasionally visited by tourists, visiting the Wrangell-Saint Elias National Park and Preserve. On May 25, 1979, the Nabesna Gold Mine District was listed on the NRHP (Saleeby 1995). Geologists from the University of Miami have studied ancient fossilized marine life, geologic formations, and geochemical studies at the Nabesna site (Stanley 1995; NPS 1995).

During the gold mining operation at Nabesna, over 2.5 tons of gold, approximately 5 tons of silver, and many tons of copper and lead were processed (USDOI 1978). Table 2-1 summarizes site operations and ownership.

During the mining operation, approximately 350,000 cubic yards of waste rock (tailings) was produced from the 70,000 tons of ore removed from the mountain and comprise approximately 2.1 acres. In the late 1980s, some of the upper tailings were containerized into 55-gallon barrels for shipment to a smelter in Tacoma, Washington, for gold extraction, after being sluiced to remove the clay particles. However, the barrels were not shipped, so the tailings remain in approximately 40 open-topped barrels located on site (Wayland 1943; NPS 1986; Stanley 1995). The tailings that had been produced from the ore process using the cyanide leaching system during the season of 1938 had been piped, using wooden troughs, to an unpatented area of the claim (referred to as the lower tailings) (Stanley 1995). Appendix D contains diagrams of the upper and lower tailings. Refer to Figure 2-3 for a map of the Nabesna mine site.

2.4.2 Gold Recovery

Gold occurs chiefly as the native metal. In ores, it is often too small (in particle size) to be seen with the unaided eye. It is recovered from the ore by several processes. The treatment utilized depends on the mineralogical character of the ore. Each process requires crushing and fine grinding. Free gold and gold-bearing sulfide minerals may then be removed from the ground ore by amalgamation, shaker tables, flotation, and cyanidation. Free gold recovered by cyanidation is sold as bullion (Brooks 1968).

The amalgamation process involves adding mercury to the grinding unit so an amalgam of gold and mercury is formed, which is caught on mercury coated copper plates and then scraped off. The gold is then recovered by distilling off the mercury. Amalgamation was attempted at Nabesna but was unsuccessful because of an oxide film on the gold (Wayland 1943).

Table 2-1
Site Operations and Ownership

Date	Site Ownership	Site Operations
1922	Carl F. Whitham	Began prospecting in the area
1924	Carl F. Whitham	Relocation of the Royal Development Company
1925	Carl F. Whitham	Discovery of the Bear vein
1929-1930	Nabesna Mining Corporation	Organization of the mining corporation, selling of stocks to finance the construction and mining operations.
1931-1939	Nabesna Mining Corporation	Mining operations until most of known veins had been worked
Late 1940s	Nabesna Mining Corporation	Royal Development Company Mine used by U.S. Army as an arms and supply cache
1945-1960	Nabesna Mining Corporation	Tried to reopen the mines, cost of production higher than quality of ore
1960-1969	Ptarmigan Company /Kirk Stanley	Prospected and conducted assay surveys to determine value of gold in tailings, cyanide leach process
1980	Minex-Alaska	Prospected and conducted assay surveys to determine value of gold in tailings, sluicing process
1986	Nabesna Corporation Limited (Ownership of tailings)	Environmental Assessment and Analysis of tailings for potential cyanide leach heap process for tailings
1960-present	Ptarmigan Company /Kirk-Stanley	Prospecting and conducting assay surveys to determine location and value of gold in ore

Source: WGM Inc. 1981; Stanley 1995; National Park Service 1978

The **shaker table** process involves placing the ore on a screened table after it has been crushed, shaking the table, and sifting the gold from the ore.

The **flotation process** involves combining finely ground ore with water, agitating it, and aerating with small amounts of certain compounds such as pine oil, which adheres to the desirable minerals and floats them to the surface, where they are skimmed off as a concentrate (Brooks 1968). The concentrates were then shipped to the Tacoma, Washington, smelter (Brooks 1968; Spude 1984).

The cyanidation process, involves placing finely crushed ores or concentrates in vats containing a dilute solution of sodium or potassium cyanide. The gold dissolves to form sodium or potassium gold cyanide. The solution is then brought into contact with zinc or aluminum, which causes the gold to precipitate (Brooks 1968; EPA 1978; Smith 1982). Appendix D contains cyanide process flow charts.

The following chemical reactions occur when cyanide is used in the gold recovery process:

$$\begin{aligned} O_2 + 2H_2O + 2e^- &\rightarrow 2OH^- + H_2O_2 \\ Au &\rightarrow Au^+ + e^- \\ Au^+ + CN^- &\rightarrow AuCN \\ AuCN + CN^- &\rightarrow Au(CN)^-_2 \end{aligned}$$

The overall reaction is presented below:

$2Au + 4CN^- + O_2 + 2H_2O \rightarrow 2Au(CN)^-_2 + 2OH^- + H_2O_2$ (Habashi 1967)

This gold cyanide compound is then mixed with zinc or aluminum, which causes the gold to precipitate. Zinc or aluminum cyanide is the resulting waste product of this process.

Cyanide and acid releases from mining wastes may occur through runoff from waste piles during storm events; leaching of constituents from waste piles by infiltrating rainwater; seepage of constituents through the bottoms of tailings ponds; runoff to surface water, percolation into groundwater; and the atmosphere. Some ores contain metals that form insoluble, stable, metallo-cyanide complexes that do not readily leach or dissociate (Versar 1986).

The rate at which cyanide is released into the environment is determined by the molecular state of the cyanide; the pH of the waste material; the permeability of the impoundment liners, and the temperature (which affects various natural degradation processes) (Versar 1986). Cyanide present in wastes degrades biologically and chemically at varying rates (degradation processes result in significant reductions in cyanide concentrations in older wastes) (Versar 1986). The environmental fate and transport of cyanide is presented in Table 2-2.

2.5 PREVIOUS SITE SAMPLING AND INVESTIGATIONS

In August 1981, WGM, Inc., examined the mine tailings to determine their extent, thickness, and volume. In addition, assay tests were conducted to determine the content of gold and silver per ounce per ton of tailings. The sample results are shown in Table 2-3. Results from the assay tests indicated that the upper tailing deposit has a

Table 2-2
Summary of Environmental Fate and Transport of Cyanide From Mining Wastes

Environmental Process	Summary Statement
Photolysis	HCN is virtually unreactive in the troposphere and probably diffuses to the stratosphere before being destroyed. Some metallocyanides (ferrocyanide and ferricyanide) can be decomposed by sunlight in water to yield iron hydroxide and cyanide ion.
Oxidation	Free cyanide is not oxidized in air or water by molecular oxygen or hydroxyl radicals, but it is oxidized by polysulfides and polythionates in high sulfur ores to thiocyanate ion. Iron-rich ores may also promote the oxidation of cyanide through formation and decomposition of ferricyanide.
Hydrolysis	Hydrolysis of the CN bond of cyanide in mining wastes is too slow to be relevant as a fate process. Degradation of metallocyanide complexes can be considered to be their hydrolysis with release of cyanide ion. This latter process may be responsible for maintaining low levels of free cyanide in old waste piles.
Volatilization	If the alkalinity of liquid wastes is assumed to be pH 8-9, the half-life for volatilization of free cyanide is estimated to be 0.4 - 4.0 days. Volatilization from solid waste piles is much slower with a half-life that probably varies from several months to a few years.
Sorption	Free cyanide and most complex cyanides are sorbed to only a small extent and are therefore mobile in the environment. The exception is some complex cyanides which are sparingly soluble and are therefore apparently immobile.
Bioaccumulation	Free cyanide does not accumulate but some metallocyanides may accumulate in fish.
Biodegradation	Biodegradation of cyanides may be universal, but most organisms can only tolerate very low concentrations. Some microbial cultures can become acclimated to higher concentrations under aerobic conditions, but anaerobic degradation may proceed only at concentrations of a few parts per million.

Notes:
CN Cyanide
HCN Hydrogen cyanide

Source: Versar Inc. 1986.

Table 2-3
Previous Sampling Results

Inorganic	1981 WGM Inc. Samples of Mine Tailings	1983 Bondar-Clegg Samples of Mine Tailings	1994 NPS Samples of Mine Tailings	1994 NPS Drinking Water Wells	1994 USGS Background Surface Water	1994 USGS Surface Water Below Tailings	1994 USGS Leachate Below Tailings	1994 USGS Surface Water Sediment Below Tailings
Antimony	NA	140 ppm	NA	NA	0.0002 ppm	< 0.0002 ppm	< 0.1 ppm	4.4 ppm
Arsenic	NA	1,300 ppm	326 ppm	< 0.003 ppm	0.0043 ppm	< 0.0008 ppm	4.0 ppm	300 ppm
Cobalt	57 ppm	NA	36.0 ppm	< 0.018 ppm	< 0.002 ppm	0.002 ppm	0.9 ppm	27.0 ppm
Copper	3,400 ppm	2,000 ppm	2,660 ppm	< 0.005 ppm	0.002 ppm	0.013 ppm	35 ppm	410 ppm
Iron	NA	NA	121,000 ppm	0.019 - 0.136 ppm	0.02 ppm	0.7 ppm	1470 ppm	9.7 pct
Lead	3,900 ppm	2,400 ppm	3,360 ppm	< 0.002 ppm	< 0.005 ppm	< 0.005 ppm	6.0 ppm	340 ppm
Molybdenum	7 ppm	NA	NA	NA	0.021 ppm	< 0.004 ppm	0.035 ppm	4.7 ppm
Silver	NA	NA	100 ppm	NA	< 0.0001 ppm	< 0.0001 ppm	17.0 ppm	7.0 ppm
Zinc	2,700 ppm	2,000 ppm	83 ppm	NA	NA	NA	NA	10.0 ppm

Notes:

NA	Not analyzed
<	Not detected; value shown is detection limit
pct	percent

Source: URS 1995; USDOI 1995, Appendix I relatively high gold content, while the lower tailings deposit may be considerably lower in grade. The results also indicate that a positive relationship may exist between gold content, copper, and cobalt, and a negative relationship may exist between gold and zinc (URS 1995).

In 1993, Bondar-Clegg & Company Limited of Canada analyzed the mine tailings for inorganics at the request of the U.S. Bureau of Mines. The results of this analysis are provided in Table 2-3. The results of the samples taken from the tailings indicate high concentrations of inorganics. Background samples were not collected for comparison (URS 1995).

In 1994, the Wrangell-Saint Elias National Park and Preserve collected and analyzed soil samples of the tailings and water samples from the two drinking water wells closest to the site (Table 2-3). The results from the sampling indicate that the inorganics present in the tailings are not present in the drinking water wells (NPS 1994).

In 1994, the United States Department of the Interior, Division of Geological Survey, conducted environmental geochemical studies of the Nabesna mine and surrounding area to determine the extent of possible environmental hazards associated with historic mining areas and to establish pre-mining background levels for selected elements (Table 2-3) (USDOI 1995).

In November 1993, the Nabesna Mine site was reported to the EPA by citizen petition. On June 20 and 21, 1995, URS Consultants, Inc., performed a site screening investigation that included the collection of surface water, sediment, soil, and mine tailing samples. The owner of the mine and an environmental specialist from the Wrangell-Saint Elias National Park and Preserve accompanied URS. The results from the sample analysis are presented in Section 5.

3.0 EXPOSURE PATHWAYS AND POTENTIAL TARGETS

3.1 GROUNDWATER PATHWAY

Groundwater levels near Nabesna range from 42 to 81 feet below ground surface (bgs), and the groundwater flow is toward the northeast.

There is a well on site that was used for the mining operations; however, its use has long since been discontinued. Water for the operation of the mine was also piped with wooden troughs from Cabin Creek to the site (Stanley 1995).

Devil's Mountain Lodge is a hunting and fishing guide outpost located approximately 2 miles northeast of the mine site. The lodge owners/operators and their extended families live in the area and use private domestic wells (Ellis Well and Stanley Well) for drinking water and irrigation (see Table 3-1).

Table 3-1
Groundwater Drinking Populations
Within 4 Miles of the Site

Distance (Miles)	Number of Domestic Wells	Domestic Well Population	Total Groundwater Population
0-1/4	0	0	0
1/4-1/2	0	0	0
1/2-1.0	0	0	0
1.0-2.0	2	10	10
2.0-3.0	0	0	0
3.0-4.0	0	0	0
TOTAL	2	10	10

Source: Stanley 1995; Ellis 1995; Happe 1995

The nearest well (with a well log) is located at Milepost 26 on Nabesna Road, 17 miles northwest of the site. Table 3-2 presents the stratigraphy of the area, and Appendix F contains the well log.

Table 3-2
Stratigraphy

Depth (in feet)	Composition
0 - 12	Gravel
12 - 68	Gravel/Sand
68 - 73	Wet Sand
73 - 81	Gravel with Water

Source: USGS Water Resource Division 1995

3.2 SURFACE WATER PATHWAY

The Nabesna site is located on the west side of the Nabesna River Valley. Cabin Creek is 0.25 mile southwest of the site and its flow is seasonally dependent. Cabin Creek meanders, submerges, and re-emerges in places as it flows toward Jack Creek. Cabin Creek flows within 0.25 mile of the lower tailings. There is evidence that the surface water (which is composed of either precipitation or the spring runoff of Cabin Creek) has eroded the lower tailings. Cabin Creek flows northeast of the mill to join Jack Creek, which flows approximately 5 miles to join the Nabesna River, which is fed from the Nabesna Glacier. The surface water pathway for 15 miles downstream of Nabesna is summarized in Table 3-3.

Table 3-3
Description of Surface Water 15 Miles Downstream

Surface Water Body	Distance from Site (miles)	Annual Average Flow Rate (cfs)	Fish Production per Year (lbs)
Cabin Creek	0 - 4	3	0
Jack Creek	4 - 9	760	65
Nabesna River	9 - 15	6000	100

Source: Hoffman 1995; National Park Service 1994

The net precipitation is 4.41 inches and the 2-year, 24-hour rainfall is 0.8 inch (U.S. Department of Commerce 1992). (See Appendix G.)

The site is situated within the Wrangell-Saint Elias National Park and Preserve. Fishing occurs in Jack Creek and the Nabesna River for arctic grayling (*Thymallus arcticus* [*Pallus*]). The Nabesna River is identified as a river with anadromous fish; Chum salmon *(Oncorhynchus keta)* and Coho salmon *(Oncorhynchus kautch)*, however, are not found within the 15-mile section downgradient of the site (Hoffman 1995) (Wise 1995).

A spring believed to be fed by Jack Creek is located approximately 5 miles northeast of the site. This spring is being used by a resident in the area for drinking water (McGuinness 1995).

3.3 SOIL EXPOSURE PATHWAY

Currently, no one resides at Nabesna; however, during the summer months, geologists from the University of Miami stay in the cabins in the Nabesna mine ghost town and are involved with a geochemical study of the area. No day care facilities or schools are located within 200 feet of this site. The tundra is considered a sensitive terrestrial environment, and 6,250 acres of tundra are located within a 4-mile radius. The site is situated within the boundaries of a national park and preserve. The nearest residents are located approximately 2 miles northeast of the site. There are approximately 10 residents within 4 miles of Nabesna.

Access to the site is unrestricted and the Alaska Department of Transportation has a right of way on the site.

After the mining operations ceased over 50 years ago, and the process of using a cyanide leaching method to recover gold from the tailings in the 1980s was discontinued, little revegetation occurred; however, some vegetation is present on the tailings. This could possibly be due to the acidity of the tailings (pH 2-5) and the unsuitability of the substrate (NPS 1986).

3.4 AIR EXPOSURE PATHWAY

The contaminants present at this site are inorganics, cyanide, and semivolatile organics compounds (SVOCs), some of which are readily released to the air. However, because operations at the site ceased in the 1940s, releases to the atmosphere are expected to be negligible (i.e., only occur when the ground is disturbed by someone or something traveling across it).

The peregrine falcon *(Falco peregrinus)*, which is federally listed as endangered, has been observed migrating through the area within 4 miles of the site.

The Wrangell-Saint Elias National Park and Preserve has the site within its boundaries. There are approximately 6,250 acres of tundra within a 4-mile radius of the site. There are 10 residents that live within a 4-mile radius of the site (Table 3-4).

Table 3-4
Residents and Wetland Acreage within a 4-Mile Radius

Distance (miles)	Residents	Tundra Acreage
0-¼	0	50
¼-½	0	100
½-1	0	500
1-2	10	1,400
2-3	0	1,700
3-4	0	2,500
Total	10	6,250

4.0 SAMPLING PROGRAM

4.1 OBJECTIVES AND SCOPE

The field sampling conducted for this SI was intended to gather data about potential releases from this site to surface water. The sampling objectives for the Nabesna mine SI were to assess the (1) presence or absence of inorganic compounds, cyanide, pesticides, PCBs, and semivolatile organic compounds (SVOCs) in soil; and (2) assess the presence or absence of inorganic compounds and cyanide in the upper and lower tailings, surface water, and sediments. Samples were collected from the following locations:

- Upstream Cabin Creek: surface water and sediment
- Cabin Creek downstream of the mine tailings: surface water and sediment
- Cabin Creek before confluence with Jack Creek: surface water and sediment
- Jack Creek before confluence with Cabin Creek: surface water and sediment
- Jack Creek after confluence with Cabin Creek: surface water and sediment
- Upper tailings: surface and subsurface soil
- Lower tailings: surface and subsurface soil
- Mill: soil samples
- Background soil samples
- Background mineralized soil sample—to compare with tailings

The environmental samples collected to accomplish these objectives are described in the next subsection. Soil samples were analyzed for inorganics, cyanide, pesticides, PCBs, and SVOC. Surface water samples were analyzed for inorganics, cyanide, and hardness. Field testing was done on surface water for pH, conductivity, and temperature. Sediment samples were analyzed for inorganics and cyanide.

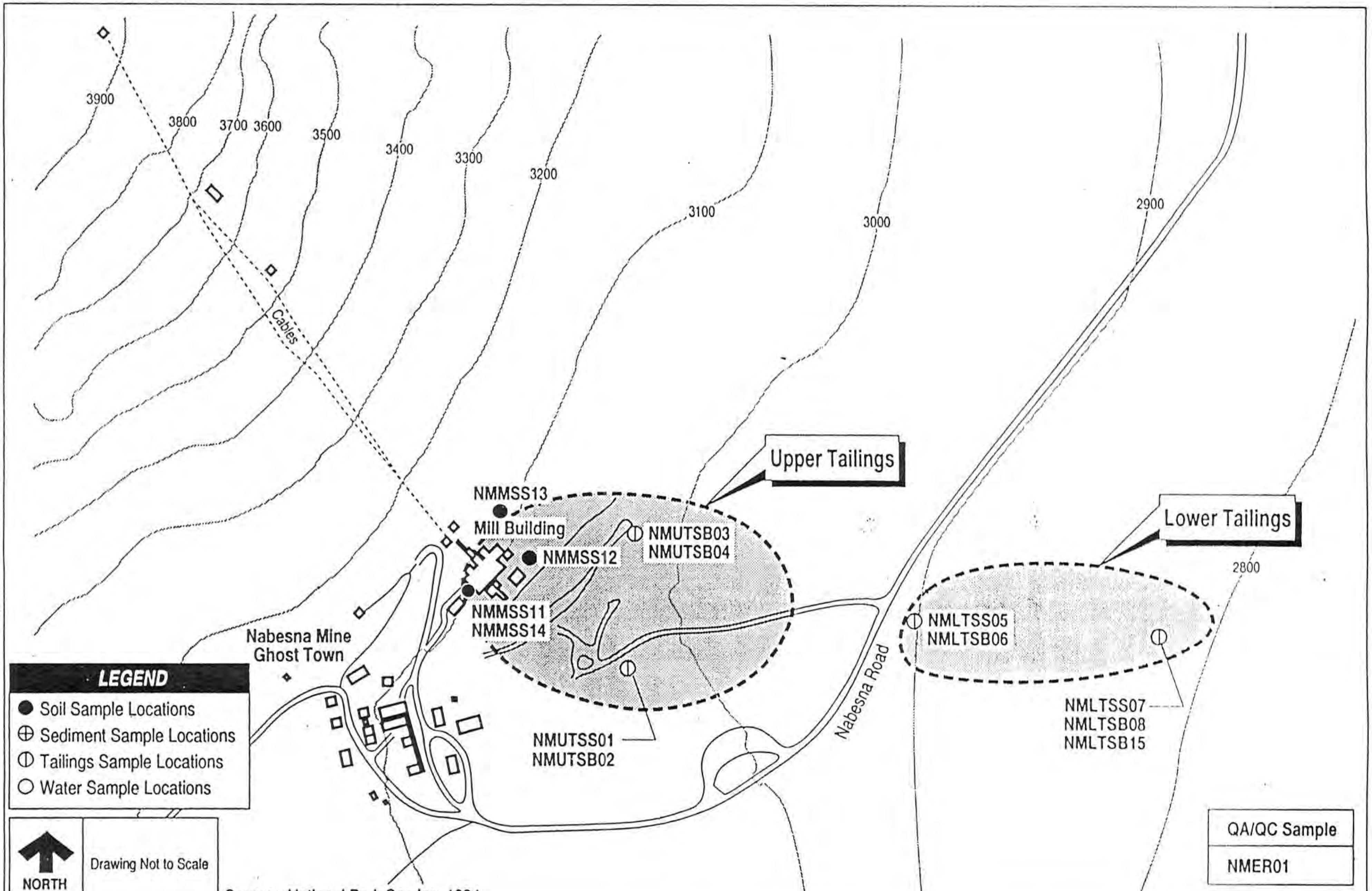
The samples collected during the Nabesna field sampling event are summarized in Table 4-1. Figure 4-1 illustrates the approximate locations of the on-site samples, and Figure 4-2 illustrates the approximate locations of the off-site samples.

Table 4-1
Sample Descriptions

Matrix	Sample Number	Location	Rationale	Date / Time Sample Collected
Sediment	NMCSD01	Cabin Creek background sample, southwest, upgradient of the mill.	Background	6/20/95 / 1317
	NMCSD02	Cabin Creek downgradient of the mill, at the suspected probable point of entry.	Characterize sediments	6/21/95 / 1145
	NMJSD03	Jack Creek background sample, northeast, upgradient of the mill.	Background	6/21/95 / 1819
	NMJSD04	Jack Creek, downgradient of the mill, below the confluence of Cabin Creek and Jack Creek.	Characterize sediments	6/21/95 / 1352
	NMJSD05	Duplicate of Jack Creek, downgradient of the mill, below the confluence of Cabin Creek and Jack Creek (NMJSD04).	Quality assurance	6/21/95 / 1352
	NMCSD06	Cabin Creek, downgradient of the mill, before the confluence of Jack Creek.	Characterize sediments	6/21/95 / 1314
Tailings	NMUTSS01	Upper tailings surface sample	Characterize soil	6/20/95 / 1541
	NMUTSB02	Upper tailings subsurface sample	Characterize soil	6/20/95 / 1546
	NMUTSS03	Upper tailings surface sample	Characterize soil	6/20/95 / 1532
	NMUTSB04	Upper tailings subsurface sample	Characterize soil	6/20/95 / 1545
	NMLTSS05	Lower tailings surface	Characterize soil	6/21/95 / 0928
	NMLTSB06	Lower tailings subsurface	Characterize soil	6/21/95 / 0949
	NMLTSS07	Lower tailings surface	Characterize soil	6/21/95 / 1000
	NMLTSB08	Lower tailings subsurface	Characterize soil	6/21/95 / 1010
	NMLTSB15	Duplicate subsurface sample (NMLTSB08)	Quality assurance	6/21/95 / 1010
Soil	NMBSS09	Northwest of the site surface soil	Background	6/21/95 / 1824
	NMBSB10	Northwest of the site subsurface soil	Background	6/21/95 / 1830
	NMMSS11	Surface soil sample around mill.	Characterize soil	6/20/95 / 1656
	NMMSS12	Surface soil sample around mill.	Characterize soil	6/20/95 / 1454
	NMMSS13	Surface soil sample around mill.	Characterize soil	6/20/95 / 1440

Table 4-1 (Continued)
Sample Descriptions

Matrix	Sample Number	Location	Rationale	Date / Time Sample Collected
Soil	NMMSS14	Duplicate surface soil sample around mill (NMMSS12).	Quality assurance	6/20/95 / 1521
	NMSS16	Soil sample, upgradient of mine—used for comparison with tailings	Background mineralized soil	6/20/95 / 1350
Water	NMCSW01	Cabin Creek background sample, southwest, upgradient of the mill.	Background	6/20/95 / 1310
	NMCSW02	Cabin Creek downgradient of the mill, at the suspected probable point of entry	Characterize water	6/21/95 / 1134
	NMJSW03	Jack Creek background sample, northeast, upgradient of the mill.	Background	6/21/95 / 1810
	NMJSW04	Jack Creek, downgradient of the mill, below the confluence of Cabin Creek and Jack Creek.	Characterize water	6/21/95 / 1343
	NMCSW05	Duplicate of Cabin Creek downgradient of the mill, at the suspected probable point of entry (NMCSW02).	Quality assurance	6/21/95 / 1145
	NMCSW06	Cabin Creek downgradient of the mill, before the confluence of Jack Creek.	Characterize water	6/21/95 / 1306
	NMER01	Equipment rinsate	Quality assurance	6/20/95 / 1755



Source: National Park Service, 1994

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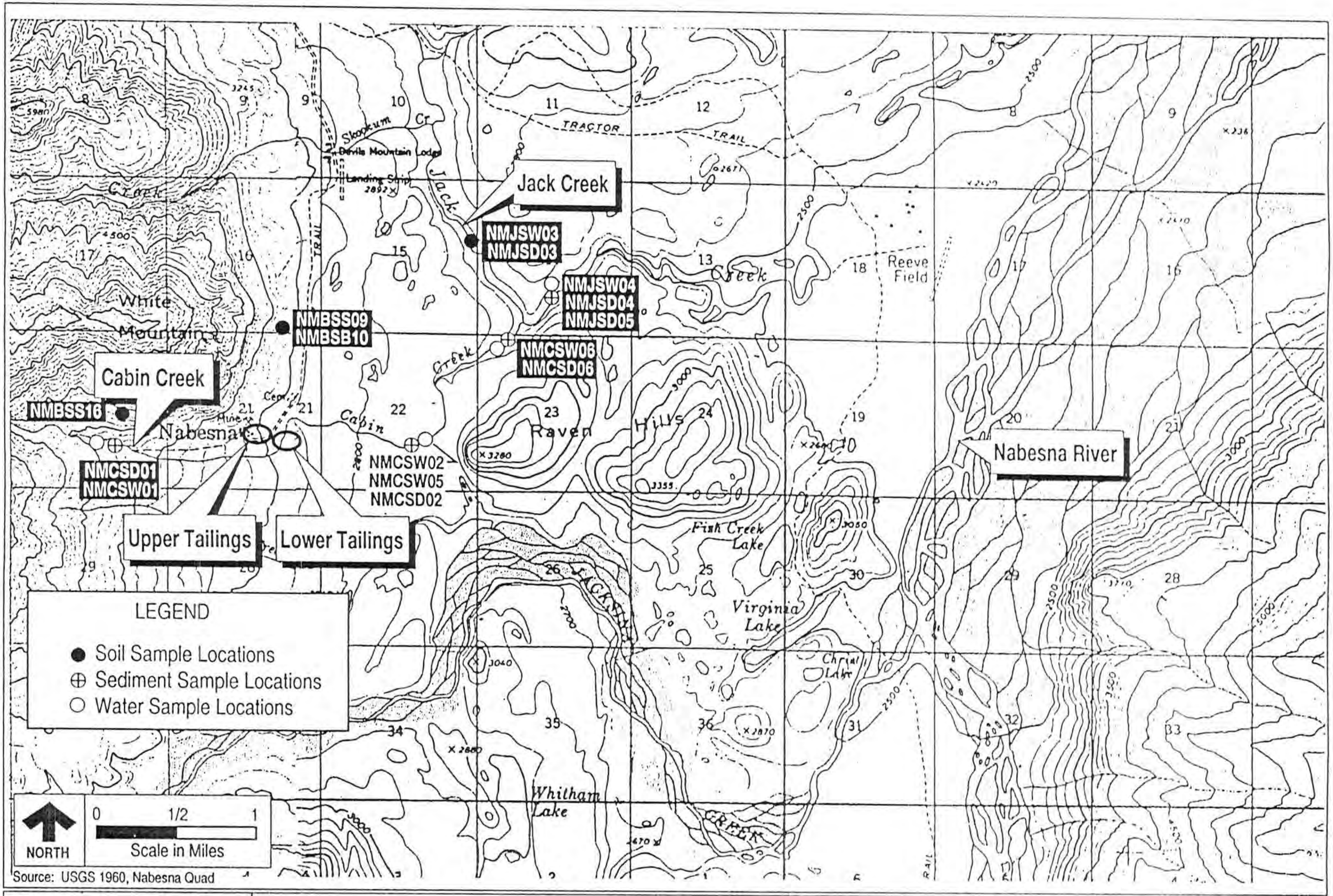
Figure 4-1
On-Site Sampling Locations

Nabesna Mine
Nabesna, Alaska
SITE INSPECTION

416276035-1-112095



Source: USGS 1960, Nabesna Quad

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Figure 4-2
Off-Site Sampling Locations

Nabesna Mine
Nabesna, Alaska
SITE INSPECTION

416276035-3-091895

4.2 SAMPLING METHODS

The media-specific procedures used during the field sampling conducted at the Nabesna site were consistent with methodologies described in the *Quality Management Plan* (QMP) (URS 1990a) and *Technical Standard Operating Procedures* (TSOP) for the Alternative Remedial Contracts Strategy activity (URS 1990b), as well as those described in EPA's Compendium of Superfund Field Operations Methods (U.S. EPA 1987). All sampling equipment was decontaminated prior to and following use.

4.2.1 Surface Soil

Surface soil samples were collected to document the presence or absence of hazardous substances in soil and to assess whether past site practices impacted on-site soil quality. Surface samples were collected at depths ranging from 0 to 6 inches bgs at four locations around the mill area. An additional surface soil sample was collected off site to characterize background conditions.

4.2.2 Surface Tailings

Surface tailing samples were collected to document the presence or absence of hazardous substances in surface tailings and to assess whether the waste produced from the mining process could potentially impact on-site soils, surface water, and groundwater. Surface samples were collected at depths ranging from 0 to 6 inches bgs at two locations in the upper tailings area and two locations in the lower tailings area, where wastes were suspected to have been placed.

4.2.3 Subsurface Tailings

Subsurface tailing samples were collected to document the presence or absence of hazardous substances in subsurface tailings and to assess whether the waste produced from the mining process could potentially impact on-site soils, surface water, and groundwater. Subsurface samples were taken from two locations in the upper tailings area and two locations in the lower tailings area. These samples were collected directly below the locations where the surface tailings samples were taken, at depths ranging from 18 to 24 inches. The tailings samples were collected using a decontaminated trowel.

4.2.4 Surface Water

Surface water samples were collected to document the presence or absence of hazardous substances in surface water and to assess the potential release of contaminants to Cabin and Jack creeks. Surface water samples were collected prior to the collection of sediment samples. At the time of sample collection, the pH, conductivity, and temperature of the water body was noted.

4.2.5 Sediment

Sediments were collected to document the presence or absence of hazardous substances in Cabin Creek and Jack Creek. All sediment samples were collected as grab samples and co-located with surface water samples. The sediment was taken from the creek bottom. When encountered, sticks, rocks, and other large organic matter were removed. Sediment samples were collected as close as possible to an area of sediment deposition.

4.3 ANALYTICAL AND HANDLING REQUIREMENTS

Region 10 EPA chain-of-custody procedures were followed in accordance with requirements outlined in URS's TSOP (URS 1990b) and QMP (URS 1990a). Due to the potential evidentiary nature of the data collected during this project, all samples intended for analysis in the EPA Region 10 laboratory were handled and documented in accordance with procedures specified in EPA's *User's Guide to the Contract Laboratory Program* (U.S. EPA 1991), URS' QMP (URS 1990a), and National Enforcement Investigations Center Policies and Procedures (U.S. EPA 1985). Sample packaging conformed with applicable Department of Transportation regulations (49 CFR 171-177).

5.0 SAMPLE RESULTS AND DISCUSSION

The conditions used to define an "observed release" of a particular substance to any of the matrices sampled during the data evaluation process are summarized in Table 5-1 (U.S. EPA 1990). When data results are discussed in this report, the term "significant" is used to classify concentrations of detected chemicals based on the criteria described in Table 5-1. The results discussed in the following subsections are limited to those concentrations of substances determined to be significant (as defined in Table 5-1).

Table 5-1
Significance Criteria for Chemical Analysis

Sample Measurement < Sample Quantitation Limit[a]	
No observed release is established, the result is not identified as "significant"	
Sample Measurement ≥ Sample Quantitation Limit[a]	
An observed release or "significant" result is established as follows:	
	If the background concentration is not detected (or is less than the detection limit), an observed release or significant result is established when the sample measurement equals or exceeds the sample quantitation limit[a].
	If the background concentration equals or exceeds the detection limit, an observed release or significant result is established when the sample measurement is three times or more above the background concentration.

[a] If the SQL cannot be established, determine if there is an observed release as follows: If the sample analysis was performed under the EPA CLP, use the EPA CRQL in place of the SQL. If the sample analysis was not performed under the EPA CLP, use the DL in place of the SQL.

Source: U.S. EPA 1993

According to EPA Region 10 policy, aluminum, calcium, iron, magnesium, potassium, sodium, and zinc (common earth crust metals) generally are employed only in water mass tracing, which is beyond the scope of this report. Therefore, the results of the analysis of these analytes will be included but not discussed.

The tables in this section include all reported concentrations of compounds or analytes detected in at least one sample collected during the June 20 and 21, 1995, sampling event. Appendix H includes the laboratory data results and data validation reports, as well as a summary table of the target and actual data quality objectives of the Nabesna field sampling.

5.1 SOIL SAMPLE RESULTS

Soil data results that satisfy the criteria listed in Table 5-1 are highlighted in Tables 5-2, 5-3, and 5-4. Soil samples collected during this investigation were analyzed for SVOCs, PCBs, pesticides, inorganics, and cyanide as described in the field sampling plan (URS 1995). No information was available in the data validation reports to assign a bias (high or low) to the qualified ("J") sample results identified in the tables.

5.1.1 SVOC Analyses

SVOCs detected in the surface soil samples collected on site are summarized in Table 5-2.

Table 5-2
Semivolatile Organic Compounds in Surface Soil

Compound	Background Soil NMBSS09 (μg/kg)	Onsite Soil around Mill Area NMMSS11 (μg/kg)	Onsite Soil around Mill Area NMMSS12 (μg/kg)	Onsite Soil around Mill Area NMMSS14 (Duplicate of NMMSS12) (μg/kg)	Onsite Soil around Mill Area NMMSS13 (μg/kg)
2-Methylphenol	207 U	151 U	166 J	522 U	214 U
4-Methylphenol	13.5 J	151 U	364	322 J	214 U
4-Nitroaniline	1,030 U	756 U	1,400 U	273 J	1,070 U
Benzoic acid	8,260 U	6,050 U	9,700 J	13,300 J	8,560 U
Benzyl alcohol	207 U	151 U	563	529	214 U
Fluoranthene	207 U	151 U	279 U	18.1 J	214 U
Isophorone	207 U	151 U	279 U	522 U	26.4 J
Napthalene, 2-methyl	207 U	18.0 J	279 U	522 U	214 U
Phenol	20.9 J	151 U	304	369 J	34.2 J

Notes:

J	Value is an estimate
U	Sample was not detected; value shown is the quantitation limit
UJ	Analyte was not detected above the reported sample quantitation limit; the reported quantitation limit is an estimate.

Table 5-4
Inorganics in Soils

Analyte	Background Soils NMBSS09 (mg/kg)	Background Subsurface Soils NMBSB10 (mg/kg)	Soil Around Mill NMMSS11 (mg/kg)	Soil Around Mill NMMSS12 (mg/kg)	Soil Around Mill NMMSS14 (Duplicate in NMMSS12) (mg/kg)	Soil Around Mill NMMSS13 (mg/kg)
Aluminum	11,000	12,100	1,930	1,760	2,490	9,660
Arsenic	9.32 J	6.64 J	6.92 J	**449**	**729**	**56.8**
Barium	190	238	19.5	32.1	66.9	47.5
Beryllium	0.32 J	0.35 J	0.25 U	0.5 U	0.5 U	0.16 J
Cadmium	0.21 J	0.21 J	1.0 U	**6.5 J**	**5.3 J**	1.26
Calcium	9,200	13,200	290,000	1,870	3,020	28,000
Chromium	23.5	23.4	7.4 J	**117**	62.5	**91.8**
Cobalt	11.0	12.4	5.0 U	21	12 J	8.31
Iron	23,500	25,400	4,720	329,000	263,000	20,500
Lead	7.38	5.36	**38.3 J**	**2,470**	**5,820**	**483**
Magnesium	9,450	10,400	5,040	724	1,220	5,900
Manganese	443	509	145	449	525	611
Mercury	0.0692	0.153	**0.317**	**0.944**	**1.85**	**3.0**
Nickel	26.3	27.4	6.7 J	**242**	74.5	57.3
Potassium	812	790	310 J	610	1,100	543
Silver	0.34 J	0.34 J	1.5 U	**35.5**	**75.1**	**10.1**
Sodium	405	350	85.0	253	281	408
Vanadium	54.1	61.2	5.59	26.0	25.6	30.1
Zinc	57.2	60.3	35.5	2,320	1,440	165
Selenium	0.45 J	0.44 J	0.4 U	0.6 U	2.6 J	0.4 U
Cyanide	0.33 U	0.33 U	0.28 U	**3.94**	6.57	**0.41**

Notes:
Bolded values represent significant concentrations
J Value is an estimate
U Sample was not detected; value shown is the quantitation limit

Table 5-3
PCBs/Pesticides in Sediments, Soil, and Rinsate

Compound	Background Sediment NMCSD01 (µg/kg)	Downgradient Cabin Creek Sediments NMCSD02 (µg/kg)	Background Soil NMBSS09 (µg/kg)	Onsite Soil around Mill Area NMMSS11 (µg/kg)	Onsite Soil around Mill Area NMMSS12 (µg/kg)	Onsite Soil around Mill Area NMMSS14 Duplicate of NMMSS12 (µg/kg)	Onsite Soil around Mill Area NMMSS13 (µg/kg)	Equiment Rinsate ER01 (µg/L)
Endrin	1.43 U	3.67 U	1.61 U	1.18 U	2.80	2.04 U	1.67 U	0.00347 UJ

Notes:

J	Value is an estimate
U	Sample was not detected; value shown is the quantitation limit
UJ	Analyte was not detected above the reported sample quantitation limit; the reported quantitation limit is an estimate.

- **Background Soils**—Two SVOCs were detected in the background sample (NMBSS09) at estimated concentrations.

- **On-Site Soils**—Three compounds were detected in soil around the mill (NMMSS12): 4-methylphenol, benzyl alcohol, phenol, and an estimated concentration of benzoic acid.

5.1.2 PCB Analyses

No PCBs were detected in any of the surface soil samples collected on site during the Nabesna field sampling event.

5.1.3 Pesticide Analyses

Pesticides detected in the soil samples collected around the mill are summarized in Table 5-3.

- **Background Soils**—Pesticides were not detected in the background sample (NMBSS09).

- **On-Site Soils**—Endrin was detected in soil sample NMMSS12, at a concentration of 2.80 μg/kg.

5.1.4 Inorganic Analyses

Inorganic analytes detected in surface soil samples collected on site are provided in Table 5-4. (Those inorganics detected at significant concentrations are highlighted.)

- **Background Soils**—Inorganics were detected in the background surface soil sample (NMBSS09), and the background subsurface soil sample (NMBSB10).

- **On-Site Soils**—Seven inorganic analytes were detected at concentrations elevated above background: arsenic (NMMSS12, NMMSS13, and NMMSS14), cadmium (NMMSS12 and NMMSS14), chromium (NMMSS12 and NMMSS13), lead (NMMSS11, NMMSS12, NMMSS13, and NMMSS14), mercury (NMMSS11, NMMSS12, NMMSS13, and NMMSS14), nickel (NMMSS12), and silver (NMMSS12, NMMSS13, and NMMSS14). The soil samples were collected from the area surrounding the mill (Figure 4-1).

5.1.5 Cyanide Analyses

Cyanide detected in the surface soil samples collected on site are summarized in Table 5-4. (Those inorganics detected at significant concentrations are highlighted.)

- **Background Soils**—Cyanide was not detected in the background soil sample.

- **On Site Soils**—Analytical results of three soil samples collected from around the mill revealed the presence of cyanide at significant concentrations (NMMSS12, NMMSS13, and NMMSS14).

5.2 SURFACE AND SUBSURFACE MINE TAILINGS

Data that satisfy the criteria listed in Table 5-1 are highlighted in Table 5-5. The surface and subsurface tailings samples collected during this investigation were analyzed for inorganics and cyanide as described in the field sampling plan (URS 1995). No information was available in the data validation reports to assign a bias (high or low) to the qualified ("J") sample results indicated in the tables.

5.2.1 Inorganic Analyses of Mine Tailings

Inorganic analytes detected in upper and lower surface and subsurface mine tailings are listed in Table 5-5. (Those inorganics detected at significant concentrations are highlighted.)

- **Background Mineralized Soils**—Inorganics were detected in the background mineralized soil sample (NMSS16). The background mineralized soil sample is more representative of the crushed ore that the tailings would consist of than the background soil sample.

- **Upper Tailing Soil Samples**—Five inorganics were detected in both the surface and subsurface mine tailings at concentrations above background: arsenic (NMUTSS01, NMUTSB02, NMUTSS03, and NMUTSB04), cadmium (NMUTSS01), lead (NMUTSS03), mercury (NMUTSS01, NMUTSB02, and NMUTSS03), and thallium (NMUTSS03).

- **Lower Tailing Soil Samples**—Seven inorganics were detected in both the surface and subsurface mine tailings at concentrations above background: arsenic (NMLTSS05, NMLTSB06, NMLTSS07, and NMLTSB08), cadmium (NMLTSS05, NMLTSS07, and NMLTSB08), chromium (NMLTSB08), cobalt (NMLTSS06),

Table 5-5
Inorganics in Tailings

Analyte	Background Mineralized Soil NMMSS16 (mg/kg)	Upper Tailings Surface NMUTSS01 (mg/kg)	Upper Tailings Subsurface NMUTSB02 (mg/kg)	Upper Tailings Surface NMUTSS03 (mg/kg)	Upper Tailings Subsurface NMUTSB04 (mg/kg)	Lower Tailings Surface NMLTSS05 (mg/kg)	Lower Tailings Subsurface NMLTSB06 (mg/kg)	Lower Tailings Surface NMLTSS07 (mg/kg)	Lower Tailings Subsurface NMLTSB08 (mg/kg)	Lower Tailings Subsurface NMLTSB15 (Duplicate of NMLTSB08) (mg/kg)
Aluminum	1,860	1,560	2,210	411	3,780	1,460	2,710	1,610	2,690	2,490
Arsenic	21.1 J	**1,170**	**739**	**205**	**960**	**1,780**	**1,190**	**948**	**1,350**	**1,240**
Barium	24.5	3.64	20.2	4.76	59.1	6.82	2.5 J	8.14	8.85	10.4
Cadmium	8.6 J	**5.32**	3.3 J	1.5 J	3.4 J	**11.3**	8.2 J	**7.22**	**11.4**	**11.9**
Calcium	13,000	114,000	80,400	147,000	17,700	112,000	71,800	109,000	120,000	121,000
Chromium	6.9 J	3.2 J	4.0 J	3.6 J	7.6 J	5.0 U	5.0 U	2.5 U	**135**	5.1 J
Cobalt	19 J	5.0 U	5.0 U	4.6 J	7.0 J	19 J	**70.4**	9.4 J	21 J	20 J
Iron	211,000	96,200	94,200	42,700	106,000	157,000	125,000	67,300	140,000	145,000
Lead	44.0 J	1,330	825	**4,190**	57	1,040	163	939	827	788
Magnesium	3,190	594	795	320	1,700	1,050	2,230	920	2,790	2,390
Manganese	1,070	147	98.5	65.4	71.8	270	265	187	225	208
Mercury	0.14	**0.442**	**0.241**	**3.87**	0.105	**0.740**	**0.806**	**2.47**	1.05	0.897
Nickel	10 U	5.0 U	5.0 U	10.8	5.0 U	10 U	11 J	5.0 U	**88.7**	10 U
Potassium	930 J	470 J	380 J	479	740 J	450 U	450 U	890 J	620 J	450 U
Silver	109	36.7	20.8	73.8	2.2 J	24.8	7.4 J	19.8	18.6	17.5
Sodium	112	68.6	413	101	2,250	71 J	37 J	205	92.4	71 J
Vanadium	23.5	14.8	19.1	5.89	39.0	16.5	18.4	17.3	16.8	15.6
Zinc	2,200	225	152	139	107	1,600	942	661	2,070	1,960
Selenium	28.7	3.43	2.47	10.6	1.6 J	7.49	5.77	9.34	5.08	3.97
Thallium	0.75 U	0.25 U	0.25 U	**4.78**	0.25 U	0.94 J	0.57 J	**2.83**	0.75 U	0.45 J
Cyanide	0.33 U	**1.44**	**1.25**	**0.72**	0.47 U	0.32 U	0.30 U	0.33 U	**0.41**	0.35 U

Notes:
Bolded values represent significant concentrations
J Value is an estimate
U Sample was not detected; value shown is the quantitation limit

mercury (NMLTSS05, NMLTSB06, and NMLTSS07), nickel (NMLTSB08), and thallium (NMLTSS07). However, nickel was not detected in the duplicate sample (NMLTSB16) of sample NMLTSB08.

5.2.2 Cyanide Analyses for Mine Tailings

Surface and subsurface samples of the upper and lower mine tailings revealed the presence of cyanide. A summary of sample results is found in Table 5-5. Concentrations considered significant are highlighted.

- **Upper Tailing Samples**—Cyanide was detected in three mine tailing samples (NMUTSS01, NMUTSB02, and NMUTSS02).

- **Lower Tailing Samples**—Cyanide was detected in one tailing sample (NMLTSB08); however, cyanide was not detected in the duplicate sample (NMLT15).

5.3 SURFACE WATER SAMPLE RESULTS

Surface water data results that satisfy the criteria listed in Table 5-1 are highlighted in Tables 5-6 and 5-7. Surface water samples collected during this investigation were analyzed for cyanide, inorganics, hardness, conductivity, temperature, and pH, as described in the field sampling plan (URS 1995). No information was available in the data validation reports to assign a bias (high or low) to the qualified ("J") sample results identified in the tables.

5.3.1 Inorganic Analyses

Inorganics detected in the surface water samples for Cabin Creek and Jack Creek are summarized in Table 5-6. (Those inorganics detected at significant concentrations are highlighted.)

- **Background Surface Water**—Inorganics were detected in the background surface water samples for Cabin Creek (NMCSW01) and Jack Creek (NMJSW03).

- **Downgradient Surface Water**—The following inorganics were detected in the downgradient samples for Cabin Creek (NMCSW02) and duplicate sample (NMCSW05): arsenic, barium, manganese, and zinc. Arsenic was detected in the downgradient sample (NMJSW04) for Jack Creek.

Table 5-6
Inorganics in Surface Water

Analyte	Background Cabin Creek NMCSW01 (μg/L)	Downgradient Cabin Creek NMCSW02 (μg/L)	Downgradient Cabin Creek NMCSW05 (Duplicate of NMCSW02) (μg/L)	Downgradient Cabin Creek Before Jack Creek NMCSW06 (μg/L)	Background Jack Creek NMJSW03 (μg/L)	Downgradient Jack Creek NMJSW04 (μg/L)
Aluminum	245	20 U	23 J	40 J	72 J	42 J
Arsenic	1.0 U	**9.36**	**9.75**	3.6 J	1.0 U	**1.4 J**
Barium	2.8 J	**14.7**	**15.1**	4.3 J	31.1	21.8
Calcium	6,380	63,300	63,700	63,500	45,800	43,900
Iron	123	2,660	2,620	81.1	99.5	67.0
Lead	0.52 J	1.2 J	0.5 U	0.5 U	0.5 U	0.5 U
Magnesium	1,190	8,130	8,220	11,700	11,400	10,100
Manganese	5.87	**643**	**642**	7.18	6.04	11.9
Potassium	1,200 J	1,800 J	1,500 J	1,700 J	2,030 J	1,800 J
Sodium	1,810	3,540	3,630	4,350	5,190	4,940
Vanadium	3.0 J	3.0 U	3.0 U	3.4 J	3.0 U	3.0 U
Zinc	4.0 U	**7.8 J**	**8.3 J**	4.0 U	4.0 U	4.0 U

Notes:
Bolded values represent significant concentrations
J Value is an estimate
U Sample was not detected; value shown is the quantitation limit

Table 5-7
Surface Water Properties

Sample Number	Hardness (mg/L)	Conductivity (siemens/cm)	Temperature (°F)	pH
NMCSW01 Background Cabin Creek	21.6	69.4	66.8	8.20
NMCSW02 Downgradient Cabin Creek	195.3	440.0	55	7.76
NMJSW03 Background Jack Creek	161.6	324.0	60.4	8.39
NMJSW04 Downgradient Jack Creek	149.5	289.0	58.5	8.39
NMCSW05 Cabin Creek Duplicate	191.9	440.0	55	7.76
NMCSW06 Downgradient Cabin Creek Before Jack Creek	206.5	366.0	58.3	7.96

5.3.2 Cyanide Analysis

- **Background Surface Water**—Cyanide was not detected in the background surface water sample for Cabin Creek (NMCSW01) or Jack Creek (NMJSW03).

- **Downgradient Surface Water**—Cyanide was not detected in the downgradient samples taken from Cabin Creek or Jack Creek.

5.3.3 Hardness Analysis

- **Surface Water**—Surface water properties such as hardness, conductivity, temperature and pH were measured and presented in Table 5-7.

As the surface water passes through the mineralized soils and rock, its ability to act as a universal solvent with the inorganics it comes in contact with will increase the amount of particles that are held in suspension or dissolved in the water. Increased levels of iron and manganese will increase the hardness and conductivity and lower the pH of the surface water.

5.4 SEDIMENT SAMPLE RESULTS

Sediment data results that satisfy the criteria listed in Table 5-1 are highlighted in Tables 5-3, 5-6, and 5-7. Sediment samples collected during this investigation were analyzed for SVOCs, PCBs, pesticides, cyanide, and inorganics as described in the field sampling plan (URS 1995).

5.4.1 SVOC Analyses

No significant concentrations of SVOCs were detected in surface water sediments, the concentrations are presented in Table 5-8.

Table 5-8
Semivolatile Organic Compounds in Sediments

Compound	Background Sediments NMCSD01 (μg/kg)	Downgradient Cabin Creek Sediments NMCSD02 (μg/kg)
2,4-Dimethylphenol	183 U	22.6 J
2-Methylphenol	183 U	53.8 J
4-Methylphenol	183 U	34.1 J
Isophorone	183 U	23.0 J
Naphthalene, 2-methyl	183 U	68.7 J

Notes:

J	Value is an estimate
U	Sample was not detected; value shown is the quantitation limit
UJ	Analyte was not detected above the reported sample quantitation limit; the reported quantitation limit is an estimate.

- Background Surface Water Sediment—SVOCs were not detected in the upgradient surface water sediment sample collected at Cabin Creek (NMCSD01).

- **Downgradient Surface Water Sediment**—SVOCs were not detected in the downgradient surface water sediment sample (NMCSD02).

5.4.2 PCB Analyses

PCBs were not detected in the background or downgradient surface water sediment samples.

5.4.3 Pesticide Analyses

Pesticides were not detected in the background or downgradient surface water sediment samples.

5.4.4 Inorganic Analyses

Inorganics detected in sediment samples are summarized in Table 5-9. (Those inorganics detected at significant concentrations are highlighted.)

- **Background Surface Water Sediment**—Inorganics were detected in the background sediment samples for Cabin Creek (NMCSD01) and Jack Creek (NMJSD03).

- **Downgradient Surface Water Sediment**—Three inorganics were detected in Cabin Creek sediments below the mine tailings (NMCSD02): arsenic, lead, and manganese. Eight inorganics were detected in Cabin Creek before the confluence of Jack Creek (NMCSD06): arsenic, cadmium, chromium, lead, manganese, mercury, silver, and selenium. Inorganics were not detected above background concentrations in the downgradient Jack Creek sample (NMJSD04) or in the duplicate sample (NMJSD05).

5.4.5 Cyanide Analysis

- **Background Surface Water Sediment**—Cyanide was not detected in the background sediment samples for Cabin Creek (NMCSD01) or Jack Creek (NMJSD03).

- **Downgradient Surface Water Sediment**—Cyanide was not detected in downgradient samples in Cabin Creek or Jack Creek (Table 5-9).

Table 5-9
Inorganics in Sediments

Analyte	Background Cabin Creek NMCSD01 (mg/kg)	Downgradient Cabin Creek NMCSD02 (mg/kg)	Downgradient Cabin Creek Before Jack Creek NMCSD06 (mg/kg)	Background Jack Creek NMJSD03 (mg/kg)	Downgradient Jack Creek NMJSD04 (mg/kg)	Downgradient Jack Creek NMJSD05 (Duplicate of NMJSD04) (mg/kg)
Aluminum	3,760	2,960	5,380	10,300	8,550	7,850
Arsenic	1.29	**49.0**	**15.4**	4.57	3.47	3.53
Barium	19.2	37.6	37.6	138	86.2	76.8
Beryllium	0.11 J	0.068 J	0.16 J	0.33 J	0.29 J	0.28
Cadmium	0.2 U	0.71 J	**0.62 J**	0.23 J	0.21 J	0.2 U
Calcium	5,060	4,250	11,600	12,800	15,600	20,100
Chromium	4.1	1.6 J	**13.9**	20.6	14.5	43.8
Cobalt	3.3	6.41	7.05	9.86	8.28	8.01
Copper	10.8	12.9	26.0	32.2	25.0	24.2
Iron	6,630	18,500	11,500	21,600	17,000	15,800
Lead	1.04	**6.81**	**11.9**	2.00	3.03	2.21
Magnesium	1,380	1,060	4,310	8,810	8,290	11,100
Manganese	129	**1,350**	**969**	449	456	432
Mercury	0.02 U	0.02 U	**0.0331**	0.047	0.0376	0.0301
Nickel	5.54	4.2 J	11.9	25.1	19.0	37.1
Potassium	200 J	170 J	307	608	590	485
Silver	0.3 U	0.38 J	**0.37 J**	0.3 J	0.3 U	0.39 J
Sodium	420	290	413	323	407	351
Vanadium	22.5	17.7	37.1	50.5	43.1	38.2
Zinc	15.6 J	72.3	57.3	52.3	42.7	39.4
Selenium	0.2 U	0.2 U	**1.03**	0.33 J	0.25 J	0.2 J

Notes:
Bolded values represent significant concentrations

J	Value is an estimate
U	Sample was not detected; value shown is the quantitation limit

5.5 INVESTIGATION-DERIVED WASTE

No investigative-derived wastes were generated during this field sampling event.

5.6 QUALITY CONTROL SAMPLES

During the field sampling event, an equipment rinsate sample (NMER01) was collected, the results for which are provided in Table 5-10. The equipment rinsate sample was collected after the stainless-steel hand auger was decontaminated following the collection of the lower tailing subsurface sample (NMLTSB15). The detected compounds in the rinsate sample were butylbenzylphthalate and n-nitrosodiphenylamine.

The quality control samples also included laboratory method blanks that contained detectable concentrations of the compounds listed in Table 5-1.

None of these compounds were detected in the environmental samples. These results have not affected the quality of the data.

Duplicate samples of soil, sediment, tailings, and surface water were collected to verify analytical precision. Due to the heterogeneity of soil, sediment, and tailings, the relative percent differences (RPDs) for duplicate sample results of these media are expected to exceed 35 percent routinely. RPDs for results within 5 times the reporting limit are considered unusable. RPDs for results when one or both are qualified as estimated are unreliable. Soil field duplicate results for metals have higher variability than that normally expected (40 to 45 percent), but because the laboratory duplicate samples and other quality control samples are within EPA guidelines, it is likely that the difference in results is the result of differences in soil metals concentrations over short distances.

5.7 SUMMARY

Analytical results of samples collected from the Nabesna mine site revealed the presence of contaminants in tailings, sediment, and soil. Significant concentrations of inorganics were detected in sediment, soil, and tailings samples. Concentrations of semivolatiles were detected in soil samples. Significant concentrations of cyanide in the subsurface lower tailings might indicate the presence of the cyanide that was used in the early mining activities. Significant concentrations of cyanide in the upper tailings might indicate the presence of the cyanide that was used in the cyanide leaching activities occurring in the 1980s. Table 5-11 lists the media and location at which various contaminants are present in significant concentrations.

Spude, R., L.S., Taylor Dan, Lappen Michael, 1984. *Historic Structures Inventory: in Wrangell-St. Elias National Park and Preserve.*

United States Department of Commerce. 1992. Probable Maximum Precipitation and Rainfall-Frequency Data for Alaska. Data Report 92-11. Alaska State Climate Center. September 1992.

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———. 1987. *A Compendium of Superfund Field Operations Methods*, Office of Emergency and Remedial Response, EPA/540/P-87/001.

———. 1978. *Development Document for Effluent Limitations Guidelines and New Source Performance Standards for the Ore Mining and Dressing Point Source Category, Volume 1.* PB-286 520. Effluent Guidelines Division, Office of Water and Hazardous Materials. Washington D.C. July 1978.

Versar Inc. 1986. *Quantities of Cyanide-Bearing and Acid-Generating Wastes Generated by the Mining and Beneficiating Industries, and the Potential for Contaminant Release.* Prepared for the U.S. Environmental Protection Agency. June 27, 1986.

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———. 1990a. *Quality Management Plan (QMP) for Alternative Remedial Contracting Strategy (ARCS)*, Contract No. 68-W9-0054.

———. 1990b. *Technical Standard Operating Procedures (TSOP) for ARCS*, Contract No. 68-W9-0054.

Wayland, R. 1943. *Geology of the Nutzotin Mountains, Alaska, and Gold Deposits Near Nabesna.* Geological Survey Bulletin 933-B.

6.0 REFERENCES

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Habashi, F. 1967. *Kinetics and Mechanism of Gold and Silver Dissolution in Cyanide Solution*. Montana Bureau of Mines, Geology Bulletin 59. Butte, Montana.

Happe, P. (Environmental Specialist, National Park Service). 1995. Telephone conversation with Rebecca Juul, URS Consultants, Inc., Seattle, Washington, re: Nabesna Mine Site, Alaska. March 16, 1995.

Hoffman, A. (Biologist, Anchorage Fish and Game Department). 1995. Telephone conversation with Rebecca Juul, URS Consultants, Inc., Seattle, Washington, re: Nabesna Mine Site, Alaska. March 22, 1995.

McGuinness, S. (Ranger, Wragell Saint Elias National Park and Preserve). 1995. Telephone conversation with Rebecca Juul, URS Consultants, Inc., Seattle, Washington, re: Nabesna Mine. March 22, 1995.

National Park Service (NPS). 1986. Environmental Assessment and Analysis, 1986 Plan of Operation. Nabesna Mine, Sunshine Lode Patented Claim. Alaska Regional Office. July 31, 1986.

Saleeby, B. (Archeologist, U.S. Department of Interior National Park Service). 1995. Historic Structures Inventory in Wrangell-Saint Elias National Park and Preserve 1984.

Smith, S.L. 1982. *Cyanidation of Gold and Silver Ores and Laboratory Instructions*.

Stanley, K. (Owner of Ptarmigan Co. and the Nabesna Mine). 1995. Site visit conducted with site owner and Kara Steward and Rebecca Juul of URS Consultants Inc., Seattle, Washington. June 20-21, 1995.

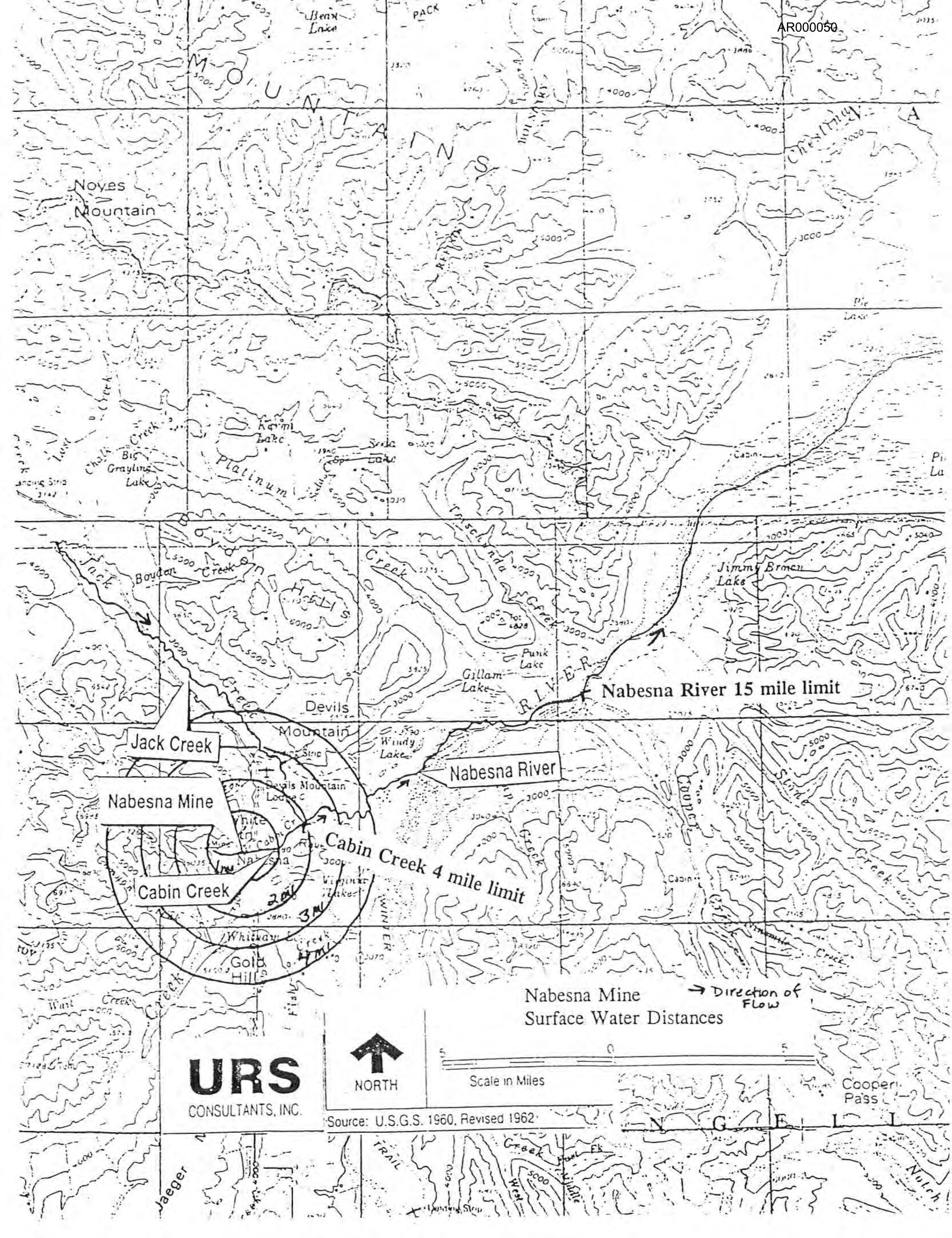
Table 5-10
Semivolatile Organic Compounds and Inorganics in Equipment Rinsate and Laboratory Method Blanks

Analyte	Equipment Rinsate NMER01 (μg/L)	Lab Blank BW5380 (μg/L)	Lab Blank BW5380D (μg/L)	Lab Blank S950630A (μg/L)
Aluminum	24.0 J	NA	NA	2.0 U
Arsenic	1.0 U	NA	NA	5.0 U
Barium	2.0 U	NA	NA	0.20 U
Bis(2-ethylhexyl)phthalate	0.44 UJ	231 J	0.59 U	NA
Butylbenzylphthalate	43.4 J	0.089 J	0.59 U	NA
Cadmium	2.0 U	NA	NA	0.20 U
Calcium	78.0	NA	NA	1.30
Chromium	5.0 U	NA	NA	0.50 U
Cobalt	10 U	NA	NA	1.0 U
Copper	6.8 J	NA	NA	0.30 U
Cyanide	0.005 U	NA	NA	NA
Diethylphthalate	0.44 UJ	0.044 J	0.59 U	NA
Endrin	0.00347 UJ	NA	NA	NA
Iron	26.8	NA	NA	1.0 U
Lead	0.50 U	NA	NA	2.5 U
Manganese	20 U	NA	NA	0.10 U
Nickel	10 U	NA	NA	1.0 U
n-Nitrosodiphenylamine	0.11 J	0.56 U	0.59 U	NA
Potassium	670 J	NA	NA	45 U
Silver	3.0 U	NA	NA	0.30 U
Sodium	103	NA	NA	3.2 J
Thallium	1.0 U	NA	NA	NA
Vanadium	3.0 U	NA	NA	0.30 U
Zinc	4.0 U	NA	NA	0.40 U

Notes:

J	Value is an estimate
U	Sample was not detected; value shown is the quantitation limit
NA	Not analyzed

APPENDIX A
PHOTOGRAPHIC LOG OF JUNE 20 AND 21, 1995 SITE VISIT



Nabesna Mine
Surface Water Distances

→ Direction of Flow

URS CONSULTANTS, INC.

Source: U.S.G.S. 1960, Revised 1962

URS Consultants, Inc.	ARCS Photograph Log	DCN # 62760.35.20.1011 45.a	
Project Number 4162760.35	Project/Site Name Nabesna Mine	Photographer(s) Kara Steward	
Camera Type Canon	Film Type/Speed Kodak 200	Roll Number 2	Date 6/28/95

Frame	Date	Time	Orientation	Subject
1	6/21/95	0900	W	White Hills from Nabesna Road
2	6/21/95	0910	E	Mill tailings runoff (NPS property)
3	6/21/95	0911	SW	Tailings runoff
4	6/21/95	0915	SW	Upper tailings. Panorama 1/2
5	6/21/95	0915	W	Upper tailings and mill. Panorama 2/2
6	6/21/95	0915	NE	Tailings runoff from upper area
7	6/21/95	0950	W	Lower tailings sample
8	6/21/95	1005	W	Stressed vegetation and surface water runoff through tailings
9	6/21/95	1045	W	Lower tailings sample location
10	6/21/95	1050	W	Lower tailings location and mill
11	6/21/95	1148	S	Cabin Creek downstream sample
12	6/21/95	1205	W	Cabin Creek view of mill
13	6/21/95	1310	W	Tailings visible in creek slopes >2 miles from lower tailings
14	6/21/95	1347	NE	Confluence of Cabin Creek and Jack Creek
15	6/21/95	1350	SW	Cabin Creek above confluence

URS Consultants, Inc.	ARCS Photograph Log	DCN # 62760.35.20.1011 45.a	
Project Number 4162760.35	Project/Site Name Nabesna Mine	Photographer(s) Kara Steward	
Camera Type Canon	Film Type/Speed Kodak 200	Roll Number 1	Date 6/28/95

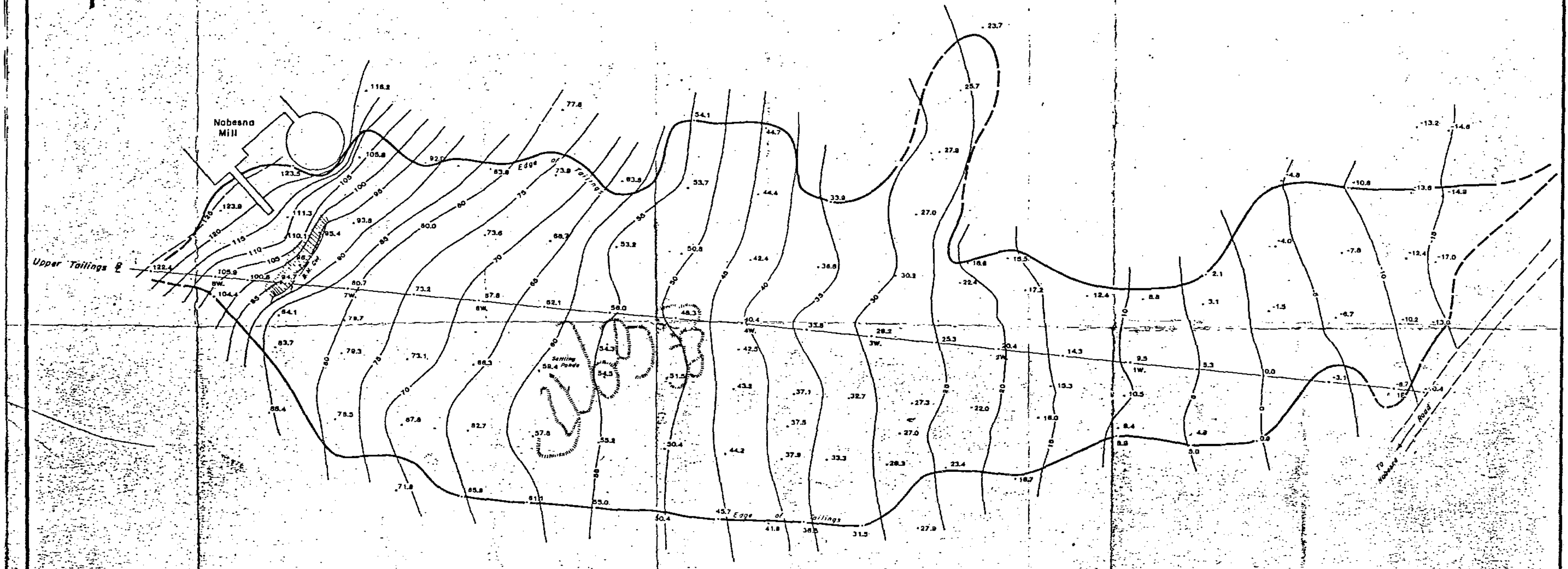
Frame	Date	Time	Orientation	Subject
1	6/20/95	1106	NE	Mill building from south entrance
2	6/20/95	1106	E	East wall of mill building
3	6/20/95	1107	S	Tanks in building
4	6/20/95	1111	NE	Cyanide tank in NW corner of mill building
5	6/20/95	1111	SE	Ore grinder
6	6/20/95	1115	N	Zinc solution tank
7	6/20/95	1115	E	Tailings view from mill building
8	6/20/95	1120	W	Mine portal in hillside
9	6/20/95	1130	NE	Panorama 1/4, Tailings
10	6/20/95	1130	E	Panorama 2/4, Tailings
11	6/20/95	1130	SE	Panorama 3/4, Tailings
12	6/20/95	1130	E	Panorama 4/4, Tailings
13	6/20/95	1138	W	Mill building and tailings from east
14	6/20/95	1142	E	Drums filled with tailings
15	6/20/95	1146	SW	Surface water drainage through tailings
16	6/20/95	1205	W	Former Nabesna post office
17	6/20/95	1208	NW	Nabesna town boardwalk
18	6/20/95	1313	W	Cabin Creek upgradient of mill sample location
19	6/20/95	1350	W	Background mineralized sample location
20	6/20/95	1450	SW	North mill soil sample location
21	6/20/95	1515	N	South mill soil sample location, Assay office
22	6/20/95	1550	W	Tailings east of mill sample location
23	6/20/95	1550	W	East of mill sample location view of mill
24	6/20/95	1700	W	Southwest of mill building sample location
25	6/20/95	1800	SE	Field crew use of ATV for gear transport

APPENDIX B
USGS MAP OF THE GEOLOGY OF THE AREA

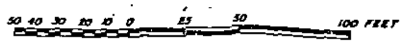
To receive a copy of Appendix B, please submit a written request to USEPA Region 10. Your request should refer to the Nabesna Mine Site Investigation report.
Upon receipt of a request, EPA will reproduce the 42"x26" colored USGS map.
The above is being suggested due to the current resource/funding situation.

APPENDIX C
CROSS-SECTION MAP OF THE NABESNA MINE

APPENDIX D
DIAGRAMS OF THE UPPER AND LOWER MINE TAILINGS



NOTE: STATION ELEVATIONS AND ELEVATION CONTOURS ARE IN FEET ABOVE OR BELOW THE 0+00 BASELINE STATION. TRUE ELEVATION OF 0+00 STATION IS BEWEEN 2900 AND 3000 FEET ABOVE SEA LEVEL.



WGM INC.
MINING & GEOLOGICAL CONSULTANTS
ANCHORAGE, ALASKA

Rambler Mine Project

NABESNA MILL TAILINGS

TOPOGRAPHIC MAP
OF UPPER TAILINGS

SCALE: 1" = 50'			FIG.
DATA BY: GC	DATE: 10/1981	REVISED	

APPENDIX E
CYANIDE PROCESS FLOW CHART

APPENDIX F
WELL LOG

APPENDIX G
NET PRECIPITATION

APPENDIX H
DATA RESULTS AND VALIDATION

United States Department of the Interior

NATIONAL PARK SERVICE
Alaska Regional Office
240 W. 5th Avenue, Room 114
Anchorage, Alaska 99501

IN REPLY REFER TO:

L3032(AKSO-RPR) CERTIFIED MAIL RETURN REQUESTED

APR 28 2004

The Ptarmigan Co., Inc.
C/O Mr. Kirk Stanley, President
P.O. Box 200956
Anchorage, Alaska 99502-0956

Re: Nabesna Mine, Wrangell St. Elias National Park and Preserve, Alaska
General Notice Letter and Request for Information
Pursuant to Sections 104 and 107 of CERCLA

Dear Mr. Stanley:

This letter notifies you that The Ptarmigan Co., Inc. ("Ptarmigan") may be liable under Section 107(a) of the Comprehensive Environmental Response, Compensation, and Liability Act of 1980, 42 U.S.C.§ 9607(a), as amended ("CERCLA") in connection with the Nabesna Mine Site ("Site") near Nabesna, Alaska. This letter also notifies you of past and future response activities at the Site which Ptarmigan may be asked to facilitate, finance or otherwise participate in. Additionally, this letter requests that you provide certain information regarding the ownership and operation of the Site and the relationship of Ptarmigan to the Site. Our records show that Ptarmigan has held an ownership interest in the Site since 1968.

HISTORY OF SITE

The Site is located in Wrangell-St. Elias National Park and Preserve, Alaska, in Section 21, Township 7 North, Range 13 East, Copper River Meridian. The Site is accessible by way of the 58 mile long Nabesna Road, a state right of way, beginning at Slana, and ending at the mine. The road is state maintained from Slana to a location approximately two miles north of the Site.

The Site consists of the Sunshine patented lode mining claim and lapsed unpatented mining claims located downslope of the Sunshine claim and now managed by the National Park Service ("Park Service") as part of Wrangell-St. Elias National Park and Preserve. All of the claims which gave rise to the Site, including the Sunshine claim, were originally staked between 1903 and 1905. The Sunshine claim was patented in 1932.

Nabesna Mining Corporation performed hard rock gold mining at the Site from 1929 to 1946. The mill used by Nabesna Mining Corporation for its mining operations is located on the Site, along with various other buildings used to support past mining operations. The Site is located near tree line on the talus slopes of White Mountain at an elevation of

3,100 feet. Tailings from the gold mining operations were deposited on the Site and cover approximately nine acres. We estimate that roughly 25 percent of the tailings are located on the Sunshine claim, and approximately 75 percent are downslope on lands currently managed by the Park Service.

NOTICE OF POTENTIAL LIABILITY

The United States Environmental Protection Agency ("USEPA"), the United States Geological Survey ("USGS") and the Park Service have conducted various investigations of the Site and have documented the release of hazardous substances as defined under CERCLA into the environment. Specifically, these investigations document that metals from the tailings have been released into soils and surface water which present exposure hazards to visitors to the Site and the environment. As a result, the Site was placed on USEPA's CERCLA sites database. The State of Alaska also added the Site to its contaminated sites database, which is maintained by the Contaminated Sites Division of the Alaska Department of Environmental Conservation. Additionally, the State of Alaska added Cabin Creek to its Clean Water Act list of impaired water bodies.

Pursuant to the authority granted to it under Executive Order 12580 to respond to releases of CERCLA hazardous substances, the Park Service has undertaken actions to investigate and control releases and threatened future releases of hazardous substances at the Site and is considering expending additional funds towards that end. The Park Service explored various options for remediation of the Site and has selected a preferred alternative involving diversion of surface waters from the tailings and possible capping of the tailings with a local talus source. Under Section 106(a) and 107(a) of CERCLA, potentially responsible parties ("PRPs") may be ordered to perform response actions necessary to protect the public health, welfare, or the environment and may be held liable for all costs incurred by the Park Service in responding to any release or threatened release at the Site.

PRPs under CERCLA include current owners at the Site, past owners at the time hazardous substances were disposed of at the Site, persons who arranged for the disposal of hazardous substances at the Site and transporters of hazardous substances to the Site. Based on information reviewed by the Park Service to date, the Park Service believes that Ptarmigan, as a current owner and operator of the Site, may be a PRP at the Site. By this letter, the Park Service notifies you of your potential liability with regard to this matter and encourages your continued cooperation with the Park Service with respect to planned response activities at the Site.

REQUEST FOR INFORMATION

The Park Service appreciates that Ptarmigan has expressed interest in participating in implementation of the preferred remediation alternative for the Site and looks forward to working with Ptarmigan in that regard. Nevertheless, in responding to the documented release of hazardous substances at the Site, the Park Service is required to follow a prescribed regulatory process of inquiring into various matters. These matters include identifying the nature and quantity of hazardous substances that have been released at the Site and the connection between PRPs and the release of hazardous substances at the Site. Additionally, the Park Service must also seek information relating to the ability of PRPs to pay for or perform a cleanup of the Site. As a result, pursuant to the authority of Section 104 of CERCLA, 42 U.S.C. § 9604, as amended, the Park Service hereby requests that Ptarmigan respond to the information request set forth in Enclosure 1, attached hereto.

Your response to this Information Request should be sent
C/O Linda Stromquist
CERCLA Program Manager
National Park Service
240 W. 5th Avenue #114
Anchorage, Alaska 99501-2327

The Park Service strongly encourages Ptarmigan to give this matter its immediate attention and to respond to this Information Request within 60 days. Under CERCLA, failure to respond to this request with 60 days or to adequately justify any failure to respond could result in the commencement of judicial or administrative action to compel compliance with the information request or the imposition of civil penalties not to exceed $32,500 per day of noncompliance (see 42 U.S.C. §§ 104(e)(5)(A) & (B)).

If you have any questions regarding this Information Request, or Ptarmigan's role in response activities planned for the Site, please contact Linda Stromquist at (907) 644-3576 or, in her absence, Danny Rosenkrans at (907) 822-7240. Alternatively, Ptarmigan's attorney may contact Lisa Toussaint of the Regional Solicitor's Office for the Department of the Interior at (907) 271-4131 regarding this matter.

Sincerely,

Marcia Blaszak

Marcia Blaszak
Regional Director

Enclosures 2
1-Information Request (5 pp)
2-Notarized Certificate (1 p)

cc:
Lisa Toussaint, DOI-SOL
Linda Stromquist, NPS-AKSO
Gary Candelaria, NPS-WRST
Danny Rosenkrans, NPS-WRST

Nabesna Mine Site – Enclosure

INFORMATION REQUEST

Definitions

The following definitions shall apply to the following words as they appear in this Enclosure:

1. The term "Ptarmigan" shall mean The Ptarmigan Co., Inc. its officers, managers, employees, contractors, trustees, partners, successors, assigns, and agents.

2. The term "person" shall have the same definition as in Section 101(21) of CERCLA: an individual, firm, corporation, association, partnership, consortium, joint venture, commercial entity, United States Government, State, municipality, commission, political subdivision of a State, or any interstate body.

3. The term "the Site" shall mean the Nabesna Mine site.

4. The term "hazardous substance" shall have the same definition as that contained in Section 101(14) of CERCLA and includes any mixtures of such hazardous substances with any other substances, including petroleum products.

5. The term "release" has the same definition as that contained in Section 101(22) of CERCLA, 42 U.S.C. § 9601 (22), and includes any spilling, leaking, pumping, pouring, emitting, emptying, discharging, injecting, escaping, leaching, dumping, or disposing into the environment, including the abandonment or discharging of barrels, containers, and other closed receptacles containing any hazardous substance.

6. The terms "document" and "documents" shall mean any writing, recording, or stored information and includes, but is not limited to, writings of any kind, formal or informal, whether or not wholly or partially in handwriting, including by way of illustration and not by way of limitation, any invoice, manifest, check, deposit slip, withdrawal slip, order, correspondence, record book, minutes, memorandum of telephone and other conversations, including meetings, agreements, and the like, diary, calendar, desk pad, scrapbook, notebook, bulletin, circular, form, pamphlet, statement, journal, postcard, letter, telegram, telex, report, notice, message, analysis, comparison, graph, chart, interoffice or intra office communications, photostat or photograph, sound recording or any type of device, any punch card, disc or disc pack: any tape or other type of memory generally associated with computers and data processing (together with the programming instructions and other written material necessary to use such punch card, disc, or disc pack, tape or other type of memory and together with printouts of such punch card, disc, or disc pack, tape or other type of memory); and (a) every copy of each document which is not an exact duplicate of a document which is produced,

(b) every copy which has writing, figure or notation, annotation or the like on it, (c) drafts, (d) attachments to or enclosures with any document, and (e) every document referred to in any other document.

7. The term "property interest" means any interest in property including, but not limited to, any ownership interest, including an easement or right of way, any interest in the rental of property, any interest as either the trustee or beneficiary of trust that owns or rents, or owned or rented property.

8. The term "mining operations" shall mean mining, milling, smelting, exploration, sampling, drilling, or moving materials, as well as developing or improving any road or trail to facilitate access to the site for the purpose of any of the foregoing activities.

Questions

Insurance Information

1. Please identify all liability insurance policies held by Ptarmigan that cover or may cover activities associated with the Site or Ptarmigan's potential liability at the Site. For each such policy, please state:

   a. the name and address of the insurer and the insured;

   b. the amount of coverage under the policy;

   c. the dates of the commencement and expiration of the policy;

   d. whether the policy contains a "pollution exclusion" clause; and

   e. whether the policy covers or excludes sudden, non-sudden or both types of accidents.

2. Please provide copies of all policies identified in response to Question 1.

Corporate and Financial Information

3. Please identify all of Ptarmigan's current assets and liabilities.

4. Please provide copies of all financial statements and financial reports filed by Ptarmigan with any governmental entity (e.g., the Securities and Exchange Commission) or any financial institution (e.g., bank) for the last five (5) years.

5. Please identify any other person or entity that may be responsible for the liabilities of Ptarmigan arising from or related to the release or threatened release of hazardous substances at the Site.

6. Please identify all parent corporations of Ptarmigan.

7. Please identify all subsidiaries of Ptarmigan.

8. Please identify all of the shareholders of Ptarmigan and their respective percentage of ownership of shares in Ptarmigan.

9. Please provide copies of all financial statements or financial reports filed by each of the shareholders of Ptarmigan with any governmental entity (e.g., the Securities and Exchange Commission) or any financial institution (e.g., bank) for the past five (5) years.

Ptarmigan's Property Interest in the Site

10. Our records identify Ptarmigan as one of the current owners of the Site. With regard to Ptarmigan's property interest at the Site, please identify:

    a. The date when Ptarmigan acquired its property interest in the Site; and

    b. The party or parties from whom Ptarmigan acquired its property interest in the Site.

11. Did Ptarmigan ever transfer any portion of its property interest at the Site to another party? If the answer to this question is "Yes," with regard to each such property interest transferred, please identify:

    a. the name of the parties to whom Ptarmigan transferred such a property interest;

    b. the nature of the property interest transferred; and

    c. the date on which the transfer of the property interest occurred.

Mining Operations at the Site

12. Has Ptarmigan or any of its agents, assignees, leasees or contractors ever performed any mining operations, as defined in the Definitions section herein, at the Site? If the answer to this question is "Yes," please identify for each such mining operation:

    a. the nature of the mining operation;

    b. the date or dates on which the mining operation occurred; and

    c. the specific location at the Site of the mining operation.

13. Does Ptarmigan have any knowledge that Sierra Industries, Inc. performed any mining operations at the Site? If the answer to this question is "Yes," please identify for each such mining operation:

    a. the nature of the mining operation;

    b. the date or dates on which the mining operations occurred; and

c. the specific location at the Site of the mining operations.

14. Does Ptarmigan have any knowledge that Nabesna, Inc. performed any mining operations at the Site? If the answer to this question is "Yes," please identify for each such mining operation:

  a. the nature of the mining operation;

  b. the entity which performed the mining operation;

  c. the date or dates on which the mining operation occurred;

  d. the specific location at the Site of the mining operation.

Corporate History of Other Entities

15. Does Ptarmigan have any knowledge of any acquisition, asset or stock sale, merger or consolidation involving any two or more of the following business entities:

  a. Nabesna Mining Corporation;

  b. Nabesna Mining Company, Inc.;

  c. Sierra Industries, Inc.; or

  d. Nabesna, Inc.

  e. Ptarmigan

16 If the answer to Question 15 is "Yes," please identify for each such acquisition, sale, merger or consolidation:

  a. the name of the party or parties engaged in such transaction;

  b. the date when such transaction occurred; and

  c. the nature of such transaction.

17. Please provide copies of any documents related to each such transaction identified in response to Question 16.

18. Does Ptarmigan have any knowledge of whether Nabesna Mining Corporation or Nabesna Mining Company, Inc. was involved in a merger, asset or stock sale, or consolidation with any other entity not identified in Question 15? If the answer to this question is "Yes," please identify with regard to each such merger, sale or consolidation:

  a. the name of the party or parties with whom Nabesna Mining Corporation or Nabesna Mining Company, Inc. engaged in such a transaction;

   b. the date when such transaction occurred;

   c. the nature of such transaction.

19. Please provide copies of any documents related to each such transaction identified in response to Question 18.

20. Does Ptarmigan have any knowledge of whether Nabesna Mining Corporation or Nabesna Mining Company, Inc. liquidated its assets, went into bankruptcy or otherwise dissolved? If the answer to this question is "Yes," please identify:

   a. the nature of such liquidation, bankruptcy or dissolved; and

   b. the date when such liquidation, bankruptcy or dissolved occurred.

21. Please provide copies of any documents related to each such transaction identified in response to Question 20.

22. If you have reason to believe that there may be persons able to provide a more detailed or complete response to any of the questions contained herein or who may be able to provide additional responsive documents, please identify those persons and the additional information or documents that you believe they may have.

NOTARIZED CERTIFICATE
FOR THE NABESNA MINE SITE

1.____________________________, having been duly sworn and being of legal age, hereby state:

I am the person authorized by Ptarmigan, Inc. to respond to the National Park Service information request concerning the Nabesna Mine Site located in Wrangell-St. Elias National Park and Preserve, Alaska.

2. I have made a complete and thorough review of all documents, information, and sources relevant to the request.

3. I hereby certify that the attached response to the Park Service's request is complete and contains all information and documents responsive to the request.

____
(Signature and Title)

PTARMIGAN COMPANY, INC.
P.O. Box 200956
Anchorage, Alaska 99502-0956

June 7, 2004

Ms. Linda Stromquist
National Park Service
240 W.5th Avenue #114
Anchorage, Alaska 99501-2327

Re: Nabesna

Dear Ms. Stromquist:

I, as President of Ptarmigan Company, Inc., caused Ptarmigan to acquire Nabesna Mine (USMS 1591) nearly 40 years ago. I am generally Ptarmigan's spokesperson, and, as such, am providing the enclosed responses to questions posed in your April 28, 2004, letter. However, your letter itself, in at least one respect, seems to call for a response. Specifically, I refer to your portraying Ptarmigan as responsible for the Nabesna mill tailings, tailings that are the focus of your questions and my answers to those questions.

I should not doubt you would have no difficulty in concluding from the sometimes vague and second-hand response to many of your questions, the best that I can provide, just exactly what I am disclosing here: That my knowledge, while studied and often documented-supported, does not result from first-hand experience with the deposition of the tailings, either on lot 22 of the Sunshine Claim or on adjoining land. This, of course, means that Ptarmigan has had nothing whatsoever to do in reality with that deposition.

I became interested in the geology of the Nabesna mine in my college years in the 1950's, leading me to write my master's thesis on a nearby area. What I saw at the mine, some 50 years ago, is almost exactly what anyone would see there today. In other words, nothing, and most materially the tailing pile, has changed there in all that time.

What I came to learn from records and from talking with locals in the area, many of whom are now dead, is that the mine flourished primarily in the1920's and 1930's and was stilled at the outbreak of World War II. I was a boy in Montana when the mine operated, then in WW II served in the South Pacific theatre. Nabesna, obviously, was not even known to me when the deposition of the tailings was complete.

What I learned and what every geologist knows is that the mill tailings are nothing more than a ground-up pile that is chemically like the mountain above and from which they came and not unlike the thousands of acres of the surrounding natural country. I had no reason then, and that holds today, to doubt their benignity. I learned from records and 'old timers' that Nabesna mine intending to reprocess those tailings, and just as you would have done, created an earth dam down slope from the mill to contain the tailings on mine property. Then in the summer of 1941, the Federal Government used the mine as a staging area for a massive airfield building project (Reeve Field). That was the time, so old timers say, when the government contractors flattened the earth dam when taking a short cut through the tailing area in bulldozers. Afterward, in the 1940's and '50's, one would assume, natural processes caused some of the tailing material to migrate downslope. What I know is that since the late '50's movement of the material has been negligible. Like I said, what I see now at the mine, and what you could see now is what I saw when I first visited it some 50 years ago. The tailings have remained static all the time Ptarmigan has owned the mine (since1968).

Another point I have discussed voluminously differs from the point that Ptarmigan is not a causative for the tailings as they are situated. It is nevertheless related to any question of responsibility. It is that for any person or entity to be "responsible" for anything there must be something for which he might be responsible: In sum there is no "something" for which Ptarmigan could be responsible for the mill tailing placed there 75 to 58 years ago and nearly 30 years before Ptarmigan acquired the property.

The tailings have some historical significance. They are on the National Register. Nevertheless I would not necessarily disagree that in that tiny area on which they are located there are some that perceive them unsightly, or different. Therefore, because one paramount interest I have is in preserving the scenic beauty and attractiveness of the Nabesna site, Ptarmigan is willing, as I have indicated previously, to contribute significantly in ways outlined to a reasonable program of abatement of the tailings.

I answer your questions in this spirit of cooperation. I am expecting that Ptarmigan and the NPS will very soon enter into an agreement, materially as previously outlined and as discussed, so that we may actually begin this cooperative venture. If this is not now your intention, please let me know.

Sincerely,

Kirk W. Stanley

Kirk W. Stanley

Cc: Gary Candelaria, Superintendent NPS-WRST

2005_06_22_104E_Supplement_Stanley

MARCH 3, 1849

United States Department of the Interior

NATIONAL PARK SERVICE
Alaska Regional Office
240 W. 5th Avenue, Room 114
Anchorage, Alaska 99501

IN REPLY REFER TO:

(AKRO-RNR)
N3035

CERTIFIED MAIL
RETURN RECEIPT REQUESTED

JUN 22 2005

Ptarmigan Company, Inc.
c/o Mr. Kirk Stanley, President
P.O. Box 200956
Anchorage, Alaska 99502-0956

RE: Nabesna Mine, Wrangell-St. Elias National Park and Preserve, Alaska.
Supplemental Request for Information - Section 104 of CERCLA

Dear Mr. Stanley:

This letter supplements the information requests set forth in our April 28,2004, letter to Ptarmigan Company, Inc. ("Ptarmigan") pursuant to Section 104(e) of CERCLA, 42 U.S.C.§9604(e), as amended, in connection with the Nabesna Mine Site located in Wrangell-St. Elias National Park and Preserve in Alaska.

Please respond to the information requested in the enclosure attached to this letter. We ask that you provide the information within thirty(30)days of receiving it and that your response is sent to:

C/O Linda Stromquist
CERCLA Program Manager
National Park Service
240 West 5th Avenue #114
Anchorage, Alaska 99501-2327

If you have any questions regarding this request, please contact Linda Stromquist at (907)644-3576 or, in her absence, Danny Rosenkrans at (907)822-7240. Alternatively, Ptarmigan's attorney may contact Lisa Toussaint of the Regional Solicitor's Office for the Department of the Interior at (907) 271-4131.

Sincerely,

Marcia Blaszak
Regional Director

Enclosures (3)
1-Information Request(2pp)
2-Notarized Certificate(1p)
3-Exhibit A (2pp)

cc
Lisa Toussaint,DOI-SOL

Nabesna Mine Site - Enclosure 1 INFORMATION REQUEST Definitions The following definition shall apply to the following words as they appear in this
Enclosure:

> The Term "Ptarmigan" shall mean The Ptarmigan Company, Inc., its officers, manager, employees, contractors, trustees, partners, successors, assigns, and agents.

Questions

1. Provide copies of all income tax returns filed by Ptarmigan with the federal Internal Revenue Service for the past five (5) years.

2. Identify the total amount of gross income Ptarmigan has received in each of the following calendar years: 2001, 2002, 2003, 2004, and 2005.

3. Identify all assets of Ptarmigan that have been distributed to any shareholder of Ptarmigan at any time since January 1, 2001 to the present.

4. Identify the salaries which have been paid to the President of Ptarmigan during each of the following calendar years: 2001, 2002, 2003, 2004 and 2005.

5. Identify the salaries which have been paid to the-Vice-President of Ptarmigan during each of the following calendar years: 2001, 2002, 2003, 2004, and 2005.

6. Identify the salaries which have been paid to the Treasurer ofPtarmigan during each of the following calendar years: 2001, 2002, 2003, 2004, and 2005.

7. Identify the current balance in each checking account Ptarmigan has with a bank or other financial institution.

8. Identify all assessments or appraisals ofthe Ptarmigan property (USMS 1591) made at any time after January 1, 2001, including but not limited to any assessed value of the property for property tax purposes and any appraisal prepared for the purpose of selling the property.

9. Identify the date and amount of each financial contribution to capital made by each shareholder ofPtarmigan since January 1, 2001.

10. Please provide a copy ofthe Biennial Report filed by Ptarmigan with the State of Alaska for the period ending December 31, 2004.

11. The attached page marked as Exhibit A is from the corporate database available on the website for the State of Alaska Department of The page states that neither you (Kirk Stanley) nor any of the other officers ofPtarmigan owns any shares of Ptarmigan. However, in your response to the 104 (e) Information Commerce.

PTARMIGAN COMPANY, INC.
P.O. Box 200956
Anchorage, Alaska 99502-0956

August 2,2005

Ms. Marcia Blaszak
Regional Director, National Park Service
240 W. 5th Avenue, Room 114
Anchorage, Alaska 99501

Re: Nabesna

Dear Director Blaszak:

Superintendent Jed Davis twice in July came to Nabesna. Few others ever bothered to do that. He got a good look at the place and the 70-year-old mill tailings.

Several in NPS have for the past 11 years made a career out of those old tails, caused the government to spend hundreds of thousands of dollars and accomplished practically nothing.

Superintendent Davis on his second time at Nabesna asked in a reasoned manner if I would be willing to work with DEC regarding the mill tailings on private land. NPS would confine their interest to park managed lands. I agreed absolutely. He said he would work out the details.

Something of value, I believe, will come out of this new arrangement.

I wonder in view of the new arrangement if there is any useful reason for the very personal information sought by your June 22, 2005 letter, the letter I understand Ms. Stromquist drafted.

Thank you.

Sincerely yours,

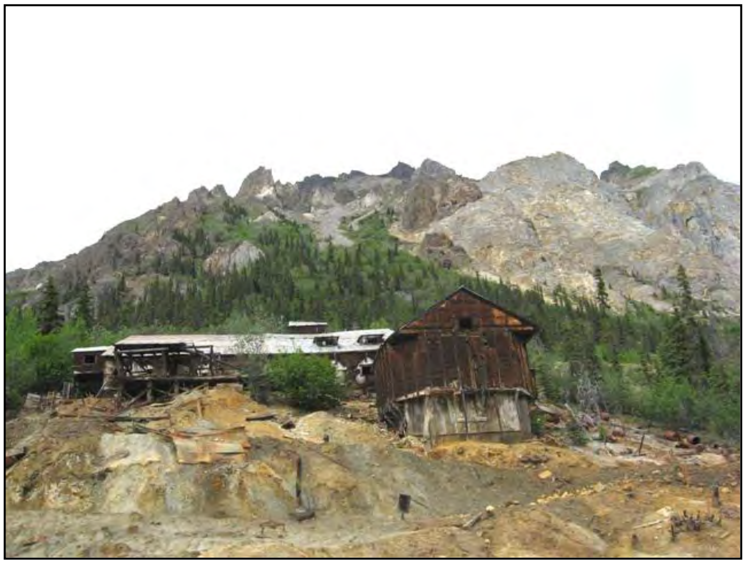
Kirk W. Stanley

Cc: Superintendent Jed Davis

Community Fact Sheet
Nabesna Mine Site

National Park Service
U.S. Department of the Interior

Wrangell-St. Elias National Park and Preserve

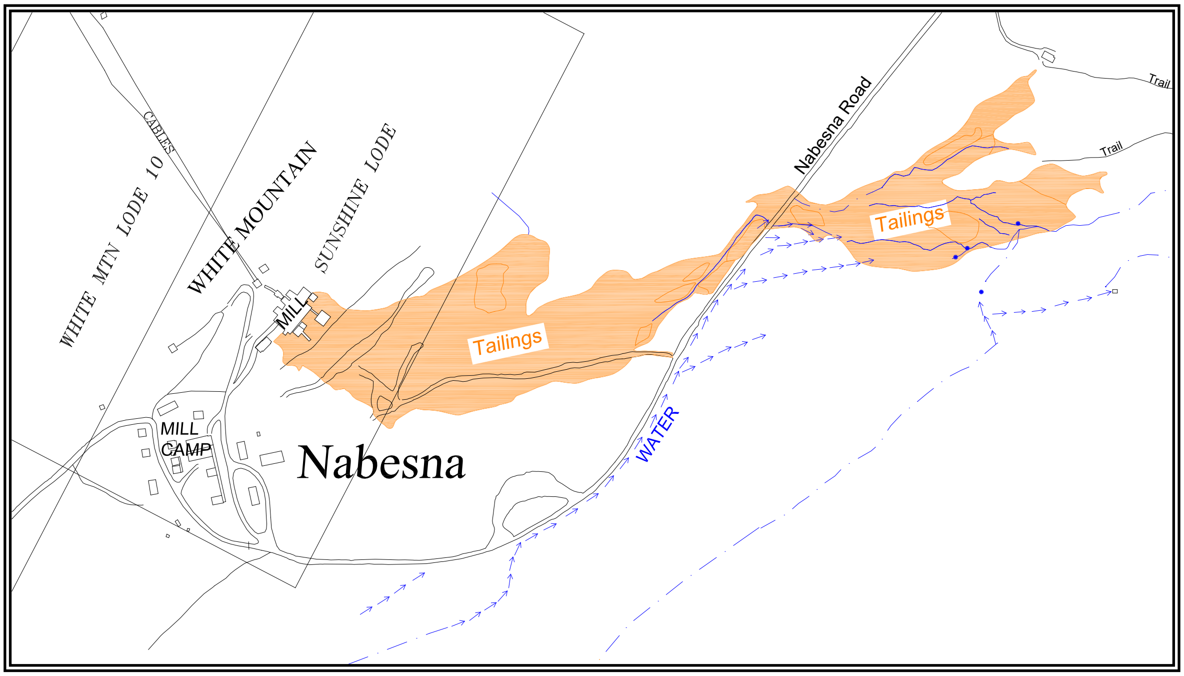


A SITE HISTORY…

Wrangell-St. Elias National Park and Preserve (WRST) encompasses nearly 13.2 million acres of land in southeastern Alaska and is part of a World Heritage Area. The Nabesna Mine and mill buildings are located within WRST on land owned by the Ptarmigan Company at the end of the 46-mile long Nabesna Road. The Nabesna Mine and mill camp includes approximately 35 historic buildings that were utilized throughout the 1930s. It is on the National Register of Historic Places. Gold mining and milling operations were conducted between 1925 and 1940; past milling processes included grinding and flotation and the use of both mercury and cyanide at different times. Finely milled pyrite (iron and sulfur) tailings left over from the ore processing are located down slope from the buildings.

AND NOW…

The mine, mill, and some of the associated mill tailings, are located on the Sunshine Lode mining claim, patented to the Nabesna Mining Corporation. The remaining tailings are situated on federal land managed by the National Park Service (NPS), on the north and south sides of Nabesna Road. The mill tailings cover approximately 9 acres, with an average thickness of approximately 1.5 feet. Currently, the mill and camp are in disrepair and the tram system used to transport ore from the mine adits is partially collapsed. The iron-rich surface of the tailings has oxidized and appears as a bright orange and grey packed crust. In general, the tailings do not support vegetation, are acidic, and contain heavy metals such as lead, cadmium, nickel, and arsenic (a metalloid).



ENVIRONMENTAL INVESTIGATIONS…

Environmental investigations at the Site have been undertaken previously to define the area covered by tailings and to determine the risks the tailings may pose to human health and the environment. Samples indicate that there are concentrations of metals in the tailings which are above regulatory standards. These metals may have washed and leached into Cabin Creek during periods of high water flow, such as spring runoff. Compounds of potential concern in the tailings and surface soils include arsenic, cadmium, chromium, mercury, nickel, and lead. Sediments in Cabin Creek contain elevated levels of silver, arsenic, cadmium, and lead. Metals also have been found to be mobilized to Cabin Creek with surface water runoff during the wet season, with some metals remaining in surface water through the dry season. Subsequent to these investigations, the NPS constructed ditches along the southern side of the tailings that redirect surface water flow away from the tailings.

The NPS has initiated an Engineering Evaluation/Cost Analysis (EE/CA) to determine the full nature and extent of contamination at the Site pursuant to the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA). As part of the EE/CA, previously collected data and new data collected in the 2009 field season will be used to conduct ecological and human health risk assessments to identify potential risks posed by Site contaminants. The EE/CA also will evaluate the need for cleanup action and the effectiveness, feasibility, and cost of a range of cleanup alternatives. Additional information necessary for removal action design will be identified in the EE/CA Report, which will include an outline of design information needs. A cleanup action, if deemed necessary, will be selected as part of the EE/CA process.

COMMUNITY INVOLVEMENT…

The public and local community will have the opportunity to review and comment on the Nabesna EE/CA Report, including the preferred cleanup alternative. The EE/CA Report is expected to be available for public review by spring 2010. The administrative record file, which contains all of the documents upon which the selection of cleanup action will be based, has been established and is available for public review at the following two locations:

National Park Service
Alaska Regional Office
240 West 5th Avenue
Anchorage, Alaska 99501
Contact: Linda Stromquist
Phone: (907) 644-3576
Mon.-Fri. 9:00 a.m. – 5:00 p.m.

National Park Service
1050 Walnut Street, Suite 220
Boulder, Colorado 80302
Contact: Gregory Nottingham
Phone: (303) 415-1483
Mon.-Fri. 9:00 a.m. – 4:00 p.m.

FOR MORE INFORMATION…

If you have questions concerning the Nabesna Mine EE/CA, please contact Greg Nottingham at (303) 415-1483 or Danny Rosenkrans at Park Headquarters in Copper Center (907) 822-7240.

March 3, 1849

United States Department of the Interior
NATIONAL PARK SERVICE

Wrangell-St. Elias National Park & Preserve
Mile 106.8 Richardson Hwy. P.O. Box 439
Copper Center, AK 99573-0439
907 822 5234 Fax 907 822 7216

L3023 (WRST-AD)

June 10, 2009

Mr. Kirk Stanley
Ptarmigan Company
P.O. Box 200956
Anchorage, AK 99502-0956

Dear Mr. Stanley:

As you know, the National Park Service (NPS) is in the process of evaluating potential cleanup actions for the Nabesna Mine Site (Site). Additional data is needed to fully characterize the Site and NPS would like to collect that data this field season. This correspondence is intended to let you know about the upcoming activities at the Site and to solicit your continued cooperation in this effort.

Our contractor, The Johnson Company, plans to arrive at the Site on or around August 7 to meet with my staff, Danny Rosenkrans, and receive Site orientation and safety information. Site investigation activities are expected to take place between August 11 and September 6, 2009. These activities will include the installation of several ground water wells, as well as soil, tailings, sediment, and surface water sampling.

In preparation for this field work, our drilling subcontractor, Denali Drilling, will visit the Site with Danny on June 12 to evaluate Site conditions and plan for the August field work.

For your reference, enclosed are two Community Fact Sheets that provide additional information on Site activities. We greatly appreciate your willingness to provide NPS and its contractor's access to your property as we take this important step toward resolution of contaminant concerns at the Site. If you have any questions or concerns, please contact me at 907-822-7202 or Danny Rosenkrans at 907-822-7240.

Sincerely,

Meg Jensen

Meg Jensen
Superintendent

Enclosures

Cc: G. Nottingham
L. Stromquist
Nabesna District Ranger

2009 Field Investigation Community Fact Sheet
Nabesna Mine Site

National Park Service
U.S. Department of the Interior

Wrangell-St. Elias National Park
and Preserve

This fact sheet is a supplement to the May 2009 Community Fact Sheet for the Nabesna Mine Site, describing Site conditions and the Engineering Evaluation/Cost Analysis (EE/CA) process underway at the Site.

SUMMER 2009

During the month of August 2009, the National Park Service (NPS) will be completing an environmental investigation of the Nabesna Mine Site (Site) at the end of the Nabesna Road in Wrangell-St. Elias National Park and Preserve (WRST). The field work will be led by NPS contractor, The Johnson Company, who will be performing environmental drilling and sampling from approximately **August 10 to September 6, 2009**. Although most of the work will focus on the tailings piles located on either side of Nabesna Road, NPS also will be accessing creeks and streams to the north and south of the tailings. The investigation will include drilling soil borings and installing groundwater monitoring wells on and near the tailings, collecting groundwater samples, sampling surface water and sediment from Cabin Creek and Jack Creek, and collecting soil samples. This investigation is needed to fill data gaps and update Site information to permit the full characterization of the Site consistent with applicable laws and regulations. The data will be used to identify Site contaminants, determine pathways of contaminant migration, evaluate human and ecological risk, and analyze an array of potential cleanup alternatives. The resulting information will be presented for public review and comment in an EE/CA Report expected to be completed by spring 2010. This will be a significant milestone in the process of addressing human health and environmental concerns at the Site.

The investigation will involve the use of two track-mounted drill rigs. These rigs are expected to make one trip each way along Nabesna Road and spend the remaining time at the Site. Trucks and all-terrain vehicles also will be used to transport equipment and workers to and from the Site each day.

The Nabesna area of WRST and Nabesna Road will **not** be closed to traffic or visitors during this investigation. Residents and visitors, however, are asked to take extra precautions for their safety and the safety of the sampling crew. Please drive carefully between Devil's Mountain Lodge and the Nabesna Mine Site since the crew will use this road often. It is recommended that a safety zone of 25 feet be maintained around any working drill rig. Drums should not be opened or otherwise disturbed at the Site because they could contain contaminated material from the drilling and sampling activities. If you are hunting in the area, be aware that a sampling crew may be moving within a mile radius of the Site through brush or trees by foot or on off-road vehicles. If you see or know of any dangerous conditions or potentially threatening animal activity, please advise a member of the sampling team or a WRST Ranger immediately.

FOR MORE INFORMATION

If you have questions concerning the field work or any aspect of the Nabesna Mine Site EE/CA, please contact Greg Nottingham at (303) 415-1483 or Danny Rosenkrans at Park Headquarters in Copper Center (907) 822-7240.

June 2009

United States Department of the Interior
NATIONAL PARK SERVICE
Wrangell-St. Elias National Park/Preserve
Mile 106.8 Richardson Hwy. P.O. Box 439
Copper Center, AK 99573-0439
907 822 5234 Fax 907 822 7216

L3023 (T10-114_Lands)

July 1, 2009

Dear Alaskan:

The National Park Service (NPS) at Wrangell-St. Elias National Park and Preserve is undertaking studies in the Nabesna Mine area to document and assess current environmental conditions associated with past mining. Our records indicate that you live near, recreate, engage in subsistence, hunt or potentially would have an interest in our proposed activities which are planned for this summer. Copies of two fact sheets pertaining to the Nabesna Mine are enclosed. We anticipate that there will additional mailings in the future. If you have any questions regarding the NPS activities at the Nabesna Mine after reading the fact sheets, please contact me or the Land Manager, Danny Rosenkrans at 907-822-5234.

Sincerely

Superintendent
Meg Jensen

Enclosures

Cc: AKRO_Stromquist

Nabesna Mine Site

Community Fact Sheet

National Park Service

February 2010 Update

This fact sheet is an update of recent activities related to the Engineering Evaluation/Cost Analysis (EE/CA) process underway at the Nabesna Mine Site.

SUPPLEMENTAL SITE INVESTIGATION

In August 2009, the National Park Service (NPS) undertook environmental sampling of the Nabesna Mine Site (Site), located at the end of the Nabesna Road in Wrangell-St. Elias National Park and Preserve (WRST). This Supplemental Site Investigation (SSI) was conducted to address data gaps and update existing Site information for characterization of the Site, to facilitate the evaluation of human and ecological risks at the Site, and to support the development and evaluation of Site cleanup alternatives.

The following activities were conducted as components of the 2009 SSI. Additional groundwater data were acquired to fully assess environmental contamination and transport mechanisms. These data were collected through the installation and sampling of eight monitoring wells. In the process of drilling the monitoring wells, soil borings were taken. These boreholes provided information regarding the relationship between subsurface geology and permafrost on groundwater and surface water. The SSI included sampling of surface water and sediment at 23 locations. The Site is located in an area with naturally occurring metal-rich soils. Hence it required a thorough examination of the background characteristics of soil, sediment, and surface water in order to establish Site-specific background concentrations for consideration in the selection of Site cleanup goals. A delineation of the tailings was completed through visual observations and field screening of metals in surface soils at approximately 230 locations.

This information will be used in the assessment of site conditions, risk to human health and ecological receptors, regulatory compliance, and cleanup alternatives. The results will be incorporated into an EE/CA Report that will be made available to the public upon completion (anticipated to be fall 2010 or later).

FOR MORE INFORMATION

If you have questions concerning the field work or any aspect of the Nabesna Mine Site EE/CA, please contact Greg Nottingham at (303) 415-1483 or Danny Rosenkrans at Park Headquarters in Copper Center (907) 822-7240.

INDEX FOR ADMINISTRATIVE RECORD

Nabesna Mine Site
March 2021

Document: AR000001 AR000081 Date: 1995 09 26
Title: Site Inspection Report for the Nabesna Mine, Nabesna, Alaska, CERCLIS ID No. AK0000333021
Document Type: Report
Authors: URS Consultants, Inc
Author Affiliation: EPA Region 10 Contractor

Document: AR000082 AR000090 Date: 2004 04 28
Title: Ptarmigan Co. Notice Letter and Information Request 2004 04 28
Document Type: 104(e) information request
Authors: Marcia Blaszak
Author Affiliation: Regional Director, National Park Service Alaska Regional Office
Addressees: Kirk W. Stanley
Addressee Affiliation: Landowner, private portion of Nabesna site

---

Document: AR000091 AR000092 Date: 2004 06 07
Title: Letter to Linda Stromquist from Kirk Stanley: Response to CERCLA 104(e) information request 04/28/2004
Document Type: Letter
Authors: Kirk W. Stanley
Author Affiliation: Landowner, private portion of Nabesna site
Addressees: Linda Stromquist
Addressee Affiliation: National Park Service Alaska Regional Office

---

Document: AR000093 AR000094 Date: 2005 06 22
Title: Supplemental Request for Information to Mr. Stanley 2005 06 22
Document Type: 104(e) information request
Authors: Marcia Blaszak
Author Affiliation: Regional Director, National Park Service Alaska Regional Office
Addressees: Kirk W. Stanley
Addressee Affiliation: Landowner, private portion of Nabesna site

---

Document: AR000095 AR000095 Date: 2005 08 02
Title: Letter to Marcia Blaszak from Kirk Stanley: Response to supplemental information request
Document Type: Letter
Authors: Kirk W. Stanley
Author Affiliation: Landowner, private portion of Nabesna site
Addressees: Marcia Blaszak
Addressee Affiliation: Regional Director, National Park Service Alaska Regional Office

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Document: AR000096 AR000097 Date: 2009 05
Title: Community Fact Sheet: Nabesna Mine Site
Document Type: Community Fact Sheet
Authors: Wrangell-St. Elias National Park & Preserve
Author Affiliation: Wrangell-St. Elias National Park & Preserve

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Document: AR000098 AR000098 Date: 2009 06
Title: 2009 Field Investigation Community Fact Sheet, Nabesna Mine Site
Document Type: Community Fact Sheet
Authors: Wrangell-St. Elias National Park & Preserve

Document: AR000099 AR000099 Date: 2009 06 10
Title: Letter to Kirk Stanley from Meg Jensen 2009 06 10
Document Type: Letter
Authors: Meg Jensen
Author Affiliation: Superintendent, Wrangell-St. Elias National Park and Preserve
Addressees: Kirk W. Stanley
Addressee Affiliation: Landowner, private portion of Nabesna site

---

Document: AR000100 AR000100 Date: 2009 07 01
Title: Cover Letter for May and June 2009 Nabesna Community Fact Sheets
Document Type: Cover Letter
Authors: Meg Jensen
Author Affiliation: Superintendent, Wrangell-St. Elias National Park and Preserve
Addressees: Nabesna mine interested parties mailing list

Document: AR000101 AR000485 Date: 2009 08
Title: Nabesna Mine Supplemental Site Investigation Report
Document Type: Supplemental Site Investigation
Authors: The Johnson Company
Author Affiliation: National Park Service Contractor

Document: AR000486 AR000486 Date: 2010 02
Title: Nabesna Mine Site Community Fact Sheet: February 2010 Update
Document Type: Community Fact Sheet
Authors: Wrangell-St. Elias National Park and Preserve

Document: AR000487 AR000488 Date: 2021 05
Title: Community Update: Nabesna Mine Site Administrative Record File Update
Document Type: Community Fact Sheet
Authors: Wrangell-St. Elias National Park & Preserve

Document: AR000489 AR000526 Date: 2021 05
Title: Community Involvement Plan: Nabesna Mine Site, Wrangell-St. Elias National Park and Preserve, Alaska
Document Type: Community Involvement Plan
Authors: National Park Service Environmental Compliance and Cleanup Division

NABESNA MINE

AUGUST 2009 SUPPLEMENTAL SITE INVESTIGATION REPORT

AR000102

Title: Nabesna Mine Supplemental Site Investigation Report

Site Name: Nabesna Mine Site

Site Location: WRST, Alaska

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LIST OF ATTACHED TABLES

LIST OF FIGURES

LIST OF ATTACHMENTS

5 Daily Logs

ABBREVIATIONS AND ACRONYMS

AAC Alaska Administrative Code

ADEC Alaska Department of Environmental Conservation

ADOT Alaska Department of Transportation

amsl Above Mean Sea Level

bgs Below Ground Surface

8F Degrees Fahrenheit

COC Chain of Custody

DS Discrete Sample

EE/CA Engineering Evaluation/Cost Analysis

EPA United States Environmental Protection Agency

FSP Field Sampling Plan

GPS Global Positioning System

JCO The Johnson Company, Inc.

L Liter

mg/L Milligrams per liter

mL Milliliter

µg/L Micrograms per liter

mg/kg Milligrams per kilogram

MI Multi-Increment

MS/MSD Matrix Spike/Matrix Spike Duplicate

MW Monitoring Well

NOAA National Oceanic and Atmospheric Administration

NPS National Park Service

ORP Oxidation-Reduction Potential

PE Performance Evaluation Sample

PVC Polyvinyl chloride

QAPP Quality Assurance Project Plan

RPD Relative Percent Difference

SAP Sampling and Analysis Plan

SSI Supplemental Site Investigation

SOP Standard Operating Procedure

USGS United States Geological Survey

WRST Wrangell-St. Elias National Park and Preserve

XRF X-Ray Fluorescence Analyzer

1. INTRODUCTION

The following Supplemental Site Investigation (SSI) Report details the methodology used in and results of the Supplemental Site Investigation performed by The Johnson Company, Inc. (JCO) in August 2009 at the Nabesna Mine located on the eastern slopes of White Mountain, a peak on the northeastern edge of the Wrangell Mountain Range within the Wrangell-St. Elias National Park and Preserve (WRST) at Nabesna, Alaska (the Site), as shown on Figures 1 and 2. The SSI was conducted in accordance with the Site-specific Field Sampling Plan (FSP) dated August 3, 2009, the FSP addendum dated September 2009, and the Quality Assurance Project Plan (QAPP) dated August 3, 2009, which together comprised the Sampling and Analysis Plan (SAP).

This SSI report summarizes background information on the Site, describes field investigation activities, and presents the investigation results. This SSI Report is provided as a supporting document for the Engineering Evaluation/Cost Analysis (EE/CA) Report for the Site.

2. SITE BACKGROUND

The geographic location, Site contamination history, and summary of previous investigations and previous response actions are detailed in the EE/CA Report.

2.1 GENERAL SAMPLING OBJECTIVES

Previous investigations provided a substantial amount of data, but some information necessary for removal action selection was insufficient, outdated, or absent. This information was collected through additional sampling performed during the SSI. Figure 3 presents an overview of actual sampling conducted during the SSI. The general objectives and methods of the SSI were as follows.

- Additional groundwater data were required to fully assess environmental contamination and transport mechanisms. These data were collected through the installation and sampling of eight monitoring wells (seven of which were sampled). The geologic logging of these boreholes provided information regarding the influence of geology and permafrost on groundwater and surface water migration.

- The effects of a partial response action (i.e., ditch rehabilitation completed in 2002) on surface water quality had not been evaluated. Surface water and sediment quality was assessed through sampling at 23 locations.
- The location of the Site in an area of naturally mineral-rich soil deposits required a thorough examination of the background characteristics of soil, sediment, and surface water to establish Site-specific background concentrations that could affect Site cleanup goals. In addition to the background surface water and sediment samples collected upstream of the mill, five multi-increment (MI) samples were collected from soils outside of areas impacted by mining activities to determine appropriate and representative background concentrations in soils at the Site.
- Migration of the tailings had not been evaluated since the most recent delineation of the tailings in 1998. This delineation was updated through visual observations and screening analysis of metals concentrations in surficial soils at approximately 230 locations.
- Test pits (three in the Upper Tailings and one in the Lower Tailings) for soil sampling were excavated in 2004; results indicated the possibility of downward metals leaching from the tailings, but the depth and number of metals screened were limited. In the SSI, screening and laboratory analysis for metals was performed in eleven soil borings completed below the bottom of visible tailings.
- No data were available regarding the potential effectiveness of reprocessing the tailings for gold at existing mills. Additional sampling was performed to evaluate potential recovery and waste generation issues.
- In order to accurately evaluate the possibility of creating an on-site tailings stockpile, geotechnical analysis was performed on samples from the tailings and underlying soils. Samples of the underlying soils were obtained through the completion of 10 soil borings on the Upper Tailings.

Concentrations of metals in soil, sediment, surface water, and groundwater at the Site have been compared against the more conservative (i.e., the lowest) of either the federal from deposition by Cabin Creek. In some locations, the silt deposit has been eroded by surface water flow; sands and gravels are more common in these areas. Currently, Cabin Creek is not able to flow over the Site because the Southern Historic Ditch redirects surface water away from the Site.

Two drill rigs were used at numerous locations on and outside the tailings areas for various components of the SSI, as described in later sections of this report. Layers of different soil types with depth in each boring were logged in boring logs resulting in a record of the surficial geology (i.e., all soil layers above bedrock) at each location; by spatially relating these recorded geological layers, cross-sectional views of the surficial geology were created (Figures 4 through 8). Individual boring logs are presented in Attachment 2. As shown on Figure 5, cross section A-A' is oriented approximately west-southwest to east-northeast downhill through the length of the Upper and Lower Tailings. Cross section B-B' is oriented south-southwest to north-northeast and captures all monitoring wells and geologic borings completed adjacent to the north side of Nabesna Road. Cross section C-C' is approximately perpendicular to cross section A-A' and incorporates all monitoring wells installed in the Lower Tailings, connecting to cross section B-B' at MW-J1. Cross section D-D' has an approximately south to north orientation bisecting the Upper Tailings.

Cross section A-A' has the most continuous and complete record of the surficial Site geology because it incorporates numerous borings located across both the Upper and Lower Tailings. The more prominent features of the Site surficial geology include the following points.

- A layer of silt immediately underlies the tailings and the area surrounding the tailings where borings were completed, including above apparently higher energy depositional environments of talus and fluvial sands and gravel such as those beneath southwestern portion of the Upper Tailings.
- Permafrost in silt was observed in only three borings, all outside the tailings area apparently where the upper geologic profile contained silt, as shown at boring location MW-J2 in cross section A-A', location MW-J8 in cross section B-B', and MW-J5 in

cross section C-C'. Permafrost was not detected at boring location MW-J1 northeast and outside of the tailings area on cross section C-C' presumably because there are well-drained and relatively more permeable sand and gravel deposits from the ground surface to approximately 30 feet below ground surface (bgs) and the water table is relatively deep (approximately 45 feet bgs).

- Sand and gravel underlie the silt throughout the area of investigation except downgradient of the Lower Tailings (boring location MW-J2, shown in cross section A-A'), where the upper silt unit increases in thickness to approximately 30 feet. The silt unit at this location is of greater thickness than in other investigated areas and is situated in an area of significantly lower topographic slope.
- A unit of well-sorted, fine sands underlies the sand/gravel/silt units only in the area of the Lower Tailings, apparently southeast of Nabesna Road (cross section A-A'). Where the fine sand unit was encountered in boring locations MW-J4 and MW-J2, the sands were flowing upward into the drilling casing as a result of high water pressure confined in this unit.
- In addition to the fine sand encountered only in the Lower Tailings area, a dense silty clay unit was observed beneath the fine sand, emphasizing the change in depositional environments southeast of Nabesna Road (cross section A-A').
- Three borings northwest of Nabesna Road, MW-J6, MW-J7, and MW-J8, encountered limestone bedrock, which is assumed to also underlie the silty clay in the area of the Lower Tailings, but because the thickness of the silty clay is unknown, the depth to the bedrock in the Lower Tailings area is also unknown (the presumed location is shown on the cross sections).

3. BACKGROUND SOIL SAMPLING

3.1 PURPOSE AND GENERAL APPROACH: BACKGROUND SOIL SAMPLING

To establish background soil concentrations, MI surficial soil samples were collected from five locations above or across the slope from the Site, as shown on Figure 9. The MI method was selected because it provides the most accurate representation of the soils available to an ecological receptor, is well suited to surficial soil sampling, and is likely to be the method used for cleanup verification sampling if a removal action is implemented. Although the Site is relatively remote, the Nabesna Road, former mine operations (including a tram, mill, and adits), and associated living areas have resulted in human and/or mine related impacts to the surficial soils in several directions around the Site; locations with no visible disturbance were sought as suitable background MI sampling locations. Each location encompassed a total area of approximately 0.25 acre, which is similar to the smallest home range of a typical ecological receptor (a shrew or other small burrowing mammal). Preliminary field observations and discussions of geology indicated that native soils near the ground surface in the Site area were likely to be composed of fluvial, alluvial, and talus deposits of variable thicknesses depending on proximity to the cliff face of White Mountain (as discussed above in Section 2.2, it was later determined that silt was the dominant surface soil at the Site, deposited either by water or wind). Since the surficial soil types under the tailings had the potential to vary significantly, efforts were made to collect at least one background MI sample that would be representative of each potential soil type.

The presence of a mineralized zone in the cliff face of White Mountain above the Site has created the geologic formation that was ultimately mined for gold. The mined zone above the Site is composed of massive sulfides (primarily pyrite containing gold, pyrrhotite, arsenopyrite, minor chalcopyrite, sphalerite, and galena) and surrounding skarn rock; in this case, the term “skarn” refers to a localized zone of intrusive quartz diorite and host limestone that was heavily altered through contact metamorphism at the time of the intrusion. Because this skarn rock is relatively rare in the general area, it may have a unique geochemical influence on the soils in the fall zones beneath the mine. As such, the area providing representative background sampling locations was necessarily limited to soils immediately around, but not impacted by, the Site.

3.2 LOCATIONS: BACKGROUND SOIL SAMPLES

The five targeted background soil sampling locations were host to soils likely composed of the three primary types of local bedrock specific to the area surrounding the tailings: 1) un-mineralized talus slopes largely composed of intrusive granodiorite and quartz-diorite mixed with minimal limestone scree; 2) mineralized talus slopes largely composed of skarn bedrock from the contact region of the intrusive bedrock and the host Nabesna limestone; and, 3) fluvial deposits from channels of Cabin Creek that consist of organic material, silt, and sand and gravel from the extensive Wrangell Lava cap bedrock that overlies the Nabesna Limestone and from other rock types present on the hillside. Soil presumed to be primarily influenced by deposition of the widespread limestone of the Nabesna River valley (such as the region north of the mine adits) was not sampled as a representative background soil because both local topography and soil boring samples showed little indication of limestone-only deposition in the area beneath and surrounding the tailings.

The locations of the five MI sample areas, as surveyed with a global positioning system (GPS) hand-held unit with sub-meter accuracy, are shown on Figure 9. MI sample locations SS-J1 and SS-J2 were located west of, and at a higher elevation than, the Upper Tailings. These areas were within the first of the target zones identified above (un-mineralized talus slopes). SS-J1 was located downslope from primarily intrusive quartz-diorite outcrop with minimal influence from the limestone cliff further to the south and the mineralized contact zones to the north. SS-J2 was located on steep slopes below outcrop that exhibited a region of un-mineralized contact between intrusive quartz-diorite and altered host limestone (Photoplate 11).

MI locations SS-J3 and SS-J5 were in the second target zone identified above (mineralized talus slopes with skarn bedrock and limestone). Sample SS-J3 was collected from sandy soils at a similar elevation as the top of the Upper Tailings, whereas SS-J5 was located at a lower elevation to account for the likelihood of soil deposition from fluvial deposits mixed with more mineralized talus and alluvium. SS-J5 is considered to most accurately represent the native soil deposits under the mine tailings, including the materials from the skarn fall zone and the silt blanket deposit that underlies the tailings.

Sample location SS-J4 was within the third targeted zone (the expected historical channel paths and floodplains of Cabin Creek), but significantly upstream of creek depositional areas that could be influenced by the tailings. Soils at this location were fluvial, consisting of organic material, silt, and sand from intrusive quartz-diorite and Wrangell Lava cap bedrock.

3.3 METHODS: BACKGROUND SOIL SAMPLING

At each background location, a handheld GPS unit was used to mark four corners of an approximate 100 foot x 100 foot square (approximately 0.25 acre) sampling area (the positions of the corners are illustrated on Figure 9. Within the sampling area, an approximate 9 foot x 9 foot grid was created and a sample increment was collected from the center of each grid cell, for a total of 81 increments per sampling area. Sample increments were generally collected from the top 6 inches of soil using a stainless steel spoon or trowel in order to retrieve an approximately equal mass of soil from each location, and placed in a 3.8 liter (1 gallon) polyethylene container for transport to the laboratory. Some increments were collected after using a hand auger or trowel to remove up to 1.5 feet of organic material from the surface to expose the soil.

Sample SS-J3 was collected in triplicate by performing the sampling process three times. The SS-J3 area was first sampled on August 17, 2009. Duplicate and triplicate samples (SS-DUP and SS-TRP) were collected simultaneously on August 18, 2009, using dedicated sample equipment and containers. All sampling equipment was decontaminated between decision units. The samples were processed by TestAmerica in North Canton, Ohio, using a subsampling method and analyzed via EPA Methods 6020 and 7470A for the 14 target metals in soil.

3.4 RESULTS: BACKGROUND SOIL SAMPLING

Analytical results of the five background soil locations are provided in Table 2. All of the soil samples contained arsenic at levels above the Federal Industrial Regional Screening Level (RSL) level of 1.6 milligrams per kilogram (mg/kg); however, to account for background levels in Alaska that are typically above this level, the ADEC Level II Soil Cleanup Standard of 4.5 mg/kg has been used for comparison instead. This practice is accepted in several states, and is reasonable for Alaska as a preliminary screening level because ADEC also requires that background arsenic levels be evaluated where anthropogenic impacts are suspected (ADEC, 2008 and ADEC, 2009). Arsenic was present in four of the five samples at concentrations from 24.7 to 130 mg/kg, exceeding the ADEC soil screening level of 4.5 mg/kg. In sample SS-J4, collected from alluvium south of the Upper Tailings, the arsenic concentration (estimated at 1.3 mg/kg by the laboratory), was below the ADEC screening level. Concentrations of all other targeted metals were below PSLs in all samples. The ranges of all 14 targeted elements in soil in the background samples are summarized in Text Table 3.4.2, below.

Text Table 3.4.2 Summary of Background Soil Concentrations

Analyte	Concentration Range (mg/kg)	Location of Highest Concentration	Location of Lowest Concentration
Arsenic	1.3 – 130	SS-J5	SS-J4
Cadmium	0.21 – 1.87	SS-J3	SS-J1
Chromium	12.9 – 110.0	SS-J1	SS-J4
Cobalt	3.9 – 11.5	SS-J2	SS-J4
Copper	17.8 – 532-7	SS-J3	SS-J4
Iron	9,270 – 30,400	SS-J5	SS-J4
Lead	1.1 – 83.4	SS-J3	SS-J4
Manganese	150 – 1,280	SS-J2	SS-J4
Mercury	0.017 – 0.085	SS-J5	SS-J4
Nickel	10.0 – 50.1	SS-J1	SS-J4
Selenium	5.1 – 5.3	SS-J1	SS-J4
Silver	0.32 – 2.1	SS-J5	SS-J2
Vanadium	14.5 – 31.8	SS-J4	SS-J3
Zinc	23.1 – 363.0	SS-J2	SS-J4

Upon review of the surficial geology at the Site, which includes silt immediately beneath the tailings and north of the tailings Site, it is apparent that the alluvial sample from SS-J4 is unlikely to be similar to the natural surficial soils at the Site. Thus, there are two identified target zones remaining that could be considered to be representative of soil types at the Site: the un-mineralized talus slopes (SS-J1 and SS-J2) and mineralized talus slopes (SS-J3 and SS-J5) as described above in Section 3.2. However, the presence of silt immediately beneath the tailings indicates that a fourth target zone should be considered: one that is likely to contain silt from the same source as that at the Site. Since silt was observed at the surface in a significant majority of the borings at the Site, it is considered a blanket deposit that resulted from water or wind deposition. Extrapolating from cross section D-D’, in which silt is present across the entire width of the Upper Tailings, it is expected that sampling location SS-J5 would also have silt at the surface, since it is in an area that does not appear to be affected by stream channels and is at a similar elevation to the ground surface of the borings that comprise cross-section D-D’. In addition, SS-J5 is located within the relatively narrow fall zone of the mineralized/skarn rock, and is the location nearest to the Site tailings area. However, the sampling area was chosen specifically because it was undisturbed and did not appear to have been impacted by mining activities. Since the area is approximately 250 feet away from the closest visible tailings, not immediately downslope of the tailings, and separated from the tailings by the northern historic ditch, it is unlikely that it has been impacted by tailings. As such, SS-J5 is considered the soil sample that is most representative of background conditions at the Site.

Although the background samples were selected to include a range of soil types in the general vicinity of the tailings, it is not appropriate to average all of the MI area results for each metal to derive a representative background concentration. The MI sampling method establishes a statistically defensible "average" exposure concentration for each of the MI areas, which are based on the smallest home range of a typical ecological receptor that would be expected to be present at the Site. At this Site, the combination of erosional deposition from the skarn deposits upgradient of the tailings and the silt deposits present on the lower slopes greatly influences the metals concentrations that are naturally present at the Site. The SS-J1, SS-J2, and SS-J3 MI areas were located at elevations too high on the mountain to include the silt deposit, and the SS-J1 and SS-J2 locations are not within the fall zone of the skarn deposits. The SS-J4 surficial geology differs greatly from the geology immediately beneath the tailings because of the significant influence of erosion and deposition by Cabin Creek. The extent of the silt deposit beneath the tailings was characterized only after the investigation was complete and the boring logs were reviewed (as discussed in Section 2.2). As such, it was not possible to focus all of the MI sampling locations in areas that were considered to be more representative of soils beneath the tailings, although Figure 9 illustrates that the locations in which the three criteria for representative background (i.e., those that included silt, were within the skarn rock fall zone, and were not in areas of tailings impact) can be met are limited to a relatively narrow expanse of land that parallels the Nabesna Road to the north of the tailings, starting at the southern end with the SS-J5 sampling area.

Although the background concentration for arsenic is significantly higher than the PSL, it is considered to be representative because of the mineralized nature of the Site and the presence of Nikolai Greenstone at the Site. As Health Canada explains in their risk assessment guidance, Greenstone belts and other geologic deposits that may contain gold ore are typically high in arsenic, both in rock and naturally occurring soil at the Site (Health Canada, 2004). The Health Canada guidance states, "prospecting for mineral deposits is often accomplished by surveying soils for anomalously high arsenic levels." This type of prospecting is described in a 1983 report completed by the State of Alaska to assess the mineral potential of a proposed subdivision in an area of Fairbanks, Alaska (Clautice, 1983). The report states that arsenic and antimony are most indicative of lode gold mineralization in the Fairbanks district, and arsenic in soil samples (at a location where no mine was present), ranged from10 ppm to 149 ppm, and indicates that these values are similar to a 1982 study at Ester Dome in which arsenic in samples ranged from18 ppm to 148 ppm. Further evidence that the use of 130 ppm as a reasonable background arsenic concentration is presented in the Health Canada guidance, which explains, "[i]n Yellowknife, [Northwest Territories], the natural soil-borne levels of arsenic average approximately 150 ppm" because the city is located on a greenstone belt (Health Canada, 2004). This background concentration is reflected in the Northwest Territories' "Environmental Guideline for Contaminated Site Remediation," which states that the remediation objectives for residential and industrial soil in Yellowknife are 160 mg/kg and 340 mg/kg, respectively based on the assumption yard soil that is accessible for exposure for 5 months of the year (Mackenzie Valley Review Board, 2003).

4. DELINEATION OF TAILINGS IMPACTS

4.1 PURPOSE AND GENERAL APPROACH: DELINEATION OF TAILINGS IMPACTS

The most recent effort to delineate the areal extent of tailings was performed by NPS in the late 1990s, following an earlier depth and metals assay survey between 1979 and 1981 (WGM, 1981). Since that time, tailings may have been transported through erosion to the ground surface or to surface water sediments beyond previously mapped areas. In addition, sampling conducted during the excavation of test pits by NPS in 2004 indicated that metals may have leached downward from the tailings.

4.1.1 PURPOSE AND GENERAL APPROACH: AREAL EXTENT OF TAILINGS IMPACTS

Surficial and subsurface sampling was conducted during the SSI to update the characterization of the areal and vertical extent of tailings impact. On the ground surface, the tailings were first delineated visually, by mapping the boundary of the unvegetated tailings area with a GPS unit with sub-meter accuracy. After completing this visual delineation, surficial soils on all sides of the tailings were screened for metals in north-south transects with a portable Innov-X Alpha X-ray fluorescence (XRF) metals analyzer to evaluate the extent of tailings-impacted soil. Use of the XRF to screen metals concentrations in soil allowed for screening of a large number of samples rapidly, which also allowed the length and spacing of the transects to be determined in an adaptive manner. The XRF operates on the principle that X-rays emitted when electrons change their configuration are characteristic of a given element. Calibration curves within the instrument allow it to calculate element concentrations from relative intensities of the X-rays. At some locations, duplicate samples were submitted for laboratory confirmation analysis to verify the reliability of the field screening results.

4.1.2 PURPOSE AND GENERAL APPROACH: VERTICAL EXTENT OF TAILINGS IMPACTS

Subsurface sampling to determine the extent of metals leaching was performed in 11 borings located throughout the Upper and Lower Tailings (Figure 10). In each boring, samples were collected at approximate 1-foot intervals to an approximate depth of 5 feet below the visible bottom of the tailings. Sample intervals were selected in the field in order to evaluate whether metals concentrations are influenced by soil type as well as depth.

4.2 SAMPLING LOCATIONS: DELINEATION OF TAILINGS IMPACTS

4.2.1 SAMPLE LOCATIONS: AREAL EXTENT OF TAILINGS IMPACTS

Surficial soils were analyzed at 232 locations along 20 transects, which were positioned 75 to 200 feet apart across the visible tailings area, oriented approximately north-south (Figures 11a and b, and 12a and b). XRF screening analysis for the 14 targeted metals in soil (Tables 1a and 1b) was performed at 6 to 19 locations along each transect, beginning inside the visible edge of the tailings and proceeding outwards until a boundary of the tailings-impacted soil was observed, based on visual observations and iron, arsenic, and lead concentrations. In general, transects were split on the north and south sides to not include visible tailings, which were already known to be impacted by metals. All sample locations were recorded with a sub-meter accurate GPS.

In addition to the samples collected along the transects, surficial samples were collected throughout the course of the investigation at locations where soils having the appearance of tailings were observed; locations of these additional samples were above the mill building (TRAM, Figures 11a and 11b), in between the Upper and Lower Tailings (DS-113 through 117, Figures 12a and 12b), and adjacent to Cabin Creek downstream of the tailings (BANK, Figures 12a and 12b).

4.2.2 SAMPLE LOCATIONS: VERTICAL EXTENT OF TAILINGS IMPACTS

The vertical extent of tailings impact in soils beneath the tailings was evaluated through subsurface sampling performed in 11 soil borings (Figure 10). Metals XRF screening was performed on samples from eight borings (SB-J5, J6, J8, J9, J11, J12, J15, and J17) completed in the Upper Tailings and three borings (MW-J3, MW-J4-D, and SB-J2) located in the Lower Tailings. Boring locations were selected for adequate spatial coverage in addition to geotechnical sampling or monitoring well installation.

Soil samples from certain borings were selected for XRF screening analysis after the completion of all soil borings. XRF screening was performed on soil samples from borings where a clear visual base of the tailings could be observed, where the tailings did not appear to have been moved since their initial deposition (e.g., during construction of the switchbacks across the Upper Tailings), and where recovery in the split spoons was acceptable.

4.3 METHODS: XRF SCREENING

The successful delineation of the extensive horizontal and vertical area of the tailings relied primarily on the XRF screening. The recommended drying and sieving procedures described in EPA Method 6200 for XRF analysis were followed to ensure that samples were adequately homogenized and, therefore, the subsamples analyzed by the XRF and the laboratory would have a similar composition. At locations where a sample was collected for processing, approximately 120 mL of soil was removed and placed in a Ziploc bag for transport to a field laboratory located at Devil’s Mountain Lodge, approximately 3 miles from the Site. Since the outside weather conditions were slightly above freezing with high humidity, and the remoteness of the Site did not allow for a field laboratory to be set up in a temperature-controlled facility with a constant electricity supply, the processed XRF and corresponding laboratory confirmation samples were dried in a toaster oven set at 150 degrees (the lowest setting, which minimized the loss of mercury to the extent possible). The processing step involved breaking the dried samples apart with a mortar and pestle, sieving them with a No. 20 screen (the screen size was chosen because it is typically used for sediments, which were also processed and analyzed in a separate part of the investigation for sediment analysis), and retaining the passing fraction for analysis (the coarse fraction was discarded). The samples that were processed in this manner and screened using the XRF were called "processed XRF" samples. Following processing of a small percentage of the planned number of screening samples, it became clear that drying and sieving all screening samples would significantly limit the number of samples analyzed because the generator that powered the toaster oven could not be operated for as many hours as would be necessary to dry all of the samples. Since the purpose of this portion of the investigation was to fully delineate the extents of the tailings, it was imperative to screen as many samples as possible while in the field. Therefore, a field study was conducted between August 19 and 21, 2009, to evaluate the difference between using the XRF to screen processed soils versus analyzing soils in-situ at the Site. In-situ screening was conducted by removing the layer of duff or other organics off the ground surface, then pressing the XRF to the soil without further disturbance and recording the field result. Concentrations of both lead and arsenic in processed XRF samples were greater than the results of the in-situ XRF samples by a median factor of 1.5. This difference was judged to be acceptable given the Site conditions. The decision was made to screen the majority of samples in-situ, allowing an immediate decision regarding the length of the transect, in conjunction with collection and processing of approximately 10 percent of these samples for additional XRF screening at the field laboratory at Devil's Mountain Lodge (i.e., the "processed samples").

Half of all processed samples (corresponding to 1 out of every 20 surficial sample locations) were transferred to a 60 mL plastic jar and submitted TestAmerica in North Canton, Ohio for confirmatory analysis of the 14 target metals in soil (arsenic, cadmium, chromium, cobalt, copper, iron, lead, manganese, mercury, nickel, selenium, silver, vanadium, and zinc) by EPA Methods 6020 and 7471 (mercury). All of the confirmation samples sent to the laboratory were subsampled from processed XRF samples (i.e., the dried and sieved fraction of the original sample).

4.3.1 METHODS: AREAL EXTENT OF TAILINGS IMPACTS

At each location, soil was generally accessed by scraping vegetation from the ground surface using a trowel. For in-situ screening samples, the XRF analyzer was then placed directly on the ground in contact with the soil, and a reading was performed for 2 minutes. At some locations, recent overflow of the Southern Historic Ditch and Cabin Creek had deposited several inches of grey sand over a large area. At these locations, a trowel or hand auger was used to remove the recently deposited sand, and material in the layer below was analyzed. At locations where a thick layer of organic material was present, a hand auger was used to expose soil beneath the organic layer for analysis.

4.3.2 METHODS: VERTICAL EXTENT OF TAILINGS IMPACTS

Continuous cores of soil in each boring were collected from the ground surface until a minimum depth of 5 feet below the visible bottom of the tailings using a 2-foot split spoon sampler (tailings were typically less than 2 feet thick, although at some locations in the Upper Tailings, they were mixed with soil to deeper depths). After the soil types in each split spoon were logged, the contents of the spoon were divided into individual plastic bags, with a separate bag for each soil type indentified in the spoon. Following review of the boring logs, one bag of soil from each 1-foot depth interval was selected for XRF screening, resulting in five to six samples per boring, with a range of soil types represented, although a greater percentage of fine-grained soils were selected to evaluate their ability to retain or retard migration of metals through sorption or lower permeability.

One out of every five processed samples was transferred into a 60 mL plastic jar and submitted TestAmerica in North Canton, Ohio, for confirmatory analysis of the 14 target metals in soil (arsenic, cadmium, chromium, cobalt, copper, iron, lead, manganese, mercury, nickel, selenium, silver, vanadium, and zinc) using EPA Methods 6020 and 7471 (mercury).

4.4 RESULTS: DELINEATION OF TAILINGS IMPACTS

4.4.1 RESULTS: AREAL EXTENT OF TAILINGS IMPACTS

Laboratory and XRF screening results from the 234 surficial soil samples are presented in Tables 1a and 1b. In general, the only target metals/metalloids that appeared to be consistently elevated compared to background (SS-J5) concentrations were iron, lead, and arsenic. Although some metals were detected above ADEC screening levels in soil samples, areas of visible tailings contained consistently elevated iron, lead, and arsenic levels. Iron concentrations were reported between 885 mg/kg and over 100,000 mg/kg (the maximum calibration range of the instrument). Because iron concentrations in the tailings regularly exceeded the maximum calibration range of the XRF, lead and arsenic were chosen as target elements to delineate the migration of tailings impacts. XRF arsenic screening concentrations ranged from less than 3 mg/kg in organic soils to approximately 3,900 mg/kg in soil adjacent to the visible tailings. Lead concentrations ranged from less than 4 mg/kg in organic soils adjacent to the tailings to approximately 4,400 mg/kg within the visible tailings. Results from in-situ XRF screening analysis of lead are shown on Figure 11a and 11b and arsenic are shown on Figures 12a and 12b for the Upper and Lower Tailings, respectively. The areal extent of visibly-impacted soils (i.e., where tailings were observed mixed with soils either at the surface or immediately beneath the surface) is shown on Figures 11a and b and 12a and b.

The use of visual observations to delineate the areal extent of tailings was chosen after comparing these observations with areas delineated by arsenic and lead concentrations above the levels in the most representative background sample (SS-J5, with an estimated arsenic concentration of 130 mg/kg and a lead concentration of 68 mg/kg). In general, these three methods provided similar results. The concentration of arsenic from the MI soil sample at location SS-J5 was chosen to define arsenic impacts because using the ADEC screening level for arsenic of 4.5 mg/kg for comparison resulted in nearly all of the sampling locations, including all but one background location, considered “impacted”, which is an unreasonable conclusion that does not account for naturally-occurring concentrations.

In the Upper Tailings, the north-south migration of the tailings has largely been controlled by the Site topography and the Northern and Southern Historic Ditches. The ground surface rises at the southern edge of the Upper Tailings, and few concentrations of lead above the ADEC screening level or arsenic above the background level (assumed to be the concentration at SS-J5) were observed beyond the southern visible edge of the Upper Tailings. No visible tailings were observed inside the Southern Historic Ditch. North of the Upper Tailings, tailings were observed within the Northern Historic Ditch, and concentrations of lead and arsenic above background levels were observed in ditch excavation spoil (locations DS-064, DS-079, and DS-104) and sample locations as far as 100 feet north of this ditch (DS-083).

Soil screening results and visual observations showed no indication of northerly tailings migration beyond the visible northern edge of the Lower Tailings. However, shallow soils having the appearance of tailings were observed along the westernmost transect through the Lower Tailings, from the visible edge of the surficial tailings until the Southern Historic Ditch (i.e., in samples DS-121 to DS-128). Additional transects completed further to the east showed apparent tailings deposits in shallow soil extending only partway to the Southern Historic Ditch, and no visual evidence of tailings was found in the ditch.

At the eastern end of the Lower Tailings, the trails created by game, all-terrain vehicles, and, possibly, the drill rig used to install MW-2 in 1998, have permitted the migration of a thin veneer of tailings in numerous long, narrow fingers. Based on the lack of visible tailings beyond the easternmost transect and the observation that the arsenic and lead concentrations declined considerably over the approximately 200 feet between the easternmost and next nearest transects, the extent of the Lower Tailings is considered to have been fully delineated. This does not preclude the possibility of small, localized, or covered deposits, but these are likely to be extremely small with respect to the area of tailings that has been delineated.

During the SSI, small, isolated deposits of tailings were discovered by visual observation and XRF soil screening. Results of the five samples collected from the vegetated area between the Upper and Lower Tailings (samples DS-113 to DS-117; see Figures 12a and b) indicate that tailings may be present but covered with vegetation in the area between the Upper Tailings and Lower Tailings. In the vicinity of these samples, the ground surface was uneven and appeared to have been redistributed by heavy machinery. The soils analyzed in this area did not have the orange color distinctive of tailings, but the homogeneous appearance of these soils distinguished them from other nearby native soils. In addition, mineralized waste rock may have been deposited beneath the tram lines extending up White Mountain from the mill building. One soil sample having the appearance of tailings was collected beneath the tram line approximately 400 feet northwest of the mill building (TRAM, see Figures 11a and 11b). XRF screening of this sample showed lead and arsenic concentrations at more than ten times the background levels (1,783 mg/kg lead and 1,853 mg/kg arsenic). In addition, lead and arsenic were detected at 2,774 mg/kg and 1,989 mg/kg, respectively, in a sample (BANK) collected approximately 1 mile east of the Lower Tailings near SW-J23 (see Figures 12a and 12b). These results are in agreement with those previously reported by the USGS (sample 6NA025), which sampled this isolated tailings deposit in 1999.

4.4.2 RESULTS: VERTICAL EXTENT OF TAILINGS IMPACTS

Results from the XRF screening of subsurface soils are presented in Table 4. Lead and arsenic results from the XRF screening analysis are depicted on Figure 10 and on individual boring logs in Attachment 2. Among the list of targeted metals (arsenic, cadmium, chromium, cobalt, copper, iron, lead, manganese, mercury, nickel, selenium, silver, vanadium, and zinc), only lead, arsenic, and copper were found to exceed ADEC soil screening levels at any locations. Furthermore, copper was limited to one exceedance, in sample SB-J8 (6.6-7.3’). Therefore, as with the areal tailings delineation, focus is given to lead and arsenic in assessing the extent of leaching beneath the tailings.

In general, lead concentrations in soils beneath the tailings were below ADEC screening levels. Where detected, lead concentrations did not follow a trend indicative of transport by leaching (i.e., no significant decline in concentration was observed with depth), nor was there a discernable pattern to the areal distribution of lead concentrations, except that levels were highest in silty soils below the southern portions of the Upper Tailings. The only location where lead concentrations were above ADEC soil screening levels immediately below the tailings was at SB-J5, between 1 and 3 feet bgs, but it appears that tailings have been mixed into soils to a depth of approximately 4 feet bgs at this location. Therefore, lead does not appear to have significantly leached from the tailings into underlying soil.

At some locations (e.g., SB-J9, MW-J4, and SB-J2; see Figure 9), there was a trend of decreasing arsenic with depth; however, this was not the case at all locations. Additionally, arsenic concentrations remained relatively high (above 50 mg/kg) in some lower depths, such as at SB-J8, where the arsenic levels showed little decrease between 7 and 12 feet bgs or MW-J3, where concentrations were highest at 5 to 6 feet bgs. In all samples collected, the arsenic concentration or detection limit was significantly greater than the ADEC screening criterion of 4.5 mg/kg, which again suggests that the use of the background arsenic result is appropriate for delineating tailings impacts. In general, arsenic concentrations were higher in silty layers relative to layers composed of sand or gravel. In the Upper Tailings, a total of eight soil borings were completed, and of these, arsenic concentrations immediately beneath the tailings were below the background level of 130 mg/kg at three locations. At the remaining five borings beneath the Upper Tailings, the arsenic concentrations declined to less than 130 mg/kg within 1.8 feet below the bottom of tailings. Among all borings on the Upper Tailings, the average depth of impact as delineated through a comparison to the background concentration of 130 mg/kg was 0.8 foot. In the Lower Tailings, a total of three soil borings were completed, and in one of these the arsenic concentration immediately beneath the tailings was below 130 mg/kg. In the other two borings, the arsenic concentrations declined to below 130 ppm between 1.8 and 1.9 feet. On average, the depth of tailings impacts to the soil beneath the Lower Tailings is estimated at 1.2 feet.

5. GROUNDWATER INVESTIGATION

5.1 PURPOSE AND GENERAL APPROACH: GROUNDWATER INVESTIGATION

5.1.1 PURPOSE AND GENERAL APPROACH: MONITORING WELLS

In order to determine the extent of dissolved metals transport in groundwater beneath the tailings, monitoring wells (including one shallow and deep monitoring well couplet) were installed at seven locations on or adjacent to the tailings. Where permafrost was encountered, the soils collected above the permafrost were inspected for signs of water that would indicate a perched water table and a potential need for a well both above and below the permafrost.

However, the presence of substantial water above the permafrost was not observed. Instead, all wells were installed with screens that crossed or were immediately below the apparent water table to collect samples of the groundwater nearest the tailings, except at one location (MW-J4) where a deep well was coupled with a water-table well to evaluate potential impacts to deeper groundwater beneath a possible confining layer of silt.

5.2 LOCATIONS: GROUNDWATER INVESTIGATION

5.2.1 LOCATIONS: MONITORING WELLS

All monitoring well locations are shown on Figure 13 and the total well depths with respect to the surficial geology are depicted in Figures 5 through 8. Well locations were selected to create two transects perpendicular to the presumed direction of groundwater flow (to the east). A part of each transect was located on the Upper or Lower Tailings to evaluate potential impacts from surface water infiltration through the tailings. The eastern transect (locations MW-J3 through J5) approximately bisected the Lower Tailings from north to south. At the MW-J4 location, the top of the screen at the “D” (deep) well was installed approximately 18 feet below the bottom of the screen at the co-located “S” (shallow) well, which was screened at the water table.

The western transect (locations MW-J6 through J8) was located near the base of the Upper Tailings. The water table at MW-J7 was not crossed during drilling; instead, dry, gray limestone was encountered from 35 feet to 44 feet bgs. MW-J7 was completed with a monitoring well to confirm the absence of the water table above bedrock at this location. MW-J6, drilled after and located uphill from MW-J7, was abandoned and filled with bentonite grout after drilling through dry overburden followed by dry, gray limestone from 47.5 to 52.5 feet bgs.

An additional well, MW-J2, was installed downgradient of the Lower Tailings to evaluate groundwater impacts at an increased distance from the tailings. A background well, (MW-J1) was installed along the Nabesna Road at a location presumed to be unimpacted by tailings; its location was also influenced by ease of access from the Nabesna Road.

5.3 SAMPLING AND ANALYTICAL PROCEDURES: GROUNDWATER INVESTIGATION

5.3.1 SAMPLING AND ANALYTICAL PROCEDURES: WELL INSTALLATION

Well installation occurred over a 13-day period between August 11 and August 23, 2009. All borings were drilled by Denali Drilling of Anchorage, Alaska, using an air-rotary track-mounted rig or a hollow-stem auger track-mounted rig (see Photoplates 1 and 2 in Attachment 1). The air rotary method incorporated a 4.5-inch outer diameter casing that was advanced slightly behind an underreamer bit, which expanded to a 5-inch outside diameter when the drill rod was rotated clockwise beneath the casing. Cuttings were blown via compressed air up the inside of the casing and were contained in a drum using a diverter and hose or, alternatively, were shoveled from the ground into drums. Soil samples for observation were collected by removing the underreamer bit, lowering a 2-foot long, 3-inch diameter split-spoon sampler to the bottom of the boring and hammering it into the soil with repeated 30-inch drops of a 340-lb hammer attached to a pulley rope. The hollow stem auger method is described in Section 8.1.3.

Continuous soil sampling was conducted for the first 25 feet of each boring, then every 5 feet thereafter. Once the soil sample was collected, the split spoon was lifted to the surface and opened to allow for stratigraphic logging, soil and rock sample collection, inspection for the presence and thickness (or absence) of permafrost, evaluation of the potential for and location of perched groundwater on top of the permafrost, and observation of the approximate location of the water table. All field notes were documented on field logs, which were used to create the final boring logs provided in Attachment 2. The wells were completed by installing 2-inch inner diameter, pre-packed, 0.010-inch slotted polyvinyl chloride (PVC) well screens of 10-foot lengths attached to PVC riser that extended above the ground surface. Screens were set from approximately 5 to 15 feet below the water table, as drilling conditions permitted, to ensure sufficient water would be present for sampling in all seasons. A sand pack was installed to at least 2 feet above the top of the screen and a bentonite clay plug was installed to at least 1 foot above the top of the sand. Bentonite slurry or additional bentonite chips were then added to extend the plug to ground surface. Additional bentonite grout or chips were periodically added to the annular space as the grout settled below ground surface. Pea gravel was then placed at ground surface around the PVC riser and over the grout. A locking well cap was installed on the PVC riser; a copy of the accompanying key is located at the WRST headquarters.

All downhole drilling equipment was decontaminated on-site using a pressure washer after each boring was completed. Each well was developed within one week of installation using a downhole submersible pump. Development was typically initialized at a high discharge rate with periodic surging actions, followed by more consistent pumping at a lower rate until discharge water was observed to be clear. However, if the formation permeability was too low to allow a high discharge rate (e.g., MW-J3), the well was developed at a lower rate.

5.3.2 SAMPLING AND ANALYTICAL PROCEDURES: WATER LEVEL MONITORING

A survey was performed by Phillips Surveying on August 25, 2009. Phillips Surveying surveyed the top of casing elevations of all new monitoring wells and the ground surface of all soil borings using a level and a rod for elevation and a sub-meter GPS for location. The elevation datum was derived using the National Oceanic and Atmospheric (NOAA) GPS online positioning user status process. For ease of interpretation between groundwater elevations and ground contours, the surveyed ground elevations were adjusted to match the contour map provided by NPS (there was a consistent difference between the surveyed elevations and the mapped contours of approximately 25 feet). On August 26, 2009 and August 30, 2009, the depth to groundwater in all eight monitoring wells was gauged using an electronic water-level tape.

5.3.3 SAMPLING AND ANALYTICAL PROCEDURES: MONITORING WELL SAMPLING

On August 22, August 26, August 27, and August 29, 2009, the seven wells that contained water (MW-J1, MW-J2, MW-J3, MW-J4-D, MW-J4-S, MW-J5, and MW-J8) were sampled using slow purge sampling techniques, except at MW-J1 where low flow rate could not be achieved. However, parameters were monitored and sampling occurred at MW-J1 after parameter stabilization. Monitoring well MW-J7 and the previously installed monitoring well MW-3 did not contain enough water to develop or sample; MW-3 appeared to be obstructed by ice beginning 10 feet below the top of casing and the boring at MW-J7 did not cross the water table before encountering dry bedrock. Sampling was conducted on the following days.

- August 22: MW-J2 was initially sampled immediately after development because it was uncertain whether the water column would freeze after rising into the 30-foot layer of permafrost.
- August 26: MW-J1, MW-J8, and MW-J5
- August 27: MW-J4D was sampled and MW-J2 was re-sampled because the water column had not frozen and a longer time period between drilling and development was preferred (both MW-J2 samples were analyzed).
- August 29: MW-J4S and MW-J3

At each well, purge water was monitored for temperature, pH, oxidation-reduction potential (ORP), dissolved oxygen, and specific conductance using a YSI multi-parameter instrument equipped with an enclosed flow-through cell. Turbidity was analyzed using a HACH 2100P turbidimeter. Groundwater samples were collected after these parameters stabilized with less than 10 percent change between sequential readings recorded over a period of at least ten minutes.

All groundwater samples were placed in coolers that were sent via two-day delivery under chain of custody protocol to TestAmerica for analysis. Groundwater samples were analyzed for the following constituents: arsenic, barium, cadmium, chromium, copper, iron, lead, nickel, selenium, silver, vanadium, and zinc by EPA Method 6020, and mercury by EPA Method 7470A. The samples were preserved with nitric acid during collection. As planned, the samples were not chilled when collected or shipped because this step was technically impracticable and would not appreciably affect the quality of the samples since the preserved metals would not degrade or volatilize under typical ambient temperatures.

Water necessary for decontamination, grout mixing, and drilling at MW-J2 only, was pumped from Skookum Creek near its crossing with the Nabesna Road and placed in polyethylene tanks for transport to the Site. Two samples were collected from these polyethylene tanks (WT-1 and WT-2) on August 17, 2009 analyzed for the same list of metals as for groundwater samples. In addition, surface water sample SW-J10 was collected on August 15, 2009 from Skookum Creek at the approximate location of water withdrawal.

5.4 RESULTS: GROUNDWATER INVESTIGATION

5.4.1 RESULTS: HYDRAULIC GRADIENTS AND GROUNDWATER FLOW DIRECTION

Groundwater elevations calculated from water-level data collected on August 26, 2009, and August 30, 2009 are provided in Table 6. A map of the August 30, 2009 data (the set of data collected after all development and sampling) is provided in Figure 14

The Site and regional area topographic slope direction to the northeast and the flow direction of the local creeks and regional rivers provide sufficient information to estimate a groundwater gradient direction to the northeast (shown in Figure 14). The water-level data collected from the monitoring wells show a similar pattern; however, a consistent northeast gradient could not be mapped between all monitoring wells. Significantly lower water levels were measured at locations MW-J1 and MW-J2 relative to monitoring wells installed within the tailings area, resulting in apparent gradient directions to the north and east relative to higher water levels in the center of the Lower Tailings at MW-J5, MW-J4, MW-J3, and near the Upper Tailings at MW-J8. These higher water levels could be influenced by perched groundwater or permafrost, while the relatively lower water levels at MW-J1 and MW-J2 may reflect the actual water table within the upgradient limestone bedrock. Regardless, the water-level elevations between upgradient and downgradient wells do not follow an entirely consistent and predictable pattern, which may indicate the wells are monitoring significantly different hydrogeologic units (e.g., an upper perched aquifer versus a water table aquifer from the upgradient limestone bedrock).

Vertical hydraulic gradient directions could be determined at the only well couplet, MW-J4-S and MW-J4-D. In this well couplet, groundwater gradient was upward between the lower and upper aquifers as evidenced by a higher potentiometric head in the deep well than in the shallow well. This gradient indicates that dissolved contaminants, if present, would be less likely to migrate downward in this area.

5.4.2 RESULTS: GROUNDWATER ANALYSIS

All metals sampling results for the monitoring wells are presented in Table 7. No metal concentrations exceeded the ADEC groundwater screening levels. The only couplet of wells at the Site, MW-J4-S and MW-J4-D, shows increased concentrations of arsenic, copper, iron, nickel, vanadium, and zinc with increased depth, and decreased concentration of lead with increased depth.

6. SURFACE WATER AND SEDIMENT ASSESSMENT

6.1 PURPOSE AND GENERAL APPROACH: SURFACE WATER AND SEDIMENT ASSESSMENT

The impact of mine tailings on surface water at the Site has been investigated previously by URS (1995), USGS (1999), and NPS (2004), during both the wet season and the dry season. Sample results indicated that, under some conditions, surface water at the Site is impacted by aluminum, cadmium, copper, iron, and zinc. However, relatively little background surface water quality data is available. Since the studies conducted by URS (1995) and USGS (1999), ditches around the tailings have been rehabilitated and constructed in an effort to divert surface water flow away from the tailings. Sampling conducted during the SSI was intended to increase the body of data documenting background surface water quality, and evaluate the impact of the ditching on surface water quality. Although August had been identified as a wet season, little rainfall during the three weeks of investigation, coupled with reportedly no rain in June and July, effectively resulted in these samples being considered “dry season” samples.

In addition, the reported locations of stream channels have varied between the previous investigations conducted at the Site, highlighting the dynamic nature of surface water flow at the Site. The stream channels of Cabin Creek were mapped during this investigation in order to determine how current flow patterns compare to those documented in the past.

6.2 LOCATIONS: SURFACE WATER AND SEDIMENT ASSESSMENT

Twenty-six locations for surface water sampling were proposed in the Field Sampling Plan, based on the review of Site maps, aerial photographs, and documentation of previous surface water sampling conducted at the Site. Because the investigation was performed during a relatively dry period, the streams were dry at some of the locations chosen for sampling. Of the was analyzed using a HACH 2100P turbidimeter. Field duplicates were collected at three sample locations by filling a second bottle from the same filter vessel. At two locations, an additional 500 mL of sample was sent to the lab to permit a matrix spike/matrix spike duplicate analysis. Following the completion of surface water sampling, an equipment blank was collected by filling the filter vessel with distilled water and pumping it through a disposable filter into a sample container.

6.3.3 SAMPLING AND ANALYTICAL PROCEDURES: SEDIMENT SAMPLING

At each surface water sampling location, a sediment sample was collected by scooping a volume of approximately 200 mL of sample into a plastic bag. Following completion of the sediment sampling, the bagged samples were brought to the field laboratory for XRF metals screening analysis. All samples were processed according to the procedures for soil samples detailed in Section 4.3 to obtain the most accurate results possible.

After screening the 23 processed samples with the XRF, 6 processed samples were submitted to the laboratory for confirmation analysis. Confirmation samples were selected to include three upstream and three downstream samples, with five samples having high screening concentrations and one sample having low screening concentrations.

An equipment blank was collected after the completion of sediment sampling by pouring distilled water over the sampling trowel into a sample container.

6.4 RESULTS: SURFACE WATER AND SEDIMENT ASSESSMENT

6.4.1 RESULTS: STREAM CHANNEL MAPPING

Stream channels mapped during the SSI are plotted on Figure 15. Mapping of the stream channels revealed a complex flow pattern that likely has strong seasonal and long-term variability. The upper reach of Cabin Creek, from SW-J2 to SW-J7, is a rocky channel with an approximate width of 50 to 100 feet; the channel bed contained rocks up to several feet in diameter. Flow in the channel occupied only a narrow portion (2 to 5 feet) of the total channel width, and in much of the upper reach no surface water flow was observed: on August 9, 2009, water was observed to be flowing from SW-J2 (the farthest upstream extent of mapping) until a point approximately 1,800 feet downstream, where the flow migrated below the ground surface.

A small portion of this flow re-emerged at a point approximately 1,300 feet further downstream and flowed for approximately 200 feet prior to submerging again. No flow was observed on this date between this point and SW-J7. Several showers occurred between this date and August 15, 2009, when this reach of the creek was revisited. On August 15, continuous flow between SW-J2 and SW-J7 was observed.

No water was observed between SW-J7 and a point approximately 300 feet south of the eastern edge of the Lower Tailings, where water from nearby seeps flows into the Cabin Creek channel. Below SW-J7, the Cabin Creek streambed becomes more vegetated; it appeared that during periods of flow water would disperse into numerous smaller channels up to approximately 3 feet wide.

Between the eastern end of the Lower Tailings and sample location SW-J29 (approximately 1 mile to the east) is a large and relatively flat area with numerous seeps. Many stream channels were observed in this area, several of which emerged from seeps and extended for only a few hundred feet before infiltrating into the ground. As reported by the USGS (1999), three relatively well-established channels are present in this area, indicated on Figure 15 as the Main Branch, North Branch, and South Branch of Cabin Creek. In these three channels, continuous surface flow was observed only in the Main Branch. Vegetative growth patterns suggest that the layout of these channels may change during large events. For example, dry channels were observed with characteristic streambank vegetation such as willows and alders, but more recently developed flow channels without this type of vegetation were also present. Because the topography in this area is relatively flat, disturbances such as all-terrain vehicle use can result in the diversion of flow from established channels.

The North Branch of Cabin Creek was observed to begin at a series of seeps a short distance (approximately 50 feet) north of the Main Branch near SW-J30. The channel remained distinct until entering a wetland area with several interconnected ponds approximately 500 feet downstream of SW-J19. At the eastern edge of this wetland area, a distinct channel was mapped from the base of a beaver dam to its confluence with the Main Branch of Cabin Creek near SW-J21.

The South Branch of Cabin Creek was more poorly defined than the North Branch or the Main Branch. The channel appeared to originate about 500 feet south of the Main Branch, where several seeps were observed to discharge into a well-defined channel with banks approximately 10 feet high. Water flowed through this channel until spreading out into a wetland approximately 1,000 feet downstream of SW-J18. This wetland appeared to discharge into a small channel (approximately 1 foot wide) that joined the Main Branch of Cabin Creek near SW-J29.

Below SW-J29, Cabin Creek enters a V-shaped valley that allows for little horizontal migration of the stream channel. Flow was observed to increase significantly after SW-J22, below the confluence with a large tributary reported to drain the Rambler Mine area (USGS, 1999). Below this confluence, the grain size of stream sediments is markedly larger than upstream, and it is likely that the higher flow rates in this portion of the channel would largely prevent deposition of fine-grained tailings that may be transported by Cabin Creek.

6.4.2 RESULTS: SURFACE WATER AND SEEP SAMPLING

The field-measured parameters for surface water are summarized in Table 8. In general, the pH of Cabin Creek was found to be slightly basic, especially in the samples collected from the concentrated channel downstream of SW-J22. Measurements of pH collected during the SSI showed no discernable impact to Cabin Creek by acidic runoff during the SSI. Specific conductance was higher in surface water samples collected from below the tailings than in samples collected above the tailings.

Complete analytical results of the surface water sampling are provided in Table 8. Exceedences of screening levels are summarized on Figure 16. Background samples collected at eight locations indicate a range of surface water quality. The highest concentrations of targeted metals were found at springs located above the mill buildings (locations SW-J6 and SW-J31). SW-J6, which had been sampled previously by the USGS, contained high concentrations of all metals, except vanadium, relative to other background samples. Aluminum was detected in this sample at 229 ug/L, above the ADEC screening level of 87 ug/L. Metals concentrations in SW-J31 were also high relative to other background samples, but no screening levels were exceeded. The surface water from each of these seeps traveled overland for a short distance in the direction of Cabin Creek before submerging below ground, so no direct connection between the seeps and Cabin Creek was observed during the SSI.

Metal concentrations in the background Cabin Creek samples (SW-J2, SW-J3, and SW-J7) were generally low. Higher concentrations of metals were observed in background samples collected from other streams, suggesting that the surficial geology at each area has an effect on the water quality. These samples from intermediate reaches of other streams may be most representative of a background concentration in the intermediate reaches of Cabin Creek.

Results of downstream sampling indicated a minimal impact to surface water quality, constrained to approximately 500 feet downstream of the tailings, with the exception of iron, which was elevated at locations up to 0.3 mile below the eastern edge of the Lower Tailings. Cadmium was found to exceed ADEC screening levels in the three samples closest to the Lower Tailings (SW-J32, SW-J13, and SW-J14). Cadmium was also detected in SW-J20, an additional 1,900 feet downstream of SW-J14, but at a concentration below its ADEC screening level. Iron was found to exceed screening levels at three locations downstream of the tailings: SW-J19, SW-J30, and SW-J28. Stream sediments in these three locations were observed to have a rust-orange color, indicating the likely presence of iron bacteria. Concentrations of iron in these samples ranged from 1,150 ug/L to 1,970 ug/L, comparable to the iron concentrations observed in groundwater.

6.4.3 RESULTS: SEDIMENT SAMPLING

Complete laboratory and XRF screening results of the sediment sampling are provided in Table 9. Exceedences of sediment screening levels are summarized on Figure 17. Samples collected from Cabin Creek upstream of the mill building (SE-J2, SE-J3, and SE-J7) contained generally low metals concentrations, with no exceedances of sediment screening levels for the list of targeted analytes. Concentrations of copper determined by the XRF were only slightly below screening levels in SE-J3, and exceeded screening levels in SE-J2 (although the laboratory result was less than the screening level).

Sediment samples from background locations in other streams contained generally low metals concentrations, comparable to those reported in the Cabin Creek background samples. Like those samples, copper concentrations determined by XRF analysis were just below the screening level. Additionally, the arsenic concentration in SE-J23 from a creek reported to drain the Rambler Mine Area (USGS, 1999) was 16 mg/kg, in excess of the screening level.

Elevated concentrations of several targeted metals were found in sediment samples collected below two springs above the mill building (SE-J6 and SE-J31). Sample SE-J6 contained arsenic, cadmium, copper, nickel, and zinc at concentrations significantly above sediment screening levels; the concentration of copper exceeded the screening level by a factor of nineteen. Concentrations of arsenic in samples SE-J6 and SE-J31 exceeded the screening level of 5.9 mg/kg, with 33.9 mg/kg in SE-J36 and 46.2 mg/kg in SE-J31. Although these samples were collected beneath flowing water, they do not likely represent material transported by surface flow, and may be considered more representative of background soils than background sediments.

Downstream of the tailings, lead was detected above its screening level of 35 mg/kg in the three sediment samples closest to the tailings (SE-J32, SE-J13, and SE-J14). Among these samples, the highest laboratory-measured lead concentration was 114 mg/kg in SE-J32. Cadmium was detected above its screening level in the two sediment samples collected closest to the tailings (SE-J32 and SE-J13). No cadmium was detected in sediments downstream of this point; however, the high detection limits achieved with the XRF inhibited the ability to screen for this metal at concentrations near the screening level.

Arsenic was detected above its screening level of 5.9 mg/kg in all Cabin Creek samples downstream of the tailings, with the exceptions of SE-J20 and SE-J30, located in the Main Branch of the creek. In general, arsenic concentrations decreased with greater distance downstream; however, the samples with the most elevated concentrations of arsenic (SE-J19 and SE-J29) were on the spring-fed North Branch and South Branch of Cabin Creek, approximately 0.3 mile and 1.5 miles, respectively, from the tailings.

Zinc was detected above its screening level of 123 mg/kg in five locations, including the three locations closest to the tailings (SE-J32, SE-J13, and SE-J14). The most elevated concentration of zinc was from SE-J6, located above the mill building; however, as discussed above, this sample may not be representative of background sediments. In laboratory-analyzed samples where zinc exceeded the screening level, concentrations were relatively close to the screening level (156 mg/kg and 145 mg/kg in SE-J13 and SE-J32, respectively). The zinc concentration determined by the XRF in SE-J14 was more elevated, at 394 mg/kg. This may reflect the generally high bias of the XRF relative to the laboratory.

Sediment samples collected from SE-J22 and SE-J23 did not exhibit elevated concentrations of lead or arsenic. However, the stream bank in the vicinity of these two locations appeared to be composed of mill tailings, and a sample of this bank (BANK) analyzed with the XRF showed concentrations reflective of tailings (approximately 2,000 mg/kg arsenic and 2,700 mg/kg in duplicate samples), as discussed in Section. In addition, a sample collected in the middle portion of the South Branch by the USGS was reported to have an appearance and composition characteristic of tailings (USGS, 1999), but this deposit was not observed during the SSI.

Metals concentrations were not elevated in the samples from SE-J24, taken at the mouth of Cabin Creek, or SE-J26, collected from a point just downstream from its confluence with Jack Creek.

7. ANALYSIS: NATURE AND EXTENT OF CONTAMINATION

7.1 ANALYSIS: BACKGROUND SOIL CONCENTRATIONS

Results of the background soil sampling indicate naturally-occurring elevated concentrations of arsenic in soils collected above the mill building and cross-gradient of the tailings. In these soils, arsenic concentrations ranged from 24.7 to 130 mg/kg. The arsenic concentration was found to be low (1.3 mg/kg) in the alluvium south of the Upper Tailings. Because the soils beneath the tailings represent the contributions of talus and alluvium, this range of background concentrations is representative of the range that would be expected to be mutually-occurring beneath the tailings.

7.2 ANALYSIS: BACKGROUND SURFACE WATER CONCENTRATIONS

Although August is considered to be relatively wet, based on the low rainfall amounts in the summer of 2009, the sampling appears to have occurred during a dry season. Results of background surface water sampling showed no targeted metals to be present above ADEC screening levels at the six stream locations tested. More elevated concentrations of some metals were detected in samples from SW-J6 (the aluminum concentration was particularly high in this sample) and SW-J31, located at seeps above the mill building. These seep samples may or may not be representative of surface water quality upgradient of the Site, but they do indicate the potential of naturally-occurring metals in groundwater to impact surface water in areas of widespread groundwater discharge, such as the area below the Lower Tailings. It is possible that these seeps include water from mine shafts or mineralized fractures in the upgradient bedrock.

7.3 ANALYSIS: BACKGROUND SEDIMENT CONCENTRATIONS

Results of sediment sampling upstream of the mill building indicate generally low metals concentrations, with no exceedances of sediment screening levels for the targeted metals. Copper concentrations were elevated and were only slightly below the screening levels. Metals concentrations were comparable in the three samples collected from other streams, although arsenic was found to exceed the screening level in SE-J23, collected from a tributary to Cabin Creek. Results from SE-J6 and SE-J31, which were collected from sediment beneath spring discharges above the mill, should be disregarded as potential background concentrations because they are likely to be more representative of surface soils than sediments. It is unlikely that the soil beneath these springs is used by any receptors that would typically live in freshwater sediments.

7.4 ANALYSIS: EXTENT OF TAILINGS AND IMPACTED SOIL

The visible extent of the continuous tailings deposits have changed little since the most recent delineation by NPS in the late 1990s. Chemical data collected during this SSI indicate that tailings have migrated to or were initially deposited over an area that is substantially larger than is visible but has since become vegetated. In addition, chemical data confirm that tailings have migrated east of the visible end of the Lower Tailings, likely as a result of transport by surface water over continually changing depressions caused by animal and ATV use.

Among the background samples collected in this SSI, the SS-J5 sample was judged most representative of the soils at the Site. The arsenic concentration from this sample (estimated at 130 mg/kg) and the ADEC screening level for lead (400 mg/kg), in combination with visual observations of orange- or grey-stained soil, were used to differentiate native soil from tailings-impacted soil. Generally, the extent of tailings-impacted soil north and south of the Upper Tailings was bounded by topography immediately beyond visible edge of the tailings to the south and by topography immediately beyond the historic drainage ditch to the north. Conversely, local topography appears to have controlled northerly migration of the Lower Tailings, with no evidence of tailings impact found beyond the northern edge of the visible tailings. South of the visible Lower Tailings, tailings and impacted soil extended in some cases to the recently rehabilitated Southern Historic Ditch, up to approximately 200 feet south of the visible edge of the tailings. Easterly migration of the Lower Tailings appears to be confined to long, narrow fingers that follow small depressions such as those left by game trails. These fingers were found to extend up to 200 feet beyond the main body of the Lower Tailings, beyond which point no visible tailings were observed.

In addition, limited sampling conducted between the Upper and Lower Tailings indicates that tailings or soil significantly impacted by tailings may extend continuously between the two bodies of tailings, mixed in or covered by disturbed soil.

Sampling conducted in soil borings advanced beneath the tailings indicated that only lead, arsenic, and copper are found in soil at concentrations exceeding ADEC screening levels (copper exceeded ADEC standards in 1 of 55 samples analyzed). Lead exceeded screening levels in only three samples, and concentration profiles with depth do not indicate leaching of lead from the tailings (i.e., concentration was not observed to decrease with depth). However, arsenic appears to have leached beneath the tailings to varying depths beneath each deposit. The average depth of arsenic impacted soil was estimated at 0.8 feet beneath the bottom of the Upper Tailings and 1.2 feet beneath the bottom of the Lower Tailings.

7.5 ANALYSIS: IMPACTS TO GROUNDWATER

None of the groundwater samples contained concentrations of any analyzed metals that exceeded ADEC screening levels, and there do not appear to be any discernable impacts to groundwater from the tailings.

7.6 ANALYSIS: IMPACTS TO SURFACE WATER AND SEDIMENT

Investigation results showed surface water impacts from the tailings to be minimal, with only iron and cadmium detected above ADEC standards in the reaches below the tailings. The elevated concentrations of cadmium are indicative of tailings impact, but exceedances of ADEC standards were confined to the outflow of seeps located along the Lower Tailings, and the reach of Cabin Creek within approximately 1,000 feet of the Lower Tailings. The pH of Cabin Creek was slightly basic in all downstream samples, indicating a lack of impacts due to acidic runoff at the time of the SSI.

Impacts to sediments from the tailings appear to be confined to approximately 1,000 feet downstream of the Lower Tailings, based on elevated concentrations of arsenic, copper, lead, and zinc. Although arsenic and copper concentrations continued to be elevated in multiple samples collected from all branches of Cabin Creek until its confluence with Jack Creek, there is no discernable trend of decreasing concentrations with distance and, given the generally high arsenic concentrations in surrounding soils, there is insufficient evidence that would implicate the tailings as the sole source of elevated arsenic. It is notable, however, that isolated deposits of tailings have been observed on the streambanks well downstream of the tailings, including one deposit that was observed and sampled in 2009 (“Bank”; no other deposits were observed in 2009, although others have been noted previously).

8. CHARACTERIZATION TO SUPPORT POTENTIAL RESPONSE ACTIONS

8.1 GEOTECHNICAL SAMPLING

8.1.1 PURPOSE AND GENERAL APPROACH: GEOTECHNICAL SAMPLING

Previous to the Johnson Company SSI, the soils on the eastern part of the Upper Tailings had been characterized by three soil borings completed in 1998 (B-1, located on the southern side of the Southern Historic Ditch near the approximate middle of the Upper Tailings; and MW-2 and 4, shown on Figure 13). This general area was preliminarily identified as a potential location for on-site consolidation, which could be among the array of potential alternatives considered in the EE/CA Report. To determine design parameters for such a consolidated tailings pile, the characterization of the soils beneath the potential tailings consolidation area was refined with additional soil borings through the Upper Tailings. At some of these locations, undisturbed samples were collected to determine the compressive and shear strength of the cohesive silt. Tailings samples were also collected and analyzed for geotechnical parameters that could dictate the height and sidewall slopes of a consolidated pile.

8.1.2 LOCATIONS: GEOTECHNICAL SAMPLES

Locations of the ten soil borings used for geotechnical sampling are shown in Figure 18. These geotechnical borings were situated on the Upper Tailings, with SB-J4, J5, J12, and J15 dispersed across the western portion of the Upper Tailings, and SB-J10, J11, J13, J14, J16, and J17 more closely concentrated in the eastern portion, which appeared to be a more suitable consolidation area based on the gentler ground slope. Undisturbed samples of cohesive soils were collected from SB-J6 (2 to 4 feet), SB-J10 (1 to 3 feet), SB-J15 (0 to 3 feet), and SB-J16 (2 to 4 feet). Locations of the 20 surficial tailings samples (Tail-MW-J3 and J4, Tail-SB-J2 through J17, and Tail-19 and 20) are shown on Figure 19. Surficial tailings samples were collected from both the Upper and Lower Tailings in order to assess if and how the properties vary.

8.1.3 METHODS: GEOTECHNICAL SOIL BORINGS

All soil borings were drilled using a track-mounted hollow stem auger rig. The hollow stem auger method operated by rotating a 4.25 inch inside diameter/8 inch outside diameter spiral drilling rod (the hollow stem auger) attached to a pilot auger bit. Soil cuttings generated during drilling were brought to the surface via the auger flights and shoveled into drums. A 2-foot long, 3-inch diameter split-spoon sampler was placed inside the hollow center of the augers and hammered into the soil with a hydraulic 30-inch-drop, 340 pound hammer. The number of hammer blows required to drive the split spoon every 6-inch interval was recorded on the field boring logs.

8.1.4 SAMPLING AND ANALYTICAL PROCEDURES: GEOTECHNICAL SOIL SAMPLING

Disturbed soil samples were collected continuously by driving the 2-foot split spoon from ground surface to a maximum depth of 20 feet below ground surface. Soils retrieved in the split spoon samplers were logged and then retained in Ziploc bags, with a separate bag for each type of soil identified in each spoon. Following review of the boring logs, samples of selected soils were submitted for grain size analysis (ASTM D422 with hydrometer analysis to determine the percentage of fine materials). Between two and four samples were collected per boring, creating a total of 29 grain size samples.

Co-located borings were drilled at four locations (adjacent to SB-J6, J10, J15, and J16) and 3-inch diameter, 3-foot long Shelby tubes were used to collect undisturbed samples of the shallow silt layer between 0 and 4 feet below ground surface. The Shelby tubes were capped on both ends and remained upright during transport to the laboratory. Undisturbed samples were analyzed for grain size by ASTM Method D422, uniaxial compression via ASTM Method D2435, and specific gravity using ASTM Method D854. Permeability testing was not requested because the samples were dry. All geotechnical soil samples were delivered on August 31, 2009, by The Johnson Company to DOWL HKM Alaska Testlab of Anchorage, Alaska, for analysis.

8.1.5 SAMPLING AND ANALYTICAL PROCEDURES: TAILINGS SAMPLES FOR GEOTECHNICAL ANALYSIS

On August 20, 2009, a total of 20 tailings samples were collected from 0 to 1.5 feet bgs and placed in dedicated 5-gallon buckets. Denali Drilling transported the samples to DOWL HKM Alaska Testlab of Anchorage, Alaska on August 21, 2009. Tailings samples were analyzed for grain size according to ASTM D422. Based on the grain size analysis, three samples (one tailings sample and two composited soil samples containing a mixture of silt, sand, and gravel) were then selected to undergo testing for maximum density using native moisture content via a modified 1-Point Proctor test. Sufficient tailings volume was available to perform additional analysis on the tailings samples, since a large volume of sample had been submitted for each location. However, the laboratory reported that after performing the grain size testing on the soil samples (submitted in smaller volumes because they were collected from the split spoons) the silts had been washed out of the samples (the presence of silts was known from earlier stratigraphic logging). The decision was made to add a percentage of fines from the additional tailings samples to the washed sand and gravel from the soil samples (based on the original grain size results) to effectively recreate two representative composited samples.

8.1.6 RESULTS: GEOTECHNICAL SAMPLING

The geotechnical sampling results are summarized in Table 5. The grain size analysis of the tailings indicated that the composition of the tailings is relatively uniform, with all samples characterized as silty sand or sandy silt (Engineering Classification ML). The soil types from the soil borings ranged from silty sand to gravel with silt and sand. All soil samples contained at least some fraction of silt. In general, the grain size classifications verified the classifications made in the field, and the surficial geology is illustrated on the cross sections in Figures 5 through 8.

8.2 TAILINGS REPROCESSING SAMPLES

8.2.1 PURPOSE AND GENERAL APPROACH: TAILINGS REPROCESSING SAMPLES

In order to evaluate the potential for reprocessing the tailings, seven samples were collected on August 12, 2009. Samples were analyzed for metals, cyanide bottle roll, acid-base accounting, ore characterization, and meteoric water mobility. These analyses provide data relevant to the efficacy of processing the tailings at an existing gold extraction mill.

8.2.2 LOCATIONS: TAILINGS REPROCESSING SAMPLES

Tailings reprocessing samples were collected by compositing approximately 75 pounds of tailings surrounding each of the seven locations (W841 through W847) selected at the Upper and Lower Tailings, as shown on Figure 20**.**

8.2.3 SAMPLING AND ANALYTICAL PROCEDURES: TAILINGS REPROCESSING SAMPLES

A potential reprocessor conducted all of the sampling and prepared all samples as necessary for analysis. The Johnson Company personnel were on-Site during sampling. Samples were submitted to ACZ Laboratories for the following analyses: 1) meteoric water mobility tests for 33 metals, which expresses leaching potential under natural weather conditions; 2) acid generation potential, which compares the sulfur content of the material, which can generate sulfuric acid when the parent minerals are oxidized, with the neutralizing potential of other minerals present; and 3) sulfur forms, including pyritic and sulfate. Samples were submitted to Alaska Assay Laboratories for the following analyses: 1) metallic screening for gold; 2) LECO analysis, which measures the percent carbon and percent sulfur in a sample; and 3) total metals concentrations for 40 metals. The potential reprocessor conducted the following analysis at its laboratory: 1) bottle roll test, which measures the consumption of lime and cyanide during recovery of gold from a sample.

8.2.4 RESULTS: TAILINGS REPROCESSING SAMPLES

The raw laboratory data is summarized in Table 3. In general, the average gold assay values were slightly lower than the values reported in the WGM 1981 study, but the results preliminarily indicate that the tailings can be reprocessed and the gold recovered. The tailings have a high potential to generate acid runoff, with little buffering capacity. The recovery process would require a relatively high amount of lime and cyanide reagents, limiting the number of mills for which the Nabesna tailings might be suitable.

9. FIELD OPERATIONS

9.1 SITE RECONNAISSANCE, PREPARATION, AND RESTORATION PROCEDURES

Representatives of Denali Drilling and NPS WRST staff walked the Site on June 16, 2009, to discuss proposed drilling locations and drum storage areas. Alaska Digline was contacted regarding buried utilities in the area, and the Site was cleared by the only utility service in the area, Copper Valley Telephone, on July 24, 2009. On July 24, 2009, NPS requested the services of an archeologist to provide monitoring during all soil-disturbing field work to minimize impacts to historical artifacts at the Site, and Northern Land Use Research, Inc. (NLUR) was subcontracted for this purpose. Representatives of JCO and NPS walked the Site on August 8, 2009, to discuss proposed drilling locations, clearing necessary for drum storage and equipment access, and general procedures for operating within the Park. Drilling locations and access routes were planned to minimize the disturbance of the tailings, clearing of vegetation, and visual impact. These locations and access routes were further refined after a representative of NLUR met with the Cultural Resource Specialist at WRST headquarters on August 11, 2009, to discuss specific tasks for the Site. A letter report prepared by NLUR documenting their observations during the investigation is included as Attachment 3. No significant disturbances to historical artifacts resulted from the SSI activities.

Following completion of the field work, an effort was made to return each work area or sampling location to its original condition. With the exception of flagging used to indicate surface water monitoring points and multi-increment sample locations, all flagging was removed from the Site prior to demobilization. All garbage was removed from the Site, and all drums containing waste soils were moved to the designated drum storage area. Drums containing purge water and decontamination water were left in-place pending analytical results to determine disposal. Following receipt of the analytical results, which showed that the water contained in the drums had only naturally-occurring concentrations of metals and was well below regulatory standards, the water was slowly discharged to the ground surface (away from the tailings) before ambient temperatures fell below freezing to avoid any uncontrolled releases that could occur if the drums froze.

9.2 BOREHOLE ABANDONMENT

All boreholes intended for geophysical or environmental sampling (i.e. sampling locations with prefixes SB) were abandoned in place by one of two methods. Boreholes SB-J4, SB-J5, SB-J6, SB-J7, SB-J10, and SB-J12 were filled from bottom to top using a tremie pipe and grout pump containing a bentonite slurry composed of bentonite powder and drilling water from Skookum Creek. If settling of grout occurred, sufficient amounts of bentonite chips and drilling water were added to fill the hole to ground surface. Boreholes SB-J2, SB-J8, SB-J9, SB-J11, and SB-J13 through SB-J17 were filled with bentonite chips hydrated in-situ with drilling water. Additionally, borehole MW-J6, which was intended as a monitoring well location, was abandoned after drilling to bedrock without encountering groundwater. MW-J6 was abandoned in place by filling it from bottom to top with a bentonite slurry via a tremie pipe grout pump.

9.3 SURVEYING

The location of all monitoring wells was determined by a certified land surveyor, Phillips Surveying, and provided in reference to the Alaska State Plane system. The elevations of all monitoring wells at the water level measuring point were included in the survey, as were the ground surface elevations of all soil boring locations. The elevation datum was derived using the National Oceanic and Atmospheric (NOAA) GPS online positioning user status process. For ease of interpretation between groundwater elevations and ground contours, the surveyed ground elevations were adjusted to match the contour map provided by NPS (there was a consistent difference between the surveyed elevations and the mapped contours of approximately 25 feet). A GPS survey was conducted by The Johnson Company of all of surface water, sediment, background soil, and tailings delineation sampling locations using a GPS with submeter accuracy. All observed channels of Cabin Creek within approximately 1.5 miles of the tailings were mapped using a handheld GPS accurate to approximately 10-20 feet.

9.4 EQUIPMENT DECONTAMINATION

All equipment that directly or indirectly contacted samples was decontaminated before and after use with a pressure washer or, in the case of the auger flights, with a wire brush and water. Equipment included casing, drill bits, auger flights, split spoons, and instruments. Dedicated tubing was used in each well. For sampling and smaller drilling devices, a mixture of potable water and Alconox was used to wash the equipment, followed by a rinse with deionized water.

9.5 FIELD WORK DOCUMENTATION

Standardized sampling forms were used whenever possible to document sampler installations, soil logging, and sample collection. A daily log was completed each day that work occurred at the Site. These logs are provided in Attachment 5.

10. QUALITY CONTROL

10.1 QUALITY CONTROL FOR FIELD SCREENED SAMPLES

This section presents an evaluation of quality control (QC) procedures applied to the analysis of soil and groundwater samples collected during the August 2009 SSI field program. The data quality review was performed using the Data Quality Objectives (DQOs) outlined in the

QAPP and the U.S Environmental Protection Agency (EPA) Contract Laboratory Program National Functional Guidelines for Inorganic Data Review (October, 2004) for guidance. The results of the QC review are summarized below and in the referenced tables.

10.1.1 PROCESSED AND UNPROCESSED IN-SITU SCREENING SAMPLES

Soil samples for XRF screening collected between August 12 and 28, 2009, were homogenized, dried, pulverized, and sieved in a field laboratory before being analyzed using the XRF. As described in Section 4.3, the processing step had the potential to prevent the full delineation of the tailings extents, and a field study was performed to determine the difference between analytical results for unprocessed in-situ soil samples and soil samples that were processed at the field laboratory. Thirteen samples from the Upper Tailings and 10 samples from the Lower Tailings were included in the field study conducted concurrently with the delineation activities. Concentrations of both lead and arsenic in processed XRF samples exceeded the results in the in-situ XRF samples by a median factor of 1.5. This difference was judged acceptable given Site conditions.

10.1.2 LABORATORY CONFIRMATION OF SCREENING SAMPLES

The accuracy of XRF results is evaluated by comparing results of laboratory and processed XRF samples. The RPD between laboratory results and processed XRF screening results for the surficial soil samples are summarized in Tables 1a and 1b, for subsurface samples in Table 4, and for sediment samples in Table 9. Unless noted below, RPDs were either within control limits (i.e., below the QAPP upper limit of 50 percent) or not calculated because an analyte was not detected above the reporting limit in one or both of the samples compared.

Approximately 5 mL of the homogenized sample was then placed in a disposable plastic cup and analyzed with the XRF for 2 minutes. This container was then recombined with the sample, and the analysis was repeated with a second 5 mL portion of the homogenized sample. Comparison of these two readings of the processed sample allows for verification of the efficacy of the homogenization process. In addition, comparison of the processed and in-situ readings provides a qualitative assessment of soil heterogeneity.

Calculated RPDs Exceeding DQOs- Samples from Transects on Upper Tailings (Table 1a):

- DS-014- arsenic 136 percent (higher in processed XRF sample), cobalt 192 percent (higher in processed XRF sample), lead 75 percent (higher in processed XRF sample); and
- DS-016- manganese 50 percent (higher in processed XRF sample)

RPD comparisons indicate in some samples, arsenic, cobalt, lead, and manganese may be reported at higher concentrations in processed XRF screening samples than in laboratory samples, but no consistent trend was present for any of the analytes.

Calculated RPDs Exceeding DQOs- Samples from Transects on Lower Tailings (Table 1b):

- DS-139- copper 60 percent (higher in processed XRF sample), iron 96 percent (higher in processed XRF sample), manganese 89 percent (higher in processed XRF sample), and vanadium 67 percent (higher in processed XRF sample);
- DS-150- cobalt 189 percent (higher in processed XRF sample), iron 75 percent (higher in processed XRF sample), lead 110 percent (higher in laboratory sample), manganese 81 percent (higher in laboratory sample), zinc 108 percent (higher in laboratory sample);
- DS-167- cobalt 169 percent (higher in processed XRF sample), iron 73 percent (higher in processed XRF sample);
- DS-177- iron 72 percent (higher in processed XRF sample), manganese 77 percent (higher in processed XRF sample), mercury 195 percent (higher in processed XRF sample), silver 168 percent (higher in processed XRF sample);
- DS-190- iron 61 percent (higher in processed XRF sample), mercury 196 percent (higher in processed XRF sample);
- DS-201- chromium 177 percent (higher in processed XRF sample), iron 97 percent (higher in processed XRF sample), manganese 79 percent (higher in processed XRF sample), mercury 196 percent (higher in processed XRF sample), zinc 68 percent (higher in processed XRF sample);
- DS-218- iron 77 percent (higher in processed XRF sample);

- DS-220- chromium 180 percent (higher in processed XRF sample), iron 101 percent (higher in processed XRF sample), manganese 78 percent (higher in processed XRF sample), zinc 72 percent (higher in processed XRF sample); and
- DS-227- copper 66 percent (higher in processed XRF sample), iron 89 percent (higher in processed XRF sample), manganese 104 percent (higher in processed XRF sample).

As with the Upper Tailings, the XRF processed results were consistently higher than the laboratory results in cases where the RPD exceeded 50 percent. The reported XRF screening concentrations of cobalt, copper, iron, manganese, and zinc are considered to be biased high and have been flagged with a "J+" in Table 1b.

Calculated RPDs Exceeding DQOs: Samples from Soil Borings (Table 4):

- MW-J3 (2.6-3.0 feet)- manganese 117 percent (higher in processed XRF sample);
- SB-J2 (6.3-6.9 feet)- iron 93 percent (higher in processed XRF sample), manganese 101 percent (higher in processed XRF sample);
- SB-J6 (3.1-3.4 feet)- chromium 130 percent (higher in processed XRF sample), iron 60 percent (higher in processed XRF sample), manganese 78 percent (higher in processed XRF sample);
- SB-J8 (7.3-8.0 feet)- chromium 126 percent (higher in processed XRF sample), iron 65 percent (higher in processed XRF sample);
- SB-J12 (2.7-3.2 feet)- iron 57 percent (higher in processed XRF sample); and
- SB-J17 (2.1-2.8 feet)- iron 81 percent (higher in laboratory sample), manganese 119 percent (higher in processed XRF sample), zinc 81 percent (higher in processed XRF sample).

In soil boring samples (all processed before XRF screening), manganese and iron appear to be biased high in the XRF screening compared to laboratory data. Detected concentrations with calculated RPDs that exceeded control limits have been flagged with a "J+" in Table 4, indicating that the XRF screening result is an estimated quantity, but the result may be biased high.

Calculated RPDs Exceeding DQOs: Samples from Sediments (Table 9):

- SE-J2- copper 111 percent (higher in processed XRF sample), iron 151 percent (higher in laboratory sample),manganese 144 percent (higher in processed XRF sample);
- SE-J6- arsenic 66 percent (higher in processed XRF sample), chromium 159 percent (higher in processed XRF sample), iron 93 percent (higher in processed XRF sample), manganese 53 percent (higher in processed XRF sample);
- SE-J31- arsenic 55 percent (higher in processed XRF sample), iron 102 percent (higher in processed XRF sample), manganese 60 percent (higher in processed XRF sample), zinc 64 percent (higher in processed XRF sample);
- SE-J13- iron 103 percent (higher in processed XRF sample), manganese 92 percent (higher in processed XRF sample);
- SE-J32- arsenic 64 percent (higher in processed XRF sample), iron 110 percent (higher in processed XRF sample), manganese 105 percent (higher in processed XRF sample; and
- SE-J18- arsenic 69 percent (higher in processed XRF sample), iron 98 percent (higher in processed XRF sample), manganese 78 percent (higher in processed XRF sample), zinc 81 percent (higher in processed XRF sample).

In sediment samples (all processed before XRF screening), arsenic, manganese, iron, and zinc were consistently biased high in the XRF screening compared to laboratory data. Where detected by either the laboratory or XRF screening, chromium also appears to be biased high in the XRF screening. Detected concentrations with calculated RPDs that exceeded control limits have been flagged with a “J+” in Table 9, indicating that the XRF screening result is an estimated quantity, but the result may be biased high.

10.2 FIELD QUALITY CONTROL

Field QC measures used during the investigation consisted of the following: daily calibrations for each field instrument (results of which were recorded on forms provided in Attachment 6); adherence to field standard operating procedures (SOPs) for collection of samples; and collection of field QC samples for submittal to the analytical laboratory. Field QC samples were collected during groundwater, surface water, sediment, and soil sampling to assess the accuracy and precision of the analytical data. These samples included trip blanks, field duplicates, and Matrix Spike/Matrix Spike Duplicates (MS/MSDs). The collection of QC samples and the acceptance criteria for these samples is described below.

Hold Times – All samples were analyzed within recommended hold times.

Trip blanks – One trip blank was included with the single shipment of aqueous sampling containers. It was prepared in the laboratory by filling a metals sampling bottle with deionized water and preservative and sealing the container. The trip blank accompanied the sample bottles to the Site and remained unopened in the shipping container until the sample bottles were received at the laboratory. As summarized in Table 12, zinc was reported in the surface water trip blank at an estimated concentration (below the laboratory reporting limit) of 2.7 ug/L. Zinc was also reported in the laboratory method blank, suggesting that the detection reported for the trip blank was a result of laboratory contamination.

Field duplicates and triplicates – Field replicates were collected at a frequency of one duplicate for every 20 or fewer samples of each medium (soil, sediment, surface water, or groundwater) submitted for analysis. Samples for aqueous field duplicates were collected consecutively, with the replicate sample collected immediately following collection of the primary sample. For soil and sediment samples, a field duplicate was prepared by collecting a second subsample from a single processed (dried and sieved) soil sample.

One triplicate multi-increment sample was collected and analyzed. The triplicate sample was collected by consecutively sampling the same decision unit three times. Sampling equipment was decontaminated after collection of the primary and duplicate samples.

As specified in the QAPP, field duplicate RPDs are considered acceptable if they are less than 30 percent for aqueous samples and less than 50 percent for solid samples. For multi-increment sampling, the relative standard deviation (RSD) between the triplicate sample results was considered acceptable if it was 30 percent or less. RPDs were calculated only if the laboratory reported a detection above the reporting limit in both the primary and duplicate samples.

Based on the comparative analysis of concentrations reported for each primary and duplicate sample (Tables 4, 7, 8, and 9), results were within the acceptable RPD criteria, with the following exception:

- MW-J4-S (groundwater) - copper 36 percent.

RSDs calculated for the multi-increment sample triplicate were within acceptable RPD criteria with the following exceptions:

- cadmium 34 percent and zinc 35 percent.

Detected concentrations outside respective control limits have been “J” flagged (estimated) in Tables 2 (background soil) and 7 (groundwater).

Matrix Spike/Matrix Spike Duplicates – Additional sample volumes for MS/MSD samples were collected at a minimum frequency of one per every 20 or fewer samples of each matrix. MS/MSD acceptance criteria were determined by the laboratory, as detailed in the QAPP. A discussion of MS/MSD results for samples in each medium follows.

Sediment

Spike recoveries for arsenic, copper, iron, manganese, and zinc could not be assessed in the sediment sample submitted for MS/MSD analysis because the primary sample contained concentrations of these metals that were more than four times the spike amount. Recoveries for all other analytes were within acceptable limits.

Surface Water

MS/MSD analysis was performed on two surface water samples: SW-J22, collected from the Main Branch of Cabin Creek; and SW-J29, collected from the South Branch of Cabin Creek. Samples were spiked for all target analytes. All spike recoveries were within acceptable limits.

Groundwater

Groundwater sample MW-J5 was designated for MS/MSD analysis. This sample was spiked for all targeted analytes. All spike recoveries were within acceptable limits.

Background Soils

The SS-Dup sample (collected from location SS-J3) was submitted for MS/MSD analysis. As summarized in Table 2, recoveries for copper, iron, lead, manganese, and zinc could not be assessed because the primary sample contained concentrations of these metals that were more than four times the spike amount. In the MS sample, arsenic spike recovery was higher than laboratory acceptance limits of 125 percent (144 percent). In the MSD sample, arsenic recovery was low (27 percent) but considered within acceptable limits by the laboratory. Arsenic data from this QC batch, which includes all background MI samples, are qualified as estimated (“J”). Chromium recovery was below acceptance criteria in both the MS and MSD samples (0% and 6.1%, respectively). Chromium data from this batch are qualified as estimated, but the result may be biased low (“J-“). All other spike recoveries were within acceptable limits.

Surficial Soil Sample

Sample DS-218, collected during the tailings delineation sampling, was submitted for MS/MSD analysis. However, this sample was not used for the MS/MSD analyses due to a laboratory oversight. Instead, a sample from a separate project, which is not representative of the soil matrix at the Site, was used for the preparation batch. No data qualifiers have been applied to the results for the surficial soil samples (DS-201, 139, 220, 190, and 167).

Subsurface Soil Samples

One soil sample from beneath the tailings was designated for MS/MSD analysis: SB-J12 (2.7-3.2’). As summarized in Table 4, recoveries for arsenic, copper, iron, manganese, or zinc could not be assessed because the original sample contained concentrations of these metals that were more than four times the spike amount. All other spike recoveries were within acceptable limits, with the exception of vanadium in the MS sample, which was higher than the laboratory acceptance criteria of 39 to 129 percent, but the duplicate sample recovery was within the acceptance range. Vanadium data from this batch are qualified as estimated ("*J*") (Table 4).

10.3 LABORATORY QUALITY CONTROL

The analytical laboratories used for this investigation have QC programs in place to ensure the reliability and validity of the analyses performed at the laboratory. Laboratory QC narratives were provided and reviewed. Relevant laboratory QA/QC protocols were followed per the QAPP and were acceptable.

As part of the laboratory QC measures, a Performance Evaluation (PE) sample was submitted for analysis of the list of target metals in groundwater: arsenic, barium, cadmium, chromium, copper, iron, lead, nickel, selenium, silver, vanadium, and zinc by EPA Method 6020, and mercury by EPA Method 7041A. The PE sample was prepared by Environmental Resource Associates of Arvada, Colorado to contain a certified concentration of each target metal. As summarized in Table 12, results of the PE sample analyses were acceptable for all analytes. Differences between the certified concentrations and the laboratory reported results ranged from 0 to 9 percent.

10.4 DATA USABILITY

With the exception of the issues summarized above, all other quality control results met acceptance criteria. All data are considered usable for the purposes of this investigation, based upon review of the results and the overall DQOs outlined in the QAPP. However, concentrations of some constituents from certain samples should be treated as estimates.

11. SAMPLE DOCUMENTATION, PACKAGING, AND CUSTODY REQUIREMENTS

This section describes the sample collection protocols required to satisfy the DQOs for this field effort.

11.1 SAMPLE COLLECTION DOCUMENTATION

During field work, field forms and chain-of-custody (COC) records were completed by the field team to maintain a comprehensive record of sample collection, transfer of samples between personnel, shipment of samples, and receipt by the laboratory.

11.2 FIELD NOTES

Field notes and forms were completed to document all field activities. Sufficient data and information were recorded to reconstruct field activities for each specific day. All field forms were collected at the end of each day or as appropriate by the Sampling Team Leader. All entries were made in indelible ink. A Daily Log was completed at the end of each day to track personnel on site, as well as general field tasks completed or ongoing for each day. Daily logs are included in Attachment 5, and copies of the field notes and forms are included in Attachment 6.

11.3 SAMPLE PACKAGING AND SHIPPING

Samples for laboratory analysis were placed in containers and preserved in accordance with Table 9-1 of the QAPP. The samples were packaged for shipment in protective media (i.e., bubble-wrap) and shipped to the laboratory via commercial carrier.

11.4 CUSTODY PROCEDURES

11.4.1 FIELD CUSTODY PROCEDURES

The field sampler was responsible for the care and custody of field samples until they were transferred or dispatched. Field procedures were designed such that as few people as possible maintained custody and/or handled the field samples.

Sample containers were identified using sample labels on which were recorded sample numbers, sampling locations, date/time of collection, and type of analysis. Sample labels were completed using waterproof ink unless prohibited by weather conditions.

All samples were shipped with an accompanying COC form that listed sample identifications and locations. Individuals involved in the transfer of samples (i.e., relinquishing and receiving individuals) signed, dated, and noted the time of transfer on the COC. The COC forms documented transfer of custody of samples from the field sampler to another person, to the laboratory, or to/from a secure storage location.

A custody seal was attached to the outside of each shipping container such that the seal needed to be broken to access to the container, thus providing evidence of any unauthorized access. All samples were shipped under accompanying COC pursuant to JCO SOP “Chain-of-Custody Procedures”. All shipped containers were received with the custody seals intact.

For the samples that were sent by common carrier, a copy of the waybill has been retained as part of the permanent documentation. Commercial carriers are not required to sign COC forms because the COC forms are sealed inside the shipping container and sealed with the custody seals.

Due to the difficulty of transporting samples from the Site, all chemical samples were shipped to the laboratory in a single shipment immediately following completion of the field effort. Tailings samples for geotechnical analysis were delivered to the geotechnical laboratory immediately following their collection, while the rest of the geotechnical samples were delivered to the laboratory following completion of the field effort.

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TABLES

ATTACHMENT 1
PHOTOPLATES

ATTACHMENT 2
BOREHOLE LOGS

ATTACHMENT 3

CULTURAL RESOURCE MONITORING REPORT

ARCHAEOLOGICAL MONITORING OF SUPPLEMENTAL SITE INVESTIGATION
NABESNA MINE SITE
WRANGELL-ST. ELIAS NATIONAL PARK AND PRESERVE

Report prepared for:

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February 2011

CONFIDENTIALITY NOTICE

The locations of cultural resources given in this report are provided to facilitate environmental and engineering planning efforts only. Under the provisions of the Archaeological Resources Protection Act and the National Historic Preservation Act, site location information is confidential; disclosure of such information is exempt from requests under Federal and State freedom of information laws. This report is not a public document. It is intended for release to the Johnson Company, National Park Service, SHPO, and appropriate permitting agencies only.

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LIST OF FIGURES

1.0 INTRODUCTION

The National Park Service (NPS) is conducting environmental investigations pursuant to its authorities under the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA), 42 U.S.C. §§ 9601 et seq., in the vicinity of the Nabesna Gold Mine National Historic District (NAB-011), which is located within the Wrangell-St. Elias National Park and Preserve. These investigations are in response to NPS concerns over possible threats to human health and the environment resulting from conditions at the site. NPS contracted with The Johnson Company (Johnson) to complete an Engineering Evaluation/Cost Analysis (EE/CA) to evaluate alternatives for remediation of tailings associated with the mine. NPS determined that additional data was needed to complete the EE/CA and conducted a multi-faceted sampling effort during the summer of 2009 to acquire the needed information (Johnson Company 2009:1).

As part of its compliance with Section 106 of the National Historic Preservation Act for that sampling effort, NPS required that an archaeological monitor be present during any significant surface-disturbing activities. Johnson contracted with Northern Land Use Research, Inc. (NLUR) to provide those monitoring services. NLUR personnel monitored operations in the vicinity of the historic mine during the entire sampling effort, which occurred during the period of August 10 to August 28, 2009. All surface-disturbing activities were monitored by either NLUR Associate Archaeologist Howard Smith, M.A., or NLUR Associate Archaeologist Charles Holmes, PhD.

1.1 Project Setting

The Nabesna gold mine is located about five miles west of the Nabesna River, on the eastern slope of White Mountain, between Jack and Jacksina creeks (Figure 1). Access to the area is via a 46-mile unpaved road that connects to the Tok Cutoff at milepost 60. The mill building and other developments are located on private land at and above 3,000 ft. Mine tailings extend down slope to the east, covering an area of approximately nine acres, primarily on lands managed by the NPS (NPS 2001:3). The Nabesna mine access road crosses the tailings, dividing them into upper and lower regions. Figure 2 shows a general view of the mine and adjacent tailings.

Cabin Creek, a small tributary of Jack Creek, runs immediately to the south of the mine. Except during periods of high water, Cabin Creek is an intermittent stream (NPS 2001:12). The mine and tailings areas are located on an alluvial fan associated with the creek (NPS 2001:13).

Vegetation in the vicinity of the mine is primarily open spruce forest composed of white spruce interspersed with black spruce (NPS 2001:14). Vegetation noted during NLUR monitoring activities included spruce (*Picea spp.*), balsam poplar (*Populus balsamifera*), willows (*Salix spp.*), alders (*Alnus sp.*), wild rose (*Rosa acicularis*), blueberry (*Vaccinium uliginosum*), high bush cranberry (*Viburnum edule*), Labrador Tea (*Ledum palustre*), baneberry (*Actaea rubra*), Arctostaphylos sp., and crowberry (*Empetrum nigrum*). Various grasses, sedges, mosses, and lichens are also common.

1.2 Area History

The history of mining developments in the Nabesna area has been described in considerable detail in a number of sources. Wayland (1943) contains a brief sketch of the mine’s history based on United States Geological Survey publications and information gathered from a 19-day visit to the mine in 1940. The National Register nomination form (Stanley 1978) includes information derived in part from reports of the Nabesna Mining Corporation and from personal papers of Carl F. Whitman, president of the corporation. Perhaps the most detailed history available to NLUR at this time is an unpublished manuscript entitled “Gold Mining in the Nabesna River Region” (Bleakley n.d.) that was supplied by the NPS office in Copper Center. This manuscript, which may be part of a larger report, includes published and unpublished sources and information from Alaska newspapers. The following historical sketch is based on these sources.

The initial discovery of lode gold near the head of Jacksina Creek dates to 1899. Claims were first staked in 1903 by a miner named Field (sometimes Fjeld). In 1905 Field and another miner named Paulson formed the Royal Gold Mining Company, and in 1906 they hauled a three-stamp mill to the property via dog sled from Valdez. The stamp mill is apparently still at the mine site.

In 1907, the Royal Development Company processed about 60 tons of ore, but gold recovery was insufficient to meet costs, and while they continued work for several more years, they never managed to make the mine profitable. In 1914, they allowed the claims to lapse. For the next several years different individuals prospected in the area with little result.

In 1924, Whitman filed on the claims, and in the following year discovered the first of the major gold veins to be located in the area. Whitman continued working the mine for the next several years, and in 1929 formed the Nabesna Mining Corporation (NMC). For the next few years after that, NMC developed the mine, digging several hundred feet of shafts, constructing support buildings, and expanding milling capacity.

Significant production at the Nabesna mine apparently started in 1933, the same year in which the road was completed connecting the mine to the Richardson Highway. Peak production was reached in the late 1930s, at which time the mine employed 60 to 70 men and processed more than 5,000 tons of ore annually.

In late 1939, faced with severely declining ore reserves, the NMC suspended operations for the winter, opening again the following year, but producing only a small fraction of what it had the previous year. The company continued development work on the property in 1941, but no ore was processed. In 1942 the mine closed as the government terminated all non-essential mining in response to World War II. It has not operated since.

2.0 MONITORING AND TESTING METHODS

Personnel from NLUR (either Howard L. Smith, M.A., R.P.A., or Charles Holmes, Ph.D., R.P.A.) were present at the Nabesna gold mine site from August 10 to August 28, 2009. During this period, a series of different sampling activities were monitored, a very limited amount of surface inventory was conducted in advance of certain surface-disturbing activities, and some non-sampling activities were observed. Frequently, one or more sampling procedures were carried out simultaneously, but the pace and nature of the activities allowed a single individual to adequately monitor the program.

2.1 Sampling Activities

Sampling procedures consisted of soil test borings, drilling, and construction of water quality monitoring wells, surficial soil sampling to delineate mine tailings, collection of a limited number of hand-dug samples to evaluate the gold content of the tailings, and collection of surface water and sediment samples. NLUR monitors actively observed all of these procedures except for surface water and sediment sampling, which involved no potential for significant surface disturbance. Figure 3 is a map of the project area, showing the area in which sampling occurred, and specific locations of the drill holes.

The two drilling programs, and the concomitant need to move drill rigs on and near the tailings, posed the highest potential for impacts to historic materials. Two drill rigs were utilized simultaneously, both mounted on flex-tracked Nodwell vehicles. One was a rotary-driven hollow stem auger, used primarily for the soil test borings. The second rig, which was used primarily for the monitoring wells, was an air rotary machine. Figures 4 and 5 show the two rigs in operation at the mine site.

For the drilling programs, monitoring consisted of several discrete steps. First, prior to the beginning of any sampling activities, Johnson Company personnel marked prospective drill sites with flagged pins and also flagged several surface occurrences of historic material to facilitate avoidance. As drilling progressed, NLUR personnel used survey flagging to mark additional locations containing historic debris in the vicinity of proposed drill sites. Second, prior to any drilling, a representative of Johnson and the NLUR monitor inspected access routes to each drill site, and developed an acceptable route. The NPS furnished a detailed map resulting from past archaeological survey of the area, which was a significant aid in identifying and avoiding historic remains. Third, the NLUR monitor observed the drill rig during any movement on the upper tailings, where almost all of the known historic materials were located, and during most or all of the movement elsewhere. Finally, NLUR monitors used digital cameras to record each bore hole location, before and after drilling.

Water quality monitoring wells were laid out in two general locations. Four wells were drilled on the uphill side of the mine access road and another five on and adjacent to the lower tailings (Figure 3). Five of the monitoring wells were located in undisturbed areas either immediately adjacent to the access road or on the margins of the lower tailings. NLUR monitors inspected all well locations in undisturbed areas prior to drilling, monitored the movement of rigs into the areas, and observed drilling in progress. As with soil test bore holes, digital images were obtained prior to and drilling and after the rig had vacated the site.

Monitoring wells were drilled to groundwater and, therefore, were much deeper than soil test bore holes. Once groundwater was reached, considerable time and effort was needed to construct the well. As a result, the drill rig utilized for monitoring wells moved much less frequently than the one drilling soil test bore holes. As a general rule, soil tests proceeded at a rate of one or two borings per day, while monitoring wells were completed at a rate of one every two or three days. This pace made it possible for a single monitor to keep track of activities at two different drilling locations, plus have ample time to inspect access routes and drilling locations ahead of time, and to monitor other activities.

Tailings delineation was conducted utilizing an X-ray fluorescence (XRF) analyzer, and involved minimal surface disturbance. Originally, the intent was to gather small soil samples that would be transported back to the lodge, dried in an oven and then analyzed for iron, arsenic, and lead content. After a small number of samples were processed in this fashion, Johnson personnel determined that adequate data could be obtained by conducting on-site testing with the XRF analyzer. Consequently the bulk of tailings delineation involved clearing vegetation from a small area (seldom more than 10 cm^2) then the XRF analyzer was placed in contact with the soil and readings were taken. Figure 6 shows a typical surface disturbance resulting from this sampling activity. Coordinates for each sample site were obtained using a GPS receiver with sub-meter accuracy. Toward the bottom of the lower tailings area, wetter soils were encountered, and a hand auger was used to retrieve samples for XRF data. This resulted in somewhat less surface disturbance, but deeper penetration. The bulk of the tailings delineation work occurred after the drilling program was completed, and could consequently be observed closely by the NLUR monitor.

One final sampling activity involved the collection of a number of hand-dug samples of tailings material to determine the gold content. This sampling was conducted by personnel from Kinross Gold from Fairbanks, and involved the excavation of a small trench using short-handled shovels. A small amount (no more than 0.5 ft^3) of material was removed from each trench and placed in a plastic bucket to be transported off-site for analysis. This sampling was conducted on August 12, when the drilling program was just commencing. Consequently, it was only possible to directly observe hand sampling in the top part of the upper tailings area. Almost all of the known historic debris is located in this area, so hand sampling was actively monitored in the locations most likely to conflict with cultural resources. Because this activity involved minimal surface disturbance and was carried out only in disturbed areas, NLUR personnel concluded it was not necessary to directly monitor sampling in those portions of the tailings containing few or no known historic materials. The small trenches left by hand sampling were inspected. Figure 7 shows one of the locations sampled in this manner.

2.2 Non-Sampling Activities

NLUR monitors observed some non-sampling activities as well. There were three activity areas where foot and vehicle traffic was concentrated enough to entail some potential for surface disturbance, and a crew of two surveyors were on site for two days to obtain precise locations and elevations associated with the project. The first concentrated activity area consisted of a decontamination station located adjacent to the road at the lower end of the upper tailings, essentially at the same spot as monitoring well MW-J6. This area was used to clean boots, ATVs and other vehicles, and the drill rigs and drilling equipment prior to any of them leaving the tailings area. This location was used on a daily basis and sustained a significant amount of traffic. Figure 8 shows the decontamination station.

All the wash water generated by decontamination, cuttings produced by drilling, used absorbent pads and any other potentially hazardous materials were placed in drums and stockpiled for future disposal. An area across the road and northeast of the decontamination station was cleared of large vegetation and used to collect these drums. A moderate amount of foot and ATV traffic took place in the stockpile area. The drum collection area is shown in Figure 9.

A third concentrated activity area was located on the northern margin of the lower tailings area, along an existing road and trail and next to a single log cabin and associated artifact scatters (NAB-292). According to the Alaska Heritage Resources Survey database, the site is named “Little Al’s Cabin” and dates to the 1950s. This area was used to park ATVs and as a short-term storage area for tools and equipment used in the various sampling activities on the lower tailings. Figure 10 shows the third activity area.

NLUR monitors inspected all three activity areas prior to any significant amount of use. In the case of the area adjacent to NAB-292, the cabin and surrounding artifact scatters were periodically examined to determine if anything had been disturbed.

The survey crew established a GPS base station in the vicinity of NAB-292, and two slave units along the edge of the Nabesna Road. A roving GPS unit on a tripod was then set up on each point to be located, and allowed to gather data for a period of five minutes before being moved to the next point. The stationary units were installed using small personal ATVs, while the roving unit was transported by foot. A monitor accompanied the survey crew as they located points in the top portion of the upper tailings area.

3.0 MONITORING AND TESTING RESULTS

All activities observed by NLUR monitors were conducted without significant impacts to historic or prehistoric resources. Several aspects of the project contributed to the minimization of impacts. First, the vast majority of the sampling activities took place in previously disturbed areas covered by mine tailings, reducing the potential for impacts. Because the tailings are largely devoid of vegetation, surface artifacts were easily seen. Where activities did take place in undisturbed areas, NLUR monitors inspected the locations prior to use. No cultural materials were discovered as a result of these inspections.

Second, previous work done by NPS archaeologists had located numerous historic artifacts. This inventory appeared to be thorough and accurate. NLUR monitors noted only a few historic objects that were not included in the NPS inventory, and these were largely the result of erosion that more than likely exposed them since the NPS inventory was done. NPS furnished the NLUR monitors with a detailed map and description of known historic materials, which helped to locate and avoid them.

Third, the design and location of sampling activities were such as to reduce the likelihood of impacts. Hand sampling and X-ray fluorescence analysis involved little surface disturbance and were inherently unlikely to impact historic materials to any significant degree. The drilling program clearly involved enough surface disturbance to pose a threat, but was mostly located away from concentrations of historic debris. Almost all known historic objects are located near the top part of the upper tailings area, and most of these in the brushy areas to the north and south of the tailings. Only a few sampling activities took place in the vicinity of these known historic materials. Where they did –in the vicinity of soil tests SB-J4, SB-J7, SB-J8, SB-J9, and SB-J15 – historic materials were distributed in such a manner that it was possible to avoid them and still access the drill hole locations.

No operation of the sort described here can be conducted completely without impacts and NLUR monitors did observe some disturbance of cultural materials. On three occasions small isolated pieces of wood or lumber were disturbed by operations. Twice, drill rigs crushed small pieces of lumber that were obscured by vegetation and consequently had not been observed prior to rig movement. In a third instance, an NLUR monitor manually moved a deteriorated piece of wood to allow the drill to pass, and returned it once the drilling was completed. This piece of wood was located in an erosion channel and likely had been redeposited. These are extremely minor disturbances and do not represent a significant impact on the historic property at the mine.

By far the largest impact to the area around the historic district resulted from the tracks left by the drill rigs as they moved across the tailings. To the extent that the tailings are a contributing element to a historic mining landscape, the tracks do represent a limited and transitory impact. The tracks are only noticeable from a short distance, and do not constitute a visual intrusion from a medium or long distance. For example, looking toward the mill building from the bottom of the upper tailings, the tracks are not particularly noticeable. Figure 2 shows this view after all drilling was completed. The surface of the tailings is unstable to a certain extent, and it is likely that normal surface erosion will obscure the tracks within a short period of time.

4.0 SUMMARY AND RECOMMENDATIONS

Northern Land Use Research, Inc. provided archaeological monitors to observe operations in the vicinity of the Nabesna Historic Mining District during August of 2009. Operations were conducted by The Johnson Company of Vermont, under contract to the National Park Service. Operations were conducted to gather information to help the Park Service evaluate alternatives for possible remediation of mine tailings. During the course of monitoring this project, NLUR observed no significant impacts to the historic property involved.

4.1 Limitations

This project was carried out, and this report prepared, in accordance with generally accepted professional practices for the nature and conditions of the work completed in the same or similar localities, at the time the work was performed. It is intended for the exclusive use of The

Johnson Company and NPS for specific application to the referenced project. It should be noted that NLUR relied upon information and/or verbal accounts provided by the agencies and individuals indicated in the report. NLUR can only relay this information and cannot be responsible for its accuracy or completeness. This report is not meant to represent a legal opinion.

We do not warrant that we have identified all potentially significant cultural resources present at the referenced properties, as these may be hidden in such a way that only extensive excavations, use of remote sensing equipment (e.g., ground penetrating radar, magnetometer), or other technologies/methods not included in our scope of work will reveal them. No other warranty, express or implied, is made. Any questions regarding our work and this report can be directed to NLUR Operations Manager Burr Neely or to NLUR Principal Archaeologist Peter Bowers.

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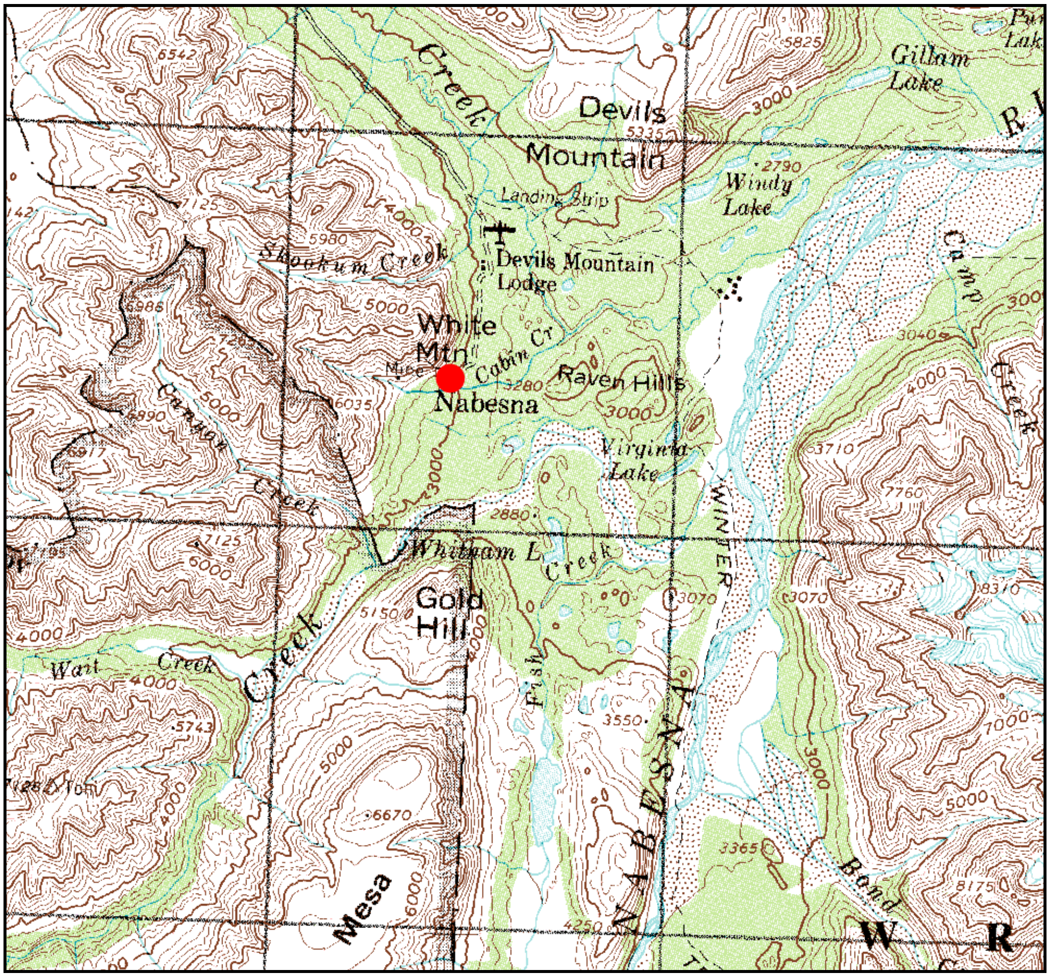

Figure 1. Map of the Nabesna area, showing the relationship of the mine to surrounding geographic features.

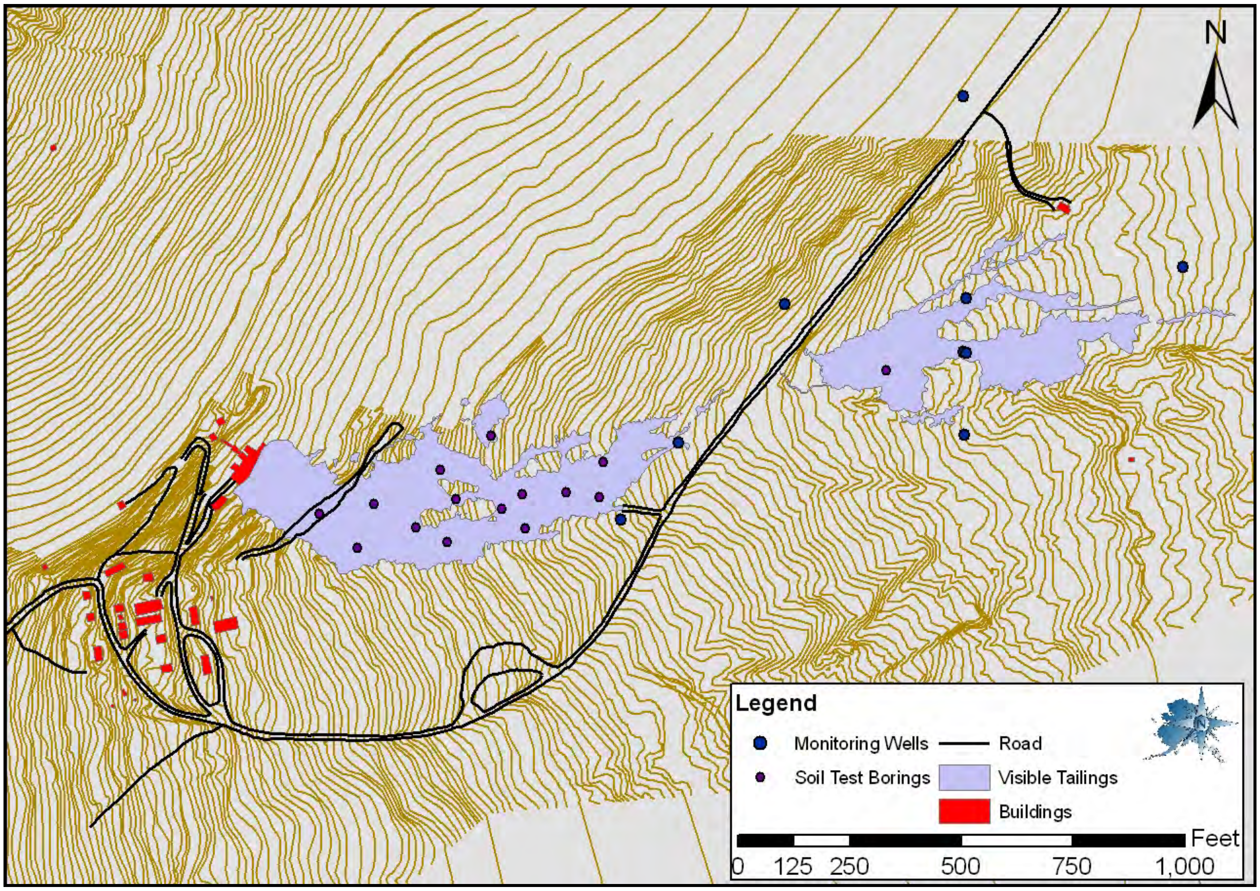

Figure 3. Map of project area showing locations of drill holes and other features referenced in text.

ATTACHMENT 4

LABORATORY ANALYTICAL RESULTS

THE LEADER IN ENVIRONMENTAL TESTING

ANALYTICAL REPORT

PROJECT NO. 3-0700-6

NABESNA MINE SITE

Lot #: A9I010228

Rhonda Kay

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TESTAMERICA LABORATORIES, INC.

Patrick O'Meara

Approved for release.
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September 21, 2009

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ACCREDITED IN ACCORDANCE WITH nelac

CASE NARRATIVE
A9I010228

The following report contains the analytical results for twenty-seven water samples and one quality control sample submitted to TestAmerica North Canton by The Johnson Company, Inc. from the Nabesna Mine Site, project number 3-0700-6. The samples were received September 01, 2009, according to documented sample acceptance procedures.

TestAmerica utilizes USEPA approved methods in all analytical work. The samples presented in this report were analyzed for the parameter(s) listed on the analytical methods summary page in accordance with the method(s) indicated. Preliminary results were provided to Daniel Baston and Rhonda Kay on September 16, 2009. A summary of QC data for these analyses is included at the back of the report.

TestAmerica North Canton attests to the validity of the laboratory data generated by TestAmerica facilities reported herein. All analyses performed by TestAmerica facilities were done using established laboratory SOPs that incorporate QA/QC procedures described in the applicable methods. TestAmerica's operations groups have reviewed the data for compliance with the laboratory QA/QC plan, and data have been found to be compliant with laboratory protocols unless otherwise noted below.

The test results in this report meet all NELAP requirements for parameters for which accreditation is required or available. Any exceptions to NELAP requirements are noted in this report. Pursuant to NELAP, this report may not be reproduced, except in full, without the written approval of the laboratory.

All parameters were evaluated to the method detection limit and include qualified results where applicable.

Please refer to the Quality Control Elements Narrative following this case narrative for additional quality control information.

If you have any questions, please call the Project Manager, Patrick J. O'Meara, at 330-497-9396.

This report is sequentially paginated. The final page of the report is labeled as "END OF REPORT."

CASE NARRATIVE (continued)

SUPPLEMENTAL QC INFORMATION

SAMPLE RECEIVING

The temperatures of the coolers upon sample receipt were 16.4, 16.6, and 18.2°C, with no coolant present.

See TestAmerica’s Cooler Receipt Form for additional information.

METALS

The sample(s) that contain results between the MDL and the RL were flagged with "B". There is the possibility of false positive or mis-identification at these quantitation levels. The acceptance criteria for the ICB, CCB, and Method Blank are +/- the standard reporting limit (SRL).

The sample(s) that contained concentrations of target analyte(s) at a reportable level in the associated Method Blank(s) were flagged with "J". Refer to the sample report pages for the affected analyte(s).

QUALITY CONTROL ELEMENTS NARRATIVE

TestAmerica conducts a quality assurance/quality control (QA/QC) program designed to provide scientifically valid and legally defensible data. Toward this end, several types of quality control indicators are incorporated into the QA/QC program, which is described in detail in QA Policy, QA-003. These indicators are introduced into the sample testing process to provide a mechanism for the assessment of the analytical data. Program or agency specific requirements take precedence over the requirements listed in this narrative.

QC BATCH

Environmental samples are taken through the testing process in groups called QUALITY CONTROL BATCHES (QC batches). A QC batch contains up to twenty environmental samples of a similar matrix (water, soil) that are processed using the same reagents and standards. TestAmerica North Canton requires that each environmental sample be associated with a QC batch.

Several quality control samples are included in each QC batch and are processed identically to the twenty environmental samples.

For SW846/RCRA methods, QC samples include a METHOD BLANK (MB), a LABORATORY CONTROL SAMPLE (LCS) and, where appropriate, a MATRIX SPIKE/MATRIX SPIKE DUPLICATE (MS/MSD) pair or a MATRIX SPIKE/SAMPLE DUPLICATE (MS/DU) pair. If there is insufficient sample to perform an MS/MSD or an MS/DU, then a LABORATORY CONTROL SAMPLE DUPLICATE (LCSD) is included in the QC batch.

For 600 series/CWA methods, QC samples include a METHOD BLANK (MB), a LABORATORY CONTROL SAMPLE (LCS) and, where appropriate, a MATRIX SPIKE (MS). An MS is prepared and analyzed at a 10% frequency for GC Methods and at a 5% frequency for GC/MS methods.

LABORATORY CONTROL SAMPLE

The Laboratory Control Sample is a QC sample that is created by adding known concentrations of a full or partial set of target analytes to a matrix similar to that of the environmental samples in the QC batch. Multi peak responders may not be included in the target spike list due to co-elution. The LCS analyte recovery results are used to monitor the analytical process and provide evidence that the laboratory is performing the method within acceptable guidelines. All control analytes indicated by a bold type in the LCS must meet acceptance criteria. Failure to meet the established recovery guidelines requires the repreparation and reanalysis of all samples in the QC batch. Comparison of only the failed parameters from the first batch are evaluated. The only exception to the rework requirement is that if the LCS recoveries are biased high and the associated sample is ND (non-detected) for the parameter(s) of interest, the batch is acceptable.

At times, a Laboratory Control Sample Duplicate (LCSD) is also included in the QC batch. An LCSD is a QC sample that is created and handled identically to the LCS. Analyte recovery data from the LCSD is assessed in the same way as that of the LCS. The LCSD recoveries, together with the LCS recoveries, are used to determine the reproducibility (precision) of the analytical system. Precision data are expressed as relative percent differences (RPDs). If the RPD fails for an LCS/LCSD and yet the recoveries are within acceptance criteria, the batch is still acceptable.

METHOD BLANK

The Method Blank is a QC sample consisting of all the reagents used in analyzing the environmental samples contained in the QC batch. Method Blank results are used to determine if interference or contamination in the analytical system could lead to the reporting of false positive data or elevated analyte concentrations. All target analytes must be below the reporting limits (RL) or the associated sample(s) must be ND except under the following circumstances:

- Common organic contaminants may be present at concentrations up to 5 times the reporting limits. Common metals contaminants may be present at concentrations up to 2 times the reporting limit, or the reported blank concentration must be twenty fold less than the concentration reported in the associated environmental samples. (See common laboratory contaminants listed in the table.)

Volatile (GC or GC/MS)	**Semivolatile (GC/MS)**	**Metals ICP-MS**	**Metals ICP Trace**
Methylene Chloride, Acetone, 2-Butanone	Phthalate Esters	Copper, Iron, Zinc, Lead, Calcium, Magnesium, Potassium, Sodium, Barium, Chromium, Manganese	Copper, Iron, Zinc, Lead

QUALITY CONTROL ELEMENTS NARRATIVE (continued)

- Organic blanks will be accepted if compounds detected in the blank are present in the associated samples at levels 10 times the blank level. Inorganic blanks will be accepted if elements detected in the blank are present in the associated samples at 20 times the blank level.

- Blanks will be accepted if the compounds/elements detected are not present in any of the associated environmental samples.

Failure to meet these Method Blank criteria requires the repreparation and reanalysis of all samples in the QC batch.

MATRIX SPIKE/MATRIX SPIKE DUPLICATE

A Matrix Spike and a Matrix Spike Duplicate are a pair of environmental samples to which known concentrations of a full or partial set of target analytes are added. The MS/MSD results are determined in the same manner as the results of the environmental sample used to prepare the MS/MSD. The analyte recoveries and the relative percent differences (RPDs) of the recoveries are calculated and used to evaluate the effect of the sample matrix on the analytical results. Due to the potential variability of the matrix of each sample, the MS/MSD results may not have an immediate bearing on any samples except the one spiked; therefore, the associated batch MS/MSD may not reflect the same compounds as the samples contained in the analytical report. When these MS/MSD results fail to meet acceptance criteria, the data is evaluated. If the LCS is within acceptance criteria, the batch is considered acceptable.

For certain methods, a Matrix Spike/Sample Duplicate (MS/DU) may be included in the QC batch in place of the MS/MSD. For the parameters (i.e. pH, ignitability) where it is not possible to prepare a spiked sample, a Sample Duplicate may be included in the QC batch. However, a Sample Duplicate is less likely to provide usable precision statistics depending on the likelihood of finding concentrations below the standard reporting limit. When the Sample Duplicate result fails to meet acceptance criteria, the data is evaluated.

For certain methods (600 series methods/CWA), a Matrix Spike is required in place of a Matrix Spike/Matrix Spike Duplicate (MS/MSD) or Matrix Spike/Sample Duplicate (MS/DU).

The acceptance criteria do not apply to samples that are diluted.

SURROGATE COMPOUNDS

In addition to these batch-related QC indicators, each organic environmental and QC sample is spiked with surrogate compounds. Surrogates are organic chemicals that behave similarly to the analytes of interest and that are rarely present in the environment. Surrogate recoveries are used to monitor the individual performance of a sample in the analytical system.

If surrogate recoveries are biased high in the LCS, LCSD, or the Method Blank, and the associated sample(s) are ND, the batch is acceptable. Otherwise, if the LCS, LCSD, or Method Blank surrogate(s) fail to meet recovery criteria, the entire sample batch is reprepared and reanalyzed. If the surrogate recoveries are outside criteria for environmental samples, the samples will be reprepared and reanalyzed unless there is objective evidence of matrix interference or if the sample dilution is greater than the threshold outlined in the associated method SOP.

The acceptance criteria do not apply to samples that are diluted. All other surrogate recoveries will be reported.

For the GC/MS BNA methods, the surrogate criterion is that two of the three surrogates for each fraction must meet acceptance criteria. The third surrogate must have a recovery of ten percent or greater.

For the Pesticide and PCB methods, the surrogate criterion is that one of two surrogate compounds must meet acceptance criteria. The second surrogate must have a recovery of 10% or greater.

TestAmerica Certifications and Approvals:

The laboratory is certified for the analytes listed on the documents below. These are available upon request.

California (#01144CA), Connecticut (#PH-0590), Florida (#E87225),
Illinois (#200004), Kansas (#E10336), Minnesota (#39-999-348), New Jersey (#OH001), New York (#10975), Nevada (#OH-000482008A), OhioVAP (#CL0024), Pennsylvania (#008), West Virginia (#210), Wisconsin (#999518190),NAVY, ARMY, USDA Soil Permit