Pebble Project

NORTHERN DYNASTY MINES INC.

DRAFT ENVIRONMENTAL BASELINE STUDIES

2004 PROGRESS REPORTS

CHAPTER 14. CULTURAL RESOURCES

JUNE 2005

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ACRONYMS

ADEC	Alaska Department of Environmental Conservation
ADF&G	Alaska Department of Fish and Game
ADOT/PF	Alaska Department of Transportation and Public Facilities
agl	above ground level
AHRS	Alaska Heritage Resource Survey
ANCSA	Alaska Native Claims Settlement Act
APE	Area of Potential Effect
ASTt	Arctic Small Tool tradition
BBNA	Bristol Bay Native Association
BLM	Bureau of Land Management
BP	before present
^{14}C	Carbon 14
CRM	cultural resources management
DEM	digital elevation model
EIS	environmental impact statement
EPA	Environmental Protection Agency
FAA	Federal Aviation Administration
FR	Federal Register
GIS	geographic information system
GMU	Game Management Unit
GPS	global positioning system
GLM	general linear model
LIDAR	light detection and ranging
M.A.	Master of Arts
MCHTWG	Mulchatna Caribou Herd Technical Working Group
mi^2	square mile(s)
MMS	Minerals Management Service
MODIS	moderate resolution imaging spectroradiometer
mph	miles per hour
NASA	National Aeronautics and Space Administration
NDM	Northern Dynasty Mines Inc.
NEPA	National Environmental Policy Act
NMFS	National Marine Fisheries Service
NPS	National Park Service
NRCS	Natural Resource Conservation Service

NRHP	National Register of Historic Places
NWR	National Wildlife Refuge
PSD	Prevention of Significant Deterioration
QA	quality assurance
QAPP	quality assurance project plan
SHPO	State Historic Preservation Officer
SRB&A	Stephen R. Braund & Associates
SWE	snow water equivalent
USC	United States Code
USDA	United States Department of Agriculture
USFS	United States Forest Service
USFWS	U.S. Fish and Wildlife Service
USGS	U.S. Geological Survey
VHF	very high frequency

14. CULTURAL RESOURCES

14.1 Introduction

This report presents the findings of the 2004 cultural resources survey in the vicinity of the proposed Pebble Project mine and associated facilities as proposed in May 2004. Erik D. Hilsinger, M.A., of Stephen R. Braund & Associates (SRB&A), led four trips to conduct field and pedestrian surveys, subsurface testing, and monitoring of ground-disturbing activities.

14.2 Study Objectives

The objective of the cultural resources survey was to locate, identify, delineate, inventory, and assess the eligibility of archaeological, historical, ethnographic, and other cultural use areas for inclusion on the National Register of Historic Places (NRHP) and the Alaska Heritage Resource Survey (AHRS). Cultural resources may include historic structures and landscapes, prehistoric and historic archaeological sites, and traditional and religious use areas. No sites were located or identified during field investigations. Had they been, SRB&A would have determined the extent of these resources and delineated them where practicable. As surveys of portions of the proposed project are completed, SRB&A will record and inventory any discovered sites. As part of the baseline study and throughout the project, SRB&A will document and assess any identified sites in the Area of Potential Effect (APE) as to their eligibility for the AHRS and the NRHP.

14.3 Study Area

SRB&A based the study areas for the 2004 field surveys on the alternative footprints proposed for the project and depicted on maps provided by Northern Dynasty Mines Inc. (NDM). Project components included in the survey are the mine pit, meteorological monitoring stations, proposed and existing VHF repeater sites, water reservoir, reactive-rock storage areas, and low-grade-ore stockpile (Figure 14-1).

Because all project components but the mine pit are subject to changes as project alternatives solidify, much of the survey effort was dedicated to intensively sampling the mine-pit area. Other project areas received primarily pedestrian survey, and SRB&A personnel monitored ground-disturbing activities as necessary. As project alternatives solidify, an updated area of potential effect (APE) can be outlined and surveyed during the 2005 and 2006 field seasons.

Figure 14-1 is an overview of the project area with the two alternative project-component arrangements, G/J3 and A4, proposed as of August 2004. Green-shaded polygons show project components that have been surveyed for cultural resources, while those shaded red have not been surveyed. Black dots represent waypoints taken with a global positioning system (GPS) during the survey to record travel routes and landmarks. Yellow squares represent hand-excavated test pits. Fuchsia squares represent the geotechnical test pits monitored by Amy Tomson in September of 2004.

Figure 14-2 shows the extent of the last glacial maximum in the Iliamna-Nushagak area with the proposed mine site marked with a red asterisk. The timing of this glacial event puts a bottom time limit on potential archaeological resources in the vicinity of the project. Areas not covered by the maximum extent of the last major glaciation, including areas above the surface of the glacial ice or downstream of the glacier's maximum extent, may contain early, well preserved archaeological sites.

Figure 14-3 is a selection from a map of Russia's possessions in the New World, published in 1802, showing Lake Clark, Lake Iliamna, and Little Lake Clark. This map demonstrates relatively good early knowledge of the Pacific Coast and parts of the Alaska Peninsula, but limited knowledge of the interior or the area north of the peninsula. The area of the lakes is clearly well known if not surveyed to modern levels of cartographic detail.

Figure 14-4 is a map detail from a chart published in Russia in 1844 showing the increase in knowledge and mapping effort put into SOUTHWEST Alaska by the Russian America Company in response to the growing demand for beaver pelts. Compared to Figure 14-3, this map demonstrates much more precise knowledge of the Wood-Tikchik lakes area, the Nushagak-Holitna portage to the Kuskokwim River, and the portages over the Alaska Peninsula from the Pacific side to the Bristol Bay side via the lake and river systems draining north.

Figure 14-5 shows the proposed mine-pit outline as described in June 2004. The area has since expanded along the northern half of the polygon in response to results of the drilling program. The archaeological field crew performed pedestrian surveys using a hub and spoke arrangement with the camp (Camp 2 on Figure 14-5) as the hub. Survey crews landed on the high ground to the west and proceeded downhill, on a glacial feature to the north, and at the camp for surveys to the south and east. Red points with letter sequences (e.g., WSWPNT, NRTHPN, and NRTHST) were the former pit outlines as described during field-work planning and programmed into the GPS unit. The Meteorological Station Area on the 1,567-foot ridge to the west is also a candidate location for the mill component of the project.

Figure 14-6 shows the pedestrian survey and monitored geotechnical test pits for a proposed reactive-rock storage area under alternative G. The stream feeds into the North Fork of the Koktuli River through a narrow cutoff and leads into a wider area in the valley floor. The survey team began on the west ridge and followed the ridge line north-northeast to the area above the confluence of the creek with the river. This gave a good overview of the valley and any potential large-scale features in the vicinity, such as caribou fences or stone caches.

Figure 14-7 shows the survey route of the reservoir component. The west side of the valley was not surveyed in 2004 and will be completed in 2005 or later seasons, as necessary should this component alternative be selected.

Figure 14-8 shows the mountaintop sites surveyed on the east side of the project area. The two VHF repeater sites were on the peaks of Koktuli Mountain, covered with glacial rubble, and scoured by wind and weather. The proposed meteorology station location is a knoll rising out of the valley floor.

14.4 Scope of Work

The research and field work for this study were conducted during the spring, summer, and fall of 2004. Erik D. Hilsinger, M.A., led the study team that included SRB&A personnel Alan Baldivieso, Raena Schraer, Amy Tomson, and Richard O. Stern, Ph.D., and a student intern on loan from the Bristol Bay Native Association (BBNA), Tim Dyasuk. SRB&A conducted the study in accordance with the approach described in the Proposed 2004 Study Plan, Draft Baseline Study Plan for Environmental Baseline Studies (Northern Dynasty Mines Inc., 2004) as follows:

- Alaska Heritage Resource Survey (AHRS) files were examined for known, existing cultural resources in the vicinity of the project area.
- A review of the archaeological, ethnographic, historical, and geological literature was conducted before, during, and after the 2004 field work.
- A methodology was developed for identifying and surveying high probability areas and areas with the highest likelihood of impact in the vicinity of the mine pit and associated facilities.
- Four field trips were made to the project area for pedestrian surveys and subsurface testing.
- Pedestrian surveys were performed in the following areas: mine pit, pyritic-tailings storage areas G and A4, two VHF repeater sites, two meteorology station sites, a water-storage reservoir, and portions of the low-grade-ore stockpile.
- Subsurface testing in the mine-pit area included 58 test pits.
- Eighteen geotechnical test pits, excavated mechanically, were monitored.
- Preconstruction survey was conducted of the meteorology stations and VHF repeaters prior to ground-disturbing activity.
- Drill-rig ground surface and subsurface areas in the mine-pit area were inspected.

14.5 Methods

A review of documents included the AHRS files, archaeological literature for southwest and southcentral Alaska, an investigation into the surface geology of a relatively broad region centered on Iliamna, and a review of ethnographic and historical literature and accounts of the general area. Consultation with the State Historic Preservation Officer (SHPO) was initiated prior to field work and was ongoing with Native groups over the course of field work.

14.5.1 Literature Review

The literature review included a review and analysis of the geology, glaciation, and prehistoric environment in order to establish a potential maximum time-depth of human occupation in the study area. In addition, the literature review included a review of the contact and historic period to enable an understanding of historic land use to determine what potential range of artifacts and sites might occur in the project area.

14.5.1.1 Geology, Glaciation, and Prehistoric Environments

Surface geology of the proposed mine pit is based on a long history of glacial advances and retreats throughout the Pleistocene. Detterman and Reed (1973) define the region of the proposed mine as the Nushagak-Big River Hills (after Wahrhaftig 1965) upland, elevated above the Nushagak-Bristol Bay Lowland by 600 to 1,000 feet. The terrain consists of low rolling hills composed of remnants of Tertiary volcanic activity with valley infill of glacial debris that originated in the Alaska Range (Figure 14-9). Aeolian (wind-carried) deposits of tephra (volcanic ash) and glacially derived sands, silt, and loess are additive to existing sands and silts derived from locally decomposed rock. The area of the proposed mine shows evidence of relict permafrost features and ongoing perennially frozen ground, including frost wedging, frost polygons, beaded lakes at polygon intersections, thermokarst lakes, and angular and expanded oxbows in streams that follow former polygon margins (Detterman and Reed, 1973). Cobbles and gravels in the silt and sand matrix of the area are a combination of blocky angular frost-shattered bedrock and rounded tumbled granite cobbles. Valley floor deposits contain larger rocks with evidence of seasonal artesian events, as meltwater appears to flow through the highly permeable matrix between frozen soil levels and to erupt as geysers or boils during the spring thaw, carrying away sand and gravel and redepositing the material down stream (Knight Piésold Consulting, 2004; Water Management Consulting Inc., 2004). Gelifluction combined with graviturbation has resulted in the tops of hills being denuded of vegetation and soil, as the water-saturated soils creep downslope in arcuate waves during freeze-thaw cycle events in the spring and fall (Figures 14-9, 14-10, 14-11, 14-12, and 14-13) (Detterman and Reed, 1973; Wood and Johnson, 1978).

Recent work on the glacial history of southwest Alaska has refined the timing of the sequence of glacial advances and retreats that have carved the landscape of the Iliamna area into its present form. The vicinity of the proposed mine appears to have been under glacial ice during the last major glaciation of the Late Wisconsin period (Figure 14-2) (Manley and Kaufman, 2002; Stillwell and Kaufman, 1996). These glaciers began retreating approximately 12,600 Carbon 14 (^{14}C) years before present (BP), approximately the same time as the inundation of the Beringian plain, which had connected Siberia to North America and was the presumed migration route of early peoples to North America (Dumond, 1987; Karlstrom, 1964; Stillwell and Kaufman, 1996; West 1996). Reger and Pinney (1996) further refined the Karlstrom sequence for Cook Inlet glaciation using ^{14}C dating techniques and a broader selection of samples. By 9,500 BP, most glaciers had retreated into mountain valleys (West, 1996). Because of this timing sequence, it is unlikely that early materials like those at Lime Hills or potentially older materials such as that of Bluefish Caves would be present in the proposed mine vicinity (Ackerman, 1996; Dumond, 1984, 1981; West, 1996).

Vegetation followed the retreating glaciers, as evidenced by analysis of pollen caught in lake sediments. During glaciations, herbaceous tundra was dominant, but as the glaciers retreated, birch and willow pollen began to rise in prominence, creating shrub tundra. It appears from these records that as glaciers retreated, mossy tundra was replaced by shrub tundra, which in turn was replaced by spruce forest, and the sequence was reversed as glaciers re-advanced (Briner, Kaufman, Axford, et al., 2000; Briner, Kaufman, Hu, et al., 2000). At present, the glaciers have been generally retreating further into the alpine zones, with few re-advances of significance in the last several thousand years. By 5,500 BP, spruce pollen appears, indicating a further shift from shrub tundra to forest in the lowland. No deposits of large mammal remains have been discovered in the Iliamna area, but it may be inferred that the species, variety, and numbers of herbivores changed over time with the succession of plant types during glacial advances and retreats (West, 1996). In post-glacial time, the number of available game species has been fairly consistent and in some areas has increased as retreating glaciers created more fish and bird habitat. Therefore, it appears that the area could have hosted human populations from approximately 12,000 BP onward.

14.5.1.2 Prehistory

It is possible that early peoples specializing in the use of glacial margin habitats could have been present in the vicinity and left some traces of their presence on the land. The nearest early sites are located along the Kuskokwim drainage (Ackerman, 1996), in the Aleutians (West, 1996), and on Cook Inlet (Reger, 1996; W. Workman, 1996). The older sites of the middle Alaska Range and Nenana Valley are relatively distant, but it is not inconceivable that materials from Denali and other early complexes could be found in the vicinity of the project (Ackerman, 1996; West, 1996). The early traditions share many similarities with those of Siberia and appear to change in response to variations in climate. Frederick Hadleigh West (1996) noted the similarities between Denali and Dyuktai and a later tradition tentatively called Late Beringian that resembles Sumnagin tradition assemblages in Siberia, with examples of the latter from Kagati Lake in southwest Alaska. These traditions disappear suddenly in association with climactic shifts, which may indicate that climactic and environmental instability made continued use of the far north occasionally untenable for hunters and gatherers and required new strategies for group subsistence (Vasil'ev, et al., 2002).

Limited archaeological survey work has been done in the vicinity of the proposed project, and no large-scale survey has previously been conducted in the Iliamna region. Researchers found lithic artifacts on the ground's surface 25 miles east of the mine pit during surveys conducted for a proposed hydroelectric project and associated infrastructure which were to be built at Tazimina Lake with road and power connections to Nondalton and Iliamna villages (Arndt, 1982; M.R. Yarborough, 1986a, 1994). L.F. Yarborough surveyed the area of the Iliamna Airport in 1984 prior to an expansion project there (L.F. Yarborough, 1984). Dr. Robert Ackerman conducted archaeological survey work north and west of the mine site and discovered sites with the greatest regional time-depth in the vicinity (Ackerman, 1964, 1996). Further to the east, Dr. Joan Townsend discovered numerous sites during reconnaissance work and excavated sites in the vicinity of Pedro Bay that included prehistoric deposits (Townsend and Townsend, 1961, 1964; Townsend, 1966, 1970a, 1970b, 1970c, 1973). More recent archaeological surveys have discovered more sites and features in the Pedro Bay area as a result of proposed airport, road, sewer, and waste-handling facilities (M.R. Yarborough, 1985a, 1985b, 1986a, 1986b, 1993).

The earliest known archaeological culture is the Paleo Indian horizon, presumably dating from the first people entering the new world through the Beringian plain. Artifacts of this style have been dated to as old as 27,000 BP, and most have been solidly dated to approximately 12,000 BP (West, 1996). This horizon is presumed to include core and blade technologies and fluted projectile points or knives. The lithic reduction technique involves relatively large cores of appropriate material fashioned into roughly triangular blanks, with sharpened blades on two faces of the material. These bifaces may be tools themselves or may be further reduced into projectile points, knives, scrapers, and other tools. The bifaces themselves could be from two to several inches long. These bifaces may have been fashioned into fluted points which were usually several inches long in unbroken form with a fluted groove from the flat base on one or both flat faces of the blade, presumably for hafting into a handle or shaft (Dumond, 1981, 1984).

Subsequent to, and probably overlapping, the period attributed to the Paleo Indian horizon are a number of regionally distinct archaeological cultures, comparatively better represented and well dated, that include microblade technology. These archaeological cultures date from approximately 9,000 BP to 2,000 BP, with local and regional variations as well as variations based on season of use and intended use of the tools (Dumond, 1981, 1984). Microblade technology uses small stone cores to create large numbers of small, roughly rectangular blade units that were used individually or were embedded in handles or shafts made of wood, bone, or ivory using pitch or hide glue. This technology made very efficient use of lithic raw material as compared to the large flakes and waste material of the Paleo Indian technology.

Associated tools made from stone include a number of types of scrapers, gravers, and other tools to facilitate the manufacture and maintenance of composite organic-lithic hunting and crafting tools. Occasionally stone projectile points are discovered with these materials and may include stemmed, notched, straight, and curved-based projectile point forms (Dumond, 1981, 1984; West, 1996).

Dumond (1981, 1984, 1987) provides syntheses of the named archaeological constructs containing microblade technology as they are described in the literature of arctic archaeology. These named units may or may not have any bearing on the date, age, or artifact composition of sites at this time, but serve as comparison sets for further research and analysis as more sites are excavated and analyzed. Dumond proposes the two largest units of analysis as being the Northwest Microblade tradition and the Arctic Small Tool tradition (ASTt), contrasting the two by reduction-flake fineness, the sizes of the tools themselves, and the variety of tool types found in assemblages of each type. ASTt is the more refined lithic technique of the two, with smaller reduction and sharpening flakes, finer tool sizes, and a wider variety of small, specialized stone tools. Regional subsets of these two traditions include the American Paleo-Arctic tradition of the Alaska Peninsula and Kobuk River areas, the Denali complex of the central Alaska Range, the Northern Archaic on the Kobuk River, the Tuktu or Tuktu-Naiyuk tradition, and the Athabaskan tradition.

The most recent interior-Alaskan stone-tool tradition is dubbed “Athabaskan” for its ubiquity in historic and late prehistoric contexts linked to Athabaskan-language-speaking peoples of interior Alaska and Cook Inlet (Dumond, 1981: K.W. Workman, 1996). This period extends from about 2,000 BP through the very recent past, with the last 250 years displaying an increasing rapidity of technological replacement as metal replaced stone and the hunting-tool complex was supplemented by and then replaced with firearms. During this period, it appears that group territories were solidifying, and the Dena’ina were occupying the shores of Cook Inlet and contesting territory with the Yup’ik- and Sugcestun-speaking peoples of coastal southwest Alaska, the Alaska Peninsula, and outer Cook Inlet (Reger and Boraas, 1996; K.W. Workman, 1996).

Coastal sites present the best sequence for the subsequent several thousand years from 7,000 to 4,500 BP as divergent archaeological cultures appear, floresce, and retreat. Anangula, a long-used site in the Aleutians, has the longest record of use and occupation. Materials from the Anangula Village phase resemble the Ocean Bay I materials of Kodiak, which may share some features of the Northern Archaic tradition north of the Alaska Peninsula (McCartney and Veltre, 1996). By 4,500 BP, a shift in technology was underway in the coastal sites from percussion technique or flaked tools to ground and polished tools made of softer materials. In the Aleutians, the material from this time presents a direct continuity with those noted at first contact, showing an evolutionary refinement over time. ASTt materials are found in coastal and some interior sites in strata dating from 4,000 to 3,000 BP (Dumond, 1984, 1987; W. Workman, 1996). The sudden appearance of this material in the archaeological record with no signs of its naissance and development in Alaska may represent the arrival of new peoples from Siberia, where similarly manufactured artifacts are found (West, 1996). This may represent the initial colonization of the coastal and riverine areas of southwestern Alaska by predecessors of contemporary Eskimo groups (W. Workman, 1996). On the Alaska Peninsula, this shift from ASTt to Norton appears to take place at approximately 2,500 BP (Dumond, 1984).

The main technological shifts in material-culture manufacturing techniques from ASTt to Norton are the almost complete abandonment of percussion techniques in favor of pecking, polishing, and grinding techniques of stone-tool manufacture and the advent of well-developed, high-temperature-fired ceramics. The early phases of this shift begin in a phase called Norton, after the geographic area in which the key site defining the tradition was discovered (Dumond, 1987). The replacement of most percussion-formed tools with polished-stone tool manufacturing and the gradual decline in the quality and manufacture of ceramics defines the later Thule tradition, which segues into the contact-period Eskimo material culture. This indicates a relatively successful adaptation by the bearers of this technological suite to reduced climactic variability, a broadened variety of potential subsistence resources, and an ability to exploit the resources of maritime, riverine, and interior provinces. Sites of Norton and Thule affiliation also represent a shift in emphasis to marine-mammal harvests, particularly seals and sea lions in southwest Alaska, and the advent of whaling in the Bering Straights and northern Alaska. Thule in general represents the material culture of contact-period Eskimo people (Dumond, 1984, 1987).

14.5.1.3 Contact and the Historic Period

Direct contact with Euroamericans in the vicinity of Iliamna likely took place in the late eighteenth century as Russian explorer-entrepreneurs searched for people with furs to trade for items such as knives, beads, cloth, tobacco, tea, and tea-related ceramic ware (Black, 2004; VanStone, 1967). In 1792, Bocharov explored the Alaska Peninsula and Lake Iliamna areas for the Shelikhov-Golikov Company, portaging over the mountains to the lake that now bears a variation of his name (VanStone, 1967). In 1799, Medvednikov, a member of Bocharov’s 1792 party, returned to the area to explore further into the interior and specifically to find a portage to the Kuskokwim River (Figure 14-3) (Black, 2004). The competing Lebedev-Lastochkin Company had an outpost somewhere on the lake (likely Old Iliamna) that Athabaskans attacked and destroyed sometime prior to 1798, leaving the territory free of competing traders (Black, 2004).

Until 1799, the individual traders associated with poorly regulated Russian fur-trading firms operated in coastal Alaska in a sometimes openly hostile fashion, pitting indigenous groups against one another or attacking indigenous villages associated with competing companies in order to increase one’s market share at the expense of a competitor’s workforce (Black, 2004). Employees of the Lebedev-Lastochkin Company reputedly plundered villages befriended by Bocharov (VanStone, 1967). As a result of these and similar abuses and in the interest of extending dominion over the new territories in advance of Great Britain, the Russian American Company was chartered by the Russian imperial government as a business monopoly with limited governmental power and certain responsibilities to the indigenous people of Alaska (Black, 2004). Sea otters, the pelts of which had driven trade from the 1740s to the 1840s, had been exhausted in coastal Alaskan waters and were intensively managed in Alaska while company ships proceeded down the Pacific coast of North America, establishing posts in California for sea-otter harvests and to grow crops and to trade with the Spanish to support the Alaskan enterprises (Gibson, 1976). The shift to beaver and other land and river-mammal pelts was driven by a desire for those pelts in China and the trend for beaver-felt hats in Europe and Great Britain (Gibson, 1976).

Russian outposts in southwest Alaska were usually built on the coast in places with good harbors or anchorages, such as nearby Novo-Aleksandrovsky Redoubt on the Nushagak River, with interior ports on portages and river-transportation routes like Kolmakovsky Redoubt on the Kuskokwim River and the post located at Old Iliamna (Figure 14-4) (Townsend and Townsend, 1961; VanStone, 1988). The post at Old Iliamna appears to have been constructed between the early 1790s, when Ivanov crossed a portage from Cook Inlet to Lake Iliamna, and 1818, when Korsakovskiy’s expedition passed through Lakes Clark and

Iliamna, using the trading post built by Eremy Rodionov, the Tyonek-based trader tasked with engaging the Tanaina and Yup'ik of the lakes region into the broader fur trade (VanStone, 1988). The Iliamna region became a central area for Russian fur trade, as those wishing to trade peltry could take advantage of the different pricing schemes and selection of goods available at Novo Alexandrovsky on the Nushagak and Cook Inlet posts at Kenai and Tyonek, or could sail directly to Kodiak, the first capital and major port for Russian America and key stop en route to the new capital at Sitka (Figure 14-4). As beaver peltry became more important to the business of fur trading, the peoples of the interior became more sought after for trade, and with that trade, Russian Orthodoxy, education, medical care, and other positive and negative by-products of contact accrued (Black, 2004; Fortuine, 1992; VanStone, 1967). In 1838, an epidemic of smallpox spread rapidly throughout the region and caused significant mortality in the Native communities, which had not yet been exposed to that and several other diseases (Fortuine, 1992). Ongoing epidemic and endemic diseases kept the Native population below what it had been at contact, and each successive epidemic disease caused significant population loss and subsequent cultural and social disruption (Fortuine, 1992).

Beaver peltry served as the main economic engine for the region's indigenous people through the sale of Russian America to the United States in 1867. The Russian monopoly was sold to a de facto American monopoly, the Hutchison-Kohl Company of San Francisco, and the trade in beaver and other pelts continued at varying levels of activity based on prices and fashion trends (VanStone, 1967).

With the sale of Russian America to the United States and the subsequent sale of Russian American Company assets to the Hutchison-Kohl Company, a new era of trade and management was begun. The United States administered Alaska through the Army, the Navy, and finally through the U.S. Revenue Service. The first new economic development in the Iliamna region was the establishment of commercial salmon fishing, salting, and soon canning plants on the Nushagak and Kvichak rivers (VanStone, 1967). Following the gold rush to the Klondike in the 1890s, numbers of gold prospectors traveled along the rivers of the region, often supporting their prospecting with fur trapping. Prospectors discovered gold on the Mulchatna and Koktuli rivers, and prospects for other minerals were undertaken soon after (USGS, 2004). Private and government parties undertook exploration beginning in the late 1880s, and exploration continued through today in the case of mineral exploration (Unrau, 1994).

American-period exploration retraced the paths of Russian explorers along the portages and pathways to the interior from the coast (Figures 14-3 and 14-4) (Unrau, 1994). An expedition into the Iliamna region was undertaken by a group sponsored by Frank Leslie's Illustrated Newspaper in 1890-1891. The expedition included John Clark of the AC Company post at Nushagak (later Clark's Point), who traveled through the Koktuli area en route to Lake Clark. Lake Clark received its current name from the AC Company manager through the offices of A.B. Schanz, expedition leader (Unrau, 1994; VanStone, 1967). Other exploration parties explored the interior areas of the Upper Nushagak, Mulchatna, Koktuli, and Stuyahok rivers looking for gold, first in 1887-1888 and later in 1912, when a minor gold rush took place on the upper Mulchatna at Bonanza Creek (VanStone, 1967).

Most commercial fishing and fish packing appears to have taken place downstream from Lake Iliamna on the Kvichak River, as Native workers from the Iliamna area traveled to Bristol Bay for seasonal work in commercial fisheries (Branson, 1999; Ellanna and Balluta, 1992; VanStone, 1967). These canneries were in place and operational by 1894, but were operated primarily by outside workers and management with relatively little use of Alaska Native workers (Ellanna and Balluta, 1992; Moser, 1902; Unrau, 1994;

VanStone, 1967). Following World War II, Alaska Native participation in fishing and processing peaked after slowly increasing through the 1930s, with the Koggiung (Libbeyville) cannery on the Kvichak River operating with an entirely Native crew in 1947 (Unrau, 1994).

Reindeer herding was practiced for nearly 40 years in the vicinity of Lake Iliamna, but it does not appear to have been a commercial success (VanStone, 1967). The first herd mentioned was sent south from Bethel in 1904 and was to proceed east to the Copper River area to support a school there (Unrau, 1994; VanStone, 1967). Hedley E. Redmyer, a Norwegian Saami, could not find a route that would allow the herd to travel there, and he received permission to relocate to Kokhanok in 1905 from Sheldon Jackson. In 1909, the reindeer were herded to Koggiung on the Kvichak River because it was a better environment with more reindeer browse (Unrau, 1994). The numbers of reindeer in the Iliamna district increased to 9,000 in 1920 and 14,000 in 1923, divided between herds at Kulukak Bay, Wood River, Kvichak River, Egegik River, Ugashik River, and Iliamna Lake. After reorganization in 1930, more than 9,000 reindeer were kept at Ugashik, Togiak, Kulukak, Koggiung, and Kanakanak. A herd managed from Newhalen numbered over 1,000 reindeer in 1936, shortly before reindeer herding ended. The animals from this herd were moved frequently due to the shortages of browse, and the practice of reindeer herding ended by 1940 (Unrau, 1994). Reasons for the demise of reindeer herding included poor range conditions due to overgrazing, impacts to the wild caribou populations, better wages in the Bristol Bay fisheries, and the contraction of the market for reindeer meat due to the Depression and troubles with marketing and transporting the meat to the United States (Unrau, 1994).

None of the historic-period activities noted above left traces in the vicinity of the proposed mine project. It is possible that subsistence activities and reindeer herding took place in the area, but little trace of any accumulation of historic materials was apparent in the historic records or during field surveys. Subsistence-hunting evidence of modern vintage was present in the area in the form of caribou skulls with antlers intact, placed with the noses of the animals pointing towards Nondalton. This tradition is based on a belief that harvested animals will return if they are treated appropriately and that pointing the skull towards the hunters' community will direct the reborn animals there (Ellanna and Balluta, 1992).

Known historic resources in the vicinity of the mine project area are few in number. Along the Newhalen River are several sites associated with a portage route that bypassed the rapids called Petroff Falls on maps (Table 14-1). Also in Newhalen is the historic Russian orthodox church, the Transfiguration of Our Lord Chapel, which is listed on the NRHP. Other buildings in the community of historic importance are the Federal Aviation Administration (FAA) buildings in Iliamna, Severson's Roadhouse, and Fish Village on Sixmile Lake. To the northeast are Nondalton's Saint Nicholas Russian Orthodox Chapel and the historical site and district of Kijik, also listed on the NRHP. See Table 14-1 for a list of properties in the Iliamna quadrangle which are considered eligible for the NRHP.

TABLE 14-1
List of properties in the Iliamna 1:250,000 quadrangle known to be eligible for the National Register of Historic Places

AHRS No	Site Name	USGS Map Sheet
ILI-00038	Oil Bay Drilling Site	C1
ILI-00039	Oil Company Cabin	C1
ILI-00005	Dutton	C2
ILI-00052	AC Point	C2
ILI-00132	William's Port to Pile Bay Road	C2D3
ILI-00011	Slatin (slamun house?)	C3
ILI-00018	Fish Camp	C3
ILI-00019	Zip Creek	C3
ILI-00020	Ephium Squirrel Village	C3
ILI-00028	Japanese Point	C3
ILI-00029	Old Nikolai's Point	C3
ILI-00046	Iliamna River Site Complex	C3
ILI-00017	ILI-00017	C4
ILI-00098	George Wassillie Allotment Site	C4
ILI-00130	Pope-vanoy Community Site and Sue Woods Reported Site	C4
ILI-00035	Copper River Mouth	C5
ILI-00076	Leon Bay Cabin Site	C5
ILI-00013	Newhalen Upper Rapids	C6
ILI-00014	ILI-00014	C6
ILI-00015	ILI-00015	C6
ILI-00016	Newhalen Lower Rapids Site	C6
ILI-00024	Transfiguration of Our Lord Chapel, Newhalen [ROC]	C6
ILI-00030	ILI-00030	C6
ILI-00031	Newhalen Middle Rapids Site	C6
ILI-00123	Prehistoric Sites — Housepits and Caches	C6
ILI-00036	Seal Spit	D1
ILI-00077	ILI-00077	D1
ILI-00078	ILI-00078	D1
ILI-00083	NPS Using	D1
ILI-00084	NPS Using	D1
ILI-00085	NPS Using	D1
ILI-00001	Pedro Bay Site	D3
ILI-00003	Russian Point	D3
ILI-00010	Old Iliamna (Ilyamna)	D3
ILI-00021	Lonesome Bay Village	D3
ILI-00022	St. Nicholas Chapel, Pedro Bay [ROC]	D3
ILI-00026	ILI-00026	D3
ILI-00027	White Rock Site	D3
ILI-00043	Iliamna Mission, Iliamna Village [ROC]	D3

AHRS No	Site Name	USGS Map Sheet
ILI-00047	ILI-00047	D3
ILI-00048	ILI-00048	D3
ILI-00049	ILI-00049	D3
ILI-00050	ILI-00050	D3
ILI-00057	Hanak Site	D3
ILI-00131	Iliamna River Bridge, on the William's Port to Pile Bay Road	D3
ILI-00135	ILI-00135	D3
ILI-00006	Chekok (Cheekok, Chikak)	D4
ILI-00032	Knutson Bay	D4
ILI-00033	ILI-00033	D4
ILI-00034	ILI-00034	D4
ILI-00054	Chekok Bay	D4
ILI-00004	Fish Village	D5
ILI-00023	St. Nicholas Chapel, Nondalton [ROC]	D5
ILI-00037	Stonehouse Cave	D5
ILI-00040	Seversen's Roadhouse (Severn's Roadhouse)	D5
ILI-00108	Iliamna FAA Facility [Iliamna FAA]	D5
ILI-00109	FAA Building 100 - Quarters [Iliamna FAA]	D5
ILI-00110	FAA Building 102 - Quarters [Iliamna FAA]	D5
ILI-00111	FAA Building 103 - Quarters [Iliamna FAA]	D5
ILI-00112	FAA Building 105 - Quarters [Iliamna FAA]	D5
ILI-00113	FAA Building 200 - Storage Building/Shop [Iliamna FAA]	D5
ILI-00114	FAA Building 300 - Utility [Iliamna FAA]	D5
ILI-00115	FAA Building 600 - Well House Building [Iliamna FAA]	D5
ILI-00116	FAA Building 601 - Engine Generator Building [Iliamna FAA]	D5
ILI-00133	USBIA ANCSA Using	D5
ILI-00134	USBIA ANCSA Using	D5
ILI-00012	Bear Creek Site	D6
ILI-00086	ILI-00086	D6
ILI-00087	ILI-00087	D6
ILI-00105	NPS Using	D6
ILI-00106	NPS Using	D6
ILI-00107	NPS Using	D6
ILI-00117	FAA Building 400 - Flight Service Station [Iliamna FAA]	D6

14.5.2 Field Survey Methods

Field survey methods were based on pedestrian surveys using one of the following patterns.

- The mine-pit area was surveyed using the camp as the hub of a spoke-and-wheel arrangement and using GPS waypoints to determine the routes and boundaries of the survey (Figure 14-5).
- The reservoir and pyritic-tailings storage areas were surveyed based on the assumption that the areas with the highest probability of having archaeological sites are those around waterbodies and streambeds, along ridges and bluffs, and atop hills and mountains with broad overviews of surrounding territories (Figures 14-6 and 14-7).
- For sites of the VHF repeaters and meteorology stations, the footprint of the project served as the center of an expanding spiral until the slope became difficult to traverse (Figure 14-8).

Conditions for these pedestrian surveys were nearly ideal, with relatively little obscuring vegetation and generally good weather for much of the time spent in the field.

Subsurface testing consisted of 58 test pits (Table 14-2), with 55 located in the mine-pit area (Figure 14-5) and three in the proposed water reservoir (Figure 14-7). Test pits were excavated by hand to approximately two feet square and, in most cases, to more than one foot deep, with the goal being at least two feet or deeper. In practice, this effort was stymied by the surface geology, which consisted of decomposed angular blocks of local bedrock and rounded cobbles to boulders of glacially deposited granites. In areas where soil had accumulated, test pits were excavated. Removed soil and the surface vegetation mat, where present, were chopped finely with trowels and examined for artifacts, lithic debris, organic deposits, and other indications of human use or occupation.

Amy Tomson of SRB&A conducted monitoring of geotechnical assay pits excavated by NDM for the purposes of identifying and characterizing potential deposits of gravel for construction of dams, dikes, and other facilities associated with mine construction. NDM excavated 18 pits over the course of two days in the locations noted on Figure 14-1 and Table 14-3, and in detail in Figures 14-6 and 14-7. Ms. Tomson accompanied the two geotechnical crews by helicopter and monitored the soil being excavated using small backhoe-type excavators to depths up to approximately five feet (Figures 14-14 and 14-15). Ms. Tomson used a shovel and a trowel to partition the back dirt and examined the soil for artifacts, organic layers, and other structures in the soil with the assistance and cooperation of the excavator crews.

TABLE 14-3
Locations of geotechnical test pits monitored by Amy Tomson.

Test Pit	Latitude	Latitude	Longitude	Longitude	Elevation (ft.)
TP04-108	59	55.228	-155	23.638	645
TP04-107	59	50.172	-154	13.082	1155
TP04-105	59	54.514	-155	24.433	1326
TP04-106	59	54.848	-155	24.598	1302
TP04-102	59	53.911	-155	24.542	1333
TP04-104	59	54.49	-155	25.329	1306
TP04-101	59	53.589	-155	25.772	1360
TP04-103	59	54.108	-155	25.065	1290
TP04-100	59	51.313	-155	26.733	1118
TP04-098	59	50.912	-155	26.04	1007
TP04-099	59	51.093	-155	25.381	1035
TP04-097	59	50.547	-155	25.617	993
TP04-096	59	49.913	-155	25.972	632
TP04-095	59	49.896	-155	25.067	1100
TP04-094	59	49.675	-155	24.81	1042
TP04-093	59	49.559	-155	25.989	1012
TP04-092	59	49.121	-155	26.43	1018
TP04-091	59	49.337	-155	24.732	973

The proposed mine pit (Figure 14-5) received the most intensive survey, as its location is the least likely to change and, should the project go forward, where the surface features are most likely to be removed completely. Areas of particular interest were the ridges and benches above the pit to the east (Figure 14-16) and west (Figures 14-17, 14-18 and 14-19) — from which the Mulchatna Caribou Herd was observed in June 2004 — and the elevated glacial deposits at the north side of the valley perched above the Upper Talarik Creek with streams and lakes feeding into that drainage (Figures 14-20, 14-21, and 14-22). The lake shores were also of interest as caribou-hunting sites, fishing areas, and bird-hunting areas. The streams in the valley bottom hosted numerous beaver lodges of impressive size. Figures 14-16, 14-17, and 14-19 are overviews of the valley, showing some solifluction lobes that support alders and willows, with interstitial areas hosting thin moss, grass, lichen, and berry plants. Figure 14-23 shows an overview from the southwest above a chain of lakes and benches, with predominantly lichens, mosses, and berries as surface mat and patches of alder and willow where wind and water have deposited soil. No artifacts or sites were located here, but one interesting piece of frost-shattered rock resembled in passing a semi-lunate knife or scraper (Figure 14-24). No signs of retouch, polish, platform preparation, or use-wear were seen on the piece, and it appeared to refit with neighboring fragments.

Frying Pan Lake was examined, with particular attention to the area along the southeast quarter where Andrew Balluta indicated his beaver-trapping camp had been for many years (Figure 14-25). No signs of this camp were found, although it may be that the camp area was only a clearing in the willows and not an accumulation of usable and discarded material. Figure 14-26 shows an overview of the north half of the lake where water from the valley-bottom complex of streams, beaver ponds, and marshy ground feeds into Frying Pan Lake. Along the northwest 1/4 of the lake the shore changes to sand and sediment which appears to be seasonally pushed up by wind-driven lake-ice into a large stabilized bank. Two test pits were excavated into this sand bank in places that looked like rectangular pits, but there was no indication of cultural material in or around these features. On the west side of the lake, evidence of contemporary use was found, with an array of discarded aluminum cans on the surface and some buried refuse dug out by scavengers (Figure 14-27).

The reactive-rock storage area under proposed alternative G was surveyed on foot over two days (Figures 14-1 and 14-6). The west ridge over the valley was exposed to strong winds from the west during the survey, and woody shrubs and trees grew only in the lee of rock formations on that ridge where wind-deposited soils could accumulate (Figure 14-28). The surface is primarily exposed or moss- and lichen-covered large angular boulders and cobbles (Figure 14-23). Descending the ridge at the northern end revealed a dense growth of willow and alder, with some large cottonwood trees along the creek (Figures 14-29 and 14-30). The eastern ridge featured thin layers of moss and lichen over angular cobbles and, in some cases just cobbles with islands of vegetation as shown in Figure 14-31. This talus slope may have been a persistent snowfield in the past, but neither artifacts nor faunal remains were found. Along the eastern valley slope were numerous boulder fields (Figure 14-32) and rock formations (Figure 14-33) which could have been used as rock shelters, navigation points, and caches for hunting equipment and harvested food. The rock faces were examined for cached material, glyphic art, and other signs of human use, but none were found.

Figures 14-34, 14-35, and 14-36 show the vicinity of the proposed water reservoir depicted in Figure 14-7. The area consists of thinly vegetated gravels with patches of alder and willow and a greater variety and density of woody plants in the creek bed. Test pits were excavated on an alluvial feature at the confluence of the main stream and a side stream, where a flattened area gave the impression of some human activity in leveling the ground surface (Figure 14-36, center right). As the stream appeared to have a population of beavers, it is conceivable that it could have been a winter trapping camp. No artifacts were found.

Surveys conducted on the eastern margin of the project area included two VHF repeater sites (Figure 14-37) and proposed meteorology station sites (Figures 14-38 and 14-39). The repeater sites, one built and one proposed, are located on the peaks of Koktuli Mountain in areas with virtually no soil or vegetation (Figure 14-22), reducing the likelihood that artifacts, if present, would be found. The meteorology station sites — one at the proposed mill location on a 1,567-foot ridge west of the camp (Figure 14-38) and one located on a 1,267-foot-tall knoll south of the outlet of Frying Pan Lake (Figure 14-39) — produced no artifacts or sites, but were presumed to have high probabilities of containing sites as they have commanding views over valleys of the north and south forks of the Koktuli River.

Field surveys were suspended at the end of September 2004 as the weather deteriorated and snow covered the project area (Figures 14-20 and 14-21). Subsequent heavy rains and cold temperatures coupled with strong winds made safely working outdoors difficult and reduced the likelihood that any surface features present could be identified.

Some project components were not available for survey as anticipated in the 2004 work plan (NDM, 2004). Roads, power-line corridors, pipeline rights-of-way, and the port sites were not ready for archaeological survey during the 2004 field season and are anticipated for survey in the 2005 and later field seasons.

14.6 Results and Discussion

No artifacts or archaeological or historic sites were located during the 2004 field season. The camp produced the only artifact found: a reproduction of an Eastern Woodlands arrowhead made by former archaeologist Don Quillman (pers. comm., 2004) from heat-treated Missouri chert (Figure 14-40). Erik Hilsinger did not anticipate the negative results of the cultural resource surveys , as the area seemed highly likely to have archaeological sites based on similarities to other areas in Alaska that contain archaeological sites, including Anaktuvuk Pass (Rausch 1988), the Matanuska Valley (Reger and Bacon, 1996; Robinson, West, and Reger 1996), and in central Alaska (West 1996, Chapters 6, 7, 8). Archaeological sites from cultures preceding the Late Wisconsin glaciation of the project area would not have survived the advance and retreat of that period’s final glacial thrust (Figure 14-2).

Figure 14-41 shows a typical test pit excavated in the project area. Relatively thin soils appear to overlay poorly sorted round cobbles and gravels with little stratification. Stratification was noted in some locations and may indicate the presence of volcanic ash, as in Figure 14-42, which shows a light grey band in the two visible pit walls. The test pit in Figure 14-43, which was excavated in a grassy area indicative of better-developed soils, also showed a grey band of ash. Further research may benefit from sampling these possible ash layers and submitting them for geochemical analysis to find out if they correspond to known ash falls, particularly if cultural resources are found in future surveys. Tephras (fine materials ejected from volcanoes and transported through the air) may be used to provide reference dates for archaeological sites based on relative stratigraphic position and are particularly useful for sites with no radiocarbon-datable material, narrowing down the potential date ranges of these sites. Figure 14-44 shows a typical deposit from the uplands above the valley floor, where very thin layers of moss and lichen cover fractured gravels with very little in the way of finer sediments. With little or no soil-formation processes to cover artifacts, they may remain on the surface where they are subject to damage, dispersion, or destruction by natural processes.

Several hypothetical scenarios may account for the negative results. The first scenario is the possibility that the area may not have been used by Native people in the recent or distant past, which could reflect the emphasis on salmon as the core of subsistence and the difficulty of travel into the high country. A second scenario is that the area may have been used infrequently or use may have been extensive geographically to the degree that no one area received enough use to create an archaeological deposit. Coupled with this would be the Athabaskan notion of a “clean camp,” wherein discarded materials are disposed of in a culturally ordered fashion that leaves very little material behind (K.W. Workman, 1996). A third scenario is that some archaeological deposits may have been formed, but were destroyed or dispersed by natural soil-disturbance processes. A fourth explanation is that the surveys simply did not locate any cultural material, but it may still exist there, perhaps in deep deposits.

The peoples of southwest Alaska based their subsistence activities on the wide availability of sufficiently large quantities of salmon at predictable locations and on being able to store the fish for deferred consumption through drying, freezing, fermenting, pickling, salting, and/or packing in oil or fat (Osgood, 1966; VanStone, 1967; Zagoskin, 1967). The reliance on salmon, supplemented by other fish, birds, and terrestrial, marine, and lacustrine mammals, may have served to minimize the need for people to travel to the interior areas for moose and caribou hunting and made residing, traveling, and hunting along lakes, rivers, and streams preferable. Ease of travel and hunting from the water using boats would make overland travel by foot unattractive. This model for residence and land use is somewhat supported by the disposition of known archaeological and historical sites in these areas. Known finds of surface artifacts in the lowlands between the Newhalen River and the mountains to the east would indicate the adequacy of the survey method for finding artifacts where present (M.R. Yarborough, 1994, 1986a). It must be noted that absence of evidence is not evidence of absence; other factors may have better explanatory power and the dearth of surveys of any kind in the Nushagak-Big River Hills zone may be of greater explanatory power in understanding the apparent lack of sites.

Infrequent use of the area or frequent use over time and dispersed over a wide area may explain the lack of identifiable sites, as no large sealed, unified deposit would be created by dispersed or infrequent use. The area of the project is not particularly well suited for long-term human occupation in some important ways. The availability of fresh water is an issue in snow-free months, because the rock rubble underlying the area does not entrain water well, and the streams and lakes may be dry by mid-July in some years (Knight Piésold Consulting, 2004; Water Management Consultants, 2004). There is little protection from wind and weather in the project vicinity. Infrastructure sometimes used to harvest caribou may not have been permanent, suitable to the terrain, or considered necessary if other resources were preferred, easier to get, and more plentiful. Moose habitat tends to be along streams where cover and arboreal browse are available. Other resources such as furbearers, berries, bears, grayling, and trout were all available closer to the river and lake shores where people most likely lived. Frying Pan Lake is at the limit of most known historic travel from historic villages for beaver trapping and winter hunting by hunters on snowshoes or using dog traction. The area is remote even with modern snowmachines and four wheelers (Ellanna and Balluta, 1992). Before the deglaciation of the lakes and lowlands of the Iliamna/Lake Clark area, however, the project area may have been suitable for glacier-margin hunting of large fauna, potentially including mammoth, mastodon, bison, and the like in the earliest time following the retreat of glaciers at the end of the Late Wisconsin period (West, 1996). More recently, for the Dena'ina, the suggestion of preferential, ordered waste disposal has emerged as a cultural value, which would further limit the formation of recognizable archaeological deposits (K.W. Workman, 1996).

Soil-disturbance processes (pedoturbation) caused by freezing and thawing (cryoturbation) and animal activities (faunalturbation) are prominently in evidence in the project area (Detterman and Reed, 1973, 1980; Detterman, Reed, and Rubin, 1965; Wood and Johnson, 1978). Arctic ground-squirrel burrows are ubiquitous in every project component surveyed, and the disturbance caused by predators (bears, wolves, and foxes) that prey on these abundant animals includes burrows that have been dug out entirely (Figures 14-38 and 14-45). Floralturbation, disturbance caused by plant root action, is present but is a relatively minor contributor to soil disturbance.

Cryotubation observed in the project area includes patterned ground, patterned rock, frost boils, artesian geysers, solifluction, gelifluction, slumping, and frost-jacking and sorting (Wood and Johnson, 1978). Patterned ground refers to the geometric patterns created in repeatedly frozen organic silts — polygons with raised outlines of grasses, sedges, mosses, or dwarf shrub vegetation. Patterned rock formations were observed atop Koktuli Mountain, with polygons generated from the angular blocky cobbles by freeze and thaw processes (Figure 14-37). Frost boils are locations where soils saturated with liquid water under pressure burst through frozen surface layers, pushing soil and rock out into a surface mound (Figure 14-46). Animal burrows that flood in the spring thaw may exaggerate the regular boil formation process, or may themselves flood and deposit soil from underground on the surface (Figures 14-47 and 14-48). Artesian geysers are created when water pressure from meltwater trapped in permeable soil between two frozen layers on a slope travels down slope at increasing pressure to be released at a weak point, bursting out under high pressure and washing away finer soils and leaving large sorted rocks with little matrix in context (Figure 14-9). Evidence of this process is found southeast of the camp near the lakes, where patterned ground vegetation of woody shrubs has blown out deposits of boulders and cobbles rather than silt and sand. Solifluction and gelifluction are processes wherein water-saturated soils in perennially or permanently frozen grounds become mobile, either sliding down slopes or oozing between frost fronts and other subsurface impediments. One example is the visible waves sliding down the bedrock cored mountains of the project area. As the soil creeps down the slope, the top is left bare, the slope appears wavy, and the base becomes relatively steep as soil piles up (Figures 14-11, 14-12, 14-13, 14-17, and 14-31) (Detterman and Reed, 1973; Wood and Johnson, 1978). Slumping caused by changes in soil cohesion may be due to freeze and thaw cycles and is usually seen in banks and bluffs where soil will break off in chunks or slide if gelid and fall into a pile at the slope bottom. Frost jacking and sorting are related processes in which items longer than they are tall can be oriented vertically by repeated freeze and thaw cycles, then forced out of the ground to lay flat on the surface (Figures 14-20 and 14-21) (Wood and Johnson, 1978). In the same set of processes, soils and rocks are sorted by size as the frost front moves through the soil and depending on soil moisture and saturation, direction of freezing, presence of permafrost, and size and shape of the rocks (Figure 14-22) (Wood and Johnson, 1978).

Recent experiments conducted in the Katmai National Monument indicate that over relatively short periods, surface deposits of lithics associated with stone tools and their manufacture can move relatively large distances (Hilton, 2002). In addition to cryoturbatory effects, wind and rain apparently had some effects on the disposition of artifacts after their deposition. Buried objects moved little after the first year, but objects on the surface but protected from wind moved 4.7 centimeters the first year. Objects on the surface not protected from the wind moved an average of 18 centimeters per year, which would decontextualize the artifacts in a relatively short amount of time (Hilton, 2002). Loss of context, if it involved the entire site, would likely render the site ineligible for the NRHP and reduce its value to archaeology significantly. Damage from freeze- and thaw-cracking, tumbling, and wind movement could further destroy visible artifacts, soil structures, and surface improvements, making it difficult or impossible to identify those sites subject to these processes over time (Hilton, 2002).

14.7 Summary

Pedestrian surveys, subsurface testing, and monitoring of geotechnical test-pit excavation were performed in areas which may be disturbed by the proposed mine project. The mine-project area is located primarily in an upland zone with potential for archaeological and historic sites; however, no sites were identified during the summer 2004 surveys. Hypotheses addressing the absence of archaeological and historical sites were constructed, and methods for testing these hypotheses will be developed for the 2005 field season. Questions about historic and prehistoric use may be informed by inferences drawn from ongoing historic research coupled with subsistence interviews and land-use mapping interviews to be conducted in 2005 and later.

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APPENDIX A
TABLE 14-2

TABLE 14-2
Summary of test pit data for the summer 2004 archaeological field season

Test Pit Code	Date	Max. Depth Below Surface (ft)	Root Mat Thick-ness (ft)	Layer 1		Layer 2		Layer 3		Notes	Latitude 59	Longitude -155
				Thick-ness (ft)	Description	Thick-ness (ft)	Description	Thick-ness (ft)	Description			
TB-001	6/29/2004	19	3	14	Dark brown sand loam with cobbles and boulders	2	Yellow-brown sand and silt, cobbles and boulders	0		Grass roots infiltrate boulder and cobbles with silt-loam matrix	54.461	18.096
TB-002	6/29/2004	18	3	3	Gravel: pebble layer, angular blocky material	13	Dark brown silt loam	0		A layer of small subangular and rounded pebbles under the root layer	54.31	18.347
TB-003	6/29/2004	24	3	21	Light brown undifferentiated sand and silt loam; no gravels, cobbles in matrix	0		0			54.141	18.792
TB-004	6/30/2004	21	3	17	Dark brown sandy soil, undifferentiated	1	Small subangular and rounded cobbles and pebbles at 20 inches below surface, pavement-like	0			53.575	17.492
TB-005	6/30/2004	23	4	1	Thin layer, 1-3 inches, of organic and weathered soil under heather and berry bush root layer	15	Light brown sandy soil with subangular and rounded pebbles and cobbles	0		Crowberry, cloudberry, and salmonberry surface vegetation with lichen and mosses; well-aerated root layer, almost peat-like	53.37	16.916
TB-006	6/30/2004	24	1	23	Wet clay under thin mat of grasses and mosses. Large boulder in center, water infiltration rapid from pit walls	0		0			53.54	17.118

Test Pit Code	Date	Max. Depth Below Surface (ft)	Root Mat Thick-ness (ft)	Layer 1		Layer 2		Layer 3		Notes	Latitude 59	Longitude -155
				Thick-ness (ft)	Description	Thick-ness (ft)	Description	Thick-ness (ft)	Description			
TB-007	6/30/2004	17	2	2	Pebbles and sand	5	Silt and sand with rounded and angular to subangular pebbles and cobbles, unsorted, light brown	0			53.792	16.574
TB-008	6/30/2004	19	2	17	Unstratified, unsorted silt loam with occasional small subangular cobbles	0		0			54.087	16.652
TB-009	7/1/2004	23	2	21	Undifferentiated dark brown silt loam with unsorted small cobbles	0		0			54.815	18.377
TB-010	7/1/2004	14	2	10	Mud and matted organic material with rounded cobbles and boulders	0		0		Water table at 12 inches; roots matted organic material (peat horizon developing)	54.902	17.965
TB-011	7/1/2004	23	3	5	Cobble to boulder layer with sand and silt loam matrix	15	Undifferentiated silt loam, tan brown	0			53.584	16.009
TD-001	7/27/2004	27	4	3	Black organic soil below root layer	18	Tan silt loam	0			53.928	17.982
TD-002	7/27/2004	24	2	6	Dark brown organic loam, unsorted blocky cobbles	6	Brown weathered silt loam, unsorted blocky cobbles	7	Tan silt loam, unsorted blocky cobbles	Last 9 inches blocky cobbles with silt loam matrix as in layer 3	53.782	17.878
TD-003	7/27/2004	19	7	12	Brown sandy silt with unsorted rounded cobbles throughout	0		0			54.079	18.662
TD-004	7/27/2004	12	2	10	Light brown sand to silt loam with intrusive grey clay lobes	0		0			53.986	18.542

Test Pit Code	Date	Max. Depth Below Surface (ft)	Root Mat Thick-ness (ft)	Layer 1		Layer 2		Layer 3		Notes	Latitude 59	Longitude -155
				Thick-ness (ft)	Description	Thick-ness (ft)	Description	Thick-ness (ft)	Description			
TD-005	7/27/2004	19	4	15	Brown to tan sand and silt loam with unsorted rounded cobbles	0		0			53.573	18.5
TH-001	6/28/2004	25	5	20	Undifferentiated dark brown silt loam with unsorted cobbles to boulders throughout the soil column	0		0			53.855	17.598
TH-002	6/28/2004	24	5	4	Light brown to tan clay and silt	16	Light brown to tan silt and clay with subangular and rounded pebbles to cobbles	0		Root layer in this pit included rootlets with dark brown to brown silt loam mixed with numerous slatey fracturing pebbles, frost fractured	53.883	17.732
TH-003	6/28/2004	21	4	17	Silt loam with rounded fractured pebbles and cobbles	0		0		Root layer is well developed with indications of stratification in the subtle gradation of color from surface to mineral soil layer	54.054	17.829
TH-004	6/29/2004	24	4	21	Brown silt loam with unsorted cobbles to boulders, rounded	0		0		Caribou visible to the north in North Fork Koktuli River valley	54.319	18.36
TH-005	6/29/2004	16	4	12	Brown silt loam with poorly sorted cobbles	0		0		Root layer includes well developed root mat and dark brown silt loam; surface vegetation is lichen, berries, grasses, sedges, and sorrel	54.137	18.8

Test Pit Code	Date	Max. Depth Below Surface (ft)	Root Mat Thick-ness (ft)	Layer 1		Layer 2		Layer 3		Notes	Latitude 59	Longitude -155
				Thick-ness (ft)	Description	Thick-ness (ft)	Description	Thick-ness (ft)	Description			
TH-006	6/29/2004	22	4	3	Black peaty decomposing vegetable matter	4	Silt	4	Silt and cobbles	Layer 4, 2 inches buried soil, balance unsorted pebbles and clay; water saturated throughout; clearly a relict lakebed	53.568	17.525
TH-007	6/30/2004	19	3	15	Poorly sorted gravels, pebbles and cobbles, rounded, in brown silt loam	1	Cobble pavement	0		Edge of bench	53.385	16.891
TH-008	6/30/2004	23	4	10	Dark brown silt and sand with rounded cobbles, unsorted	9	Cobbles, rounded and sorted, with some silt matrix	0		Above lake on bench SSE of camp; former lake shore; surface vegetation moss, grass, crowberries	53.553	17.109
TH-009	6/30/2004	36	6	18	Brown silt loam with poorly sorted rounded and subangular pebbles and cobbles	12	Tan silt to loess. Not compacted, easily excavated; Aeolian or low energy fluvial deposit?	0		On edge of bank above lake/wetland area partway down the slope; root mat and peat mixed with sand and silt	53.798	16.582
TH-010	6/30/2004	19	4	5	Silt, sand, and rounded subangular cobbles	10	Sand matrix with pebbles, cobbles, and rounded granite cobbles, poorly sorted	1	Well sorted rounded pebbles with sand matrix, washed	Thin layer of later deposits over relict fluvial deposit-former stream channel	54.093	16.631
TH-011	6/30/2004	20	2	18	Sorted cobbles with sticky clay matrix; larger rounded granite cobbles nearest surface in the top 6 inches; cobbles penetrate root layer	0		0		Large cobbles with thin lichen and grass covering, up to 2 inches but cobbles visible through mat; tricky walking	54.823	18.386

Test Pit Code	Date	Max. Depth Below Surface (ft)	Root Mat Thick-ness (ft)	Layer 1		Layer 2		Layer 3		Notes	Latitude 59	Longitude -155
				Thick-ness (ft)	Description	Thick-ness (ft)	Description	Thick-ness (ft)	Description			
TH-012	7/1/2004	18	4	8	Cobbles, pebbles, gravel and silt; ranges from 5-8 inches deep, sorted	6	Rounded subangular pebbles, pea sized rounded subangular, with a dense clay matrix binding layer together	0		Root layer from 4-8 inches thick; cut made through animal trail on bank edge of gelifluction lobe	54.906	17.954
TH-013	7/1/2004	26	4	6	Large rounded cobbles	12	Brown silt loam	4	Gravel and sand	Root layer is grass roots; grass tall, looked good for site; pit in gelifluction mound on rim of kettle lake-like object	53.937	17.996
TH-014	7/27/2004	25	5	3	Brown modified soil with silt and sand	9	Silt with extensive root infiltration	1	Grey silt lens; possible tephra?	Layer 4: 3 inches buried peat Layer 5: 3 inches brown silt Layer 6: 2 inches tan clay Rounded pebbles throughout; well stratified test unit	53.768	17.864
TH-014	7/27/2004	25	4	7	Black to dark brown soil with root infiltration and numerous pebbles	4	Black sand to gravel, rounded	10	Tan sand and silt	Large subangular rounded cobbles throughout the layers; heavy frost damage	54.073	18.68
TH-016	7/28/2004	24	3	10	Brown sand and silt	3	3-5-inch-thick band of gray sand to silt	11	11- to 8-inch thick layer brown silt and sand	Rounded subangular pebbles and cobbles sorted near the lower levels	53.997	18.534
TH-017	7/28/2004	12	3	10	Large subangular blocky cobbles, occasional boulders, with some large roots	0		0		Probably a former lake or streambed area; rocks densely packed with sand to pebble matrix	53.565	18.47

Test Pit Code	Date	Max. Depth Below Surface (ft)	Root Mat Thick-ness (ft)	Layer 1		Layer 2		Layer 3		Notes	Latitude 59	Longitude -155
				Thick-ness (ft)	Description	Thick-ness (ft)	Description	Thick-ness (ft)	Description			
TH-018	7/28/2004	13	2	6	Silt loam with blocky cobbles	5	Silt loam with gravel, angular fractured and densely packed	0		On a bench over a creek	54.655	17.341
TH-019	7/28/2004	27	3	4	Brown soil, cobbles, sandy loam, root infiltrated	5	Reddish tan loess	6	Brown silt loam with pebbles	Layer 4: tan loess with red bands Good view of Koktuli from bench; no artifacts, debitage, organic layers; grass, shrubs, fireweed, horsetails	53.565	18.469
TT-001	6/28/2004	24	1	10	Loose dark organic loam, sandy	14	10- to 15-inch layer yellow-brown loose clay loam	0		Boulders with interstitial cobbles first thought to be a stone cache; sorted large boulders a pedoturbatory feature	52.062	17.349
TT-002	6/28/2004	20	5	7	Loose dark sand and silt loam, unsorted rounded pebbles throughout	1	Reddish brown silt loam, weathered	8	Yellow-brown loose clay loam	Grass-covered bench overlooks valley; good view, flat spot, cover	50.407	25.414
TT-003	6/28/2004	24	4	8	Brown sand loam with small pebbles, unsorted rounded	4	4-9-inch-thick dark brown to black sand loam with grey band or lens; tephra?	3	Yellow-brown loose clay loam with angular fractured pebbles	Grey band may be tephra or fire event; on open, flat, narrow ridge near top of hill west of camp	53.581	16.041
TT-004	6/29/2004	21	6	15	Cobbles and pebbles, rounded and unsorted, in brown clay to silt loam	0		0		Surface vegetation is berries, grass; thick root layer; pit on flat, gentle slope about 30 feet from Alan B. pit; gravel is very dense	50.415	25.418

Test Pit Code	Date	Max. Depth Below Surface (ft)	Root Mat Thick-ness (ft)	Layer 1		Layer 2		Layer 3		Notes	Latitude 59	Longitude -155
				Thick-ness (ft)	Description	Thick-ness (ft)	Description	Thick-ness (ft)	Description			
TT-005	6/29/2004	14	4	10	Dark organic silt loam with rounded blocky pebbles. Densely packed soil. Infiltrated with alder roots	0		0		Excavated in alder patch in small alluvial valley off hill west of camp	53.577	15.976
TT-006	6/29/2004	22	8	14	Dark brown silt loam with occasional angular gravel	0		0		Surface mat is forest duff with grass, ferns, detritus; on brushy ridge over a series of ponds in alder patch	54.102	18.679
TT-007	6/30/2004	22	4	18	Silt loam, brown, few angular rounded pebbles and small cobbles	0		0		Surface vegetation is crowberries, grass, some moss	53.983	18.573
TT-008	6/30/2004	19	3	16	Brown to tan silt loam with unsorted rounded pebbles and cobbles throughout	0		0		More lichen in the surface vegetation	53.559	18.515
TT-009	6/30/2004	20	3	7	Unsorted rounded cobbles and pebbles with large cobble capping level, weathered silt loam matrix	10	Brown silt loam with rounded pebbles, sorted	0		Grassy area, moist with fireweed, on slope of esker; mottled lenses of grey-brown sandy soil may be filled-in squirrel dens or ash lenses	53.857	17.582
TT-010	6/30/2004	15	3	12	Undifferentiated brown silt loam with blocky rounded gravel and pebbles	0		0			53.888	17.679
TT-011	6/30/2004	14	3	11	Brown clay loam, or moist silt; fractured angular pebbles, unsorted, throughout	0		0		On east slope of ridge northeast of camp	54.063	17.813

Test Pit Code	Date	Max. Depth Below Surface (ft)	Root Mat Thick-ness (ft)	Layer 1		Layer 2		Layer 3		Notes	Latitude 59	Longitude -155
				Thick-ness (ft)	Description	Thick-ness (ft)	Description	Thick-ness (ft)	Description			
TT-012	7/1/2004	18	4	10	Rounded gravel and cobbles with silt loam matrix	4	Yellow-brown clay with angular fractured gravel	0		Along ridge west of camp below hill crest line	54.467	18.092
TT-013	7/1/2004	22	4	8	Brown organic silt loam, root infiltrated	5	Grey sandy loam with rounded pebbles, 8-13 inches below ground surface	9	Interbedded grey and reddish sandy loam and grey clay, with red sandy loam continuing to floor	Grey clay base layer continues in the SE corner below reddish loam; interbedded lenses <1 inch thick	54.307	18.33
TS-001	7/28/2004	14	2	2	Dark brown organic soil below lichen and moss roots	10	Mustard-colored sandy loam with numerous rounded and a few angular unsorted pebbles and cobbles	0			54.144	18.785
TS-002	7/28/2004	12	4	8	Undifferentiated brown silt loam, root infiltrated	1	Frost-shattered pebble pavement, dense surface	0		On bench near edge of gelifluction lobe or stepped topography	53.603	17.508
TS-003	7/29/2004	2	2	1	Unsorted frost-shattered pebbles and cobbles with some rounded granite cobbles, some sand matrix	0		0		Surface is reindeer moss, some small vascular plants, grasses and sedges occasionally; hard digging	53.399	16.894
TH-020	9/2/2004	30	2	28	Undifferentiated sand in berm on north side of Frying Pan Lake; rectangular-appearing feature; cleared profile in possible feature	0		0		ALT noted 2 possible features, roughly rectangular cut outs in sand berm, neither produced artifacts or soil staining	53.563	17.104

Test Pit Code	**Date**	**Max. Depth Below Surface (ft)**	**Root Mat Thick-ness (ft)**	**Layer 1**		**Layer 2**		**Layer 3**		**Notes**	**Latitude 59**	**Longitude -155**
				Thick-ness (ft)	**Description**	**Thick-ness (ft)**	**Description**	**Thick-ness (ft)**	**Description**			
TT-014	9/2/2004	30	2	28	Undifferentiated sand in lakeshore deposit; possible cache pit features observed and tested	0		0		No cultural remains noted	53.784	16.565
TH-021	9/5/2004	24	3	10	Brown silt loam, some rounded pebbles	9	9 inches below surface is a lenticular dark brown soil stain, buried soil or squirrel burrow	13	13 inches below surface another lenticular soil stain	17 inches below surface rounded blocky large cobbles to boulders	54.089	16.602
TH-022	9/28/2004	18	3	4	Angular fractured gravel to cobbles	11	Clay soil with silt to sand inclusions	0		Area is a seasonal outflow channel for stranded lakes on glacial esker/moraine features in NE pit area	54.834	18.397
TR-001	9/5/2004	16	2	2	Brown silt loam	6	4-6-inch cobbles, rounded and frost-shattered, with brown silt-loam matrix	6	10-16-inch cobbles to boulders with frost-shattered gravel matrix, brown silt loam	Noted sorting of rock material, smaller on top and larger going down	54.896	17.957
TR-002	9/28/2004	16	3	6	Angular frost-shattered pebbles	7	Pebbles to cobbles with some silt and sand matrix	0		Surface is peat, 3 inches of snow	52.069	17.335
TB-012	9/28/2004	18	4	14	Unsorted angular pebble, frost-shattered, with sand and silt matrix	0		0		In 4x8-foot depression on bench/moraine above lake area northeast of mine pit	50.429	25.432

FIGURES

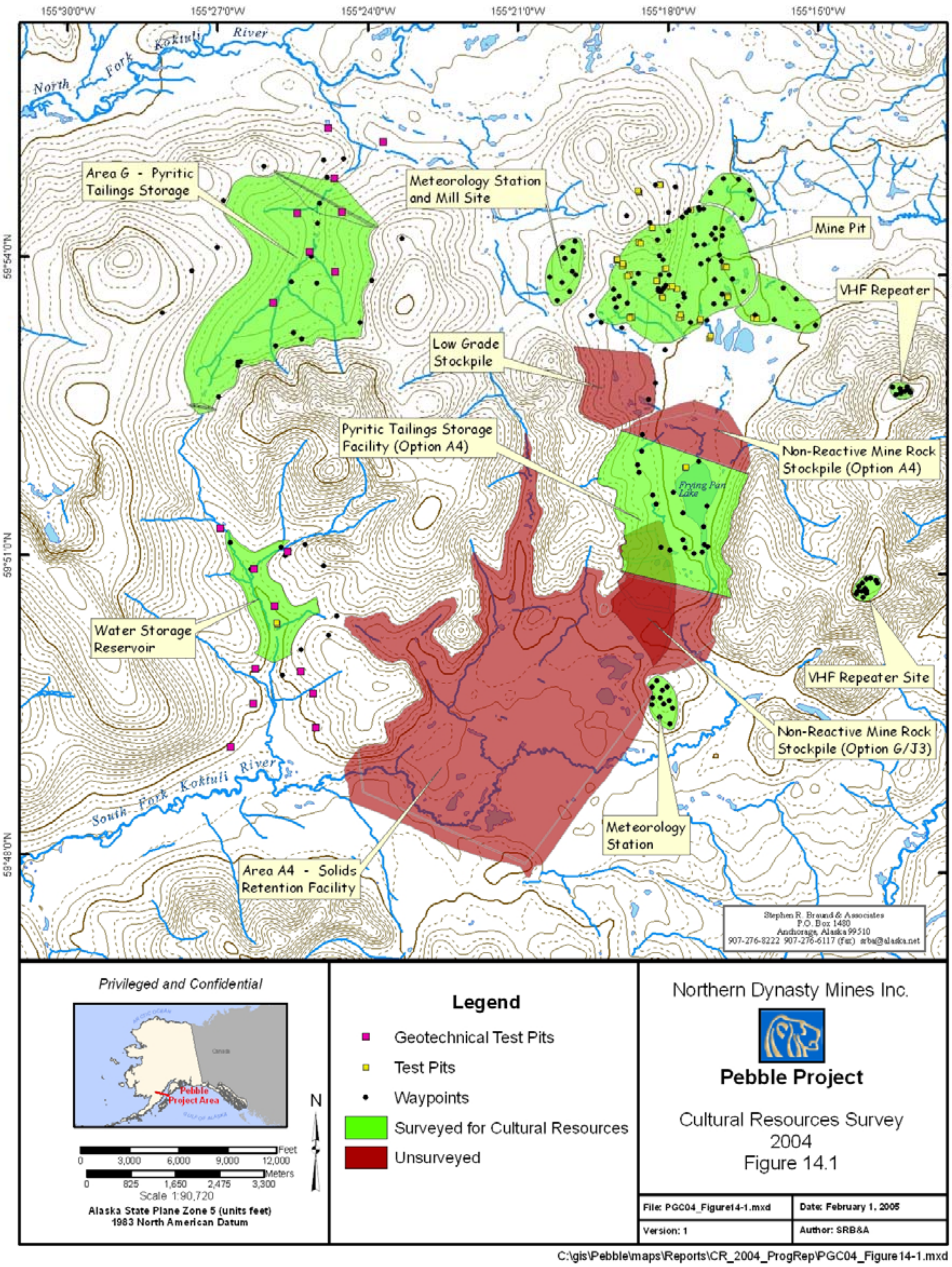


Figure 14.1 Overview Map.

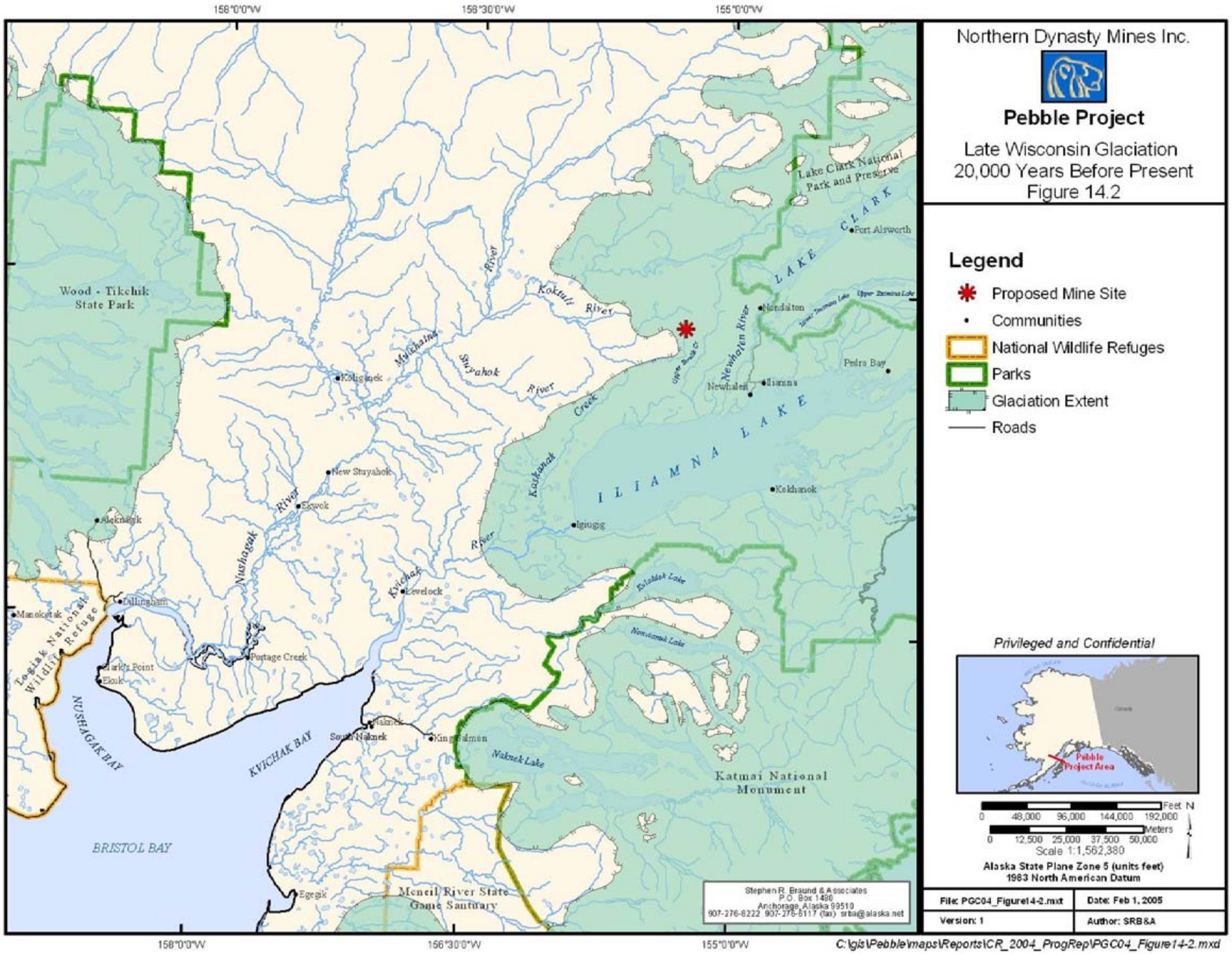


Figure 14.2 Late Wisconsin Glacial coverage.

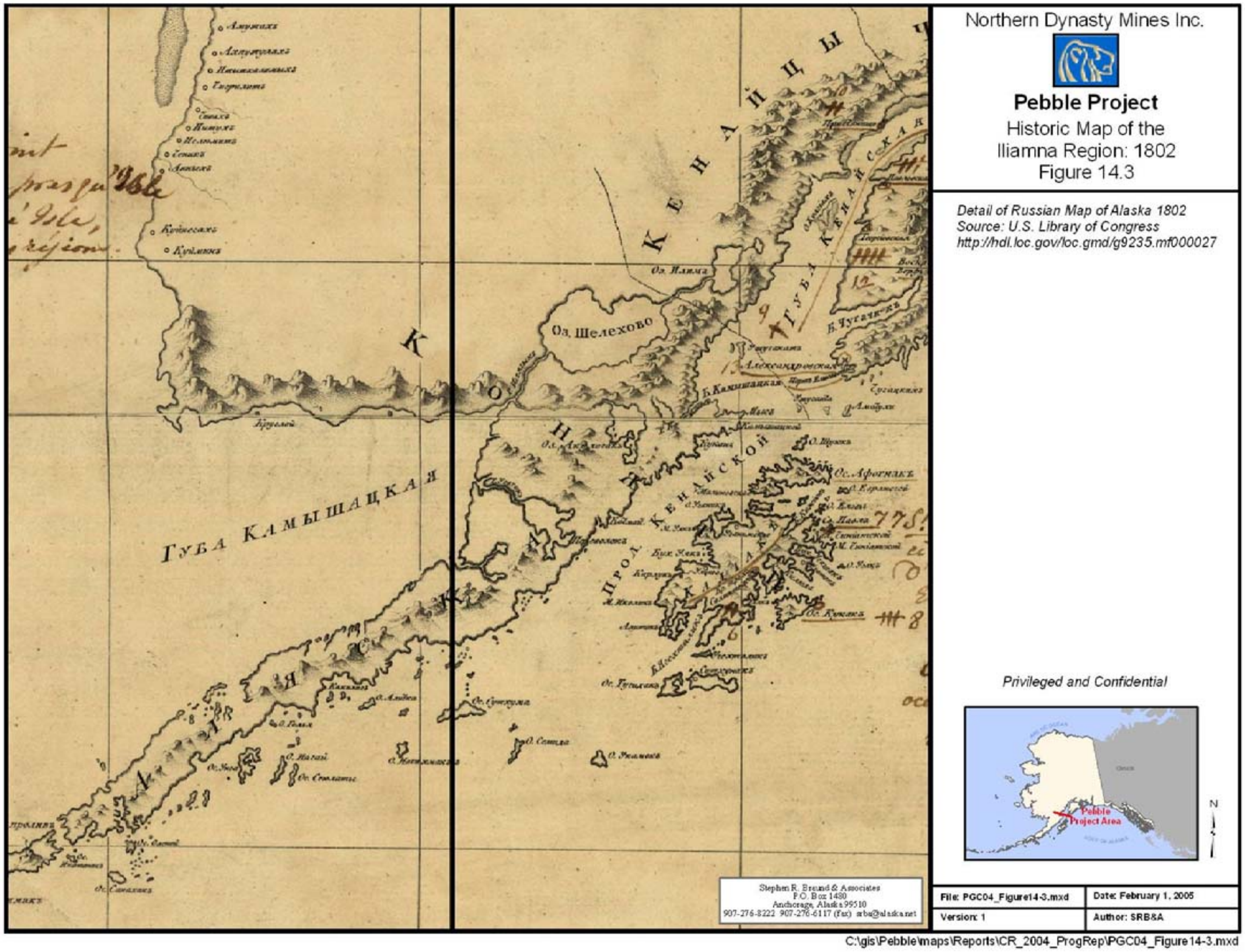
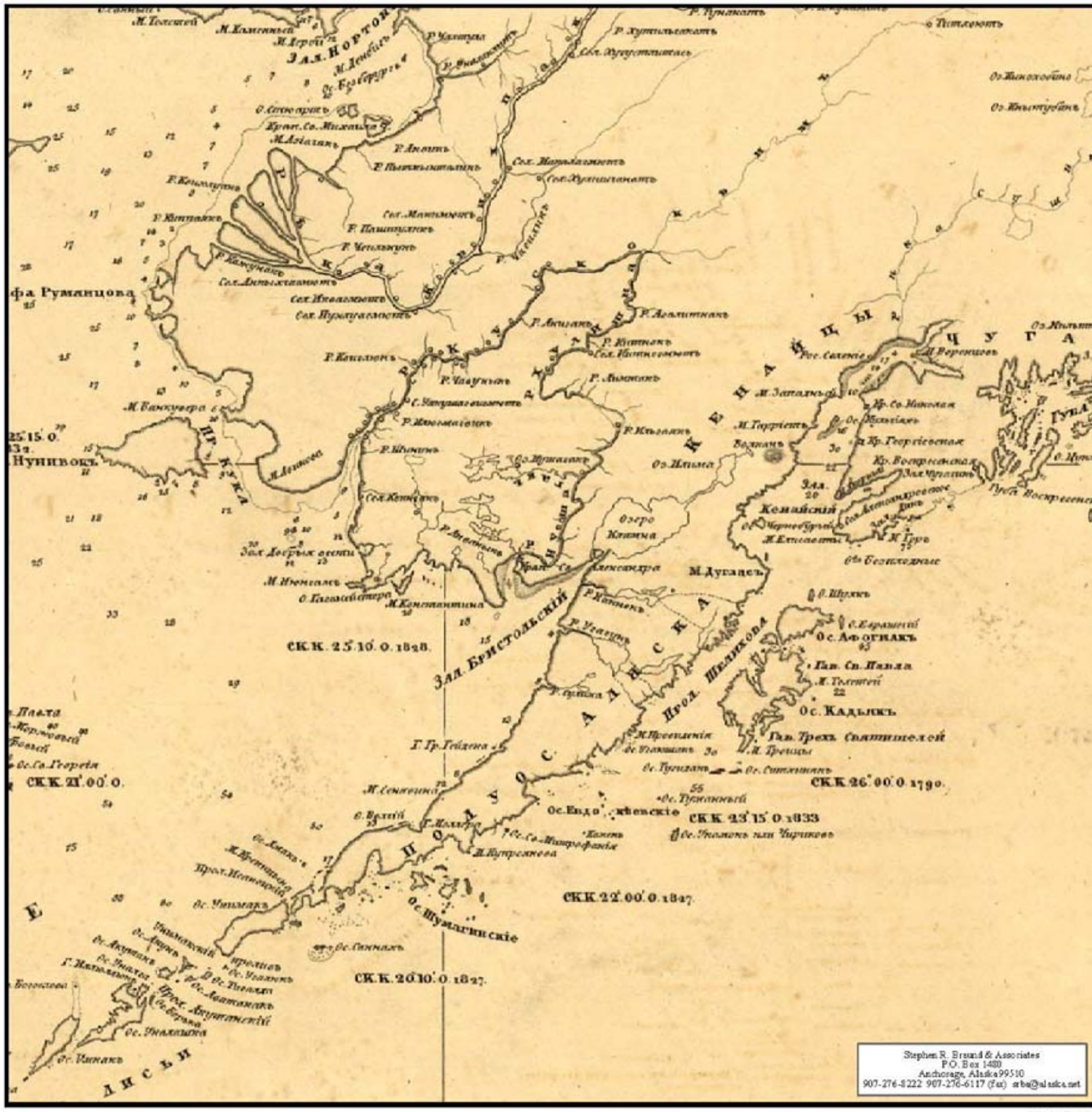


Figure 14..3 1802 Russian Map Detail.

Figure 14.4 1844 Russian Map Detail.



Northern Dynasty Mines Inc.

Pebble Project

Historic Map of the
Iliamna Region: 1844
Figure 14.4

Detail of Russian Map of Alaska 1844
Source: U.S. Library of Congress
http://hdl.loc.gov/loc.gmd/g9780.mf000026

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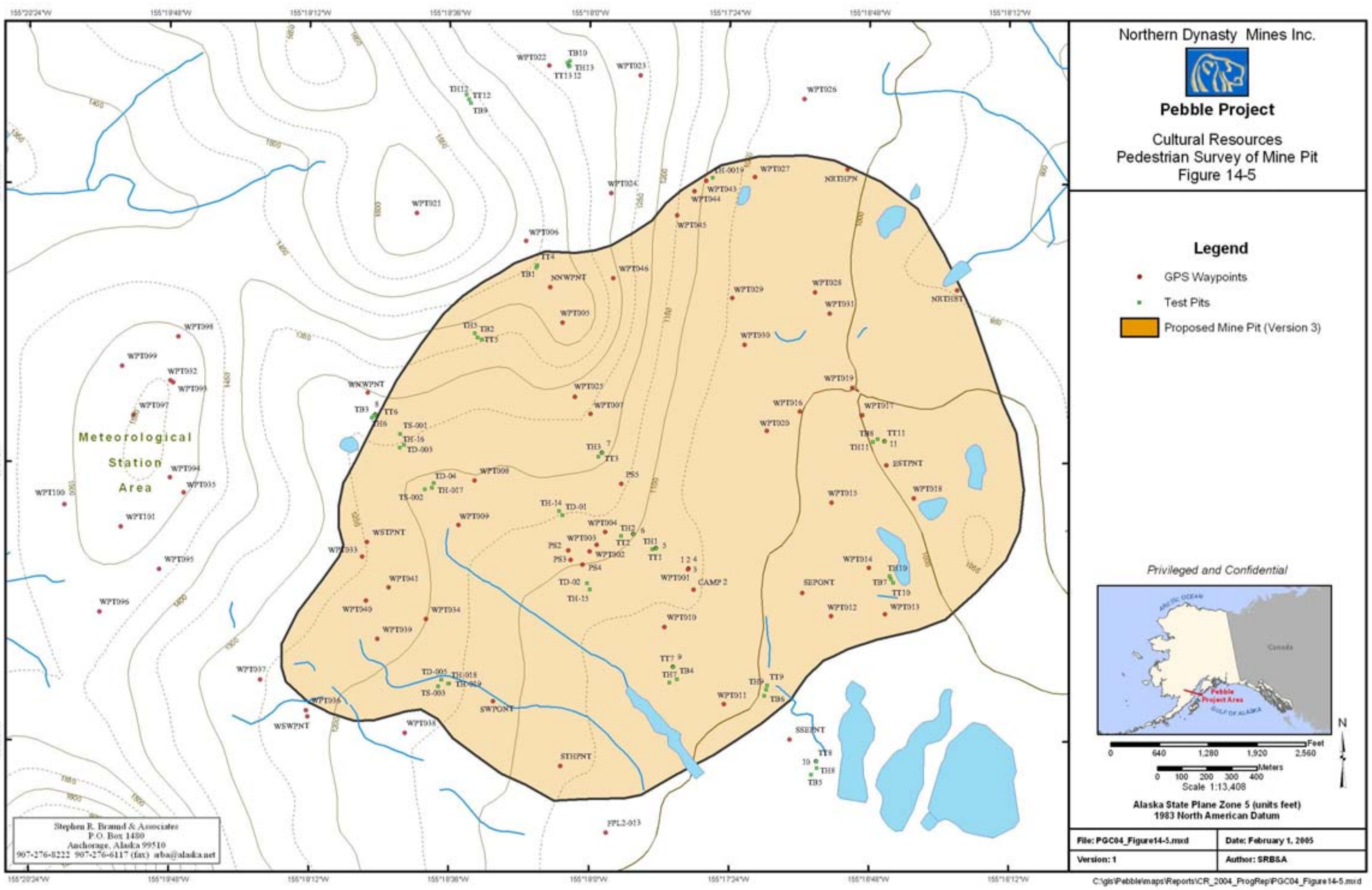
Figure 14.5 Mine pit survey.



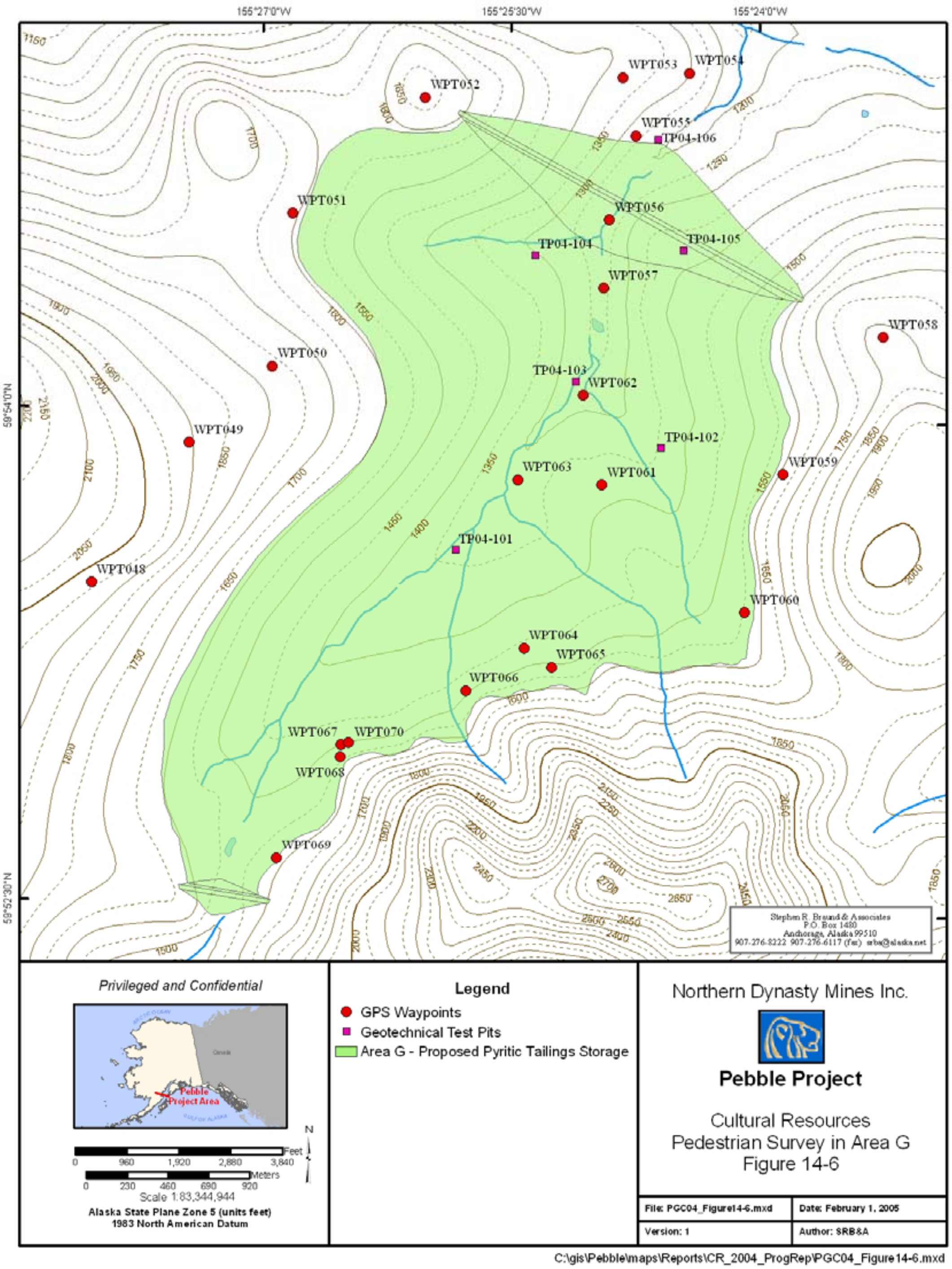


Figure 14.6 Reactive Rock Storage Survey Area G.

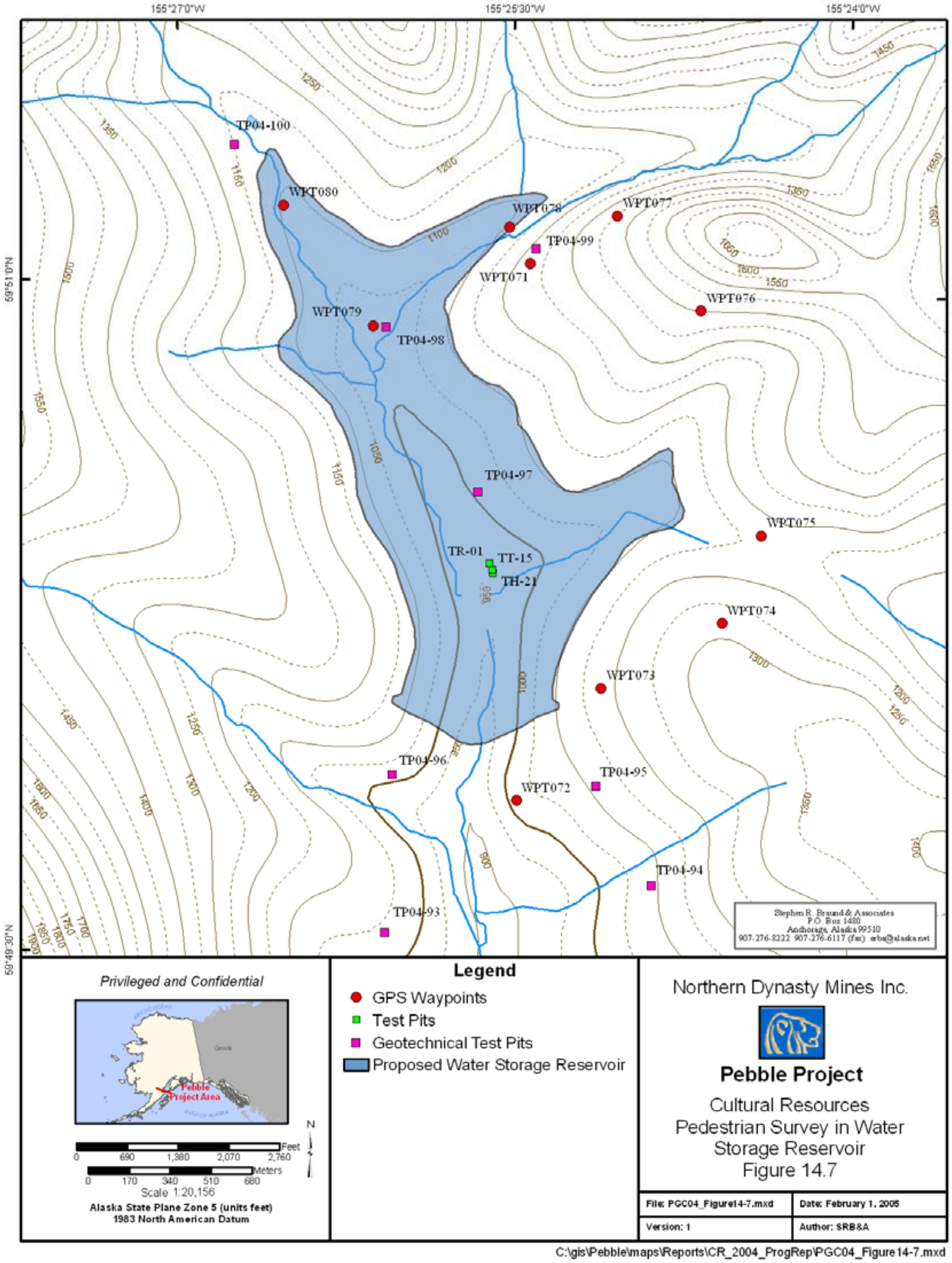


Figure 14.7 Reservoir survey.

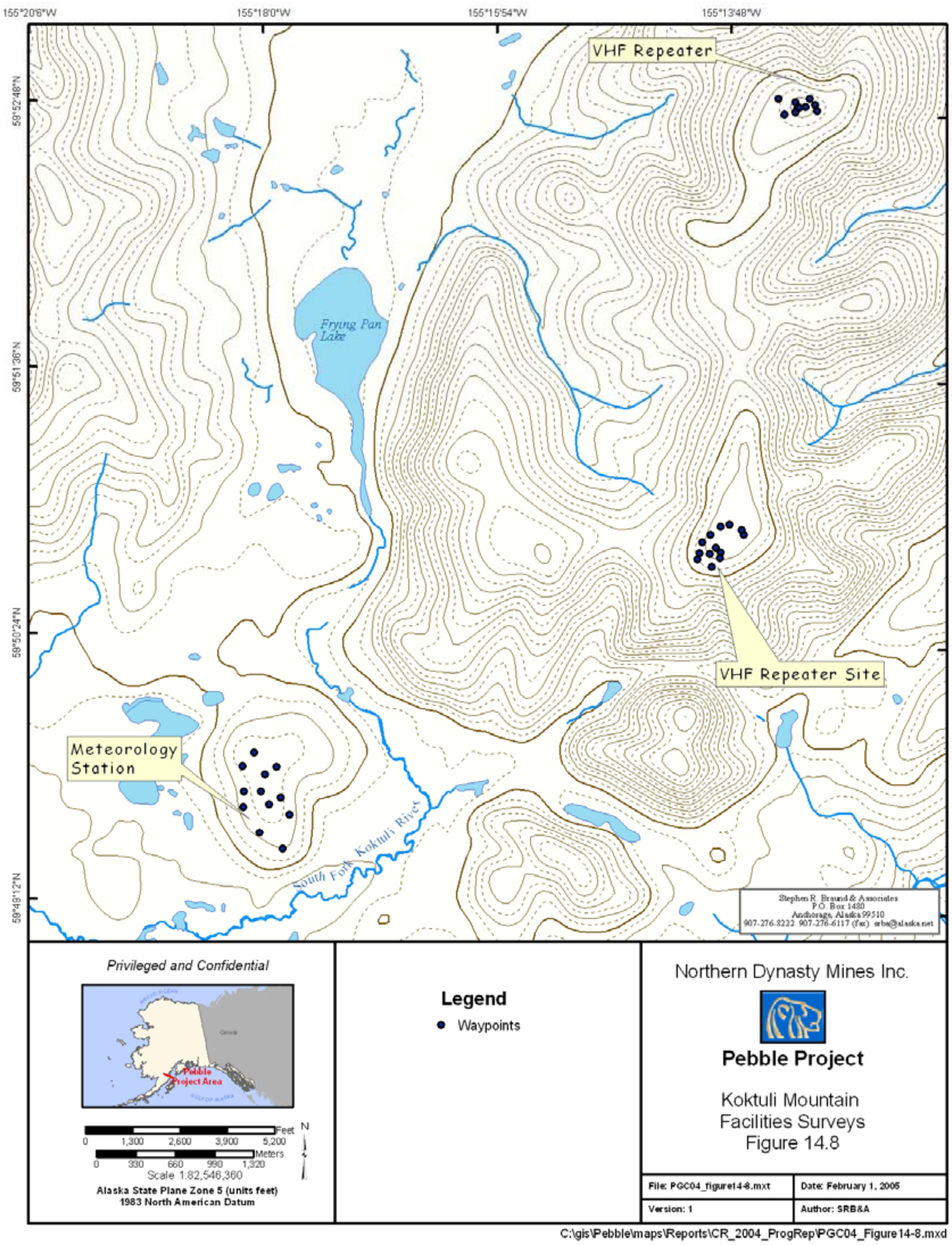


Figure 14.8 Koktuli Mountain surveys.

FIGURE 14-9: Detail of one of several blown out areas near the lakes in the valley bottom. No sand or gravel remains in the matrix of the cobble deposit, and some were still level with the water table in June 2004.

FIGURE 14-10: Glacial rubble formation shows patterned plant growth and dearth of topsoil on elevated features. Alluvial features collect soil and decomposed rock, hosting different plant communities.

FIGURE 14-11: Solifluction lobes on southeast-facing slope by proposed low-grade-ore stockpile.

FIGURE 14-12: Arcuate patterned-ground cryoturbation on ridge above and west of the mine pit. View to the northeast.

FIGURE 14-13: Patterned rock formations on west ridge of proposed pyritic-tailings storage area G. Mountains in distance have glacially derived benches; valley below is outwash formation.

FIGURE 14-14: Geologist investigating a geotechnical test pit. Amy Tomson examined the sidewalls and back dirt for artifacts, stratigraphic differentiation, and any paleontological remains.

FIGURE 14-15: Another geotechnical test pit monitored by Amy Tomson. The excavators had an advantage in that they could dig much deeper than hand shoveling in the difficult glacial rubble.

FIGURE 14-16: Overview of the proposed mine pit from glacial deposit east of the camp. Relict stream below is seasonal stream, then a chain of lakes. Surface moss grew over rounded and angular blocky cobbles to boulders, with steep slopes leading to lakes.

FIGURE 14-17: View over valley bottom showing array of frost disturbance caused by gelifluction. Soil and rock are pushed down slope by gravity, water, and ice formation, forming waves and areas where gravels are expelled under pressure.

FIGURE 14-18: Overview of valley from vicinity of Waypoint 33. Frying Pan Lake is to the right in the distance, and the camp just out of sight to the left. The valley in the mountain in the center background is another possible tailings-storage option.

FIGURE 14-19: Surface area detail southwest of the camp in the area of the string of lakes below the 1,567-ft. ridge.

FIGURE 14-20: Upper Talarik Creek vicinity at margin of extended mine pit area. End of field season for archaeology.

FIGURE 14-21: Lakes northeast of the camp at the end of the field season. Very little protection from wind and weather was available. Vegetated areas visible here were in the lee of the prevailing wind.

FIGURE 14-22: Overview of the channeled glacial deposit in the northern portion of the proposed mine pit from vicinity of GPS Waypoint WPT024. North Koktuli Mountain, center upper right peak, is the current VHF repeater site.

FIGURE 14-23: Surface detail of southwest pit area. Thin moss over rounded granite cobbles, with erratic on surface in left foreground.

FIGURE 14-24: A semi-lunate fragment of frost-shattered cobble found during the last survey of the season. No polishing, retouch, sharpening, or use-wear was present on the piece.

FIGURE 14-25: East side of Frying Pan Lake in willow and alder patch looking north. This is the location of a winter subsistence camp, but no trace was found of one. It is possible that locally hired workers cleared the camp as part of clearing a helicopter landing area in this location.

FIGURE 14-26: View north of valley from glacial deposit west of Frying Pan Lake. Deposit of sand and silt along north shore of lake may also be responsible for predominantly wetlands-like terrain in valley bottom. Numerous beaver lodges impound water in the valley as well.

FIGURE 14-27: Remains of a modern camp at Frying Pan Lake.

FIGURE 14-28: Surface of west ridge of proposed pyretic-rock storage area G. Large, angular frost-shattered boulders are covered in areas with Aeolian-deposited soils or are infilled with mosses and lichens.

FIGURE 14-29: Above the proposed dam area for pyretic-rock containment. Willows, alder, and cottonwoods grow in a soil and moisture trap at the mouth of the valley. The valley mouth is a likely area for sites due to the presence of water, willows, and a canyon terrain that concentrates animals.

FIGURE 14-30: Creek at bottom of valley in pyretic-tailings storage area G. Cleared areas along the creek may have been camp sites, but no artifacts or caches were found.

FIGURE 14-31: Talus slope on east side of pyretic-tailings storage area G.

FIGURE 14-32: Rock outcrops in alluvial fan from a valley that splits the mountain to the east. Area was closely inspected for evidence of human use.

FIGURE 14-33: Another area where volcanic bedrock protrudes from the valley glacial rubble. Area was inspected for tool caches, rock art, rock shelters, and caves, but none were found.

FIGURE 14-34: Side stream to west of main channel in proposed reservoir valley.

FIGURE 14-35: Mouth of valley where proposed water-reservoir dam would be built. Ridge surface has little soil present in vegetational islands. South Fork Koktuli River meanders in the channel in the middle distance, with the bluffs indicating a period of much higher water flow in the past.

FIGURE14-36: Excavating a series of test pits on bench over stream confluence of main stem and northeast trending streambed. Large cobbles and boulders with alluvial deposits of sand and silt were present.

FIGURE 14-37: Alan Baldivieso inspects patterned rock formations atop Koktuli Mountain. Angular blocky frost-shattered rocks have been formed into a network of polygons by freeze/thaw cycling.

FIGURE 14-38: Area at proposed mill site where bears harvested the contents of ground squirrel burrows.

FIGURE 14-39: View west from meteorology station hill (1,267 feet tall) over the proposed tailings-disposal area below.

FIGURE 14-40: Arrowhead found in the camp kitchen. Based on Eastern Woodlands style using a heat-treated chert from Missouri, the point was made by project contractor Don Quillman.

FIGURE 14-41: Test Pit TH-012, showing the typical deposit found along the slopes, where some soil accumulation and formation has occurred.

FIGURE 14-42: Test Pit TH-106, one of a few test pits with stratified deposits. Note the grey band, a possible tephra deposit.

FIGURE 14-43: Test Pit TT-013, also featuring a grey layer that may be a volcanic ash layer. For the 2005 field season it may be desirable to sample the material for comparison with other dated tephras in Alaska, which could help date features in the soil column over a wider geographic area.

FIGURE 14-44: One of many test pits near the lakes and valley bottoms that showed very thin soil accumulated over beds of frost-shattered gravels and cobbles.

FIGURE 14-45: Area at the proposed mill site showing the impacts of bear activity in the ground squirrel burrows.

FIGURE 14-46: Frost boil feature on top of Koktuli Mountain in area where Aeolian deposited soil was present.

FIGURE 14-47: Flooded ground squirrel burrow which expelled runoff or snowmelt and created an erosional feature, redistributing buried material to the surface. On glacial feature in north half of proposed pit area.

FIGURE 14-48: An example of cryoturbatory soil redistribution. Meltwater washed out the substrate, leaving a plume of sorted gravel, sand, and silt on the surface.