Environmental Assessment of the Kodiak Launch Complex

Kodiak Island, Alaska

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Federal Aviation Administration
Office of the Associate Administrator for Commercial Space Transportation
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ACRONYMS

AADC	Alaska Aerospace Development Corporation
CEQ	Council on Environmental Quality (U.S.)
CFC	Chlorofluorocarbon
DOD	U.S. Department of Defense
DOT	U.S. Department of Transportation
ENRI	Environment and Natural Resource Institute (University of Alaska)
EPA	U.S. Environmental Protection Agency
HCl	Hydrochloric acid
ICF	Integration and Checkout Facility
IPP	Instantaneous Impact Point
IPF	Integration and Processing Facility
KLC	Kodiak Launch Complex
LCC	Launch Control Center
LMLV	Lockheed Martin Launch Vehicle
LSS	Launch Pad and Service Structure
NASA	National Aeronautics and Space Administration (U.S.)
NEPA	National Environmental Policy Act
NAAQS	National Ambient Air Quality Standards
NRMP	Natural Resource Management Plan
OCST	Office of the Associate Administrator for Commercial Space Transportation, Federal Aviation Administration, Department of Transportation
PCB	Polychlorinated biphenyl
PFRR	Poker Flat Research Range (near Fairbanks, Alaska)
PPF	Payload Processing Facility
RSS	Revolving Service Structure
RTI	Research Triangle Institute
SCAT	Spacecraft Assemblies Transfer Facility
SHPO	State Historic Preservation Officer
SPIF	Spacecraft Processing and Integration Facility
USAF	U.S. Air Force
USCG	U.S. Coast Guard
WFF	Wallops Flight Facility (NASA)

UNITS OF MEASURE

g/L	grams per liter
gpm	gallons per minute
L	liter
lb	pound
mg	milligram
µ	micron
µCi	microcurie
µg	microgram
°C	degrees Celsius
°F	degrees Fahrenheit
dBA	A-weighted decibel

Visualizing units of measure

1 mg/L	1 part per million; an example of a unit of one millionth is 1 second in 11.6 days
1 µg/L	1 part per billion; an example of a unit of one billionth is 1 second in 31.7 years

USE OF SCIENTIFIC NOTATION

Very small and very large numbers are sometimes written using "scientific notation" or "E-notation" rather than as decimals or fractions. Both types of notation use exponents to indicate the power of ten as a multiplier (i.e., 10^n, or the number 10 multiplied by itself "n" times; 10^{-n}, or the reciprocal of the number 10 multiplied by itself "n" times).

For example: $10^3 = 10 \times 10 \times 10 = 1{,}000$

$$10^{-2} = \frac{1}{10 \times 10} = 0.01$$

In scientific notation, large numbers are written as a decimal between 1 and 10 multiplied by the appropriate power of 10:

4,900 is written $4.9 \times 10^3 = 4.9 \times 10 \times 10 \times 10 = 4.9 \times 1{,}000 = 4{,}900$

0.049 is written 4.9×10^{-2}

1,490,000 or 1.49 million is written 1.49×10^6

A positive exponent indicates a number larger than or equal to one, a negative exponent indicates a number less than one.

CONVERSIONS

The following rules were used in the conversion and rounding of numbers for this EA:

1. Original numbers were converted from metric to English equivalents (or vice versa) according to standard conversion factors.

2. Original numbers were not rounded before they were converted.

3. Converted numbers were rounded to their appropriate level of precision; normally they were rounded to two significant figures including decimals, for numbers below 10,000. Numbers greater than 10,000 were normally rounded to three significant figures.

4. Metric units are referred to first, with English units in parentheses, regardless of which was the original number.

5. English acres were converted to square meters (if less than 50 acres) and square kilometers (if greater than or equal to 50 acres).

EXECUTIVE SUMMARY

INTRODUCTION

The Kodiak Launch Complex (KLC) is a proposed commercial space rocket launch facility to be located on Kodiak Island, Alaska. The purpose of this environmental assessment is to examine the potential for environmental impacts resulting from proposed KLC construction and operation. The proposed KLC would support commercial rocket launches to place small satellites into orbit.

Alaska Aerospace Development Corporation (AADC), established by the Alaska State Legislature as a public corporation located for administrative purposes within the Alaska Department of Commerce and Economic Development, would be responsible for construction and operation of the proposed KLC. The Secretary of Transportation has been authorized by the Commercial Space Launch Act to oversee and coordinate U.S. commercial launch activities. The Secretary is implementing this authority through the Federal Aviation Administration's Office of the Associate Administrator for Commercial Space Transportation (OCST); the proposed KLC would be licensed through this office. This environmental assessment will provide input to the OCST's determination regarding issuance of the KLC license.

PURPOSE AND NEED

The proposed action would provide a commercial alternative to launching small satellites from Federal installations. OCST promotes commercial space transportation activities and encourages the establishment of commercial launch sites and complementary facilities as an important element of the space transportation system in order to complement U.S. Government sites and assist the Unites States' competitive position internationally (49 USC § 70101). The provision of launch services by the private sector is consistent with the national security and foreign policy interest of the United States. A commercial space launch vehicle facility represents an important national security asset. The proposed KLC would provide infrastructure for placing telecommunications, remote sensing, military, scientific, and research payloads in polar low-earth orbit.

In accordance with implementing regulations issued under authority of the Commercial Space Launch Act, AADC will apply to OCST for a commercial space launch site operator license. This document covers construction and operation of the proposed facilities. Launch-related issues would be addressed on a launch-specific basis, as launches are proposed.

DESCRIPTION OF PROPOSED ACTION

This environmental assessment will inform OCST prior to OCST's determination regarding issuance of a license to operate the proposed KLC launch site. The complex would be located on state-owned land at the eastern side of Kodiak Island, 20 miles south-southeast of Kodiak, Alaska (Figure S-1). The proposed 3,100-acre site is on a peninsula that is commonly referred to as Narrow Cape. Current site uses include grazing, a 190-meter (625-foot) high navigational aid tower and support buildings, and recreation (hunting, birdwatching, fishing, fossil collecting, whale-watching). Principal proposed KLC facilities would include a Launch Control and Management Center, a Payload Processing Facility, and a launch area (Figure S-2). AADC customers would use proposed KLC facilities to place small payloads (up to 5,000 pounds) into orbit using expendable solid-fuel launch vehicles. In the first year of operation, AADC would conduct 1 launch using a team of approximately 100 professionals onsite for up to 6 weeks before the launch. Over the next 22 years, AADC would phase up to a maximum of 9 launches per year with staffing reduced (through operations experience) to teams of approximately 40 professionals onsite for up to 4 weeks before each launch.

CONSIDERATION OF ALTERNATIVES

AADC conducted a statewide survey to identify candidate locations, preliminary screening of 27 locations, detailed literature review and limited fieldwork for four locations, and detailed fieldwork for three locations, resulting in recommendation of the proposed location for KLC. Screening criteria were (1) availability of suitable property; (2) availability of support services nearby; (3) availability of year-round logistical support; (4) availability of food and lodging; (5) availability of safe launch zones; (6) relative environmental concerns; and (7) weather concerns. Figure S-3 identifies the location of sites evaluated.

SUMMARY OF ENVIRONMENTAL IMPACTS

Air Resources

Impacts to air quality from construction and operation activities of the proposed KLC are expected to be localized and short term. Land clearing and the temporary operation of a cement batch plant would increase ambient concentrations of particulates; however, anticipated concentrations would be lower than both state and Federal air quality standards. Operational emissions from the use of diesel generators would be temporary and are not expected to be appreciable off site. Ambient air quality impacts due to particulate emissions from expendable launch vehicles have been estimated to be less than the 24-hour

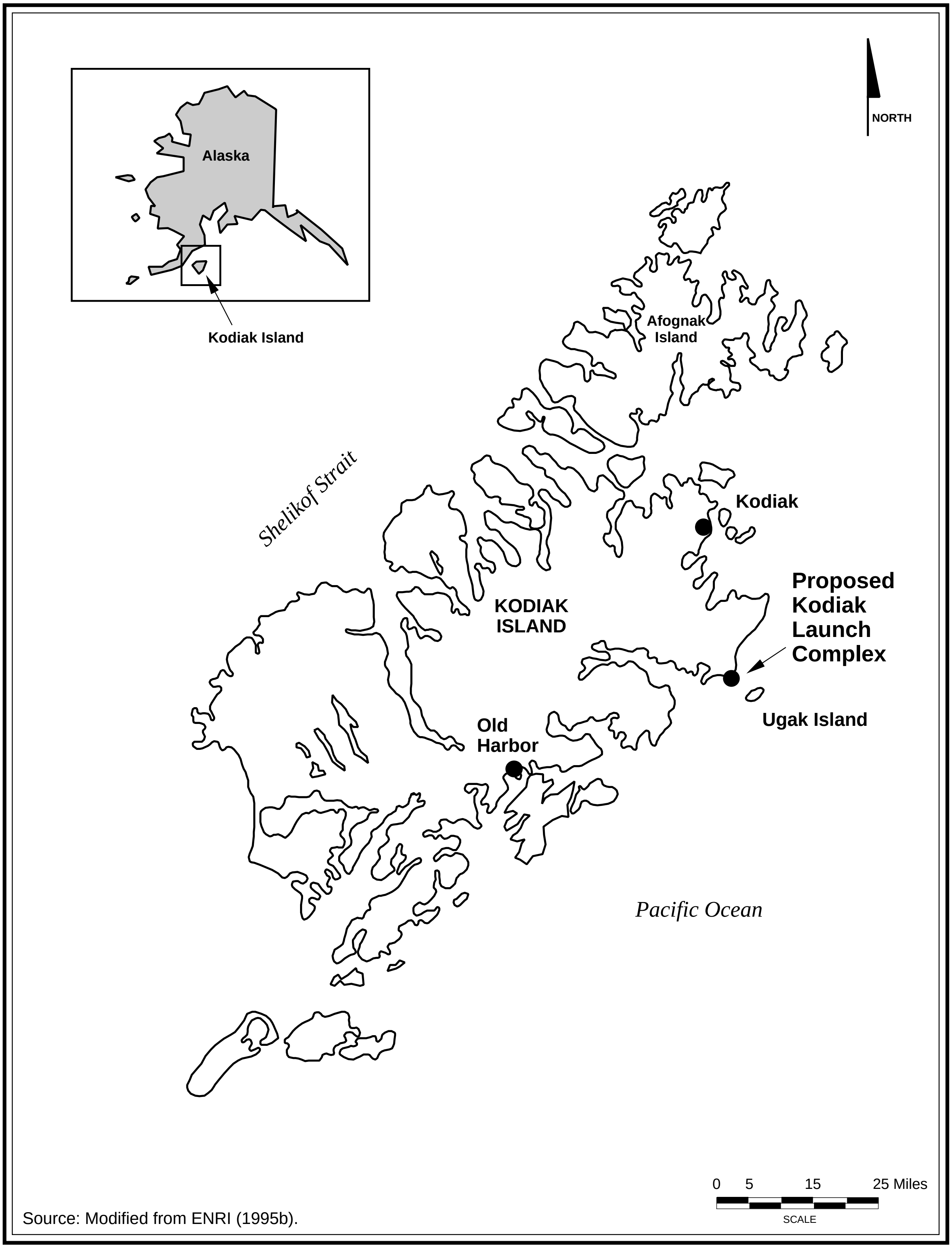

Figure S-1. Proposed Kodiak Launch Complex site location.

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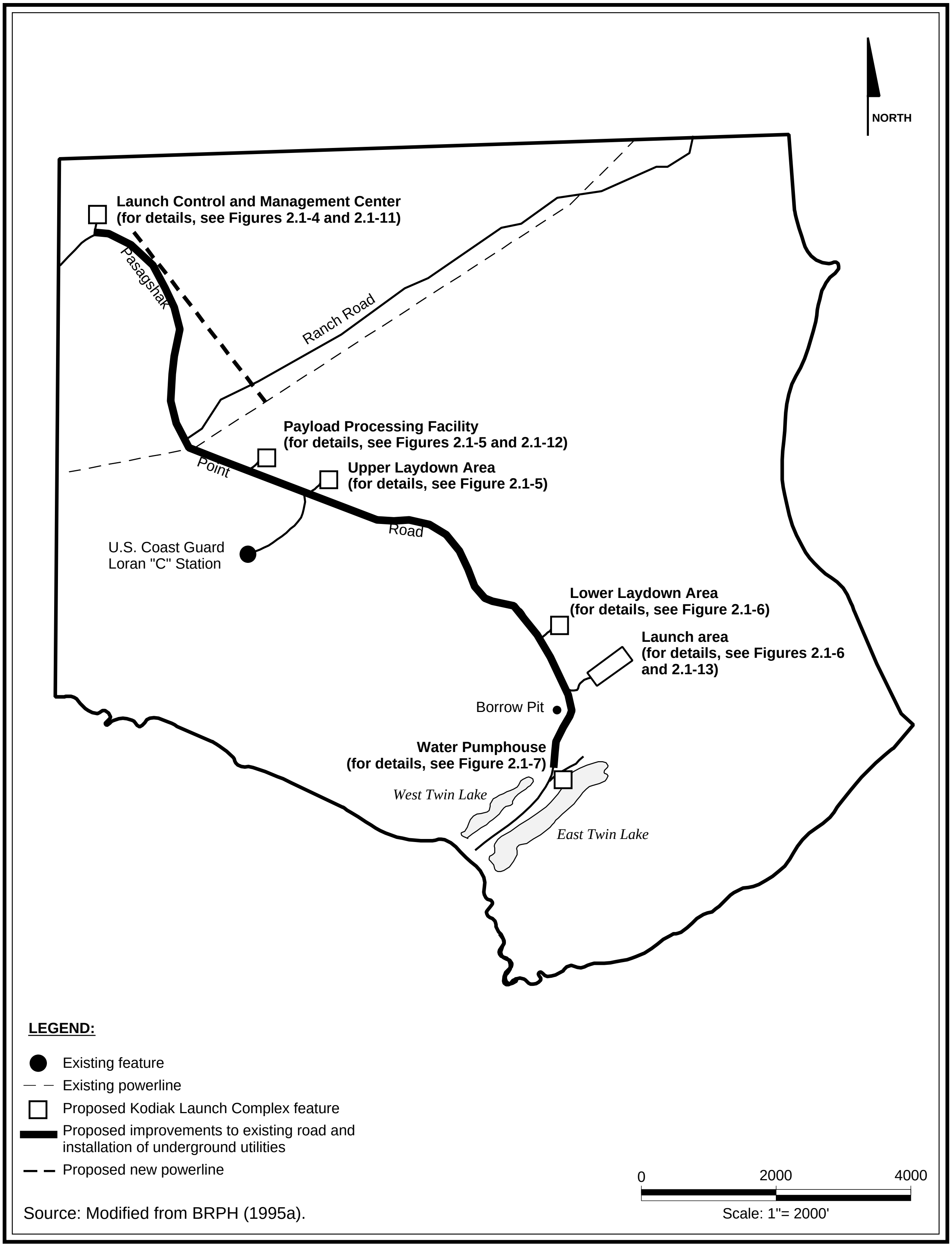

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Figure S-2. Proposed KLC site layout.

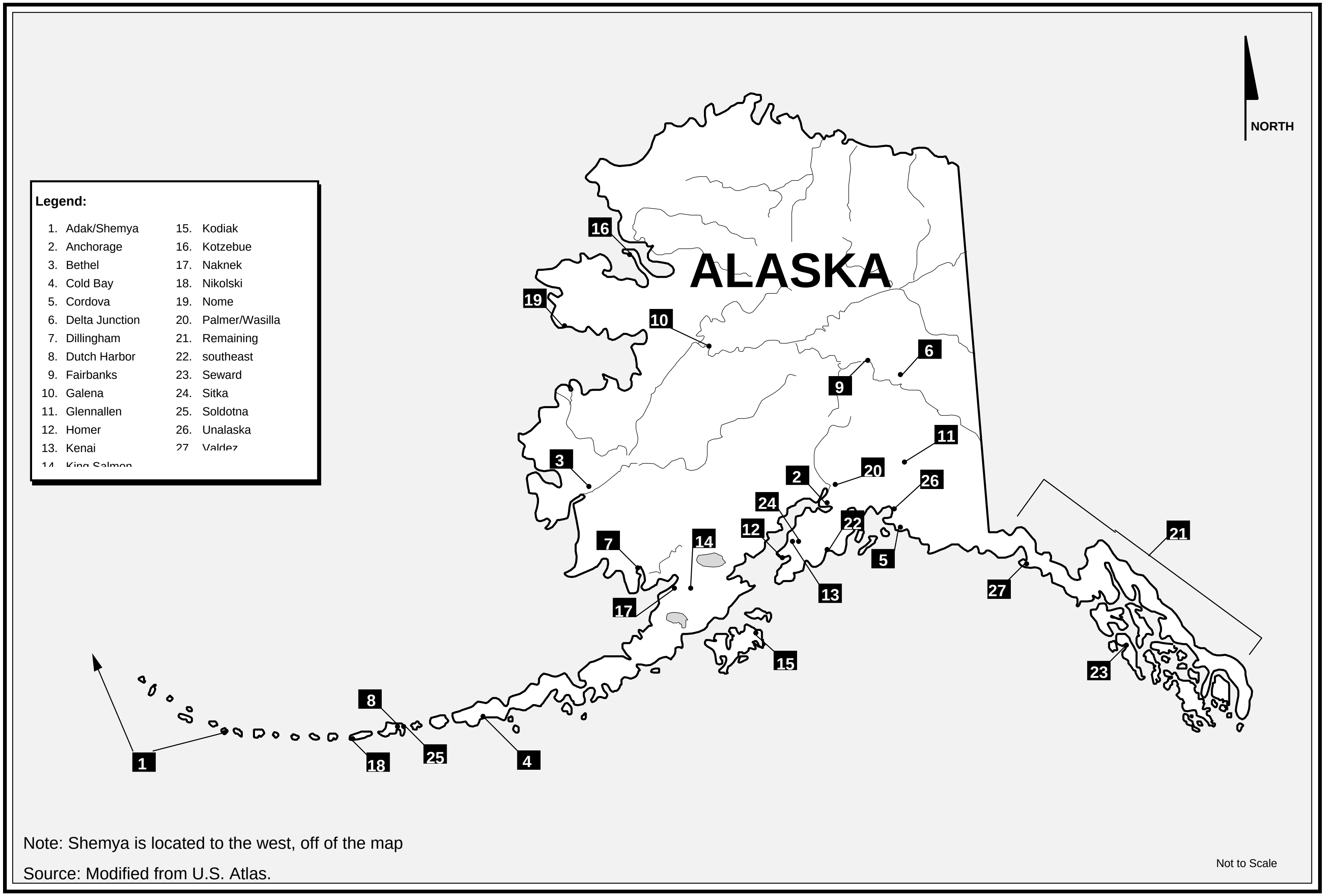

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Figure S-3. Alternative launch site locations.

average National Ambient Air Quality Standard. Emissions of hydrogen chloride (which converts to hydrochloric acid in the atmosphere) and aluminum oxide from launches would slightly degrade local air quality, but impacts would be temporary and are not expected to be substantial. Emissions of toxic air pollutants from liquid fuels are expected to be minimal due to the enclosed nature of storage and the small quantities (maximum 100 gallons) involved. Potential contributions to the upper atmosphere include emissions from ground-level operations as well as exhaust emissions from launch vehicles. Emissions from the proposed nine yearly KLC rocket launches would have a small impact on the levels of ozone found in the stratosphere; however, the release of chlorine and aluminum into the stratosphere would make a minimal contribution to the overall impact of ozone depletion. A Clean Air Act conformity analysis is not required because the air quality control region is in attainment.

Water Resources

Water quality in the area would be protected during construction by erosion and sediment controls established under a Stormwater Pollution Prevention Plan and permitted under the National Pollutant Discharge Elimination System. Potable water would be transported to the site during the construction period; therefore, water resources in the area would not be used for this purpose. Use of portable toilets during this period would also protect the water quality of the area. Some water from East Twin Lake and or groundwater would be used for the temporary cement batch plant during construction, for potable water during operations, and (if necessary) fire protection and personnel deluge during operation. Atmospheric deposition of hydrochloric acid from solid rocket motor exhaust would occur in nearby surface waters. However, pH changes would be mitigated since local streams and lakes have a high capacity for buffering acid inputs as a result of ions (calcium and magnesium) that have been carried into the atmosphere with sea spray and ultimately returned in rainfall. This occurrence, combined with periodic flushing as a result of steep gradients, small catchment basins, and heavy precipitation, would result in small, transitory pH changes.

Geology And Soil Resources

Construction activities for the proposed facilities at KLC would result in the disturbance of approximately 174,000 square meters (43 acres) of topsoil. Although topsoil removal would not impact underlying bedrock, some amount of the area's geologic material could be used for road and foundation work. Adverse impacts to the remaining geologic and soil resources would not be expected. Some erosion would be expected at slopes of 7 percent and greater; however, soil erosion control practices, implemented through the Stormwater Pollution Prevention Plan, would keep erosion damage to a minimum. Changes in soil pH due to acid deposition from launch combustion products would not be expected; KLC soils have a high cation exchange capacity.

Noise

Minor impacts from noise would occur during construction of the proposed KLC, during pre-launch operations, and during launches. Adverse impacts to the occupational health of construction personnel are not expected because workers near activities producing unsafe noise levels would be required to wear hearing protection and worker exposure times would be limited according to standards set by the Occupational Safety and Health Administration. Launch noise would be audible on Kodiak Island for a distance of approximately 19 kilometers (12 miles) for approximately 1 minute. Sonic booms would be heard only on the open ocean. Given the infrequency and short duration of launches, adverse impact to the public is expected to be minimal. Noise levels outside of the Launch Control and Management Center, in which site personnel would be located during a launch, would be within OSHA standards.

Ecological Resources

Construction of the proposed KLC would require clearing, grading, or disturbance of approximately 174,000 square meters (43 acres) of native vegetation. The removal of vegetation would create a reduction in available habitat for birds and mammals. The vegetation types that would be disturbed are abundant on the proposed KLC site and are not considered high-quality wildlife habitat; therefore, impacts to bird and mammal populations would be small.

The noise and activity of construction would cause some disruption to wildlife, causing departure from the immediate area of construction. Construction activity would take place more than 910 meters (3,000 feet) away from a presumed eagle nest site on Narrow Cape and would not be visible from the nest. At this distance, construction noise would be less than 70 dBA and would not be expected to disturb nesting eagles. AADC will advise its construction workers to remain alert to the presence of any eagle nest and will advise the U.S. Fish and Wildlife Service if a nest is found on the construction site.

Launch-related noise could impact terrestrial mammals in the form of species-specific startle responses and possible temporary hearing impairment, but these impacts are expected to be minor, short-term, and localized. Noise impacts to land birds at the proposed KLC would be minimal since startle disturbances are anticipated only during launches, causing birds within an approximate 8- to 10-kilometer (5- to 6-mile) radius of the proposed KLC to fly away from nesting sites, then return within several minutes. Launch-related noise would temporarily disrupt normal activities (resting, feeding, grooming) of pinnipeds and sea otters, but long-term changes in behavior patterns are not expected. Two Federally-listed endangered whale species migrate through the area in spring and fall but would not be measurably affected by infrequent launches from the proposed KLC. The Steller sea lion, a Federally-listed threatened species, and the Steller's eider, a Federally-proposed threatened species, could be disturbed by launch noise; however, disturbances would be brief and noise levels expected from launches would not be anticipated to have a lasting impact.

Substantial impacts to vegetation from the deposition of launch combustion products, primarily hydrogen chloride and aluminum oxide, are not expected. For birds that would receive direct exposure to launch emissions, some harmful effects would be expected; however, few birds would be exposed to the plume since the launch activity is expected to frighten most birds away from the immediate area. Predicted ground-level concentrations of emission products (hydrochloric acid and aluminum oxide) are relatively low; therefore, impacts from toxicity to terrestrial mammals would not be expected. Since these compounds would be dispersed over a large area and immediately diluted and/or neutralized by receiving waters, direct (i.e., acute or chronic health effects) or indirect (i.e., damage to prey species) impacts to marine mammals would not be expected from these chemical releases.

Land-clearing during construction would be carefully planned and temporary; therefore, impacts to down-gradient streams are not likely, and impacts to the freshwater fisheries resources of Narrow Cape are not expected. Measurable impacts to stocked trout, native game fish, and non-game fish are not expected from atmospheric releases of hydrogen chloride and attendant pH changes. Anadromous and marine fisheries would not be affected by construction or operation of the proposed KLC.

Launch Safety

AADC would initiate a flight safety program to protect the public, range participants, and property from the risk created by conducting launch operations, based on the safety regulations in force at U.S. government launch facilities. Proposed KLC facilities would be located so that launch vehicles would fly primarily over open water, minimizing the risk to the public should flight termination be necessary. The flight safety program would result in a total public casualty risk, for all mission activities, that would be less than 1 in 1,000,000.

Land Use

Approximately 174,000 square meters (43 acres) of land would be converted to commercial use from its current use for grazing; land use for the rest of the 13-square kilometer (3,100-acre) site would remain unchanged. The proposed KLC site is state-owned land and represents less than one-tenth of 1 percent of the state-owned land area in the Kodiak Island Borough. The proposed action underwent a review for consistency with standards established under the Alaska Coastal Management Program (Alaska Administrative Code, Title Six, Chapter 80) and was issued a final consistency determination. These standards require that there be balanced utilization and protection of coastal lands and waters, and that there is a higher priority for uses that are economically or physically dependent on a coastal location when compared to uses that do not require a coastal location.

Socioeconomics

Construction of the proposed KLC would result in expenditures of approximately $18 to $24 million on goods and services, which would support the construction industry as well as have an indirect positive effect on the local economy. Adverse impacts on community resources and infrastructure are not expected because the population increase due to construction of the facility would be small (an estimated 45 employees) and temporary (18 month construction schedule). Permanent employment opportunities associated with operation of the facility would be limited because each launch customer is expected to bring its own professional staff for temporary assignments; it is estimated that each launch could require as many as 20 local workers.

Recreation

Impacts to recreational resources would be small. The site would be closed immediately before and during launch activities but would remain open for recreational activities at all other times. It is expected that launches would present additional recreational opportunities because AADC would work with local government and community groups to arrange for viewing sites and bus transportation for interested residents to view launches.

Visual Resources

The construction and operation of the proposed KLC would affect the visual resources of Narrow Cape by placing five new man-made structures into the area. Due to the flat terrain of the Narrow Cape site, the Launch Service Structure, which would be 52 meters (170 feet) in height, would be visible over most of the cape and from offshore. Care during and after construction to return areas adjacent to the structures and site access roads to their pre-construction condition would mitigate visual impacts. The visual impact of the structures themselves would be minimized by painting them a color (steel blue or gray) that would blend into the background of the most common viewing angles. The isolation of the site and limited number of viewers further diminish visual impacts.

Cultural Resources

Cultural resources would not be directly impacted because none have been noted in the area to be developed. Based upon consultation with the State Historic Preservation Officer (SHPO), there are no properties in, or eligible for inclusion in, the National Register of Historic Places within the project's area of potential effect. However, two archaeological sites and a complex of World War II era facilities in the vicinity of proposed construction could experience indirect impacts due to the increase of human activity associated with construction and operation of the proposed KLC. As recommended by the SHPO, these two sites will be taken into account in future overall facility planning.

Hazardous Materials And Waste Management

Construction of the facilities at the proposed KLC would use small quantities of hazardous material that would result in the generation of some hazardous and non-hazardous wastes. The use, management, and disposal of the materials would be handled so that impacts to the environment would be small.

Public Involvement

AADC has obtained public input on its proposed operation of a launch site through legislative approval in open session, open Board meetings, public presentations, meetings, hearings, media coverage, and a citizens advisory committee. From December 1993 through March 1996, AADC has sponsored or participated in 35 events in Kodiak and Chiniak presenting and discussing facts related to the siting, construction, and operation of the proposed KLC. Total attendance by the public has exceeded 600 individuals. In addition, AADC officials have participated in two separate radio call-in shows and responded to 16 callers. Finally, OCST will afford the public the opportunity to review a proposed Finding of No Significant Impact for 30 days because the proposed action, licensing a commercial space launch site, is one without precedent.

SUMMARY

Overall, the construction and operation of the proposed KLC would produce little or no adverse impact to the quality of air, water, or soil in the area. Disturbance of vegetation during construction would result in short-term, localized impacts to birds and mammals. Launch noise is expected to temporarily disturb seabirds and mammals resting and feeding in a 13-kilometer (8-mile) radius of the proposed KLC, but long-term impacts are not expected. Risks to the public would be small and limited to those experienced at existing national launch complexes. Small impacts to recreational and visual resources would be expected. Socioeconomic impacts to Kodiak Island and the state would be beneficial.

CHAPTER 1. PURPOSE AND NEED FOR PROPOSED ACTION

1.1 Introduction

The State of Alaska proposes to construct and operate a commercial space launch facility, the Kodiak Launch Complex (KLC), to be located on Kodiak Island, Alaska (Figure 1.1-1). This environmental assessment describes the proposed action and alternatives considered, the proposed KLC environment, potential effects on that environment, and measures to be taken to mitigate environmental effects.

1.2 Purpose

The purpose of the proposed action is to provide a commercial alternative to launching small satellites from Federal installations. The proposed KLC would make available infrastructure for placing telecommunications, remote sensing, military, scientific, and research payloads in polar low-earth orbit.[1] The facilities would be capable of handling a variety of small, expendable solid-fuel-fired launch vehicles[2] and payloads weighing between approximately 45 and 2,300 kilograms (100 and 5,000 pounds). In the first year of operation, Alaska Aerospace Development Corporation (AADC) would conduct 1 launch using a team of approximately 100 professionals onsite for up to 6 weeks before the launch. Over the next 20 years, AADC would phase up to a maximum of 9 launches per year with staffing reduced (through operations experience) to teams of approximately 40 professionals onsite for up to 4 weeks before each launch.

1.3 Need for Action

In 1984, Congress passed, and in 1990 amended, the Commercial Space Launch Act[3] to accomplish the following:

- Promote economic growth and entrepreneurial activity through use of the space environment for peaceful purposes

- Encourage the U.S. private sector to provide launch vehicles and associated services

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1 Polar orbits revolve around the earth in a generally north-to-south (or south-to-north) direction. Kodiak Island's location is advantageous from a launch safety standpoint, allowing southerly launches over uninhabited ocean.

2 Conestoga, LMLV 1 and 2, Minuteman II, and Taurus, for example.

3 Title 49 Appendix, United States Code, Sections 2601 to 2623 (49 USC 2601-2623), as codified at 49 USC 70101-70119.

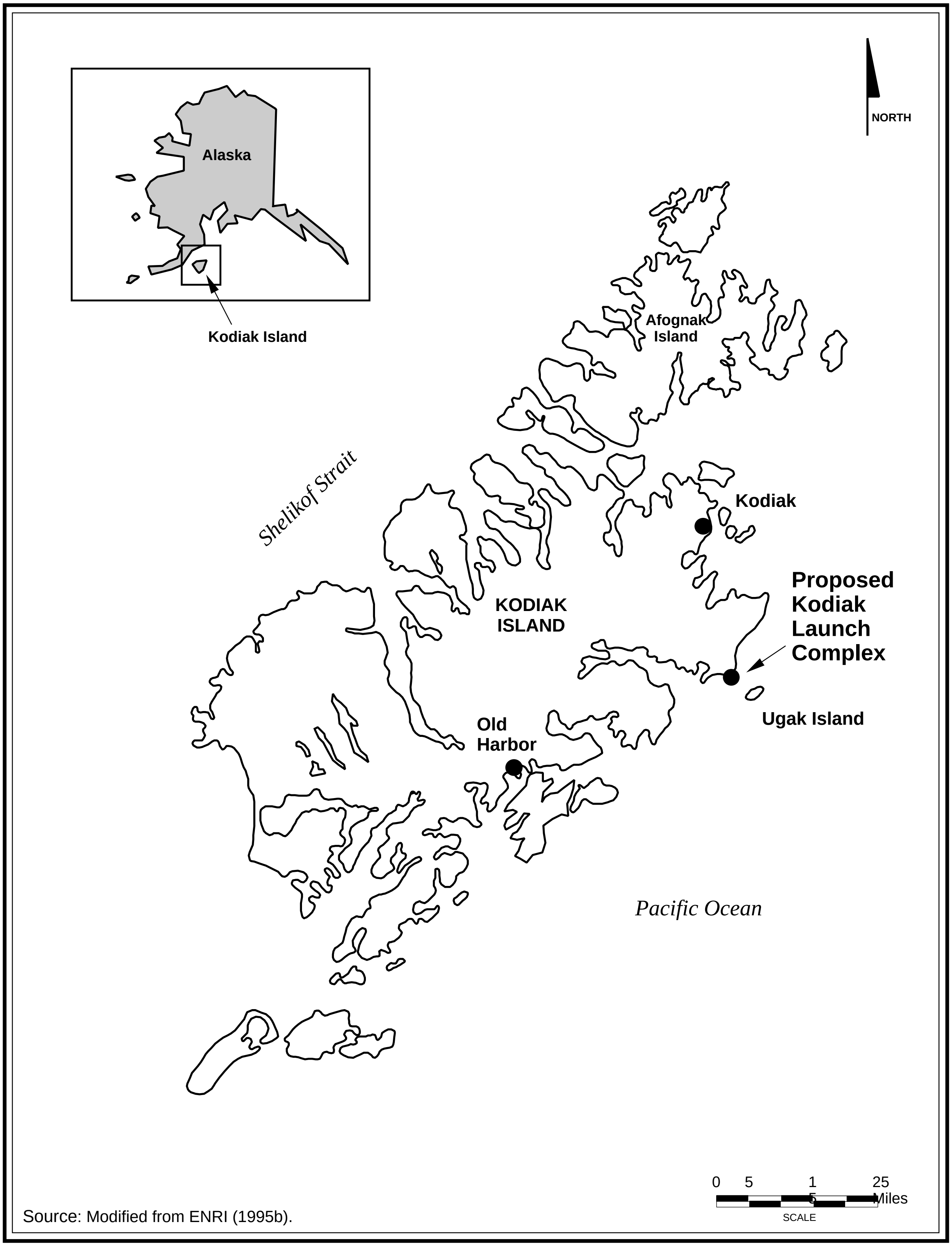

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Figure 1.1-1. Proposed KLC site location.

- Strengthen and expand the U.S. space transportation infrastructure

- Protect the public health and safety, safety of property, and national security and foreign policy interests of the United States

Congress also found that participation of State governments, particularly through establishment of space transportation-related infrastructure such as launch sites and launch site support facilities, is in the national interest and is of substantial public benefit.

The Act authorizes the U.S. Secretary of Transportation to oversee and coordinate U.S. commercial launch operations and issue licenses authorizing commercial launches and the operation of launch sites. In accordance with the Commercial Space launch Act, the Federal Aviation Administration's Office of the Associate Administrator for Commercial Space Transportation (OCST) exercises its licensing authority consistent with its mandate to protect public health and safety, safety of property, and national security and foreign policy interests of the United States. The Secretary is implementing this authority through OCST.[4] In accordance with the Act and Commercial Space Transportation Licensing Regulations, Alaska will apply for a license to operate a launch site.

Space transportation infrastructure can be divided into two major categories: facilities for large expendable launch vehicles that launch large communications satellites into stationary, geosynchronous earth orbit,[5] and facilities for small expendable launch vehicles that launch smaller satellites,[6] most of which are expected to be in low earth orbit. OCST has determined that current infrastructure is neither sufficient to satisfy the demand for small expendable launch vehicles nor able to support envisioned market expansion. A consequence of not increasing U.S. infrastructure capacity could be loss of business to foreign competitors; therefore, development of new sites is needed (OCST 1993).

The proposed KLC would be consistent with the objectives of the Commercial Space Launch Act and the needs that OCST has identified (OCST 1995).

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[4] Title 14, Code of Federal Regulations, Chapter III, Section 411.3(b).

[5] A satellite in geosynchronous orbit revolves in the same direction and at the same speed as the earth, enabling it to stay above a single position on the earth's surface.

[6] "Small" satellites weigh up to 2,000 kilograms (5,000 pounds).

1.4 Background

1.4.1 ALASKA AEROSPACE DEVELOPMENT CORPORATION

The Alaska State Legislature established the Alaska Aerospace Development Corporation (AADC) as a public corporation located for administrative purposes within the Alaska Department of Commerce and Economic Development and affiliated with the University of Alaska. AADC's statute specifies some and the Governor appoints other members to the Corporation's Board of Directors, who oversee the legislatively appropriated budget. The Corporation's primary statutory mission is to develop an orbital rocket launch complex in Alaska.[7] The Corporation would be responsible for the proposed KLC construction and operation.

1.4.2 ENVIRONMENTAL ASSESSMENT SCOPE

The National Environmental Policy Act[8] and implementing regulations of the President's Council on Environmental Quality[9] require Federal agencies to evaluate the impact that proposed Federal actions would have on the environment. The Act and regulations authorize Federal agencies to prepare environmental assessments jointly with state agencies in order to minimize duplication of effort. OCST and AADC have prepared this environmental assessment pursuant to an interagency agreement to document the basis for determining whether the proposed action would have significant impact on the environment. The agreement outlines relative responsibilities of the agencies, including OCST responsibility to independently evaluate the legal sufficiency of the final document (*Joint Lead Agency Agreement Between United States Department of Transportation Office of Commercial Space Transportation and Alaska Aerospace Development Corporation*, February 23, 1995).

OCST regulations differentiate between a launch operation and operation of a launch site and require separate licenses for each. The latter, which involves continuing operations at a permanent location, is the subject of this environmental assessment. The document covers, in general, launches and, in detail, construction and operation of proposed facilities. Specific transportation, payload, and launch vehicle

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7 Alaska Statutes Section 14.40.821, et seq.
8 42 USC 4321 et seq.
9 40 CFR 1500 et seq.

details would be the responsibility of an applicant for a launch license and would be covered by separate environmental documentation.[10]

The recently enacted Interstate Commerce Commission sunset legislation (Public Law 104-88) addresses National Environmental Policy Act applicability to licensing actions as follows:

> Sec. 401. CERTAIN COMMERCIAL SPACE LAUNCH ACTIVITIES.
> The licensing of a launch vehicle or launch site operator (including any amendment, extension, or renewal of the license) under chapter 701 of title 49, United States Code, shall not be considered a major Federal action for purposes of Section 102(C) of the National Environmental Policy Act of 1969 (42 U.S.C. 4332(C)) if--(1) the Department of the Army has issued a permit for the activity, and (2) the Army Corps of Engineers has found the activity has no significant impact.

This provision does not affect preparation of a KLC environmental assessment but obviates the need for preparation of an environmental impact statement as long as the two conditions are met. The Department of the Army Corps of Engineers has reviewed an AADC permit application for KLC activity affecting wetlands, pursuant to the Clean Water Act Section 404, proposes to find that the activity would have no significant impact, and is holding permit issuance pending completion of this environmental assessment.

1.4.3 PUBLIC INVOLVEMENT

As a state agency, the AADC has a fiduciary responsibility to develop its projects with open and full public discussion and in compliance with all Federal, state, and local laws and regulations. The Corporation has obtained public input on its proposed action alternatives through legislative approval in open session, open Board meetings, public presentations, meetings, hearings, media coverage, and a citizens' advisory committee. Appendix A identifies these activities in detail. OCST will make a proposed Finding of No Significant Impact available for public review for 30 days because the nature of the proposed action, licensing operation of a commercial space launch site, is one without precedent.

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[10] OCST has prepared programmatic environmental documentation for launches (U.S. Office of Commercial Space Transportation, Programmatic Assessment of Commercial Expendable Launch Vehicle Programs, February 1986). OCST is preparing an update in the form of an environmental impact statement (61 FR 763, 1/10/96); launch-specific documentation would tier to the programmatic document.

1.4.4 PERMITS, APPROVALS, AND CONSULTATIONS

Several proposed KLC activities require prior permits, approvals, or consultation with Federal, State, and local agencies. Table 1.4-1 identifies these requirements and the proposed KLC compliance status, and Appendix B contains copies of applicable correspondence. In addition, Appendix B summarizes and contains copies of related correspondence, including confirmation that particular permits or approvals are not required (e.g., air permit).

1.4.5 OTHER ENVIRONMENTAL ANALYSES

The environmental effects of launch operations and launches have been extensively analyzed at existing launch and test sites in Alabama, Alaska, California, Florida, Mississippi, Virginia, Canada, and worldwide. The OCST, the National Aeronautics and Space Administration, and the U.S. Department of the Air Force have published dozens of National Environmental Policy Act documents for the following:

- Space programs
- Launch vehicle development and testing
- Launch site construction
- Launches of specific types of vehicles (including those proposed for the KLC)
- Launches of specific types of payloads

Many of these documents address issues that are also relevant to the proposed KLC, such as launch vehicle emissions and noise, effects on marine mammals and seabirds, and launch safety. Therefore, review of these analyses helps in defining KLC issues of concern, determining the appropriate depth of analysis, and evaluating the reasonableness of KLC conclusions. Table 1.4-2 identifies some of the environmental analyses that are relevant to the KLC assessment.

Table 1.4-1. Permits, approvals, and consultation requirements.

Activity	Requirement	Basis	Authority	Agency	Comments
			Federal		
KLC[a] operation	License	Operation of commercial launch site	· Commercial Space Launch Act (49 USC[b] 2601 et seq.) · 14 CFR[c] 143	U.S. Department of Transportation, Office of Commercial Space Transportation	Application process initiated.
	Environmental review	Major Federal action affecting the environment	· National Environmental Policy Act (42 USC 4321 et seq.) · 40 CFR 1500 et seq.	U.S. Department of Transportation, Office of Commercial Space Transportation	Environmental assessment preparation.
LCC[d] construction and Pasagshak Point Road improvements	Permit	Activity affecting wetlands	· Clean Water Act Section 404 (33 USC 1344) · 33 CFR 323	U.S. Department of the Army, Corps of Engineers	Provisional permit to be granted on completion of State of Alaska consistency review.
KLC construction and operation	Consultation	Potential impact to threatened and endangered species	· Endangered Species Act Section 7 (16 USC 1536) · 50 CFR 402	U.S. Department of Interior, Fish and Wildlife Service U.S. Department of Commerce, National Marine Fisheries Service	Consultation initiated.
KLC construction and operation	Consultation	Potential impact to cultural resources	· National Historic Preservation Act Section 106 (16 USC 470f) · 36 CFR 800	See comments	Requires consultation with State Historic Preservation Office. Consultation complete (negative determination).
KLC construction and operation	Certification	Potential to affect state water quality standards	· Clean Water Act Section 401 (33 USC 1341)	Alaska Department of Environmental Conservation	Certification issued.
KLC construction	Permit	Stormwater runoff from construction area	· Clean Water Act Section 402 (33 USC 1342) · 40 CFR 122.26	U.S. Environmental Protection Agency	Notice of Intent (to be covered by General Permit) to be submitted.
KLC construction and operation	Consistency review	Activity within coastal area	· Coastal Zone Management Act (AS[e] 46.40) · 6 AAC[f] 50, 80, and 85	Alaska Office of the Governor	Final consistency determination issued.

Table 1.4-1. (continued).

Activity	Requirement	Basis	Authority	Agency	Comments
			Federal		
Pasagshak Point Road culvert replacement	Permit	Construction that may affect anadromous fish habitat	· AS 16.05.870 · 5 AAC 95.010	Alaska Department of Fish and Game, Habitat and Restoration Division	Permit issued.
Potable water supply and sanitary waste systems	Plan approval	Use of potable water supply and sanitary waste systems	· AS 46.03 · 18 AAC 72.060	Alaska Department of Environmental Conservation	Permit issued.
Water withdrawal from East Twin Lake	Permit	Appropriation of state waters	· AS 46.15.030 et seq. · 11 AAC 72	Alaska Department of Natural Resources, Division of Mining and Water Management	Permit issued.
Pasagshak Point Road improvements	Approval	Modification to state-owned road		Alaska Department of Transportation and Public Facilities	Plans submitted.
Driveway construction	Permit	Driveway encroachment of state row	· AS19.25.200	Alaska Department of Transportation and Public Facilities	Application submitted.
Open burning	Permit	Burning of slash during land clearing/ construction activities	· 18 AAC 50.030	Regional Office of the Alaska Department of Environmental Conservation	Application will be submitted prior to construction activities.
			Local		
KLC construction	Permit	Land use in conservation district	· Kodiak Island Borough Code Chapter 17.13.040[g]	Kodiak Island Borough Planning and Zoning Commission	Approved (contingent upon review and approval of the project by applicable Federal and state permitting agencies).

a. KLC = Kodiak Launch Complex.
b. USC = United States Code.
c. CFR = Code of Federal Regulations.
d. LCC = Launch Control Center.
e. AS = Alaska Statutes.
f. AAC = Alaska Administrative Code.
g. Submitted as matter of comity.

Table 1.4-2. Environmental analyses at other U.S. launch sites.

Site/Documentation	Launch vehicles	Acid Rain	Air	Flora and Fauna: Birds, marine	Freshwater biota	General	Intertidal biota	Sea lions	Seals	Fauna, terrestrial	Flora, terrestrial	Whales	Hazardous materials	Noise	Radiation	Safety	Socioeconomics	Surface water	Waste	Water quality	Water supply	Visual	Weather modification
Vandenberg Air Force Base, California																							
U.S. Department of the Air Force, Environmental Assessment; Titan IV Space Launch Vehicle Modification and Operation, February 1988	Titan IV		x	x	x		x	x	x		x	x	x	x		x	x	x	x	x	x	x	
U.S. Department of the Air Force, Environmental Assessment for the California Spaceport, December 2, 1994	Aquila Conestoga Eagle S-Series LMLV1, 2, 3 Minuteman II Orbex PA-2 Taurus		x	x	x			x	x	x			x	x		x	x		x	x	x		
U.S. Department of Transportation, Office of Commercial Space Transportation, Programmatic Environmental Assessment of Commercial Expendable Launch Vehicle Programs at Vandenberg Air Force Base, California, January 1988	Atlas Atlas/Centaur Delta Scout D Titan Titan/Centaur		x			x								x					x	x			
U.S. Department of the Air Force, Environmental Impact Assessment, Space Shuttle Program, Vandenburg Air Force Base, California, January 1978	Space Shuttle		x					x		x	x			x			x						
U.S. Department of the Air Force, Final Environmental Assessment, Atlas II Program, Vandenburg Air Force Base, California, August 1991	Atlas II, Atlas IIA, Atlas IIAS		x	x				x	x	x	x	x		x			x		x	x	x	x	

Table 1.4-2. (continued).

Site/Documentation	Launch vehicles	Acid Rain	Air	Flora and Fauna										Hazardous materials	Noise	Radiation	Safety	Socioeconomics	Surface water	Waste	Water quality	Water supply	Visual	Weather modification
				Birds, marine	Freshwater biota	General	Intertidal biota	Sea lions	Seals	Fauna, terrestrial	Flora, terrestrial	Whales												
U.S. Department of the Air Force, Environmental Impact Statement, Construction and Operation of Space Launch Complex 7, Vandenberg Air Force Base, California, July 20, 1989	Titan IV/ Centaur, Titan IV/NUS		x	x	x				x	x	x				x		x	x		x		x	x	
National Aeronautics and Space Administration, Goddard Space Flight Center, Environmental Assessment, Modification of Space Launch Complex 2W, Medium Expendable Launch Vehicle Services, Vandenberg Air Force Base, California, March 1991	Delta II		x	x											x						x			
U.S. Department of the Air Force, Environmental Assessment, Lockheed Launch Vehicle, Vandenberg Air Force Base, California, April 1994			x	x					x					x	x									
U.S. Department of the Air Force, Environmental Assessment, Taurus Standard Small Launch Vehicle Program, Vandenberg Air Force Base, California, April 1992 and May 1993			x	x										x	x		x	x		x			x	x
Cape Canaveral Air Force Station, Florida																								
U.S. Department of the Air Force, Environmental Assessment, Medium Launch Vehicle Program, Cape Canaveral Air Force Station, Florida, May 1988	Delta II MLV		x		x									x										
Edwards Air Force Base, California																								
U.S. Department of the Air Force, Environmental Assessment, Titan IV Solid Rocket Motor Upgrade Testing at Edwards Air Force Base, California, May 10, 1988	Titan IV		x							x	x				x				x					

Table 1.4-2. (continued).

Site/Documentation	Launch vehicles	Acid Rain	Air	Flora and Fauna										Hazardous materials	Noise	Radiation	Safety	Socioeconomics	Surface water	Waste	Water quality	Water supply	Visual	Weather modification
				Birds, marine	Freshwater biota	General	Intertidal biota	Sea lions	Seals	Fauna, terrestrial	Flora, terrestrial	Whales												
U.S. Department of the Air Force, Environmental Assessment for the Testing of Titan Solid Propellant Rocket Motors, Edward Air Force Base, California, December 1986			x							x	x			x		x								
Programmatic																								
U.S. Department of Transportation, Office of Commercial Space Transportation, Programmatic Environmental Assessment of Commercial Expendable Launch Vehicle Programs, February 1986	Atlas Delta Scout D Titan	x	x			x							x	x	x	x	x		x	x			x
U.S. Department of the Air Force, Environmental Assessment for Commercial Atlas IIAS, June 1991	Atlas IIAS		x											x		x	x	x	x					
U.S. Department of the Air Force, Environmental Assessment, Air Force Small Launch Vehicle, Vandenberg Air Force Base, Edwards Air Force Base, and San Nicolas Island, California, May 1991	SLV		x	x	x			x	x							x	x		x			x	
U.S. Department of the Air Force, Environmental Assessment, U.S. Air Force Titan IV/Solid Rocket Motor Upgrade Program, Cape Canaveral Air Force Station, Florida and Vandenberg Air Force Base, California, February 1990	Titan IV		x	x				x	x	x	x			x			x	x					
National Aeronautics and Space Administration, Environmental Impact Assessment; Advanced Solid Rocket Motor Program, Stennis Space Center Mississippi, Yellow Creek, Mississippi, and John F. Kennedy Space Center, Florida, March 1989	Space Shuttle		x	x						x	x		x	x	x	x	x	x	x		x		
National Aeronautics and Space Administration, Space Shuttle Program, April 1978	Space Shuttle	x	x			x							x	x			x						

CHAPTER 2. PROPOSED ACTION AND ALTERNATIVES

2.1 Proposed Action

2.1.1 INTRODUCTION

The Alaska Aerospace Development Corporation (AADC) proposes to construct and operate the Kodiak Launch Complex (KLC), a commercial space launch facility. Such facilities are subject to the requirements of the Commercial Space Launch Act, as implemented by 14 CFR Chapter III (Table 1.4-1). The proposed KLC would be located at the eastern side of Kodiak Island, 30 kilometers (20 miles) south of Kodiak, Alaska, on a peninsula that is commonly referred to as Narrow Cape (Figure 2.1-1). The 13-square kilometer (3,100-acre) site is state-owned land accessible by road from Kodiak. Current site uses include grazing, a 190-meter (625-foot) high navigational aid tower and support buildings,[1] and recreation (hunting, birdwatching, fishing, fossil collecting, whale-watching). The state-owned, uninhabited Ugak Island is located approximately 5.3 kilometers (3.3 miles) offshore.

AADC proposes to construct the following new facilities (Figure 2.1-2):

- Launch Control and Management Center
- Payload Processing Facility
- Launch area
  - Integration and Processing Facility
  - Spacecraft Assemblies Transfer Facility
  - Launch Pad and Service Structure
- Water pumphouse

In addition, AADC proposes to construct two laydown areas for temporary storage of materials and equipment during KLC construction. As Figure 2.1-2 shows, these facilities would be located in separate areas of the site. The proposed location of the Launch Pad is 57 degrees, 36 minutes, 16 seconds north latitude; 152 degrees, 9 minutes, 16 seconds west longitude. Finally, the State of Alaska would upgrade one switchback on the road to the site. The following sections provide further construction and operation information.

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[1]U.S. Coast Guard Loran "C" station.

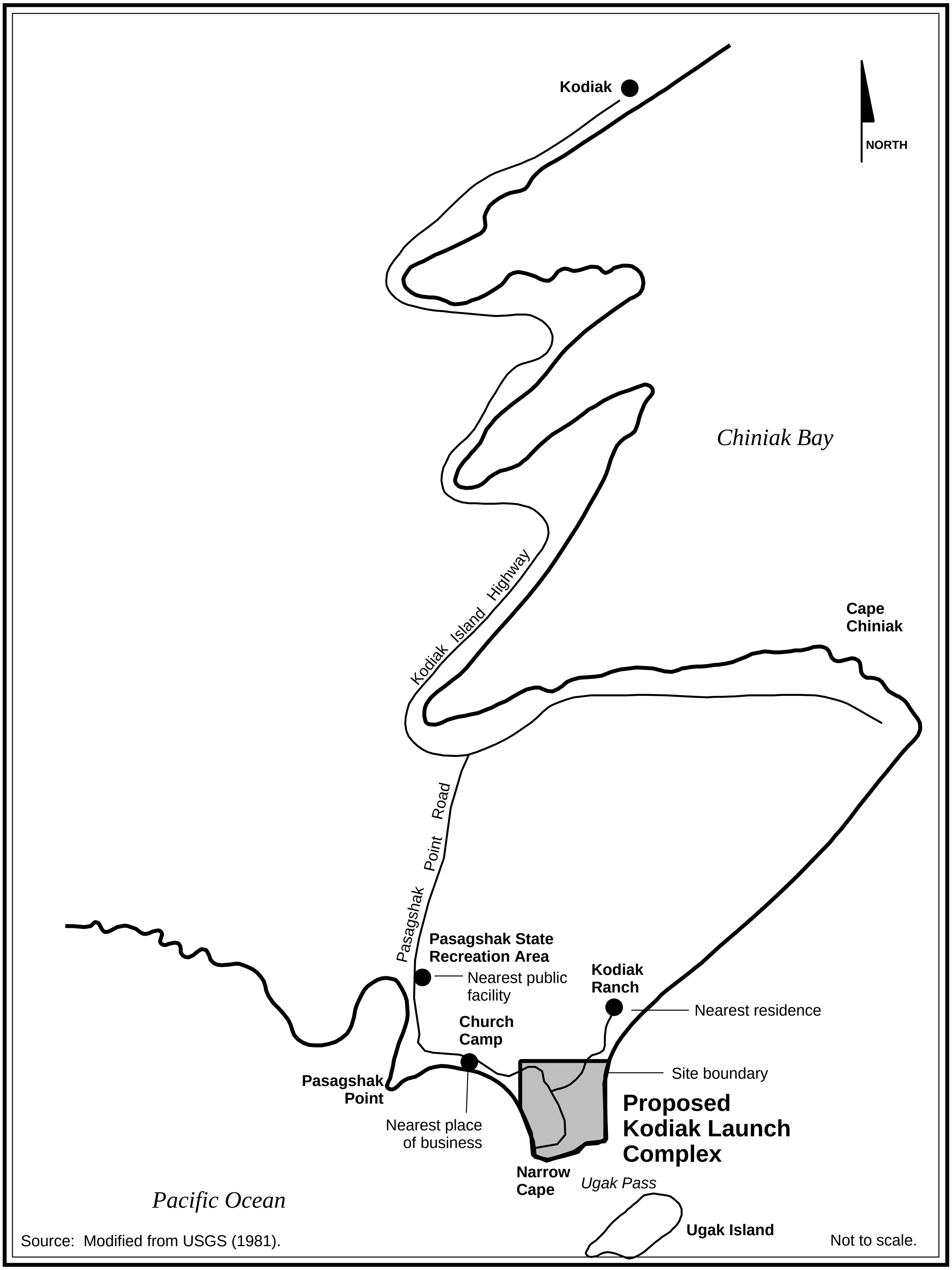

Figure 2.1-1. Proposed KLC vicinity.

4A43-3

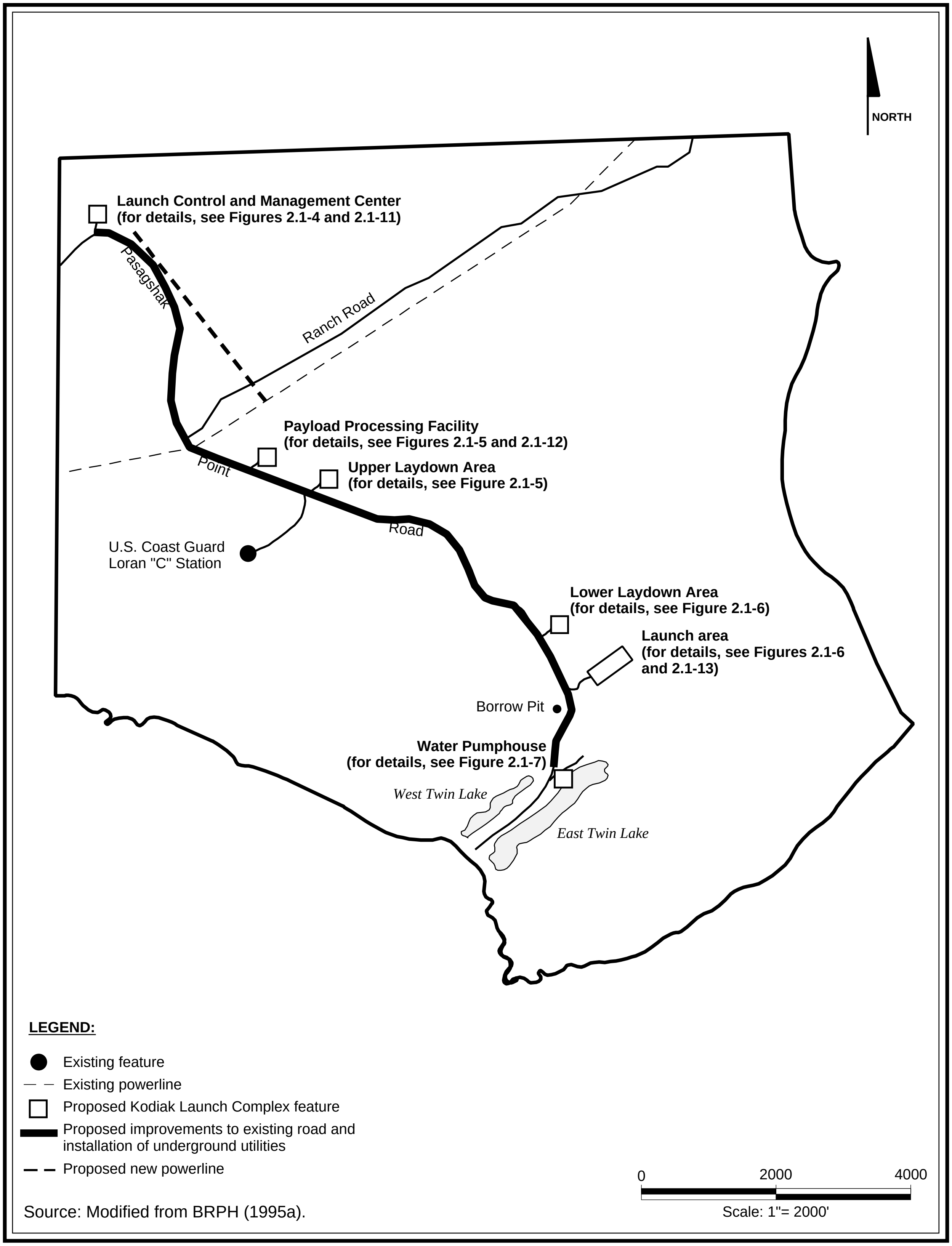

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Figure 2.1-2. Proposed KLC site layout.

2.1.2 CONSTRUCTION

2.1.2.1 General

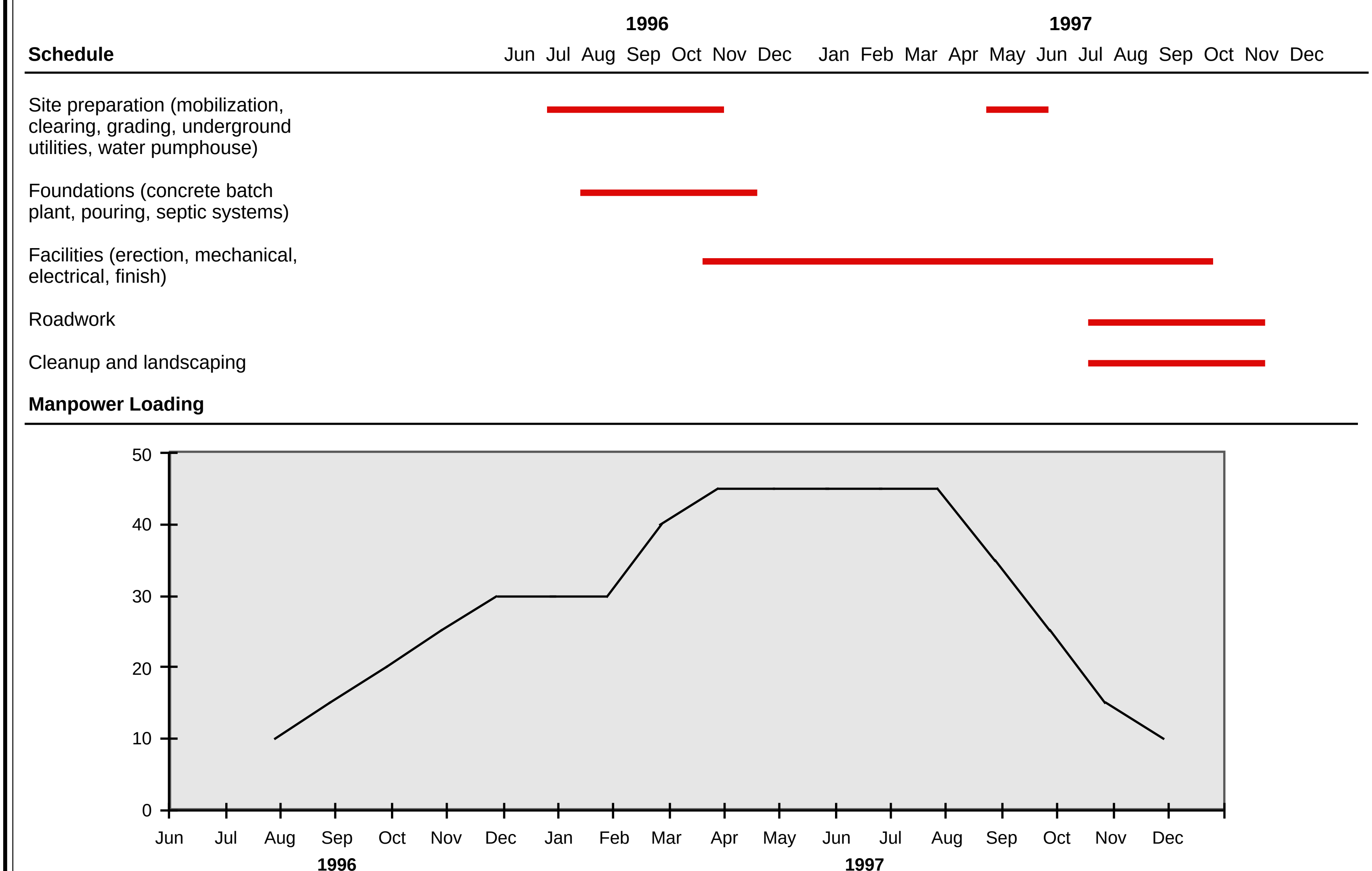
Subject to completion of applicable environmental requirements, the proposed KLC construction is tentatively scheduled to begin in 1996 and take 18 months, at an estimated cost of $18 to $24 million. Each of the areas to be developed for facilities would undergo site preparation, foundation preparation, utility connection, and building assembly activities (from prefabricated components). In addition, general site work would involve road upgrade and utility installation. Finally, the site would be cleaned up and landscaped. Figure 2.1-3 shows the proposed construction schedule.

The work force would average 30 workers, with a peak of approximately 45 during spring 1997. Figure 2.1-3 shows estimated manpower loading by month. The construction schedule would include 10-hour workdays during peak outside work periods (i.e., summers). Hiring local construction labor would be encouraged, but some of these workers would probably have to be hired off the island due to specific skill requirements. Workers would commute to work from the Kodiak area. During the construction period, a maximum of approximately 17,000 liters (4,500 gallons) per week[2] of potable water would be transported from the Kodiak municipal water system to the site, and approximately the same amount of sewage per week from portable toilets would be transported offsite for disposal at the Kodiak municipal wastewater treatment plant.

Construction equipment would include the following:

- Bulldozer
- Grader
- Power shovel
- Dump truck
- Front-end loader/backhoe
- Roller
- Compactor
- Concrete batch plant
- Mixer
- Concrete pump
- Cherry lift
- Cranes
- Gas welders
- Power hand tools
- Asphalt spreader
- Generators

[2] 110 liters (30 gallons) per day per worker for 30 workers.



Source: Modified from BRPH (1995b and 1995c) and Brechan (1995).

4A43-9

Figure 2.1-3. Construction schedule and manpower loading.

Some construction equipment is available on Kodiak Island; other equipment and materials would be barged to the island from the mainland.

Table 2.1-1 summarizes site preparation work for each area, and Figure 2.1-2 shows the general locations of on-site construction areas. Table 2.1-1 and Figure 2.1-2 also provide references to figures that provide more detailed site location information (Figures 2.1-4, 2.1-5, 2.1-6, and 2.1-7). Table 2.1-2 summarizes the quantity of aggregate (gravel and sand) needed for various purposes. This material would be obtained from the site borrow pit (Figure 2.1-2) and off-site locations, depending on the required coarseness.[3] Assuming that half of the aggregate would come from offsite [i.e., approximately 6,700 cubic meters (8,700 cubic yards)], approximately 870 truckloads would be required.

Table 2.1-1. Construction disturbance area.

Area	Site Description	Acreage to be Disturbed[a]	Figure
Launch Control and Management Center	Flat meadow plus 0.2 acres wetland	3	2.1-4
Payload Processing Facility	Flat meadow	7	2.1-5
Launch Area	Flat. Access road through trees; remainder meadow	12	2.1-6
Water Pumphouse	Sloping meadow	0.3	2.1-7
Upper Laydown Area	Flat meadow	6	2.1-5
Lower Laydown Area	Flat meadow	6	2.1-6
Pasagshak Point Road	Existing gravel road	2 miles[b]	2.1-2
Borrow pit[c]	Existing 1-acre pit cut into grassed slope	1	2.1-2
Total		43	

a. To get square meters, multiply by 4047. To get kilometers, multiply by 1.609.
b. Due to roadway widening (includes 1.3 acres of wetlands and 6.6 acres of meadow).
c. Excess natural material resulting from construction may be temporarily stockpiled here for later reuse.

Table 2.1-2. Aggregate (gravel and sand) needs.

Purpose	Quantity (cubic yards)[a]
Roadbeds, parking areas, structural fill	10,400
Concrete	4,300
Asphalt	2,600
Total	17,300

a. To get cubic meters, multiply by 0.7646.

[3]The Pasagshak Point area and commercial sites near Kodiak are available.

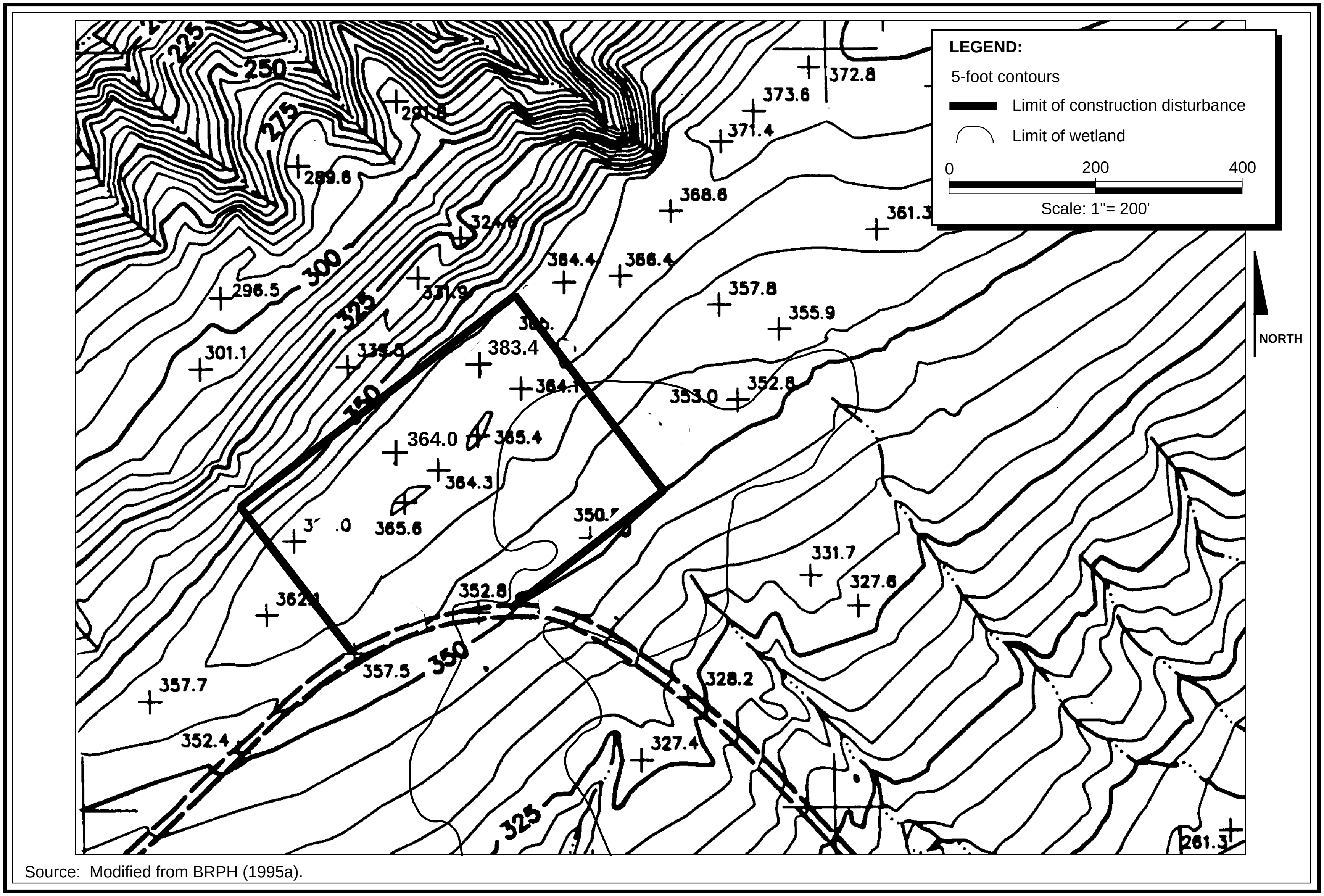


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Figure 2.1-4. Proposed Launch Control and Management Center site location.

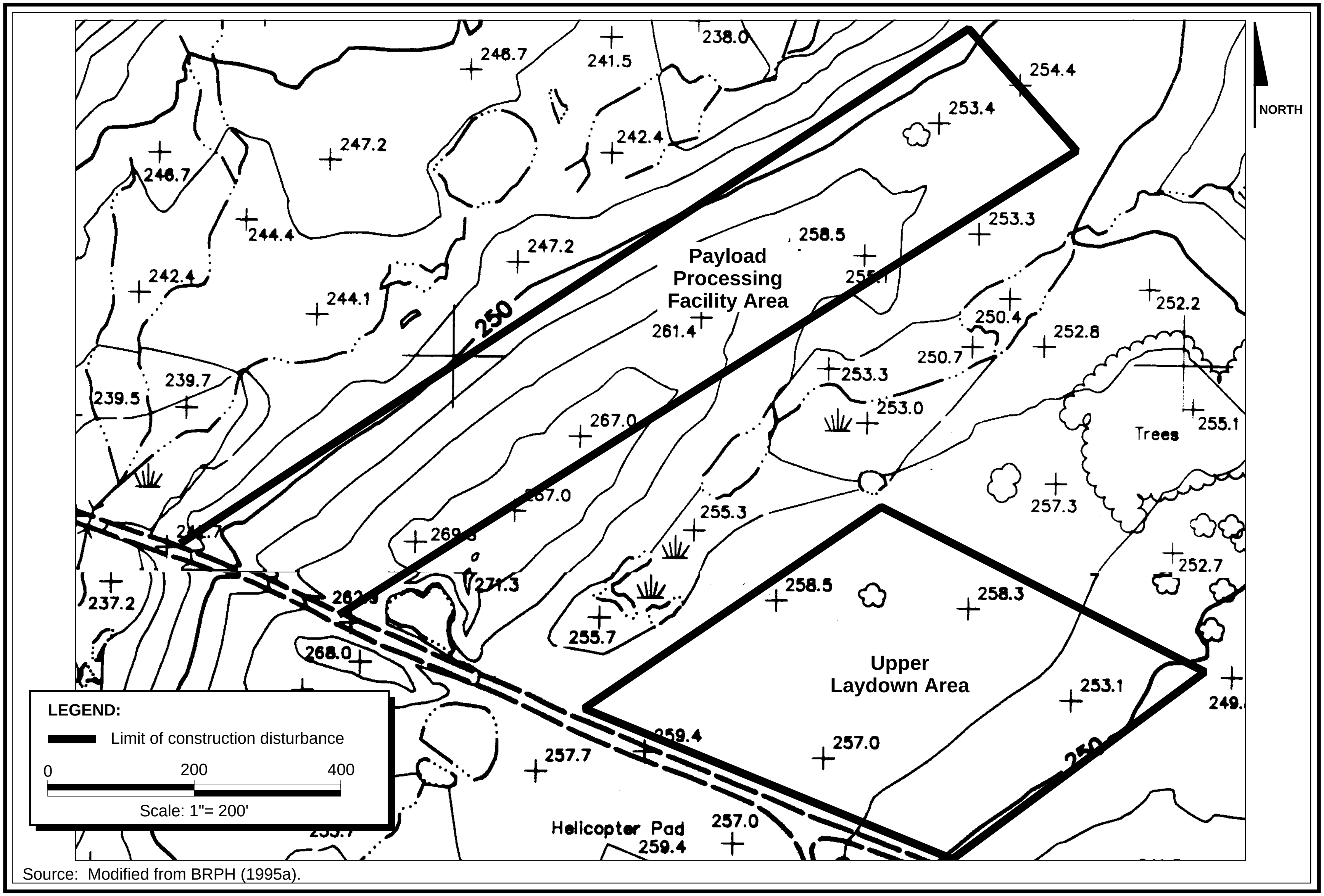

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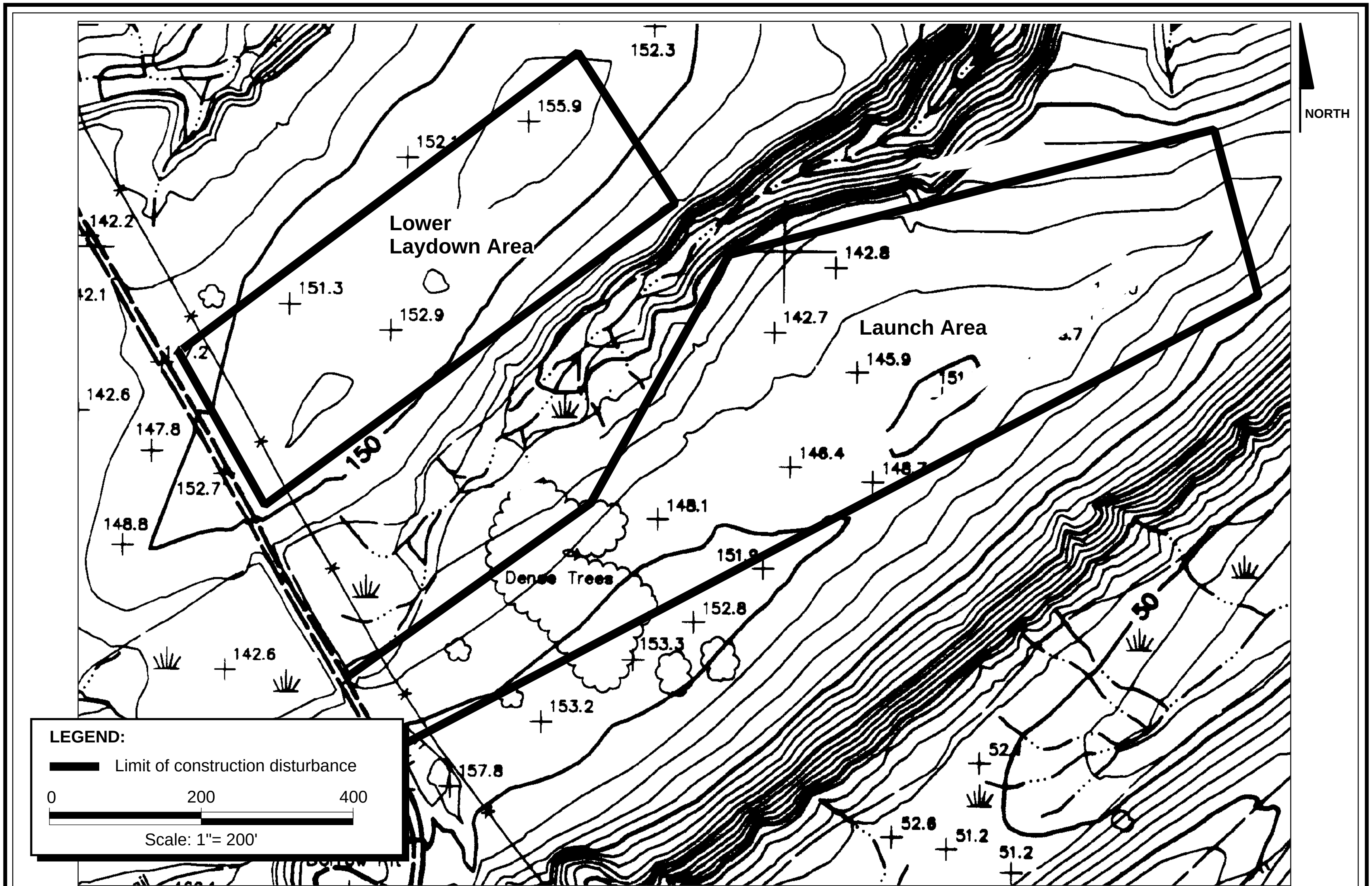
Figure 2.1-5. Proposed Payload Processing Facility site location.



Source: Modified from BRPH (1995a).

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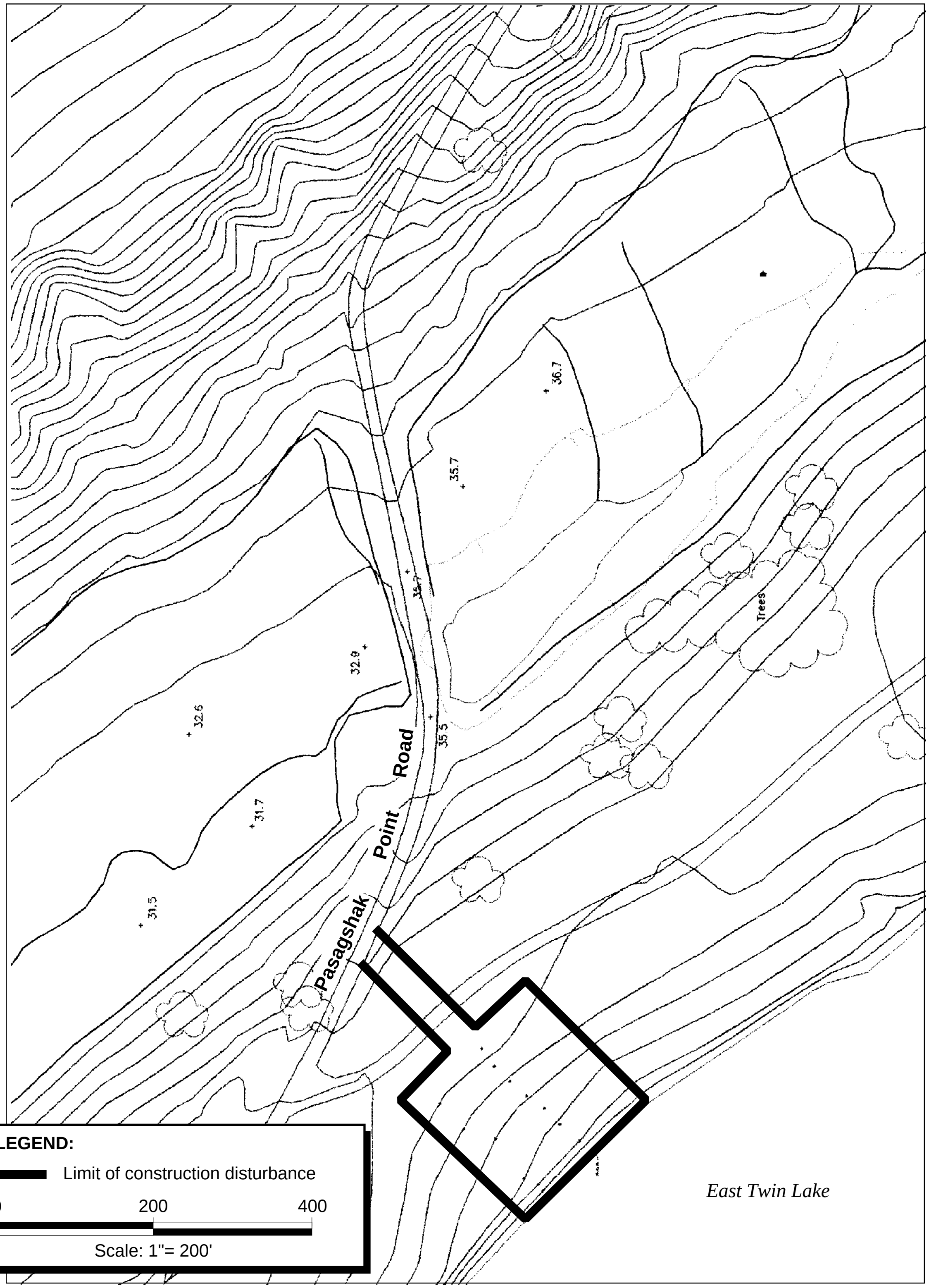
Figure 2.1-6. Proposed Launch Area site location.



Source: Modified from BRPH (1995a).

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Figure 2.1-7. Proposed Water Pumphouse site location.

2.1.2.2 Facility Construction

Site preparation would include installation of portable toilets and placement of temporary construction office trailers. Earthwork would disturb approximately 174,000 square meters (43 acres), including two 24,200-square meter (6-acre) construction laydown areas. Each facility site would be cleared and grubbed, stumps would be removed, and a minimum of 15 centimeters (6 inches) of topsoil would be removed in areas to receive fill. Cleared vegetation would be burned, and excavated topsoil would be stockpiled for reuse in landscaping. Weathered bedrock under building locations would be removed and used for fill elsewhere. A balanced cut and fill design is expected, in which approximately 49,700 cubic meters (65,000 cubic yards) of earth would be moved. In addition, approximately 7,960 cubic meters (10,400 cubic yards) of gravel and sand would be used for roadbeds, parking areas, structures, and walkways.

Preparation for foundation and utility work would include establishing a cement batch plant at the Launch Control and Management Center area. A 50-kilowatt generator would provide electricity to operate a dry-type plant nominally rated at 46 cubic meters (60 cubic yards) of concrete per hour. The largest 1-day pour would be approximately 150 cubic meters (200 cubic yards), and the total would be approximately 4,600 cubic meters (6,000 cubic yards) of concrete. Approximately 3,300 cubic meters (4,300 cubic yards) of gravel and sand would be obtained offsite; a maximum of 28,300 liters (7,500 gallons) of water per day would be pumped from East Twin Lake for use in making concrete and, if necessary, fire protection. Foundation work would include sinking anchors, pouring concrete for building piers and slabs, and installing utility connections. The launch pad concrete flame duct would be poured, and septic systems (septic tank and absorption bed) would be installed at the Launch Control and Management Center, Payload Processing Facility, and Integration and Processing Facility.

All proposed KLC structures would be prefabricated by manufacturers and shipped to the site for final assembly. This would reduce costs and limit on-site activity to primarily erecting the prefabricated structures, bolting them together, and performing finish work. Activities such as welding and metalworking would be minimal. Interior work would include installation of electrical systems; heating, air conditioning, and ventilation equipment; and water and wastewater systems.

2.1.2.3 Cleanup and Landscaping

Grounds-related work would include construction debris removal; site restoration; and landscaping with native plants, including stabilization of the construction laydown areas.

2.1.2.4 Pasagshak Point Road

AADC anticipates that the Alaska Department of Transportation would make improvements to one switchback on Pasagshak Point Road, the existing gravel road to the site. The switchback, located south of the Pasagshak State Recreation Area (Figure 2.1-1), would be widened to increase its effective turning radius.

The existing roadbed onsite averages 4.9 meters (16 feet) wide with no shoulders and some steep grades. Cut and fill slopes begin at the edge of the gravel surface with a relatively steep slope forming the transition to natural grade. Existing culverts are deteriorating, and most are undersized. In some places, the roadbed was placed over peat soils. Approximately 3 kilometers (2 miles) [a total affected area of 32,000 square meters (8 acres)] of the road would be upgraded, from the site entrance to the Launch Area access road. Activities would include the following:

- Excavate and replace culverts; fill to raise the roadbed above the new, larger [61-centimeter (24-inch)] culverts
- Excavate peat soils
- Cut and fill to reduce some grades
- Cut and fill to add 0.6 meters (2 feet) of shoulder on both sides of the road
- Cut and fill to increase the toe width and reduce slope angles
- Pave with asphalt [approximately 920 cubic meters (1,200 cubic yards) of gravel and 1,100 cubic meters (1,400 cubic yards) of sand]

Mesh erosion protection would be placed on slopes, and silt fences would be placed at the toes of fill slopes adjacent to wetlands. Underground utilities (water, electricity, communications) would be direct-buried in the road right-of-way. Figure 2.1-8 illustrates the plan and profile, and Figure 2.1-9 illustrates a typical cross section.

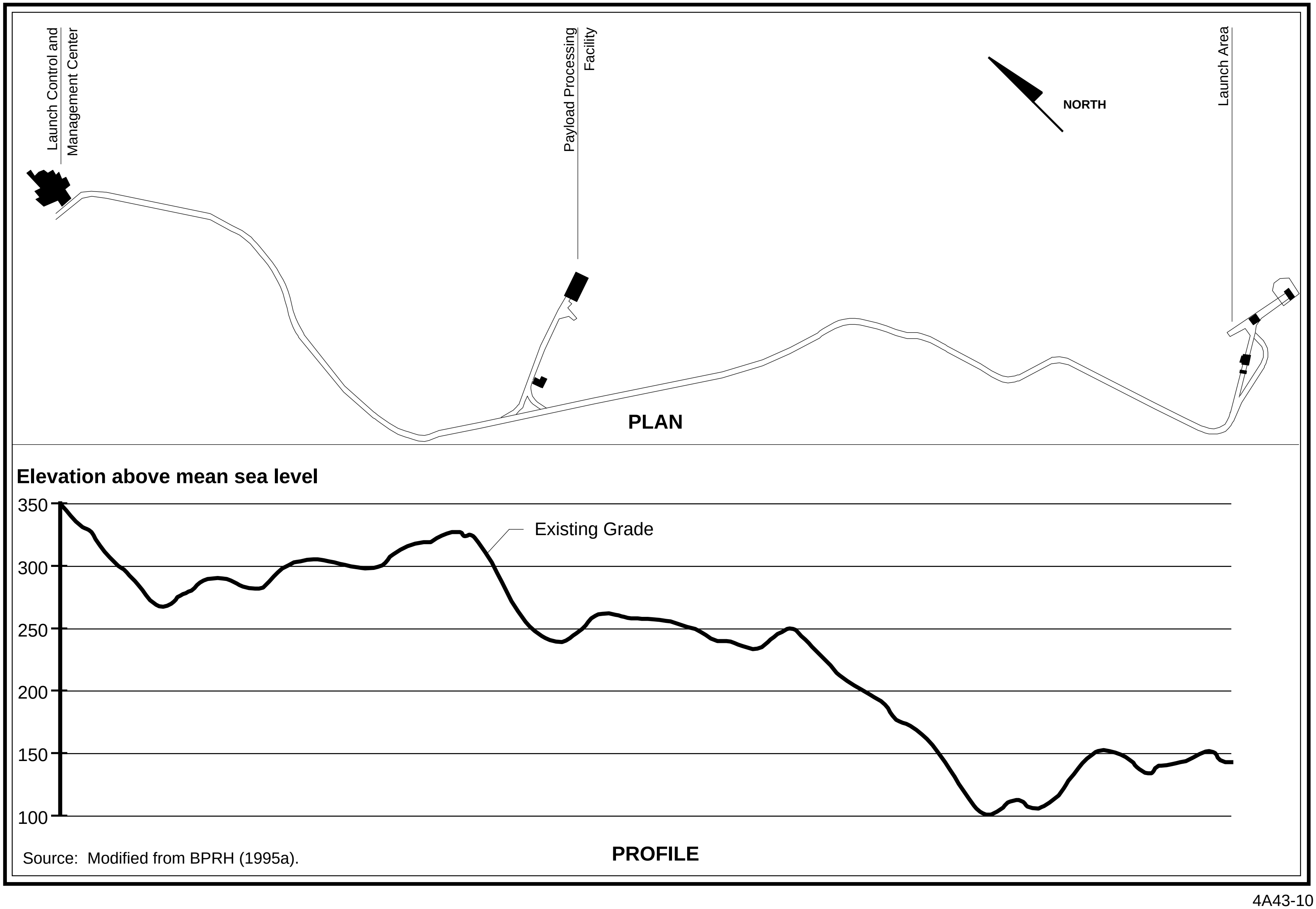
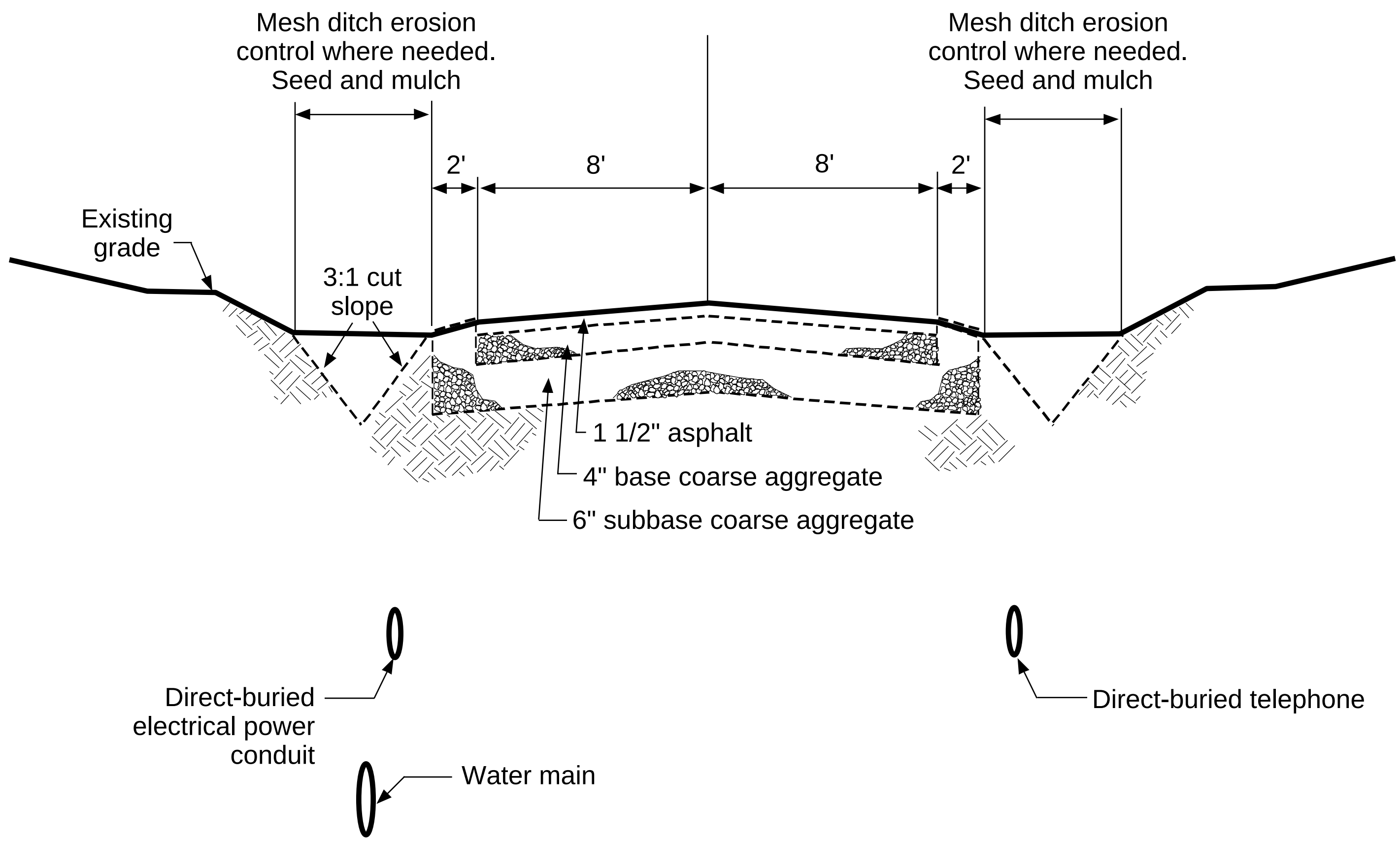


Figure 2.1-8. Pasagshak Point Road plan and profile.



Source: Modified from BPRH (1995a).

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Figure 2.1-9. Pasagshak Point Road typical cross section.

2.1.2.5 Electrical Power Supply

A Kodiak Electric Association three-phase, 24.9/14.4 kilovolt overhead electric powerline terminates approximately 640 meters (2,100 feet) north of the U.S. Coast Guard Loran Station (Figure 2.1-2). The line is a radial feed from a substation located 9.7 kilometers (6 miles) away. A single phase overhead line runs from that point to the east to serve an off-site ranch, and an underground line runs to the Station.[4]

The Kodiak Electric Association would upgrade the single phase line and extend it to serve the Launch Control and Management Center and would extend the three-phase line to each main building. The three-phase line to the Launch Control and Management Center and the Payload Processing Facility would be underground in the Pasagshak Point Road shoulder. The line to the Launch Area would be underground to a distance of approximately 670 meters (2,200 feet) south-southeast of the Station. At this point, overhead lines would be installed to the Launch Area access road, where the line would be installed underground to avoid interference with tall vehicular loads at access road crossings (AADC 1994a).

2.1.3 OPERATIONS

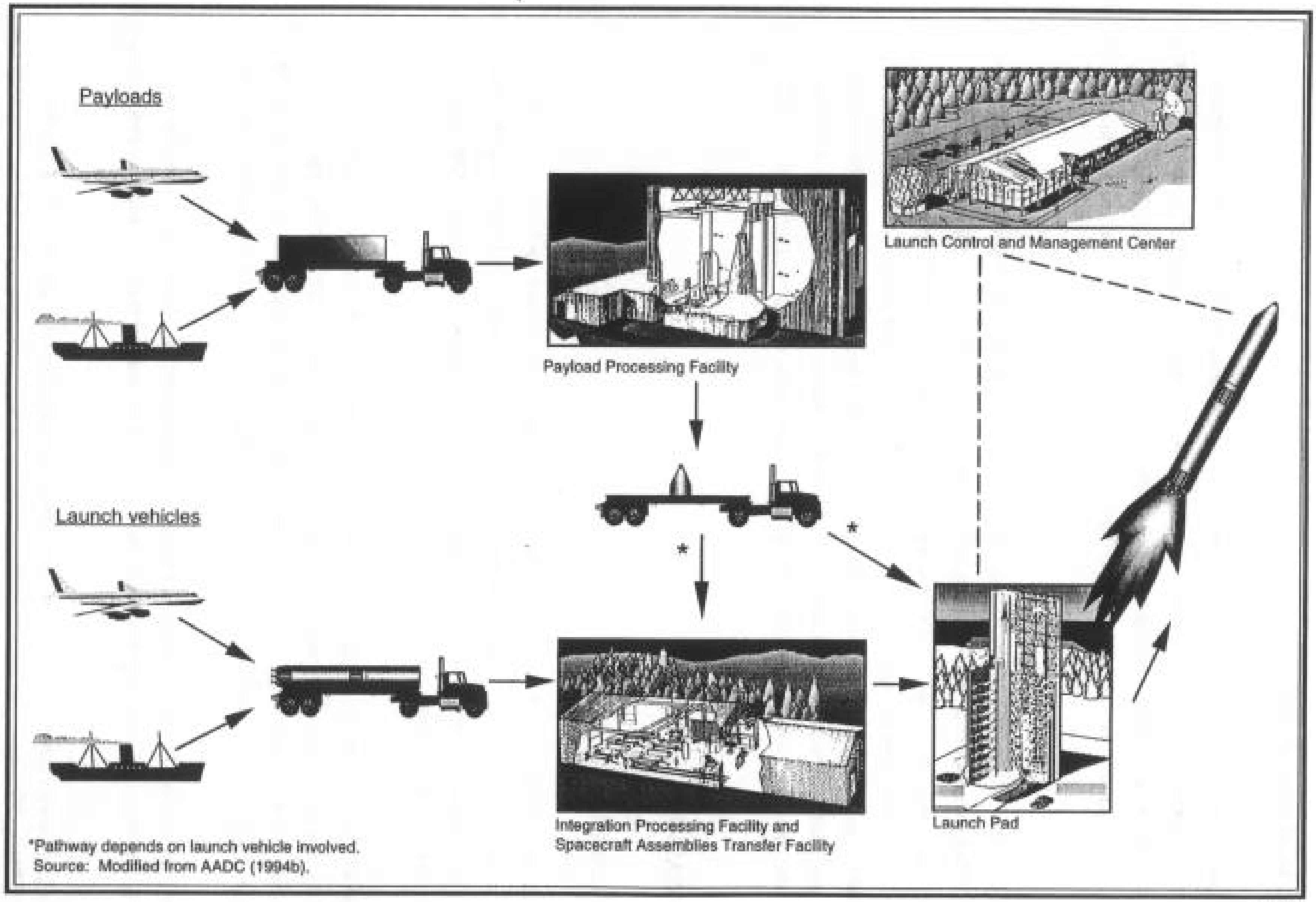
2.1.3.1 Introduction

AADC customers would pay a fee to use the proposed KLC facilities to launch payloads into orbit. The customers would transport launch vehicle rocket components, payloads, and associated parts, hardware, and staff to the site; conduct preparations for launch; and launch and track payloads into orbit. Figure 2.1-10 illustrates this basic operation.

The number of launches per year would increase over a period of 22 years to a maximum of nine (Table 2.1-3). Earlier design work evaluated higher launch rates, as well as different facility configurations. Market forecasting, budget planning, and the time that it would take to ready the facility for another launch, however, have resulted in the currently planned maximum of nine launches per year.

Initially, approximately 100 people would be onsite for 6 weeks before a launch. Over time, due to anticipated operations efficiency improvements, the number of people and the time needed to prepare for

[4]Underground installation in the proximity of the Station is necessary to avoid electrical interference with the Station's Loran "C" signal.



*Pathway depends on launch vehicle involved.
Source: Modified from AADC (1994b).

Figure 2.1-10. Proposed KLC operations.

Table 2.1-3. Proposed KLC staffing and preparation time.

	1997	1998	1999	2000	2001-2003	2004-2011	2012-2018	2019
Launches per year	1	3	4	5	6	7	8	9
Staff onsite to prepare for launch (per launch)	100	100	90	80	70	60	50	40
Weeks of launch preparation time (per launch)	6	6	5	5	4	4	4	4
Weeks staffed for launches	6	18	20	25	24	28	32	36

a launch would decrease. By the year 2019, it is estimated that only 40 people would be needed onsite for 4-week launch preparation periods. Through local training programs, it may be possible that these would be permanent positions. If not locally filled, each launch customer would continue to bring its own professional staff for temporary launch assignments.

Between launches, contractors to AADC would provide security, routine maintenance, and grounds-keeping services (equivalent of approximately 1 full-time position) (AADC undated).

2.1.3.2 Transportation

The primary shipping modes for launch vehicles would be by highway or railway to Seattle, Washington and by container ship or ocean barge (inside passage) to the Lash Dock at the city of Kodiak, or by airplane to the Kodiak airport. From the city, transportation would be by flatbed tractor trailer to the site Integration and Processing Facility. The Lash Dock is located 12 kilometers (8 miles) from town, enroute to the site, and is licensed for explosive and hazardous materials handling. The route from town to the site is via the Kodiak Island Highway [9 kilometers (6 miles) paved and 32 kilometers (21 miles) gravel] and Pasagshak Point Road [23 kilometers (14 miles) gravel]. Smaller hazardous components, such as ordnance,[5] upper-stage motors, and liquid propellants[6] also could be handled at the Sealand Dock in Kodiak.

Payloads and other non-hazardous parts and equipment would be transported by air or sea to Kodiak and by tractor trailer to the site. Payloads would go to the Payload Processing Facility. Personnel would travel by air or ferry to Kodiak and by rented vehicles to the site.

[5]Small explosive devices for destroying launch vehicles in case of accidents after launch.
[6]Hydrazine monopropellant for payloads and attitude adjustment on some upper stages (Section 2.1.3.4).

2.1.3.3 Facilities

General

Principal proposed KLC facilities[7] would be blue-gray corrugated metal buildings designed to meet the Uniform Building Code Seismic Zone 4 requirements. Each facility would be contained within a wire mesh and barbed-wire fence to provide for year-round security needs. All would be electrically heated and air-conditioned, and three would have backup diesel generators. Each diesel generator would be equipped with a silencer to limit noise emissions to 85 A-weighted decibels (dBA)[8] at a distance of 3 meters (10 feet). Number 2 diesel fuel storage would be within above-ground, self-diked storage tanks, and underground fuel piping would be double walled. The generators would operate as backup for 5 hours during launches, 1 hour per week for testing during non-launch periods, and during commercial power outages (estimated maximum total 240 hours per year). Maximum electrical use would be approximately 2 megawatt-hours per year[9] with a design load of 1,570 kilowatts. The Kodiak Electric Association currently has 20,000 kilowatts of baseload (hydroelectric) and 25,088 kilowatts of peaking (diesel) generating capacity, with a forecast 1995 system peak demand of 22,730 kilowatts (KEA 1995). KLC design load would represent 8 percent of the Kodiak Electric Association reserve generating capacity.

Water would be pumped from East Twin Lake[10] (Figure 2.1-2) to a water tank farm building located near the Payload Processing Facility. Pumpage would be to fill five 114,000-liter (30,000-gallon) tanks for fire protection, personnel deluge purposes, and potable water. A maximum of approximately 13,100 liters (3,450 gallons) per day would be pumped from storage during launch preparation. The Launch Control and Management Center, Payload Processing Facility, and Integration and Processing Facility would have septic systems that would include mounded absorption beds.[11] Stormwater runoff would follow natural drainage patterns.

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[7]Launch Control and Management Center, Payload Processing Facility, Integration and Processing Facility, Spacecraft Assemblies Transfer Facility, and Service Structure.
[8]A unit for expressing the relative intensity of sound.
[9]Assuming 9 launches, 6-week preparation time per launch, and 169,000 kilowatt-hours usage per month.
[10] AADC is also investigating the possibility of obtaining water from wells.
[11]Designed in accordance with U.S. Environmental Protection Agency, *Design Manual - Onsite Wastewater Treatment and Disposal Systems*, EPA 625/1-80-012.

Launch Control and Management Center

The Launch Control and Management Center would be the administrative and engineering support facility for the proposed KLC. Figure 2.1-11 shows an artist's rendition and a plan view of the Launch Control and Management Center. The Center would be approximately 53 meters long, 24 meters wide, and 12 meters high (175 feet long, 80 feet wide, and 40 feet high) [1,300 square meters (14,000 square feet)]. Visible exterior features would include the following:

- Paved access road and parking for staff vehicles and tractor trailer vans, and parking area lighting
- A paging and area warning system
- Communications antennas
- A transformer
- A 200-horsepower, 200-kilowatt diesel generator[12] [maximum 56.0 liters (14.8 gallons) of fuel per hour]
- A 9,500-liter (2,500-gallon) storage tank for Number 2 diesel fuel
- A 170-square meter (1,800-square foot), 1.8-meter (6-foot) high mounded absorption bed [buried 11,400-liter (3,000-gallon) septic tank]

The Center would be designed for a 100-person occupancy because during launches almost all site personnel would be located here. Interior features would include the Launch Command Center, offices, instrument calibration and repair laboratories, computer areas, conference rooms, rest rooms with showers, a break room, and utility rooms. Uninterruptible-Power-Supply batteries would serve critical loads. Peak water demand and sanitary discharge would be 9,500 liters (2,500 gallons) per day.

Payload Processing Facility

The Payload Processing Facility would be a single building comprised of two distinct sections. Figure 2.1-12 shows an artist's rendition and a plan view of the Payload Processing Facility. The high

[12]Caterpillar model 3208 or equivalent.

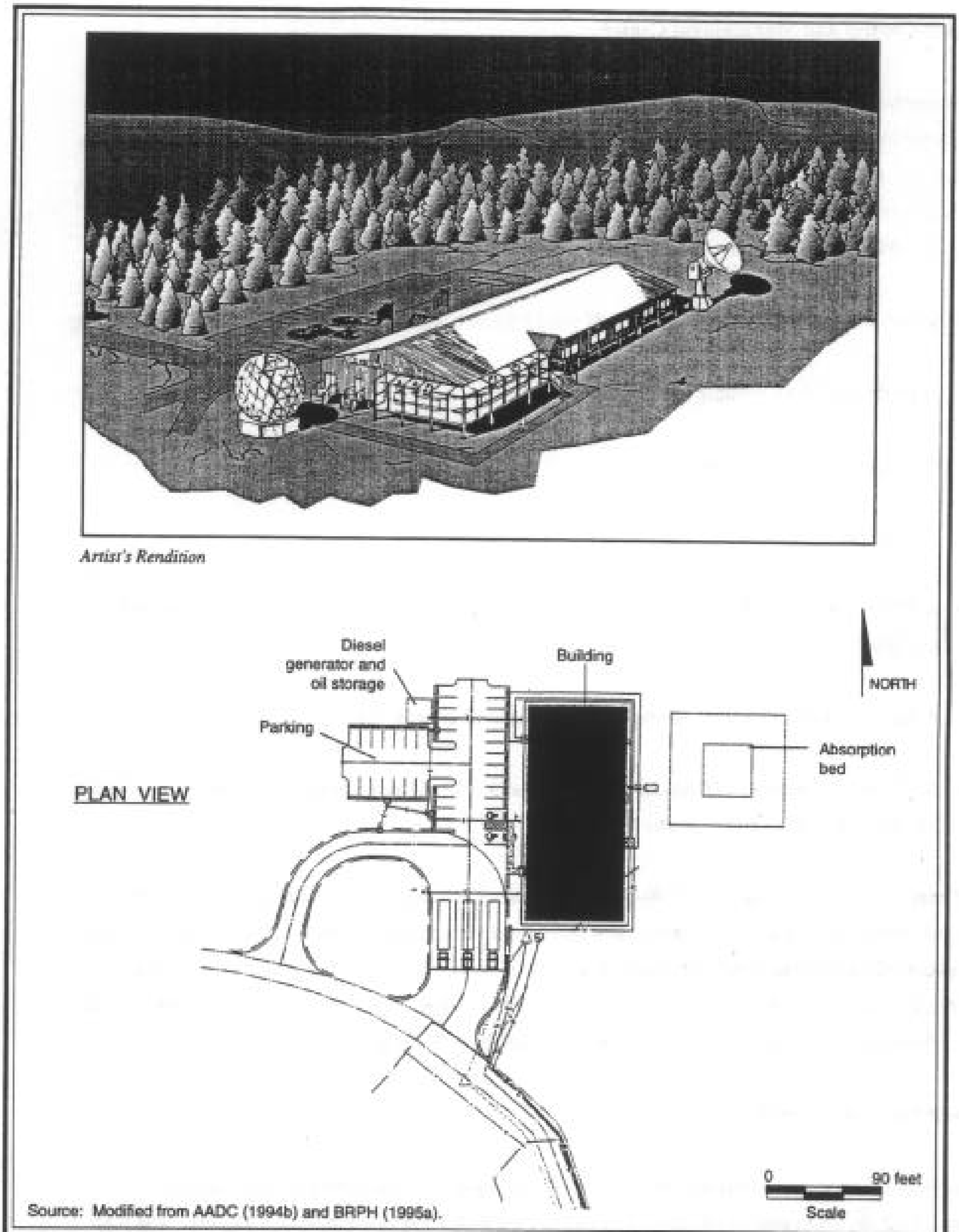

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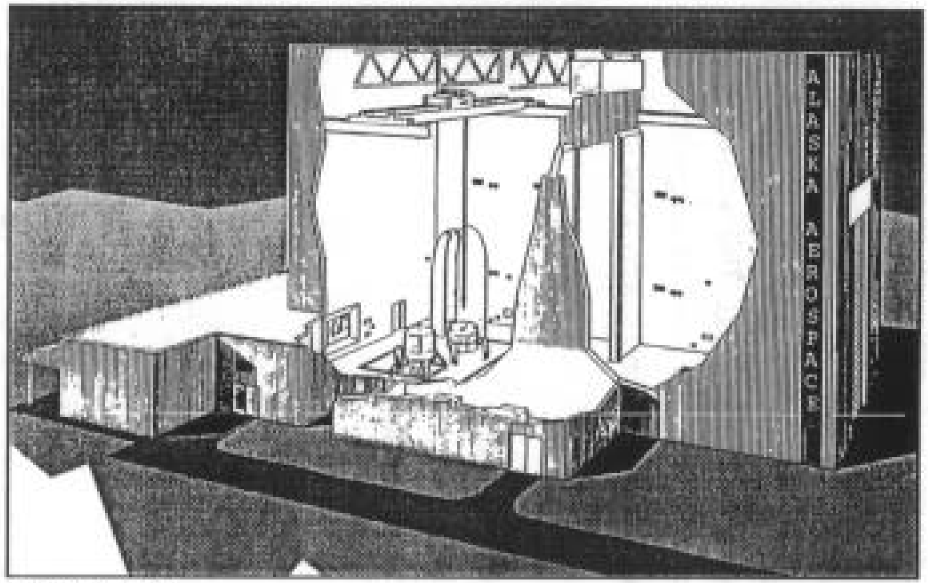
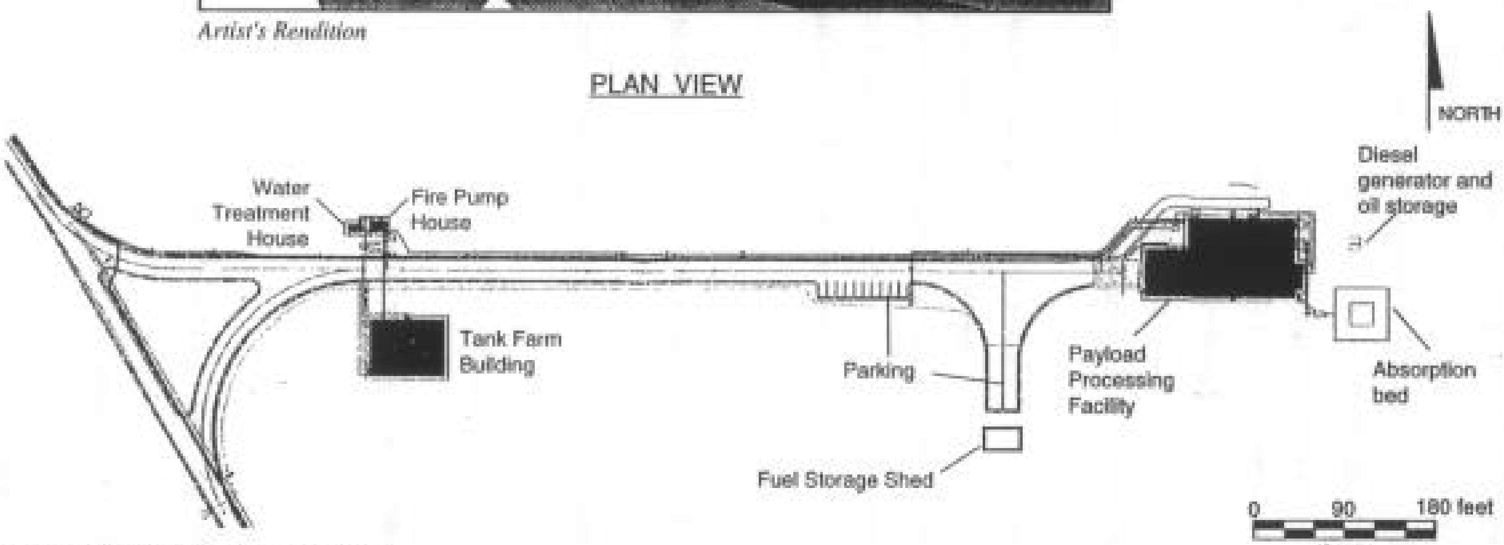
Figure 2.1-11. Proposed Launch Control and Management Center.



Artist's Rendition



Source: Modified from AADC (1994b) and BRPH (1995a).

4A43-8

Figure 2.1-12. Proposed Payload Processing Facility.

bay section would be 12 meters wide, 37 meters long, and 18 meters high (40 feet wide, 120 feet long, and 60 feet high). This section would contain an air lock, processing bay, and lifting cranes. These facilities would provide a clean-room atmosphere for receiving, checking out, fueling, and testing payloads and enclosing them in exterior housing (i.e., fairings). Pressurized inert gas (helium and nitrogen) would be used to purge lines. Although the quantities of liquid fuel involved would be small, approximately less than 380 liters (100 gallons), fueling activity would be hazardous because hydrazine (N_2H_4) would be a fuel component. The fuel would be transported to the proposed KLC enclosed in a payload or in containers in accordance with U.S. Department of Transportation requirements.[13] Containers would be stored in a separate Fuel Storage Shed (Figure 2.1-12) until needed for fueling.

The second section of the Payload Processing Facility would be a 12-meter-high (40-foot-high), L-shaped structure that wraps around the high bay section, giving an overall structure size of approximately 24 meters wide and 46 meters long (80 feet wide and 150 feet long). This section would house a change room, rest room, control room, and utility rooms. The facility would be designed for a 20-person capacity. Peak water demand and sanitary discharge would be approximately 1,100 liters (300 gallons) per day.

Payload Processing Facility exterior features would include the following:

- Paved access road and parking for staff vehicles and tractor trailers
- A paging and area warning system
- Wall mounted sodium-vapor lighting
- Aircraft obstruction lighting
- A 500-kilowatt diesel generator[14] [maximum 149 liters (39.3 gallons) of fuel per hour]
- A 9,500-liter (2,500-gallon) storage tank for Number 2 diesel fuel
- A 45-square-meter (484-square-foot), 1.8-meter-high (6-foot-high) mounded absorption bed [buried 4,730-liter (1,250-gallon) septic tank]

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[13]Title 49, Code of Federal Regulations, Part 178.
[14]Caterpillar model 3412 or equivalent.

- A 3.7-meter (12-foot) square storage shed for fuel cart

- A 1.8-meter by 4.6-meter (6-foot by 15-foot) Water Treatment Building for potable water treatment (chlorination and filtration)

- A 3-meter by 4.6-meter (10-foot by 15-foot) Fire Pump Building

- A 15-meter by 21-meter (50-foot by 70-foot) Tank Farm Building that would store potable water

Integration and Processing Facility

The Integration and Processing Facility would be the location for processing launch vehicles and, for some configurations, mating of fairing-enclosed payloads to launch vehicles. Figure 2.1-13 shows an artist's rendition and a plan view of the Integration and Processing Facility. The Facility would be 15 meters wide, 30 meters long, and 18 meters high (50 feet wide, 100 feet long, and 60 feet high) [460 square meters (5,000 square feet)]. Exterior features would include the following:

- Paved access road and parking for staff vehicles and tractor trailers

- A paging and area warning system

- Wall mounted sodium-vapor lighting

- Aircraft obstruction lighting

- A 500-kilowatt diesel generator[15] [maximum 149 liters (39.3 gallons) of fuel per hour]

- A 9,500-liter (2,500-gallon) storage tank for Number 2 diesel fuel

- A 58-square-meter (625-square-foot), 1.8-meter-high (6-foot-high) mounded absorption bed [buried 4,700-liter (1,250 gallon) septic tank]

- Paved roadway to Launch Pad and Service Area

[15]Caterpillar model 3412 or equivalent.

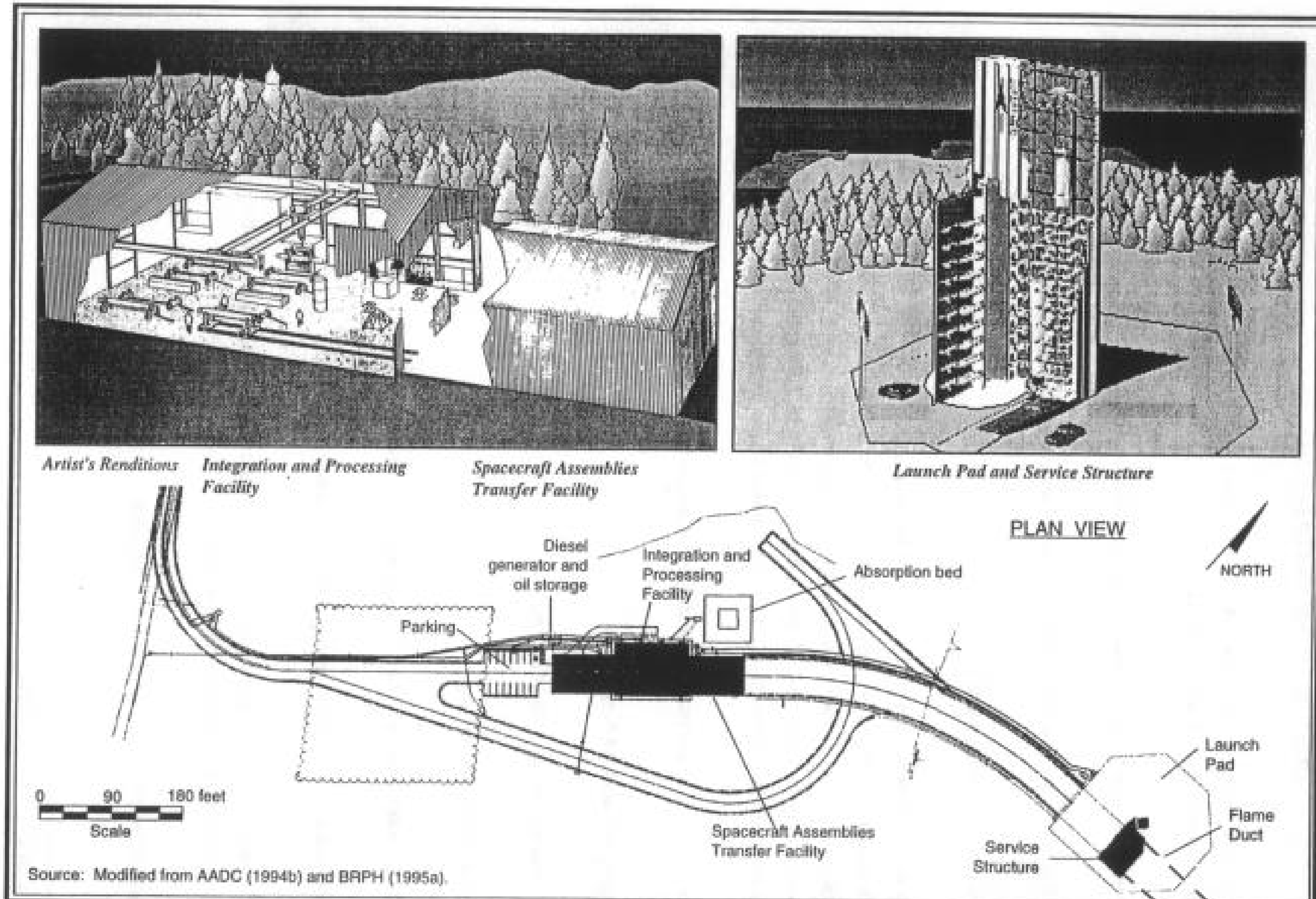


Figure 2.1-13. Proposed Launch Area.

The interior would contain a large, central working area with an overhead crane and a peripheral entry room, rest room, utility rooms, and an equipment airlock. Portable detectors would be used to monitor for hazardous vapors. Depending on the type of launch vehicle involved, fairing-enclosed payloads would be connected to the launch vehicles, and multi-stage launch vehicles inter-connected, in a horizontal position on carts. The integrated spacecraft assemblies would be electronically tested. The facility would be designed for a 20-person capacity. Peak water demand and sanitary discharge would be approximately 2,400 liters (650 gallons) per day.

Spacecraft Assemblies Transfer Facility

The Spacecraft Assemblies Transfer Facility is a mobile structure used to enclose spacecraft assemblies for transfer to the launch pad. Figure 2.1-13 shows an artist's rendition and a plan view of the Facility. The Facility would have walls, roof, and doors at both ends of the 15-meter wide, 21-meter long, and 18-meter-high (50-foot wide, 70-foot long, and 60-foot high) structure. The structure would be mounted on rollers on steel rails imbedded in concrete foundations. The spacecraft assemblies would be wheeled on carts out of the Integrated Processing Facility and into the Spacecraft Assemblies Transfer Facility through abutting doorways. Portable detectors would be used to monitor for hazardous vapors. After closing doors and securing carts, a tractor would move the Facility 152 meters (500 feet) to the Service Structure.

Launch Pad and Service Structure

The Service Structure would lift the launch vehicle and payload from the horizontal to the vertical position and enclose it until the time of launch, at which time it would rotate away. Figure 2.1-13 shows an artist's rendition and a plan view of the Launch Pad and Service Structure. The structure would be a corrugated metal building approximately 12 meters wide, 21 meters long, and 52 meters high (40 feet wide, 70 feet long, and 170 feet high). External features would include the following:

- A 53-meter (175-feet) square concrete pad

- Steel-lined concrete ductwork to deflect launch-exhaust flame and accompanying noise towards the east

- A paging and area warning system

- Wall mounted sodium-vapor lighting
- Aircraft obstruction lighting

Internal features include vertically adjustable platforms for accessing various levels of the launch vehicle and payload, a crane, clean work areas, utility rooms, and communications umbilicals to link the launch vehicle to the Launch Control and Management Center. Emergency power would be supplied from the Integration and Processing Facility, and Uninterruptible-Power-Supply batteries would serve critical loads.

Spacecraft assemblies would be rolled from the Spacecraft Assemblies Transfer Facility to the Service Structure through abutting doorways, or payloads trucked from the Payload Processing Facility, hoisted onto the launch mount, and inspected before launch. Depending on the configuration, some staging (stacking) of rocket motors might be performed in the Service Structure. Portable detectors would be used to monitor for hazardous vapors.

Water Supply System

The water pumphouse would contain two 7.5 horsepower [maximum 230 liters (61 gallons) per minute] electric pumps for withdrawing water from East Twin Lake. The pumphouse would be a 3-meter (10-foot) by 3-meter (10-foot) by 3-meter-high (10-foot-high) blue-gray fiberglass building located adjacent to the lake. Withdrawal would be through two redundant pipes, the ends of which would be fitted with well screen, placed on the lake bottom, and covered with gravel. Water would be pumped to the Tank Farm Building located at the Payload Processing Facility.

2.1.3.4 Launch Vehicles

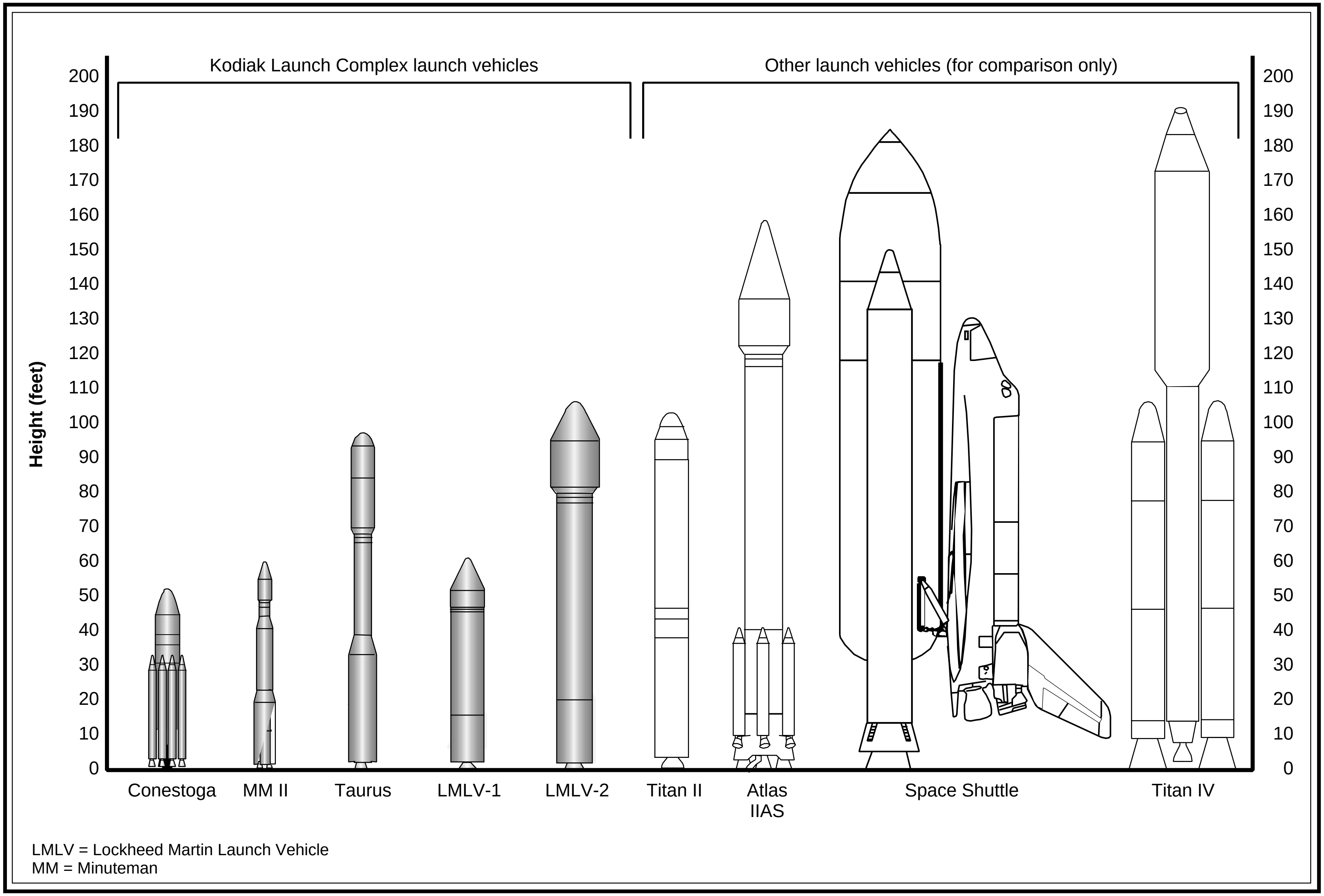
The proposed KLC would be designed to accommodate a variety of small, solid rocket motor launch vehicles; current planning includes Lockheed Martin Launch Vehicles (LMLVs) 1 and 2, Minuteman II (modified for commercial use), Taurus, and Conestoga. These launch vehicles would use the same type of solid fuel (ammonium perchlorate and aluminum powder in hydroxyl-terminated polybutadiene), would generate similar exhaust products (aluminum oxide, carbon monoxide, hydrogen chloride; and nitric oxide), and would have similar first-stage launch profiles. Table 2.1-4 summarizes basic characteristics of each of these vehicles, and Figure 2.1-14 illustrates their relative size.

Table 2.1-4. Launch vehicle characteristics.

Vehicle	Height in meters (feet)	Weight in kilograms (pounds)[a]	Payload in kilograms (pounds)	First stage propulsion	First stage propellant	First stage fuel weight in kilograms (pounds)	First stage thrust in kilograms (pounds)	First stage action time in seconds
Proposed KLC launch vehicles								
Lockheed Martin Launch Vehicle 2	28 (93)	120,000 (264,000)	2,000 (4,400)	Castor-120™	solid[b]	49,000 (108,000)	166,000 (366,000)	94
Conestoga (1620)	15 (50)	87,500 (193,000)	900 (2,000)	2 Castor IVAs™ and 2 Castor IVBs™	solid[b]	45,300 (100,000)	161,000 (355,600)	64
Taurus	27 (90)	73,000 (160,000)	1,400 (3,100)	Castor-120™	solid[b]	49,000 (108,000)	166,000 (366,000)	94
Lockheed Martin Launch Vehicle 1	18 (60)	65,700 (145,000)	820 (1,800)	Castor-120™	solid[b]	49,000 (108,000)	166,000 (366,000)	94
Minuteman II	18 (60)	32,700 (72,000)	680 (1,500)	Thiokol M55A1™	solid[c]	23,100 (51,000)	90,900 (200,400)	60
Other launch vehicle (for comparison only)								
Space Shuttle	56 (184)	2,040,000 (4,500,000)	2,400 (5,200) to 24,400 (53,800)	two 46-meter (150-foot) solid rocket motors and 1 orbiter with 47-meter (154-foot) external tank	solid and liquid[d]	2 × 502,000 (1,107,000) = 1,004,000 (2,214,000) and 703,000 (1,550,000))	2 × 1,202,000 (2,650,000) = 2,404,000 (5,300,000) and 499,000 (1,100,000)	123

Source: Isakowitz (1991) except as noted otherwise

a. Gross lift-off weight.
b. Ammonium perchlorate and aluminum powder in hydroxyl-terminated polybutadiene binder.
c. Ammonium perchlorate and aluminum powder in epoxy or polybutadiene binder (NASA 1989).
d. Solid = Ammonium perchlorate, aluminum powder, and iron oxide in polybutadiene acrylonitrile binder. Liquid = liquid oxygen and liquid hydrogen.



4A43-2

Figure 2.1-14. Representative launch vehicles.

As discussed in Section 1.4.5 and Table 1.4-2, documentation is available for numerous reviews of launch vehicle environmental effects, particularly for Vandenberg Air Force Base in California and Kennedy Space Center in Florida. Most recent documentation is for launch vehicles that are larger than those proposed for the KLC and generally have proportionally greater potential for environmental impact (e.g., more noise, additional exhaust products). Figure 2.1-14 identifies some of these larger vehicles. OCST has prepared a programmatic environmental assessment for commercial expendable launch vehicles. The assessment was based on different vehicles[16] than those anticipated for the proposed KLC but on ones that have comparable fuel and other characteristics. Finally, environmental effects of each proposed KLC launch vehicle have recently been analyzed for launches from Vandenberg Air Force Base and found to be not significant (USAF 1994).

2.1.3.5 Launches

The proposed KLC would be designed to be an all-weather, indoor processing facility that would be capable of supporting launches year around. Launches would be high inclination,[17] and launch azimuths would range anywhere from 125 degrees to 225 degrees in direction.[18] As illustrated in Figure 2.1-15, this means that at the eastern-most azimuth, launch vehicle paths would cross over the eastern edge of Ugak Island. At that time, approximately 70 seconds after launch, the vehicle would be more than 13 kilometers (8 miles) high (Figure 2.1-16).[19] At the western-most azimuth, the launch vehicle paths would pass along the southern edge of the Kodiak Archipelago. Spent first-stage rocket motor and fuel casings would impact from 20 to 582 kilometers (11 to 314 nautical miles[20]) down range, depending on the launch vehicle (Section 4.6). Casings of the largest launch vehicle motors (Castor 120ä) are graphite epoxy and are expected to shatter upon impact (Germaine 1995). Casings of the smaller Conestoga and Minuteman II stages are steel (Isakowitz 1991).

KLC security personnel would temporarily close Pasagshak Point Road to public access while transferring payloads from the Payload Processing Facility to the Launch Area. On launch days, KLC security personnel would close Pasagshak Point Road to public access at the site boundary and, before the launch, would survey the ground-hazard area around the launch pad to ensure that no unauthorized people were in the area. Before launches, AADC would establish a launch vehicle- and payload-specific safety area. A notice of the impending launch would be issued to aviators and mariners at least 24 hours

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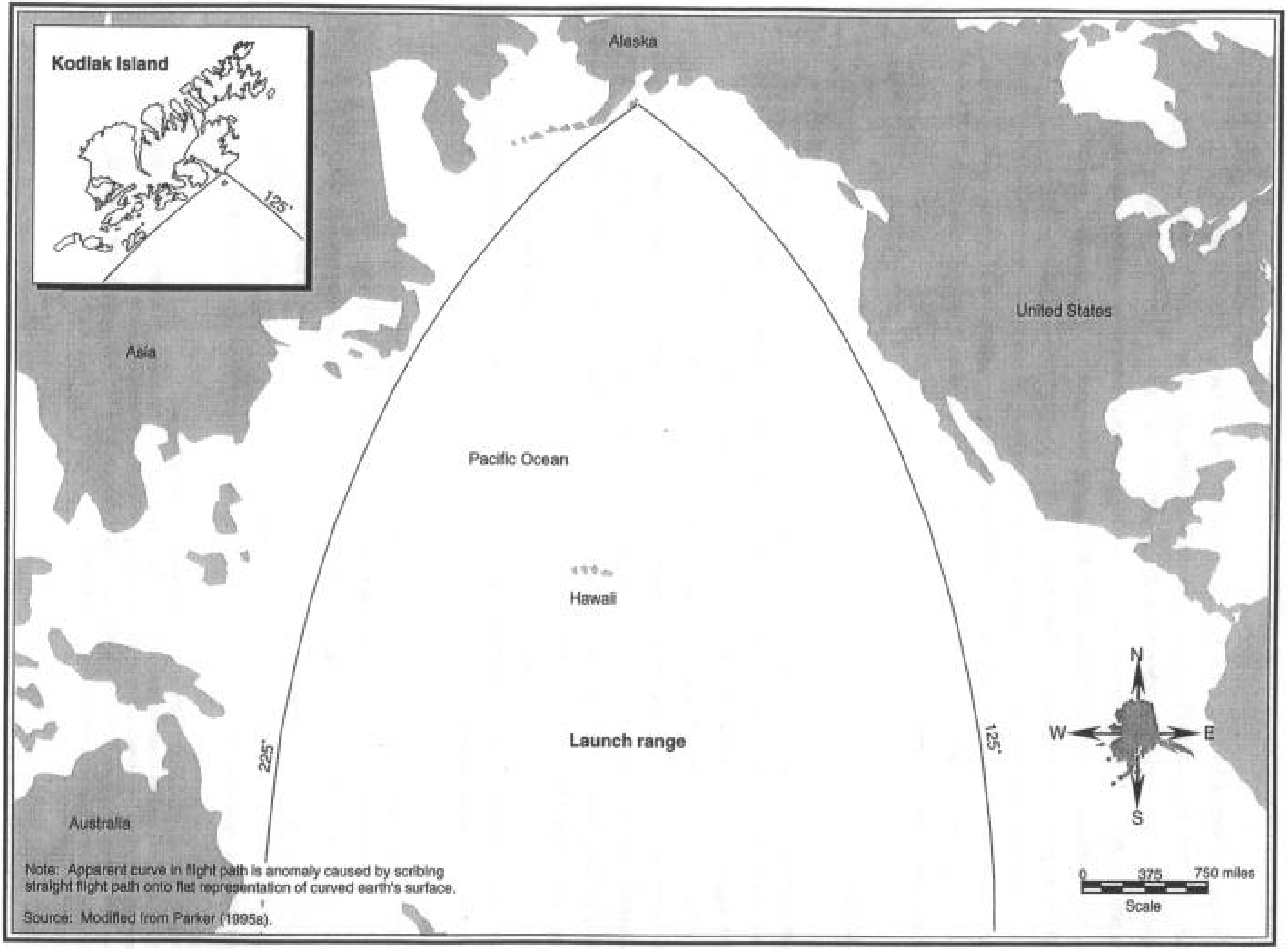
[16]Scout D, Delta, Atlas and Atlas/Centaur, and Titan and Titan/Centaur.

[17]High inclination launches at the proposed KLC would be aimed almost straight up, as compared to low inclination launches which would be aimed closer to the horizon (e.g., 45 degrees above horizontal).

[18]Based on Universal Transverse Mercator grid (e.g., 0 degrees equals due north, 180 degrees equals due south).

[19]Based on Lockheed Martin Launch Vehicle 2 flight path.

[20]A nautical mile equals 6,076 feet.



Note: Apparent curve in flight path is anomaly caused by scribing straight flight path onto flat representation of curved earth's surface.

Source: Modified from Parker (1995a).

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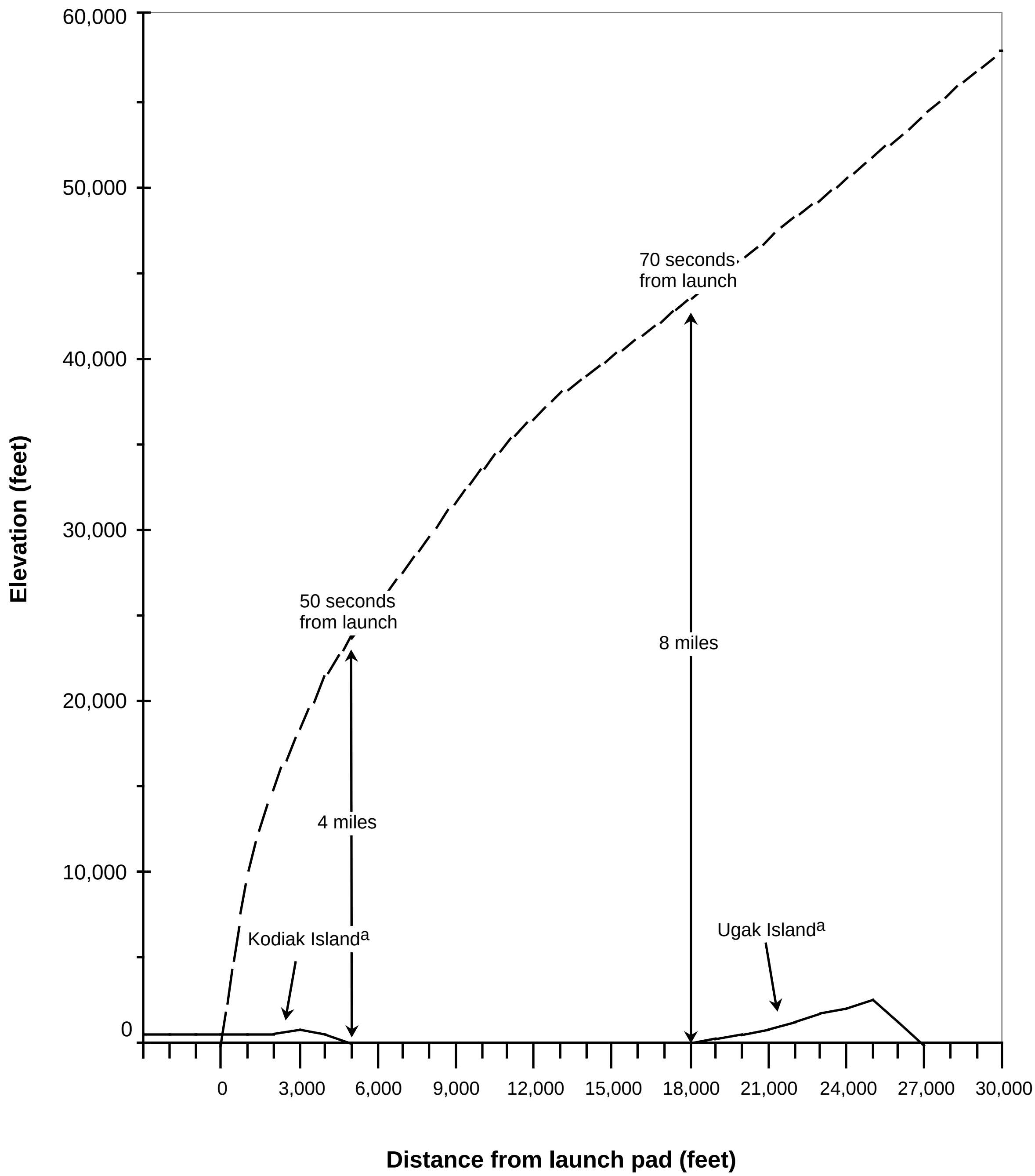
Figure 2.1-15. Launch range and azimuths.



[a] Kodiak Island elevation (150 feet maximum) and Ugak Island elevation (1,050 feet maximum) exaggerated for visual purposes.

Source: Modified from Parker (1995b).

4A43-3

Figure 2.1-16. Launch profile based on Lockheed Martin Launch Vehicle 2.

before a launch. For the period beginning 2 hours before a launch, the safety area would be continually monitored to ensure that it remains clear. A launch would be delayed if air or marine traffic were detected in the safety area; while AADC does not have authority to clear the area, requests to move would be made if boaters or aviators are present.

AADC expects that cleanup after a launch would be limited to repainting scorched areas of the Launch Service Structure (no general area washdown). Preparatory to the next scheduled launch, AADC would then undertake internal modifications (if any) necessary to support configuration of the next launch vehicle.

2.1.3.6 Demobilization

AADC holds the proposed KLC site under a 30-year renewable interagency land management assignment from the Alaska Division of Land (ADL 1994). Upon closure of the proposed KLC, site facilities and equipment could be used for other governmental purposes or handled as government surplus (e.g., sold). The land would be returned to the Division of Land in a condition acceptable to the Director, which may include rehabilitation.

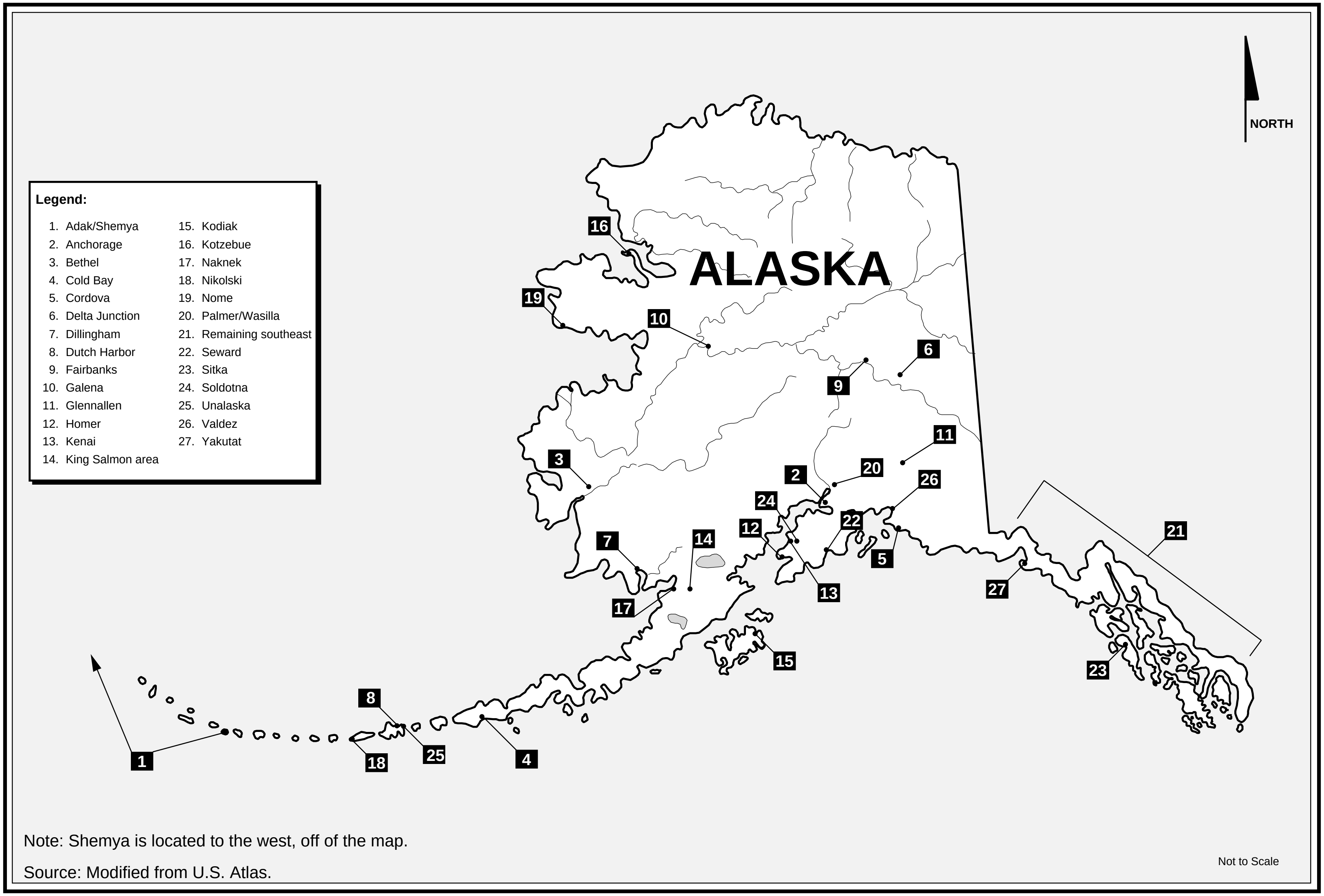
2.2 Alternatives

2.2.1 ALTERNATIVE SITES

Section 2.2.1 describes the evaluation of alternative sites and explains why OCST afforded substantial weight to the preferences of AADC in selecting the proposed site located at Narrow Cape, Kodiak Island. The evaluation consisted of a state-wide survey to identify candidate locations, preliminary screening of 27 locations, detailed literature review and limited field work for 4 locations, detailed field work for 3 locations, and recommendation of the proposed location for the Kodiak Launch Site.

AADC conducted a state-wide siting survey using existing literature, community profiles published by the Alaska Office of Community Development and Regional Affairs (e.g., CDRA 1995). This survey identified 27 general locations for consideration; Figure 2.2-1 identifies these locations. After identifying the locations, AADC used the following criteria to screen the locations:

Suitable property available - The site must include parcels suitable for launch pad [minimum 330 square meters (3,600 square feet) with a 1.6-kilometer (1-mile) radius, controllable access and safety zone)] and launch control [minimum 20,200 square meters (5 acres) for launch control,



4A43-10

Figure 2.2-1. Alternative launch site locations.

located 1.6 to 8 kilometers (1 to 5 miles) from launch pad]. The site must be appropriately zoned, have stable soils, not be in a floodplain, and have minimal grades.

Support services nearby - Launch site maintenance and repair support must be available all year within 80 kilometers (50 miles) via all-year maintained roads. Support must be available for the following:

- Machine shop
- Plumbing
- Heating
- Electrical
- Phone
- General radio and electronics
- General building maintenance

Logistically supportable year-round - Location must have all-year capability to receive and ship heavy, oversized cargo [single shipment of two 62,100-kilogram 2.7- by 2.7- by 8.8-meter (137,000-pound 9- by 9- by 29-foot) containers]. An airport must be located within 80 kilometers (50 miles) of the site via all-year maintained roads. The airport must have regularly scheduled daily commercial air service for 20 launch personnel and baggage per flight, and rental cars must be available.

Food and lodging available - All-year, commercial eating facilities must be located within 24 kilometers (15 miles) via all-year maintained roads. All-year, commercial full-service lodging for 50 personnel must be available within 80 kilometers (50 miles) via all-year maintained roads.

Safe launch zones available - The location must be able to support launches into low-earth orbit with at least one direct polar inclination azimuth through sun-synchronous orbit. No launch can be over, or have a trajectory line within 8.0 kilometers (5 miles) of, any permanently inhabited areas immediately down range to first stage separation and impact zone. Second and subsequent stages must impact safely and fly-out analysis must be accomplished.

Relative environmental concerns - Compare alternative locations assuming that proximity to and impact on designated Federal, State, and local parks and wilderness areas represents an environmental concern.

Weather concerns - Identify whether location has frequent weather events [winds (greater than 48 kilometers (30 miles) per hour, rain, or snow] or precipitation that would substantially affect all-year operations.

Safe launch zone availability, suitable property availability, and logistical supportability, in descending order of priority, were considered critical siting criteria. Table 2.2-1 presents the results of this qualitative screening. Based on this screening, AADC identified three candidate locations (Fairbanks, Seward, and Kodiak Island) for additional evaluation to identify candidate sites in Alaska.

AADC performed detailed literature reviews and limited field surveys for the three locations, eventually dividing the Kodiak location into separate sites at Cape Chiniak and Narrow Cape.

The Fairbanks evaluation focused on the Poker Flats Research Range and adjacent areas. The range is primarily dedicated to the launch of suborbital sounding rockets for the purpose of auroral and middle to upper atmospheric research (Geophysical Institute 1992). Established in 1968, the facility has launched approximately 2,000 rockets in northerly azimuths for downrange land recovery. Evaluation for commercial space launch included identifying land ownership and purchase options, preliminary site layouts and operational concepts, and early design. Concerns about meeting OCST safety criteria[21] of one-in-one million risk eliminated the use of the majority of proposed launch vehicles and launch inclinations. Safety was determined to be a limiting factor since the first stages of these vehicles could land near developed areas (see Section 4.6 and Figure 4.6-2 for discussion of impact points). Dwell time of the larger rockets over Europe and the Middle East also would severely limit payload capacity for launches from this location.

Site choice in the Seward area was constrained by the fjord-like setting on Resurrection Bay. A site evaluated on the east side of the Bay was found to be within a mile of a prison. A site on the west side of the Bay was located 4.8 kilometers (3 miles) beyond the end of the road, necessitating development across multiple properties, a state park trail, and a stream that supported an anadromous (salmon) fishery. In addition, the road route and site were densely forested. It was estimated that access development would double the cost of the facility.

During its February 2, 1994, public meeting, the AADC Board of Directors eliminated as infeasible the Fairbanks site (the Poker Flat Research Range) from further consideration because it could not meet OCST safety criteria. Similarly, the Board eliminated the two possible sites near Seward, one because it posed safety problems and the other because it posed substantial site development problems and costs. Finally, the Board directed further evaluation of two sites on Kodiak Island; an abandoned military facility at Cape Chiniak and the proposed site at Narrow Cape.

[21]Title 14, Code of Federal Regulations, Part 415.13(a).

Table 2.2-1. Alternative sites screening.

	Site	Screening criteria							Conclusion:
		Suitable property available	Logistically supportable year around	Food and lodging available	Support services nearby	Safe launch zones available	Relative environmental concerns	Weather concerns	Further evaluation warranted
1.	Adak/Shemya	questionable	no	no	no	yes	low	wind and rain	no
2.	Anchorage	yes	yes	yes	yes	no	moderate	none	no
3.	Bethel	questionable	no	limited	limited	no	moderate	none	no
4.	Cold Bay	questionable	no	limited	limited	yes	low	wind and rain	no
5.	Cordova	questionable	yes	limited	limited	yes	high	high precipitation	no
6.	Delta Junction	yes	yes	yes	limited	no	moderate	none	no
7.	Dillingham	yes	no	limited	limited	no	moderate	none	no
8.	Dutch Harbor	questionable	no	limited	limited	yes	low	wind and rain	no
9.	Fairbanks	yes	yes	yes	yes	questionable	low	none	yes
10.	Galena	yes	no	no	no	no	low	none	no
11.	Glennallen	yes	yes	yes	limited	no	moderate	none	no
12.	Homer	yes	yes	yes	yes	no	high	none	no
13.	Kenai	yes	yes	yes	yes	no	high	none	no
14.	King Salmon area	yes	no	limited	limited	no	moderate	wind	no
15.	Kodiak	yes	yes	yes	yes	yes	low	surface winds	yes
16.	Kotzebue	questionable	no	limited	limited	no	moderate	wind and cold	no
17.	Naknek	yes	no	limited	limited	no	moderate	wind	no
18.	Nikolski	questionable	no	limited	limited	yes	low	wind and rain	no
19.	Nome	yes	no	limited	limited	no	moderate	wind and cold	no
20.	Palmer/Wasilla	yes	yes	yes	yes	no	moderate	none	no
21.	Remaining southeast	questionable	yes	yes	limited-yes	no	high	high precipitation	no
22.	Seward	questionable	yes	yes	yes	questionable	high	winds aloft	yes
23.	Sitka	questionable	yes	yes	limited	no	high	high precipitation	no
24.	Soldotna	yes	yes	yes	yes	no	high	none	no
25.	Unalaska	questionable	no	limited	limited	yes	low	wind and rain	no
26.	Valdez	questionable	yes	yes	yes	no	high	heavy snow	no
27.	Yakutat	questionable	yes	limited	limited	yes	high	wind	no

Cape Chiniak is located approximately 26 kilometers (16 miles) southeast of Kodiak (Figure 2.1-1). The site contains abandoned World War II-era bunkers, living quarters, and roads. Detailed evaluation identified the following limiting siting factors:

- Potential conflicts with ongoing U.S. Army Corps of Engineers remediation efforts for polychlorinated biphenyls and other contaminants

- Potential impacts to seabird colonies located immediately offshore

- Potential limitations to launch azimuths due to the presence of a private residence and the U.S. Coast Guard Loran-C station located immediately down range

- Legal uncertainty regarding site ownership due to an ongoing lawsuit challenging the status of the Alaska Native corporation (Leisnoi, Inc.) that currently holds Cape Chiniak surface rights

- Scheduling conflicts with ongoing logging activities

Due to these factors, the AADC Board of Directors determined during its March 31, 1994, public Board meeting that the Cape Chiniak alternative was infeasible and directed that subsequent KLC planning focus on the Narrow Cape site. The Cape Chiniak and the other alternative sites determined to be infeasible are not evaluated further in this environmental assessment.

OCST is responsible for ensuring that the environmental assessment demonstrates compliance with all applicable Federal environmental laws and for independently evaluating the sufficiency of the final document. OCST has decided to afford substantial weight to AADC’s preferences because there is no substantially superior alternative from an environmental standpoint.

2.2.2 NO ACTION

The no-action alternative would consist of not developing a commercial space launch facility at the proposed or any other Alaska site. Lands on Kodiak Island have been considered for other development such as prisons, schools, and other facilities; the proposed site is located on one of the few improved roads on the island, and, as state-owned land, is legally available for development. There are no other reasonably foreseeable development projects at this time, and this assessment assumes that the no-action alternative would result in no development and compares the proposed action to a no-development scenario at the proposed site.

CHAPTER 3. AFFECTED ENVIRONMENT

This chapter describes the existing environmental and socioeconomic characteristics of the proposed Kodiak Launch Complex (KLC) and nearby region that could be affected by the proposed action as described in Chapter 2 of this environmental assessment. The data presented in this chapter are required to assess the consequences of the proposed action.

3.1 Air Resources

3.1.1 CLIMATE AND METEOROLOGY

The climate at Narrow Cape in Kodiak, Alaska is characterized as maritime, with long, mild winters and short, cool summers. Throughout the year, the weather is affected by cool and humid air masses due to Narrow Cape's proximity to the Pacific Ocean. The average annual wind speed is 4.9 meters per second (10.9 miles per hour) (NOAA 1995). The prevailing wind direction is from the northwest (NOAA 1995).

Winter-type weather usually lasts from November through March, when the area is strongly influenced by a persistent Aleutian low pressure system located in the outer Aleutian Islands area. Monthly average wind speeds are approximately 5.4 meters per second (12 miles per hour). Average daily temperatures are approximately -1°C (30°F) from November through March. Climatological records for Kodiak indicate that minimum temperatures are below 0°C (32°F) for approximately 15 to 20 days during each winter month. Minimum temperatures rarely fall below -18°C (0°F). The coldest temperature ever recorded in Kodiak was -27°C (-16°F) in January 1989. The largest average monthly snowfalls occur in the period of December through February with average monthly totals ranging from an average of 36 centimeters (14 inches) in December to an average high of 46 centimeters (18 inches) in February. Average monthly snowfall rates are calculated over a period from 1963 through 1994. Daily snowfalls of 2.5 centimeters (1 inch) or more occur about 4 to 5 times per month from December through March (NOAA 1995). However, snow does not normally persist more than 1 week.

The fall months of September and October are characterized by temperatures generally in the 4° to 10°C (40° to 50°F) range and average windspeeds of 4.5 meters per second (10 miles per hour). Daily precipitation greater than a trace amount occurs on approximately 16 days per month with a monthly average of 18 centimeters (7 inches). Average monthly snowfall ranges from a trace in September to 5 centimeters (2 inches) in October.

During the summer, the climate at Narrow Cape is generally cool, humid, and windy. Average daily high temperatures reach 15.6°C (60°F), and record high temperatures range from the high to middle 20°sC (low to middle 80°sF). On a daily basis, maximum temperatures can vary 10 to 20 degrees, depending on whether the northwest gradient wind is strong enough to maintain a flow of air from over the island, or whether it is weak enough that the sea breeze predominates. During each summer month, precipitation occurs on approximately 15 days, and sky cover is generally overcast for approximately 20 days. Average monthly precipitation ranges from 8 to 10 centimeters (3 to 5 inches) during the summer (NOAA 1995).

The spring months of April and May are characterized by cool temperatures with normal monthly average temperatures ranging from 1°C to approximately 4°C (middle 30°sF to approximately 40°F), and windspeeds of 5.4 meters per second (12 miles per hour). Daily precipitation greater than a trace amount occurs approximately 17 days per month. Average monthly snowfall is 33 centimeters (13 inches) for March and 20 centimeters (8 inches) for April (NOAA 1995).

3.1.2 OCCURRENCE OF HAZARDOUS WEATHER CONDITIONS

Hazardous weather conditions include heavy fog, large snowfall accumulations, and high winds. Heavy fog with visibility of a quarter of a mile or less typically occurs 1 day per month during an average year. The highest incidence of fog occurs during the month of July with an average of 3 days of heavy fog during the month (NOAA 1995).

High winds are common throughout the year. Local climatological data for 1994 indicates that monthly peak wind gusts ranged from 16 meters per second (35 miles per hour) in June to 37 meters per second (83 miles per hour) in December (NOAA 1995). Peak wind gusts generally occur from the northwest. The fastest observed monthly 1 minute average wind speeds during 1994 ranged from 13 meters per second (28 miles per hour) in June to 28 meters per second (62 miles per hour) in November (NOAA 1995).

The largest monthly snowfalls occur during the months of December and January with maximum snowfalls ranging from 100 to 110 centimeters (40 to 45 inches) per month. The maximum 24-hour snowfall recorded in Kodiak, Alaska was 48 centimeters (19 inches) in February of 1992 (NOAA 1995).

3.1.3 SITE AIR QUALITY

The air quality at Narrow Cape can be generally classified as unimpaired. Ranching, occasional vehicular traffic, and the occasional operation of two standby generators at the U.S. Coast Guard Loran Station are the only human activities within the vicinity of Narrow Cape that would affect background air quality (Baudreau 1996). Wind-blown volcanic dust is the primary air contaminant on the Island (Lytle 1995). The Alaska Department of Environmental Conservation Division of Air and Water Quality does not maintain air monitoring activities on the island due to minimal industrial activity and overall good air quality in the area (Lytle 1995).

As an area in attainment with the National Ambient Air Quality Standards (NAAQS), Kodiak Island is classified as a class II area (ADEC 1993). Air quality control regions are classified either as class I, II, or III to indicate the degree of air quality deterioration that the State/Federal government will allow while not exceeding NAAQS. With Kodiak being designated as a class II area, a moderate change in air quality due to industrial growth would be allowed while still maintaining air quality that meets NAAQS.

The dispersion of air pollutants on Kodiak Island is based on factors such as atmospheric stability, wind speed, and surface roughness. Based on the climatology of Kodiak discussed above, the atmosphere would generally be classified as neutral (D stability) for the dispersion of air pollutants (EPA 1988). D stability occurs during periods of high winds and overcast skies, which are common on Kodiak Island.

3.1.4 STRATOSPHERIC OZONE

The stratospheric ozone layer protects the earth from harmful ultraviolet radiation. National and international consensus holds that certain industrially produced halocarbons [including chlorofluorocarbons (CFCs), halons, carbon tetrachloride, methyl chloroform and hydrochlorofluorocarbons] can carry chlorine and bromine to the stratosphere where they can contribute to the depletion of the ozone layer. As ozone is depleted, more ultraviolet radiation can penetrate, resulting in potential health and environmental harm, including higher rates of certain skin cancers and cataracts, suppression of the immune system, damage to crops and aquatic organisms, and increased formation of ground-level ozone.[1]

[1]Federal Register, Volume 57, page 19166, May 4, 1992.

A study on the depletion of ozone in the stratosphere showed a 1.7 to 3.0 percent ozone loss between 1969 and 1986 at latitudes between 30 and 64 degrees in the northern hemisphere.[2] This decrease was calculated after correcting for the effects of natural variation and is more pronounced in the winter than the summer. After comparing these measurements with model calculations, the study observed that changes may be due wholly, or in part, to the increased atmospheric abundance of trace gases (CFCs, carbon monoxide, methane, nitrous oxides, halons), primarily CFCs, which originate from human activities.[3]

3.2 Water Resources

The principal streams in the northeastern portion of Kodiak Island flow from the mountains and hills into the steep-walled bays located along the irregular coastline. These streams, generally less than 16 kilometers (10 miles) long, flow mostly through fairly narrow, flat-bottomed valleys bordered by strips of rolling or hilly land (USDA 1960). At the proposed KLC site, the topography is relatively flat and low-lying; the streams draining this area are generally less than 3.2 kilometers (2 miles) in length, small in size, and have an average discharge of less than 1.3 cubic meters per second (46 cubic feet per second) (ENRI 1995a). Figure 3.2-1 shows the streams at and near the KLC.

Lakes located at the proposed KLC are also depicted in Figure 3.2-1. West and East Twin Lakes are freshwater lakes, and Triple Lakes and Barry Lagoon are considered to be salt water-influenced lagoons (ENRI 1995a).

East Twin Lake is about approximately 490 meters long and 60 meters wide (1,600 feet long and 200 feet wide), which is more than twice as large as the adjacent West Twin Lake (ENRI 1995b). Each of these lakes drain through a berm of sand and gravel that separates the lakes from the beach and extends an estimated 1.5 to 4.6 meters (5 to 15 feet) above the surf zone. The depths of East Twin Lake range from less than approximately 0.9 meters (3 feet) at the bermed end near the beach to an unknown deeper depth at the opposite northeast end (the bottom of the lake cannot be seen) (ENRI 1995b). West Twin Lake is only about approximately 1 meter (3 feet) in depth (Sadlowski 1995a).

The average recharge rate for East Twin Lakes is estimated to be 870 liters per minute (230 gallons per minute) while the average recharge rate for West Twin Lake is estimated to be 370 liters per minute (98 gallons per minute). Runoff from the surrounding watershed (comprising about 38.8 percent of the

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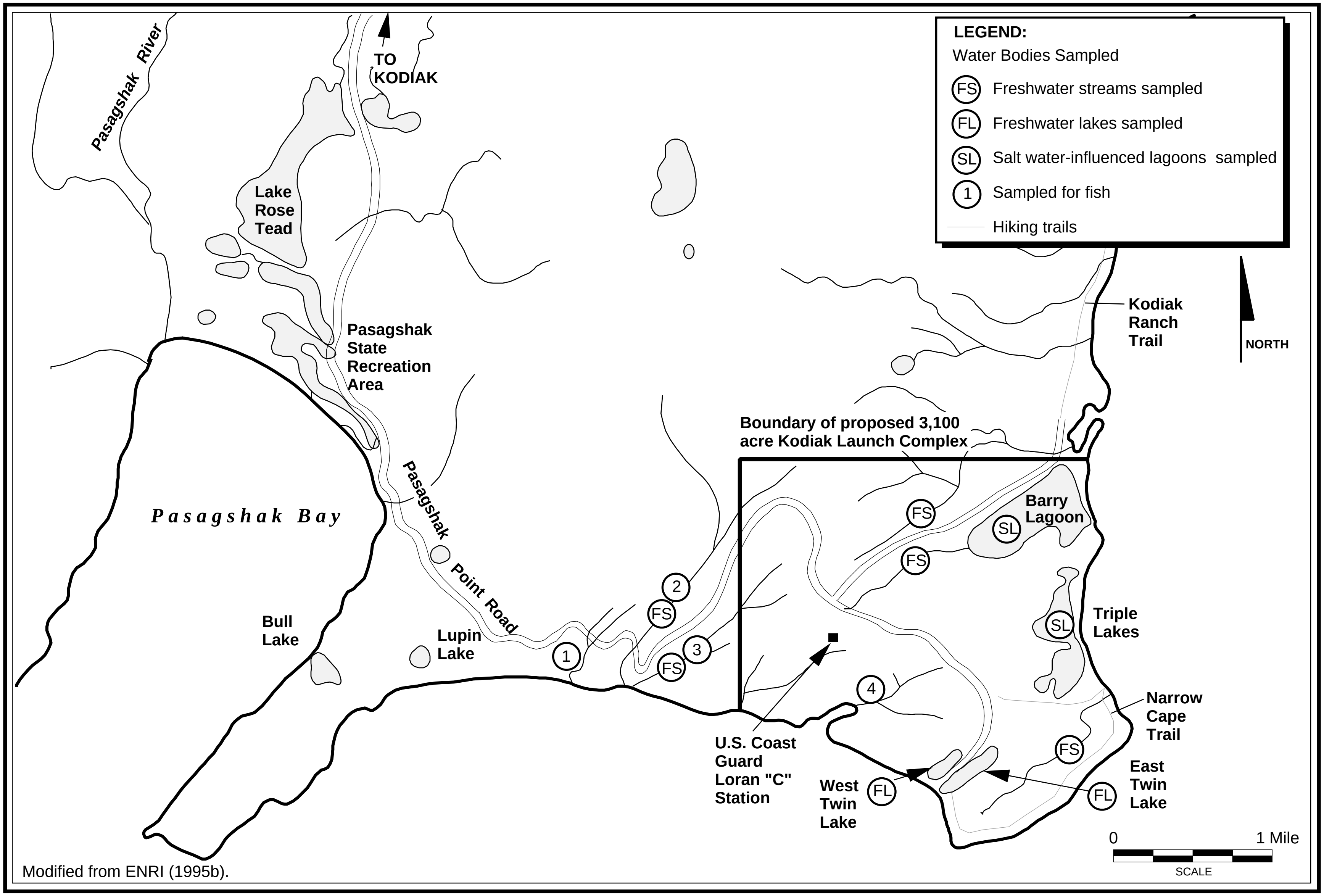
[2]Federal Register, Volume 53, page 30605, August 12, 1988.
[3]Federal Register, Volume 53, page 30605, August 12, 1988.



4A43-1

Figure 3.2-1. Water quality sampling and recreational areas in the vicinity of the proposed KLC.

annual precipitation falling on the watershed) and precipitation into and evaporation from the lake were quantified in the estimation of these recharge rates. The size, capacity, and watershed areas for East and West Twin Lakes that were used in the development of the average recharge rates are provided in Table 3.2-1. On a monthly basis, the inputs used in the calculation of runoff and lake recharge rates (e.g., precipitation, evaporation, weighted unit runoff, etc.) and the calculated recharge rates are provided in Table 3.2-2. Recharge of the lakes by groundwater flow, however, was not included in the recharge calculations because it makes a minor contribution in areas such as the project site (ENRI 1995a).

Table 3.2-1. Capacity and watershed of freshwater lakes at the proposed KLC.

	Capacity[a]	Surface Area			
Area	(gallons)	Acres[b]	Square Feet[c]	Square Miles	Square Kilometers
East Twin Lake					
Lake	15,000,000	15	670,000	0.024	0.062
Drainage Area	N/A[d]	145	6,100,000	0.23	0.58
Total	N/A	160	6,800,000	0.25	0.64
West Twin Lake					
Lake	5,200,000	5.4	230,000	0.0084	0.021
Drainage Area	N/A	62	2,700,000	0.10	0.25
Total	N/A	67	2,900,000	0.11	0.27

a. A uniform depth of approximately 1 meter (3 feet) for both lakes is assumed when calculating their capacities. To get liters, multiply by 3.785.
b. To get square kilometers, multiply by 0.004047.
c. To get square meters, multiply by 0.0929.
d. N/A is Not Applicable.

Assuming that East and West Twin Lake are uniformly approximately 1 meter (3 feet) in depth, a capacity of more than 57 million liters (15 million gallons) is calculated for East Twin Lake and 20 million liters (5.2 million gallons) for West Twin Lake. Using the average recharge rates estimated above, the average water residence time in East Twin Lake is 45 days [i.e., 57 million liters (15 million gallons) capacity divided by a recharge rate of 870 liters per minute (230 gallons per minute)] while the average water residence time in West Twin Lake is 37 days [i.e., 20 million liters (5.2 million gallon) capacity divided by a recharge rate of 370 liters per minute (98 gallons per minute)].

As described in ENRI (1995a and 1995b), two surface water quality sampling events were conducted during 1994 in the vicinity of the proposed KLC. Figure 3.2-1 depicts the surface water sampling locations including freshwater streams, West and East Twin Lakes (freshwater lakes), and Triple Lakes and Barry Lagoon (salt-water influenced lagoons). As shown in Table 3.2-3, the conductivity (measure of salt content), pH (measure of the hydrogen ion activity), dissolved oxygen, and alkalinity (measure of

Table 3.2-2. Recharge rates of freshwater lakes at the proposed KLC.

Month	Precipitation (inches)[a]	Evaporation (inches)[a]	Lake Recharge (gallons per minute)[b]	Weighted Unit Runoff (cubic feet per second per square mile)[c]	Runoff Recharge (gallons per minute)[d]	Total Recharge (gallons per minute)[e]
			East Twin Lake			
January	7.38	1.08	59	2.5	250	310
February	5.28	1.04	44	1.8	180	220
March	4.63	133	31	1.6	160	190
April	4.20	1.65	25	1.4	140	170
May	5.52	1.79	35	1.9	190	220
June	4.78	1.78	29	1.6	160	190
July	3.70	1.60	20	1.3	130	150
August	5.15	1.64	33	1.8	180	210
September	6.99	1.43	54	2.4	240	290
October	7.18	1.47	53	2.5	240	300
November	5.96	1.27	45	2.0	200	250
December	6.81	1.16	53	2.3	230	280
Total	67.58	17.24	N/A[f]	N/A	N/A	N/A
Average	5.63	1.44	40	1.93	190	230
			West Twin Lake			
January	7.38	1.08	21	2.5	110	130
February	5.28	1.04	15	1.8	79	94
March	4.63	133	11	1.6	69	80
April	4.20	1.65	8.7	1.4	62	71
May	5.52	1.79	12	1.9	82	94
June	4.78	1.78	10	1.6	71	81
July	3.70	1.60	7.0	1.3	55	62
August	5.15	1.64	11	1.8	77	88
September	6.99	1.43	19	2.4	100	120
October	7.18	1.47	19	2.5	110	130
November	5.96	1.27	16	2.0	89	110
December	6.81	1.16	18	2.3	100	120
Total	67.58	17.24	N/A	N/A	N/A	N/A
Average	5.63	1.44	14	1.93	84	98

a. Normal monthly precipitation from NOAA 1995. Shallow lake evaporation calculated from net solar radiation (Eagleson 1970), mean daily air and dew point temperatures, and wind speed (NOAA 1995). To get centimeters, multiply inches by 2.540.

b. Lake recharge equals the amount of precipitation falling directly into the lake minus evaporation from the lake. To get liters per minute, multiply by 3.785.

c. Weighted Unit Runoff is weighted in proportion to monthly rainfall based on the Copper, Susitna, and Nushagak Rivers (Geraghty et. al, 1973). To get cubic meters per second per square kilometer, multiply Weighted Unit Runoff by 0.0109.

d. Recharge of lake due to runoff from surrounding drainage area is based on the Weighted Unit Runoff.

e. Summation of lake and runoff recharge.

f. N/A is Not Applicable.

Table 3.2-3. Water quality of Kodiak Island and at the proposed KLC.

Water Quality Parameter	Unit of Measure	Source[a]	Kodiak Island Max	Kodiak Island Min	Kodiak Launch Complex[b] Max	Kodiak Launch Complex[b] Min	Kodiak Launch Complex[b] Ave
Freshwater Streams							
Temperature[c]	°Centigrade	3	---[d]	---	13	8	10
Conductivity	Micromhos per centimeter	1,2,3	206	24.0	92.8	46	55.4
pH		1,2,3,4	8.5	6.2	7.5	6.8	7.1
Dissolved oxygen	Percent saturation	3	---	---	92	65	84
Alkalinity	Milligrams calcium carbonate per liter	1,3	30	10	24	13	19
Freshwater Lakes							
Temperature	°Centigrade	3	---	---	12	11	12
Conductivity	Micromhos per centimeter	2,3	165	52	97.3	76.6	86.2
pH		2,3,4	8.0	5.8	7.3	7.1	7.2
Dissolved oxygen	Percent saturation	3	---	---	93	77	87
Alkalinity	Milligrams calcium carbonate per liter	3	---	---	26	15	20
Salt Water-Influenced Barry Lagoon[e]							
Temperature	°Centigrade	3	---	---	---	14	---
Conductivity	Micromhos per centimeter	3	---	---	---	119	---
pH		3	---	---	---	7.1	---
Dissolved oxygen	Percent saturation	3	---	---	---	91	---
Alkalinity	Milligrams calcium carbonate per liter	3	---	---	---	14	---

a. The data presented are summarized from the following portions of ENRI (1995a and 1995b):
   1. ENRI (1995a) (Table 6 on page 20, 1978 and 1979 water characteristics of five Kodiak Island streams).
   2. ENRI (1995a) (Table 8 on page 22, Historic water quality data from Kodiak Island streams and lakes).
   3. ENRI (1995a) (Table 5 on page 18 of Volume 1, Summary of 1994 water quality study in the vicinity of the proposed KLC).
   4. ENRI (1995b) (Water quality analytical test results from the vicinity of the proposed KLC).

b. Sampling locations are shown in Figure 3.2-1.

c. °Fahrenheit = °Centigrade x 9/5 + 32.

d. --- means no information is available.

e. Only one water quality sample was collected from Barry Lagoon.

capacity to neutralize acid) of the surface water in the vicinity of the proposed KLC are within typical ranges found at Kodiak Island. The conductivity, pH, and dissolved oxygen content of the surface waters near the proposed KLC are suitable for a range of aquatic organisms. In addition, biological toxicity testing of sediments collected from these surface water sampling sites indicates that the sediments have no potential toxicity (ENRI 1995a).

Some of the alkalinity levels measured in surface waters at Kodiak Island and near the proposed KLC are below 20 milligrams of calcium carbonate per liter, and these values indicate a low capacity, relative to the range of alkalinities in waters of the U.S. for some of these waters to buffer pH changes (EPA 1986a). Although the alkalinity is marginal, it is apparently adequate for maintaining pH at a neutral level. Additional analyses of surface water collected from East Twin Lake and Triple Lakes showed that none of the following contaminants were detected (ENRI 1995b):

- Volatile organic compounds (analytical detection level was 1.0 micrograms per liter)
- Pesticides/herbicides (analytical detection level was 0.5 micrograms per liter)
- Polychlorinated biphenyls (PCBs) (analytical detection level was 0.02 micrograms per liter)
- Nitrates or nitrites (analytical detection level was 0.1 milligrams per liter)
- Gross alpha radioactivity (analytical detection level was 2.0 picocuries per liter)
- Total cyanide (analytical detection level was 0.01 milligrams per liter)
- Metals including barium, nickel, antimony, arsenic, chromium, mercury, selenium, thallium, and fluoride (analytical detection level was 0.025 milligrams per liter)

Cadmium was detected in both East Twin Lake and Triple Lakes at a concentration of 0.1 micrograms per liter (ENRI 1995b). Beryllium was detected in Triple Lakes at a concentration of 0.9 micrograms per liter (ENRI 1995b). These levels of cadmium and beryllium are below the national water quality criteria for the protection of aquatic organisms [0.25 and 5.3 micrograms per liter, respectively (assuming a hardness of 15 milligrams of calcium carbonate per liter for the cadmium criteria)] (EPA 1986a). The cadmium concentration detected in these lakes (0.1 micrograms per liter) is also well below the maximum contaminant level of 5.0 micrograms per liter established under the Federal Safe Drinking Water Act and the State of Alaska Drinking Water Regulations.[4]

ENRI (1995b) evaluated East Twin Lake and Triple Lakes for suitability as sources of drinking water. The results revealed that the levels of total coliform bacteria measured during the 1994 sampling events (23 colonies per milliliter at Twin Lakes-East and less than 23 colonies per milliliter at Triple Lakes) exceeded the "no detect" criteria of the State of Alaska Drinking Water Regulations and that pre-treatment would be necessary (ENRI 1995b).

[4]Alaska Administrative Code, Title 18, Environmental Conservation, Chapter 80, Drinking Water.

Bedrock sampling at the proposed KLC was also conducted in 1994 at four locations to depths of approximately 7.6 meters (25 feet) (ENRI 1995b). While the presence of water bearing zones within the underlying bedrock was found in three of the bedrock borings, information concerning water quality or potential groundwater yields is not available (ENRI 1995b).

3.3 Geology and Soil Resources

3.3.1 TOPOGRAPHY

Mountains and hills dominate the northeastern portion of Kodiak Island, with elevations ranging from sea level to 1,000 meters (3,366 feet) at the summit of Center Mountain [about 23 kilometers (14 miles) northwest from the proposed KLC]. The irregular coastline has prominent headlands and sea cliffs and many narrow, steep-walled bays, while some coastal areas are level or rolling (USDA 1960). The unpaved roads leading from Kodiak to the proposed KLC site (i.e., Kodiak Island Highway and Pasagshak Point Road) are built on the coastal headlands to Kalsin Bay [up to 60 meters (200 feet) or more in elevation], then turn south and inland following valleys [up to 120 meters (400 feet) or more in elevation] through the Marin mountain range to the proposed KLC. The proposed KLC is located in a low-lying coastal area of the Gulf of Alaska with peaks in the Marin mountain range situated about 3.2 kilometers (2 miles) to the northwest. Peaks in this mountain range reach elevations of up to 640 meters (2,106 feet) above sea level (USGS 1983).

The surface topography of the proposed KLC is characterized by a series of gently undulating, northeast-southwest trending ridges approximately 43 to 110 meters (140 to 350 feet) in elevation. The ridge tops are broad, and the ground surface on the ridgetops is relatively level with very little topographic relief. The flanks of the ridges typically have moderate to steep slopes, and there is approximately 15 to 46 meters (50 to 150 feet) of topographic relief between ridge tops and adjacent valleys. The ridges terminate on the southwest end in a near-vertical bluff of exposed silty fine sandstone to a siltstone that meets the beach above the high tide line. The northeast ends of the ridges slope gradually down to the beach and lagoons located along the eastern shore of Narrow Cape (ENRI 1995b).

Figures 2.1-4, 2.1-5, and 2.1-6 show that the proposed KLC facilities would be placed at elevations of 43 or more meters (140 or more feet) above sea level in upland and relatively flat areas with an immediate topographic slope of zero to less than ten percent [i.e., less than a 3-meter (10-foot) vertical drop in elevation over a 30-meter (100-foot) horizontal distance].

3.3.2 GEOLOGY

Kodiak Island is an extension of the Kenai Mountains on the mainland to the north where metamorphic rocks predominate. In the general vicinity of the proposed KLC, gently folded sandstone occurs (USDA 1960). The sandstone bedrock underlying the proposed site is predominantly soft and friable silty fine sandstone (ENRI 1995b). This massive bedrock is overlain by a mantle of completely weathered bedrock grading downward to moderately weathered intact bedrock. The completely weathered bedrock has a field textural classification of sand with traces of some silt, grading to highly weathered bedrock with a textural classification of sand with trace silt and gravel, with particles of sandstone core stones making up the gravel fraction. The thickness of the completely weathered bedrock is about 0.3 to 2 meters (1 to 7 feet), with the thicker weathered zones occurring in low points (ENRI 1995b).

Occurrences of natural geologic hazards specific to the proposed KLC are summarized below.

- Seismicity - The region is located near the margin of the North American and Pacific Tectonic Plates. A northeast to southwest trending fault is located approximately one mile west of the proposed KLC. The fault is part of a major system that crosses the southeast coast of Kodiak Island and extends approximately 140 kilometers (85 miles) to the southwest. The region is seismically active with low intensity earthquakes frequently recorded. An earthquake in March 1964 that was estimated to have a Richter magnitude of 8.4 to 8.5 with an epicenter 400 kilometers (250 miles) northeast of Kodiak resulted in an uplift of 0.6 to 0.91 meters (2 to 3 feet) at Narrow Cape (ENRI 1995b).

- Tsunamis - The tsunamis resulting from the 1964 earthquake did not disturb the proposed location of the KLC, which is located above the 30-meter (100-foot) elevation above sea level recommended by Kodiak for safe refuge from flooding due to tsunamis (ENRI 1995a).

- Flooding - The proposed upland location for the KLC is not located in a floodplain (ENRI 1995a).

- Landslides - A landslide approximately 430 meters (1,400 feet) long is located on slopes of 15 to 35 percent along a valley just north of Ranch Road, where it intersects Pasagshak Point Road just north of the project site. The landslide feature itself may actually extend to within the project site boundaries and was apparently caused by rotational slumping of the poorly indurated sandstone (ENRI 1995b).

3.3.3 SOILS

The soils in the vicinity of the proposed KLC vary depending on their physiographic position. The upland soils that comprise the bulk of this area are described by USDA (1960) as being in the Kodiak soils series. These soils developed from the weathered bedrock (sandstone) and were covered by volcanic ash from a 1912 eruption about 140 kilometers (90 miles) west of Kodiak Island. A surface litter 10 centimeters (4 inches) thick of partly decayed vegetation has accumulated on the volcanic ash. These upland soils are well-drained but are always moist due to frequent rains. Erosion of these upland soils located on slopes of less than 7 percent is not considered to be a problem. As the slopes of these upland areas increase toward the adjacent valleys (i.e., greater than 7 percent), the erosion hazard may become serious (USDA 1960).

Specific physical and chemical information on these upland soils is provided in Table 3.3-1. These strongly acidic soils have a relatively high cation exchange capacity (i.e., the sum total of exchangeable cations that a soil can adsorb) due to the high organic content of the ash-buried soils. Broadly speaking, a cation is a positively charged atom or group of atoms. Hydrogen makes up most of the exchangeable cations of these soils resulting in (1) strong acidity of the soil and (2) low natural fertility (USDA 1960).

The soils in the valleys near the proposed KLC are a combination of Saltery peat and Ugak silt loam soils (USDA 1960). The access road at the proposed KLC crosses these valley soils at several points. The Saltery soils have developed where the water table is always at or near the surface and consist of a deep layer of peat 76 centimeters (30 inches) or more in depth overlain by about a 30 centimeter (12-inch) layer of ash and a new 8- to 10-centimeter (3- to 4-inch) layer of peat at the surface. The Ugak soils associated with these valley soils have only a 2.5-centimeter (1-inch) layer of peaty material beneath the layer of volcanic ash. These soils occur in poorly drained areas and are very strongly acidic to strongly acidic (USDA 1960). Soils in the more steep and mountainous areas inland from the proposed KLC are very similar to the Kodiak soil series except that the ash layer was washed away so it is missing from the soil profile (USDA 1960).

Soil cores (a total of fifty-six test borings) collected along the road in the vicinity of the proposed KLC and in the areas of proposed facilities are classified and described in ENRI (1995b):

- Along the road - Soils encountered consisted of a surficial road cover material of grey, coarse angular gravel fill that appears to be crushed rock from an off-site source. The average depth of this surficial fill was estimated to be 5 to 20 centimeters (2 to 8 inches). In low-lying areas, the

Table 3.3-1. Typical soil profile from the proposed KLC.

Soil depth (inches)	Soil Particle Size Distribution[a] (percent by dry weight of mineral soil)			Organic Carbon Content[a] (percent by dry weight of soil)	pH	Cation Exchange Capacity[b] (milliequivalents per 100 grams of soil)	Exchangeable Cations[b,c] (milliequivalents per 100 grams of soil)		Base Saturation[b] (percent)
	Sand	Silt	Clay				As H	As Ca, Mg, K, and Mn	
Straw and leaves									
+4 to +1	---[d]	---	---	---	---	---	---	---	---
Partly decomposed organic material									
+1 to 0	---	---	---	---	4.3	---	---	---	---
0 to 2	37.8	60.0	1.3	1.35	4.5				
Volcanic ash									
2 to 6	40.3	56.8	2.9	0.55	4.8	2.0	1.4	0.6	30
6 to 8	71.8	26.2	2.0	0.34	5.1				
8 to 11	87.0	11.4	1.6	0.27	5.3				
11 to 15	30.9	63.8	5.3	23+	4.3	102.0	95.5	6.5	6
Weathered sandstone in the Narrow Cape area									
15 to 20	42.0	57.3	0.7	12+	4.7	110.3	106.6	3.7	
20 to 23	42.0	57.3	0.7	12+	4.7	51.9	50.1	1.8	4
23 to 27	---	---	---	---	---				
27+	55.9	37.1	7.0	3.01	4.8	94.0	91.4	2.6	3

a. Summarized from Table 7 of USDA (1960) (Particle-size distribution and organic carbon in a typical profile of Kodiak silt loam).
b. Summarized from Table 8 of USDA (1960) (Chemical analyses of Kodiak soil from uplands between Middle Bay and Kalsin Bay).
c. H = Hydrogen, Ca = calcium, Mg = magnesium, K = potassium, and Mn = manganese.
d. --- means not provided or not available.

fill is underlain by wet native peat and volcanic ash over silty sands that represent completely weathered bedrock.

- At proposed construction areas - Soils consist of a surface peat layer of 7.6 centimeters (3 inches), underlain by a layer of volcanic ash up to 0.5 meters (1.7 feet) thick. The ash layer is absent from some locations and thicker in others. Completely weathered sandstone was encountered from depths of 0.49 to 2.1 meters (1.6 to 6.9 feet).

Soil buffering capacity is defined as the capacity of a soil to resist appreciable change in pH [pH is a measurement of the hydrogen cation (H^+) concentration in solution; a low pH (e.g. pH = 4) is acidic while a high pH (e.g. pH = 10) is basic or alkaline]. Two chemical processes occur in soils to resist (i.e., buffer) changes in pH from acid inputs. One chemical process is neutralization of the acid by buffer compounds (e.g., carbonates and phosphates). However, as described in Table 3.3-1, the soils in the vicinity of KLC are already very strongly to strongly acidic with pHs ranging from 4.1 to 5.3, which indicates that most soil buffering compounds are already neutralized and are no longer present in the soil system. Therefore, KLC soils cannot buffer pH changes using neutralization.

The second soil buffering process is by cation exchange whereby H^+ is attracted to negative charges on the surfaces of soil particles and organic matter. This electrostatic attraction removes the H^+ from the soil solution (the H^+ is adsorbed to the surfaces and is called "exchangeable H^+") and effectively prevents a change in the soil pH. That is, buffering of the acidic input has occurred. Soils vary in their ability to adsorb cations as measured by their cation exchange capacity. The cation exchange capacity of a soil depends on the amounts and types of clays present and its organic matter content. The soils at KLC are high in organic matter (see Table 3.3-1) which results in their having a relatively high cation exchange capacity. As described by Foth (1978), "Soils with the largest cation exchange capacity offer the greatest resistance to change in pH and are the most strongly buffered." This means that KLC soils can buffer pH changes using cation exchange.

In the soil system, an equilibrium is reached between solution H^+ (i.e., H^+ in the soil solution resulting in acidic conditions) and exchangeable H^+ (i.e., H^+ electrostatically adsorbed to cation exchange sites on surfaces of soil particles and organic matter) so that a change in one produces a change in the other (Foth 1978). As further determined by reviewing Table 3.3-1, H^+ ions are the most prevalent exchangeable cations occupying between 70 to 97 percent of the cation exchange sites in the KLC soils. Comparing exchangeable H^+ to solution H^+ in the rooting zone of the soils at the KLC provides an equilibrium or a ratio of about 23,000:1. This ratio was calculated using the (1) weighted average of exchangeable H^+ values provided in Table 3.3-1 for soil depths from 28 to 58 centimeters (11 to 23 inches), (2) lowest measured pH in the rooting zone (i.e., most acid with the most solution $H^{+})$, (3) assuming a soil density of 1.3 grams per cubic centimeter on a dry-weight basis, and (4) assuming pH measurements in Table 3.3-1 were taken after mixing 10 grams of dry soil with 10 milliliters of water. An equilibrium of exchangeable H^+ to solution H^+ of 23,000:1 means that KLC soils can adsorb a large amount of acid without altering the overall soil pH.

3.4 Noise

Baseline studies of noise levels in the Narrow Cape area have not been conducted; however, as described in Section 3.6, the proposed KLC is remote from typical man-made sources of noise. Based on land use in the Narrow Cape area, the most common man-made noise results from occasional traffic on the road from Kodiak to Narrow Cape, from nearby off-road recreational vehicles, and from intermittent noise from standby generators at the nearby Loran Station.

Critical human receptors for noise from proposed KLC construction and operation are located at the nearest residence [Kodiak Ranch; 3 kilometers (2 miles)], the nearest business [Church Camp; 5 kilometers (3 miles)], and the nearest public facility [Pasagshak State Recreation Area; 10 kilometers (6 miles)]. These locations are indicated on the map in Figure 2.1-1. Critical wildlife receptors are located at the shoreline around Narrow Cape and Ugak Island (the locations and distances from the proposed site are discussed in Section 4.5).

3.5 Ecological Resources

ENRI conducted baseline natural resource inventories in 1994 of approximately 13 square kilometers (3,100 acres) of land on Narrow Cape (the proposed KLC site) and documented the occurrence and status of terrestrial birds, marine birds, and marine mammals known to occur within a 25-kilometer (15.5-mile) radius of the study area on Narrow Cape (ENRI 1995b, c). ENRI also conducted seabird colony surveys within an approximate 56-kilometer (35-mile) radius of Narrow Cape. The scope of these surveys was determined by reviewing the literature on the extent of impacts from large launch vehicles such as the Titan IV and the Space Shuttle. The ENRI surveys and inventories served as the primary source for the description of the affected environment that follows. Baseline information was augmented where necessary using contacts with local ecological resource experts and confirmatory site visits.

3.5.1 TERRESTRIAL BIOTA

3.5.1.1 Vegetation

The Kodiak Archipelago can be divided into two major life zones, the Hudsonian Zone and the Arctic Zone. The Hudsonian Zone is dominated by spruce forest and extends along the Gulf of Alaska including Afognak Island and the northeastern portion of Kodiak Island. The remainder of Kodiak Island is characteristic of the Arctic Zone. The proposed KLC site is located in an area of transition, with the native vegetation of the site consisting of grass-forb meadows alternating with shrub patches of alder and willow and scattered islands of spruce forest.

Vegetation covers 88 percent of the proposed 13-square kilometer (3,100-acre) KLC and is predominantly meadows, shrublands, wetlands, and intermittent spruce stands. The remaining 12 percent is open water. A 1994 field study was conducted by ENRI to map and describe the vegetation types at the proposed KLC site (ENRI 1995a). Vegetation polygons were delineated by aerial photo interpretation and field verified by ground surveys. The three major plant communities found in the vicinity of the proposed KLC site are described below and shown in Figure 3.5-1. A complete description of the twenty-three plant communities found on the proposed KLC site is provided in Appendix C.

Meadows, which are the most prevalent plant communities on the proposed KLC site, are further categorized into five associations. Hairgrass-mixed forb meadow is the most common. The hairgrass-mixed forb meadow is dominated by *Deschampsia beringensis*, *Deschampsia caespitosa*, *Geranium eriantham*, *Lupinus nootkatensis*, *Sanguisorba stipulata*, *Solidago lepida*, *Festuca rubra*, *Archillea borealis*, *Salix barclayi*, *Viola* sp., and *Castilleja unalaschcensis*. Other meadow types include the low shrub-forb meadow, the open willow-hairgrass-mixed forb meadow, mixed dwarf shrub-graminoid meadow, and lupine meadows.

Two shrub associations, closed alder and closed mixed alder-willow shrublands, are found on the proposed KLC site. The closed alder shrubland is common in the southwestern portion of the proposed KLC site and is dominated by dense alder (*Alnus sinuata*) thickets (greater than 75 percent alder) with an understory of *Rubus spectabilis*, *Sambucus racemosa*, and *Aplopanax horridus*. Closed mixed alder-willow shrubland is common in the western portion of the study area and along road margins. It is characterized by greater than 75 percent coverage of dominant species including alder, *Salix barclayi*, and *Calamagrostis canadensis*.

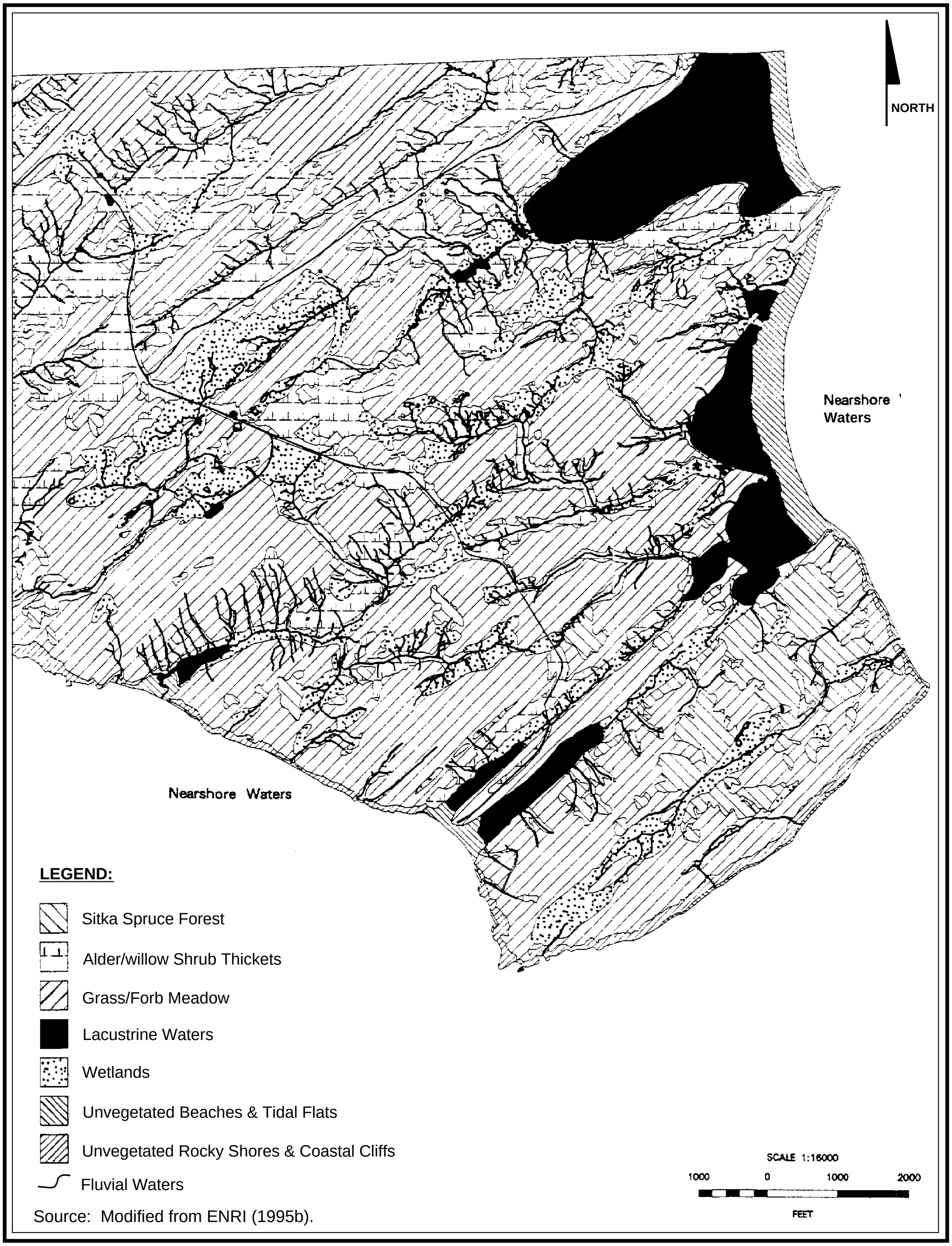


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Figure 3.5-1. Major vegetation communities of the proposed KLC.

Sitka spruce forest is common in the southeastern portion of the proposed KLC site and is dominated by sitka spruce (*Picea sitchensis*). The understory consists of hairgrass-mixed forb species including *Deschampsia beringensis*, *Deschampsia caespitosa*, *Salix barclayi*, *Geranium erianthum*, and *Solidago lefida*. In dense areas where the canopy is 80 percent closed, *Cerastium* sp. or feathermosses (*Hylocomium splendens* and *Pleurozium schreberi*) cover the forest floor. In more open areas the understory is continuous with the surrounding meadows.

As noted previously, vegetation covers 88 percent [11 square kilometers (2,730 acres)] of the proposed KLC site. The nonwetland vegetation described above makes up 71 percent [7.9 square kilometers (1,940 acres)] of the vegetated cover, and wetlands cover the remaining 29 percent [3.2 square kilometers (790 acres)] of the proposed KLC site.[5] Vegetated wetlands on the proposed KLC site include semi-permanently flooded areas, saturated emergent wetlands, and marshes. Descriptions of these wetland areas, including the dominant and associated species, are given in Appendix C.

Although upland soils on the proposed KLC site are well drained, they are always moist due to the frequent rainfall (see Sections 3.1 and 3.3). These moist soils support vegetation normally associated with wetlands, seemingly independent of slope and elevation. As a result, plants such as alder (*Alnus sinuata*) and willows (*Salix fuscescens* and *S. barclayi*) are sometimes found on the site on slopes and hillsides, particularly when seeps are present.

3.5.1.2 Birds

Kodiak Island provides habitat for 221 bird species. The proposed KLC site provides seasonal habitat for approximately 143 species of terrestrial and marine-oriented birds (ENRI 1995c). Table 3.5-1 lists the habitat classifications and typical species observed in each habitat.

3.5.1.3 Mammals

The Narrow Cape area supports 12 species of mammals, 6 native and 6 introduced. During a 1994 survey by ENRI, 11 of the species were observed in the proposed KLC area. Although the mountain goat was not observed, this species has been observed by others in the vicinity of Shaft Peak approximately 4.0 kilometers (2.5 miles) northwest of the proposed KLC site boundary (ENRI 1995c).

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[5]Wetlands were classified according to the U.S. Fish and Wildlife Service's *Classification of Wetlands and Deepwater Habitats of the United States* (Cowardin et al. 1979). This hierarchical classification system defines the limits of wetlands according to ecological characteristics and not according to administrative or regulatory programs.

Table 3.5-1. Avian habitats of the proposed KLC site.[a]

Habitat	Description	Typical Species
Lacustrine waters	Fresh and brackish waters of lakes and ponds and their immediate shorelines	Loons, grebes, dabbling ducks, and phalaropes
Fluvial waters	Flowing waters and their immediate shorelines	Harlequin ducks, mergansers, glaucous and mew gulls, and kingfishers
Sitka spruce forests	Greater than 25 percent cover of sitka spruce	Golden-crowned kinglets, boreal chickadees, dark-eyed juncos, varied thrushes, white-winged crossbills, and goshawks
Shrub thickets	Dense alder stands and bands of mixed alder-willow shrubs	Golden-crowned sparrows, orange-crowned sparrows, Wilson's warblers, gray-cheeked thrushes, fox sparrows, and tree sparrows
Wetlands	Variety of wetlands characterized by semi-permanently flooded areas, saturated emergent wetlands, and marshes	Greater yellowlegs, common snipe, mew gulls, arctic and Aleutian terns, American pipits, and savannah sparrows
Beaches and tidal flats	Unvegetated shorelines	Least and western sandpipers, semipalmated plovers, green-winged teal, mallards, bald eagles, short-billed dowitchers, and glaucous-winged gulls
Rocky shores and coastal cliffs	Bedrock coastal cliffs and erosional deposits of rock and rubble	Cormorants, ravens, peregrine falcons, glaucous-winged gulls, and black oystercatchers

a. Source: ENRI (1995b; 1995d).

Table 3.5-2 lists terrestrial mammals found in the Narrow Cape area. Horses, cattle, and bison graze under lease to a local ranch over all parts of the proposed KLC site.

Table 3.5-2. Terrestrial mammals of Narrow Cape.[a]

Common Name	Scientific Name
Little brown bat	*Myotis lucifugus*
Snowshoe hare[b]	*Lepus americanus*
Red squirrel[b]	*Tamiasciurus hudsonicus*
Tundra vole	*Microtus oeconomus*
Muskrat[b]	*Ondatra zibethicus*
Beaver[b]	*Castor canadensis*
Red fox	*Vulpes vulpes*
Brown bear	*Ursus arctos*
Short-tailed weasel	*Mustela erminea*
River otter	*Lutra canadensis*
Sitka black-tailed deer[b]	*Odocoileus hemionus*
Mountain goat[b]	*Oreamnos americanus*

a. Source: ENRI (1995c).
b. Introduced to Kodiak Island.

3.5.2 AQUATIC AND SEMI-AQUATIC BIOTA

3.5.2.1 Fisheries

Freshwater and Anadromous

Twelve percent of the proposed KLC site is occupied by open water (Figure 3.2-1). This includes small unnamed streams, two freshwater lakes, and a series of saltwater-influenced lagoons. Streams on the proposed KLC site drain small areas and are less than two miles long. Two long narrow lakes known as Twin Lakes occur near sea level and are located on the south side of the site. East Twin Lake is the larger of the two with a length of 490 meters (1,600) feet and width of 60 meters (200 feet). Because streams and lakes on the proposed KLC site are relatively small and shallow, freshwater fishery resources are limited.

In 1994, a fish survey was conducted by ENRI in the proposed KLC area. The study concentrated on four small streams draining south to the Gulf of Alaska. Figure 3.2-1 shows the location of streams draining the proposed KLC area. Fish presence was documented by direct observation and by trapping with baited wire minnow traps. Dolly Varden char (*Salvelinus malma*) were numerous in all four streams. Coho salmon (*Oncorhynchus kisutch*) juveniles were captured in streams 1 and 2 (Figure 3.2-1). Sculpin (*Cottus* sp.) were captured in stream 2, and stickleback (presumably *Gasterosteus aculeatus* or *Pungitius pungitius*) were captured in stream 4 and in East Twin Lake.

Prior to 1994, the closest streams to the proposed KLC site with known runs of anadromous fish (salmonids) were several small streams north of Barry Lagoon (Schwarz 1993) (see Figure 3.2-1). These streams support small populations of pink and coho salmon. The closest major salmon stream to the proposed KLC site is the Pasagshak River (Figure 3.2-1), located approximately 10 kilometers (6 miles) from the proposed KLC site. The river supports spawning of chinook, coho, sockeye, and pink salmon in summer and fall. With the identification of coho salmon juveniles in streams 1 and 2, the Alaska Department of Fish and Game will incorporate these two streams into its anadromous stream catalog (ENRI 1995b).

The Alaska Department of Fish and Game currently stocks three lakes in the survey area [Bull, Lupin, and East Twin (Figure 3.2-1)] with rainbow trout. Since 1988, 4,000, 2,000, and 1,600 hatchery-reared fish have been stocked annually in East Twin, Bull, and Lupin lakes respectively (Schwarz 1993). Of those, only East Twin Lake lies within the boundaries of the proposed KLC site.

Marine

Numerous species of fish and invertebrates inhabit nearshore and offshore waters around Kodiak Island. The most common marine fish are flounder, sole, pollock, skate, cod, and halibut. Other marine organisms that inhabit the shallow continental shelf water around Kodiak Island are crabs (king, tanner, Dungeness, kelp, rock, and hermit), scallops, octopus, shrimp, cockles, razor and butter clams, sea anemones, chitons, jellyfish, sea urchins, limpets, snails, mussels, sea cucumber, starfish, and barnacles (ENRI 1995c). Fish inhabiting waters in the immediate area of the proposed KLC are typical of those in the waters of Kodiak Island as a whole.

3.5.2.2 Marine Birds

Two systematic surveys of marine birds in the vicinity of the proposed KLC site were conducted in 1994 (ENRI 1995c). These surveys had nearshore and offshore components along the eastern coastline of Kodiak Island. The survey area included a 56-kilometer (35-mile) radius of the proposed KLC site extending north to Viesoki Island in Chiniak Bay and south to Sheep Island in the Sitkalidak Strait. The nearshore surveys censused 32 seabird colonies (all but 2 were previously documented). The offshore surveys recorded species and numbers encountered by position along transects. Thirty-eight species were observed; however, no seabird colonies were found in the immediate vicinity of the proposed 13-square kilometer (3,100-acre) KLC site or on Ugak Island.

The seabird colony closest to the proposed KLC site is believed to be an Arctic and Aleutian tern colony located 3 to 5 kilometers (2 to 3 miles) north of the proposed launch pad (see Figure 3.5-2) in a wet meadow/wetland (MacIntosh 1995). This colony was not occupied in 1994 but has generally been active since 1975 (Mendenhall 1995). There may also be a colony of 140 or more tufted puffins along the west-facing cliffs of the Pasagshak Peninsula, approximately 8 kilometers (5 miles) west of the project site (Mendenhall 1995).

ENRI (1995c) surveys conducted in June and July of 1994 confirmed the presence of active seabird colonies at Long Island, Mesa Island, and Gull Point (see Figure 3.5-2), all further removed [13 to 18 kilometers (8 to 11 miles)] from the proposed KLC site. Seabird species observed at the Long Island and Mesa Island colonies in June and July 1994 were (in decreasing order of abundance) black-legged kittiwake, glaucous-winged gull, tufted puffin, pelagic and/or red-faced cormorant (it is difficult to distinguish between these species at a distance), and horned puffin (ENRI 1995c). Species observed at the Gull Point colony included (in decreasing order of abundance) glaucous-winged gull, pelagic and/or red-faced cormorant, tufted puffin, black-legged kittiwake, pigeon guillemot, and horned puffin. The

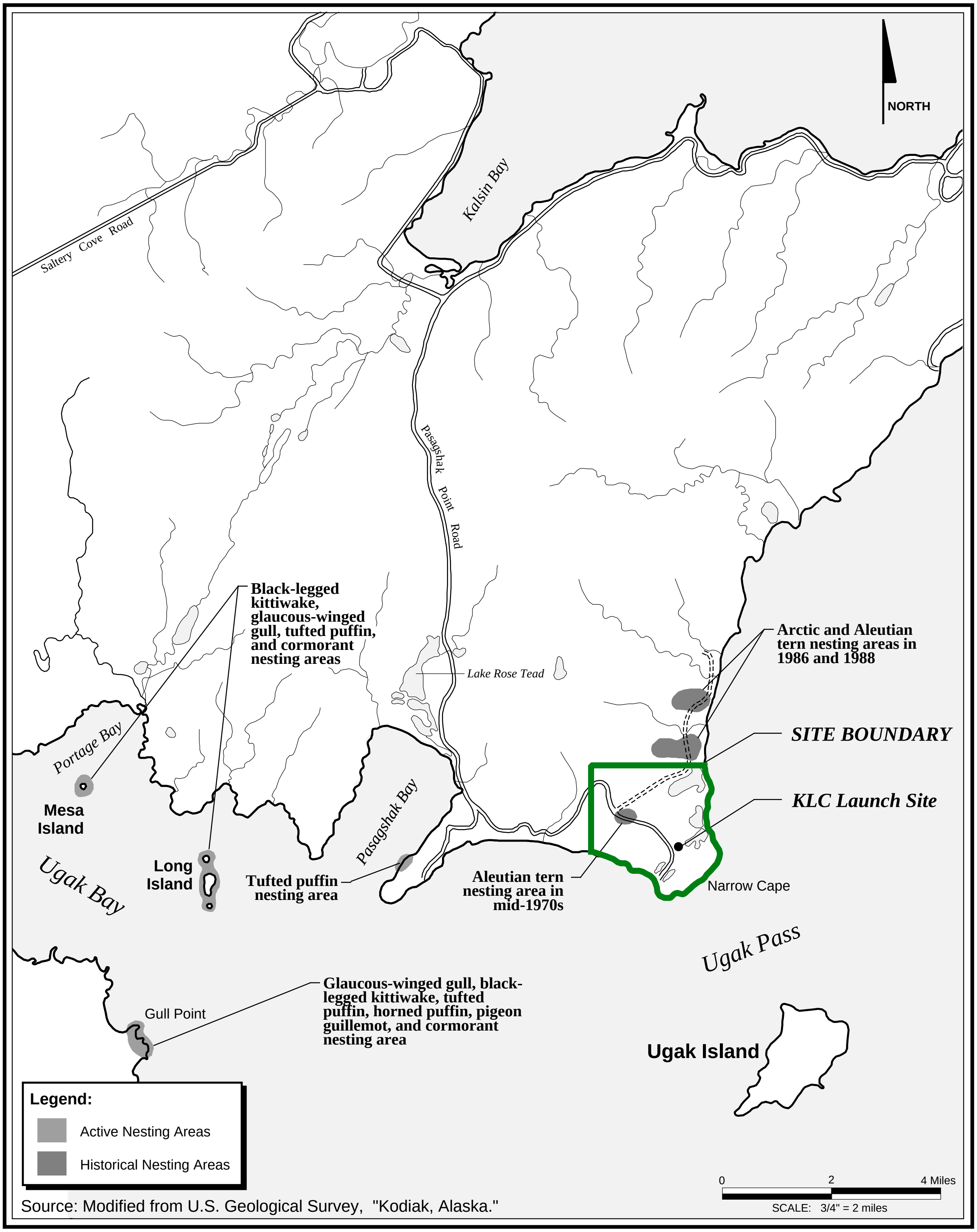

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Figure 3.5-2. Seabird colonies in KLC vicinity.

authors of the ENRI baseline material on Kodiak seabird colonies (ENRI 1995c) suggest that the census methods (which involved daytime surveys from a research vessel stationed several hundred meters from shore to minimize disturbance to nesting birds) may have underestimated numbers and diversity of nesting seabirds because many species in the region are cavity or burrow nesters (e.g., Cassin's auklet and parakeet auklet) and others are largely nocturnal (e.g., marbled murrelet and Kittlitz's murrelet).

Information assembled by ENRI (1995c) shows that Ugak Pass, the strait between Narrow Cape and Ugak Island, is attractive to marine birds year-round because of its shallow waters and abundant supplies of fish and invertebrates. Eiders and sea ducks common to the area include King eiders, Steller's eiders, harlequin ducks, oldsquaw, black scoters, surf scoters, and white-winged scoters. These species occur in large numbers from November to May. King eiders commonly form large rafts (500 to 2,000 or more birds) near the middle of the pass. Scoters often occur with King eiders but also congregate in large numbers north along the northeastern entrance to Ugak Pass. Steller's eiders and oldsquaws occur in tight bunches scattered throughout the area. During winter months, Steller's eiders are commonly observed in numbers ranging up to 600 off Narrow Cape in the vicinity of the proposed KLC site.

The (western) harlequin duck, formerly a candidate (Category 2) for listing under the Endangered Species Act and now a "species of concern," ranges from Siberia in the west to Colorado in the east. The species apparently breeds over much of southern Alaska and the Aleutians, and as far north as the Brooks Range. They are found in the Kodiak Archipelago in all months of the year (Kodiak Island Borough Community Development Department 1985; ENRI 1995c). As many as 500 birds may be found in the Narrow Cape area during winter months (ENRI 1995c), where they are seen in shallow waters along rocky shorelines. In summer months, harlequin ducks are often found well inland in streams and rivers, even in fast-flowing, whitewater streams (Bellrose 1980). Gabrielson and Lincoln (1959) describe this species feeding close to rocky shores and diving through the surf, "seemingly at play." The harlequin duck is a strong diver and swimmer, skills it uses to its advantage in rough coastal waters and turbulent streams where it feeds on aquatic insects, crustaceans, crabs, and mollusks. Although harlequin ducks are year-round residents of Kodiak Island (ENRI 1995c), there is no evidence to suggest that this species nests in the Narrow Cape area. This species nests on the ground near cold, rapidly-flowing freshwater streams, frequently in forested areas (Bellrose 1980; Armstrong 1995). Streams in the Narrow Cape area are either tidally-influenced or very small; none are heavily forested. None provide optimal nesting habitat.

Gulls (particularly black-legged kittiwakes) are very common in the Ugak Pass area year-round. Mew and glaucous-winged gulls are also common (ENRI 1995c). Arctic and Aleutian terns occasionally migrate through the area, and hundreds may be seen feeding there in summer. A previously recorded Aleutian tern colony in the vicinity of the proposed KLC site was not occupied in 1994. However, this species is known to routinely shift colony sites on a random basis and to return to previously occupied colony areas.

Alcids can be found throughout the area, particularly at the north and south ends of the Ugak Pass. Common murres and pigeon guillemots are common year-round, with winter numbers occasionally exceeding 1,000. Ancient murrelets are common during summer and fall. Crested auklets, Rhinoceros auklets, tufted puffins, and horned puffins are common seasonally. Thick-billed murres, parakeet auklets, and least auklets can sometimes by seen in small numbers as well.

The marbled murrelet, formerly a candidate (Category 2) for listing under the Endangered Species Act and now a “species of concern,” ranges from southeastern Alaska to northern California. It is most abundant in sheltered waters along the coast of southeastern Alaska and the Prince William Sound area where there are large protected bodies of salt water (Gabrielson and Lincoln 1959). Although small-winged and ungainly on land, murrelets are surprisingly strong fliers and equally capable swimmers, feeding on small fish that they capture underwater.

Although Gabrielson and Lincoln (1959) describe the marbled murrelet as non-migratory, there is well-documented seasonal movement from coastal areas (where the species winters) to more inland areas (where the species breeds). This adaptable species apparently uses a variety of habitats for nesting, from treeless alpine meadows to old-growth rainforests (Gabrielson and Lincoln 1959; National Geographic Society 1987; ENRI 1995c). The marbled murrelet is a year-round resident of the Kodiak Archipelago, with largest numbers occurring in the Ugak Bay, Shelikof Strait, and Izhut Bay areas (Kodiak Island Borough Community Development Department 1985). Although marbled murrelets are common residents of Kodiak Island, they are uncommon residents in the Narrow Cape/Ugak Pass area. The marbled murrelet population of Kodiak Island is estimated as high as 13,000, but only 100 or so inhabit the Narrow Cape/Ugak Pass area. No nests of this species were located during the 1994 surveys of meadows and forested lowlands of the proposed KLC area (ENRI 1995c).

Kittlitz’s murrelet is an uncommon resident (200 birds) of Kodiak Island that is reported to be a rare visitor to the Narrow Cape area. It has been observed in small numbers (5 to 10 birds) feeding in Ugak Pass and is most often observed in summer months. This species, formerly a candidate (Category 2) for listing under the Endangered Species Act and now a “species of concern,” is similar in appearance and behavior to the marbled murrelet (Gabrielson and Lincoln 1959). It apparently winters in Asia and breeds near glaciers on the west and south coasts of the Alaskan mainland (Robbins et al. 1966; National Geographic Society 1987). Kittlitz's murrelet is an uncommon-to-rare resident of the Kodiak Archipelago in all months of the year (ENRI 1995c). This species is occasionally seen in the Narrow Cape area in summer months but in smaller numbers than the marbled murrelet (ENRI 1995c).

Common loons (50 to 100 or more) pass through the proposed KLC area during migrations. Red-throated loons are frequently seen; yellow-billed loons are uncommon. Both horned and red-necked grebes are common during fall migration but are uncommon during the winter. Northern fulmars occur in numbers of up to 500, particularly during easterly winds. Sooty and short-tailed shearwaters occur in the Ugak Bay area in the thousands during spring, summer, and fall. Red-necked phalaropes are common in tide rips and number in the hundreds during spring and fall.

The number of colony sites observed in the 1994 ENRI survey was compared with data compiled by Lensink (1984) for colony sites in the entire Gulf of Alaska. Although data from long-term, continuous monitoring would have been preferred, the only available baseline data on seabirds that nest in colonies were from 1984. The survey area supports an estimated 14 percent of the black-legged kittiwake colonies, 10 percent of the Aleutian tern colonies, 5 percent of the tufted puffin colonies, and 5 percent of the glaucous-winged gull colonies in the Gulf of Alaska (ENRI 1995b).

Although the number of colonies within the survey area is substantial, the number of birds using these colonies is comparatively small relative to the total Gulf of Alaska breeding population (ENRI 1995b). Data indicate that colonies in the study area support about 2 percent of the Gulf's breeding double-crested cormorant; about 0.3 percent of the breeding pelagic cormorant; about 0.02 percent of the breeding red-faced cormorant; about 1 percent of the breeding glaucous-winged gull; about 2 percent of the breeding black-legged kittiwake; about 0.002 percent of the breeding common murre; about 0.004 percent of the breeding horned puffin; and about 7 percent of the Arctic tern population.

During the offshore surveys conducted in 1994, 38 different species were observed. In the June survey, 3,480 birds of 26 species were recorded. In July, 3,812 birds representing 31 species were observed. The most common species in June were sooty shearwater (49 percent of total), northern fulmar (20 percent of total), and common murre (3 percent of total). This general pattern was observed in July as well, with the main change being the addition of red-necked phalaropes (11 percent of total).

3.5.2.3 Marine Mammals

As many as 7 species of large cetaceans, 12 species of medium to small cetaceans, 6 pinniped species, and 1 marine mustelid occur in the Gulf of Alaska (Calkins 1987). These mammals use the Gulf for a number of activities such as migration and summer feeding or as year-round range. A few of these species are year-round residents and several seasonally range in the waters off Kodiak Island. These species common to the proposed KLC area are discussed below.

Three species of pinnipeds, the Steller sea lion (*Eumetopias jubatus*), the harbor seal (*Phoca vitulina*), and the Northern fur seal (*Callorhinus ursinus*) are found in the proposed KLC area. The Steller sea lion population nationally (including Alaska) has declined from 69,100 adults and juveniles in 1989 to 52,200 adults and juveniles in 1995 (NMFS 1995). There are four major rookeries (breeding grounds) in the Kodiak Archipelago (Calkins 1987) and seventeen sea lion haulouts on Kodiak Island (ENRI 1995b). Three of these, Chiniak Point, Ugak Island, and Gull Point, occur within 25 kilometers (15.5 miles) of the proposed KLC site (Figure 3.5-3). Ugak Island, approximately 5 kilometers (3 miles) southeast of the proposed KLC site, is the closest. Approximately 400 sea lions use this haulout area (Morris 1994).

The harbor seal is a year-round resident of the area. Several haulouts and general use areas occur in the vicinity of the proposed KLC site including Ugak Island and Long Island (Figure 3.5-3). Although the number of harbor seals on Ugak Island had been reported to exceed 2,000 (Morris 1994), recent data showed numbers of 300 to 400 (Wynne 1995).

K. Wynne, of the Alaska Sea Grant Advisory Program, has conducted surveys of harbor seals in the Ugak Bay-Narrow Cape area since 1993 during the peak pupping season (June) and molting season (late-August/early-September), periods when animals spend more time than normal hauled out on land (Wynne 1996). Tables 3.5-3 and 3.5-4 show numbers of harbor seals observed at the two haulouts (Ugak Island and Long Island) closest to the proposed KLC launch site in June and August-September, respectively.

The Northern fur seal occurs from January through April offshore of the KLC site near the continental shelf break (ENRI 1995c). This species was designated as “depleted” under the Marine Mammal Protection Act in 1988 because population levels had declined to less than 50 percent of those observed in the 1950s (NMFS 1993). The most recent estimate of the number of fur seals in the Northern Pacific population is approximately 1,000,000 animals (Small and DeMaster 1995).

The sea otter (*Enhydra lutris*), nearly extinct by the late 19th century, has recolonized much of its historic range in Alaska. There may be as many as 150,000 animals in Alaskan waters, making up more than 90 percent of the world total (Rotterman and Simon-Jackson 1988). Sea otter numbers are increasing in the Gulf of Alaska as animals recolonize unoccupied parts of their historic range (Rotterman and Simon-Jackson 1988). A remnant population of sea otters in the northern part of the Kodiak Archipelago (Shuyak Island and/or the Barren Islands, both north of Afognak Island) has grown

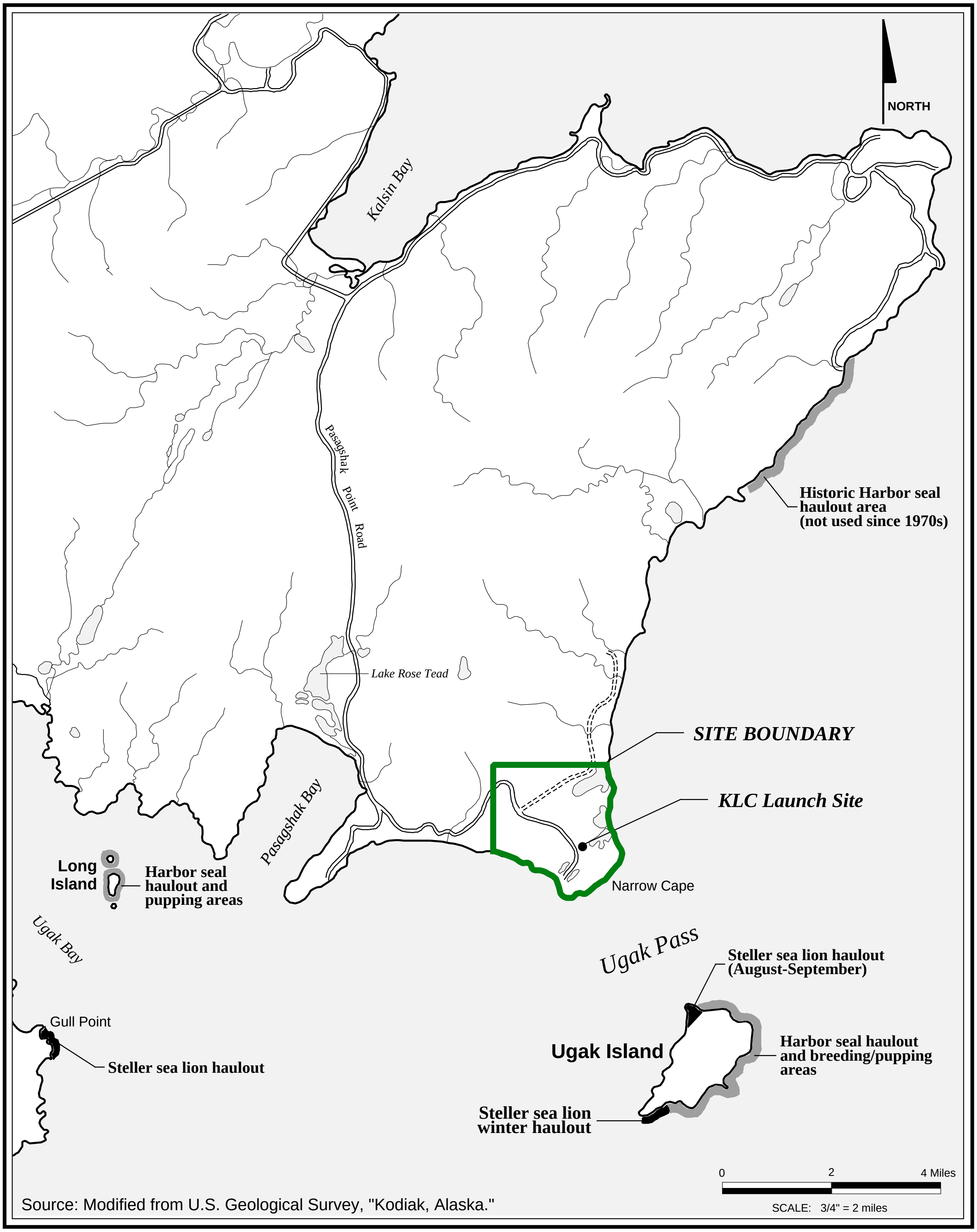

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Figure 3.5-3. Pinniped haulouts in KLC vicinity.

Table 3.5-3. Numbers of harbor seal adults and pups at Ugak Island and Long Island, 1993-1994.

	Maximum number observed			
	1993		1994	
Location	Adults	Pups	Adults	Pups
Ugak Island	290	88	292	96
Long Island	178	54	185	59

Source: Wynne (1996).

Table 3.5-4. Numbers of harbor seals using Ugak Island and Long Island haulouts, 1993-1995.

	Maximum (mean) number observed		
Location	1993	1994	1995
Ugak Island	268 (206)	335 (299)	319 (269)
Long Island	74 (60)	134 (105)	153 (115)

Source: Wynne (1996).

substantially and spread southward, and sea otters are now common along most of coastal Kodiak Island (Rotterman and Simon-Jackson 1988). Sea otter populations are at or near carrying capacity in the Narrow Cape/Ugak Bay area (ENRI 1995c). The sea otter is found in the proposed KLC area in all months of the year.

Seven of the nine Pacific species of great whales, the killer whale, and several smaller cetacean species seasonally range in the waters off Kodiak Island. The California gray whale (*Eschrichtus robustus*) population in the eastern Pacific is estimated to be 21,000 (Wynne 1992). The migratory path of gray whales takes most of the population nearshore along the eastern edge of Kodiak Island in spring and fall. Numbers are the highest in this area during April, May, November, and December. A major area of spring concentration and probable feeding area occurs from the north end of Chiniak Bay south to the Narrow Cape/Ugak Island area. According to information presented in ENRI (1995c), most whales passing by Narrow Cape travel within 760 meters (2,500 feet) of shore. During fall, they frequently spend time lolling about in an area off the west end of the cape. The reason for this behavior is unknown.

The California gray whale was removed from the U.S. Fish and Wildlife Service's list of endangered species[6] in June 1994. This de-listing resulted from a NMFS determination that the eastern North Pacific

[6]Title 50, Code of Federal Regulations, Part 17.11.

(or “California”) population of the gray whale “...has recovered to near its estimated original population size and is neither in danger of extinction throughout...its range, nor likely to again become endangered within the foreseeable future....”[7]

The humpback whale (*Megaptera novaeangliae*) moves north to the Gulf of Alaska in the summer and appears to have a high affinity for nearshore waters. In summer months, humpbacks can generally be found in the nearshore areas of Kodiak Island, Prince William Sound, and in southeastern Alaska. Groups of humpback whales are occasionally observed in the Narrow Cape and Ugak Island area in the late spring, summer, and fall. The North Pacific population of humpback whales is estimated to be less than 2,000 (Wynne 1992) and is the second most depleted whale population in the North Pacific, after the North Pacific right whale (Calkins 1987).

Cetacean species found year round in the water surrounding Kodiak Island are killer whale (*Orcinus orca*), Dall’s porpoise (*Phocoenoides dalli*), and harbor porpoise (*Phocoena phocoena*). Pacific white-sided dolphin (*Lagenorhynchius obliquidens*), Risso’s dolphin (*Grampus griseus*), northern right whale dolphin (*Lissodelphis borealis*), pilot whale (*Globicephela macrorhynchus*), and several species of beaked whale also reportedly occur but are rarely seen because they are primarily pelagic (i.e., deep-water) (ENRI 1995c). A number of other cetacean species occur in the northern Gulf of Alaska but are not commonly found in nearshore waters and embayments along Kodiak Island. These species include the Sei whale (*Balaenoptera borealis*) and the northern right whale (*Balaena glacialis*). The sperm whale (*Physeter macrocephalus*) and the blue whale (*Balaenoptera musculus*) occur in the Kodiak Island area but are primarily pelagic (ENRI 1995c).

3.5.3 SPECIAL STATUS SPECIES

This section addresses plant and animal species of special interest that are known to occur in the area of Narrow Cape and which are either known to occur or may occur specifically within the proposed KLC site. A species is considered to be of “special interest” if it is federally- or state-listed or a candidate to be federally- or state-listed. Agencies with responsibility and/or authority for the species addressed in this document include the U.S. Fish and Wildlife Service, the National Marine Fisheries Service, and the Alaska Department of Fish and Game. Species that are federally listed as threatened or endangered are protected under the Endangered Species Act of 1973[8] as amended. Under this legislation, a species is considered endangered if it is “...in danger of extinction throughout all or a significant portion of its

[7]Federal Register, Volume 59, page 31094, June 16, 1994.
[8]Federal Register Volume 41, page 22915, June 7, 1976.

range...,” and threatened if it is “likely to become an endangered species within the foreseeable future throughout all or a significant portion of its range.” This legislation designates candidate species as species for which “...the Service has enough substantial information on biological vulnerability and threat(s) to support proposals to list them as endangered or threatened.”

Candidate species were formerly designated by the U.S. Fish and Wildlife Service as either Category 1, 2, or 3 candidate species. Prior to the February 28, 1996 Federal Register notice,[9] candidate species (as defined above) were known as Category 1 candidate species; Category 2 candidate species were defined as those species that “...the best available scientific and commercial information indicates the species might qualify for protection under the Act, but the Service needs further status survey information, evaluation of threats, or taxonomic clarification before the need for listing can be determined;” and Category 3 candidates included “...taxa that once were considered for listing as threatened or endangered but are no longer under such consideration.” By this notice, the U.S. Fish and Wildlife Service discontinued the designation of Category 2 and 3 species as candidates.

Occurrences of endangered, threatened, or candidate species in the vicinity of the KLC site were determined by ENRI through consultation with Federal agencies with oversight of the Endangered Species Act (U.S. Fish and Wildlife Service and National Marine Fisheries Service), dedicated field surveys, interviews with local experts, and literature reviews. No federally listed endangered, threatened, or candidate terrestrial species were found within the proposed boundaries of the KLC site. However, several special status species occur in marine waters in the proposed KLC area. ENRI identified 17 listed (endangered, threatened, and candidate) species that occur on or offshore of Kodiak Island, with 7 occurring with regularity in the vicinity of the proposed KLC site. After ENRI conducted its study, the U.S. Fish and Wildlife Service removed three of the seven species (harlequin duck, Kittlitz's murrelet, and marbled murrelet) from its list of candidate species. Section 3.5.2.2 discusses the status of these three species; Table 3.5-5 identifies the remaining threatened, endangered, and proposed threatened species.

[9]Federal Register, Volume 61, pages 7596-7613, February 28, 1996.

Table 3.5-5. Special status species of the proposed KLC area.

Common Name	Scientific Name	Status
Steller sea lion	*Eumetopias jubatus*	Threatened
Fin whale	*Balaenoptera physalus*	Endangered
Humpback whale	*Megaptera novaeangliae*	Endangered
Steller's eider	*Polysticta stelleri*	Proposed Threatened
Bald eagle	*Haliaeetus leucocephalus*	Protected

The National Marine Fisheries Service has proposed to change, from "threatened" to "endangered," the status of a portion of the Steller sea lion population.[10] The change would apply to animals found in the Kodiak Island area and would be in response to a continued decline in Steller sea lion abundance. A change in food availability is the leading hypothesis for the cause of the decline.

A small portion of the world's Steller's eiders nest in Alaska (in the North Slope region), and the U.S. Fish and Wildlife Service has proposed to classify this nesting population as "threatened".[11] Most of the world's population of Steller's eiders winters along the Alaskan Peninsula from the eastern Aleutian Islands to southern Cook Inlet, an area that includes Kodiak Island.

The bald eagle (*Haliaeetus leucocephalus*) is considered a special status species because it is protected under the Eagle Protection Act (16 USC 668-668c). In its current form, the Eagle Protection Act prohibits anyone, except under permits authorized by the Secretary of the Interior, from "taking" bald eagles, their eggs, nests, or any part of these birds. This legislation defines "taking" as "to pursue, shoot at, poison, wound, kill, capture, trap, collect, molest, or disturb." The Alaska population of bald eagles is stable. These birds are common in all months of the year on Kodiak Island and are often seen in the Narrow Cape area. Winter surveys conducted by the U.S. Fish and Wildlife Service found the highest numbers of eagles in Uyak Bay, Sitkalidak Island, islands near the city of Kodiak, and Alitak Peninsula (Kodiak Island Borough Community Development Department 1985).

In the Narrow Cape area, eagles congregate around streams and wetlands in the Lake Rose Tead area in the fall and winter to feed on spawning and spawned out salmon. Bald eagles have historically nested in the Narrow Cape area and on the KLC property. A map provided by the U.S. Fish and Wildlife Service shows that, when surveyed in 1991, bald eagle nests were relatively common in the area (Appendix B, page B-50). The survey identified one nest located on the proposed KLC site and one nest located northwest of the site. ENRI biologists conducted surveys of the proposed KLC site in June 1994 and

[10]Federal Register, Volume 60, page 51968, October 4, 1995.
[11]Federal Register, Volume 59, page 35896, July 14, 1994; Federal Register, Volume 60, page 34225, June 30, 1995.

found no evidence of nesting eagles, but theoretically could have missed inconspicuous ground nests located in remote parts of the site well removed from proposed construction areas. An eagle was observed on the cliffs at the southern-most point of the Site displaying nesting behavior (sitting in a depression in a grassy area) during Brown & Root Environmental site visits on April 28 and 29, 1996. Nest materials were not visible. This location appears to be the same one identified on the map that the U.S. Fish and Wildlife Service supplied and is approximately 910 meters (3,000 feet) from the nearest proposed construction area (Water Pumphouse). The ENRI and Brown & Root site visits in 1994 and 1996, respectively, confirmed that no nests were present in the construction areas.

3.6 Land Use

The Kodiak Archipelago includes approximately 13,000 square kilometers [3.2 million acres (5,000 square miles - approximately the size of Connecticut)][12] of land with ownership divided as follows (Kodiak Chamber of Commerce 1992):

·	Federal	6,800 square kilometers (1,680,000 acres)
·	Native corporations	3,786 square kilometers (935,480 acres)
·	State of Alaska	1,950 square kilometers (482,580 acres)
·	Local governments	280 square kilometers (70,000 acres)
·	Private property	130 square kilometers (32,000 acres)

Kodiak Island itself has an area of about 2.2 million acres (3,400 square miles) and is primarily mountainous with substantial stands of sitka spruce in the northeast. In the southwest of the island, the terrain is largely wet and moist tundra with limited vegetation growth. The topography of the Narrow Cape site is described in Section 3.3.1.

Traditionally and currently used for ranching and recreation, Narrow Cape is also the location of the U.S. Coast Guard's 190-meter (625-foot) tall Loran-C navigation transmitter station (ENRI 1995b). The Loran station is the location of an identified diesel fuel spill that is scheduled for characterization and eventual remediation. Other man-made structures in the vicinity include a small number of ranch-related structures and a summer church camp. The Pasagshak State Recreation Area, a small park containing seven campsites, picnic areas, potable water and latrines, is approximately 10 kilometers (6 miles) from the Narrow Cape location. The Pasagshak State Recreation Area is located on the Pasagshak Point Road

[12]These figures are representative only of the islands in the Kodiak Island Borough and do not include mainland holdings. The estimated division of holdings does not include recent and continuing changes in ownership as a result of the Exxon Valdez Trusteeship process and other ongoing transactions.

on the way to Narrow Cape from Kodiak (Figure 2.1-1). As an alternative use, current Borough zoning would allow development of the area for single family residences (or small-scale lodges of up to 6 clients) with a minimum lot size of approximately 20,200 square meters (5 acres). Approximately 20 percent of the area would be set aside to allow for minimum easements and access areas. Conditional use permits could allow options for other industries such as large-scale lodges.

The Narrow Cape location consists of 13 square kilometers (3,100 acres) of state land leased to AADC by the Alaska Department of Natural Resources, Division of Land. The coastal plateau of the proposed KLC site is not on a floodplain. A detailed description of vegetation cover is provided in Section 3.5.1.1.

Figure 2.1-1 illustrates the road system between the City of Kodiak and the proposed KLC site. Land use along this 41-kilometer (26-mile) stretch of Kodiak Island Highway is primarily undeveloped, with approximately 6 small commercial establishments and one ranch located along the way. The 23 kilometers (14 miles) of Pasagshak Point Road is completely undeveloped to the Pasagshak Bay area, where approximately a dozen mostly small (1- to 2-room) vacation homes are located.

3.7 Socioeconomic Resources

This section describes the existing social and economic environments of the Kodiak Island Borough, which includes the entire Kodiak Archipelago and some land on the Alaska peninsula.

3.7.1 AREA ECONOMY

The State of Alaska has traditionally relied on resource extraction for the bulk of its economic infrastructure. Oil extraction, fishing, logging, and mining are major economic activities in the state (ENRI 1995b).

Employment by major sector for 1994 in the Kodiak Island Borough is listed in Table 3.7-1. As shown, seafood processing and harvesting is the largest employment sector in the area with approximately 41 percent of total employment (ISER 1996). Income generated from fishing and fish processing forms the economic base and livelihood for many of the communities in the Kodiak Island Borough.

Government employment is the second largest sector and accounts for about 25 percent of total employment (ISER 1996). The U.S. Coast Guard (USCG), which maintains a station near Womens Bay, is the largest government employer on the island. Other key private-sector industries on Kodiak Island

Table 3.7-1. Employment by sector for Kodiak Island Borough, 1994.

Employment Sector	Employment	Percent
Mining	80	1
Construction	154	2
Miscellaneous Manufacturing	168	2
Food and Kindred Products	2,092	24
Transportation/Communications/Utilities	301	3
Wholesale Trade	72	1
Retail Trade	769	9
Financial/Insurance/Real Estate	148	2
Services	890	10
Fishing[a]	1,460	17
Agriculture and Forestry	99	1
Federal Government	166	2
State Government	252	3
Local Government	695	8
U.S. Coast Guard	1,028	12
Military - Civilian[b]	320	4
Total	8,694	100

Source: ISER (1996).

a. Traditional employment figures are based on payments of state unemployment insurance and do not count commercial fishermen. This estimate made by Impact Assessment in a 1990 study and is latest available information (ISER 1996).

b. U.S. Department of Defense civilian employees.

include logging and tourism. It is estimated that 14,700 people visit Kodiak Island each year (Kodiak Chamber of Commerce 1995). In 1991, it was estimated that fishing, tourism, and logging contributed approximately $62 million to the local economy as wages earned (ENRI 1995b).

In 1990, the Kodiak Island Borough had an average unemployment rate of 5 percent compared to a statewide average of approximately 7 percent (Kodiak Chamber of Commerce 1992). Per capita income for the Kodiak Island Borough increased approximately 3.6 percent from $20,087 in 1990 to $20,805 in 1992 (ENRI 1995b). In 1994, unemployment had risen to an average of 11.9 percent compared to a statewide average of 7.8 percent (Kodiak Chamber of Commerce 1995).

As noted above, commercial fishing and fish processing are the largest industries and major employers in the Kodiak Island Borough. In fact, the port at Kodiak is among the three most productive fishing ports in the United States, and there are approximately 2,000 commercial fishing vessels operating in the area of Kodiak. In 1992, the total value of the Kodiak Island Borough fishery catch was approximately $103 million (ENRI 1995b). This dropped to approximately $86 million in 1994 (Kodiak Chamber of Commerce 1995).

Table 3.7-2 lists the major fish species harvested commercially and corresponding seasonal information for those species. As shown, commercial fishing activities take place during nearly every season of the year. However, openings and season lengths are subject to yearly cancellations or adjustments due to continuous change in the status of fish stocks. Fish species harvested commercially from Kodiak waters include salmon, herring, shrimp, crab, halibut, whitefish, blackcod, and scallops.

Table 3.7-2. Major commercial fisheries on Kodiak Island and seasonal information.

Species	Opening Date	Length of Season
Tanner crab[a]	January 15	3 weeks
Herring (food and bait)[b]	August	Through February
Herring (roe)[b]	April	Through June
Salmon[a]	June	Through September
Dungeness crab[a]	May	Through December
Sablefish[a]	April	Through July
Halibut[c]	March	Through November
Groundfish[d]	January	Through December
Shrimp[e]	June	Through February
Scallops[e]	July	Through December

a. ENRI (1995b).
b. ADFG (1993a).
c. Probasco (1995).
d. ADFG (1993b).
e. Kodiak Island Borough Community Development Department (1985).

The salmon fishing is the largest and most consistent, and it takes place closest to Kodiak Island in the nearshore marine waters (ENRI 1995c). The closest salmon stream to Narrow Cape is the Pasagshak River (Figure 3.2-1), approximately 10 kilometers (6 miles) west of the proposed launch area, which has small commercial and subsistence salmon fisheries (ENRI 1995c).

Fishing activities between Cape Chiniak and Narrow Cape (Figure 2.1-1) are somewhat limited because the currents, sea swells, wind, and direction of the tides combine to create rough waters (Pearson 1995). However, almost all vessels traveling to fishing areas on Kodiak's east side from the Port of Kodiak do transit through the waters south of the proposed KLC. The Alaska Department of Fish and Game estimates that traffic is heaviest between April and early October when commercial herring, salmon, and groundfish fisheries take place (Probasco 1995). The specific timing of the traffic would vary according to the fishing areas and opening and closing of the various fish seasons. These are established annually by the Alaska Department of Fish and Game based on a number of factors including quotas, bag limits, and harvest levels. These seasons can be changed on short notice under emergency provisions granted to the Commissioner of the Department (AFDG 1993a and AFDG 1993b). Information on the route each vessel uses to reach specific fishing grounds is not collected or maintained (Probasco 1995).

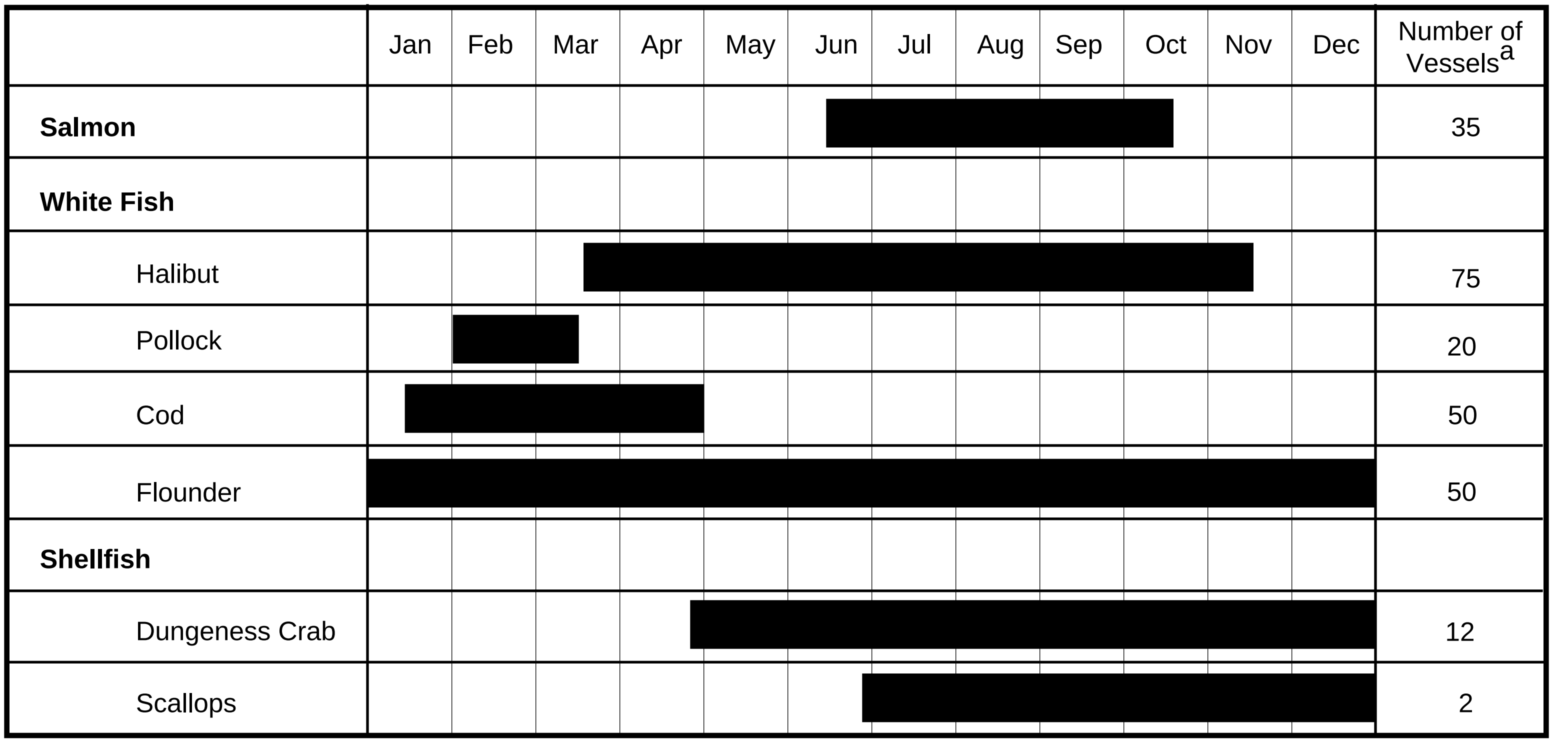
According to the Alaska Department of Fish and Game commercial fish ticket database, there are approximately 470 vessels involved in the salmon fishery, 250 vessels participating in the herring fishery, and over 600 vessels involved in groundfish fisheries (Probasco 1995). Figure 3.7-1 shows the timing of fishing activity in the launch area and the estimated number of vessels involved with each fishery.

Sport fishing in the area also occurs year round but most is from April to October. The area around Ugak Island is a sportfishing location for halibut (Probasco 1995). Definitive information on how many vessels are involved in this area is not collected by either the Alaska Department of Fish and Game or National Marine Fisheries Service (Probasco 1995 and Pearson 1995).

Commercial shipping in the immediate Kodiak Island area are primarily of small tonnage, including 2 to 3 logging vessels each month to Afognak Island and approximately 6 ships per month (during the 6 month fishing season) which travel to the Kodiak Island villages and Kodiak City to purchase fish. Within the immediate area of Narrow Cape [out to 80 kilometers (50 miles)] there are no commercial shipping lanes for large ocean-going vessels (over 1,600 tons) (McKeown 1996).

Commercial air corridors enter and exit the Kodiak State Airport (located on Woody Island, northeast of Kodiak City) to and from the east south east (corridor V 506) and west south west (corridor G 10). These corridors are well to the north of the Narrow Cape area [more than approximately 24 kilometers (15 miles) from the launch area to the edge of the V 506 corridor] (DOC 1993).

Alaska Military Operations Areas for the U.S. Air Force training exercises are located on the mainland. The nearest, Naknek 2, is more than approximately 320 kilometers (200 miles) north northwest of Kodiak Island (USAF 1995a).



[a] Estimated average number of vessels that fish the area with variable activity from week to week. Most vessels operate around the clock.
Source: Probasco (1995).

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Figure 3.7-1. Commercial fishing calendar for the area south of the proposed launch site.

3.7.2 POPULATION

The population on Kodiak Island is concentrated primarily in Kodiak and in other smaller population centers along the roadway within the northeastern portion of the island. The rest of the island is largely uninhabited with roughly two thirds of the western side being made up of the Kodiak National Wildlife Refuge (ENRI 1995c).

As shown in Table 3.7-3, the 1993 total population for the Kodiak Island Borough was approximately 15,000. The most populous areas are Kodiak, with approximately 50 percent of the population, and the U.S. Coast Guard Station, with about 13 percent of the total population (ENRI 1995c).

Table 3.7-3. Kodiak Island Borough population for 1980, 1990, 1993.

Area	1980	1990	1993
Kodiak	4,756	6,365	7,428
U.S. Coast Guard Station	1,370	2,025	2,016
Other road-connected areas	2,716	3,909	4,468
Traditional villages	1,097	1,010	1,100
Total Kodiak Island Borough	9,939	13,309	15,012

Source: ENRI (1995c).

Between 1980 and 1990, the Kodiak Island Borough population increased approximately 34 percent (Table 3.7-3). During this period, the population in Kodiak also grew nearly 34 percent to about 6,400. Kodiak's population increased another 17 percent between 1990 and 1993 making it the sixth largest city in Alaska. The population on Kodiak Island tends to be transient because of the seasonal nature of the fishing industry, changes in personnel at the U.S. Coast Guard Station, and cyclical construction projects (ENRI 1995c).

Executive Order 12898, "Federal Actions to Address Environmental Justice in Minority Populations and Low-Income Populations," requires that Federal agencies identify and address, as appropriate, disproportionately high and adverse human health or environmental effects of its activities on minority populations and low-income populations. In accordance with the Executive Order, the following paragraphs are provided to identify minority communities and communities of low income.

Census data by race for the Kodiak Island Borough is provided in Table 3.7-4. This shows the Borough population as 30.2 percent minority (sum of non-white), while Kodiak City has a 36.7 percent minority population (or approximately 57 percent of the entire minority population).

Table 3.7-4. Kodiak Island Borough population by race, 1990 census.

	All persons	Race			American Indian, Eskimo, or Aleut				Other Race
		White	Black	Asian or Pacific Islander	Total	American Indian	Eskimo	Aleut	
Kodiak Island Borough	13,309	9,289	135	1,492	2,126	268	135	1,723	267
Percent		69.8	1.0	11.2	16.0	12.6	6.4	81.0	2.0
Kodiak City	6,365	4,028	47	1,282	811	106	76	629	197
Percent		63.3	0.8	20.1	12.7	13.1	9.4	77.5	3.1
Chiniak	69	63	0	2	4	0	0	4	0
Percent		91.3	0	2.9	5.8	0	0	100.0	0
Womens Bay	620	541	5	9	65	35	4	26	0
Percent		87.2	0.8	1.5	10.5	53.9	6.1	40.0	0
Traditional Villages Combined	1,010	155	0	6	841	18	17	806	8
Percent		15.3	0	0.6	83.3	2.2	2.0	95.8	0.8
Remainder	3,220	2,688	12	118	371	80	37	254	31
Percent		83.5	0.4	3.6	11.5	21.6	9.9	68.5	1.0
USCG Station	2,025	1,814	71	75	34	29	1	4	31
Percent		89.6	3.5	3.7	1.7	(85.3)	(2.9)	(11.8)	1.5

Source: ENRI 1995b.

An examination of Census data by tracts and block groups identifies only the six traditional villages (Akhiok, Karluk, Larsen Bay, Old Harbor, Ouzinkie, and Port Lions, see Figure 3.7-2) as communities considered as minority communities under the Executive Order. The population of these traditional villages is more than 83 percent Native American, predominately Aleut.

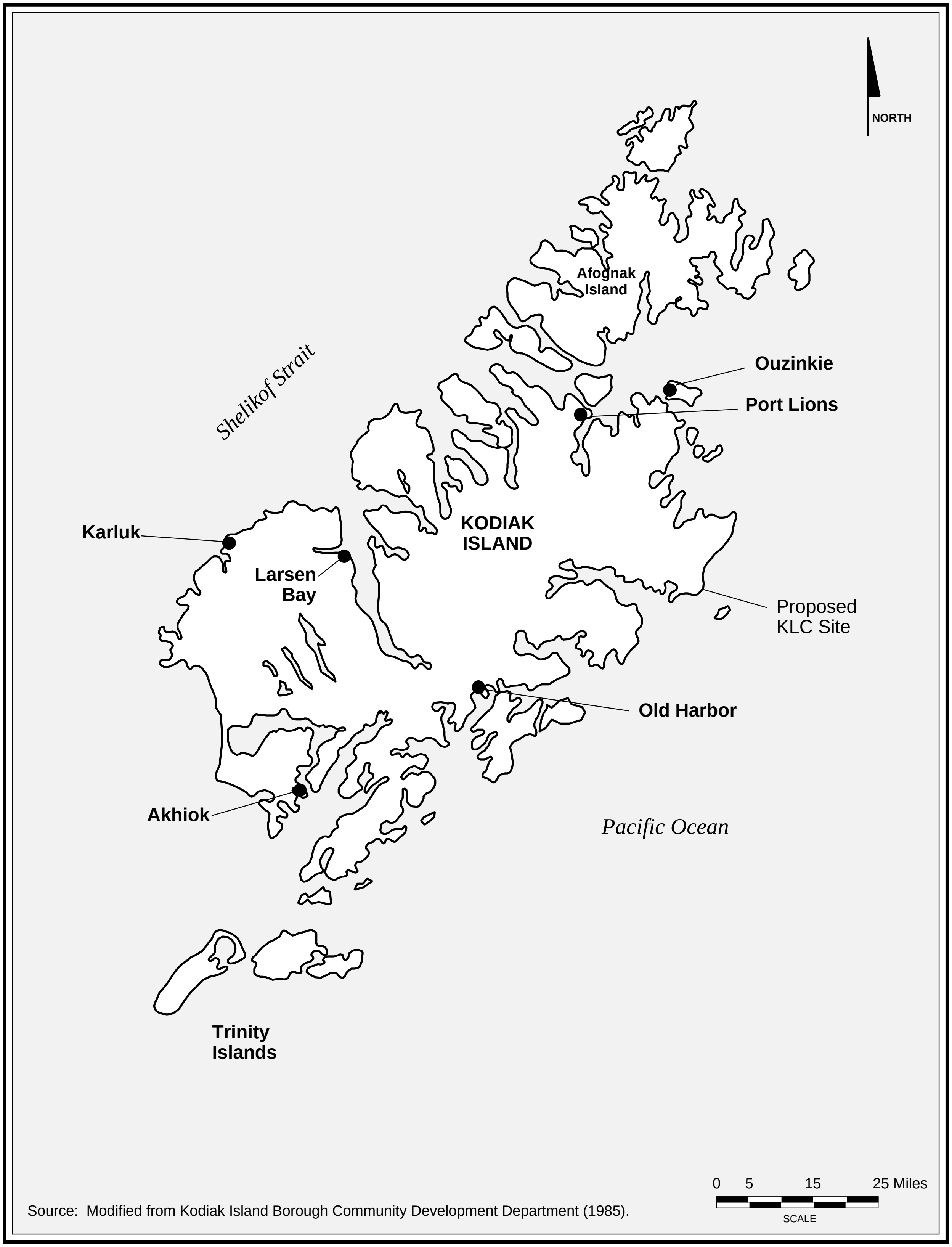
For the purpose of analysis, low income communities are often defined as communities containing a higher than normal concentration of persons identified by the U.S. Census Bureau as being in poverty.

In Kodiak Island Borough, there are 703 out of 12,753 persons (5.5 percent) for whom poverty status is determined (USDOC 1990). However, because poverty status data for census tracts and block groups are not available for Kodiak Island Borough, this measurement cannot be used at the community level. Instead median household income, which is provided at the block group level, will be used as an indicator of community low-income status. While this measure is not as meaningful as identification of numbers of persons defined as in poverty, it does provide some insight. Specifically, the two block groups which comprise the entire southern portion of Kodiak Island (including the traditional villages of Old Harbor, Akhiok, Larsen Bay, and Karluk) have median household incomes of $33,000 and $21,667, as compared to median household incomes of $44,815 and $41,408 for the Kodiak Island Borough and Alaska, respectively.

3.7.3 HOUSING AND COMMUNITY RESOURCES

In 1990, there were an estimated 4,400 residential housing units in the Kodiak urban area. This number includes U.S. Coast Guard Station housing. In addition, another 445 residential units were located in more rural areas of the island. The Kodiak Convention and Visitor's Bureau reports that there are 263 rooms available at hotels, motels, and bed and breakfast facilities in Kodiak City. While data is not collected on monthly vacancy rates, the Bureau estimates an average annual vacancy rate of 45 to 50 percent (Pfeifer 1996). In addition, the Alaska Department of Labor annual survey estimates a vacancy rate of 3.3 percent for rental apartments/houses (ADL 1995).

The hospital facility in Kodiak includes a 25-bed acute care facility and a 19-bed intermediate care facility. The present hospital, built approximately 30 years ago to serve a population of about 7,500, is currently undergoing a major renovation and modernization that will be better suited for Kodiak's larger population. This renovation will increase the level of care by improving existing services and adding new services. The renovation will add 18,300 square meters (60,000 square feet) to the hospital, including new surgical and radiological facilities, and will be operational by October of 1996. The existing hospital will then be renovated for use by hospital administrative services. In addition, the



Source: Modified from Kodiak Island Borough Community Development Department (1985).

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Figure 3.7-2. Kodiak Island Borough traditional villages.

Kodiak Area Native Association contracts with the Bureau of Indian Affairs to provide health care services to Native Americans in and around Kodiak as well as in the outlying villages (Kodiak Chamber of Commerce 1992).

Kodiak supplies water and sewer services in and around the city while outlying residents rely on private wells and septic systems. Electric services are provided by the Kodiak Electric Association (Kodiak Chamber of Commerce 1992).

3.8 Recreation

Kodiak Island offers extensive outdoor recreational opportunities that are important to both residents and nonresidents. These include fishing, hunting, hiking, camping, boating, beachcombing, and wildlife and scenic viewing. These activities are also an important source of income for residents who provide related services. Recreation activities occur year-round, peaking during the summer months. These activities take place at specific recreation facilities such as state parks, along the road system that offers access to other locations, and at remote locations such as the Kodiak National Wildlife Refuge, which occupies roughly the southwest half of Kodiak Island, approximately 48 kilometers (30 air-miles) from the proposed KLC site. Recreational opportunities in the Kodiak Island Borough include 15 designated facilities owned by the Borough, 3 state parks, and the Federal Kodiak National Wildlife Refuge.

Narrow Cape is easily accessed by the island’s road network and offers recreational opportunities. Fishing in the area is concentrated at East Twin Lake, which is stocked with rainbow trout (Probasco 1995), and at the Pasagshak State Recreation Area approximately 10 kilometers (6 miles) away (Figure 2.1-1). Fishing peaks from mid-July until early October, and Pasagshak is one of the most popular recreational fishing spots on Kodiak Island that is accessible by road. Hunting in the Narrow Cape area focuses on Sitka black-tailed deer during the late summer and fall. In addition, a nearby ranch offers for-fee bison hunting and horseback riding. The area includes sandy beaches on the eastern coast and Fossil Beach on the west where fossilized marine organisms can be dug up or found on the beach. Additional activities in the area include beachcombing, picnicking, and wildlife sighting of whales, birds, harbor seals, sea lions, and sea otters. Offshore sport fishing occurs year-round but is concentrated from April through October. North of the proposed KLC area at Cape Chiniak, Cape Greville, and Sequel Point, there is an established troll fishery for chinook and coho salmon, as well as for halibut and rockfish. Approximately 3.2 kilometers (2 miles) southeast of Narrow Cape, the area around Ugak Island, is visited by sportfishing boats in pursuit of halibut (Probasco 1995).

A brochure published by the Alaska Natural History Association identifies two hiking trails in the vicinity of the proposed KLC, the Narrow Cape Trail (Trail 18) and the Burton Ranch Trail (Trail 17) (ANHA undated). Figure 3.2-1 presents the trail locations as identified by the Association. AADC field observations on April 29, 1996, suggest that portions of the trails may be former jeep trails used during World War II, but the trails are not maintained and only portions remain visible. Some trail eradication can be attributed to the activities of buffalo grazing in the area; buffalo trails, wallows, and droppings are very much in evidence. Although the brochure shows the Narrow Cape Trail passing close to the proposed KLC launch area, that portion of the trail could not be located in the field. Given the lack of an obvious path, it is assumed that the trail receives little, if any, use in this area.

The state-maintained Pasagshak State Recreation Area is located approximately 10 kilometers (6 miles) from the proposed KLC Launch Area. The recreation area is comprised of seven campsites, picnic areas, potable water, and pit toilets, located on 20 acres of land. Sited as it is on a road beside a river that supports runs of king and silver salmon, Pasagshak is a popular fishing spot during the summer and fall when the salmon are traveling upstream to spawn. Figure 3.2-1 illustrates the recreation area.

While Kodiak Island receives approximately 14,700 visitors each year, these primarily visit other areas of the Island, including the Kodiak Wildlife Refuge. The Kodiak Chamber of Commerce was not able to locate definitive information on how many persons visit the Narrow Cape each year, and the Alaska Department of Transportation has not conducted a traffic survey to determine road usage to the Narrow Cape area (Pfeifer 1996). Primary users of the Narrow Cape area are Kodiak Road residents, not visitors from off the island (Kodiak Island Borough Community Development Department 1985).

3.9 Visual Resources

Scenic values in the Narrow Cape area are classified as high; natural values dominate (ENRI 1995b). The area ranges from low grass-covered mountains that level off into a plateau to flatlands near the beach. The mountains are covered with wildflowers in season, with patches of Sitka spruce, alder, and willow. Bedrock beaches border the cape and include Fossil Beach. Barrier beaches and lagoon systems dominate the eastern shoreline, creating a long strip of sandy beaches. Wildlife sightings of whales, harbor seals, sea lions, and sea otters are possible. Additional details can be found in Section 3.3.1 and Section 3.5.

Man-made structures in the area include the U.S. Coast Guard’s 190-meter (625-foot) tall Loran-C navigation transmitter tower and associated buildings, which are painted white; a small number of ranch-related structures; unimproved roads; and one complex of structures associated with World War II activities. Background colors on the Cape vary considerably during the year. Vegetation colors range from green to brown during the year, and during winter snow often covers the ground, although snow cover does not normally last more than one week. See Section 3.1 for additional discussion. While the climate at the proposed KLC site has not been well documented, it is expected to be similar to Kodiak City, where throughout the year clouds cover an average of 70 percent of the sky and it is completely overcast 50 percent of the time (ENRI 1995b). As a result, the sky is often gray due to clouds and fog, conditions caused by the confluence of cold arctic air with the warmer waters of the nearby Japanese Current. From some points on the cape or from offshore, the background contains mountains. At a distance, the mountainous background appears as a darker brown. Persons who view the Narrow Cape area include recreational users of the Cape, employees and visitors at the Loran-C station and the Kodiak Ranch, and occupants of offshore vessels.

3.10 Cultural Resources

Kodiak Island has documented archaeological, historical, and cultural resources. Prior to its discovery by Russian explorers, Native settlements were transitory, moving in response to the availability of resources. As a result, archaeological and traditional use resource sites are fairly well distributed along the coastline but are concentrated along major bays and fish streams. Historical sites on the island are related to Russian occupation, the period of transition to American governance, and defense facilities built during World War II (Kodiak Island Borough Community Development Department 1985).

3.10.1 SUBSISTENCE

Subsistence is an aspect of social, cultural, and economic life on Kodiak Island, especially in the isolated traditional villages (Akhiok, Karluk, Larsen Bay, Old Harbor, Ouzinkie, and Port Lions) where for-cash employment opportunities are limited and populations are predominately Alaska native. All of these communities are located on the coast away from Kodiak Island's road-connected areas. According to subsistence use maps and surveys developed by the Alaska Department of Fish and Game Division of Subsistence, a small number of residents from Old Harbor (Figure 3.7-2) use the coastal and adjacent inland areas around Narrow Cape for subsistence. Maps showing the historical subsistence harvesting area for Old Harbor residents show the area immediately offshore Narrow Cape as being on the edge of the harvest area of marine resources. However, according to the AFDG, this use pattern no longer occurs (ENRI 1995b). Resources typically harvested by these residents include salmon, halibut, crab, waterfowl, seal, sea lion, and deer (ADFG 1987). The Narrow Cape area is currently used as a working ranch, which gives primacy on the site to the rancher. The potential for additional migration of terrestrial game to Narrow Cape is therefore minimized, as is the potential growth of subsistence use of the area.

Inhabitants of Kodiak, the island's road-connected areas, and the Narrow Cape area also engage in subsistence activities. Kodiak inhabitants harvested almost 90 different kinds of resources in 1991. Household use averaged 12.1 different resources per household, and household harvest averaged 7.6 different resources (McMillan 1995). The per capita harvest in 1991 was 63 kilograms (138 pounds) of edible weight; the mean household harvest was 200 kilograms (439 pounds) (ENRI 1995d). Table 3.10-1 shows the road-connected households reporting subsistence use in the Narrow Cape area for 1991, based on a survey of eighty households identified as extensive subsistence harvesters.

Table 3.10-1. Households reporting subsistence use of the Narrow Cape area in 1991 by category.

	Households		
Category of subsistence use	Kodiak	Kodiak Road	USCG Station
Deer	5	5	
Freshwater fish	1	2	1
Salmon	1	1	
Marine fish		1	
Waterfowl		1	
Plant		1	

Source: ENRI (1995c).

Between 1980 and 1990, Kodiak Island's subsistence harvest was the third largest among seven state-wide regions. During that period, the non-commercial harvest of fish, game, and plants on Kodiak Island averaged about 2.5 million kilograms per year (5.5 million pounds per year) (ADFG 1990).

3.10.2 ARCHAEOLOGICAL AND HISTORIC RESOURCES

In August 1994, the Alaska State Office of History and Archaeology conducted an archaeological and historic resource survey of the Narrow Cape area where the proposed KLC would be built. The survey included walking transects, excavating seven test pits, and examining disturbances that indicated subsurface deposits. Evidence of cultural resources was not noted during the survey. However, there are two archaeological sites (KOD-081 and KOD-441) and one historic World War II era bunker complex (KOD-456) within approximately 1.6 kilometers (1 mile) of proposed construction (ENRI 1995c).

The two archaeological sites are known and catalogued by the State Historic Preservation Office; however, their exact location and nature are maintained as confidential to prevent looting or unauthorized excavation. The World War II complex consists of reinforced concrete bunkers used as lookout posts during World War II.

CHAPTER 4. ENVIRONMENTAL CONSEQUENCES

This chapter describes the potential environmental consequences of the proposed action and the no-action alternative. The analyses are based on Kodiak Launch Complex (KLC) information from Chapter 2, descriptions of the existing environment in Chapter 3, and other information described or referenced in this chapter. Impacts are addressed in terms of direct physical disturbance, consumption of affected resources, and the effects of waste streams, effluents, and emissions on the chemical and physical quality of the environment. Assessments focus on socioeconomic changes and potential impacts to air, water, and biota, as well as to people.

4.1 Air Resources

As discussed in more detail in the following paragraphs, KLC impacts on air resources would be *de minimis*. Because the proposed KLC site is located in an air quality control region that has always been in attainment with Federal and State ambient air quality standards, an analysis of conformity to the Clean Air Act Section 176(c) is not required.

4.1.1 CONSTRUCTION

Impacts to ambient air quality could occur due to the construction and operation of the proposed KLC. Construction activities potentially affecting air quality include the clearing of land, burning of scrub, operation of heavy-duty construction equipment, and the temporary operation of a cement batch plant. The types of construction equipment that may be used are discussed in Section 2.1.2.1. Air contaminants associated with these activities include fugitive dust from soil transfer operations, particulates and carbon monoxide from the burning of scrub, and engine exhaust emissions [nitrogen oxides, sulfur dioxide, carbon monoxide, particulate matter less than or equal to 10 microns in diameter (PM-10), and volatile organic hydrocarbons] from vehicle and equipment engines.

The quantity of fugitive dust produced during land clearing and soil transfer operations is proportional to the land area disturbed and the amount of soil moved. Table 4.1-1 presents an estimate of fugitive particulate emissions and emissions associated with the burning of scrub, based on U.S. Environmental Protection Agency (EPA) AP-42 (Compilation of Air Pollutant Emission Factors) (EPA 1985) and the number of acres cleared. Exhaust emissions from construction equipment were calculated from estimates of the types and number of earth-moving equipment required and from EPA AP-42 emission factors.

Table 4.1-1. Comparison to State[a] and Federal standards[b] of predicted maximum downwind concentrations due to construction activities.

Contaminant	Averaging Time[c]	Predicted Concentration (μg/m^3)	State and Federal Standard (μg/m^3)	Predicted Concentration as Percent of Standard (percent)
Carbon monoxide	1-hour	2,685	40,000	6.7
	8-hour	1,824	10,000	18
Sulfur oxides	3-hour	857	1,300	66
	24-hour	111	365	30
	Annual	1.24	80	1.6
PM-10	24-hour	99	150	66
	Annual	0.5	50	1.0
Nitrogen dioxide	Annual	3.3	100	3.3

a. Source: AAC (1988).
b. Source: 40 CFR Part 50.
c. Averaging times derived from U.S. Environmental Protection Agency guidance to protect health and safety.

The amount of fugitive dust generated during concrete batching is proportional to the amount of cement produced. Fugitive dust emissions are based on EPA AP-42 emission factors, an estimated annual production rate of 4,600 cubic meters (6,000 cubic yards) of concrete, and an estimated maximum daily rate of 150 cubic meters (200 cubic yards). The cement batch plant would incorporate particulate control techniques such as the enclosure of conveyors and elevators, filters on storage bin vents, and the use of water sprays.

Approximately 870 truckloads of aggregate would be used during site preparation at the proposed KLC during the approximately 18-month long period of construction activities. Approximately 50 percent of the truckloads would originate from onsite; the remainder would originate offsite. Some of the off-site loads may be shipped over 69 kilometers (43 miles) of roads, of which 16 kilometers (10 miles) are paved and 53 kilometers (33 miles) are gravel. Fugitive dust from trucking activities would average approximately 0.86 kilograms (1.9 pounds) per vehicle mile driven (EPA 1985). Impacts from fugitive dust are expected to occur in the vicinity of gravel roads and to be temporary. Due to the frequency of precipitation at the proposed KLC and use of on-site borrow pits, the watering of dirt roads to suppress fugitive dust would not be necessary.

Maximum downwind concentrations of pollutants associated with construction activities are calculated using EPA's SCREEN2 model (EPA 1986b). As shown in Table 4.1-1, the estimated increases in ambient background concentrations due to planned construction activities would be less than either state or Federal ambient air quality standards. Actual particulate concentrations would be attenuated by the high frequency of precipitation at Narrow Cape. Impacts are expected to be localized and short-term.

4.1.2 OPERATION

Operational emissions would result from stationary sources associated with the launch facility, as well as from the launch vehicle during liftoff. The stationary sources are composed of three standby diesel generators, which would operate as backup for approximately 5 hours during launches, 1 hour per week for testing during non-launch periods, and during commercial power outages (estimated maximum total 240 hours per year). The diesel generators, which would have a total combined capacity of 1,200 kilowatts, would not require a construction or operation air permit from the Alaska Department of Environmental Conservation (Lytle 1995). Using EPA's SCREEN2 air dispersion model (EPA 1986b), the maximum 24-hour downwind concentration for particulates due to the operation of the diesel generators would be 0.02 micrograms per cubic meter. Air quality impacts from the operation of the generators would be temporary and negligible off site.

The launching of solid rocket fueled vehicles produces emissions of hydrogen chloride, carbon monoxide (CO), nitrogen oxides (NO_x), and aluminum oxide (Al_2O_3). Hydrogen chloride and CO emissions are in the form of a gas; Al_2O_3 is emitted as a particulate. The gaseous hydrogen chloride combines with water in the atmosphere to create a hydrochloric acid (HCl) aerosol. Under conditions of high humidity or precipitation, most of the hydrogen chloride gas in the rocket exhaust plume can become hydrochloric acid aerosol which would fall out in the vicinity of the launch pad (Sebacher 1980). Assuming that all of the hydrogen chloride emissions from the LMLV 2 within the first 3,000 meters (10,000 feet) of altitude were to be deposited on the ground as hydrochloric acid, Whimpey (1995a) estimates that a 10-square-kilometer (3.9-square-mile) area would be affected with hydrochloric acid deposition of 0.427 grams per square meter [(4.7 tons HCl × 2000 lb/ton × 454 grams/lb/(10 km^2 × 1,000,000 m^2/km^2) = 0.427 g/m^2)].

CO and NO_x emissions are further oxidized to carbon dioxide (CO_2) and nitrogen dioxide (NO_2), respectively, due to the high exhaust temperatures occurring from solid rocket fueled vehicles. NO_2 represents only 2 to 3 percent by weight of the exhaust products, and since the NAAQS for NO_2 is an annual average, it has negligible impacts on ambient air quality (Bennett 1996).

Ambient air quality impacts due to hydrochloric acid and Al_2O_3 from the launching of a LMLV 2 launch vehicle have been estimated using the U.S. Environmental Protection Agency's Gaussian Integrated PUFF model (INPUFF) (SECOR 1995). Table 4.1-2 lists the rates of release for hydrogen chloride and Al_2O_3 from the first stage of each type of launch vehicle proposed for the proposed KLC. As shown, the

Table 4.1-2. First stage hydrogen chloride and aluminum oxide emission rates from proposed KLC launch vehicles and the Space Shuttle.

			Emission Rate (lb/sec)[c]	
Vehicle Type	Propulsion	Fuel Average Burn Rate (lb/sec)[a,b]	Al_2O_3	Hydrogen chloride
Lockheed Martin Launch Vehicle 2	Castor-120™	1,350	462	250
Lockheed Martin Launch Vehicle 1	Castor-120™	1,350	462	250
Taurus	Castor-120™	1,350	462	250
Conestoga	2 Castor IVAs and 2 Castor IVBs	1,139	408	240
Minuteman II	Thiokol M55A1	760[d]	230	165
Space Shuttle	2 Thiokol solid rocket motors[e]	18,500	5,600	3,960

a. (Isakowitz 1991).
b. To get grams per second, multiply by 454.
c. (Bennett 1996).
d. (Sadlowski, 1995b).
e. Space Shuttle has both solid-fueled and a liquid-fueled rocket motors. Data presented are for solid fuel motors rockets only.

Castor-120™ motor was modeled because it is common to most of the launch vehicles compatible with the proposed KLC; it represents a "worst-case" condition for ambient air quality impacts (see Table 2.1-4).

As an input parameter to the model, the exhaust plume emitted during a launch is divided into two parts. The first part consists of a ground cloud, which is all of the exhaust emitted by the vehicle during its first 200 meters (656 feet) of rise. The second part consists of the exhaust contrail, which is the portion of exhaust emitted during the remainder of the vehicle's ascent. For purposes of estimating ground level concentrations of air contaminants, only the lowest 3,000 meters (10,000 feet) of exhaust products are analyzed. Exhaust above this elevation has very little effect on ground level concentrations because this elevation is above the mixing zone for this area (SECOR 1995). The emissions of hydrogen chloride and Al_2O_3 occurring from the Castor-120™ LMLV 2 up to an altitude of 3,000 meters (10,000 feet) are 4.2 metric tons (4.7 tons) and 7.9 metric tons (8.7 tons), respectively. In comparison, the emissions of hydrogen chloride and Al_2O_3 for the Space Shuttle are 71 metric tons (78 tons) and 101 metric tons (111 tons), respectively.

The results of the dispersion modeling analysis for both PM-10 and hydrogen chloride are shown in Appendix D (SECOR 1995). As shown in Appendix D, the maximum worst-case downwind concentrations typically occur when wind speeds are 1 meter per second (2.3 miles per hour). Wind speeds greater than 1 meter per second generally result in lower values for predicted concentrations. These results indicate that downwind concentrations would be within acceptable ambient air quality standards. As shown in Appendix D, the maximum 24-hour average PM-10 concentration would be 146 micrograms per cubic meter, which is less than the 24-hour average PM-10 National Ambient Air Quality Standard of 150 micrograms per cubic meter. Typical downwind concentrations for PM-10 are in the range of 20 to 90 micrograms per cubic meter farther than 1.6 kilometers (1 mile) from the launch pad. The contributions to PM-10 concentrations due to the operation of emergency diesel generators at the proposed KLC during the launching of a rocket would be negligible (0.02 micrograms per cubic meter) when compared to the concentrations resulting from the rocket launch.

The 8-hour threshold limit value for Al_2O_3 in an industrial facility is 10,000 micrograms per cubic meter, which is significantly higher than the maximum 24-hour average concentration of 146 micrograms per cubic meter predicted for the proposed KLC (ACGIH 1994). Safety limits for industrial facilities, however, are not directly applicable to space launch facilities since emissions from space launch facilities are infrequent and temporary. There are no directly applicable standards.

Table 4.1-3 shows a comparison between worst-case downwind concentrations at or beyond the proposed KLC facility boundary line and applicable standards. Analyses of HCl emissions from the Castor-120™ predict a maximum worst-case 1-minute peak concentration of 8 parts per million at a distance of 5 kilometers (approximately 3 miles) from the launch pad due to a natural rise in the terrain at approximately 5 kilometers (3 miles) (SECOR 1995). The 8 parts per million concentration was modeled with an assumed wind speed of 1 meter per second (2.3 miles per hour) which typically occurs 2 percent of the year (Whimpey 1995b). This concentration is less than the population exposure guideline of 10 parts per million averaged over a 30-minute period established by the U.S. Air Force for space and missile launch operations (USAF 1995b). Typical 1 hour time-weighted HCl concentrations offsite would be less than 2 parts per million. Peak 1-minute concentrations from 0.8 kilometers (0.5 miles) from the launch pad up to approximately 5 kilometers (3 miles) would typically be between 1 and 2 parts per million, which is notably less than the maximum worst-case peak concentration of 8 parts per million. Prevailing wind directions at the proposed KLC are from the northwest, which would normally transport the ground cloud created during a launch towards the ocean and away from populated areas (NOAA 1995).

Table 4.1-3. Comparison of maximum predicted downwind concentrations and applicable standards.

Exhaust Constituent	Maximum Predicted Concentration	Applicable Standard[a]	Percent of Standard
Hydrogen Chloride	8 ppm	10 ppm	80
Aluminum Oxide (Particulate)	146 µg/m^3	150 µg/m^3	97

a. The applicable standard for hydrogen chloride is the population exposure guideline established by the U.S. Air Force for space and missile launch operations. Applicable standard for aluminum oxide is 40 CFR 50.

The Occupational Safety and Health Administration (OSHA) guideline for HCl exposure is 5 parts per million as a ceiling limit for exposures in an industrial plant (NIOSH 1989). This ceiling limit is not applicable to space launches since rockets are classified as mobile sources and their emissions are temporary. At Vandenberg AFB, the launch commitment decision is based on a predicted HCl concentration not to exceed 10 parts per million (Nyman 1996).

The receipt and handling of liquid propellant (hydrazine-based) would occur only under controlled conditions and in accordance with established safety procedures (Section 4.12). The propellant would be stored in sealed containers [approximately 380 liters (100 gallons)], and emissions of toxic air pollutants are expected to be minimal.

In summary, under worst-case meteorological conditions which occur 2 percent of the time, the maximum downwind concentrations of AL_2O_3 and hydrogen chloride would occur at an uninhabited 610 meter (2,000 foot) high mountain peak. These maximum concentrations (146 micrograms per cubic meter of AL_2O_3 and 8 parts per million HCl) are within the most directly applicable air quality standards for space launch facilities. With typical meteorological conditions, the prevailing winds are from the northwest, which would carry the ground-cloud to the ocean. In all cases, adverse air quality impacts due to rocket launches are not expected.

4.1.3 UPPER ATMOSPHERE

Potential contributions to the upper atmosphere include emissions from ground-level operations and exhaust emissions from launch vehicles. Construction activities are not anticipated to generate substantial quantities of ozone-depleting materials. The types of ozone-depleting chemicals typically found in ground-level operations are chlorofluorocarbons (CFCs), with sources such as refrigeration systems. The types of ozone-depleting chemicals found in rocket exhaust emissions are nitrogen oxides, hydrogen chloride, and aluminum oxide, a portion of which are deposited directly into the stratosphere during the ascent of a rocket.

Ozone in the stratosphere is continuously being produced and destroyed by naturally occurring photochemical processes involving nitrogen, hydrogen, oxygen, and chlorine. Figure 4.1-1 shows the chemical and photochemical processes that are important in the formation of ozone from molecular oxygen in the stratosphere and the reactions associated with ozone destruction. Each of these chemical species is involved in a catalytic cycle in that the ozone-depleting species is regenerated so that it can reenter the cycle to destroy additional ozone molecules (McDonald and Bennett 1994).

The most important impact to the ozone layer from solid fuel rocket launches is the chlorine resulting from the decomposition of hydrogen chloride in the stratosphere. As hydrogen chloride is exhausted from the rocket, the afterburning in the plume converts it into atomic chlorine (Cl) and chlorine monoxide (ClO), and these chemical species can have an immediate effect on ozone (Brady et al. 1993). The average global stratospheric ozone depletion rate for each ton of chlorine emitted is 0.000025 percent reduction of stratospheric ozone (USAF 1989). With an estimated hydrogen chloride emission of 8.3 metric tons (7.5 tons) in the stratosphere for each launch of an LMLV 2, along with the potential for 9 launches per year, the global annual stratospheric ozone depletion rate would be 0.0017 percent (7.5 tons/launch × 9 launches/year × 0.000025 percent/ton of chlorine) (Brady et al. 1993, USAF 1994a). The chlorine released into the stratosphere is removed by reacting with methane gas to form hydrogen chloride, which eventually circulates into the troposphere and is removed by precipitation (McDonald and Bennett 1994).

Alumina particulates emitted from rocket launches could affect ozone by providing a site for chlorine reactions to occur. The particles can destroy ozone directly or act as a catalyst for chlorine reactions (Brady et al. 1993).

The everyday manufacture and use of CFCs currently releases 272,000 metric tons (300,000 tons) of active chlorine into the stratosphere annually. In contrast, the total chlorine released per year into the stratosphere by United States' solid rocket motors above 15 kilometers (9.4 miles) is 660 metric tons (725 tons) (Jackman, et al. 1996), which is only 0.25 percent of the total stratospheric chlorine accumulating from other anthropogenic activities. The maximum KLC chlorine release into the stratosphere of 62 metric tons (68 tons) (7.5 tons per launch × 9 launches) is very small when compared to total United States chlorine release into the stratosphere by solid rocket motors, which is 660 metric tons (725 tons per year). In comparison, the amount of hydrogen chloride estimated to reach the stratosphere due to the occurrence of volcanoes is 40,800 metric tons per year (45,000 tons per year) (McDonald and Bennett 1994). Therefore, the impact to the stratosphere from rocket launches would be small compared to the impact of CFCs.

Ozone Production

$$O_2 \xrightarrow{h\nu} 2O$$

$$O + O_2 + M \longrightarrow O_3 + M$$

Ozone Destruction

$$O_3 \xrightarrow{h\nu} O + O_2$$

$$O_3 + O \longrightarrow 2O_2$$

$$Cl + O_3 \longrightarrow ClO + O_2$$

$$ClO + O \longrightarrow Cl + O_2$$

$$H + O_3 \longrightarrow HO + O_2$$

$$HO + O \longrightarrow H + O_2$$

$$OH + O_3 \longrightarrow HO_2 + O_2$$

$$O + HO_2 \longrightarrow OH + O_2$$

$$NO + O_3 \longrightarrow NO_2 + O_2$$

$$NO_2 + O \longrightarrow NO + O_2$$

$$Br + O_3 \longrightarrow BrO + O_2$$

$$BrO + O \longrightarrow Br + O_2$$

Note: hν = requires ultraviolet energy input.
Source: McDonald and Bennett (1994).

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Figure 4.1-1. Natural stratospheric ozone pathways.

Ground-level operations at the proposed KLC may involve the use of CFCs or hydrochlorofluorocarbons in refrigeration equipment that has closed systems. However, the usage of CFCs would be closely monitored, and leaks from these systems would be promptly repaired in accordance with Federal regulations.

Rocket launches from the proposed KLC would have a small impact on the levels of ozone found in the stratosphere; however, the release of chlorine and alumina into the stratosphere would make a minimal contribution to the overall impact of ozone depletion, which would be primarily from the release of CFCs into the atmosphere.

Results of the World Meteorological Organization's studies of Shuttle and Titan IV rockets have indicated reduction of ozone within the expanding exhaust trail can be substantial (> 80 percent), but these effects last a maximum of 3 hours, and due to the slant trajectory, the column ozone is probably reduced by less than 10 percent. Local plume ozone reductions decrease to near zero within 24 hours. In addition, steady-state model calculations show that ozone decreases are less than 0.2 percent locally and changes in the ozone column would be less than 0.1 percent (WMO 1995). Exhaust from the rockets proposed for launch at KLC would be significantly less (< 25 percent) than the Shuttle or Titan, and effects to ozone would be correspondingly reduced.

4.2 Water Resources

4.2.1 CONSTRUCTION

Construction activities of the proposed facilities at KLC would include upgrading approximately 3 kilometers (2 miles) of road from the site entrance to the launch area access road and installing inground electric and other utilities. It is expected that these activities would cause only slight impacts to water quality in the project area (i.e., temporarily increased turbidity when replacing road culverts located in waterways). As described in Section 4.3, adequate soil erosion and sediment controls would be used during site preparation, foundation and utility connection, and building assembly activities to avoid sediment loading of nearby surface waters. Impacts to streams and wetlands would be mitigated by using mesh on slopes and silt fences during both facility construction and when Pasagshak Road is upgraded. In addition, the replacement of culverts in waterways (where some increase in turbidity of the water is unavoidable) would only be conducted in accordance with permits issued by the Habitat and Restoration Division of the Alaska Department of Fish and Game (Table 1.4-1, Item 9) so as to ensure that anadromous fish in affected streams are protected.

Since the construction of the entire project would involve land-disturbing activities of more than 20,000 square meters (5 acres), authorization for construction of the project would be required under Alaska's National Pollutant Discharge Elimination System general permit for stormwater discharges. In accordance with Alaska's general permit requirements, a Notice of Intent for authorization would be submitted prior to construction activities and related stormwater discharges. A Stormwater Pollution Prevention Plan describing the erosion, sediment, and stormwater management controls to be used and the best management practices to minimize pollutant discharges via stormwater would also be prepared and implemented during construction.

Potable water would be transported to the site during the construction period; therefore, water resources in the area would not be used for this purpose. A maximum of 28,400 liters (7,500 gallons) of water per day would be pumped from East Twin Lake for use in the temporary cement batch plant and for fire protection (if necessary). This planned withdrawal from East Twin Lake [average of 61 liters per minute (16 gallons per minute) for an 8-hour period each day] is very small compared to the average recharge rate [870 liters per minute (230 gallons per minute)] and the capacity of East Twin Lake [57 million liters (15 million gallons)] as calculated in Section 3.2. Further evaluation of the reservoir capacity of East Twin Lake would be performed prior to its use during the construction period to ensure it has adequate reservoir capacity.

Because portable toilets would be used during the construction phase and the collected sewage would be transported offsite for appropriate disposal, the water quality of the area would be protected from these activities.

4.2.2 OPERATION

Impacts to water quality could occur from atmospheric deposition of launch combustion products to nearby surface waters and from domestic sewage leaching to groundwater. However, as described further below, cumulative impacts on the water quality of the area from deposition of launch combustion products are very remote. The use of mounded septic systems and the transportation of sewage periodically collected from septic tanks for appropriate off-site disposal would also protect the groundwater and surface water quality of the area. The cut and fill activities proposed in Section 2.1.2.4 for the upgrading of the last 3 kilometers (2 miles) of the Pasagshak Point Road to reduce steeper grades and slopes would also serve to protect water quality by slowing down the rate of run-off and erosion from these existing areas during heavy rains. Finally, the launch flame duct (see Figure 2.1-11) is directed towards the east side of the launch pad. This flame duct direction is away from the smaller freshwater East and West Twin Lakes and towards the much larger and brackish Triple Lakes.

The principal product of combustion of potential concern is hydrogen chloride, which combines with water or water vapor to form hydrochloric acid (HCl). As discussed in Section 4.1.2, the firing of a Castor-120™ solid rocket motor (in an LMLV 2) would result in the maximum deposition of 0.427 grams HCl per square meter of surface area over a 10 square kilometer area (about 4 square miles). The LMLV 2 is the largest launch vehicle expected to be used at the proposed KLC; it would have the greatest products of combustion after a launch.

Although soils in the Narrow Cape area are strongly acidic, pH of local surface waters is around 7, ranging from 6.8 to 7.5 in streams and 7.1 to 7.3 in lakes. The relatively high pH and capacity of local streams and lakes to buffer acid inputs from natural and man-made sources are presumed to be the result of ions (e.g., calcium and magnesium) that have been carried into the atmosphere with sea spray and subsequently returned in rainfall. This is a common occurrence in coastal maritime regions (Wetzel 1975).

As a result, pH changes to area streams and lakes from acid deposition are expected to be small and transitory. In addition, local topography would also mitigate possible impacts of acid deposition from rocket combustion products. Because precipitation in the area is relatively heavy, catchment basins are small and stream gradients are steep, chemical compounds deposited by rocket launches would pass quickly out of stream drainages. The potential for a launch to cause a measurable change in surface water chemistry is discussed below in relation to East and West Twin Lake.

The most likely impact to surface water from launching would be deposition of hydrochloric acid (HCl). Worst case high estimates of HCl loading to East Twin Lake and West Twin Lake were made by assuming that:

- It is raining during a launch and that the storm is intense enough to cause runoff
- The fraction of rainfall that is considered runoff is 0.388 (based on recharge data in Table 3.2-2)
- None of the HCl in the runoff is neutralized before it enters the lakes
- Delivery of the HCl to the lakes is instantaneous and it is not diluted by the rainwater transport

Watershed areas, lake surface areas, and lake volumes used in the calculations are listed in Table 3.2-1. Further assuming that the deposition rate from one launch event of 0.427 grams HCl per square meter was applied uniformly to the watersheds and lake surfaces and that all deposition to lake surfaces was mixed in the lake; the mixed concentration of HCl would be 2.15 and 2.56 milligrams per liter in East and West Twin Lakes, respectively. These HCl concentrations would reduce 15 and 18 percent of the background alkalinity in the lakes, using a midrange alkalinity of 20 milligrams $CaCO_3$ per liter for both lakes. EPA water quality guidance (1986a) suggests a limit of 25 percent reduction when the natural alkalinity is below 20 milligrams per liter calcium carbonate. This limit would probably not be exceeded at the proposed KLC.

Based on a simple carbonate system in equilibrium with carbon dioxide in the atmosphere, the changes in alkalinity described above would result in a 0.1 to 0.2 unit drop in pH (Stumm and Morgan 1970). The natural system would also be affected by bases blown in on sea spray, organic acids from wetlands and forests, supersaturated carbon dioxide conditions resulting from aquatic respiration, and properties of the eroding parent material. Assuming a linear relationship between pH and alkalinity (i.e., straight titration curve), the resulting pH drop would be 0.4 to 0.5 units.

There may be higher concentrations of HCl in the slug of affected water moving through streams to the lakes. It would be very speculative to estimate a concentration, but it is very likely that the residence time of this slug at any location in the high-gradient streams in the launch area would be short.

Another factor mitigating the potential impact of HCl deposition is the frequency of rain events causing runoff. Based on standard techniques (USDA 1973, 1975) and the properties of the soils occurring in the site vicinity, it is estimated that rainfall events exceeding 1.4 centimeters (0.56 inches) would result in runoff. Forty-nine events exceeded this level in one year (NOAA 1995), indicating that there is an average probability of about 0.13 that runoff would occur on a launch day. Assuming nine launches per year, only one or two launches would occur during a rain event likely to cause runoff. Coupled with the average water residence time in East and West Twin Lake of 45 days and 37 days, respectively (see Section 3.2), the potential for cumulative impacts on the aquatic systems is very remote.

Aluminum oxide (Al_2O_3) would also be deposited following a launch. However, it is only a hazard to aquatic biota in acidic environments where Al_2O_3 dissociates (i.e., dissolves) into the free aluminum cation. Al_2O_3 should be insoluble between pH 5 and pH 9.5 because aluminum hydroxide, a much more soluble compound than Al_2O_3, is insoluble between pH 5 and 9.5 (Stumm and Morgan 1970). These pH values should not be exceeded in any natural waterway due to a launch; therefore, the co-deposition of Al_2O_3 during launches is not a concern.

Two sources of potable and fire protection water could be used during operations. These sources include East Twin Lake and groundwater. The removal of water from East Twin Lake [at 11 liters per minute (3 gallons per minute)] to fill the fire protection reservoir would result in a one-time 0.91 centimeter (0.36 inch) drawdown of the lake. Potable water usage [13,200 liters (3,500 gallons per day maximum during launch operations)] would also result in a negligible drawdown of East Twin Lake by less than

0.025 centimeters per day (0.01 inch per day) (Waite 1995). Again, these planned withdrawals would be very small compared to the average calculated recharge rate of 870 liters per minute (230 gallons per minute) and lake capacity of greater than 57 million liters (15,000,000 gallons). Further evaluation of groundwater (capacity and quality) would be performed before using it for these purposes. In addition, water intended for potable use would be pre-treated in accordance with applicable permit requirements.

No measurable impact to the Pacific Ocean is expected from launches. Rocket cases are made of inert materials including graphite epoxy, aluminum, steel, and rubber, which represent no threat to the ocean water quality (Germaine 1996a). Therefore, no impact would result from spent rocket cases landing in the ocean after burning all propellants and sinking to the bottom (see Section 2.1.3.6 for a discussion on the trajectory of the launches over the Pacific Ocean). Early termination of a flight, however, would result in some amount of solid propellant remaining in the rocket case (or released as free solid propellant) when it landed in the ocean. The propellant used in the motor case is an inert, solid rubber material impregnated with ammonium perchlorate salt which also sinks in water. Studies have shown that the ammonium perchlorate would rapidly leach (i.e., within just a few minutes) out of only the first 0.32-centimeter (0.12-inch) layer of solid propellant and that the rest would remain encased in the rubber matrix indefinitely; it does not dissolve further in water (Germain 1996a and 1996b). In the event propellant landed in the ocean from the early termination of a flight, most of the ammonium perchlorate would begin leaching from the surface of the rubber propellant matrix (i.e., the surface 0.32 centimeters) as it sinks and would dissipate in the surrounding sea water column (Germaine 1996b). The small amount of residual leachable ammonium perchlorate remaining in the rubber propellant matrix after settling on the ocean floor would be further dissipated by natural ocean currents (Germain 1996b). Due to the low toxicity of ammonium perchlorate, toxic concentrations would be expected only in the immediate vicinity (within a few meters) of the submerged propellant if they occur at all (USDOT 1986).

4.3 Geology and Soil Resources

4.3.1 CONSTRUCTION

Construction activities for proposed facilities at KLC would result in the disturbance of about 174,000 square meters (43 acres) of soil but would not cause an adverse impact to underlying bedrock except that some amounts of geologic materials from the area (e.g., borrow materials for road and foundation work) could be used. Although adverse impacts to the remaining resources are not expected, the design and construction of facilities at the complex would take into account geologic hazards and soil considerations as described below (ENRI 1995b):

- Seismicity - Facility foundations have been designed to resist predicted maximum seismic loads and overturning moments induced by wind loads.

- Tsunamis - Scouring by tsunami wave action or tectonic subsidence may breach the beach berms of Twin Lakes and may form tidal lagoons. The planned structures at the project are sited above the recommended 30 meters (100 feet) above sea level for protection from tsunamis (City of Kodiak in ENRI 1995a).

- Differential settling of structures - Peat deposits in soils beneath existing roadways at the site and planned foundations would be removed. Where frost heaving in subgrade soils is a concern (e.g., beneath slabs on grade), subsoils would also be removed to a depth of at least 120 centimeters (48 inches) below final grade and replaced with suitable fill. If necessary, pile foundations and rock anchors into the underlying bedrock would also be used.

Although the planned facility construction activities would take place on ridge tops, slopes up to 10 percent may be encountered near the edge of soil grading activities. Erosion of these upland soils located on slopes of less than 7 percent is not considered to be a problem. However, the soil erosion hazard may become serious at slopes of 7 percent and greater (USDA 1960). Therefore, soil erosion control practices would be used during construction activities. In addition, soil erosion control practices would be used during utility installation and when upgrading the 3.2 kilometers (2 miles) of road from the site entrance to the launch area access road.

Examples of soil erosion control measures that would be applied as necessary during construction activities include:

- Site preparation - Preservation and protection of vegetation, topsoil preservation, temporary gravel construction entrance and exit, and dust control

- Surface stabilization - Temporary and permanent seeding and use of mulches and fabric and gravel blankets

- Runoff control and conveyance measures - Installation of diversions, dikes, grassed waterways, and temporary slope drains

- Sediment barriers - Straw bale barrier, sediment fences, and rock barriers
- Sediment traps and basins
- Stream protection - temporary stream crossings and streambank stabilization
- Protection of soil and fill storage piles

The Stormwater Pollution Prevention Plan discussed in Section 4.2 would be used to implement these soil erosion control practices during construction activities.

4.3.2 OPERATION

Atmospheric deposition of launch combustion products to nearby areas would occur as discussed in Section 4.1.2. However, the only combustion product of potential concern for deposition to the area is the acid, HCl (HNUS 1993; USAF 1994b). Any HCl deposition on area soils from these launches would dissociate into the Cl^- anion (no impact on acidity) and into H^+. As described below, measurable long-term changes in the pH (i.e., more acidity) of soils in this area are not expected from the deposition of H^+ from up to nine launches of an LMLV 2 per year.

The soils in and around the proposed KLC have a high cation exchange capacity with an exchangeable H^+: solution H^+ equilibrium of about 23,000:1 favoring exchangeable H^+. As described in Section 3.3.3, these soil properties are important because they provide buffering capacity to the KLC soils to resist changes in pH from acid inputs. In addition, the "worst case" acid deposition rate for nine launches in one year is 3.843 grams HCl per square meter of surface area which equates to less than 0.03 percent of the exchangeable H^+ found in the rooting depth of soils in the KLC.

Given the equilibrium in these soils favoring exchangeable H^+ and the small amount of potential H^+ deposition, most of the added H^+ would be removed from the soil solution as exchangeable H^+. Therefore, any reductions in soil pH which may occur immediately after launches would be localized and of short duration resulting in no substantial impact to soils. No long-term measurable changes in soil acidity (i.e., less that a tenth of a pH unit) is expected because of the inherent buffering capacity of these soils as reflected in (1) the high cation exchange capacity of these soils, (2) the equilibrium established in these soils heavily favoring exchangeable H^+ to solution H^+, and (3) the small amount of potential H^+ input from launches.

Aluminum (as aluminum oxide, Al_2O_3) is also another combustion product from launches that may deposit to area soils. The potential deposition of Al_2O_3 on area soils would result in no additional impacts because (1) aluminum comprises 8 percent of the earth's crust by weight (Foth 1978) and is therefore ubiquitous throughout the environment, and (2) the solubility and availability of aluminum is dependent on pH (acidity), which is not expected to change in soils to a measurable degree as a result of the proposed launches.

4.4 Noise

Noise impacts would occur during construction of the launch complex, during pre-launch operations, and during launches. Furthermore, the noise of an expendable launch vehicle launch is of two types: the noise from the rocket engine and the potential downrange noise of a sonic boom after launch. The noises from construction and operations would have the potential to affect the hearing and working conditions of the proposed KLC operations personnel; the aesthetic quality of the area for the non-KLC individuals nearby; and the feeding, breeding, and nurturing of wildlife.

Noise values used in this analysis are provided in terms of the A-weighted sound level in decibels (dBA). For comparison, typical sound levels from various common noise sources are provided in Figure 4.4-1.

4.4.1 CONSTRUCTION

Construction activities, such as excavation, leveling, digging and pouring of foundations, building assembly, and construction of roads and utilities, would temporarily increase ambient noise levels at and adjacent to the proposed KLC. Traffic noise from worker vehicles and trucks on the road from Kodiak to the proposed KLC would also increase. Construction noise could be expected to last about 12 to 18 months, with outdoor activities (and resulting noise) restricted during the winter. See Figure 2.1-3 for the construction schedule.

Table 4.4-1 indicates the peak and attenuated noise levels from operation of various pieces of construction equipment. Construction workers near activities producing unsafe noise levels would be required to wear hearing protection equipment. OSHA limits noise exposure to workers to 115 dBA for a period of no longer than 15 minutes in an 8-hour work shift and to 90 dBA for an entire 8-hour shift (29 CFR 1910.95). Therefore, impacts to the occupational health of construction workers as a result of construction noise would not be expected.

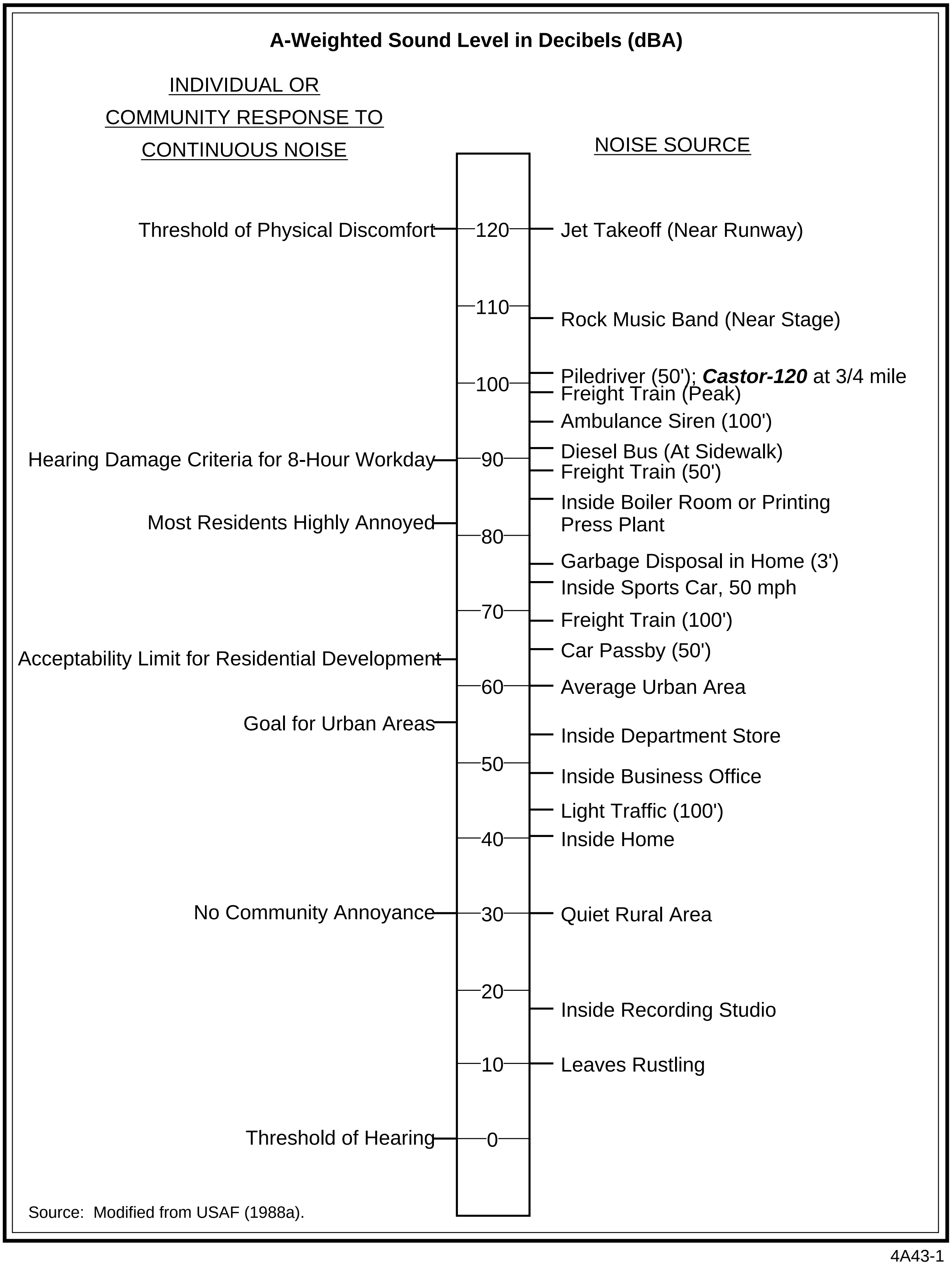


Figure 4.4-1. Typical sound levels from noise sources and their effect on people.

Table 4.4-1. Peak and attenuated noise (in dBA) levels expected from operation of construction equipment.[a]

Source	Noise Level (peak)	Distance from Source: 50 feet[b]	100 feet	200 feet	400 feet
Heavy trucks	95	84-89	78-83	72-77	66-71
Dump trucks	108	88	82	76	70
Concrete mixer	105	85	79	73	67
Jackhammer	108	88	82	76	70
Scraper	93	80-89	74-82	68-77	60-71
Dozer	107	87-102	81-96	75-90	69-84
Generator	96	76	70	64	58
Crane	104	75-88	69-82	63-76	55-70
Loader	104	73-86	67-80	61-74	55-68
Grader	108	88-91	82-85	76-79	70-73
Dragline	105	85	79	73	67
Pile driver	105	95	89	83	77
Fork lift	100	95	89	83	77

a. Source: Golden et al. 1980.
b. To get meters, multiply by 0.3048.

Because of their exclusion from the immediate vicinity of the construction site, members of the public would not be exposed to unsafe noise levels. However, members of the public within a few miles of the proposed KLC would be subject to noise that could decrease the existing aesthetic quality. The nearest residence is approximately 3 kilometers (2 miles) from the site. Individuals living near the Pasagshak Point Road would experience increased traffic noise.

Discussion of potential impacts to wildlife is found in Section 4.5.

4.4.2 PRE-LAUNCH OPERATIONS

Pre-launch operations would occur up to 9 times a year for a maximum of 6 weeks before each launch. Noise would be generated by mechanical equipment such as worker vehicles, trucks, and by the use of public address systems. Transportation noise would increase as up to 100 launch support personnel drive to the site and additional trucks bring material to the site.

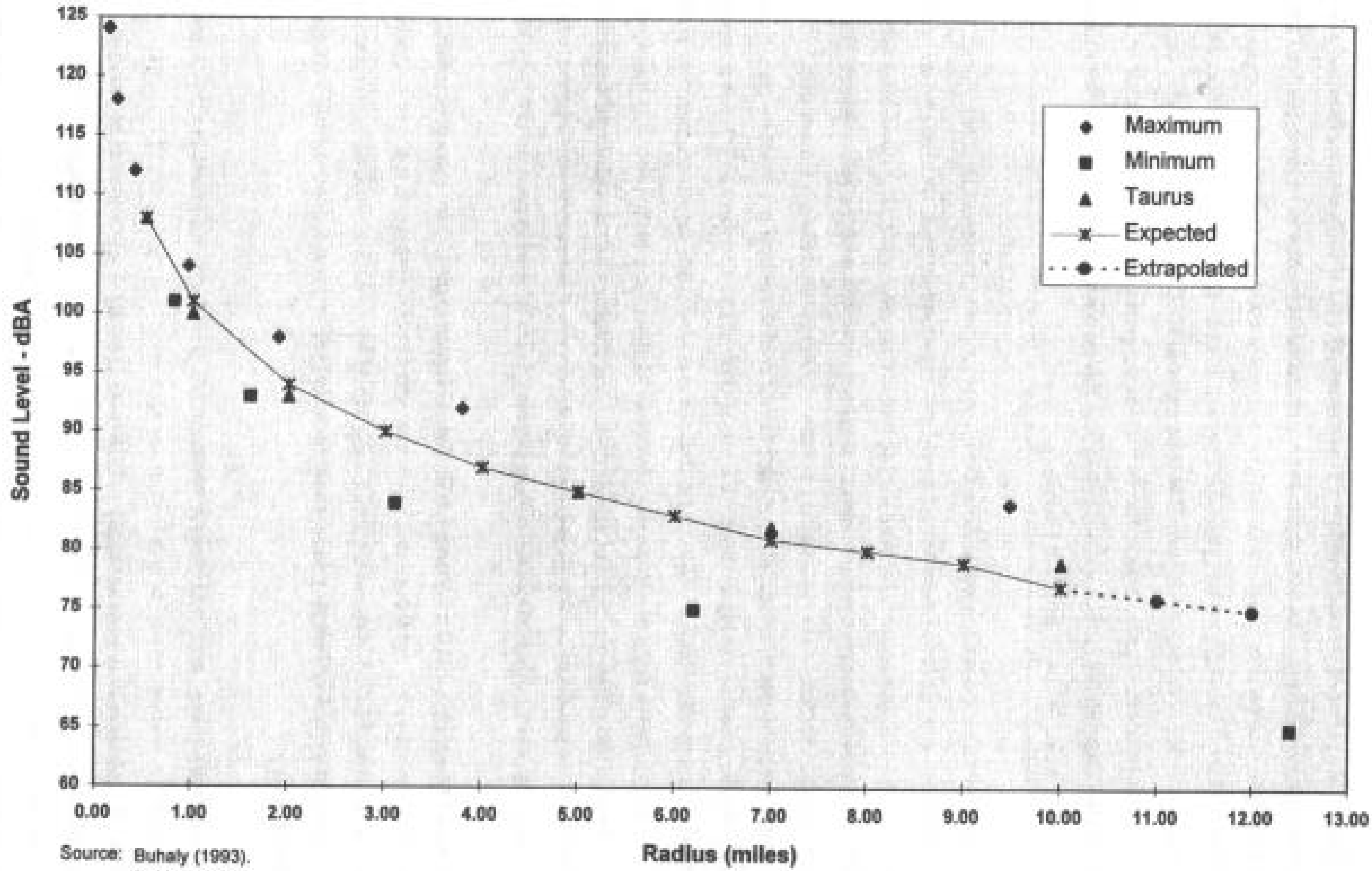
4.4.3 LAUNCHES

Rocket launch noise is a result of the interaction of the exhaust jet with the atmosphere and, to a lesser extent, the combustion of the fuel. The sound pressure from a rocket is related to the engine's thrust level and other design features. For the purpose of this analysis, the Castor-120™ rocket engine is used to quantify noise effects. This engine was selected because it is used as the first stage of many of the expendable launch vehicles considered for launch at the proposed KLC (LMLV 1, LMLV 2, and Taurus), it is the loudest rocket engine expected to be used at the proposed KLC, and data on this engine are readily available. Expendable launch vehicles with less thrust, such as the Minuteman multi-service launch system, would be expected to produce less noise.

Figure 4.4-2 shows the expected launch noise from the Castor-120™ at various distances from the launch pad. The expected noise curve was derived from several sources of noise data. A lower bound estimate was determined from actual measurements taken during two static tests in which ground attenuation was a factor, and the measurement points were 90 degrees from the direction of the exhaust plume (Buhaly 1993). An upper bound estimate was calculated by Buhaly (1996) by modeling a launch using assumptions designed to produce a conservatively high estimate of the sound pressure levels (Johnson 1996). An intermediate set of sound levels for the Taurus rocket (also a Castor-120™) was reported in an Environmental Assessment (USAF 1992). These data were scaled from measurements of a Titan rocket launch using parameters appropriate for the Taurus. The curve in Figure 4.4-2 that indicates the expected launch noise is the mean of the three sets of data. The frequency distribution of the noise peaks is around 70 hertz (cycles per second), which is typical of the very low frequency noise from rocket engines. At frequencies above 200 hertz, the sound pressure level is greatly decreased (Buhaly 1996).

KLC workers would normally be at the Launch Control and Management Center during launches. At approximately 3 kilometers (2 miles) from the Launch Pad and Service Structure, these individuals would be exposed to about 94 dBA outside the building. This value is within the OSHA standard of 115 dBA over 15 minutes. Nevertheless, workers subject to excessive launch noise would be required to wear hearing protection.

Public access could be as near as approximately 3 kilometers (2 miles). Noise levels at this location would be approximately 94 dBA, which is less than the peak level of a freight train. The nearest residence (Kodiak Ranch) is also approximately 3 kilometers (2 miles) away, and launch noise is expected to be audible at the Pasagshak Recreation Area approximately 10 kilometers (6 miles) away. Given the infrequency of the launches and the short duration of a launch (about 1 to 2 minutes), adverse public impacts from launch noise are expected to be minimal.



Source: Buhaly (1993).
Buhaly (1996).
VAFB (1992).

Figure 4.4-2. Expected launch noise from a Castor-120™.

The launch noise on the eastern shoreline of Narrow Cape could exceed 108 dBA. At approximately 5.6 kilometers (3.5 miles) distance, the northern shoreline of Ugak Island would be subject to approximately 88 dBA during launches. Potential ecological impacts of these sound levels are examined in Section 4.5.

In addition to the noise of the rocket engine, sonic booms are possible. A sonic boom is a sound that resembles an explosion and is produced by a shock wave that forms at the nose of a vehicle that is traveling faster than the speed of sound. The potential for, and the intensity of, a sonic boom being heard on the surface of the earth are dependent on the vehicle length, the nose cone shape, the trajectory of the launch, the vehicle velocity, and weather conditions. As the launch vehicle rises from the pad and achieves supersonic speed, the shock wave is projected over the horizon without impacting the earth's surface. After launching almost vertically, the vehicle begins to tilt, or pitch over, a maneuver designed to align the vehicle's path more closely to that of an orbit around the earth. Pitch-over also points the shock wave downward towards the earth's surface where the sonic boom can be heard, not unlike a flashlight beam moving down a wall onto a floor. As the vehicle increases speed and pitches over, the point on the surface where the sonic boom can be heard, known as the footprint, moves up-range from the far horizon back towards the launch point. Eventually, the launch vehicle trajectory and continued travel down-range reverses this sonic boom footprint movement, and the footprint moves downrange. People and animals in the path of the footprint can hear the sonic boom.

Modeling of the sonic boom footprint for the LMLV 1 indicates that under typical conditions it can be expected to occur from 21 to 35 miles down range (Parker 1995c) and range from approximately 50 to 100 dBA in intensity (Lockheed ES&T 1995). Since the launch azimuths for the proposed KLC are southerly and sonic booms do not occur over land, they are not expected to impact Kodiak Island or Ugak Island. Vessels impacted by sonic booms would be expected to experience sound resembling mild thunder.

Sonic booms for the LMLV 2 are expected to be of lesser intensity than the LMLV 1. Based on comparison of sonic boom footprints (Lockheed ES&T 1995), the intersects with the earth's surface would occur at even greater down range distances.

4.5 Ecological Resources

The following sections provide an assessment of potential impacts to ecological resources resulting from construction and operation of the proposed KLC. Potential impacts from construction and operation of the proposed KLC are discussed relative to their effects on terrestrial and aquatic biota and special status species.

4.5.1 TERRESTRIAL BIOTA

4.5.1.1 Vegetation

Construction

Construction activities described in Section 2.1.2 would result in the clearing, grading, or disturbance of approximately 174,000 square meters (43 acres), approximately 1 percent of the proposed 13-square kilometer (3,100-acre) KLC site. The area disturbed for each of the major construction areas is given in Table 2.1-1.

Most construction activity would be in meadow-like areas with hairgrass-mixed forb vegetation. Facilities have been sited in upland meadows to avoid impacts to wetlands when possible. The Payload Processing Facility and the access to the Launch Area were re-sited to eliminate wetland impacts. The Launch Control and Management Center was re-designed to minimize wetland impacts but siting considerations made elimination of wetland impacts impracticable. The minimum distance between the Launch Control and Management Center and the other facilities is dictated by safety considerations; moving the Center closer would place personnel unacceptably close to explosion hazard. A second siting consideration is the need to have line-of-sight control of the Launch Area; this constrains lateral siting adjustments due to the presence of intervening terrain. Finally, moving the Center further away from the Launch Area would result in access road construction that would impact more wetlands.

A total of 6,100 square meters (1.5 acres) of wetland vegetation would be impacted by the construction of the Launch Control Complex and improvements to Pasagshak Point Road. Construction of the Launch Control Complex would disturb 800 square meters (0.2 acres) of saturated, tall shrub thicket and graminoid-dwarf shrub-moss wetlands (see Appendix C for description of wetland plant communities). Improvements to the existing Pasagshak Point Road would include culvert replacement and widening. As a result, a total of 5,200 square meters (1.3 acres) of wetlands would be cut and filled. These wetlands would include both saturated, tall shrub thickets and graminoid-dwarf shrub-moss and saturated, emergent sedge-forb or sedge-forb-moss meadows. Approximately 27,000 square meters (6.6 acres) of mixed alder/willow shrubland and hairgrass-mixed forb meadows would also be disturbed by road improvements.

Given the lack of practicable alternatives in the form of alternative sites (Section 2.2.1) and given the measures taken to locate the facilities onsite so as to minimize wetland impacts, compliance with the Executive Order 11990 requirement regarding wetland impacts has been demonstrated.

New road construction for access to the launch area would result in the removal of a small number of Sitka spruce trees. Reduction in local or regional diversity of plants and plant communities would not result from the proposed action.

Land clearing associated with construction would be carefully planned and conducted according to best management practices to minimize erosion and soil loss and to prevent impacts to downgradient wetlands and streams (see Section 4.3). For example, silt fences would be placed at the toe of fill slopes adjacent to wetlands.

The U.S. Army Corps of Engineers has reviewed the AADC permit application (Table 1.4-1, Item 3) to impact wetlands and has issued a finding of no significant impact for the construction of the proposed KLC (COE 1995). Permit issuance is pending completion of this environmental assessment.

Operation

Because the launch pad would be located on a ridge (Figure 2.1-6), the launch pad flame duct (Figure 2.1-11) would direct hot exhaust gases into the air. This orientation would minimize impacts to vegetation through scorching. Impacts from operations would, therefore, occur primarily during the up to nine launches per year as a result of launch vehicle exhaust product deposition. Vehicle launch exhaust products include hydrogen chloride, aluminum oxide, carbon monoxide, carbon dioxide, and nitrogen oxides. The emission product that has the greatest potential for impacts is gaseous hydrogen chloride, which combines with water vapor in the exhaust to form hydrochloric acid (HCl). As discussed in Section 4.1, an INPUFF model was used to predict ground-level concentrations of HCl. Direct impacts as a result of acid deposition to vegetation could include discoloration, partial or complete loss of foliage, and a decline in seedling survivorship, seed germination response, and seedling emergence.

The extent of these impacts would be a function of weather (wind speed, wind direction, and humidity) and behavior of the ground cloud. High winds occur throughout the year in the Narrow Cape area. The average annual wind speed in the area (measured at a meteorological station in the city of Kodiak) is 17.5 kilometers (10.9 miles) per hour with peak gusts up to 130 kilometers (83 miles) per hour (NOAA 1995). Prevailing winds are northerly in all months of the year (NOAA 1995). Given these meteorological conditions, the launch ground clouds should in most instances be dispersed over an expanse of open ocean, limiting impacts to Narrow Cape's plant communities.

As conservatively predicted by Whimpey (1995a), the firing of a LMLV 2 launch vehicle could result in the maximum deposition of 0.427 gram HCl per square meter of surface area over a 10-square-kilometer area (4 square miles). Serious deposition damage to many plant species occurs when chloride deposition values are greater than 1.0 gram per square meter (NASA 1992). Acute impacts of acid ground clouds on the environment near the Space Shuttle launch pad have been documented (NASA 1992). Impacts to vegetation include defoliation, alteration in community structure, and changes in species composition. These cumulative effects have been observed only in areas receiving nearfield acid deposition (Schmalzer et al. 1993). Actual deposition of up to 127 grams per square meter of chlorides has been measured in the near field zone [that within a 2-kilometer (1-mile) radius of the launch pad] (NASA 1992). In comparison, the predicted maximum acid deposition for vehicles launched from the proposed KLC is 0.427 grams per square meter which is one third of one percent (0.0033) of the deposition from Space Shuttle launches. Farfield deposition [that beyond a 2-kilometer (1-mile) radius of the launch pad] monitoring following 43 Space Shuttle launches indicates HCl deposition ranges from <0.025 grams per square meter up to 5 grams per square meter. As a result, spotting on vegetation has occurred, but cumulative effects (long-term changes in plant community composition or structure) have not been found (Schmalzer et al. 1993). This suggests that there could be minor damage to vegetation in the immediate area of the proposed KLC launch pad.

Observations of the plant communities at other active launch sites, such as Vandenberg Air Force Base's SLC 4 East and West (Titan IV vehicle), indicate that plants are able to thrive in the immediate area [approximately 0.8 square kilometer (half-mile)] of launch pads (USAF 1994b). The Titan IV vehicle generates 132 metric tons (146 tons) of hydrogen chloride in exhaust emissions (USAF 1989). The largest vehicle that would be launched from the proposed KLC, the LMLV 2 shown in Figure 2.1-14, would generate 4.3 metric tons (4.7 tons) of hydrogen chloride, approximately 5 percent of the Titan IV emissions. In addition, Titan IV vehicles use a water sound suppression system that adds over 75,700 liters (20,000 gallons) of water to the exhaust products. Adding water allows hydrogen chloride in the Titan IV exhaust to form hydrochloric acid (HCl) droplets that are deposited directly upon near-field plants. The launch operations at the proposed KLC would not employ a water sound suppression system, thus eliminating the major source of acid deposition to plants. Rapid acceleration of the smaller expendable launch vehicles that would be launched from the proposed KLC further reduces the effect of rocket exhaust products on near-field plants when compared with the slower, heavier Titan. Since the Titan has a longer residence time on the launch pad after ignition and prior to lift-off, a greater percentage of its exhaust products are emitted at ground level.

The Delta II vehicle is also launched from Vandenberg Air Force Base and is approximately two times the size of the LMLV 2. Like the vehicles that would be launched from the proposed KLC, it does not use a water sound depression system. In conjunction with the November 1995 Delta II launch, pH changes in the surrounding air were monitored. No changes in pH were indicated outside a 91-meter (100-yard) radius from the launch pad (USAF 1995c), and no visible impact on the surrounding vegetation was observed (Gillespie 1996). Observations at both Kennedy Space Center and Vandenberg Air Force Base suggest that there would be only minor damage to vegetation in the near-field area of the proposed KLC launch pad.

Indirect impacts to plants from acid deposition can result through changes in soil chemistry. As described in Section 4.3.2, the soils of the proposed KLC site are strongly acidic (pH ranging from 4.1 to 5.3) with a very high cation exchange capacity due to the high organic content. This high exchange capacity makes acid input by deposition (0.427 grams per square meter) inconsequential, so change in soil pH would not be expected. Therefore, indirect impacts to vegetation by changes in soil chemistry are not expected to occur.

Aluminum oxides represent the visible plume of a vehicle launch. After launch, aluminum oxide would be expected to fall out from the ground cloud. However, analyses of launch-related deposition of aluminum oxide have not shown it to be harmful to plant life (ES 1990).

4.5.1.2 <u>Birds</u>

<u>Construction</u>

During construction, impacts to land birds would consist primarily of removal of vegetation, which results in loss of habitat. Construction activities including clearing and grading would remove a small amount of shrub thicket and spruce trees, thus reducing the available habitat [174,000 square meters (43 acres)] for perching birds. Table 3.5-1 lists the typical species for these habitats. Based on the total habitat available, this disturbance would not result in an appreciable impact to local and regional populations of these birds.

<u>Operation</u>

During operation, potential impacts to land birds could result from launch-related noise and vehicle launch emissions. As shown in Figure 4.4-2, land birds within a 10-kilometer (6-mile) radius of the proposed KLC launch pad could be exposed to noise levels above 83 dBA. Golden et al. (1980) reported that noise levels of 85 dBA frighten birds. Although birds would be disturbed, they would be expected to return to the area within minutes of the launch. Monitoring studies of birds during the breeding season indicate that adults responded to noises from Space Shuttle launches by flying away from the nests, but they returned within 2 to 4 minutes (USAF 1994b). In addition, studies of birds, some within 250 meters (820 feet) of the Titan launch complexes at Cape Canaveral, have shown no mortality and no reductions in habitat use by species were related to noise from Titan launches. Noise levels in the study area were as high as 115 dBA (USAF 1994b). Based on the above information, impacts to land birds from launch-related noise generated from the proposed KLC launches are not expected.

Appendix E discusses relative sensitivities of birds and marine mammals to sounds of different frequencies. Birds are most sensitive to sounds in the 1,000 to 5,000 hertz range, which is higher than the peak frequency (70 hertz) of the Castor-120™ rocket motor (see Section 4.4).

As described in Section 4.5.1.1, the vehicle launch emission products of concern include hydrogen chloride and aluminum oxide. Birds flying through the exhaust plume might be exposed to concentrations of hydrochloric acid (HCl), which could irritate eye and respiratory tract membranes. Concentrations of HCl up to 8 parts per million have been modeled to be present in areas downwind of the proposed KLC launch pad (SECOR 1995). This level is below the maximum permissible exposure (10 parts per million) used by the U.S. Air Force to safeguard personnel involved in missile launch operations (USAF 1995b). HCl concentrations are expected to be below levels thought to be safe for humans, and physiological impact to birds are not expected. Aluminum oxide is known to have a low toxicity for humans and would not be expected to impact resident wildlife populations (USAF 1989). Since most birds would be frightened away by the noise of the launch, it is unlikely that many would come into contact with the exhaust plume.

4.5.1.3 Mammals

Construction

Impacts to terrestrial mammals from construction would consist of removal of vegetation, which could lead to permanent or temporary loss of habitat and degradation of value of adjacent habitat due to an increase in noise and human activity. Construction activities such as clearing, excavating, and grading would result in impacts to terrestrial mammals through elimination of vegetation communities (habitats) and their associated fauna. Small numbers of less-mobile, burrow-dwelling animals (e.g., tundra voles) inhabiting the construction area could be displaced by construction activity or killed if burrows are filled, crushed, or paved over. Larger, more-mobile animals (e.g., red fox and Sitka black-tailed deer) would be expected to disperse to less-disturbed areas of the proposed KLC site or offsite. As described in Section 4.5.1, most of the proposed KLC construction activity would be in areas with hairgrass-mixed forb vegetation (habitat). The vegetation types that would be disturbed are abundant on the proposed KLC site and are not considered high-quality wildlife habitat. The loss of 174,000 square meters (43 acres) of habitat would result in a small impact to the terrestrial mammals of the proposed KLC site.

Construction of the launch complex would also involve the movement of workers and construction equipment and would be associated with relatively high noise levels from earth moving equipment, portable generators, pile driving equipment, pneumatic tools, drills, hammers, and the like. Although noise levels in construction areas could be high (up to 110 dBA), these high local noise levels would not be expected to propagate far beyond the boundaries of the project site. Table 4.4-1 illustrates the rapid attenuation of construction noise over relatively short distances. At 120 meters (400 feet) from the proposed KLC construction sites, construction noises would range from approximately 60 to 80 dBA. These are below noise levels known to startle or frighten small mammals (fox), bison, and waterfowl (Golden et al. 1980). Although noise levels would be relatively low outside of the immediate area of construction, the combination of construction noise and human activity would be expected to displace small numbers of small mammals (e.g., tundra voles and red squirrel) that possibly may forage, feed, nest, rest, or den in the area. Some animals would be driven from the area permanently, while others probably would become accustomed to the increased noise and activity levels and would return to the area. These disturbances are expected to create impacts to terrestrial mammals that would be small, short-term, and localized.

Operation

Potential impacts to terrestrial mammals may result from launch-related noise, sonic booms, and vehicle launch emissions. Launch-related noise and sonic booms may produce temporary hearing impairment and a startle response in terrestrial mammals (ES 1990). Figure 4.4-2 describes the expected launch noise at various distances from the launch pad. At a distance of 1.2 kilometers (three-quarters of a mile) from the launch pad (at the eastern-most point of Narrow Cape), launch noise could exceed 108 dBA. This value is below the threshold for temporary hearing impairment in humans that has been recorded to be 115 to 120 dBA (Engineering Science and Sea World Research Institute 1988). Launches from KLC would elicit species-specific startle responses in wildlife. Based on aircraft disturbance studies (Golden et al. 1980), responses can be expected at noise levels of 82 dBA and higher. More sensitive species, such as red fox, within a 10-kilometer (6-mile) radius of the launch pad would be expected to react. It has been documented that launch-related noise for both the Space Shuttle and Titan IV launches has not had a substantial effect on wildlife on or near the launch complex (USAF 1988a; USDOT 1986; USAF 1989;

USAF 1994b). These vehicles create much higher launch-related noise levels [as high as 138 dBA at 1.2 kilometers (three-quarters of a mile) (USAF 1994b)] than the LMLV 2, the vehicle with the highest launch noise to be launched from the proposed KLC.

Sonic booms are another potential source of launch-related noise impacts to terrestrial mammals. The intensity of and potential for sonic booms are dependent on the vehicle, the trajectory, the velocity, and weather conditions. Modeling of sonic boom footprint for the LMLV 1 indicates that under typical conditions it can be expected to occur from 34 to 56 kilometers (21 to 35 miles) down range of the proposed KLC launch area (Parker 1995c). Since the expected sonic booms would be over the Pacific Ocean, on-site or regional impacts to terrestrial mammals would not occur.

Ground cloud deposition would involve aluminum oxide and HCl. Aluminum oxide would have a relatively short-term presence in the atmosphere, and it is known to have a low toxicity in humans (USAF 1989). Exposure to aluminum oxide would not be expected to impact resident terrestrial mammals. As discussed in Section 4.1, conservative estimates of the maximum ground-level concentration of HCl could vary between 0 and 8 parts per million within 5 kilometers (approximately 3 miles) of the launch pad. This is below the maximum permissible exposure (10 parts per million) used by the U.S. Air Force to safeguard personnel involved in missile launch operations (USAF 1995b). Studies associated with the Titan IV/Centaur launch vehicle at Vandenberg AFB have shown that actual emissions of these substances (aluminum oxide and HCl) have been considerably lower than predicted and have not resulted in appreciable impacts to terrestrial wildlife (USAF 1989). Therefore, vehicle launch emissions are not expected to have a substantial impact on terrestrial mammals.

4.5.2 AQUATIC AND SEMI-AQUATIC BIOTA

4.5.2.1 Fisheries

Construction

Proposed construction of the KLC would involve clearing and grading approximately 174,000 square meters (43 acres) and replacing culverts, but land-disturbing activities would be carefully planned and executed to minimize erosion and sedimentation. Areas disturbed by construction would be revegetated with suitable native plants and would be periodically checked to ensure that plants were surviving. Any erosion and sedimentation would be temporary, lasting only as long as it took to establish ground cover (probably one growing season or less). Impacts to down-gradient streams are not likely, and impacts to the limited freshwater and anadromous fisheries resources of Narrow Cape are not expected (culvert replacement performed in accordance with permits). Marine fisheries would not be affected by construction of the proposed KLC.

Operation

Section 4.1 describes the potential impacts of atmospheric releases of hydrogen chloride [which becomes hydrochloric acid (HCl) when combined with water vapor] to surface waters in the Narrow Cape area. Based on the buffering capacity and volume of water in West Twin Lake, the shallow body of water most likely to be affected by acid deposition, preliminary indications are that small pH changes could result from atmospheric deposition of HCl. Measurable impacts to stocked rainbow trout in three area lakes (Bull Lake, Lupin Lake, and East Twin Lake) are not expected from atmospheric releases of HCl and attendant pH changes.

Fish kills have occurred in a small lagoon and impoundment near two Kennedy Space Center launch pads following launches of the Space Shuttle (Schmalzer et al. 1993). These fish kills were the direct result of rapid pH decreases in the water bodies resulting from drainage of deluge water (not used at KLC) containing high levels of HCl. Changes in pH in surface waters of the lagoon often exceeded 5.0 pH units following launches (Schmalzer et al. 1993). Based on predictions of HCl deposition and buffering capacity of lakes in the proposed KLC area (see Section 4.2), launches from the proposed KLC could lower pH in nearby Twin Lakes by 0.1 to 0.5 pH units. Changes of this magnitude are not unusual in the pH of natural waters, and can result naturally from day-night changes in CO_2 equilibrium. Changes of this magnitude are not expected to result in fish kills or damage to fish gills from increased acidity or increased solubility and toxicity of aluminum.

Because rainfall in the region is high and streams in the area are short (no more than a couple of miles long), steep, headwater streams with small drainage areas, small amounts of HCl deposited by launches would be quickly flushed from stream drainages. As a result, long-term impacts to native game fish (salmonids) and non-game fish (sculpin and sticklebacks) in area streams are not anticipated. The design of the East Twin Lake water withdrawal structure, within a gravel bed, would increase the effective area of withdrawal, reducing the approach velocity in the lake and minimizing the risk of fish impingement effects. Anadromous and marine fisheries would not be affected by operation of the proposed KLC.

4.5.2.2 Marine Birds

Construction

Construction of the proposed KLC would involve the movement of workers and vehicles and would be associated with relatively high local noise levels from construction equipment. Although noise levels in construction areas could be high (up to 110 dBA), these high local noise levels would not be expected to propagate far beyond the boundaries of the project site. Table 4.4-1 illustrates the rapid attenuation of construction noise over relatively short distances. Construction noise could be audible to ducks and seabirds resting and feeding in the waters of Ugak Pass but would be below levels (80-90 dBA) known to disturb waterfowl and wildlife (Golden et al. 1980; Bowles and Stewart 1980). Ducks and seabirds resting and feeding in the waters off Narrow Cape would be exposed to peak noise levels of approximately 72 dBA from heavy equipment working in the area of the proposed Water Pumphouse, the construction area closest to Ugak Bay and Ugak Pass.

Operation

As discussed in Section 3.5, the shallow waters of the Narrow Cape/Ugak Pass area are heavily used by sea ducks, gulls, and alcids (murres, murrelets, auklets, and puffins) in most months of the year. Waterfowl and seabirds feeding and resting in these waters could be exposed to launch noise levels ranging from 90 to 101 dBA, depending on the launch vehicle and weather conditions (e.g., wind direction and wind speed). At these noise levels, ducks and seabirds would be startled and could be driven from the area for a short time.

Disturbance to waterfowl and seabirds from KLC launches would be brief (a matter of minutes) and would not be expected to have a lasting impact. Because launches would be infrequent (approximately 9 per year) and spread over a 12-month period, seabirds and waterfowl would be able to quickly resume normal patterns of feeding and resting after completion of a launch campaign. Waterfowl driven from preferred feeding and resting areas by aircraft, explosions, and hunters generally return soon after disturbances cease, unless the disturbances are severe and repeated (Thornburg 1973; Owens 1977; Korschgen et al. 1985).

Bowles and Stewart (1980) reported that noise levels of 80 to 90 dBA were sufficient to produce startle responses in marine mammals and seabirds. Golden et al. (1980) reported that waterfowl “flock” (move together) when exposed to noise levels of 80-85 dBA, and show a pronounced startle response when exposed to 95 to 105 decibels (no A-weighted value provided).

Rylander et al. (1974) monitored reactions of migrating waterfowl (mallard, tufted duck, eider) in Sweden to 9 supersonic (no noise exposures provided) and 12 subsonic overflights of fighter aircraft that produced noise exposures of from 75 to 110 dBA. Sonic booms caused feeding waterfowl to stop feeding and move more closely together. On two of nine occasions, ducks flew short distances in response to sonic booms. The visible effect of subsonic overflights on feeding and resting ducks varied considerably. In most instances, ducks showed a weak startle response, raising their heads and showing an increased level of alertness. Sometimes overflights produced no visible reaction.

Tuite et al. (1984) ranked susceptibility to disturbance of nine species of wintering waterfowl in England based on responses of birds to a variety of recreational activities such as power boating and shooting. Recreational activities having the greatest impact were those, such as sailing and rowing, that involved participants being on the water near birds for extended periods of time. Activities having the least impact were those, such as powerboating, in which participants passed quickly through areas used by ducks or in which participants remained hidden or inconspicuous (e.g., bird watching and duck hunting). Species most affected were those, such as the goldeneye and northern shoveler, with minimal exposure to humans. Species least affected were those, such as mallards and swans, that spent most of their lives in areas of high human activity.

The North Carolina Wildlife Resources Commission (1966) monitored responses of ducks and geese in Back Bay and Currituck Sound (northeastern North Carolina) to human disturbance from 1958-1964 and concluded that diving ducks (mostly ring-necked ducks, ruddy ducks, scaup, bufflehead, redheads, and canvasbacks) and Canada geese were more sensitive to disturbance than dabbling ducks (mostly American widgeon, mallards, black ducks, northern pintails, and green-winged teal). The anonymous author suggested that disturbance was the primary factor determining diving duck and Canada goose usage of prime feeding areas within traditional wintering grounds. Diving ducks and Canada geese avoided prime foraging areas during the hunting season and returned to these areas when the hunting season ended. Dabbling ducks were able to tolerate relatively high levels of human disturbance (e.g., duck blinds, boats, and hunters) if high-quality food supplies were abundant.

Cronan (1957) observed a similar phenomenon in Long Island Sound, with wintering greater and lesser scaup feeding in preferred areas from dawn to dusk even during severe weather (high winds and waves, sleet, snow) but avoiding these same areas when hunters and recreational boaters were present.

Based on these studies and others, it appears that diving ducks and sea ducks are more sensitive to human disturbance than dabbling ducks. Two diving duck species (greater scaup and harlequin duck) were observed in July 1994 ENRI surveys of the Narrow Cape area, and four diving/sea duck species (greater scaup, harlequin duck, black scoter, and white-winged scoter) have been observed since 1983 during the North American Breeding Bird Survey (NABBS) conducted in June (ENRI 1995c). The area of Narrow Cape surveyed during the NABBS encompasses a larger area than the ENRI surveys and includes areas more likely to contain sea ducks, such as the two scoter species.

Greater scaup could nest in small numbers around wetlands and ponds in the Narrow Cape area. There is no suitable nesting habitat for the harlequin duck in the Narrow Cape area (see Section 3.5.2). The degree to which the Narrow Cape area is used by nesting black scoters and white-winged scoters is unknown but is expected to be limited based on the known breeding range and nesting biology of these species (Gabrielson and Lincoln 1959; Bellrose 1980; Brown and Brown 1981; Armstrong 1995). It is possible that small numbers of nesting greater scaup, black scoters, and white-winged scoters could be disturbed by launches from the proposed KLC.

Diving ducks and sea ducks (including eiders) feeding and resting off Narrow Cape would be most affected by launch noise. Large numbers of sea ducks use the Narrow Cape-Ugak Pass area in the late fall, winter, and spring (ENRI 1995c). Impacts to "wintering" diving ducks and sea ducks (those in the area from November through April) would be limited to energy losses incurred as a result of being startled and temporarily driven from preferred feeding and resting areas in the Narrow Cape/Pasagshak Bay area.

Belanger and Bedard (1990) observed two basic responses of staging (birds that have paused in fall migration to rest and feed) snow geese in Quebec to human-induced disturbance (airplane overflights and hunting): some geese flushed but promptly returned to foraging areas to resume feeding, while other geese flew away, leaving foraging areas for roost sites. Birds that flew to roost areas either rested or preened until the following day or compensated for lost foraging time by feeding more during periods normally allocated to resting (e.g., middle of the day and middle of the night).

Belanger and Bedard (1990) estimated that a 4 percent increase in night feeding would compensate for energy losses caused by a single disturbance flight and return to foraging area. An estimated 32 percent increase in night feeding would restore energy losses incurred when birds left normal foraging areas for the day and did not resume feeding. Energy balances of geese that immediately resumed feeding or that compensated by feeding more later in the day or at night were essentially unaffected by disturbance rates of less than 0.5 per hour (a disturbance every 2 hours). At disturbance rates of greater than 1.5 per hour, no amount of compensatory feeding could counterbalance the energy deficit. Belanger and Bedard (1990) suggest that disturbance is detrimental to migrating waterfowl only if it reduces energy intake so much that it cannot be compensated for by increasing food intake during undisturbed periods.

The Belanger and Bedard (1990) study provides evidence that snow geese could tolerate several disturbance flights a day, if allowed to feed at night or earlier/later in the day to compensate for energy losses. Although this study was conducted on a species not commonly found in the Kodiak Archipelago (ENRI 1995c), it is a species that nests in the Arctic and winters in the U.S. like many of the ducks and geese found at Kodiak.

A number of authorities have suggested that waterfowl and waterbird species in remote areas are more sensitive to human disturbance than those in more developed areas (Titus and VanDruff 1981; Brown and Brown 1981; Tuite et al. 1984). As noted in previous paragraphs, migrating waterfowl are apparently able to tolerate several disturbances a day without incurring energy deficits. Even taking into consideration the fact that many species of waterfowl wintering in the Kodiak Island area are “wilderness” species less tolerant of human disturbance, the bioenergetic consequences of several launch-related disturbances per year (never more than one per day) would be infinitesimal.

As noted earlier in Section 3.5.3, three marine bird species (harlequin duck, marbled murrelet, and Kittlitz’s murrelet) that were formerly candidate species occur in the vicinity of the proposed KLC. The U.S. Fish and Wildlife Service now refers to these species as “species of concern,” but they are afforded no special consideration under the Endangered Species Act.

Bellrose (1980) suggests that the harlequin duck has suffered less from habitat loss and sport hunting than most waterfowl species because most of its range lies within remote regions. The degree to which this species is sensitive to human disturbance and loud noises is unknown but is assumed to be comparable to other diving ducks and sea ducks. Rocket launches from the proposed KLC could disturb harlequin ducks feeding and resting along the rocky shores of Narrow Cape, but the disturbance would be brief (a matter of minutes) and would not be expected to have a lasting impact. The fact that launches would be infrequent (nine per year) and spread over a 12-month period would also help to mitigate impacts by allowing harlequin ducks to quickly recover after launches and resume normal patterns of feeding and resting.

Wintering ancient and marbled murrelets in Puget Sound appear to tolerate the presence of large numbers of commercial salmon fishermen, retreating from powerboats but quickly returning to preferred resting and feeding areas when powerboats are no longer present (Anderson 1995). However, murrelets are easily driven from nests by human disturbances, and eggs and young in unprotected nests are often taken by avian predators, particularly crows and ravens. Because there is little or no marbled murrelet nesting in the Narrow Cape area, launches from the proposed KLC are not expected to result in reduced reproductive success or reduced survival of eggs and young.

Rocket launches from the proposed KLC could disturb marbled murrelets feeding and resting in Ugak Pass and in waters west of Ugak Island, areas where birds were found in surveys conducted in June and July 1994 by ENRI (1995c). As noted previously in the discussion of impacts to the harlequin duck, disturbances caused by a launch would be brief (a matter of minutes) and would not be expected to have a lasting impact.

There is evidence that the Kittlitz's murrelet forages closer to shore than the marbled murrelet (ENRI 1995c), and (anecdotal) evidence that the Kittlitz's murrelet is less tolerant of human disturbance than the marbled murrelet (Gabrielson and Lincoln 1959). However, this species is expected to respond to perturbation much like the marbled murrelet, and is not expected to be affected to an appreciable degree by the brief, infrequent disturbances produced by launches from the proposed KLC.

The effect of human disturbance on colony-nesting waterbirds and seabirds is well known. Detrimental effects may include predation on eggs and nestlings; nest or colony abandonment; cooling, heating, or dehydration of eggs or nestlings; accidental breakage of eggs; or unnecessary stress on adults and young (Ellison and Cleary 1978; Henry et al. 1989; Bowman et al. 1994).

Based on the analysis of launch noise levels in Section 4.4 (see Figure 4.5-1), launch noise levels at the five seabird colonies closest to the proposed KLC site were estimated. Table 4.5-1 lists these colonies, the seabird species associated with them, and predicted noise levels at the colonies from the proposed KLC launches. Actual noise exposures at the seabird colonies west and southwest of the proposed launch site may be slightly lower as a result of vegetation and topography dampening and deflecting sound waves.

Launch noise would range from 90 dBA [at the tern colony 5 kilometers (3 miles) north of the proposed launch site) to 95 dBA [at the tern colony 3 kilometers (2 miles) north of the proposed launch site). Noises of this intensity would startle nesting terns in these areas, and could drive terns away from nests. Given the Arctic tern's propensity for defending its nests and young against intruders (Gabrielson and Lincoln 1959; Ehrlich et al. 1988) and the strong attachment that the genus *Sterna* has for nest sites and eggs (Welty 1982), it is unlikely that noise from infrequent launches would cause Arctic terns in the Narrow Cape area to desert nests or young. The Aleutian tern is more sensitive to disturbance, however, fleeing its nest when disturbed, and does not actively defend its nest when approached by predators or human intruders (Ehrlich et al. 1988). It is possible that Aleutian terns nesting within several miles of the KLC site could be driven by launch noise from nest sites long enough to result in damage to incubating eggs (due to cooling) or loss of eggs and young to predators.

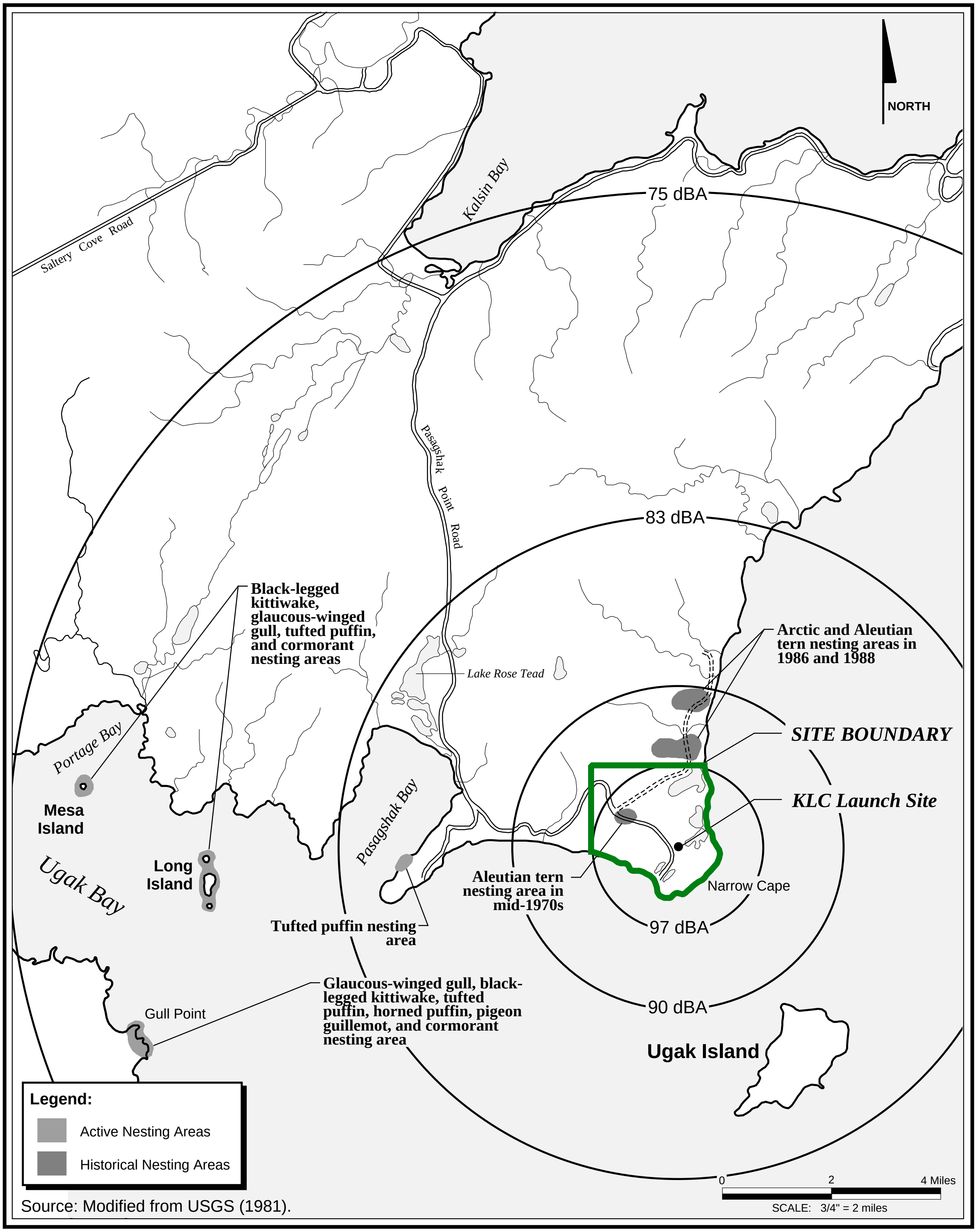


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Figure 4.5-1. Seabird colonies in the vicinity of the proposed KLC. (Concentric circles represent lauch noise isopleths.)

Table 4.5-1. Predicted noise levels at five seabird colonies near the proposed KLC.

Colony Name	USFWS Colony Number	Location[a]	Major Species Present	Predicted Noise Levels from Launches (dBA)
Kodiak Ranch	104	2-3 miles north of KLC	Arctic/Aleutian tern	90-95
Pasagshak Peninsula	69	5 miles west of KLC	Tufted puffin	85
Long Island	67	8.5 miles west of KLC	Black-legged kittiwake, glaucous-winged gull, cormorant sp.	79
Gull Point	10	10.5 miles southwest of KLC	Glaucous-winged gull, black-legged kittiwake, tufted puffin, horned puffin, pigeon guillemot	77
Mesa Island	65	11 miles west of KLC	Black-legged kittiwake, glaucous-winged gull, tufted puffin	75

a. To get kilometers, multiply by 1.609.

The degree to which these areas north of the site currently provide nesting habitat is unknown. There is evidence to suggest that land use changes have made these wetland (and adjacent upland) areas unsuitable for tern nesting. Cattle, buffalo, and horses graze in areas where terns formerly nested. Other areas once used for nesting are apparently mowed in summer by Kodiak Ranch personnel (MacIntosh 1995). The removal of beaver dams has lowered water levels in some wetland areas on the ranch (MacIntosh 1995), and may have made areas adjacent to these wetlands less attractive to nesting terns. Given these land use changes and the fact that no terns were observed nesting in 1994, there is reason to believe that the northeast Narrow Cape area is not an important nesting area for terns.

Launch noise from the proposed KLC could be as high as 85 dBA at the tufted puffin colony on the Pasagshak Peninsula, high enough to produce startle responses in these birds. Launch noise levels at other seabird colonies in the region (depending on topography, wind direction, wind speed, and the proximity of the colony to loud surf) would probably be below levels (~80 dBA) known to produce startle responses in seabirds.

Dunnet (1977) observed the reaction of a mixed seabird colony (fulmars, herring gulls, kittiwakes, gullemots, razorbills, and puffins) nesting on a cliff on the coast of Scotland to low-flying [91 meters (300 feet) above the colony] aircraft. This study was conducted during periods of egg laying and hatching. The large Sikorsky helicopter and twin-engine airplane had no detectable effect on the attendance of nesting kittiwakes and guillemots. Other species appeared to be undisturbed, but data sets were too small to permit statistical analyses. Roosting and resting birds on nearby cliffs (non-breeders) took flight in response to approaching aircraft but did so frequently over the course of the day for no apparent reason.

Burger (1981) observed reactions of nesting and loafing herring gulls to supersonic transport planes (the Concorde), subsonic aircraft, and other noise sources at Jamaica Bay National Recreational Area, near Kennedy Airport (New York). Nesting gulls did not respond to subsonic aircraft generating noise levels of 88-101 dBA (mean = 91.8) but often took flight in response to the Concorde, which generated noise levels of 101-116 dBA (mean = 108.2). When these gulls returned to nests they often engaged in prolonged fights that resulted in eggs being broken. The mean clutch size of birds decreased markedly during the incubation period as a result.

Schreiber and Schreiber (1980) studied responses of cliff-nesting Brandt's cormorants and Western gulls to auditory and visual disturbances. Little response was noted to purely auditory stimuli (shotgun blasts and carbide cannon explosions). Generally only roosting birds flew in response to auditory stimuli, and those that left the roost returned immediately. The typical response of nesting birds to blasts and explosions (in the absence of visual cues) was a "head-jerk" with return to normal activities within 1 to 3 minutes. The most severe behavioral reactions occurred in response to auditory stimuli accompanied by visual stimuli (blasts and human form). Neither species knocked eggs out of nests when fleeing disturbances. "Unemployed" (non-breeding) birds were most reactive to disturbance and generally flew in response to disturbances.

A number of studies have determined that launch noise well in excess of that expected from the proposed KLC has no long-term effect on colony-nesting waterbirds. Launches of the Minuteman missile from Vandenberg AFB did not appear to affect the behavior of the least tern (Atwood et al. 1981). Launches of the Space Shuttle did not appear to reduce reproductive success in a wood stork colony less than a mile from the Kennedy Space Center launch complex that received peak noise levels of up to an estimated 137.7 dBA (Smith in USAF 1994b). Adults left nests when startled by launches but returned in 2 to 4 minutes. Ten minutes after launches, adults and juveniles appeared to have resumed normal activities. No young were pushed from nests or injured by adults fleeing nests in response to launch noise.

Waterbirds that nest in colonies are most sensitive to human disturbance during courtship and nest site selection and least sensitive when young are present (Buckley and Buckley 1976; Mueller and Glass 1988). Birds, including colony nesters, are reluctant to leave eggs and young unprotected even when harassed by humans, threatened by predators, buzzed by low-flying aircraft, or exposed to loud noises (e.g., gunshots and explosions) (Gabrielson and Lincoln 1959; Dunnet 1977; Ehrlich et al. 1988; and Schreiber and Schreiber 1980). Brandt's cormorants and western gulls were reluctant to leave their eggs and young unprotected, even when repeatedly exposed to simulated sonic booms measuring 130 to 140 dBA (Schreiber and Schreiber 1980). Disturbance of nesting waterbirds resulting from KLC launches would be brief (one to two minutes), of relatively low intensity (maximum noise levels less than

86 dBA at active colonies), and would not be expected to result in abandonment of eggs or young. This assumes no nesting at the tern colony on the Kodiak Ranch.

As noted in Section 4.5.1, combustion products in launch vehicle emissions would include aluminum oxide and HCl. Aluminum oxides in the concentrations expected from launches are non-toxic and would not pose a threat to waterfowl or seabirds that nest in colonies in the KLC area. Based on modeling results, concentrations of HCl of up to 8 parts per million could be present in areas downwind of the launch pad. These levels are below the maximum permissible exposure (10 parts per million) used by the U.S. Air Force to safeguard personnel involved in missile launch operations (USAF 1995b). Studies at South Vandenberg AFB (California) found that wildlife in near-field areas were not harmed by direct deposition of HCl from launches (USAF 1994b). Studies at Kennedy Space Center determined that wildlife occupying near-field and far-field habitats (including nesting wood storks less than a mile from the launch site) were apparently unaffected by Space Shuttle exhaust plumes containing HCl (Schmalzer et al. 1986; Schmalzer et al. 1993).

4.5.2.3 MARINE MAMMALS

Construction

Construction of the launch complex would involve the movement of workers and vehicles and would be associated with relatively high local noise levels from earth moving and construction equipment. Although noise levels in construction areas could be high (up to 110 dBA), these high local noise levels would not be expected to propagate far beyond the boundaries of the project site. Table 4.4-1 illustrates the rapid attenuation of construction noise over relatively short distances. Given the distance from the proposed KLC site to pinniped haulouts on Ugak Island [approximately 5 kilometers (3 miles) from site boundary to Ugak] and the relatively high background noise levels on the beach (surf and wind), it is unlikely that construction noises would be audible to pinnipeds at haulout areas on Ugak Island.

Operation

As noted earlier in Section 4.4, there are two types of noise associated with rocket launches: the noise of the rocket engine at takeoff and the downrange noise of a sonic boom when the rocket reaches supersonic speeds. It is estimated that launch noise on the eastern shore of Narrow Cape could exceed 108 dBA, while the noise at the northern shoreline of Ugak Island, approximately 5.6 kilometers (3.5 miles) downrange, would be approximately 88 dBA (see Figure 4.5-2). Sonic booms from vehicles are

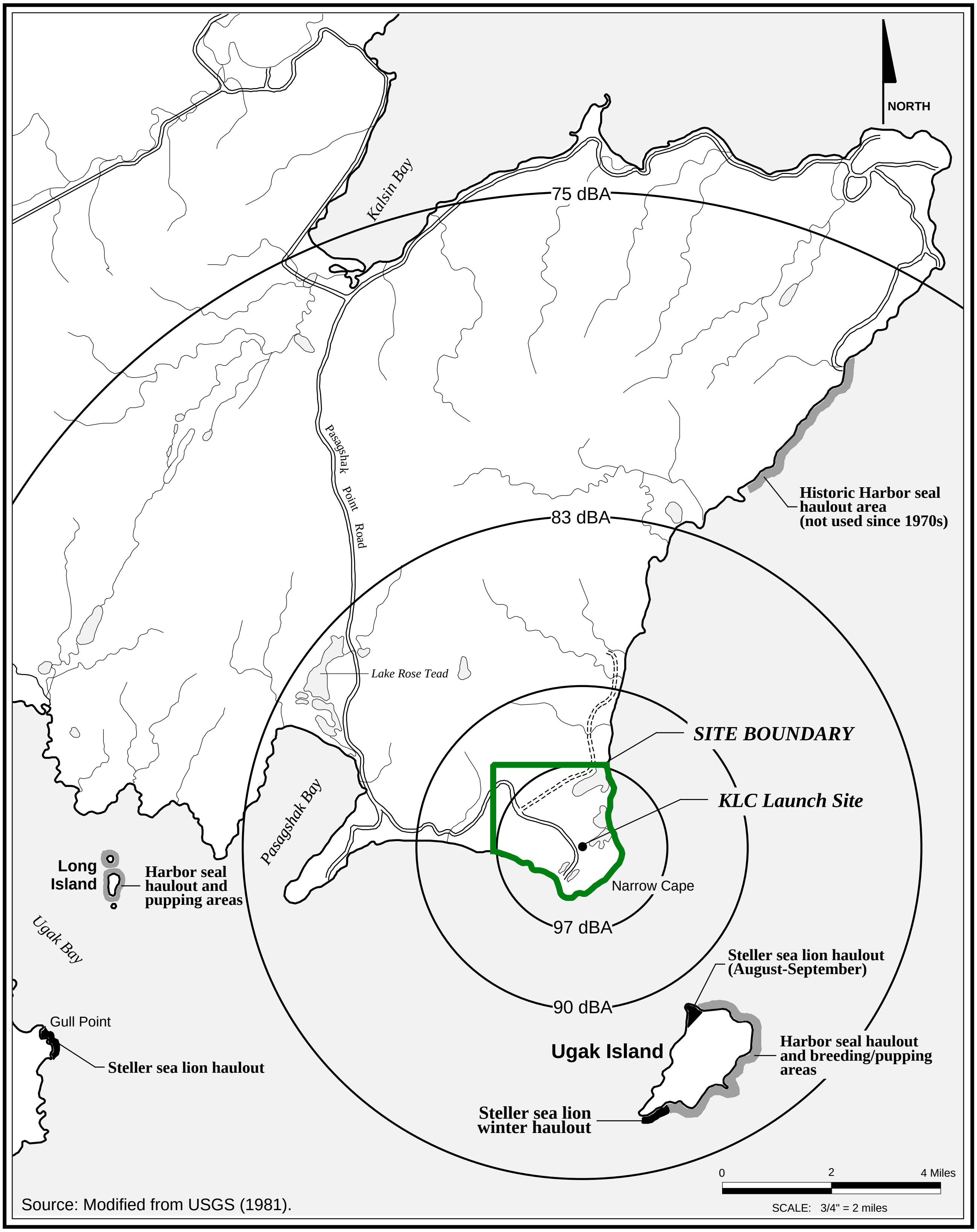

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Figure 4.5-2. Pinniped haulouts in the vicinity of the proposed KLC. (Concentric circles represent lauch noise isopleths.

expected to be most intense 34 to 56 kilometers (21 to 35 miles) down range (see Section 4.4.3), over open ocean, and should have no effect on marine mammals.

Noise levels from large launch vehicles such as the Titan IV and Atlas are thought to be high enough (>140 decibels) to cause temporary hearing damage in marine mammals occupying haulouts near launch pads (ES 1990). The predicted noise levels from the proposed launch vehicles that would be used at KLC are considerably lower and would not produce hearing damage in pinnipeds using haulouts on Ugak Island or Long Island (see Figure 4.5-2). However, launch noise could frighten and startle these pinnipeds.

The nature of the startle response would probably differ among the three pinniped species known to use the area (harbor seal, Steller sea lion, and northern fur seal) but could range from a heightened state of alertness to nervous milling about to headlong, panic-stricken flight. Bowles and Stewart (1980) found California sea lions and harbor seals were more reactive than northern fur seals and Steller sea lions to sonic booms. In studies of California sea lions and northern fur seals, both species responded to aircraft overflights and sonic booms by running, but there were no instances of crushed pups, panic leaping, overheating due to exertion, or pup abandonment (Bowles and Stewart 1980).

Harbor seals reportedly are more sensitive to disturbance than other pinnipeds (Bowles and Stewart 1980). Low-flying aircraft, particularly helicopters and large, multi-engine planes, cause harbor seals to panic and vacate haulout sites en masse, sometimes for two hours or more (Johnson et al. 1989). However, they are not likely to permanently abandon favored haulout sites, particularly not in response to noise stimuli alone (Speich et al. 1987).

Harbor seals may be more likely to suffer mother-pup separation than other pinnipeds when disturbed because they are less tied to specific haulout sites (Johnson et al. 1989). Since harbor seals may not always haul out at the same location when they return to shore, pups deserted at one location may be permanently separated from their mothers. Several authors have suggested that purely acoustic stimuli, such as launch noise, would result in relatively controlled movements that would allow pups to follow their mothers (Bowles and Stewart 1980; Stewart et al. 1994).

Pitcher and Calkins (1979) present evidence for a critical post-partum period of several hours for harbor seals in which a strong pup-mother bond is formed. When driven from haulouts during this brief period, mothers and pups may be permanently separated. In a particularly dramatic instance, a helicopter flew over a haulout at an altitude of less than 61 meters (200 feet), resulting in the permanent separation of a newborn pup from its mother. Pitcher and Calkins (1979) note that even these kinds of extreme disturbances did not appear to adversely affect older pups (several days to several weeks old) that had developed strong maternal bonds.

Calambokidis et al. (1986) described harbor seals leaving a haulout daily in response to regular tour boat cruises in Muir Inlet, Alaska, indicating that frequent, low-intensity disturbances may alter short-term haulout patterns (the length of time and time of day that animals haul out) but do not necessarily result in abandonment of haulouts. Allen et al. (1984) studied the effect of different kinds of disturbances on harbor seal haulout patterns at Bolinas Lagoon, in northern California. Hauled-out harbor seals did not react “differentially” to any kind of disturbance: seals were no more reactive to powerboats than canoes or aircraft or dogs on the beach. Distance, rather than the nature of the disturbance, appeared to be the key element, with seals reacting more strongly to sources of disturbance at distances of less than 100 meters (300 feet) than those between 100 and 300 meters (300 and 1,000 feet) away. The importance of visual cues was also noted, as seals reacted more strongly to boats moving towards them than boats moving by.

Pitcher and Calkins (1979) observed responses of harbor seals to a variety of natural disturbances (including rock slides, foraging ravens and bald eagles, and aggressive seals) and human-related disturbances (including aircraft overflights, all-terrain vehicles, and hikers) and concluded that either could represent a “major” disturbance. Major disturbances were those in which all seals occupying a particular haulout fled into the water and did not return for “long” (undefined) periods. Seals were particularly sensitive to visible low-flying aircraft, with helicopters producing the most disturbance, presumably because they are flown at low altitudes and are very loud.

Most (20 of 23) harbor seals exposed to sound levels of 108.1 dBA from the launch of a small (Taurus) launch vehicle at Vandenberg AFB immediately fled a haulout site and were slow to return after the disturbance (Stewart et al. 1994). At a haulout site further removed from the launch and exposed to A-weighted sound levels of 80 dB, 20 of 74 seals left the haulout site and most of these returned in less than 30 minutes. No pups at the second haulout site were separated from mothers; two of four pups resumed nursing 30 seconds after the disturbance. Seals did not appear to suffer mortality or injury as a result of launch noise at either location.

As a condition of a Letter of Authorization issued by the National Marine Fisheries Service allowing unavoidable incidental takes of marine mammals, the U.S. Air Force has monitored reactions of marine mammals to four Titan IV launches from Space Launch Complex-4 at Vandenberg AFB (USAF 1995d). The loudest of the four launches, which produced a maximum noise exposure of 101.8 dBA, caused all 41 harbor seals occupying a haulout on the coast of South Vandenberg to flee into the ocean (Stewart et al.

1993). Seventy-five percent of these seals returned to shore within 90 minutes and no long-term changes in haulout pattern were observed. No seals were killed or injured.

Virtually all Pacific harbor seals at Rocky Point, the South Vandenberg haulout monitored during the four Titan launches (five miles southwest of SLC-4), responded to launch noise (maximum noise exposures ranging from 98.7 to 101.8 dBA) by fleeing to the ocean (USAF 1995d). Most harbor seals returned to the haulout areas within several hours of the launches. Haulout patterns returned to normal within 24 hours of launches. No harbor seal deaths or injuries were linked to Titan launches. Although no impacts (other than the energetic expense of fleeing and returning to haulouts) have been documented over the course of four launches, the U.S. Air Force report notes that more study of harbor seal responses to launches during the pupping season is needed (USAF 1995d).

Harbor seals hauled out at Ugak Island would be exposed to launch noise ranging from 85 to 88 dBA, noise levels sufficient to cause a startle response. Based on the reactions of harbor seals to similar launch noise levels at Vandenberg AFB (USAF 1995d), some (but not all) animals would be expected to flee haulouts for a short periods. Given the results of 4 years of monitoring harbor seal responses to launch noise from large Titan launch vehicles (USAF 1995d), no long-term impacts on harbor seals are expected from proposed launches from KLC of smaller, less-noisy LMLV and Taurus vehicles. Impacts would be limited to short-term physiological stresses (e.g., elevated heart rate and blood pressure) and bioenergetic expenditures (i.e., energy "wasted" fleeing and returning to the haulout), the same stresses that would result from any kind of disturbance of a haulout area, whether a low-flying airplane or a fishing boat approaching too closely.

Appendix E discusses relative sensitivities of birds and mammals to sounds of different frequencies. Marine mammals are most sensitive to sounds in the 1 to 80 kilohertz range under water (pinnipeds and toothed whales) and 2 to 20 kilohertz range in air (pinnipeds). Noise from the Castor-120™ rocket motor peaks around 70 hertz, below the lower limit of hearing in most marine mammals and well below the range of maximum sensitivity.

The influence of season, time of day, weather, and tide on haulout patterns must be considered when evaluating potential impacts of disturbances to harbor seals. Harbor seals haul out on land in largest numbers (1) during pupping and molting seasons, (2) during daylight hours, especially mid- to late afternoon, (3) on calm, clear days, and (4) during low tide (Brown and Mate 1983; Allen et al., 1984; Calambokidis et al. 1986; Hoover 1988; Withrow and Loughlin 1995).

Numbers of harbor seals using haulouts are expected to be highest in summer and early fall and lowest in winter and early spring. These are general trends, however, and patterns of usage are subject to considerable daily and day-to-day variability as a result of the factors discussed earlier (e.g., weather and tides). Even during peak (June and August) haulout periods, harbor seals on Tugidak Island (in the southern part of the Kodiak Archipelago) used haulouts in less than half of days studied (49.6 percent of days in June; 41.3 percent of days in August) (Pitcher and Calkins 1979). Studies of harbor seals in the Grand Island area of southeastern Alaska during the August-September molting period revealed that males spent an average of 27.1 percent of their time hauled out, while females and pups spent 9.7 percent and 7.0 percent, respectively (Withrow and Loughlin 1995). Given the daily and seasonal fluctuations in haulout use and the small number of launches planned per year, the probability that large numbers of seals would be present at Ugak Island and Long Island haulouts during a given launch is small.

Speich et al. (1987) studied responses of northern (Steller) sea lions and harbor seals on the Olympic Peninsula of Washington to overflights (bombing practice) of A-6 jet aircraft and noticed that alarm responses were more pronounced when aircraft passed directly overhead at low altitude (less than 500 feet). Johnson et al. (1989) described the range of responses sea lions show to aircraft and suggested that environmental factors, such as weather and tide, play a role in determining responses, as well as type, speed, and altitude of approaching aircraft. There is evidence that sex, age, and reproductive status influence behavioral responses to aircraft and airborne noise, with older, sexually mature animals at rookeries less likely to panic or stampede than younger animals or pregnant females.

Northern fur seals at haulouts typically show little reaction to small, single-engine aircraft but may stampede when buzzed by larger, multi-engine aircraft (Johnson et al. 1989). Fur seals usually respond to sonic booms by assuming an upright posture (a startle response) and sometimes stampede from the beach into the water. Johnson et al. (1989) note that National Marine Fisheries Service studies of sonic boom effects on northern fur seals at San Miguel Island, California, have determined that mortality rarely, if ever, results from such stampedes. Although northern fur seals in the Narrow Cape/Ugak Island area would not be exposed to loud sonic booms, they could be exposed to launch noise greater than 80 dBA (see Figure 4.5-2) if feeding or sleeping in the waters around Ugak Island.

The northern fur seal is more oceanic than the harbor seal or Steller sea lion, spending 7 to 10 months a year at sea (Wynne 1992). Adults congregate briefly on rookeries in the Pribilof Islands during the breeding season (Calkins 1987; Wynne 1992). They are most abundant in the Kodiak Island area in the spring as they migrate through the Gulf of Alaska en route to the Pribilof rookeries. Some young males and non-pregnant females are present in the Gulf all summer (Calkins 1987). As a consequence, this species would be largely unaffected by vehicle launches in fall and winter, and minimally affected by launches in summer. Launch disturbances to fur seals would be most likely in spring, when animals are migrating through the northern Gulf of Alaska. However, the species' preference for open water suggests that even in spring fur seals would be well offshore of Narrow Cape and would be less susceptible to human disturbance than either the harbor seal or Steller sea lion.

In summary, review of the scientific literature suggests that there would not be long-term impacts to pinniped populations in the surrounding area or the western Gulf of Alaska from launches at the proposed KLC. Although launch noises from expendable launch vehicles would likely produce startle responses in the three pinniped species and could disrupt normal activities (resting, feeding, grooming) for short periods, serious injuries and long-term changes in pinniped behavior patterns (e.g., abandonment of traditional haulouts) are not expected. Although loud, low-flying aircraft and other extreme sources of disturbance during critical periods can cause mother-pup separation and abandonment of harbor seal pups (Pitcher and Calkins, 1979), infrequent vehicle launches 5.6 or more kilometers (3.5 or more miles) from the Ugak Island haulouts producing maximum noise exposures of less than 90 dBA are not expected to result in higher-than-normal mortality rates among newborn seals or abandonment of older pups.

Launch-related impacts to the sea otter, a common year-round resident of the Narrow Cape area, are not expected. Although sea otters will withdraw from preferred feeding and resting areas in response to a "regime of intentional and persistent disturbance" such as unusually-heavy boat traffic (Garshelis and Garshelis 1984), sea otters tolerate human activity and human intrusion better than hauled-out pinnipeds (Garshelis 1996). In the absence of visual cues such as boats approaching at high speed or veering toward resting or feeding animals, sea otters do not appear to be particularly sensitive to noise. Sea otters in Prince William Sound, Alaska did not react to fixed-wing aircraft flying regular surveys on calm, clear days at an altitude of from 100 to 150 meters (300 to 500 feet), even when animals were circled several times to obtain accurate counts (Garshelis and Garshelis 1984; Garshelis 1996). When buzzed by low-flying [less than 61-meter (200-foot) altitude] aircraft, sea otters generally reacted (either by looking intently at the airplane or diving) but did not abandon preferred feeding and resting areas (Garshelis 1996). This species is not expected to be affected by noise and activity associated with launch campaigns at the proposed KLC site.

Of the seven species of great whales found in the waters of the Kodiak Archipelago, only two, the humpback whale and gray whale, use the nearshore waters of Narrow Cape and Ugak Island with seasonal regularity (ENRI 1995c). Humpback whales move annually between summer feeding grounds in the Bering Sea and winter breeding grounds around Hawaii. Although one source (Kodiak Island Borough Development Department 1985) reported that "few (humpback whales) spend any time in Kodiak waters," others suggest that humpbacks spend from four to eight months (late spring, summer, and fall) in the waters around Kodiak Island (Calkins 1987; ENRI 1995c). Gray whales travel near the eastern shore of Kodiak Island as they migrate between summer feeding grounds in the Arctic and winter breeding grounds near Baja, California. The migratory path takes most of the gray whale population through Ugak Pass (ENRI 1995c). Numbers are highest in this area during April-May and November-December (ENRI 1995c). Given the (1) relatively small number of launches planned per year from the proposed KLC, (2) the fact that the whales are found in the Narrow Cape area only during part of the year, (3) the fact that calving and breeding would not be disrupted by the proposed KLC operations, and (4) the expected attenuation of launch noise (approximately 94 dBA at the center of Ugak Pass) at the air-water interface, humpback and gray whales should not be affected by operation of the proposed KLC.

Speich et al. (1987) observed that gray whales and harbor porpoises showed no behavioral response to A-6 aircraft on training runs near Sea Lion Rock, Washington. Kaufman and Wood (1981) concluded that low-flying aircraft had no effect on humpback whale movement and behavior. This is additional evidence that noise from rocket launches alone would have little or no effect on cetaceans in Ugak Pass and the surrounding area.

Section 4.1 describes impacts to air quality from launches, while Section 4.2 addresses potential impacts to surface waters. Preliminary assessments indicate that quantities of HCl and aluminum oxides that would be released by combustion of solid fuels would not result in measurable degradation of surface water quality because these chemical compounds would be dispersed over a large area and would be immediately diluted and/or neutralized by receiving waters. As a result, direct (e.g., acute or chronic health effects) or indirect (e.g., damage to aquatic organisms that serve as prey) impacts to marine mammals are not expected from these atmospheric chemical releases.

Normal day-to-day operations of the proposed KLC (exclusive of launch campaigns) are not expected to have impact on marine mammals.

4.5.3 SPECIAL STATUS SPECIES

Section 7 of the Endangered Species Act requires a biological assessment for the purpose of identifying an endangered or threatened species which is likely to be affected by a proposed Federal action. Such assessment may be undertaken as part of a Federal agency's compliance with the National Environmental Policy Act (NEPA).[1] The U.S. Fish and Wildlife Service (USFWS) advised the OCST and the National Marine Fisheries Service (NMFS) during an April 9, 1996, teleconference that the USFWS would defer to

[1] 16 USC 1536(c)

the NMFS regarding requirements for a biological assessment since the Steller sea lion is a listed threatened species under NMFS purview whereas the Steller's eider, a species under USFWS purview, is not listed.

Based on this environmental assessment, and as discussed in more detail below, OCST reasonably expects that the NMFS would agree that there would be no significant impact on endangered or threatened species and that no further analysis would be necessary. Monitoring and mitigation activities for special status species would be addressed in the KLC Natural Resources Management Plan (Section 5.13). NMFS, as well as other Federal, State, and local agencies and the public, would be afforded the opportunity to review the proposed Finding of No Significant Impact for 30 days and OCST would consider any comments received.

Steller's Eider

Steller's eider, proposed by the U.S. Fish and Wildlife as a "threatened" species under the Endangered Species Act, breeds on the tundra of the Arctic Slope of Alaska, the Seward Peninsula, and the Alaska Peninsula and winters in the eastern Aleutian Islands and the Kodiak Archipelago (Bellrose 1980; Armstrong 1995). This species apparently feeds on small crustaceans and mollusks in shallow coastal waters in winter (Gabrielson and Lincoln 1959; Bellrose 1980). Most of the world's estimated 150,000 to 200,000 Steller's eiders winter in Alaska[2]. The world-wide population may have been as high as 500,000 birds in the 1960s.

Forsell and Gould (1981) estimated, based on limited aerial and shipboard surveys, that 1,000 to 1,100 Steller's eiders overwintered in the Kodiak Archipelago in 1980-1981. Concern about apparent declines in Steller's eider (and other sea duck) populations in Alaska prompted personnel at the Kodiak National Wildlife Refuge to conduct late-winter aerial surveys of the east coast of Kodiak Island in 1992, 1993, and 1994 to assess and monitor Steller's eider and other sea duck populations wintering in the area (Larned and Zwiefelhofer 1995). Table 4.5-2 shows results of the Steller's eider surveys.

[2]Federal Register, Volume 59, page 35896, August 14, 1994.

Table 4.5-2. Numbers of Steller's eiders observed during Kodiak Island aerial surveys, 1992-1994.

Area Surveyed	1992	1993	1994
Chiniak Bay to Pasagshak Bay (includes Ugak Island)	2,120	Not surveyed	2,191
Ugak Bay	Not surveyed	249	223
Gull Pt. to Sitkalidak Strait	566	527	Not surveyed
Areas south of Sitkalidak Strait	206	3,256	2,935
Total Steller's eiders	2,892	4,032	5,349

Source: Larned and Zwiefelhofer (1995).

Although the estimated total number of Steller's eiders varied considerably from year to year due to differences in survey coverage (caused by weather and aircraft problems), numbers of Steller's eiders using specific areas of Kodiak Island showed surprising consistency between years. Larned and Zwiefelhofer (1995) suggest that this is indicative of repeated use of "traditional" areas by discrete wintering populations and populations at or near carrying capacity.

Steller's eiders were most abundant in sheltered lagoons and eelgrass (*Zostera marina*) shoals, where birds feed on abundant marine macroinvertebrates (Larned and Zwiefelhofer 1995). Although Pasagshak Bay is not one of the areas Larned and Zwiefelhofer (1995) list as a "hot-spot" (wintering more than 500 Steller's eiders), it appears to be an important feeding or resting area for wintering Steller's eiders. There were 105 Steller's eiders observed in Pasagshak Bay during the March 1994 survey. Flocks of up to 600 birds have been observed rafting off Narrow Cape in winter (ENRI 1995c).

As noted previously in Section 4.5.2.2, Steller's eiders and other sea ducks feeding or resting off Narrow Cape in winter could be exposed to launch noise levels ranging from 90 to 101 dBA, depending on (1) the precise location of a particular flock, (2) the launch vehicle, and (3) weather conditions. Steller's eiders feeding or resting in Pasagshak Bay [7.2 to 10 kilometers (4.5 to 6.0 miles) west of the launch site] could be exposed to launch noise levels ranging from 84 to 87 dBA.

Bowles and Stewart (1980) reported that noise levels greater than 80 dBA were sufficient to produce startle responses in seabirds. In a review of several studies of the effects of noise on birds, Golden et al. (1980) reported that waterfowl "flock" (move together) when exposed to noise levels of 80 to 85 dBA and show a pronounced startle response when exposed to 95 to 105 decibels (no A-weighted value provided).

Rylander et al. (1974) monitored reactions of migrating waterfowl (mallard, tufted duck, eider) in Sweden to 9 supersonic (no noise exposures provided) and 12 subsonic overflights of fighter aircraft that produced noise exposures of from 75 to 110 dBA. Sonic booms caused feeding waterfowl to stop feeding and move more closely together. On two of nine occasions, ducks flew short distances in response to sonic booms. The visible effect of subsonic overflights on feeding and resting ducks varied considerably. In most instances, ducks showed a weak startle response, raising their heads and showing an increased level of alertness. Sometimes overflights produced no visible reaction.

This suggests that Steller's eiders rafting off of Narrow Cape in winter could be disturbed by launch noise from the proposed KLC. Eiders could, depending on the severity of the disturbance, (1) simply evidence nervousness, (2) flush and fly short distances, or (3) flush and fly several miles to nearby areas (such as Ugak Bay) that offer freedom from disturbance and ample food.

When harassed by boaters or low-flying aircraft, most ducks and geese will leave preferred feeding and loafing areas but will return in a day or less unless repeatedly disturbed (Owens 1977; Korschgen et al. 1985). Ducks that are repeatedly harassed or approached by hunters will continue to use preferred feeding areas but may do so at night when boaters and hunters are not present (Thornburg 1973). No lasting effects to this species are expected from the proposed KLC launches, which would take place no more than nine times a year. Because the Steller's eider breeds in northwest Alaska (from the Yukon Delta north and east along the coast to Prudhoe Bay), operation of the proposed KLC would not affect breeding or nesting success of this species.

Steller Sea Lion

Steller sea lions are common in coastal waters of the Gulf of Alaska, including the waters surrounding Kodiak Island. There were an estimated 140,000 Steller sea lions in the Gulf of Alaska in 1979 (Calkins 1987). This number had been reduced to approximately 64,000 animals by 1992 (ENRI 1995c). Pup counts in 1993 indicated a "continuing decline" in sea lion numbers over most of Alaska (NMFS 1994). This species is currently listed under the Endangered Species Act as threatened throughout its range, which extends from California to Alaska[3].

Sea lions use established haulouts on land for resting and tend to return to the same island rookeries every spring and summer to pup and breed. Calkins (1987) reported that there were 61 locations in the Gulf of Alaska where sea lions hauled out on a regular basis and another 46 that were used less regularly. There are 17 haulouts on and around Kodiak Island, three of which lie within approximately 24 kilometers (15 miles) of Narrow Cape (ENRI 1995c). These haulouts are near Ugak Island

[3]Federal Register, Volume 6, October 4, 1995.

[approximately 5 kilometers (3 miles) southeast of the proposed KLC site), Gull Point [approximately 16 kilometers (10 miles) southwest of the project site], and Cape Chiniak [approximately 24 kilometers (15 miles) northeast of the project site]. ENRI (1995) reports that about 300 sea lions use the haulout on Ugak Island. K. Wynne (Alaska Sea Grant Marine Advisory Program) saw as many as 356 sea lions using the Ugak Island haulout on August 26, 1995 (Sadlowski 1995c).

There are no major sea lion rookeries near the proposed KLC site on Narrow Cape. The two closest major rookeries are at Marmot Island [approximately 88 kilometers (55 miles) north of Narrow Cape] and Chirikof Island [nearly 299 kilometers (186 miles) southwest of Narrow Cape] (Calkins 1987).

Construction of the proposed KLC would involve the movement of workers and vehicles and would be associated with relatively high noise levels from earth moving and construction equipment. Although noise levels in construction areas could range up to 110 dBA, these increased localized noise levels would not be expected to propagate far beyond the boundaries of the project site. Table 4.4-1 illustrates the rapid attenuation of construction noise over relatively short distances. Given the distance from the KLC site to Ugak Island [roughly 5 kilometers (3 miles] and the relatively high background noise levels on the beach (surf and wind), it is unlikely that construction noises would be audible to sea lions at haulout areas on the island.

Section 4.1 describes impacts to air quality from launches, while Section 4.2 addresses potential impacts to surface waters. These assessments indicate that quantities of HCl and aluminum oxides that would be released by combustion of solid fuels would not result in measurable degradation of surface water quality because these chemical compounds would be dispersed over a large area and would be immediately diluted and/or neutralized by receiving waters. As a result, direct (e.g., acute or chronic health effects) or indirect (e.g., damage to aquatic organisms that serve as prey) impacts to Steller sea lions are not expected from these atmospheric chemical releases.

As noted earlier in Section 4.4, there are two types of noise associated with rocket launches: the noise of the rocket engine at takeoff and the downrange noise of a sonic boom when the rocket reaches supersonic speeds. It is estimated that launch noise on the eastern shore of Narrow Cape would be in excess of 108 dBA, while the noise at the haulout on the northern shoreline of Ugak Island, approximately 5.6 kilometers (3.5 miles) downrange, would be approximately 88 dBA. The launch noise level at the sea lion haulout on the southwestern portion of Ugak Island could be as high as 85 dBA, while the noise level at the Gull Point haulout could be as high as 77 dBA. These noise estimates are based on noise levels associated with the Castor-120™ rocket engine, the loudest rocket engine that would be used to launch commercial payloads from the KLC.

Calkins (1983) noted that at haulout sites where Steller sea lion are not breeding or pupping, approaching aircraft will usually frighten some animals into the water. On some occasions, approaching aircraft can cause complete panic and stampede all sea lions into the water. Speich et al. (1987) studied responses of northern (Steller) sea lions on the Olympic Peninsula of Washington to overflights (bombing practice) of A-6 jet aircraft and noticed that alarm responses were more pronounced when aircraft passed directly overhead at low altitude [less than 150 meters (500 feet)]. Johnson et al. (1989) described the range of responses sea lions show to aircraft and suggested that environmental factors, such as weather and tide, play a role in determining behavioral responses, as well as type, speed, and altitude of approaching aircraft.

There is evidence that sex, age, and reproductive status influence behavioral responses to aircraft and airborne noise, with older, sexually mature animals at rookeries less likely to panic or stampede than younger animals or pregnant females. Awbrey (in Lockheed 1995) found that only 10 percent of California sea lions fled haulout areas during pupping season when exposed to sonic booms of 90 dBA and concluded that sea lions were capable of acclimating to low level sonic booms. Stewart (in Johnson et al. 1989) reported that habitat use and pup survival of California sea lions were unaffected by periodic exposure to intense airborne noise (a pest control cannon).

Section 4.5.2.3 summarizes findings of a number of studies of effects of human disturbance on pinnipeds. Studies of pinniped reactions to a variety of human disturbances – aircraft, rocket launches, sonic booms – indicate that rocket launches are likely to produce some level of alarm response in Steller sea lions hauling out on Ugak Island. Depending on a number of factors (weather, time of day, age and sexual status of animals), these reactions could range from a heightened state of alertness (simply raising the head) in a few animals to total flight of all sea lions from the haulout. There is no evidence to suggest that serious injuries or mortality would result. Because Ugak Island is not used as a rookery by sea lions, there is little potential for rocket launches disrupting courtship behavior, mating, or pupping. The likelihood of pups being abandoned or trampled by stampeding adults is also much smaller than it would be if the area were used as a rookery.

Normal day-to-day operations of the proposed KLC (exclusive of launch campaigns) should not have an impact on marine mammals in general and Steller sea lions in particular.

Fin whale

The fin whale, an endangered baleen whale species, migrates between winter breeding grounds off the coast of California and Mexico and summer feeding grounds in the Bering Sea and Chukchi Sea (the body of water between Siberia and Cape Lisburne, Alaska). About 16,000 fin whales are thought to inhabit the eastern north Pacific (Wynne 1992). Seasonal concentrations occur in the Gulf of Alaska, in Prince William Sound, and along the Aleutian Islands (Evans 1987; ENRI 1995c). Most sightings in these areas have been in summer in waters shallower than approximately 210 meters (700 feet) either along or inshore of the continental shelf (Calkins 1987; ENRI 1995c). Fin whales have been sighted well offshore [more than 10 kilometers (6 miles)] of Narrow Cape to the east and off Gull Point to the southwest of Narrow Cape [between 5 and 10 kilometers (3 and 6 miles) from the proposed KLC site] (ENRI 1995c).

No controlled studies of auditory sensitivity have been conducted on live baleen whales (Malme et al. 1989). Most information on responses of baleen whales to human disturbance is anecdotal, based on uncontrolled studies and observations of whale reactions to boats and aircraft. Most of these observations were of baleen whale species other than the fin whale, such as the bowhead and gray whale.

Bowhead whales were most sensitive to low-altitude [below 300 meters (1,000 feet)] aircraft, but reactions varied with water depth and whale activity (whether feeding or involved in social activities) (Malme et al. 1989). Migrating gray whales reacted to "most" helicopter approaches at altitudes below 250 meters (820 feet), "some" at 300 to 370 meters (1,000 to 1,200 feet), and none at altitudes greater than 430 meters (1,395 feet) (Malme et al. 1989). Fifty percent of gray whales exposed to recorded helicopter noise levels greater than 120 dB showed avoidance responses. Malme et al. (1989) observed that baleen whales often react to aircraft overflights by hasty dives and turns but concluded that single or occasional aircraft overflights did not cause long-term displacement of whales.

Given (1) the relatively small number of launches planned per year from the KLC, (2) the fact that the fin whale is found in the Kodiak Archipelago for no more than six months (April to September) out of the year, (3) the fact that breeding and calving (which take place off the coasts of California and Mexico) would not be disrupted by the proposed KLC operations, and (4) the expected attenuation of launch noise (approximately 94 dBA at the center of Ugak Pass) at the air-water interface, this endangered species would not be affected by operation of the proposed KLC.

Humpback whale

The humpback whale, a "strongly-migratory species" according to Evans (1987) uses summer feeding grounds in the Bering Sea and Gulf of Alaska and winter breeding grounds off the coast of Japan, the

Hawaiian Islands, and the Baja Peninsula. Humpback whales have been occasionally sighted in the waters off Narrow Cape and Ugak Island (ENRI 1995c).

Studies have shown that humpback whales respond to increased boat traffic with longer dives, shorter periods at the surface, and movement away from vessels (Baker et al. 1982). Individuals may be temporary displaced from preferred feeding areas. Studies on the effect of aircraft and airborne noise sources have apparently been less conclusive, with at least one investigation concluding that low-flying aircraft had no effect on humpback whale movement and behavior (Kaufman and Wood 1981).

Given (1) the relatively small number of launches planned per year from the KLC, (2) the fact that the humpback whale is found in the Kodiak Archipelago only in summer and early fall, (3) the fact that breeding and calving (which take place in the Hawaiian Islands and along the coast of Mexico) would not be disrupted by the proposed KLC operations, and (4) the expected attenuation of launch noise (approximately 94 dBA at the center of Ugak Pass) at the air-water interface, this endangered species would not be affected by operation of the proposed KLC.

Bald Eagle

The U.S. Fish and Wildlife Service (Alaska Region) has published recommendations for managing human activities near nesting bald eagles in Alaska (USFWS undated). These recommendations include:

- a Primary Management Zone extending a minimum of 100 meters (330 feet) from the nest to provide protection of the nest and to screen the nest from human activities. The Service recommends that vegetation clearing, timber cutting, industrial development, road building and other activities likely to disturb nesting eagles be avoided altogether within the Primary Management Zone and that operation of heavy equipment and other noisy human activities be avoided during the nesting season (March through August).

- a Secondary Management Zone extending outward from the Primary Zone an additional 100 meters (330 feet) to protect the nest from particularly loud or obtrusive activities. The Service recommends that construction of long-term or permanent facilities be avoided in this Secondary Management Zone and that land-use and construction activities within this zone that produce intermittent loud noise should be scheduled to avoid the nesting season.

- no blasting within a half mile of an active eagle nest during the nesting season.

- no toxic chemicals (e.g., pesticides, fertilizers) should be broadcast or widely applied in areas used by bald eagles.

As discussed in Section 3.5.3, closest that proposed KLC construction would come to a presumed eagle nest is approximately 910 meters (3,000 feet). This would be more than 4 times the minimum 200-meter (660-foot) buffer zone (Primary Zone plus Secondary Zone) recommended by the Service to protect nesting eagles. Topography would also serve to minimize construction disturbance because the presumed nest lies on a south-facing ledge well below the crest of a hill that is the highest point in the area. No construction activity would occur within line-of-sight of the presumed nest. No blasting is planned. AADC has no plans to broadcast or widely apply pesticides, fertilizers, or other toxic chemicals in areas used by bald eagles. AADC will advise its construction workers to remain alert to the presence of any eagle nest and will advise the U.S. Fish and Wildlife Service if a nest is found on the construction site.

Noise from proposed KLC launches would be high enough (85 dBA) to disturb perching or foraging eagles within an 8-kilometer (5-mile) radius of the launch pad and could be high enough (84-85 dBA) to disturb eagles in the Lake Rose Tead area if conditions were suitable (i.e., a large rocket and meteorological conditions conducive to the transmission of sound). Responses could range from increased alertness to nervousness or agitation to avoidance flight (Stalmaster and Newman 1978; Grubb and King 1991; McGarigal et al. 1991). The nature of the alarm response would depend on the age and state of maturity of an individual bird (Stalmaster and Newman 1978), whether resting or feeding (Stalmaster and Newman 1978), whether perched in a tree or on or near the ground (Knight and Knight 1984), the relative scarcity of food (Knight and Knight 1984), and previous exposure to human disturbance (Knight and Knight 1984).

There is considerable evidence to suggest that eagles would be less disturbed by KLC launch noise than by other disruptive human activities, such as hikers, hunters, or motorists. In an extensive study of bald eagle responses to five classes of human activity, Grubb and King (1991) found that pedestrian traffic was most disturbing and aircraft traffic least disturbing to nesting eagles. Distance to a source of disturbance appeared to be the most important factor in determining the probability and severity of a response, followed by duration, and whether or not the disturbance source was visible. McGarigal et al. (1991) found that low-flying (within 500 meters) aircraft produced a visible disturbance in bald eagles on 5 of 31 occasions (16 percent). Aircraft were less likely to produce a flush response than approaching automobiles or pedestrians but more likely than boats or trains.

A number of wildlife managers have recommended that buffer zones and activity restriction areas be established around eagle breeding and foraging areas. Stalmaster and Newman (1978) suggest that wintering bald eagles in Washington be protected by "restriction zones" with boundaries of 250 meters (820 feet). McGarigal et al. (1991) recommend a 400- to 800-meter (1,300- to 2,600-foot) buffer zone around high-use foraging areas in Oregon. Grubb and King (1991) recommend a minimum primary buffer zone of 600 meters (2,000 feet) for Arizona eagles and suggested that a 1,200-meter (3,900-foot) secondary buffer zone would "accommodate most of the distant responses from vehicle, noise, and aircraft disturbance." The area of highest eagle use in the Narrow Cape area, the Lake Rose Tead system, is approximately 8,000 meters (approximately 5 miles) from the proposed KLC launch pad.

4.6 Launch Safety

Detailed review of a launch site's system safety is part of a launch site license application review that OCST would perform,[4] and KLC launch safety details would be included in the AADC application to OCST. In accordance with OCST guidance (OCST 1990), the AADC application would include information on risk assessment, safety organization, safety personnel qualifications, equipment, safety policies and procedures, and accident investigation plans. In addition, OCST has published a detailed analysis of commercial space transportation hazards, including launch hazards (OCST 1988). Section 4.6 addresses safety more generally as it relates to the environment, as is appropriate for National Environmental Policy Act documentation.

The goal of the proposed KLC flight safety program is to protect the public, range participants, and property from the risk created by conducting potentially hazardous operations (WFF 1993). These potential risks would include risks to members of the public and KLC workers from launches. Although these risks cannot be completely eliminated, flights would be carefully planned to minimize the risks involved while enhancing the probability for attaining the mission objectives (WFF 1993). The level of launch safety at the proposed KLC would meet or exceed that of other national launch sites.

The flight safety program for KLC missions must accurately and reliably perform the following functions (OCST 1988):

- Continually monitor the launch vehicle performance and determine whether the vehicle is behaving normally or failing

- Track the vehicle and predict (in real-time) where the vehicle or pieces of the vehicle would fall in case of failure and if flight termination action is taken

[4]Title 14, Code of Federal Regulations, Part 143.

- Determine if there is a need to delay or abort the launch or destruct the vehicle, based on a comparison of current vehicle status to predetermined criteria

- If necessary to protect the public, send a command to abort the mission either by vehicle destruct or engine shutdown (thrust termination)

To accomplish these objectives, AADC would implement a flight safety program to protect the public and participating personnel from the proposed KLC launch. This flight safety program would be based on the safety practices contained in the National Aeronautics and Space Administration Wallops Flight Facility Range Safety Manual (WFF 1993). The Wallops Flight Facility is similar to the proposed KLC in that both facilities are located on a coast and launch similar small vehicles. For these reasons, the Wallops Flight Facility Range Safety Manual is appropriate for use at the proposed KLC. These safety practices were established to ensure that the following risk criteria would not be exceeded (WFF 1993):

- The total public casualty risk, for all mission activities, shall be less than 1 in 1,000,000

- The total participating personnel (worker) risk, for all mission activities, shall be less than 1 in 100,000

- The probability of hitting an aircraft shall be less than 1 in 10,000,000

AADC has also consulted with the U.S. Coast Guard to ensure that electromagnetic interference would not occur between operations of the U.S. Coast Guard Loran station and the proposed KLC. The U.S. Coast Guard has determined that there is no apparent interference and is committed to equipment monitoring during launches to ensure that problems do not arise (see Appendix B, USCG 1995).

4.6.1 OFF-NOMINAL LAUNCHES

The proposed KLC range safety system would track the flight of the launch vehicle and would destroy it if an abnormal occurrence took place or the vehicle went beyond flight limits. For each flight, the proposed KLC would establish flight termination boundaries (“destruct lines”). These flight termination boundaries would be derived by computing an Instantaneous Impact Point (IPP), based on launch vehicle velocity and position information (OCST 1988). The boundaries would also take into account populated areas near the planned flight path (i.e., the flight termination boundaries would be chosen to minimize potential adverse impacts on populated areas). The actual progression of the IPP would be observed during the launch. Figure 4.6-1 presents a depiction of typical IPP and associated flight termination boundaries. Flight termination would be required if the launch vehicle were to violate a flight termination boundary, or if launch vehicle performance is unknown and the vehicle is capable of violating a flight termination boundary. The flight could also be terminated as a result of gross trajectory deviation or obvious erratic flight (WFF 1993). Other flight termination criteria could be used due to the uniqueness of a particular mission. These additional criteria would be documented in the flight safety plan.

Each vehicle would carry explosive devices to safely destroy the launch vehicle if necessary. For instance, in the case of the LMLV 2, the main booster engines (Castor-120™) and equipment section booster (Orbus 21D) have a charge attached to each engine. Other launch vehicles would be similarly equipped with destruct systems.

From 1970 through 1995, the U.S. has launched 504 orbital vehicles from land (Atlas, Delta, Titan, Space Shuttle, Conestoga, Lockheed Martin Launch Vehicle, and Taurus) (AADC 1996). Of these launches there have been 32 failures, one on and near the launch pad and the rest downrange over the ocean. None involved damage to property outside of the launch site or impacts to members of the public.

In its programmatic assessment (OCST 1986), OCST evaluated environmental impacts and consequences of launch site accidents and launch failures. The analysis of Scout and Delta launch vehicles is most applicable to the proposed KLC because, like KLC launch vehicles, the Scouts and Deltas had solid-fueled first stages (unlike KLC and Scout vehicles, the Deltas also had liquid oxygen- and Aerozine-fueled upper stages). OCST concluded that no significant hazards appeared to be indicated for launch pad aborts, fuel propellant spills, in-flight failure and abort, or reentry debris.

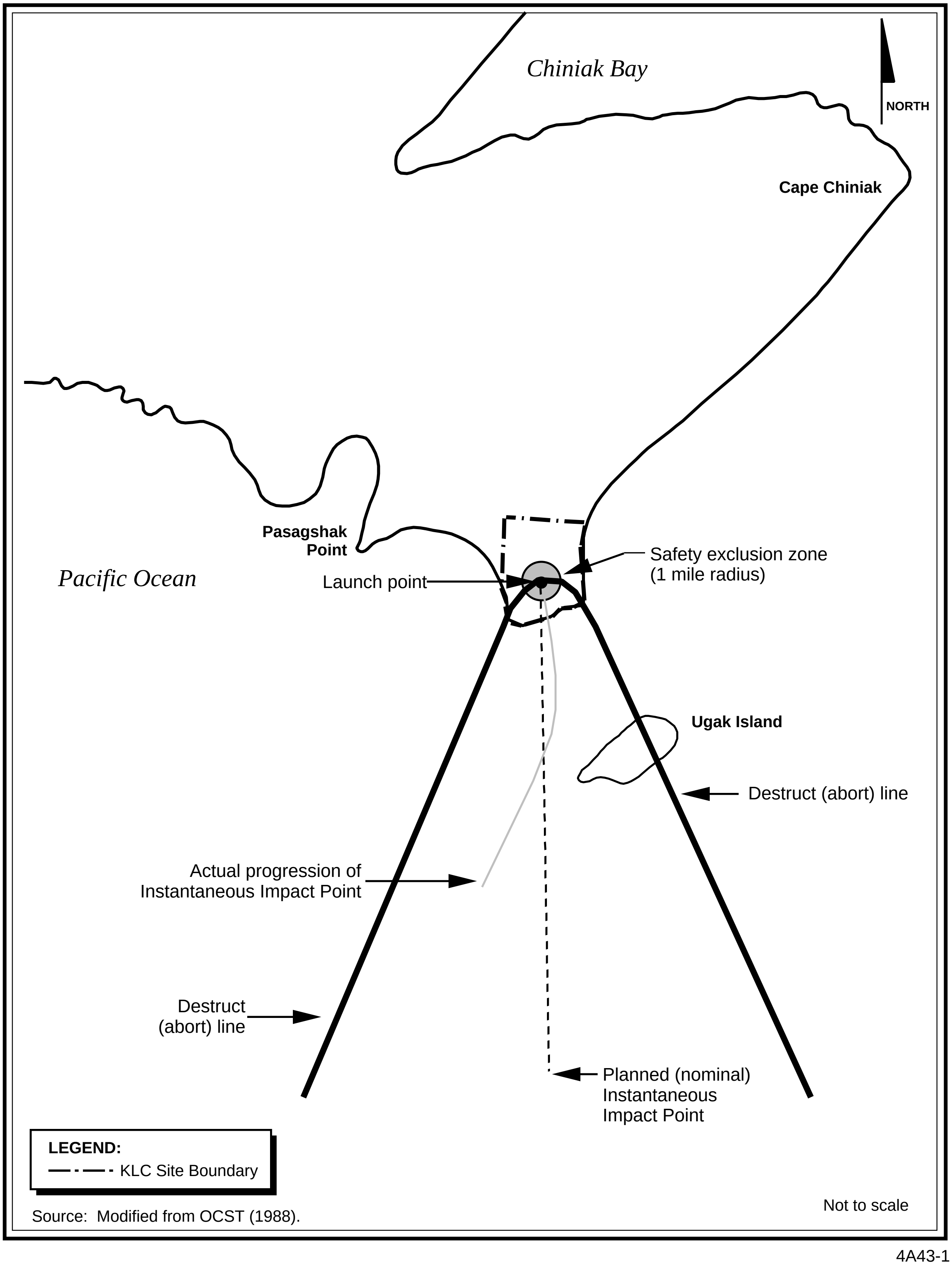

Figure 4.6-1. Typical instantaneous impact point, destruct line, and safety exclusion zone.

In addition to preparing launch safety documentation as part of its launch site license application, AADC would prepare a site emergency response plan. This plan would describe emergency actions and responses, including any arrangements with emergency response authorities, mitigative measures, and cleanup and recovery measures.

4.6.2 NOMINAL LAUNCHES

A debris hazard would exist for normal launches, primarily resulting from jettisoned payload fairings, stages, and other components. These impacts would be contained within the flight termination boundaries because, as discussed above, the flight would be terminated if the launch vehicle violates these boundaries. As illustrated in Figure 4.6-2, KLC launch facilities would be located so that the vehicles would fly primarily over oceans, minimizing the risks to members of the public from debris hazards. As noted in Figure 4.6-2, the only major inhabited area within the launch profiles for the proposed KLC missions would be the Hawaiian islands. Nominal flight profile data indicate that debris from the proposed KLC missions would not fall within approximately 100 nautical miles of these islands. This risk would be evaluated on a launch-specific basis for each mission, and events would be controlled so that risk would remain below 1 in 1,000,000.

An additional risk would be to airplanes flying over the launch area and to fishermen operating off the coast of Kodiak Island. Preparatory to launches, AADC would establish a safety area within which risk to the public would exceed one in one million if air or sea traffic was present during a launch. AADC would minimize risk to such population by doing the following (as discussed in Section 2.1.3.6):

- Provide notification to aviators and mariners at least 24 hours before launch.
- Monitor the area visually and with surface radar for 2 hours before launch.
- Delay a launch if traffic is detected in the safety area.

KLC would coordinate its operations with the Federal Aviation Administration Flight Standards District Office, the U.S. Navy [as specified by the Wallops Flight Facility Range Safety Manual (WFF 1993)], the U.S. Coast Guard, the Alaska Department of Fish and Game, local fishing fleets, boating organizations, and other organizations, as required.

Preparatory to each launch, in accordance with OCST licensing requirements, AADC would define a safety exclusion zone. This zone would typically be a 1.6-kilometer (1-mile) radius around the launch pad (Figure 4.6-1). However, the actual radius would be launch specific, based on criteria such as the payload, the vehicle being launched, and meteorological conditions at the time of launch. To protect

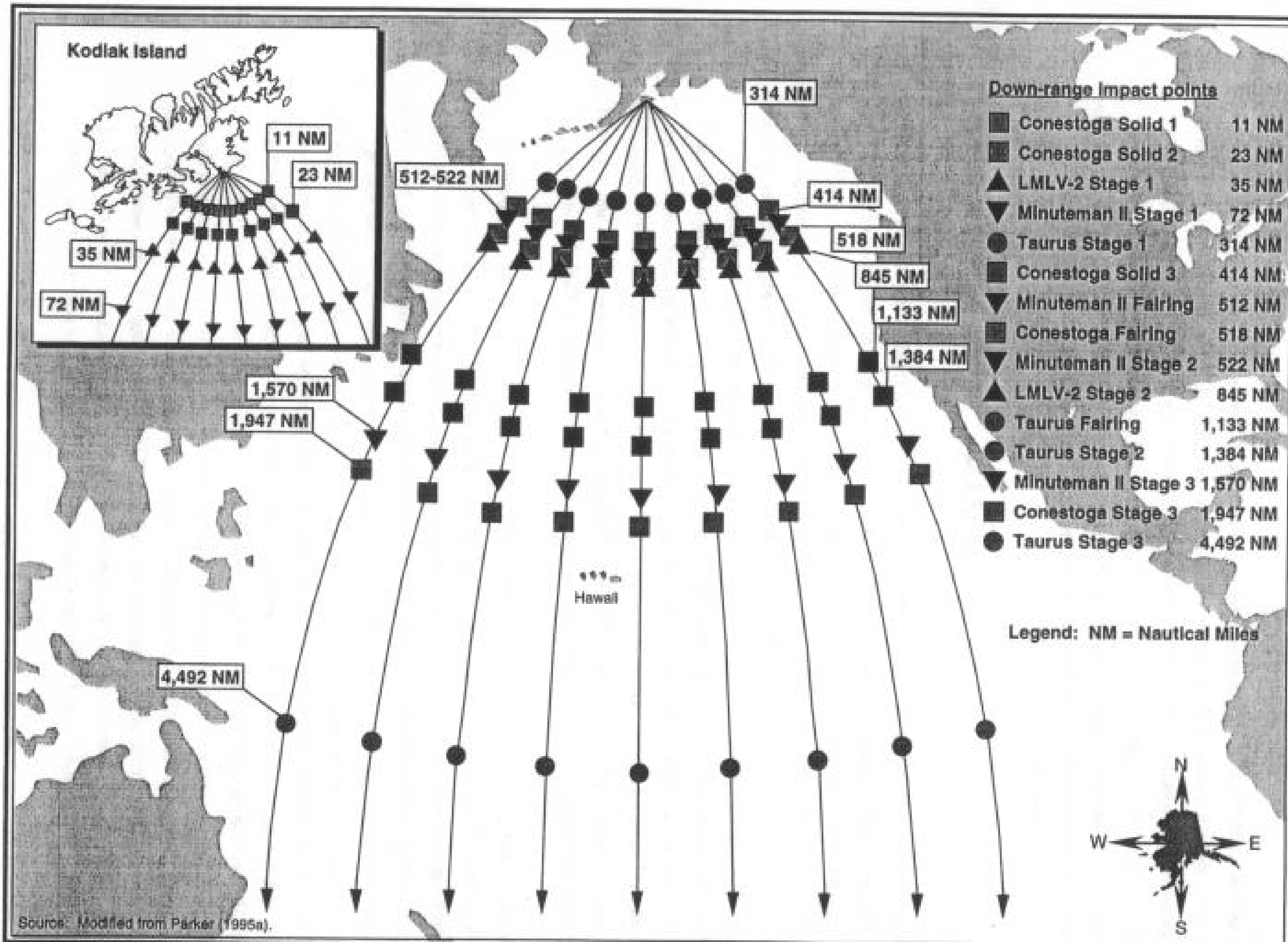

Figure 4.6-2. Launch profiles from Kodiak Island, Alaska.

4A43-1

persons on Kodiak Island prior to and during each launch, AADC would exclude nonparticipants from the safety exclusion zone. KLC personnel would survey the safety exclusion zone to ensure that for the 20 minutes prior to each launch all areas within the safety exclusion zone are verified to be clear of people (except mission-essential personnel). All site personnel (including any LORAN Station staff) would be relocated to the Launch Control and Management Center for the actual launch. Because of the distance that separates the Center from the launch pad, 3,000 meters (10,000 feet), blast-hardened protection is not necessary.

4.7 Land Use

The proposed conversion of the Narrow Cape location to KLC would result in minimal land use impacts since a very small percentage of land within the Kodiak Island Borough is directly involved. The developable land on the island includes that owned by the state, native corporations, local governments and private property. Although this amount is being reduced through transfers to the Federal government as part of the Exxon Valdez Trusteeship process, the total acreage owned by the above entities remains in excess of one million acres. The proposed KLC leased area [approximately 13 square kilometers (3,100 acres)] is an extremely small portion of the total area; it is less than one-tenth of one percent of the state-owned land area in the Kodiak Island Borough. The total footprint of the proposed structures and planned site roads is approximately 174,000 square meters (43 acres), or approximately 1 percent of the site. The proposed KLC leased area does not include any of the privately owned land and is located more than approximately 40 kilometers (25 miles) from the Kodiak National Wildlife Refuge.

The conditional use permit requested by AADC in accordance with Section 17.13.040.8, Conditional Uses, of the Kodiak Borough Code, and approved by the Kodiak Island Borough Planning and Zoning Commission stipulates that the proposed KLC "will preserve the value, spirit, character and integrity of the surrounding area to the extent that potential impacts on mammal and bird life, wetlands, down-range fisheries, and existing grazing uses are effectively mitigated." Although exempted by State statute, AADC participated in the planning and zoning process to encourage public participation and community support. As development of the area would have minimal changes on the value, spirit, character and integrity of the surrounding area to the extent that potential impacts on human and natural resources are small, the development and operation of KLC meets local planning requirements (Freed 1995). In addition, the conditional permit system requires that the Planning and Zoning Commission must find that the proposed use of the land will maximize public benefits. The Commission found that the AADC was created by the state (Alaska State Legislature, House Bill 548 1994) to develop the aerospace industry and diversify the state economy, and that the conditional use permit for the KLC at Narrow Cape will serve that public function (Freed 1995). The Commission also found that the conditional use would fulfill all other requirements of Chapter 17.13 (C-Conservation Zoning District) of the Borough Code, including those "concerning impacts on the natural environment and preservation of natural features" (Freed 1995). Impacts to existing grazing uses of the land would not be substantial due to the small footprint of new facilities and the small amount of land withdrawn for KLC use. Recreational impacts are discussed in Section 4.9.

In addition to obtaining a conditional use permit and other Federal and state permits, the proposed action underwent a review for consistency with standards established under the Alaska Coastal Management Program (Alaska Administrative Code, Title Six, Chapter 80). Key elements of the standards require that there be balanced utilization and protection of coastal lands and waters, and that there is a higher priority for uses that are economically or physically dependent on a coastal location when compared to uses that do not require a coastal location. AADC proposes to develop the Narrow Cape site after extensive analysis and public consideration by its board of directors because it is both the best site technically and is the site that would require the least construction and make the least environmental impact. Actions by the state legislature to establish AADC demonstrate the economic development purposes and high priorities of developing and operating KLC.

4.8 Socioeconomics

4.8.1 CONSTRUCTION

Construction of the proposed launch complex is estimated to cost approximately between $18 to $24 million and require approximately 45 workers for a period of 12 to 18 months as discussed in Section 2.1.2. These expenditures would help to stimulate the Kodiak Island construction industry as well as support additional indirect jobs in other local business sectors. Benefits associated with these expenditures include wages paid to local residents (since this money would be spent in the local area), goods purchased on the island, and taxes paid to the borough. Wages paid to local residents (direct effects) would have a disproportionately high beneficial economic impact since wages cycle through the economy, creating indirect effects. Taxes paid to the Borough would also be disproportionately beneficial since the local government expenditures required to support construction workers would be lower than those required to provide services for permanent residences (e.g., schools).

Many of the construction workers would be local Kodiak Island residents, but some nonresidents probably would be hired. As a result, there would be a small (less than 1 percent) increase in population. This increase in demand would be temporary and existing facilities and resources would be sufficient to satisfy the increase. The estimated 30 construction workers, with a peak of 45 (Section 2.1.2.1) would put additional demand on Kodiak Island, but with average availability of approximately 130 rooms, this impact is not expected to be major.

4.8.2 OPERATION

Staffing information for operation of the proposed KLC is listed in Table 2.1-3. As shown, peak employment is expected during the initial years of operation when approximately 100 people would be onsite for 6 weeks before a launch. Over time, due to anticipated efficiency improvements, the number of people and time needed to prepare for a launch is expected to decrease.

Each launch customer is expected to bring its own professional staff for temporary launch assignments. It is expected that each launch could require as many as 20 workers from local construction trades and with other skills. In addition, approximately one full-time position would result from security, routine maintenance, and grounds-keeping services required between launches.

As noted in Section 3.2.7, tourism is a major component of Kodiak Island's economy with over 14,000 visitors per year. In addition, the island's population is somewhat transient due to the seasonal nature of the commercial fishing industry and changes in personnel at the U.S. Coast Guard station. As a result, the island and its resources are accustomed to and able to adapt to temporary increases in employment and population.

The expenditures associated with 100 temporary workers and the requirement for local trades' support for each launch to conduct as many as nine launches per year would have a beneficial impact on the local economy. Although unlikely, population changes could be somewhat larger because some of the workers may bring families. In 1990, the average household size in the United States was 2.63 (HNUS 1992). Assuming that all 100 workers would bring a family (a highly unlikely assumption), there could be a population increase of 263 people or 1.8 percent over 1993 population levels. Housing availabilities for operations would be the essentially the same as discussed in Section 4.8.1 except that the rental market would become more flexible during the next several years as the U.S. Coast Guard, which has approximately 275 personnel living off base, adds about 130 new housing units. The first 30 units will be available in spring 1997 (Kodiak Daily Mirror 1996). Since the island is accustomed to large and frequent fluctuations in population as a result of the tourism and fishing industries, this change would not impact negatively on Kodiak community resources or infrastructure.

AADC expenditures for goods and services on a year-round basis would include wages paid to local residents, goods purchased on the island, and taxes paid to the Borough. These expenditures would result in a small beneficial impact to the local economy.

As discussed in Section 4.6, access to waters in the Narrow Cape area would not be restricted prior to launches. Because of the extensive coordination proposed with state and local fishing and marine safety organizations, coupled with the lack of restrictions, impacts to commercial fishing activities in the Narrow Cape area are not anticipated.

Because commercial air lanes are to the north of the proposed launch area, there would be no adverse socioeconomic impacts from launches to commercial air traffic to and from Kodiak State Airport. Launches from Kodiak would have no interaction with U.S. Air Force training exercises, and neither operation would impact (economically or otherwise) the other. Socioeconomic impacts to commercial fishing and commercial shipping would be minimal as there would be no restricted areas. As discussed in Section 4.6, Launch Safety, safety areas would be surveyed prior to launch to ensure risk to the public would be less than one in one million, and launches would be delayed if necessary to meet the risk parameters.

Section 3.7.2 identified the six traditional villages as minority communities and identified the traditional villages on the southern part of Kodiak Island as having a lower median household income than either Alaska or the Island as a whole. In accordance with Executive Order 12898, potential areas of highly adverse and disproportionate impacts to these communities have been examined, and it is determined that impacts to minority communities or communities of low income are not highly adverse and disproportionate.

First, the conclusions of this environmental assessment are that physical impacts of launch site construction and operations to local communities are not highly adverse. In addition, the conclusion that any physical impacts to traditional communities are not highly disproportionate is demonstrated by a comparison of the distances from the proposed launch area to the nearest traditional villages versus the distance to Kodiak City, which is approximately 37 kilometers (23 miles) from the proposed launch site. In comparison, the nearest traditional village is Ouzinkie, approximately 53 kilometers (33 miles) from the proposed launch site and on the other side of Kodiak City from the proposed site. The nearest traditional village on the southern part of the island is Old Harbor, approximately 61 kilometers (38 miles) from the proposed site. Second, there have been no identified adverse economic impacts to minority or low income communities. In fact, diversification and subsequent economic growth of the Kodiak economy as a result of the construction and operation of the proposed launch center should benefit all sectors of the economy. These benefits are discussed in more detail in “Economic Impacts of the Kodiak Launch Complex” (ISER 1996). The summary conclusions of that study were that operation of the launch center would increase local employment 0.5 to 1.5 percent and add $1.5 to $4.2 million to Kodiak payrolls annually.

Potential impacts on operation of the proposed facility on cultural resources, including subsistence use, is discussed in Section 4.11.

4.9 Recreation

Potential impacts to recreational uses of Kodiak Island or to the Narrow Cape area would be of three types, which are discussed in this section:

- Additional usage of the recreational opportunities by non-resident KLC workers
- Reduction in the availability of the Narrow Cape or Kodiak Island recreational opportunities caused by operation of the KLC
- An additional recreational opportunity attractive to residents and tourists.

Impacts to recreational resources from use by non-resident KLC workers would not appreciably decrease the availability of recreational resources to residents. Should non-resident workers stay over after their work is done, their small numbers (total of 50 to 100 persons for early launches) relative to the estimated numbers of visitors (14,700) to Kodiak Island each year would not have a measurable effect on the availability of recreational opportunities.

The availability of Narrow Cape for recreation would not be substantially impacted by proposed KLC operations. The proposed KLC would maintain an open site except for temporary closures of the Pasagshak Point Road at the site boundary during payload transfers to the launch area and full day closures on launch days (up to 9 per year). For safety and security purposes, these site closures would curtail shelling, bird and whale watching, and fishing at Twin Lakes on these days. Any closings would be in the newspaper and announced on Kodiak radio. When considering the wealth of recreational opportunities available elsewhere on the island, these short-duration closures of Narrow Cape would not have an appreciable impact.

Where feasible and prudent, OCST is required to avoid the use of significant publicly owned recreation lands, such as parks, wildlife refuges, and recreational areas. If there is no feasible and prudent alternative, the OCST is required to minimize possible harm resulting from such use (49 USC Section 303). Per this requirement, consideration was given to potential impacts to Pasagshak State Recreation Area and the Narrow Cape Trail (Figure 3.2-1). Based on the characteristics of the construction and operation of the proposed action, substantial adverse impacts to either area are not anticipated.

Pasagshak State Recreation Area (see Section 3.6 description) is not expected to suffer substantial harm because the proposed KLC would not require the actual use, acquisition, incorporation, or control of any portion of the Pasagshak State Recreation Area. Air quality, water resources, and aesthetic resources are not expected to be substantially impacted. Construction noise would be inaudible due to the intervening distance of 10 kilometers (6 miles) and mountainous terrain. Launch noise would be loud, approximately 83 dBA (slightly less than a freight train at 50 feet), but the noise would be audible only 1 to 2 minutes and a maximum of 9 times per year. Launch noise is not expected to interfere with the area’s fishing or camping. Therefore, the proposed KLC would not result in a use of any protected properties under 49 USC 303. As to historic, archaeological, and cultural resources, see Section 4.11.

KLC construction would not physically impinge on the Narrow Cape Trail but might have an aesthetic impact due to visual presence of construction equipment and constructed facilities. Because usage of the trail, and its location in the launch area, could not be verified (Section 3.8), it is assumed that this impact would be minimal. Due to the need to close public access to the site, trail usage would be eliminated on launch days, but site (e.g., road) improvements and staffing may increase trail usage at other times.

As discussed in Section 4.6 on launch safety, no restrictions would be imposed on sport or commercial fishing vessels. It is expected that the launches would present additional recreational and educational opportunities for Kodiak Island residents, particularly for the early launches when interest would be highest. AADC would work with local government and community groups to arrange for bus transportation to an appropriate viewing site outside the launch safety zone. Bus transportation would minimize traffic impacts of viewers on the incoming road and minimize crowd impacts. AADC would coordinate the provision of services in the designated cordoned viewing area, including portable toilets, refreshments, and sitting areas.

The Kodiak National Wildlife Refuge is not expected to be affected by the proposed KLC because of the distance between the sites [48 kilometers (30 air miles)], because roads to the proposed KLC site do not pass near the refuge, and because KLC launch vehicles would not pass over the refuge. The refuge administrative agency, the U. S. Department of Interior, has been afforded opportunity to review and comment on KLC project documentation and has not indicated any concern with the proposal.

4.10 Visual Resources

The impacts on visual resources are a matter of aesthetics influenced by the relative size (particularly height), dissimilarity to surroundings (shape and color), and quantity and frequency of viewers.

The construction and operation of the proposed KLC would affect the visual resources of Narrow Cape by placing five new man-made structures into a relatively isolated area. Care during and after construction to return areas adjacent to the structures and site access roads to their pre-construction condition would limit visual impacts of the structures, except for the Launch Service Structure, to the immediate vicinity of the structures, a relatively small area.

The Launch Service Structure would be 52 meters in height, 12 meters wide, and 21 meters long (170 feet in height, 40 feet wide, and 70 feet long). Due to the flat terrain of the Narrow Cape site the Launch Service Structure would be visible over most of the cape and from offshore. Although the U.S. Coast Guard's Loran-C transmitter is taller, the Launch Service Structure would be considerably bulkier and therefore more noticeable. The visual impact of the structure would be minimized by painting it a color that blends into the background of the most common viewing angles. The Launch Service Structure would be painted steel blue or gray in color to blend with either the sky or mountainous backgrounds, which would be viewed from afar. In addition, due to the isolation of the site and the consequent lack of permanent viewers, the KLC is expected to have minimal impact on visual resources.

4.11 Cultural Resources

Subsistence

Potential impacts to subsistence harvesting from the construction and operation of the proposed launch facility could occur from effects to the ecological resources in, or the prevention of access to, harvesting areas. Because public access to some areas would be prohibited for only 9 days per year prior to a launch, harvesting of subsistence resources in those areas would be likewise minimal. The limitation of access would be due to safety precautions taken prior to and during a launch, including the temporary closure of Pasagshak Point Road to public access at the site boundary and assuring that no unauthorized people are in the ground-hazard area around the launch pad. Pasagshak Point Road would also be closed during payload transfers (see Section 2.1.3.6).

The proposed launch complex borders the northern edge of an area that has been documented as historically used by Native Americans for subsistence harvesting, although, as discussed in Section 3.10, this use pattern no longer occurs. More definitive subsistence-use-area map information was gathered in conjunction with the 1992 Alaska Department of Fish and Game (ADFG), Division of Subsistence household survey of Kodiak Island's road connected areas. As described in the ENRI Baseline of Narrow Cape, Kodiak, Alaska, about 80 households identified as being extensive subsistence harvesters were asked to plot their resource-use area on 1:250,000-scale USGS maps. These maps have not been synthesized but indicate some limited subsistence activities occur in the Narrow Cape area, primarily for harvesting deer and freshwater fish in the vicinity of Twin Lakes. Estimates are presented in Table 3.10-1 (ENRI 1995b). In that the Narrow Cape area appears to host only limited subsistence harvesting activities, while essentially the entire coast from Pasaghak Bay to the far southern end of the island is a harvesting area, the potential temporary access restrictions that may result in the Pasagshak Bay and Twin Lakes areas are small given the total size of the range.

An ADFG report indicates that "During the 1980's...there were about 110,075 people in about 225 communities who participated in subsistence practices to some degree. Of these, about 50,000 were Alaska Native, and 60,000 were not Alaska Native" (ADFG, 1990). Although these ratios cannot be directly applied to Kodiak Island, they do indicate that subsistence harvesting in the State of Alaska is practiced by a large number of individuals, both native and non-native. As discussed in the ENRI report, a 1992 household survey conducted by ADFG of Kodiak Island's road-connected areas showed subsistence participation to be very high (98.6 percent). The study notes that it was difficult to separate recreation and sport harvests from the subsistence harvests of respondents (ENRI 1995b).

Given the documented limited use of the Narrow Cape area and the fact that restriction of the area would be limited and temporary in nature, no impacts to subsistence harvesting activities on Kodiak Island are expected. No disproportionate impacts on Native Americans, low income, or minority populations are expected due to the large harvesting areas available and the fact that the Narrow Cape area does not appear to be a high usage area.

Archaeological and Historic Resources

In accordance with Section 106 of the National Historic Preservation Act, the AADC initiated a formal consultation with the State Historic Preservation Officer (SHPO). Because evidence of cultural resources on the proposed KLC was not noted during the survey conducted in August 1994, construction of the proposed KLC would not have an impact on archaeological resources.

As noted in Section 3.10, there are two archaeological sites and a complex of World War II era facilities in the vicinity of proposed construction. Although these sites would not be directly affected by construction or operation of the proposed KLC, the increase in human activity in the area may increase the likelihood of secondary or indirect impacts.

The SHPO has concurred with the finding that there are no known historic properties in the area of potential effect (see Appendix B). Although damage could occur as either direct looting of the sites or as a result of increased pedestrian activities in the area, the presence of additional KLC security in the area would deter such acts. In addition, AADC would notify the SHPO in the event that new archaeological resources are discovered during construction. As recommended by the SHPO, AADC would prepare a management plan to further protect these sites.

OCST has reviewed the potential impacts to archaeological and historical resources to determine whether project approval would be in accordance with 49 USC Section 303. The project would not remove or physically impinge on such resources; it would comply with SHPO direction; and substantial adverse impacts are not anticipated.

Native American Participation

Also required under Executive Order 12898, Federal agencies shall provide opportunities for community input in the National Environmental Policy Act process, and shall ensure that the public, including minority communities and low income communities, has adequate access to public information relating to human health or environmental planning.

From December of 1993 through April of 1996, the AADC has sponsored or participated in 25 events in Kodiak and Chiniak presenting and discussing facts related to the siting and operation of the proposed KLC. Total attendance by the public has exceeded 600 individuals. Additionally, AADC participated in two separate radio call-in shows and responded to 16 callers. Appendix A provides information on additional public participation activities that have occurred since January 1995.

Specific examples of Native American participation include meetings with the Board of the Leisnoi Corporation and representation by Native Americans on the AADC Board. The Kodiak Launch Complex Advisory Committee is a volunteer group of 19 concerned members of the community representing a broad spectrum of interests on the island including those of Native Americans. This is discussed in greater detail in Appendix A. The public participation events that have occurred have been attended by a range of individuals from different ethnic and economic groups. No attempt has been made during meeting registration to categorize individuals.

4.12 Hazardous Materials and Waste Management

4.12.1 CONSTRUCTION

The construction of the proposed KLC facilities would use small quantities of hazardous materials, which would result in the generation of some hazardous and non-hazardous wastes (HNUS 1993). As shown in Table 4.12-1, the hazardous materials that are expected to be used are common to construction activities and include Number 2 diesel fuel, anti-freeze, hydraulic fluid, lubricating oils, welding gases, and small amounts of paints, thinners, and adhesives. The use, management, and disposal of these hazardous materials is also described in Table 4.12-1. Substantial impacts to the environment are not expected from the presence of hazardous materials and the generation of wastes during the construction activities.

To minimize (1) the amount of hazardous materials stored, (2) the threat of their accidental and unplanned release into the environment, and (3) the quantity of hazardous waste generated, the following hazardous materials management techniques would be used during the construction period:

- Structures would be prefabricated by manufacturers and shipped for final assembly at the site using bolts to minimizing the need for welding, painting, and other activities involving hazardous materials

- Diesel fuel would be stored in above ground storage tanks with secondary containment and inspected daily in accordance with the provisions of the Spill Prevention, Control, and Countermeasures Plan (as appropriate)

- Bulk hazardous materials [e.g., 210-liter (55-gallon) drums of anti-freeze, hydraulic fluid, compressed welding gasses] would be stored in approved containers that meet industrial fire protection codes and required containment systems

- Spill response materials (e.g., sorbents, drain covers, mops, brooms, shovels, drum repair materials and tools, warning signs and tapes, and personal protective equipment) would be readily available for use in the event of an unplanned release

Table 4.12-1. Hazardous materials at the proposed KLC.[a]

Hazardous Material	Use	Location: LCMC[b]	Location: PPF[c]	Location: LA[d]	Management
Construction Period					
Anti-freeze	Construction equipment	√	√	√	Stored on impervious surface with spill materials available and would be removed when construction is completed.
Hydraulic fluid and lubrication oils	Construction equipment	√	√	√	
Welding gases	Welding building structures	√	√	√	Welding of structures would be at a minimum due to pre-fabrication/bolting.
Launch Periods					
Number 2 diesel fuel[e]	Fuel for construction vehicles and emergency diesel generator	√	√	√	Stored in above ground storage tanks with secondary containment and inspected daily.
Paints, thinners, solvents, cleaning fluids, adhesives, lubricants, batteries, etc.[e]	Groundskeeping and maintenance activities on backup generators, heating and cooling system, communication system, etc.	√	√	√	After construction, only small quantities less than 4 liters (less than 1 gallon) of each substance would be stored on-site at any one time. Materials used for launch purposes would be removed by the launch vendor.
HCFCs[f]	Cooling and fire suppression	√	√	√	No venting of systems are planned
Solid rocket fuel	Fuel for launch vehicles			√	Fuel would be brought to site sealed within rocket motor.
Compressed gaseous helium and nitrogen	Evacuate atmospheric oxygen during transfer of propellants into payloads.		√		Pressurized gas cylinders would be removed from site by launch vendors.
Isopropyl alcohol	Wipe clean dust-sensitive payloads and for flushing liquid propellant from transfer carts		√		Would be removed from site by launch vendors.
Hydrazine propellants	Payload propellant for post-launch steering		√		Would be brought/removed by launch vendor. Less than approximately 380 liters (100 gallons) would be temporarily stored or transferred from specialized shipping containers by trained personnel.
H_2O_2 and $Ca(OCl)_2$[g]	Neutralizing water mixed with aspirated propellant during payload fueling		√		
Waste Products Expected					
Construction materials	Scrap lumber, metal, cardboard, paper, etc.	√	√	√	Removed for off-site recycling or disposal during construction phase
Spent solvents, paper, waste oil, batteries, spill cleanup materials, anti-freeze, and empty containers	From construction, groundskeeping, housekeeping, maintenance, and spill response (if necessary) activities	√	√	√	Removed for appropriate off-site recycling or disposal during construction and after each launch [expected rates of hazardous waste generation range from 91 to 770 kilograms (200 to 1,700 pounds per year].
Diluted washdown water and isopropanol	Wash down from the transfer of liquid propellants into payloads		√		Removed for appropriate off-site disposal after each launch [expected rates of hazardous waste generation range from 91 to 1,020 kilograms (200 to 2,250 pounds) per year during operations)].
Sewage	From portable toilets during construction and permanent toilets, showers, and sinks	√	√	√	Septic tank and mounded absorption bed. Contents of septic tank would be drained and removed for off-site disposal.

a. Adapted from USAF (1994), HNUS (1993), and USAF (1991).
b. Launch Command and Management Center.
c. Payload Processing Facility.
d. Launch Area.
e. Also present/used during construction phase.
f. Hydrochlorofluorocarbons.
g. Hydrogen peroxide and calcium hypochlorite.

- Hazardous materials would be inspected before accepting a shipment (e.g., to validate container integrity, expiration date, etc.)

- Hazardous materials would be purchased in appropriately sized containers (e.g., if the material is used by the can, it would be purchased by the can rather than in bulk-sized containers)

- Over-purchasing of hazardous materials would be avoided

- Hazardous material containers would be appropriately labeled

- At the completion of the construction period, unused amounts of hazardous materials would be the responsibility of the construction contractors and would be safely removed from the site.

Nonhazardous and hazardous waste generated during construction activities include construction debris, empty containers, spent solvents, waste oil and anti-freeze, spill cleanup materials (if necessary), and lead-acid batteries from construction equipment. AADC would ensure that construction contractors safely remove these wastes from the site for appropriate disposal in accordance with applicable requirements. The Alaska Hazardous Waste Management Regulations (Alaska Administrative Code, Title 18 - Environmental Conservation, Chapter 16) include hazardous waste requirements for identifying and characterizing hazardous wastes; obtaining a hazardous waste facility I.D. number; and storage, shipment, and recordkeeping requirements. The hazardous waste generator category for the proposed KLC during the construction activities is expected to be no more than a "small quantity generator" [i.e., generates more than 100 kilograms and less than 1,000 kilograms (between 220 and 2,200 pounds) or 100 liters to just under 1,000 liters (27 to just under 264 gallons) of hazardous waste in any calendar month]. Since no permitted hazardous waste treatment or disposal facilities exist on Kodiak Island, all hazardous waste would be shipped to the mainland for appropriate treatment or disposal. Only licensed hazardous waste transporters may transport hazardous wastes off site. Sewage generated during construction activities (e.g., from portable toilets) would also be removed for appropriate off-site treatment and or disposal.

The volume of nonhazardous construction generated waste is expected to be small based on past experience at Vandenberg Air Force Base and other similar facilities. The construction schedule for the facility is relatively short with a peak employment of about 45 individuals. Buildings are to be prefabricated metal that should result in relatively small volumes of non-recyclable construction waste. Debris resulting from site preparation such as tree stumps would be burned onsite, and soil excavated during construction activities would be stockpiled for on-site use. During the operational phases of the facility, personnel onsite would fluctuate between approximately 1 full-time employee to a staff of 40 to

100 for periods of 4 to 6 weeks before and during a launch. Given the varying levels of site personnel, volumes of non-recyclable nonhazardous waste are also expected to be small.

Nonhazardous waste would be stored onsite for no more than 30 days before transporting to the Kodiak Island Borough's permitted landfill facility. The capacity of the current landfill is expected to be reached sometime after 1998. The Kodiak Island Borough is considering the expansion (vertical and lateral) of the current landfill to increase its available capacity (Alexander 1996). In the event no landfill capacity at Kodiak Island is available for nonhazardous waste generated during the construction or operation of the proposed KLC, nonhazardous waste would be transported to the Alaska mainland for appropriate disposal.

The proposed KLC does not require a solid waste disposal permit related to the temporary storage of nonhazardous waste generated during the construction and operation of the facility (see Appendix B-4). On-site nonhazardous waste management practices would include:

- The containerization of waste to prevent discharges of waste or leachate
- The prevention of litter
- Controlling access by wildlife or disease vectors
- Keeping the premises free of solid waste
- The use of best available management practices for the control and prevention of runoff and erosion

Transporters of solid waste would also be required to contain waste during transport, promptly remove any waste spilled, and clean the affected areas.

4.12.2 OPERATION

The handling and use of hazardous and toxic materials at the launch site during and between launch operations would be limited. Hazardous materials used for maintenance, groundskeeping, and housekeeping activities would normally consist of various solvents and cleaners, paints and primers, adhesives, and lubricants. It is expected that no more than 4 liters (1 gallon) of each of these types of materials would be present at any one time (USAF 1994b), with no more than 38 liters (10 gallons) in total. Table 4.12-1 provides a complete list of hazardous materials expected to be used during launch operations and describes their use, storage location, management, and disposal. The hazardous material management techniques described for construction would also be followed during operations to minimize their use and waste disposal. Again, substantial impacts to the environment are not expected from the presence of hazardous materials and wastes during operations.

Some payloads might use a hydrazine-based liquid mono-propellant for attitude adjustment. The quantities involved would be small, from a few ounces to less than approximately 380 liters (100 gallons). Hydrazine is toxic and can ignite spontaneously on contact with oxidizers or porous materials such as earth, wood, and cloth (NIOSH 1989). The primary potential impact from liquid propellant would occur if it was spilled or otherwise released in a uncontrolled manner to the environment.

Liquid propellant would be transported to the proposed KLC within an approved container or within a specially designed storage cart; there would be no permanently installed payload fueling system at the proposed KLC. The launch operator would be responsible for transporting the fuel in accordance with U.S. Department of Transportation requirements. Because of the sealed nature of this mode of transport, the likelihood of release and environmental effect is small.

Hydrazine-based propellant handling onsite would be performed in accordance with KLC safety procedures required by OCST (OCST 1989). Storage carts would be stored near the Payload Processing Facility (Figure 2.1-12) in a Fuel Storage Shed that would be designed to fully contain a “worst case” propellant spill. For fueling operations, the cart would be moved into the Facility processing bay where trenches filled with a non-reactive absorbent material would be provided to contain spilled material. Fueling would be monitored by safety personnel, and portable detectors would be used to monitor for hazardous vapors. Personnel would be trained to respond to unplanned releases (inside or outside) in accordance with the site spill response plan, and spill response equipment would be maintained in a readily available condition. Wastes generated from spill response activities would be managed in accordance with Federal and State requirements. Because (1) fuel storage and handling would occur inside, (2) small quantities would be involved, and (3) appropriate spill response measures would be implemented, the potential for environmental impact from liquid propellant fueling operations or spills is small.

Solid rocket launch propellants present at the Launch Area would be (1) contained in the launch vehicles themselves, (2) fueled at the factory and (3) delivered in completely assembled, painted, encapsulated units.

Small amounts of hazardous and non-hazardous wastes are expected to be generated during operations including spent solvents, lead-acid batteries, waste oil and anti-freeze, spill cleanup materials (if necessary), and empty containers. Scrubber water and waste isopropanol would also be generated during the fueling of payloads as described in Table 4.12-1. The hazardous waste generator category for the proposed KLC during operations is again expected to be no more than a “small quantity generator.” Nonhazardous waste would be managed as described in Section 4.12.1 for appropriate disposal at the Kodiak Island Borough landfill or on the Alaska mainland. Finally, sewage from toilets, showers, and sinks, which would be collected in septic tanks at each facility, would also be generated. Similarly, as described for the waste management during construction activities, AADC would ensure that launch vendors safely remove these wastes for appropriate off-site disposal after the completion of each launch in accordance with applicable Alaska and Federal requirements.

4.13 Summary and Cumulative Impacts

This section summarizes the foreseeable environmental effects that would occur as the result of the proposed KLC and identifies those KLC impacts that would accumulate with impacts from other actions.

Sections 4.1 through 4.12 analyze environmental impacts from constructing and operating the proposed KLC, including phasing launch operations up from 1 to a maximum of 9 launches per year for the lifetime of the facility. OCST and AADC have also identified three potential sources of cumulative impact. In addition to contributing to ozone impacts from other solid rocket launch sites (Section 4.1.3), the proposed KLC would contribute to the filling of the Kodiak Island Borough municipal landfill (Section 4.12.1), and the proposed KLC construction would be contemporaneous with logging activities elsewhere on Cape Chiniak (Figure 2.1-1).

The logging activities and the proposed KLC would result in fugitive dust emission and noise along the stretch of Kodiak Island Highway (Figure 2.1-1) that worker and equipment traffic from the two projects would share. As discussed in Section 4.1.1, however, the frequency of rainfall on Kodiak Island minimizes dust problems. Noise would be a continuing, although intermittent, impact. As discussed in Section 3.7, the route between the City of Kodiak and the KLC site includes approximately 41 kilometers (26 miles) of Kodiak Island Highway, most of which is gravel road. This stretch of road is also used by logging equipment that moves between the City of Kodiak and Cape Chiniak (Figure 2.1-1). Land use along this route (approximately 6 small commercial establishments and one ranch) is currently subjected to the noise of logging traffic and would, in addition, be subjected to the noise from proposed KLC traffic.

Precise traffic counts along this route are unavailable; however, an estimated 15 to 18 logging trucks move between the City of Kodiak and Cape Chiniak logging sites daily (Sadlowski 1996). As noted in Section 4.1.1, approximately 50 percent of the total truckloads (435 loads) of aggregate required for site preparation would have to be obtained from off-site sources. Some of this material may have to come from sources near the City of Kodiak. Using the worst case estimate---all 435 truckloads coming from the City of Kodiak---results in an average of 2.2 additional truckloads passing by the ranch and commercial establishments daily. This number was obtained by assuming 260 work days per annum, two-way (round trip) truckloads, and an 18 month construction schedule. However, in order to minimize the need to travel to the City of Kodiak, AADC completed an additional geotechnical study (R&M 1995) to identify aggregate sources in the vicinity of the proposed KLC. The study indicated that materials similar to those found near the City of Kodiak may be found in adequate quantities within 10 road miles of the proposed KLC site. AADC intends to use these sources, which should greatly reduce or eliminate the need to travel to the City of Kodiak and pass the commercial establishments and ranch. Proposed KLC noise impacts along this route are expected to be minimal whether considered individually (a single truck) or cumulatively (the addition of KLC trucks to existing logging truck traffic).

Table 4.13-1 summarizes the direct and indirect impacts analyzed in the previous sections; cumulative impacts; and, for each proposed KLC impact, proposed mitigation measures that Chapter 5 describes in more detail.

4.14 No Action

If the no-action alternative were selected, Alaska would not construct the proposed KLC. Grazing would continue, and the land would remain available for development.[5] In addition, the goals of the Commercial Space Launch Act would not be furthered. The proposed KLC site environmental effects would not occur. Some launch business loss to foreign competitors would also be expected, counter to the goals of the Commercial Space Launch Act.

[5]By law, state-owned lands are available for development.

Table 4.13-1. KLC impacts summary.

	Cumulative Impacts[a]			
	Proposed Action (KLC)		Incremental Impacts From	
Category	Direct Impacts[b]	Indirect Impacts[c]	Other Actions	Mitigative Measures[d]
Air				
Construction	Construction equipment and vehicle emissions	Fugitive dust emissions from traffic on gravel access roads (Kodiak Island Highway and Pasagshak Point Road)	Fugitive dust from logging traffic on gravel road (Kodiak Island Highway)	Construction equipment fugitive dust control. Use of on-site batch plant and borrow pit (reduces off-site traffic and resulting dust)
Operation	Standby diesel generator, fuel handling, and launch vehicle emissions (impacts do not accumulate with multiple launches); stratospheric ozone depletion from launch vehicle emissions	Fugitive dust emissions from traffic on gravel access roads (Kodiak Island Highway and Pasagshak Point Road)	Fugitive dust from logging traffic on gravel road (Kodiak Island Highway); Stratospheric ozone depletion from launch vehicle emissions worldwide	Paved site road (reduces dust); use of commercial power and using diesel generators for backup and testing only; Natural Resources Management Plan
Water				
Construction	Increased stream turbidity during road improvements; surface water usage for fire protection	Use of municipal water supply and sanitary waste treatment system during construction	None identified	Implement construction-phase stormwater pollution prevention plan; use erosion control measures
Operation	Surface water usage for domestic supply and fire protection; launch vehicle deposition (no accumulation from multiple launches)	Use of municipal water supply and sanitary waste treatment system by non-resident KLC workers in off-site lodging	None identified	Evaluate East Twin Lake further to verify capacity before using as water source; perform post-launch water quality monitoring; Natural Resources Management Plan
Geology and Soils				
Construction	Soil erosion minimal during construction	None identified	None identified	Facilities would not be located on slopes (minimizes erosion potential); use construction-phase erosion control measures; revegetate post-construction
Operation	Launch vehicle deposition (no accumulation from multiple launches)	None identified	None identified	Perform post-launch soil chemistry monitoring; Natural Resources Management Plan

Table 4.13-1. (continued).

	Cumulative Impacts[a]			
	Proposed Action (KLC)		Incremental Impacts From	
Category	Direct Impacts[b]	Indirect Impacts[c]	Other Actions	Mitigative Measures[d]
Noise				
Construction	Construction equipment and vehicle noise	Noise from traffic on access roads (Kodiak Island Highway and Pasagshak Point Road)	Noise from logging traffic on Kodiak Island Highway	None identified
Operation	Diesel generator operation and launch noise	Noise from traffic on access roads (Kodiak Island Highway and Pasagshak Point Road)	Noise from logging traffic on Kodiak Island Highway	Launch pad design and flame duct orientation for maximum noise attenuation before sound reaches sensitive habitats; limit diesel generator operating hours; contact established to receive complaints about noise and submit annual report to OCST
Ecology				
Construction	Loss of 174,000 square meters (43 acres) of habitat which generally is meadow but includes 5,300 square meters (1.3 acres) of wetlands. Loss or displacement of resident wildlife	None identified	None identified	State-wide siting analysis included environmental protection criterion; facility locations onsite chosen to minimize wetland and spruce impacts
Operation	Startle behavior due to launch noise (birds flush, pinnipeds dive). Startle impact to 1 threatened species (Steller sea lion), 1 proposed threatened species (Steller's eider), and one protected species (bald eagle)	None identified	None identified	Flame duct design minimizes vegetation scorching; revegetation using acid-tolerant species if needed; East Twin Lake water intake design to minimize impingement; coordination with natural resource agencies for special status species; Natural Resources Management Plan

Table 4.13-1. (continued).

	Cumulative Impacts[a]			
	Proposed Action (KLC)		Incremental Impacts From	
Category	Direct Impacts[b]	Indirect Impacts[c]	Other Actions	Mitigative Measures[d]
Launch Safety				
Construction	Not applicable	Not applicable	Not applicable	
Operation	Launch risk equals less than 1 in 1 million for public and public property and less that than 1 in 100,000 for KLC personnel	None identified	None identified	State-wide siting analysis included safety as critical criterion; aircraft warning lighting; emergency action and response plan and flight safety program; coordination with Federal and State agencies; notice to air and sea traffic 24 hours before launch; launch day site closure to public; site monitoring 2 hours before launch; personnel located 2 miles from pad during launch
Land Use				
Construction	Substitution of commercial use for grazing on 174,000 square meters (43 acres) of land	None identified	None identified	After closure, site rehabilitation as necessary
Operation	None identified	None identified	None identified	None identified
Socioeconomic				
Construction	Average 30 construction jobs for 18 months	Increased demand for housing	None identified	None identified
Operation	100 workers for 6 weeks before early launches; 40 workers for 4 weeks before later launches	Increased demand for housing; $1.5 to $4.2 million per year to local payrolls	None identified	Impact on commercial fishing minimized through coordination with State agency and local fishing and marine safety organizations
Recreation				
Construction	Elimination of 43 acres from site recreational opportunities	Use of Kodiak Island recreational facilities by non-resident KLC workers	None identified	Rest of site [12 square kilometers (3,057 acres)] available for recreational use
Operation	Restriction of public access to site on launch days; launch noise impacts on Pasagshak State Recreation Area; creation of recreational opportunity (launch watching)	Use of Kodiak Island recreational facilities by non-resident KLC workers	None identified	12 square kilometers (3,057 acres) available for recreational use except for launch days (maximum 9 per year); Natural Resources Management Plan

Table 4.13-1. (continued).

	Cumulative Impacts[a]			
	Proposed Action (KLC)		Incremental Impacts From	
Category	Direct Impacts[b]	Indirect Impacts[c]	Other Actions	Mitigative Measures[d]
Visual				
Construction	4 large buildings, one 52 meters (170 feet) in height; short stretch of additional above-ground utility line	None identified	None identified	Structure color (blue-gray) chosen to blend into background from distance; most utility lines underground
Operation	None identified	None identified	None identified	None identified
Cultural				
Construction	None identified	None identified	None identified	
Operation	None identified	Potential for increased looting (because more people attracted to site)	None identified	Past and present Native American representation on AADC Board and KLC Advisory Committee; coordinate with State Historic Preservation Officer; Natural Resources Management Plan
Hazardous Materials and Waste				
Construction	Use of common construction hazardous materials; small quantity hazardous waste generator (e.g., batteries, cleaning supplies, paint supplies)	None identified	Kodiak Island Borough municipal landfill is expected to reach capacity sometime after 1998, and the Borough is planning expansion. Proposed KLC operation would increase filling rate; if disposal capacity becomes unavailable, AADC would transport solid waste to the mainland for treatment or disposal (hazardous waste will go to mainland because Kodiak Island has no treatment or disposal capacity)	Spill Prevention, Control, and Countermeasure Plan
Operation	Solid rocket fuel, small quantities [approximately 380 liters (100 gallons)] liquid rocket fuel (hydrazine); office waste; small quantity hazardous waste generator (e.g., batteries, waste cleaning supplies)	None identified		Spill Prevention, Control, and Countermeasure Plan, safety procedures, emergency response plan; use of approved transportation containers; design of fuel handling equipment, on-site spill response equipment on hand

a. Cumulative impact is the impact on the environment which results from the incremental impact of the proposed action when added to other past, present, and reasonably foreseeable future actions regardless of what agency (Federal or non-Federal) or person undertakes such other actions (40 CFR 1508.7).

b. An impact is direct if it is caused by the proposed action and occurs at the same time and place [40 CFR 1508.8(a)].

c. An impact is indirect if it is caused by the proposed action but occurs at a later time or farther removed in distance [40 CFR 1508.8(b)].

d. If monitoring detects significant impacts, AADC would take action, if possible, to avoid or eliminate further similar impacts.

CHAPTER 5. MITIGATION

This chapter summarizes mitigative measures that Alaska Aerospace Development Corporation (AADC) would take to reduce or offset the potential environmental consequences of construction and operational activities. Mitigation measures described in the following sections include administrative or management controls and engineered systems that are required by environmental regulations and implemented through operating procedures. Further mitigation would be conducted in consultation with Federal and State agencies on an as needed basis.

5.1 Air Resources

Construction of the proposed Kodiak Launch Complex (KLC) facilities would require the operation of a temporary cement batching plant. Mitigation measures to minimize fugitive dust generated during concrete batching would include particulate control techniques such as enclosure of conveyors and elevators, filters on storage bin vents, and the use of water sprays. The need for fugitive dust control on roads is not anticipated due to the frequency of rainfall (average 15 days per month) and use of the on-site borrow pit would reduce the number of trips offsite for fill material (mitigating fugitive dust generation). Paving site roads would eliminate the source of fugitive dust during operation. Operation of the diesel generators and associated emissions would be limited to 250 hours per year or less.

5.2 Water Resources

5.2.1 SURFACE WATER

AADC would develop and implement a construction phase Stormwater Pollution Prevention Plan. This plan would describe erosion, sediment, and stormwater management controls to be used and best management practices to be used to minimize pollutant discharges via stormwater and to minimize sediment loading to nearby surface waters. These techniques would include the use of mesh erosion protection on slopes and the use of silt fences at the toe of cut and fill slopes adjacent to wetlands to minimize impacts to streams and wetlands during both facility construction and Pasagshak Point Road upgrades. In addition, cut and fill techniques would be employed to increase the width and reduce slope angles to minimize soil erosion and resulting turbidity in adjacent surface waters.

Water would be withdrawn from East Twin Lake for fire protection, personnel deluge purposes, and potable water. A maximum of 28,400 liters (7,500 gallons) of water per day would be pumped from East Twin Lake. This planned withdrawal [61 liters per minute (16 gallons per minute) for 8 hours per day] is very small compared to the average recharge rate [870 liters per minute (230 gallons per minute) as calculated in Section 3.2] and the capacity of East Twin Lake [more than 57 million liters (15 million gallons)]. However, further evaluation of the reservoir capacity of East Twin Lake would be performed prior to its use during the construction period to ensure it has adequate reservoir capacity. During operations, AADC would perform post-launch water quality monitoring.

5.2.2 GROUNDWATER

The use of groundwater for potable and fire protection purposes has been proposed for operations at KLC. However, an evaluation of the groundwater supply including groundwater capacity and recharge capability and groundwater quality analyses would be performed before using it for these purposes.

5.3 Geology and Soil Resources

Construction activities would disturb 174,000 square meters (43 acres) of soil and vegetation. Facility locations onsite were chosen to minimize construction on slopes (minimizing erosion potential). A mitigation plan involving revegetation and erosion control would be implemented during construction activities to protect soil resources from erosion. Areas disturbed by construction would be revegetated by native plants, and the removed topsoil would be stockpiled and used in subsequent landscaping efforts to restore areas impacted by construction.

Examples of soil erosion control measures that would be applied as necessary during construction activities include:

- Site preparation - Preservation and protection of vegetation, topsoil preservation, temporary gravel construction entrance and exit, and dust control

- Surface stabilization - Temporary and permanent seeding and use of mulches and fabric and gravel blankets

- Runoff control and conveyance measures - Installation of diversions, dikes, grassed waterways, and temporary slope drains

- Sediment barriers - Straw bale barrier, sediment fences, and rock barriers

- Sediment traps and basins

- Stream protection - temporary stream crossings and streambank stabilization

- Protection of soil and fill storage piles

Facility foundations have been designed to resist maximum seismic loads and overturning moments induced by wind loads. In an effort to further stabilize the proposed structures of KLC, peat deposits and wet soils would be removed to a depth of at least approximately 1.2 meters (48 inches) and would be replaced with suitable fill material. This technique would prevent differential settling and frost heaving of the proposed structures and roadways.

Although significant changes in soil chemistry are not anticipated to result from launch exhaust product deposition, AADC would perform post-launch monitoring.

5.4 Noise

Substantial noise levels would be generated with each launch. The flame duct and orientation of the launch pad have been designed for the maximum noise attenuation to occur before reaching habitat areas of species of concern.

Mitigation measures would be required to protect workers at the launch facility during construction and operation of the proposed KLC. Although predicted noise levels during construction are below OSHA noise limits, construction workers would be required to wear hearing protection. During launch operations, workers would be removed from the immediate launch area to the Launch Control and Management Center, approximately 3.2 kilometers (2 miles) away.

In the event that noise generated during operation of the proposed KLC is disruptive to activities in the area, a designated point of contact would be in place to receive complaints regarding noise. Each complaint would be recorded and would be compiled into an annual report submitted to OCST.

5.5 Ecological Resources

The Narrow Cape location for the proposed KLC project was selected following a state-wide site survey. To ensure the protection of the State of Alaska's protected ecological resources, the alternative site analyses included an environmental component. This component identified the proximity of each potential launch facility's location to Federal, State, and local parks and wilderness areas. Mitigation measures that would be taken by AADC to protect the ecological resources of the proposed KLC and surrounding area are discussed in the following sections.

5.5.1 TERRESTRIAL BIOTA

Facilities have been sited in flat open areas atop ridges to minimize loss of Sitka spruce and to minimize impacts to wetland habitat areas. Land clearing in conjunction with facility construction would be carefully planned and conducted according to best management practices to minimize soil erosion and soil loss, and to prevent impacts to downgradient wetlands and streams. These affected areas would be revegetated with native plants to restore loss of habitat and would be periodically checked to verify survival.

The launch pad flame duct has been designed and located to minimize scorching of vegetation. In areas where existing plants were to become deteriorated or destroyed by acid deposition, acid-tolerant native plants would be used to re-establish ground cover.

5.5.2 AQUATIC AND SEMI-AQUATIC BIOTA

The East Twin Lake water supply system has been designed to prevent entrainment or impingement of fish at the intake. The raw water intakes in East Twin Lake would be screened [0.6 centimeter (1/4 inch) maximum opening] and buried in a 1.9 to 6.4 centimeters (0.75 to 2.5 inches) gravel berm on the bottom of the Lake. The estimated flow in the intake pipe would be 1.57 feet per second while flow at the face of the gravel bed would be “nil due to the large tributary intake area” (BRPH 1995d). The gravel overlying the intake would both dissipate the velocity of the water entering the intake structure and block fish access to the pipes.

5.5.3 SPECIAL STATUS SPECIES

Although significant impacts to species of concern in the Narrow Cape area are not anticipated, AADC would coordinate with the respective agencies for post-launch monitoring as required.

5.6 Launch Safety

A flight safety program would be implemented to protect the public and participating KLC personnel. Safety practices identified in this program have been established to minimize total public casualty risk, total participating personnel (worker) risk, and probability of hitting an aircraft. Preparatory to launch, AADC would minimize risk by (1) 24-hour notification to aviators and mariners; (2) visual monitoring 2 hours prior to launch; and (3) launch delay if traffic is in area. In addition, AADC would coordinate with the Federal Aviation Administration, U.S. Navy, U.S. Coast Guard, the Alaska Department of Fish and Game, local fishing fleets, boating organizations, and others as required.

The nominal launch design flight path is over the ocean to minimize risk to members of the public from debris hazards. Risk would be evaluated on a launch-specific basis for each mission, and events would be controlled so that risk would remain below 1 in 1,000,000. Impacts resulting from an off-nominal launch would be minimized by the KLC range safety system. Flight termination boundaries would be set taking into account populated areas to minimize risk to the public.

To ensure the safety of launch personnel, all workers would be moved to the Launch Control and Management Center prior to launches. This facility would be located at a distance outside the exclusion area. To ensure the safety of non participants, AADC would designate a ground hazard area specific to each launch. KLC personnel would survey the ground hazard area 20 minutes prior to launch and verify launch clearance. In addition, AADC would coordinate with local government and community groups to arrange for bus transportation to an appropriate area to safely accommodate viewing and reduce transportation impacts.

To reduce the impacts of local accidents, AADC would develop an emergency action and response plan. This plan would identify specific procedures to be used; equipment, materials, and facilities which would be available; and agencies to be notified. Aircraft warning lights would be installed on the structures including the Launch Pad Service Structure to reduce accident risk to local aircraft.

5.7 Land Use

No mitigation measures are anticipated during the construction and operational phases. After closure, land would be returned to the Alaska Division of Land in a condition acceptable to the Director, and AADC would rehabilitate areas as required.

5.8 Socioeconomic Resources

AADC would coordinate launches with the Alaska Department of Fish and Game, as well as local fishing and marine safety organizations, to ensure minimal impact on commercial fishing.

5.9 Recreation

Most of the site [13 square kilometers (3,057 of 3,100 acres)] will remain open for public recreational use except for launch days (maximum 9 days per year).

5.10 Visual

The proposed KLC has been sited in a relatively isolated area. Care during and after construction to return disturbed areas adjacent to structures and access roads to their pre-construction condition would limit visual impacts of structures. The facilities to be constructed are 18 to 24 meters (60 to 80 feet) in height except for the Launch Services Facility, which would stand at approximately 52 meters (170 feet) in height. Due to the relatively flat terrain of the Narrow Cape, this structure would be visible over most of the cape and offshore. The visual impact of the structure would be minimized by painting it a blue gray color to blend with either the sky or mountainous backgrounds when viewed from afar. To further reduce the visual impact to this isolated area, most utilities (electrical, water, and communication lines) would be placed underground.

5.11 Cultural Resources

Native American groups are represented on the AADC Board and the KLC Advisory Committee. The State Historic Preservation Officer (SHPO) has concurred with the finding that construction of the proposed launch facility would not have an impact on cultural resources. Increase in human activity in the area may increase the likelihood of secondary or indirect impacts to the archeological sites and historical facilities located in the vicinity of the proposed construction and identified in Section 3.10. The presence of additional KLC security in the area would deter such acts as direct looting of the sites and would minimize pedestrian activities in the area. In addition, in the unlikely event that new archeological resources are discovered during construction, AADC would work with the SHPO to mitigate impacts in accordance with the KLC Natural Resources Management Plan (Section 5.13).

5.12 Hazardous Materials and Waste Management

Construction and operation of the proposed KLC facilities would involve the use of small quantities of hazardous materials. The threat of accidental and unplanned release of hazardous materials, the amount of hazardous materials generated, and the amount of hazardous material stored would be minimized through management techniques identified in the following KLC plans and procedures: KLC Spill

Prevention, Control, and Countermeasure Plan; KLC Safety Procedures; KLC Emergency Response Plan; and the Site Spill Response Plan.

5.13 Natural Resources Management Plan

AADC would develop a Natural Resources Management Plan (NRMP) for the proposed KLC operations to establish sound land management practices and ensure that responsible stewardship is practiced. The NRMP would contain the following components:

- Soils and water management (e.g., erosion and sediment control)
- Air management (e.g., fugitive dust control)
- Cultural and archaeological resources management (e.g., protection of existing cultural resources sites)
- Outdoor recreation (e.g., bird watching and nature study)
- Road management (e.g., grading and resurfacing roads to minimize erosion)
- Vegetation management (e.g., establishment of ground cover in disturbed areas)
- Monitoring and mitigation activities in consultation with Federal and State resource management agencies, such as U.S. Army Corps of Engineers, National Marine Fisheries Service, U.S. Fish and Wildlife Service, Alaska Department of Environmental Conservation, and Alaska Department of Fish and Game (e.g., post-launch water quality monitoring)

The NRMP would provide specifics on each of these program areas including program goals, responsible parties, and specific commitments made to resource management agencies. If monitoring detects adverse impacts greater than those identified in this EA, AADC would take action, if possible, to avoid or eliminate further similar impacts.

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This list presents the individuals who contributed to the technical content of this environmental assessment. The preparation of the environmental assessment was directed by David Sadlowski of Alaska Aerospace Development Corporation and Dan Evans and Jon Cudworth of Brown & Root Environmental. The environmental assessment was prepared by the Brown & Root Publications Department and coordinated by Susan Dier and Priscilla Godbee.

Some of the individuals listed below prepared specific sections in accordance with their technical qualifications. Other technical experts provided input to those sections through in-depth review and data verification. Still others provided overall technical or management reviews for their respective disciplines.

NAME:	**MARTIN J. BARRACK**
AFFILIATION:	Special Counsel, Partnow Sharrock & Tindall
EDUCATION:	• J.D., UCLA School of Law, 1988 • B.S., Industrial and Labor Relations, Cornell University, 1983
TECHNICAL EXPERIENCE:	Eight years of experience concentrating on the legal issues and policy issues of space transportation.
EA RESPONSIBILITY:	Prepared initial draft.

NAME:	**JOHN B. BLAND**
AFFILIATION:	Brown & Root Environmental
EDUCATION:	• M.A., Economics, University of South Carolina, 1982 • B.S., Mathematics, Wake Forest University, 1970
TECHNICAL EXPERIENCE:	Twelve years experience in environmental and emergency management and planning including emergency exercise development, control, and evaluation.
EA RESPONSIBILITY:	Prepared land use, recreation, and visual resources sections in Chapters 3 and 4.

NAME:	**SHARON D. W. BODDIE**
AFFILIATION:	U.S. Department of Transportation Federal Aviation Administration/Office of the Associate Administrator for Commercial Space Transportation (AST-200)

EDUCATION:	• B.S., Chemical Engineering, Howard University, 1984
TECHNICAL EXPERIENCE:	Seven years systems engineering experience and seven years experience with commercial space regulatory issues including launch and launch site safety, environmental, licensing, and inspections.
EA RESPONSIBILITY:	Former FAA Project Manager.

NAME:	**BRUCE H. BRADFORD, Ph.D.**
AFFILIATION:	Brown & Root Environmental
EDUCATION:	• Ph.D., Civil Engineering, Colorado State University, 1974 • M.S., Civil Engineering, University of Missouri at Rolla, 1966 • B.S., Civil Engineering, University of Missouri at Rolla, 1965
TECHNICAL EXPERIENCE:	Twenty-nine years experience in civil engineering, specializing in hydrology, hydraulics, and water resources. As Principal Investigator of the SRS Waste Management EIS, managed all facets of the National Environmental Policy Act process from scoping through distribution of the Final EIS.
EA RESPONSIBILITY:	Assisted in preparation of soil and water sections of Chapters 3 and 4.

NAME:	**JULEA F. BRADLEY**
AFFILIATION:	Brown & Root Environmental
EDUCATION:	• M.S., Environmental Science, University of South Carolina, 1996 • B.S., Biology, Georgia Southern University, 1987
TECHNICAL EXPERIENCE:	Six years experience in environmental studies, laboratory programs, data validation programs, and technical and copy editing.
EA RESPONSIBILITY:	Prepared biological resources sections and Chapter 5.

NAME: **STEVEN J. CONNOR**

AFFILIATION: Brown & Root Environmental

EDUCATION:
- M.S., Physics, Georgia Institute of Technology, 1974
- B.S., Physics, Georgia Institute of Technology, 1973

TECHNICAL EXPERIENCE: Twenty-one years of experience in scientific, engineering, and educational disciplines, including environmental impact analyses for RCRA, CERCLA, and NEPA documents.

EA RESPONSIBILITY: Prepared noise sections.

NAME: **WILLIAM J. CRAIG**

AFFILIATION: Brown & Root Environmental

EDUCATION:
- M.S., Planning, University of Tennessee, 1977
- B.S., Forestry, University of Tennessee, 1972

TECHNICAL EXPERIENCE: Seventeen years experience in environmental project management, nuclear fuel planning and analyses, natural resource management, and nuclear powerplant siting and relicensing.

EA RESPONSIBILITY: Assisted in preparation of land use, recreation, and visual resources sections in Chapters 3 and 4.

NAME: **JON A. CUDWORTH, J.D.**

AFFILIATION: Brown & Root Environmental

EDUCATION:
- J.D., Cooley Law School, 1982
- M.S., Resource Development, Michigan State University, 1978
- B.S., Resource Development, Michigan State University, 1973

TECHNICAL EXPERIENCE: Sixteen years experience in environmental project management and regulatory compliance.

EA RESPONSIBILITY: Project Management, prepared Chapters 1 and 2.

NAME: **ROBERT T. EDGAR, Ph.D.**

AFFILIATION: Brown & Root Environmental

EDUCATION:
- Ph.D., Environmental Science, University of Texas at Dallas, 1987
- M.S., Environmental Science, University of Texas at Dallas, 1977

- B.S., Meteorology, New York University, 1971
- B.S., Mathematics, University of North Texas, 1969

TECHNICAL EXPERIENCE: Sixteen years technical and managerial experience in air quality monitoring.

EA RESPONSIBILITY: Prepared air resources sections.

NAME: **DANIEL M. EVANS**

AFFILIATION: Brown & Root Environmental

EDUCATION:

- M.S., Planning, University of Tennessee at Knoxville, 1985
- B.A., Political Science, Knox College, 1976

TECHNICAL EXPERIENCE: Seventeen years experience in National Environmental Policy Act project management and impact analysis. Managed the Environmental Impact Statement for the proposed Space Launch Complex 7 at Vandenberg Air Force Base, California; the Defense Acquisition Board Milestone I environmental document for the National Launch System; and Environmental Assessments for a variety of U.S. Air Force space-related projects.

EA RESPONSIBILITY: Project Management.

NAME:	**CAROLE FLORES**
AFFILIATION:	U.S. Department of Transportation Federal Aviation Administration/Office of the Associate Administrator for Commercial Space Transportation (AST-200)
EDUCATION:	• B.A., Physics, Mary Washington College of the University of Virginia, 1969
TECHNICAL EXPERIENCE:	Thirteen years experience with the National Aeronautics and Space Administration (NASA) in launch operations including eight years aerospace engineering and management experience in NASA's Sounding Rocket Program. Almost eight years experience with commercial space regulatory issues, including launch and launch site safety, environmental, licensing, inspections, investigations, and enforcement.
EA RESPONSIBILITY:	Technical reviewer.

NAME:	**LAURA LAFE´ GOULD**
AFFILIATION:	Alaska Aerospace Development Corporation
EDUCATION:	• B.B.A., International Business, University of Alaska Fairbanks, 1992
TECHNICAL EXPERIENCE:	Six years experience in administration, coordination, planning, accounting, budgeting, and public relations.
EA RESPONSIBILITY:	Coordinated State of Alaska permitting effort and assisted in compilation of environmental data.

NAME:	**RONALD K. GRESS**
AFFILIATION:	U.S. Department of Transportation Federal Aviation Administration/Office of the Associate Administrator for Commercial Space Transportation (AST-200)
EDUCATION:	• B.A., Physics, University of California, Berkeley, 1967 • MBA, Operations Research, California State University, 1970
TECHNICAL EXPERIENCE:	Nearly twenty-five years of experience in analysis and risk assessment involving weapon systems, computer systems and federal regulatory issues and requirements. Approximately 10 years of experience in commercial launch and site safety operations, including licensing, inspections, investigations, and enforcement.
EA RESPONSIBILITY:	Technical reviewer.

NAME:	**KRISTINE A. GUNTHER**
AFFILIATION:	Brown & Root Environmental
EDUCATION:	• M.B.A., The University of Alabama, 1992 • B.A., Economics, Rhodes College, 1990
TECHNICAL EXPERIENCE:	Three years experience in conducting socioeconomic studies.
EA RESPONSIBILITY:	Prepared socioeconomics and cultural resources sections.

NAME:	**SARAH MICHELE HARMON**
AFFILIATION:	Brown & Root Environmental
EDUCATION:	• B.S., Biology, University of South Carolina - Aiken, 1987
TECHNICAL EXPERIENCE:	Eight years experience in environmental consulting in the field of toxicology and risk assessment.
EA RESPONSIBILITY:	Prepared Executive Summary.

NAME:	**KATHRYN B. HAUER**
AFFILIATION:	Brown & Root Environmental
EDUCATION:	• M.A., English, College of William and Mary, 1985 • B.A., English, College of William and Mary, 1983
TECHNICAL EXPERIENCE:	Eight years experience in technical writing, editing, and teaching in both government and business disciplines.
EA RESPONSIBILITY:	Editor.

NAME:	**G. NIKOS HIMARAS**
AFFILIATION:	U.S. Department of Transportation Federal Aviation Administration/Office of the Associate Administrator for Commercial Space Transportation (AST-200)
EDUCATION:	• B.S., Aerospace Engineering, Polytechnic University of New York, 1979 • M.S., Aeronautics and Astronautics, Polytechnic University of New York, 1980
TECHNICAL EXPERIENCE:	Fourteen years experience in systems engineering and management with five years experience with commercial space regulatory issues, including launch and launch site safety, environmental, licensing, and inspections.
EA RESPONSIBILITY:	FAA Project Manager and technical reviewer.

NAME:	**DR. ANN HOOKER**
AFFILIATION:	U.S. Department of Transportation Federal Aviation Administration/Office of the Associate Administrator for Environment and Energy (AEE-300)
EDUCATION:	• B.A., Geology, Colorado College, 1972 · M.S., (joint geography and education), University of Oregon, 1974 · M.S., Forest Science, Yale, 1981 · Doctor of Forestry and Environmental Studies, Yale, 1992 · J.D., (natural resources program), University of New Mexico, 1992
TECHNICAL EXPERIENCE:	Over 20 years of environmental research, policy analysis, and education.
EA RESPONSIBILITY:	Technical reviewer.

NAME:	**E. JONATHAN JACKSON**
AFFILIATION:	Brown & Root Environmental
EDUCATION:	• M.S., Soil Science, University of Wisconsin-Madison, 1987 • B.S., Molecular Biology, University of Wisconsin-Madison, 1981
TECHNICAL EXPERIENCE:	Twelve years environmental experience including 8 years hazardous materials management and regulatory compliance.
EA RESPONSIBILITY:	Prepared water quality, soils, and hazardous materials sections.

NAME:	**PAT LADNER**
AFFILIATION:	Alaska Aerospace Development Corporation
EDUCATION:	• M.P.A., Public Administration, Golden Gate University, 1974 • B.S., Industrial Management and Technology, University of Southern Mississippi, 1969
TECHNICAL EXPERIENCE:	Twenty-four years of management experience in all phases of corporate and DOD program management. Extensive background in the DOD budget process, systems acquisition, weapons system deployment, test and training ranges, systems engineering, electronic warfare, threat systems, cruise missile acquisition and deployment, space launch programs, and spaceport development.
EA RESPONSIBILITY:	Management Reviewer.

NAME:	**CAMILLE H. MITTELHOLTZ**
AFFILIATION:	U.S. Department of Transportation/Office of the Environment, Energy and Safety, Environmental Division (P-14)
EDUCATION:	• B.A., Political Science, Vassar College, 1968 • Graduate work in Urban Affairs, Virginia Polytechnic Institute
TECHNICAL EXPERIENCE:	Two years experience preparing environmental documentation for the Federal Aviation Administration and twenty years experience reviewing environmental impact statements and developing transportation and environmental policy.
EA RESPONSIBILITY:	Technical reviewer.

NAME:	**PHILIP R. MOORE**
AFFILIATION:	Brown & Root Environmental
EDUCATION:	• M.S., Wildlife & Fisheries Biology, Clemson University, 1983 • Post-baccalaureate study, Zoology, Clemson University, 1977-1979 • B.A., English, University of South Carolina, 1975
TECHNICAL EXPERIENCE:	More than 14 years experience in environmental impact assessment of hydroelectric, fossil, and nuclear powerplants and DOE/DOD facilities.
EA RESPONSIBILITY:	Prepared biological resources sections.

NAME:	**KAREN K. PATTERSON**
AFFILIATION:	Brown & Root Environmental
EDUCATION:	• M.A., Biology, Wake Forest University, 1977 • B.A., Biology, Randolph-Macon Woman's College, 1973
TECHNICAL EXPERIENCE:	Twenty-one years in technical and management roles in multidisciplinary environmental programs.
EA RESPONSIBILITY:	Prepared Chapters 6 and 8.

NAME:	**DAVID SADLOWSKI**
AFFILIATION:	Alaska Aerospace Development Corporation
EDUCATION:	• M.S., Business Organizational Management, University of LaVerne, 1990 • B.S., Human Resource Management, New School for Social Research, 1978
TECHNICAL EXPERIENCE:	Twenty-eight years of progressively responsible management positions beginning with directing highly technical maintenance efforts through the implementation of complex projects, management methods, development, acquisition, and logistics programs. Also provided leadership for the implementation of budgets, marketing strategies, purchasing plans, designs, manufacturing, and contracts.
EA RESPONSIBILITY:	Directed and assisted in development of entire document; reviewed document and ensured consistency of information contained within; coordinated Federal, state, and local agency involvement.

NAME:	**PHILIP L. YOUNG**
AFFILIATION:	Brown & Root Environmental
EDUCATION:	• M.S., Health Physics, Georgia Institute of Technology, 1989 • B.S., Radiation Health (Health Physics), Oregon State University, 1988
TECHNICAL EXPERIENCE:	More than seven years in safety and health and environmental assessment with emphasis on protection of workers and the public.
EA RESPONSIBILITY:	Prepared launch safety section.

CHAPTER 8. LIST OF AGENCIES CONTACTED

This chapter contains a general list of Federal, State, and other agencies that were consulted or referenced in this environmental assessment. Table 8.1-1 lists the agency, the type of consultation, the date, and describes the topics discussed.

Federal Agencies

Kodiak National Wildlife Refuge
U.S. Department of Interior

Maintenance and Logistics
Command Pacific
U.S. Coast Guard
U.S. Department of Transportation

National Marine Fisheries Service
National Oceanic and Atmospheric
Administration
U.S. Department of Commerce

U.S. Fish and Wildlife Service
U.S. Department of Interior

State of Alaska, Statewide Offices and State Agencies

Air Quality Maintenance
Division of Air and Water Quality
Department of Environmental Conservation

Alaska Natural Heritage Program
Environmental and Natural Resources Institute
University of Alaska

Alaska State Parks
Department of Natural Resources

Division of Governmental Coordination
Office of the Governor

Division of Subsistence
Department of Fish and Game

Habitat Division
Department of Fish and Game

State of Alaska (continued)

Office of History and Archaeology
Division of Parks and Outdoor Recreation
Department of Natural Resources

Solid Waste Program
Division of Environmental Health
Department of Environmental Conservation

State Historic Preservation Officer
Division of Parks and Outdoor Recreation
Office of History and Archaeology

Local Agencies and Units of Government

Kodiak Field Office
Department of Environmental Conservation

Planning and Zoning Commission
Kodiak Island Borough
City of Seward

Southcentral Regional Office
Division of Land
Department of Natural Resources

Table 8.1-1. Consultations.

Agency	Activity	Date	Description
ADEC	Meeting (Kodiak)	12/9/94	Meeting with Alaska Department of Environmental Conservation
ADEC	Correspondence (letter from J. Frechinone, ADEC, to P. Ladner, AADC)*	9/19/95	Confirmation that a solid waste permit will not be required and guidelines for the temporary storage and transport of solid waste
ADEC	Correspondence (letter from S. Lytle, ADEC, to P. Ladner, AADC)*	9/26/95	Statement that an air quality control permit would not be required prior to construction or operation of the facility
ADEC and DOT	Telephone conversation to B. Rieth from R. Edgar (BRE)	2/29/96	Emergency generators at LORAN Station
ADFG	Correspondence (letter from D. Sadlowski, AADC, to P. J. Probasco, ADFG)*	9/11/95	Request for information on surface vessel traffic that transits or anchors in the waters around Narrow Cape
ADFG	Correspondence (letter from P. J. Probasco, ADFG, to D. Sadlowski, AADC)*	9/26/95	Description of surface vessel traffic and fisheries of the Narrow Cape area
ADNR	Correspondence (letter from P. Ladner, AADC, to J. E. Bittner, ADNR)*	10/3/95	Transmission of an environmental study that includes a cultural resource survey; the letter requests concurrence with the information in the study
ADNR	Correspondence (letter from J. E. Bittner, ADNR, to P. Ladner, AADC)*	10/18/95	Concurrence with the information provided in the environmental study and additional information on archaeological and historical sites in the area of KLC
Alaska Department of Transportation and Public Facilities	Correspondence (letter from R. H. Wilson to P. Ladner, AADC)	2/20/96	Comments on KLC road improvements
Alaska Division of Governmental Coordination	Correspondence (letter from P. Ladner, AADC, to F. E. Heitz, ADGC)*	11/1/95	Submission of AADC's permitting package for KLC
Alaska Divison of Governmental Coordination	Correspondence (letter from F. E. Heitz, ADGC, to D. Sadlowski, AADC)*	11/2/95	Notice that ADGC received permitting package and will begin review
Alaska Division of Governmental Coordination	Correspondence (letter from F. Heitz, ADGC, to D. Sadlowski, AADC)	1/18/96	Final Consistency Determination
Alaska Fire Marshall	Meeting (Anchorage)	12/8/94	Meeting with the state Fire Marshall
Kodiak Island Borough	Meeting (Kodiak)	12/9/94	Meeting with Kodiak Island Borough
Kodiak Island Borough	Correspondence (letter from P. Ladner, AADC, to the Kodiak Island Borough Planning and Zoning Commission)*	9/20/95	Submission of a Conditional Use Permit application for review
Kodiak Island Borough	Correspondence (fax from L. Freed, Kodiak Island Borough, to D. Sadlowski, AADC)*	10/23/95	Report that the Planning and Zoning Commission had granted the conditional use permit request, but a motion had been filed to reconsider

*Copy included in Appendix B.

Table 8.1-1. (continued).

Agency	Activity	Date	Description
Natives of Kodiak, Inc.	Correspondence (letter to T. Knowles, Governor, State of Alaska)	2/96	Support for KLC
NMFS	Correspondence (letter from R. J. Morris, NMFS, to P. Ladner, AADC)*	3/15/94	Response to a request for information on the occurrence of threatened or endangered species in the vicinity of the two alternative sites for the KLC on Kodiak Island
NMFS	Correspondence (fax from T. Pearson, NMFS, to D. Sadlowski, AADC)*	10/10/95	Description of surface vessel traffic and fisheries of the Narrow Cape area
NMFS	Correspondence (letter from D. Sadlowski, AADC, to T. Pearson, NMFS)*	10/10/95	Request for information on surface vessel traffic that transits or anchors in the waters around Narrow Cape
NOAA	Correspondence (letter from B. R. Quisenberry, OCST, to D. Weiting, NOAA)*	3/20/95	Requests participation as a cooperating agency for NEPA activities related to development of KLC
NOAA	Correspondence (letter from B. R. Quisenberry, OCST, to D. Weiting, NOAA)*	6/8/95	Requests a formal Section 7 consultation related to development of KLC
NOAA	Correspondence (letter from R. K. Gress, OCST, to D. Weiting, NOAA)*	7/31/95	Designation of a non-Federal representative from AADC, S. V. Cuccarese, to resolve issues through an informal consultation process.
NOAA	Correspondence (letter from S. Pennoyer, NOAA, to B. R. Quisenberry, OCST)*	10/23/95	Authorization of NMFS as the primary NOAA contact for NEPA activities
U.S. Air Force	Meeting (Kodiak)	8/11-12/94	Accompany U.S. Air Force environmental engineer to KLC
U.S. Army Corps of Engineers	Correspondence (letter from B. R. Quisenberry, OCST, to G. McConnell, COE)*	3/20/95	Requests participation as a cooperating agency for NEPA activities related to development of KLC
U.S. Army Corps of Engineers	Correspondence (letter from R. K. Gress, OCST, to G. McConnell, COE)*	6/8/95	Requests a formal Section 7 consultation related to development of KLC
U.S. Army Corps of Engineers	Correspondence (letter from R. K. Gress, OCST, to G. McConnell, COE)*	7/31/95	Designation of a non-Federal representative from AADC, S. V. Cuccarese, to resolve issues through an informal consultation process.
U.S. Army Corps of Engineers	Facsimile transmission from J. J. Duplantis, COE, to L. Gould, AADC*	11/13/95	Response to USFWS comment regarding need for EIS review
U.S. Coast Guard	Meeting (Kodiak)	3/29/94	Meeting with U.S. Coast Guard to discuss support for KLC activities
U.S. Coast Guard	Correspondence (letter from R. C. Vaca, U.S. Coast Guard, to P. Ladner, AADC)*	6/3/94	Provides operational information on the Narrow Cape Loran station
U.S. Coast Guard	Meeting (Kodiak)	8/24/94	Meeting with U.S. Coast Guard to discuss support for KLC activities

*Copy included in Appendix B.

Table 8.1-1. (continued).

Agency	Activity	Date	Description
U.S. Coast Guard	Meeting (Kodiak)	1/30/95	Meeting with U.S. Coast Guard to discuss development of Coast Guard support for DOD, NASA, and commercial operations at KLC
U.S. Coast Guard	Correspondence (letter from D. Sadlowski, AADC, to Captain E. Thompson, U.S. Coast Guard)*	9/6/95	Request for information on surface vessel traffic which transits or anchors in the waters around Narrow Cape
U.S. Coast Guard	Correspondence (letter from D. Sadlowski, AADC, to R. B. van De Loo, U.S. Coast Guard)*	10/4/95	Provides information related to the effects of KLC operations on the Narrow Cape Loran station
U.S. Coast Guard	Correspondence (letter from R.B. Van De Loo, U.S. Coast Guard, to D. Sadlowski, AADC)	12/4/95	Requirement for securing LORAN signal interference by KLC development and Operation
U.S. Coast Guard	Correspondence (letter from D. Sadlowski, AADC, to R.B. Van De Loo, U.S. Coast Guard)	4/19/96	LORAN signal at Narrow Cape
USFWS	Correspondence (letter from D. McGillivary, USFWS, to P. Ladner, AADC)*	3/31/94	Response to a request for information on endangered and threatened species and critical habitats at Narrow Cape and Cape Chiniak
USFWS	Correspondence (letter from B. R. Quisenberry, OCST, to D. Allen, USFWS)*	3/20/95	Requests participation as a cooperating agency for NEPA activities related to development of KLC
USFWS	Correspondence (letter from B. R. Quisenberry, OCST, to D. Allen, USFWS)*	6/8/95	Requests a formal Section 7 consultation related to development of KLC
USFWS	Correspondence (letter from A. G. Rappaport, NOAA, to B. R. Quisenberry, OCST)*	6/20/95	States that a formal Section 7 consultation is unnecessary if issues can be resolved through informal consultation
USFWS	Correspondence (letter from R. K. Gress, OCST, to D. Allen, USFWS)*	7/31/95	Designation of a non-Federal representative from AADC, S. V. Cuccarese, to resolve issues through an informal consultation process
USFWS	Correspondence (letter from A. G. Rappaport, USFWS, to P. A. Topp, Alaska District COE)*	10/10/95	Request that the Corps not issue a permit to fill wetlands at the KLC until completion of an EIS and a site survey by USFWS
USFWS	Internal Correspondence (Memorandum from V. Mendenhall, USFWS, to V. Moran, USFWS)*	10/13/95	Provides comments with regard to seabird issues covered in the EA submitted by ENRI
USFWS	Meeting (Kodiak)	10/24/95	Visit to proposed KLC site with Federal agency.
USFWS	Meeting (Anchorage)	4/26/96	AADC meeting to discuss USFWS comments on 12/95 Draft EA
Various Federal	Meeting (Washington, D.C.)	7/26-8/7/94	Meeting with NASA, Department of Commerce, DOT, VEDA Corporation, Pentagon, and various members of Congress to discuss a range of issues including government support, equipment requirements, and environmental issues

*Copy included in Appendix B.

Table 8.1-1. (continued).

Agency	Activity	Date	Description
Various Federal	Meeting (Lanham; Washington, D.C.)	9/21-22/94	Meeting with ASA and EOSAT to discuss issues related to design, business, and environment
Various Federal	Meeting (Washington, D.C.)	10/3-7/94	Meeting with the U.S. Air Force, NASA, Senator Murkowski, OMB, OSTP, DOT, GSFC, and the Department of Commerce to discuss design and environmental requirements
Various Federal	Meeting (Washington, D.C.)	12/4-9/94	Meeting with DOT, NASA, and U.S. Air Force to discuss a range of regulatory issues
Various Federal	Conference call	4/9/96	OCST conference call with USFWS, NMFS, and COE to discuss Endangered Species Act Section 7 Consultation requirements for marine mammals
Various state and Federal	Meeting (Anchorage)	12/12/94	Pre-application meeting with the Office of Governmental Coordination, USFWS, Department of Environmental Conservation, NMFS, EPA, COE, and ADFG

AADC = Alaska Aerospace Development Corporation.
ADEC = Alaska Department of Environmental Conservation.
ADFG = Alaska Department of Fish and Game.
ADGC = Alaska Division of Governmental Coordination.
ADNR = Alaska Department of Natural Resources.
ASA = Aerospace States Association.
COE = U.S. Army Corps of Engineers.
DOD = Department of Defense.
DOT = Department of Transportation.
EA = Environmental Assessment.
EIS = Environmental Impact Statement.
ENRI = Environment and Natural Resources Institute.
EOSAT = Earth Observation Satellite Company.
EPA = U.S. Environmental Protection Agency.
GSFC = Goddard Space Flight Center.
KLC = Kodiak Launch Complex.
NASA = National Aeronautics and Space Administration.
NEPA = National Environmental Policy Act.
NMFS = National Marine Fisheries Service.
NOAA = National Oceanographic and Atmospheric Administration.
OCST = Office of Commercial Space Transportation.
OMB = Office of Management and Business.
OSTP = Office of Space Transportation Policy.
USFWS = U.S. Fish and Wildlife Service.

APPENDIX A. PUBLIC PARTICIPATION

Appendix A contains tables that list meetings held regarding the siting, construction, and operation of the proposed Kodiak Launch Complex (KLC).

Table A-1 lists the activity, the date, location, the number of people attending, if known, and describes the meeting. From December 1993 through March 1996, the Alaska Aerospace Development Corporation (AADC) has sponsored or participated in 35 events in Kodiak and Chiniak presenting and discussing facts related to the siting, construction, and operation of the proposed KLC. Total attendance by the public has exceeded 600 individuals. Additionally, AADC officials have participated in 2 separate radio call-in shows and responded to 16 callers. Native American participation has included meetings with the Board of the Leisnoi Corporation and representation by a Native American on the AADC Board.

Table A-2 identifies the individuals that comprise the Kodiak Launch Complex Advisory Committee and their affiliation. The Kodiak Launch Complex Advisory Committee is a volunteer group of 19 concerned members of the community representing a broad spectrum of interests on the island including those of the Native Americans. The public participation events that have occurred have been attended by a range of individuals from different ethnic and economic groups. No attempt, however, has been made during meeting registration to categorize individuals.

Table A-1. Public participation.

Activity	Date	Location	Number of Attendees	Description
AADC Board of Directors Meeting[a]	7/15/94	Anchorage	13	Meeting to discuss proposed project
AADC Board of Directors Meeting	3/31/94	Kodiak	31	Meeting to discuss proposed project
AADC Board of Directors Meeting	10/25/94	Anchorage	39	Meeting to discuss proposed project
AADC Board of Directors Meeting	2/2/94	Anchorage	27	Meeting to discuss proposed project
AADC Board of Directors Meeting	1/31/95	Anchorage	14	Meeting to discuss proposed project
AADC Board of Directors Meeting	3/28/95	Anchorage	31	Meeting to discuss proposed project
AADC Board of Directors Meeting	6/22/95	Anchorage	17	Meeting to discuss proposed project
AADC Board of Directors Meeting	9/26/95	Anchorage	11	Meeting to discuss proposed project
Alaska Congressional Delegation Visit	8/18/95	Kodiak	NA	Community presentation to elected officials and Kodiak community
Audubon Society Meeting	10/27/94	Kodiak	21	Attend meeting to discuss proposed project
Chamber of Commerce Meeting	3/31/94	Kodiak	70	Attend meeting to discuss proposed project
Chamber of Commerce-hosted Meeting	4/30/96	Kodiak	200	Meeting to receive public comments on 12/95 Draft EA
Community Meetings	9/2-4/94	Kodiak	NA	Various community question and answer session
Community Forum	3/29/94	Kodiak High School Auditorium	15	Community question and answer session
Community Forum	10/26/94	Kodiak High School Auditorium	38	Community question and answer session
Community Meeting	3/30/94	Kodiak	52	Community question and answer session for the Chiniak community
Foreign Trade Zone Meeting	10/5/95	Kodiak	NA	Public Hearing
Kodiak Island Borough Assembly Meeting	1/18/96	Kodiak	NA	Question & answer session
Kodiak Island Borough Conditional Use Meeting	10/11/95	Kodiak	NA	Work Session
Kodiak Island Borough Planning and Zoning Committee Meeting	10/18/95	Kodiak	NA	Public Hearing
Kodiak Island Borough Planning and Zoning Committee Meeting	11/15/95	Kodiak	NA	Public Hearing
Kodiak Launch Complex Advisory Committee Meeting[b]	10/27/94	Kodiak	15	Attend meeting to discuss proposed project
Kodiak Launch Complex Advisory Committee Meeting	12/12/94	Kodiak	12	Meeting to discuss proposed project
Kodiak Launch Complex Advisory Committee Meeting	1/30/95	Kodiak	13	Attend meeting to discuss proposed project
Kodiak Launch Complex Advisory Committee Meeting	1/16/96	Kodiak	NA	Discuss proposed project
Kodiak Lions Club	10/26/94	Kodiak	22	Attend meeting to discuss proposed project
Leisnoi Board Meeting	1/13-14/94	Kodiak	6	Attend meeting to discuss proposed project
Leisnoi Board Meeting	12/16-17/93	Kodiak	8	Site survey; attend meeting to discuss proposed project
Lions Club Meeting	3/30/94	Kodiak	28	Attend meeting to discuss proposed project
Radio Appearance on KMXT	3/30/94	Kodiak	9 calls	Community question and answer session

Table A-1. (continued).

Activity	Date	Location	Number of Attendees	Description
Radio Appearance on KVOK/KJJZ	3/29/94	Kodiak	7 calls	Community question and answer session
Rotary Club Meeting	3/29/94	Kodiak	30	Attend meeting to discuss proposed project
Rotary Club Meeting	10/26/94	Kodiak	31	Attend meeting to discuss proposed project
Rotary Club Meeting	3/30/94	Kodiak	26	Attend meeting to discuss proposed project
School Presentation	3/31/94	Kodiak	150	Presentation to Kodiak Borough schools

a. AADC Board of Directors meetings require 15 day public notice and are open to the public.
b. The Kodiak Launch Complex Advisory Committee is a volunteer group of 19 concerned members of the community representing a broad spectrum of interests on the island.
NA - Not available.

Table A-2. Kodiak Launch Complex Advisory Committee.

Name	Affiliation
Carolyn Floyd	City of Kodiak
Nancy Freeman	Kodiak Daily Mirror
Linda Freed	Kodiak Island Borough
Michael Machulsky	Buskin River Inn
Betty Odell	Chiniak Community
Bob Pfutzenreuter	Audubon Society
Jerome Selby	Kodiak Island Borough
Cliff Stone	State Legislature and VFW
Wayne Stevens	Kodiak Chamber of Commerce
Stacy Studebaker	Kodiak High School
Frank Townsend	KVOK-KJIZ
Howard Valley	Afognak Joint Venture
Mike Waller	Leisnoi, Inc.
Betty Walters	Kodiak Island School District
Dave Woodruff	Fisheries
Tony Drabek	Natives of Kodiak
Gloria Bishop	Kodiak Area Native Association
Tavis Davidson	Student, Kodiak High School
Kristin Stahl-Johnson	Kodiak Conservation Network

APPENDIX B. CONSULTATIONS

Appendix B contains consultation letters between the Alaska Aerospace Development and federal, state, and other agencies and organizations.

This Section has been omitted because it is not available in electronic format.

APPENDIX C. VEGETATION INVENTORY AND MAPPING

Twenty-three vegetated and nonvegetated habitat types were identified on the proposed Kodiak Launch Complex site (ENRI 1995a). These habitat types are mapped in Figure C-1 and described in the following sections.

C.1 NONWETLAND VEGETATION HABITAT TYPES

C.1.1 CLOSED (GREATER THAN 60 PERCENT COVER) SITKA SPRUCE FOREST

Large tracts of closed Sitka spruce (*Picea sitchensis*) forest are common in the southeastern portion of the study area. Small, circular stands have sporadically invaded the drier meadows throughout the area. Surrounding hairgrass-mixed forb meadow species such as *Deschampsia beringensis*, *Deschampsia caespitosa*, *Salix barclayi*, *Geranium erianthum*, and *Solidago lepida* occupy the understory, especially near the edges of stands. Where the canopy cover exceeds 80 percent, *Cerastium* sp. or feathermosses such as *Hylocomium splendens* and *Pleurozium schreberi* cover the forest floor.

C.1.2 OPEN (25 - 59 PERCENT COVER) SITKA SPRUCE FOREST

Open Sitka spruce forest has a canopy cover of 25 to 59 percent and occupies sites surrounding closed Sitka spruce forest. It generally represents a Sitka spruce woodland where surrounding hairgrass-mixed forb meadows are continuous through the understory.

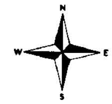
C.1.3 CLOSED (GREATER THAN 75 PERCENT COVER) ALDER SHRUBLAND

Closed alder (*Alnus sinuata*) shrublands occupy well-drained, upland areas surrounded by closed mixed alder-willow shrublands and hairgrass-mixed forb meadows. They are also prevalent in draws and on the sides of steep, north-facing drainageways. This shrubland is particularly common in the southwestern portion of the study area. Closed alder shrubland is characterized by a dense understory of *Rubus spectabilis*, *Sambucus racemosa*, and *Aplopanax horridus*. Associated species include *Epilobium angustifolium*, *Calamagrostis canadensis*, *Heracleum lanatum*, *Dryopteris* spp., *Boschniakia rossica*, and *Geum macrophyllum*.

Source: ENRI (1995b).

4A43-5

Figure C-1. Major vegetation types in the vicinity of the proposed KLC site.



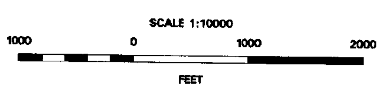
LEGEND:

1....Closed Sitka Spruce Forest
2....Open Sitka Spruce Forest
3....Closed Alder Shrubland
4....Closed Mixed Alder/Willow Shrubland
5....Low Shrub-Forb Meadow
6....Open Willow-Hairgrass-Mixed Forb Meadow
7....Mixed Dwarf Shrub-Graminoid Meadow
8....Hairgrass-Mixed Forb Meadow
9....Lupine Meadow
10.. Disturbed
101..Permanently flooded bodies of water
102..Permanently flooded waterbodies with rooted vascular aquatic vegetation
103..Semipermanently flooded areas, less than 30 percent cover of vegetation
104..Saturated, emergent sedge-forb or sedge-forb-moss meadows
105..Semipermanently flooded emergent sedge marshes
106..Saturated, tall shrub thickets and graminoid-dwarf shrub-moss
107..Saturated, shrub meadows and shrub bogs with semipermanently flooded, emergent sedge
108..Saturated sedge-moss
109..Subtidal, low energy, brackish bodies of open water
110..Brackish marsh and beach vegetation flooded irregularly by tidal water
111..Unvegetated beaches
112..Unvegetated upper beaches and rocky coastlines

Wetland

Existing & Planned Roads

Fluvial Waters



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C.1.4 CLOSED (GREATER THAN 75 PERCENT COVER) MIXED ALDER-WILLOW SHRUBLAND

Closed mixed alder-willow shrubland occupies sites surrounding closed alder shrubland and is transitional to open willow-hairgrass-mixed forb meadows. It is very common in the western portion of the study area and also occupies road margins that have been colonized since roadway establishment. Dominant species are *Alnus sinuata*, *Salix barclayi*, and *Calamagrostis canadensis*. Associated species include: *Epilobium angustifolium*, *Rubus spectabilis*, *Geranium erianthum*, *Deschampsia beringensis*, *Deschampsia caespitosa*, *Lupinus nootkatensis*, *Festuca rubra*, *Solidago lepida*, *Phleum commutatum americanum*, *Rubus stellatus*, *Heracleum lanatum*, *Angelica genuflexa*, *Castilleja unalaschcensis*, and *Athyrium filix-femina*.

C.1.5 LOW SHRUB-FORB MEADOW

A low shrub-forb meadow type occupies a narrow band on the steep, east-facing slopes of the benchland above Twin Lakes. Dominant species are *Rosa nutkana*, *Rubus spectabilis*, and *Deschampsia beringensis*. Associated species include: *Athyrium filix-femina*, *Heracleum lanatum*, *Calamagrostis canadensis*, and clumps of *Salix barclayi*.

C.1.6 OPEN (25 - 74 PERCENT COVER) WILLOW-HAIRGRASS-MIXED FORB MEADOW

Open willow-hairgrass-mixed forb meadow is the second-most common vegetation type of the study area. It is transitional between closed mixed alder-willow shrubland and the hairgrass-mixed forb meadows. Open willow-hairgrass-mixed forb meadow is most common on benchlands away from the coast and on the steep slopes of most drainageways. It is characterized by a hummocky terrain and a patchy mosaic of 0.5 meter-high *Salix barclayi*. Overall species composition is similar to the surrounding hairgrass-mixed forb meadow vegetation type but varies in the amount of willow complimenting the dominant grasses *Deschampsia beringensis* and *Deschampsia caespitosa*. Dominant forbs include *Geranium erianthum*, *Solidago lepida*, *Lupinus nootkatensis*, *Achillea borealis*, and *Sanguisorba stipulata* over a moss understory. Associated species are treated under the hairgrass-mixed forb meadow type.

C.1.7 MIXED DWARF SHRUB-GRAMINOID MEADOW

A mixed dwarf shrub-graminoid meadow occupies steep north-northwesterly slopes of some coastal drainageways. Long, narrow ridges and troughs run parallel to the slope and are predominantly covered by *Cornus suecica*, *Vaccinium uliginosum*, *Empetrum nigrum*, *Deschampsia beringensis*, *Deschampsia caespitosa*, *Carex macrochaeta*, and *Geranium erianthum*. Associated species include *Rubus stellatus*, *Sanguisorba stipulata*, *Achillea broealis*, *Salix barclayi*, *Parnassia palustris*, *Festuca rubra*, *Phleum commutatum americanum*, *Euphrasia mollis*, and *Solidago lepida* over a moss understory.

C.1.8 HAIRGRASS-MIXED FORB MEADOW

Hairgrass-mixed forb meadow is the dominant upland vegetation type of the study area and occupies most benchlands near the coast. It grades into open willow-hairgrass-mixed forb meadow inland and into drainageways and wetlands. This rich association of grasses and forbs is dominated by *Deschampsia beringensis*, *Deschampsia caespitosa*, *Geranium erianthum*, *Lupinus nootkatensis*, *Sanguisorba stipulata*, *Solidago lepida*, *Festuca rubra*, *Achillea borealis*, *Salix barclayi*, *Viola* sp., *Castilleja unalaschcensis*, and occasionally a moss understory. Associated species include, but are not limited to, *Trisetum spicatum*, *Achillea borealis*, *Cornus suecica*, *Luzula multiflora*, *Platanthera dilatata*, *Fritillaria camschatcensis*, *Campanula rotundifolia*, *Phleum commutatum americanum*, *Epilobium angustifolium*, *Calamagrostis canadensis*, *Parnassia palustris*, *Poa* sp., *Hordeum brachyanterum*, and *Iris setosa*.

C.1.9 LUPINE MEADOW

Lupine meadows occupy the more coastal reaches of nonwetlands above the ocean cliffs. Species composition is very similar to adjacent hairgrass-mixed forb meadows; however, lupine meadows are dominated by *Lupinus nootkatensis* and associated forbs rather than *Deschampsia beringensis*. Heavy bison grazing of lupine has altered the cover estimate of forbs and grasses in favor of the latter.

C.1.10 DISTURBED

Disturbed sites in the vicinity of the Loran-C station are generally being colonized by adjacent vegetation types and closed mixed alder-willow shrubland. A large gravel pad at the Loran road junction is largely covered by *Poa* sp. Associated species include *Hordeum brachyantherum*, *Plantago major*, and various moss species.

C.2 WETLAND VEGETATION TYPES

C.2.1 PALUSTRINE SYSTEM

The palustrine system includes wetlands dominated by trees, shrubs, persistent emergents, emergent mosses and lichens that are not influenced by ocean-derived salinity. Wetland types commonly referred to as bogs, muskegs, fens, marshes, and swamps are grouped in the palustrine system. Lakes and ponds less than 20 acres in size are also a part of the palustrine system (USFWS 1988).

C.2.1.1 Permanently flooded bodies of water

Vegetation is generally lacking within the open water area, but aquatic beds or persistent emergents may provide sparse (less than 30 percent) cover along the shoreline.

C.2.1.2 Permanently flooded waterbodies with rooted vascular aquatic vegetation

This vegetation generally occurs in sheltered areas where there is little water movement. West Twin Lake is predominantly covered by *Nuphar polysepalum*. Associated species include *Equisetum fluviatile*, *Eleocharis acicularis*, *Ranunculus reptans*, *Ranunculus trichophyllus*, *Callitriche verna*, *Lysimachia thyrsiflora*, and *Isoetes muricata*.

C.2.1.3 Semipermanently flooded areas, with a sandy substrate and less than 30 percent cover of vegetation

The only plant species recorded was *Equisetum fluviatile*.

C.2.1.4 Saturated emergent meadows

These sedge-forb and sedge-forb-moss wetlands occur on gentle slopes, hillside seep areas and drainageway bottoms. Soils are usually mineral but may be overlain by a shallow organic layer. Dominant species include *Eriophorum angustifolium*, *Eriophorum russeolum*, *Carex lyngbyaei*, *Carex livida*, *Comarum palustre*, *Parnassia palustris*, and *Sphagnum* moss species. Other emergent species of importance are *Menyanthes trifoliata*, *Equisetum fluviatile*, *Potamogeton* sp., *Hippuris vulgaris*, *Ledum decumbens*, *Vaccinium uliginosum*, *Deschampsia beringensis*, *Juncus* sp., *Alnus sinuata*, *Luzula multiflora*, *Epilobium* sp., *Calamagrostis* sp., and *Salix fuscescens*.

C.2.1.5 Semipermanently flooded emergent sedge marshes

These hummocky *Carex saxatilis* marsh areas usually exhibit standing water throughout the growing season but were nearly dry when surveyed. This wetland type occurs in depressions and pools not associated with patterned bogs. Associated species include *Carex kelloggii*, *Poa* sp., *Callitriche verna*, *Deschampsia beringensis,* and *Calamagrostis* sp.

C.2.1.6 Saturated tall shrub thickets and graminoid dwarf shrub moss with 70 percent or greater coverage of broad-leaved deciduous shrubs

These occupy depressional areas on benchlands, gentle slopes, and hillside seep areas. Typical vegetation includes an association of *Alnus sinuata*, *Salix fuscescens*, *Vaccinium uliginosum*, *Vaccinium caespitosum*, *Eriophorum angustifolium*, *Eriophorum russeolum*, *Carex saxatilis*, *Carex livida*, *Rubus stellatus*, *Sanguisorba stipulata*, and a dense, hummocky *Sphagnum* moss understory. Other species include *Salix barclayi*, *Empetrum nigrum*, *Vaccinium vitis-idaea*, *Parnassia palustris*, *Equisetum arvense*, *Achillea borealis*, *Deschampsia beringensis*, *Polemonium acutiflorum*, and *Calamagrostis* sp.

C.2.1.7 Saturated shrub-meadows and shrub bogs

Shrub-meadows and shrub bogs are wetlands dominated by low, broad-leaved deciduous shrubs. The remaining vegetative cover consists of persistent emergents and semipermanently flooded areas. This is a common muskeg-like wetland occurring in basin areas of benchlands, on hillside seeps, and on gently sloping areas in valleys.

C.2.1.8 Saturated sedge-moss

In saturated, bog-type areas, persistent emergents and mosses form a predominantly sedge-moss wetland. A low shrub or dwarf shrub layer is lacking. Hummocky vegetated areas are surrounded by seasonally-flooded depressions. Persistent emergent vegetation includes: *Carex saxatilis*, *Carex livida*, *Eriophorum russeolum*, *Eriophorum angustifolium*, and *Trichophorum caespitosum* over a dense *Sphagnum* moss mat. Associated species are *Rubus stellatus*, *Deschampsia beringensis*, *Parnassia palustris*, *Sanguisorba stipulata*, *Salix fuscescens*, *Equisetum fluviatile*, *Comarum palustre*, *Vaccinium uliginosum*, *Achillea borealis*, and *Alnus sinuata*.

C.2.2 RIVERINE SYSTEM

All rivers and stream channels upstream from the confluence of ocean-derived salinity are included in the riverine system (USFWS 1988). Various-sized streams from 0.3 m to 3 m wide occupy ravines and drainageways in the study area. Streams indicated on the map appear to carry some water throughout the year.

C.2.3 ESTUARINE SYSTEM

The estuarine system is confined to bays, inlets, tidal marshes, and brackish river channels. Estuarine areas exhibit a salinity lower than that found in the marine system. Estuarine coastlines are considered low-energy since they are protected from the full force of wave action of the open ocean (USFWS 1988).

C.2.3.1 Subtidal, low-energy brackish bodies of open water

Subtidal, low-energy brackish waters include the permanently flooded portion of bays, inlets, and adjacent brackish river channels, and small tidal ponds located in high marsh zones which are inundated by high tides.

C.2.3.2 Brackish marsh and beach vegetation flooded irregularly by tidal water

Surface drainage following tidal inundation is generally good in these areas. In the study area, they generally exhibit a drift line above ocean and lagoon beaches. Dominant persistent emergent species include *Carex lyngbyaei*, *Elymus arenarius*, *Triglochin palustris*, *Deschampsia beringensis*, *Potentilla egedii*, *Lathyrus maritimus*, and *Senecio pseudo-Arnica*.

C.2.4 MARINE SYSTEM

The water within these marine areas is characterized by full sea-strength salinity. Shorelines are generally exposed to the full force or impact of waves originating in the open ocean (USFWS 1988).

C.2.4.1 Unvegetated beaches

Intertidal, regularly flooded, unvegetated beaches are exposed to high-energy wave action. The substrate is typically composed of cobble, gravel, or sand-sized particles.

C.2.4.2 Unvegetated upper beaches and rocky coastlines

Marine intertidal, high-energy, unvegetated upper beaches, and rocky coastlines are where tidal water floods the substrate daily or less often than daily. The area consists of 75 percent or more coverage by bedrock, stones, or boulders. Vegetation cover is less than 30 percent. Most of the type within the study area are precipitous rocky cliffs.

C.3 Literature Cited

ENRI (Environmental and Natural Resources Institute-University of Alaska, Anchorage), 1995a, *Environmental Baseline of Narrow Cape, Kodiak Island, Alaska*, Volume 2 of 3, Final Report, Anchorage, Alaska, February.

ENRI (Environmental and Natural Resources Institute-University of Alaska, Anchorage), 1995b, *Environmental Baseline of Narrow Cape, Kodiak Island, Alaska*, Volume 1 of 3, Final Report, Anchorage, Alaska, February.

USFWS (U.S. Fish and Wildlife Service), 1988, *National Wetlands Inventory*, USFWS Region 7, Anchorage, Alaska.

APPENDIX D. AIR DISPERSION MODELING

Air dispersion modeling for rocket launches at the proposed KLC was performed using EPA's INPUFF model. The INPUFF model is a Gaussian integrated PUFF model that predicts downwind concentrations from non-continuous sources that can be simulated as a series of puffs.

The emissions from the Castor-120ä LMLV 2 are released at nearly a constant rate during a typical launch. The exhaust plume emitted during a launch is divided into two parts. The first part consists of a ground cloud, which is all of the exhaust emitted by the vehicle during the first 200 meters (656 feet) of rise. The second part consists of the exhaust contrail, which is the portion of exhaust emitted during the remainder of the vehicle's ascent. For purposes of estimating ground level concentrations of PM_{10} and HCl, only the lowest 3,000 meters (10,000 feet) of exhaust products are analyzed (SECOR 1995). Exhaust above this elevation has no effect on ground level concentrations.

Emissions from a Castor-120ä LMLV 2 launch, including all emissions emitted up to 3,000 meters (10,000 feet) above ground are as follows:

- HCl	4.3 metric tons (4.7 tons)
- PM_{10}	7.9 metric tons (8.7 tons)

Since emissions from a launch are not stationary and last for less than one minute within the lower layer of the atmosphere, they must be simulated using a semi-instantaneous source PUFF model, as determined by EPA in 1988 for the Space Shuttle Solid Rocket Motor static test firings.

Tables D-1 and D-2 show the INPUFF modeling results of downwind concentrations for PM_{10} and HCl, respectively. In each table, maximum downwind ground-level concentrations are presented for 50 different receptor points at distances varying from 1 kilometer (0.63 miles) (X=1) to 10.8 kilometers (6.8 miles) (X=10.8) from the launch pad. For each receptor point, concentrations were calculated for seven different scenarios of atmospheric stability and wind speed. The column on farthest right lists the maximum concentration found from each of the seven scenarios. For both PM_{10} and HCl, the maximum concentration beyond 1 kilometer (0.63 miles) from the launch pad occurs at a distance of 5 kilometers (3.1 miles) where the ground cloud intersects a mountain range.

Table D-1. Thiokol Castor 120ä - LMLV2; Site: Kodiak, Alaska PM_{10} air quality impact analysis.

				No Terrain Mix ht=500	Terrain Mix ht=500	Terrain Mix ht=500	Terrain Mix ht=550	Terrain Mix ht=1000	Terrain Mix ht=10000	Terrain Mix ht=10000	Maximum
Stability				A	A	A	D	D	E	E	A - E
Wind Speed				1	1	3	1	20	4	3	1 - 20
				24hr	24hr	24hr	24hr	24hr	24hr	24hr	24hr
Recp#	X	Y	Z	ug/m^3	ug/m^3	ug/m^3	ug/m^3	ug/m^3	ug/m^3	ug/m^3	ug/m^3
1	1	0	1	119.9	119.9	29.2	6.3	0.0	0.3	0.4	119.9
2	1.2	0	1	106.4	106.4	27.1	7.8	0.0	0.4	0.4	106.4
3	1.4	0	1	96.0	96.0	24.7	8.4	0.0	0.4	0.4	96.0
4	1.6	0	1	87.5	87.5	22.6	9.1	0.0	0.3	0.4	87.5
5	1.8	0	1	80.5	80.5	20.7	9.8	0.0	0.3	0.4	80.5
6	2	0	1	74.7	74.7	19.1	10.4	0.0	0.3	0.4	74.7
7	2.2	0	1	69.7	69.7	17.8	11.1	0.0	0.3	0.3	69.7
8	2.4	0	1	65.4	65.4	16.7	11.7	0.0	0.3	0.3	65.4
9	2.6	0	1	61.6	61.6	15.7	12.4	0.0	0.3	0.3	61.6
10	2.8	0	1	58.3	58.3	14.8	13.0	0.0	0.3	0.3	58.3
11	3	0	1	55.3	55.3	14.0	15.8	0.0	0.4	0.4	55.3
12	3.2	0	1	52.6	52.6	13.3	16.3	0.0	0.4	0.4	52.6
13	3.4	0	1	50.2	50.2	12.7	16.8	0.0	0.4	0.4	50.2
14	3.6	0	1	48.1	48.1	12.2	17.3	0.0	0.3	0.4	48.1
15	3.8	0	1	46.1	46.1	11.7	17.7	0.0	0.3	0.4	46.1
16	4	0	1	44.3	44.3	11.2	60.8	0.0	4.8	4.6	60.8
17	4.2	0	1	42.6	42.6	10.8	58.9	0.0	4.7	4.5	58.9
18	4.4	0	1	41.1	41.1	10.4	57.1	0.0	4.6	4.4	57.1
19	4.6	0	1	39.7	39.7	10.0	55.3	0.0	4.5	4.3	55.3
20	4.8	0	1	38.4	38.4	9.7	53.7	0.0	4.4	4.2	53.7
21	5	0	1	37.1	114.1	9.4	146.4	1.5	29.8	32.7	146.4
22	5.2	0	1	36.0	110.0	9.1	140.8	1.5	29.2	32.0	140.8
23	5.4	0	1	34.9	106.1	8.8	135.6	1.5	28.5	31.3	135.6
24	5.6	0	1	33.9	102.6	8.5	130.7	1.5	27.9	30.6	130.7
25	5.8	0	1	33.0	99.3	8.3	126.2	1.5	27.3	30.0	126.2
26	6	0	1	32.1	55.1	8.1	86.1	1.0	23.4	24.2	86.1
27	6.2	0	1	31.3	53.8	7.9	83.4	1.0	22.9	23.8	83.4
28	6.4	0	1	30.5	52.7	7.7	80.9	1.0	22.4	23.3	80.9
29	6.6	0	1	29.7	51.5	7.5	78.5	1.0	22.0	22.9	78.5

Table D-1. (continued).

				No Terrain Mix ht=500	Terrain Mix ht=500	Terrain Mix ht=500	Terrain Mix ht=550	Terrain Mix ht=1000	Terrain Mix ht=10000	Terrain Mix ht=10000	Maximum
				A	A	A	D	D	E	E	A - E
Stability				1	1	3	1	20	4	3	1 - 20
Wind Speed				24hr	24hr	24hr	24hr	24hr	24hr	24hr	24hr
Recp#	X	Y	Z	ug/m^3	ug/m^3	ug/m^3	ug/m^3	ug/m^3	ug/m^3	ug/m^3	ug/m^3
30	6.8	0	1	29.0	50.5	7.3	76.2	1.0	21.6	22.4	76.2
31	7	0	1	28.4	70.2	7.1	93.1	1.2	22.9	24.5	93.1
32	7.2	0	1	27.7	68.4	7.0	90.4	1.2	22.5	24.1	90.4
33	7.4	0	1	27.1	66.8	6.8	87.8	1.2	22.1	23.6	87.8
34	7.6	0	1	26.5	65.1	6.7	85.3	1.2	21.7	23.2	85.3
35	7.8	0	1	26.0	63.6	6.5	82.9	1.2	21.3	22.9	82.9
36	8	0	1	25.4	62.1	6.4	80.7	1.2	20.9	22.5	80.7
37	8.2	0	1	24.9	60.8	6.3	78.5	1.2	20.6	22.1	78.5
38	8.4	0	1	24.4	59.4	6.1	76.5	1.2	20.3	21.8	76.5
39	8.6	0	1	24.0	58.1	6.0	74.5	1.2	19.9	21.4	74.5
40	8.8	0	1	23.5	56.9	5.9	72.6	1.1	19.6	21.1	72.6
41	9	0	1	23.1	55.8	5.8	70.9	1.1	19.3	20.8	70.9
42	9.2	0	1	22.7	54.6	5.7	69.2	1.1	19.0	20.5	69.2
43	9.4	0	1	22.3	53.6	5.6	67.5	1.1	18.7	20.2	67.5
44	9.6	0	1	21.9	52.5	5.5	66.0	1.1	18.5	19.9	66.0
45	9.8	0	1	21.5	51.5	5.4	64.5	1.1	18.2	19.6	64.5
46	10	0	1	21.1	50.6	5.3	63.0	1.1	17.9	19.4	63.0
47	10.2	0	1	20.8	49.7	5.2	61.6	1.1	17.7	19.1	61.6
48	10.4	0	1	20.5	48.8	5.2	60.3	1.1	17.5	18.8	60.3
49	10.6	0	1	20.1	48.0	5.1	59.0	1.1	17.2	18.6	59.0
50	10.8	0	1	19.8	47.1	5.0	57.8	1.0	17.0	18.4	57.8
51	11	0	1	19.5	46.3	4.9	56.6	1.0	16.8	18.1	56.6
52	11.2	0	1	19.2	45.6	4.8	55.5	1.0	16.6	17.9	55.5
53	11.4	0	1	19.0	44.8	4.8	54.4	1.0	16.3	17.7	54.4
54	11.6	0	1	18.7	44.1	4.7	53.3	1.0	16.1	17.5	53.3
55	11.8	0	1	18.4	43.4	4.6	52.3	1.0	15.9	17.2	52.3
56	12	0	1	18.2	42.8	4.6	51.3	1.0	15.7	17.0	51.3

Table D-2. Thiokol Castor 120ä - LMLV2; Site: Kodiak, Alaska HCl air quality impact analysis.

				No Terrain Mix ht=500		Terrain Mix ht=500		Terrain Mix ht=500		Terrain Mix ht=550		Terrain Mix ht=1000		Terrain Mix ht=10000		Terrain Mix ht=10000		Maximum
Stability				A		A		A		D		D		E		E		A - E
Wind Speed				1		1		3		1		20		4		3		1 - 20
Recp#	X	Y	Z	ug/m^3		ug/m^3		ug/m^3		ug/m^3		ug/m^3		ug/m^3		ug/m^3		ug/m^3
1	1	0	1	8412	5.61	8412	5.61	5999	4.00	753.1	0.50	0	0.00	125.7	0.08	119	0.08	5.61
2	1.2	0	1	6645	4.43	6645	4.43	5210	3.47	864.4	0.58	0	0.00	122.2	0.08	121.7	0.08	4.43
3	1.4	0	1	5391	3.59	5391	3.59	4238	2.83	889.3	0.59	0	0.00	127	0.08	110.9	0.07	3.59
4	1.6	0	1	4468	2.98	4468	2.98	3519	2.35	901.1	0.60	0	0.00	124.8	0.08	100.7	0.07	2.98
5	1.8	0	1	3772	2.51	3772	2.51	2971	1.98	907.3	0.60	0	0.00	117.3	0.08	91.2	0.06	2.51
6	2	0	1	3242	2.16	3242	2.16	2544	1.70	926.1	0.62	0	0.00	106.6	0.07	85.1	0.06	2.16
7	2.2	0	1	2824	1.88	2824	1.88	2205	1.47	934.5	0.62	0	0.00	94.5	0.06	82.2	0.05	1.88
8	2.4	0	1	2483	1.66	2483	1.66	1931	1.29	937.8	0.63	0	0.00	85.7	0.06	78.8	0.05	1.66
9	2.6	0	1	2201	1.47	2201	1.47	1706	1.14	950.5	0.63	0	0.00	86.7	0.06	75	0.05	1.47
10	2.8	0	1	1966	1.31	1966	1.31	1519	1.01	955	0.64	0	0.00	84.6	0.06	71.1	0.05	1.31
11	3	0	1	1769	1.18	1769	1.18	1362	0.91	1114	0.74	0	0.00	110.3	0.07	88.8	0.06	1.18
12	3.2	0	1	1603	1.07	1603	1.07	1228	0.82	1110	0.74	0	0.00	102.3	0.07	83.5	0.06	1.07
13	3.4	0	1	1459	0.97	1459	0.97	1114	0.74	1102	0.73	0	0.00	93.2	0.06	78.3	0.05	0.97
14	3.6	0	1	1335	0.89	1335	0.89	1015	0.68	1087	0.72	0.1	0.00	87.2	0.06	73.3	0.05	0.89
15	3.8	0	1	1226	0.82	1226	0.82	931.4	0.62	1080	0.72	0.1	0.00	87	0.06	69	0.05	0.82
16	4	0	1	1131	0.75	1131	0.75	860.5	0.57	36.21	2.41	8.7	0.01	1239	0.83	842.8	0.56	2.41
17	4.2	0	1	1048	0.70	1048	0.70	797.8	0.53	3402	2.27	9.4	0.01	1180	0.79	813.4	0.54	2.27
18	4.4	0	1	973.1	0.65	973.1	0.65	741.6	0.49	3191	2.13	9.3	0.01	1106	0.74	782.2	0.52	2.13
19	4.6	0	1	906.4	0.60	906.4	0.60	691.2	0.46	2998	2.00	10.9	0.01	1023	0.68	749.8	0.50	2.00
20	4.8	0	1	846.6	0.65	846.6	0.56	645.8	0.43	2833	1.89	14.2	0.01	974.3	0.65	716.8	0.48	1.89
21	5	0	1	793.5	0.53	9613	6.41	604.8	0.40	12380	8.25	676.2	0.45	6701	4.47	5498	3.67	8.25
22	5.2	0	1	745.3	0.50	9008	6.01	567.7	0.38	11620	7.75	748.9	0.50	6503	4.34	5227	3.48	7.75
23	5.4	0	1	701.3	0.47	8360	5.57	533.9	0.36	10810	7.21	766.5	0.51	6220	4.15	4961	3.31	7.21
24	5.6	0	1	661.2	0.44	7848	5.23	503.1	0.34	10130	6.75	727.8	0.49	5878	3.92	4701	3.13	6.75
25	5.8	0	1	624.9	0.42	7410	4.94	474.9	0.32	9568	6.38	640.3	0.43	5496	3.66	4557	3.04	6.38
26	6	0	1	591.8	0.39	2847	1.90	449.1	0.30	5120	3.41	360.4	0.24	4628	3.09	3641	2.43	3.41
27	6.2	0	1	561.2	0.37	2724	1.82	425.3	0.28	4840	3.23	425	0.28	4556	3.04	3523	2.35	3.23

Table D-2. (continued).

				No Terrain Mix ht=500		Terrain Mix ht=500		Terrain Mix ht=500		Terrain Mix ht=550		Terrain Mix ht=1000		Terrain Mix ht=10000		Terrain Mix ht=10000		Maximum
Stability				A		A		A		D		D		E		E		A - E
Wind Speed				1		1		3		1		20		4		3		1 - 20
Recp#	X	Y	Z	ug/m^3		ug/m^3		ug/m^3		ug/m^3		ug/m^3		ug/m^3		ug/m^3		ug/m^3
28	6.4	0	1	532.9	0.36	2616	1.74	403.4	0.27	4619	3.08	466.2	0.31	4428	2.95	3401	2.27	3.08
29	6.6	0	1	506.9	0.34	2493	1.66	383.9	0.26	4388	2.93	477	0.32	4256	2.84	3277	2.18	2.93
30	6.8	0	1	483	0.32	2391	1.59	366	0.24	4161	2.77	456.2	0.30	4051	2.70	3152	2.10	2.77
31	7	0	1	460.8	0.31	4132	2.75	349.3	0.23	5746	3.83	499.7	0.33	4136	2.76	3367	2.24	3.83
32	7.2	0	1	440.1	0.29	3918	2.61	333.7	0.22	5450	3.63	427.5	0.29	4017	2.68	3230	2.15	3.63
33	7.4	0	1	420.8	0.28	3729	2.49	319.1	0.21	5167	3.44	495.9	0.33	3951	2.63	3095	2.06	3.44
34	7.6	0	1	402.9	0.27	3569	2.38	305.5	0.20	4939	3.29	538.3	0.36	3847	2.56	3000	2.00	3.29
35	7.8	0	1	386.2	0.26	3397	2.26	292.7	0.20	4701	3.13	547.9	0.37	3712	2.47	2923	1.95	3.13
36	8	0	1	370.5	0.25	3240	2.16	280.8	0.19	4469	2.98	523.8	0.35	3554	2.37	2844	1.90	2.98
37	8.2	0	1	355.5	0.24	3111	2.07	269.5	0.18	4285	2.86	471.2	0.31	3380	2.25	2762	1.84	2.86
38	8.4	0	1	341.6	0.23	2972	1.98	258.9	0.17	4093	2.73	399.9	0.27	3300	2.20	2679	1.79	2.73
39	8.6	0	1	328.5	0.22	2843	1.90	248.9	0.17	3903	2.60	456.5	0.30	3245	2.16	2594	1.73	2.60
40	8.8	0	1	316.2	0.21	2737	1.82	239.5	0.16	3752	2.50	491.2	0.33	3165	2.11	2510	1.67	2.50
41	9	0	1	304.6	0.20	2624	1.75	230.6	0.15	3595	2.40	498.8	0.33	3065	2.04	2426	1.62	2.40
42	9.2	0	1	293.6	0.20	2516	1.68	222.4	0.15	3437	2.29	478.8	0.32	2948	1.97	2342	1.56	2.29
43	9.4	0	1	283.3	0.19	2428	1.62	214.8	0.14	3312	2.21	434.9	0.29	2819	1.88	2273	1.52	2.21
44	9.6	0	1	273.6	0.18	2334	1.56	207.5	0.14	3182	2.12	374.6	0.25	2764	1.84	2223	1.48	2.12
45	9.8	0	1	264.3	0.18	2244	1.50	200.6	0.13	3049	2.03	414.1	0.28	2718	1.81	2171	1.45	2.03
46	10	0	1	255.5	0.17	2170	1.45	194	0.13	2945	1.96	442.2	0.29	2655	1.77	2117	1.41	1.96
47	10.2	0	1	247.3	0.16	2092	1.39	187.7	0.13	2836	1.89	448.4	0.30	2577	1.72	2062	1.37	1.89
48	10.4	0	1	239.4	0.16	2015	1.34	181.8	0.12	2724	1.82	432.1	0.29	2488	1.66	2007	1.34	1.82
49	10.6	0	1	231.9	0.15	1952	1.30	176.1	0.12	2635	1.76	396.3	0.26	2391	1.59	1952	1.30	1.76
50	10.8	0	1	224.8	1.15	1886	1.26	170.7	0.11	2543	1.70	346.4	0.23	2351	1.57	1896	1.26	1.70

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APPENDIX E. HEARING SENSITIVITY AND FREQUENCY RESPONSES OF WILDLIFE

E.1 Birds

Sound reception in animals is a function of both sound pressure level (or intensity), measured in decibels, and frequency (or "pitch"), measured in cycles per second or hertz. Birds are less sensitive to a wide range of sound frequencies than mammals, but more sensitive to differences in intensities (Dooling 1978; Welty 1982). Songbirds can discriminate between frequencies differing by only 0.3 percent (Schwartzkopf 1963; Schwartzkopf 1973). Birds are clearly superior to most mammals (echo-locating bats are the exception) in their ability to distinguish discrete sounds separated in time. Calls and songs of birds often contain rapid sequences of sounds that man is unable to follow (Greenewalt 1968). Konishi (1969) found that birds can discriminate discrete sounds separated in time by as little as 0.6 (white-throated sparrow) to 2.0 (song sparrow) millisecond intervals.

A healthy young human ear can detect sounds ranging from 20 to 20,000 cycles per second (hertz), with greatest sensitivity in the 1,000 to 4,000 hertz range (Glorig 1965). As a rule, the frequency range that a given species can hear is narrower in birds than in humans. Table E-1, below, shows the range of hearing in representative waterfowl, upland (gallinaceous) game species, raptors, and songbirds.

Table E-1. Hearing frequency ranges in birds, in cycles per second (hertz).

Species	Lower Limit	Greatest Sensitivity	Upper Limit
Mallard	300	2,000-3,000	8,000
Ring-necked pheasant	250	unknown	10,500
Long-eared owl	100	6,000	18,000
Great horned owl	60	1,000	8,000
Starling	100	2,000	16,000
House sparrow	675	unknown	18,000
Pigeon	0.05	1,000-2,000	7,500

Source: Welty (1982).

Most birds are unable to hear ultrasonic vibrations (sounds greater than 20,000 cycles per second) (Welty 1982). In most birds, sensitivity to sound volume (or intensity) is high and relatively constant between 1,000 and 6,000 cycles per second, but beyond this upper level, sensitivity drops off dramatically.

As discussed in Section 4.4, noise from the Castor-120™ rocket engine peaks around 70 hertz, below the lower limit of hearing in many birds and well below the range of maximum sensitivity. The A-weighted measurements (dBA) of launch noise and noise exposures used in this evaluation reflect human responses to sound frequencies. A healthy young human ear can detect sounds ranging from 20 to 20,000 hertz, with greatest sensitivity in the 1,000 to 4,000 hertz range (Glorig 1965).

Dooling (1978) notes that in the region of from 1 to 5 kHz, birds show a level of hearing sensitivity similar to that found in the most sensitive mammals, with avian performance “clearly inferior” above and below this range of frequencies. Humans are among the most sensitive of mammals to low frequency noise, and among the least sensitive to high frequency noise (Heffner and Heffner 1985). This suggests that A-weighted noise measurements may overestimate impacts to some bird species, because the human ear is generally more sensitive than the bird ear to low-frequency sounds.

There are exceptions however, such as owls and columbids (pigeons and doves), which are very sensitive to low frequency sounds. Several owls (e.g., the short-eared owl and the boreal owl) are known to occur in the Narrow Cape area (ENRI 1995c). The mourning dove is known to occur in the Kodiak Archipelago but has not been observed in the Narrow Cape area.

E.2 Marine Mammals

Sensitivity of marine mammals to sound frequency is quite variable, with differences presumably related to differences in the anatomy of the outer ear, inner ear, and skull. Species-specific hearing thresholds for a number of marine mammals are listed in Table E-2.

Table E-2. Hearing frequency ranges in marine mammals, in cycles per second.

Species	Lower Limit[a]	Greatest Sensitivity[b]	Upper Limit[a]
Killer whale (underwater)	500	11,000-28,000	30,000
Harbor porpoise (underwater)	1,000	3,000-80,000	140,000
California sea lion (underwater)	250	1,000-30,000	64,000
Northern fur seal (underwater)	1,000	2,000-30,000	42,000
Harbor seal (underwater)	1,000	4,000-47,000	180,000
California sea lion (in air)	1,000	2,000 and 11,000	32,000
Northern fur seal (in air)	500	2,000 and 19,000	32,000
Harbor seal (in air)	1,000	2,000 and 15,000	23,000

Source: Derived from Malme et al. (1989) and Renouf (1991).
a. Limit of reported data.
b. Defined as frequencies within approximately 12 dB of maximum sensitivity.

Phocid (true) seals can apparently detect very high frequency underwater sound, up to 180 kHz in the case of the harbor seal. Although the detection of very high frequency sounds in water has been documented, it appears that the effective upper limit of hearing in phocids is around 60 kHz (Malme 1989; Renouf 1991). At around 60 kHz, the hearing sensitivity of most phocids shows a dramatic decrease, and flattens out at around 100 kHz. The low-frequency hearing threshold of phocids is quite flat (sounds of the same intensity produce the same behavioral response, regardless of frequency) between 1 kHz and 50 kHz, with frequencies below this difficult to test (Malme et. al 1989).

Thresholds have been measured in air between 1 and 23 kHz in harbor seals and 1 and 32 kHz in harp seals (Renouf 1991). Peak sensitivities in harbor seals appear to occur at around 2 and 11 kHz. In air, the harbor seal shows a large loss in sensitivity (32 dB) at 23 kHz, suggesting an effective upper hearing limit of approximately 20 kHz (Renouf 1991).

Although some otariids (fur seals and sea lions) are able to detect frequencies as high as 64 kHz under water, there is a marked decrease in sensitivity at frequencies higher than 36 to 40 kHz (the high frequency "cutoff"). The fur seal has a peak sensitivity between 2 and 30 kHz, while the California sea lion has a peak sensitivity of between 1 and 30 kHz. The hearing threshold of the California sea lion rises from about 87 dB at 1 kHz to about 116 dB at 250 Hz.

In air, otariids have slightly greater sensitivity and more elevated high frequency cutoff (threshold) than phocids. The northern fur seal is more sensitive at all frequencies tested (in air) than any other pinniped (Renouf 1991). The cutoff frequency of otariid hearing in air is about 32 kHz, which is much lower than the underwater cutoff of 36 to 40 kHz. In contrast, the in-air cutoff of the harbor seal is around 20 kHz, considerably lower than its underwater cutoff of around 60 kHz. Based on behavioral observations, both otariids and phocids (the harbor seal) are most sensitive to sounds at 2 kHz and at 8 to 16 kHz and less sensitive to sounds at intermediate frequencies (Renouf 1991).

Most odontocetes (toothed whales) can hear underwater sounds over a very wide range of frequencies, from as low as 75 Hz in the bottlenose dolphin to 105 to 150 kHz in several species (e.g., bottlenose dolphin, false killer whale, harbor porpoise). Most species are sensitive to sounds in the 1 to 100 kHz range, with maximum sensitivity at 15 to 70 kHz.

No controlled studies of auditory sensitivity have been performed on a live baleen whale. On the basis of anatomical evidence, it has been suggested that baleen whales are adapted for hearing low frequencies. Several authors have suggested that marine mammals probably hear best in the frequency range of their calls. Most baleen whale sounds are concentrated at frequencies less than 1 kHz, though sounds up to

8 kHz are not uncommon. It is reasonable to suggest, however, that baleen whales are most sensitive to frequencies somewhat less than 1 kHz.

As discussed in Section 4.4, noise from the Castor-120™ rocket engine peaks around 70 kHz, below the lower limit of in-air hearing in many pinnipeds and well below the range of maximum sensitivity. The A-weighted measurements (dBA) of launch noise and noise exposures used in this evaluation reflect human responses to sound frequencies. Pinnipeds are less sensitive than humans to low frequency sounds and more sensitive than humans to high frequency sounds. This suggests that A-weighted measurements may overestimate impacts of low frequency launch noise to marine mammals.

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