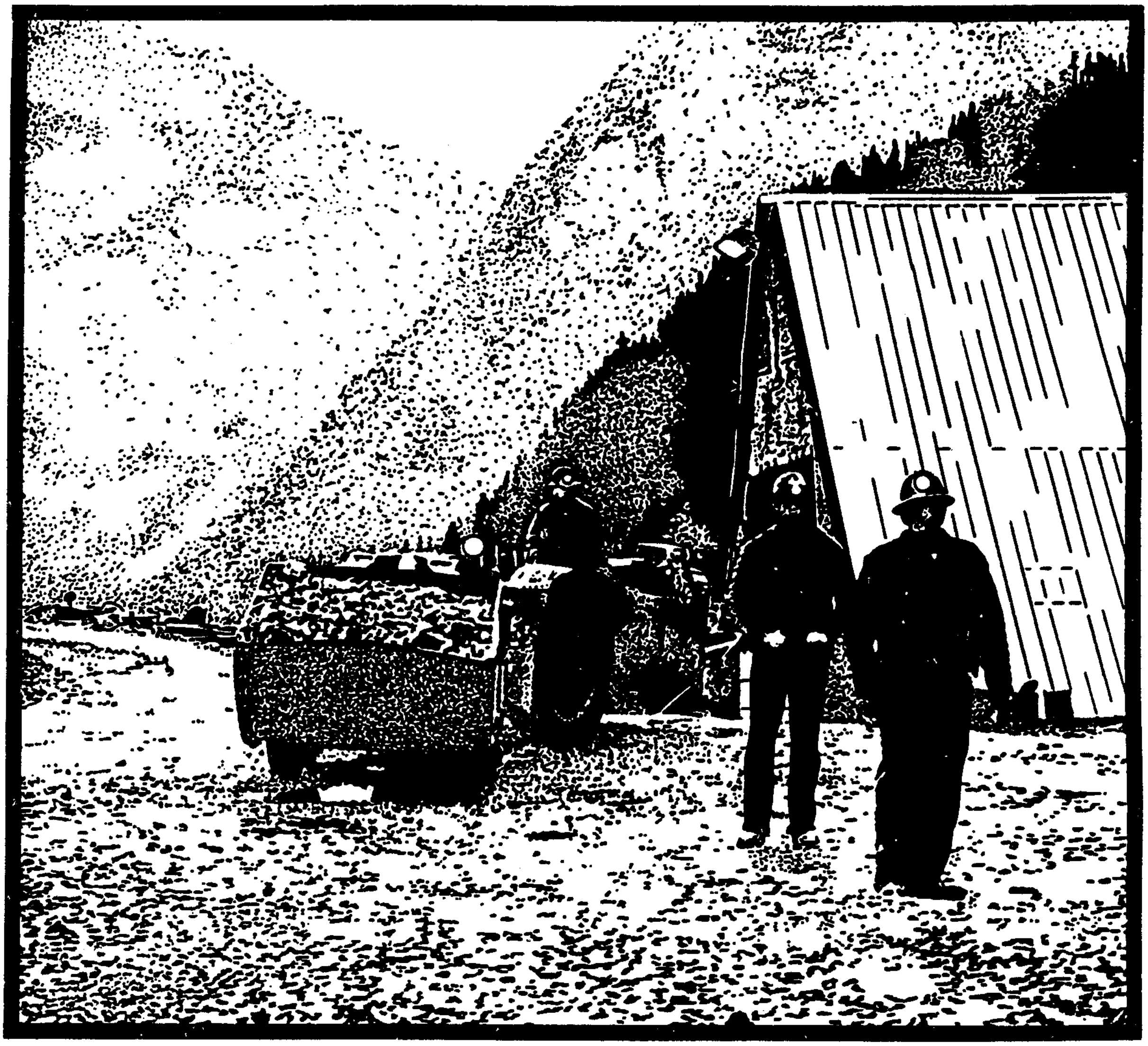
REGULATORY ASPECTS OF SUBMARINE TAILINGS DISPOSAL
- The Quartz Hill Case History -



U. S. DEPARTMENT of the INTERIOR

Bruce Babbitt, Secretary

U.S. BUREAU of MINES

Hermann Enzer, Acting Director

U.S. BUREAU OF MINES ★ ALASKA FIELD OPERATIONS CENTER ★

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REGULATORY ASPECTS OF SUBMARINE TAILINGS DISPOSAL
- THE QUARTZ HILL CASE HISTORY -

Prepared for
U.S. Bureau of Mines
Alaska Field Operations Center
P.O. Box 20550
Juneau, Alaska 99802-0550
Telephone: 907-364-2111
Fax: 907-364-3622

Prepared by
Hesse Associates
2701 Lake Hollywood Drive
Los Angeles, California 90068

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REGULATORY ASPECTS OF SUBMARINE TAILINGS DISPOSAL

- THE QUARTZ HILL CASE HISTORY -

By C.A. Hesse and K.M. Reim

ABSTRACT

The Quartz Hill Molybdenum Project, in Southeast Alaska, was the first mining project to attempt the permitting of a submarine tailings disposal system in the United States, since the passage of the National Environmental Policy Act of 1969 and the Clean Water Act of 1977. Over $20 million was spent by the project developer in baseline data gathering and in funding the preparation of the four Environmental Impact Statements and other environmental documents required at various stages of the project between 1977 and 1988.

Because of the timing and a unique set of environmental, legal and regulatory requirements which applied to this project, innovative approaches were developed. This report describes those requirements and the developments, and gives a full historical account of the campaign for permitting submarine tailings disposal at Quartz Hill, until denial of the NPDES permit application by EPA in September 1990.

The extensive studies done for Quartz Hill suggested that under certain conditions, the selection of submarine tailings disposal can be the overall environmentally preferred alternative for a mining project. The Quartz Hill story illustrates the complexity of the existing permitting structure and points out the desirability of rationalization to achieve a more effective system.

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LIST OF ABBREVIATIONS

ADCED	Alaska Department of Commerce and Economic Development
ADEC	Alaska Department of Environmental Conservation
ADF&G	Alaska Department of Fish and Game
ADNR	Alaska Department of Natural Resources
ANILCA	Alaska National Interest Lands Conservation Act
BC	British Columbia, Canada
Bechtel	Bechtel Civil & Minerals, Inc.
Borax	United States Borax & Chemical Corporation
BPJ	Best Professional Judgment
CEQ	Council of Environmental Quality
cu yd	Cubic yards
d	Day
DEIS	Draft Environmental Impact Statement
DGC	Division of Governmental Coordination
dstpd	dry short tons per day
EA	Environmental Assessment
EIS	Environmental Impact Statement
EPA	Environmental Protection Agency
ER	Environmental Report
ft	feet
FEIS	Final Environmental Impact Statement
Fig.	Figure
gpm	gallons per minute

HDPE	high-density polyethylene
IDT	Interdisciplinary Team
IMS	Institute of Marine Science, University of Alaska
kg	kilogram
km	kilometer
lb	pound
m	meter
mg	milligram
mg/l	milligrams per litre
MDCAD	Mine Development Concept Analysis Document
MOU	Memorandum of Understanding
NOAA	National Oceanic and Atmospheric Administration
NEPA	National Environmental Policy Act
NMFS	National Marine Fisheries Service
NPDES	National Pollutant Discharge Elimination System
NSPS	New Source Performance Standards
ODC	Ocean Discharge Criteria
ODCE	Ocean Discharge Criteria Evaluation
p.	Page
RDEIS	Revised Draft Environmental Impact Statement
Ref.	Reference
ROD	Record of Decision
SEACC	Southeast Alaska Conservation Council, Inc.
SIP	State Implementation Plan (Clean Air Act)

STD	Submarine Tailings Disposal
stpd	short tons per day
SUP	Special Use Permit
tpd	tons per day
tpy	tons per year
UBC	University of British Columbia
U.S. Borax	United States Borax & Chemical Corporation
USBM	United States Bureau of Mines
USDA	United States Department of Agriculture
USFS	United States Forest Service
yr	year

ENGLISH TO METRIC CONVERSION TABLE

FROM	TO	MULTIPLY BY
acres	hectares (ha)	0.045
cubic feet (ft^3)	cubic meters (m^3)	0.0283
cubic yards (yd^3)	cubic meters (m^3)	0.765
dollars per pound ($/lb)	dollars per kilogram ($/kg)	2.204
feet (ft)	meters (m)	0.305
gallon (g)	liters (1)	3.785
gallons per minute (gpm)	cubic meters per second (m^3/s)	0.0631
inches (in)	meters (m)	0.024
miles (mi)	kilometers (km)	1.609
pounds (lb)	kilograms (kg)	0.454
pounds per cubic feet (lb/ft^3)	kilograms per cubic meter (kg/m^3)	16.018
short tons (st)	metric tons (mt)	0.907

As of January 1, 1993, the Bureau of Mines converted completely to the metric system. This report was contracted and largely completed during 1992. Therefore most units of measurement use the English system. The above table can be used to convert English units into metric.

1.0 INTRODUCTION

1.1 Scope

Between 1976 and 1990, United States Borax & Chemical Corporation (U.S. Borax), as Operator of the Quartz Hill Molybdenum Project in Southeast Alaska, conducted an intensive campaign to obtain the principal permits for large-scale submarine tailings disposal (STD) into one of two fjords adjacent to a large, low grade molybdenum deposit. The Quartz Hill Project was the first to apply for a discharge permit based on STD, since passage of the National Environmental Policy and Clean Water Acts. Because of this and extraordinary environmental, legal and regulatory factors, the development of innovative approaches was required. The Quartz Hill case history thus provides a unique example of the development of permitting requirements for STD in the United States regulatory climate of the 1980's. This report is intended as a full but concise account of the history of the effort to permit STD at Quartz Hill.

1.2 Background

Disposal of mill tailings into the marine environment was practiced in a few instances in the United States long before the current era of environmental awareness and close regulation. A notable example is the Alaska Juneau mine, which operated in the first half of this century until 1944, discharging gold-mill tailings into the adjacent marine channel. In Canada and other parts of the world, marine tailings disposal had been used more extensively (examples: Britannia mine, British Columbia (BC); Greenex zinc mine in Greenland). Tailings disposal into fresh water environments was also done on some mining projects in Canada and the U.S. (Bluebell Mine, BC; Polaris and Nanasivik in the Canadian Arctic; Stanleigh Uranium and other Elliot Lake, Ontario, mines; Reserve Mining in Minnesota).

As the regulatory climate developed, a few mines in Canada pioneered the successful use of engineered submarine tailings disposal systems and established ways of working effectively with the permitting agencies and representatives of the public. The Island Copper and Kitsault Molybdenum mines in BC, in particular, were foremost in developing well-engineered facilities and effective monitoring methods. Quartz Hill, however, was the first mining project in the U.S. to attempt permitting of STD since passage of the National Environmental Policy Act (NEPA) of 1969 and the Clean Water Act of 1977.

Some of the extraordinary legal factors which formed the regulatory framework for the Quartz Hill STD permitting effort included the passage of the Alaska National Interest Lands Conservation Act (ANILCA) in 1980, the exclusion of Quartz Hill from the Clean Water Act effluent limitation guidelines promulgated by the Environmental Protection Agency (EPA) for the Ore Mining and Dressing industrial category in 1982, and the 1986 classification by the U.S. Department of State of the two adjacent fjords which provided the potential sites for STD, as "internal waters" under jurisdiction of the State of Alaska. These occurrences and their effects are described in more detail in succeeding sections of this report.

For no other waste disposal project has the same set of conditions applied. For this and other reasons, such as the environmental sensitivity of the orebody location, the pioneering nature of the technology and the difficult regulatory setting, the Quartz Hill STD story is unique.

1.3 Previous Work and Acknowledgements

The technical aspects of STD for Quartz Hill are covered in a separate report being developed for the U.S. Bureau of Mines (USBM) by the University of British Columbia (UBC) entitled "Case Studies Related to Submarine Tailings Disposal." That work includes a section on the Quartz Hill project.

The bulk of the source material used in the preparation of this report came from the USDA Forest Service's Final Environmental Impact Statement (FEIS) for the Quartz Hill Project (Ref. 30), the files of U.S. Borax, the project developer during the permitting period under consideration (1975-1990), and the files of Cominco Ltd. and its affiliate, the current owner of Quartz Hill. Public documents and documents now in the files of the USBM and the Forest Service were also relied upon.

The cooperation and assistance of U.S. Borax, Cominco, USBM, the Forest Service, and UBC are gratefully acknowledged.

Subsequently in this document, reference will be made to specific company names or individual names only where this is important to the context. Personnel will usually be referred to by title or function, and the mine owner and operator companies as "the Company". The purpose of this philosophy is to allow concentration on the process rather than on the personalities and companies involved.

2.0 PROJECT DESCRIPTION

2.1 Discovery, Exploration and Early Development

The Quartz Hill mineral deposit is located on the Alaska mainland about 45 miles east of Ketchikan (Figures 2.1 and 2.2), roughly equidistant from the ends of two fjords named Wilson Arm of Smeaton Bay, and Boca de Quadra.

Discovery was made late in the summer of 1974 as a result of regional geochemical surveys being conducted in Southeast Alaska by U.S. Borax geologists. Mining claims were located in the Tongass National Forest and later transferred to Pacific Coast Molybdenum Company, an affiliate of U.S. Borax, which acted as Operator. A single 100 ft deep small diameter core hole was drilled in January 1975 to test the continuity of the mineralization. When the initial work yielded encouraging results, a full-scale exploration program was organized commencing in the summer of 1975, including in later years, a grid of larger diameter core holes of generally about 1000 ft depth. Drilling was to continue every summer through 1983, eventually totalling over 268,000 linear feet.

By 1976, the existence of a huge low-grade deposit of molybdenite had been established. Planning for development, environmental investigations and permitting activities began. Early reconnaissance had indicated the desirability of access and tailings disposal on the Wilson Arm side. However, emphasis was shifted to Boca de Quadra because of concerns over the salmon resources of the Wilson and Blossom Rivers, flowing into Wilson Arm; and the volumetric capacity of the Wilson Arm/Smeaton Bay fjord system to contain mill tailings from the entire mineral deposit.

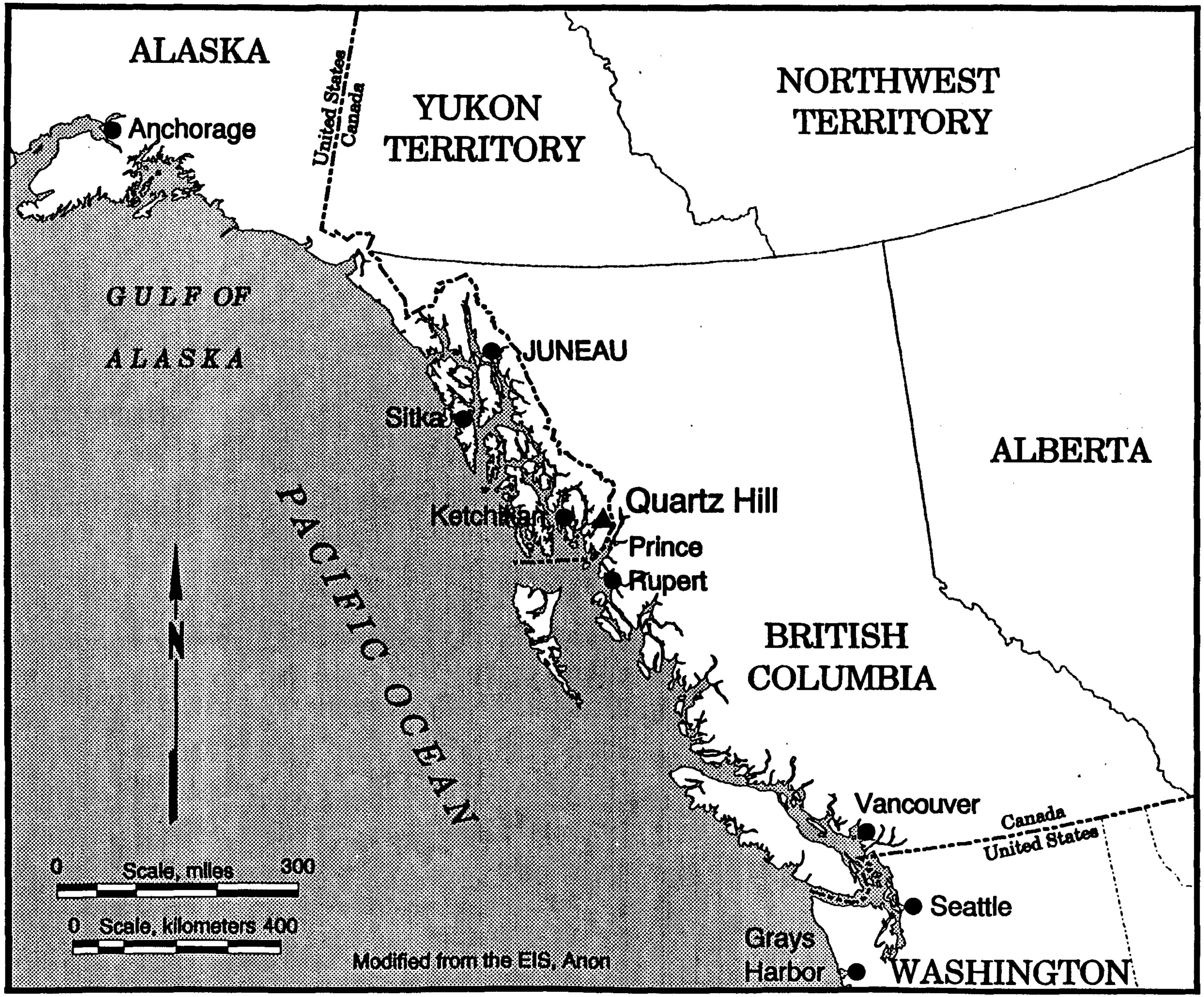

Figure 2.1 - Project location map.

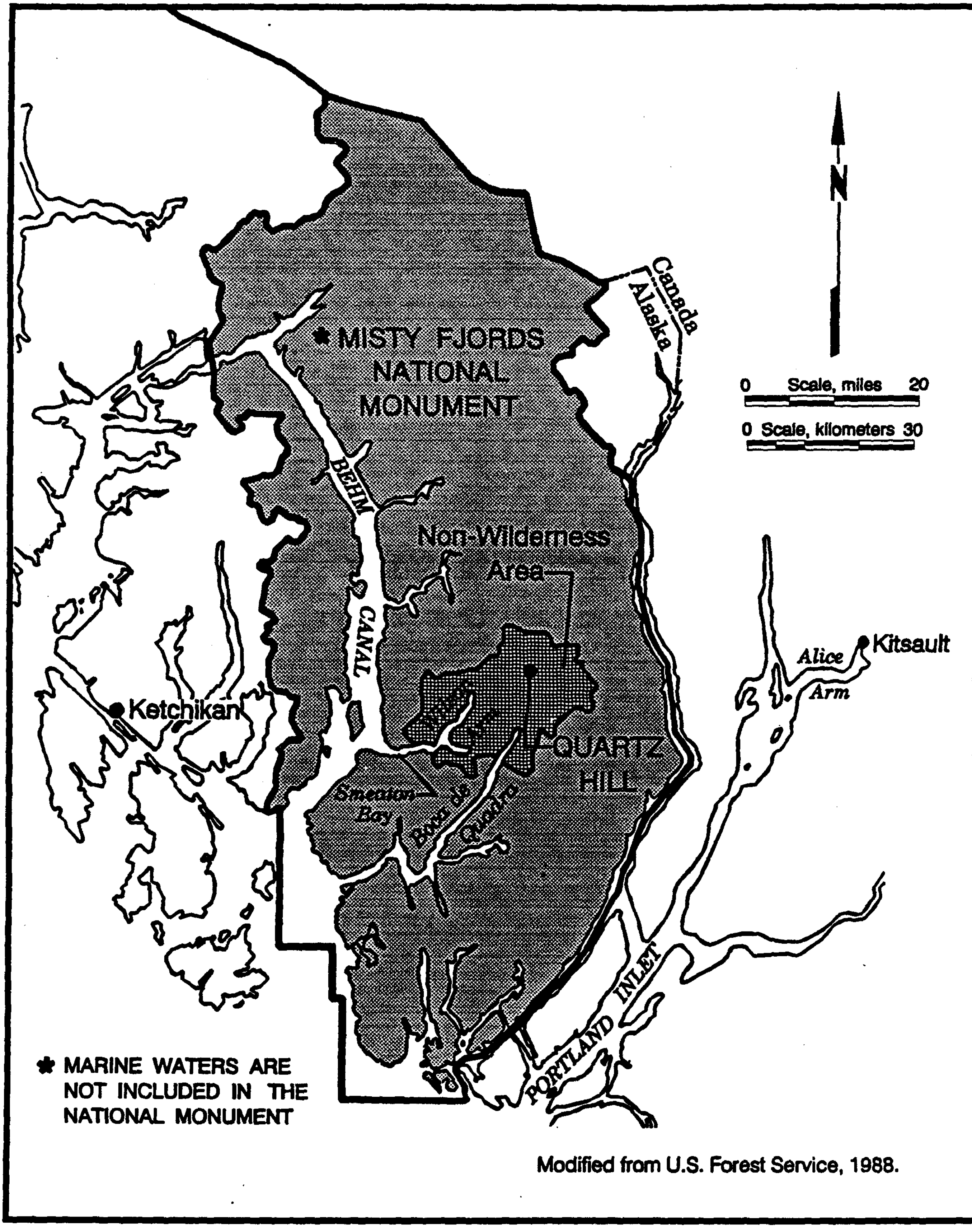

Figure 2.2 - Quartz Hill location map.

Application was made in 1976 to the Forest Service for a Special Use Permit (SUP) to construct an access road for bulk sampling up the Keta River valley, from the Boca de Quadra side. This permit was granted in November 1977 and a subsequent appeal by the Sierra Club Legal Defense Fund and associated commercial fishing groups was denied.

On December 1, 1978, however, President Carter by Presidential Proclamation withdrew 56 million acres of public land in Alaska from mineral entry. This included over two million acres in the Tongass National Forest around Quartz Hill, which was designated the Misty Fjords National Monument. Concurrently, the Secretary of Agriculture cancelled the SUP for road construction and ruled that access for bulk sampling must be by helicopter.

In January 1979, the Carter Administration proposed Wilderness designation for Misty Fjords National Monument. A difficult period for U.S. Borax followed, during which the Company was forced to assume a high-profile lobbying position as it argued its case in Washington. This attracted the attention of national environmental groups, which made the Quartz Hill Project a "cause célèbre".

On December 2, 1980, the rights of a mineral discoverer conferred by the 1872 General Mining Law were recognized in the passage of the Alaska National Interest Lands Conservation Act (Ref. 2), which provided for the development of Quartz Hill under environmental guidelines. ANILCA confirmed the establishment of the Misty Fjords National Monument of 2,285,000 acres and classified all of it as Wilderness, except an enclave of 152,610 acres surrounding Quartz Hill. This permitted the active development of the project to resume.

By the end of 1980 also, two pre-feasibility studies by outside engineering companies had indicated the economic potential of the deposit. This was accentuated by the rising price of molybdenum, which reached a peak of well over $8 per pound in 1980. The Company decided to do a full feasibility evaluation and organized a dedicated project group in April 1981. In the summer of 1981, development drilling continued, the driving of two bulk-sampling adits commenced, and environmental baseline data gathering was in full swing. Geotechnical work was performed, socioeconomic work began and bids for road building were requested. The camp population at Quartz Hill reached a peak of about 120 residents. However, opposition and legal challenges by environmental groups continued. Much of the physical work at Quartz Hill had to be temporarily halted in September 1981 because of a Court Order which mandated the preparation of an Environmental Impact Statement (EIS) to cover the Company's 1980-83 Operating Plan, which had been approved by the Forest Service.

After completion of this EIS and another to cover bulk sampling, a road from tidewater at Wilson Arm was finished in 1983. Bulk samples, totalling about 4800 tons, were removed in August of that year and used for process testing and pilot plant runs at the Hanna Research facilities in Minnesota between November 1983 and February 1984.

By mid-1984, the technical work of the feasibility evaluation was virtually completed, and a decision had been made by U.S. Borax that project construction could not proceed immediately because of falling molybdenum prices. Nevertheless, the campaign to secure the principal permits was continued, so that the next phase of the project would be able to proceed swiftly when the economic conditions were right.

Thenceforth, environmental baseline data gathering continued sporadically, and permitting activities were carried on into 1990. Details are described in succeeding sections.

2.2 Quartz Hill Area Description

2.2.1 Environmental Setting

The Quartz Hill area is typical of rugged, west-coast fjord country which has had no previous development. Except for historical references to occasional use of the coastal areas by native peoples and evidence of some old timber cuts along the fjord margins, there is little record of previous human usage of the land and no current habitations.

The maritime climate is cool and wet, with approximately 150 inches annual precipitation, little sunshine, high humidity and low evaporation. Winters at tidewater are mild, with the ground often free of snow; but at the elevations of the mineral deposit (1400 to 2700 ft), annual snowfall is estimated at between 400 and 800 inches.

Vegetation near tidewater is very dense, west-coast rain forest, but growth rates and timber sizes decrease rapidly with increasing elevation. At orebody elevations, vegetation is sub-alpine and timber quality poor when present. There are many open slopes. Soils are generally shallow and coarse grained, resulting from a relatively short formation period since areal glaciation seven to ten thousand years ago.

Topography is extremely rugged, with over 4000 ft of relief between sea level and the highest ridges. The adjacent fjords and river valleys are characteristically glacially scoured, U-shaped valleys with sills providing an uneven bottom configuration.

Wildlife comprises scattered populations of mountain goat, bear, wolf, beaver, raptors and waterfowl, most of which (except for goats) are found at lower elevations. Bald eagles nest at the fringes of the fjords. Bear, goat and beaver have been observed at the orebody elevations.

Rivers flowing into the upper ends of Boca de Quadra to the south, and Wilson Arm to the west, are well regarded as salmon spawning streams, particularly the Wilson/Blossom Rivers on the Wilson Arm side. These rivers support four of the five Pacific salmon species (chum, pink, silver and king), plus Dolly Varden char and steelhead trout. In addition, there are crustaceans in the shallower fjord bottoms and herring use both fjords (particularly Boca de Quadra) as breeding and juvenile rearing areas.

In the mid-1980's, both fjords supported a limited shrimp and crab fishery, with estimated annual value of less than $100,000 (Ref. 31). The upper reaches of Boca de Quadra were generally regarded as too far away from Ketchikan to support a viable fishery, but there was an active herring fishery at Kah Shakes, just outside of Boca de Quadra.

2.2.2 Geological Setting

The Quartz Hill molybdenum deposit is located within the transitional zone between a Mesozoic metamorphic complex to the west and the Mesozoic Coast Range batholith to the east (Ref. 23). The Coast Range batholith is a large mass of igneous intrusive rocks.

During Tertiary time, plutonic rocks of intermediate composition were intruded into both complexes. The Quartz Hill porphyritic stock was one of these Tertiary plutons and is the primary host and presumed source of the molybdenum mineralization in the area. After intrusion about 27 million years ago, magmatic forces shattered the crystallized rocks and flooded the fine cracks and openings with mineralizing solutions which deposited molybdenite (MoS_2) and quartz in an interlacing stockwork pattern. Probably there was only one principal pulse of mineralization.

The Quartz Hill stock is composed of a series of closely related intrusives. The mineral composition of these rocks consists of plagioclase, orthoclase, and quartz, with minor amounts of biotite ranging from 1 to 2 percent. All of the rocks have been affected by fracturing, silicification, potassic alteration, and molybdenite mineralization. Post-mineralization dikes cut across the deposit from northeast to southwest. A major fault cuts across the deposit trending northwest, but does not appear to have offset the mineralization significantly.

Molybdenum mineralization at Quartz Hill predominantly occurs as very fine-grained molybdenite in quartz veinlets, along fractures and, rarely, as disseminations in the host rocks. The quartz veining and associated molybdenite mineralization occur as a stockwork of veinlets of various types related to a system of intense fracturing. The molybdenite-bearing veinlets are rarely more than a few millimeters wide. Some quartz veins reach widths of several centimeters, but the molybdenite is usually restricted to narrow sections of the vein.

Pyrite is ubiquitous in the Quartz Hill rocks and occurs as disseminations, veinlets, and coatings along joint surfaces. The average pyrite content in the Quartz Hill deposit, however, is only approximately 1 percent. Other sulfide minerals present in very minor amounts include chalcopyrite, galena, and sphalerite. Alteration of the Quartz Hill rocks is widespread and consists primarily of silicification and potassic alteration.

2.2.3 Orebody Description

The orebody takes an elongated form with dimensions of about 5000 by 7000 feet in plan, by about 1700 feet deep. Mineable tonnage is estimated at 1.1 billion short tons at a cutoff grade of 0.10 percent MoS_2, rising to 1.7 billion tons at 0.05 percent cutoff. Grades vary between 0.05 and 0.25% MoS_2. Stripping ratio (waste:ore) for a 0.10% cutoff grade is about 1:1. The orebody includes a higher grade section of approximately 230 million tons grading about 0.22% MoS_2.

Of interest for evaluation of STD potential is the mineralogical composition of the orebody, particularly those minerals which would appear in the tailings. It is notable that the Quartz Hill ore is a "clean" molybdenum ore, with no other economically recoverable minerals. Insoluble minerals, such as quartz, feldspar, biotite and chlorite, comprise over 96 percent of the total minerals. This subject is treated at greater length in Section 6.2.

2.3 Project Description

2.3.1 Operating Plan

In December 1981, U.S. Borax engaged Bechtel Civil & Minerals, Inc. (Bechtel) of San Francisco as its engineering contractor for the full feasibility evaluation. With the assistance of Bechtel, a plan for exploiting the molybdenum deposit was developed in 1982, based on the knowledge of that time. The plan called for a nominal design operating rate of 35,000 short tons of ore per day initially, followed by an increase within the first four to six years (depending on market development) to 70,000 stpd through the addition of a second duplicate ore processing line. Since daily operating peaks could exceed the "name plate" design rate by up to 15 percent, the target for permitting purposes was set at 80,000 stpd. Figure 2.3 shows a generalized plan of the site facilities utilizing one of the three possible options for submarine tailings disposal.

2.3.2 Mining

Since the ore outcrops on surface, mining was to be done by standard large-scale open-pit methods. Quartz Hill was regarded as an unusual mining project for several reasons, which included the remote location, difficulty of initial access, the high precipitation and snowfall, the need for stringent sediment control and the rugged terrain causing problems in facilities siting and mine waste disposal. The ore mining rate was planned to be 12.4 million tons per year initially, rising to 24.8 million tpy rate in Year 6. High-capacity equipment used would include 26-cu yd electric shovels and 170-ton diesel-electric trucks. The run-of-mine ore would be dumped into a gyratory crusher located near the northwest edge of the pit at 1650 ft elevation. The minus 8-inch size crushed ore would be discharged to a 60-inch conveyor belt about 20,500 ft long, located in a tunnel leading to a coarse ore stockpile at 585 ft elevation.

2.3.3 Processing

The concentrator would be located on the north slope of Tunnel Creek valley, about one mile east of the upper end of Wilson Arm (See Figure 2.3). This site was chosen after a comprehensive evaluation of all feasible project development concepts including tailings disposal; the tailings disposal evaluations are described separately in Section 3.0. Some of the advantages of the Tunnel Creek plant site include good access, adequate space, and good foundation conditions. Compared to sites near the orebody at over 1600 ft elevation, there are also much lower snow loads because of the milder climate incumbent with the lower elevation of between 585 and 410 feet.

From the 365,000 ton storage pile, the coarse ore would be conveyed to two (at full capacity) grinding lines, each consisting of a 34-ft diameter semiautogenous mill in closed circuit with two 18-ft diameter ball mills. Water for grinding and small quantities of reagents would be added and the ore ground to a flour-like consistency (about 80% minus 100 mesh), prior to the separation of the molybdenite (MoS_2) from the gangue minerals in a series of froth-flotation cells.

In the flotation cells, air would be bubbled through the slurry to cause frothing. The collector reagents added would promote the attachment of the fine molybdenite particles to the air bubbles, causing them to rise to the surface of the cells where the concentrate would be skimmed off. The depressant reagents added would decrease any tendency of the gangue minerals to adhere to the air bubbles. These minerals report to the tailings. In the processing plan proposed, copper and other sulfide minerals would be depressed to improve molybdenite concentrate quality.

A number of flotation steps, some with regrind stages in between, would be required to clean the concentrate to marketable quality. Figure 2.4 gives a block diagram outlining the process.

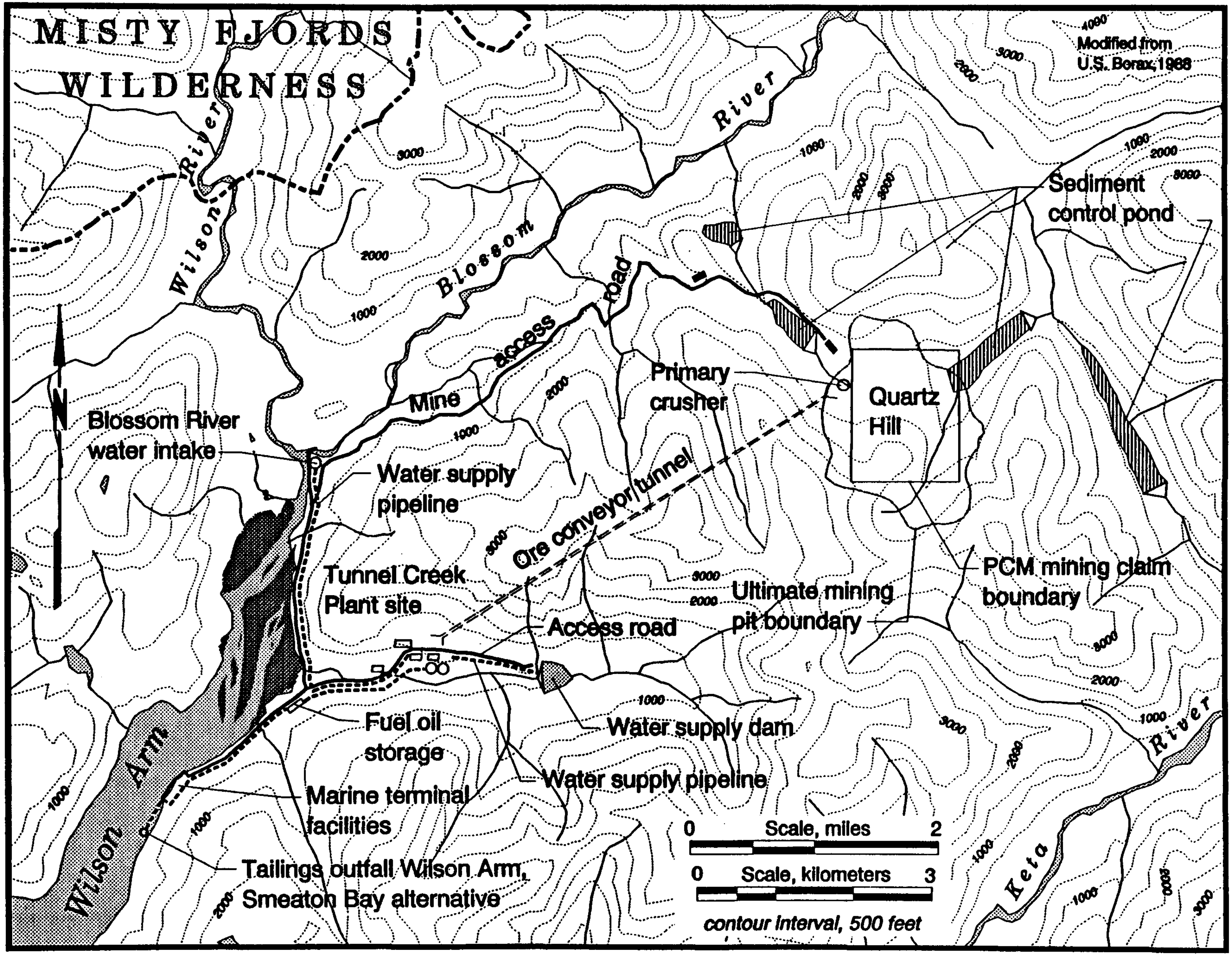

Figure 2.3 - General facility site plan.

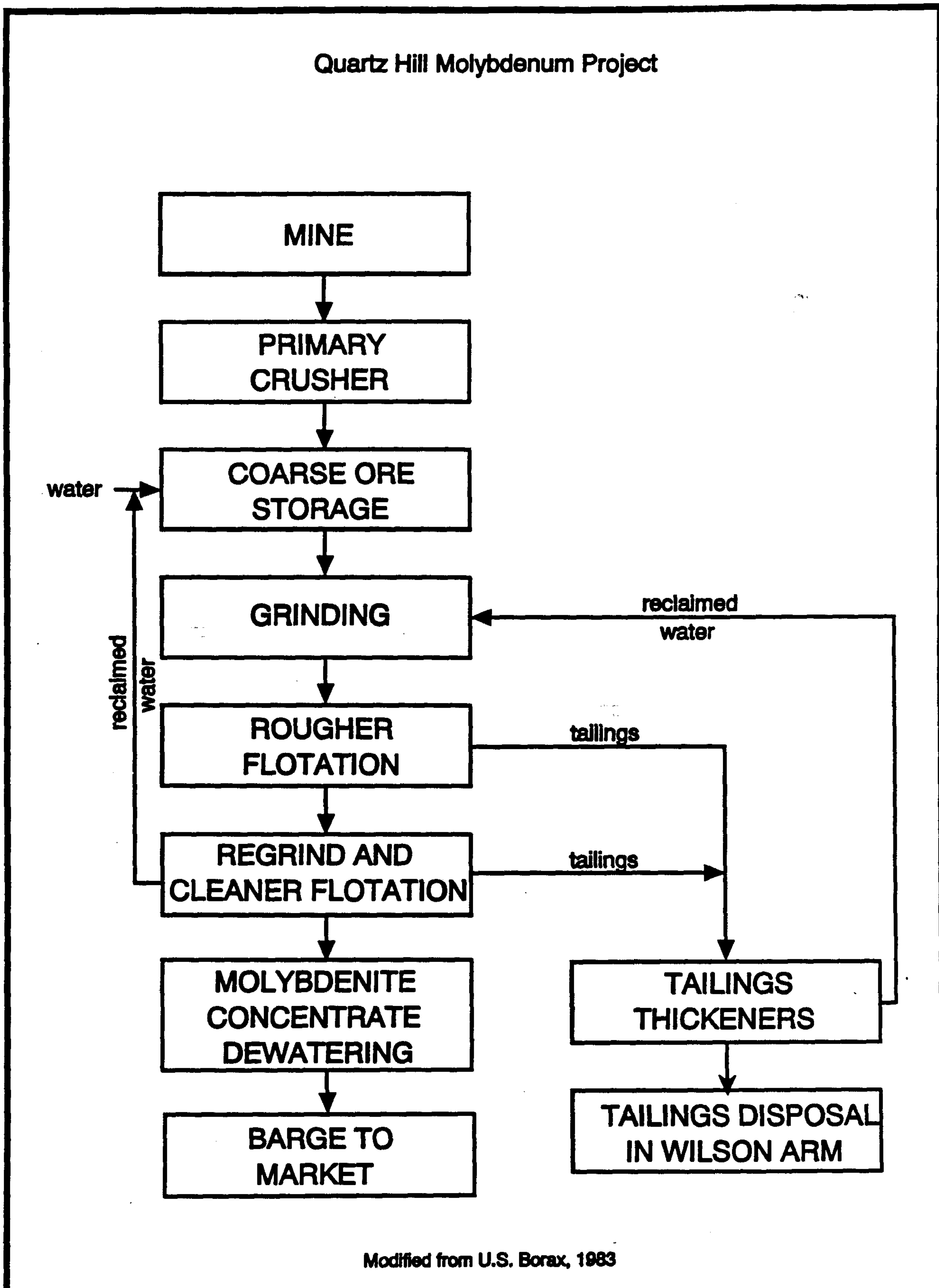

Figure 2.4 - Concentrator process block flow diagram.

Final concentrate would be filtered to about 10% moisture and bagged in 3750-lb bags for periodic shipment by barge to a refinery planned for location at Grays Harbor, WA. The tailings slurry, consisting of the unwanted gangue minerals drawn from the bottoms of the flotation cells, would be thickened to about 45% solids in two 400-ft diameter thickeners. Reclaimed water would be recycled back to the grinding circuits. The thickened tailings would be combined with other minor plant waste streams prior to disposal. The tailings disposal system is described in Section 7.1.

2.3.4 Tailings Volume

Because the molybdenite in the ore averages only about 0.15 percent, the weight of solids in the tailings slurry would almost equal the plant throughput. Tailings quantity at peak throughput of 80,000 tpd would be about 79,880 equivalent dry short tons per day. At plant design capacity, tailings quantity would be 69,895 dstpd. Since plant design operating days were established at 355 days per year, annual equivalent dry weight of tailings disposed at full design capacity would be 24.8 million short tons. This is an approximation, since ore grades, actual plant capacity and operating factors could vary somewhat from design. Table 2.1 shows an estimate of liquid and solid phases of concentrator effluent for the initial and expanded daily peak capacity rates.

TABLE 2.1. Estimated Quartz Hill Concentrator Effluent

Both Cases Peak Plant Capacity (tpd)	Effluent Solid Phase (tpd)	Effluent Liquid Phase (tpd)
40,000	39,940	49,800
80,000	79,880	99,700

The plant water would be supplied from a reservoir on Tunnel Creek above the plant, with supplemental supply from the Blossom River.

3.0 ASSESSMENT OF TAILINGS DISPOSAL ALTERNATIVES

3.1 Early History and Initial Evaluation

Given the topographic and climatological conditions prevailing in the Quartz Hill area, the appeal of STD was obvious to project planners from the start. The development concept of a mill at Tunnel Creek with tailings disposal into Wilson Arm, was conceived in the mid-1970's. It was readily apparent that this would likely result in less overall environmental impact, and probably less cost, than on-land tailings disposal or disposal into Boca de Quadra.

However, early concerns were expressed by commercial fishing groups and by some of the State and Federal agencies charged with fisheries protection. Effect on salmon was the foremost concern. There were also questions about whether the volumetric capacity of Wilson Arm/Smeaton Bay was sufficient to hold the tailings from the entire ore deposit. No accurate bathymetric surveys had been made. The settled density of tailings on the fjord bottom was not known and the consequences of any tailings spill-over into Behm Canal were a matter for conjecture.

Environmental and fisheries groups, supported by some elements within the State agencies, were opposing road access to the orebody for bulk sampling purposes; and in particular, were against construction of a road up the Blossom River, from the Wilson Arm side. They felt that any development in the vicinity of the Wilson/Blossom river system would likely reduce its salmon spawning capabilities, which are considered superior to those of the Keta River on the Boca side.

U.S. Borax therefore turned its attention to Boca de Quadra. After completion of an EIS, the Forest Service issued a Special Use Permit in November 1977 for a bulk sampling access road up the Keta River and Hill Creek to the deposit. This decision was appealed by the Southeast Alaska Conservation Council (SEACC) and the Sierra Club Legal Defense Fund, but the appeal was denied by the Chief Forester in July 1978.

Oceanographic work was initiated in Boca de Quadra in October 1978; however, plans for more active development were halted by President Carter's December 1978 proclamation establishing the Misty Fjords National Monument, and the Secretary of Agriculture's concurrent cancellation of the SUP for the Keta access road.

During the hiatus that followed, the Company made comparative engineering and safety evaluations of the two competing access routes. The Keta River/Hill Creek route crossed a number of avalanche paths, which raised the threat of road closures and significant hazards to personnel in winter. Rerouting was not practicable and snowshed protection would be uncertain and expensive. ANILCA, passed in December 1980, called for a Mine Development Concepts Analysis Document to be prepared, which would examine the mine development concepts under consideration, their environmental impacts and the question of access. Studies and environmental baseline data gathering in Boca de Quadra continued, but it was becoming apparent that the hazards of the Keta River/Hill Creek route could not be tolerated during mine operations. A Supplemental EIS for road access and bulk sampling issued by the Forest Service in April 1982, selected the Blossom River route as the preferred alternative.

However, controversy over route selection continued. In June 1982, the President of U.S. Borax, Dr. Carl Randolph, in order to obtain the backing of the State for the Blossom River route, made a written commitment to the Governor of Alaska, Jay Hammond, that the Company would not place tailings in Wilson Arm/Smeaton Bay. Consequently, the Company filed with EPA in July 1983, an application for an NPDES permit for tailings disposal in the inner basin of Boca de Quadra.

New information, however, would soon be developed. Fisheries experts advised that, since returning salmon would use only the upper 20 or 30 meters of the fjord waters, spawning and salmon escapement would be unaffected by STD in either fjord. By July 1982, most members of the Forest Service's Interdisciplinary Team (IDT), which included representatives of the concerned agencies and a fisheries research organization, were convinced on the advisability of STD over land disposal for Quartz Hill and the Forest Service was acknowledging that STD in Wilson Arm/Smeaton Bay would have to be examined in the EIS as one of the possible alternatives.

Further investigations included a definitive bathymetric survey of Wilson Arm/Smeaton Bay by the National Oceanic and Atmospheric Administration (NOAA) published in February 1984, and tests by the University of British Columbia of the unit volume occupied by settled tailings on the fjord bottom. The results revealed that the below-sill volume of Wilson Arm/Smeaton Bay was indeed large enough to contain the tailings from the entire orebody. Other information indicated that the marine impacts from tailings would be minimal and similar in both fjords. Meanwhile, the Forest Service issued a Draft EIS for mine development in July 1984, with the middle basin of Boca de Quadra designated as the preferred discharge site.

In the opinion of the Company, the new information on Wilson Arm/Smeaton Bay warranted a re-examination of this fjord as a possible STD site, on an equal footing with Boca de Quadra. If approval for Wilson Arm could be obtained, the impacts of the project could be limited to one drainage system, impacts of a tunnel portal in the Wilderness would be avoided, a large capital outlay would be saved and future operations would be simplified.

In September 1984, Dr. Randolph met with the then incumbent Governor, Bill Sheffield, to present the new information and request that the Company and the Forest Service be allowed to evaluate Wilson Arm as an alternative STD site. He also offered to bring the state of knowledge for Wilson Arm/Smeaton Bay in a number of areas to the same level as that for Boca de Quadra. Governor Sheffield granted the request but did not release Borax from the 1982 commitment. Former Governor Hammond was also contacted and indicated his concurrence with the State considering new information.

This new information was collected and presented in the Forest Service's Revised Draft EIS (RDEIS) issued in January 1986. Based on the information, the Forest Service's preferred alternative for tailings disposal was now Wilson Arm/Smeaton Bay.

In July 1987, the State of Alaska comments on the RDEIS (Ref. 22) supported tailings disposal in Wilson Arm/Smeaton Bay if two conditions were met. First, a monitoring program must be developed to detect any divergence from predicted tailings movements and any violations of water quality standards. Second, an acceptable contingency plan must be prepared. The contingency plan would enumerate what operational actions could be taken, including relocation of the tailings outfall, if monitoring showed that the discharged tailings were not behaving as expected. It was still up to U.S. Borax to demonstrate that it should be released from its 1982 promise; however, a new Alaskan Governor, Steve Cowper, felt that, "We believe that the modelling of the Smeaton site is the best in the business and has demonstrated that disposal of the tailings can occur in a manner which protects the fisheries water quality, and local environment" (Ref. 6). Governor Cowper stated "support for the Smeaton site is conditional upon development of acceptable monitoring and contingency plans".

3.2 Legal and Regulatory Baselines

A unique framework of laws and agency determinations established the ground rules for the permitting of STD at Quartz Hill. The most important of these included: (1) Congressional directives for Quartz Hill development codified in ANILCA, (2) EPA's exclusion of Quartz Hill from effluent limitations established under the Clean Water Act for the Ore Mining and Dressing industrial category, and (3) the Department of State classification in 1986 of Boca de Quadra and Wilson Arm/Smeaton Bay as internal waters under jurisdiction of the State of Alaska.

3.2.1 ANILCA's Congressional Directives

Signed into law on December 2, 1980, The Alaska National Interest Lands Conservation Act (Ref. 2) confirmed the establishment of the Misty Fjords National Monument of 2,285,000 acres and directed that it be managed by the Secretary of Agriculture. ANILCA provided for development of the Quartz Hill project by excluding the land needed for facilities from the Wilderness classification applied to the rest of the National Monument, but the Act also established a strict set of environmental standards for project design, construction and operation. Many of these, directly and indirectly, applied to tailings disposal.

Section 503(f)(2)(A) of ANILCA directed that any holder of a valid mining claim within the Monument be permitted to carry out activities in accordance with "reasonable regulations promulgated ...to assure that such activities are compatible, to the maximum extent feasible, with the purposes for which the Monument(s) were established." This (and other Sections of ANILCA) was intended to be interpreted in the light of the report of the Senate Committee on Energy and Natural Resources (Senate Report No. 96-413, Ref. 3), which gives the legislative intent.[1] In referring to the Quartz Hill claims, that Report states (pp. 209-210) "The Committee intends that the evaluation and development of these claims be permitted to continue should that prove economically feasible, and intends to avoid the implication that mining or related activities are inherently incompatible with the purposes for which the monument was established."

ANILCA did not apply to the adjacent fjords because the fjords had been specifically excluded from the National Moment. However, ANILCA recognized the possibility of future use of these fjords for STD, but left the decision to be made through existing permitting procedures under other laws. Section 503(h)(8) reads:

> Designation by section 703 of this Act of the Misty Fjords National Monument Wilderness shall not be deemed to enlarge, diminish, add, or waive any substantive or procedural requirements otherwise applicable to the use of offshore waters adjacent to the Monument Wilderness for activities related to the development of the mineral deposit at Quartz Hill, including, but not limited to, navigation, access, and the disposal of mine tailings produced in connection with such development.

An entire section of the Act (505) was devoted to protection of fisheries on Alaskan National Forest lands. This section empowered the Secretary of Agriculture to promulgate "reasonable regulations...to maintain the habitats, to the maximum extent feasible, of anadromous fish and other foodfish, and to maintain the present and continued productivity of such habitat when such habitats are affected by mining activities on national forest lands in Alaska." This was to be done in consultation with the State of Alaska and the Secretaries of Commerce and the Interior.

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[1] An additional aid in interpretation of ANILCA is the colloquy in connection with ANILCA which appeared in the Federal Register on August 19, 1980 (Appendix F).

Specifically for Quartz Hill, Section 505 directed that significant mining operations be in accordance with approved plans of operation and that such plans include studies for "evaluating the water quality and water quantity, fishery habitat, and other fishery values of the affected area". The plans were also to include provisions for evaluating the sensitivity of the fishery habitat at various life stages to environmental degradation from mining related activities, identifying the risks to fisheries posed by operations, and preventing significant environmental impacts to the fishery habitat.

If he determined that any mining-related activity was harmful to fishery productivity, the Secretary was directed to require a modification of the project operating plan. If necessary, the Secretary was empowered to suspend activities for up to seven days unless otherwise required by a United States district court.

Considered as a whole, ANILCA is a remarkable document. It not only singled out a specific commercial venture and encouraged development, but also established comprehensive but reasonable provisions to protect fishery values. As stated in the 1979 Report of the Senate Committee on Energy and Natural Resources to accompany H.R. 39 (Ref. 3), the goal was "to maintain the habitat of the fisheries producing system so that such system is capable of producing at or above current levels of production after the mine has ceased operations."

3.2.2 Exclusion of Quartz Hill from NSPS

In June 1982, EPA published for the Clean Water Act, proposed effluent limitation guidelines and New Source Performance Standards (NSPS) for the Ore Mining And Dressing point source category of industry (47 Federal Register 25682 et seq.). According to the Final EIS (Ref. 30, p. A-104), the NSPS rules, as then proposed, would essentially allow no discharge of process wastewaters from molybdenum mills using the froth-flotation process. A source was defined as a New Source if construction commenced after proposal of NSPS, assuming that the proposed regulations would be subsequently promulgated.

Application of this rule to Quartz Hill would have dramatically lessened the practicability of tailings disposal, and therefore, project development; because: (1) In the case of STD, economics dictate that some process waters must accompany the tailings in the discharged slurry. (2) In the case of on-land disposal in tailings ponds, zero discharge by means of pond water recycling would be practicably unachievable in the climate of the Quartz Hill area, because the excess of annual precipitation over evaporation would greatly exceed plant requirements.

After attending an EPA sponsored workshop on the proposed rules, the Company and its consultants prepared comments and a request for exemption because of Quartz Hill's special conditions. These were submitted to EPA on August 24, 1982. The submission argued for reformulation of rules that would make provision to allow an STD option to be examined. For Quartz Hill this might prove to be the more desirable option given the climate, topography, snowslide and seismic hazards, esthetic values and sensitivity of the fishery resources of the area. The comments concluded that:

> The regulations as proposed, pose an unreasonable, burdensome and costly impediment to the development at Quartz Hill.... In view of the unique environmental, technological, economic and legislative constraints the Quartz Hill Molybdenum Project faces, U.S.

> Borax...requests that EPA revise the proposed regulatory language, as appropriate, to provide for a deferral of definition of Best Available Technology (BAT) and NSPS for Quartz Hill until sufficient data becomes available. (Ref. 27)

On December 3, 1982, EPA promulgated NSPS and the effluent limitations for the Ore Mining and Dressing category, of which Subpart J (40 CFR 440.100) dealt with the Copper, Lead, Zinc, Gold, Silver and Molybdenum Ores Sub-category. Quartz Hill was specifically exempted from the provisions of that Subpart. The preamble to the regulations stated:

> the Agency believes it would be premature to subject the mine and mill to regulation at this time, before the environmental review process is fully completed.... Accordingly, the Agency is excluding this mine and mill from the regulations applicable to molybdenum mines and mills, thereby postponing consideration of the appropriate limitations for this facility until the permit proceedings. (46 Fed. Reg. 54601, Dec. 3, 1982)

EPA thus indicated that it would not promulgate special regulations to cover the Quartz Hill situation. Instead, the permit writers of Region X would determine appropriate technology-based standards on an individual basis in the permit proceeding for an NPDES permit pursuant to Section 402 of the Clean Water Act.

3.2.3 Department of State Fjord Classification

Section 403 of the Clean Water Act requires that proposed discharges into the ocean, "contiguous zone", or "territorial seas" require evaluation by EPA under a set of Ocean Discharge Criteria (ODC). These are supported by regulations in 40 CFR 125, Subpart M. The question remained, however, as to whether fjords such as Boca de Quadra and Smeaton Bay were considered part of the ocean as defined, and thus subject to these regulations. In a February 1984 letter to the Company, the Director of the Water Division of EPA Region X, stated that in the absence of any State Department determination on the classification of the fjords, EPA would apply the Ocean Discharge Criteria.

Although the consequences of ODC application were not entirely clear, it was believed by the Company's legal consultants that this would impose yet another regulatory hurdle by adding additional and unnecessary requirements. In addition to requiring review of new technical questions about the effects of any discharge into the ocean, EPA's regulations provide that EPA will not issue a permit unless it can determine that there will not be "unreasonable degradation of the marine environment" (40 CFR 125,123 (a) and (b)). That determination in turn is based on an assessment of technical factors set forth in 40 CFR 125.122. Application of these regulations, designed for discharge of wastes in the open ocean, was felt to be inappropriate because of the closed nature of the fjord basins.

In February 1986, the Company requested by letter from the Department of State a determination of the "baseline for measuring the breadth of the territorial sea" in the vicinity of Smeaton Bay and Boca de Quadra. The Department of State responded by defining "closing lines" across the mouths of the fjords (Ref. 46). This had the effect of classifying Smeaton Bay and Boca de Quadra as "internal waters" and placing them under the administration of the State of Alaska rather than the Federal government.

EPA was therefore no longer legally required to consider the discharge under the more restrictive requirements of the Ocean Discharge Criteria. This removed a potential roadblock. Nevertheless, EPA felt that the criteria would provide useful guidelines and chose to evaluate the discharge by conducting a Best Professional Judgment (BPJ) evaluation under the guidance of the Ocean Discharge Criteria. EPA's final BPJ report was issued in June 1988 and included in the Final EIS as Appendix S (Refs. 30 and 48).

3.3 Comparative Assessment of Alternatives

In July 1983, U.S. Borax submitted to EPA an application for an NPDES permit to discharge 80,000 tpd of tailings into the inner basin of Boca de Quadra. At the same time, Borax also applied for a Certificate of Reasonable Assurance from the Alaska Department of Environmental Conservation (ADEC). In its applications, the Company noted that additional information on certain items would be developed and submitted as it became available.

Permitting strategy was formulated by the Company and its legal and engineering consultants in the second half of 1983. It was believed that while EPA had agreed not to apply NSPS to the Quartz Hill facility, EPA was still not convinced that land disposal would not ultimately prove to be a feasible option. EPA would therefore have to be provided with more-than-adequate technical justification, against possible charges of having applied a less rigorous standard to Quartz Hill as compared to the rest of industry. In scoping the project development EIS, for which it was a "cooperating agency", EPA had also requested answers to a number of questions. These were to be provided in the EIS so that EPA could make an informed decision on the NPDES application.

Consequently, Bechtel was commissioned to conduct a full, objective analysis of possible tailings disposal methods, as a more detailed extension of its earlier analysis of project development concepts. A two-inch thick report entitled "Comparative Assessment of Tailings Disposal Alternatives" (Ref. 28) was submitted to EPA in December 1983 in support of the NPDES application and as a reference document for EIS preparation.

The report evaluated five tailings disposal concepts for the project which recognized constraints imposed by ANILCA and the Clean Water Act, and provided a side-by-side comparison of the engineering, environmental and cost aspects of the five alternatives. The report was supported by appendices which provided back-up design data, calculations and more detailed evaluation of specific questions raised in project scoping.

The five alternatives were:

Land Disposal

1. Plant at Beaver Creek, on-land tailings disposal impoundments in Tunnel Creek and Aronitz Creek valleys

Submarine Disposal

2. Plant at Tunnel Creek, submarine tailings disposal in Boca de Quadra (the then-proposed project)

3. Plant at Tunnel Creek, submarine tailings disposal in Wilson Arm/Smeaton Bay

4. Plant at Beaver Creek, submarine tailings disposal in Boca de Quadra

5. Plant at Beaver Creek, submarine tailings disposal in Wilson Arm/Smeaton Bay

The Beaver Creek plant site was to be located about one mile northwest of the ultimate pit boundary, at an elevation of about 1700 ft. Figure 3.1 depicts the first of the above alternatives.

In addition to the five alternatives studied in depth, several other possibilities were looked at but rejected and therefore not included in the report. These included disposal in the open ocean by barge, rejected because of extremely high cost and unacceptable operating problems such as weather delays (Ref. 32).

The discussion of the on-land disposal alternative noted that the feasible sites for tailings storage are volumetrically inefficient because of their wide-mouthed valley configurations with steeply sloping floors. Two sites would be required to contain the tailings from the entire 1.5 billion ton orebody. Rock core dams of 1000 ft and 780 ft height would eventually be needed, ranking these dams as among the highest in North America.

Power requirements would be higher than for any of the STD options and water supply more costly. Use of Tunnel Creek valley for tailings disposal would also eliminate the favored Tunnel Creek plant site and the personnel housing in conjunction with this site; other locations would have to be developed. Construction of the dams would alter the downstream flows and quality of Tunnel and Aronitz Creeks, resulting in loss of about 1.5 percent of the salmon escapement in the Quartz Hill area. About 2700 acres of riparian and terrestrial habitat behind the dams would also be lost. The difficulty of dam maintenance in perpetuity after operations had ceased, and seismic risk, were also considered.

Finally, the combined capital and operating cost of the on-land disposal scheme was estimated at $3.6 billion, more than three times the cost of constructing and operating the entire project with STD.

In evaluating the environmental effects of the STD alternatives, it was stated that the bathymetry of the fjords would be significantly affected. Also, some benthic organisms would be smothered while mobile species would be displaced. However, rapid recolonization was expected after cessation of disposal and water quality impacts during operation would be ameliorated by natural sedimentation. Impacts on the fjord environment, while long term, were not expected to be permanent.

The conclusions of the study were as follows:

- While on-land tailings disposal and subsequent recovery and recycling of run-off from the tailings is a general practice in molybdenum mines in the interior areas of the lower 48 United States, climatic and topographic considerations render such a system uneconomic and environmentally unacceptable at Quartz Hill.

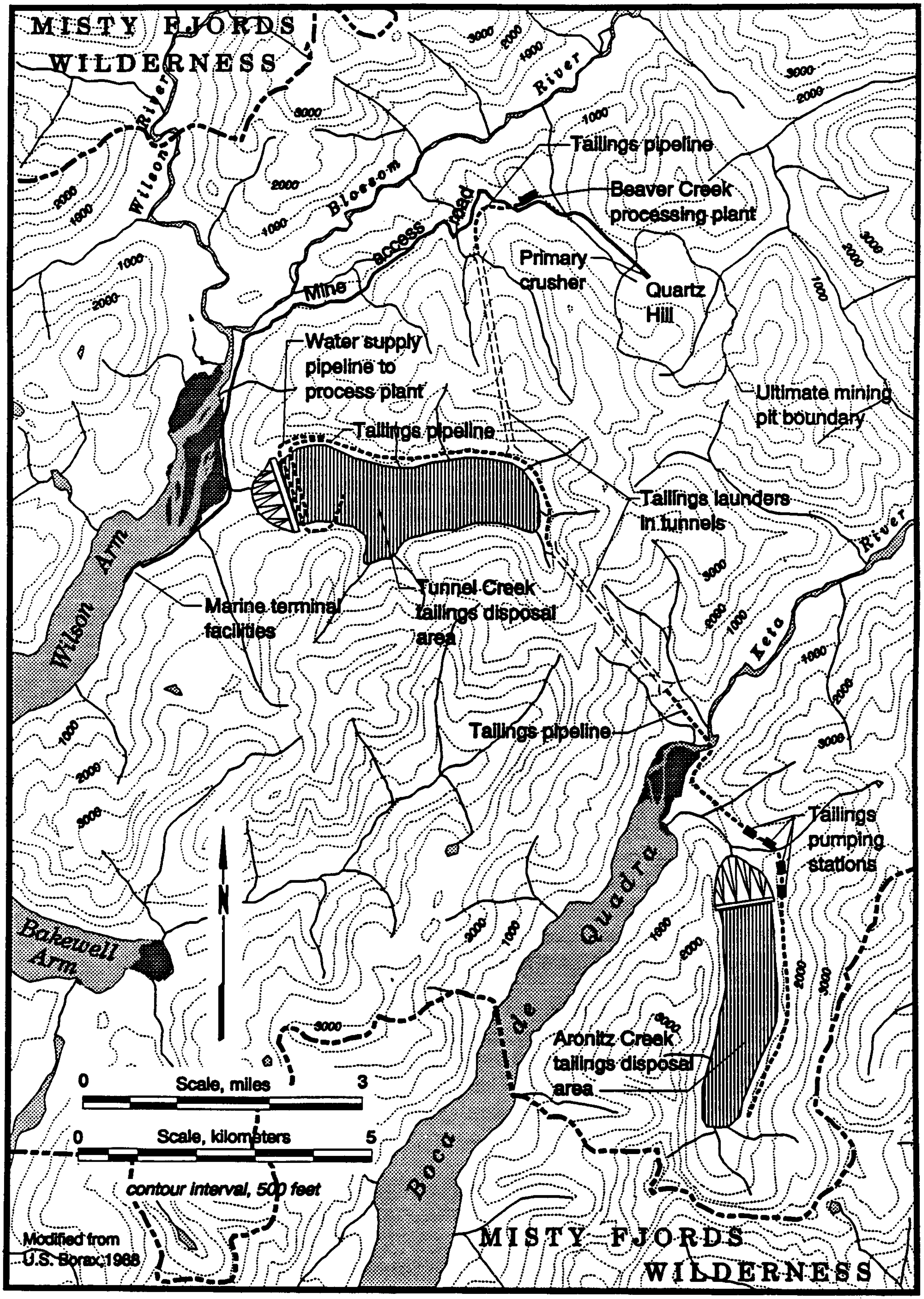


Figure 3.1 - Beaver Creek processing plant, on-land tailings disposal (Tunnel-Aronitz).

- Constraints on mine development, as a result of special recognition of Quartz Hill by ANILCA, place particular value on terrestrial and fishery habitat and aesthetics of Misty Fjord National Monument, which are not compatible with on-land disposal.

- Discharge of similar tailings in deep marine waters by projects in similar climatic and topographic areas in British Columbia have been found to have relatively low impact on biota, the primary impacts being loss of bottom habitat and smothering of benthos during project operation.

- Use of submarine tailings disposal would reduce considerably the adverse impact on the values of the Misty Fjord National Monument, by reducing terrestrial habitat loss, potential downstream impacts on fishery habitat, and long-term aesthetic impact.

- The capital, replacement and operating costs and energy requirements of submarine tailings disposal are significantly less than those of on-land disposal.

U.S. Borax stated as its position that the analysis supported selection of STD for Quartz Hill. Since the Forest Service had ruled out Wilson Arm/Smeaton Bay in the Record of Decision for the Road Access and Bulk Sampling EIS, the Company proposed, in December 1983, to dispose of tailings in Boca de Quadra.

The Director of the Water Division, EPA Region X, confirmed in February 1984 that the Quartz Hill Molybdenum Project was excluded from not only the New Source Performance Standards, but also all effluent guidelines applicable to the Copper, Lead, Zinc, Gold, Silver, and Molybdenum Ores Subcategory of Ore Mining and Dressing. He stated that "in lieu of applicable guidelines, the EPA NPDES permit for your project will be based on a best professional judgment (BPJ) determination of best available technology economically achievable (BAT) and best conventional pollutant control technology (BCT)" (Ref. 47). EPA requested additional information to allow a fully objective evaluation in the EIS of land disposal versus STD.

4.0 REGULATORY REQUIREMENTS FOR SUBMARINE TAILINGS DISPOSAL

Outlined in this section are the Federal and State of Alaska regulatory and permit requirements for the submarine tailings disposal portion of the Quartz Hill Project. There was also the requirement to define the characteristics of the tailings slurry to be discharged and the receiving marine environment, to enable design of the submarine tailings disposal system. These requirements are covered in Sections 5 and 6.

The Quartz Hill Project is located in the non-Wilderness portion of the Misty Fjords National Monument, within the Tongass National Forest managed by the Forest Service. The Bureau of Land Management, United States Department of Interior, has delegated its responsibility for minerals management under a Memorandum of Understanding (MOU) to the Forest Service. The State of Alaska manages the tidelands, submerged lands and "internal waters", which include all of Wilson Arm/Smeaton Bay and Boca de Quadra fjords.

The tailings disposal system of an ore milling facility consists of many components, such as pipelines to transport the tailings, a disposal site, and ancillary facilities. While the discussion herein mentions overall mine development, the primary emphasis is on permitting the tailings outfall and discharge of the tailings slurry on the fjord floor, the tailings disposal site.

4.1 Federal Regulations and Permits

There are a large number of federal laws, executive orders and implementing regulations that apply to the overall construction and operation of the proposed mine and milling facilities. Those applicable to the submarine tailings disposal portion of this project are primarily in the areas of mining and land management, protection of environmental resources and water quality, which are highlighted below.

- Mining Law of 1872, as amended
- Organic Act of 1897
- Fish and Wildlife Coordination Act of 1934
- National Environmental Policy Act of 1969
- Coastal Zone Management Act of 1972
- Endangered Species Act of 1973
- Clean Water Act of 1977, as amended
- Council of Environmental Quality Regulations, 1979
- Alaska National Interest Lands Conservation Act of 1980

A more complete list of laws and regulations applicable to the Quartz Hill Project as of 1983 is in Appendix A.

The primary Federal permitting agencies and their principal permits are as follows:

USDA, Forest Service
- Environmental Impact Statement (EIS)
- Plan of Operations
- Special Use Permits

U.S. Environmental Protection Agency
- National Pollutant Discharge Elimination System Permit (NPDES)

U.S. Army, Corps of Engineers
- Rivers and Harbors Act of 1899, Section 10
- Clean Water Act of 1977, Section 404

A list of permits and approvals for overall mine development for the construction and operation phases is shown in Appendix B. In the permitting of the Quartz Hill Project, permits were prioritized by the Company; with the first phase devoted to the Priority 1 permits, to be followed at later stages of the project by Priority 2 and 3 permits.

Other Federal agencies such as Fish and Wildlife Service of United States Department of Interior and National Marine Fisheries Service of United States Department of Commerce, along with various State of Alaska agencies, had a review function for these and State permits. Permitting flow diagrams for the above three Federal permitting agencies are in Appendix C.

4.2 State of Alaska Regulations and Permits

State of Alaska laws and regulations are in the areas of land and water management, protection of environmental resources and water quality. Those of significance are listed below, and a more complete list is in Appendix A.

- Water Use Act of 1966
- Environmental Conservation Law of 1971
- Alaska Coastal Management Program Law of 1977
- Department of Environmental Conservation, Water Quality Standard Regulations (18 AAC 70)
- Department of Natural Resources, Tide and Submerged Lands and Water Management

The primary State of Alaska permitting agencies and their principal permits are as follows:

Office of the Governor, Division of Governmental Coordination (DGC)
- Coastal Management Program Certification of Consistency

Alaska Department of Environmental Conservation
- Certification of Reasonable Assurance

Alaska Department of Natural Resources
- Water Rights
- Tideland Lease
- Submerged Lands Lease

Most State and Federal agencies with permitting authority have their proposed permits reviewed by a number of other State and Federal agencies, and this usually includes public review. Flow diagrams showing the State permitting processes are presented in Appendix C.

5.0 ENVIRONMENTAL EVALUATION OF SUBMARINE TAILINGS DISPOSAL OPTIONS

Engineering, environmental and cost analyses were made by the Company of a wide range of concepts for the location of ore milling facilities and tailings disposal sites on-land, in the ocean and in the fjords adjacent to this molybdenum deposit. As described in Section 3.3, on-land tailings and open ocean disposal were determined to be unacceptable alternatives based on environmental and cost factors. The fjord system was chosen as the preferred alternative, pending further environmental analyses.

5.1 Description of Available Options

The fjords in Southeast Alaska are long, narrow, formerly glaciated valleys, many of which have sills at their outer ends forming closed submerged basins. These closed marine basins are favorable geomorphologic features for the containment of mill tailings. The fjords with closed basins near the Quartz Hill mineral deposit are Wilson Arm/Smeaton Bay and Boca de Quadra.

The geographic features and axial bathymetry of these two fjord systems are shown in Figures 5.1 and 5.2 (Ref. 30, p. F-3, F-4). The characteristics of these two fjords as to length, depth and volume are given in Table 5.1.

Table 5.1 a/. Quartz Hill Fjord Characteristics

Fjord / Basin	Length, miles	Sill Depth, feet	Maximum Basin Depth, feet	Volume Below Sill Depth, million ft^3
Wilson Arm / Smeaton Bay	12.4	425	970	27,440 c/
Boca de Quadra				
Inner	4.4	345	560	3,530
Central	20.5	280	1280	151,850 b/
Outer	12.4	280	1215	

a/ Ref. 30, p. 3

b/ Ref. 18, p. 18

c/ Based on calculations from Professional Design Resources, 1985.

Wilson Arm/Smeaton Bay has one sill and one submerged closed basin, whereas Boca de Quadra is longer and deeper than Wilson Arm/Smeaton Bay and has three sills forming three basins (Figures 5.1 and 5.2). The proposed tailings outfall in Wilson Arm would be near the head of the fjord, with the tailings flowing in a coherent stream to the bottom of the basin. The three possible tailings outfall alternative sites considered for Boca de Quadra were near the center of the inner basin, just downfjord of the inner sill in the middle basin (Figure 5.3), and 2.1 miles downfjord of the inner sill in the middle basin (not shown). The latter site was proposed at one point by EPA but was rejected as being environmentally unnecessary and inordinately costly.

After evaluation of all the project conceptual factors, the preferred surface mine access route was from Wilson Arm up the Blossom River valley, and the preferred plant site in Tunnel Creek valley about one mile easterly of the head of Wilson Arm. Thus, transport of the tailings from the Tunnel Creek plant site to the various outfall alternatives would be as follows:

Wilson Arm outfall - 14,000 feet by pipeline
Boca de Quadra
  Inner Basin outfall - 28,000-ft tunnel
  Middle Basin outfall - 38,000-ft tunnel or longer

The surface facilities for the middle basin outfall would be located in the designated Wilderness area. Figure 5.3 shows the three STD alternatives.

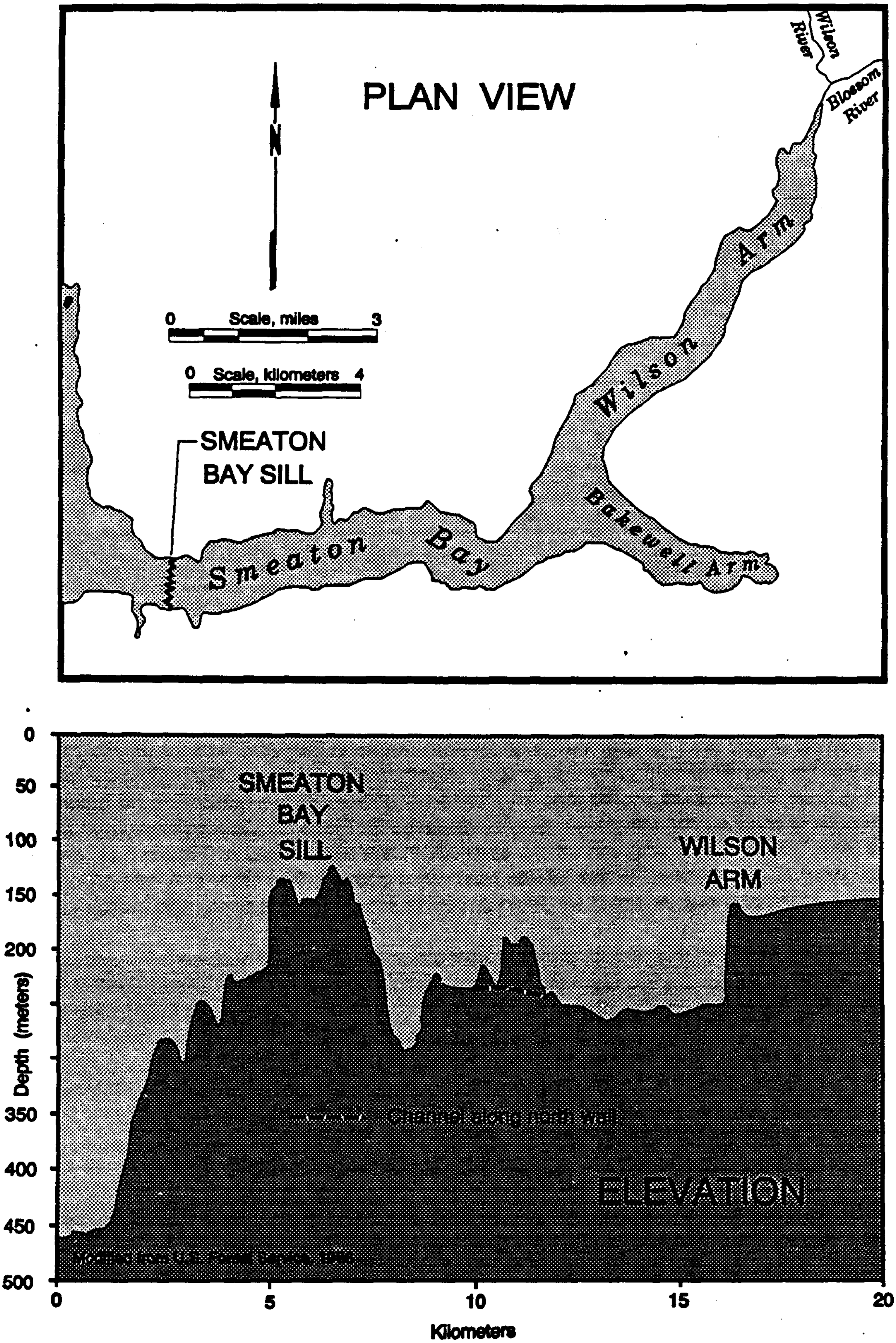


Figure 5.1 - Geographic features and axial bathymetry for Wilson Arm/Smeaton Bay.

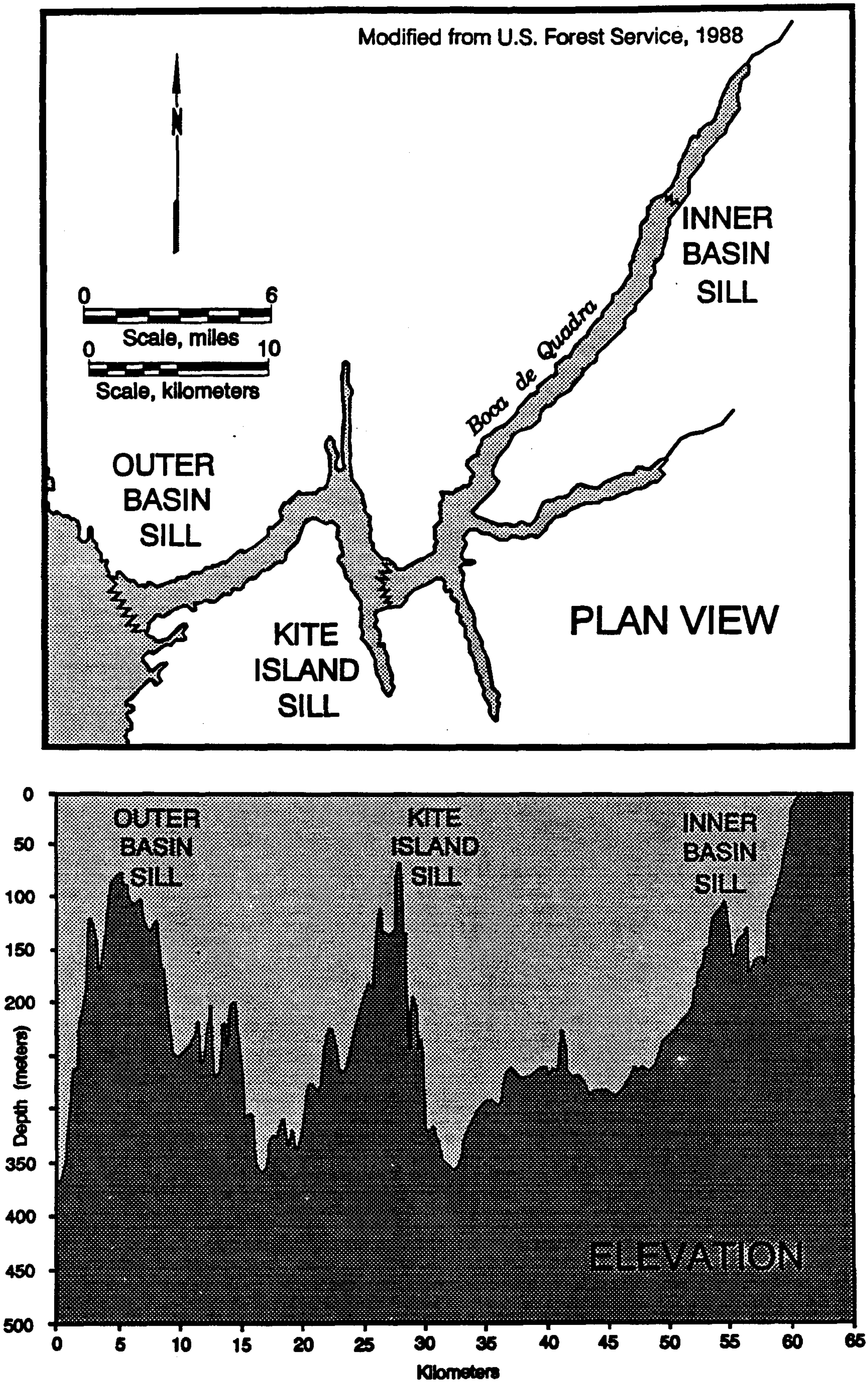


Figure 5.2 - Geographic features and axial bathymetry for Boca de Quadra.

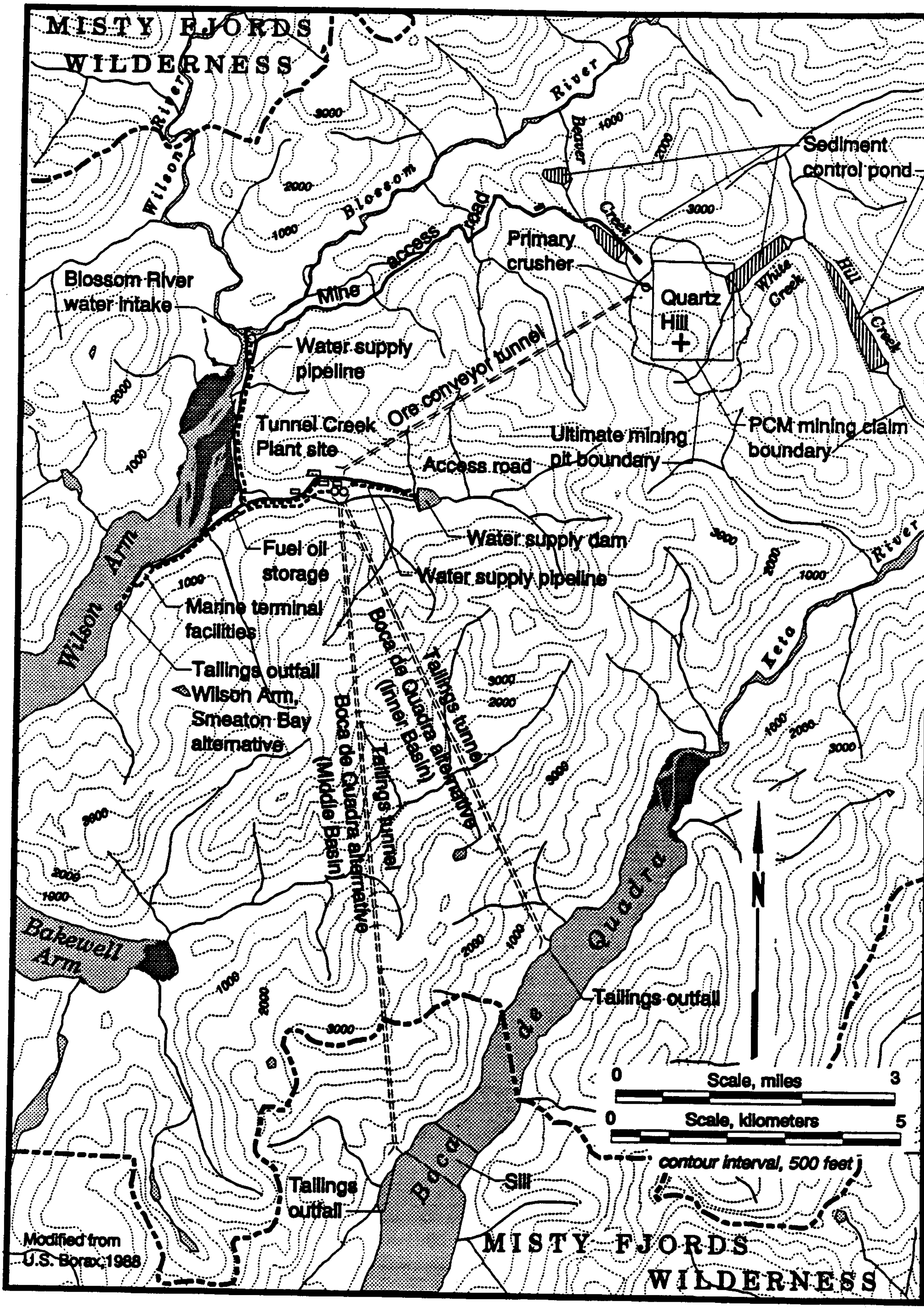


Figure 5.3 - Tailings disposal plan and alternatives.

5.2 Environmental Baseline Data Collection

The objective of the environmental baseline data collection program was to characterize the physical, biological, social and economic environment of the project area sufficiently to define a preferred mine development plan which would minimize the overall environmental impacts. For the submarine tailings disposal component of the project, baseline data collection consisted primarily of characterizing the physical and chemical oceanography, and the marine biology of Wilson Arm/Smeaton Bay and Boca de Quadra.

5.2.1 Summary of Work Completed

The waters of both fjord systems are vertically stratified with variations throughout the year. Current meters were deployed to measure continuously over the seasons the velocity and direction of currents at various depths. Up to a total of nine moorings and 25 current meters were used. In addition, tide level measurements, selected echo soundings, meteorological measurements and bathymetric surveys were made. Seawater samples were taken seasonally at the current meter mooring stations throughout the water column. The oceanographic sampling stations are shown on Figure 5.4.

Samples were analyzed for conductivity, salinity, temperature, depth, turbidity, dissolved oxygen, redox potential, carbonate, alkalinity, nutrients (NO_3, NO_2, NH_4, PO_4), silicates, iron and trace metals. In addition, shallow cores were taken of the fjord floors to measure sediment physical and chemical properties.

The coastal and marine environs of Wilson Arm/Smeaton Bay and Boca de Quadra may be divided into five major habitat systems; (1) epipelagic or open water photic (<100 ft deep), (2) mesopelagic, below the photic zone (>100 ft deep to 30 ft of bottom), (3) deep benthic (>100 ft deep including bottom and the water to 30 ft above the bottom), (4) nearshore (benthic habitat <100 ft deep and within 300 ft of shore) and (5) estuary region. The epipelagic, nearshore and estuarine habitats are biologically the most important. The epipelagic habitat includes the euphotic zone extending from the fjord surface to a maximum depth of about 25 or 30 meters. This is the zone through which sufficient light penetrates to permit growth of green plants, and most of the biological activity occurs within this layer. Estuarine habitat includes the area at the mouths of rivers where fresh water and salt water interact with fine grained alluvial sediments. Birds, including bald eagles, frequent the estuaries, and harbor seals are present in the surface waters of both fjords, concentrating near the estuaries during periods of smelt and salmon spawning. Whales sporadically visit both fjords.

Coastal and marine biological baseline data were collected as the basis for determining the potential biological effects of submarine tailings disposal. This is central to the issuance of EPA's NPDES permit. Data collection included surveys at over 70 stations in each fjord system. Parameters measured often overlapped those of the oceanographic data collection. The following surveys were made:

- Hydrography and chemistry
- Phytoplankton
- Zooplankton
- Ichthyoplankton

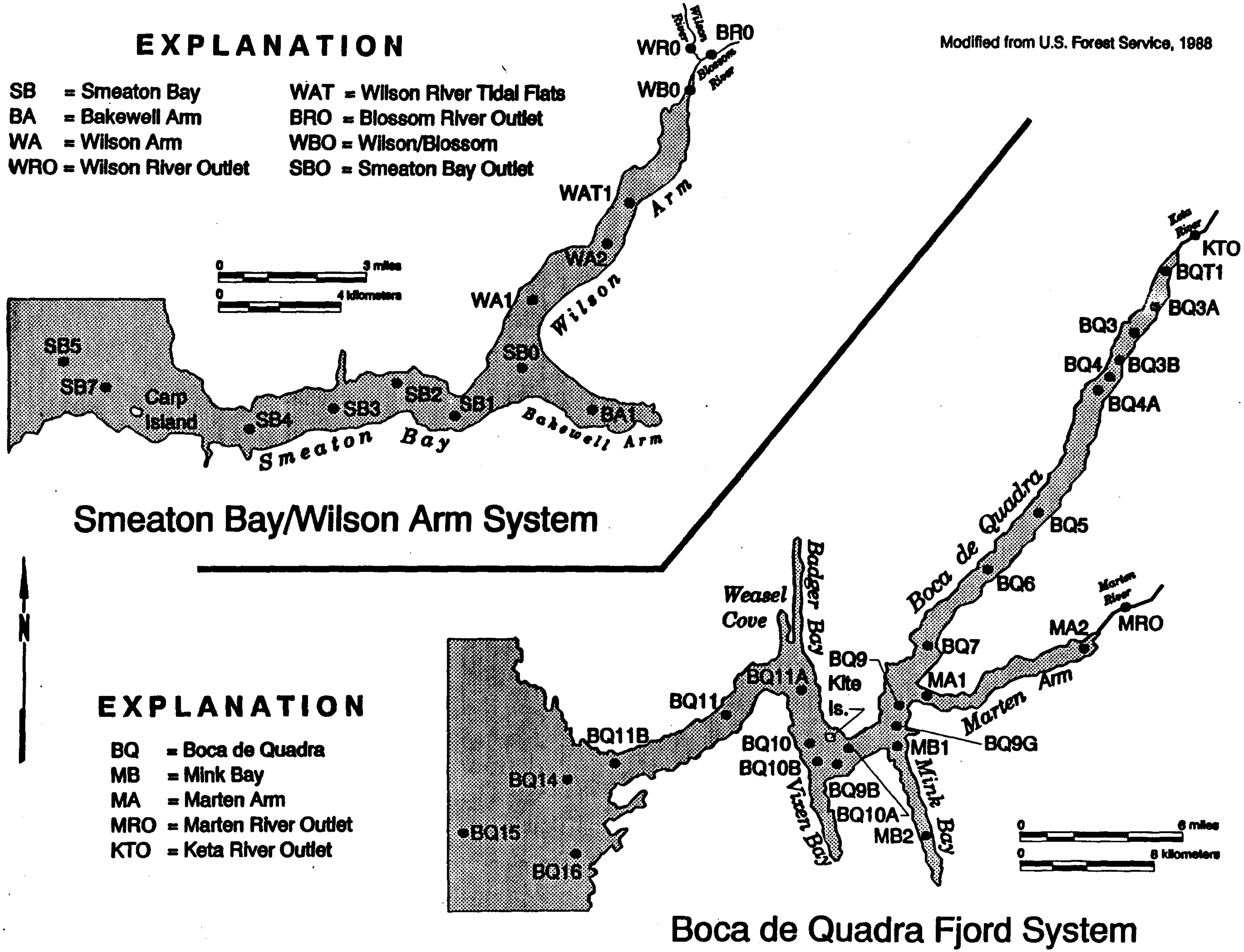


Figure 5.4 - Oceanographic sampling stations.

- Benthos of rocky and soft-bottom intertidal, and rocky and soft-bottom subtidal zones
- Benthic recolonization
- Fish nearshore, estuarine, and demersal
- Estuarine wildlife
- Marine mammals

Acute and chronic bioassay programs using actual mill tailings from pilot plant tests were conducted on selected marine biological species.

A number of contractors were used to collect the marine environmental baseline data, and their areas of responsibility were as follows:

- Institute of Marine Science, University of Alaska-physical and chemical oceanography, and circulation modeling.
- VTN Consolidated, Inc. - marine biology and meteorology.
- Sea-Lease, Inc. - leased 80-foot vessel, M/V REDOUBT.
- E.V.S. Consultants - acute and chronic bioassays.
- Seakem Oceanography - seawater trace metal analyses.
- Dobrocky Seatech Ltd. - survey of Boca de Quadra and monitoring strategies.
- Tetra Tech, Inc. - bathymetric survey of portion of Boca de Quadra.
- Rescan Environmental Services Ltd. - analyses of seawater, tailings and technical data.
- National Oceanographic and Atmospheric Administration (NOAA) - detailed bathymetric surveys of Wilson Arm/ Smeaton Bay and Boca de Quadra in 1982.

The Institute of Marine Science , University of Alaska (IMS) collected oceanographic data in both fjords from October 1978 through December 1983 (Ref. 30, p. 3-33). The initial three cruises used the IMS vessel R/V ACONA, and subsequent cruises used the Company's leased vessel, the M/V REDOUBT, first placed in service in August 1979. VTN Consolidated, Inc. collected coastal and marine biological baseline data from August 1978 through September 1983. Sampling periods varied from 5 to 7 per year for 1980-82.

5.2.2 Wilson Arm/Smeaton Bay

The circulation pattern of Wilson Arm/Smeaton Bay is fairly simple, in that this fjord consists essentially of one basin and one sill. Circulation is dominated by the large tidal range with occasional high tides exceeding 20 ft, strong vertical density gradients, and seasonal changes in the seas outside the fjord. Bottom water replacement occurs late spring and summer by denser saline water moving over the sill. In late fall and winter, the basin below sill level is essentially isolated from the outside sea. The above-sill water structure tends to follow the behavior exhibited outside the fjord throughout the year. A schematic and model of the circulation are shown in Figures 5.5 and 5.6 (Ref. 30, p. F-8; Ref. 13; Ref.30, p. 3-46; and Ref. 9).

The upper water column is most stable during spring and summer and least stratified during winter. The continual discharge of fresh water from the Wilson and Blossom Rivers into Wilson Arm comprises only a few percent of the tidal prism. Thus, freshwater-driven estuarine circulation is not a major feature of the fjord circulation.

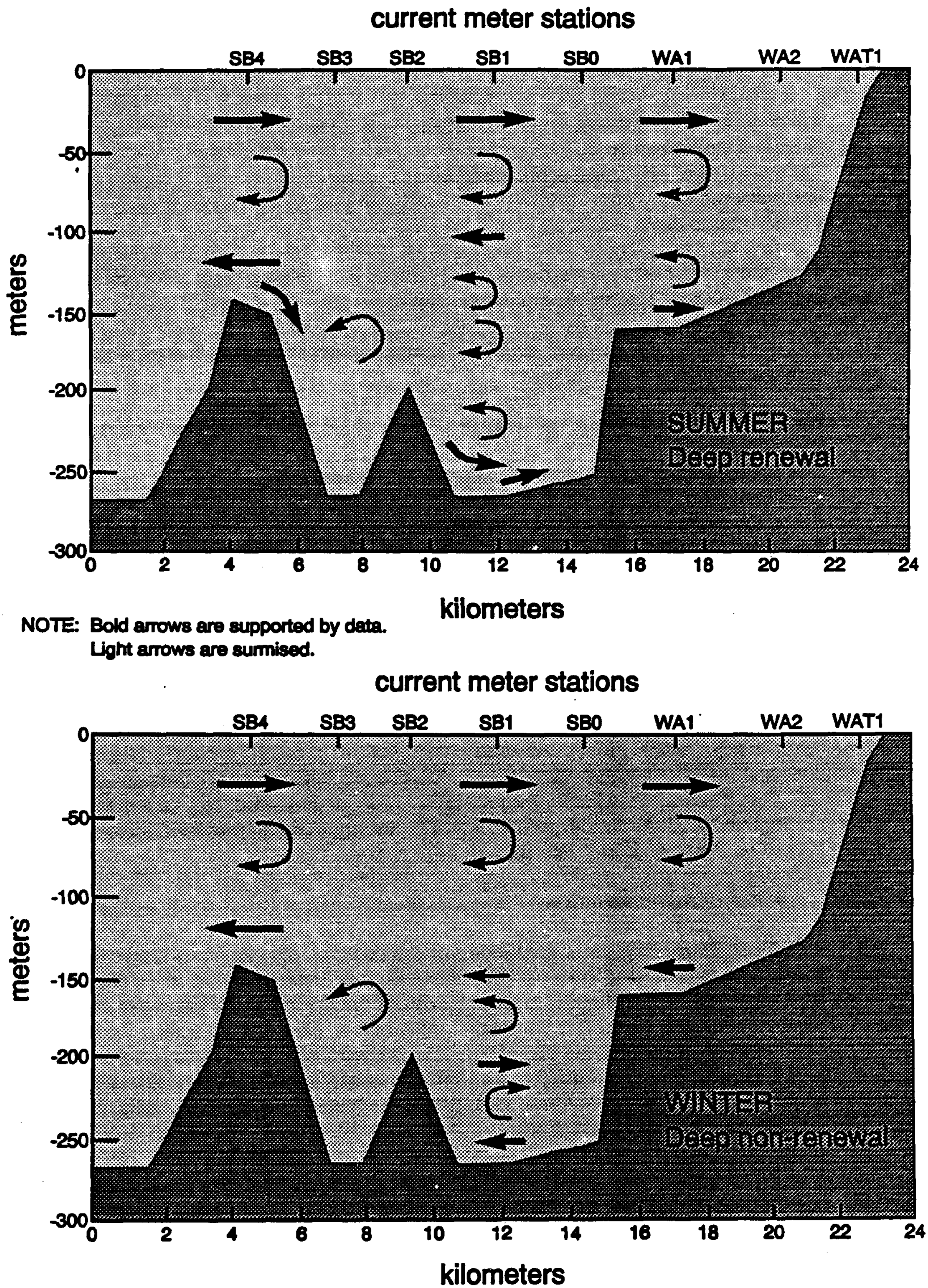


Figure 5.5 - Schematic circulation patterns for Wilson Arm/Smeaton Bay.

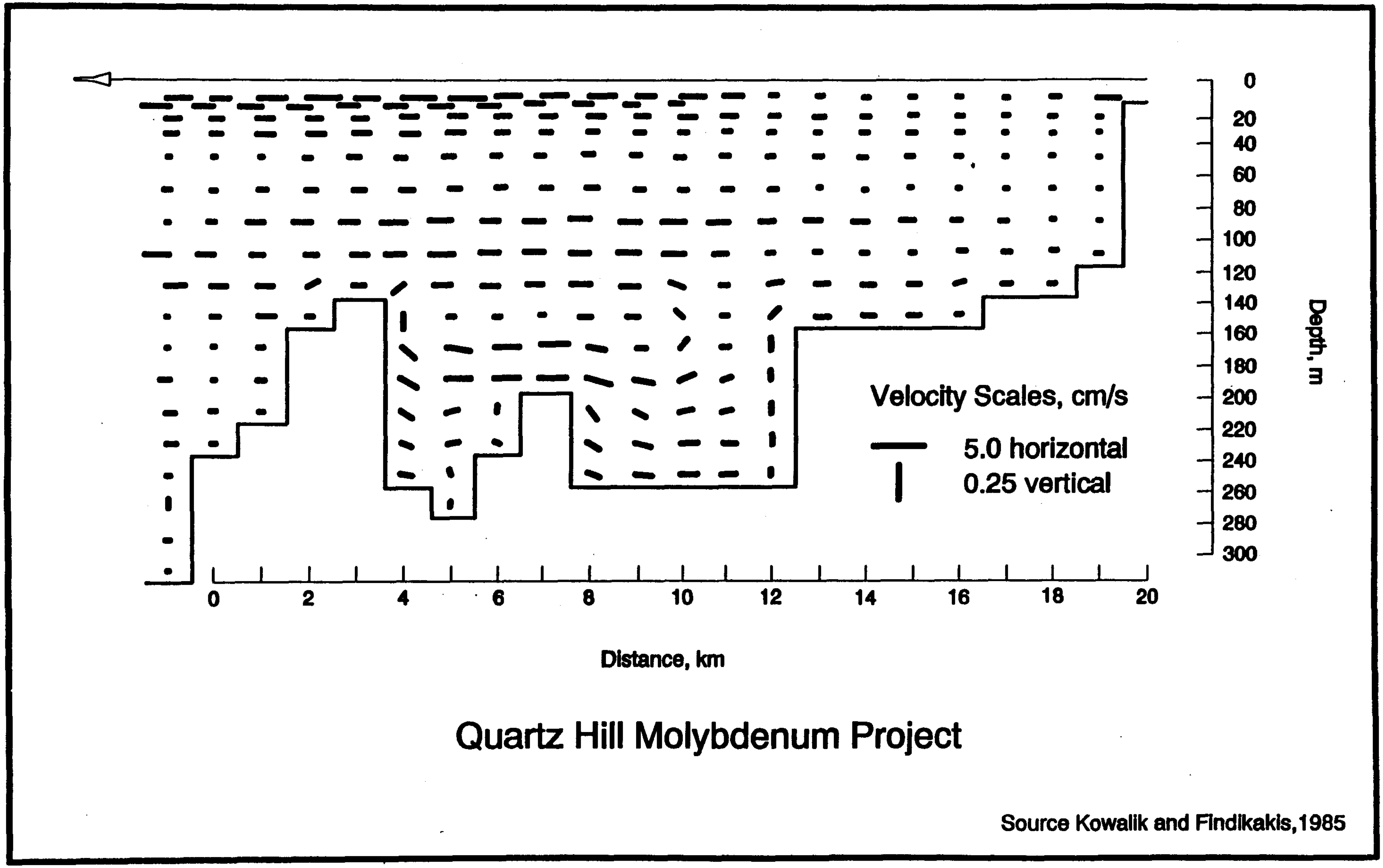


Figure 5.6 - Pre-mine Wilson Arm/Smeaton Bay Currents computed by the Tide and Density Driven Circulation Model - Deep Water Renewal Period.

The chemical oceanographic program defined the baseline for marine water and sediment quality. The high water quality is typical of uncontaminated coastal waters in this region. The dissolved oxygen within the fjord follows the seasonal water circulation pattern. Maximum oxygen concentrations of 8-9 mg/l are found in the euphotic zone and minimum concentrations of less than 2.5 mg/l are in the deep part of the basin. Organic carbon input is derived primarily from river-borne input and in-situ primary production. Heavy metal concentrations of Wilson Arm/Smeaton Bay are in the normal range of seawater, and concentrations in the river water entering the fjord are low. The sedimentation rate within the main basin is in the range of 0.1 to 1.0 cm/year. There is a concentration of heavy metals in the fine sediments on the floor of the basin, resulting from a natural solubility decrease of incoming dissolved heavy metals when mixed with the slightly alkaline seawater. The Final EIS may be consulted for further information on this area (Ref. 30, pp. 3-47 to 3-52).

The marine ecology program examined the five marine habitats, (1) epipelagic, (2) mesopelagic, (3) deep benthic, (4) near shore and (5) estuary region. Areas examined included composition of the biological communities, food chains, spawning and nursery areas, migration pathways, areas important to critical life cycle stages of organisms, and the existing and potential recreational and commercial fishery opportunities. Salmon is the most important fishery. Juvenile salmonids upon leaving the streams utilize the estuaries for rearing, then pass through the fjord to enter the ocean. Upon returning to spawn in the streams, the upper waters of Wilson Arm/Smeaton Bay is their primary pathway from the open ocean to the streams. The details of the results of this program are summarized in the Final EIS (Ref. 30, pp. 3-87 to 3-110).

5.2.3 Boca de Quadra Fjord

Three sills divide Boca de Quadra into three basins, the inner, middle and outer basins (Figure 5.2). The Keta River, a salmon spawning stream, flows into the upper extremity of this fjord, and several other rivers flow into various arms of the fjord. Figure 5.4 shows the sampling stations for the physical and chemical oceanographic program.

The circulation pattern is generally similar to that discussed in Section 5.2.2 for Wilson Arm/Smeaton Bay. Boca de Quadra has three sills and is longer and deeper than Wilson Arm/Smeaton Bay; thus, its circulation pattern is somewhat more complex. Current velocities are low in the upper waters and inner basin, increase in the lower portions of the middle basin, and are highest in the vicinity of the middle sill at Kite Island. See Figures 5.7 and 5.8 (Ref. 30, Appendix S, p. 57; Ref. 30, p. 3-43; and Ref. 10).

The chemical oceanography of Boca de Quadra was found to be similar to Wilson Arm/Smeaton Bay, with minor variations. The mean heavy metal concentrations of surficial bottom sediments are shown in Table 5.2.

Smeaton Bay heavy metal concentrations are similar, but concentrations of manganese appear to be higher in Boca de Quadra. In the chemically basic marine environment, heavy metals tend to precipitate out or be removed from solution by bacteria, which is demonstrated by the concentration of heavy metal nodules in various areas on the ocean floor in other parts of the world. A summary of these baseline data is in the Final EIS (Ref. 30, pp. 3-47 to 3-52).

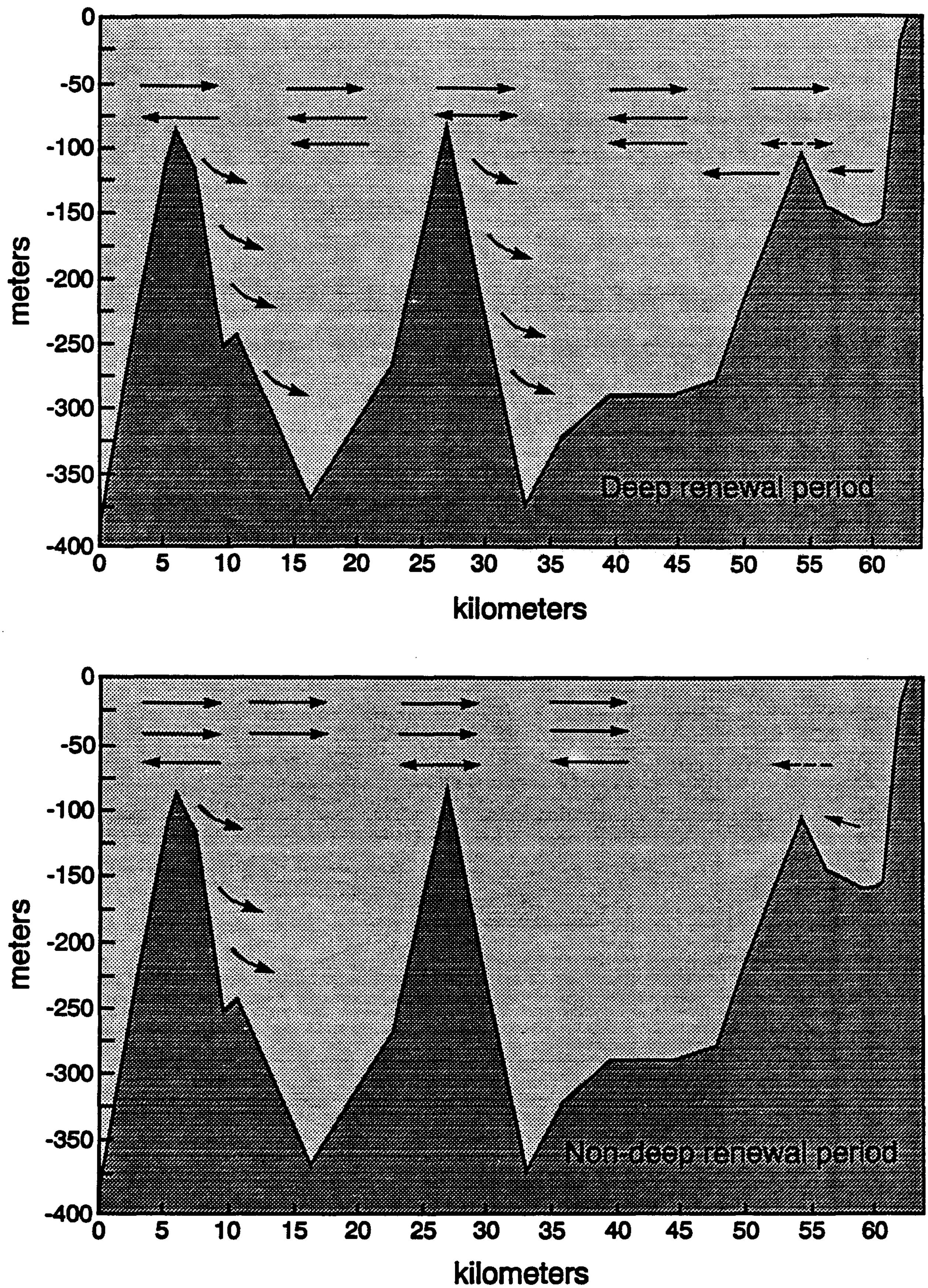


Figure 5.7 - Schematic circulation patterns (generalized) for Boca de Quadra.

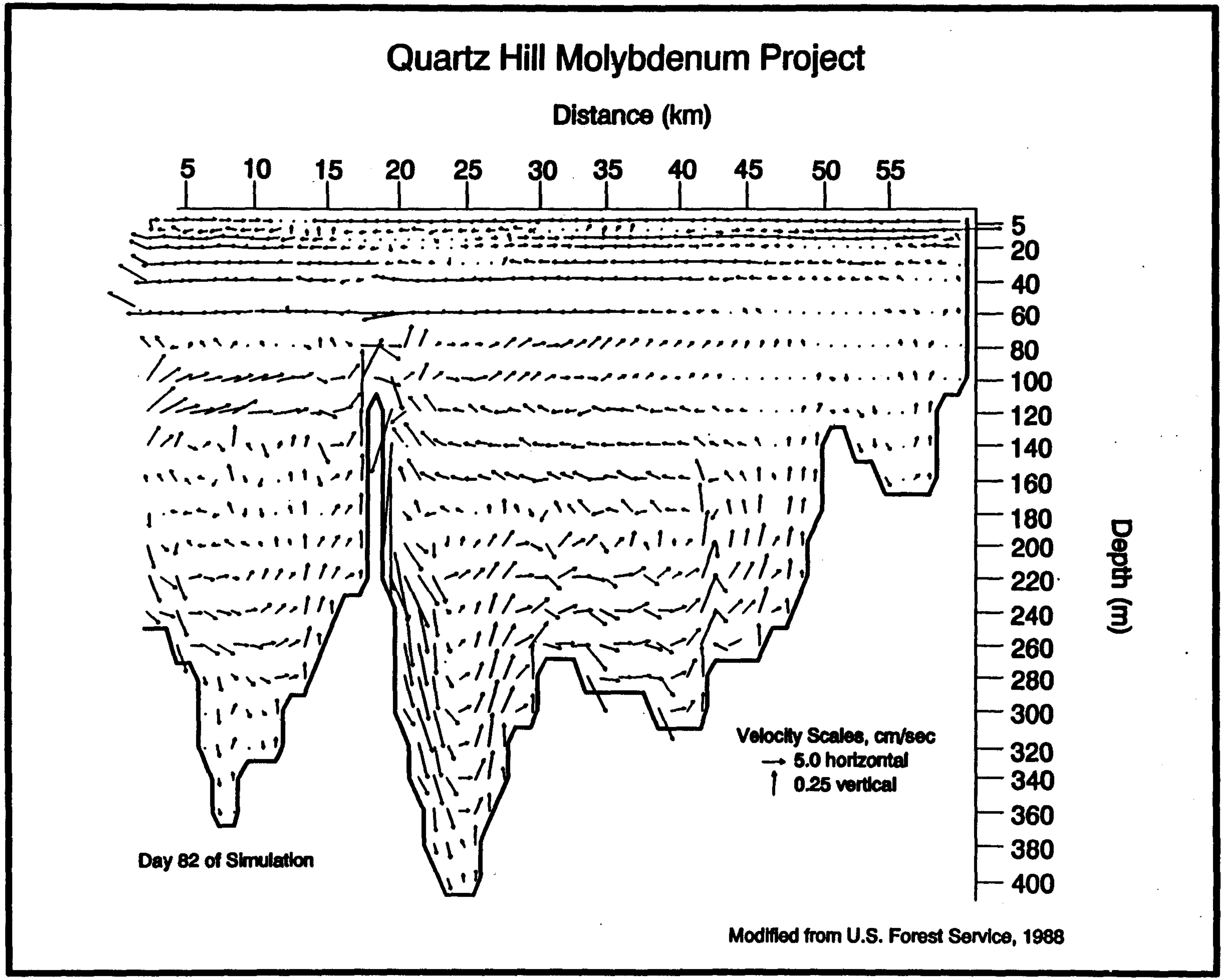


Figure 5.8 - Pre-mine Boca de Quadra currents computed by tide and density circulation model-deep renewal period.

The marine biological data collection program was similar to that for Wilson Arm/Smeaton Bay. These two fjord systems are similar, with only minor variations. The salmon escapement from the Wilson and Blossom Rivers is higher than from the Keta River. Boca de Quadra and the area near the mouth of this fjord have a higher herring population. These data are summarized in the Final EIS (Ref. 30, pp. 3-87 to 3-110).

Table 5.2 a/. Mean Heavy Metal Concentrations of Surficial Bottom Sediments

Metals	Micrograms
Copper	32
Lead	<15
Molybdenum	2
Zinc	60
Manganese	550
Cadmium	<1

a/ Ref. 5, Chapter 7, Table 7.20

5.3 The Containment Factor

The mine life was estimated to be 55 years, resulting in the need for disposal of up to 80,000 tpd, or about 1.4 billion tons of tailings. In order to allow evaluation of the volumetric suitability of the fjords for STD, the in-place density of the tailings placed on the bottom of the fjord was required to determine its volume and what the altered bathymetry of the fjord would ultimately be after deposition. Tailings density measurements using Quartz Hill tailings, were made by the University of British Columbia and found to be 100 lbs/ft^3, dry basis (Ref. 14). The long depositional slope of the top of the deposited tailings was estimated to average 0.5 percent, based on the experience of existing similar operations (Ref. 30, p. 4-48).

In selecting a submarine tailings disposal site, one desirable feature would be a submerged basin that would confine the tailings to the bottom of the fjord and restrict the movement of the fines fraction, during tailings deposition, from the fjord into the estuary and open ocean. The fjord bathymetry and oceanographic seasonal circulation patterns influence the suspension and deposition of the fines fraction. The concern about fines distribution, especially in the epipelagic zone, is its possible effect on the marine biological food chain.

For middle basin Boca de Quadra tailings disposal, some fines would be circulated and deposited in the inner basin; however, no significant quantity would leave the middle basin because of its length and depth. In Smeaton Bay, some suspended tailings fines would be transported out into Behm Canal. In the Final EIS, based on certain worst-case assumptions, the amount of tailings leaving Smeaton Bay was estimated to be in the order of one percent of the tailings discharged or 300,000 tons/yr, decreasing toward zero in the later years of operation. During operations, the average quantity of escaping tailings was expected to be significantly lower than the above estimate. The concentrations of tailings fines would be very small in Behm

Canal, and probably less than background concentrations of suspended solids from natural events (Ref. 30, p. 4-73). The National Marine Fisheries Service expressed a view that this eventually "would not likely result in a discernable impact to the fishery resources of Behm Canal" (Ref. 12).

5.4 Comparison of Disposal Sites

5.4.1 Physical Characteristics

The ideal site for submarine tailings disposal would probably include the following characteristics:

- Provides containment of the deposited tailings
- Low current velocities
- High salinity gradients
- A sharply defined and stable pycnocline
- A moderately steep sloping bottom topography at the outfall to below 100 m depth

Containment in a fjord or submarine canyon is important primarily to obtain quick deposition and avoid resuspension. The same reason lends importance to the current velocities (particularly near bottom) and the lack of any upwelling currents caused by tidal impingement. As discussed later, a high salinity gradient with a sharply defined pycnocline (the zone where seawater density increases rapidly with depth) will often act as a horizontal barrier to upward migration of tailings fines. This would keep impacts of STD away from the biologically important euphotic zone. A moderately steep sloping bottom at the outfall helps keep the tailings fines close to bottom, avoiding "split plume" formation (See section 7.3.1).

The three potential STD sites for Quartz Hill provide all of these characteristics to some degree. In both Wilson Arm and Boca de Quadra, the selected outfall sites have fjord walls which descend rapidly at an angle of about minus 25 degrees to the fjord bottoms at depths (opposite the outfall) of 350 ft for Wilson Arm to 450 ft or greater for the Boca sites. The pycnocline in both fjords varies seasonally in both strength and position. In the summer from May to October, the fjord water column is stratified with fresher water on top. At this time the pycnocline is strongest in both fjords and fluctuates in depth between 40 and 100 m. With the stable water column which exists in summer, there is a more definite tendency for the pycnocline to act as a barrier to upward circulation and movement of fines. This keeps fines below the level of the euphotic zone, which in these fjords typically extends to about 25 m in depth. In winter, when vertical mixing takes place, the pycnocline level deepens and while stratification is less, it is still significant. Of the two fjords, Boca de Quadra has the stronger stratification and pycnocline; however, near the Kite Island sill, it has also the stronger vertical component of currents causing mixing. It was concluded in EPA's PBJ analysis (Ref. 48, p. 80) that fines probably would not appear as high in the water column in Smeaton Bay as they might in Boca de Quadra; however, at comparable depths where suspended tailings are present, the concentration in Smeaton Bay would generally be higher. Increased turbidity from tailings discharge was not expected to occur above 50 m depth in either fjord (Ref. 48, p. 97).

As discussed in Section 5.3, both fjords provide adequate containment for the tailings. The middle basin of Boca, however, provides the greatest factor of safety, in that only 20 percent of its below-sill capacity would be filled at the conclusion of milling, as compared with 100 percent for the inner basin and 78 percent for Smeaton Bay (see Table 7.2).

5.4.2 Biological Comparison

The following is excerpted from EPA's BPJ Evaluation using Ocean Discharge Criteria (Ref. 48).

"There appear to be no significant differences in total primary phytoplankton productivity or zooplankton abundance between the fjords....Boca de Quadra appears to be generally more variable in plankton productivity and abundance due to its greater size and environmental heterogeneity" (Ref. 48, p. 81).

The economically important epifauna, such as Dungeness crab and shrimp, are most abundant at the shallow depths of both fjords. One of the largest herring spawning grounds in Southeast Alaska occurs at the mouth of Boca de Quadra. Both fjords are important herring rearing habitats, but Boca de Quadra probably has relatively greater density and abundance of juvenile herring because of its proximity to the spawning grounds and its larger size.

"The tributaries entering Wilson Arm support a much larger salmon run than tributaries to Boca de Quadra....The estuaries and nearshore areas of both fjords are also important rearing habitats for juvenile salmon, which occupy the upper 20 m of the water column. Certain demersal fish species (e.g., walleye pollock and slender sole) are substantially more abundant in shallow areas of Wilson Arm and Boca de Quadra inner basins than in the deeper areas..." (Ref. 48, p. 82).

As previously noted, fisheries experts agreed that salmon would not be affected by STD at any of the alternative sites.

5.4.3 Cost Comparison

In the mid-1980's, U.S. Borax estimated the cost differential between tailings disposal in Wilson Arm and Boca de Quadra middle basin to be $59 million in capital cost, plus $1.6 million in annual operating cost. This represented the additional expense for driving a 38,000-ft tunnel to the middle basin and added facilities at the Boca de Quadra portal, plus additional pumping and labor costs for servicing the remote facilities. When the cost of financing the additional capital was added, the equivalent increased expense in 1984 dollars for producing each pound of molybdenum was estimated to be 55 cents.

This is a significant figure with regard to consideration of the risk of closure of the operating mine during periods of fluctuating molybdenum prices. With the break-even cost 55 cents per pound higher, the operation would be forced to shut down earlier and remain closed longer, causing an adverse socioeconomic impact on the Ketchikan area.

5.4.4 Overall Evaluation

Several evaluations of the relative merits of the three STD sites were made by Rescan Environmental Services between March 1984 and October 1985 (Ref. 15). These evaluations addressed all facets of tailings disposal including tailings transport to the outfalls, outfall design, tailings behavior and dispersal patterns in the marine environment and the ecological significance of each component.

For the March 1984 report, twenty indices were developed for each basin to indicate relative biological productivity. Comparison indicated that "there is no statistically significant difference between biological productivity of the Wilson Arm/Smeaton Bay system and the Boca de Quadra central basin. The inner basin of Boca de Quadra was found to have slightly lower productivity....Thus, it was concluded that there is little to distinguish a preferred option on ecological grounds" (Ref. 16).

After considering new information on Wilson Arm/Smeaton Bay, the July 1985 evaluation noted that while deep water movements could cause some resuspension at depth, "there are no indications that resuspended material would circulate into the euphotic zone in any of the basins...the data supports a conclusion that suspended sediments will not encroach on the euphotic zone and, indeed, that nearly all fine tailings would remain below a depth of 60 meters. The new information on the Wilson Arm/Smeaton Bay system thus allowed us to conclude that this basin is the preferred alternative for submarine disposal of tailings from the Quartz Hill Project."

The Rescan evaluations were done by a team of eight internationally known specialists in marine ecology, oceanography, sedimentology, marine biology, fisheries and tailings system design and operation; several of whom had been involved as independent reviewers of the monitoring program for the Island Copper STD operation.

6.0 CHARACTERIZATION OF TAILINGS EFFLUENTS

6.1 Summary of Work Done

Much research and test work was done at various stages during the Quartz Hill project development to define the process and reagents, establish percent recovery, provide design information and economic data for the feasibility evaluation and to characterize the effluents from the plant. The testing included both bench scale and pilot plant tests. Representative samples of plant feed material were obtained at various times from diamond drill core splits, several tons of ore samples flown out prior to completion of road construction, and about 4800 tons of bulk samples of various ore types removed in August 1983 from the two adits driven into the orebody.

The bulk samples were treated in a series of pilot plant tests conducted at Hanna Mining Company's Research Center in Minnesota between November 1983 and February 1984. This information provided much of the data for the Final EIS. Other data were provided by smaller scale process testing done by the U.S. Borax Research Corporation at Anaheim, California. A number of specialist consultants and research organizations were also utilized. From these process tests were obtained representative samples of plant tailings, which in turn were used for other tests.

In addition to the process research, other investigations included mineralogical and chemical determinations, tailings slurry rheology, tests on settled tailings density, reagent toxicity investigations, and acute and chronic bioassays of the tailings samples. Literature searches were made on all aspects of STD. Field visits were made to operations that were using or had used

STD successfully; these included AMAX of Canada at Kitsault, BC and the Island Copper Mine on Vancouver Island. A data exchange program was arranged with the latter.

The objective of these efforts was to be in a position to provide the best possible information for project evaluation and permitting purposes, a part of which was the characterization of the tailings effluent.

6.2 Characterization of Quartz Hill Tailings

6.2.1 Ideal Characteristics

A list of desirable characteristics of a slurry for possible disposal into the submarine environment could be summarized as follows:

Solid phase:
- Simple mineralogy, primarily non-reactive
- Fresh and unaltered
- Little or no soluble constituents
- Low in heavy metals content
- Similar to erosional material already in the water
- Coarse grind, easily settleable
- Low in fines or slimes

Liquid phase:
- Low in dissolved heavy metals
- Low in other dissolved toxic constituents
- pH in neutral range
- Temperature close to receiving medium
- Specific gravity close to seawater

The importance of the specific gravity is to minimize the possibility of a gravity separation between a lighter, freshwater slurry constituent and the denser, seawater receiving medium. This could cause fines to rise in a freshwater plume towards surface. In practice, this risk is minimized by adding seawater, in the mixing chamber near the outfall, to the slurry as discharged from the mill. Mixing ratios of seawater:slurry of from 1:1 to up to 6:1 could be used.

The characterization of the Quartz Hill tailings, both solid and liquid phases, which resulted from the extensive test programs is summarized in the Final EIS (Ref. 30).

6.2.2 Solid Phase Characterization

Table 6.1, from Appendix A of the FEIS (Ref. 30, p. A-42) shows a chemical balance and a mineralogical balance of the solid phase of Quartz Hill tailings, based on pilot plant data. It is interesting to note that these data are closely comparable with similar data obtained at an earlier time, from different ore samples and different test runs.

In this representative sample, insoluble non-reactive minerals comprised 96 percent of the total. Few alteration minerals, which tend to form slow settling fines or slimes, were present. Heavy

TABLE 6.1 a/
PRELIMINARY TAILINGS THICKENER EFFLUENT CHARACTERIZATION
SOLID PHASE

Component	Tailings Concentration Weight Percent 1/
Chemical Balance	
Silicon dioxide (SiO_2)	77.0
Aluminum oxide (Al_2O_3)	11.4
Iron (total) (Fe)	1.2
Magnesium oxide (MgO)	0.3
Calcium oxide (CaO)	0.5
Sodium oxide (Na_2O)	3.2
Potassium oxide (K_2O)	5.0
Carbon dioxide (CO_2)	0.4
Others [TiO_2 (titanium dioxide), P_2O_5 (phosphorus pentoxide), MnO_2 (manganese dioxide), and H_2O (water)]	0.5
	100.0
Mineral Balance	
Quartz	34
Feldspar (total)	60
Biotite	2
Chlorite	1
Molybdenite	0.02
Pyrite	1
Magnetite	0.7
Calcite	0.8
Others	0.48
	100.00

1/ Typical weight percents are from nine whole rock analyses and these mineralogical/chemical analyses of tailings samples.

Source: U.S. Borax 1984a with modifications by Stine 1984.

a/ Ref. 30, p. A-42

metals other than molybdenum were present in only small or trace amounts. Sulfides were low and there were almost no soluble oxides.

Except for the presence of anomalous amounts of molybdenite, the ore-forming rocks are very similar to the average igneous crustal rocks of the Earth. The erosional products from these are transported by rivers naturally to the sea along the west coast of North America by the millions of tons annually and, along with organic material, form the natural sediment currently existing on the fjord bottoms. Table 6.2 gives a comparison between the average igneous rock and expected Quartz Hill millfeed (Ref. 20). Dr. J.R. Snook of Eastern Washington University, who did a mineralogical examination of the Quartz Hill ore types, concluded in 1982 that "the ore rock is quite uniform in both its physical and chemical properties, which simplifies the predictability of waste materials and metal recovery. The ore lacks significant amounts of objectionable elements, which should eliminate most environmental concerns. It is evident from these facts that most of the problems involving tailings disposal will be concerned with the grain size and volume of the tailings to be handled." (Ref. 20).

Table 6.3 gives comparisons of the metals in the tailings solids with natural sediment levels in the Ketchikan area and other west coast points. In Table 6.3, the average copper content of the Quartz Hill tailings solids is 26.0 mg/kg (parts per million), as compared with an average of 31.0 for the Southeast Alaska and British Columbia locations and 70 for the Earth's crust (Ref. 28).

Table 6.4 shows the particle size distribution of tailings from six bulk sample pilot plant tests in 1983. The target grind was 20 percent plus 100 mesh, which is relatively coarse. Percent passing 10 micron size was 18.0; this is the less easily settleable portion which could be advected by fjord currents.

6.2.3 Liquid Phase Characterization

The liquid phase of the tailings slurry consists of the plant water remaining with the tailings after passing through the thickeners, or about 55 percent of the slurry by weight. At the design operating rate, the amount of liquid phase discharged would be about 3,700 tons per hour. This stream would be untreated except for possible pH adjustment with lime, and flocculation to promote faster fines settling.

Table 6.5, from the Final EIS (Ref. 34) gives the liquid phase characteristics prior to mixing with seawater. Temperature and pH would be close to fjord conditions after seawater addition of between 1:1 and 4:1 (seawater to slurry). The calculations in the Final EIS were based on an assumed dilution of 1:1 by weight, which corresponds to approximately 2:1 by volume for seawater to liquid portion of the effluent. This is the minimum that would be used in practice.

6.3 Toxicity

Perhaps the primary concern about tailings effluent discharge was the potential toxicity of the effluents to marine biota and, through the food chain, to humans. The toxicity is influenced not only by dissolved (or leachable) constituents introduced through the ore, but also through process reagents and any other waste streams added to the tailings discharge. The ultimate tests are bioassays conducted on living organisms in representative samples of the projected tailings effluent.

Table 6.2

Comparative Oxide and Elemental Percentages

for Quartz Hill and "Average" Igneous Rock

(after Snook) (Ref. 20)

	Quartz Hill	Igneous Rock
SiO_2	78.08	59.14
Al_2O_3	11.52	15.34
Fe_2O_3	0.29	3.08
FeO	0.59	3.80
MgO	0.24	3.49
CaO	0.39	5.08
Na_2O	2.98	3.84
K_2O	5.09	3.13
Cu	0.0018	0.003
W	0.0003	0.0002
Pb	0.001	0.002
Zn	0.0005-0.002	0.0065-0.0094
Sn	0.0005	
Au	0.00002	
Ag	0.00002	
Mo	0.15	0.0001

Table 6.3 a/

COMPARISON OF METALS IN THE TAILINGS SOLIDS WITH NATURAL SEDIMENTS LEVELS, mg/kg

Sample Data		Reference	As	Cd	Cu	Fe	Hg	Mn	Mo	Ni	Pb	Zn
Earth Crust		(Burling)	5	0.15	70	50,000	0.5	1,000	15	80	16	132
Ketchikan Quadrangle Stream Sediment	Mean	(USDE)	12.5	6.2	35.7	60,300				30.2	19.5	154
	Std. Dev.		23.4	2.8	23.9	18,600				14.8	130	74.6
Petersburg Area, Stream Sediment		(USGS)			23.5						18	86.7
Boca de Quadra Sediment,		(Burrell)										
inner basin					30	2,000		150				48
central basin					29	12,200		496				65
Rupert Inlet		(Waldichuk)	5	2	44		.06	640	2	40	25	88
S. Calif. Coast		(Bascom)										
	1977 Ave.			.33	8.3					12	6.1	43
	1980 Max.			1.4	31					35	12	62
	1980 Ave.			.6	10					20	12	46
Quartz Hill Tailings Sample LCT 1-11	Low	(U.S.Borax)			10	9,400			46		3	17
	Ave.	(U.S.Borax)			18	14,903			69		11	30
	High	(U.S.Borax)			43	21,300			142		22	42
Sample MD79-8-31		(U.S.Borax) (U.S.Borax)	<0.2	0.03	40	10,000			160	26	30	18
Sample MD79-8-108		(U.S.Borax)	<5.0	<1.0	20	10,000		100	120	20	20	<20
Environmental Report		(U.S.Borax)			22	14,900			62		11	30
Sample LCT-12		(U.S.Borax) (U.S.Borax)	0.61	0.5	29.9			374	60.3	9.8	5.6	20.1

a/ Ref. 27, p. A-24

TABLE 6.4 a/

CONCENTRATOR EFFLUENT
TAILINGS PARTICLE SIZE DISTRIBUTION

Upper Limits, Microns	U.S. Standard Sieve Equivalent No.	Weight Percent Passing 1/
595	28	98.8
297	48	95.1
210	65	90.0
149	100	80.9
105	150	69.4
74	200	53.0
53	270	46.3
44	325	42.4
37	400	38.9
30	-	35.2
25	-	32.4
20	-	28.5
15	-	23.4
10	-	18.0
5	-	10.7

1/ From analyses of samples from the Bulk Sample Pilot Plant grinding tests on October 14, 15, and 18, November 30, December 1 and 19, 1983 (six tests). The grinding target for the concentrator is 20 percent plus 100 mesh (149 microns).

Source: U.S. Borax 1984a.

a/ Ref. 30, p. A-48

TABLE 6.5 a/
PRELIMINARY TAILINGS THICKENER EFFLUENT CHARACTERIZATION
LIQUID PHASE

Parameter1/	Approximate Concentration (in micrograms per liter unless otherwise noted)
pH (standard units)2/	8.7
Temperature (°F)3/	51
Total dissolved solids mg/l4/	160
Conductivity (μmho/cm)5/	256
Dissolved oxygen (mg/l)5/	7
Total organic carbon (mg/l) 5/ 6/	13
Arsenic7/	6.8
Cadmium7/	15
Chromium7/	34
Copper7/	35
Iron7/	1790
Lead7/	120
Manganese7/	330
Mercury7/	1.2
Molybdenum7/	1080
Nickel7/	290
Selenium7/	6.6
Silver7/	7
Zinc7/	77

Note: The concentrator would produce about 3,780 tph (80,000 tpd) of solids and 3,700 tph of water from thickener underflow. No further treatment of this stream is planned after possible pH adjustment and flocculation. This characterization does not include washdown water, power plant wastewater, adit drainage water, runoff or others.

1/ Prior to transport and mixing with seawater.
2/ pH value is from Bulk Sample Pilot Plant testing without lime addition (hourly tests for four days).
3/ Temperature is an engineering estimate of the tailings before mixing with seawater.
4/ Total dissolved solids was calculated from conductivity, based on 16 analyses of conductivity.
5/ Conductivity, dissolved oxygen, and total organic carbon values are from Bulk Sample Pilot Plant testing from October 24-27, 1983. Dissolved oxygen based on 16 analyses.
6/ Total organic carbon is the parameter which indicates the amount of residual reagents. Value based on three analyses.
7/ From analyses of the tailings samples from Bulk Sample Pilot Plant flotation testing from October 24 to 27, 1983. Number of samples for each parameter are As (32), Cd (32), Cr (29), Cu (53), Fe (17), Pb (32), Hg (32), Mo (32), Mn (19), Ni (32), Se (32), Ag (32), Ni (32).

Source: U.S. Borax 1984a with modifications by Stine 1984 and U.S. Borax 1984d.

a/ Ref. 30, p. A-42

Although the actual discharge would contain treated sewage, washdown and some runoff from the plant, camp and wharf areas, the volume of this (85 gpm excluding runoff) was relatively small enough to be ignored. Runoff from the plant and camp areas would be caught in a retention pond for recyling through the plant, or held for sampling and possible treatment before release either to Tunnel Creek or the tailings disposal system.

The process reagents planned for use were all typical of those used elsewhere in the minerals industry, and similar to those used at the Island Copper and Kitsault operations. Table 6.6 (Ref. 35) gives a list of planned reagents and the quantities to be used for peak production. The reagent specification sheets for each of the proposed reagents were checked for safety and toxicity data and submitted to the permitting agencies for review.

Bioassays were done in 1984 using samples of tailings produced from the pilot plant runs, by E.V.S. Consultants of North Vancouver, BC. The work included acute, chronic and sublethal bioassays and bioaccumulation studies, using a number of marine species and life history stages which included crab, mussel, amphipod, clam, flatfish and algae. Comparative chemical and acute toxicity data for two sets of pilot plant tailings were developed and tests were undertaken to explore whether manganese or molybdenum, either singly or in combination, could be responsible for acute toxic effects.

In its report dated December 1984, E.V.S. stated that the "bioassay results confirmed the low acute nature of the Quartz Hill tailings to be in the range of 86,000 - 197,000 mg/L (range of LC 50 and EC 50 values). Sublethal tailings concentrations of 7,500, 2,400 and 750 mg/L did not affect growth and development of crab zoea over a 30 d exposure period....the tailings had no demonstrable effect on clam burrowing behavior during a 16 week exposure period. Quartz Hill mine tailings did not contribute to bioaccumulation of any metals in fish, clams or crabs during a 4 month exposure period." (Ref. 11).

Overall, sublethal effects could only be demonstrated for phytoplankton, but this inhibition of growth was initial only and had ended by day 3 or day 4 of testing, possibly due to biological acclimatization. This was followed at the highest tailings concentrations by enhanced growth rates, attributed to enrichment of nutrients or trace elements associated with the tailings. This suggested to the investigators the possibility of increased primary productivity, should the tailings reach the euphotic zone at the described levels (10,000 mg/L).

The report concluded that:

> The inability of the tailings to induce inhibitory sublethal effects is important for the assessment of long-term environmental impact, and shows that representative species and life history stages can survive, grow, and actively burrow in a mine tailings environment. The results of the sublethal bioassays confirm determinations from acute toxicity tests that Quartz Hill mine tailings have a relatively low toxicity.

The final EIS in its evaluation of toxicity, referred to data gaps on certain of the reagents, but stated that additional information would be obtained and evaluated prior to issuance of the NPDES permit (Ref. 36). Any bioaccumulation of heavy metals expected to occur had been demonstrated by tests at Quartz Hill, Island Copper and Kitsault "to be below levels believed to be hazardous to aquatic life and human health....In summary, the existing information suggests

TABLE 6.6 a/

MILL REAGENT USE

Reagent 1/	Purpose	Usage 2/ lb/ton	Usage lb/day for 80,000 ton/day
Lime	pH modifier	0.134	10,720
Sodium Silicate	gangue dispersant	0.063	5,040
Dowfroth 250 1/	frother	0.003	240
Methyl Isobutyl Carbinol (MIBC)	frother	0.088	7,040
Stepanfloat 85-L 2/	frother/dispersant for the collector	0.011	880
No. 2 Diesel Fuel Oil	molybdenite collector	0.634	50,720
Nokes Reagent 3/	depressant for Cu, Pb, Fe	0.054	4,320
M-502 4/	flocculant	0.199	15,920
Aerodri 100 5/	surfactant	0.0002	16

1/ During the pilot plant operations several reagents were tested to find suitable alternatives. It was found that MG700 could be replaced by M502 or SF330 (a cationic polyamine). Sodium silicate could be partially replaced by CMC-7 (carboxyl methyl cellulose). Dowfroth 250 could be replaced by ALFOL 6 (alcohol).

2/ From Bulk Sample Pilot Plant flotation testing from October 24 to 27, 1983. Based on fifty checks of reagent addition rates.

3/ Polypropylene methyl ether ($CH_3-(O-C_3H_6)_x-OH$).

4/ Sodium fatty alcohol ether sulfate in alcohol-water solution.

5/ 43.5 percent phosphorus pentasulfide and 56.5 percent NaOH.

Source: U.S. Borax 1984a.

a/ Ref. 30, p. A-38

that tailings from the proposed Quartz Hill facility would possess a low acute toxicity to marine organisms larger than plankton."

EPA's BPJ analysis (Ref.48, p. 105) concluded that the "tailings are not highly toxic during short-term exposures, even for zooplankton and larval organisms considered highly sensitive to a wide variety of toxicants....It is...expected that the toxicity of the dissolved phase of Quartz Hill tailings will not be greater than that of Kitsault tailings. Bioassays with Kitsault tailings indicate suspended solids concentrations of 560 mg/l over a 40 day period are necessary before ecologically important effects are noted. ...concentrations of suspended tailings particulates approaching 500-1000 mg/l are unlikely to occur or persist in either fjord except near the bottom...".

7.0 PROPOSED TAILINGS DISPOSAL SYSTEM

In order to give some understanding of the content of the permit applications relating to STD, the proposed tailings disposal system is described briefly in this section. Also described are the physical and numerical models used to predict the behavior of the tailings in the fjords and the technical review Board of Consultants established to guide development of these state-of-the-art models. Further details on the technical aspects can be found in various appendices of the Final EIS (Ref. 30); the models are described in FEIS Appendix F.

7.1 The Delivery System

The ore treatment process at Quartz Hill up to the tailings thickeners has been described in Section 2.3.3.From the two thickeners, the tailings slurry would be discharged at about 45% solids through control valves into the system for transport of the tailings to the outfall site.

For the Wilson Arm STD site option, the tailings would flow by gravity through two high-density polyethylene (HDPE) 24-inch diameter pipes, sloped at an angle (about 1.5 percent) sufficient to avoid settling but not steep enough to create a high pressure head within the pipes. The pipes would be mounted on a bench beside the access road between the plant and the wharf area, over two miles distant. The head loss of over 500 feet would be dissipated in a series of vertical "drop boxes". A ditch between the pipes and the road would carry any leakage into a holding pond near the wharf. Where this is not possible, the tailings pipes would be encased in larger pipes. Leak detection equipment would be installed.

About 3000 feet beyond the wharf, the pipes would empty into a 20-ft diameter vertical mixing chamber positioned just off the shoreline, with its foundation about 35 ft below Mean Lower Low Water (MLLW). In this chamber, baffles would allow any accompanying air bubbles to escape and seawater would be mixed with the tailings slurry in a variable ratio between 1:1 and over 4:1. Figure 7.1 shows the concept of the mixing chamber for the Wilson Arm outfall site.

After mixing, the tailings would flow through the 48-inch HDPE outfall pipe to the discharge point at a depth of at least 150 ft (50 m) below MLLW. The outfall pipe would be anchored to the sloping fjord side wall and oriented in a down-fjord direction. Total length of the Wilson Arm delivery system would be about 14,000 feet.

For the Boca de Quadra STD site options, the delivery system generally would be similar, except that tailings transport to Boca de Quadra would be through a tunnel in an open, concrete lined

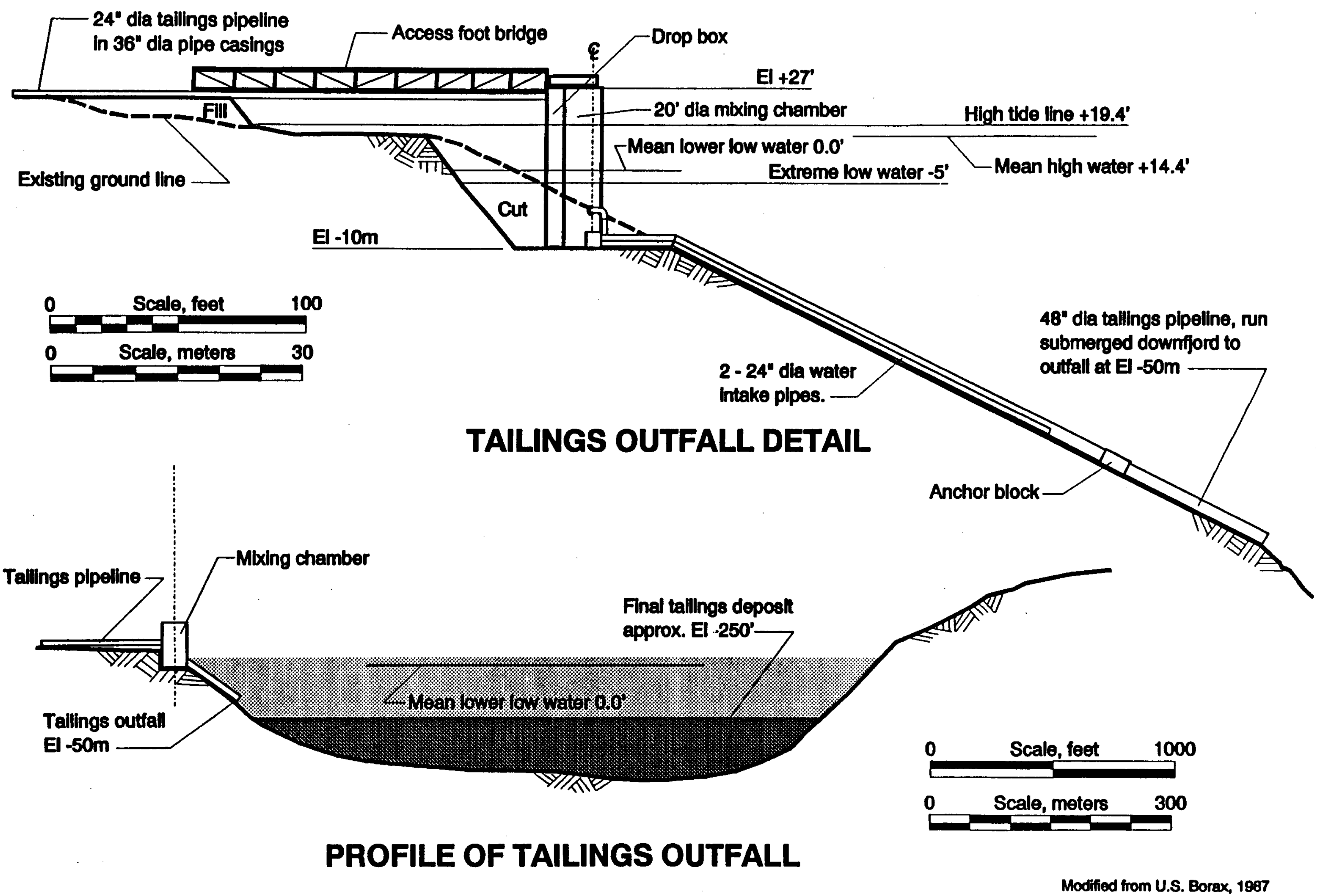


Figure 7.1 - Mixing chamber concept for Wilson Arm outfall site.

launder, or ditch. In the case of the inner basin disposal site, the 28,000-ft long tunnel would exit at about the mid-point of the inner basin, between the Keta estuary and the inner sill. For the middle basin site, the tunnel length would be 38,000 ft or longer, depending on the exact portal location probably within a half mile of the outer edge of the sill. This site is positioned within the Wilderness portion of the Misty Fjords National Monument. Figure 5.3 in Section 5 shows a plan of the alternative sites with the tunnel orientations.

Because of the slope necessary to ensure gravity flow in the tunnel, the plant-side portal elevation would be above the thickener bottoms, requiring pumping of the tailings to the portal. At the Boca end, the slurry would be channeled into a series of dual HDPE pipes, with drop boxes as necessary, leading to the mixing chamber. From this point, the system would be similar to that for Wilson Arm. Additional facilities would be required at the remote Boca de Quadra sites in order to maintain the tunnels and the STD systems; this would require a surface disturbance of up to about 25 acres.

7.2 The Board of Consultants

In permitting the first submarine tailings disposal in the United States since the passage of the National Environmental Policy Act of 1969 and the Clean Water Act of 1977, the need to have "state of art" modeling for the placement of the tailings on the fjord floor was recognized. Bechtel's Hydraulics/Hydrology Group was retained to evaluate the deposition of mill tailings in a seawater/fjord system. To supplement Bechtel's expertise, it was decided to form a Board of Consultants composed of leading North American experts with special knowledge, to assist in scoping and developing what was needed to permit submarine tailings disposal.

The organization, Board of Consultants and Technical Advisors consisted of the following:

Management-Bechtel's Hydraulics/Hydrology Group
Mr. Rex A. Elder, Manager
Dr. Patrick J. Ryan

Board of Consultants

Dr. Norman H. Brooks, Chairman
Professor and Director, Keck Laboratory
California Institute of Technology
Expert in water quality and sediment transport

Dr. Ray B. Krone
Professor of Civil Engineering
University of California at Davis
Expert in sediment transport

Mr. Duncan Hay
Expert in physical modeling, with emphasis on tailings transport.Modeled tailings transport in marine environments for Island Copper and Kitsault Mines in British Columbia.

Dr. J. Dugan Smith
Professor, University of Washington
Expert in behavior of stratified fjords.

Technical Advisors

Mr. Clem A. Pelletier
President, Rescan Environmental Services, Ltd.
Vancouver, British Columbia
Formerly Manager of Island Copper Mine's submarine tailings disposal system, and worldwide consultant on mill tailings disposal in marine environments.

Dr. George W. Poling
Professor and Head of Department of Mining and Mineral Process Engineering, University of British Columbia
On British Columbia environmental review committee for Island Copper Mine's submarine tailings disposal system.

Dr. Donald F. Winter
Professor, University of Washington
Interpretation of echo soundings and numerical modeling specialist.

The Board of Consultants and its Technical Advisors met periodically to scope and review the proposed program and monitor the technical progress on modeling the deposition of mill tailings in these two fjord systems. An overview of this evaluation of marine disposal of mill tailings is given in a paper by A.N. Findikakis, P.J. Ryan and J.F. Kerl (Ref. 8).

The scope of this program consisted of field data collection (as described in Section 5.2) and development of unique physical and mathematical models to allow prediction of discharge behavior. These consisted of a physical model to define the behavior of the tailings slurry in the vicinity of the outfall, a sedimentation/density current model (see Section 7.3.2) to predict deposition patterns over the mine's 55-year operational life and a fjord circulation model to predict distribution of fines and the liquid fraction of the tailings discharge within the fjords.

These models were calibrated based on field measurements of Island Copper Mine's tailings disposal operation located on Vancouver Island, British Columbia, Canada and were shown to provide a reliable forecast of the behavior of the tailings in their movements on the floor of the fjords. The Board of Consultants provided the overall direction for the development of these models. The program included plans for later refinement of the models using monitoring data from the actual Quartz Hill tailings operation after commencement of discharge.

7.3 Tailings Discharge Dynamics

7.3.1 Near-field Model

The "near-field" is the transitional area within a radius of 100 m of the outfall, roughly 100 pipe diameters. When early questions about the behavior of the discharge stream in the near-field could not be satisfactorily answered from the existing technical literature, the project developers decided to construct a physical model to obtain basic empirical data (Ref. 37). Specifically, information was needed on system design, plume dilution and the effects of bottom topography.

The modelling was done at the Institute of Hydraulic Research, University of Iowa, under the direction of S.C. Jain and J.F. Kennedy, overseen by Bechtel and U.S. Borax. A schematic diagram of the arrangement of the 1:50 scale model is given in Figure 7.2. The sloping floor at the discharge end was hinged. The discharge pipe on the floor, modelling the outfall, was attached to a slurry mixing tank. A moveable instrument carriage supported sampling devices and temperature probes.

To avoid logistics problems, it was decided to use fresh water instead of seawater as a receiving medium. The feed for the test runs was tailings produced by the 1983-84 pilot plant runs of the representative Quartz Hill ore bulk samples. This was screened to a size distribution to achieve settling velocities to compensate for model scale and the fresh water medium. The slurry mixture was heated and distribution of the plume in the receiving medium was monitored by temperature measurements. After each run, bottom sediment profiles in the tank were measured and photographs taken.

The effects, on the plume and dilution, of varying the slope, premixing ratios, exit jet velocities and outlet diameters were measured in a total of 49 runs. Bottom slope was found to be the most influential factor, with the maximum measured slope giving the best results. Dilution of the plume at the edge of the near-field was found to increase with slope and varied between 5 to 1 and 42 to 1 over the slope range tested of 5 to 25 degrees.

Some model tests were aimed at investigating the possible development of a "split plume" which had been observed at Kitsault (Ref. 4), where a separate cloud of suspended fines at an average concentration of 3.6 mg/l developed at depths of between 200 and 360 ft. None of the tests indicated such a phenomenon would occur, if air bubbles in the discharge were first eliminated. In all cases the tailings plume was coherent and attached to the bottom.

The test laboratory was visited during modelling by personnel from several of the permitting agencies. By demonstrating the coherence of the tailings plume, the near-field tests appeared to be a major factor in relieving some nagging doubts about the fundamental feasibility of STD at Quartz Hill.

7.3.2 Far-field Model

Literature searches had indicated that no reliable means were available for predicting the flow and deposition of tailings sediments on the fjord bottom over the 55 year project life. Some ability to do this was important not only to the permittability of STD, but also as a monitoring tool. To fill the informational gap, a mathematical sedimentation/density current model was developed by Dr. A.N. Findikakis and Dr. P.J. Ryan of Bechtel, using the principles of sedimentation and hydraulics.

Consistent with observations at Kitsault and Island Copper, it was assumed that beyond the near-field area the tailings would flow along the fjord bottom in a stream of coarser particles known as a "density current" or "turbidity current". This can be defined as a fairly cohesive mixture of

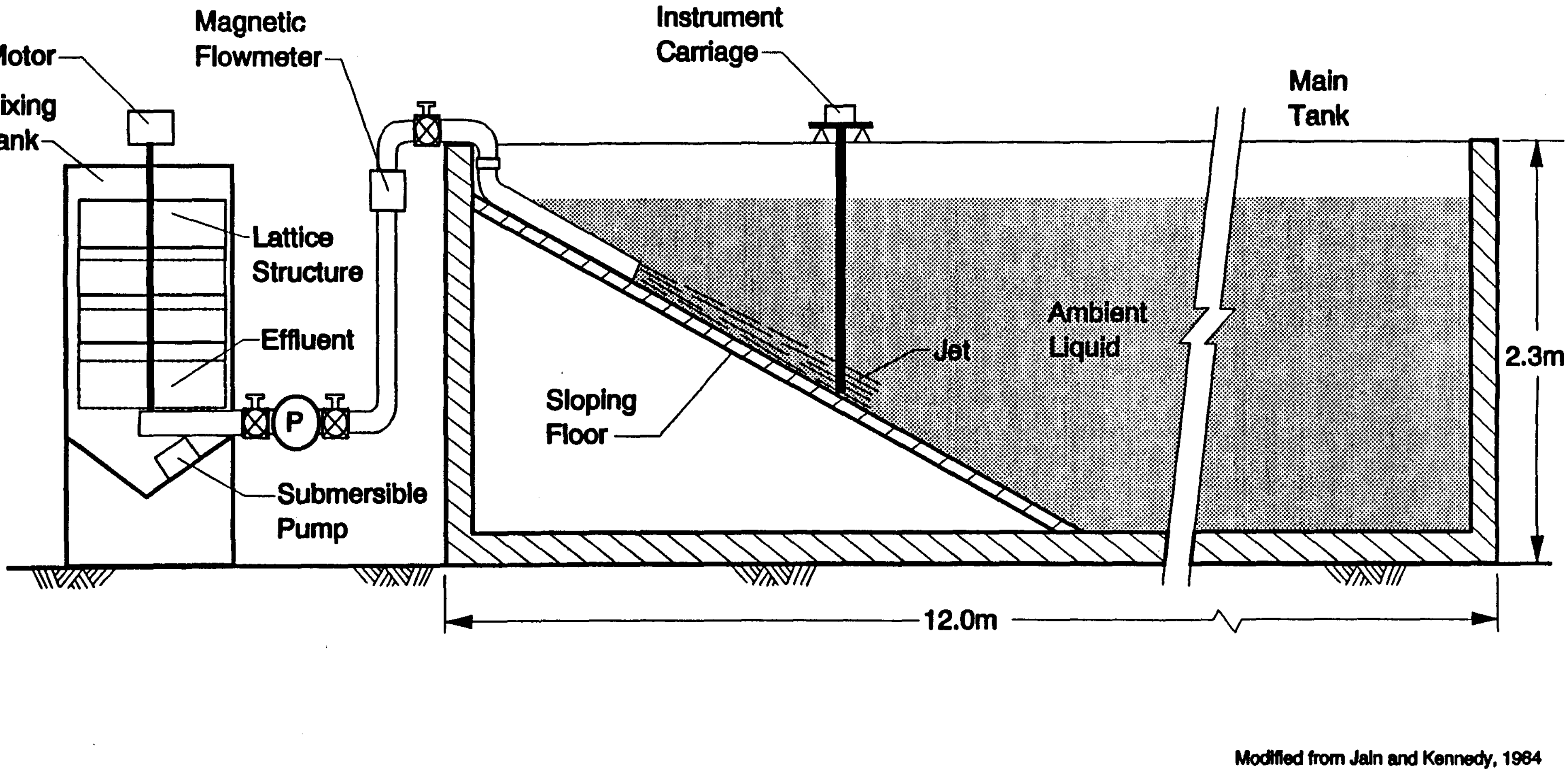


Figure 7.2 - Schematic diagram of the 1:50 scale model of near-field tailings discharge.

tailings slurry and seawater of perhaps 5 to 25 m in thickness, having a high solid:liquid ratio which varies depending on the distance from the bottom.

The turbidity current would be confined usually within a leveed channel meandering across the top of the previously deposited tailings. Upon reaching the tailings depositional front, many of the particles would settle in the quiescent waters along the upper portion of the tailings bank. Periodic slumping events would help move the front forward. Although only about ten percent of the fjord bottom would be under active deposition at any given time, these events would distribute tailings more or less evenly across the relatively narrow width of the fjord. Figure 7.3 illustrates these phenomena (Ref. 38).

Initial concentration of the tailings plume at the edge of the near-field was estimated from the near-field model. The outfall positions modelled were those of the three earlier-described STD site alternatives. The validity of the model was successfully calibrated against about ten years of depositional data from Island Copper, then applied to the Quartz Hill alternative sites to provide time-dependent thickness estimates for deposition at various positions along the fjord. This model was able to answer many of the questions posed regarding the movements of the tailings after discharge.

7.3.3 Circulation Models

Models to predict the dispersion in the fjord waters of tailings fines (below 10 microns) and the liquid fraction of the tailings slurry were also devised by both U.S. Borax and EPA. The common purpose was to predict effects of the discharge on water quality, but the two numerical models used different approaches toward the same end.

The Company's dynamic model was developed by Dr. Z. Kowalik at the University of Alaska's Institute of Marine Science (IMS), assisted at later stages by Bechtel's Dr. Findikakis, using fjord current data provided by IMS from the data gathering program. The Board of Consultants provided guidance on the development of assumptions used in constructing the model and subsequently reviewed it. For purposes of simplification, the Kowalik model approximated the fjord cross-sectional geometry as a rectangle and ignored cross-fjord currents. Other simplifying assumptions were also employed. The driving forces for the dynamic model were salinity structures at the mouths of the fjords, surface wind stresses and tidal action. The suspended sediment source at the bottom of the fjord was assumed to be a constant value at the top of the density current, which was taken to be 20 mg/l, based on a 1983 survey of suspended solids profiles down-fjord of the Island Copper outfall (Ref. 17).

Figure 7.4 depicts two of these profiles. The top of the density/turbidity current is represented graphically by a sharp decrease in the suspended sediment level or alternatively, by the point where the percent light transmission increases suddenly from near-zero.

EPA's steady-state model was designed to permit assessment of a greater range of variability in the fjord system. This model used a mass balance approach to predict the movement of fines of below 10 microns in diameter (18 percent of the total discharge) using probability calculations based on diffusion, advection and particle settling factors. As with the Kowalik model, the seasonal circulation patterns derived from current meter measurements were used as input, using best judgments where data were sparse. For the source of fines, rather than using a constant

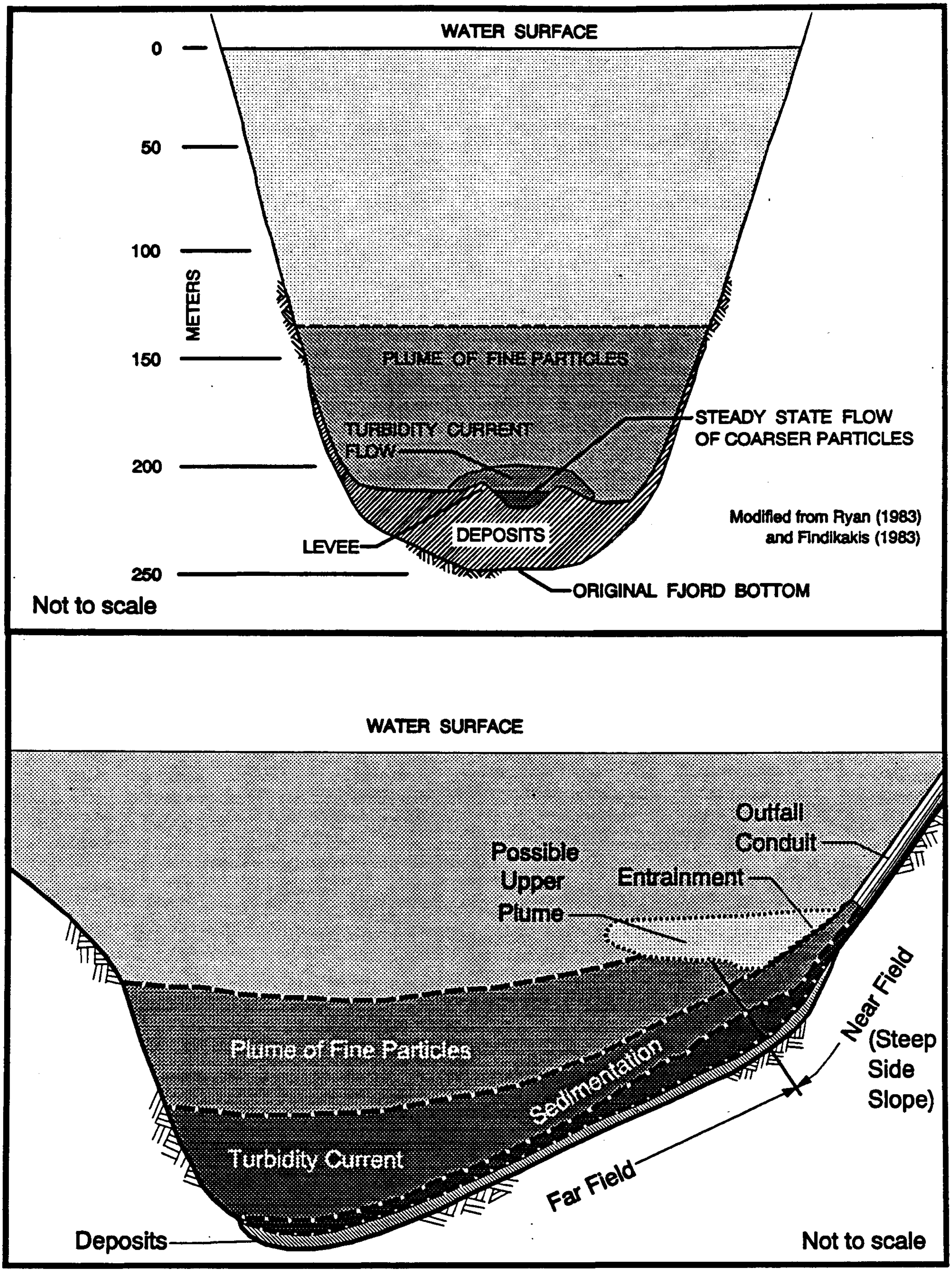


Figure 7.3 - Schematic cross-fjord sections of tailings density current and sedimentation process.

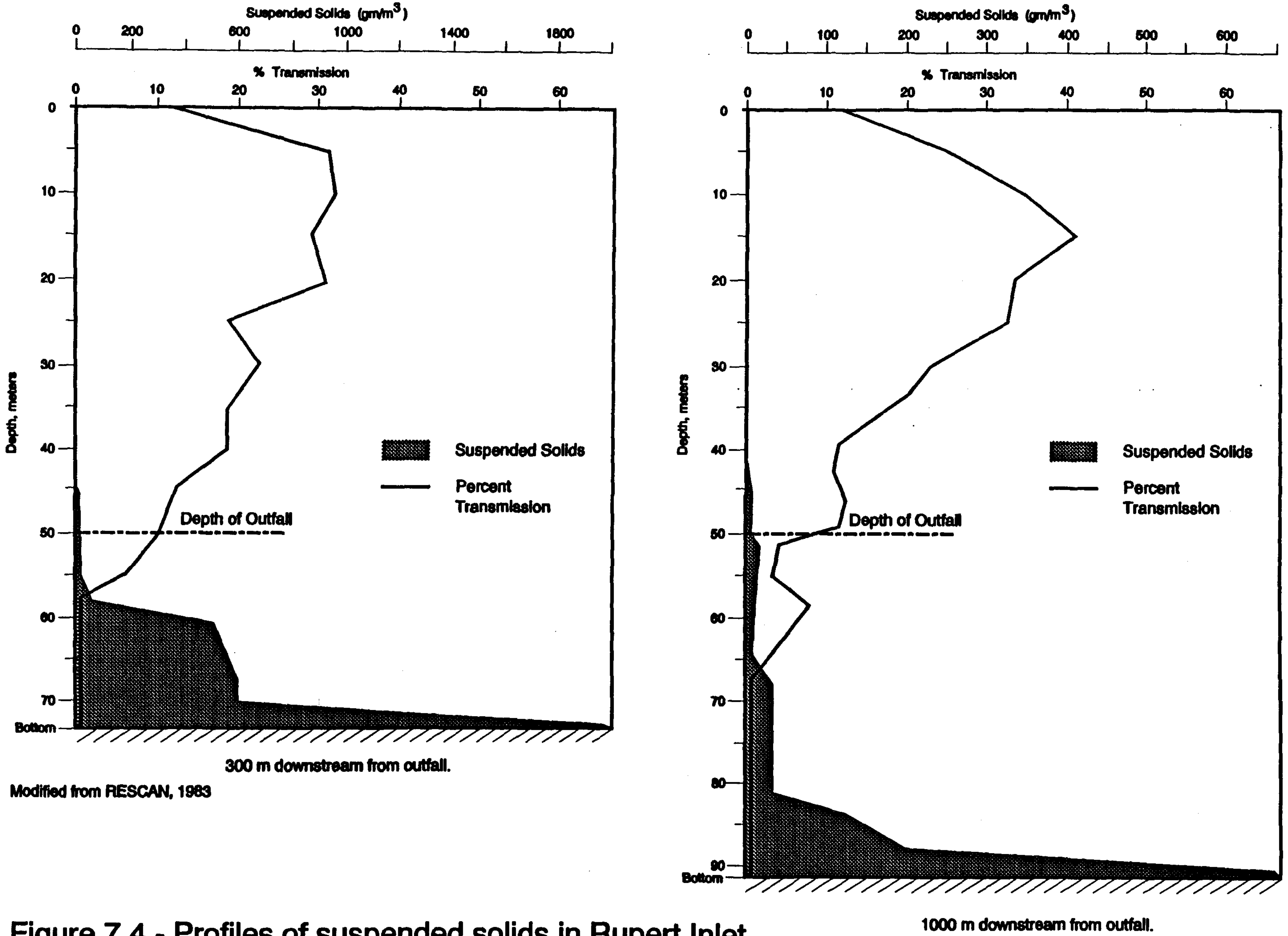


Figure 7.4 - Profiles of suspended solids in Rupert Inlet.

value at the fjord bottom, EPA assumed that 10 percent of the tailings would be injected into the bottom boundary layer of the fjord over a 10 km distance. However, for the boundary value, EPA chose 600 mg/l (as compared to 20 mg/l chosen by Kowalik and 40 mg/l chosen by USFS) using the same basic data from the 1983 Rupert Inlet survey. This difference in data interpretation appears to be the greatest single cause for the variations in predictions between the two models. Table 7.1, below, reproduces data from the Rupert Inlet survey. As can be seen from both Figure 7.4 and Table 7.1, EPA interpreted the boundary layer (top of the density current) to occur substantially closer to the sea bed.

Table 7.1. Suspended Tailings Concentrations Downstream of Island Copper Discharge In Rupert Inlet, B.C. a/

Depth (m)	Depth Above the Bottom (m)	Concentration at 300 m	Depth (m)	Depth Above the Bottom (m)	Concentration at 1,000 m
45	28	0	43	48	3
50	23	4	49	42	4
55 b	18	12	55	36	12
58	15	55	61	30	7
61	12	500	67	24	19
64	9	550	73	18	15
67	6	600	79 b	12	17
70	3	600	85 c	6	120
73	0	2000	91	0	630

(Source: Ref. 17, modified)

a/all concentrations in mg/l. Outfall depth at 50 m.
b, c/interpreted locations for top of density current for Kowalik model (b) and EPA model (c).

7.4 Predicted Physical Behavior

Predictions of the physical behavior of the tailings in the fjords were possible, based on (1) the characterization of the tailings effluent, (2) the oceanography of the fjords and the outfall sites, (3) the four models previously described, (4) the field data from the Kitsault and Island Copper STD operations and (5) the literature on other operations.

In the near-field, the behavior at all three outfall sites would be similar, since all have similar bottom topography. At Wilson Arm and the inner basin of Boca de Quadra, the bottom of the fjord wall slopes at approximately 25 degrees, which is the same as the maximum slope angle tested in the near-field model. Since the exact location of the middle basin site was not specified, the bottom slope there could differ. Other minor differences in behavior could be introduced by local current variations, but there is no evidence to suggest any major anomalous influences.

In general, at all three sites the tailings would be expected to descend rapidly in a coherent stream down the fjord wall toward the center of the fjord, slightly downstream of the outfall. Initially there would be some backup toward the estuary, but before long the primary movement of tailings would be down-fjord. A leveed density current would form on the top of the deposited tailings as previously described (illustrated in Figure 7.3) and slumping events would occur periodically. These events could cause some local turbidity at depth but the models predicted that no fines would reach the euphotic zone. No split plume would be expected to occur, based on the near-field model results. Overall, there is no reason to believe that there would be a significant difference in behavior among the three sites.

Differences in far-field behavior would be governed by bathymetric differences in the fjords and variations in the current patterns, both described in Section 5. With the tailings disposal outfall at a depth of 150 feet (or 50 m) in the inner basin of Boca de Quadra, the inner basin would fill in about 12 years. The tailings would then flow over the inner sill (345 ft depth) to the middle basin. At the end of the mine life, the below-sill volume of the inner basin would be 100 percent filled and the volume of the middle basin would be 15 percent filled.

Tailings disposal at the middle basin outfall site would fill the below-sill volume of the middle basin to about 20 percent of capacity. The inner basin would be left relatively unchanged, except for the possible limited deposition of fine tailings from tidal currents. In both these cases, the middle basin would still remain a deep basin after 55 years of tailings deposition. Figure 7.5 shows predicted tailings deposition in Boca de Quadra using the inner basin disposal site.

For Wilson Arm tailings disposal, at operational year 55, the deposited tailings would be about 245 feet below the surface at the outfall, and from there would gently slope downward to about 150 feet below the top of the sill (near the mouth of Smeaton Bay) at a depth of about 570 feet (see Figure 7.6). After 55 years of mine operations, about 78 percent of the below-sill volume would be filled with tailings, and the bathymetry of Wilson Arm/Smeaton Bay would be significantly changed to a shallower fjord. If it were thought desirable to keep the tailings at the outfall below 100 m depth (328 ft), the outfall could be moved downfjord in the later operating years, leaving still sufficient capacity for the tailings below the top of the sill.

As previously noted, the circulation models predicted that the fines and liquid fraction of the effluent would remain below the euphotic zone for all these cases. The prediction of the Kowalik model was that fines would probably not rise to levels higher than 60 meters. Table 7.2 at the end of this section includes comparison of the physical effects of disposal on the fjords for the three alternative sites.

7.5 Discussion of Comparative Environmental Impacts

Significant bathymetric changes in the fjord basins, such as would occur with Boca de Quadra inner basin discharge and in Wilson Arm/Smeaton Bay, would have some effects on the current circulation patterns; and the seasonal deep water renewal cycle in Smeaton Bay would be affected. However, adverse consequences from these effects were not predictable. Small

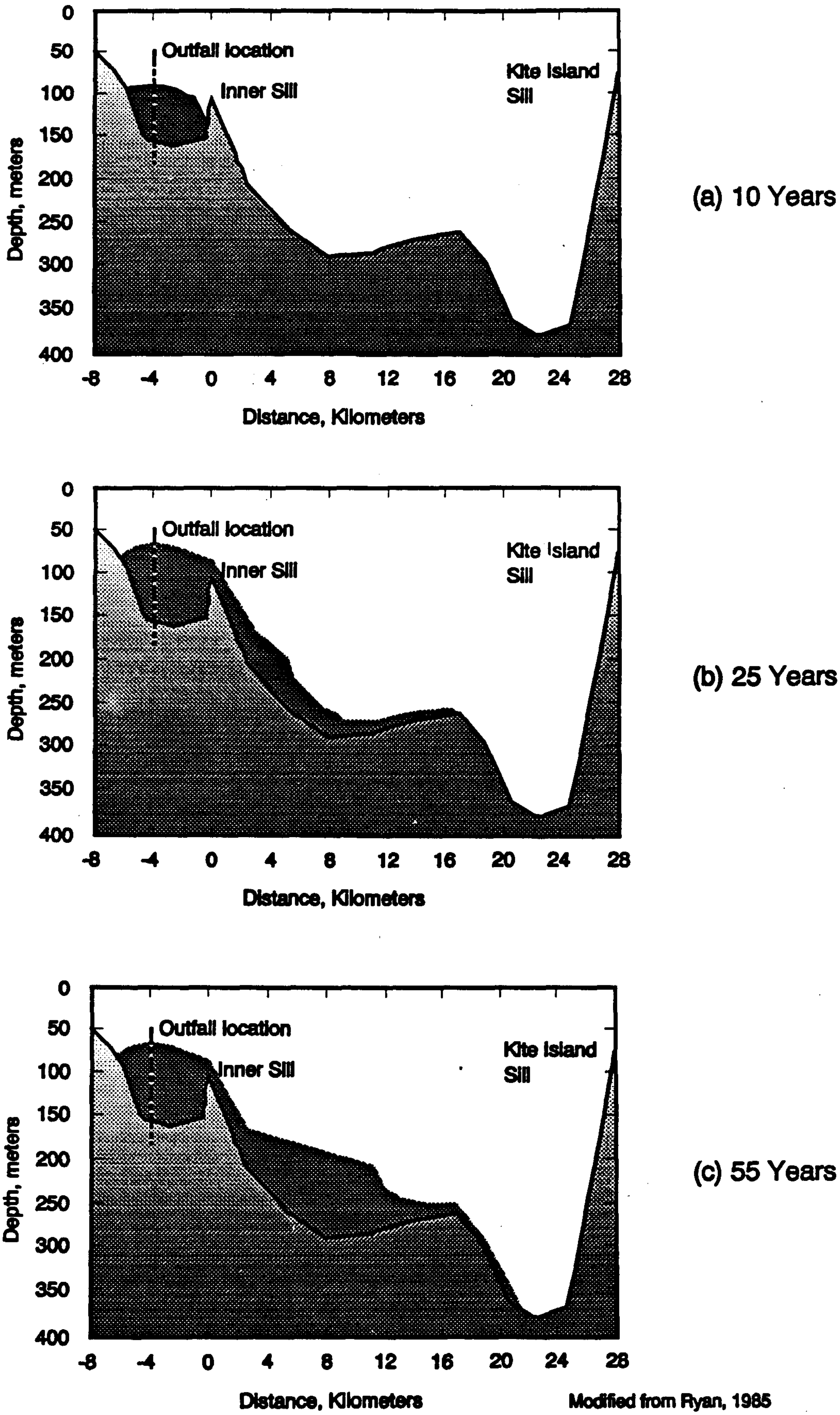
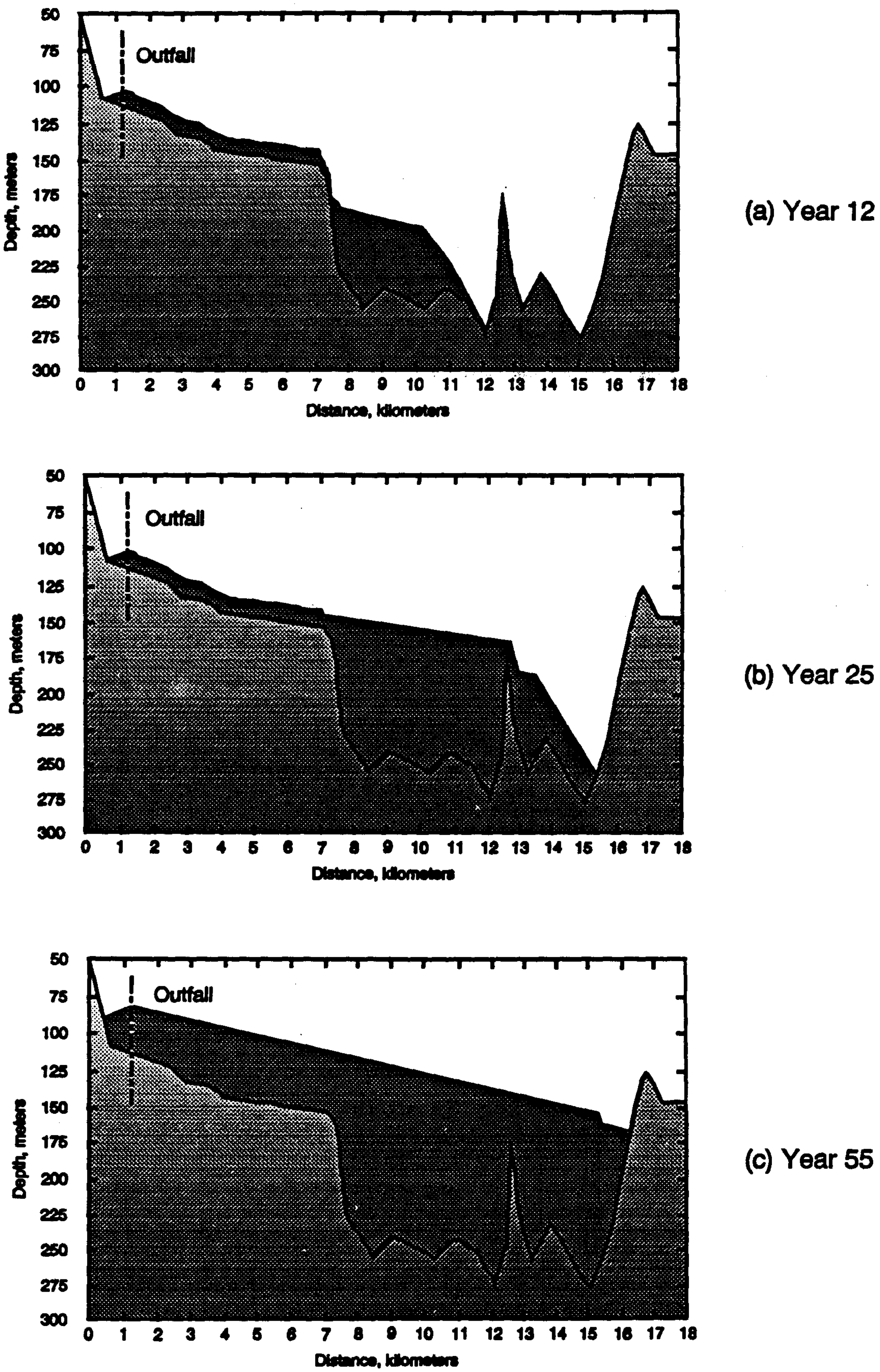


Figure 7.5 - Predicted tailings deposition in Boca de Quadra - discharge in Inner Basin.



Modified from Envirosphere Co., 1985

Figure 7.6 - Predicted tailings deposition in Wilson Arm/Smeaton Bay.

quantities of tailings fines would be transported over the Smeaton Bay sill into Behm Canal, but without significant consequences.

The greatest effect from bathymetric changes was expected to be a change in the benthic biota composition from a deep water (>200 m) assemblage to a mid-depth to shallow water assemblage. This was predicted (Ref. 48, p. 117) to have long-term beneficial effects, some time after tailings deposition has ceased, by increasing shrimp and crab commercial fishery resources. In the middle basin of Boca de Quadra, bathymetric changes would not be sufficient to cause any significant effects.

Turbidity increases were generally expected to be confined to the deeper portions of the water column except for possible short-term occurrences. EPA's BPJ analysis stated "Modelling suggests concentrations of 5-20 mg/l at depths of 50 m (160 ft) during summer (strongest stratification), and no detectable solids in the euphotic zone" (Ref. 49). The circulation model predicted that tailings would remain below the pycnocline, but the FEIS (Ref. 41) noted that while the circulation model is "the best tool available for predicting impacts to the fjord..., the model does not have the spatial resolution to predict random-type disturbances that could impact the surface waters. Surface water impacts would be limited to short-term events and to small areas in the vicinity of the fjord sills." Because of the limited nature of these events, their impacts were considered insignificant. Turbidity in the upper mesopelagic zone, however, could reduce the rearing areas of juvenile herring by a small percentage. Juvenile salmon would not be affected in either fjord.

Acute toxicity impacts for discharged tailings were expected to be low, according to EPA's BPJ analysis (Ref. 50). The most likely effects would be physical in nature. Long-term effects on zooplankton, an indicator species for toxicity combined with physical effects, were shown at Kitsault to occur only at suspended solids concentrations of 560 mg/l or more; this was expected to occur at Quartz Hill only within 20 m of bottom (Fig. 7.4, Table 7.1). The likelihood of any effects on human health was considered low (Ref. 51).

In areas of active deposition, a rain of tailings would smother those benthic organisms unable to avoid the discharge. In Wilson Arm/Smeaton Bay, an estimated 4100 acres of benthic habitat would be affected at various times during deposition, while in Boca de Quadra, the corresponding numbers are 1100 acres for the inner basin and 4000 acres for the middle basin. Discharge to the inner basin thus would affect 5100 acres. However, only 10 percent of these areas were predicted to be active at any given time. No information was available on the expected rate of meander or shifting of the path of active deposition.

Recolonization has been shown to occur rapidly in areas not subject to active deposition. Studies at Kitsault (Refs. 4 and 52) showed significant increases in biomass and species diversity within one year. Writings by Dr. Derek Ellis of the University of Victoria (Ref. 7) have also described recolonization rates to be rapid. Experiments on Quartz Hill tailings by VTN in 1983 (Ref. 58) showed recolonization by many species after one year. VTN estimated complete recolonization time for the benthic community under Quartz Hill conditions to be 6 to 25 months. Thus, although the time required for complete recolonization could not be accurately predicted, the effects of STD on the benthos (at comparable depths) were expected to be only temporary.

Overall, the impacts of discharge on the marine environment would be least on Boca de Quadra's middle basin, because of its size and distance from the ocean. Because of the depth of the middle basin, significant deposition and slumping events would not occur above the pycnocline, which, in EPA's view, made it less likely that fines would be subject to vertical mixing in the upper water column. With middle basin discharge, bathymetry would be least affected and fewer organisms would be exposed to the highest concentrations of tailings. The middle basin would also be the only one of the three alternative sites where post-discharge benthic recolonization would approximate the pre-discharge assemblages; however, the importance of this is debatable. In Wilson Arm/Smeaton Bay, deposition of tailings would cause significant shallowing from a maximum depth of about 980 ft to a maximum depth after deposition of about 570 ft at the sill. Discharge to Boca's inner basin would cause the greatest marine impacts.
The impacts of constructing mixing tanks and outfalls at all three locations would be similar, but at Boca de Quadra, a second drainage basin would be impacted and additional servicing facilities occupying up to 25 acres would be required. For middle basin discharge, this land disturbance would occur within the Wilderness area. The Wilson Arm site has the advantage of restricting impacts of the project to a much smaller area.

There are significant differences in the impacts of the on-land delivery system among the three sites. For Wilson Arm, the total length of the surface pipeline delivery system is about 14,000 feet. For the Boca sites, tunnels of 28,000 to at least 38,000 ft would be required. The additional costs of middle basin disposal, estimated in 1984 dollars to be equivalent to 55 cents per pound of molybdenum produced, could have an adverse socioeconomic effect on the Ketchikan area by making employment less stable. Safety risks associated with tunnel construction, considered a relatively hazardous industrial occupation, could also be considered a social impact.

Table 7.2, taken from the FEIS (Ref. 40) gives a summarized comparison of the impacts of STD for the three alternatives. An error in the reduction of below-sill fjord volume has been corrected. Of interest are the estimates of annualized losses of commercial fishing harvests. These were estimated in the FEIS (Ref. 41) to have a value totalling less then $8,000 per year. The estimates represent value of lost biomass of commercial species immediately after cessation of discharge at the end of the mine life, before the onset of any recovery period.

Further discussion of the relative impacts of STD at the three sites can be found in the Final EIS (Ref. 30) on pages 2-36 et seq. and in Appendix S.

8.0 PERMITTING FOR SUBMARINE TAILINGS DISPOSAL

Following is a review of the permitting process for the submarine tailings disposal component of the overall mine development plan. Emphasis herein is on permitting the tailings slurry outfall and the disposal site, which is the floor of the fjord.

8.1 Permitting Summary and Chronology

Following the location of mining claims in the fall of 1974, the early work at Quartz Hill was permitted annually under Environmental Assessments (EA), Decision Notices, and Findings of No Significant Impacts made by the Forest Service, followed by Forest Service approval of U.S. Borax's Plan of Operations. This included the initial baseline data gathering work for the NPDES permit application for STD.

ANILCA, passed on December 2, 1980, directed the Secretary of Agriculture to prepare a Mine Development Concept Analysis Document (MDCAD) by September 2, 1981 and to complete a Draft Environmental Impact Statement (DEIS) covering road access and bulk sampling within the following two months.

Table 7.2 a/. Comparison of Impacts of Tailings Disposal in the Three Basin Alternatives with a Tunnel Creek Mill

	Disposal Basin Alternative		
Impact	Wilson Arm / Smeaton Bay	Inner Basin Boca de Quadra	Direct to Boca de Quadra Middle Basin
Would change circulation of the discharge basin	Yes	Yes	No
Tailings would impact salmon	No	No	No
Reduction in below-sill fjord volume	78%	100%	~~15%~~ 20% b
Resulting fjord depths	75 to 100 m over about 30% of basin	80 to 100 m over about 100% of basin	More than 140 m over about 98% of basin
Change in resulting ecological community structure	To community of shallower depth	To community of shallower depth	No
Annualized loss of Dungeness crab	960 kg	1,630 kg	660 kg
Annualized loss of pot shrimp	480 kg	740 kg	250 kg
Annualized loss of demersal fish	4,570 kg	7,070 kg	2,790 kg
Suspended tailings may reach near-surface waters	Possibly at sills	Possibly at sills	Possibly at sills

a/ Ref. 30, p. 2-37.
b/ Error in Ref. 30 corrected.

In permitting the overall mine development, U.S. Borax submitted to the Forest Service an application for "Initial Plan of Operations" in November 1982. The permitting chronology is highlighted in Table 8.1, and described in more detail in Appendix D. Figure 8.1 illustrates the number of phases and the long permitting process from 1976 to 1990.

8.2 Environmental Concerns and the EIS Process

The environmental areas affected by this planned mine development generally were water and air quality, terrestrial and marine biology, wildlife, socioeconomics, and Wilderness values for one tailings disposal outfall site at Boca de Quadra. Those environmental issues considered to be significant for the submarine tailings disposal portion of the project are tabulated in Appendix E (Ref. 30, Appendix B).

8.3 Forest Service EIS and Permitting Process

Except for the mining claims patented in the mid-1980s, the planned mine development was primarily on lands managed by the Forest Service.U.S. Borax's Plan of Operations application for mine development was submitted November 3, 1982 to the Forest Service. In its review of this application, the Forest Service determined that approval would be a significant Federal action; thus, an Environmental Impact Statement (EIS) would be required under the Council of Environmental Quality (CEQ) regulations. The Forest Service would be the lead agency, with EPA and the Corps of Engineers as cooperating agencies. This EIS would provide the environmental documentation and basis for subsequent permits issued by all three agencies.

Pursuant to a Memorandum of Understanding (MOU) signed with the Forest Service, U.S. Borax contracted with the Envirosphere Company in January 1983 to prepare the mine development EIS under Forest Service direction. Envirosphere spent six years in preparing the EIS and its various drafts and revisions. The Final EIS was issued October 1988, with U.S. Borax paying all of Envirosphere's costs.

The Forest Service formed an Interdisciplinary Team (IDT) consisting of concerned Federal and State agencies, and including representatives of the Ketchikan Gateway Borough and Southern Southeast Regional Aquaculture Association. The Forest Service invited government groups, associations and individuals to a Public Scoping Meeting held on January 19, 1983, with written comments to be submitted by February 23, 1983. With this public input and the IDT, the "significant issues" were defined as the basis for preparing the EIS for mine development. With respect to STD, nearly all issues raised were considered to be "significant issues" (See Appendix E).

Upon completion of the Final EIS, the designated responsible Forest Service official (in this case the Regional Forester) issued on October 24, 1988 a Record of Decision (ROD) defining the Preferred Alternative for mine development. Normally, the Forest Service would then issue permits. However,in this case the ROD was appealed by the Sierra Club et al., which appeal was still pending in early 1993. See Appendix C for Forest Service permitting flow diagram.

Table 8.1. Quartz Hill Mine Development Permitting Chronology

January 1977	Draft EIS for Keta River access road and bulk sampling. Final EIS issued July 1977.
November 1977	Special Use Permit (SUP) issued to construct Keta River access road and bulk sampling.
December 1978	SUP for Keta River access road and bulk sampling cancelled.
December 1980	Passage of Alaska National Interest Lands Conservation Act (ANILCA).
May 1981	Draft Mining Development Concept Analysis Document (MDCAD). Final MDCAD issued September 1981.
December 1981	Draft EIS for access road and bulk sampling.
April 1982	Supplemental EIS for access road and bulk sampling, with Blossom River route being the preferred alternative.
July 1982	Final EIS and Record of Decision (ROD) for Blossom River access road and bulk sampling. SUP issued August 1982. Road construction started August 31.
November 1982	U.S. Borax filed Initial Plan of Operations for overall mine development.
February 1983	Draft EIS on U.S. Borax's 1980-83 Operating Plan, Amendments 2, 3 & 4. Final EIS issued April 1983.
July 1984	Draft EIS for mine development with submarine tailings disposal in middle basin, Boca de Quadra.
April 1987	Revised Draft EIS for mine development with submarine tailings disposal in Wilson Arm/Smeaton Bay.
October 1988	Final EIS and Record of Decision (ROD) with environmentally preferred tailings disposal alternative in Wilson Arm/Smeaton Bay.
November 1988	EPA issued draft NPDES permit for tailings disposal in Wilson Arm/Smeaton Bay.
September 1990	EPA denied NPDES permit for tailings disposal in Wilson Arm/Smeaton Bay.

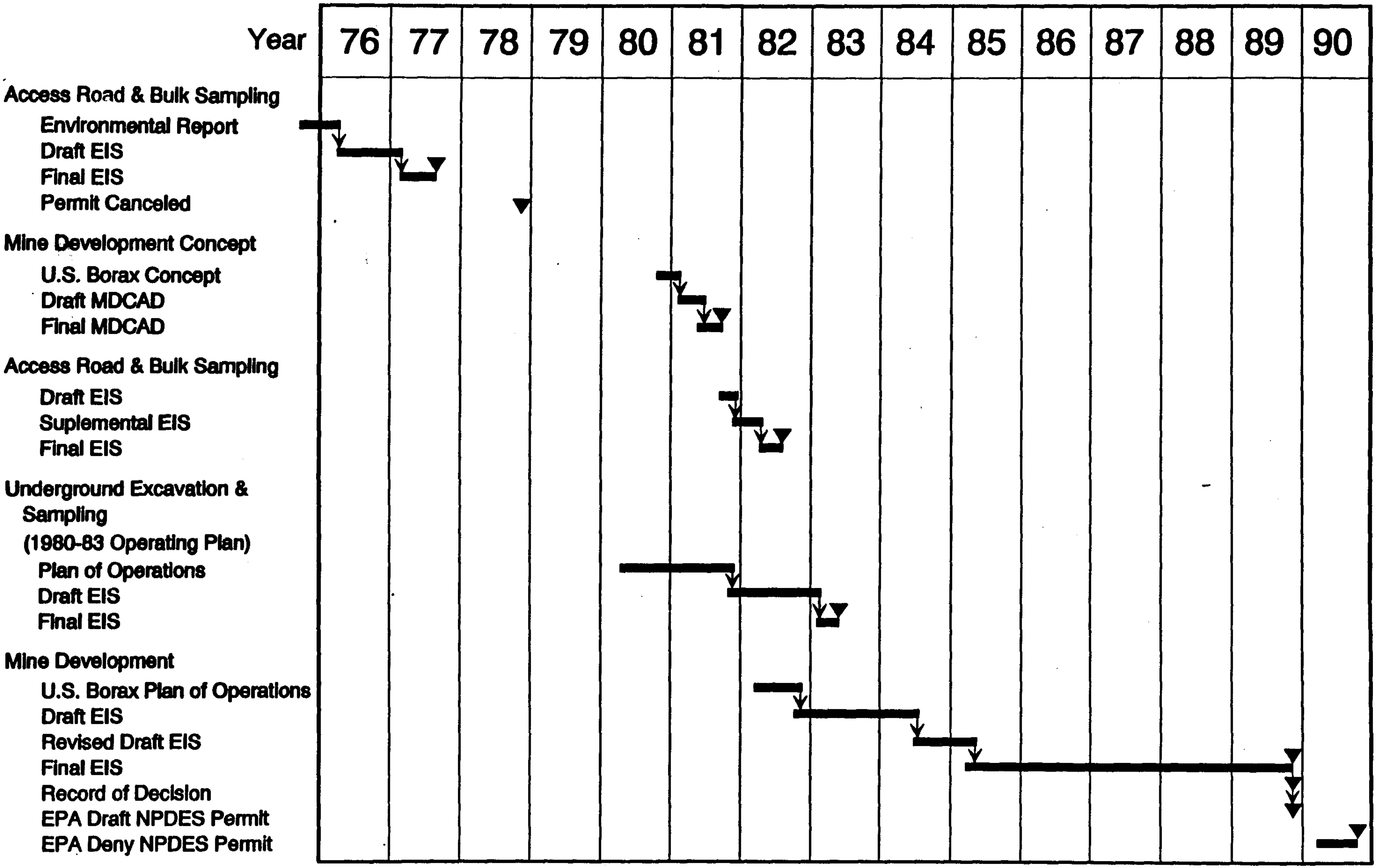


Figure 8.1 - Quartz Hill project permitting schedule.

8.4 Public Participation

A required part of the EIS and the permitting process for development of new mining projects is public participation. The Federal and State environmental and permitting regulations generally provide for public notice, public meetings (if sufficient interest is shown), and public written comments. The responsible agency must respond to these comments prior to finalizing an EIS and issuing permits. Various interest groups, some of which appear to be opposed to mineral development, can appeal the permit decision administratively, if not satisfied with the permitting agency's response to their concerns. If dissatisfied with the appeal decision, they can then litigate in the courts, and appeal to a higher court if not satisfied with the lower court's decision. This appeal process can delay projects an undefinable time and adds costs and a significant additional risk to existing technical, market, economic and overall business risks. These additional costs ultimately have to be paid for by the consumers.

The public in Southeast Alaska, and to a lesser degree nationally, showed a keen interest in the development of the Quartz Hill Project, located in the scenic Misty Fjords National Monument with the project area surrounded by designated Wilderness. Two principal views were in conflict, one being industrial diversification and jobs, and the other the avoidance of any action which would affect the existing environment. There was very active public and other agency participation in the Forest Service's scoping of the EIS, with many comments on the MDCAD and the various EIS's. The public, Federal and State agencies also commented extensively on EPA's evaluations and permits, such as the ODCE, BPJ, draft monitoring plan and permit drafts; Corps of Engineers various public notices, and various State permits.

There were concerns in the greater Ketchikan area of the socioeconomic impact of this project on the community. Options considered for housing the work force and their families included a new townsite near Quartz Hill, or new housing in Ketchikan with workers commuting periodically to the site. Ultimately, housing of the work force in Ketchikan was selected as the preferred alternative. Besides housing, the community concerns included employment, community services and taxes/revenues. U.S. Borax held extended discussions with representatives of the City of Ketchikan, City of Saxman and the Ketchikan Gateway Borough on the potential project impacts and how to mitigate them. A Memorandum of Understanding was signed between the Ketchikan Communities and U.S. Borax on procedures for discussing and resolving potential socioeconomic impacts and became part of the Final EIS (Ref. 30, pp. I-56 to I-65).

The Company endeavored to keep the public and agencies informed through public meetings, issuance of fact sheets, and tours of the project site. The concerns of the public were considered in defining the various development options and in selecting the preferred alternatives.

8.5 EPA Permit Application

In Alaska, EPA retains the responsibilities for the Clean Water Act regulations. Thus, all discharges to water bodies require EPA's National Pollutant Discharge Elimination System permits (NPDES).

Because EPA on December 3, 1982 ruled that the NSPS should not apply to discharges from the Quartz Hill Molybdenum Project (47 FR 54609), the NPDES permit conditions would be developed through the environmental/permit review process using the EIS (prepared by USFS, with EPA as a "cooperating agency") as the basis (see Section 3.2.2).

U.S. Borax in July 1983 filed a NPDES permit application for five effluent outfalls, one of which was an inner basin, Boca de Quadra tailings disposal outfall. Five months later, the Company submitted to EPA its report entitled "Comparative Assessment of Tailings Disposal Alternatives" in support of its NPDES permit application (see Section 3.3). Using this information, EPA made a detailed analysis of on-land versus submarine tailings disposal, and determined submarine tailings disposal to be the preferred alternative, subject to an environmental analysis. The initial EPA evaluation of this permit application was based on Ocean Discharge Criteria (40 CFR Part 125, Subpart M) for an environmental evaluation of estuarine and marine impacts. EPA acted as a cooperating agency with the Forest Service in the preparation of the Draft EIS issued July 17, 1984. EPA issued a draft Ocean Discharge Criteria Evaluation (ODCE) in June 1984, which formed part of the Draft EIS (Ref. 50). A draft NPDES permit was issued in August of that year for a tailings outfall in the middle basin of Boca de Quadra, 2.1 miles down-fjord of the inner sill, in the Wilderness. This draft ODCE did not include Wilson Arm as a possible alternative tailings discharge site.

Meanwhile, U.S. Borax had developed more information on Wilson Arm/Smeaton Bay, which indicated that previous concerns about the adequacy of this fjord could be satisfactorily addressed. In January 1985, the Company submitted a revised NPDES permit application for tailings disposal in Wilson Arm/Smeaton Bay. A draft monitoring plan was also submitted by the Company to EPA at that time.

In May 1986, the United States Department of State confirmed that Smeaton Bay and Boca de Quadra were "internal waters" under jurisdiction of the State of Alaska (see Section 3.2.3), which did not require application of ODC regulations. EPA subsequently decided to use the ODCE as the Best Professional Judgment (BPJ) to evaluate the environmental impacts. EPA issued a BPJ in November 1986. In March 1988, EPA issued a draft report "Ecological Risk Assessment of Submarine Tailings Disposal in Boca de Quadra versus Wilson Arm/Smeaton Bay" (Ref. 53). A final BPJ for tailings disposal was submitted June 1988, and became Appendix S of the Final EIS, issued by the Forest Service in October 1988 (Ref. 30, Appendix S).

Subsequent events are covered in succeeding sections. In Appendix C is a flow diagram for the processing of EPA's NPDES permit.

8.6 Corps of Engineers Permit Application

The Corps of Engineers has jurisdiction over construction or work in or affecting navigable waters under Section 10 of the Rivers and Harbors Act of 1899; and regulates discharge of dredged or fill material in waters of the United States, including wetlands, under Section 404 of the Clean Water Act of 1977.

U.S. Borax submitted to the Corps in July of 1983 a pre-application for a permit to cover those project phases primarily related to submarine tailings disposal, which included the construction of tailings outfall facilities and deposition of "fill material" (tailings) into navigable waters of the U.S. The Corps first issued a Public Notice July 20, 1984. As changes were made by the Company to the plan for project development, the application was amended. Revised Public

Notices were issued by the Corps of Engineers in August 1984, May 1987, June 1987 and in October 1988; the last of which was included in the Final EIS (Ref. 30, Appendices O and P). The Corps of Engineers received comments on the Public Notices from other agencies and the public, and the Company assisted in answering them.

8.7 State of Alaska Permit Applications

The State of Alaska regulations directly or indirectly applicable to Quartz Hill STD permitting are primarily concerned with State water quality standards, water rights, anadromous fish protection, solid waste disposal, Coastal Zone management; and tidelands and submerged lands rights. The significant permitting by the various State agencies is outlined below.

8.7.1 Office of the Governor, Division of Governmental Coordination

U.S. Borax submitted permit applications directly to the various responsible State agencies, but also submitted copies of these and the Federal permits applications as a Master Application to the Division of Governmental Coordination (DGC). DGC coordinated the review of all these applications by the various interested State agencies. After this review, each responsible agency could then issue its respective permits.

A flow diagram of this process is shown in Appendix C. As shown on this diagram, initially the Master Application was submitted in April 1983 to the Department of Environmental Conservation, but subsequently this procedure was modified. Updated information was submitted to DGC in 1988.

The Office of the Governor has responsibilities for the Alaska Coastal Management Program Certificate of Consistency for the project. In June 1983, U.S. Borax filed a request for Coastal Management Program Certification. After issuance of the Final EIS and the Regional Forester's Record of Decision in October 1988, the DGC initiated a project consistency review in February 1989. This consistency review was suspended late the same month, awaiting information from EPA on a monitoring program for tailings disposal in Wilson Arm/Smeaton Bay. Upon DGC's receipt of a draft monitoring plan and other data from EPA, and additional data from the Company, the consistency review was reinitiated in January 1990; and again suspended later that month, pending receipt from EPA of a revised draft monitoring plan. Since EPA never released the plan, this review process was not completed.

8.7.2 Alaska Department of Environmental Conservation

A Certificate of Reasonable Assurance is required for those Federal permits involving activities which result in discharge into navigable waters or which may affect water quality. This certification is required to comply with Section 401 of the Clean Water Act. EPA's NPDES and Corps of Engineers Section 404 permits require this certification. A flow diagram for processing this certification is shown in Appendix C.

Alaska Department of Environmental Conservation (ADEC) participated with DGC, along with other State agencies, in the review of the Master Application for Coastal Management Program Certificate of Consistency. This included ADEC's review of the Quartz Hill Project for Certificate of Reasonable Assurance requirements (see above DGC permitting section). The certification by

ADEC is the State's way of ensuring project compliance with State Water Quality Standards. U.S. Borax submitted a tailings disposal contingency plan in 1989 addressing what actions could be taken if tailings disposal did not behave as forecast and permitted. ADEC's certification process for the project was never completed because of EPA's failure to release a draft monitoring plan for Wilson Arm/Smeaton Bay.

8.7.3 Alaska Department of Natural Resources

The ore milling process would use significant quantities of fresh water, which would ultimately be discharged with the tailings slurry to the floor of the fjord. The permits required of the Alaska Department of Natural Resources (ADNR) are water rights for water supply, tidelands leases for tailings disposal pipelines and outfall facilities, and submerged lands leases for the area of the fjord floor where the tailings would be deposited.

Applications for the above permits were submitted during the 1980's and supplemental information was provided as mine development plans were revised. ADNR issued a public notice on the water permit applications and received no significant public comments. ADNR also participated in the Master Application review process. In early 1990, ADNR was proceeding toward issuance of permits but required DGC's certification of the Coastal Management Program and ADEC's issuance of a Certificate of Reasonable Assurance before permits could be issued.

8.7.4 Alaska Department of Fish and Game

The Habitat Division of the Alaska Department of Fish and Game (ADF&G) administers Alaska Statutes 16.05.840 (Fishway Act) and 16.05.870 (Anadromous Fish Act). These statutes require permits if there are any project-related activities in an anadromous waterbody. For the Quartz Hill Project, such permits would be required for the water supply facilities, roads, wharf and pipelines/outfall for the tailings disposal system. These Title 16 permits were considered to be a lower priority by U.S. Borax, scheduled to be applied for when a commitment to construct was made.

8.8 Summary of Agency Coordination

Since the Forest Service manages most of the lands required for project development, it was the lead agency for the Federal EIS and permitting processes. EPA and the Corps of Engineers were the other two Federal agencies with permitting authority. U.S. Fish and Wildlife and National Marine Fisheries Service had a statutory and significant review function.

The principal State of Alaska permitting agencies were DGC, ADEC and ADNR; with ADF&G having primarily a review responsibility. As indicated above, significant coordination was required. For the State, this was the responsibility of DGC, which formulated the State position based on input from the other State agencies.

The principal formal coordinating mechanism used by the Forest Service for all concerned parties was the Interdisciplinary Team (IDT). This was formed by the Forest Service and composed of all interested Federal and State agencies, representatives of the community, the regional aquaculture association and the Company, to scope the EIS and advise on its preparation.

DGC and ADEC's certifications of Coastal Management Program and meeting Alaska Water Quality Standards (Certificate of Reasonable Assurance) are required prior to the Corps of Engineers and EPA issuing their respective permits. Thus, a close working relationship was necessary between all State and Federal agencies, the community and the permit applicant, in order to permit mine development in a timely and cost effective manner.

8.9 Mitigation, Monitoring and Reclamation

In the processes of project engineering, preparing the EIS and permitting; evaluation of alternative mine development plans resulted in definition of the preferred alternative for project development. This alternative included in its design many mitigations of environmental impacts. The construction and operational plans when formulated would also include mitigation measures. These are discussed at length in the Final EIS (Ref. 30, pp. 4-280 to 4-310).

The objective of the environmental baseline data collection program was to characterize the environment sufficiently for selection of the preferred mine development alternative. After defining the plan for mine development, monitoring programs could be scoped. Monitoring for impacts would be initiated just prior to construction, and continued during construction, operations and post operations. The Forest Service formed a committee of various agencies to scope a fisheries monitoring program. U.S. Borax submitted to EPA a separate monitoring program for submarine tailings disposal. EPA's draft revision of this plan for Wilson Arm/Smeaton Bay was to be issued for U.S. Borax and public comment. This monitoring program when finalized would have been part of the NPDES permit. Monitoring was discussed further in the Final EIS (Ref. 30, pp. 4-310 to 4-313).

The Final EIS discussed reclamation and post-mining reclamation. The Forest Service would include reclamation requirements, along with monitoring and mitigation, as terms and conditions of the future approved Plan of Operations. The permitting process had not progressed to the point where these plans were finalized. The Forest Service would require a reclamation bond based upon the costs associated with requirements of an approved reclamation plan. Reclamation was discussed in the Final EIS (Ref. 30, p. 2-8).

9.0 THE FINAL EIS AND VARYING INTERPRETATIONS

9.1 The Forest Service's Record of Decision

The Final EIS for the Quartz Hill project was published on October 21, 1988 by the U.S. Department of Agriculture, Forest Service, with the Forest Service acting as lead agency and the EPA and Corps of Engineers acting as cooperating agencies. Both of the latter were involved or consulted in the FEIS preparation. The intention was that all three agencies would use the Final EIS as the basis for their subsequent permitting procedures.

The Record of Decision (ROD), issued separately on October 24, 1992 and written in consultation with the EPA and the Corps of Engineers, selected tailings disposal in Wilson Arm/Smeaton Bay as part of the "environmentally preferred" alternative. The ROD stated (Ref. 42):

> The environmentally preferred alternative for tailings disposal is marine disposal in Wilson Arm/Smeaton Bay. Impacts of the discharge will be evaluated through a monitoring program

developed by EPA in conjunction with issuance of a National Pollution Discharge Elimination System (NPDES) permit for the tailings disposal. The monitoring is primarily intended to ensure that unreasonable or unanticipated degradation to the aquatic environment is not occurring. The NPDES permit will be designed to avoid exceeding water quality criteria outside the mixing zone for the discharge. Depending on the results of the monitoring program, the permit for tailings disposal may be modified or even terminated, if necessary, prior to the completion of the design life of the project.

> There is a slightly higher risk of adverse consequences to the environment with tailings disposal in the Wilson-Smeaton basin than in the Boca de Quadra basin because the overall capacity to receive the tailings is less. Studies demonstrate, however, there is ample capacity, so the difference in risk is not significant. Coupling this with consideration of the impacts on Misty Fjords Wilderness from disposing of tailings in Boca de Quadra, the overall environmentally preferred alternative is disposal in Wilson/Smeaton Basin. Therefore, the preferred alternative is the environmentally preferred alternative.

The ROD went on to explain, as rationale for the selection:

> There is little difference in the environmental effects of tailings disposal in the marine environment between the Wilson Arm and Boca de Quadra fjords. The effect of disposal on anadromous fish, other food fish, and fish habitat is similar in both fjords.
>
> The Wilson Arm alternative offers added advantages. First, the impacts of the mine development are confined to a single, smaller drainage. Second, it reduces the impacts on wilderness values since it is not necessary to construct facilities for tailings disposal in the Misty Fjord National Monument Wilderness as would be required if disposal were in the Boca de Quadra. Third, based on historic and projected molybdenum markets, disposal in the Wilson Arm would result in greater community stability for Ketchikan and southeast Alaska. The frequency of mine shutdown will be less and the duration of shutdown would be shorter as a result of the difference in operating costs.

In detailing his decision in the ROD, the Regional Forester for Southeast Alaska stated that he would authorize approval of the U.S. Borax operating plan as described in the Final EIS, subject to further mitigation measures. With respect to tailings disposal, these were outlined as follows:

> Mine tailings disposal will be allowed in the submarine environment of Wilson Arm/ Smeaton Bay in accordance with the provisions of the NPDES permit to be issued by the Environmental Protection Agency. A comprehensive monitoring program will be required to provide early signals of tailing behavior so that comparisons to the predictive modeling can be made. Should it be discovered that tailings fill at a faster rate, behave in a detrimental manner, or cause unpredicted resource damage, changes will be needed. The changes could run the spectrum of reducing mine life to altering the tailings disposal site depending on the type and magnitude of variance from the predictive models.

Regarding the issuance of permits by the cooperating agencies based on the Final EIS, Section VIII of the ROD, "Determinations," stated that:

The EPA will issue a draft National Pollution Discharge Elimination System (NPDES) permit for tailings disposal in Wilson Arm/Smeaton Bay for public review and comment in the immediate future. Following the review period the EPA will issue a final permit. The purpose of the NPDES permit is to ensure compliance with section 402 of the Clean Water Act. The permit will be designed to prevent unreasonable degradation of the marine environment. Section 403 (c) guidelines have been used to evaluate the proposed discharge and are documented in Appendix S of the FEIS.

The ROD also stated that the Corps of Engineers would be issuing its permits for the project, under the Rivers and Harbors Act and under Section 404 of the Clean Water Act.

9.2 The Environmental Protection Agency's Position

EPA's environmental assessments in May and June 1988 (the BPJ Analysis and Risk Assessment documents respectively, Refs. 48 and 53) had expressed a preference for tailings disposal directly into the middle basin of Boca de Quadra; the concept of STD over land disposal having long since been accepted. This preference was based on the evaluation of comparative risks to the marine environment only. On some other non-related rulings, however, EPA had in the past taken the position that broader considerations such as socioeconomics should also play a role in a permit decision. In remarks given at the American Mining Congress convention in San Francisco in September 1985, Milton Russell, EPA's Assistant Administrator in Washington in charge of policy, planning and evaluation stated, "the implications of (EPA's) actions on the production of goods and services and on standards of living must be given due weight" (Ref. 19).

In making the ruling that EPA concurred with the Forest Service's ROD, Robie Russell, Region X Administrator, recognized the need to balance the various environmental and socioeconomic factors relating to project impacts (Ref. 56, p. 5). In spite of the environmental reservations of Region X staff, his decision was confirmed in a letter dated December 6, 1988 by the Director of the Water Division of Region X to the Forest Service's Forest Supervisor in Ketchikan (Ref. 54). That letter stated: "The Preferred Alternative as described in the FEIS is acceptable to EPA....Our position is that the projected risk does not preclude tailings disposal in either fjord, provided that appropriate environmental monitoring is conducted." The Water Division Director's letter also stated that Boca de Quadra remained EPA's primary choice for STD for environmental reasons. However, in a notice published in the Federal Register on December 23, 1988, the statement was made "EPA feels this Final EIS is acceptable as described."

Meanwhile, EPA's Region X staff prepared a draft NPDES permit for Wilson Arm/Smeaton Bay, which was issued in November 1988. This included a draft of monitoring requirements, to which U.S. Borax responded with comments. Throughout 1989, EPA Region X staff continued to work on the Wilson Arm/Smeaton Bay permit application but delayed issuance of the permit, partly because of a Clean Air Act provision (Section 176(c)) which required State approval of EPA's proposed State Implementation Plan (SIP) before other permits could be issued. As late as December 28, 1989, Robie Russell, EPA's Region X Administrator, indicated in a letter to U.S. Borax (Ref. 55) that the Wilson Arm/Smeaton Bay NPDES permit would be issued as soon as the SIP had been approved, and U.S. Borax had amended its air permit application to comply with SIP requirements. Other events, however, would soon bring this activity towards approval of the Wilson Arm STD site to a halt.

Early in 1990, Mr. Russell left the Agency. Subsequent allegations made by employees of Region X resulted in a Special Review by EPA's Office of the Inspector General of the Region's handling of air and water issues. The Inspector General's report, issued on May 3, 1990 (Ref. 56), found that the Regional Administrator's decision to approve a draft NPDES permit for the disposal of mine tailings into Wilson Arm/Smeaton Bay failed "to adequately protect the environment..., was not supportable based on available economic or scientific data...(and) was also contrary to the unanimous recommendations of the Water Division management and staff" that Boca de Quadra was the environmentally preferred site. The report also stated that "disposal of mine tailings into the Wilson Arm of Smeaton Bay fjord will turn the fjord into a bay. This has the potential to destroy a valuable salmon resource."

One day after the issuance of the Inspector General's report, the newly appointed Acting Regional Administrator of Region X, Thomas Dunne, issued a tentative denial of the NPDES application for STD into Wilson Arm/Smeaton Bay. This met with strong protest from the Forest Service, who had not been consulted. Michael Barton, Regional Forester in Juneau, designated as the responsible Federal official for the Quartz Hill EIS process, wrote in a letter to Mr. Dunne on May 8th: "I am astonished by this unexpected action on behalf of EPA. The Forest Service has worked closely for over a decade with the Environmental Protection Agency, the State of Alaska, and many other agencies on this project. This was culminated by release of the Record of Decision and Final Environmental Impact Statement..."(Ref. 43). An early meeting was requested, but no meeting had been held by the first week of July, when Mr. Barton wrote a second letter requesting that further action on the permit should be suspended until the Chief of the Forest Service could rule on a related Sierra Club appeal of the ROD (Ref. 44).

Public hearings on EPA's proposed permit denial were held in Ketchikan and Juneau, Alaska, in June 1990. These were followed by a public comment period which elicited 120 letters both for and against the tentative denial, and a "petition in support of Borax Mine" with approximately 420 signatures. On July 5, the Ketchikan City Council passed Resolution 90-1632 urging EPA to "allow U.S. Borax the chance to discharge tailings in Wilson Arm with close monitoring to assure the company complies with its promise of operating in an environmentally sound manner and not adversely affect other resources, especially commercial fishing."

9.3 Corps of Engineers

As one of the three cooperating agencies in the preparation of the EIS, the Corps had an important role to play in issuing the Section 10 (Rivers and Harbors Act) and Section 404 (Clean Water Act) permits for the project. However, the Corps did not express publicly any preference as to STD site alternative and did not appear to play a part in the NPDES permit denial.

9.4 The State of Alaska

The State agencies and administration had a more direct role. Their permitting functions included water quality, fisheries protection and furthering economic development; in addition to the basic governmental function of representing the will of the majority of voters.

The State agencies most directly concerned with Quartz Hill seemed to hold varying views on the choice of the preferred STD alternative, roughly compatible with their functions. As the agency overseeing water quality, ADEC was the most concerned with technical evaluations on the effects of the discharge. This agency also had the responsibility for setting the limits of the mixing zone (the zone starting at the outfall within which Alaska water quality standards may be exceeded) under guidelines set forth in the Alaska Administrative Code.

One of ADEC's concerns was that the size of the mixing zone needed would violate certain limiting provisions of the guidelines, which were not written with the requirements of STD in mind. However, the Administrative Code contains language giving ADEC discretionary authority to waive these provisions. ADEC also was concerned about the exceedance of water quality criteria for suspended sediments above the 100 m level predicted by both circulation models, the exceedance in dissolved copper predicted by the EPA model, and the projected loss of tailings fines over the Smeaton Bay sill into Behm Canal. ADEC, however, did not necessarily accept EPA's definition of the 100 m depth as being the level above which water quality standards had to be met (Ref. 1). U.S. Borax attempted to meet ADEC's concerns by presenting information and proposals at meetings held in September 1989 and June 1990 with ADEC and other State agencies (see next section).

ADF&G preferred Boca de Quadra as an STD site because of lesser perceived marine impacts and this agency's role of safeguarding the interests of the fishing industry; however, ADF&G agreed that salmon would not be affected in either fjord. ADCED favored the Forest Service's ROD selection of Wilson Arm/Smeaton Bay, while ADNR did not publicly express a position.

In July 1990, DGC in its role of coordinating the State's position, wrote to EPA stating that the State could find "no technical basis for objecting to the proposed denial of the current NPDES permit application." The letter also recommended that EPA should provide opportunities for discussion of technical and procedural issues prior to a final decision (Ref. 21).

9.5 The Developer's Position

In the previously mentioned meetings in 1989 and June 1990, U.S. Borax sought also to respond to the conditions made by the State in its 1987 conditional acceptance of Wilson Arm/Smeaton Bay (Ref. 22). Pursuant to EPA's request, Borax submitted draft water quality and toxicity monitoring plans to EPA and a draft contingency plan was discussed and submitted to the State.

The Company had a number of basic disagreements and concerns with EPA's evaluation of the NPDES application for Wilson Arm/Smeaton Bay, many of which had to do with the handling and interpretation of data. For example, the Company felt that a misinterpretation of the Rescan suspended sediment data from Rupert Inlet led to the selection by EPA of an inappropriate boundary value for suspended sediments used as input to EPA's circulation model. This was 30 times higher than that used by the University of Alaska's Kowalik (supported by Bechtel and its Board of Consultants), and 15 times higher than that considered reasonable by the Forest Service. In the Company's opinion, this led to gross overestimates of the distribution and concentrations of suspended sediment levels in the fjord. These overestimates, in turn, led to overestimates of the predicted copper concentrations; because EPA added to the dissolved copper values a percentage of the acid extractable portion of the copper in the fines, on the theory that they would be leached out. Use of EPA's acid extractable protocol for determining copper in seawater was in itself a subject of disagreement, and seemed to the Company's scientists to be inappropriate in view of the slightly basic and buffered waters of the fjord.

Another area in which the Company disagreed was EPA's seemingly arbitrary selection of 100 m as the depth above which all water quality standards must be met. Based on its interpretations of the scientific evidence, the Company felt that minor exceedances of water quality standards between 100 m and 60 m depth could be tolerated without any detectable effect on the marine ecology, because the biologically important euphotic zone extends to a maximum depth of only 25 to 30 m.

U.S. Borax therefore proposed that the top of the mixing zone be set at 60 m, with the exception of a 300 m radius cylinder extending to surface around the outfall. The western edge of the mixing zone would be at the Department of State closure line drawn across the mouth of Smeaton Bay. In attempts to resolve some of the other outstanding points of disagreement, the Company also made some important commitments in letters to EPA in June 1990 (Ref. 24). These included:

- Borax would lower the depth of the outfall to 100 m.
- There would be no significant effect from the discharge to the marine biota above the 100 m level.
- The actual dissolved copper concentration in the discharge would meet the EPA one hour average criterion (2.9 ug/l) at the end of the discharge pipe.

EPA made no direct response to these commitments prior to the final denial. Nor was there any reply to requests from the Company for meetings to resolve remaining differences of opinion. Had there been opportunities for discussion as recommended by the State, the Company planned to propose mitigation measures to alleviate most of the concerns by means of process modifications and other technical changes.

The Company position in June 1990 was outlined in a position paper and the testimony of its Vice-President and Quartz Hill Project Manager, at the EPA hearings in Ketchikan and Juneau on June 19 and 20 (Ref. 25). In summary, Borax felt that EPA's reversal of its previous tentative decision was not supported by any new scientific or socioeconomic data and there was no explanation of how the same technical evaluations could now be interpreted to yield a totally different conclusion. The Company believed that EPA's perceived problem concerning tailings deposition above the 100 m level late in the mine life could be handled by moving the outfall downfjord prior to operating year 45, or by simply shortening the mine life. EPA was felt to have adequate environmental control, through required renewals of the NPDES permit every five years. EPA's concern about undue shallowing was not considered valid since the fjord would still be between 250 and 570 ft deep, and the change in benthic biota composition would be economically beneficial in the long term to the commercial fishery.

Borax felt that the evidence from the extensive investigations over 12 years showed that the risks from marine disposal in either fjord would be small and acceptable. In the absence of any significant differences between fjords, the Company urged EPA in making its decision to take a broader view of considering all the project impacts, other than simply looking at the marine impacts; and to recognize the other offsetting factors. These were listed as:

- Confining the impacts of the project to a single, smaller drainage basin,

- Avoiding direct Wilderness intrusion from a tunnel portal in the Wilderness,

- Maximizing the socioeconomic benefits to Southeast Alaska by avoiding unnecessary project costs which would weaken the project financially,

- Minimizing risk of worker injury by eliminating the need to construct a 7¼ mile tunnel to Boca de Quadra,

- Reduction in terrestrial impact area, noise and visibility.

Objective consideration of these offsetting factors, the Company felt, would confirm the Forest Service's conclusion that STD in Wilson Arm/Smeaton Bay was the overall environmentally preferred alternative. More detailed comments were sent to EPA by letter in early July 1990 (Ref. 26).

10.0 THE PERMIT DECISION

10.1 EPA's Permit Denial

The denial of U.S. Borax's application on behalf of Pacific Coast Molybdenum Company to dispose of Quartz Hill mill tailings into Wilson Arm/Smeaton Bay was affirmed by EPA on September 27, 1990. The Final Decision of the Acting Regional Administrator (Ref. 57) stated that EPA's earlier proposal to permit the discharge was re-evaluated because of "several" public comments opposing the proposal. The comments were to the effect that the proposed discharge would impact the fisheries, benthic organisms and biologically significant upper water column of Smeaton Bay and violate Alaska water quality standards.

In its re-evaluation, EPA found that in order for water quality criteria to be met, the top of the mixing zone would need to extend upward "into the important habitat for marine organisms identified as the water column above 100 m depth. Allowing a mixing zone to extend into this habitat would have a significant adverse impact on the beneficial uses of Wilson Arm/Smeaton Bay". The permit application was therefore denied on the basis that "The proposed discharge would significantly impact the existing beneficial use of Wilson Arm/Smeaton Bay and exceed the water quality standards for sediment and copper." No comment was made on the ultimate acceptability of Boca de Quadra as a STD site.

10.2 Subsequent Developments

The Company had the option at this point of requesting an evidentiary hearing within 30 days to attempt to have Region X's decision overturned, but chose not to do so for policy reasons and because the depressed state of the molybdenum market would not justify further large expenditures on the project at that time. Instead, Borax announced in Ketchikan in October 1990 that the project was postponed indefinitely.

A year later, the Quartz Hill project was sold by U.S. Borax to Bonna, Incorporated, an affiliate of Cominco, Ltd., an international mining group with headquarters in Vancouver, BC, Canada.

As of early 1993, the new owners had not announced any resumption of Quartz Hill permitting activities.

By March 1993, the Chief Forester of the Forest Service had not yet ruled on the ROD appeal of the Sierra Club Legal Defense Fund et al., which argued many of the same points cited by EPA in its denial of the Wilson Arm/Smeaton Bay NPDES permit application.

11.0 OBSERVATIONS ON THE STD PERMITTING PROCESS

11.1 Discussion of Permitting Issues

A number of issues were addressed during the project developer's attempt to obtain the permits for the first regulated STD operation in the United States. Some of these were technical and others procedural in nature. A brief discussion of some of the problems which arose may be beneficial in reflecting on what lessons can be learned from the Quartz Hill experience. The discussion below is intended to illustrate some of the more obvious flaws of the permitting system (or state of development of the system) existing during the 1980's.

Many of the technical problems involved differing interpretations of scientific findings and empirical data. An example previously mentioned is the three different interpretations of data from the Rupert Inlet suspended solids survey. The estimates by Bechtel's Board of Consultants and the University of Alaska, the Forest Service, and EPA for the suspended solids value at the top of the turbidity current spanned a range from 20 mg/l to 600 mg/l, leading to the varying predictions of the circulation models. It is arguable that it would have been possible to narrow the range by means of direct discussion among the scientists involved; however,this was never done. To the Company, EPA appeared reluctant to enter into discussions aimed at working out problems with the applicant.

The non-standardization of criteria and the lack of parameters set for evaluating the criteria could be considered a systemic flaw which resulted from the lack of experience with STD in the United States. The Company did not agree with EPA that the 100 m depth was the level above which all marine life must be protected, but did not immediately contest this determination. When EPA applied this depth to define the top of the mixing zone, the effect was that of mandating that all water quality standards must be met above the 100 m level. Both circulation models had already indicated that minor exceedances of suspended solids criteria could occur on occasion up to about the 60 m level. Suspended tailings fines, however, would remain below the euphotic zone and generally below the pycnocline. The disagreement centered on the importance of occasional minor incursions of fines between the 100 and 60 m levels and, therefore, on what level to hold inviolate for permitting purposes.

The Final EIS, in which EPA participated, had concluded that marine tailings disposal would not affect migration of anadromous fish and that "all tailings impacts to salmon would be insignificant" (Ref. 44). However, EPA took the position that any fines incursions above 100 m could affect important marine biota. The Company was sufficiently convinced about the insignificance of these predicted occasional incursions to issue a commitment in June, 1990 that there would be "no significant effect" from the tailings discharge on the marine biota above the 100 m level, with the exception of the prescribed mixing zone in the immediate area of the outfall (Ref. 24). A related issue was the lack of an appropriate approved protocol for copper determinations on suspended solids in seawater.

Some questions seemed to cause undue concern long after evidence had been presented which should have put the matter to rest. One example is the estimated loss of fines over the Smeaton Bay sill, which was not regarded in the Final EIS as unacceptable and was considered in 1986 by National Marine Fisheries Service to have an undetectable effect on the fishery resources of Behm Canal (Ref. 12). The opinion of NMFS was not challenged; nevertheless, the point was still being raised in 1990 by some agencies and opponents of the project (Appeal to the Chief of the United States Forest Service, Appeal No. 3080, Sierra Club Legal Defense Fund). Another example is the statement of EPA's Inspector General, in April 1990, that STD in Wilson Arm/Smeaton Bay would have potential to "destroy a valuable salmon resource", long after fisheries experts had agreed that salmon resources would not be affected.

Among the procedural problems encountered was the complexity of the existing permitting structure. This led to time requirements and expense, for both the developer and the permitting agencies, which most observers would consider excessive. Appendix C is illustrative of this complexity. For the Quartz Hill STD permitting, there was direct involvement of three Federal agencies and four State agencies. The time involved spanned over twelve years, from the start of baseline data gathering to the permit denial. During this time U.S. Borax spent over $25 million on overall project environmental and permitting activities, the majority of which was connected with STD permitting. Estimates for agency expenditures are not available, but must run in the millions of dollars. While some of the delays were caused by other factors, the extreme cost and length of the proceedings alone argue for a simplification of the permitting procedure. The addition of provisions to encourage a closer working relationship between the permitting agencies and the applicant would also assist in expediting permit issuance.

A legal problem which delayed EPA's activity on the permit application in 1989 (Ref. 55) was the Clean Air Act provision in Section 176(c) that prohibited the issuance of all permits by Federal and State agencies until State approval of EPA's State Implementation Plan (SIP). This caused a serious setback to the project schedule for reasons totally unrelated to the merits of the STD application and beyond the control of either the applicant or the agency personnel dealing with the application.

11.2 Conclusions

The extensive studies at Quartz Hill have suggested that under certain conditions, the choice of the submarine tailings disposal alternative for a mining project can result in the least impact to the overall environment among the "action" scenarios. The closely monitored experience at Island Copper has shown that STD can be designed and practiced effectively without unacceptable effects on the marine ecology. What remains is a rationalization of the regulatory system which would allow STD to be permitted efficiently, while at the same time ensuring that the project will operate with no unacceptable degradation and irreparable harm to the environment. The Quartz Hill experience has indicated that a more effective permitting structure could be attained under the aegis of one agency, which would focus on all of the impacts of the project, including socioeconomic, to arrive at a decision in the public interest, while preserving the traditional rights of responsible and timely development inherent in a free enterprise system.

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APPENDICES

A - Federal and State Laws, Executive Orders and Regulations Applicable to Quartz Hill Facility Sites

B - Permits and Approvals Required for Mine Development

C - Permitting Flow Diagrams for Significant Federal and State Submarine Tailings Disposal Permits

D - Permitting Chronology, Quartz Hill Project, Southeast Alaska

E - Quartz Hill EIS Significant Issues for Submarine Tailings Disposal

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G - About the Authors

APPENDIX A

FEDERAL AND STATE LAWS, EXECUTIVE ORDERS AND REGULATIONS APPLICABLE TO QUARTZ HILL FACILITY SITES

FEDERAL LAWS, EXECUTIVE ORDERS, AND
IMPLEMENTING REGULATIONS APPLICABLE TO
QUARTZ HILL SITE FACILITIES

Title	Citation
Mining and Land Management	
Mining Law of 1872	17 Stat. 91-96
Organic Act of 1897	30 Stat. 36
Submerged Lands Act of 1953 (P.L. 31)	67 Stat. 29-33
Multiple Surfaces Use Act of 1955 (P.L. 167)	69 Stat. 367-373
Alaska Offshore Lands Act of 1957 (P.L. 85-303)	71 Stat. 623-625
Mining and Minerals Policy Act of 1970 (P.L. 91-631)	84 Stat. 1876
Alaska Native Claims Settlement Act of 1971 (P.L. 92-203)	85 Stat. 688-716
Federal Land Policy and Management Act of 1976 (P.L. 94-579)	90 Stat. 2743-2794
Misty Fjords National Monument - Proclamation 4623 (12/1/78)	93 Stat. 1466-1468
Alaska National Interest Lands Conservation Act of 1980 (P.L. 96-487)	94 Stat. 2371-2551
National Materials and Mineral Policy, Research and Development Act of 1980 (P.L. 479)	94 Stat. 2305-2310
Bureau of Land Management - Mining Claims under the General Mining Laws	43 CFR 3800-3870
Forest Service - Land Uses, Minerals	36 CRF 251, 228
Forest Service Manual - Special Use Permits	FSM 2710
Forest Service Manual - Road and Trail Right-of-Way Grants	FSM 2730

Title	Citation
Mining and Land Management (Cont'd)	
Forest Service Manual - Mining Claims	FSM 2810
Protection of Environmental Resources	
Rivers and Harbors Act of 1899	30 Stat. 1121-1161
Antiquities Act of 1906 (P.L. 209)	34 Stat. 225
Fish and Wildlife Coordination Act of 1934 (P.L. 121) and 1946 Amendments (P.L. 732)	48 Stat. 401-402 60 Stat. 1080-1082
Historic Sites Act of 1935 (P.L. 292)	49 Stat. 666-668
National Historic Preservation Act of 1966 (P.L. 89-665)	80 Stat. 915-919
National Environmental Policy Act of 1969 (P.L. 91-190)	83 Stat. 852-856
Coastal Zone Management Act of 1972 (P.L. 92-583)	86 Stat. 1280-1289
Marine Protection, Research, and Sanctuaries Act of 1972 (P.L. 95-632)	86 Stat. 1052-1063
Endangered Species Act of 1973 (P.L. 93-205) and 1978 Amendments (P.L. 95-632)	87 Stat. 884-903 92 Stat. 3751-3767
Archaeological and Historic Preservation Act of 1974 (P.L. 93-291)	88 Stat. 174-176
Archaeological Resources Protection Act of 1979 (P.L. 96-95)	93 Stat. 721-728
Executive Order 11514 - Protection and Enhancement of Environmental Quality	35 FR 4247; 3 CFR, 1971-1975 Comp., p902
Executive Order 11593 - Protection and Enhancement of the Cultural Environment	36 FR 8921; 3 CFR, 1971-1975 Comp., p559
Executive Order 11991 - Relating to Protection and Enhancement of Environmental Quality	42 FR 26967; 3 CFR, 1977 Comp., p123

Title	Citation
Protection of Environmental Resources (Cont'd)	
Executive Order 11990 - Protection of Wetlands	42 FR 26961; 3 CFR 1977 Comp., p121
Council on Environmental Quality - Regulations Implementing NEPA	40 CFR 1500-1508
Secretary of the Interior - Preservation of American Antiquities	43 CFR 3
Advisory Council on Historic Preservation - Protection of Historic and Cultural Properties	36 CFR 800
Corps of Engineers - General Regulatory Policies	33 CFR 320-329
Forest Service Manual - Forest Service National Environmental Policy Act Process	FSM 1950
Water Quality	
Water Quality Act of 1965 (P.L. 89-234)	79 Stat. 903-910
Federal Water Pollution Control Act Amendments of 1972 (P.L. 92-500)	86 Stat. 816-904
Clean Water Act of 1977 (P.L. 95-217)	91 Stat. 1566-1611
Environmental Protection Agency - NPDES Program Regulations	40 CFR 121-125
Environmental Protection Agency - Oil Pollution Prevention	40 CFR 112
U.S. Coast Guard - Oil Pollution Regulations	33 CFR 154-157
Air Quality	
Federal Air Pollution Control Act of 1955 (P.L. 159)	69 Stat. 322-323
Clean Air Act of 1963 (P.L. 88-206)	77 Stat. 392-401

Title	Citation
Air Quality (Cont'd)	
Air Quality Act of 1967 (P.L. 90-148)	81 Stat. 485-507
Clean Air Act Amendments of 1970 (P.L. 91-604)	84 Stat. 1676-1713
Clean Air Act Amendments of 1977 (P.L. 95-95)	91 Stat. 685-796
Solid and Hazardous Wastes	
Solid Waste Disposal Act of 1965 (P.L. 89-272)	79 Stat. 997-1001
Resource Recovery Act of 1970 (P.L. 91-512)	84 Stat. 1227-1235
Resource Conservation and Recovery Act of 1976 (P.L. 94-580)	90 Stat. 2795-2841
Environmental Protection Agency - Generators and Transporters of Hazardous Wastes	40 CFR 262-263
Energy	
Powerplant and Industrial Fuel Use Act of 1978 (P.L. 95-620)	92 Stat. 3289-3347
Natural Gas Act of 1938 (P.L. 688)	52 Stat. 821-833
Executive Order 10485 - Natural Gas Facilities Located on the Borders of the United States	18 FR 4957; 3 CFR, 1949-1953 Comp., p970
Health and Safety	
Federal Coal Mine Safety and Health Act of 1969 (P.L. 91-173)	83 Stat. 742-804
Occupational Safety and Health Act of 1970 (P.L. 95-596)	84 Stat. 1590-1620
Federal Coal Mine Safety and Health Act of 1977 (P.L. 95-164)	91 Stat. 1290-1322

Title	Citation
Health and Safety (Cont'd)	
Enactment of Title 14 U.S. Code "Coast Guard" (P.L. 81-207)	63 Stat. 495-565
Ports and Waterways Safety Act of 1972 (P.L. 92-340)	86 Stat. 424-432
Port and Tanker Safety Act of 1978 (P.L. 95-474)	92 Stat. 1471-1493
Federal Aviation Act of 1958	72 Stat. 740
Mine Safety and Health Administration - Administrative, Education, and Training Requirements	30 CFR 40-49
Mine Safety and Health Administration - Metal and Nonmetallic Mine Safety and Health	30 CFR 55, 57
Federal Aviation Administration - Objects Affecting Navigable Airspace	14 CFR 77
U.S. Coast Guard - Private Aids to Navigation	33 CFR 66

STATE LAWS AND REGULATIONS APPLICABLE TO QUARTZ HILL SITE FACILITIES

Title	Citation
Protection of Environmental Resources	
Environmental Conservation Law of 1971	AS 46.03.101-46.03.900
Alaska Coastal Management Program Law of 1977	AS 46.40.010-46.40.210
Anadromous Fish Act of 1968	AS 16.05.870-16.05.900
Alaska Historic Preservation Act	AS 41.35.010-41.35.240
Administrative Order 78 - Consolidated State Permitting Review	
Office of the Governor - Standards of the Alaska Coastal Management Program, Guidelines for District Coastal Management Programs	6 ACC 80, 85 5 ACC 95
Department of Fish and Game - Fish and Game Habitat	5 ACC 95
Department of Natural Resources - Historic, Prehistoric, and Archaeological Resources	11 AAC 16
Land and Water Management	
Alaska Land Act	AS 38.05.010-38.05.900
Water Use Act of 1966	AS 46.15.010-46.15.270
Department of Natural Resources - Tide and Submerged Lands	11 AAC 62
Department of Natural Resources - Miscellaneous Land Use	11 AAC 96
Department of Natural Resources - Water Management	11 AAC 93
Department of Natural Resources - Mining Rights	11 AAC 86

Title	Citation
Water Quality	
Environmental Conservation Law of 1971	AS 46.03.010-46.03.900
Oil Pollution Control Law of 1980	AS 46.04.010-46.04.120
Department of Environmental Conservation - Drinking Water	18 AAC 80
Department of Environmental Conservation - Wastewater Disposal	18 AAC 72
Department of Environmental Conservation - Water Quality Standards	18 AAC 70
Department of Environmental Conservation - Oil and Hazardous Substances Pollution Control	18 AAC 75
Air Quality	
Environmental Conservation Law of 1971	AS 46.03.010-46.03.900
Department of Environmental Conservation - Air Quality Control	18 AAC 50
Solid and Hazardous Wastes	
Environmental Conservation Law of 1971	AS 46.03.010-46.03.900
Department of Environmental Conservation - Solid Waste Management	18 AAC 60
Health and Safety	
Public Health Law	AS 18.05.040
Public Safety Law	AS 18.70.080
Department of Health and Social Services - Occupational Health	7 AAC 20
Department of Public Safety - Fire Protection, Prevention, and Investigation	13 AAC 50

APPENDIX B

PERMITS AND APPROVALS REQUIRED FOR MINE DEVELOPMENT

PERMITS AND APPROVALS REQUIRED FOR MINE DEVELOPMENT[a]

Permit or Approval	Priority	Construction or Operation	Applicability
Federal			
U.S. Forest Service			
Environmental Impact Statement	1	C	Entire project development, as presented in the Plan of Operations
Plan of Operations	1	C, O	Any mining development activity that causes significant surface disturbance; excludes any patented mining claims, unless activity affects federal lands
Special Use Permit	1	C, O	Use or construction of facilities on national forest land; excludes area of mining claims
Mineral Material Permit	3	C, O	Use of mineral materials (borrow materials) taken from national forest land
Timber Sale Contract	3	C	Value of timber removed from national forest land
Utility Corridor Approval	1	C	Pipelines, transmission lines, or other facilities that may be constructed in a wilderness area
Antiquities Permit	2	C	Preconstruction cultural resources survey of project area
U.S. Army Corps of Engineers			
Department of the Army Permit	1	C	Discharge of dredged or fill material in tidelands, streams, or adjacent wetlands; structures within navigable waterways

Permit or Approval	Priority	Construction or Operation	Applicability
U.S. Department of Energy			
Authorization to Import Natural Gas	3	O	Natural gas pipeline, only if constructed
Presidential Permit	3	C	Natural gas pipeline, only if constructed
U.S. Coast Guard			
Permit to Handle Hazardous Materials	2	O	Vessels or waterfront facilities handling, storing, loading, discharging, and transporting hazardous materials
Application for Private Aids to Navigation	3	O	Navigational aids required or authorized by the U.S. Coast Guard
Bridge Permit	3	C	Bridges over navigable waterways
Federal Aviation Administration			
Notice of Landing Area Proposal	3	C	Seaplane bases and heliports
Determination of No Hazard	3	C	Structures such as stacks, antennas, transmission lines, and buildings that may be a hazard to air navigation
Federal Communications Commission			
Radio and Microwave Station Authorizations	3	C, O	Land mobile radio service and operational fixed microwave service

Permit or Approval	Priority	Construction or Operation	Applicability
U.S. Environmental Protection Agency			
National Pollutant Discharge Elimination System Permit	1	C, O	Point-source wastewater discharges, including mine drainage, construction effluents, mill process effluent, mill tailing, and sewage effluent
Spill Prevention, Containment, and Countermeasures Plan	2	C	Onshore and offshore oil storage facilities, such as tank farm at wharf, power plant, and construction staging areas
Notification of Hazardous Waste Activity	1	O	Covers onsite generation and transportation of hazardous wastes
U.S. Department of Labor			
Legal Identity Report	3	O	Registration of surface and underground mining facilities
Training Plan Approval	3	C, O	Training of surface and underground miners
State			
Office of the Governor			
State Certification and Consistency Determination	1	C	Overall state approval of project, including certification of consistency of proposed activities with Alaska Coastal Management Program

Permit or Approval	Priority	Construction or Operation	Applicability
Department of Environmental Conservation			
Solid Waste Management Permit	2	C, O	Disposal of solid wastes, such as garbage, sludges, incinerator ash, mine waste, spoils, and overburden
Prevention of Significant Deterioration Review and Air Quality Permit to Operate	1	C	All significant emissions of air pollutants associated with project development
Oil Facilities Approval of Financial Responsibility	2	O	Operation of oil terminals, oil barges, and tank vessels at the wharf site
Oil Facilities Discharge Contingency Plan	2	O	Oil storage facilities, such as tank farm at the wharf, power plant, and construction staging areas
Water and Sewerage Plan Approval	3	C	Plans for water supplies and sewage treatment and disposal at construction camps and permanent facilities at the mine, processing facilities, wharf, and townsite
Food Service Permit	3	O	Food service operations at construction and permanent facilities
Department of Natural Resources			
Land Use Permit	1	C	Temporary use of state land, including access to and location of temporary construction facilities

Permit or Approval	Priority	Construction or Operation	Applicability
Department of Natural Resources (Cont'd)			
Tidelands Lease	2	C	Any project facilities, such as wharf, tank farm, and tailings outfall, to be located on tidelands
Right-of-Way Easement	2	C	Permanent project facilities crossing state tidelands
Pipeline Right-of-Way Lease	3	C	Natural gas pipeline, only if constructed
Water Rights Permits	1	C	Temporary and permanent use of water for potable and process purposes
Permit to Construct or Modify a Dam	3	C	Sedimentation dams for mine drainage and possibly a retention pond near Tunnel Creek
Field Archaeology Permit	2	C	Preconstruction cultural resources survey of state lands
Department of Fish and Game			
Anadromous Fish Protection Permit	1	C	Construction of project facilities that will affect the flow or bed of a specified anadromous fish stream
Department of Public Safety			
Life and Fire Safety Plan Check	3	C	All occupied buildings and facilities for compliance with state fire regulations

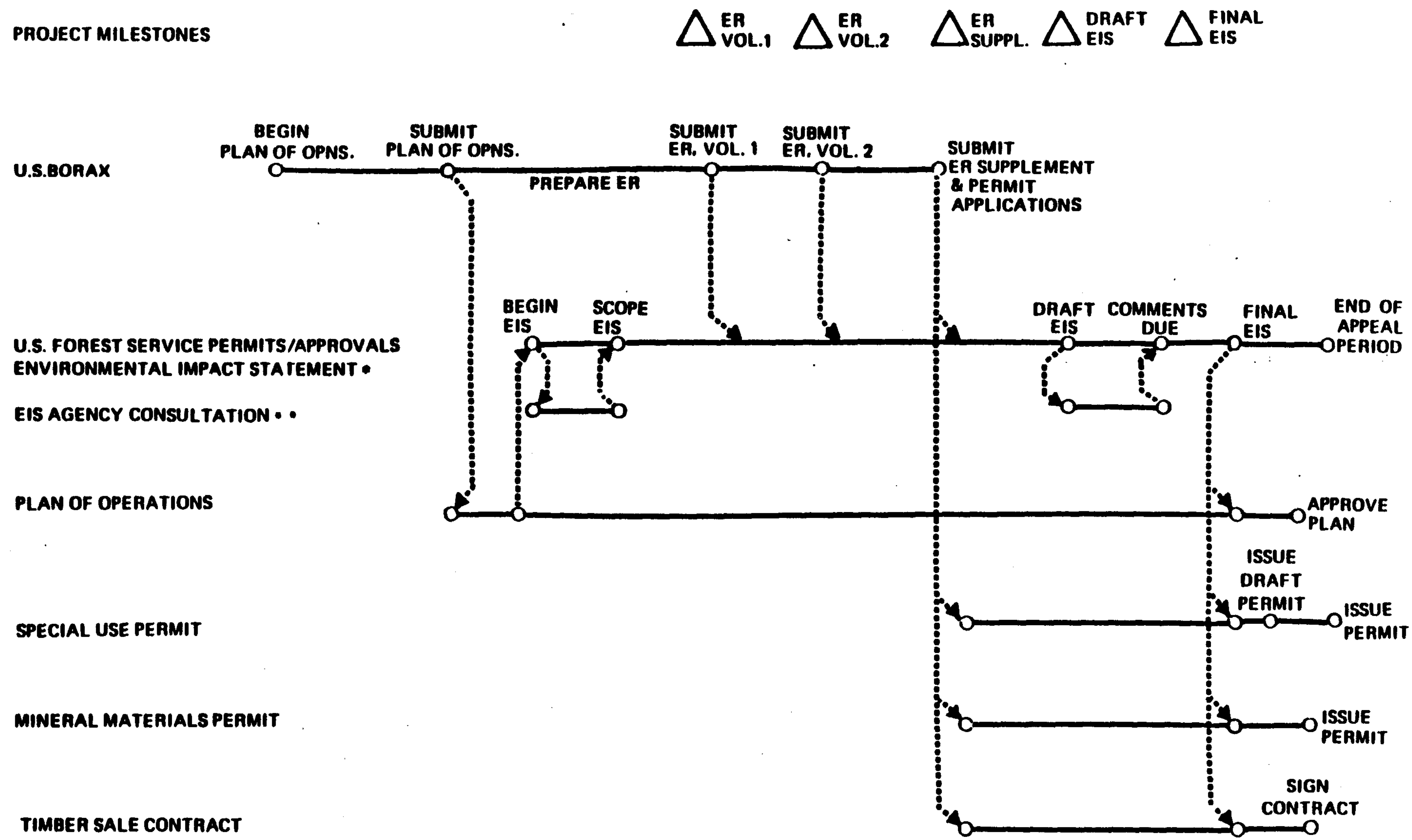
Permit or Approval	Priority	Construction or Operation	Applicability
Department of Labor			
Fired and Unfired Pressure Vessel Certificate	3	O	Postconstruction inspection of pressure vessels
Elevator Certificate of Operation	3	O	Inspection of elevators in buildings occupied by employees
Department of Revenue			
Affidavit for Non-Resident Business Taxation	3	O	To be determined
Alaska Business License	3	O	Required to conduct business in Alaska
Alaska Mining License	3	O	Required to conduct mining operations in Alaska

(a) More than one permit or approval may be required for each category, e.g., one for each major facility, activity, or site

APPENDIX C

PERMITTING FLOW DIAGRAMS FOR SIGNIFICANT FEDERAL AND STATE SUBMARINE TAILINGS DISPOSAL PERMITS

USFS: PERMITS/APPROVALS

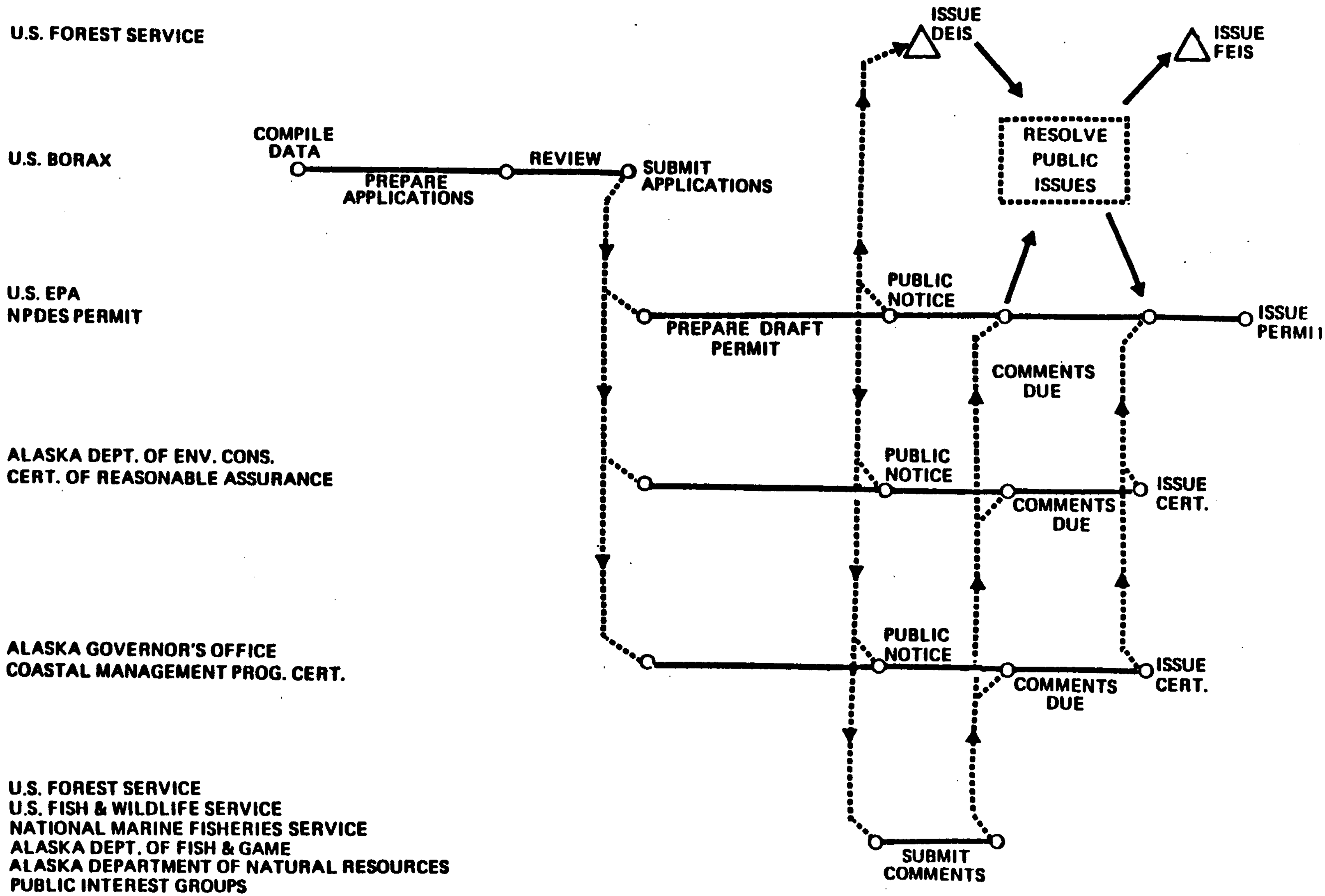


• THE USFS ALSO MUST OBTAIN BALD EAGLE VARIANCES FROM THE U.S. FISH & WILDLIFE SERVICE FOR ANY WORK TO BE DONE WITHIN 330 FEET OF KNOWN EAGLE NESTS.

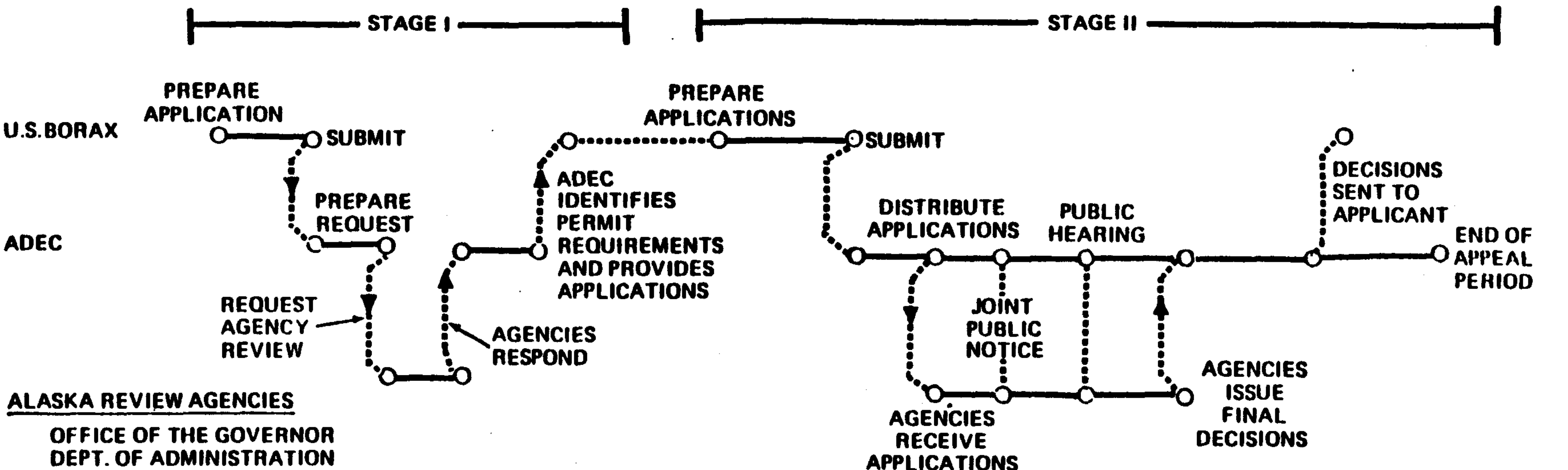
• • FOR PURPOSES OF THIS PROJECT, VIRTUALLY ALL FEDERAL, STATE AND NEARBY LOCAL AGENCIES WILL BE ASKED FOR COMMENTS ON THE DRAFT EIS.

ER = ENVIRONMENTAL REPORT SUBMITTED BY APPLICANT

EPA: NPDES PERMIT



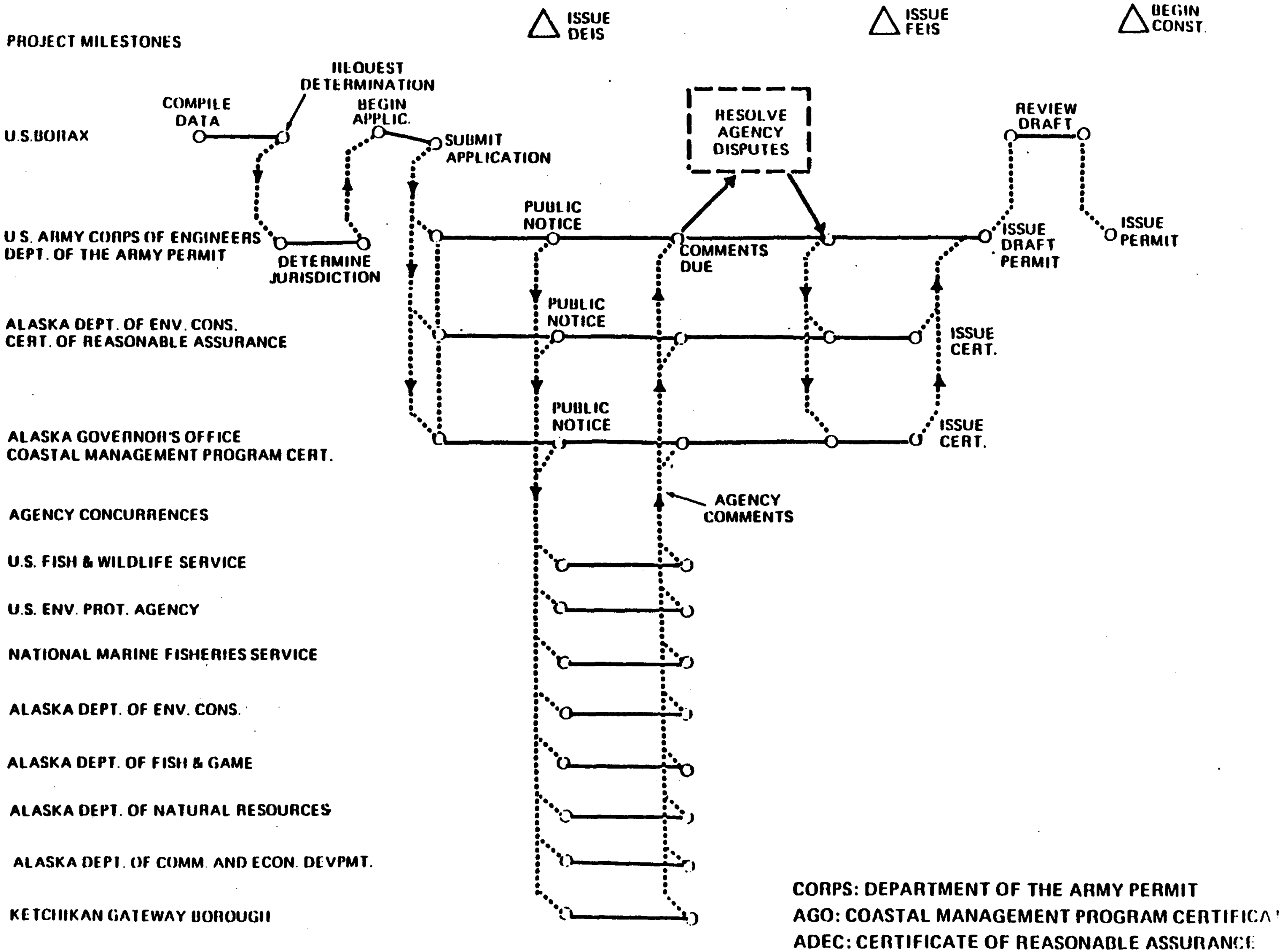
MASTER APPLICATION



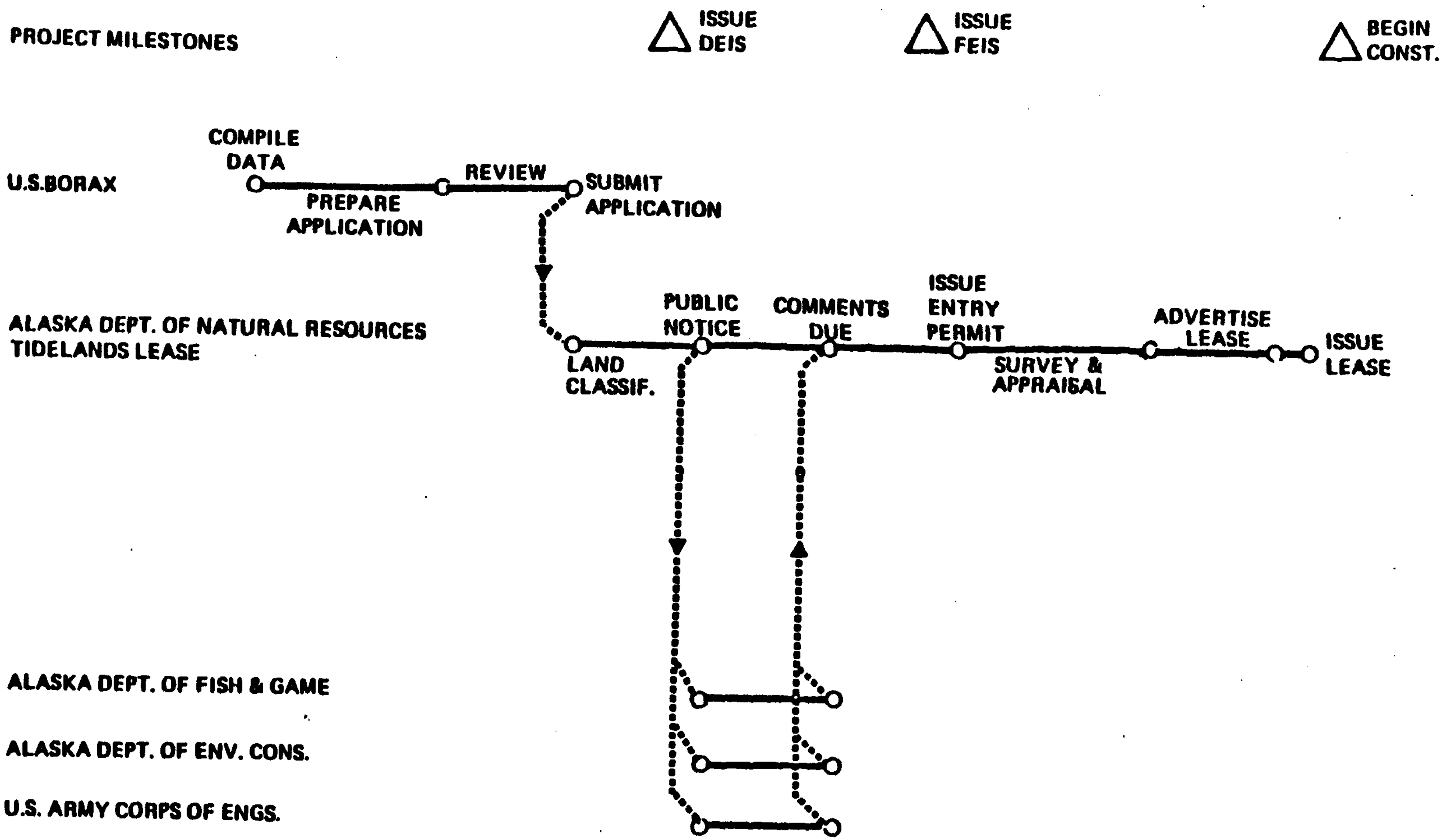
ALASKA REVIEW AGENCIES

- OFFICE OF THE GOVERNOR
- DEPT. OF ADMINISTRATION
- DEPT. OF COMMERCE AND ECONOMIC DEVELOPMENT
- DEPT. OF COMMUNITY & REGIONAL AFFAIRS
- DEPT. OF EDUCATION
- DEPT. OF ENVIRONMENTAL CONSERVATION
- DEPT. OF FISH & GAME
- DEPT. OF HEALTH & SOCIAL SERVICES
- DEPT. OF LABOR
- DEPT. OF LAW
- DEPT. OF MILITARY AFFAIRS
- DEPT. OF NATURAL RESOURCES
- DEPT. OF PUBLIC SAFETY
- DEPT. OF REVENUE
- DEPT. OF TRANSPORTATION & PUBLIC FACILITIES

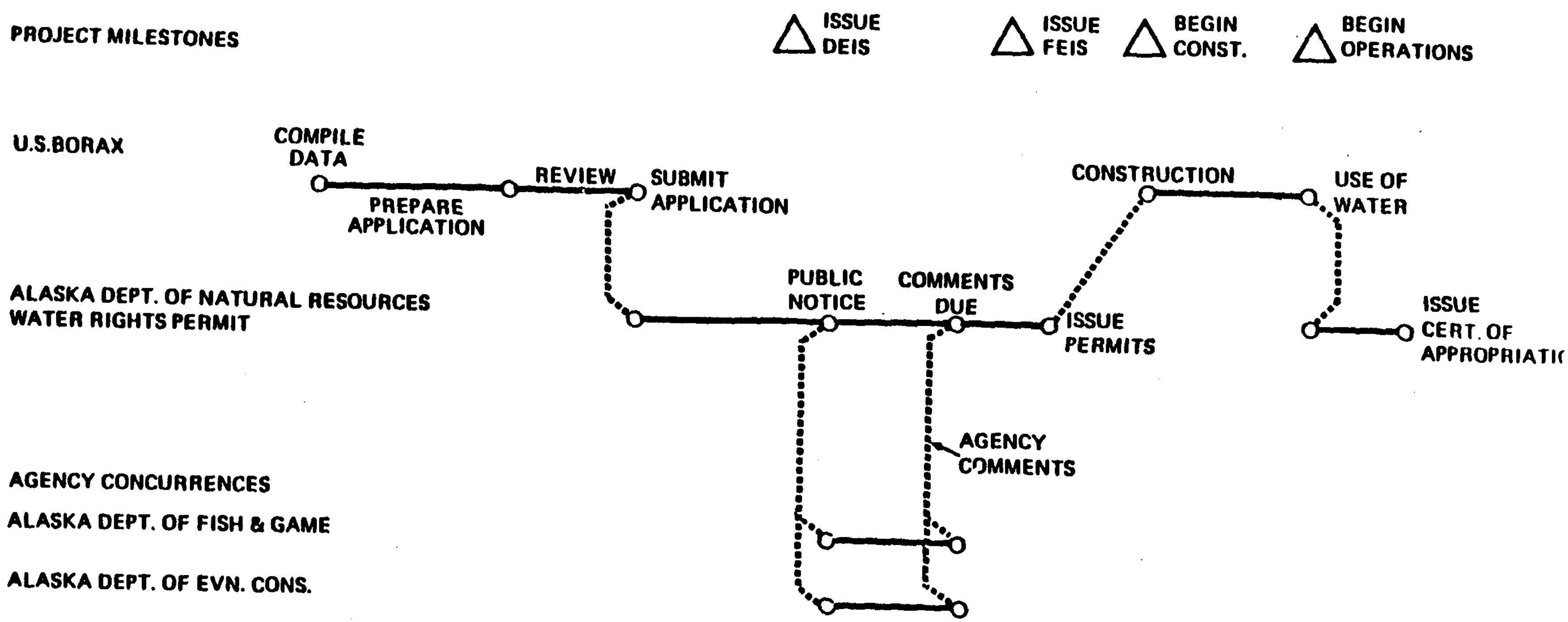
NOTE: STAGE I IS AN OPTIONAL PROCEDURE FOR DETERMINING PERMIT REQUIREMENTS. STAGE II IS AN OPTIONAL "STREAMLINED" JOINT STATE PERMITTING PROCEDURE AND DOES NOT NECESSARILY FOLLOW STAGE I.


ISSUE DEIS
ISSUE FEIS
BEGIN CONST.
PROJECT MILESTONES
REQUEST DETERMINATION
COMPILE DATA
BEGIN APPLIC.
SUBMIT APPLICATION
RESOLVE AGENCY DISPUTES
REVIEW DRAFT
U.S. BORAX
PUBLIC NOTICE
ISSUE DRAFT PERMIT
ISSUE PERMIT
U.S. ARMY CORPS OF ENGINEERS
DEPT. OF THE ARMY PERMIT
DETERMINE JURISDICTION
COMMENTS DUE
PUBLIC NOTICE
ALASKA DEPT. OF ENV. CONS.
CERT. OF REASONABLE ASSURANCE
ISSUE CERT.
PUBLIC NOTICE
ALASKA GOVERNOR'S OFFICE
COASTAL MANAGEMENT PROGRAM CERT.
ISSUE CERT.
AGENCY CONCURRENCES
AGENCY COMMENTS
U.S. FISH & WILDLIFE SERVICE
U.S. ENV. PROT. AGENCY
NATIONAL MARINE FISHERIES SERVICE
ALASKA DEPT. OF ENV. CONS.
ALASKA DEPT. OF FISH & GAME
ALASKA DEPT. OF NATURAL RESOURCES
ALASKA DEPT. OF COMM. AND ECON. DEVPMT.
KETCHIKAN GATEWAY BOROUGH
CORPS: DEPARTMENT OF THE ARMY PERMIT
AGO: COASTAL MANAGEMENT PROGRAM CERTIFICA
ADEC: CERTIFICATE OF REASONABLE ASSURANC

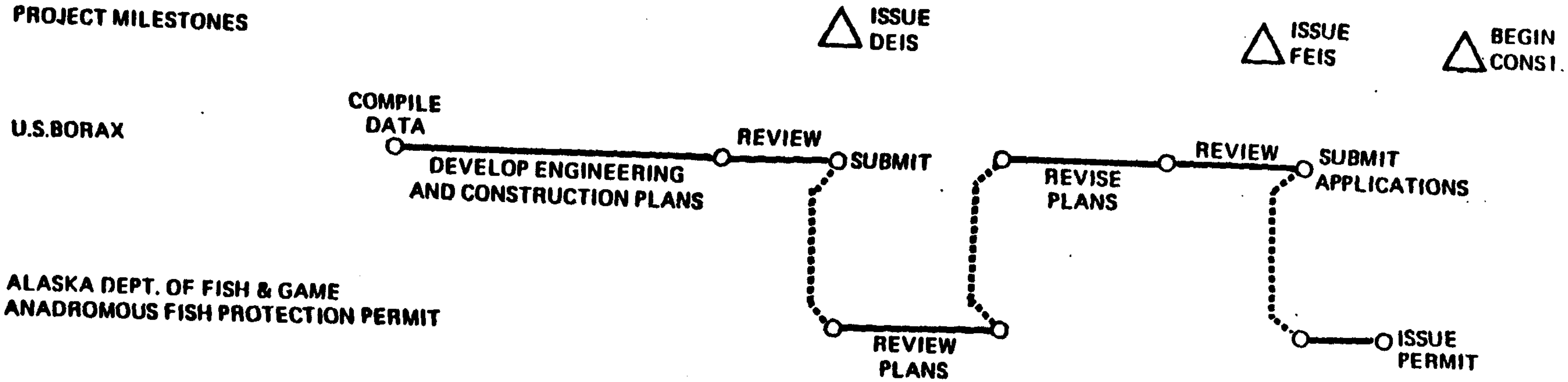
ADNR: TIDELANDS LEASE



ADNR: WATER RIGHTS PERMITS



ADF & G: ANADROMOUS FISH PROTECTION PERMIT



APPENDIX D

PERMITTING CHRONOLOGY
QUARTZ HILL PROJECT, SOUTHEAST ALASKA

March 1976

U.S. Borax a/ submitted to the Forest Service an Environmental Report (ER) and Plan of Operations application for Keta River access road and bulk sampling.

January 1977

Forest Service issued Keta River access road and bulk sampling Draft Environmental Impact Statement (DEIS).

July 18, 1977

Forest Service issued Final Environmental Impact Statement (EIS) for Keta River access road and bulk sampling.

November 9, 1977

Forest Service issued Special Use Permit (SUP) for construction of Keta River access road and bulk sampling. Decision appealed December 22, 1977 by Southeast Alaska Conservation Council, Inc. (SEACC), Sierra Club Legal Defense Fund (SCLDF) and associated fishing and environmental organizations.

July 1978

Chief Forester denied SEACC access road appeal.

December 1, 1978

President Carter designated by Presidential Proclamation No. 4623, 56 million acres, including the Quartz Hill area, as Misty Fjords National Monument, and withdrew the area from mineral entry. The Secretary of Agriculture found the July 1977 Keta River access road and bulk sampling EIS was adequate, however, the access alternative that should be used for bulk sampling was helicopter. The Special Use Permit issued November 9, 1977 for construction of the access road was denied December 5, 1978.

January 1979

President Carter Administration proposed Wilderness designation for all of Misty Fjords National Monument, including the Quartz Hill area and this known molybdenum mineral deposit.

Fall 1979

U.S. Borax submitted Plan of Operations to continue seasonal core drilling and other field activities for the period 1980-83; this was subsequently approved by the Forest Service for the start of the 1980 field season.

Late 1980

U.S. Borax supplemented its Plan of Operations for 1980-83 through Amendments 2, 3 and 4, which included excavation of two adits and production of about 42 tons of ore samples for process and environmental testing.

December 2, 1980

President Carter signed the Alaska National Interest Lands Conservation Act (ANILCA). This Act confirmed the Misty Fjords area as a National Monument and designated the area as Wilderness, except for 152,610 acres surrounding Quartz Hill. ANILCA provided for the development of the Quartz Hill Project under environmental guidelines.

February 16, 1981

U.S. Borax submitted to the Forest Service a report on "Development Concepts for the Quartz Hill Molybdenum Project", with the preferred mine development concept being an access road from Wilson Arm up the Blossom River Valley with tailings disposal in Wilson Arm. This mine development plan report was required by ANILCA.

April 17, 1981

Forest Service approved Plan of Operations 1980-83, Amendments 2, 3, and 4, and work was initiated on excavation of two adits the latter part of April. The Southeast Alaska Conservation Council, Inc. (SEACC) appealed the Forest Service decision, which was denied.Subsequently, SEACC filed a lawsuit in Federal Court in Anchorage against the Forest Service (SEACC vs. James Watson).

May 29, 1981

Forest Service issued for public review and comment a Draft Mining Development Concept Analysis Document (MDCAD). U.S. Borax entered into a Memorandum of Understanding (MOU) with the Forest Service providing for preparation of the MDCAD under Forest Service supervision, to be paid for by U.S. Borax.

September 1, 1981

Forest Service issued Final MDCAD.

September 11, 1981

A temporary Restraining Order granted by the Federal Court in Anchorage suspended the underground orebody assessment operations as approved under the Plan of Operations 1980-83, Amendments 2, 3, and 4. The Court issued a preliminary injunction September 22, 1981 to permit operations to be resumed on a restricted basis. The underground assessment operations were suspended October 18, 1981 for the winter.

December 3, 1981

Forest Service issued Draft Environmental Impact Statement (DEIS) for road access and bulk sampling, without selecting a preferred route. The Federal Court issued a permanent injunction prohibiting any ground-disturbing activities associated with adit construction and resultant sample production, preparation, and removal to saltwater access (as approved under Plan of Operations 1980-83, Amendments 2, 3 and 4), and ordered the Forest Service to prepare an EIS.

April 2, 1982

Forest Service issued Supplemental EIS for road access and bulk sampling, with the Blossom River route being the preferred route.

May 6, 1982

In the case SEACC vs. James Watson, the Ninth Circuit Federal Court in San Francisco granted a motion for expedited review of the injunction prohibiting work on the underground assessment program.

July 16, 1982

Forest Service issued Final EIS with Chief Forester's Record of Decision (ROD) for construction of the Blossom River road access and bulk sampling.

August 23, 1982

Forest Service issued Special Use Permit, and the final permit required for the start of access road construction was received from the Corps of Engineers August 30th. Road construction started August 31.

November 3, 1982

U.S. Borax filed "Initial Plan of Operations" for overall mine development with Forest Service.

December 1982

Envirosphere Company was contracted by U.S. Borax to assist the Forest Service in preparing EIS for overall mine development, starting in January 1983. The Forest Service managed Envirosphere and U.S. Borax paid for Envirosphere's services under a Memorandum of Understanding (MOU) with the Forest Service. This service contract with Envirosphere continued until the Final EIS was published in October 1988.

January 1983

Ninth Circuit Federal Court in the case of SEACC vs. James Watson, after issuance of the Final EIS, demanded strict compliance with environmental protection provisions, as set forth in ANILCA, for the completion of the underground assessment program.

February 11, 1983

Forest Service issued Draft EIS on U.S. Borax's 1980-83 Operating Plan, Amendments 2, 3 & 4.

April 1983

U.S. Borax submitted to the Forest Service and other agencies its Environmental Report (ER) for mine development and the affected environment. Forest Service issued Final EIS on 1980-83 Plan of Operations, Amendments 2, 3, & 4, with Chief Forester's Record of Decision (ROD), on April 21, 1983, and the Federal Court lifted the injunction against the underground assessment program. Forest Service approved this Plan of Operations with implementation being no sooner than May 30, 1983. The driving of the two adits resumed on that date, followed by bulk sampling of the orebody.

July 1983

U.S. Borax filed permit applications for mine development which included tailings disposal in the inner basin of Boca de Quadra, with EPA (NPDES), Corps of Engineers (discharge of dredged or fill material), Alaska Department of Environmental Conservation (Certificate of Reasonable Assurance) and Forest Service (Supplement No. 1 to Initial Plan of Operations, filed November 3, 1982).

August 1983

Construction of access road was completed August 8, and removal of the 4800-ton bulk ore sample was completed August 20 for pilot plant testing of the process.

December 9, 1983

Forest Service issued Preliminary Draft Environmental Impact Statement (PDEIS) on mine development, for agencies and U.S. Borax review.

December 16, 1983

U.S. Borax submitted to EPA a report entitled "Comparative Assessment of Tailings Disposal Alternatives" (CATDA), comparing on-land tailings disposal with four submarine tailings disposal options. This was submitted to support the NPDES permit application submitted to EPA in July 1983.

January 6, 1984

U.S. Borax submitted to Forest Service, Supplement II to its Plan of Operations filed November 3, 1982.

June 29, 1984

EPA issued Draft Ocean Discharge Criteria Evaluation (ODCE) for submarine tailings disposal in Boca de Quadra.

July 17, 1984

Mine Development Draft EIS was issued by the Forest Service and the preferred alternative was a middle basin tailings discharge site in Boca de Quadra.

July 1984

U.S. Borax filed with Alaska Department of Natural Resources (ADNR) permit applications for five water rights, two tidelands leases and two for dam construction.

August 6, 1984

EPA issued Draft NPDES permit for a submarine tailings disposal outfall 2.1 miles down-fjord from the inner sill in the middle basin, Boca de Quadra, for review and comment.

September 5, 1984

U.S. Borax sponsored a submarine tailings disposal workshop in Ketchikan with a panel of North American experts, and another workshop in Juneau on October 1, for the benefit of agency staff.

January 25, 1985

U.S. Borax filed revised EPA (NPDES) and Corps of Engineers permit applications changing the tailings disposal site from Boca de Quadra to Wilson Arm/Smeaton Bay. In response to EPA's draft NPDES permit issued August 6, 1984, U.S. Borax submitted a monitoring plan for tailings disposal.

April 26, 1985

Forest Service decided to prepare a Revised Draft EIS (RDEIS) to address additional data available for the alternative of tailings disposal in Wilson Arm/Smeaton Bay, so as to allow the agencies and public to comment prior to reaching a final decision.

August 21, 1985

EPA's consultant, Jones & Stokes, finalized the Draft Ocean Discharge Criteria Evaluation (ODCE) for tailings disposal in Wilson Arm/Smeaton Bay and the inner and middle basins of Boca de Quadra; and EPA issued this report for agency, U.S. Borax and public comment.

May 1986

U.S. Borax received from the United States Department of State confirmation of the establishment of "closure lines" across the mouths of Smeaton Bay and Boca de Quadra, reclassifying these as "internal waters" under jurisdiction of the State of Alaska. This removed the legal requirement for EPA to prepare and administer an NPDES permit for tailings disposal under the Ocean Discharge Criteria (40CFR 125) of the Clean Water Act. Instead, EPA used these Criteria as a guideline for permit preparation, based on Best Professional Judgment (BPJ).

November 1986

EPA issued Best Professional Judgment (BPJ) evaluation of marine tailings disposal in Wilson Arm/Smeaton Bay and Boca de Quadra, including public comments on the draft ODCE issued August 21, 1985.

April 17, 1987

Forest Service issued Revised Draft EIS (RDEIS) with Wilson Arm/Smeaton Bay as its preferred tailings disposal site alternative, with EPA preferring Boca de Quadra. In this RDEIS, EPA's BPJ evaluation of these two tailings disposal sites was included as Appendix S.

July 2, 1987

After reviewing the April 17, 1987 RDEIS, the State of Alaska also expressed preference for the Wilson Arm/Smeaton Bay tailings disposal site, subject to approval of monitoring and contingency plans.

March 1988

EPA issued draft report on "Ecological Risk Assessment" of submarine tailings disposal in Boca de Quadra versus Wilson Arm/Smeaton Bay.

May 1988

EPA's Regional Administrator, Robie Russell, selected Wilson Arm/Smeaton Bay as the preferred site. EPA issued report on "Ecological Risk Assessment" as a Final Draft.

June 1988

EPA issued Final Best Professional Judgment report, "A BPJ Evaluation Using the Ocean Discharge Criteria for Mill Tailings Disposal from the Proposed Quartz Hill Molybdenum Mine".

October 1988

Final EIS issued October 21 and Forest Service Record of Decision (ROD) issued October 24, 1988, with the overall environmentally preferred tailings disposal alternative being Wilson Arm/Smeaton Bay. EPA's BPJ included in this Final EIS as Appendix S.

November 9, 1988

EPA issued Draft NPDES permit for tailings disposal in Wilson Arm/Smeaton Bay.

November 1988

Sierra Club Legal Defense Fund, et al., appealed Forest Service's October 24, 1988 Record of Decision.

December 1988

EPA, in letter to Forest Service, stated that either Wilson Arm/Smeaton Bay or Boca de Quadra was acceptable, provided environmental monitoring is conducted. EPA stated in Federal Register "EPA feels this Final EIS is acceptable as described".

January 1989

U.S.Borax submitted environmental and toxicity monitoring plans, to be part of NPDES permit, to EPA as comments on the November 9, 1988 draft NPDES.

February 1989

State of Alaska initiated Coastal Management Program Certification of Consistency, and Certification of Reasonable Assurance under Section 401 of the Clean Water Act for Federal and State permits. This review was suspended in the latter part of February.

September 1989

EPA issued a report, "Draft Technical Plan, Environmental Monitoring Program, Wilson Arm/Smeaton Bay, Southeast Alaska", for public comment. This report was prepared for EPA by Jones & Stokes Associates, Inc.

November 1989

U.S. Borax submitted Contingency Plan for tailings disposal to the State of Alaska as part of the requirements for Certification of the Project. Alaska Department of Natural Resources gave public notice on November 21, 1989 for five water permit applications.

January 1990

State of Alaska reinitiated its Consistency Review of project permits. Late January, the State again suspended its project Consistency Review, awaiting the issuance of a revised Draft Monitoring Plan for public comment by EPA.

May 1990

The EPA Inspector General's field office in Sacramento completed investigation of the permitting of the Quartz Hill Project and other projects in Region 10, and recommended the denial of the NPDES permit for Quartz Hill Project tailings disposal in Wilson Arm/Smeaton Bay.EPA's Acting Regional Administrator of Region 10 in Seattle, Washington, reversed the prior decision granting Wilson Arm/Smeaton Bay tailings disposal and issued a tentative denial of the NPDES permit on May 4, 1990. A fact sheet supporting the tentative denial was issued by EPA on May 7, 1990.

June 1990

EPA held public hearings June 19 in Ketchikan and June 20 in Juneau, on the tentative denial of the NPDES permit application for tailings disposal in Wilson Arm/Smeaton Bay. Written comments were to be submitted to EPA by July 6, 1990.

July 6, 1990

Office of the Governor, State of Alaska, changed its position of July 2, 1987 and concurred with EPA's May 4, 1990 tentative decision to deny the NPDES permit to discharge mill tailings in Wilson Arm/Smeaton Bay.

September 27, 1990

EPA denied NPDES permit for tailings disposal in Wilson Arm/Smeaton Bay, effective October 29, 1990, unless an evidentiary hearing was requested. EPA responses to agency, U.S. Borax and public comments were also issued on that date.

October 1990

U.S. Borax decided not to request an evidentiary hearing on EPA's denial of the NPDES permit on September 27, 1990, and advised the permitting agencies of the discontinuance of permitting on Quartz Hill, until the schedule for economic development could be better defined.

a/ The mining claims at Quartz Hill were originally located in the fall of 1974 by Pacific Coast Mines, Inc., and subsequently transferred to Pacific Coast Molybdenum Company, both companies affiliated with United States Borax & Chemical Corporation, who acted as manager for the development of the mining claims. Permits were generally applied for and issued in the name of Pacific Coast Molybdenum Company.

The early annual exploration drilling permitting was not included in this chronology.

APPENDIX E

QUARTZ HILL EIS SIGNIFICANT ISSUES FOR SUBMARINE TAILINGS DISPOSAL a/

a/Final Environmental Impact Statement, Vol. 2, pp. B-6, B-7, B-18, B-19 and B-25

SIGNIFICANT ISSUES

ISSUE	TYPES OF POTENTIAL IMPACTS	SIGNIFICANCE LEVEL 1/	IMPACT ANALYSIS METHODS	IMPACT CRITERIA
PHYSICAL OCEANOGRAPHY				
The development including marine tailings disposals will alter the physical characteristics of Wilson Arm and/or Boca de Quadra	1. Alteration in the circulation pattern of the fjord as the volume, bathymetry, and ratio of tidal prism to the volume of resident water changes; changes in temperature and stratification; changes in sedimentation processes and patterns.	H	Evaluate diffusion and circulation mathematical models. Estimate changes to circulation, bathymetry, stratification, and sedimentation processes.	Changes in bathymetry and circulation as related to chemical and physical oceanography and aquatic resources.
	2. Changes in circulation patterns and siltation from construction and operation of marine terminal and small boat harbor.	H	Review existing circulation data, and facility design. Estimate changes to circulation	Changes in bathymetry and circulation as related to chemical and physical oceanography and aquatic resources

1/ The significance or importance of an issue is listed here as the most conservative (i.e., highest) raised by one or more members of the interdisciplinary team (IDT). Judgements concerning significance did not consider the possibility for mitigating the potential impact or issue. H = high, M = moderate, L = low.

SIGNIFICANT ISSUES

ISSUE	TYPES OF POTENTIAL IMPACTS	SIGNIFICANCE LEVEL[1/]	IMPACT ANALYSIS METHODS	IMPACT CRITERIA
CHEMICAL OCEANOGRAPHY				
The mine, its potential attendant facilities, and tailings disposal will affect the water quality of Wilson Arm and Boca de Quadra	1. Changes in marine water quality due to alteration of freshwater quality (to be resource specific for both construction and operation phases).	H	Following estimation of freshwater resource water quality effects, estimates of marine water quality changes will be developed.	Mass per unit volume of regulated and other key parameters; selected key physical parameters.
	2. Changes in marine water quality and sediment composition due to construction of: a. marine terminal b. roads c. townsite	H	Hydrologic and geology/soils data, and sediment and erosion control methods will be reviewed. Estimates of loadings will be developed.	Mass per unit volume of regulated and other key parameters; selected key physical parameters.
	3. Changes in marine water quality due to process water and tailings discharge.	H	Review process water and mass balances. Determine effluent flows and concentrations. Review diffuser models. Determine spatial requirements for various dilutions.	Mass per unit volume of regulated and other key parameters and dilution zones.
	4. Changes in marine water quality and sediment composition due to tailings disposal	H	Review chemical inputs, evaluate seawater transport and mixing rates. Evaluate chemical removal rates. Estimate chemical concentrations in water column and sediments.	Mass per unit volume of regulated and other key parameters; selected key physical parameters.
	5. Changes in marine water quality and sediment composition due to: a. marine terminal operation (runoff spills) b. shipping traffic (spills, ballast) c. road runoff d. small boat harbor e. sanitary waste discharges	 H H H H H	Review facility plans and design incorporated mitigation measures, estimate mass inputs. Estimate water quality changes.	Mass per unit volume of regulated and other key parameters; selected key physical parameters.

SIGNIFICANT ISSUES

ISSUE	TYPES OF POTENTIAL IMPACTS	SIGNIFICANCE LEVEL[1]	IMPACT ANALYSIS METHODS	IMPACT CRITERIA
AQUATIC RESOURCES				
Alternate - Marine Disposal				
Tailings slurry discharge	33. Below a certain depth, the continuous deposition of tailings may bury benthos and eliminate use by marine biota. At shallower depths, there may be losses of some marine biota and reduced primary and secondary productivity. Possible rupture of slurry pipeline will also be considered.	H	To gauge the effects of sedimentation, estimate depth of sediment expected in the following zones: intertidal, sublittoral to a depth of 100 feet (ft), and subtidal greater than 100 ft depth. Estimate areal extent of sedimentation and contrast to depth range and areal extent of distributions of economically important benthic and epibenthic fish and invertebrates. These include crab (e.g., king crab) shrimp (e.g., spot shrimp), demersal fish (e.g., flatfish and cod), and molluscs (e.g., bay mussels). Also included are intertidal and sublittoral invertebrates that are important prey for chum and pink fry. Use literature to estimate sediment depths that sessile benthic infauna and mobile epifauna can tolerate. Assume that all habitat below depth of discharge will be uninhabitable. To assess biotic effects of suspended solids in water column, attempt to estimate suspended solids concentrations expected in the water column at the following depths: surface, mean low water to mean high water, euphotic zone, sublittoral to depth of 100 feet, and greater than 100 ft. Compare estimates to literature detailing effects of suspended sediment on filter-feeding invertebrates, on avoidance by fish, and on toxicity to fish and invertebrates. Estimate effect of suspended solids on depth of euphotic zone and on primary production.	Sedimentation effects: area (acres) o habitat loss for economically importan fish and invertebrates (i.e., crab, shrimp, demersal fish). Suspended solids effects: percentages of fish and filter-feeding invertebrates avoiding or being killed by suspended solids and reduction in biomass (carbon) production in fjord due to a depressant effect on primary production.

ISSUE	TYPES OF POTENTIAL IMPACTS	SIGNIFICANCE LEVEL 1/	IMPACT ANALYSIS METHODS	IMPACT CRITERIA
AQUATIC RESOURCES (Continued)				
Alternate - Marine Disposal				
Toxicity of slurry	34. Toxicity of slurry to marine biota may reduce productivity	H	Estimate dilutions of slurry that will occur at the following depths: surface, depth range corresponding to mean low water to mean high water, euphotic zone, sublittoral to 100 ft, and greater than 100 ft. Based on expected concentrations of trace metals, milling reagents, and other chemicals introduced that have a significant aquatic toxicity, estimate concentrations that would occur at different depths. Based on the fjord's flushing rate at different depths and on chemical data indicating biodegradation, hydrolysis, etc. rates, judge the extent to which the chemicals would accumulate or be removed from the fjord. Contrast anticipated exposure concentrations and duration with acute and chronic toxicity data for fish. Consider bioaccumulation and biomagnification potential for fish and higher carnivores.	Areas (acres) and general depths within fjord possessing water quality that may be acutely or chronically toxic to fish and invertebrates and result in significant chemical residues in economically important fish. Based upon EPA (1980) water quality criteria, Alaska water quality standards, and literature.

ISSUE	TYPES OF POTENTIAL IMPACTS	SIGNIFICANCE LEVEL[1/]	IMPACT ANALYSIS METHODS	IMPACT CRITERIA
TERRESTRIAL RESOURCES (Continued)				
Marine Disposal Alternative				
Effects of slurry	25. Impacts on marine mammals and birds.	H	Impacts are expected to be primarily on food supplies of seals, waterfowl, and shorebirds. Therefore, define food habits and requirements of key species and compare to predicted availability of their prey as per the evaluation of aquatic impact 33. Effects on population sizes of key wildlife species from changes in prey availability will be qualitative; percentage reductions in prey habitat will be assumed to lead to corresponding reductions in predator use of area.	Numbers or percentages of key marine wildlife species.
Rupture of slurry pipeline	26. Impact all biological resources down slope.	H	Assume all biological resources downstream would be destroyed. Calculate habitat destroyed, wildlife use lost.	

APPENDIX F

ANILCA COLLOQUY
FEDERAL REGISTER - SENATE
AUGUST 19, 1980

IX on pending litigation regarding native selection of lands selected by the State of Alaska. It is my understanding that nothing in this title is intended to affect in any way pending litigation regarding the selectability under ANCSA of any particular tract of land including lands previously reserved to or selected by the Territory or State of Alaska under any provision of Federal law.

Mr. JACKSON. The Senator is correct. We do not intend to affect pending litigation on such questions by the passage of title IX of this bill.

Mr. STEVENS. There has been some question raised as to whether the lands conveyed to the State of Alaska under the university, school land and mental health grants are State lands under the definition of the Statehood Act and this act. I would like to clarify that these lands are State lands and are subject to the same protection and status of any lands conveyed under the Alaska Statehood Act.

Mr. JACKSON. The Senator is correct. We clearly intended at the passage of the Alaska Statehood Act that such lands conveyed to the State of Alaska or its political subdivisions, including the University of Alaska, would be considered State lands for purposes of Federal law. This bill reaffirms that status of these lands.

Mr. STEVENS. Senator TSONGAS, as we both know, the U.S. Borax molybdenum deposit at Quartz Hill is located within a national monument. It is my understanding that the classification of these lands as national monument will not impinge on U.S. Borax's ability to develop that deposit. Does this comport with your understanding?

Mr. TSONGAS. My distinguished colleague from Alaska knows that it has always been our intention to allow the Quartz Hill deposit to be developed if it is economically feasible for U.S. Borax to do so. Let there be no misunderstanding, U.S. Borax will have to comply with some very restrictive environmental regulations incorporated into the bill. But, we have taken care in this legislation to do nothing which would directly or indirectly prevent the development of this mineral deposit solely because the deposit is located inside a national forest monument.

Mr. STEVENS. I thank the Senator who has worked so long and hard on this legislation for restating the sense of the Senate of this matter.

In various sections of the bill reference is made to U.S. Borax & Chemical Corp. Although I understand that the corporation discovered the deposit, and is managing its development, I assume the benefits and burdens of the bill would apply as well to its assigns or successors in interest.

Mr. TSONGAS. That is correct.

Mr. President, I would like to ask for clarification on a change from the Senate committee bill regarding the Denali scenic highway study. This study which is in both the House and Senate bills and is in the Tsongas substitute provides for a 3-year study of the road link between Mount McKinley and Wrangells National Parks. During that time, the Senate committee made it clear that the withdrawal from mining during the study did not affect the ability of the State of Alaska from proceeding with road realinement, maintenance and other activities involved in the maintenance of these highways which are part of the State highway systems.

The Tsongas amendment adopts the Senate language regarding the road realinement issue, but it adds the qualifying word "minor" to references concerning road improvement and realinement. I would ask that a clarification be made on the floor here today that his word "minor" would not affect the State's ability to maintain roads in at least the same condition that they have been in the past. For example, the State of Alaska plans to repave portions of the Richardson highway which were severely strained during the building of the Alaska pipeline. It is very important that these road improvements be carried out on schedule. It is my understanding that the intent of this amendment was aimed mainly at a concern that the Chitina-McCarthy road would be upgraded prior to the study being completed.

It is also my understanding that there are no plans to upgrade this portion of the highway, but I am hopeful that other projects which are in nature of keeping highways in their present condition are not jeopardized by this amendment.

Mr. TSONGAS. The Senator from Alaska is correct. There is no intention to prevent ongoing projects which are legitimate improvements and maintenance from occurring. We do not want to see the Chitina-McCarthy road upgraded until the study has been completed and our intent was to prevent that by withdrawal from mining and the insertion of the word minor to insure that major changes in the nature of various segments of the highway would not occur during the study.

Mr. STEVENS. Mr. President, the substitute contains language in section 506 providing for exploration permits, patent to minerals and so forth for certain unperfected mining claims as defined in the section. We have negotiated these terms with great care in order to be fair and to allow for the full and proper development of the Quartz Hill molybdenum deposit. It is my understanding, and the Senator will correct me if I am wrong, the exploration permits, patents, surface leases, access rights, and so forth will all be provided by the Secretary. It has been established here that our intention is to permit full development of valid mining claims—the "core claims" to the molybdenum deposit at Quartz Hill—and also to allow for development of certain unperfected claims. I assume we do agree that we have given full protection to valid existing rights.

Mr. TSONGAS. My colleague from Alaska is quite correct. Section 506 was carefully drafted to give full protection to all valid existing rights—to patented claims and to permit perfection of certain unpatented claims. However, the provisions we set out for these claims will not apply if the unperfected claims are located within 1 mile of the center line of the Blossom River. This is stated in subsection (j). We agreed to this language in order to minimize impacts on the river from activities on unperfected claims near the river. Of course, the understanding was that nothing in this section would impair valid existing rights to valid miners' claims.

Mr. STEVENS. If I understand the Senator, then, this body does not intend that there be any interference with or impairment of valid mining claims or valid existing rights, regardless of whether the claims or rights are located within 1 mile of the Blossom River from its head waters to its confluence with the Wilson Arm.

Mr. TSONGAS. My colleague is correct.

Mr. STEVENS. I am gratified that this body does not wish to create problems or conflicts over access and entitlement with respect to valid claims and valid existing rights. It is important to state our intent only to restrain activities related solely to any unperfected mining claims located within 1 mile of the center line of the Blossom River; which is to say that we do not intend subsection (5) to impair valid existing rights, including valid mining claims. This is what I understand that the Senator has indicated, and I wanted to insure that my understanding repeated here conforms to his understanding and to the intent of this body with respect to section 506.

I wish to clarify the intent of this body with respect to section 503h(8) of this act. As I understand it, we have agreed that the waters adjacent to the Monument Wilderness, are not affected by our actions concerning the land.

Mr. TSONGAS. My colleague is correct. We are not doing anything to change the status of navigable salt water in the Misty Fiords area. For example, the Boca de Quadra or the Wilson Arm remain open to traffic and open to any other use permitted in the current body of law with respect to navigable salt water.

Mr. STEVENS. Then the intent of this body is to leave the status of the offshore waters adjoining the Monument Wilderness unchanged. No new or additional regulations or substantive or procedural requirements that might affect use of offshore waters for access related to the development of the mineral deposit at Quartz Hill are intended to be created by this section. We are not changing existing law.

Mr. TSONGAS. The Senator from Alaska is correct.

Mr. STEVENS. I am concerned, and I believe many others also to be concerned, that we have the committee report language that accompanied the legislative language of the "Borax compromise" as a part of the permanent RECORD. It is essential that we include that report language in the RECORD, so that the totality of this accord is a matter of record. I want there to be no mistake in interpreting the intentions of the parties who negotiated that compromise and the intentions of this body regarding the future regulations which may be promulgated by the Secretary of Agriculture.

Mr. TSONGAS. As I understand it, that agreement was the result of many hours of negotiation between your staff and my staff, representatives of the State of Alaska, representatives of the executive branch, and representatives of U.S. Borax.

Mr. STEVENS. That is correct. The negotiations on this section of the bill were very precise. In many instances, requests for specific legislative language were waived on the condition that the intentions of the parties would be clearly spelled out in the committee report. The legislative language dealing with this section of the bill does not accurately capture the total spirit of the accord. In order to understand the full measure of the compromise, I am adding the committee report language in Senate Report 96-413 dealing with sections 505 through 507 to the RECORD at this point.

Mr. JACKSON. I agree, often, in order to fully understand a carefully worded compromise, such as this one, report language that accompanied the legislative language must be made a part of the permanent RECORD. In this instance, I believe that the report language when examined side by side with the legislative language will give the true picture of the parties' intent and the intent of this body.

Mr. STEVENS. I thank the chairman. As he knows, the Borax compromise was made possible because all of the interested parties were able to agree that it would be better if certain sections were explained in the report as opposed to being included in the legislative language. Therefore, this report language is vital in interpreting these sections of the bill in administrative or judicial review settings.

I ask unanimous consent that this portion of the committee report be printed in the RECORD.

There being no objection, the excerpt was ordered to be printed in the RECORD, as follows:

TITLE V—NATIONAL FOREST SYSTEM

SECTION 505: MISTY FJORDS NATIONAL MONUMENT

The Misty Fjords is an essentially untouched 1.453-million-acre area in the Coast Mountains representing nearly all of the wilderness features found in southeast Alaska. Spectacular fjords with sea cliffs rising thousands of feet, low rocky shorelines, sheer water falls, coastal and interior mountains rising over 6,000 feet, active glaciers, high and lowland rivers and lakes are interlaced with salt water channels, inlets, and bays. Wildlife representative of nearly all ecosystems in southeast Alaska can be found here. The Monument is neatly bound into a management unit by the Portland Canal and the international boundary to the east, the Unuk River drainage and international boundary to the north and the East Behm Canal to the west.

The Misty Fjords would be established as a national monument containing approximately 1.483 million acres of public lands, and managed by the U.S. Forest Service.

The Unuk River, with headwaters in Canada, has major recreational potential. The watershed is steeply mountainous with numerous glaciers and lakes, and the climate and surroundings vary from marine coastal to interior. Geological features such as colorful mineral springs and lava flows around blue lake add to the significance of the area. South of the Unuk, the Chickamin River system and the Le Duc River originate in glaciers high in the mountains of the monument. Rudyerd Bay Fjords and beautiful Walker Cove are surrounded by high, cold lakes, and mountains extending eastward into the Canadian ranges. Numerous lakes throughout the monument provide backcountry access to the heart of the area and offer excellent fishing and opportunities for outdoor recreation. Of the 2,000 salmon streams in southeast Alaska fewer than 20 support King Salmon. Five of those King Salmon streams are within the monument, the Unuk, Chickamin, Wilson, Blossom, and Keta.

The committee last year established the area of the monument as a unit of the National Park System. After consideration of that designation, the committee agreed with the House that the area should remain in the Tongass National Forest as a statutorily created monument. The boundary of the monument is identical to the boundary of the National Park Preserve established by the Committee amendment last year except for a minor boundary adjustment along the Portland Canal.

The committee amendment provides statutory direction to the Forest Service regarding management of the monument. The area is to continue to be managed as part of the Tongass National Forest subject to specific exceptions:

1. The area is statutorily withdrawn from the mining and mineral leasing laws and from future selection under Alaska Statehood Act or the Alaska Native Claims Settlement Act;

2. The area is closed to the sale or harvest of timber under Forest Service timber sale program;

3. The area is to be treated under section 1106(b) for the purpose of granting rights-of-way for transportation and utility systems under title XI of this act.

The committee adopted a number of specific provisions regarding the effect of the monument designation on the evaluation and operation of mining claims in the monument.

The committee intends that mining on existing claims shall be permitted under reasonable regulations designed to make that activity compatible to maximum extent feasible with the purposes of the monument. Mining in the monument centers around the Quartz Hill mineral deposit, a series of claims held by the U.S. Borax and Chemical Corp. These claims are presently being evaluated, but there are indications that the deposit represents one of the largest molybdenum discoveries in the world. The committee intends that the evaluation and development of these claims be permitted to continue should that prove economically feasible, and intends to avoid the implication that mining or related activities are inherently incompatible with the purposes for which the monument was established. The committee amendment also includes a number of provisions to allow qualified claims to be further evaluated and developed. The committee also recognizes the great fisheries values of the area and has included specific direction to the Secretary of Agriculture to use his existing authority to protect these values.

The committee intends that existing Forest Service regulations governing mining operations apply except to the extent that new regulations are promulgated. These new regulations are to be designed to provide environmental safeguards under which development of the claims can continue, not to prevent their evaluation and development.

In order to aid in validating these claims, special provision is made to determine validity as of November 30, 1978. The Committee does not intend this to affect litigation concerning withdrawals made subsequent to that date. A further provision states that the Mining in the Parks Act applies only to National Park Monuments, and thus not to this unit.

The committee has provided a process under which the Secretary is to issue a special use permit for a surface access road to the Quartz Hill deposit for bulk sampling purposes. The process includes preparation of a document by U.S. Borax and the managing agency analyzing the major design concepts for development of the mine, as part of the process for issuance of the special use permit. The analysis is not expected to outline any final plan for the development, as the committee realizes that the claims are still in the process of evaluation, and that final plans for the possible development have not yet been formulated by the company.

The committee believes that this analysis will assist the Secretary in the preparation of the environmental impact statement for access and bulk sampling which is to be prepared concurrently. This EIS is to use the information developed for the existing EIS previously prepared on the application by the U.S. Borax for access to the Quartz Hill area. The Committee has provided specific areas which it feels need to be examined in addition to updating the old information such as the effects of the road on groundwater flow and the impacts associated with widening an existing road as opposed to providing for such widening during construction of the access road for bulk sampling. A prime concern is that the surface access road be one that can be utilized in the eventual mine development phase, if possible, and that the construction of the road be accomplished with such use in mind where feasible. The EIS is to be prepared within 12 months, and the Secretary is to make his final decision within four months thereafter, provided that the Secretary has determined that the field work for gathering baseline data and data analysis for the 1981 field season have been completed. The committee has allowed the next two field seasons for the gathering of baseline data prior to issuance of the special use permit, and urges the Secretary to initiate data collection in the 1980 season.

It is the committee's intent that the Secretary issue the special use permit unless he determines that the construction would cause an unreasonable risk of significant irreparable harm to the viable productivity of the habitats of fish management indicator species (including but not limited to anadromous and other foodfish species). If the Secretary denies the permit, the burden of proof is on him in any judicial review of that decision.

The committee adopted a modified version of section 1109, of this act which provides for expedited judicial review of any administrative action regarding this section.

The committee provided a specific entitlement to a lease and necessary associated permits for the holder of claims at Quartz Hill, determined to be valid as of November 30, 1978. Such leases shall be issued only if three specific criteria are met and shall be limited to a size necessary to permit the "mining or milling" operations associated with milling purposes to be carried out. The committee intends that such lease encompass functions directly connected with or facilitating the removal and processing of the ore—for example, pumping works, miners' accommodations, mine offices, workshops, ore storage, or waste and tailing disposal. The committee also intends that the Secretary issue necessary and associated permits to allow the purposes of the lease to be carried out. Other functions such as power generation, transmission of power, transportation facilities, and impoundment of water to the extent they are not associated with a conventional millsite or "mining or milling purposes" as that phrase is interpreted under the mining laws of the United States—should be subject to the customary special use permit process within the Department of Agriculture.

SECTION 506: UNPERFECTED MINING CLAIMS IN MISTY FJORDS NATIONAL MONUMENT

A series of provisions drawn from the House-passed bid which permit the expansion of rights to explore unperfected mining claims were included in the committee amendments. These provisions permit the holder of an unperfected claim to continue working towards making a valid discovery under the mining laws on such claims within three-quarters of a mile of claims on which valid discovery has already been made. A patent for such expanded claims would be for the minerals only with the right to use the surface to develop the claim.

A provision has been included to permit the leasing of sites for milling purposes. Because of the statutory withdrawal from operation of the mining laws, a holder of a valid mining claim cannot locate such sites under the general mining laws. This provision authorizes the Secretary to lease a site for milling purposes to the holder of a claim.

The committee intends that the Secretary use his discretion to lease sites for mining or milling purposes consistent with the conditions of this section, but that he not unreasonably deny a site or lease in order to block development of a claim. The committee expects the Secretary to work with the claimants to determine appropriate locations in order to permit economic operations, but that the limitation on size and number of leases issued be consistent with the mining laws of the United States. The Committee recognizes that "mining or milling purposes" can include a number of appurtenant uses, directly connected with or facilitating the removal and processing of ore—for example, but not necessarily limited to, pumping works, miners' accommodations, mine offices or shops, ore storage, or waste and tailing disposal. The committee does not intend that lease uses include uses customarily dealt with through special use permits, but it does intend that necessary and associated permits be issued to allow the purposes of the lease to be carried out if a lease is issued.

The term of the lease for milling purposes is to be continued until the deposit is exhausted or the lessee has failed to use the leased site for 2 years. The Secretary may extend the lease even if it is not used under special circumstances, such as casualty, or force of nature, or governmental action beyond the control of the lessee which prevent the sites leased from being utilized.

The committee notes that nothing in this title affects the authorities of the Secretary to regulate mining activities, including, but not limited to, the issuance of special use permits for activities undertaken under an approved operating plan, or for the use of timber and other materials within rights-of-way under general regulation of the mining laws.

SECTION 507: FISHERIES ON NATIONAL FOREST LANDS IN ALASKA

The committee recognizes that there may be a potential for conflict between mineral development and a healthy commercial fishery. The committee has included this section to assure, to the maximum extent feasible, that the developing mineral industry does not conflict with an existing industry, commercial fishing. The general section directs the Secretary to review existing regulations and promulgate new ones, consistent with his existing authorities, should he determine necessary, to protect fisheries habitat under his jurisdiction. An additional subsection deals specifically with the Quartz Hill project, and emphasizes areas of concern to be addressed by the Secretary as further mining plans are considered for development of that deposit. The committee received assurances that this deposit can be developed in an environmentally sound manner, and has included these provisions to aid in attaining that goal. Only one subsection dealing with emergencies, extends the Secretary's existing authority. Otherwise, these provisions provide no new statutory authority to the Secretary. This section does not alter the State of Alaska's authority over fish and game management, water quality, or other responsibilities under existing law.

The more general subsection, 507(a), applies to all National Forest lands in Alaska, and directs the Secretary to review existing regulations and those under development to determine what, if any, new regulations are necessary to carry out the directive to maintain fisheries habitat, the maximum extent feasible, and to maintain present and continued productivity of the habitat from mining impacts. Any new regulations would be pursuant to his existing authority and promulgated following standard procedures. This section specifically requires the Secretary to consult with the State of Alaska in order to coordinate his efforts with those of the State in its capacity as manager of the fishery populations.

The committee recognizes that the "present and continued" productivity of fishery habitat can be variable or cyclical due to changes in the natural environment and in fisheries regulation. By maintaining present and continued productivity, the committee intends that the casual effects of mining operations on the habitat not significantly reduce the ability of that habitat to produce fish as it could have produced had mining activities not occurred. Maintenance of productivity is not intended to mean maintenance of a specific level in that natural productivity cycle but rather is maintenance of such productivity of specific fisheries systems without adding through mining activities impetus to any natural decline in productivity. The committee recognizes that the State of Alaska is involved in measuring these variations or cyclical changes as part of its role in fisheries management and intends the Secretary to seek assistance from and cooperate fully with the State in determining the productivity of the habitat and the cyclical nature of such productivity and the cause of such variations or cyclical changes.

Section 507(b) provides a framework for preparation and evaluation of mining plans governing operations at the Quartz Hill deposit. These provisions emphasize that such plans must be based on adequate information and studies which the Secretary determines are adequate and are needed to evaluate the environmental impacts of such development. These provisions are not intended to require unattainable standards in order to prevent approval of the plans, nor are they mere paperwork hurdles in the path of unhindered development. The committee has provided areas of emphasis for the Secretary to deal with during the development of mining plans.

The goal is to maintain the habitat of the fisheries producing system so that such system is capable of producing at or above current levels of production after the mine has ceased operations. The committee intends that required studies be carried out in a timely manner so that necessary information and data are developed to support succeeding stages of the plan of operations. The committee believes that such studies can go forward concurrently with development of the various stages of the mining plan.

The studies performed under this section are to be commensurate with the level of activities proposed by the operator. Since some proposed activities will require extensive studies including the collection of data over an extended period, it is recommended that the operator carry out those studies well in advance of the application for permit. This is to help ensure that the Secretary has the required studies completed to the degree necessary to evaluate the impacts of the proposed action and design. The studies required in this paragraph should have as their ultimate goal the development of a model of the fisheries producing system that is capable, if possible, of estimating the quantitative effects of mining operations on the fishery habitat and populations. It is also recognized that such knowledge does not now exist, but over time, better approximations should be obtainable. In formulating such models, areas of uncertainty should be identified, and the risks evaluated to the extent feasible. The range of possible effects should be fully explored and delineated. The responsibility for determining the adequacy of the studies lies with the Secretary.

Under this section, the Secretary is charged with the responsibility of determining that the plan includes adequate provisions for preventing, to the maximum extent feasible, significant adverse environmental impacts to the fishery habitat. Mitigation through reclamation, through offsetting impacts by other activities, or through other means, should be considered part of this standard if it is not feasible to prevent such impacts.

A specific suspension authority, applicable only to the operation at Quartz Hill, is included in subsection (b). It is the intent of the committee that this authority be utilized only in exigent circumstances and only if no other alternative, including modification of mining plans, can be effective. The Committee notes that the suspension authority is limited to seven (7) days after which time a court order is required and that authority is to be utilized only to suspend that part of operations which is causing the harm.

SUBSISTENCE IN NATIONAL PARKS AND MONUMENTS

Mr. HATFIELD. Is it true that under the substitute additional areas in the national parks and national monuments have been opened to subsistence uses by local rural residents, and is it not true that those areas are Aniakchak National Monument, Lake Clark National Park, the additions to Mount McKinley National Park, and Wrangell/St. Elias National Park?

Mr. JACKSON. That is correct.

Mr. HATFIELD. These areas are in addition to those parks that the committee originally recommended for subsistence, Cape Krusenstern, Kobuk Valley, and Gates of Arctic.

Mr. JACKSON. The Senator is correct.

Mr. HATFIELD. Under the terms of the substitute subsistence uses shall be allowed by local rural residents in Aniakchak National Monument, Lake Clark National Park, Gates of the Arctic National Park, and the Wrangell/St. Elias National Park, and the additions to Mount McKinley National Park where such uses are traditional. Am I correct in stating that the use of the phrase "where such uses are traditional" means that those portions of the parks and those populations within the parks which have been traditionally used would be available for subsistence while the rest of the park area would not be available for subsistence.

APPENDIX G

ABOUT THE AUTHORS

Christian A. Hesse Formerly Vice-President, Engineering, for United States Borax & Chemical Corporation, Chris Hesse currently acts as a consultant to the minerals industry. While with U.S. Borax, he served as Project Manager of the Quartz Hill Project from April 1981 through June 1990, managing Borax's detailed feasibility evaluation completed during that period. Other executive assignments have included a Nevada heap-leach silver mine, design and construction of the world's largest boric acid plant and management of potash projects in Canada and England. Earlier experience included engineering work in the uranium industry and on tunnel and subway projects. Resident in California, Mr. Hesse maintains professional registration in Ontario, Canada.

Kenneth M. Reim Formerly Manager, Mining Development, United States Borax & Chemical Corporation; Ken Reim is now a Mining Consultant in Las Vegas, Nevada. As Deputy Project Manager, Engineering, on the Quartz Hill Project, Mr. Reim was responsible for engineering, environmental baseline data collection, preparation of Environmental Impact Statements and permitting from the late 1970s through mid-1991. He has also managed exploration, mine development and acquisition feasibilities in the United States and overseas, and has acquired, explored, discovered and made early evaluations of borate, trona, uranium and asbestos deposits which were subsequently developed as producing mines. Mr. Reim is registered as a Mining Engineer in New Mexico and as a Geologist in California.