2/27/09 OVERVIEW: PEBBLE MINE

THE pebble PARTNERSHIP

Pebble Prospect

Presentation to the Senate Resources Committee

John Shively, CEO

Ken Taylor, VP Environment

February 27, 2009

The Pebble Partnership

A Shared Commitment to Sustainable Development and Social and Community Responsibility.

Northern Dynasty has delineated one of the world's great orebodies, assembling one of the most extensive environmental databases in the history of resource development.

Anglo American US brings a depth of corporate resources and a successful track record of global leadership in modern mining practices.

www.pebblepartnership.com

1896

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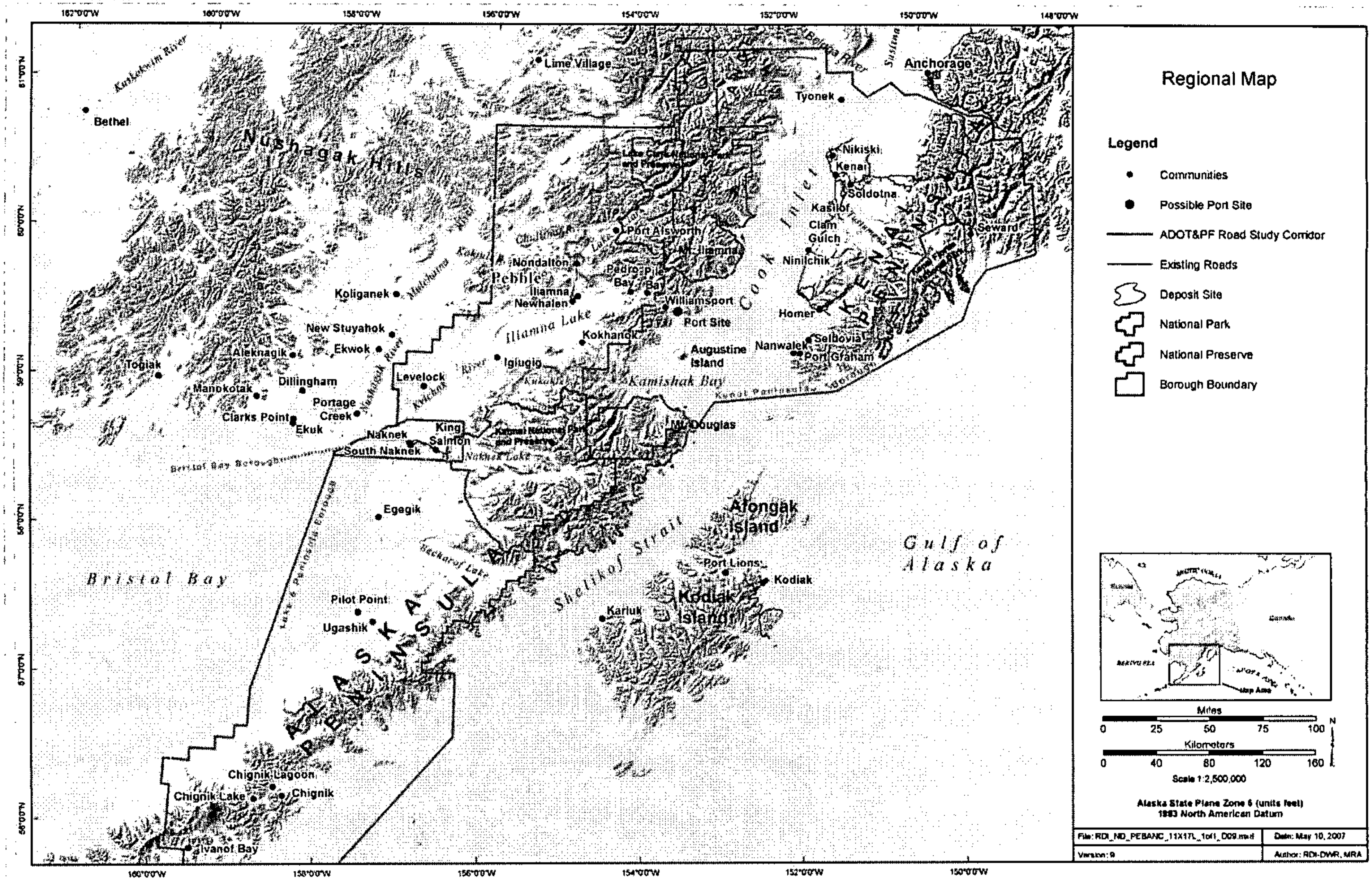
Prospect Location



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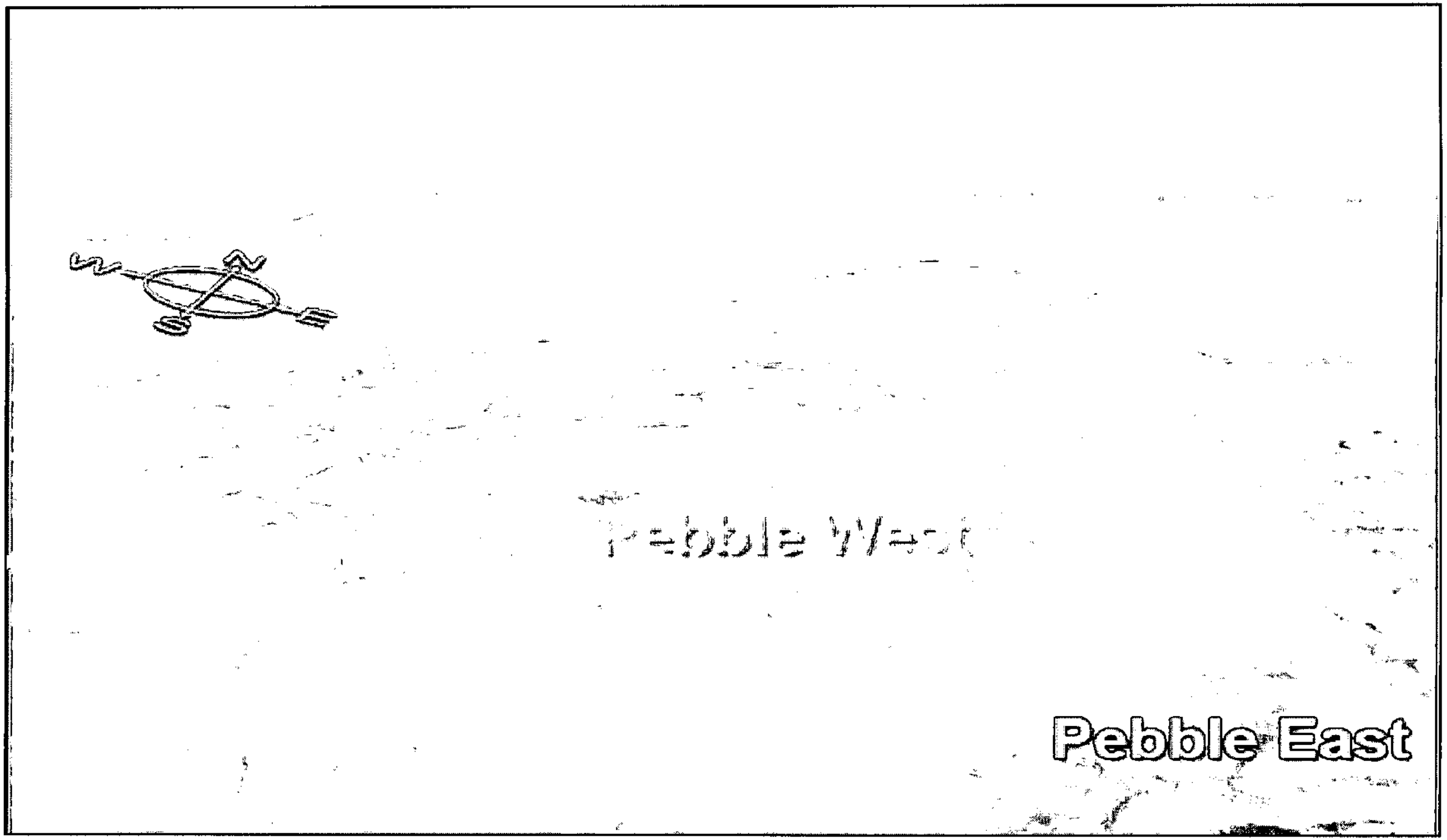
Pebble Prospect – Deposit Topography



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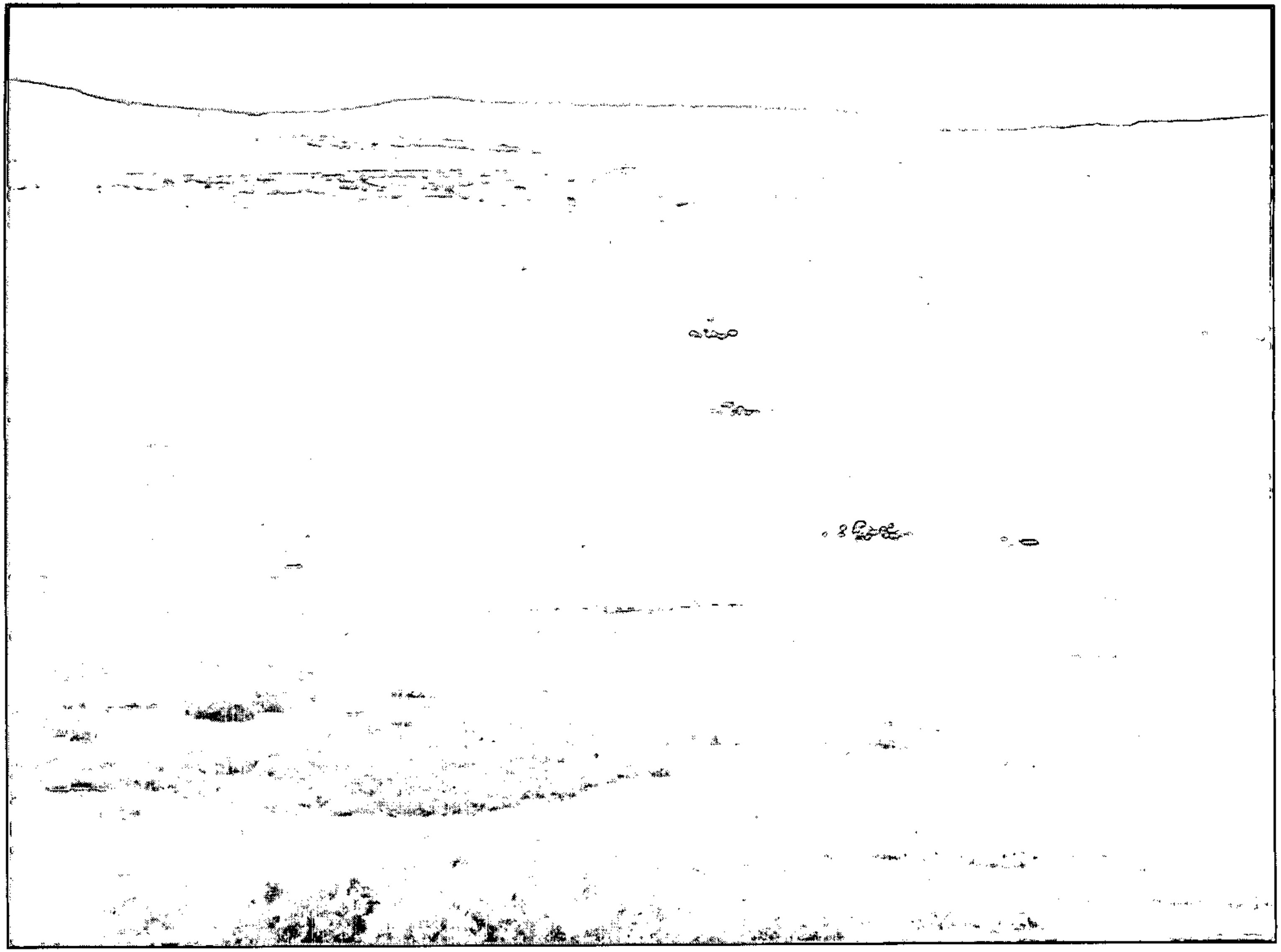
Low Footprint Exploration



1898

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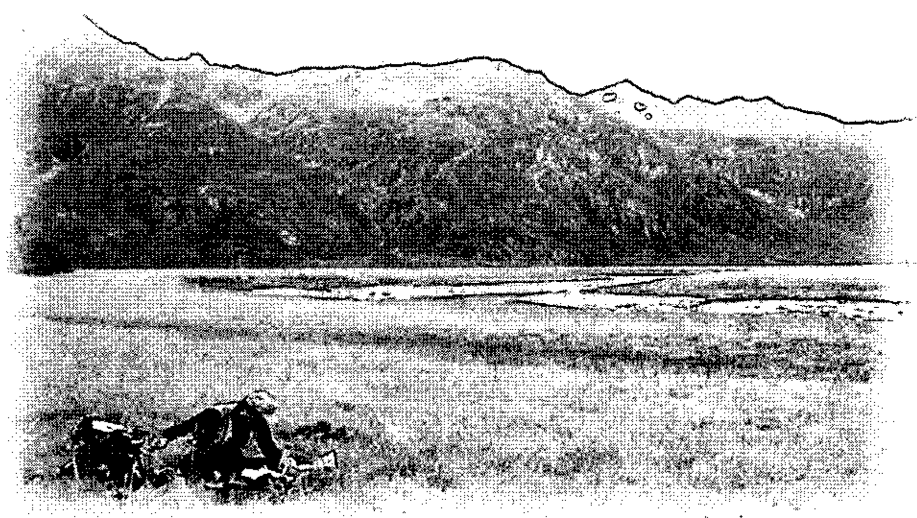
Environmental Studies

- Surface Water
- Water Quality
- Groundwater
- Geochemistry
- Snow Surveys
- Analytical QA/QC
- Fish & Aquatic Resources
- Macroinvertebrates
- Wetlands
- Trace Elements
- Flow Habitat Study
- Iliamna Lake Study
- Marine
- Wildlife
- Air Quality
- Noise
- Cultural Resources
- Subsistence
- Land Use
- Recreation
- Socioeconomics
- Visual Aesthetics
- Impact assessment & management
- Mine closure & reclamation



1899

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HydrologyStudies

1900

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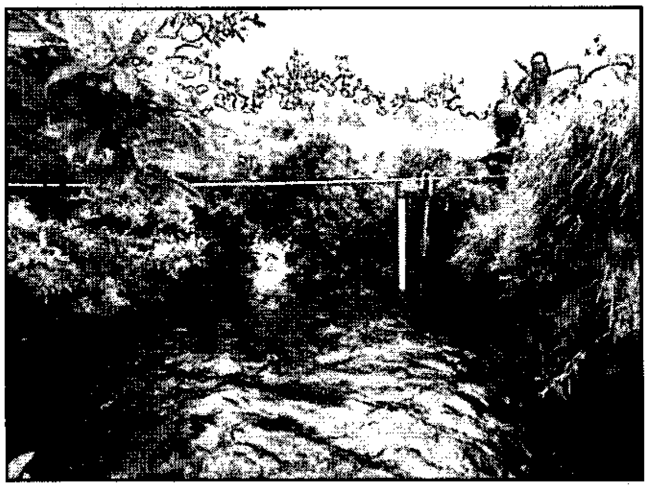
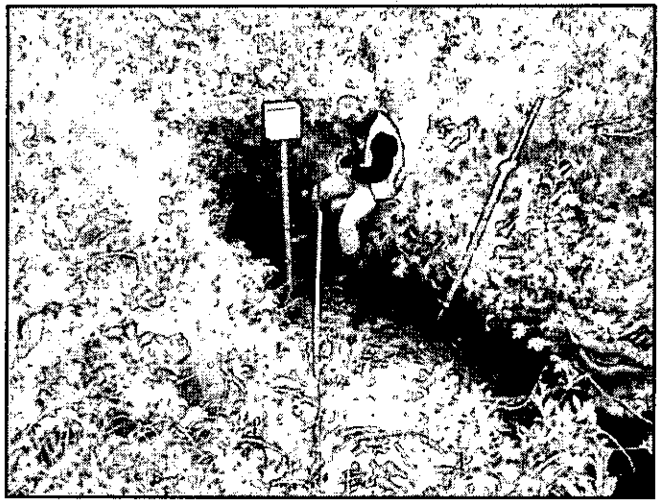
Field Activities

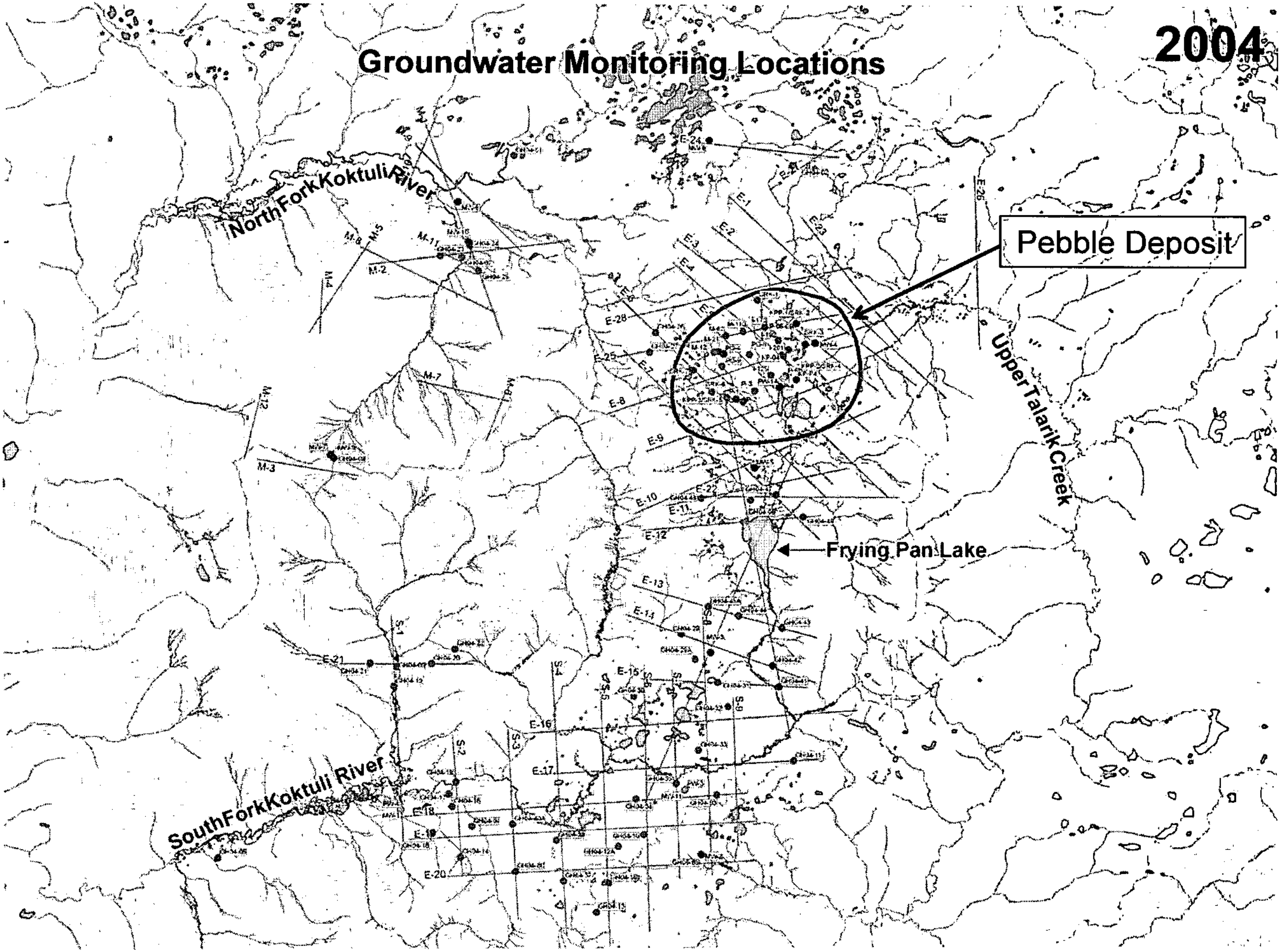
- 29 Continuously Gaged Stations
  - During Ice-Free Months
  - Winter Field Measurements
  - 3 operated by the USGS
  - 6 operated by APC Services



- >125 Instantaneous Measurement Sites
  - Water Quality
  - Groundwater Model Calibrations (baseflows)
  - Fisheries and Instream Flow Assessments

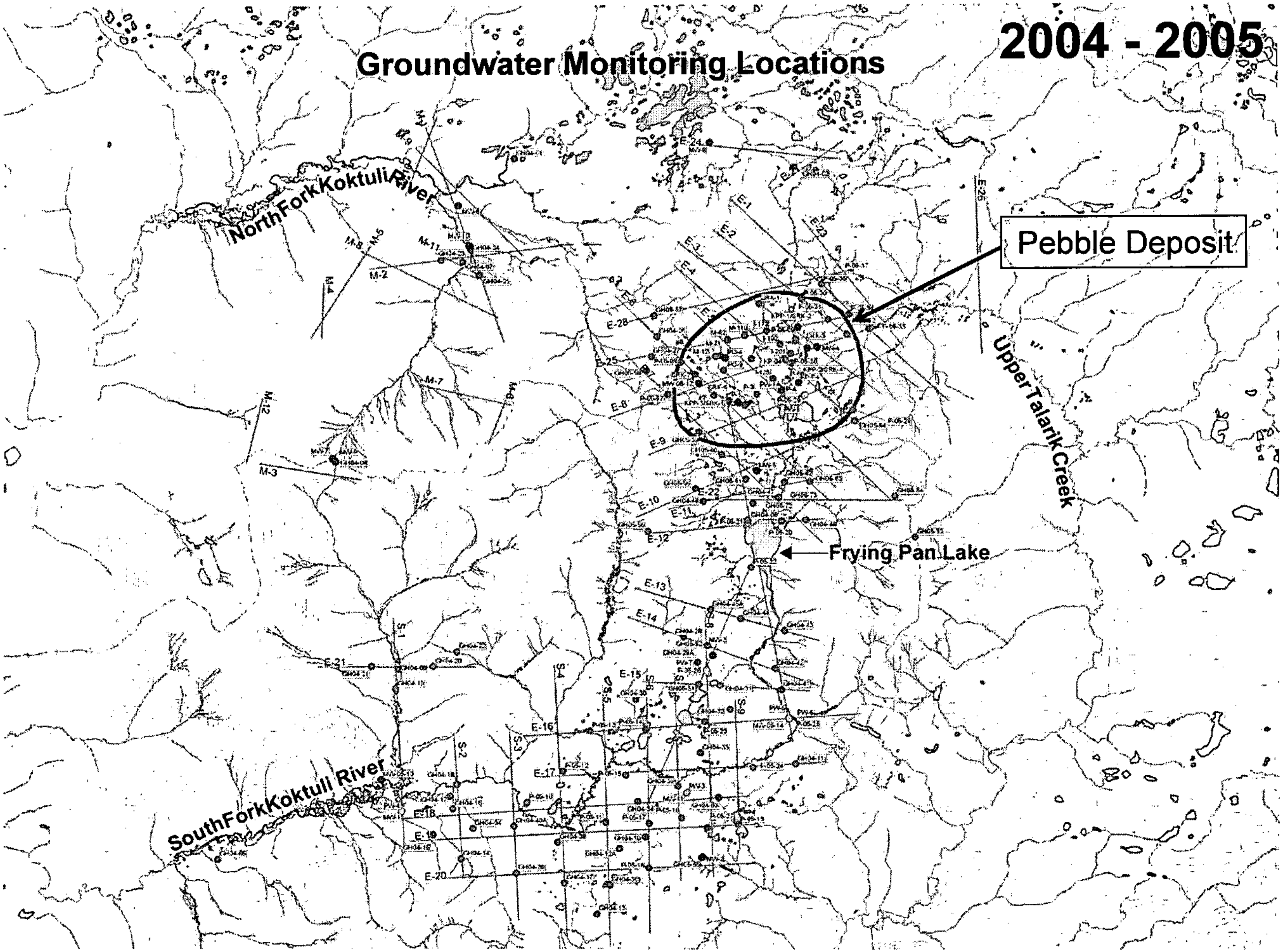
- Scheduled Monthly Field Visits
  - 42 Sites
  - 29 - all continuously gaged stations (rating curve) development)
  - 13 - Water Quality Stations
  - 12 Measurements per year per station

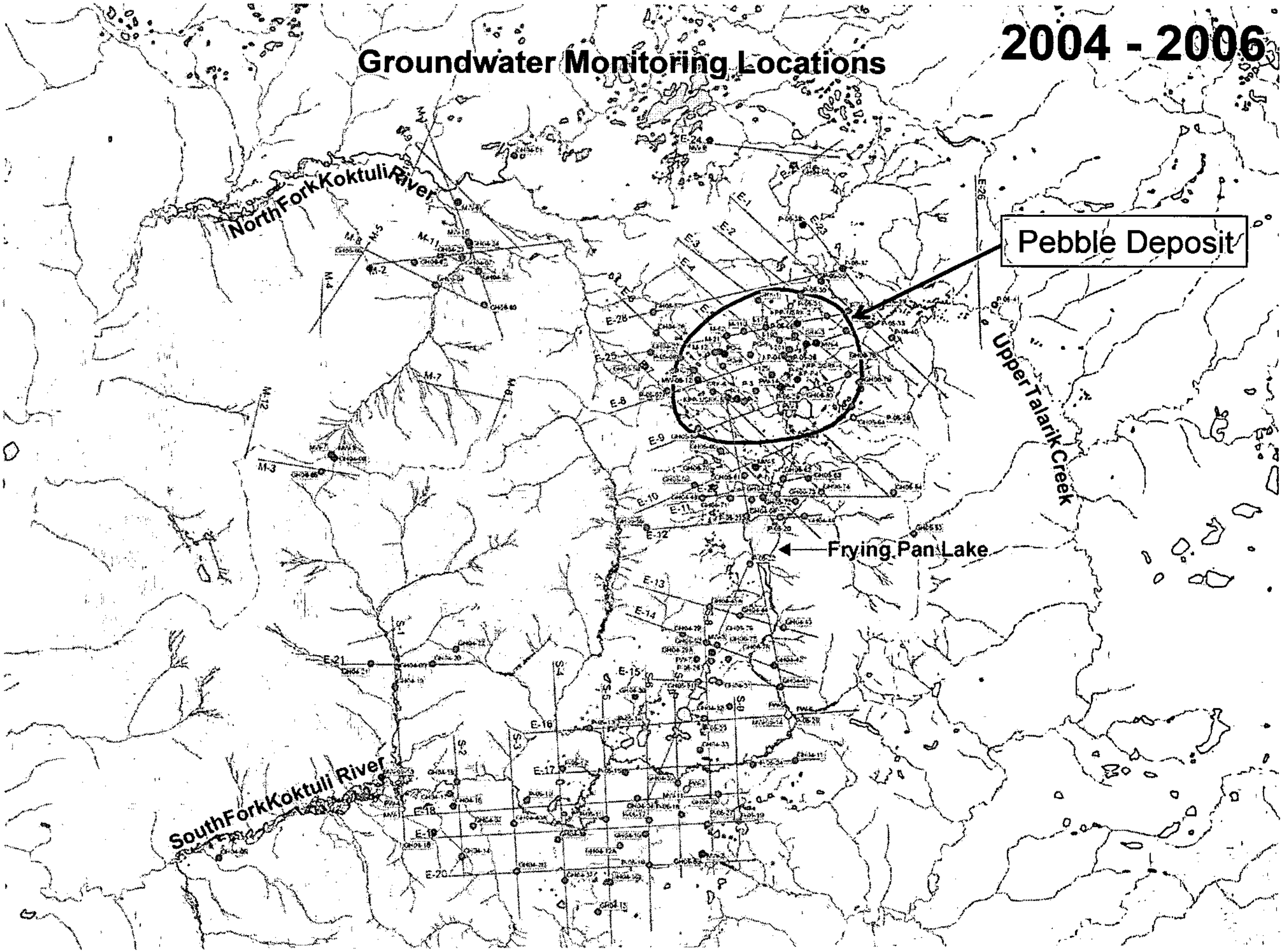



Groundwater Monitoring Locations
2004
Pebble Deposit
Upper Talarik Creek
Frying Pan Lake
North Fork Koktuli River
South Fork Koktuli River
E-1
E-2
E-3
E-4
E-8
E-9
E-10
E-11
E-12
E-13
E-14
E-15
E-16
E-17
E-18
E-19
E-20
E-21
E-22
E-23
E-24
E-25
E-26
E-28
M-2
M-3
M-4
M-5
M-6
M-7
M-8
M-11
M-12
S-1
S-2
S-3
S-4
S-5
S-9

Groundwater Monitoring Locations

2004 - 2005




Groundwater Monitoring Locations
2004 - 2006
Pebble Deposit
Upper Talarik Creek
Frying Pan Lake
North Fork Koktuli River
South Fork Koktuli River
E-1
E-2
E-3
E-4
E-8
E-9
E-10
E-11
E-12
E-13
E-14
E-15
E-16
E-17
E-18
E-19
E-20
E-21
E-23
E-24
E-25
E-26
E-28
M-2
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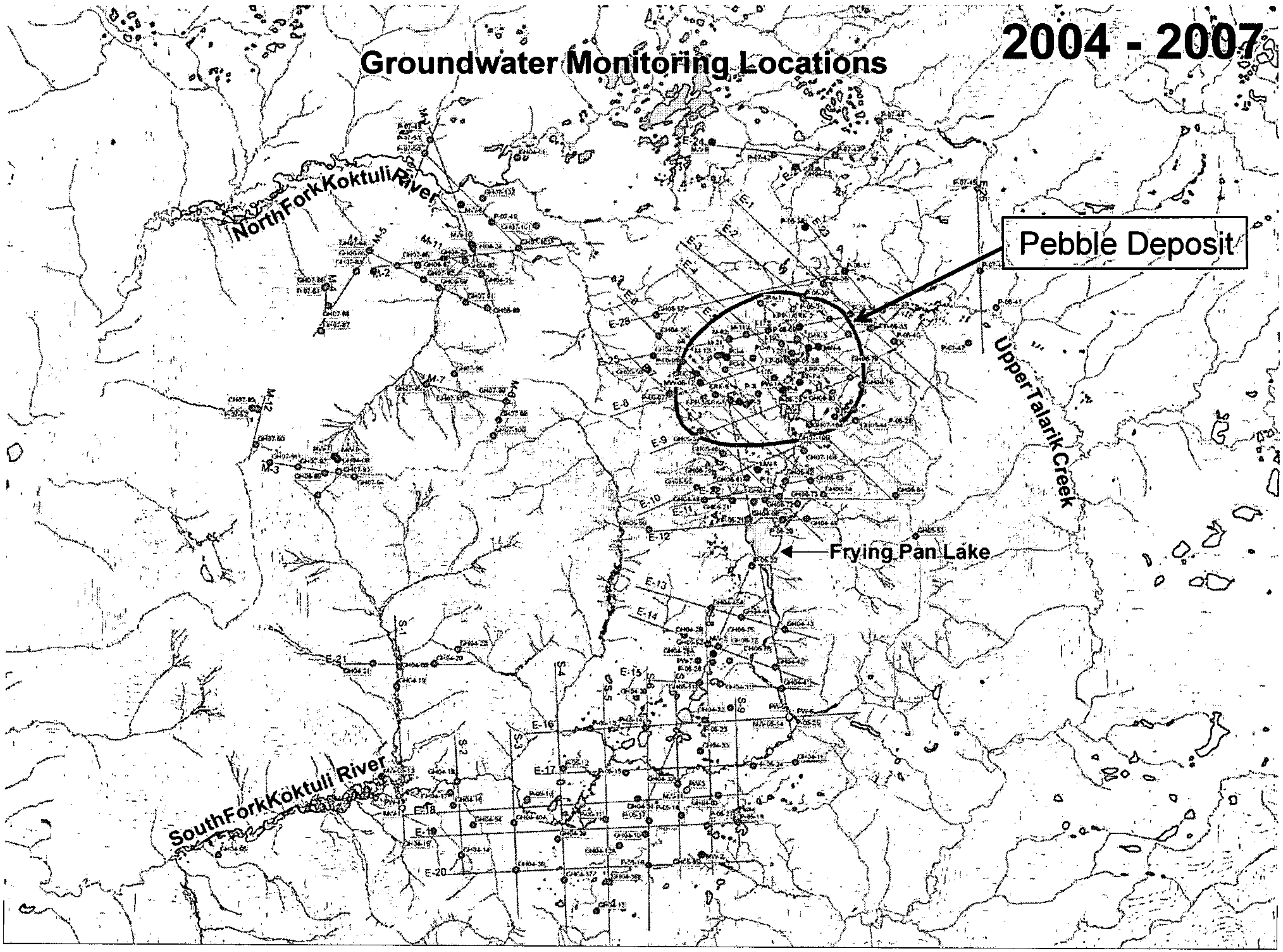
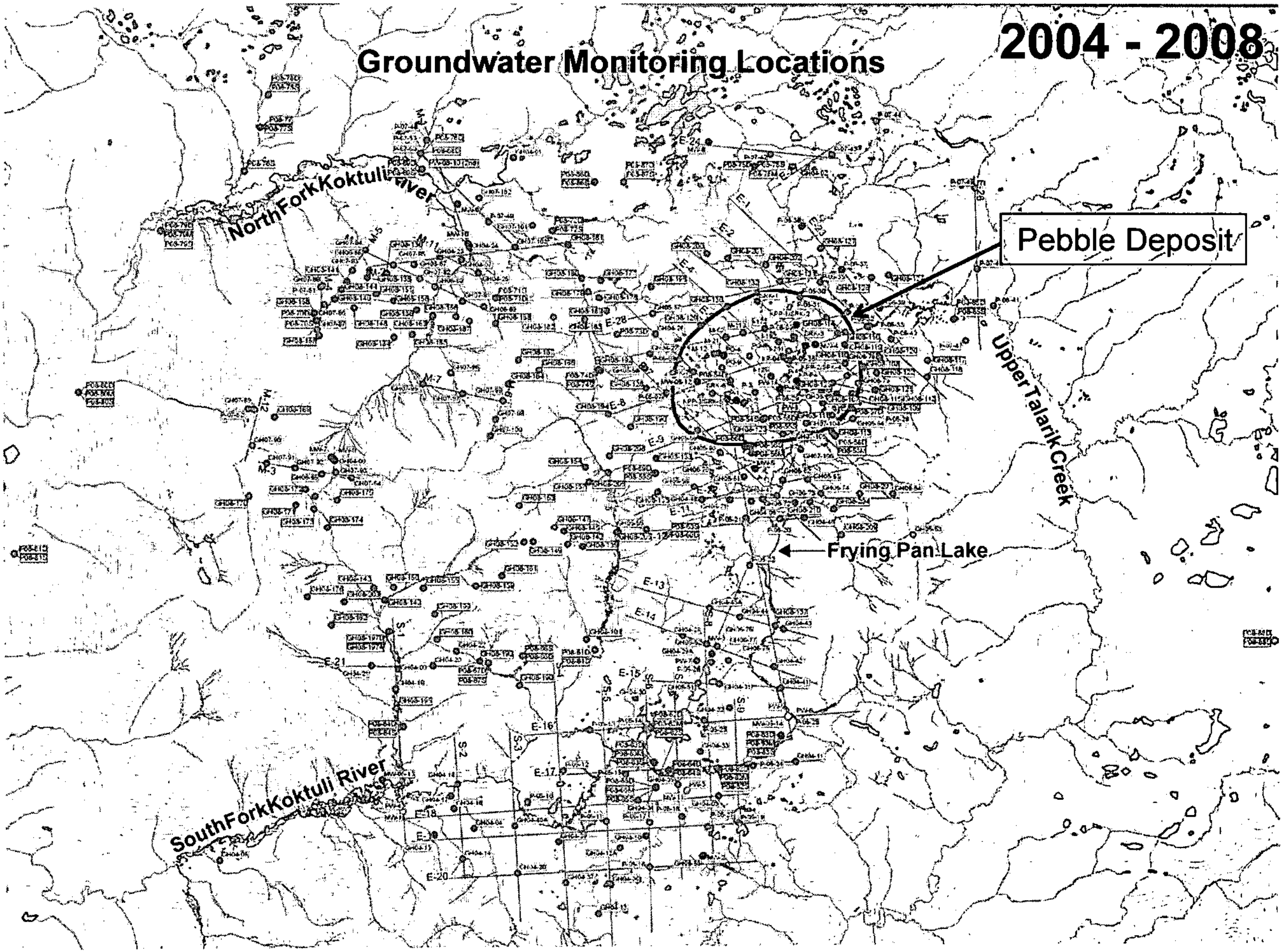
S-6
S-8


2004 - 2007
Groundwater Monitoring Locations
Pebble Deposit
North Fork Koktuli River
South Fork Koktuli River
Upper Talarik Creek
Frying Pan Lake

1905

1906


2004 - 2008
Groundwater Monitoring Locations
Pebble Deposit
North Fork Koktuli River
South Fork Koktuli River
Upper Talarik Creek
Frying Pan Lake

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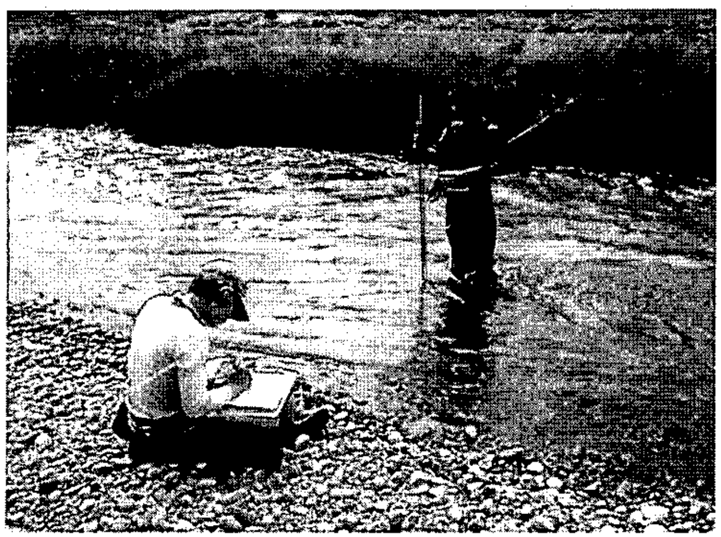
Fish Studies



Fish Data QAQC Progress Summary

2004-2007 Database	QC Method	Total # of Tables	Total # of Records	Percent Complete		
				Level 1	Level 2	Level 3
Fish Distribution	100% Hard Copy	9	23843	100	100	20
Habitat	100% Hard Copy	10	4591	100	100	40
Radio Telemetry	100% Electronic	3	1778	100	100	10
Road Corridor	100% Hard Copy	8	2872	100	100	30
Salmon Fish Counts	100% Electronic	2	674	100	100	10
Salmon Redd Locations	100% Electronic	1	2877	100	100	10
Channel Morphology	20-100% Electronic	4	3698	100	>95	0
Intragravel Temperature	20-100% Electronic	3	229791	100	85	0
Off-Channel Habitat	100% Hard Copy	1	4653	100	50	0
Y Valley	QC Level 2 Pending	6	1060	100	0	0

Pre-Permitting Environmental/Socioeconomic Data

- RELEASED:
  - Meteorology (2008)
  - Surface Water Hydrology (2008)
  - Surficial Geology (2008)
  - Groundwater Hydrology (2008)
  - Trace Elements *Sediments and Soils* (2008)
  - Groundwater and Surface Water Quality (2008)
  - Trace Elements *Vegetation and Fish/Mammal Tissue* (FEB 2009)
- Future Releases:
  - Macroinvertebrates and Periphyton (2009)
  - Marine Habitats (2009)
  - Marine Nearshore Fish and Benthic Invertebrates (2009)
  - Noise (2009)
  - Lake Iliamna Studies (2009)
  - Visual Resources (2009)
  - Terrestrial Habitat and Wildlife (2009)

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Permitting

Agencies involved in permitting large hard rock mine in Alaska:

- AK Department of Natural Resources (lead agency)
- AK Department of Environmental Conservation
- AK Department of Fish and Game
- AK Department of Transportation & Public Facilities
- AK Department of Commerce, Community and Economic Development
- AK Department of Law
- US Environmental Protection Agency
- US Army Corps of Engineers
- US Fish and Wildlife Service
- US National Marine Fisheries Service
- US Bureau of Land Management
- US Forest Service

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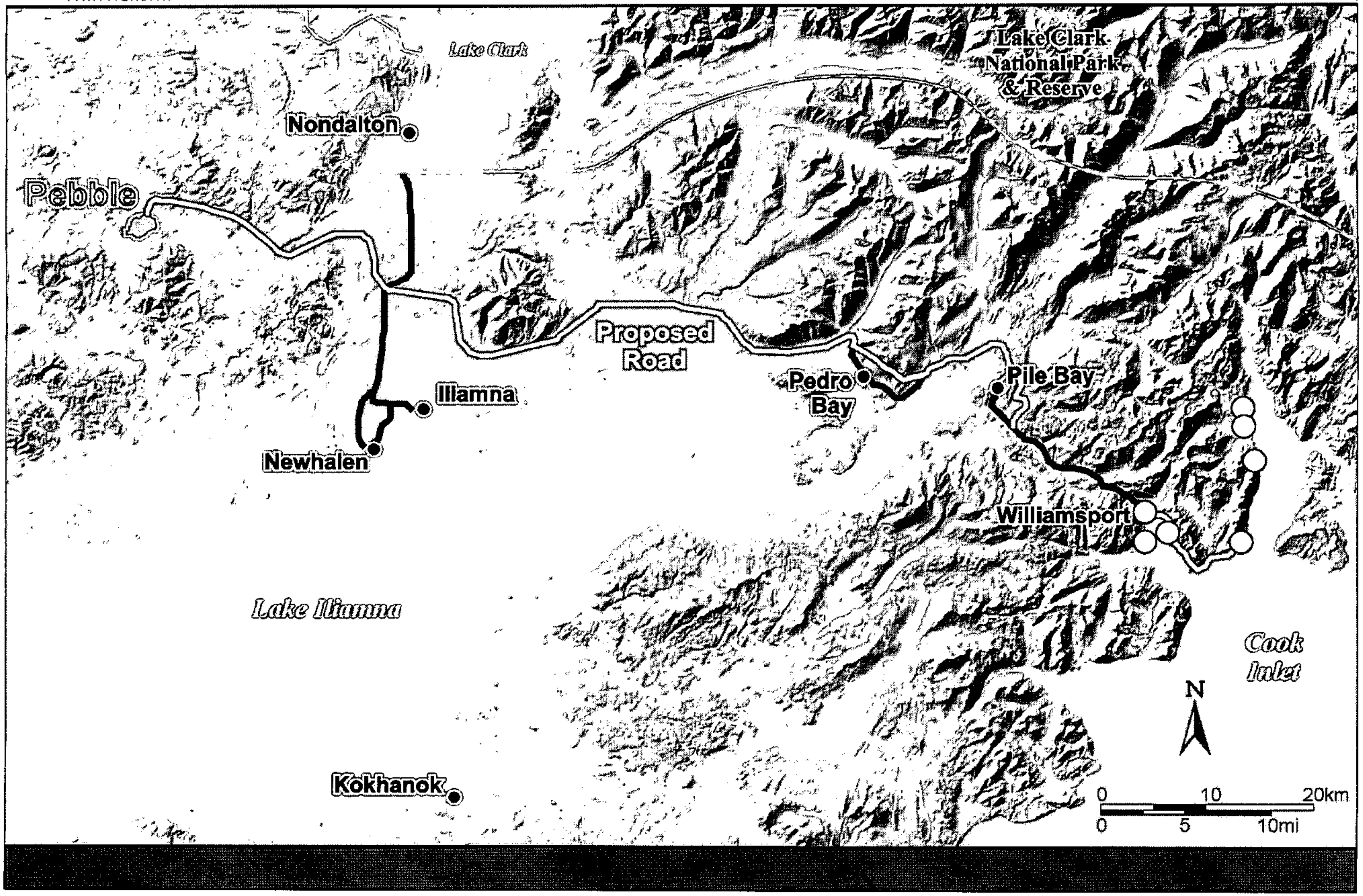
Road Corridor & Port Site



1911

1912

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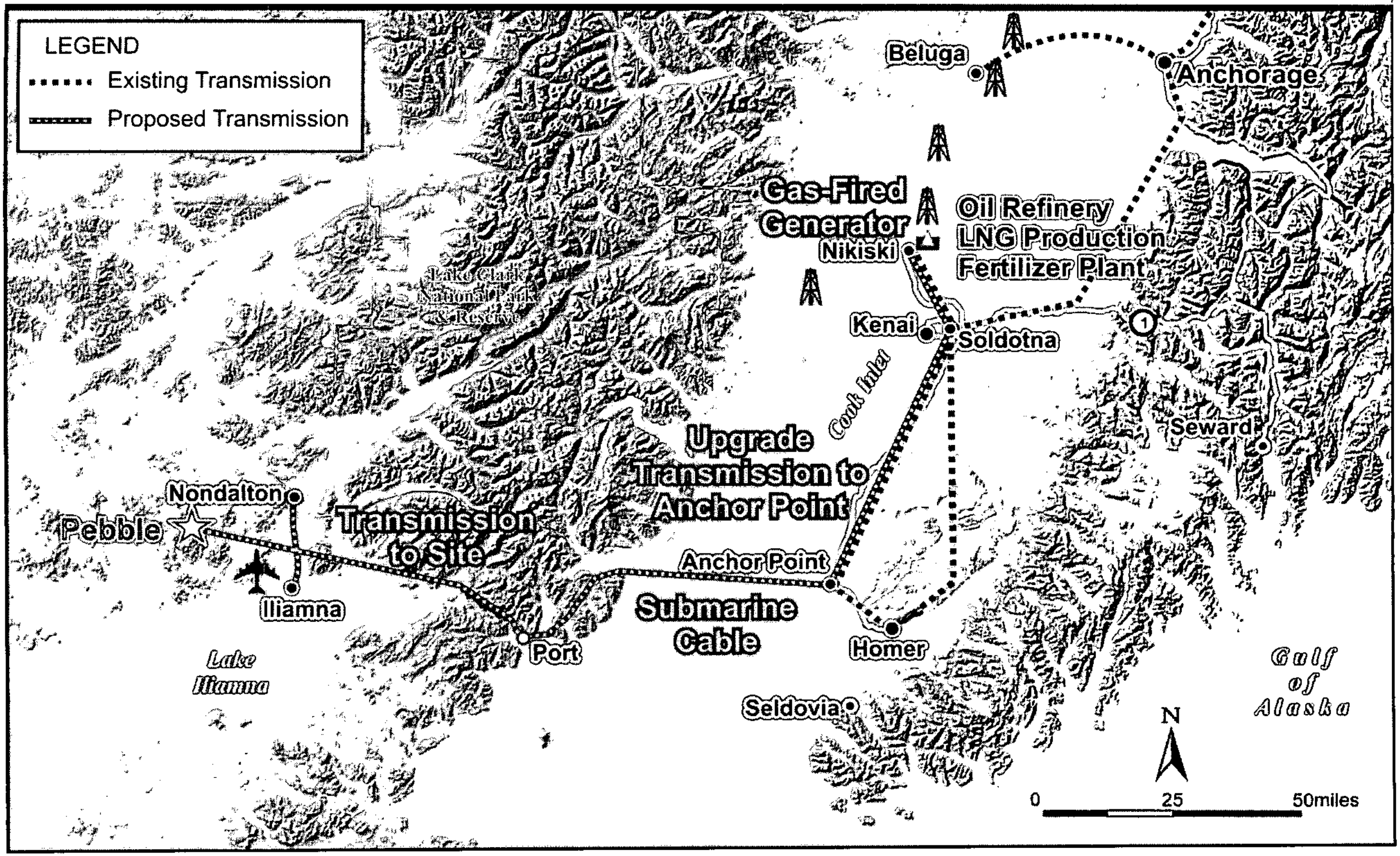
Power



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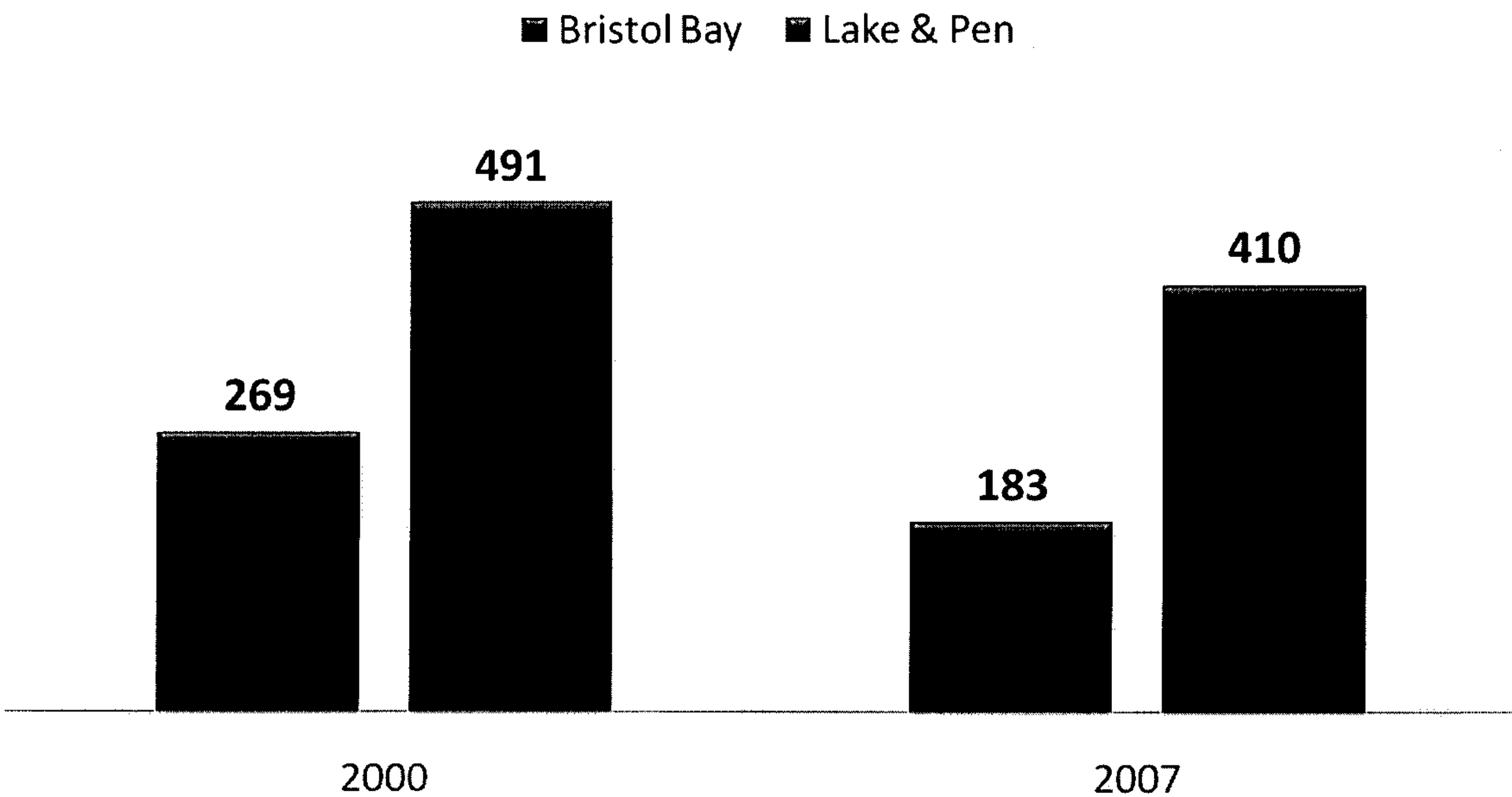
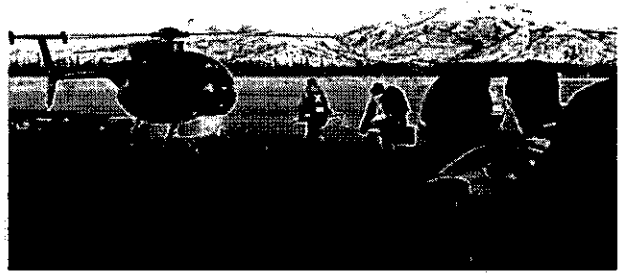
Region School Population





Pebble Prospect

www.pebblepartnership.com

1915

The Process and Requirements for Large Mine Permit Applications in Alaska

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Senate Resources Standing Committee

February 27, 2009

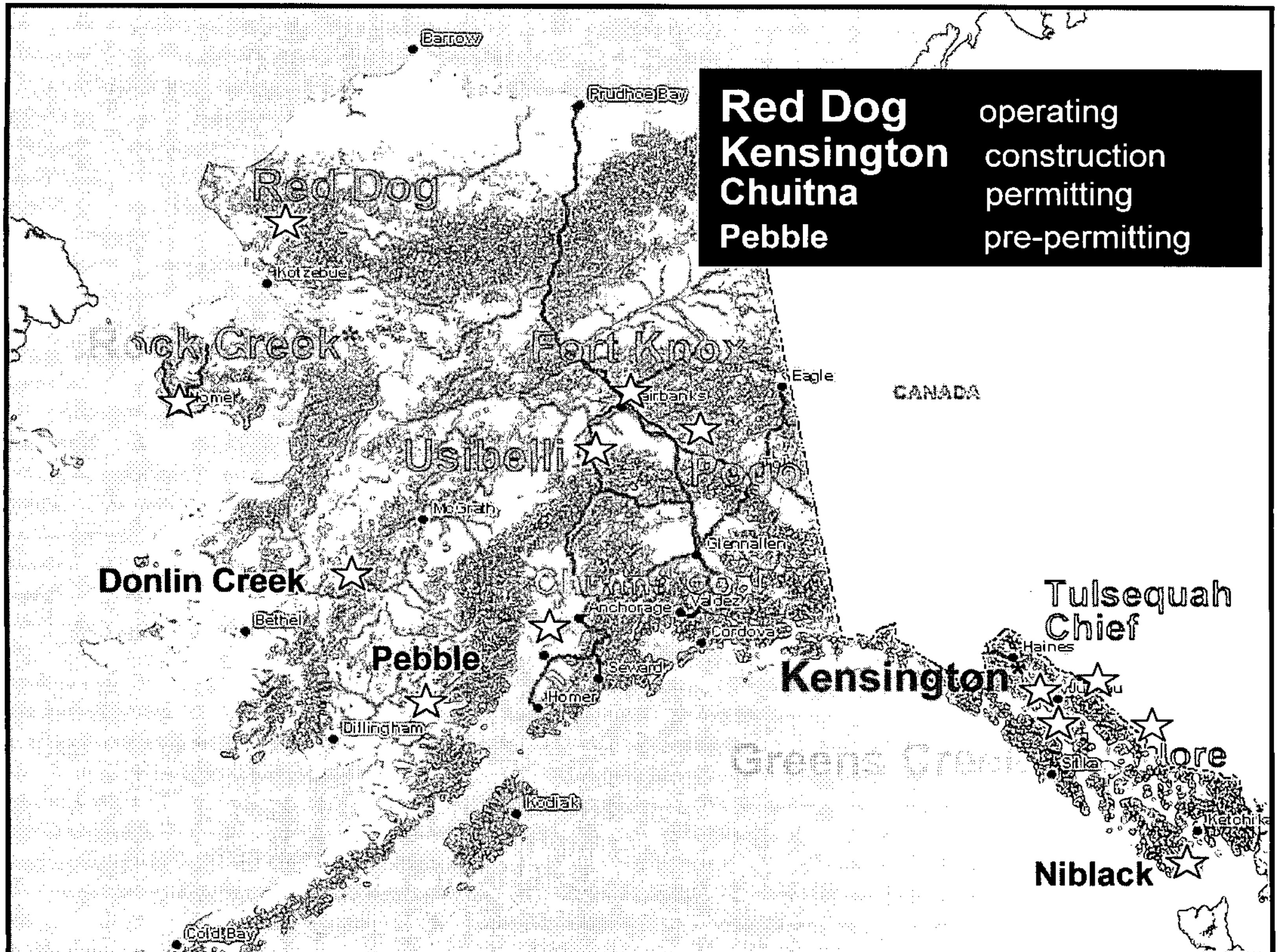
Ed Fogels, Director

Office of Project Management and Permitting

Alaska Department of Natural Resources

1916

Large mining projects in Alaska



*Temporary Closure

*Litigation

No Single Permit to Mine: there are many permits & authorizations

STATE

- Plan of Operations (DNR)
- Reclamation and Bonding (DNR)
- Waste Management Permits and Bonding (ADEC)
- Certification of NPDES and ACOE Permits (ADEC)
- Sewage Treatment System Approval (ADEC)
- Air Quality Permits (ADEC)
- Fish Habitat and Fishway Permits (ADF&G)
- Water Rights (DNR)
- Right of Way/Access (DNR/DOT)
- Tidelands Leases (DNR)
- Dam Safety Certification (DNR)
- Cultural Resource Protection (DNR)
- Monitoring Plan (Surface/Groundwater/Wildlife) (DNR/DEC)
- Coastal Zone Consistency Determination (DNR)

FEDERAL

- US EPA Section 402 NPDES Water Discharge Permit
- US EPA Air Quality Permit review
- US EPA Safe Drinking Water Act (UIC Permit)
- US ACOE Section 404 Dredge and Fill Permit
- US ACOE Section 10 Rivers and Harbors Act
- US ACOE Section 106 Historical and Cultural Resources Protection
- NMFS Threatened and Endangered Species Act Consultation
- NMFS Marine Mammal Protection Act
- NMFS Essential Fish Habitat
- NMFS Fish and Wildlife Coordination Act
- USFWS Threatened and Endangered Species Act Consultation
- USFWS Bald Eagle Protection Act Clearance
- USFWS Migratory Bird Protection
- USFWS Fish and Wildlife Coordination Act

(These are only some of the authorizations required)

State Agencies

LARGE MINE PERMITTING TEAM

- Department of Natural Resources
  Lead State agency for coordination: AS 27.05.010(b)
- Department of Environmental Conservation
- Department of Fish and Game
- Department of Transportation & Public Facilities
- Department of Commerce, Community and Economic Development
- Department of Law
- Department of Health & Social Services

Federal Agencies

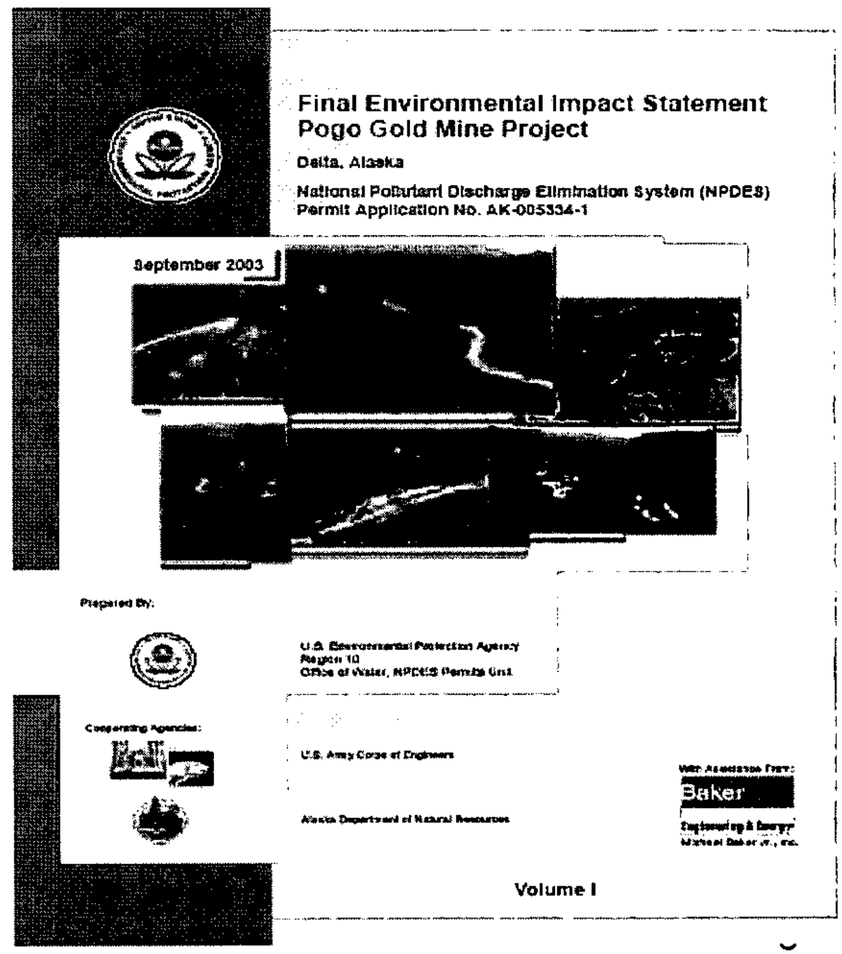
- US Environmental Protection Agency
- US Army Corps of Engineers
- US Fish and Wildlife Service
- National Marine Fisheries Service

- Bureau of Land Management
- U. S. Forest Service
- National Park Service

1920

NEPA - EIS

- EIS Content
  - proposed project and alternatives to the project
  - description of the affected environment
  - analysis of the environmental consequences of the proposed project and alternatives



Parallel Process

EIS Process

Notice of Intent

Scoping

Draft EIS

Final EIS

Record of Decision

Federal Process

EPA
NPDES

Corps
Wetlands

E.O. 13175
Tribal Consultation

USFWS/NMFS
Endangered Species Act
Consultation

NMFS
Magnuson-Stevens
Fisheries Management Act
EFH Assessment

Federal
Permit, Certification, Approval

State Process

ADFG
Habitat

ADNR
Operation Plan
Reclamation Plan
Coastal Consistency
Determination
National Historic
Preservation Act

ADEC
Waste Management
Air Quality Monitoring
Plan
401 Certification

State
Permit, Certification, Approval

Local Process

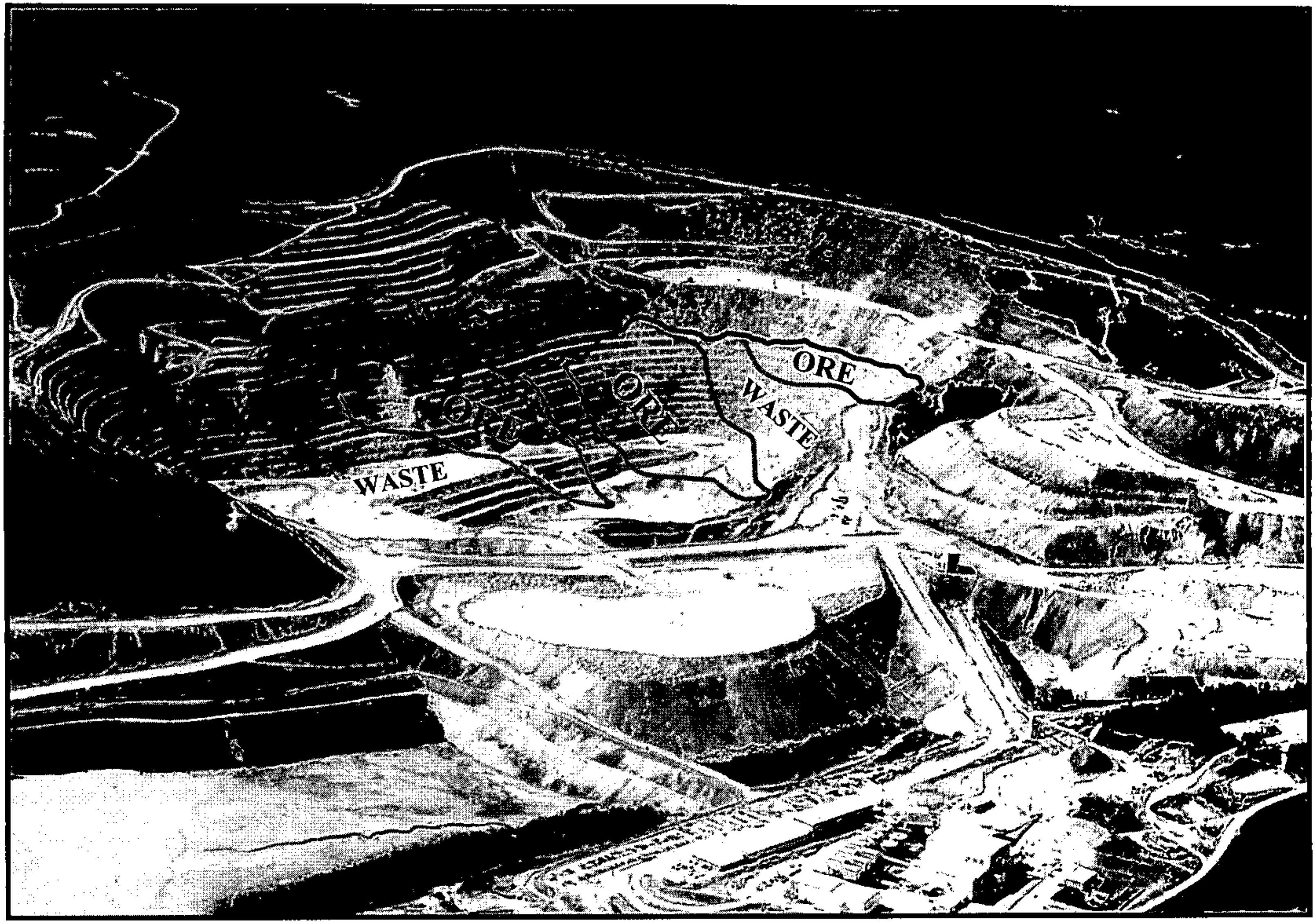
Borough Plan

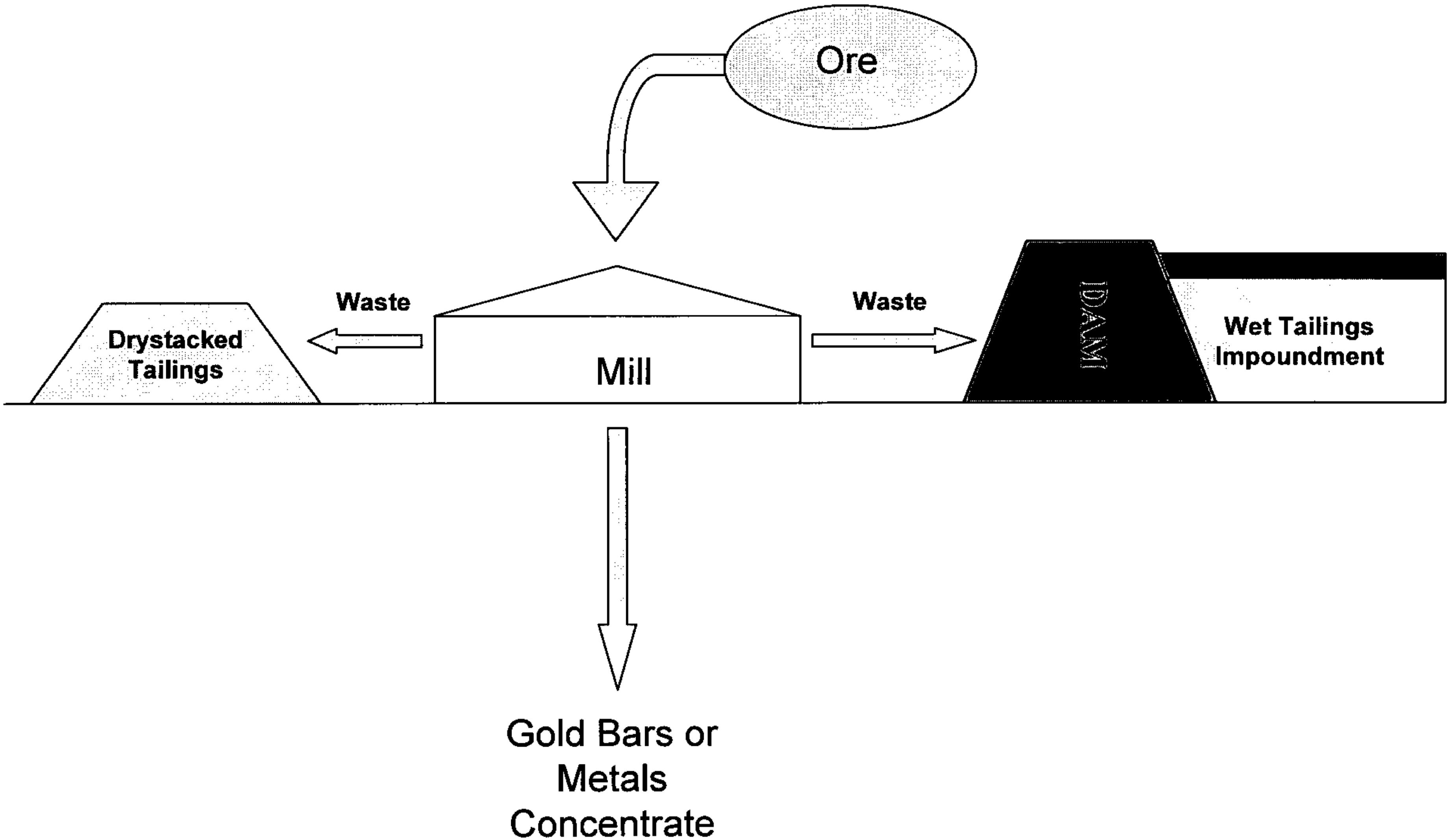
City Plan

Local
Consistency

Ore and Waste

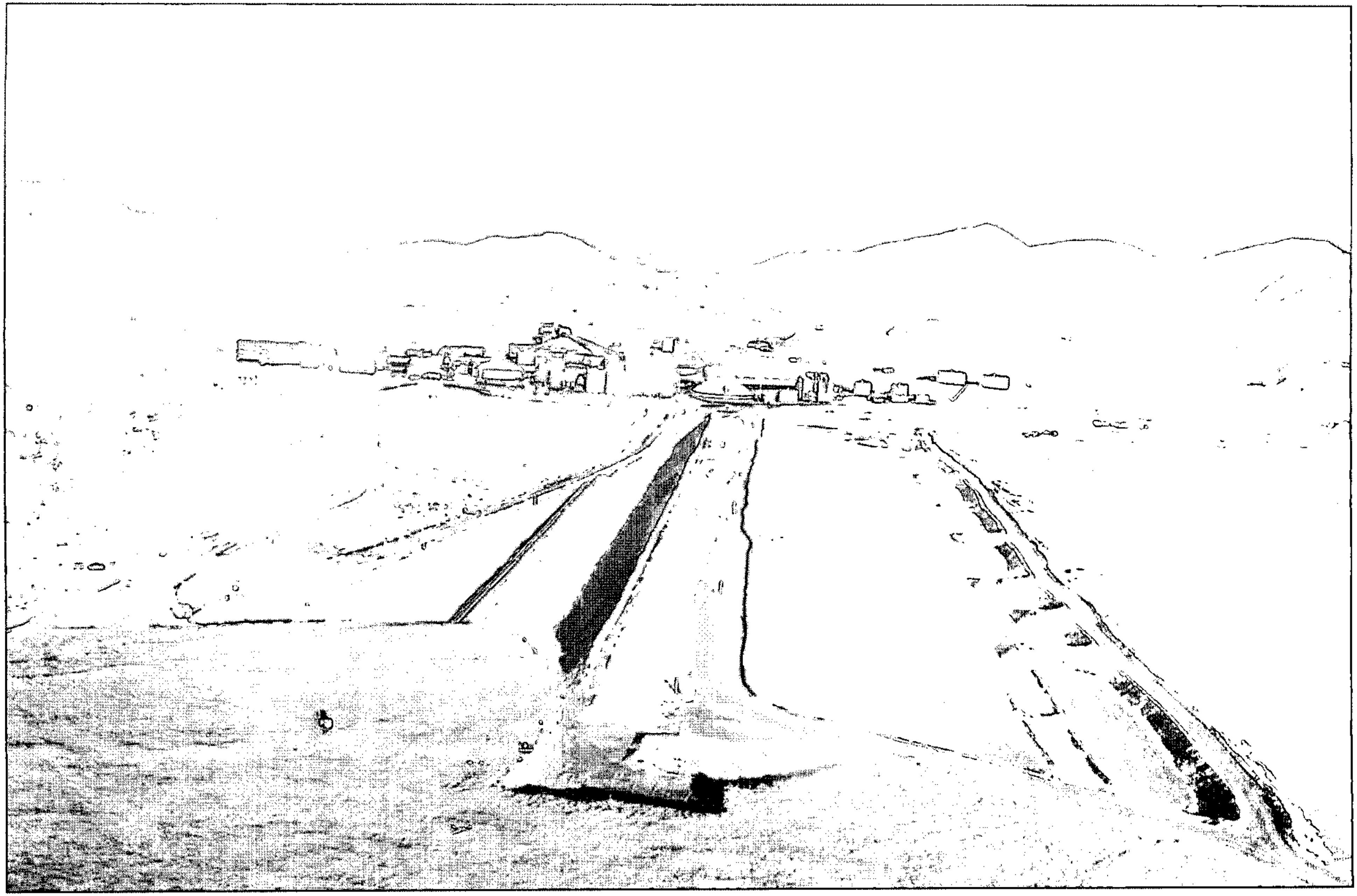
A generalized example, based on Fort Knox




Ore
Waste
Waste
Drystacked Tailings
Mill
DAM
Wet Tailings Impoundment
Gold Bars or Metals Concentrate

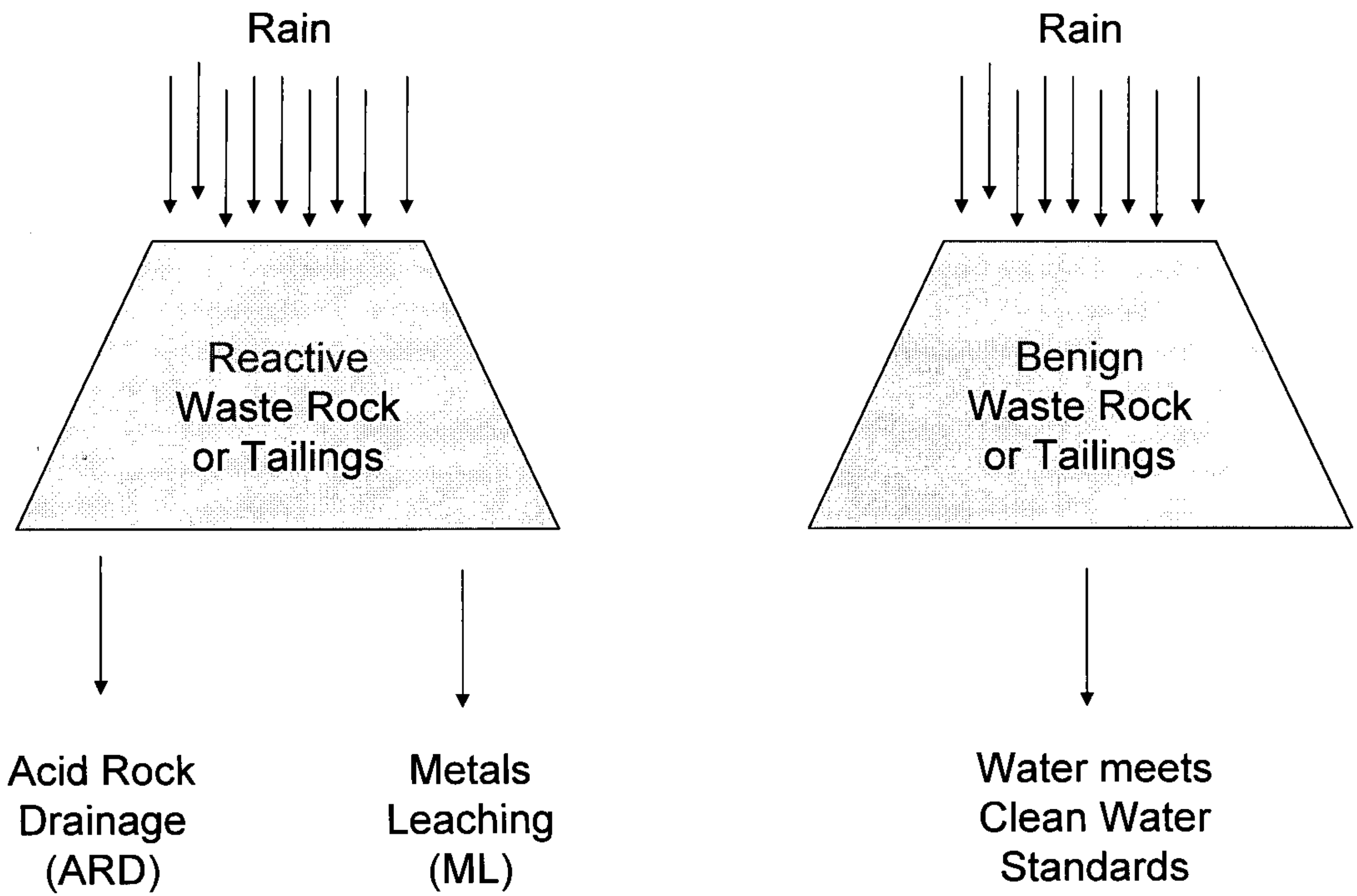
1923

Red Dog Tailings Dam & Mill Facilities



1924

1925


Rain
Reactive Waste Rock or Tailings
Acid Rock Drainage (ARD)
Metals Leaching (ML)
Rain
Benign Waste Rock or Tailings
Water meets Clean Water Standards

ADEC Integrated Waste Management Permit

- Integrated Waste Management Permit
  - 18 AAC 60 – Solid Waste Management
  - 18 AAC 70 – Water Quality Standards
  - 18 AAC 72 – Wastewater Disposal
- Typical Wastes Managed
  - Tailings
  - Waste Rock
- Potential contaminants controlled
  - Acid Rock Drainage
  - Metals Leaching
  - Process Chemicals
- Financial Assurance Required

RECLAMATION PLAN APPROVAL

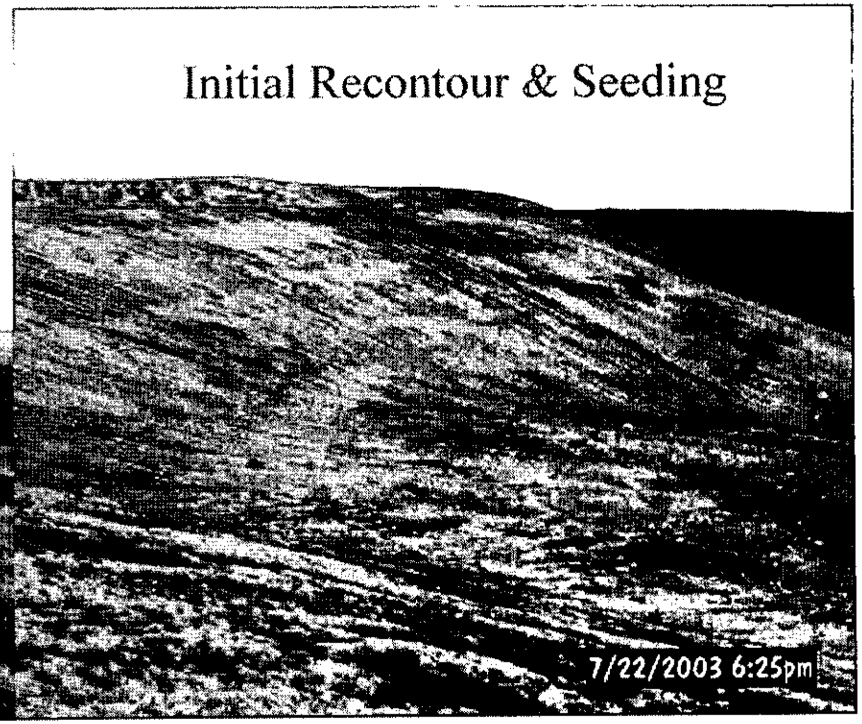
Issued by DNR

Division of Mining, Land and Water/Mining Section

- Minesite must be returned to a stable condition, compatible with the post-mining land use (AS 27.19.020)

- Financial Assurance must ensure State can do reclamation even if company cannot.

1928



Illinois Creek Reclamation

DAM SAFETY CERTIFICATION
Issued by DNR
Division Of Mining, Land And Water/Dam Safety Unit

- All dams (tailings and water storage) must be designed to State standards.
- Includes seismic standards
- Financial assurance for long term care and maintenance

1930

Financial Assurance is based on a detailed engineering analysis

Teck-Pogo Inc.
teckcominco

Reclamation & Closure Plan Update

Table F.1: Demolition Hourly Labor Wage Rages

Description		General Demolition Crew	Mechanical Crew	Heavy Equipment Operator	Electrical Crew	Foreman	Laborer
Base Hourly Rate - straight time		$26.55	$26.04	$27.77	$30.83	$30.55	$23.43
Overtime for 50 hour week	10.0%	$2.66	$2.60	$2.78	$3.08	$3.06	$2.34
Adjusted Hourly Base Rate		$29.21	$28.64	$30.55	$33.91	$33.61	$25.77
Social Security, Medicaid, Unemployment, Liability, and Workers Comp Insurance	21.7%	$6.34	$6.22	$6.63	$7.36	$7.29	$5.59
Total Direct Hourly Labor Costs		$35.54	$34.86	$37.18	$41.27	$40.90	$31.37
Labor Indirects							
Benefits - percentage of adju							.74
Field Overhead - percentage							.32
Small Tools Allowance - rate							.00
Camp and/or Travel Allowan							.00
Total Indirect Hourly Costs							.06
Total Hourly Costs							.42

Teck-Pogo Inc.
teckcominco

Reclamation & Closure Plan Update

Table F.2: Hourly Equipment Rates ($)

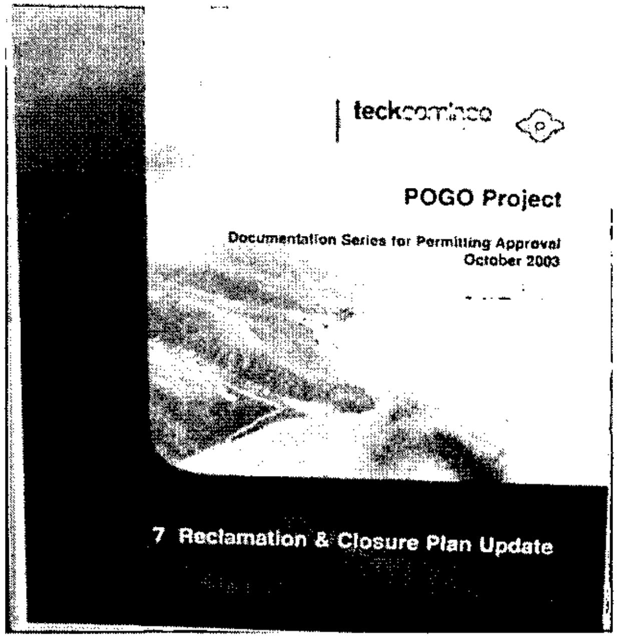
Equipment	Equipment Lease Rate	Maintenance & Fuel	Support & Transport	Total
Excavator 330	31.00	52.00	16.60	100.00
Excavator 375L	48.00	89.00	27.40	164.00
Excavator 235	31.00	52.00	16.60	100.00
Dozer D10R	73.00			
Dozer D8R	42.00			
D6R Dozer	30.00			
Grader 16G	34.00			
Water Truck	20.00			
Tamrock DHR	48.00			
Shotcrete Machine	20.00			
Picker Truck	30.00			
Re-seeding	15.00			
Shear on 375L	65.00			
FE Loader 950	30.00			
FE Loader 980G	45.00			
FE Loader 992G	62.00			
Dump Truck 14Cy	25.00			
Self Load Flat Bed	50.00			
Low Bed Truck	35.00			
Dump Truck 17cy	31.00			
Crane Truck 20T	45.00			
Crane Truck 50T	70.00			
Track Skidder 528	50.00			

amec

POGO: RECLAMATION COST ESTIMATE (SEPTEMBER 2003)

Project Number: U419F
Currency: USD 4Q2002

Description	Qty Unit	Unit Direct Hr	Total Direct Hr	Total Direct Lab Cost	Unit Mat	Total Mat Cost	Unit S/C	Total Sub Cost	Unit Equip	Total Equip Cost	Total Cost
Phase I: Post-Construction			4,988	287,345		13,213		26,400		156,977	483,935
Phase II: Reclamation Concurrent with Mining											
A-07 WELLS			115	6,294		1,200		0		0	7,494
A-09 GRAVEL PADS			383	21,312		900		0		25,013	47,224
A-12 ROCK PILES			2,928	165,891		0		0		197,786	363,677
A-13 LINERS UNDER ROCK PILES			629	35,340		0		0		41,040	76,381
A-14 PADS UNDER ROCK PILES			340	19,998		870		0		23,860	44,726
A-19 EXPLOSIVES STORAGE			406	23,515		0		0		10,904	34,418
R-01 SURFACE BOREHOLES			2,000	114,060		50,000		0		31,260	195,320
S-00 WATER QUALITY ASSURANCE			0	0		0		10,000		0	10,000
Phase II: Reclamation Concurrent with Mining			6,781	386,408		52,970		10,000		329,862	779,241



Financial Assurances for Alaska Mines

Not static, audited & recalculated every 5 years or when significant changes occur

Operation	*Total Bond ($ Millions)*
Greens Creek Mine	$29.2
Red Dog Mine	$154.9
Fort Knox (& True North) Mine	$37.6
Usibelli Coal Mine & Exploration	$11.3
Kensington Project	$7.4
Rock Creek Mine	$6.8
Pogo Mine	$27.6
Nixon Fork Mine	$3.5
TOTAL	$278.3

1932

Title 16 Permits

Issued by ADF&G Habitat Division

•AS 16.05.841: <u>Fishway Act</u>

For activities within or across a stream used by fish that could represent an impediment to the efficient passage of fish. e.g., culverts; water withdrawals; stream realignments or diversion; dams; low-water crossings; and construction, placement, deposition, or removal of any material or structure below **<u>ordinary high water</u>**

•AS 16.05.871: <u>Anadromous Fish Act</u>

All activities within or across a specified anadromous waterbody and all instream activities affecting a specified anadromous waterbody require approval from the OHMP, including construction; road crossings; gravel removal; mining; water withdrawals; the use of vehicles or equipment in the waterway; stream realignment or diversion; bank stabilization; blasting; and the placement, excavation, deposition, or removal of any material

Monitoring Plan Approval (ADEC/DNR/ADF&G)

- Air Q
- Water Q
  - Surface
  - Groundwater
- Fish & Wildlife Studies

Baseline

⇩

Operation (Compliance)

⇩

Post-Closure (Compliance)

Environmental Audits

- Environmental Audits on 5 year schedule tied to reissuance of permits
- All environmental systems audited
- Audits evaluate Agencies as well as operations
- Audits by 3rd party experts
- Financial Assurances revisited and recalculated based on Audit results

Take Home Message

- Many permits required, many agencies involved.
- Experienced agency professionals involved in permitting and regulation
- Financial Assurance required

Take Home Message

- There are many ways to prevent contamination from occurring and control or remediate contamination once it occurs.
- Key to this:
  - Understand waste characteristics, water balance, and environmental conditions.
  - Minimize footprint and minimize contact with water
  - Design for closure
  - Appropriate Monitoring & Inspection
  - 5-Year Environmental Audits

CHECK US OUT AT:

http://www.dnr.state.ak.us/opmp/

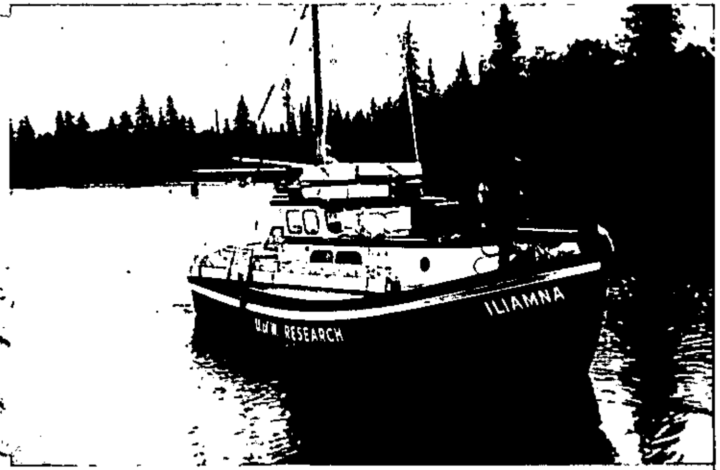
or

http://www.dnr.state.ak.us/mlw/mining/largemine.htm

Ed Fogels, Director DNR/OPMP
Ed.Fogels@alaska.gov

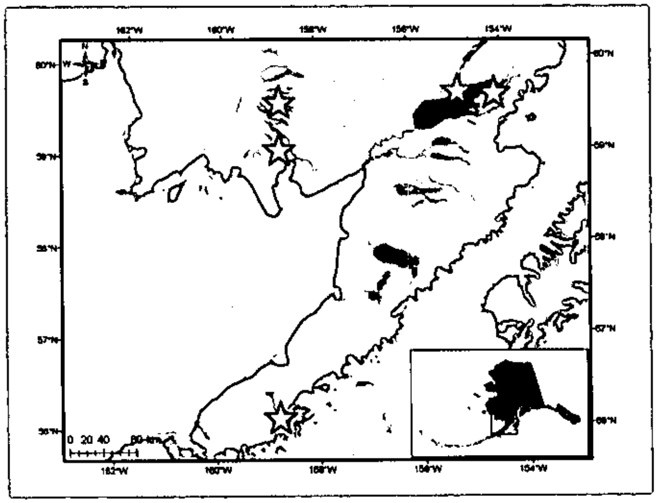
(907) 269-8423





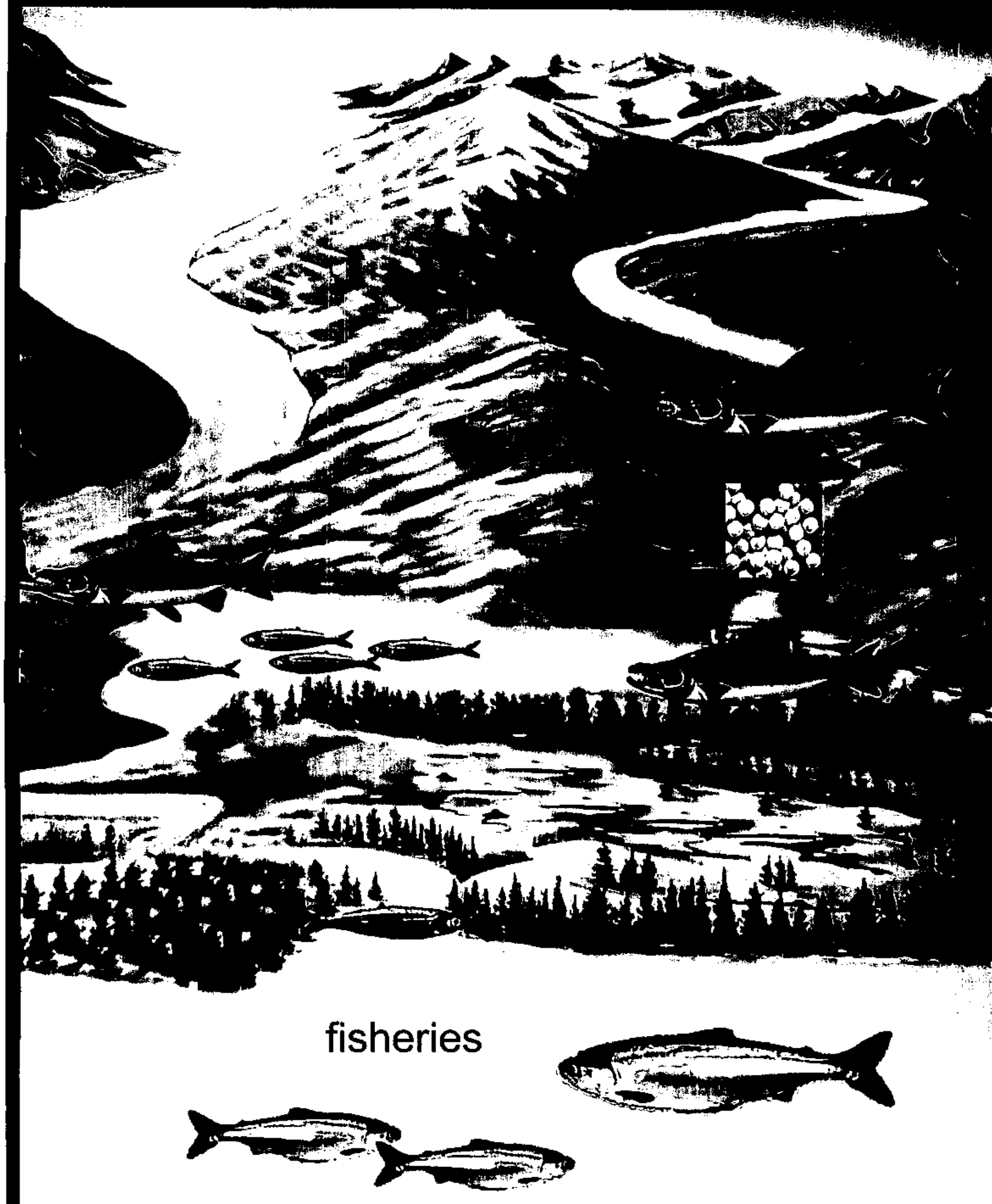
Daniel Schindler, Ph.D., (deschind@u.washington.edu)
University of Washington
Fisheries Research Institute

Salmon research in Western Alaska 1946-2009

19.39

Habitat and Life Cycle
Sockeye (Red) salmon



Adapted from Alexis Rockman painting, 1998

Spawning

Embryo incubation (~9 mos.)

Juvenile rearing in lakes
(1-2 years)

Smolt migration

Ocean residency
(1-3 years)

Return migration

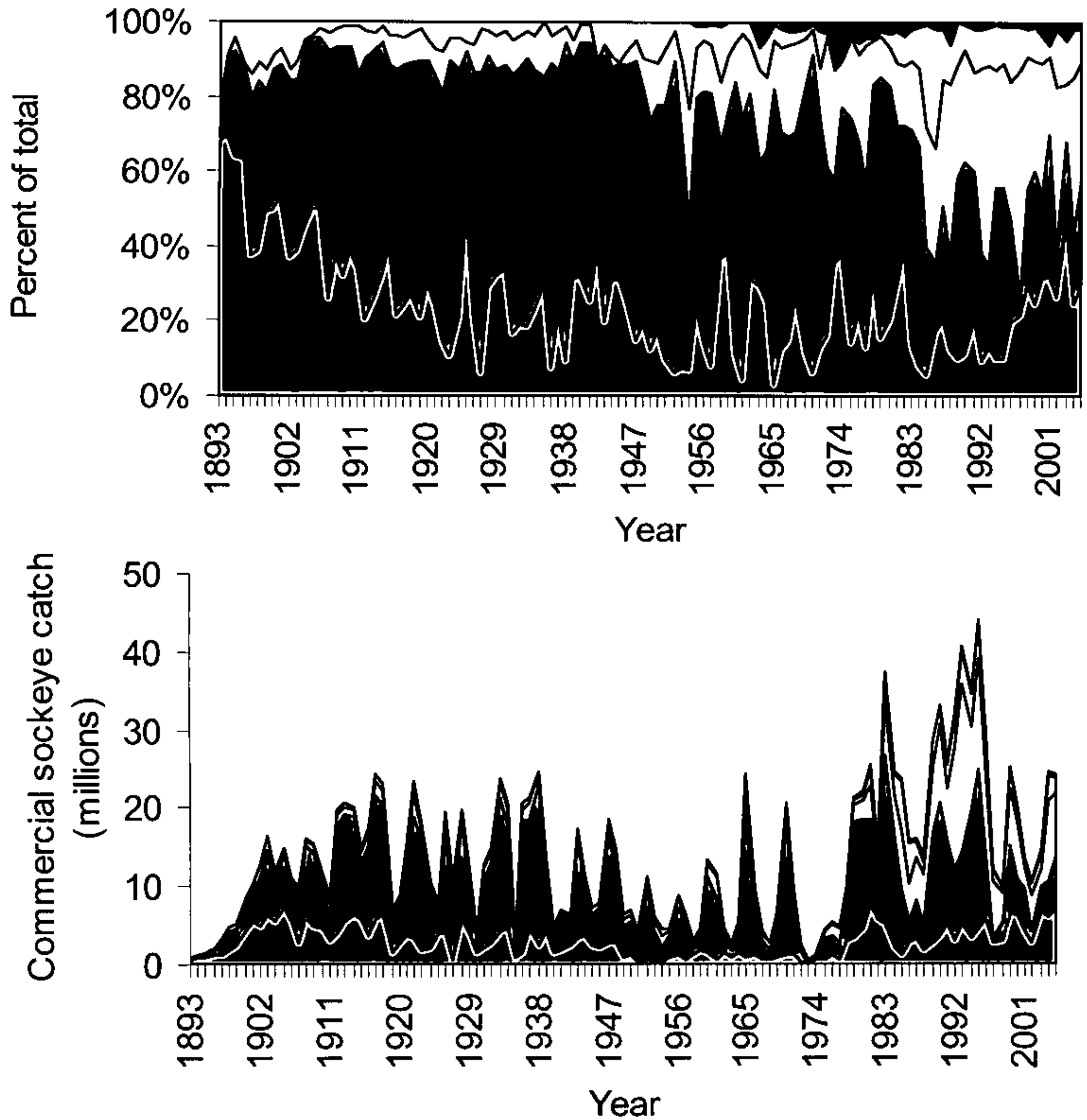
1940

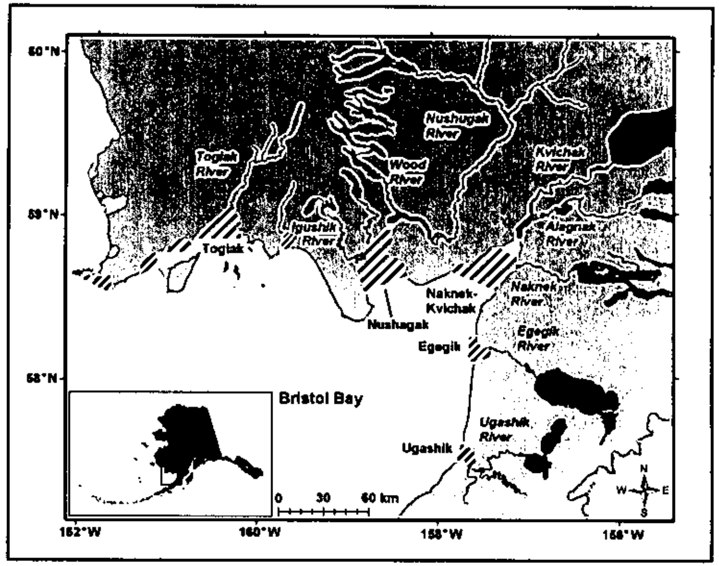
Why do habitat <u>networks</u> matter to fisheries?

- portfolio effect -

19.41

Bristol Bay sockeye salmon fisheries

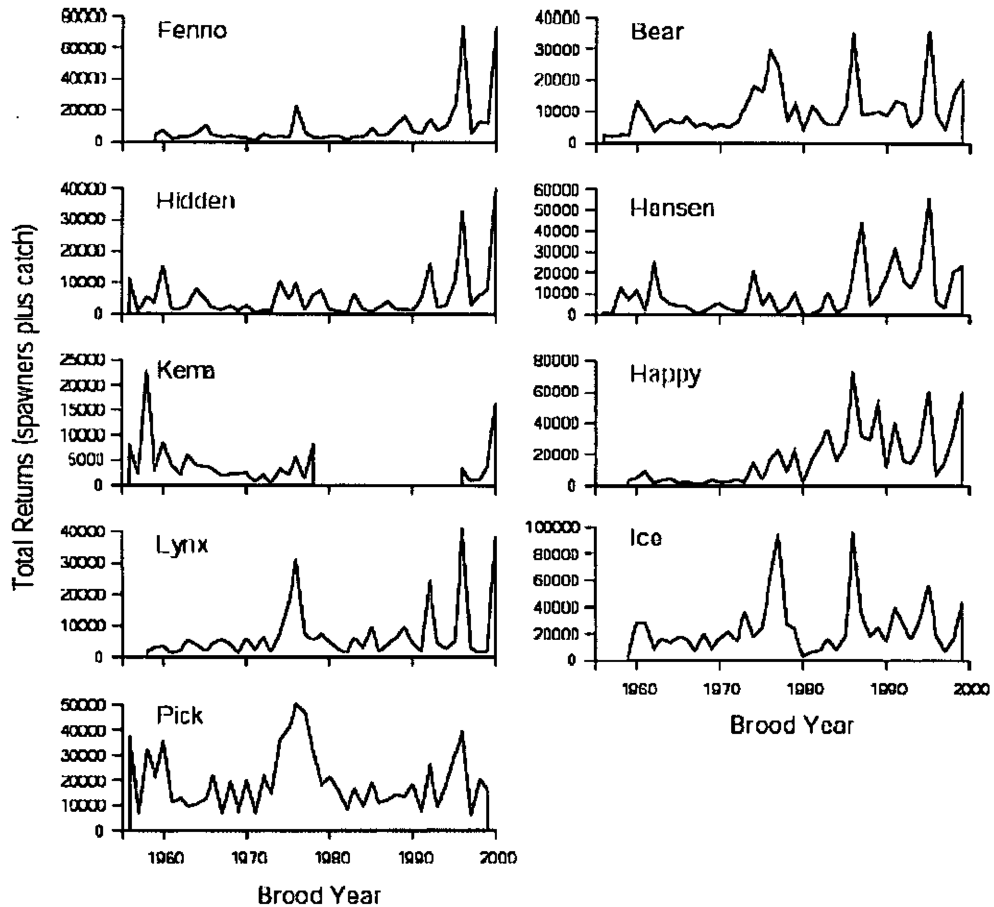




■ Togiak
□ Ugashik
□ Egegik
■ Naknek-Kvichak
▣ Nushagak

data from ADFG updated from Hilborn et al., *Proceedings of the National Academy of Sciences* (2003)

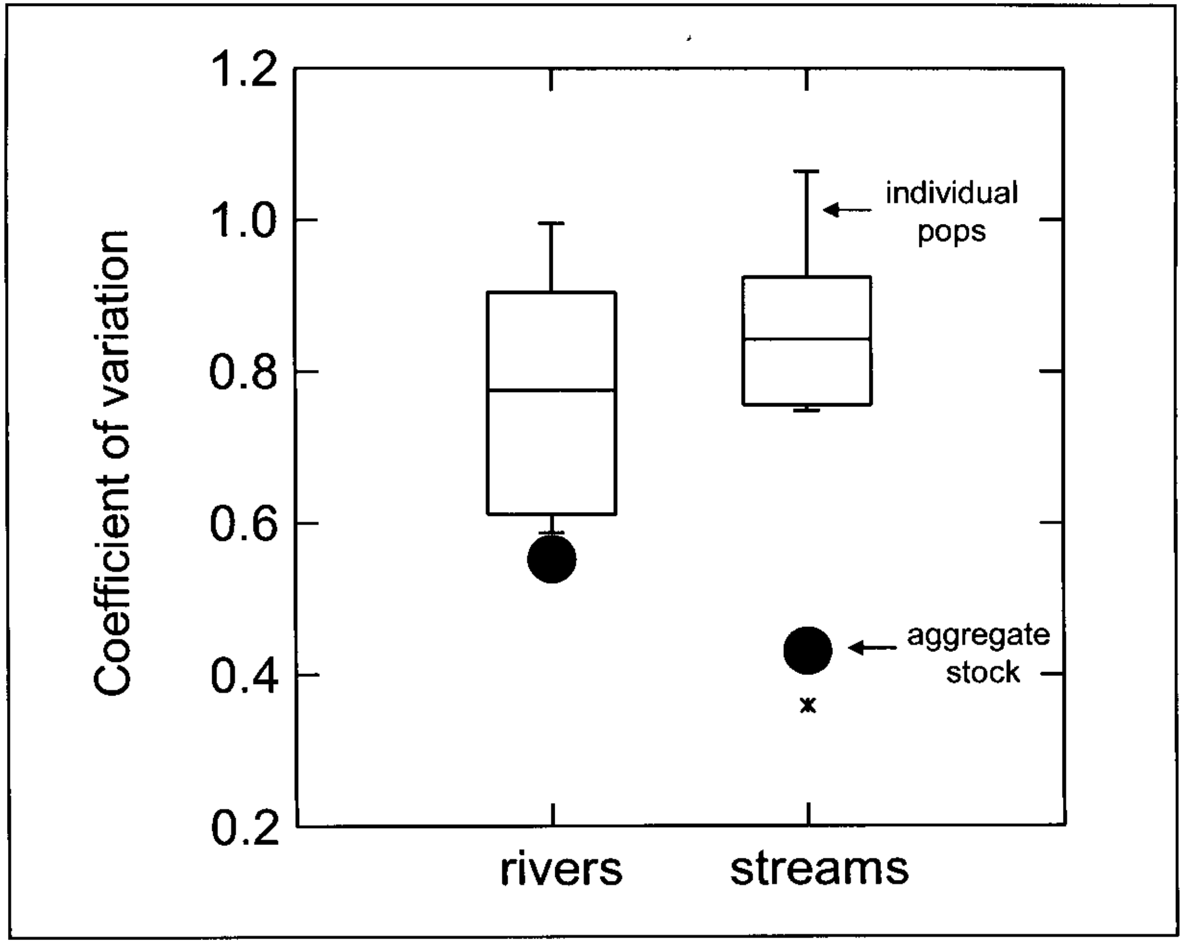
Sockeye populations in spawning streams (Wood River, Bristol Bay, Alaska)

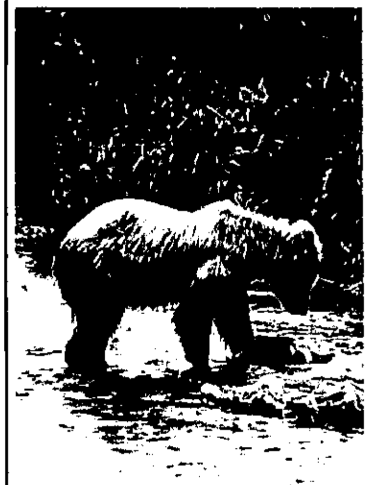


19.43

Portfolio effect in Bristol Bay sockeye salmon stocks

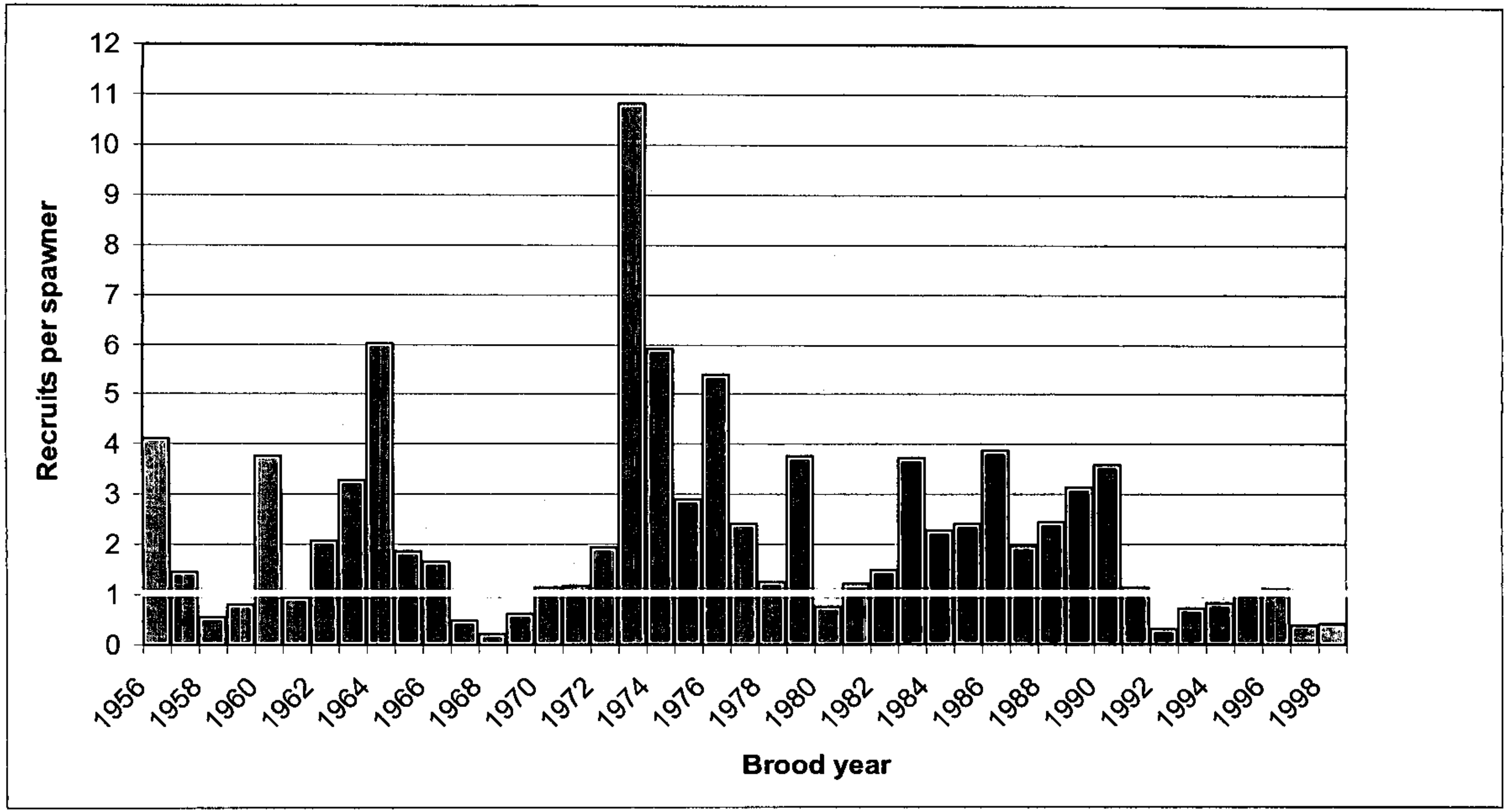
Annual returns, 1956-2007, for rivers (8) and streams(13)



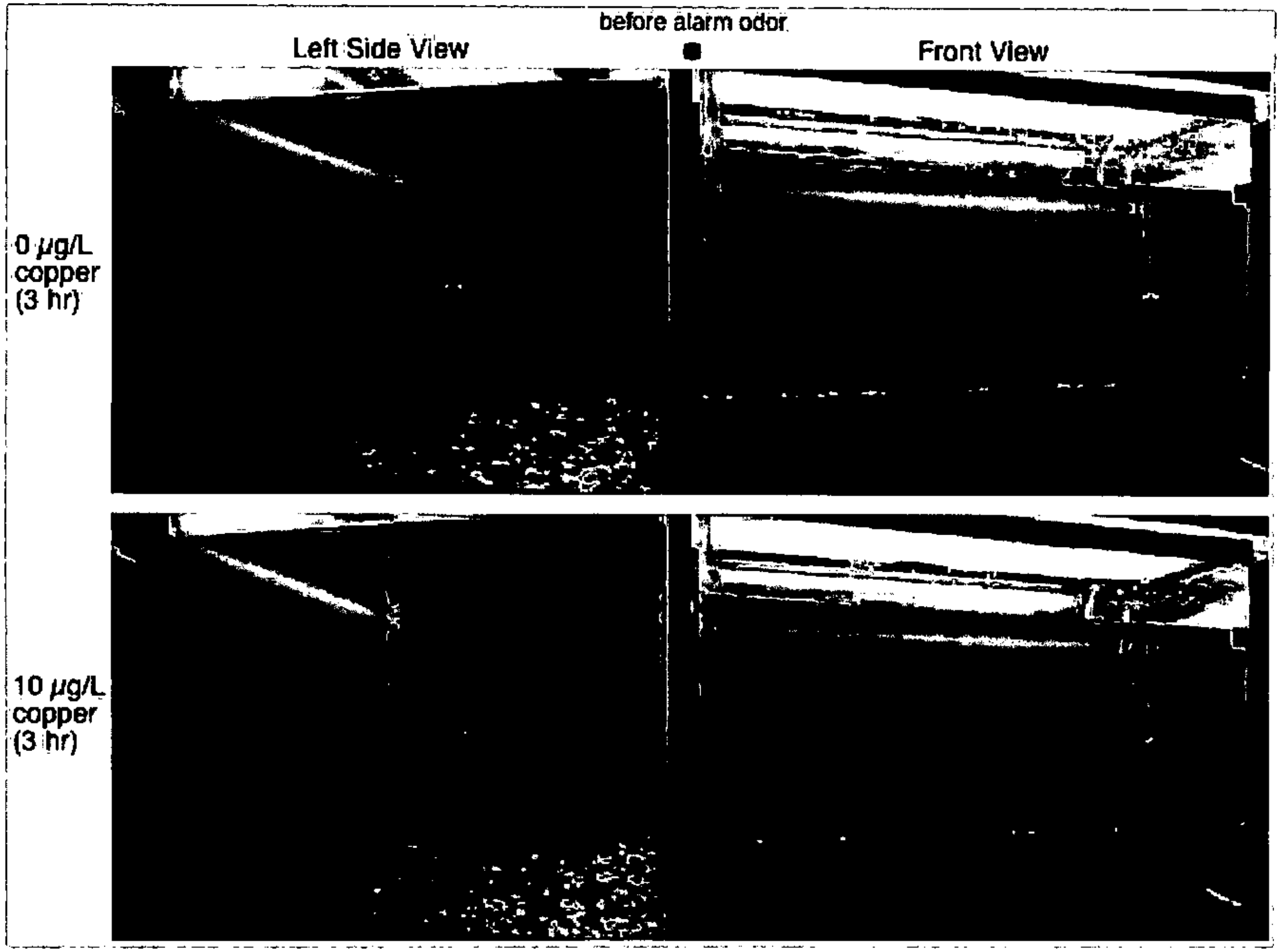


Recovery of Kvichak River sockeye

- capacity for renewal in natural populations -



Direct and <u>indirect</u> effects of toxins in the environment (copper as an example)



Sandahl et al., (2007) Environmental Science and Technology

ALASKA STATE LEGISLATURE

Senate Resources Committee

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AGENDA

Friday, February 27, 2009

Pebble Mine Overview, Permitting & Associated Issues

The Pebble Partnership: John Shively, CEO, & Ken Taylor, Vice President - Environment

Department of Natural Resources: Ed Fogels, Director, Office of Project Management and Permitting, & Dick Mylius, Director, Division of Mining Land and Water (online)

Bristol Bay Native Corporation: Mel Brown, Director

Birch Horton, Bittner & Cherot: Bill Horn, Esq. (on-line)

University of Washington Fisheries Research Institute: Dr. Daniel Schindler

Center for Science in Public Participation: Dr. Kendra Zamzow, Environmental Geochemist

Lodge owner: Brian Kraft

Written Testimony for Senate Resources Committee
Hearing on Pebble Mine Permitting and Associated Issues
February 27, 2009

Contents:

Questions and Answers for DEC/DNR/ADF&G to House Fisheries/House Resources HB 134 field hearings and Pebble site tour

These answers were provided by staff from DEC Division of Water and DNR Division of Mining, Land and Water, and DNR Office of Project Management and Permitting. For more information, please contact Ed Fogels, DNR/OPMP, (907) 269-8423 (ed.fogels@alaska.gov).

1. Large Scale Tailings Facilities

a. Is a liner always required for a large scale tailings facility?

No, liners are normally not utilized to line the 'basin area' of large tailings facilities; however, synthetic liners are sometimes used as a low-permeability layer within the tailings dam. A prospective mining company must demonstrate how they will protect groundwater quality down-gradient of the tailings facility. All tailings facilities must have some form of seepage control, typically consisting of drainage materials and grout curtains, compacted soil, and / or synthetic liners in various combinations designed to meet the unique performance requirements of each project.

b. What material are liners made from?

Liners may be made of geologic, synthetic, or geosynthetic materials. Typically a geologic liner is composed of clay or other fine-grained material, which is compacted to achieve a permeability and thickness that comply with Department of Environmental Conservation regulations (18 AAC 60). Geomembranes, commonly referred to as synthetic liners, are made of a variety of polymers including polyvinylchloride (PVC), 'high', 'linear low', and 'very low' density polyethylene (HDPE, LLDPE, VLDPE), polypropylene (PP), and ethylene interpolymer alloy (EIA), among others. A geosynthetic clay liner (GCL) includes processed bentonite clay laminated with synthetic geotextile fabrics. Geomembranes are typically 30 to 100 mils (0.030 to 0.10 inch) thick depending upon the specific synthetic material and application.

c. On a scale as large as Pebble, is this a significant cost factor?

Yes, synthetic liners and their installation are relatively expensive. Costs can vary greatly depending on the details of the design, required products (type, polymer formulation, thickness or weight, etc.), quantity of materials that are purchased (economies of scale), project location (shipping and installation environment), and any required sub-grade preparation, and are therefore very site-specific. Budget estimates for material costs for synthetic liners typically used in the mining industry may be in the range of US\$0.65/ft^2 for GCLs, US\$0.50/ft^2 for 80-mil HDPE, and US\$0.19/ft^2 for 16 oz/YD^2 geotextile fabric for sub-liner. We have seen cost estimates for lining a 1,000 acre tailings facility ranging from \$110 million to \$290 million.

d. Have advances in liner technology occurred in the recent past?

The variety of synthetic liner products has been relatively stable over the recent past, although novel products or product improvements occur regularly due to the competitive nature of the

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industry. Geotextiles in general (including synthetic liners) have provided substantial benefits to a variety of mining and civil engineering projects, but they should not be considered a panacea. Engineer's understanding of product performance continues to improve, but challenges remain. The 'long-term' life span of synthetic liners is an area of uncertainty, and depends on a number of factors such as composition, construction, stress, and exposure to sunlight. .

e. What agencies have authority over tailings facility design – does one agency take the lead role in permitting?

The Department of Natural Resources is the lead state agency for coordinating the permitting of mining projects. However, the permitting and regulatory oversight for the waste associated with tailings facilities falls mainly to the Department of Environmental Conservation through issuance of a Waste Management Permit for mine tailings disposal and any required waste water treatment and/or discharge. The purpose of this permit is to ensure that all water leaving the facility during operations and after closure meets standards, and that water quality is protected. The permit requires operational and post-closure monitoring, and requires financial assurance to make sure any long term treatment and monitoring can be funded.

The Department of Natural Resources' Office of Dam Safety conducts the technical review of proposed dams and companies must receive a Certificate to Construct prior to beginning work on the dam. The Dam Safety Engineer conducts inspections during the construction of the dam and reviews 'as-built' drawings, construction reports prepared by the professional engineer responsible for quality assurance / control, and the Dam Operating Plan. The mining company must receive a Certificate to Operate before they can place tailings in the facility. The designs for any modifications or the ultimate abandonment of the dam are also reviewed by the Dam Safety Engineer and must be approved prior to any actions being taken by the company. The construction and ultimate closure of tailings facilities is also reviewed by the Department of Natural Resources' Division of Mining, Land & Water to ensure that the closure plan complies with the requirements of the State Reclamation Act (AS 27.19). All projects must obtain a Reclamation Plan Approval prior to initiation of construction activities and projects located on state land must also receive a Plan of Operations Approval.

f. In a typical tailings impoundment, similar to what could be expected at Pebble, how deep is the water used to cover the tailings?

In a conventional tailings impoundment, water depth can vary from 0 to perhaps 50-feet depending primarily on the topography of the tailings basin, but also on the physical and chemical characteristics of the tailings, and requirements for water in the milling process. Also, some tailings facilities may have a water cover during the mine's life, but at closure, the water is removed and replaced with a dry or wet-soil cover.

g. What depth below the surface of the sediment beneath a tailings pond does the water permeate?

This depends on a number of factors, such as the permeability of the liner (if used), the nature of the material that the facility is built on, and the type of tailings stored in the facility. In all cases the applicant must model the expected seepage from the facility, and demonstrate the pathways the seepage will follow and how this seepage water will be intercepted should it not meet water quality standards. When a dam is used to impound mine tailings, water behind the dam will follow the path of least resistance. Often tailings dams are designed and constructed to convey tailings water as underground seepage to the toe of the dam where a system of wells and pumps create a barrier to outward underground flow.

h. How fine is waste rock in a hypothetical tailings pond? Is the consistency of glacial silt a fair characterization, or will the tailings be coarser?

The actual size of the tailings depends on the ore processing method. In general, tailings are usually fine sand to silt sized material, which is very similar to glacial silt.

i. At the end of operations, is it normal to completely cover the tailings and make dry land, or will a lake remain in perpetuity?

Reclamation of a tailings facility is designed based on a wide variety of factors such as the site water balance, geochemistry of the tailings, quality of the water remaining in the tailings pond, seepage chemistry, and other site-specific factors. If the tailings material has potential for acid-generation or metals leaching, it may be necessary to maintain a water cover in perpetuity. In other cases, it is quite feasible to provide for either a wet-soil or dry-soil cover with re-vegetation of the surface material.

2. Mine Pit

a. Hypothetically after the termination of operations at Pebble a large pit is left, and this fills with water. Is the rock in the Pebble area expected to leach heavy metals or other materials into the water?

At this point in the exploration process it is uncertain what the tendencies for heavy metal leaching or other water quality impacts might be. As is typical for most mines, this data is developed through extensive drilling and water quality monitoring programs that most often go on for years, prior to submission of permit applications to regulatory and resource agencies. Baseline water quality and rock characterization information that is used to predict these conditions will be submitted as part of the permitting process, and will be evaluated by DEC and DNR prior to issuance of any permits. These documents, along with proposed permits must be provided to the public and public comments received.

It is possible that the pit might fill with water containing heavy metals and acid rock drainage. If a mine were permitted, it would be based on the proposed mining plan along with extensive, supporting rock and water chemistry data. It is impossible to predict any outcomes without knowing the activity (type of mining procedure and concurrent closure techniques), specific locations, and baseline data. However, any predictions will be conservative in nature. They will protect the environment to the highest prevailing quality or level while considering a range of scenarios.

A clear understanding the rock geochemistry and the water quality of any water that contacts mine rock and tailings is usually the single most important factor that agencies consider in deciding if a mine's design is permissible or not. These water quality predictions drive the design of tailings storage facilities, waste rock dumps, and closure plans.

b. Will agencies require a contingency plan for a potential pit filling and discharge of heavy metals into adjacent streams?

State agencies must approve a closure plan for all mines, including any open pits that are to remain after closure. If the lake is to fill with water, the closure plan must show what the predicted water quality in the pit will be—if this water won't meet water quality standards, then it must be treated before leaving the site.

The major purpose for requiring rock to be characterized and baseline water quality to be established prior to permit issuance is to predict whether metal leaching will be a problem. The results of these studies are used to establish operating permit conditions, short and long term treatment requirements, and to predict water quality in the pit at closure. This information is also used to estimate the long term costs associated with mine closure so that adequate financial assurances can be required from the mine developer to protect the state.

In all cases, the natural quality of the receiving water will be strictly protected through redundant containment, and by vigilant monitoring, recordkeeping, and reporting. All discharged water must meet Alaska Water Quality Standards or the highest prevailing, natural, quality of the receiving water.

3. Water Quality Monitoring wells

a. To what extent are water quality monitoring wells required in areas downstream of a tailings dam?

The location and number of monitoring wells is dependent on very site specific hydrogeologic data and on the design of the tailings storage facility. Complicated geologic conditions may indicate that numerous wells are needed. Less complicated subsurface conditions may allow fewer wells. It is important that all the potential subsurface pathways be identified that could allow contamination to escape and that provisions for sampling such as a monitoring well be provided In general, the number of wells will depend on the site hydrogeology and the size of the facility.

b. What are the monitoring requirements during operation of the tailings facility - how often is monitoring required and by whom?

Monitoring frequency is established in a permit and again is site dependent. It is important that sampling be frequent enough to detect small changes over time. Typical monitoring and sampling for important contaminants of concern may be weekly or even daily. Less critical contaminants may be sampled monthly or even quarterly.

Environmental sampling is typically performed by the permittee or sometimes by an independent lab or firm under the permittee's direct control. By design and through mandate, the Clean Water Act requires self monitoring and reporting by permittees. Analytical work for compliance must be performed at a testing lab with an approved quality assurance and quality control plan.

c. How deep do monitoring wells go?

Monitoring wells extend into the aquifer that would most likely be affected if a release occurred. This is usually the upper most aquifer, but in some cases, deeper aquifers may need to be sampled as well.

d. How many years after the end of operations is monitoring required?

Under 18 AAC 60.397, Post-closure care requirements for a Class I or Class II MSWLF, Section (a) requires a minimum of 30 years post-closure care, which includes groundwater monitoring among several other requirements. Consequently, post-closure monitoring must continue for 30 years or until background water quality or Alaska Water Quality Standards are met, which ever is longer.

4. Bonding

a. How does mine bonding work (for instance, is there a formula that is applied, what agencies weigh in, is bonding often a commissioner level discussion)?

Bonding or Financial Assurance is the amount of money that is necessary to reclaim a mining project, under the terms of the approved reclamation plan, and conduct post-closure monitoring and water treatment, if necessary. The amount of the financial assurance is calculated as if the State has to take over the project and conduct the reclamation effort. As such, the costs are higher than it would normally take the mining company to do the job. Normally the company makes the calculation and provides all the data, including vendor quotes, to the ADNR and the ADEC to review. Our engineers thoroughly review the calculations, sometimes conducting our own independent calculations, and ultimately derive a cost figure that is protective of the State. There is no formula, since all projects are different and reclamation costs can vary considerably depending on the location and type of mine. No project can begin construction until the financial assurance package is in place. The bond calculation is not normally an issue at the Commissioner's level; however, should there be a serious dispute over the bond amount, the company can avail itself of the Commissioner's office for additional review.

Regarding DEC's part in bonding, AS 46.03.100(f) requires the permittee to provide DEC with proof of financial responsibility for managing and closing the facility in a manner DEC finds will control or minimize the risk of the release of unauthorized levels of pollutants to state waters. Consequently, DEC's portion of the bond is for managing and protecting water quality. This is dependent on the operation, the operational control strategies, and closure plan.

b. Should monitoring of water quality be required in perpetuity, how do bonding requirements treat this?

In the event that water at a closed mine site will need treatment in perpetuity, a trust fund must be established that will fund the effort. It is a sort of water treatment "permanent fund". The trust fund receives contributions from the mining company over the life of the mining operation such that at mine closure the fund is large enough that the costs of monitoring and water treatment can be funded from the annual earnings; the principal of the fund would remain untouched. Before the mine can begin operations, financial assurance must be in place to make sure that the full trust fund will be in place in the event of unexpected closure.

c. Please explain any changes to bonding standards that have occurred and if a mine as potentially large as the proposed Pebble mine will require changes to existing standards.

In the past the bonding standards were mostly set up to address the issues of placer mining and the bonding was capped at $750 per acre of land to be reclaimed. This was changed by the legislature in 2004 to make hard rock mines exempt from the $750 cap. Even a mine as large as Pebble would not require a change in bonding standards. The standards now require that an adequate financial assurance package be in place such that the State could conduct the reclamation and closure plan at any point in the life of the mine. The bond amount is monitored and updated regularly to reflect any change in conditions that warrant a significant change. This can include changes in fuel costs, the mine reclamation plan, equipment rental rates, etc. Also, the State requires that the bond be reviewed by an independent third party expert to make sure it is still adequate, or to recommend changes if it is not adequate.

BIOLOGICAL, TECHNICAL QUESTIONS AND ANSWERS ABOUT PEBBLE MINE

Compiled for the Senate Resources Committees
by Nunumta Aulukestai - Caretakers of Our Lands & Trout Unlimited Alaska
February, 2009

BIOLOGICAL QUESTIONS AND ANSWERS

1. Do sulfuric acid, copper, and other minerals at the proposed Pebble Mine site, pose significant risks to fish?

Yes. The chemical nature and location of the rock at the proposed Pebble Mine site makes the release of sulfuric acid and toxic copper into waters a virtual certainty. That is why the project is so controversial.

Pebble is a low grade metallic sulfide deposit containing copper, gold and molybdenum. The deposit is located at groundwater level, in a wet climate, where the groundwater flows through permeable soils to feed surface waters in the Bristol Bay drainages, the most productive salmon habitat and fisheries in the world.

Sulfur is chemically reactive. Exposing sulfur to air and water creates sulfuric acid, which dissolves copper (and other heavy metals) into solution where it is highly toxic to fish, particularly salmon. Mining, milling and processing the ore exponentially increases the rate of exposure of sulfur to air and water, and exponentially increases the amount of sulfuric acid generated. The mine walls,[1] the wastes, and the dust will generate sulfuric acid. A recent study of metallic sulfide mines permitted in recent years in the U.S. found that a whopping 85% of these mines polluted surface water and an astronomical 93% polluted ground water, despite that fact that at the time of permitting, fully 89% of the environmental documents predicted that the mines would not do so.[2] The proposed Pebble Mine is virtually certain to create acid mine drainage that puts metals toxic to fish into water.

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[1] The mine itself, whether by open pit or underground block caving, is likely to fill with water, be acidic, and require permanent care and treatment.

[2] Kuipers, J.R., Maest, A.S., MacHardy, K.A., and Lawson, G. 2006. *Comparison of Predicted and Actual Water Quality at Hard Rock Mines: The reliability of predictions in Environmental Impact Statements*. The authors also found that although 100 percent of the environmental impact statements prepared before mining commenced predicted that the mines would be able to comply with water quality standards. In fact, after mining was underway:

> 76% of the mines polluted ground or surface water in excess of water quality standards;
> 60% of mines polluted surface water severely enough to exceed water quality standards;
> 52% of mines polluted ground water severely enough to exceed water quality standards;
> 73% of mines exceeded surface water quality standards despite predicting that mitigation would result in compliance;
> 77% of mines that exceeded groundwater quality incorrectly predicted that mitigation to correct problems would result in compliance;

Pebble is purported to contain about 0.6% desirable metals. If developed, it will yield about 8.15 billion tons of wastes – including reactive sulfide wastes and toxic agents such as cyanide used in processing – that will have to be left forever on public land, along with the abandoned mine.

Thus, six factors make Pebble controversial: (1) it is a metallic sulfide deposit; (2) it is located at groundwater; (3) it will yield a tremendous amount of waste containing sulfur; (4) such mines are virtually certain to create sulfuric acid, that dissolves copper and other heavy metals into solution, and which is highly likely to pollute groundwater and surface water, where the dissolved metals are toxic to fish; (5) the area is in the heart of the most productive salmon habitat and fisheries in the world; and (6) the governmental success rate in permitting, so as to prevent such contamination, has been demonstrated to be exceptionally poor – a 93% failure rate.

2. How does copper affect fish?

Although copper in trace amounts is important for growth and reproduction in all living organisms, copper is extremely toxic to aquatic organisms and causes irreversible harm at concentrations just over that required for growth and reproduction. Lethal and sublethal effects are well documented. Sublethal effects on salmon include: (1) impairment of sense of smell (olfaction); (2) interference with migration; (3) impairment of ability to fight disease (immune response); (4) difficulty breathing; (5) disruption of ability to osmoregulate (move between salt and fresh water); (6) impairment of ability to sense vibrations via their lateral line canals (a sensory system that helps fish avoid predators); (7) impairment of brain function; (8) alteration of enzyme activity, blood chemistry and metabolism; and (9) alteration of natural hatch rates.[3]

3. What does the Pebble Limited Partnership propose? Answer: Huge dams and tailings facilities that must contain waste forever in an active earthquake zone.

The Pebble Limited Partnership (PLP) proposes nothing different from low grade metallic sulfide mines that have already failed. PLP simply proposes a greater scale – to accommodate as much as 8.2 billion tons of waste.

As at other large mines of metallic sulfides, PLP proposes to separate the reactive, sulfur-bearing tailings (3-5 percent), from the non-reactive "bulk" tailings (95-97 percent). The reactive tailings, and the reactive waste rock that is not of high enough metal content to process, will have to be stored under water forever in huge tailings storage facilities. These will have to be maintained forever. The allegedly non-reactive "bulk" wastes after processing will be the

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When the permitting agency tried to get the mine operator to fix the problems, the fixes failed 75% of the time; and

Of the mines analyzed that polluted ground and surface water, 63% released toxic metals such as lead, mercury, cadmium, copper, nickel, or zinc; 58% released arsenic and sulfates; and 53% released cyanide.

[3] *See* Woody, C. A., PhD, *Copper: Effects on Freshwater Food Chains and Salmon: A literature review*, submitted to the House Fisheries Committee.

texture of silt or sand, will be discharged to form what PLP calls "beaches" around the reactive tailings storage facilities.

PLP has proposed to build five dams, to create two mammoth toxic tailings lakes to store the reactive sulfur-bearing wastes plus toxic materials used in ore processing, such as cyanide or xanthates. The lakes would cover more than 10 square miles according to PLP's applications to DNR filed in 2006. The dams would be as high as 740 feet and grow to over four miles long. They would be larger, in these respects, than the Three Gorges Dam in China that is often said to be the largest dam in the world. The risk of over-topping during storm events and due to snow melt is substantial due to the relatively wet climate compared to such mines in arid parts of the western United States.

These two tailings impoundments would contain about 2.5 billion tons of waste. Given the amount of waste – 8.2 billion tons -- one can expect more dams containing more waste.

All of this would occur in an area susceptible to large earthquakes, much like the magnitude 7.9 earthquake which occurred on November 3, 2002, on a previously unrecognized splay fault south on the Denali fault system. PLP proposes dams engineered to a magnitude 7.8 seismic event, which is smaller than the quake that occurred in 2002 on the Denali Fault. Because the dams must last forever, larger seismic events are a statistical certainty.

4. Is the Pebble Limited Partnership's "no net loss of fish" policy an empty promise?

Yes. PLP's "no net loss" policy applies only to the habitats destroyed by building the mine, rather than to the greater and more complex events that occur, such as lethal and sublethal effects originating from acid mine drainage as discussed above.

Salmon memorize or "imprint" a complex map of chemical smells as they migrate from natal freshwaters to saltwater. When the fish return to natal habitats to spawn, they follow their noses using this memorized map. This behavior, called "homing," isolates breeding populations in space and time and results in genetic divergence and population-specific adaptations among local populations. If salmon cannot smell, or if the chemical signature of a salmon's natal stream changes, then fish will likely stray to and spawn in non-natal habitats, which generally reduces spawning success. Alteration of natural adaptive behaviors such as homing, migration and spawning due to water pollution can reduce wild salmon survival and change basic population structure.

For salmon, a healthy population structure is positively associated with genetic diversity and resilience to disturbance such that large, highly structured populations have high genetic diversity and probability of persistence. In contrast, small, unstructured and randomly-mating populations are vulnerable to inbreeding, demographic stochasticity (e.g. randomly induced mutation), genetic drift and thus, reduced evolutionary potential, and increased probability of extinction. Thus, the potential changes in population structure due to increased salmon straying rates arising from the effects of acid mine drainage has huge implications for sustainable fisheries, for which, probability of persistence is determined, in part, by the genetic integrity and biodiversity of stocks.

Pebble Limited Partnership's "no net loss" policy will be a source of endless dispute involving PLP, governmental agencies and the public. While loss of fish production from building the mine is a straightforward matter, the more complex and greater losses will be matters of dispute due to other variables, such as harvest, natural variation in freshwater and saltwater survival rates, climate change, etc. Thus, PLP's "no net loss" policy is an empty promise.

LEGAL QUESTIONS AND ANSWERS

5. Does the state permitting process and standards protect the public and the fish when authorizing a large project like the proposed Pebble Mine?

No. To authorize Pebble Mine, various state permits will be required. For example, DNR is likely to issue- (1) dam authorization and construction permits under AS 46.17; (2) authorizations to appropriate water under the Water Use Act, AS 46.15; (3) surface land lease permits under AS 38.05.255; (4) Anadromous Fish Act and Fishways Act permits under AS 41.14.870 and AS 41.14.840; [4] and (5) permits necessary for rights-of-way or easements under AS 38.05.850. DNR also determines whether these and other state permits are consistent with the Alaska Coastal Management Plan (ACMP). [5]

Although DNR claims that its so-called "large mine permitting process" protects the public interest, *no statute establishes this so-called process, and DNR has not adopted any regulations specific to this so-called process.* Instead, under AS 27.05.010, DNR is simply the State's lead agency for most matters involving mining in Alaska. DNR created the process to coordinate permits for large mines. DNR did so by undertaking a personnel action that established a job position for a "large mine coordinator" who works with state agency staff and the mining company to expedite permitting and implement *pre-existing* statutes and regulations.[4] So, one must look at both how the process is expedited and the pre-existing statutes.

Regarding how the process is expedited, a mining company proposing a large mine can choose to enter into a contract with DNR by which the company pays DNR employee salaries involved in reviewing and expediting the company's permit applications. This presents a

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[4] The Andromous Fish Act, AS41.14.870, requires permits for activities in anadromous waters that affect fish and game. The Fishways Act, at AS 41.14.840, requires permits for obstructions that would otherwise block fish passage. The Murkowski Administration transferred the authority for both statutes from ADF&G to DNR in eliminating the ADF&G Habitat Division.

[5]The Murkowski Administration dismantled the Coastal Management Program by eliminating enforceable guidelines and habitat standards which required that permits be consistent with a high level of protection for fish and wildlife habitat. In the same vein, ADEC issued mixing zone regulations to allow discharge of harmful substances into salmon spawning areas.

[6]Although ADF&G is charged by statute, at AS 16.05.020, with protecting, preserving and maintaining fish, game, and the uses of them, the elimination of the ADF&G Habitat Division and transfer of all ADF&G permitting authority – except for refuges – eliminates its statutory ability to implement its charge in all locales in Alaska except state refuges such as that proposed by SB 67 (the Jay Hammond State Game Refuge bill). Furthermore, given recent reports of the difficulty in hiring staff in these agencies, both DNR and ADF&G probably lack the technical capacity and staff to review a project as complex as the Pebble Mine.

palpable conflict between DNR's duties to perform objective analysis and the funding of DNR staff who perform that analysis.

Regarding existing statutes, for the most part they provide vague standards at best and lack anything approaching a standard based on actual performance by a mining company or an agency. For example, AS 38.04.005 establishes DNR's overall policy of managing "for maximum use of state land consistent with the public interest." This standard is derived from Art. VIII, section 1, of the Alaska Constitution. The result is a vague standard that allows DNR wide discretion and no guidance about how to exercise that discretion. Similarly, the Water Use Act, at AS 46.15.080, administered by DNR, provides that DNR must find that a water appropriation is in the "public interest" and that in determining the public interest, DNR shall "consider:" (1) benefit to the applicant; (2) the effect of economic activity resulting from the appropriation; (3) effect on fish and game and on public recreation; (4) the effect on public health; (5) the effect of loss of alternate uses of water; (6) harm to other persons; (7) the intent and ability of the applicant to complete the appropriation; and (8) the effect upon access to navigable or public water. Requiring that DNR "consider" a matter does not require that any particular action be taken with regards to any of the matters "considered." In contrast, performance standards might say, for example, that DNR's decision must "protect" fish and game and habitat by not allowing acid mine drainage or perpetual care and treatment of mining wastes. No such protective standards currently exist.

Finally, AS 38.05.135(e) governs leases and disposals of certain public resources, and provides DNR with wide discretion to determine what is in the "state's best interest." A "best interest finding" is not required for leases for millsites, tailings disposal, and other mine related facilities under AS 38.05.255, however. Such a lease will likely be required for the Pebble Mine, but no protections for public process are in place for that decision. This also is true for a permit, right-of-way, or easement under AS 38.05.850.[5]

Thus, DNR statutes provide vague standards to protect the public interests in fish, fishing, and other public resources and uses of them. That causes two problems:

On one hand, the lack of clear standards frustrates the ability of the public to provide meaningful input.

On the other hand,, the lack of clear standards frustrates the ability of agencies, like DNR, to make factually grounded decisions or to respond to the public in any meaningful way.

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[7] AS 38.05.850 applies to "permits, rights of way, or easements on state land for roads, … and … pipelines not subject to AS 38.05, … electric transmission and distribution lines, … and other similar uses or improvements." The access road from Cook Inlet to Pebble will require as many as 120 stream crossings. Despite efforts to protect stream habitat, road construction activities and bridge and culvert installation can be expected to impact streams and fragment habitat. Downstream habitat will be altered as runoff patterns for seasonal flows are disrupted. Roads and their associated dust, increased access, and effects on hydrology are likely to all have significant effects on natural ecosystems of this region, including increased competition between commercial, subsistence and sport users of the fish and wildlife. Contamination at mine port loading facilities in Alaska has been an issue at Skagway, Red Dog, and Greens Creek.

DNR, when faced with a 93% failure rate at similar mines around the country, and in much more arid climates, is not credible in its claim that its permitting process will work when others have failed. This is why it is so important for the Legislature to pass legislation that provides processes and standards that will serve the public by protecting Alaska citizens' interests in the natural resources that belong to them.

Finally, the track record of one of the companies that will be developing and operating Pebble Mine shows that Pebble is likely to pollute the Bristol Bay watersheds. In Colorado, a mine in which Anglo American's subsidiary, AngloGold, was the majority owner, repeatedly violated its state-issued Clean Water Act permits. The U.S. Environmental Protection Agency fined the mine operators the maximum allowed under the Clean Water Act.[8] Anglo American's record in Colorado shows that Alaskans cannot rely on the permitting system to protect the Bristol Bay watersheds. Companies routinely violate their permits and, if they are caught, they consider the fines simply a cost of doing business.[9]

6. Will an unconstitutional "taking" of private property occur if the legislature enacts a statute that applies to the proposed Pebble Mine, and that makes it more difficult or infeasible to develop the mine?

No. This is a red herring issue raised by the Pebble Limited Partnership. A mining claim is a very limited, *exclusive*, property right. It amounts to a right to be *first in line* to explore and develop the claimed minerals, but it never creates a right to obtain permits to mine the minerals. It does not preempt the State legislature's constitutional power under Article VIII, section 2, of the Alaska Constitution, to enact natural resource statutes that revise the standards under which a claim might be developed, even if those laws render the mine infeasible. Nor does a mining claim preempt the State's police powers to enact laws to protect public health, safety, its economic interests, or the environment, even if those laws render the claim infeasible.[10]

LEGAL SERVICES

DIVISION OF LEGAL AND RESEARCH SERVICES
LEGISLATIVE AFFAIRS AGENCY
STATE OF ALASKA

(907) 465-3867 or 465-2450
FAX (907) 465-2029
Mail Stop 3101

State Capitol
Juneau, Alaska 99801-1182
Deliveries to: 129 6th St., Rm. 329

MEMORANDUM December 7, 2006

SUBJECT: Taking of mineral rights, just compensation, and NAFTA (Work Order No. 25-LS0146)

TO: Representative Paul Seaton
Attn: Louie Flora

FROM: Donald M. Bullock Jr.
Legislative Counsel

You requested an opinion on the effect of the federal or state government limiting or precluding the development of a mine on state land that was open to mineral development and is being developed by a mining company. You asked about the effect of takings laws on such government action and referred me to HCR 29 (24th Alaska Legislature) that calls on the commissioner of natural resources to report to the legislature the commissioner's conclusion regarding whether mineral development is the most appropriate land use classification for the area encompassing the proposed Pebble mine project.

You also asked about the implication of chapter 11 of the North American Free Trade Agreement on a foreign mining company developing a mine in Alaska that is then subject to the tightening of state environmental standards or outright prohibition of resource extraction in an area in which the company is working.

Acquisition of mineral rights

Under Alaska law, a person obtains exclusive rights to possess and extract minerals on state land open to claim staking by discovery, location, and recording, subject to existing claims and to any denial of or restriction in the tentative approval of state selection or patent of the land to the state.[1] A person's acquisition of mineral rights requires no discretionary action by the Department of Natural Resources to authorize or permit the right to the minerals within the claim.[2] The rights are acquired simply by satisfying the

[1] Article VIII, sec. 11, Constitution of the State of Alaska; AS 38.05.195; AS 38.305.275.

[2] With your permission, I talked with Tom Crafford, Acting Large Mine Coordinator in the Department of Natural Resources regarding the discretion of the department in recognizing the rights to mineral deposits. Mr. Crafford confirmed that his department does not have discretion in the granting of mineral rights, so long as the potential location

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three requirements – discovery, location, and filing. Discovery is the finding of the mineral, location is the marking of the land where the mineral was found, and filing is the recording of the interest in the recorder's office for the region in which the interest is located.

Not all state land is open for mining. The commissioner of natural resources has the authority to classify land so that mining, mineral entry or location, mineral prospecting, or mineral leasing is precluded or designated as an incompatible use.[3] However, the discretion to classify land as being closed to mining has been exercised on a limited basis: according to the Department of Natural Resources, approximately 92 percent of the 91 million acres for which the state has received title are open to mineral entry and the acquiring of mineral rights by staking mining locations.[4]

Although a person may acquire mineral rights by performing the three necessary steps, those rights are "subject to existing claims and to any denial of or restriction in the tentative approval of state selection or patent of the land to the state."[5] In *Beluga Mining Co. v. State, Dept. of Natural Resources*, the court found that the mining company had a property right in its claims but had no right to mine because "its mining 'rights' were prospective and contingent, and were subject to existing claims."[6] Until any conflicting rights are identified and resolved, the holder of the right to extract the minerals proceeds at the holder's risk. If there are no "existing claims" or the land is not subject to the tentative approval of state selected land, my opinion is that the mining rights vest and development is then only subject to the holder obtaining any required permits.

Once a person has acquired mineral rights, state policy appears to favor the continued holding of those rights, even when the holder has failed to fully comply with statutory requirements. For example, AS 38.05.185(b) requires that the lessee or holder only comply with statutory requirements "as nearly as possible under the circumstances" to avoid the invalidation of the interest. That subsection reads as follows:

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holder meets the statutory requirements. In other words, a person whose rights are not subservient to a prior interest holder, who acquires the rights by following the statutory requirements, and who maintains those rights by satisfying the annual work and rental payment requirements, has the rights to those minerals.

[3] AS 38.05.300. See also, *Moore v. State, Dep't of Natural Resources*, 992 P.2d 576, 578 (Alaska 1999).

[4] See the page published on the Internet at *http://www.dnr.state.ak.us/mlw/mining/min_prop.htm* (accessed 11/9/2006).

[5] AS 38.05.275(a).

[6] *Beluga Mining Co. v. State, Dept. of Natural Resources*, 973 P.2d 570, 575 (Alaska 1999).

> (b) The failure on the part of a mining lessee or a locator to comply strictly with AS 38.05.185 - 38.05.275 and regulations adopted under those sections does not invalidate the rights of a mining lessee or a locator if it appears to the satisfaction of the commissioner that the mining lessee or the locator complied as nearly as possible under the circumstances of the case, and that no conflicting rights are asserted by any other person.

The statutes and cases interpreting those statutes point to the conclusion that a person holding a mineral interest that is superior to competing claims has an ownership interest in the minerals that are located. The holder of the interest can continue to hold that interest so long as the holder can "compl[y] as nearly as possible under the circumstances" with the requirements in AS 38.05.185 - 38.05.275,[7] including the satisfaction of the annual rental and labor requirements.[8]

However, perfection of the mineral rights does not in itself allow the interest owner to develop a mine; the owner must obtain all the necessary government-issued permits before extracting the minerals for which the rights are held. In the case of a large mine, the Large Mine Project Team in the Department of Natural Resources coordinates the timing and completion of the numerous permits.[9] Although there is a process of negotiation, modification, and amendment for permit terms and conditions, once the mine owner or operator qualifies for the permits, the mining operation can proceed.

Government liability for taking a mineral or mining right

Article I, sec. 18, Constitution of the State of Alaska, and amendment V of the U.S. Constitution prohibit the government taking of private property without just compensation. The acquisition of mineral rights by the first claimant who discovers a valuable mineral deposit, stakes a location, and files a mining claim has a legally

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[7] AS 38.05.185(b).

[8] AS 38.05.210 (annual labor requirement); AS 38.05.211 (annual rental requirement).

[9] For more information on permitting large mine projects in the state, go to the Internet site at *http://www.dnr.state.ak.us/mlw/mining/largemine/* (accessed Nov. 22, 2006). The large mine projects listed on that site are Chuitna Coal, Fort Knox Mine, Greens Creek Mine, Kensington, Nixon Fork Project, Pebble Gold Project, Pogo Project, Red Dog Mine, Rock Creek Project, True North Mine, and Tulsequah Project. A document summarizing the large mine permitting process is available on the Internet at *http://www.dnr.state.ak.us/mlw/mining/largemine/lmpt_process.pdf* (accessed Nov. 22, 2006).

protected interest,[10] that if taken by the government, entitles the holder to just compensation.

The takings doctrine is implicated when the state deprives a person of a property right. In the case of mineral rights that have been located and are not subject to a prior existing claim, the voiding of those mineral rights or regulatory action that denies all economically feasible use of those mineral rights may be found by a court to constitute a per se taking of that property interest.[11]

The issue of whether or not a mine may be allowed on particular state land initially is decided when the commissioner of natural resources classifies state land as either open or not open to mining.[12] The classification of land as available for mining opens the land to discovery, location, and filing for the mineral rights. For example, the land on which the proposed Pebble Gold Project may be developed is classified as available for mineral development as part of the Bristol Bay Area Plan.[13] Once a holder has established mineral rights -- a protected interest -- the state may not take those rights without just compensation. HCR 29 (24th Alaska Legislature) calls for the commissioner to revisit the decision of classifying the area in which the Pebble Gold Project is located for mineral development. Since the claims have already been filed, a reclassification of the land use could amount to a taking of the mineral rights that have vested and a court could require the state to compensate the holder for those rights.

If the state chose to terminate the mining activity, one option would be for the state to purchase the mineral rights from the holders. Presumably, the state would offer the fair market value for the rights, an appropriate measure of compensation used for

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[10] *Trustees for Alaska v. State*, 736 P.2d 324, 332 (Alaska 1987). Although this case described the federal location system for establishing mineral rights, it is applicable to the state's system. The difference between the state and federal systems was that at the time *Trustees* was before the court the federal requirements did not include the payment of rent and royalties nor was there a state requirement of payment. Following the decision in *Trustees*, the legislature enacted AS 38.05.211 that requires the payment of annual rent to the state for "each mining claim, leasehold location, prospecting site, and mining lease."

[11] See, *Beluga Mining Co. v. State, Dep't of Natural Resources*, 973 P.2d 570, 575 (Alaska 1999).

[12] AS 38.05.300.

[13] The Bristol Bay Area Plan, that describes land use and classification in the area of the proposed Pebble Gold project and includes area maps, is published on the Internet at *http://www.dnr.state.ak.us/mlw/planning/areaplans/bristol/pdf/bbap_complete.pdf* (accessed Nov. 22, 2006).

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condemning property through the state's exercise of the power of eminent domain.[14] Another possibility for the state to stop the mining activity would be to impose such extensive requirements for necessary permits that the developer could not economically proceed with the project. With regard to this second option, a regulation that denies the property owner all economically feasible use of the property may be found to be a "per se" taking by the state, and the state would again be in the position of paying just compensation.[15]

A court may also examine governmental action on a case-by-case basis for the purpose of determining whether the action amounts to a taking that justifies compensation to the holder of the property right. This type of examination involves an analysis of the following four factors: (1) the character of the governmental action; (2) its economic impact; (3) its interference with reasonable investment-backed expectations; and (4) the legitimacy of the interest advanced by the regulation or land-use decision.[16] In *Beluga*, the court used the four-factor analysis to consider whether the state had engaged in a taking. With regard to the third element, the *Beluga* court found that the plaintiff failed to establish a basis for concluding that it had "reasonable investment backed expectations" because the claims were always contingent upon state permission to mine and other adverse existing claims.[17]

As a practical matter, it seems reasonable for a mine developer to expect that permits for a mining project will eventually be issued although the requirements are subject to negotiation. My understanding from talking to a staff member[18] of the large mine project team in the Department of Natural Resources is that government agencies have discretion in developing the terms and conditions for each permit, but once the terms and conditions are agreed upon by the applicant (generally the case) the permits are issued and the mining operation proceeds. If there is some point in the permitting process that gives discretion to the decision maker whether or not to issue a permit and the denial of that permit is the basis for stopping the development of the mine, that discretionary step may be a basis for a court to find that the investment-backed expectations were not reasonable.

My impression from the existing statutory scheme and court cases on this issue is that mining rights that have vested through discovery, location, and filing, and that are not

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[14] *Dash v. State*, 491 P.2d 1069, 1073 n. 11 (Alaska 1971).

[15] *Beluga*, 973 P.2d at 575.

[16] *Spinell Homes, Inc. v. Municipality of Anchorage*, 78 P.3d 692, 702 (Alaska 2003). The four factors are referred to as the "Sandberg factors" based on the decision in *Anchorage v. Sandberg*, 861 P.2d 554 (Alaska 1993).

[17] *Beluga*, 973 P.2d at 576.

[18] Tom Crafford, Acting Large Mine Coordinator, *supra*.

subservient to prior or other existing claims are protected property interests and that the state's taking of those interests would require the payment of just compensation under the state and federal constitutions.

Compensation for the taking of mineral or mining rights

Should a court find that the taking of mineral interest constitutes a taking under art. I, sec. 18, Constitution of the State of Alaska or amendment V of the U.S. Constitution, the court, or the parties in negotiations, would need to determine the amount of just compensation to be paid to the holder. Since fair market value has been recognized as a basis for determining just compensation,[19] the fair market value of the interest must be determined.

The valuation of mineral rights was raised in ***Phillips v. United States***, in which the 9th Circuit Court of Appeals addressed the determination of the speculative value of a mining claim.[20] The Court wrote:

> 3. The "Element of Speculation" in Mineral Right Does Not Preclude Their Having an Ascertainable Market Value.
>
> "How could the jury arrive at a dollars or cents figure for a mineral interest except by pure guess?" rhetorically asks counsel for the appellee.
>
> The Supreme Court has answered this question.
>
> In Montana Railway Co. v. Warren, 1890, 137 U.S. 348, 352, 11 S.Ct. 96, 97, 34 L.Ed. 681, the Court said:
>
>> "There remains for consideration but a single point, — that there was admitted in evidence on the trial the opinions of witnesses as to the value of the land, which were not based upon the sale of the same or similar property, and were not therefore the opinions of persons competent to so testify. It appears that the land taken was a strip running through a mining claim, which had been patented and belonged to the defendants in error. The claim adjoined the Anaconda mining claim, which had been developed and worked, and demonstrated to contain a vein of great value. The claim in controversy had been developed so far as to indicate that *possibly, perhaps probably*, the same rich vein extended through its territory. It had not been developed so

[19] *Dash v. State, supra.*

[20] *Phillips v. United States*, 243 F.2d 1, 5 (9th Cir. 1957).

> far that this could be affirmed as a fact proved. The strip taken ran lengthwise through the claim; and, upon the trial witnesses were permitted to testify as to their opinion and judgment of its value. It may be conceded that *there is some element of uncertainty in this testimony, but it is the best of which, in the nature of things, the case was susceptible.* That this mining claim, *which may be called 'only a prospect,'* had a value fairly denominated a 'market value,' may, as the Supreme Court of Montana well says, be affirmed from the fact that such prospects are the constant subject of barter and sale. Until there has been full exploiting of the vein its value is not certain, *and there is an element of speculation, it must be conceded, in any estimate thereof. And yet uncertain and speculative as it is, such prospect has a market value;* * * *'!

In other words, a court determining the appropriate amount of just compensation to be paid to the holder of mineral rights taken by the state would consider testimony and other evidence relating to the fair market value. Some of the evidence will be speculative, particularly the quantity of valuable minerals in place, the cost of extraction, and the expected profit.[21] I expect the fair market value will reflect the present value of future expected earnings from the minerals. An award based on the expected market value of the minerals that does not take into consideration the cost of developing the mine and the mining, transportation, and marketing of the minerals, including the cost of financing the mining operation, would be excessive and inequitable. Ultimately, if the parties are unsuccessful in negotiating an agreed price for the taking, the determination of fair market value must be determined by a fact finder.[22]

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[21] Another example of valuation testimony is found in *United States v. L.E. Cooke Co.*, 991 F.2d 336, 339 (6th Cir. 1993). In that case, the federal government was condemning land in which the L.E. Cooke Company held coal interests. Part of the action was the determination of the value of the coal lease interests for the purpose of determining just compensation. Regarding the leasehold owners expert witness, the court wrote:

> Because Cooke had the burden of persuasion in this action, its expert witness, John Praskwiecz, testified first. Praskwiecz, a licensed mining engineer, regularly performs reserve studies, mine feasibility studies, and appraisals for his employer, Gaddy Engineering Company.
>
> . . .
>
> Praskwiecz testified that reserve evaluations involve a determination of the amount of coal that is mineable and merchantable within a given piece of property and that mine feasibility studies are economic studies to determine the cost of mining coal, such as the selection of equipment and method of mining. The coal industry categorizes reserves according to standards established by the United States Geological Survey. Praskwiecz

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<u>Foreign held mineral interests in Alaska and the relevance of chapter 11 of the North American Free Trade Agreement.</u>

You asked whether Chapter 11 of the North American Free Trade Agreement (NAFTA) may be utilized by a foreign company that has invested in exploration of a mineral resource and is then subject to tightening of state environmental standards relative to mineral extraction or the outright prohibition of resource extraction in an area where the company has been actively exploring.

The use of ch. 11 of NAFTA as a tool for a foreign corporation to bypass or otherwise challenge state law and policy was discussed in a 2004 article that appeared in STATE

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testified that such reserves are either proven, i.e., one-quarter mile from a known point of coal thickness; probable, i.e., one-quarter to three-quarters of a mile from that point; inferred, i.e., three-quarters of a mile to one and one-half miles from that point; or potential, i.e., over one and one-half miles from the known point of coal.

After explaining the procedures he used and the sources of information he relied upon, Praskwiecz concluded that the tracts at issue contained 47,000 tons of proven coal and 1,066,000 tons of probable coal, for a total of 1,113,000 tons. Praskwiecz concluded that the remaining 487,000 tons of coal reserves had no economic value, and he ignored them. When questioned about the quality of the coal in the four seams present in the Cooke property, Praskwiecz stated, "The quality is a low to middle quality steam coal, which can definitely be sold on the steam coal market, and at a price." J.A., vol. II, p. 27. On cross-examination, Praskwiecz acknowledged that only one of the data points he used in his evaluation was actually located on a Cooke tract and that the quality of the coal seams fluctuated in Lawrence County. Also, he admitted that there were some impurities present in the coal but not, in his opinion, enough to affect the coal's marketability.

Praskwiecz further testified that in his opinion the highest and best use of the Cooke tracts was coal mining. In determining market value, Praskwiecz testified that the preferred approach in the industry is to use comparable sales. However, he identified only two sales which were similar enough to be considered comparable and found that these were insufficient to establish a market trend. Instead, he used a discounted cash flow analysis. When his calculations were completed, Praskwiecz determined that the present net value of the Cooke leases was $427,000 and that this was the fair market value at the time of taking.

LEGISLATURES, a publication of the National Conference of State Legislatures (NCSL).[22] The article included a discussion of several cases in which a foreign company sought damages based on state and local government action relating to the corporation's investment. In *Methanex* v. *United States*, a Canadian corporation sought damages from the United States because of its alleged loss of future profits resulting from the California legislature's ban on MTBE.[23] In a second case, Metalclad, a U.S. multinational corporation brought suit for damages against Mexico after state and local officials in a Mexican state used their land-use regulatory authority to stop the development of a hazardous waste facility in which Metalclad has invested.[24] In another case involving California, Glamis Gold is pursuing a claim against the United States based on provisions in California's mining law that protect Native American sacred sites that Glamis Gold argues will deprive the company of future profits.[25] In each of these three cases, the federal government that was a party to NAFTA -- Mexico and the United States -- is the defendant.

In 1993, the Congress of the United States enacted the North American Free Trade Agreement Implementation Act.[26] Sec. 102 of the Act addresses the relationship between NAFTA to United States and state law.[27] With regard to state law, sec. 102 requires the President to consult with the states for the purpose of achieving conformity of state laws and practices with NAFTA and to assist the states to identify those state laws that may not conform to the agreement.[28] Further, with regard to legal challenges to state law, the section states that, "No State law, or the application thereof, may be declared invalid as to any person or circumstance on the ground that the provision or application is inconsistent with the Agreement, except in an action brought by the United States for the purpose of declaring such law or application invalid."[29]

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[22] William T. Warren, *Trade Agreement Trade-offs*, STATE LEGISLATURES, July/August 2004, at 20-23.

[23] *Id.* at 21. "MTBE" is methyl tertiary butyl ether, a fuel additive in motor gasoline. See, *http://www.epa.gov/mtbe/faq.htm#background* (accessed Dec. 6, 2006).

[24] *Warren* at 21.

[25] *Id.* at 21-22.

[26] Pub. L. 103-182. 107 Stat. 2057.

[27] Sec. 102 is codified as 19 U.S.C. 3312.

[28] 19 U.S.C. 3312(b)(1)(B).

[29] 19 U.S.C. 3312(b)(2).

Given the nature of mineral rights in this state -- that the interests vest following discovery, location, and filing -- state action that amounts to a taking requires just compensation to be paid to the holder of the property interest that is the subject of the taking. As discussed above, Alaska courts have recognized that regulatory action can amount to a taking and require compensation to be paid. The suits brought under ch. 11 of NAFTA that are based on a regulatory taking of an economic interest possibly could be resolved under Alaska law if the court finds that a regulatory taking has occurred. The remedy for a regulatory taking under NAFTA, in the form of a suit for damages against the host country, is available to a foreign corporation regardless as to whether a particular state recognizes a regulatory taking such as our court described in *Beluga*, supra.

NAFTA and the North American Fee Trade Agreement Implementation Act do seem to complicate a state's exercise of control over environmental concerns by raising the possibility of a suit against the federal government based on state regulation and, under the Implementation Act, requiring a state and federal government to coordinate regulatory actions for consistency under NAFTA.[30]

I do not know the extent of any interaction related to NAFTA between the state and federal government. You may wish to contact the office of the governor or the governor's office in Washington, D.C. for more information.

Summary

The commissioner of natural resources identifies land in the state that is open for mining. When a person acquires mineral rights through discovery, location, and filing, that person acquires a property interest that requires the state to pay just compensation if the property is taken either as a per se taking or a regulatory taking that deprives the owner of all economic use of the interest.

The North American Free Trade Agreement provides a means for a non-U.S. corporation to try to recover damages from the federal government based on what is found to be a regulatory taking by a state or local government.

If I may be of further assistance, please advise.

DMB:med
06-511.med

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[30] Northern Dynasty, the developer of the Pebble Gold Project, is a corporation based in Vancouver, British Columbia, and potentially could seek protection of its investments under ch. 11 of NAFTA.

Bristol Bay

Stronghold for Sockeye Salmon

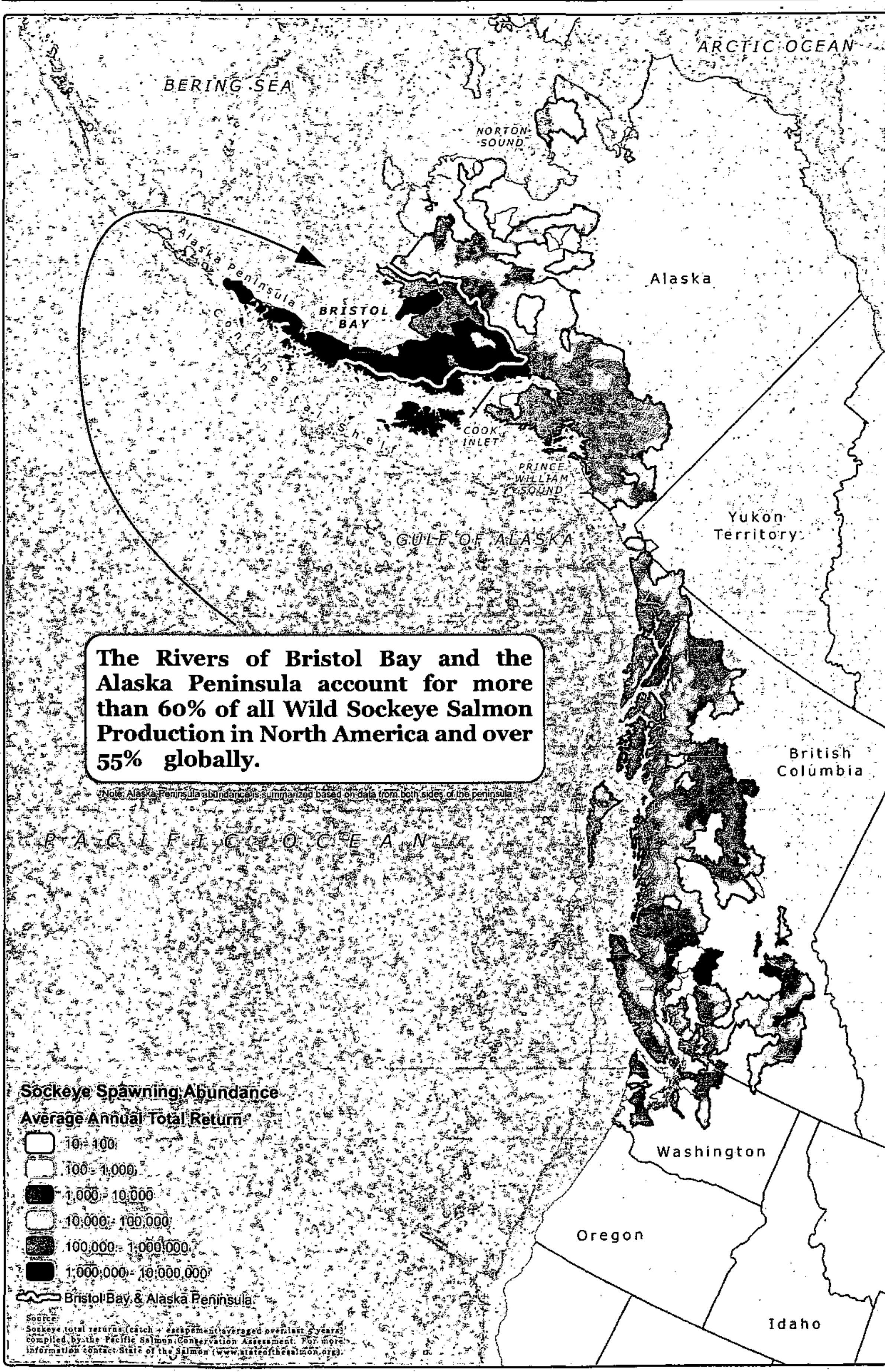
Map produced by: STATE OF THE SALMON

KNOWLEDGE ACROSS BORDERS

State of the Salmon is a joint program of Ecotrust and WSC

ecotrust

THE WILD SALMON CENTER



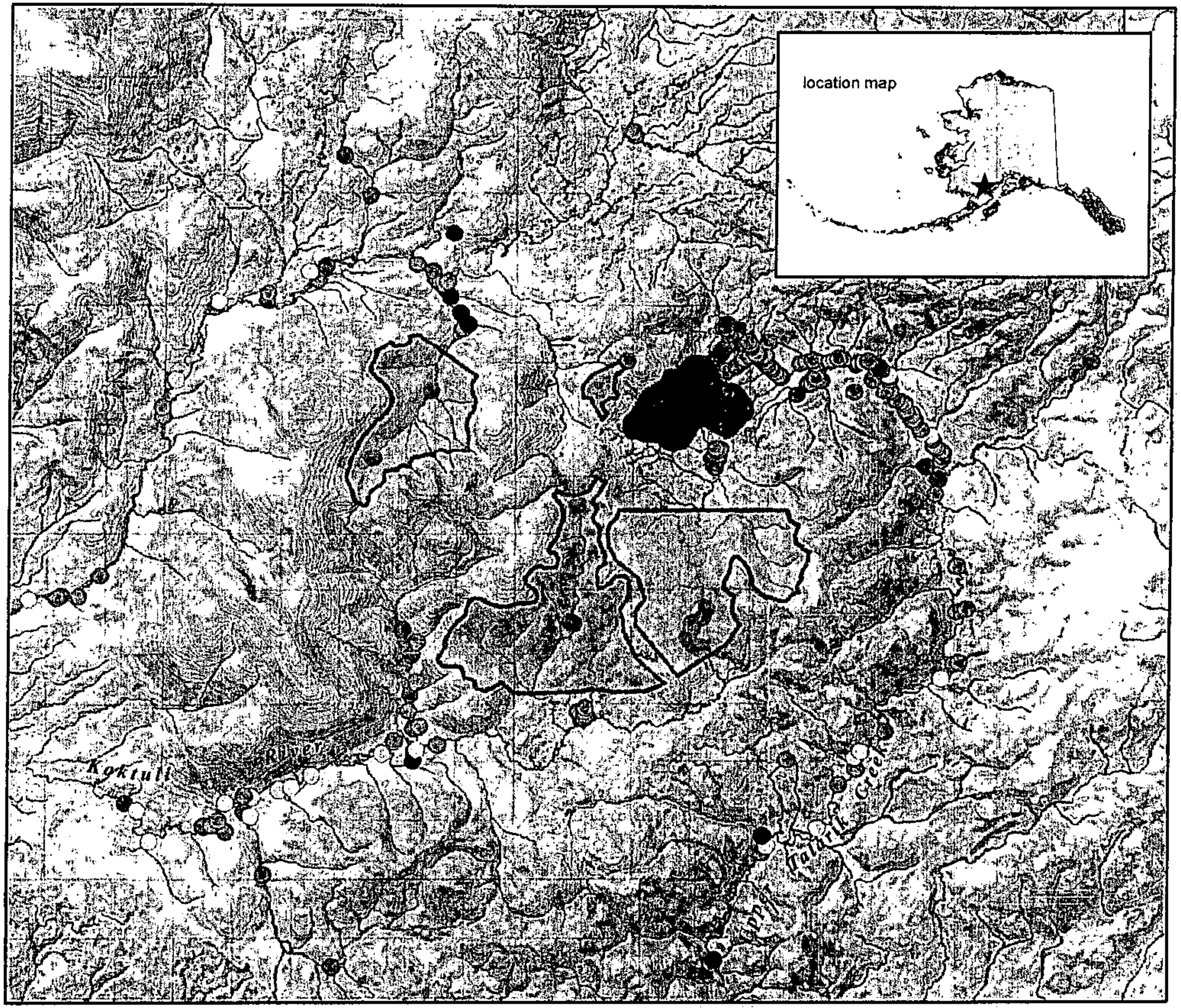
1970

Renewable Resources Coalition

True North GIS

The Proposed Pebble Mine

Relationship to Observed Salmon Populations



Legend

- Mine Pit
- Mill Site
- Tailings

Salmon Observations, 2004-2006:

- Chinook
- Chum
- Coho
- Sockeye

This map portrays the relationship between the proposed Pebble Mine and local salmon populations. Fish data depicts the distribution, abundance, and variety of species, and was supplied by the Alaska Department of Fish and Game.

Data Source:

Fish: Fisheries report in reference to Permit No. SF-2004-114 and Amendment No. SF-2004-114-A-1, from HDR Alaska, Inc., to Alaska Department of Fish and Game, Division of Sport Fish, dated November 23, 2004.

Report of collecting activities for the Pebble Project in reference to Permit No. SF-2005-049, from HDR Alaska, Inc., to Alaska Department of Fish and Game, Division of Sport Fish, dated October 25, 2005

Report of collecting activities for the Pebble Project in reference to Permit No. SF-2006-057, from HDR Alaska, Inc., to Alaska Department of Fish and Game, Division of Sport Fish, dated February 2, 2007.

Pebble Mine Project: The following files were downloaded from: http://www.dnr.state.ak.us/mlw/mining/largemine/pebble/ as of February 5, 2007:

Pebble Project Initial Application for Certificate of Approval to Construct a Dam
Tailings Impoundment A – Figures
Tailings Impoundment G – Figures

Miles: 0 0.5 1 2 3 4 5

February 23, 2007
fish_distribution_salmon.mxd
Coordinate System: UTM, Zone 5, NAD27, CM: -155.5

Analysis of the Potential Impacts of Copper Sulfide Mining on the Salmon Resources of the Nushagak and Kvichak Watersheds

Final Report
January 10, 2008

For The Nature Conservancy

Lance Trasky & Associates
January 10, 2008

This report, *Analysis of the Potential Impacts of Mining a copper sulfide deposit on the Salmon Resources of the Nushagak and Kvichak Watersheds*, was prepared by Lance Trasky and Associates, commissioned by The Nature Conservancy in Alaska, and funded by the Gordon and Betty Moore Foundation during the summer of 2007.

An Executive Summary and Key Findings, excerpted from this document, is available from The Nature Conservancy, should you wish to review the material in a more condensed format.

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APPENDICES

LIST OF ABBREVIATIONS

ADEC	Alaska Department of Environmental Conservation
ADF&G	Alaska Department of Fish and Game
ADNR	Alaska Department of Natural Resources
ADN	Anchorage Daily News
AWC	Anadromous Waters Catalog
BBAP	Bristol Bay Area Plan for State Lands
CERCLA	Comprehensive Environmental Response and Recovery Act
Corps of Engineers	United States Army Corps of Engineers
CWA	Clean Water Act 33 USC 1251
Cu	the symbol for copper
EIS	Environmental Impact Statement
EPA	The United States Environmental Protection Agency
FDA	The United States Food and Drug Administration
HCN	The symbol for cyanide
Hg	the symbol for mercury
ICMI	International Cyanide Management Institute
ICOLD	International Committee On Large Dams
LD/50	the lethal dose required to kill 50% of the test organisms in a set period of time
LMPP	Large Mines Permitting Process
mg/l	milligram per liter or one part per million or ppm
ng/l	nano gram per liter or one part per trillion or ppt
NDM	Northern Dynasty Mines, Incorporated, also known as Northern Dynasty Minerals, Ltd., a Hunter Dickinson Group Company and Pebble East Claims Limited.
NEPA	National Environmental Policy Act
N.K.	North Fork Koktuli River
RCRA	Federal Resource Conservation and Recovery Act
S.K.	South Fork Koktuli River
TRI	EPA Toxic Release Inventory
TSA	Tailings Storage Facility
USGS	United States Geological Survey
ppb	one microgram per liter or one part per billion ppb
ppt	one nanogram per liter or one part per trillion
U.T	Upper Talarik Creek
N.K.	North Fork Koktuli River
404 Permit	A wetlands fill permit issued under section 404 of the Clean Water Act
ug/l	microgram per liter, part per billion or ppb
USCOLD	United States Committee On Large Dams

INTRODUCTION: The world class salmon resources and the natural and human systems dependent on them gave The Nature Conservancy (TNC) the impetus to make the Nushagak-Mulchatna watershed a priority for conservation. There is no salmon producing system in the world that is as productive and healthy as Bristol Bay and the Nushagak system is one of the key salmon producers in Bristol Bay.

Northern Dynasty Mines, Inc's announcement that they intend to develop the world's second largest copper mine at the headwaters of the two largest sockeye salmon producing systems in Bristol Bay has raised concerns within TNC about how mining would affect salmon habitat and the Bristol Bay salmon fisheries, and whether TNC can achieve its conservation goals if the mine moves forward.

The purpose of this analysis is to inform TNC board members and staff by providing a science-based review of:

(1) the scale and duration of the proposed Pebble Project and the nature of the ore deposit;

(2) the possible extent of impacts the Pebble Project could have on fish and fishermen if developed, particularly potential impacts to salmon from copper sulfide mines and the associated mineral processing, slurry pipelines, tailings disposal sites, and access roads; and

(3) the effectiveness of State and Federal statutes and regulations in avoiding potential impacts from large mines, and particularly sulfide ore body mines.

1. DESCRIPTION OF THE PROPOSED PEBBLE MINE AND ASSOCIATED FACILITIES

1.1 Pebble Prospect: Northern Dynasty Mines Pebble Project mineral claims are located on 58,000 acres of state land located approximately 25 miles north of Lake Iliamna (Figure 1). An additional 586 square miles of claims have been staked in the surrounding area by other mining companies (Anchorage Daily News, 2007b). The Pebble Project claims are located within the Lake and Peninsula Borough. Based on reserve estimates released by NDM, the Pebble Project prospect ranks as the second largest copper mineral deposit in the world (Northern Mines, 2007). Northern Dynasty Mines estimates the ore body contains approximately 82 million ounces of gold and 67 billion pounds of copper worth approximately 200 billion dollars (Anchorage Daily News, 2007a).

The Pebble project, as currently envisioned, would include:

- An open pit mine or an underground mine, or both. The most recent plans indicate that the open pit at Pebble West would be about 1700 feet deep and cover about 2 square miles. Pebble East has not been fully explored but appears to be of comparable size and underground block caving techniques might be used to mine to a depth of 5000 feet(Northern Dynasty Mines, 2007;

- Various stream diversion channels, wells and devices to dewater the pit and extract water for mine processes;
- A mill to crush and process the ore;
- At least two tailings "ponds" to store up to 8 billions tons of reactive and non reactive mine waste and tailings. These "ponds" would cover at least 10 square miles;
- The ponds would be created by five dams constructed of waste rock from the mine(s),. Approximately 9 miles of dams would impound the reactive tailings "ponds." The largest dam would be 740 feet high;
- A deep-water port in Iniskin Bay, on the west side of Cook Inlet to load ore carriers;
- A new 104 mile road to connect the mine to the port;
- Two 104 mile long, 15 inch parallel pipelines to transport a slurry of copper ore concentrate from the mill to the port and return the water to the mine area;
- A 300 megawatt power plant and 135 mile transmission line from the Kenai Peninsula to the mine site.

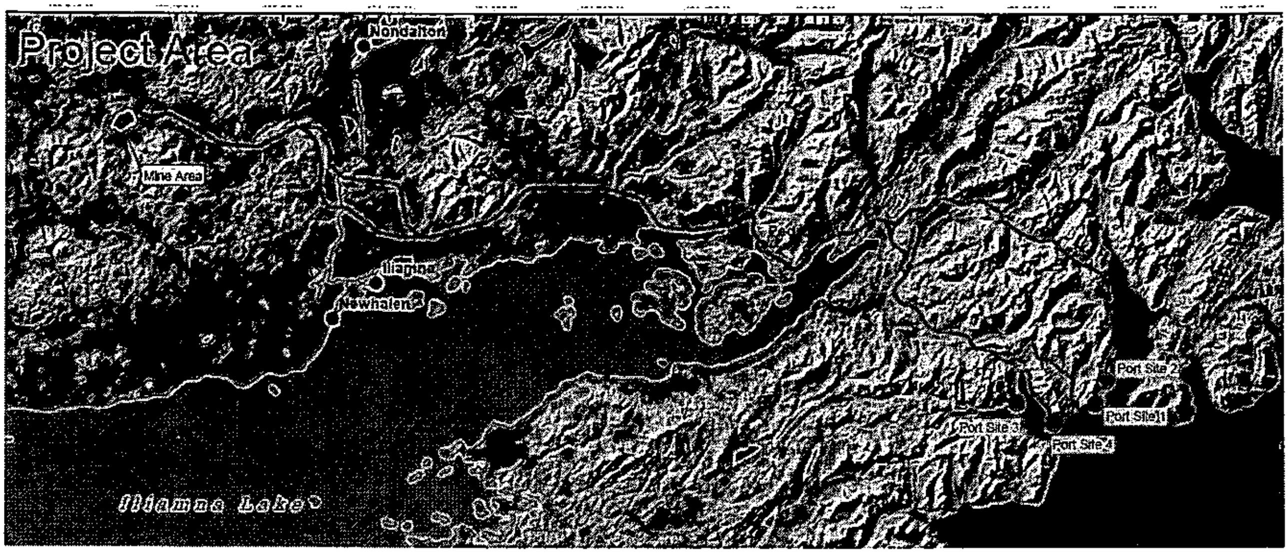

Figure 1. Location Map: Mine, Road and Port

To supply the electrical power needed for the mine a new 200 to 300 megawatt power plant would have to be constructed somewhere in the rail belt (NDM, 2007). NDM estimates that 2000 people would be employed in the construction of the mine facilities, and that 1000 people would be employed by the mine over its 40 to 70 year life span (Anchorage Daily News, March 27, 2007a). An unknown number of additional people would be employed in the construction and operation of the port, pipeline, and power plant.

1.2 Ore Deposit: The ore body is located at the headwaters of Upper Talarik Creek in the Lake Iliamna drainage and the North and South Forks of the Koktuli River in the Mulchatna River drainage (Figure 2). The deposit is low-grade copper-gold-molybdenum porphyry comprised of 0.6% copper, 0.37g/t gold, and 0.039% molybdenum. The ore body, compromised of the Pebble

East and West deposits, is approximately 12,500 feet (2.6 miles) long and up to 8,000 feet (1.6 miles) wide (Northern Dynasty Mines, 2007). The Pebble West and Pebble East deposits are approximately 1,700 and 5,000 feet deep respectively (Northern Dynasty Minerals, Ltd., 2007). According to a February 20, 2007 NDM press release, the Pebble West deposit contains 4.1 billion metric tons of ore, and the Pebble East deposit contains 3.4 billion metric tons. The total deposit of 7.5 billion metric tons is equivalent to approximately 8.4 billion U.S. tons of ore. Both the amount of ore and the size of the deposit may increase with additional drilling.

The Pebble West deposit is primarily chalcopyrite ($CuFeS_2$) and the Pebble East deposit is composed in part of bornite (Cu_5FeS_4). Both of these copper deposits are referred to as sulfide ores because the copper is locked up in a compound containing iron and sulfur. The composition of the ore is important because sulfide ores will form sulfuric acid when exposed to oxygen and water (United States Office of Surface Mining and Reclamation, 2007 and Acid Drainage Technology Initiative, 2007). At a 0.6 percent copper equivalency each ton of ore mined will yield approximately 12 pounds of copper, 0.37 grams of gold, 0.78 pounds of molybdenum and 1,987 pounds of waste rock (Phelps Dodge, 2007).

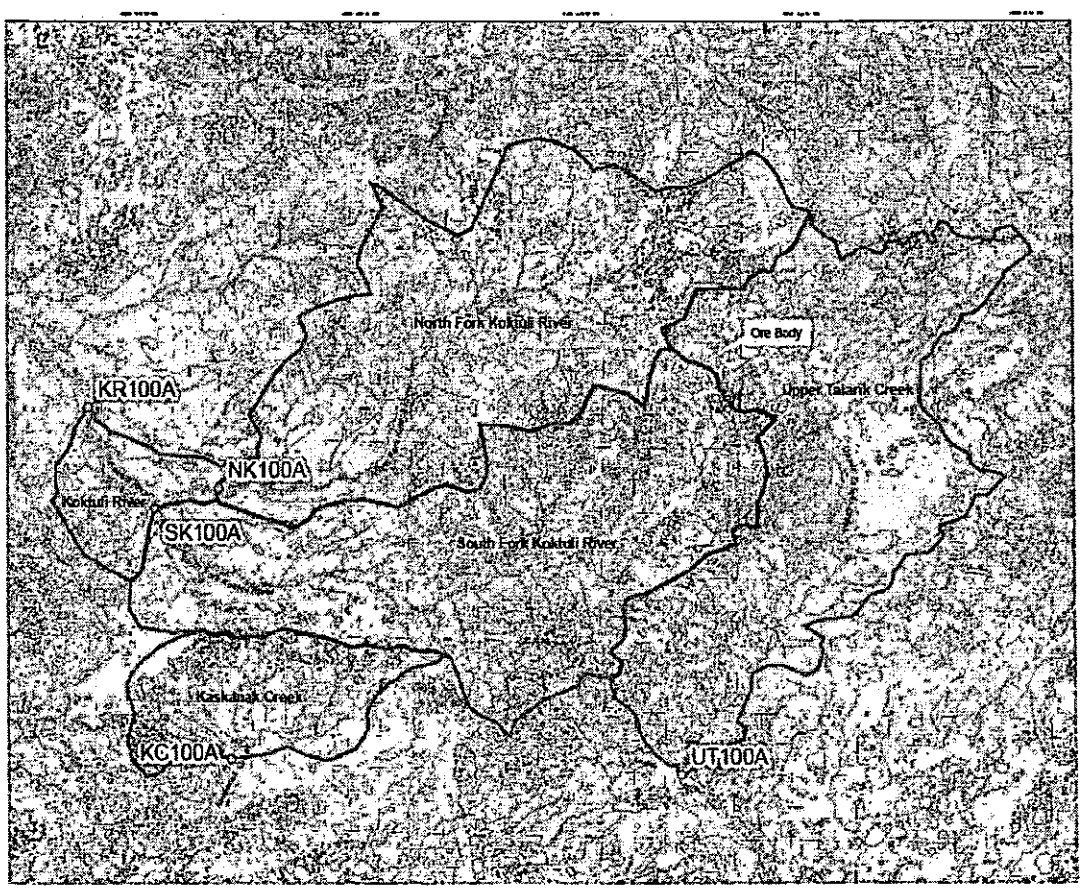

Figure 2. Stream Drainages Impacted by Pebble Mine

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1.3 The Mine: The ore body would be mined through a combination of open pit and underground-block cave mining. The Pebble West deposit is exposed at the surface and is suitable for open pit mining (Northern Dynasty Mines, 2007). Open pit mining is commonly used to extract massive amounts of low grade copper ore that are at or near the surface of the earth. An open pit mine has the appearance of a series of benches or terraces (Figure 3). The mine is opened by stripping off the vegetated overburden and non ore bearing rock which would be dumped in a tailings disposal area, or used in the construction of tailings disposal areas. The streams which flow through the mine and tailings disposal area would be diverted and the water appropriated for mine use (Northern Dynasty Mines, 2006). Because the mine would extend below the ground water table, ground water from the surrounding area would flow into the pit or tunnels. A series of wells would be drilled around the mine to prevent the mine from flooding. Water from the wells and water that enters the pit would be pumped out into a water storage area for use in milling, for forming the slurry in the waste and concentrate pipelines, to submerge reactive waste rock to prevent oxidation and acid formation, to reduce dust generation, and to protect downstream resources (Northern Dynasty Mines, 2006).

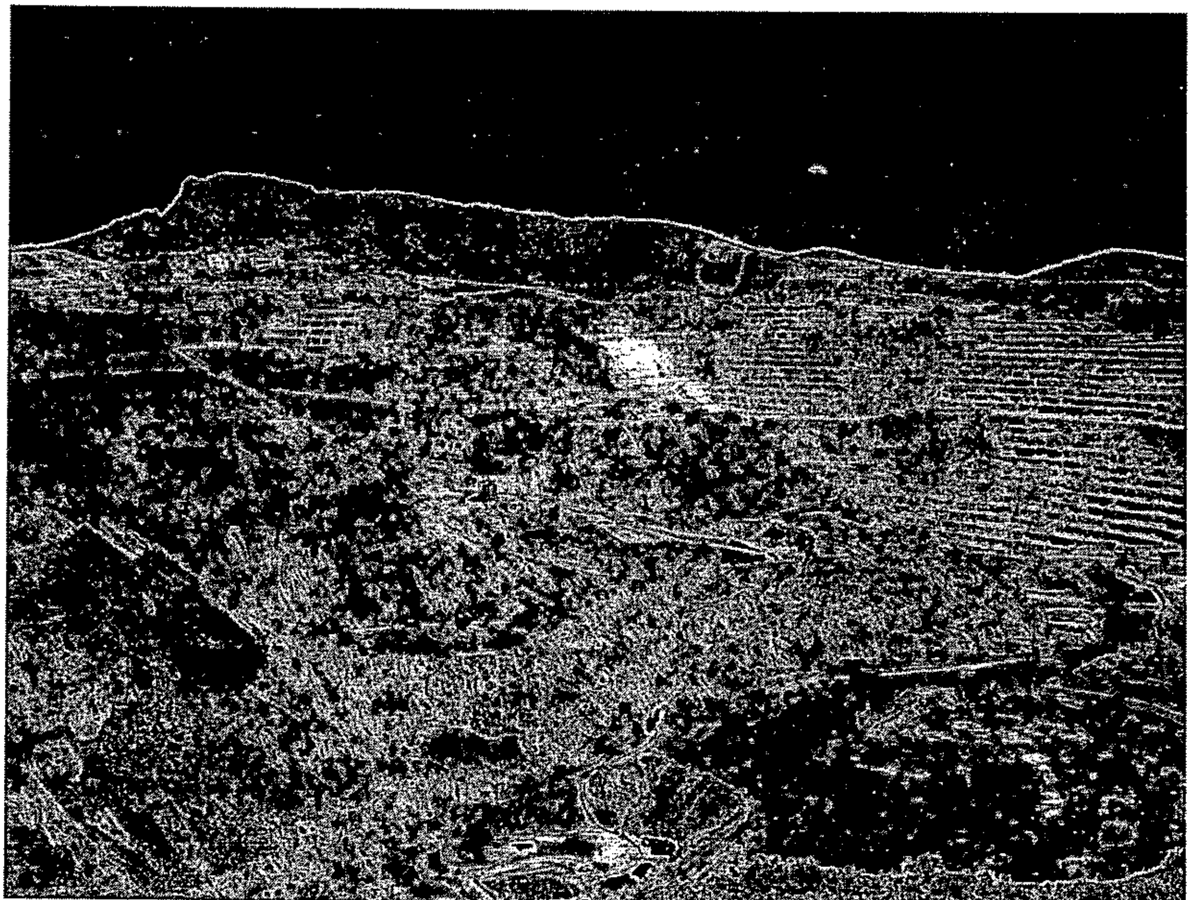

Figure 3. Chino Open Pit Copper Mine, New Mexico (source Wikipedia)

The process of recovering copper from the ore body begins when miners drill and blast the ore and overburden. Detonation of explosives placed in large patterns of deep drill holes break the

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solid rock. Large shovels, some lifting nearly 100 tons of material in a single bucket "bite", fill trucks holding up to 350 tons of ore that haul the broken rock to the mill to be crushed (Phelps Dodge, 2007).

The Pebble East bornite deposit is deeper but contains more copper per ton of ore (Northern Dynasty Mines, 2007). Because of the cost of removing and storing the overburden that covers the ore body, Northern Dynasty has said they might mine the Pebble East deposit using block caving. Block caving is an economic method of mining large underground ore bodies with a consistent grade of ore throughout. A series of large tunnels are cut into the base of the ore body. A thick block of ore is undercut by removing a slice of ore. The un-supported block of ore breaks and caves under its own weight. The broken ore is drawn off from tunnels below as the caved mass falls due to gravity (Figure 4). The broken ore is loaded into ore carriers and transported to the mill.

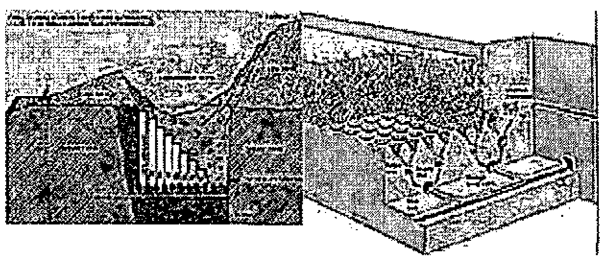

Figure 4. Block Caving (Source Atlas Copco Group)

Upon completion of mining, the Pebble West chalcopyrite pit would encompass about 2 square miles, and would be about 1700 foot deep. The Pebble East mine would cover a similar area, but would be up to 5000 feet deep (Northern Dynasty Mines, 2007). Because the water table is at the surface in the mine area, after pumping stops both Pebble West and East would fill with water and probably overflow into adjacent drainages. Based on experience from other mines where block caving was used, (Gilbride and Kehrman, 2005) the surface over the Pebble East block caving area may subside after mining is completed (Blodgett, 2002).

1.4 Processing Ore: At the mill the ore is dumped into crushers. The crusher breaks the large rocks into smaller and smaller pieces. After crushing, the ore is sent to the concentrator where huge grinding mills reduce it to the consistency of face powder. The sulfide ore is then screened to approximately 0.5mm and then sent to the froth flotation cells for recovery of copper. The copper mineral is recovered and concentrated by a process called flotation. In flotation, the finely ground ore is mixed with water to from a slurry. Certain chemicals or reagents that coat only the desired copper minerals are added in small amounts. Rising air bubbles capture the coated mineral particles and float them to the surface where they are skimmed off and dried. This dried material is called copper concentrate and is approximately 30 percent copper, 27 percent iron and 33 percent sulfur, with smaller quantities of gold, molybdenum and other metals (Phelps Dodge, 2007). A separate selective flotation step separates the molybdenite (molybdenum disulfide) from the chalcopyrite. The copper concentrate would be sent to the port site via slurry pipeline for shipment to a smelter. The tailings which remain at the bottom of the tank are disposed of in the tailings impoundments.

Gold that is associated with the copper pyrite complex would likely be processed with the copper at a remote location (Crafford, 2007). The gold that is not associated with the copper pyrite complex might be processed on site. Cyanide is the primary means used by the mining industry for leaching gold from ore (ICMI, 2007). Although Northern Dynasty Mines initially stated that no cyanide would be used at the proposed Pebble Project Mine (Anchorage Daily News, 2004j) they later backed away from that statement (Bristol Bay Times, June 23, 2005). Gold could be removed from Pebble ore by means of either heap leaching or agitated pulp leaching (ICMI, 2007). In heap or dump leaching the ore or agglomerated fine ore is stacked in heaps on a pad lined with an impermeable membrane. Cyanide solution is introduced to the heap by sprinklers or a drip irrigation system. The solution percolates through the heap leaching the gold from the ore, and the resultant gold bearing solution is collected on the impermeable membrane and channeled to storage facilities for further processing. Heap leaching is attractive due to the low capital cost involved, but is a slow process and the gold extraction efficiency is a relatively low 50-75% (ICMI, 2007).

In a conventional agitated leaching the milled ore (slurry) is conveyed to a series of leach tanks. The slurry is agitated in the leach tanks, either mechanically or by means of air injection, to increase the contact of cyanide and oxygen with the gold and enhance the efficiency of the leach process (ICMI, 2007). The cyanide then dissolves gold from the ore and forms a stable gold-cyanide complex. The waste from which the gold was removed by any means is referred to as tailings. This residue is usually partially dewatered to recover the solution, treated to neutralize or recover cyanide, and is then sent to the tailing storage facility. Because of the very large volume of ore to be processed a very large amount of cyanide would be required to process the ore.

1.5 Tailings Storage Facilities: According to Northern Dynasty's 2006 Pebble Project Initial Application for Certificate of Approval to Construct a Dam, two tailings impoundments A and G would be constructed in stages to hold approximately 2.5 billion tons of mine waste. If the ore has a 0.6% copper equivalency as reported, 99.4% of every ton of ore mined will be waste (Northern Dynasty, 2007). This means that if all of the 8.4 billions of tons of ore were extracted, approximately 8.3 billion U.S. tons of waste would be produced over the life of the mine.

Because of the potentially harmful nature of this waste, NDM has proposed to construct two very large earthen structures they call Tailings Storage Facilities (TSF) to hold the waste and prevent it from entering the environment. Because this waste would be stored in perpetuity, these facilities would need to be constructed to permanently preclude catastrophic failure, prevent leakage into ground or surface water, and prevent mobilization of wind blown dust from the surface. The TSFs would store reactive and nonreactive tailings solids from the mill, reactive mine rock and water used to process ore (Northern Dynasty Mines, 2006). Nonreactive mine rock is relatively inert. Reactive rock contains sulfur and when exposed to oxygen and water forms sulfuric acid.

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Tailings Storage Facility A would be enclosed by three earth fill dams across the valley of the South Fork Koktuli River: a north embankment 700 feet high and 2.9 miles long, a southeast embankment 710 feet high and 1.3 miles long and a southwest embankment 740 feet high and 3 miles long (Northern Dynasty Mines, 2006), (Figure 5). The surface area of TSF A would be approximately 7 square miles, not including the foot print of the dams. The containment dams would be constructed of waste rock and nonreactive tailings. Northern Dynasty is designing the tailings storage facilities to withstand a magnitude 8.7 earthquake without release of tailings or process water (Northern Dynasty Mines, 2006). According to Northern Dynasty a magnitude 8.7 earthquake would be the largest quake expected in the mine area in a 3000-5000 year period.

Tailings Storage Facility G would be constructed approximately 2 miles west of the mine pits and would fill the valley of tributary 1.190 of the North Fork of the Koktuli River with mine waste. Two earthen dams would form the impoundment (Northern Dynasty Mines, Inc., 2006). The main dam would rise to a final height of 450 feet and a smaller saddle dam would be 150 feet high (Northern Dynasty Mines, Inc. 2006). The surface area of TSF G, not including the footprint of the dams, would cover approximately 3.6 square miles and would cover approximately 4 miles of a tributary to the North Fork of the Koktuli River (Figure 5). It would be constructed to the same standards and of the same materials as TSF A.

TSF G is designed to store tailings and process water from the mill process, and would hold approximately 0.5 billion tons of reactive (acid forming), nonreactive, and potentially reactive waste. Surface water runoff and supernatant process water would form a permanent cover over a portion of the TSF, and the interstices between the tailings would be saturated to prevent oxidation of the sulfide waste. Some water would be transferred from the supernatant pond for use in the milling process. NDM contemplates total containment and recycling of all water within the impoundment with no surface water discharge to the environment. Based on Northern Dynasty Mine's water rights applications, a very large quantity of water, likely between 100 and 300 billion cubic feet, would be permanently entrained in the tailings mass over the mines 40 to 70 year life if there are no discharges from the mine or any of its facilities (Northern Dynasty Mines, 2006).

The structural integrity of the dams is critical, because the mechanical stability of the tailings mass is very poor, due to its small grain size and the typically high water content (Lottermoser, 2003). Northern Dynasty mines has stated that the mine will be a zero discharge facility and that much of the water appropriated from area streams and ground water over the mine's 40 year life would be stored in the tailings facilities. The tailings would be saturated with water to prevent oxidation of the sulfides in the waste and formation of acid. The upstream face of the dams would be lined with a high density polyethylene liner to control seepage. Because all tailing storage facilities leak, a complex system of drains, pipes, and pumps would be buried under the dams to collect leakage and return it to the tailings storage facility (Julein, et al. 2002, Bjelkevik, 2005, and Northern Dynasty Mines, 2006). After the ore is mined out and the company leaves, the tailings dams and the pollution control system would have to be maintained in perpetuity, to prevent the acid generating mine waste and other toxic chemicals in the two tailings facilities from draining into the Koktuli River or Upper Talarik Creek. Because the mine is on state land, the Department of Natural Resources would have to resume responsibility for maintenance of the tailings storage facilities after mine closure, presumably using bonds from the company to cover the costs of on-going pollution management.

Although, the ADNR Pebble Project website states that approximately 2.5 billion tons of waste rock and mill tailings would be produced and disposed of in the tailings storage facilities (Northern Dynasty Mines, Inc., 2006), those estimates don't appear to be current. The most recent reserve estimates released by Northern Dynasty Minerals Ltd. in February 2007 are 8.4 billion tons (7.6 billion metric tons) of ore containing 67 billion pounds of copper at 0.6% copper equivalency per ton of ore. Based on those reserves estimates, if all of the ore were mined the mine would produce approximately 8.3 billion tons of mine and mill waste. This is almost three times the design capacity of Tailings Storage Facilities A and G of 2.5 billion cubic yards. If correct, Tailings Facilities A and G would either have to be expanded or other tailings storage facilities would have to be constructed in another location to hold the additional waste. Other disposal options considered by Northern Dynasty include building more tailings storage facilities in other stream drainages or discharging the waste into Lake Iliamna.

1.6 Water Use: A large mine requires a tremendous amount of water. NDM has applied for all of the ground and surface water within the boundaries of the mine area, up gradient of the downstream limit of water extraction (Northern Dynasty Mines, Inc., 2006).

The mine area encompasses a drainage area of approximately 35 square miles and includes the headwaters of Upper Talarik Creek, and the North and South Forks of the Koktuli River. According to Northern Dynasty Mine's 2006 ground and surface water rights applications, all surface and ground water within the mine area would be used in the mining process or stored in the tailings storage facilities over the 40 to 70 year life of the mine (Northern Dynasty Mines, 2006). Northern Dynasty has stated that no water would be discharged from the mine, port, or tailings storage facilities.

Northern Dynasty's surface water applications from the North and South Fork of the Koktuli River and Upper Talarik Creek headwaters for the Pebble Mine are presented in Table 1 (Northern Dynasty Mines, Pebble Project Water Use Application, July 7, 2006).

Table 1. Pre and Post Development Stream Flows

Stream	Oct.	Nov.	Dec.	Jan.	Feb.	March	April	May	June	July	Aug.	Sept	Annual
SFK													
DL 1													
Pre Development (cfs)	54	41	26	17	11	8	13	109	36	19	20	82	36
Post Development (cfs)	0	0	0	0	0	0	0	0	0	0	0	0	0
SK 100B 1													
Pre Development (cfs)	338	256	159	106	69	53	83	673	237	119	129	517	228
Post Development (cfs)	284	215	133	89	58	44	70	564	201	100	109	434	192
Percent Reduction	16%	16%	16%	16%	16%	16%	16%	16%	16%	16%	16%	16%	16%
NFK													
DL2													
Pre Development (cfs)	30	30	17	6	5	5	18	81	28	15	17	39	24
Post Development(cfs)	0	0	0	0	0	0	0	0	0	0	0	0	0
NFK 100A													
Pre Development (cfs)	389	385	217	82	71	66	238	1649	365	192	216	510	315
Post Development(cfs)	359	355	201	76	66	61	220	969	337	177	200	470	291
Percent Reduction	8%	8%	8%	8%	8%	8%	8%	8%	8%	8%	8%	8%	8%
UTC													
DL3													
Pre Development (cfs)	32	29	15	9	5	3	25	42	20	15	14	38	21
Post Development (cfs)	0	0	0	0	0	0	0	0	0	0	0	0	0
UTC 100 B													
Pre Development (cfs)	341	314	117	118	77	59	279	445	222	172	164	407	231
Post Development (cfs)	309	285	162	109	72	55	254	403	202	157	150	369	210
Percent Reduction	9	9	9	8	7	6	9	9	9	9	8	9	8

Note: SK 100B1 is approximately 12 stream miles below DL1, NFK 100 A is located 18 miles downstream from DL2, and UTC 100 b is located approximately 18 stream miles below DL3

Surface water would be removed via pumping, gravity and channeling, and stored in reservoirs.

A separate application has been submitted to withdraw all of the ground water flowing from the mine area into the North and South Forks of the Koktuli River and Upper Talarik Creek drainages (Northern Dynasty Mines Ground Water Application, 2006). The Pebble Mine site receives between 35 and 40 inches of precipitation annually, The long term mean annual precipitation is estimated to be 36 inches (Northern Dynasty Mines, 2006 Application for Water Rights). The mine site is covered with permeable glacial material and is probably saturated with ground water. The upper layer of bed rock is also heavily fractured and permeable.

Northern Dynasty has requested 19.4 cubic feet per second of ground water from the Upper Talarik Creek drainage, 11.78 cubic feet per second from the South Fork Koktuli watershed, and 12 cubic feet per second from the North Fork Koktuli River drainage (NDM Pebble Project 2006 ground water application). These ground water withdrawals would be used for mine functions and to dewater the mine pit (NDM Pebble Project 2006, Application for Water Rights. Ground water withdrawals also serve a secondary purpose of preventing contaminated ground water from the mine pit, mine facilities and tailings storage facilities from leaking into fish bearing surface waters. Ground water would be removed by pumping.

Northern Dynasty has applied to take approximately 136 cubic feet per second of surface and ground water from the three watersheds which drain the site over the life of the mine. This adds up to approximately 100 to 300 billion cubic feet of water over the projected 40 to 70 years of mining. The water would be used in the milling process, dust suppression and to slurry ore concentrate in the slurry pipelines. If there is no discharge from the mine as claimed, all of the water, minus evaporation, would ultimately be stored in the tailings storage facilities (TSF).

1.7 Roads, Barge Landing Areas, Port and Pipeline: Three barge landing areas, one at Williamsport and two in Lake Iliamna are being considered for the project. These sites would be used to bring in equipment for initial construction of the road, port facility and mine. A deep water port site for the project would be sited at Iniskin Bay (Northern Dynasty Mines, 2006). Facilities would be constructed at the Iniskin Bay site to receive, dry, and store processed copper concentrate from the mine. A solid fill dock would be constructed into Iniskin Bay to load deep water vessels with copper concentrate to be transported to a foreign port for refining. A 104 mile long all weather road and a 15 inch diameter slurry pipeline would be constructed to transport copper concentrate from the mine to the Iniskin Bay port (Northern Dynasty Mines, 2007). A second pipeline would return slurry water from the port to the mine. One or more pump stations would be required to move the heavy concentrate through the 104 mile long pipeline. Another alternative would be to truck the concentrate, or a portion of the concentrate, such as molybdenum, which is not easy to transport by pipeline, to the port.

The road and the pipelines would cross approximately 120 streams including over 80 with year around flows. Many of these streams provide spawning and rearing habitat for salmon and high value resident fish species such as Dolly Varden and grayling. According to Northern Dynasty the road alignment and port site were selected by the Alaska Department of Transportation and Public Facilities. The access road corridor crosses both Native Corporation and State owned land (BBAP, 2005). According to Sean McGee, NDM spokesman, the road would be controlled by Iliamna area villages and would not be open to public use (NDM, 2007). The sites being evaluated for the port at Iniskin Bay appears to be a very productive marine environment with significant populations of marine mammals including threatened Stellar Sea Lions, seabirds and fish such as herring. Land ownership at Iniskin Bay is mixed with private, state, and ANSCA village corporation holdings.

1.8 Power Plant and Transmission Line: An enormous amount of electrical power would be required to run the Pebble Project Mine, Port Facilities, and pump stations for the slurry pipelines. According to the Pebble Project website (Northern Dynasty Mines, 2007) the power requirements for the Pebble mine would be 100 megawatts during construction and start up and 300 megawatts during operation. To put this in perspective the Pebble Project's projected power needs are 66% of Chugach Electric's highest ever peak load of 457 megawatts. Chugach Electric is Alaska's largest power producer, supplying electricity to nearly 75% of south central Alaska's population including the Homer Electric Cooperative. (Chugach Electric Association, 2006). Power for the Pebble Mine would be purchased from Homer Electric Association (HEA) and would be produced by a power plant at Nikiski and supplied to the mine via a 55 mile long submarine cable across Cook Inlet to the port site at Iniskin Bay and an 85 mile long transmission line from the port to the mine site (McGee, 2007 and Northern Dynasty Mines, 2007). One route for the transmission line would transect the Iniskin Peninsula from north to south. The source of the electricity that HEA would provide for the Pebble Mine has not been identified, but Northern Dynasty has stated that the initial 100 megawatts could be supplied from Homer Electrics current generating capacity and would not require any additional generating capacity. The additional 200 megawatts of power required for the Pebble Mine project would require HEA to acquire additional generating capacity.

2. TOXICITY OF COPPER, MERCURY, AND CYANIDE TO FISH AND AQUATIC LIFE

2.1 Overview: Of the three primary metals to be extracted from the Pebble Project ore, gold is benign. Molybdenum is generally reported in the literature to be acutely toxic to various adult fish species at relatively high concentrations (70 to over 2000ppm) but to have physiological effects at levels as low as 2.5 ppm. (Davies et al. 2005, Hamilton and Buhl, 1989 and Reid, 2002). However, copper and copper compounds are acutely toxic to fish and other aquatic life at low part per billion levels (ppb) (Eisler, 1991, Eisler, 2000, Environmental Protection Agency, 2007f, and Hamilton and Buhl, 1990).

Northern Dynasty has not provided information on the other metals and elements present in Pebble Ore. However, ground waters react chemically with rocks in their path and collect mobile components typical of the rocks they have passed through (Giblin, 2001). The analysis of water samples from the Pebble Mine area indicates that many of the other heavy metals and elements on the Environmental Protection Agency's list of priority pollutants including antimony, arsenic, cadmium, chromium, lead, mercury, nickel, selenium, and zinc are also present in ground and surface waters. (Northern Dynasty Mines Inc., 2005, Environmental Protection Agency, 2007 f). These other metals are also toxic to salmon and other fish at very low concentrations (Eisler, 2000).

The current levels of these metals in the surface and groundwaters draining the proposed Pebble Project site are measurable, but with the exception of copper and mercury, below levels known to be toxic to fish and aquatic life (Northern Dynasty Mines Inc., 2005). Mercury, which is present in the water at the Pebble Project site and is often found at elevated levels in and around mineralized areas, is a potent neurotoxin which presents a health threat to both aquatic life and humans (Munn and Short, 1997). Cyanide, commonly used in gold extraction, is one of the most rapidly acting lethal poisons known (Eisler, 1991).

A study of recently permitted large sulfide based copper and gold mines, found that mining often increases the concentrations of copper and other pollutants in ground and surface waters to levels that are toxic to fish and other aquatic life (Kuipers, et al. 2006).

Because copper and other heavy metals are already present in waters at the proposed Pebble Project site, and are toxic at extremely low levels even very small mining related increases from fugitive dust, groundwater contamination or acid mine drainage could increase the concentrations of pollutants to levels that are toxic to fish and aquatic life.

Mercury, biomagnifies, or increases in concentration as it moves up the food chain, and accumulates in the tissues of aquatic organisms such as fish. Several other metals in the deposit such as cadmium, arsenic, lead, and zinc also accumulate or build up in the tissue and organs of aquatic organisms (Sadiq, 1992 and Sorenson, 1991).

To understand how these mining related pollutants affect fish and aquatic life, three pollutants of particular concern, copper, mercury and cyanide, will be examined in greater detail. However, the same concerns apply to the other potentially harmful metals and pollutants likely present in the ore body and already present in ground and surface water at the proposed Pebble Project Mine site.

2.2 Copper Toxicity: The element copper (Cu) is essential to the growth and metabolism of fish and other aquatic life, but may cause irreversible harm at levels slightly higher than those required for growth and reproduction (Eisler, 2000). The element copper (Cu) and many copper compounds when dissolved in water are toxic to fish and other aquatic life in the low part per billion to part per trillion range. Copper ions have acute toxic, chronic, and behavioral effects on fish and the aquatic life that they feed on. Research has shown that although salmon and trout will avoid low levels of copper in water, but do not avoid high levels of copper because it destroys their olfactory nerves and then kills them if their exposure is long enough.

Table 2 contains the Environmental Protection Agencies 2007 Updated Aquatic Life Copper Criteria species mean acute and chronic toxicity copper levels for the same genus or species of aquatic organisms present in the Pebble Project area

Table 2: EPA 2007 Updated Copper Toxicity To Selected Species

	Acute Toxicity (ug/l)	Chronic Toxicity (ug/l)
Cladoceran (Daphnia sp.)	6	8.96
Amphipods	9.6	
Pink Salmon	40.13	
Coho Salmon	22.93	
Rainbow Trout	22.19	11.9
Sockeye Salmon	54.82	
Chinook Salmon	25.02	
Bull Trout (Salveliuns confluents)	25.02	19.7
Brook Trout (Salvelinι us fontinalis)		60.4
Northern Pike (Esox lucius)		

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Note: The EPA site did not list detrimental behavioral effect of copper even though those effects are documented in the scientific literature.

2.2.1 Factors Affecting Copper Toxicity: Researchers have found that copper toxicity to freshwater fish and other aquatic life is affected by several factors including hardness, alkalinity, pH, water temperature, organic and inorganic complexation, ,synergistic effects with other metals such as zinc and age, size and species of fish (Environmental Protection Agency, 2007i, Chakoumas, et al.1979 and Eisler, 2000). Water hardness, alkalinity and pH are interrelated and appear to be particularly important. Because of the variability in individual species tolerance and the effect of water hardness on toxicity some researchers have recommended that copper criteria should be developed on a site specific basis (Finlayson and Verrue, 1982). For example, in tests to determine the relative sensitivity of bull trout (Salvelinus confluentus) and rainbow trout to acute copper toxicity, bull trout were found to be as sensitive to copper mortality as rainbow trout at water hardness levels of 100 ppm of $CaCO_3$, but 2.5 to 4 times less sensitive at 220 ppm $CaCO_3$ (Hansen et. al, 2001).

Hardness is a measure of dissolved calcium and magnesium in water. Alkalinity is a measure of the capacity of water to neutralize acid. Potential of Hydrogen or pH is a measure of the acidity or alkalinity of water. The ADEC acute and chronic copper Aquatic Life Criteria for Freshwater is calculated from a formula based on the hardness of the receiving waters (Alaska Department of Environmental Conservation, 2003

Hardness: The toxicity of dissolved copper to fish is dependent on the concentrations of dissolved calcium and magnesium in water, or hardness (Alaska Department of Environmental Conservation Water Quality Criteria Manual, 2003). Copper and certain other metals such as cadmium are more toxic to fish in soft waters than in hard water (Chakoumas, R. et al. 1979, Sayer, et al. 1989, Lauren, D. and D. McDonald, 1986, Lauren, D. and D. McDonald, 1984,Waiwood, K. and F. Beamish, 1978, and Howarth, R. and J. Sprague, 1978. Water with 0-60 ppm as calcium is considered soft, 61 to 120 ppm is moderately hard, and 121 and above as hard to very hard (USGS, 2007). Hardness concentrations reported by Northern Dynasty ranged from 4.3 to 24.9 ppm in the North Fork of the Koktuli River, from 8.6 to 29.1 ppm in the South Fork of the Koktuli River, and from 10 to 45.2 ppm in Upper Talarik Creek (Northern Dynasty Mines, 2005 Water Chemistry Report). These water samples fall within the soft to moderately soft range. The fresh water aquatic life copper criterion contained in the ADEC Alaska Water Quality Criteria Manual were used to calculate the acute and chronic toxicity levels for copper for the hardness levels reported for Upper Talarik Creek, and the North and South Forks of the Koktuli River (ADEC, 2003). For the low and high hardness concentrations reports for these streams the acute fresh water aquatic life criteria for dissolved copper range from 0.722 ppb to 6.36 ppb, and the 4 day chronic criteria range from 0.600 ppb to 4.54 ppb. Dissolved copper levels in some of the water samples from all four streams exceeded the lowest ADEC Freshwater Aquatic Life Criteria for these hardness levels, including one location on the South Fork Koktuli River which exceeded the lowest water quality criteria on all but one sampling period. Copper levels at this site were between 2.5 to 4.9 ppb (Northern Dynasty Mines, 2005). Because Pebble Mine Area surface waters are relatively soft, lower concentrations of copper will be toxic to salmon and other species of fish.

Alkalinity: The acute and chronic toxicity of copper is also inversely correlated with alkalinity (Chakoumakos et al. 1979 and Lauren and McDonald, 1986). Alkalinity is a measure of the capacity of substances (usually bicarbonate and carbonate) dissolved in water to neutralize acidic pollution such as acid mine drainage. Alkalinity is important because it protects or buffers against rapid pH changes that are harmful to fish and other aquatic life. When acid is introduced the pH levels in low alkalinity streams can drop to a point which eliminates fish and acid intolerant forms of aquatic life. Copper is more toxic at low alkalinity levels and increasing alkalinity levels reduces copper toxicity in rainbow trout and Chinook salmon (Lauren, D. and D. McDonald, 1986 and Welch et al 2000). For protection of aquatic life the alkalinity should be at least 20 ppm calcium carbonate equivalent (Alaska Department of Environmental Conservation, 2003). Alkalinity concentrations in the Pebble Project study area (reported as equivalent concentrations of $CaCO3$) ranged from 11 to 32 ppm for the North Fork of the Koktuli River, from 7.0 to 35 ppm for the South Fork of the Koktuli River, and from 16 to 56 ppm for Upper Talarik Creek(Northern Dynasty, 2005). Although, site specific sampling data was not available, Northern Dynasty reports that most of the main stem sampling sites exceeded the minimum chronic aquatic-life criteria of 20ppm during the May through October sampling period

(Northern Dynasty, 2005). However, some of the sampling locations were clearly well below the minimum 20ppm criteria for protection, and no data was provided during the winter low flow periods when alkalinity levels might be lower or higher. (Sutcliffe and Carrick, 1998). To fully evaluate this issue water quality data needs to be collected throughout the year and during high and low stream flows.

pH: The toxicity of copper and certain other heavy metals is inversely correlated with the pH (i.e. copper is more toxic in acidic waters) (Welch et al. 1993, Lauren and McDonald 1986). The pH reflects the acidity or the alkalinity of a solution. The pH scale ranges from 0 to 14. A pH of 7 is considered neutral, pH numbers below 7 indicate an acidic solution and above 7 an alkaline solution. The ADEC Water Quality Standard For Designated Uses states that pH for Growth and Propagation of Fish, Shellfish , and Other Aquatic Life, " May not be less than 6.5 or greater than 8.5 and may not vary more than 0.5 pH from natural conditions." Northern Dynasty 2005, reported that pH levels ranged from 7.0 to 8.1 in the in the North Fork Koktuli River, from 6.6 to 8.4 in the South Fork Koktuli River, and from 6.8 to 7.7 in Upper Talarik Creek. Although, pH levels are currently in the slightly acidic to slightly alkaline range, the low alkalinity levels reported for these stream indicates a limited capacity to prevent harmful changes in pH if acid mine drainage occurs.

2.2.2 Acute Toxicity: Copper is a serious pollutant in the aquatic environment and its toxicity to important species has been well studied. (Sorenson, 1991, and Eisler, 2000). Exposure to copper causes ionoregulatory and respiratory problems in freshwater fish. Exposure to 49 ppb of dissolved copper for 24 hours caused a rapid decline in blood sodium, chloride, and oxygen tension and increased heart beat in rainbow trout. At the same time arterial blood pressure doubled. Heart failure caused death. Because gill tissue controls oxygen and electrolyte levels in fish, these changes were probably caused by gill tissue damage observed in fish which were exposed to copper (Wilson and Taylor, 1992).

Researchers at EPA's Corvallis Environmental Research Laboratory found that dissolved copper (Cu) is acutely toxic to juvenile Chinook salmon and steelhead trout at levels of 17 to 38 ppb of copper. Steelhead trout *(Onchorynchus mykiss)* are more sensitive than Chinook salmon *(Onchorynchus tshawytscha)*, and salmon fry and smolt are more sensitive than newly hatched alevins (Chapman, G.A., 1978). They also found that copper is acutely toxic to adult male Coho salmon and adult male steelhead at 46 and 57 ppb respectively (Chapman, G.A. and D.G. Stevens, 1978). California Department of Fish and Game toxicologists found that median lethal concentrations for juvenile Chinook salmon in 96 hour flow through tests were 26 to 34 ppb of copper.

When exposed to copper, the incipient lethal level was between 37 and 78 ppb for sockeye salmon but between 25 and 55 ppb for pink salmon during the egg to fry stage. Growth and hatching were no better than mortality as indicators of toxic effects of copper. Copper inhibited egg capsule softening, but associated mortalities during hatching occurred only at concentrations also lethal to eggs and alevins. Copper was concentrated by eggs, alevins and fry in proportion to exposure concentrations. Copper concentrations of 105 and 6.8 ppm in pink salmon eyed eggs and fry, respectively, coincided with mortalities. (Servizi, J.A. and

D.W. Martens, 1978). Several studies found that salmon fry, smolt and adults acute copper toxicities were lower than developing eggs.

Canadian researchers conducted tests in artificial stream to determine the attraction and avoidance responses of rainbow trout to lethal copper concentrations (0.5 to 4.0 ppm) over 96 hours (Pedder, S. C. J. and E. J. Maly, 1985). At all concentrations, there was an initial attraction period for copper and then subsequent avoidance of the more highly contaminated waters. Attraction was greatest in tests employing higher concentrations (3.0 and 4.0 ppm) of copper; but this attraction led to high mortality. These results indicate that observed trout behavior subsequent to copper discharges contributed to high mortality. The results also suggest that behavioral response of organisms to toxicants must be incorporated into work attempting to set reasonable water-quality standards in natural water bodies (Pedder, S. C. J. and E. J. Maly, 1985).

2.2.3 Chronic Toxicity: Exposure to elevated, but sublethal, levels of copper reduces the viability and increases the mortality rate of salmon and other fishes over time. For example, Coho salmon, which were exposed to sublethal levels of aqueous copper (1/4 and 1/2 of the dose which killed one half of the population in 4 days (LC50), lost their appetite and ceased growing or showed decreased rates of growth (Buckley, J.T. et al. 1982).

Copper is broadly toxic to the salmon olfactory nervous system (Baldwin, D.H. et al. 2003). Exposure to 1.0 to 20.0 ppb copper impaired the neurophysical responses of juvenile Coho salmon olfactory receptor neurons to natural odorants within 10 minutes of exposure. The inhibitory effects of copper were dose dependent but were not influenced by water hardness. Toxic thresholds for the different receptor pathways were found to be 2.3 to 3.0 ppb over background. Short term influxes of copper to surface waters appear to interfere with olfactory senses that are critical for spawning, feeding, predation avoidance, and migration of wild salmonids (Baldwin, D.H. et al. 2003).

In laboratory tests exposure to 25 to 300 ppb of copper significantly reduced the number of olfactory receptors in Chinook salmon and rainbow trout due to cellular necrosis (death of cells). These levels caused histological damage and neurological impairment to the olfactory system that these fish require for survival. Chinook salmon olfactory receptors were found to be harmed by lower does of copper (50 ppb) than rainbow trout (200 ppb). Chinook salmon were more susceptible to olfactory damage at lower levels of copper than rainbow trout in copper contaminated waters (Hansen, J.A. et al. 1998).

Exposure to low levels of dissolved copper reduces the resistance of rainbow trout to disease. The effect of exposure to sublethal concentrations of copper (6.4, 16.0, and 29 ppb) on the immune systems of rainbow trout was measured after 3, 7, 14, and 21 days of exposure by researchers at the University of California Davis (Dethloff and Bailey, 1989). They found that the immune system was altered at all concentrations with the greatest effects at higher concentrations. Consistent alterations in immunological parameters suggest that these parameters could serve as indicators of chronic metal toxicity in natural systems (Dethloff and Bailey, 1998).

Exposure of Chinook salmon and rainbow trout to sublethal levels of copper increased their susceptibility to *Vibrio anguillarum* infections: Vibrio is a serious disease of fish. Exposure levels were 9% (parts per trillion range) of the copper LC50 for 96 hours. Vibriosis mortality was also greater in exposed fish than unexposed fish. Rainbow trout stressed by copper required 50% less pathogens to induce a fatal infection than non-exposed fish (Baker, R.J. et al. 1983). Exposure of rainbow trout to sublethal levels of copper in water increased their susceptibility to infectious hematopoietic necrosis (IHN) virus. In most instances, the percent mortality was twice as great in the stressed groups compared with those groups which were not stressed but received the same virus dose. Although the level of copper in the water influenced the mortality rates, the length of exposure did not prove to be critical, as similar results were obtained after 1, 3, 5, 7, or 9 days of exposure. When different virus challenges were employed, the percent mortalities were again greater in the stressed fish at all virus doses tested, and at one dose, mortalities were noted in the stressed group but not in the untreated group (Hetrick. et al. 1979).

2.2.4 Behavioral Effects: Exposure to sub lethal levels of copper can have a detrimental effect on the behavior of salmonids, and reduce their survival. Rainbow trout which were exposed to copper and nickel solutions in a linear Plexiglas chamber with countercurrent flow avoided copper concentrations of 6.4 ppb total copper (Giattina et al. 1982). When copper concentrations were gradually increased, rainbow trout initially avoided low copper concentrations, but were attracted to higher concentrations (330-390 ppb) that are considered lethal. The 24-hour average concentration of these two metals presently considered adequate for the protection of freshwater aquatic life fell within the 95% confidence limits for threshold avoidance concentrations. This suggests that environmental impacts predicted on the basis of toxicity tests alone do not reflect potentially important behavioral changes caused by sub chronic concentrations of copper and nickel. Avoidance tests, therefore, may prove to be a valuable tool for screening toxic chemicals, providing additional information and a broader perspective for evaluating the impact of aquatic contaminants on fishery resources (Giattina, et al. 1982).

Tests of the responses of Chinook salmon and rainbow trout to sub lethal levels of copper, cobalt, and a mixture of copper and cobalt found that behavioral avoidance of copper varied greatly between Chinook salmon and rainbow trout in soft water (less than 40 ppm hardness). Chinook salmon avoided at least 0.7 ppb of copper, whereas rainbow trout avoided at least 1.6 ppb copper. Furthermore, following acclimation to 2 ppb of copper, rainbow trout avoided 4 ppb of copper and preferred clean water, but Chinook salmon failed to avoid any copper concentrations and did not prefer clean water. The failure to avoid high concentrations of metals by both species suggests that the sensory mechanism responsible for avoidance responses was impaired. Exposure to copper concentrations that were not avoided could result in lethality from prolonged copper exposure or in impairment of sensory-dependent behaviors that are essential for survival and reproduction (Hansen. et.al.1999).

The spawning migration of adult male Chinook salmon was monitored by radio telemetry to determine their response to the presence of copper, lead, zinc and cadmium contamination in the South Fork of the Coeur d'Alene River, in Idaho. The majority of the fish avoided the contaminated South Fork and moved up the non-contaminated North Fork to spawn. Metals levels in the South Fork waters were cadmium 6.90ppb, copper 2.0 ppb lead 23.0 ppb and zinc 2,220 ppb at hardness of 108 ppm. The results agree with laboratory findings that wild fish will avoid spawning streams with high levels of metals contamination (Goldstein, et al. 1999). The results were also consistent with a study of wild Atlantic salmon (Salmo salar) which demonstrated that spawning salmon avoided sublethal concentrations of copper and zinc in a stream contaminated by a base metal mine by returning downstream prematurely (Saunders and Sprague, 1967).

To put the potential for behavioral effects in context, background median dissolved copper levels reported in the 2004 Northern Dynasty Water Chemistry report ranged between 0.28 and 1.88 ppb (Northern Dynasty Mines, 2005). However, dissolved copper levels in some of the water samples from the North and South Forks of the Koktuli River and Upper Talarik Creek streams exceeded the lowest ADEC Freshwater Aquatic Life Criteria for these hardness levels, including one location on the South Fork Koktuli River which exceeded the lowest water quality criteria on all but one sampling period. Copper levels at this site were between 2.5 to 4.9 ppb (Northern Dynasty Mines, 2005).

2.3 Mercury Toxicity: The element mercury is a heavy metal that has no known metabolic purpose and is toxic to living organisms (United States Geological Survey, 1994). Mercury occurs in many areas of southwestern Alaska and has been found in surface and ground water in the Pebble Mine area (United States Geological Survey, 1994, Northern Dynasty, 2005). Mercury is harmless in insoluble forms such as mercuric sulfide, but is poisonous in soluble forms such as mercuric chloride or methylmercury. Most authorities agree on six points (Eisler, 1987):

- mercury and its compounds have no known biological function and the presence of metal in the cells of living organisms is undesirable and potentially hazardous;

- forms of mercury with relatively low toxicity can be transformed into forms of very high toxicity, such as methylmercury, through biological and other processes;

- mercury can be bioconcentrated in organisms and biomagnified through the food chain;

- mercury is a mutagen, teratogen, and carcinogen, and causes embroycidal, cytochemical, and histopathological effects;

- some species of fish and wildlife contain high levels of mercury that are not attributable to human activities; and

- human use of mercury should be curtailed because the difference between tolerable natural background levels of mercury and harmful effects in the environment is exceptionally small

Mercury is of particular concern because mining may increase the amount of mercury in the environment (Maprani, et.al. 2003, Sexauer et al. 2003, National Risk Management Research Laboratory, 2003 and Earthworks, 2007) and mercury levels in organisms tend to increase (biomagnify) as it moves up the food chain and build up (bioaccumulate) in predatory fish such as coho salmon, trout and pike which feed on insects and small fishes containing mercury

(Wren and McCrimmon, 1986). The toxicity of mercury to salmon, trout, and other aquatic organisms is affected by the form of mercury, environmental conditions, and the sensitivity of the individual species and life stage (NOAA, 1996). Toxilogical effects include neurological damage, reproductive impairment, growth inhibition, developmental abnormalities, and altered behavioral responses (NOAA, 1996).

Mercury is not only toxic to aquatic life, but it is very toxic to humans and animals that consume fish. Consumption of methylated mercury contaminated fish led to the poisoning of Japanese fisherman and their families in Minamata, Japan, in the 1950s. The U.S. Food and Drug Administration (FDA) recommends that pregnant women and those who may become pregnant, avoid eating any fish species known to contain elevated levels of methylmercury, an organic form of mercury that can accumulate in the food chain. The deleterious effects of mercury consumed by animals that eat fish include reproductive failure, damage to intestines, stomach disruption, DNA alteration, and kidney damage. Methylmercury is also known to cause nerve damage.

2.3.1 Acute Toxicity: Alaska Department of Environmental Conservation (ADEC) Aquatic Life Criteria for Fresh Waters one hour average for acute mercury toxicity is 1.4 ppb (ADEC, 2003). In tests, concentrations of total mercury lethal to aquatic organisms range from 0.1 to 2.0 ppb mercury per liter of water (Eisler, 1987). Survival of rainbow trout (*Oncorhynchus mykiss*) alevins hatched from eggs exposed to 0.24 ppb mercuric chloride was significantly reduced (Birge, et al. 1979). Rainbow trout eggs exposed to mercuric chloride in sediments (0.18 ppb-107 ppb) and in the overlying water (0.25 ppb-6.4 ppb) experienced 55-100% mortality in 10 days (Birge, et al. 1979). Brook trout (*Salvelinus fontinalis)* exposed to 0.93 ppb in the water column experienced increased mortality and deformities, and stopped spawning (McKim, et al. 1976).

2.3.2 Chronic Toxicity: The presence of sublethal levels of organic mercury in lakes and streams affects the health and survivability of wild fishes. At comparatively low concentrations mercury adversely affects the reproduction, growth, behavior, metabolism, blood chemistry and oxygen exchange of fish (Eisler, 1987). Reproduction is inhibited among sensitive species at water concentrations of 0.03-1.6 ppb Eisler, 1979). Fathead minnows (*Pimpephales promelas*) which were exposed to 0.12 ppm methylmercury per liter of water for 3 months failed to reproduce (Birge, 1979) Brook trout (*Salvelinus fontinalis*) exposed to 0.93ppm methymercuric chloride in the water column stopped spawning (McKim et al. 1976). Reduced growth of sensitive species of aquatic organisms has occurred at concentrations of 0.04 to 1.0 ppb of mercury per liter of water. Growth reduction in rainbow trout (*Oncorhynchus mykiss*) was observed after 64 days of exposure to 0.04 ppb of methylmercury in water (Eisler, 1987).

The ADEC four day chronic toxicity criteria for mercury in freshwater is 0.77ppb, but it is noted that this may be under protective if a substantial part of the mercury in the water column is methyl mercury. (ADEC, 2003).

2.3.3 Behavioral Effects: The presence of very low levels of mercury in the water column can alter the behavior of fish in a manner that reduces their survival. After 24 hour exposure to 100, 50, and 10 ppb of mercury, the ability of mosquito fish to avoid predation by bass was impaired. The degree of effect showed positive correlation with mercury concentration (Kania and O'Hara, 1974). Golden shiners (*Notemigonus crysoleucas)* which were fed a diet containing 959 ng (0.959 ppb) of methylmercury per gram of food for 90 days accumulated 518 ng (0.518ppb) of mercury per gram of body tissue. The predator avoidance behavior of these fish was also substantially altered. The authors concluded that mercury exposure at levels currently occurring in many lakes in the northern United States alters fish predator avoidance behavior in a manner that may increase vulnerability to predation, and has significant implications for food chain transfer of mercury to predators (Webber and Haines, 2003).

2.3.4 Mercury is Altered, Absorbed and Concentrated by Aquatic Organisms: A concern is that Pebble Project mining might release small amounts of mercury into nearby lakes and streams that would be converted to methylmercury and biomagnified to levels which would be harmful to aquatic life. Methylmercury is the most toxic form of mercury and it bioaccmulates and biomagnifies as it moves through the aquatic food chain (Wren and McCrimmon, 1986, Neuman and Ward, 1999). The mercuric ion combines with other inorganic and organic ions or molecular groups, and can be methylated (NOAA, 2005). Methylation in aquatic habitats is primarily a biological process. Microorganisms are able to convert the mercury that reaches surface water to methyl mercury and most organisms absorb this substance quickly. Fish are among the organisms that absorb methyl mercury from water. Rainbow trout, which were exposed to methyl mercury for 24 days, steadily accumulated mercury over the entire time period. Exposure was through (0.07-1.33 ug Hg/L) solutions in water, through food consumption (8.0-380.5 ng of Hg/L), or both. Nearly 70% of the methyl mercury ingested and 10% of the methyl mercury passing over the gills was assimilated by the rainbow trout and incorporated in their tissue (Phillips and Butler, 1978).

Mercury in the water column is accumulated by bacteria, aquatic plants, invertebrates, fish and mammals, and the concentration of mercury in the tissue of these species tends to increase with increasing trophic levels. This process is known as biomagnification. Even though mercury levels in the water column may be relatively low, methylmercury accumulates quickly and depurates very slowly in aquatic organisms (NOAA, 2005). As a result methylmercury often reaches very high levels in higher trophic species such as predatory fish, and birds and mammals that feed on fish. (Wren and McCrimmon, 1986, Neuman and Ward, 1999).

The percentage of methylmercury in tissue, as compared to total mercury, also increases with age in both fish and invertebrates. This is called bioaccumulation. Methylmercury levels in adult predatory fish may reach up to 100,000 times the levels in the water column (Eisler, 1987).

2.3.5 Present Levels of Mercury: Ground water samples taken near the Pebble West ore body had mercury levels that were 1.6 to 2.4 times the ADEC criteria for maximum allowable human health levels of trace metals in ground water of 50 parts per trillion (ppt) mercury (Northern Dynasty Mines, 2005). This is an indication that mercury is present in the rock and is being released into the ground water (Giblin, 2001). Because NDM has said that the mine would not intentionally discharge any water over its life and if they are successful in preventing contaminated ground water from leaving the mine site, much of this water and the mercury in it would ultimately end up stored in the tailings storage facilities.

Measurable levels of mercury have also been found in the waters of Upper Talarik Creek (0.0049 ppb), North Fork Koktuli River (0.0048 ppb), and South Fork Koktuli River (0.0053 ppb) Northern Dynasty Mines, 2005). These levels show that mercury is already present in the mine area, but in concentrations below the ADEC human health standards for drinking water and aquatic organisms of 0.050 ppb. However, it should be noted that the ADEC mercury standards for Alaska are higher than the human health and water quality standards set by the Great Lakes States. The human health criterion adopted by the Great Lakes States is 3.1 ng/L which is equivalent to a fish residue value of 0.035 ug of methyl mercury per gram of fish tissue. The water quality standard for fish and wildlife is 1.3ng/l or 0.013ppb.

Mercury was found to be present in tissue samples from Chinook and coho salmon, Dolly Varden, grayling, and northern pike taken from the North and South Forks of the Koktuli River (including Frying Pan and Big Wiggly Lakes), and Upper Talarik Creek drainages, (McLarnon, 2006). Mercury levels reported for all species appear to be well below the Food and Drug Administration human consumption action limit of 1.0 mg/kg (1 part per million wet weight) action level, except for large northern pike. Methylmercury concentrations in muscle tissue of large pike from Big Wiggly and Frying Pan Lakes were as high as 0.625 mg/kg.

The higher levels of mercury in the largest pike are consistent with previous studies which have shown that mercury bioaccumulates and that mercury levels are highest in long lived large predatory fish. The levels of mercury in northern pike muscle tissue from Big Wiggly and Frying Pan Lakes, however, exceed mercury levels in walleyes *(Stizostedion vitreum)* from Franklin D. Roosevelt Lake, a reservoir on the Columbia River, and from the upper Columbia River, an area contaminated by wastes from metal mining and associated processing activities. Mercury concentrations in walleye muscle from the Colombia river study area ranged from 0.11 to 0.44 mg/kg (wet weight) and were positively correlated with age, weight, and length of the walleye (Munn, M. and T. Short, 1997). In comparison, mean tissue concentrations of mercury in predatory fish such as walleye, northern pike, and bass from mercury contaminated areas of the Great Lakes were greater than 0.5 mg/kg with maximum levels exceeding 2 mg/kg in 1998 (Environmental Protection Agency, 2001 and International Joint Commission, 2004). The 2006 HDR report did not provide any data on mercury levels in large grayling or Dolly Varden from Upper Talarik Creek or the North and South Forks of the Koktuli River, so it is not known if they have also accumulated higher levels of mercury. Mercury levels in small juvenile resident fish and juvenile salmon were relatively low, which is to be expected because of the limited time they were exposed to mercury in the water.

2.4 Cyanide Toxicity: Cyanide in its commonly found compounds and breakdown components are toxic to fish and other aquatic life at very low levels. A cyanide is a substance that is found in combination with other chemicals in the environment. A cyanide is any chemical compound that contains the cyano group CN consisting of a carbon atom triple bonded to a nitrogen atom. There are many types of cyanide compounds but the most common are potassium, sodium, and calcium cyanide. Cyanide compounds that can release the cyanide ion are highly toxic

Cyanide compounds are widely used by the mining industry to assist in the extraction of both precious and non-precious metals from rock. Consequently, cyanide and related compounds often are contained in discarded mine wastes, or enter surface waters through spills (Moran, R., 1998). Fish kills from accidental discharges of cyanide are common (Eisler, et al. 1999).

Cyanide in waste water discharges from mines is often measured using the weak acid dissociable (WAD) analytical procedure (ICMI, 2007). The WAD analysis measures free and weakly complexed forms of cyanide. The WAD procedure has been adopted by industry and regulatory agencies because it is believed to measure the toxicologically significant forms of cyanide.

The use of the WAD procedure, however, may fail to detect other forms of cyanide and certain toxic breakdown products of cyanide (Moran and Brackett, 1998). Cyanide also tends to react readily with many other chemical elements, and is known to form, at a minimum, hundreds of different compounds. (Flynn and Haslem, 1995). The toxicity of complex cyanides is usually, but not always, low, but the degradation products often include free cyanides which are toxic. Free cyanides readily degrade in the open environment but persist in groundwater. Many of these cyanide-related breakdown compounds, while generally less toxic than the original cyanide, are known to be toxic to aquatic organisms. In addition, they may persist in the environment for long periods of time, and there is evidence that some forms of these compounds can be accumulated in plant (Eisler, 1991) and fish tissues (Heming, 1989). Despite the risks posed by these cyanide-related breakdown compounds, regulatory agencies may not require mine operators to monitor this group of chemicals in mining-related waters. Therefore, while much of the cyanide used at mining sites does break down fairly readily, either as a result of natural degradation or the various treatment processes sometimes employed, significant amounts of the original cyanide may form potentially toxic compounds that remain (Eisler, 1991. "Water samples from mining sites where cyanide is used as a process chemical may have WAD and/or total cyanide concentrations that are quite low or undetected, yet when the same samples are analyzed specifically for cyanates and thiocyanates, they may show tens of milligrams per liter (ppm) or more of these compounds." (Moran and Brackett, 1998).

2.4.1 Acute Toxicity: Cyanide toxicity is caused by the free cyanides (HCN and CN-) that inhibit cytochrome oxidase and thereby suppress aerobic respiration at the cellular level. Death comes from failure of the heart and central nervous system. The Environmental Protection Agency's acute toxic criteria for freshwater is 22 ppb (Environmental Protection Agency, 2007f).

Fish are the most susceptible organisms and sensitive species exhibit lethal effects at as low as 20 to 76 ppb. Juvenile Atlantic salmon exposed to mixtures of cyanide and ammonia in freshwater for 24 hours were killed by 73 ppb of cyanide (Alabaster et al., 1983). The lethal toxicity of cyanide to juvenile rainbow trout varied from 52 ppb for trout that received exercise before exposure, to 43 ppb for trout which didn't (McGeachy, S. and G. Leduc, 1988). Free cyanide levels apparently do not increase in an organism or in the food chain over time, as many heavy metals do. Free cyanides are toxic to aquatic plants (phytotoxic) but at higher concentrations than those associated with adverse effects in fish (Eisler, 1991).

2.4.2 Chronic Toxicity: The Environmental Protection Agency's chronic toxic criterion for cyanide is 5.2 ppb (Environmental Protection Agency, 2007h). Sublethal effects of cyanide in fish include reduced reproductive capacity (decreased egg number and viability, and reduced embryo and larval survival), impaired swimming ability, altered growth, and hepatic necrosis (Eisler, 1999). Growth of juvenile rainbow trout was reduced by 40 to 95% when exposed to hydrogen cyanide concentrations (HCN) of 20 and 30 ppb respectively for 18 days (Dixon, D. and G. Leduc, 1981). In the same study, liver damage occurred at HCN concentrations as low as 10 ppb.

Canadian scientists found that exposing male juvenile rainbow trout to concentrations of 10 to 30 ppb of HCN reduced the number of dividing spermatogonia in the testes by 13 and 50% respectively (Ruby, S. et al. 1979). They concluded "that short term exposure to sublethal concentrations of cyanide may cause permanent damage to the fixed number of primary spermatogonia within the testes, thereby reducing the reproductive capacity of the species." Exposure to sublethal levels of cyanide to a fungal pathogen increased infections in adult rainbow trout by 33% over the control (Carrballo, et al. 1995).

2.4.3 Behavioral Effects: Information on the behavioral effects of very low levels of cyanide on fish and other aquatic life is limited, probably due to its toxicity. Cyanide has a strong, immediate and long lasting inhibitory effect on the swimming ability of fish, leaving them vulnerable to predation and unable to feed efficiently (Leduc, 1984). Free cyanide concentrations as low as 10 ppb can rapidly and irreversibly impair the swimming ability of salmonids in well aerated water (Doudoroff, 1976). Osmoregulatory disturbances which were detected at HCN concentrations as low as 10 ppb, may affect migratory patterns, feeding and predator avoidance (Leduc, et al. 1982, Leduc, 1984). Loss of swimming ability, feeding ability and ability to avoid predators will reduce survival.

3. SOURCES, PATHWAYS, AND EXAMPLES OF POLLUTION FROM RECENTLY PERMITTED MINES

3.1 Overview: Based on an extensive review of the literature, the Kuipers Report and EPA records it appears that most or all sulfide ore body mines in areas where the sulfides are exposed to precipitation, ground or surface water pollute, and the only question is the degree to which they pollute and how much damage occurs (Kuipers, et al. 2006, and ADN, 8/2/2006). Annual precipitation in the Pebble Project area is projected to be 36 inches including 64 inches of snow fall (Northern Dynasty Mines, 2005, and ADCED. 2007). The water table is high and the valley floors at the project site are dotted with numerous small streams, lakes, ponds and wetlands.

There are several ways that metallic and acid pollution from sulfide ore body mines has entered surface and groundwater. These include chronic leaks of acid and heavy metal contaminated water from tunnels and mine pit walls before and after mine closure; chronic leaks from tailings piles and tailings storage areas; discharges from treatment facilities catastrophic failures of tailings dams and storage areas; slurry pipeline breaks; fugitive dust; and, failure of pollution control measures after closure or abandonment (Lottermoser, 2003).

The scale of the Pebble Mine; the amount of precipitation at the mine site; the high water table, the nature and location of the ore body: and the value of the fishery resources in the area likely to be affected by the mine , mean that the common pollution control problems associated with sulfide mines elsewhere in the U.S. and Canada, and the risks associated with chronic or catastrophic leakage would be magnified many times (Leslie, 1989, Environmental Protection Agency, 1994b and Environmental Protection Agency, 2007i).

3.2 Acid Mine Drainage: Copper sulfide mines are often sources of acid mine drainage (U.S. Office of Surface Mining Reclamation and Enforcement, 2007). Acid mine drainage at copper mines in the United States and Canada is a serious problem. Acid mine drainage from recently permitted mines has contaminated ground and surface waters and eliminated salmon and aquatic life from thousands of miles of formerly productive streams in the United States (Environmental Protection Agency, 1994b and Environmental Protection Agency, 2007i).

Because the Pebble Copper Deposit is compromised of sulfide ore it presents a high risk of developing acid mine drainage (Environmental Protection Agency, 1994b). Open pit and subsurface mining of the Pebble Copper ore body will largely occur below the water table which is very near the surface in the project area. After the mine is closed pumps, collection systems and treatment facilities will have to be maintained in perpetuity, or water will flood the mine pit and tunnels and leak into ground and surface waters (Younger, 2002). This introduction of water is the initial step in most acid rock drainage situations, where the sulfides in the waste rock and mine walls has already oxidized (Morin and Hutt, 2001). Because of the sulfide content in the mine walls if the pit fills with water there is a good chance that will develop acid sulfide conditions with high levels of dissolved metals (Northern Dynasty Mines, 2005 and Castro, J and J. Moore, 2000). Unless the tailings dams holding billions of tons of mine waste and complex systems of drains, collection systems, and pumps which collect and return leakage back into the impoundments are successfully maintained in perpetuity, the waste will eventually leak into the ground water and adjacent streams. The mine could develop an acid mine drainage problem over its 40 to 70 year life or, more likely, after it is closed or abandoned and turned back to the State of Alaska.

When the copper and iron sulfides (pyrite) in chalcopyrite and bornite ores or mine waste are exposed to oxygen rich water, the sulfide oxidizes to sulfate, the iron oxidizes to iron oxide or hydroxide, and sulfuric acid is released (Environmental Protection Agency, 1994b). Copper, nickel, zinc and other metals present dissolve in the acid water. Colonies of bacteria and other organisms also contribute to the generation of acid equivalents. These microbes occur naturally in the rock, but the limited amount of oxygen and water present keeps their numbers low. Before mining, the acid generation process is slow and the amount of metals entering ground water is low because of the limited surface of the ore body exposed to oxygen and water. However, after mining breaks up the ore body and powders the ore, the amount of surface exposed to oxygen and the speed of the process increases exponentially (U.S. Office of Surface Mining Reclamation and Enforcement, 2007).

Although, several chemical processes contribute to the formation of acid mine drainage, pyrite oxidation is the primary contributor. The following four equations are accepted to explain the pyrite oxidation process (Acid Mine Drainage Technology Initiative, 2007).

Equation 1 $FeS2 + 7/2\ O2 + H2O = Fe2+ + 2\ SO_4^{2-} + 2\ H+$
Equation 2 $Fe2+ + 1/4\ O2 + H+ = Fe3+ + \frac{1}{2}\ H2O$

Equation 3 $Fe^{3+} + 3 H_2O = Fe(OH)_3 + 3 H^+$
Equation 4 $FeS_2 + 14 Fe^{3+} + 8 H_2O = 15 Fe^{2+} + 2 SO_4^{2-} + 16 H^+$

The sulfide ore, when exposed to water and oxygen, reacts to form iron ions and sulfuric acid (H_2SO_4). This reaction is catalyzed by the bacteria *Thiobacillus ferrooxidans* (Ohmura et al. 1993). Each molecule of sulfuric acid can then dissociate to produce two acid equivalents (U.S. Office of Surface Mining, Reclamation, and Enforcement, 2007). In some mines the heat from this reaction has produced temperatures of 120 degrees and the pH has gone as low as -3.6. The chemistry of the oxidation of pyretic ores subsequently reactions of iron ions, is very complex and this complexity has inhibited the development of effective treatments for acid mine drainage.

The sulfide based chalcopyrite and bornite ores which comprise the Pebble Claims will generate acid when exposed to air and water (Acid Drainage Technology Initiative, 2007 and Environmental Protection Agency, 1994b). On page 8-11 of the Northern Dynasty Mines 2004 **Progress Report on Geochemical Characterization and ARD/ML** the report states that, "Evidence that oxidation (of core samples from the ore body) has occurred in storage is illustrated by the general increase in sulfate sulfur relative to sulfur as the age of the core increased (Figure 6). The oxidized core (95th percentile) indicates that as much as 50 percent of sulfur in the core has oxidized, though typically no more than 3 percent has oxidized, indicating that oxidation can be expected to continue for many decades if the core is exposed to weathering." The regression line for the 50th percentile implies that if core had been produced in 1983 it would be acidic." (Northern Dynasty Mines, 2005). The report summary concludes, "Testing of rock core with variable ages (1 to 15 years) stored at the site showed progressive oxidation by the conversion of sulfide to sulfate and decreasing neutralization potentials. Based on these results the overall time frame for acidification of waste rock at Pebble Project appears to be from 0 to 40 years," (Northern Dynasty Mines, 2005).

The Northern Dynasty's 2004 progress report also indicates that the mine will produce two kinds of waste rock: un-mineralized overburden which will be a minority of the waste rock, and non economic mineralized rock from in and around the ore body, the majority of the waste rock. Ore processing will produce non reactive scavenger tails and bulk cleaner tails, and acid generating pyrite tailings. Copper ore that is not economic to mine (less than 0.3% copper equivalent) will be left exposed in mine tunnels and pit walls. Drill cores from the pit area indicate that the pit walls will contain reactive rock and will generate acid if exposed to air and water (Northern Dynasty Mines, 2005).

The key questions are: (1) whether there are alkaline producing minerals in the ore which might neutralize the acid generated by the sulfide ore (U.S. Office of Surface Mining Reclamation and Enforcement, and 2007), and, (2) whether the state and federal permitting agencies will correctly classify the Pebble ore before approving the project so that acid generating rock, rock exposed on the pit walls and mine tunnels and mine waste are properly treated or stored.

David Chambers of the Center for Science in Public Participation reviewed NDM's "Draft Environmental Baseline Studies, 2004 Progress Reports, Chapter 8, Geochemical Characterization & Metals Leaching/Acid Rock Drainage (Northern Dynasty Mines, 2005). He found that the majority of the 399 samples from 65 cores from the ore body, which were analyzed for sulfur content (acid generating potential) and acid neutralizing potential (related to calcium carbonate content), were clearly in the acid generating category with a ratio of less than 1 Neutralizing Potential/1 Acid Generating Potential. This means that there does not appear to be sufficient alkaline minerals in the ore to neutralize acid that may be produced.

He also drew the following conclusions from the data in the report: (1) The sulfur in the sample is sulfide which generates acid; (2) "Sulfur concentrations in the pre-Tertiary rock (i.e., most of the ore and non-overburden waste) are typically between 1-5 % and up to 9%" (sulfur concentrations in the 1-5% range are in the range for concern for acid mine drainage); (3) "Evidence that oxidation (of core samples) has occurred in storage is illustrated by the general increase in sulfate sulfur relative to sulfur as the age of the core increases" which means that acid generation has already occurred in the older samples taken from the site; and (4) Preliminary calculations indicate that it would take 40 years for nearly all of the pre-Tertiary rock to become acidic under site conditions (Chambers, 2006). This means that the most severe problems will likely occur near or at the end of the mine life, or after closure or abandonment. (Younger, 2002).

Examples of recently permitted large mines with acid mine drainage (AMD) problems include:

Summitville Mine, Colorado: The Summitville gold mine is located in the San Juan Mountains of southwestern Colorado Environmental problems developed soon after the initiation of open-pit mining by Galactic, a subsidiary of Canadian Mining Company SCMCI. Acidic, metal rich drainage into the Wightman Fork of the Alamosa River increased significantly from numerous sources on site.

Cyanide-bearing processing solutions began leaking into an under drain system beneath the heap leach pad, where they then mixed with acid ground waters from the waste dump. Cyanide solutions also leaked from transfer pipes directly into the Wightman Fork several times over the course of mining.

Open-pit mining exposed large volumes of previously unoxidized sulfides including pyrite, enargite, and chalcopyrite to weathering. The reaction of these previously unoxidized sulfides with oxygenated ground water resulted in acid-mine drainage with high concentrations of metals. (Bigelow and Plumblee, 1995). Even though the Canadian company operating the mines was fined, at least a dozen different cyanide spills totaling more than 86,000 gallons entered Cropsy Creek, one of the waterways at the top of the drainage that leads to the Alamosa River and eventually to the Rio Grande.

In 1990, state regulators discovered that trout in three farm ponds that took in water from the Alamosa were killed and that 15,000 young trout stocked by the state in the Terrace Reservoir downstream from Summitville had died (Bigelow and Plumblee, 1995). Even though threats of further action against the mine's operators by state regulators continued and the EPA began to propose involvement in halting pollution at the mine, some 294,365 ounces of gold and 319,814 ounces of silver worth more than $113 million at current spot-market metals prices were mined before events reached a crisis point late in December, 1992.

Early in December 1992 -- just days after informing state regulators that the mine would require at least $20 million to clean up, Galactic announced it was filing for bankruptcy. At that time the estimated clean up cost exceeded the bonds Galactic had posted with state mining regulators by more than $15 million. The bankruptcy created several immediate concerns. Earlier in 1992, the company had brought a water treatment plant on line to begin treating the estimated 150 to 200 million gallons of spent cyanide processing solutions remaining in the heap; however, treatment was proceeding so slowly relative to influx of snowmelt waters that the waters were in danger of overtopping a containment dike and flowing directly into the Wightman Fork. In addition, piping carrying the processing solutions to the treatment plant would have frozen within several hours, releasing cyanide solutions and stopping water treatment.

At the request of the State of Colorado, the U.S. Environmental Protection Agency (EPA) immediately took over the site under EPA Superfund Emergency Response authority and increased treatment of the heap leach solutions, thereby averting a catastrophic release of cyanide solution from the heap. Summitville was added to the EPA National Priorities List in late May, 1994. Ongoing remediation efforts include decommissioning of the heap leach pad, plugging of the Reynolds and Chandler adits (tunnels), backfilling of the open pit with acid-generating mine waste material and capping of the backfilled pit to prevent water inflow. The total cost of the cleanup to the U.S. Government and EPA has been estimated to be in excess of $200 million dollars.

In spite of costly remediation efforts, some level of acid discharge will likely continue from the site. Significant volumes of unweathered sulfides and soluble salts are dispersed throughout the site on roadways, in soils, and in other surficial materials. These solids are a long-term source of metals and acid that will be difficult to remediate.

In May, 1994, four months after the Reynolds adit was plugged, a plug on the Chandler adit (located 150 feet above and 2400 feet north of the Reynolds adit) failed and began leaking acidic, metal-rich waters into the Wightman Fork. Although the Chandler is currently being re-plugged, the leak underscores the fact that it is difficult to prevent leakage of ground water from a highly fractured and mined mountain. The plugging of the Reynolds adit also resulted in the predictable reactivation of acid seeps and springs that had drained the site prior to underground mining (Bigelow and Plumblee, 1995). Long-term leakage of acid ground water from these natural discharge points is unavoidable.

Formosa Mine, Oregon: The 76-acre Formosa Mine is located on Silver Butte between the headwaters of the two streams, about 25 miles south of Roseburg, Oregon (The Oregonian, 2007). Pollution from the Formosa Copper Mine has killed all aquatic life in 18 miles of the two streams while changing their color to shiny bronze and silver. A Canadian mining company owned by Japanese business interests went bankrupt in 1995, leaving U.S. taxpayers with the cleanup bill, and one of the worst cases of mine pollution in Oregon history. Cleanup costs could run from $10 million to $30 million or more. At least 5 million gallons of "acid rock drainage", heavy with toxic metals, flow annually into the creeks, through both ground and surface waters (Environmental Protection Agency, 2007n).

Middle Creek and its South Fork have historically been high value habitat for steelhead, coho salmon and trout. Pollution from the mine is so severe that even insect life is gone in the upper reaches of the creeks, along with any chance of rearing fish. "It's dead. It's just a dead stream," said Ken Marcy of the U.S. Environmental Protection Agency. "If you look at the upper reaches of Middle Creek and the South Fork, there is absolutely nothing living in it." In September 2007, twelve years after the mine began polluting, EPA officials put the abandoned Formosa Copper Mine on the National Superfund List. A Superfund listing makes federal dollars available to pay for the cleanup. During the next several years the EPA will complete a remedial investigation and feasibility study that will lead to a proposed plan for clean-up of the site (Environmental Protection Agency, 2007n).

Zortman-Landusky Mine, Montana: The Zortman-Landusky Gold Mine is located in north Central Montana south of the Fort Belknap Reservation and began operating in 1977. The mine has caused extensive surface and ground water contamination (Bureau of Land Management, 2007). According to Westerners for Responsible Mining (2007) the mine has experienced over a dozen cyanide spills, including one spill that released 50,000 gallons of cyanide solution and contaminated a community drinking water supply.

Even though the environmental analysis for the mine predicted that there would not be an acid mine drainage problem, the mine developed a serious acid mine drainage problem as it began to mine environmentally risky sulfide ores in 1992 (Bureau of Land Management, 2007). In 1993 the State of Montana, the Fort Belknap Tribes and the Environmental Protection Agency filed suits against the company for impacts to water resources due to long-term water quality violations, including cyanide, acid and metal discharges to surface and groundwater. In 1997, in response to the lawsuits, the company agreed to construct an additional water treatment plant, to study environmental damage to the ground water, and to increase water quality monitoring. In 1998, the company filed for bankruptcy, leaving the state of Montana with the liability for $33 million in long-term water treatment and reclamation costs.

The State of Montana has determined that water pollution generated by the mine is so severe that expensive water treatment systems will have to be operated forever. Reclamation and water treatment at the abandoned mine cost approximately $768,000 annually (Bureau of Land Management, 2007)

In 2002 the State of Montana filed suite against BLM alleging that the reclamation plan violates state law and in 2003 the Fort Belknap tribes filed suit under the Clean Water Act again because the defunct mine site has continued to discharge toxic pollutants into ground and surface water resources (Bureau of Land Management and Westerners for Responsible Mining, 2007).

Gilt Edge Mine, South Dakota: The Gilt Edge mine is located about five miles east of Lead, in the northern Black Hills. It is a 260-acre, open-pit, cyanide heap leach gold mine operated by Brohm Mining Corporation. Early testing by Brohm Mining Corporation's (BMC) predecessor indicated that acid generating material would not be a problem. Therefore, under a state mining permit, BMC, in 1988, began developing two open pits, a large cyanide heap leach pad, and a 12 million cubic yard valley-fill waste rock dump, as well as other operations. Shortly after mining began, cyanide began leaking into the groundwater and nearby Strawberry and Bear Butte

Creeks (Westerners for Responsible Mining, 2007). As the pit was mined, sulfidic ore was exposed. Mining continued until the permitted reserve was mined out in 1992. Acid mine drainage was confirmed emanating from BMC's waste dump in 1993. At that time, the state issued BMC a notice of violation and order and required BMC to prepare a mine permit amendment to address the acid mine drainage issue and to increase the reclamation bond. BMC's parent corporation was experiencing financial difficulties at that time, which ultimately resulted in a financial reorganization in Canada in 1993 (Environmental Protection Agency, 2007h).

Due to appeals of a U.S. Forest Service approval to allow additional mining on the National Forest and lack of financing, the company notified the state that it would abandon the property in 1998. Governor William J. Janklow took BMC to the 8th Circuit Court and was successful in getting both a Temporary Restraining Order and Preliminary Injunction issued that prevented BMC from abandoning the mine. Meanwhile, environmental groups sued BMC for alleged violations of the Clean Water Act. In 1999, a creditor that had been providing limited funding to maintain operations at BMC in hopes of getting U.S. Forest Service approval for additional mining, refused to provide additional funding, and BMC's parent company filed for bankruptcy in Canada in July 1999. After the operator became insolvent, the mine was left with 150 million gallons of acidic, heavy metal-laden water in three open pits that needs to be treated, and millions of yards of acid generating waste rock that needs to be cleaned up (Environmental Protection Agency, 2007h).

South Dakota (SD) Governor, Janklow averted a discharge of acid water from the bankrupt mine by authorizing the South Dakota Department of Environment and Natural Resources (DENR) to pay for water treatment. In February 2000, Governor Janklow requested that EPA Region VIII propose the site for the Superfund National Priorities List (NPL) and provide immediate emergency response and long-term remedial cleanup. The Gilt Edge site was listed on the Superfund National Priorities List on December 1, 2000 (Environmental Protection Agency, 2007h).

Molycorp Mine, Questa, New Mexico: An EPA remedial investigation is being conducted under the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA) at the Molycorp Mine (Environmental Protection Agency, 2007o). The Molycorp Mine site is located 4 miles east and the tailings ponds are 1 mile east of Questa, New Mexico. The active mine and tailings ponds are adjacent to the Red River a tributary of the Rio Grande. There is a state fish hatchery two miles downstream and the Red River's lower reaches are designated as a Wild and Scenic River. Over the years there have been numerous pipeline breaks spilling into and along the flood plain of the Red River, threatening the fishery and nearby endangered species habitat. Other threats to ground and surface water include seepage from the tailings ponds and acid metal-laden water from the weathering of the waste rock piles at the mine site. Contaminants include arsenic, lead, cadmium, zinc, aluminum, cobalt, and molybdenum (Environmental Protection Agency, 2007o).

Red Dog Mine, Alaska: The Red Dog Mine is a massive lead zinc sulfide deposit in Northwestern Alaska at the headwaters of the Wulik River. The mine is located on NANA Regional Corporation Lands and is operated by Teck Cominco. Teck Cominco has been cited by the EPA for over 618 water quality violations since the mine began operating in 1989

(Anchorage Daily News, 2006b). In 2005 Red Dog produced nearly 500 million pounds of toxic materials - mostly waste rock containing heavy metals, such as lead, zinc, cadmium, selenium, and mercury (Environmental Protection Agency, 2007j, Anchorage Daily News, 2005b). Most of this waste was stored in permitted non-RCRA surface impoundments or disposed of on land. However, approximately 320,000 pounds of methanol, lead and zinc were discharged into the air as fugitive emissions (Anchorage Daily News, 2005b and Environmental Protection Agency, 2007j).

Most of the billions of pounds of acid generating waste produced over the mines 20 to 30 year life will be stored behind a tailings dam. The dam will have to be maintained in perpetuity to prevent chronic or catastrophic spills into surface and ground waters (Tom Crafford, DNR 2007, and Chambers, 2005). Acidic and metals contaminated water leaking from the tailings impoundment and waste rock piles will have to be captured, pumped back into treatment facilities and treated forever (Teck Cominco, 2002). The current State reclamation and long term maintenance bond for the Red Dog Mine is $11, 010,250. However, the cost of reclamation and treatment at the Red Dog Mine is estimated to be over $100,000,000 (Chambers, 2005). The Alaska Department of natural Resources is currently evaluating the size of the bond required for perpetual maintenance of the mine (Crafford, 2007). Additional discussion on pollution at the Red Dog Mine is presented in Section 5.5.

Discussion of Sulfide Mines, In General: In researching the available information on acid mine drainage in the United States, it was difficult to find examples of active or closed or abandoned sulfide ore mines which are not polluting U.S. waters to some degree. This is consistent with the findings of the Kuipers Report. It is possible that some exist. However, the fact that no mine in an area with substantial precipitation has been able to meet the criteria in Wisconsin's 1998 Sulfide Mining Moratorium Act gives credence to the finding that almost sulfide mines pollute to some degree (Kuipers et al, 2006). The Wisconsin Sulfide Bill prohibits the state issuance of permits for new metallic sulfide mines unless one such mine in North America is certified by the Wisconsin Department of Natural Resources to have operated for 10 years and been closed for 10 years without causing pollution. The criteria in the bill were directed in part at stopping the Crandon zinc-copper mine near the Mole Lake Chippewa Reservation, proposed by Toronto's Rio Algom Corporation. The bill also reflected Wisconsinites lack of confidence in state and federal regulators to prevent pollution from this mine. The Sulfide Mining Bill does not stop the mine directly, but adds the new criteria at the end of the permit process. To date no one has apparently come forward with an example, and the mine has not been approved.

At least two states Michigan and New Mexico have adopted laws designed to prevent the storage of untreated toxic mine waste in facilities which will require perpetual care (see: Section 5.6 and Appendix 6).

Researchers who studied recently permitted, large mines in the United States found that that sulfide mines are likely to develop pollution problems (Kuipers, et al. 2006). The study found that mines, such as those involving metallic sulfide deposits (like Pebble) and those that are near ground water (like Pebble), have such a high risk that water quality exceedances are near certain for acid drainage or contaminant leaching. The analysis found that 85% of these sulfide based mines polluted surface water, 93% of these mines polluted ground water, and of the mines that developed acid mine drainage, 89% of the environmental documents for these mines predicted that they would not (Kuipers, et al. 2006).

The consistently high incidence of serious surface and ground water pollution problems at large metals mines in the United States is of concern considering there have been state and federal laws and regulation in place since the early 1970's to prevent pollution. These agencies employ mining experts with many years of experience with these types of mines, but still approve mining plans which have failed to predict or prevent serious pollution problems.

3.3 Tailings Dam Failures: The failure of one of the tailings dams proposed for the Pebble Mine could release billions of tons of mine waste into the Nushagak River or Kvichak River drainages. Although, state and federal permits for all large mines in the United States since the enactment of NEPA, CERCLA, and RECRA contain provisions designed to prevent the discharge of toxic effluent from tailings storage facilities, and should contain construction standards to prevent the catastrophic failure of mine dams, a significant number of tailings dam failures have occurred in the United States.

According to the World Information Service on Energy (WISE), there have been 85 major mine tailings dam failures worldwide, reported since 1960. Of these, 17 failed because of rain or flooding, 47 failed because of structural problems and 11 collapsed in earthquakes. Twenty four of the 85 tailings dams which failed were copper or gold mines. Failures occurred in all types of tailings dams, upstream, downstream, and center, which is the type proposed for the Pebble project (USCOLD, 1994 and Northern Dynasty, 2006). The largest number of failures occurred in tailings dams constructed using the upstream technique (Bruce et al. 1997). However, the difference in reported failures could be because there are many more upstream dams constructed (Bruce et al. 1997).

The International Commission On Large Dams (ICOLD compiled information on reported tailings dams' failures, breaches, and mudflows world wide (ICOLD, 2001 and 2003, and Cambridge, 2005). ICOLD reported that there have been 72 tailings dam accidents in the U.S. and 11 in Canada since 1960 (ICOLD, 2001). Most of the reported dam failures in the United States (47) and in Canada (8) were from copper, gold, and uranium mines.

A few examples of recent tailings dam failures in the United States and elsewhere and the consequences include the following.

Martin County Coal Corporation, Ohio: On Oct 11, 2000, a coal tailings dam at Martin County Coal Corporation's preparation plant near Inez, Kentucky, USA failed, releasing slurry consisting of an estimated 250 million gallons of water and 155,000 cubic yards of coal waste into local streams (American Geological Institute, 2003). About 75 miles (120 km) of rivers and streams turned an iridescent black, causing a fish kill along the Tug Fork of the Big Sandy River and some of its tributaries. At least 395,000 fish were killed in the spill and Martin Coal has spent more than $46,000,000 on cleanup (American Geological Institute, 2003). Towns along the Tug River were forced to turn off their drinking water intakes. The spill contained measurable amounts of metals, including arsenic, mercury, lead, copper and chromium, but not enough to pose health problems in treated water. The full extent of the environmental damage isn't yet

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known, and estimates of the cleanup costs go as high as $60 million (World Information Service on Energy, 2006).

Brewer Gold Mine, South Carolina: In 1990 a tailings dam at the Brewer Gold Mine failed after heavy rains and spilled 10,000,000 gallons of sodium cyanide solution into Little Fork Creek (Environmental Protection Agency, 2005d). Fish were killed in the Lynches River for at least 49 miles downstream (EPA, 1991). The British mining company which operated the mine abandoned the site in 1999 and EPA declared it a superfund site in 2004 because of heavy metals pollution and acid mine drainage.

Baia Mare Gold Mine, Romania: In 2002 a tailings dam at the Baia Mare Gold Mine in Romania, operated jointly by Australian and Romanian mining companies, failed, releasing 130,000 cubic yards of mine waste contaminated with about 120 tons of cyanide and heavy metals into the Tisza River. The spill disrupted drinking water supplies for 2.5 million people and caused a massive fish kill in the Tiza River.

Grouse Creek Mine, Idaho: The Grouse Creek Mine operated by Hecla Mining Company began mining in 1994 and used cyanide vat leaching to extract gold. The Grouse Creek Mine was originally permitted as a zero discharge facility. When it opened, the mine was hailed as environmentally friendly by company officials and the EPA and Idaho DEQ regulators who permitted the mine. In 1994, a major landslide at the mine buried nearby Jordan Creek and numerous cyanide spills and leaks also occurred. The leaks occurred because plastic and clay liners under the tailings impoundment failed (Westerners for Responsible Mining, 2007). In 1996, Hecla was fined $85,000 by the EPA for violating its discharge permits. Cyanide and mercury exceeded allowable discharge levels by more than five times over a period of 13 months. By the time the mine ceased operations in 1997, it had over 250 water quality violations. Two years after the mine quit operations, cyanide was still flowing into Jordan Creek at over 12 times the levels at which chronic exposure to the chemical negatively affects fish and other aquatic organisms. Jordan Creek is important habitat for endangered Chinook salmon, steelhead and bull trout. The cost of cleaning up pollution at the mine is estimated to be $60 million dollars, $53 million dollars more that the $7 million dollar bond Hecla was required to post (Earthworks, 2007).

Bald Mountain Mine, Nevada: The Bald Mountain mine released 8,000 gallons of cyanide solution used in heap leaching of gold in 1993 and 1994 (U.S. EPA, 1995t).

Buffalo Creek Valley, West Virginia. On February 26, 1972 the failure of a coal waste impoundment at the head of Buffalo Creek killed 125 people, destroyed 500 homes, and caused over 400 million dollars in damages (Association of State Dam Officials, 2007).

3.3.1 Discussion: The size and location of tailings storage facilities (TSF) proposed for the Pebble Project mine and the fact that these facilities would have to remain intact for thousands of years after the mine is closed presents a substantial threat to surface waters and downstream fish populations.

According to the United States Geological Survey there were approximately 1,897 coal mines, 8 uranium mine, and 1965 mines and processing plants for 74 types of nonfuel minerals and materials operating in the United States in 1997(United States Geological Survey, 2003). There were approximately 106 active metals mines during the same period (United States Geological Survey, 2003). The Metals Mining Services reported that the number of metals mines decreased from 179 to 125 between 1997 and 2002(Metal Mining Services, 2007). No figures on the number of mines or mine tailings dams in the 1960's were found. Assuming that there were somewhere between 200 and 400 metals mines with one or more tailings dams in operation from 1960 to 1995 (the latest date figures are available from ICOLD). The failure rate from tailings dams at U.S. metals mines during that period may have been between 12 and 24 percent. However, The Environmental Protection Agency estimated that there were approximately 1000 active metals mines with one or more tailings impoundments in the United States in 1994 which if accurate would make the failure rate around 5% (Environmental Protection Agency, 1994t). This is consistent with a study by Davies and Martin who found that "the failure rate of upstream tailings dams, which is the most common type of tailings dam is quite high, and it appears that every twentieth dam fails" (Lottermoser, 2003). It also appears that the rate of tailings dam failures has increased in recent years since a pervious peak that occurred in the 1930's (Davies, 2002). Most of the tailings dam which failed was small, 300 feet or less in height, when compared to the proposed Pebble Project dams (Lottermoser, 2003).

With the exception of most power dams which are regulated by the Federal Energy Regulatory Commission, and dams owned by the federal government, the safety of dams is regulated by the states, and precise information on the number of tailings dams and the rate of tailings dam failures is not available (Bruce, 1997). The Association of State Dam Officials estimates there are approximately 78,000 dams of all types in the United States (Association of State Dam Officials, 2007). Around 3,361 dams have known structural or hydraulic deficiencies, leaving them susceptible to failure (Association of State Dam Officials, 2007).

The Pebble Project would be the largest copper mine in the United States and the second largest in the world. The two TSFs described in the Description of the Pebble Mine and Associated Facilities (Northern Dynasty Mines, 2005), are only designed to store 2.5 billion cubic yards of saturated reactive and nonreactive mine waste rock, and mill waste in perpetuity. However, the most recent reserve estimates from Northern Dynasty Mines indicates that the mine would generate over 8 billion tons of waste which would have to be disposed of (Northern Dynasty Mines, 2007). This means that if all of the reserves were mined, the two tailings storage facilities would have to be several times larger than currently proposed, or additional facilities of a similar size would have to be constructed in other drainages.

The Pebble Project TSFs would be enclosed by some of the largest earth fill dams ever constructed. The United States Large Dam Safety Program, which provides guidelines and technical assistance to state dam regulators, classifies a large dam as over 100 feet in height or a storage capacity greater than 50,000 acre feet (FEMA, 2007). The proposed Pebble Project TSF's would encompass over 10 square miles and be enclosed by over nine miles of dams with a height of up to 740 feet (Northern Dynasty Mines, 2006). The TSFs would be the final resting place of the waste rock and mill tailings which at this point have a negative economic value. The sole purpose of these TSFs would be to: (1) keep the billions of tons of mine waste saturated with water so they don't generate acid, and (2) keep the toxic waste from leaking or flowing out into the ground water and adjacent drainages.

These massive tailings facilities would be constructed on top of the present headwaters of the North and South Forks of the Koktuli River. However, because of the height of the 750 foot high dams and the topography, a dam breach at the south end of TSF A could flow into either the South Fork of the Koktuli River and the Nushagak River, or Upper Talarik Creek, and down to Lake Iliamna. If the dams were breached, it might not be economically or physically feasible to clean up the billions of tons of waste that have been washed downstream or to restore these streams.

As previously described, the most common causes of tailings dam failures are earthquakes and floods, which overflow the tailings storage facilities and cut down through the earthen dams, and cause structural failures. Northern Dynasty has said that they will construct the earth fill tailings dams to the Alaska Dam Safety Programs High Potential standards. High potential is the standard that dams are constructed to if there is a likelihood of the loss of human life if the dam fails. Any current design of tailings storage facilities has to be based on the fact that they will have to survive forever. The relatively few years of data available on the magnitude of earthquakes, volcanic eruptions, floods, and storm events in Southwestern Alaska may not adequately predict events that could happen over the time scale the facilities will have to endure.

The Pebble tailings dams would be constructed on top of glacial till and fractured bedrock in a seismically active area. The design of the dams, constructed of waste rock and overburden, is based on current understanding of the location of local faults and force of future earthquakes. However, if one earthquake in the next 10,000 years is stronger than the maximum predicted, or if a previously undetected fault extends into the mine area the dams may fail and release the stored waste into the Nushagak and Kvichak drainages. An earthquake would not have to destroy the dams to release the toxic materials stored in the TSF into the ground water and into adjacent salmon spawning streams. If an earthquake just opened cracks in the bedrock below the dam, it could allow the hundreds of billions of cubic feet of contaminated water stored in the facility to leak out into ground and surface waters.

The Pebble Mine is located in an area with heavy precipitation, frequent storms and extreme temperatures. Flooding and overtopping of earth fill dams is one of the most frequent causes of dam failures. Dam design will be based on current climatic conditions and flood data available at the time of permitting. However, there are only a few years of weather and stream flow data available for the mine site and region.

Currently available data may not be an accurate predictor of the 5,000, 10,000, or 100,000 year floods at the mine site. It also does not take into account climatic change which could result in heavier and more frequent rainfall. For example, United States Geological Survey predictions of 100 year or greater flood flows for the Kenai Peninsula which experienced at least three floods which exceeded USGS 100 year flood predictions in a 20 year period may have to be revised because of rapidly melting glaciers and more severe rainstorms (Eash and Rickman, 2004). In another example, waste from the tailings impoundment at the Red Dog Mine had to be dumped into Red Dog Creek when unanticipated levels of snowmelt and rainfall threatened to over top the dam the year after the mine opened (ADN 1990).

Even if in the short term, the risk that the tailings dams will leak or fail in any year can be reduced to a very small percentage, over the infinite period that these dams will be expected to hold their toxic contents in place, the probability that a release will occur eventually becomes 100 percent.

Complex, manmade structures deteriorate as they get older. Over enough time, the complex system of liners, pipes, drains and pumps necessary to control leakage under the mine waste and maintain the stability of the 750 foot high dams, will deteriorate and fail in the corrosive environment and crushing weight of billions of tons of tailings. Any pollution control structures placed in or under the tailings impoundments or 750 foot high earthen fill dams would either be extremely expensive to fix or would not be accessible and could not be repaired or replaced.

Northern Dynasty has stated that they would be required to establish a fund to maintain the dams in perpetuity (Crafford, 2007). However, there is no guarantee that the amount will be adequate or available to deal with the problems that will become evident over the millennia that the dams will need to remain intact. There are many recent examples where the restoration bonds accepted by state and federal agencies have proven to be inadequate to construct or maintain pollution control facilities at a mine sites after closure, or where the mining corporation has dissolved and the state and federal governments have had to pay the cleanup and restoration costs (see Summitville Mine, Gilt Edge Mine, and Illinois Creek Mine in Alaska) (Chambers 2006). There is also no way to predict how social and economic conditions may change over the thousands of years that the TSFs and associated pollution control systems will need to remain intact and function properly (Bjelkevik,2005).

3.4 Slurry Pipeline Breaks: Northern Dynasty has proposed to use a104 mile long slurry pipeline to transport more than 67 billion pounds of copper concentrate from the mine to the port site on Iniskin Bay (Northern Dynasty, 2006). A return pipeline would transport slurry water back to the mine site for reuse. No discharge is currently proposed at the port site. These pipelines would cross over 120 drainages, of which more than half support important populations of spawning and rearing salmon and high value resident fish (Northern Dynasty Mines, 2005, ADF&G, 2003, Wiedmer, 2007). Although, slurry pipelines are an economical way to transport large quantities of mineral over long distances, there is also a substantial risk that the pipeline carrying abrasive and corrosive material will leak or break one or more times over its 40 to 70 year life.

Most slurry pipeline breaks occur as the result of abrasion and corrosion, but earthquakes have caused at least one major spill (Mining Watch, 2004). In Alaska there would also be a substantial risk that the concentrate might freeze and break the pipe if the flow stopped because of a pump failure or other problem in the winter (Coulter, 1976, McKetta, 1992 and Julien, et al. 2002).

Streams are always at the lowest point in a valley. Because of the mountainous terrain between the Pebble Mine site and the Iniskin Bay port site, a large quantity of copper concentrate could flow down the pipeline and into a river or stream in the event of a break at or near the crossing.

Because of the toxicity of copper to fish and aquatic life, a slurry spill that enters one of the salmon streams transecting the proposed pipeline route, such as the Newhalen River, could do substantial short and long term damage (see section on copper toxicity. A concentrate spill in a large stream would be difficult to clean up because the material would sink to the bottom and become incorporated into the substrate (Mining Watch, 2004).

Slurry pipeline breaks are fairly common, and here are five examples of recent slurry pipeline spills in the United States and one in Argentina:

Black Mesa Pipeline, Arizona: Corrosion in the 273 mile long Black Mesa coal slurry pipeline caused ruptures and seven spills between 1997 and July 1999 (The Arizona Republic, 2002). Eight additional spills occurred in 2001-2002. The most recent incident occurred on January 19, 2002, when 500 tons of coal slurry spilled into Willow Creek, a tributary of the Big Sandy River in northwestern Arizona. Coal sludge in Willow Creek was 8 inches deep. The company did not report the spill as required by the Comprehensive Environmental Response and Liability Act (CERCLA). The Arizona Department of Environmental Quality and the EPA say the pipeline maintained by Black Mesa Pipeline, Inc. has leaked more than half a million gallons of coal slurry in 15 separate spills. The pipeline company was fined $128,000 in 2001 for illegally discharging 485,000 gallons of coal slurry in seven spills between December 1997 and July 1999 (Federal Register, 2001).

Alumbrera Mine, Argentina: An earthquake on September 17, 2004, measuring 6.5 on the Richter scale caused a pipeline to break at the Alumbrera mine in Argentina, sending copper and gold concentrate into the Villa Vil River. An unknown amount of mineral concentrate filled approximately two kilometers of the Villa Vil River, which provides water for domestic consumption and irrigation to the municipality of Andalgalá in Catamarca Province. While the flood of concentrate which reached 12 meters in height left a layer of solids on top of the riverbed and river banks, the water component of the slurry penetrated up to two meters deep, carrying with it the toxic metals (Mining Watch, 2004). As a precaution, water supplies for irrigation and domestic use were cut in the whole area.

Mountain Pass Mine, California: In 1977, a major pipeline break at the Mountain Pass Mine spilled more than 2 million gallons of radioactive water onto public land on the Ivanpah Playa (Great Basin Mine Watch, 2007). The Mountain Pass Mine is located along the I-15 corridor, between Las Vegas, NV, and Baker, CA, and borders on the Mojave National Preserve. It is a rare earth mine that produces a group of minerals called lanthanides. The mine has been listed by the EPA as California's largest polluter.

Chino Mine, New Mexico: Phelps Dodge Corp. paid a $42,150 civil penalty to the New Mexico Environment Department (NMED) over contamination resulting from pipeline spills at the company's Chino Mine in New Mexico (American Metal Market, 2003). The Phoenix-based copper producer also agreed to replace the pipeline and improve pipeline operating procedures. The settlement covered three spills of tailing slurry and process water from Chino pipelines: a 480,000 gallon spill on December 8, 2000, an 18,000 gallon spill on December 21, 2000 and a 20,000 gallon spill on January 19, 2001. According to the New Mexico Environment Department, 45 spills occurred at the Chino Mine between 1990 and 2001.

Century Mine, Ohio: In 2005, more than 30,000 gallons of coal sludge spilled from a pipeline that did not have a required permit, killing most of the fish in Capatina Creek. The spill resulted from a fist-sized hole in the three-mile-long pipeline that runs from American Energy Corp.'s Century Mine to a disposal area for slurry, a mix of water and impurities generated in coal processing (The Akron Beacon Journal, 2005).

3.4.1 Discussion: The only reported slurry pipeline break in Alaska was a 200,000 gallon concentrate spill at the Red Dog Mine in 1998 (ADN 1989). However; there have been a number of oil pipeline breaks from accidents, corrosion and sabotage. It is very difficult to protect a long unguarded pipeline from malicious acts, and impossible to prevent accidents and natural forces, such as earthquakes and floods. It is also not possible to judge the day to day diligence and effectiveness of state agencies in monitoring and regulating pipeline maintenance in Alaska, except where a notable event such as an oil spill and pipeline shut down occurs. The recent break of one of the main pipelines in Prudhoe Bay in 2006 due to corrosion and poor maintenance resulted from British Petroleum's failure to properly maintain the pipeline. However, oversight of oil pipeline safety was an Alaska Department of Environmental Conservation responsibility. This incident raises questions about the ability of state agencies to guarantee that measures to prevent slurry pipeline breaks can be effectively enforced.

3.5 Dust and other Emissions from Large Scale Mining is a Serious Environmental Problem: In the process of large-scale mining, dust and other emissions are an inevitable problem. These dust particles originate from: ore crushing, conveyance of crushed ore, loading bins, blasting, motor vehicle traffic, use of haul roads, waste rock piles, windblown tailings, processing ore and disturbed areas (Kennedy, B., 1990). Dust from the Pebble Project Mine would contain copper and iron sulfides, and likely other toxic heavy metals such as mercury, cadmium, and zinc which are present in fairly high levels in water samples from the mine area (Northern Dynasty, 2004). Sulfide dust from the Pebble Project Mine could also form sulfuric acid and dissolve the copper and other metals present when it comes in contact with water. Windblown dust can travel for miles and contaminate nearby lakes and streams with harmful levels of heavy metals. The Pebble Project Mine site, haul road, and proposed Iniskin Bay port site are areas with frequent storms and high winds (Northern Dynasty Mines, 2005, and Leslie, 1989). All of these facilities are located near salmon and high value resident fish streams, and in the case of Iniskin Bay, a productive and pristine marine environment. Dust containing heavy metals, can cause also human health problems.

Three examples of mining related dust problems that were not prevented by permit conditions or agency monitoring are:

The Red Dog Mine, Alaska: The Red Dog Mine in N.W. Alaska is an example of how dust from mining activities without effective monitoring and regulation can become a serious environmental problem. Beginning in 1989, trucks hauling concentrate for the mine to the port spread lead, zinc and cadmium dust along the haul road unbeknownst to mine officials and state and federal regulators. In 2000 scientists found extremely high levels of heavy metals in moss (*Hylocomium splendens*) on National Park Service lands adjacent to the haul road. The study confirmed that the source of this contamination was dust from trucks hauling concentrate (Ford and Hasselbach, 2001). Levels of lead, zinc, and cadmium in samples downwind from the Red

Dog haul road equal or exceeded the maximum levels of these heavy metals from samples from severely polluted regions in other areas of the world (Ford and Hasselbach, 2001).

In 2004, scientists measured the magnitude and severity of contamination from fugitive dust from the Red Dog Mine on National Park Lands adjacent to the 55 mile long haul road between the mine and port site on the Chukchi Sea (Hasselbach, L., et al. 2005). Trucks hauling sulfide based lead zinc concentrate were covered with lead zinc dust generated in the loading and unloading process at the mine and port site. The dust was then blown or washed from truck surfaces by rain during transit from the port to the mine and back. The concentrate trucks were also poorly covered (until new trucks were acquired in 2001), and concentrate-dust blew from the trucks as they were driven from the mine to the port. Surface soil levels of 27,000 mg/kg (27 times the EPA industrial cleanup standard was found near port operational areas in a 1996 monitoring summary. Researchers measured lead and cadmium levels in moss adjacent to the Red Dog haul road within the Cape Krusenstern National Monument. Lead contamination was found to extend 25 kilometers (15 miles) north of the road, and 45 kilometers (27 miles) south of the haul road (Hasselbach et al. 2005).

Mining related dust deposition can be distinguished from natural deposits in the area by the composition of the dust and dust concentrations at the soils surface (USGS, 2003). Lead and cadmium levels within 10 meters of the haul road ranged from 6.9 to 24.3 ppm for cadmium and 271 to 912 parts ppm for lead. The Environmental Protection Agency's acute toxic standard for cadmium and lead in water are 2.0 parts per billion and 65 parts per billion respectively. The chronic toxicity standard for cadmium and lead are 0.25 ppb and 2.0 ppb respectively (Environmental Protection Agency, 2007f).

The report estimates that over 3,592 (8,872acres) hectares of National Park Land are contaminated with greater than 2 ppm of cadmium and 58,067 hectares (143,425 acres) of land are contaminated with greater than 20 ppm of lead from fugitive dust resulting from the movement of ore concentrate. Trucks using the haul road and loading area are not the only source of dust pollution in the Red Dog Mine area. Similarly elevated levels of lead, cadmium and zinc have also been found in a subsequent study of mine dust on private property downwind of the mine (Clark, 2005).

Seward Coal Dock, Alaska: Coal dust from the Alaska Railroad's coal loading facility in Seward has been a problem since the 1980's (Anchorage Daily News, 2007f). After a particularly serious event in the spring of 2007 which coated boats and cars and blackened the air in Seward, the railroad was cited and ordered to come up with a plan to control emissions from the loading facility.

Nevada Gold Mines: The 1998 EPA Toxic Release Inventory (TRI) reported that northern Nevada metals mines released approximately 7 tons of mercury to the atmosphere in 1998 (National Risk Management Research Laboratory, 2000). The primary source of these omissions appeared to be ore processing. As a result of the 1998 TRI report, the State of Nevada and EPA first instituted a voluntary program to control emissions from these mines, and then in 2007 the State of Nevada instituted a mandatory regulatory program (Nevada DEP, 2007. Nevada adopted the regulations because "Mercury emissions from mining are not regulated under the National

Ambient Air Quality Standards (NAAQS) or under the National Emission Standards for Hazardous Air Pollutants (NESHAPS) for gold or silver mining." "Although, there are regulatory requirements under title V of the Clean Air Act (CAA) mercury is also not regulated under the New Source performance Standards (NSPS) Regulations." (National Risk Management Research Laboratory, 2003).

Although, a regulatory program to control emissions was instituted, it does not appear that mercury emissions from the northern Nevada mines have been abated as of 2007 (EPA, 2007e). There are also allegations that emissions from the mines have not been accurately reported (Hayes, 2005). According to a 2007 Earthworks report, researchers at the University of Nevada found very high levels of mercury in air samples taken at three Northern Nevada gold mines. Earthworks also reported that "According to EPA's (2005) Toxics Release inventory, northern Nevada gold mines release over 4,600 pounds of mercury into the air each year -- about 18 times the amount of mercury released by the average coal-fired power plant (Earthworks, 2007 and EPA, 2007e). Northern Nevada's gold mines are the largest single industrial source of U.S. mercury air emissions west of Texas." (Earthworks, 2007). Mercury emissions from Nevada mines have been implicated in high mercury levels in fish in Utah and Idaho (Hayes, 2005, and Utah Department of Environmental Quality 2007).

3.5.1 Discussion: The Pebble Mine site is located in an area with strong and frequent winds blowing from both the east and west (Northern Dynasty, 2005, Leslie, 1989). Dust would be generated by primarily from blasting, ore hauling, and storing tailings because it is not possible to completely control dust from all of these activities particularly in an open pit mine (Kennedy, 1990). It is likely that land and water downwind of the mine pits, mill, tailings storage facilities, and port would be contaminated for some distance by dust and emissions from the Pebble Mine over the 40 to 70 year life of the mine. This dust is likely to be contaminated with copper, mercury and other heavy metals found in the ore. This dust might increase concentrations of heavy metals in surface waters to levels that are harmful to fish and other aquatic life.

3.6 Groundwater Pollution: In spite of state and federal regulations and stipulations designed to prevent it, groundwater pollution continues to be a serious problem at mines in the United States (Kuipers, et al. 2006). Acid drainage, heavy metals and mine chemicals from closed and abandoned mine pits, tunnels and tailings storage facilities have seeped into the groundwater under mines tainting aquifers (see the section on acid mine drainage). This contaminated groundwater has surfaced in lakes and streams, killing aquatic life.

Groundwater is the part of precipitation that seeps down through the soil until it reaches an impermeable layer of rock material that is saturated with water. Water in the ground is stored in the spaces between rock particles (Environmental Protection Agency, 2007g). Since groundwater moves from the surface down through rocks and subsurface soil, it has a lot of opportunity to dissolve substances as it moves. Because water is such an excellent solvent it can contain lots of dissolved chemicals. For this reason, ground water will often have more dissolved substances than surface water. Naturally occurring contaminants are present in the rocks and sediments. As ground water flows through sediments, metals such as copper, mercury, iron, cadmium and manganese are dissolved and may later be found in high concentrations in the water (Environmental Protection Agency, 2007g).

Like streams and rivers, ground water moves down gradient from high areas to low areas at right angles to subterranean contour lines. However, because these contours are covered with up to hundreds of feet of permeable soil, it is often difficult to model the direction and rate of flow with any degree of accuracy. Groundwater moves through the subsurface like water on the surface, except it travels more slowly. In sand and gravel it may move up to 5 feet per day, in other types of material it may move a few inches per day (Environmental Protection Agency, 2007g). Northern Dynasty's 2004 baseline studies report indicates that the movement of groundwater in the mine area is relatively rapid (Northern Dynasty Mines, 2005).

Results from the analysis of ground water from 12 monitoring wells that Northern Dynasty drilled shows that many of the dissolved trace metals on the Environmental Protection Agency's list of priority pollutants including: antimony, arsenic, beryllium, cadmium, chromium, copper, lead, mercury, nickel, selenium, silver, and zinc (Environmental Protection Agency, 2007f) are present in the ground water in the mine area and under the proposed tailings dam sites. Most of these same metals are found in the steams which drain the mine area, albeit in lower concentrations. Dissolved metals found in monitoring wells were generally from 0.1 to 0.7 of the state human health and aquatic life criteria, except for mercury and cadmium. Four wells had mercury levels which exceed the human health standard for mercury of 0.050 parts per trillion with levels up to 0.122 parts per trillion. One well had cadmium levels 1.4 times the allowable standard (Northern Dynasty Mines, 2005.

The presence of heavy metals in ground water from undisturbed mineralized areas is common. However, because of the limited amount of ore body exposed to water and oxygen prior to mining, the levels in the ground water and entering surface waters usually do not reach toxic levels (Environmental Protection Agency, 1994b).

The streams receiving ground and surface water from the Pebble Mine site can be classified as gaining or losing. Gaining streams receive much of their water from groundwater, and the water level in the stream is generally at the same elevation as the water table in the adjacent aquifer. Water quality in the stream will be affected by the quality of groundwater entering the stream. Because the water table elevation is approximately the same as the gaining stream surface elevation, both elevations may be used to predict the general direction of groundwater flow. Losing streams lose water to the adjacent aquifer because the water table has dropped below the stream level. If there is no major source of upstream flow, the stream may dry up between rainfall events (Environmental Protection Agency, 2007g).

Northern Dynasty has installed stream gauges to monitor surface flow and monitoring wells to provide information about groundwater quality and movement. Based on stream flow information provided in Northern Dynasty Mines, Inc. 2004 Environmental Studies Reports and their 2006 water rights application, it appears that groundwater from the mine area is an important contributor to stream flow in the North and South Forks of the Koktuli River and Upper Talarik Creek (Northern Dynasty Mines, 2005 and 2006). This appears to be particularly true during critical summer and winter low flow periods when there is little precipitation and surface run off.

There was little or no precipitation in the mine area between the time the stream gauges were installed in July until mid to late September, 2004 (Northern Dynasty, 2005). During these dry periods it is assumed that the streams studied approached base flow conditions in which the only contributing flows were from groundwater. During this period, gauges on the South Fork Koktuli River showed that it gained water at station SK 136A and at the vicinity of station SK 100A. Station SK 136 is at the very headwaters of the South Fork on the southern edge of the Pebble West ore body, and SK 100A is 27 miles downstream near the confluence with the North Fork Koktuli River. The remaining 26 miles of the South Fork shows a losing pattern, where stream flow is lost to groundwater. According to the 2004 report the section from SK 100 B (mile 12.2) to SK 100 F (mile 18.45) was losing water during the study period. In mid July, the midsection of the South Fork around SK 100C (mile 17.6) was reported to be dry. The section between SK 100 C and SK 100 F is thought to be losing water to the Kaskanak Creek Basin. During the same time period, the North Fork Koktuli River lost water at all locations except NK 119B. This stream gauge is near the confluence of tributary NK 119 and the North Fork Koktuli. Similarly, Upper Talarik Creek gauges showed that it gained groundwater from its headwaters and the areas of the proposed Pebble East and West pits (UT 100D), but lost water from the area just below the Pebble East pit (UT 100D) down to UT 100B, 14.62 miles downstream.

3.6.1 Discussion: Groundwater flow dynamics in the Pebble Mine area have important implications for fish habitat and water quality. Groundwater is the most important water source to stream gravel during low flow periods in July and August when sockeye, Chinook, and chum salmon are spawning, and from January through March when incubating eggs and over wintering juvenile salmon require a consistent inflow of ground water to survive (Groot and Margolis, 1991). The removal of ground water from these drainages would reduce both the amount of available spawning area for salmon and resident fish species, and critical over wintering habitat. This in turn would reduce salmon and resident fish production from these three streams.

Based on the direction of ground water flow and the presence of seeps and upwelling there appears to be a connection between groundwater origination from the area of the Pebble West and East ore bodies, and from under proposed Tailings Storage Areas A and G, and the three streams draining the mine area (Northern Dynasty Mines, 2005). This means that pollutants leaking from the mine pit or from under the tailings storage areas into the groundwater could be conveyed into the North and South Forks of the Koktuli River and Upper Talarik Creek. Mining may also increase the level of harmful pollutants in the ground water, by breaking up the rock containing metals and sulfur and exposing them to groundwater as it percolates through the ground (Younger, et al. 2002).

Gossan Creek is an example of how groundwater pollution emanating from mines affects streams. Gossan Creek, a first-order stream in the Upsalquitch River watershed in the Canadian Province of New Brunswick, contained elevated concentrations of mercury and other heavy metals, as a result of leaching from a gold-mine tailings disposal site (Maprani, et al. 2003). Field and laboratory research revealed that the tailings pile was a point source of mercury into the aqueous system. A contaminated ground water plume originated from the tailings pile and discharged into the headwaters of Gossan Creek. The ground water and the headwaters of the stream system were found to contain high concentrations of mercury (up to 60 ppb), Cu, Al, Fe, Zn, Mn, Ni, Co, As and cyanide (CN). The levels of all mercury compounds were measured in the stream and it was found that mercury levels declined by 95-99% within 4 km from the source. The loss of mercury from the water was attributed to accumulation in the sediments and biota and to evaporation from the stream to the atmosphere (Maprani, et al. 2003).

Northern Dynasty has indicated that over the 40 to 50 year operating life of the mine they intend to try to capture all of the groundwater from the mine and tailings storage areas and use it in the mining process or return it to the tailings ponds. However, after cessation of mining, Northern Dynasty would pass on the responsibility and liability for preventing ground and surface water pollution from the closed or abandoned mine pit and or tunnels, and up to 8.2 billions tons of mine waste and hundreds of billions of cubic feet of mine process water stored in the tailings storage facilities to the ADNR. The ADNR would have to insure that (1) both the surface and ground water emanating from the water filled mine which may be acidic and contaminated with heavy metals and, (2) the water leaking from the tailings ponds which is also likely to be contaminated with heavy metals and mine chemicals would be captured and treated in perpetuity. If successful, this would prevent contaminated ground water from reaching these streams and killing aquatic life.

The questions which have to be asked are: (1) is it feasible to capture all of the ground water flowing through underground aquifers and cracks in the bedrock over a 35 square mile area during active mining; (2) is it possible that these groundwater capture systems at the mine and tailings storage facilities will not fail or breakdown over the tens of thousands of years they will have to operate to prevent chronic pollution after mine closure or abandonment; (3) is it possible that a larger than anticipate earth quake, rainfall event, or accident might occur that would result in an catastrophic release of contaminated water from the mine or tailings storage facilities , and (4) during the eons that pollution control measures will have to function at the closed or abandoned mine and tailings storage facilities , will state regulators detect and prevent leakage or an equipment failure before pollution reaches the waters of Nushagak or Kvichak drainages?

Considering that recently permitted large metals mines in the United States have consistently polluted ground water and that the state and federal regulatory process' have not been effective in preventing it, a risk of serious ground water pollution from the Pebble Project exists, particularly over an almost infinite time frame(Kuipers, et al. 2006).

4. RESOURCES AT RISK: FISH

4.1 Fish Populations at Mine Site: The proposed Pebble Project copper mine is located at the headwaters of the North and South Forks of the Koktuli River and Upper Talarik Creek. The proposed Pebble West Pit is drained by tributaries of Upper Talarik Creek and the South Fork Koktuli (Figure 5). The Pebble East Ore body is contiguous with the eastern portion of the Pebble West Pit, and appears to extend eastward under the main stem of Upper Talarik Creek. The Koktuli River is a tributary of the Mulchatna River and is part of the Nushagak River drainage. Upper Talarik Creek discharges into Lake Iliamna which is part of the Kvichak River drainage.

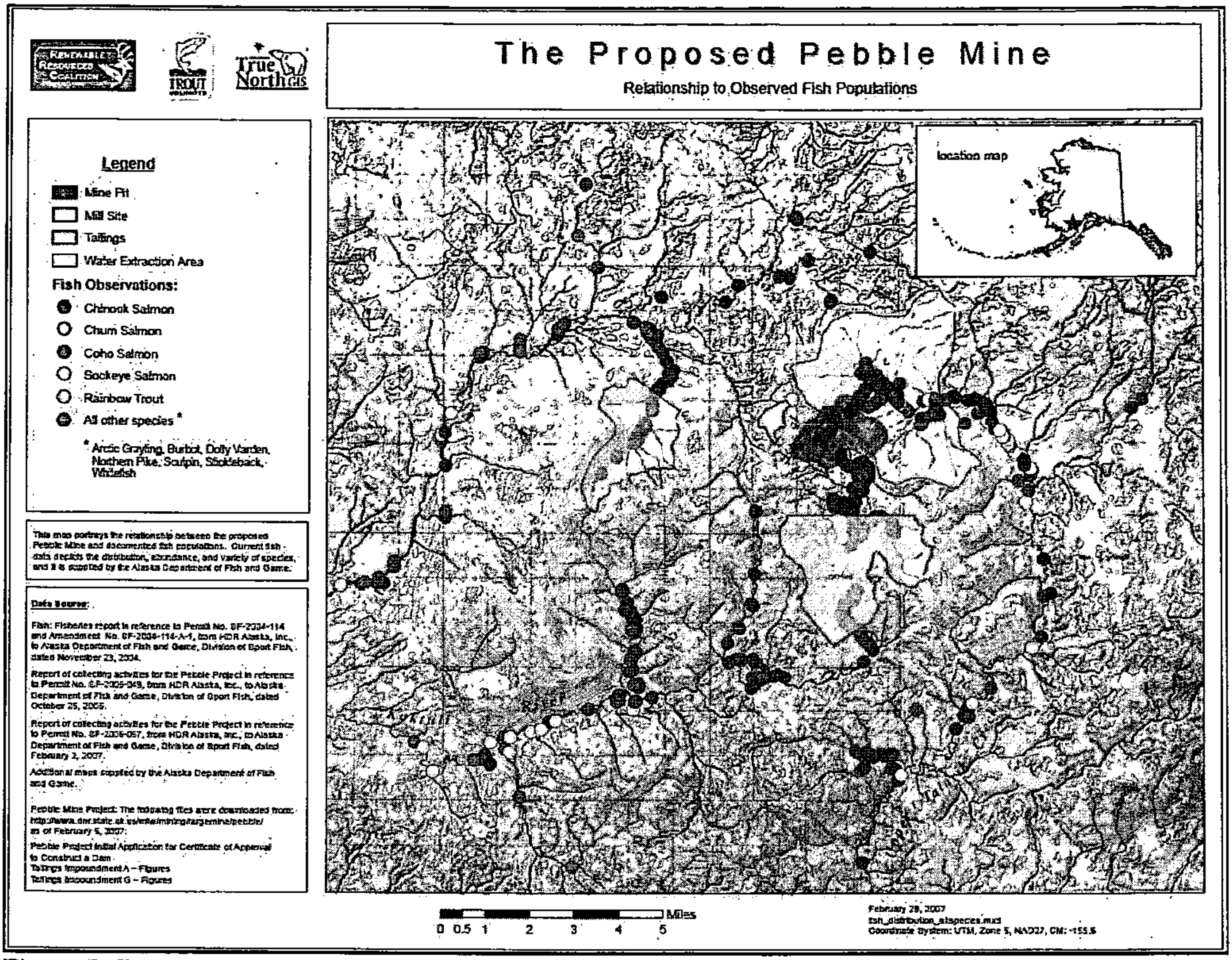

Figure 5. The Relationship of the Proposed Pebble Project Copper Mine to Existing Fish Stocks
(Note: figure used with permission of the Renewable Resources Coalition)

The fish species present in the portions of Upper Talarik Creek and North and South Fork Koktuli River drainages which would be directly affected by the Pebble Mine are shown in Table 3 (Northern Dynasty Mines, 2005).

Table 3. Number of Fish by Species from Spot Samples Taken from Area Directly Impacted by Pebble Mine and Associated Facilities

	Drainage				
	South Fork Koktuli			North Fork Koktuli	Upper Talarik Creek
Species	Below FPL	FPL	Above FPL	Stream 1.19	
coho	45	0	13	41	536
chinook	0	0	0	20	0
sockeye	0	3	0	0	0
rainbow trout	0	0	0	0	1
Dolly Varden	4	0	0	451	12
grayling	279	44	47	28	0
northern pike	27	589	40	0	0
burbot	1	0	0	0	0
scuplin	122	0	112	461	305
stickleback	1	0	0	0	0
whitefish	1	0	0	0	0

Note: FPL is Frying Pan Lake. Stream 1.19 is a tributary to the North Fork Koktuli which would be covered by Tailings Storage Facility G. (Northern Dynasty Mines, 2006)

Preliminary fish sampling by Northern Dynasty contractors in 2004 found juvenile coho, Chinook and sockeye salmon was well as high value resident fish species such as Dolly Varden (Salvelinus *malma*), Arctic grayling (Thymallus *arcticus*), and northern pike (Esox *lucius*) in the reaches of Upper Talarik Creek and the North and South Forks of the Koktuli River which would be occupied by the mine and tailings storage facilities (TSF) (Table 2). Sampling methods used included electroshocking, angling in lakes and ponds, and hoop nets in Frying Pan Lake. In the 2004 fish surveys Frying Pan Lake and its upstream tributaries were found to support adult and juvenile northern pike, Arctic grayling and rearing juvenile sockeye and coho salmon (Northern Dynasty Mines, 2005). The headwaters of Upper Talarik Creek and its tributaries, including the portion which may be impacted by the extension of the Pebble East ore body, were found to provide spawning and rearing habitat for Chinook, sockeye and coho salmon, and Dolly Varden (Table 3). The data in Table 2 is from spot samples of fish taken at a number of locations in stream segments within the mine area which would be excavated, dewatered or buried under tailings storage facilities. Most of the salmon collected were rearing juveniles, but that could be an artifact of the time and location, and method used to take the samples. The HDR fish data is not quantative, but the samples do confirm the presence of substantial numbers of rearing salmon and high value resident fish in the portions of these streams which would be dewatered, buried, or otherwise impacted by mining activities.

The amount of sampling in the mine area was limited, and fish species and numbers in the mine area could vary at different times and locations. For example, stream flow's in July and August of 2004 were unusually low (United States Geological Survey, 2007, Northern Dynasty, 2004).

If 2004 Northern Dynasty samples were taken when the upstream migration of adult and rearing juvenile salmon into the mine area was blocked or restricted because portions of the upper South Fork Koktuli were dry, the number of adult and juvenile salmon in the sampling area might be substantially less than years or months when fish movements were not restricted.

4.2. Fish Populations Downstream From The Mine: The North and South Forks of the Koktuli River and Upper Talarkik Creek downstream from the mine are important salmon and high value resident fish spawning and rearing streams. These streams are also important contributors to the Nushagak and Kvichak drainage commercial, subsistence and recreational fisheries. Estimates of the number of spawning adult salmon in Upper Talarik Creek (U.T.), North and South Fork Koktuli Rivers (SFK and NFK), and Y Valley Creek at the proposed port facility are shown in Table 4 (Northern Dynasty Mines 2005).

Table 4: Adult Salmon Point Estimates of Escapement (2004-2005)

Species	Year	U.T	SFK	NFK	Y Valley
Chinook	2004		7265	7136	
Salmon	2005	194	3243	5621	
Sockeye	2004	12,400	9295	2338	
Salmon	2005	62771	6791	4140	
Coho	2004	8452	1224	1660	
Salmon	2005	6277	3203		
Chum	2004				
Salmon	2005			1510	11149

Note: HDR Alaska , Inc.fisheries scientists conducted stream surveys and then extimated fish numbers in the study area by day, using linear interpolation for the days not surveyed.

Fish surveys by both Northern Dynasty contractors and the Alaska Department of Fish and Game confirm that the North and South Forks of the Koktuli River and Upper Talarik Creek are important and productive systems which produce substantial numbers of Chinook, coho, and sockeye salmon (ADF&G, 2007). The North Fork of the Koktuli River is also a locally important chum salmon producer. When considering aerial escapement estimates it should be noted that aerial surveys escapement counts are only indexes and may only count a fraction of the salmon in a stream (Jones et al. 1998, and Visser et al. 2002). Furthermore, in a normal year, a large, but unknown percentage of the salmon produced in these streams (50 to 65 percent), are caught in the commercial and subsistence and are not included in spawning estimates. The Koktuli River is one of the most important Chinook salmon spawning streams in the Nushagak River drainage (ADF&G, 2006). In some years it hosts up to 25% of all of the Chinook spawning in the Nushagak river system (ADF&G, 2007). Upper Talarik Creek is a very productive system, providing spawning and rearing habitat for large numbers of sockeye and coho salmon to the Kvichak river drainage.

The North and South Fork of the Koktuli River and Upper Talarik Creek also support large numbers of other high value resident fish species, including Arctic grayling, Arctic char, rainbow trout, Dolly Varden, and northern pike. The Koktuli River and Upper Talarik Creek provide sport fishing opportunities for rainbow trout, coho and Chinook salmon.

4.3 In The Nushagak And Kvichak River Drainages: Lake Iliamna, the Mulchatna River, and the portions of the Nushagak River drainage downstream from the proposed Pebble mine would be affected if high volumes of acid mine drainage and heavy metals flowed from the mine into the Koktuli River and Upper Talarik Creek. Together the Kvichak and Nushagak River drainages have historically been the biggest producers of sockeye and other species of salmon in Bristol Bay, which is the world's largest producer of sockeye salmon (Alaska Department of Fish and Game, 2007). The 2006 inshore Bristol Bay sockeye salmon run of slightly more than 43.1 million fish was the 9th largest inshore run since 1952 (Salomone, et al. 2007). Historically, the Kvichak River drainage, which includes the Alagnak, Lake Iliamna, and Lake Clark drainages, has been the largest sockeye salmon producing system in Alaska and the world (Burgner, 1991). The Nushagak River drainage, which includes the Wood River, Mulchatna and Nuyakuk Rivers, is also the largest producer of Chinook and chum salmon in Bristol Bay (Westing, et al. 2006).

Estimates of total run size, including catch and escapement from the Nushagak and Kvichak-Naknek drainages are provided in Table 5 (Westing et al. 2006).

Table 5: Total Inshore Run of Salmon, Nushagak and Kvichak River Drainages (1985-2005)

	Numbers Of Salmon		
	High	Low	20 Year Average
NUSHAGAK RIVER			
Sockeye Salmon	8,900, 322	4,527,953	6,188,579
Chinook Salmon	244,107	75,216	144,334
Chum Salmon	1,090,975	255,777	655,802
Coho Salmon see note	260,310	93	107,534
Pink Salmon see note	243,890	204	83,793
KVICHAK-INAKNEK			
Sockeye Salmon	33,229,901	1,411,225	12,673,623
Chinook Salmon see note	7,477	567	3,788
Chum Salmon see note	446,908	8,719	185,803
Coho Salmon see note	29,988	0	7,219
Pink Salmon see note	648,569	4,590	144,627

Note: numbers for Nushagak River coho and pink salmon, and Kvichak and Naknek Chinook, chum,coho, and pink salmon are catch only. No escapement numbers are available.

Commercial Fishery: The Bristol Bay sockeye salmon fishery is the largest in the world and the largest source of private sector income in the Bristol Bay region (Morstad.and Baker, 2006). The Bristol Bay fishery employs over 4239 workers and annual income from the fishery has reached as high as $350 million dollars (Dufield, 2007).

The 2006 harvest of nearly 29.0 million sockeye was the 8th largest since 1893, and the 2006 inshore run of 43.1 million sockeye was 23% above the 20-year average (Salomone, et al. 2007). The 2006 Bristol Bay commercial harvest of approximately 106 thousand Chinook salmon was the fifth largest in the last 20 years and 51% above the 20-year average of 70 thousand.
The harvest of approximately 53 thousand coho salmon in Bristol Bay was well below the 20-year average of 103 thousand, but the Nushagak River was above its 20 year average and provided 81% of the coho catch. The chum salmon harvest of approximately 2.1 million was the largest in 20 years.

The 2006 harvest of all salmon species in Bristol Bay totaled approximately 31 million fish. The ex-vessel value of the catch was $93,935,000 (Salomone et al. 2007). The ex-vessel value is the amount paid to fishermen for their fish at the dock.

The Kvichak and Nushagak River systems provided most of the Bristol Bay salmon production (catch and escapement) in 2006. The total inshore sockeye run into the Nushagak District, which includes the Nushagak River and its tributary the Wood River, was more than double the forecast, coming in at 16.0 million sockeye in 2006. The Kvichak –Naknek District which includes both the Kvichak and Naknek River drainages and the Nushagak District provided 63% of the total 2006 Bristol Bay catch of 29 million sockeye. The Kvichak River drainage (includes the Alagnak River) and the Nushagak River drainage (includes the Wood River system) together provided over 65 % of the Bays 14.6 million sockeye salmon escapement (Salomone, et al. 2007). The Nushagak River drainage provided 80% of the total Bristol Bay Chinook catch, and 81% of the coho harvest.

Subsistence and Recreational Fisheries: The Kvichak and Nushagak River drainages also support economically and socially important subsistence and recreational fisheries. Bristol Bay residents are dependent on the harvest of salmon, freshwater fish, moose and caribou for food. Surveys taken in the 1980's and 1990's indicate that the 7,611 residents of 25 Bristol Bay villages harvested about 2.4 million pounds of fish and wildlife for subsistence annually (Duffield, et al.2007). The average annual salmon harvest for the period 1983-2003 was 155,153 salmon of all species (Duffield, et al.2007). Over 90% of these salmon were caught by residents of the Nushagak and Kvichak River drainages.

According to the ADF&G Sport Fish Division, the "Bristol Bay management area contains some of the most productive salmon, rainbow trout, Arctic grayling, arctic char, and Dolly Varden waters in the world." (ADF&G 2007). The most popular drainages include the Nushagak/ Mulchatna Rivers, the Wood River Lakes system, the Kvichak River and Lake Iliamna, the Naknek River, and the Togiak River (ADF&G, 2007). According to ADF&G these rivers and lakes provide" unparalleled angling opportunities". The Bristol Bay sport fisheries employs approximately 846 people and generates around 61million dollars in annual revenues (Duffield, et al. 2007).

Ecosystem Value: Bristol Bay salmon also play a major role in the productivity of the Bristol Bay terrestrial and freshwater ecosystems. Pacific salmon and other anadromous salmonids are the major vehicle transporting marine nutrients across ecosystem boundaries (i.e., from marine to freshwater and terrestrial ecosystems) (Shindler, 2003). Salmon provide nutrients and energy to biota within aquatic and terrestrial ecosystems through various pathways (Cederholm et al.1999). The annual deposition of marine nutrients from salmon is vitally important in maintaining the productivity of the lakes, streams, and riparian areas of the region (Naiman, et al. 2002). Salmon derived nutrients make up a substantial fraction of the plants and animals in aquatic and terrestrial habitats associated with healthy salmon populations (Schindler, et al. 2003).

Salmon and salmon carcasses are a major food source for all of the terrestrial predators and scavengers in the region including brown and black bears, wolves, foxes, and eagles. These species help to transfer marine nutrients from lakes and streams to uplands (Shindler, et al. 2003, and Gresh et al. 2000). Salmon eggs and carcasses are a vital food source for rearing juvenile salmon, rainbow trout, Dolly Varden and Arctic grayling. Juvenile salmon are an important food source for the large populations of resident fish species such as rainbow trout, Dolly Varden and Arctic grayling found in Bristol Bay streams. The rich food source maintains the large number of these species found in the region. Without large salmon escapements and the associated input of marine nutrients the productivity of the region and numbers freshwater and terrestrial species in Bristol Bay dependent on salmon would diminish substantially (Gresh et al. 2000).

Discussion: Harvest and escapement figures show that the Bristol Bay drainage is clearly the premier salmon producing system remaining in the world. This is due in large part to pristine habitat, clean water, and good fisheries management. The production and harvest of salmon in Bristol Bay is critical to the regional economy, culture and ecosystem.

Proponents of the Pebble Mine have used the Frazer River, which is Canada's most productive salmon system, as evidence that hard rock mining is entirely compatible with the maintenance of salmon production in the Nushagak and Kvichak River systems (McGee, 2007 and Schindler and Hilborn, 2008). However, the collapse of the Frazer River fishery may actually be an example of how development of a watershed is incompatible with the maintenance of salmon populations. Frazer River sockeye harvests have precipitously declined from a high of around 60 million pounds in the early 1990's to a few million pounds or less by 1999 (Fisheries and Oceans Canada, 2008). This decline resulted in periodic fishing closures beginning in the late 1990's. In 2007 commercial, recreational and subsistence fishing were closed completely because of poor returns and escapement (CBC News, 2007). The outlook for 2008 remains bleak. These declines have occurred despite a substantial public investment in state of the art salmon habitat enhancement in the last three decades (Schindler and Hilborn, 2008). The Frazer River watershed has been developed for mining, logging, urban development, and agriculture. According to Canada's Fisheries and Oceans, which is responsible for Canadian fisheries policy, the reasons the continuing decline are not fully known, but "high water temperatures" and "habitat destruction" are thought to be factors (Fisheries and Oceans Canada, 2008).

4.4 Fish Populations Downstream of the Road, Pipeline, and Transmission Line Corridor: Up to 120 streams crossed by the access road, slurry pipelines, or electrical transmission line would be directly impacted by road construction, gravel extraction, wetland fills and stream crossing structures (Northern Dynasty 2004). Fish using these streams and upstream and downstream spawning areas could also be impacted by slurry pipe line breaks, and any chemical or fuel spills into these streams.

The Alaska Department of Fish and Game has identified 36 rivers, streams and small tributaries on the north shore of Lake Iliamna which provide salmon and resident fish habitat and could be affected by the Pebble Project mine, access road and pipeline corridor. The salmon streams are identified in the Catalog of Waters Important for the Spawning, Rearing or Migration of Anadromous Fish (Alaska Department of Fish and Game 2003), and include important sockeye, Chinook, and coho salmon producers, such as the Newhalen River, Knutson Creek, Canyon Creek Chekok Creek, Pile Bay River, and Iliamna River. Known salmon and resident fish streams which would be affected by the proposed Pebble mine access road and pipeline corridor are depicted in Figure 6.

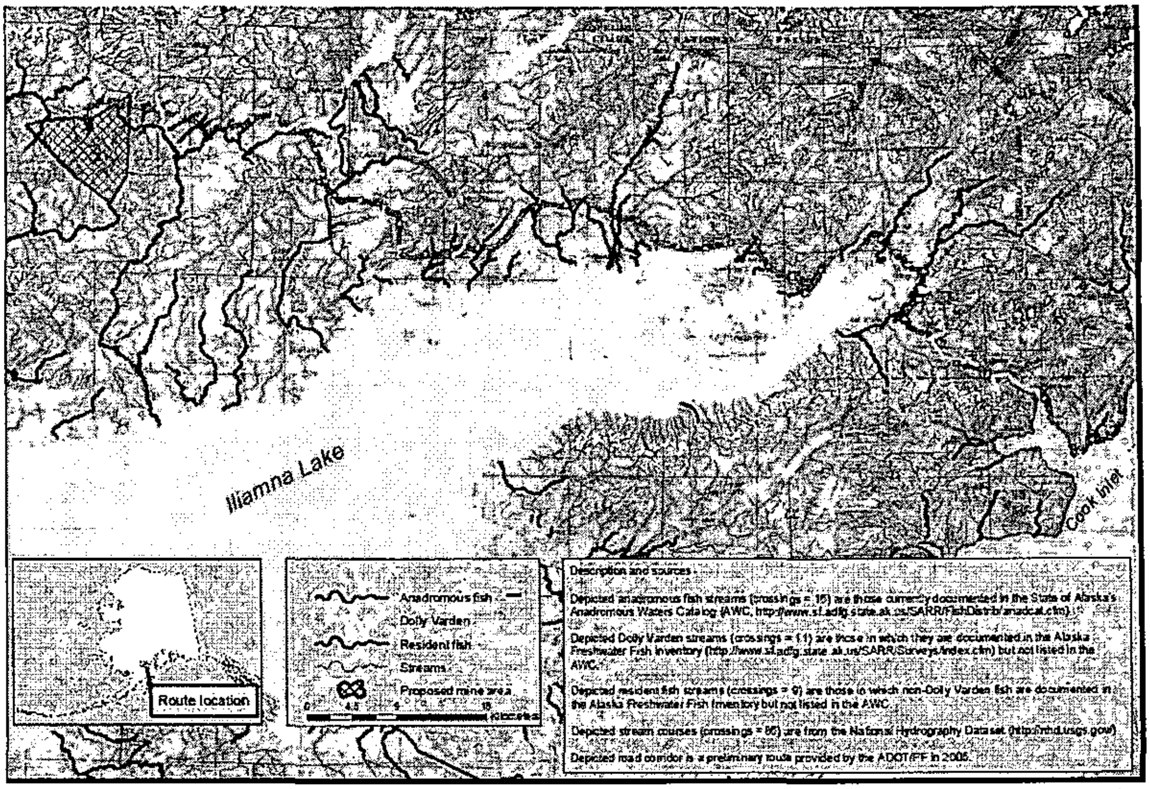

Figure 6. Known Salmon and Resident Fish Streams Which Would be Affected by the Proposed Pebble Mine, Access Road and Pipeline Corridor (Map used with permission of Michael Wiedmer, 2007.)

The north shore drainages and beaches of Iliamna Lake are also used as sockeye spawning index areas by ADF&G (Table 6). ADF&G has also identified 13 beach spawning locations along the north shore of Lake Iliamna which could be impacted by any pollutants carried downstream by road corridor drainages (Alaska Department of Fish and Game, 2003).

Table 6. High, Low and 2004 Index Numbers of Sockeye Salmon Spawners by Area, Lake Iliamna and Lake Clark Spawning Grounds Which May be Affected by Pebble Mine or Access Road (ADF&G, 2006)

Spawning Area	Escapement Index Count Low	High	2004
Upper Talarik Ck.	47	70,600	70,600
% total escapement	0.00%	0.13%	0.13%
Newhalen R. system	100	1,451,050	33,000
% total escapement	0.01%	6.40%	0.60%
N.E streams	2,200	154,000	80,700
% total escapement	0.06%	1.37%	1.40%
N.E. Ponds	30	124,711	2,200
% total esc escapement	0.01%	0.89%	0.04%
Iliamna River system	3,050	414,855	138,500
% total escapement	1.22%	3.16%	2.52%
Lake Beaches N.E Shore	1820	1,017,000	43,000
% total escapement	0.19%	6.95%	0.78%
S. Shore Beaches Pile Bay	10	8,000	1,900
% total escapement	0.00%	0.05%	0.03%
Lake Clark system	100	374,551	19,730
% total escapement	0.01%	3.34	0.36%

Total index escapement	642,340
Kvichak Tower escapement	5,500,134
%of total escapement	11.60%

Note: Index counts are only an estimate of the numbers present and are only a fraction of the actual number. The percentages of total escapement is the percentage of the actual number of sockeye entering Lake Iliamna as measured at the Kvichak Tower.

Northern Dynasty Surveys: Consultants for Northern Dynasty Mines (2005) sampled 120 streams crossed by the proposed 95 mile long Pebble Mine haul road corridor, between the mine site and proposed port site at Iniskin Bay (Figure's 1 and 4). According to Northern Dynasty, the study emphasized data collection at smaller streams where culvert crossings are most likely. Larger streams with well known resources and planned bridge crossings received less effort. The intent was to adequately characterize fish use within the sample reach (Northern Dynasty Mines, 2005). Within small, wadeable streams, the entire catch was identified to species, measured and released alive near the point of capture.

Sampling was conducted between August 5 and September 8 of 2004. Forty one streams were dry at the time of the survey. Fish collection data were provided for 69 streams in a 2004 memorandum (McLarnon, 2004). This data is summarized in Appendix 1. Of the 69 streams reported on, fish were found in 55 streams and 14 had no fish at the location and time sampled.

The Northern Dynasty survey data leaves 10 streams unaccounted for. It is not known whether the missing streams are currently documented in the ADF&G Anadromous Waters Catalog (AWC) data base or were left out of the report for other reasons. Spawning adult or rearing juvenile coho, sockeye, Chinook, chum or pink salmon were found in 25 of the streams sampled. Most of the streams with spawning salmon also contained several species of anadromous and resident fish, including Dolly Varden, rainbow trout and Arctic grayling. Dolly Varden was the primary fish species in 21 streams, rainbow trout in 1 and Arctic grayling in 1. In seven streams only sculpins or sculpins and stickleback were collected.

Only one year of survey data for the Pebble Project Road Corridor has been provided, and fish distribution and numbers could be greater or smaller in other years. The sampling was not quantitative, so the numbers of fish reported do not reflect the actual number of fish which may be using upstream or downstream reaches of the streams surveyed. Some of the surveys were conducted after the peak of Chinook, pink, and chum spawning so the numbers of adults of these species observed during the surveys may be a small percentage of the number of these species which are actually using these streams.

The number of streams with fish and the number of salmon and other fish species might also have been higher if stream flows had not been unusually low during the surveys. According to the Northern Dynasty Pebble Project 2004 Surface-Water Hydrology Report, stream flows in the area were continuously declining from July through late September in 2004 when the surveys were made (Northern Dynasty, 2004). The USGS Surface Water Monthly Statistics from the Iliamna River gauge during the period 1996 to 2006 confirm that stream flows were unusually low (less than 50% of the average stream flow) during August and September of 2004 when a lot of salmon spawning normally occurs (United States Geological Survey, 2007). Low flows limit both the amount of available spawning and rearing habitat, and the numbers of fish present. Some of the streams that were reported as being dry might be used for rearing in years with higher precipitation. If additional surveys of road corridor streams were conducted in 2005 or 2006, no reports have been made available to the agencies or the public.

5. EFFECTIVENESS OF STATE AND FEDERAL REGULATORY PROCESS IN PREVENTING WATER POLLUTION AND FISH HABITAT LOSS FROM LARGE MINES

5.1 Introduction: Because of the copper sulfide ore, the size, and the location of the proposed Pebble Project mine, it presents and unprecedented threat to the two most productive salmon producing drainages remaining in the world. There isn't a mine of comparable size, ore properties and location that gives a good comparison for this analysis. However, it is instructive to look at mining regulation and mines in Alaska to see if the patterns of problems seen elsewhere in the U.S., and described earlier in this report, are evident here.

Three of the most important questions when considering the risk of the proposed Pebble Project mine having serious and long lasting impacts on fish habitat, fisheries production and fishermen are: (1) how effective are existing state and federal regulatory systems in anticipating and preventing impacts from proposed sulfide mines; (2) does the current state authorization process give adequate weight to fish habitat protection when considering large mine projects; and (3) how effective have state and federal regulators been in monitoring mining operations and detecting and correcting problems at large mines once they begin to occur?

When faced with public calls for a prohibition on mining, or higher standards for mines in the Bristol Bay drainage, Pebble Project proponents argue that the mine should be allowed to go through the permitting process. The implication being that the present Alaska Department of Natural Resources large mine permitting process is a rigorous process with a set of detailed standards, and that state and federal participants would not issue authorizations for any mine that would harm the environment. Mine proponents also imply that current monitoring will quickly detect pollution and state and federal regulatory agencies would act swiftly to penalize any mine that does not comply with the terms of mine permits. Alaska Department of Natural Resources (ADNR) officials have also made the claim that the ADNR large mines permit coordinating process is the best in the United States.

In contrast, Pebble Mine opponents argue that the large mine permitting process is simply that – a process which, in and of itself, has no concrete standards for decision making, and is secondary to the Federal NEPA process. Opponents argue that the large mines process was established to expedite the issuance of permits for large mines, and has not been effective in preventing or correcting pollution problems. They also point out that the Murkowski Administration changed state statutes, regulations, and policies to favor large scale mining over fish habitat protection.

To judge the merit of the process for permitting large mines, it is necessary to understand what the process is, the level of protection current statutes provide for fish habitat, and how effective implementation of the statutes have been in preventing pollution at large mines in Alaska.

5.2 The Alaska Department of Natural Resources Large Mine Process: Alaska Statute 27.05.010 establishes ADNR as the state's lead agency for most matters affecting exploration, development, and mining of mineral resources in Alaska. The ADNR created the large mine permitting process to coordinate permitting activities for large mine projects. The ADNR mining website describes the process and lists the projects the large mine permitting unit has been involved in, including the Red Dog Mine, the Greens Creek Mine, the Kensington Mine, and the Pebble Mine (ADNR, 2007).

No statute or regulation creates the large mine permitting process. There are no separate regulations governing the process and no separate standards for the approval of large mine projects. It is simply a personnel action within ADNR which designates a "large mine coordinator" who works with other state and federal agency staff to implement existing statutes and regulations.

Three statutes guide the process, AS 38.04.005, 38.05.135(e), 46.15.080; and, ADNR's overall policy statute AS 38.04.005 which requires ADNR to manage "for maximum use of state land consistent with the public interest." This wording allows the ADNR wide discretion in determining what that standard means in any particular situation, such as the Bristol Bay drainages, or with respect to any particular resource, such as salmon. Similarly, AS 38.05.135(e) governs leases and disposals of public resources, such as mineral and water rights, and relies upon a vague "state's best interest" standard for leases or disposals of public resources, such as water rights. Again, ADNR has wide discretion to determine what is in the "state's best interest".

Similarly, the Water Use Act, at AS 46.15.080, administered by ADNR, provides that DNR must find that a water appropriation is in the "public interest" and that in determining the public interest, DNR shall "consider" (1) benefit to the applicant; (2) the effect of economic activity resulting from the appropriation; (3) the effect on fish and game and on public recreation; (4) the effect on public health; (5) the effect of loss of alternate uses of water; (6) harm to other persons; (7) the intent and ability of the applicant to complete the appropriation; and (8) the effect upon access to navigable or public water. It is one thing to say that an agency shall "consider" fish and game as Alaska Statute 46.15.080 does. Three other ADNR statutes come into play if the project is in a designated anadromous fish stream or would require fish passage be provided, or is in the state's coastal zone.

Although, ADNR coordinates the large mine permitting process, permitting of large mines is actually driven by the requirements of the National Environmental Policy Act (NEPA) that applies to federal permits such as those issued under Sections 402 and 404 of the Clean Water Act (ADNR, 2007). In a January 11, 2007 presentation to a Board of Fisheries subcommittee that was gathering information on the adequacy of the ADNR process to protect fish and fish habitat, ADNR presenters focused on procedures for making decisions rather than whether there are any firm standards that actually protect fish habitat. Specifically, ADNR addressed four processes: (1) its process of large mine permitting; (2) the federal process of producing federal environmental impact statements under the National Environmental Policy Act (NEPA); (3) the ADNR process of consistency review under the Alaska Coastal Management Plan; and (4) the ADNR land use planning process (ADNR, 2007). ADNR focused on process rather than protection because it has few if any clear, concrete standards to protect fish habitat and instead relies on vague standards, as demonstrated above. The fundamental point of ADNR's presentation was that all state permits for the Pebble Mine will be integrated into, and none will be issued until, the federal NEPA process is complete for federal permits. ADNR bootstraps its processes onto the federal NEPA process. This avoids creating standards to protect fish before an applicant, such as Northern Dynasty, applies for ADNR permits. This allows an applicant to say: "let the process proceed," because the applicant does not have to meet any defined or quantifiable standards to protect fish, game populations, habitat or harvest.

Alaska Department of Natural Resources officials, proponents of the Pebble Mine and others have claimed that the ADNR's large mine permitting process is the "best" in the country. However, it is not clear what "best" means. Does this mean that it is best for the mining industry, best for the public who owns the land and minerals, or best for the environment? When asked what supporting documentation there was for the claim, Deputy ADNR Commissioner Ed Fogels (2007) said that it is his opinion that the ADNR large mine process was the best process for permitting large mines in the USA, but conceded that there is no quantitative data to support the claim. He based his opinion on talks with officials from other states who said that they did not have a similar process where all the state and federal agencies got together and permitted large mines. Mr. Fogels also said that Alaska was one of the few states that were permitting large mines at all.

The only available quantitative data on the performance of the ADNR large mine process and how changes in the fish habitat permitting and the Alaska Coastal Management Program have effected permitting of large mines in Alaska is from the Fraser Institute. The Fraser Institute is a Canadian organization whose mission is to "measure, study, and communicate the impact of competitive markets and government interventions on the welfare of individuals" (Fraser Institute, 2007). Since 1997 the Fraser Institute has conducted an annual survey of metal mining and exploration companies to assess how mineral potential and public policy factors such as taxes and environmental regulations affect minerals exploration investment. Survey results reflect the opinions of executives and managers in mining and mining exploration companies around the world, on how favorable countries, states and provinces are toward large scale mineral development. The Fraser Institute produces a report called a Policy Potential Index which is a composite index measuring the policy attractiveness of 65 jurisdictions in the survey. The Policy Potential Index is a composite index that measures the effects of government policies on exploration including the enforcement of existing regulations, environmental regulations, taxation, native land claims, protected areas, labor agreements, and geological potential.

In the 2002-2003 Fraser Report, prior to the Murkowski Administration, Alaska was ranked 12th in the world wide in the Composite Policy and Mineral Potential as a favorable place for mining investment. After the Murkowski statutory and regulatory changes were implemented, Alaska rose to number 4 in the world in the 2006-2007 report (Fraser Institute, 2007).

In the environmental regulation category of the 2006/2007 survey, Alaska was ranked behind Nevada, Utah, and Arizona which have a long history of mining. However, Alaska was ranked well ahead of other states, such as California, Wisconsin and Montana, which received very low scores, possibly because these states have enacted tough laws to prevent mining pollution (Fraser Institute, 2007).

The perception that Alaska has a very favorable regulatory climate for mining is confirmed by Alaska Miners Association Executive Director Mr. Steve Borell,, who states on the Alaska Miners Association Web site, "State-owned lands cover an area larger than the State of California, and most of these lands are open to mining under a location system which is a modern version of the federal mining law. And, although operations were for so many years held to a higher standard than in other states, today the field is nearly level and in several states the requirements are more stringent than in Alaska." (Borell, 2007) The Alaska Miners Association described the Murkowski Administration's 2003 changes to the regulatory system governing mines as "massive" (Borell, 2007). Biologists who had worked under both ADF&G and ADNR testified at a legislative hearing that the level of protection and considerations given to fish habitat under ADNR has been reduced compared to that provided under ADF&G.

From the mining industries perspective the regulatory and tax climate in Alaska appears to be favorable for large mines, but there are no equivalent surveys or other type of data that would indicate that the ADNR large mines permitting process is equally as favorable for the environment.

5.3 Funding of the Large Mines Process: The process that ADNR has established to fund state agency participation and essential baseline studies in the large mine process has also raised several concerns. Companies proposing to develop large mines in Alaska have two choices, they can choose to submit their water rights, mining permits, and other applications through the regular ADNR permit and review process, or they can opt to use the large mine permitting process which offers a coordinator (ADNR, 2007). Because the legislature does not fund ADNR or other state agencies to maintain a large staff to review large mine projects, the regular ADNR process to permit a large mine could take decades. The Large Mine Process provides a means for a mining company to facilitate or expedite the permitting process by funding a coordinator and additional ADNR staff to facilitate the permitting process and process permits. The large mine permitting process requires that the applicant sign a Memorandum of Understanding agreeing to reimburse ADNR for costs that ADNR and other state agencies incur in attending project meetings, reviewing study plans and permit applications, and other actions required to obtain permits to develop the mine (ADNR, 2007). It does not provide funds for field inspections or monitoring of mining operations once permitted. In turn, ADNR hires additional staff in the ADNR Division's of Mining, Office of Habitat Management and Permitting (OHMP) and Office of Project Management and Permitting (OPMP) necessary to review the applicant's plans and issue approvals in a timely manner (Crafford, 2007). According to ADNR the Large Mine Process has "significantly streamlined mine permitting" (ADNR, 2007). ADNR may also negotiate Reimbursable Service Agreements (RSAs) with other state agencies such as ADEC and ADF&G for their participation and input to the process as necessary (Crafford, 2007). ADNR also reviews and approves plans for any studies necessary to evaluate the environmental, social and economic effects of the large mine process. The ADNR has signed a Memorandum of Agreement with Northern Dynasty Mines to fund the Large Mines Process for the Pebble Project (ADNR, 2007).

The concerns that critics have expressed are: (1) applicant funding creates an inherent bias in the regulating agency toward the company providing the funding, and (2) it allows the applicant and ADNR to limit the participation of other agencies such as the Alaska Department of Fish and Game (ADF&G) in fish and wildlife related studies and critical pre-permit application review of the project. The result is that ADNR and the applicant proceed in the absence of information on fish and wildlife related concerns until those concerns become apparent at the time of permitting. Another concern with the way the large mine process is funded is that ADNR staff that are funded by Northern Dynasty to work on the Pebble Mine, only have jobs as long as the project proceeds and the funding continues.

Critics of the large mine process feel that industry funding may create a subtle bias toward approval of the project. Although, it could only be coincidental, no large mine project has ever been rejected by the agencies participating in the ADNR large mine process , including the Kensington Mine whose 404 permit was subsequently revoked by the federal 9th Circuit court because it was in violation of the Clean Water Act.

The problems associated with industry funding of public research and the influence of funding on regulation of industry projects are discussed by the U.S. Food and Drug Administration in a recent report (U.S. Food and Drug Administration, 2000) Several studies have looked at the problem of potential funding bias. A recent study of the relationship between funding source and conclusions in scientific reports concluded that industry support of nutrition related scientific studies may bias conclusions in favor of the sponsor's products, with potentially significant implications for the public health (Lessing et al. 2007). Another report summarizes studies of how industry funding of government scientific research has influenced the outcome (Sass, 2006).

According to Tom Crafford, ADNR's Large Mine Team Coordinator, ADNR received around $200,000 from NDM under the Pebble Mine Reimbursable Services Agreement in 2006 to facilitate permitting of the mine (Crafford, 2007). In contrast, the Alaska Department of Fish and Game which has a statutory mandate to protect, preserve, maintain and where possible extend the fish and wildlife resources which would be impacted by the mine, only received $20,000 to review study plans and attend project meetings during the same time period (Brookover, 2007).

5.4. Recent Changes to Alaska Statutes and Regulations Have Reduced Protection for Fish and Habitat: Between 2003 and 2006 Alaska's laws and regulations protecting fish habitat and giving local communities a substantial voice in resource development decisions were substantially weakened. In 2003 the Murkowski administration led efforts to facilitate mining and other types of non renewable resources by changing state fish habitat and water quality statutes and regulations in a manner which reduced their effectiveness. These actions included:

1. Executive Order 107 which transferring ADF&G fish habitat protection statutes to the ADNR. In 1959 the first Alaska Legislature enacted the Anadromous Fish Act (formerly AS16.05.870; now AS 41.14.870) and the Fish Ways Act (formerly AS16.05.840; now AS 41.14.840) (Appendix 5). These seminal statutes provided that the new Department of Fish and Game, through permitting, would regulate activities on state and private land that could otherwise result block or obstruct fish passage to spawning and rearing lakes and streams or the destruction of streams important for the spawning, rearing and migration of salmon. These statutes were the foundation of fish habitat protection in Alaska and the statutes remained in the Fish and Game Code (Title 16 of the Alaska Statutes) from 1959 to 2003 when they were transferred to ADNR by executive order.

The transfer of authority was a very significant change which weakened the statutory protections for Alaska's fish and wildlife resources. During the 44 years the statute was at ADF&G the analysis as to whether a project, such as Pebble, provided "efficient fish passage" (AS41.14.840), and or provided for the "proper protection of fish and game" (AS 41.14.870) was done by teams of fish, wildlife and habitat biologists at ADF&G. What constitutes ***"proper protection of fish and game" or "efficient fish passage"*** is critical in the determination of how fish and wildlife habitat in anadromous streams is protected. However, there is no statutory definition of either ***"proper protection of fish or game" or "efficient passage"***. The interpretation of these terms is left completely to the discretion of the implementing agency.

Until 2003 the decision as to whether a project achieved "proper protection" or "efficient passage" was made by the Commissioner of Fish and Game who has a statutory mandate to ***"manage, protect, maintain, improve, and extend the fish, game and aquatic plant resources of the state in the interest of the economy and general well-being of the state" (AS16.05.020 (2)***. After the transfer to ADNR, the decision as to what constitutes "proper protection" and "efficient passage" of fish is made by the Deputy Commissioner of DNR whose statutory mandate is to develop the renewable and non-renewable resources of the state in the best interest of the state of Alaska while weighing any competing uses. Fish and wildlife are not mentioned.

Prior to 2003, the ADF&G commissioner's decision on resource development that impacted anadromous waters or fish passage had equal weight with the decisions of the commissioner of ADNR to lease, sell or otherwise permit development. Where there was a disagreement the decision, or a compromise, was made by the Governor's office in a public process, usually under the processes of the Alaska Coastal Management Program. Since 2003, the tradeoffs between fish habitat conservation and other uses can be made within DNR without public scrutiny, because there is no statutory requirement for public notice or comment on fish habitat permits

The fact that the statutory underpinnings of anadromous and resident fish protection has been eroded by the changes made in 2003 is supported by statements by both the Alaska Miners Association and biologists who have worked under ADF&G and ADNR. The Alaska Miners Association supported the move from ADF&G to ADNR because the ADF&G had been a "major stumbling block for decades."(Borell, 2007) and described the Murkowski Administrations 2003 changes to the regulatory system governing mines as "massive". Biologists who had worked under both ADF&G and ADNR testified at a legislative hearing that the level of protection and considerations given to fish habitat under ADNR has been reduced compared to that provided under ADF&G;

2. Transferring the Alaska Coastal Management Program (ACMP) from the Governor's Office, where it had successfully resolved interagency differences for over 20 years, to ADNR. ADNR then gutted the enforceable ACMP standards which protected fish and wildlife habitat. The Legislature then eliminated a citizen's right of judicial enforcement, restricted local government's ability to craft local standards for fish and wildlife habitat protection and reduced the boundaries of local coastal plans;

3. Weakening, by subjecting to DNR review, ADF&G's implementation of the federal Fish and Wildlife Coordination Act, by which ADF&G coordinates with federal agencies on federal permits to assure that those permits protect fish under ADF&G standards and science;

4. Directing the Alaska Department of Environmental Conservation (ADEC) to adopt regulations to allow mixing zones for mining and other types of waste in fish spawning areas in order to "legalize" pre-existing violations. Prior to 2006 mixing zones in fish spawning areas were prohibited. In 2006 ADEC adopted the regulations allowing exceptions from the previous prohibition on mixing zones in spawning areas (ADEC 2006). Because of strong public opposition to the regulation change, the Murkowski administration was forced to exclude Pacific salmon spawning areas from the new regulations. Mixing zones are allowed in steel head, rainbow and cutthroat trout spawing areas, even though these species are also classified as Pacific salmon (ADEC, 2006). ADEC is currently working on additional regulations relating to the exemptions allowing mixing zones in resident fish spawning areas. ADEC regulations give ADEC discretion to authorize mixing zones in all other types of fish habitat, and this reduces the protection provided by the prohibition on mixing zones in anadromous fish spawning areas. Many streams are limited by the amount of rearing habitat they provide rather than spawning habitat and juvenile fish are often as susceptible to pollutants as spawning adults, and eggs. Certain pollutants also biomagnify, and bioaccumulate, and even if discharged at very low levels

may build may build up to harmful levels in long lived resident fish species such as rainbow trout, burbot, Dolly Varden and northern pike;

5. Revised the Bristol Bay Area Plan in 2005 to favor mining over protection of fish habitat.

Because the Bristol Bay Area Plan Management Policies, Management Intent, Guidelines, and Land Use Designations will direct and guide ADNR decision making in the Pebble Mine approval process, it is important to understand how the 1984 Plan was changed.

The proposed Pebble Project is located within Regions 6 and 10 of the revised 2005 Alaska Department of Natural Resources Bristol Bay Area Plan for State Lands (BBAP), and within Management Units 6 and 10 of the original plan which was adopted in 1984 (ADNR, 1984). In recognition of the importance of the Mulchatna and north Lake Iliamna drainages as fish and wildlife habitat, and the importance of commercial, sport and subsistence fishing to the regional economy, the 1984 Bristol Bay Area Plan (BBAP) stated that the primary use of all of Management Units 6 and 10, where the Pebble claims are located, was to be "wildlife habitat and harvest and recreation" (ADNR, 1984). Minerals were designated as a secondary use. The 1984 plan also closed 64 salmon streams in mineralized areas including the portions of Upper Talarik Creek and the North and South Forks of the Koktuli River known to support salmon, and it created a buffer 100 feet on either side to mineral entry (ADNR, 1984). The purpose of these closures was to protect fish habitat from incompatible mining activities. Although not mentioned in the text of the 1984 BBAP, a map of Management Unit 6 depicted a portion of the current Pebble mining claims as an area where minerals were designated as a primary use (ADNR, 1984). This was probably based on claims staked prior to 1984. Because the map is very small it is difficult to determine if the current Pebble Project ore body is within the area where minerals were designated as a primary use in 1984.

The 2005 revisions under the Murkowski Administration changed the BBAP management emphasis in Unit 6 from protection of fish and wildlife habitat to mineral development. The 2005 plan also reduced the area which was to be managed as fish and wildlife habitat from all of Unit 6, to the Muklung Hills and the streams specified in ADNR's Anadromous Waters Catalog (ADNR, 2005). The management emphasis for a very large area surrounding the Pebble claims (Units R06-23, 24 and R10-02), which was designated as fish and wildlife habitat, in the 1984 Plan, became "Area's associated with the Pebble Copper Deposit that overlap Region 10 (and 6) are designated Mineral (Mi)." "Areas associated with significant resources, either measured or inferred, that may experience mineral exploration or development during the planning period are designated minerals" (ADNR, 2005).

At the same time the Management Intent for the Pebble Mine area in the 2005 plan revisions (page 3-111) became, "The general resource management intent for the Pebble Copper Area is to accommodate mineral exploration and development and to allow DNR the discretion to make specific decisions on how development may occur, through the authorization process." "Mineral development in this unit is ***expected to be authorized*** (emphasis added) after a public process that is as extensive as this area plan and with the benefit of site specific data and design that is prepared for the development and is not now available." (ADNR, 2005). The most straightforward interpretation of this policy is that ADNR expects to approve the Pebble Mine with conditions after receipt of a mine plan, a permit application and public hearings. The policy which directs ADNR authorizations does not mention denial as an option.

Many of the policies in the 1984 BBAP related to fish habitat protection also changed in the 2005 revisions. For example, maintenance of instream flow is an essential element in the productivity of salmon and high value resident fish streams. The instream flow management guideline in the 1984 BBAP, was "Except for public water supply and domestic use, the maintenance of fish stocks is generally the highest priority use in the study area. Therefore, the DNR will not allow an appropriation of water to fall below the amount determined necessary by ADF&G and/or USFWS to protect fish habitat and production and water fowl habitat" (BBAP, 1984). In the 2005 plan revisions the guideline was changed to, "Streams and other water bodies may be considered for instream flow reservations under AS 46.15.145.

The revised plan contains vague statements regarding protection of fish habitat such as: "Environmental Quality and Cultural Values: Protect the integrity of the environment and affected cultures when developing subsurface values", but very specific statements regarding state support of mining such as: "State Support of Mining: Aid in the development of infrastructure such as ports, roads, railroads, and continue to provide geologic and geophysical mapping and technical support to the mining industry", and "Mining in Fish Habitat: When the DNR issues a permit for mining in or adjacent to a fish stream, conditions of the permit will require any necessary measures that will allow the operation to meet water quality standards, and statutes and regulations governing the protection of fish."(ADNR, 2005). It is difficult to see how fish habitat can be "protected" when the stream bed is removed for an open pit mine such as is being proposed for the Pebble Project. The new policy permitting instream mining in the revised BBAP contrasts vividly with ADNR's finding in the 1984 mineral closures for Upper Talarik Creek and the Koktuli River that, "The development of mining claims within the active stream channel of designated anadromous streams and adjacent uplands creates an incompatible surface use conflict with salmon propagation and production and jeopardizes the economy of the Bristol Bay region and the management of the commercial, sport and subsistence fisheries in the Bristol Bay area. Mining within the active stream channel of an anadromous stream can seriously affect salmon spawning and rearing habitat and degrade water quality by the production of excessive sediment loads." (ADNR, 1984). Numerous scientific studies have documented that instream mining and the destruction of fish habitat is harmful to fish populations, and the body of scientific literature on this issue has increased since the original report was adopted in 1984 (Van Nieuwenhuyse, E. and J. Laperriere, 1986; Pierce, J. 1999; and Mol, J. and P. Outboten, 2004). What has changed is the 2005 revisions to the BBAP made protection of fish habitat and fish populations and the people that depend on fishing less important than mining.

The 2005 BBAP did leave intact the 1984 mineral closing orders for the portions of Upper Talarik Creek and the North and South Forks of the Koktuli River that were known to support salmon in 1984. These closures were put in place because the original drafters of the plan including ADNR, Bristol Bay Area residents, and State and Federal fisheries scientists who worked on the Plan recognized the threat that mining presented to the fisheries resources of the region. However, those closures were not expanded in the 2005 BBAP to include the new information on anadromous fish distribution in these streams in the proposed mine area and under the proposed tailings impoundments which become available in 2004.

Discussion: The stated purpose of the Murkowski administration's changes to state statutes, regulations and plans was to "streamline permitting" and expedite development by concentrating state authority to review and approve projects within ADNR. Although DNR and DEC claim that these actions do not adversely affect the State's responsibility to protect fish, it is not credible to conclude that in all cases the prior protections are still in place. Prior protections are certainly not in place for the Bristol Bay Area Plan or the Coastal Program. The transfer of authority to protect salmon habitat and prevent blockages of fish streams to ADNR was a fundamental change in how Alaska's fish resources are legally considered in non renewable resource decisions. The Department of Fish and Games statutory mandate is to protect, preserve, maintain, and extend the fish and wildlife resources in the interest of the economy and general well being of the State. When the two fish habitat protection statutes were transferred to ADNR, the statutory requirement to protect and preserve fish habitat was replaced by ADNR's mandate to consider fish habitat as one of many general criteria in developing non renewable resources such as large mines. During 2007 legislative hearings on HB 41, several former and present Alaska Department of Fish and Game Habitat Division and Alaska Department of Natural Resources Office of Habitat Management and Permitting biologists testified how protection for fish has been substantially weakened under ADNR. Although there has been substantial pressure to reverse these changes by the public and legislature, the Palin Administration has not acted to date.

5.5 Effectiveness of NEPA Process in Preventing Mine Pollution: The States large mine permit coordination process is dependent on NEPA, because federal permits required for large mine's are subject to the requirements of the National Environmental Policy Act (NEPA). NEPA establishes national environmental policy and goals for the protection, maintenance, and enhancement of the environment. Section 102 of NEPA requires all federal agencies to prepare detailed statements assessing the environmental impact of and alternatives to major federal actions (such as permits for large mines) significantly affecting the environment (i.e., an EIS). The federal permit for the project which is being evaluated under the NEPA process can't be issued until the final EIS and the Record of Decision (ROD) is issued. If the Environmental protection Agency doesn't agree that the EIS adequately addressed potential impacts review by the Council on Environmental Quality may be required.

Because the state large mine permitting process relies on the federal NEPA process, it is necessary to evaluate how well the NEPA process and subsequent federal and state permitting has performed in predicting and preventing pollution from large mines, in order to predict how well these same processes might do in preventing pollution from the Pebble Mine. Recently, two respected critics of the NEPA process used for large mines published a two-year study of the accuracy of predictions made in Environmental Impact Statements (EIS) for recently permitted mines in the United States (Kuipers, J.R., et al. 2006). The authors studied a representative sample of 25 recently permitted major mines where pre-mining baseline data and operational data were available. Although 100 percent of the EISs predicted that the mines would be able to comply with water quality standards, in fact:

1. 76% of the mines polluted ground water or surface water severely enough to exceed water quality standards;

2. 60% of mines polluted surface water severely enough to exceed water quality standards;
3. 52% of mines polluted ground water severely enough to exceed water quality standards;
4. 73% of mines exceeded surface water quality standards despite predicting that mitigation would result in compliance;
5. 77% of mines that exceeded ground water quality standards incorrectly predicted that mitigation to correct problems would result in compliance.

The study also found that mines, involving metallic sulfide deposits (such as the Pebble Project and the Red Dog Mine) and that are near ground water (like Pebble Copper and the Red Dog Mine), have such a high risk, that water quality exceedances are near certainty for acid drainage or contaminant leaching (Kuipers, et al. 2006). The analysis found that 85% of these mines polluted surface water, 93% of these mines polluted ground water, and of the mines that developed acid mine drainage, 89% of the environmental documents for these mines predicted that they would not. When the permitting agency tried to get the mine to fix the problem, the fixes failed 75% of the time. Of the 19 out of 25 mines that were analyzed and found to pollute ground and surface water, 63% released toxic metals such as lead, mercury, cadmium, copper, nickel, or zinc, 58% released arsenic and sulfates and 53% released cyanide.

By looking at large Alaskan mines which have been permitted under the NEPA process or both the NEPA and ADNR large mines process we can get an idea of how well the system has worked in predicting and preventing pollution:

Fort Knox Mine: The Fort Knox Mine, which was permitted under NEPA and the large mine permitting process, is often used as an example of an environmentally sound, non-polluting mine. It has generally done a good job of preventing pollution thus far. Lessons we can learn are that once a mine is permitted it may change its operating methods and it will be hard to deny a new permit. Fort Knox originally said it would not use cyanide in its process. The ADNR has recently allowed Fort Knox to build a facility for large scale use of cyanide in heap leaching of low grade ore (Fairbanks Daily News Miner, 2007).

Originally Fort Knox was determined to not have an acid mine drainage issue because of the nature of the ore body which is associated with anomalously high amounts of bismuth and is a low-sulfide deposit. Because it is a low sulfide deposit, it is less likely to pollute because it is not subject to the acid mine drainage problems that all metallic sulfide mines seem prone to. However, in 2002 Fort Knox began processing ore from its True North deposit (Fairbanks Daily News Miner, 2007). Because True North gold is associated with the sulfide minerals pyrite (iron), arsenopyrite (arsenic), and stibnite (antimony) in unoxidized zones the waste does have the potential to create acid drainage. Again, the original assumptions about the potential for pollution changed after the mine was in operation.

Mining at Fort Knox commenced in 1996. In the fall of 2006 the tailings dam at Fort Knox began leaking cyanide contaminated waste water (ADN, 2007). Although the leaks were discovered in late 2006, they were not made public until 2007. The Fort Knox tailings dams incorporate a system of perforated pipes, sumps and pumps to capture leakage and return it to the tailings pond, but in this case the leak took a different pathway. The mine caught the problem and kept pollution from getting off site. It is more likely that problems will be detected and addressed while a mine is operating and personnel and equipment are on hand than it will be years after a mine has closed and is being watched by a caretaker.

It is too early to conclude whether the Fort Knox Mine will or will not pollute at some point in the future, especially if large quantities of sulfide mine waste from the True North Mine are stored permanently on site and cyanide is used in the gold extraction process. Most pollution problems often occur over time, as mines age, and often long after the company has left and the mine is closed (Chambers, 2006).

Red Dog Mine: The Red Dog Mine is a massive lead zinc sulfide deposit located on Red Dog Creek in the Delong Mountains of the western Brooks Range. The mine consists of an open pit, a mill a large tailings pond, water supple and housing. The ore concentrate is transported to the port on the Chukchi Sea coast by a 47 mile long haul road (EPA, 1984). The mine which opened in 1989 produces more than one million pounds of lead zinc concentrate annually, demonstrates the problems and risks associated with mining sulfide ore in an area with substantial wind and precipitation.

Although, the Red Dog Mine was permitted before the ADNR's large mine permitting process, the Red Dog Mine was permitted under the same NEPA and federal permitting process that is the centerpiece of ADNR's large mine permitting process. It is also one of the mines listed on the ADNR Mining webpage as a large mine permitting project. With the exception of the changes made by the Murkowski Administration in 2003 which weakened protection for fish and wildlife habitat, and subsistence uses formerly provided under the Alaska Coastal Management Program and the Anadromous Fish and Fishways Act, the Red Dog Mine was permitted under the same state laws and regulations that are currently used by ADNR to make decisions under the large mine permitting process.

The Environmental Impact Statement (EIS) for the Red Dog Mine was completed in 1984 and predicted that the project as presented by the applicant would have "no significant or little impact" on fish and fish habitat, vegetation, wildlife, subsistence activities, and air and water quality (EPA, 1984). Topics such as the potential for dust emissions, fuel and chemical spills, ground water pollution, storage of billons of tons of mine waste in the tailings impoundment and the potential for pollution from the flooded mine pit after closure were briefly discussed, but it was concluded that the measures proposed by the applicant would prevent any impact (EPA, 1984). There was no acknowledgement of potential future problems with the permanent storage of billons of tons of acid generating waste rock and mine wastes after the mine was closed, or the possibility that permit violations might occur.

State and federal permits were issued for the project and mining operations began in 1989. Pollution related problems and deviations from predictions in the EIS began shortly after the mine opened and have continued to date. Because of its length a chronology of the pollution related events as reported in the Anchorage Daily News from 1989-2006 is presented in Appendix 4. A brief summary of the problems at the mine include:

The ADEC Toxic Release Inventory reports for 2003-2005 show that the Red Dog Mine deposits almost 500 million pounds of toxic material behind its permitted tailings dams annually (ADEC, 2003-2005). An additional 320,000 pounds of methanol, lead, and zinc are released to the air as fugitive emissions.

When mining is completed and the site closed, it will leave behind a large tailings impoundment behind an earth fill dam which will have to be maintained forever to prevent it from breaching and spilling billions of gallons of toxic lead and zinc laden water and mine waste into local streams. The water leaking from the earthen fill dam, waste rock and remaining pit and fractured ore body will also have to be captured and treated in perpetuity (Crafford, 2007). Red Dog is an example of the state and federal processes determining that it is allowable for the mine operator/owners to leave a toxic mine site and tailings disposal site in a condition that has to be treated by someone forever. The process, and resulting permits, originally required the company to provide an 11 million dollar bond, but a new bond is being evaluated and it is estimated that it will take at least $100,000,000 to provide for needed perpetual care (Chambers, 2005).

Dust from the mine, trucks hauling lead and zinc concentrate, and the port where the concentrate is loaded onto ships, has contaminated 143,000 acres of the surrounding watershed with toxic levels of lead and cadmium (Hasselbach, et al. 2005). Lead and zinc levels measured at the port are 27 times the EPA industrial cleanup level. The NEPA/EIS and the original permits did not anticipate this problem, nor did they require adequate monitoring to detect the problem. It took the National Park Service and state and federal regulators 12 years to discover dust pollution was occurring and get the mine operators to effectively cover their trucks and operate the port in a way that keeps fugitive dust in check.

The Red Dog tailings dam, which was found to be adequate in the EIS and had been approved under the state and federal permitting process, came very close to failing in 1990. It turned out that the dam, though built as permitted, was under designed to cope with the levels of effluent and precipitation encountered. To save the dam and avoid having the entire contents of the tailings impoundment flow down the Wulik River, Teck-Cominco had to open a spillway and release polluted water into Red Dog Creek. EPA fined them for the violation.

At the same time and again unanticipated by the mine developer or the permitting agencies, new groundwater with toxic levels of zinc and other heavy metals began to well up in Red Dog Creek. More than 20 miles of Red Dog Creek were fouled and the world class char fishery in the Wulik River was threatened (ADN 1990). Neither the NEPA process nor the agencies issuing permit's for the mine predicted that once the ore body began to be developed; blasting would crack adjacent rock and give groundwater new pathways to newly exposed mineralized rock and thus liberate heavy metals that caused water pollution. The company eventually addressed the problem by moving Red Dog Creek and headwater steams a number of years before its development plan called for the creek to be moved.

Because the water pollution control systems installed at the mine didn't function as expected, heavily contaminated water was dumped from the treatment facility, leaked from the ore body, and overflowed from the tailing impoundment into the middle fork of Red Dog Creek. It took years to get the water pollution control and treatment systems operating properly. As a result the mines operator was cited for over 618 violations of the mines water quality permits (ADN, 2006). Over $16,652,000 in fines and requirements for additional pollution control measures have been levied against the Teck-Cominco through 2006. None of these violations, or any of the problems described above, was anticipated in the EIS or adequately addressed in the original state and federal mine permitting process. Teck-Cominco, who operates the Red Dog Mine, is currently operating under a federal compliance order allowing it to exceed certain water quality standards. Several residents of the Village of Kivalina are suing Teck Cominco for water quality violations at the mine (Anchorage Daily News, 2007g and 2007f).

Because Red Dog was permitted under NEPA and the associated federal permitting processes, it is an example of why ADNR's large mine process cannot be depended upon to predict and prevent water quality violations. The Red Dog Mine is also an example of the how the state and federal regulatory processes often fail to anticipate serious environmental impacts of large mines, are slow to identify impacts that are occurring, and are sometimes not very effective in fixing problems after they occur.

Finally, Red Dog is also an example that the state and federal process can determine it is "in the public interest" to leave toxic tailings and a mine site in a condition that has to be actively treated forever, and that requiring a bond to pay for that perpetual care is "in the public interest".

Kensington Mine: The Kensington Mine operated by Coeur Alaska near Juneau, was permitted under the ADNR large mine process. The state and federal permits for the Kensington Mine issued under the ADNR Large Mines Process are pertinent to the Pebble Mine issue because the Corps 404 permit allowed the mine to dump its chemically processed mine tailings into Lower Slate Lake, a natural lake which supports fish. The Juneau Empire reported that Coeur found this method would be cheaper than storing the tailings on dry land (Juneau Empire, 2005).

Federal and state approval to dump mine waste into a fish bearing lake was not only an important cost savings measure for the mine, which would have had to develop a leak proof upland storage site, but it also set a precedent for other mines in Alaska, including the much larger Pebble Project mine which proposes to cover one or more lakes and approximately 16 miles of streams, supporting both resident and anadromous fish, with billions of tons of potentially acid generating waste rock and mill waste.

However, the Corps of Engineers Kensington disposal permit was recently overturned by the U.S. 9th Circuit Court of Appeals which ruled that "the mine tailings, the waste product of a chemical milling process, could not be treated like mere 'fill material' that the 2002 EPA and Corps of Engineer regulation changes allowed mining companies to dump into bodies of water." (Anchorage Daily News, 2007g and U.S. Ninth Circuit Court, 2007). Coeur Alaska, the Palin Administration, and the local Goldbelt Native Corporation appealed the court's ruling, but the Corps of Engineers and the Forest Service declined to join the appeal (Juneau Empire, 8/23/07).

Although the disposal of mine waste into Slate Lake has been blocked by the Federal court because doing so was a violation of the Clean Water Act, it raises the question of whether Corps of Engineers, ADNR and ADEC regulators, who are charged with protecting water quality and Alaska's fisheries resources, would similarly support the disposal of toxic mining wastes into

Bristol Bay drainages where much greater fisheries resources are at risk? (See Section 5.4 on the Bristol Bay Area Plan.)

Discussion: When ADNR relies upon the NEPA process as the cornerstone of its large mine permitting process, it is depending on a process that has a poor record of predicting and mitigating water pollution problems from large scale mining operations. ADNR has not shown how its process, which depends on NEPA, differs from that used for the 25 mines studied in the 2006 Kuipers report, which likewise depended on NEPA (see also section 5.7).

5.6 The Lack of Confidence in Federal and State Regulation of Mines Prompted Changes in Other State's Laws: The citizens of two states, Wisconsin and Montana, with a long and not always good history of mining passed initiatives setting higher standards for sulfide mines and prohibiting the use of cyanide in mining. Two other states, Michigan and New Mexico, have adopted statutes and regulations prohibiting or severely restricting mines which would leave behind mine pits, tunnels, or tailing storage facilities which would require perpetual care to prevent pollution of the environment.

The State of Wisconsin adopted the Sulfide Mining Moratorium Act in 1998. The Act prohibits the state issuance of permits for new metallic sulfide mines unless one such mine in North America is certified by the Wisconsin Department of Natural Resources to have operated for 10 years and been closed for 10 years without causing pollution (Appendix 2). The Act, which received strong support from Wisconsin citizens, was directed at stopping the Canadian Rio Algom Corporation's Crandon zinc-copper mine near the Mole Lake Chippewa Reservation, from being permitted by the Wisconsin Department of Natural Resources. The Act does not prohibit sulfide mining but adds the new criteria at the end of the permit process. This has effectively halted the development of new sulfide mines in Wisconsin, because no examples of sulfide mines which meet the criteria have been identified to date.

The State of Montana banned the use of cyanide through a citizen's initiative in 1998. Montana voters overwhelmingly rejected the mining industry's effort to repeal the ban in 2004. The bill I-137 prohibits cyanide heap and vat leach open-pit gold and silver mining, but allows mines to continue operating under its existing operating permit or any amended permit that is necessary for the continued operation of the mine (Appendix 3).

The initiative passed because of numerous cyanide spills and leaks and other pollution at the Beal Mountain Mine, Zortman-Landusky Mine, Golden Sunlight Mine, Kendall Mine and Basin Creek Mine that caused fish kills and threatened water supplies for ranches and communities. The Zortman- Landusky Mine alone experienced over a dozen cyanide spills, including one spill that released 50,000 gallons of cyanide solution and contaminated a community drinking water supply (Westerners for Responsible Mining, 2007).

One mining company sued the State of Montana claiming that the ban prevented it from mining and making a profit. A five-year legal showdown over Montana's historic ban on cyanide leach mining ended April 18, 2007 when the Montana Supreme Court unanimously ruled that the ban did not deprive a mining company of property or profit. The high court ruled 6-0 that Canyon Resources Corp., the principal player behind the hoped-for large open pit cyanide leach mine slated for Lincoln, Montana did not have a mining permit when voters approved the cyanide ban in November 1998. Consequently, the company had no right to mine and lost nothing when the initiative passed (Missoulian, 2007).

New Mexico and Michigan have enacted statutes designed to prevent the approval of mine or reclamation plans which require perpetual care (Appendix 6). The Red Dog Mine and the proposed Pebble Project Mine are examples of mines that would require perpetual care after closure because of the large quantity of toxic waste stored on site or generated by flooded mine pits or tunnels. The New Mexico statute N.M.S.A 1978, 69-26-12 states in part, "B. The Director shall issue the permit for a new mining operation if the director finds that: (4) the mining operation is designed to meet without perpetual care all applicable environmental requirements imposed by the New Mexico Mining Act and regulations adopted pursuant to that act and other laws following closure". Michigan statute M.C.L.A. 324.63209: "Natural Resources and Environmental Protection Act requires in part, (8) Both the mining area and the affected area shall be reclaimed and remediated to achieve a self-sustaining ecosystem appropriate for the region that does not require perpetual care following closure and with the goal that the affected area shall be returned to the ecological conditions that approximate premining conditions subject to changes caused by nonmining activities or other natural events."

These statutes appear to prohibit large tailings facilities storing toxic wastes, and mine tunnels and pits which are likely to develop acid mine drainage, such as those proposed for the Red Dog Mine and Pebble Project, that would require perpetual treatment and maintenance to prevent environmental pollution after closure.

5.7 Under Federal Statutes, Mining Does Not Receive the Same Scrutiny as Other Industries: The 1972 Clean Water Act (CWA) prohibited dumping waste into streams and lakes. However, in 2002, the Environmental Protection Agency and the Corps of Engineers under the Bush Administration, revised regulation to classify chemically processed mine waste as "fill," for purposes of the CWA, to allow the waste to be discharged into bodies of water if a permit is obtained (Perks and Wetstone, 2002 and Washington Post, 2004). Since then, the new definition has been applied widely in Appalachia, making it easier for companies to blast away mountaintops, mine coal seams underneath, and push the waste material into neighboring valleys, often obliterating streams in the process (Washington Post, 2004). The Corps of Engineers interpreted the new regulations to include waste from metals mining in approving a permit to dispose of mine waste into Lower Slate Lake at the Kensington Mine in Juneau (U.S. Ninth Circuit Court, 2007).

Mining waste has also been exempted from the Resource Conservation and Recovery Act (RCRA 42 U.S.C. s/s 6901 et esq.). The RCRA (1976) gave EPA the authority to control hazardous waste from the "cradle-to-grave". This includes the generation, transportation, treatment, storage and disposal of hazardous waste. In October, 1980, RCRA was amended by adding section 3001(b) (3) (A) (ii), known as the Bevill exclusion, to exclude "solid waste from the extraction, beneficiation, and processing of ores and minerals" from regulation as hazardous waste under Subtitle C of RCRA (Environmental Protection Agency, 2007s). According to the EPA, "Mining wastes include waste generated during the extraction, beneficiation, and processing of minerals". Most extraction and beneficiation wastes from hard rock mining (the mining of metallic ores and phosphate rock) and 20 specific mineral processing wastes are categorized by EPA as "special wastes" and have been exempted by the Mining Waste Exclusion from federal hazardous waste regulations under Subtitle C of the Resource Conservation and Recovery Act (RCRA) (Environmental Protection Agency, 2007s. These amendments to federal antipollution laws allow mining companies to store billions of tons of mine waste, containing heavy metals and toxic chemicals such as cyanide, behind tailings dams. Many of these tailings storage facilities such as the Summitville Mine, Grouse Creek Mine, Zortman-Landusky Mines and others have subsequently leaked, causing serious pollution of surface and ground waters (see sections on Acid Mine Drainage and Copper and Cyanide Toxicity).

Mining operations are also exempt from certain federal air quality standards. Mercury emissions from mining are not regulated under the National Ambient Air Quality Standards (NAAQS) or under the National Emission Standards for Hazardous Air Pollutants (NESHAPS) for gold or silver mining. Although, there are regulatory requirements under title V of the Clean Air Act (CAA) mercury is also not regulated under the New Source performance Standards (NSPS) Regulations." (National Risk Management Research Laboratory, 2003). This has resulted in substantial levels of mercury pollution from metals mines in the United States.

6. POTENTIAL IMPACTS OF THE PROPOSED PEBBLE MINE AND ASSOCIATED FACILITIES ON FISH HABITAT, FISH AND FISHERMEN

6.1 Introduction: If developed, the Pebble Project mine, mill, tailings storage facilities, access roads, pipelines, port, electrical transmission lines and associated facilities would physically destroy, dewater or otherwise affect a significant amount of salmon and high value resident fish habitat in two Bristol Bay drainages. It is also likely that during the operating life of the mine or after abandonment, the Pebble Mine and associated facilities will cause pollution resulting in substantial reductions of fish habitat and fish production in portions of the Nushagak or Kvichak River drainages.

6.2 Physical Loss of Habitat: A substantial amount of fish habitat will be (1) physically destroyed during the excavation and operation of the Pebble mine and associated facilities, (2) dewatered by water appropriations, and (3) altered or blocked by construction of the access road.

Physical destruction of fish habitat: The Pebble Mine, including the Pebble West (chalcopyrite) pit, the Pebble East (bornite) pit or block cave and the tailings ponds as currently proposed, will physically occupy or impact approximately 6.5 square miles of the North Fork Koktuli (NFK) River drainage, and 19 square miles of the Upper Talarik Creek (UTC) and South Fork Koktuli River (SFK) drainages (Figure 1). All of the resident and anadromous fish habitat in the area will be destroyed. Approximately 3.5 miles of stream 1.190, a tributary of the NFK which supports grayling, large numbers of Dolly Varden, spawning adult Coho, and rearing juvenile Coho and Chinook salmon will be buried under Tailings Pond G (NDM, 2006). In addition, all fish habitat in Frying Pan Lake and approximately 9.5 miles of SFK tributaries would be excavated for the Pebble West pit, buried under Tailings Storage Facility A, or appropriated for mine process water. The headwaters of Upper Talarik Creek and many of its tributaries are underlain by the Pebble East and West ore bodies and would be removed by mining, and the water appropriated for mine use. A portion of the headwaters of Upper Talarik Creek which would be excavated for the Pebble West pit, or underlain by the Pebble East Pit, appears to be currently specified in the Alaska Department of Natural Resources Anadromous Waters Catalog or has been identified as important for sockeye and Coho salmon spawning, and high value rearing habitat for Coho, Chinook, Dolly Varden and rainbow trout (NDM, 2006). Although, Northern Dynasty Mines has not disclosed how the deeper Pebble East Ore body would be mined (i.e., open pit or block caving), it seems almost certain that in either case the section of the main stem of Upper Talarik Creek flowing over or adjacent to the proposed Pebble East pit, would flow into the mine and would have to be rerouted around the mine or appropriated for mine use. In either event fisheries production from a one to two mile segment of the main stem of Upper Talarik Creek would be lost. Over 12 miles of Upper Talarik Creek tributaries would be similarly affected if both ore bodies were developed.

With the information available at this time, it is difficult to provide a precise estimate of the number of adult and rearing juvenile salmon and resident fish in the portions of the North and South Forks of the Koktuli River and Upper Talarik Creek which would be physically and permanently lost to mining activities over time. The numbers of spawning adult salmon and resident fish in the streams displaced by the Pebble Mine fluctuate over time due to environmental conditions and the number of returning salmon harvested. Aerial survey estimates of salmon spawning escapements are only indexes and often underestimate the actual number of fish in the stream. Information from Northern Dynasty Mine's surveys provide only qualitative information on juvenile numbers at the time and location that samples were taken, but not total population in all of the areas which may be affected by the mine. However, the loss of this much habitat in these three drainages could reduce the production of adult resident fish and salmon from these three systems by thousands and possibly up to tens of thousands of fish annually. The number of juvenile fish lost could be in the tens of thousands to hundreds of thousands. Because the production from this habitat will be permanently lost, the cumulative loss over tens of thousands of years would be substantial.

Dewatering and Loss of Instream Flow: All of the ground and surface water within the mine area, which encompasses the headwater of the North and South Forks of the Koktuli River and Upper Talarik Creeks, would be appropriated for mine use over the 40 to 70 year life of the mine (Northern Dynasty, 2005 and Northern Dynasty, 2006). Because the number of fish produced is determined by the quality and amount of habitat available in a stream, the loss of this flow over the 40 to 70 year life of the mine would reduce the number of resident and anadromous fish produced by the North and South Forks of the Koktuli River, and Upper Talarik Creek (National Research Council, 1996 and Heggenes et al. 1998).

The surface water appropriation for the mine and the tailings facilities would eliminate all flow and fish habitat in the upper main stem of the South Fork Koktuli and its headwater's tributaries, tributary 1.190 to the North Fork Koktuli, and the tributaries to Upper Talarik Creek within the Pebble East and Pebble West mine pits, upstream of the point where the water is removed (see Mine Footprint above). The fish stocks which may be genetically unique to these streams would be extirpated. The portions of these streams that would be excavated or buried under tailings would no longer produce fish even after the mine is closed.

Below the mine, stream flow would be lost and fish habitat would be dried up or severely diminished for some miles downstream. Some flow would gradually be restored downstream as unaffected tributaries empty into the main channel of these three streams. Table 1 in the section on water appropriation shows that the net reduction in stream flow on the South Fork Koktuli, 12 miles downstream, would be 16%, 8% on the North Fork Koktuli, 18 miles downstream, and 9% on the Upper Talarik Creek, 18 miles downstream. The reduction of habitat (stream width and depth) from these appropriations would substantially reduce available spawning and rearing habitat particularly during the summer low flow period when Chinook, sockeye and chum salmon are spawning and would reduce the amount of available overwintering habitat for eggs and juvenile salmon during critical low winter flows.

Northern Dynasty's 2004 hydrogeology study also found that the middle section of the South Fork Koktuli River goes dry during low flow periods during the summer. It is thought this is an indication that the South Fork Koktuli River may be contributing cross drainage ground water flow to Kaskanak Creek. The proposed surface water appropriations from the SFK would increase the frequency and length of the periods when upstream fish migration in the middle and upper South Fork Koktuli would be blocked by a dry stream bed and spawning and rearing habitat would not be available.

Northern Dynasty has also submitted a separate ground water application for 19.4 cubic feet per second from the Upper Talarik Creek drainage, 11.78 cubic feet per second of ground water from the South Fork Koktuli watershed, and 12 cubic feet per second from the North Fork Koktuli River drainage (NDM Pebble Project 2006 ground water application). The wetlands, lakes and ponds in the mine area are a manifestation of the ground water level in the mine area which appears to be quite high. Ground water flowing down gradient from the mine area also appears to provide the majority of flow to the North and South Forks of the Koktuli River and Upper Talarik Creek during July and August when there is little precipitation and Chinook, chum, and sockeye salmon are spawning. From January through March when surface runoff slows or stops, ground water is the primary source of critical winter flows to incubating salmon eggs and juvenile salmon overwintering areas. Ground water from the mine area is also likely the source of the seeps and upwelling areas in these streams currently used by salmon for spawning. The loss of ground water would reduce the amount of salmon spawning habitat in July and August when Chinook, chum and sockeye salmon spawning occurs, and would reduce the amount of viable overwintering habitat during January-March low flows. The sections of the South Fork Koktuli which currently go dry in mid summer would likely expand. Loss of salmon and resident fish habitat because of reduced and altered stream and ground water flows is well documented in the scientific literature, and is a major cause of salmon declines in the Pacific Northwest (National Research Council, 1996 and Heggnes et al. 1998) Pebble Mine ground and surface water appropriations could eliminate some or all salmon and high value fish habitat in the upper sections of the South Fork Koktuli River. Salmon and high value resident habitat and fish production would likely be reduced in downstream reaches, but to a lesser degree because of the mitigating effects of flow from downstream tributaries. Loss of ground water upwelling areas would also reduce or eliminate salmon spawning in the areas of the North and South Forks of the Koktuli River and Upper Talarik Creek where this occurs.

Predicting the impact of instream flow reductions, from the proposed surface and ground water appropriations for the Pebble Mine, on fish production is complex and imprecise without a lot of long term data. However, there is no question that the loss of ground and surface water below the mine and tailings ponds will reduce fish spawning and rearing habitat and fish production. It is likely that the proposed ground water and surface water appropriations for the Pebble Project Mine would reduce downstream production of adult salmon and other fish species by thousands and possibly into the tens of thousands of adult fish annually. The lost of rearing juvenile fish would be at least one magnitude higher. The loss of fish production would continue over the 40 to 70 year life of the mine.

After the mine is closed, the surface and ground water that is no longer captured and used by the mine would fill and then overflow the mine pits and tailings storage areas. Because this water may be contaminated with heavy metals it would have undergo an extensive treatment process before it could be discharged into these streams.

Obstruction of fish passage: The access road, pipelines, and electrical transmission line will cross at least 120 streams, and approximately half of these streams provide spawning, rearing and migratory habitat for five species of salmon and high value resident fish such as rainbow trout, Dolly Varden, and grayling. Roads impact streams when inadequately designed, poorly installed or inadequately maintained stream crossing structures, usually culverts block fish passage to upstream fish habitat. Studies of culverts by the United States Forest Service and others found that improperly installed and maintained stream crossing structures have blocked access to thousands of miles of formerly productive salmon and high value resident fish in the Pacific Northwest and Alaska (Kemset, M., 1999). According to the Alaska Department of Fish and Game Sport Fish Division, "Poorly designed or inadequately maintained culverts can block or impede fish access to upstream spawning and rearing habitat. The connectivity of a diverse suite of fish habitats is integral to supporting the abundance of fish species and their life stages found in Alaska's fresh water habitats. Tributary streams, lakes, off-channel habitats, backwater areas, small ponds, and sloughs all provide critical fish habitat. Ensuring that these habitat components remain connected allowing for the free migration of spawning adults and rearing juvenile fish is critical for maintaining healthy fish populations. However, a variety of natural and man-made barriers (particularly culverts) limits connectivity of habitats and can measurably reduce fish production in some watersheds." (ADF&G, 2007).

Although, fish passage guidelines exist for the installation of culverts, many of the culverts installed in the Pebble Mine access road will likely eventually end up as barriers to adult and juvenile fish migration. Unanticipated flood flows can erode stream channels, perch culverts and block upstream migration. Incorrectly installed or poorly maintained culverts eventually become fish passage blockages. It is estimated that up to 50% of the culverts on public road systems may impede fish passage over time (Steve Albert, 2007). Based on this estimate it is likely that over time, culverts on the Pebble Mine access road may block access to many miles of rearing and spawning habitat and will reduce fish production by tens of thousands of rearing juvenile fish and thousands of adult fish annually.

6.3 Chronic and Acute Pollution: There has never been a copper mine as large as the proposed Pebble Mine in the western hemisphere but experience from much smaller mines indicates that

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there is a substantial risk that the Pebble Mine would (1) develop an acid mine drainage problem or (2) experience a large scale pollution event during the life of the mine or after abandonment (see Toxicity, Pollution Pathways, and Effectiveness Of The Regulatory Process Sections). Even small increases in copper or mercury levels in streams draining the Pebble Mine could reduce salmon and resident fish populations or cause secondary effects such as avoidance or reduced resistance to disease outbreaks.

Acid Mine Drainage: Acid mine drainage and tailings dam failures, from small to moderate sized copper and metals mines, a fraction of the size of the proposed Pebble Project Mine, have severely impacted or eliminated aquatic life in streams for many miles downstream. The potential loss of fish habitat can be estimated by considering two examples. Copper drainage from the Washington Copper mine in British Colombia has severely reduced salmon and trout populations in the Tsolum River and several tributaries for 18 miles downstream. In the past, the Tsolum River supported large populations of steelhead and resident rainbow trout, sea-run cutthroat trout, and Coho, pink and to a lesser extent, chum salmon. The fisheries resource is believed to have declined in the basin predominantly because of the acid mine drainage from Mt. Washington. Other factors such as the reduction of summer low flows by irrigation withdrawals, over fishing, logging and gravel extraction were considered as possible contributing factors. However, the neighboring Puntledge River, which has experienced these same disturbances, has continued to support strong salmon and trout populations (Government of British Colombia, Ministry of the Environment, 1995). Acid mine drainage from the 75 acre Formosa Copper Mine in Oregon has eliminated all aquatic life from 18 miles of two streams that were formerly prime habitat for steelhead, Coho salmon and trout (The Oregonian, 2007). Because the proposed Pebble Mine would be hundreds, perhaps thousands of times larger than these mines, the potential impacts would be proportionately greater than these mines.

Considering the effect of much smaller copper mines on salmon production, acid mine drainage overflowing from the abandoned Pebble East and West water filled mine pits into Upper Talarik Creek, or pollutant laden water leaking from tailings dams holding up to 8.2 billion tons of waste rock into the North or South Forks of the Koktuli River could eliminate all aquatic life for some distance downstream. Considering the scale of the Pebble Mine and the potential amount of acid mine drainage, the dead zone could include just the North or South Fork of the Koktuli, or Talarik Creek, or extend downstream into the Mulchatna River and Lake Iliamna. Increased levels of copper and other heavy metals which are toxic to phytoplankton at very low levels would reduce food organisms that support rearing juvenile sockeye in Lake Iliamna (Roch, et al. 1985). Based on adult salmon escapement levels, the loss of one or more of these streams to acid mine drainage could reduce production of adult Bristol Bay sockeye, Chinook and coho salmon in some years by up to hundreds of thousands of fish. Large numbers of high value resident fish would also be eliminated.

Waste Water Discharges: Several mining experts and a number of state and federal regulators with mining experience, who were contacted in the preparation of this report, voiced the opinion that Northern Dynasty would not be able to achieve their goal of zero discharge if the Pebble Mine were developed. The size of the mine, its location in wetlands , the amount of precipitation, the climate at the mine site, the inability to store the amount of water proposed to be appropriated over the life of the mine and past experience were all cited as reasons. This is consistent with the United States Environmental Protection Agency's, 2004, Technical support for the 2004 effluent guidelines program plan, which found that, "Mines located in arid areas can effectively reduce effluent discharge quantities by evaporation. Other facilities, located in areas with net positive precipitation or icy conditions have less control over their discharge volumes." (Environmental Protection Agency, 2004). Sources of mine waste water discharges cited by EPA include water drained or pumped from active mining areas, process water discharges or leakage from tailings impoundments leach ponds and waste piles, and storm water runoff from the mining area (Environmental Protection Agency, 2003)

If the Pebble Mine can't achieve zero discharge, the mine can propose to discharge waste water to a nearby water body (Environmental Protection Agency, 2003). NPDES regulations allow mining operations to discharge a volume of wastewater equal to the net precipitation falling on the tailings impoundment. Considering the surface area of the tailings impoundments and the annual precipitation this discharge could amount to many cubic feet per second.

The proposed Pebble Mine might apply for a mixing zone or for reclassification of the receiving waters if it is not economically or technically feasible to treat waste water below levels that are harmful to fish.

Discharge permits are based on many factors including the composition of the waste water and the use of the receiving waters. ADEC 18AAC 70 Regulations Article 2 Exceptions to Statewide Standards allow for discharges which do not meet state water quality standards through short term variances, zones of deposit, thermal discharges, reclassification of waters, mixing zones and site specific criteria. To date ADEC has reclassified 25 stream reaches under 18.AAC 70.230e to allow nonconforming discharges from mines, including 8 for the Red Dog Mine.

Alaska Department of Environmental Conservation Mixing Zone Regulations 18 AAC 70 which were adopted in 2006 prohibit mixing zones in spawning areas and mixing zones which would "adversely affect the present and future capability of an area to support spawning, incubation, or rearing of any of the five species of salmon." However, mixing zones may be authorized in the spawning and rearing areas area of a lake, stream. river or other flowing water for all other species of resident and anadromous fish including rainbow trout, northern pike, brook trout, cutthroat trout, Arctic char, grayling and lake trout if three criteria designed to prevent or mitigate impacts to the growth and propagation of fish from discharges are met (18AAC 70).

Considering all of these factors it seems likely that the proposed Pebble Mine would have a discharge to either the Koktuli River or Upper Talarik Creek drainages. It is possible that the discharge would be piped to a lake, stream, or stream segment where 5 of the 7 species of Pacific salmon found in Alaska spawning don't spawn. Unfortunately is also likely that this discharge would exceed state water quality standards at times because of accidents, human error, and equipment breakdowns (see section on Red Dog Mine). Storm events with heavy precipitation could cause nonpoint source pollution or overwhelm treatment facilities. Depending on the size, composition and duration of the discharge, it could have acute or chronic effects on fish and other aquatic life in the receiving waters. Depending on the composition, magnitude and frequency these discharge could reduce fish production in the receiving waters.

Large Scale Pollution Event: A failure of one of the massive tailings dams planned for the Pebble Mine would have devastating short and long term consequences for the receiving waters. A tailings dam failure due to an earthquake, flood, or structural flaw would not only release a flood of polluted water downstream, but would also bury the receiving stream with silt like mine wastes. This silt would clog stream gravels and make the water in these clear water streams opaque. The tailings dam failure at the Brewer Gold Mine killed all fish in the Lynches River for 49 miles downstream (EPA, 2005d). The failure of the Martin Coal Company's tailings dam containing 250 million gallons of liquid waste and 155,000 cubic yards of solids impacted 75 miles of the Big Sandy Fork River.

The failure of one of the proposed Pebble Mine tailings dams containing several billion tons of potentially reactive mine waste and hundreds of billions of gallons of contaminated water could kill aquatic life as far downstream as the Nushagak River or out into Lake Iliamna. Mine tailings would be washed downstream and when exposed to oxygen would release acid and heavy metals for generations. Because of the billions of tons of mine waste involved, it is not clear if it would be physically or economically feasible to clean it up. A major failure of a tailings storage facility could kill hundreds of thousands to millions of adult salmon and high value resident fish depending on when and where the spill occurred. Fish production might be permanently eliminated or impaired in the stream impacted by the spill. Planktonic food organisms that are the food source for juvenile sockeye salmon in Lake Iliamna would decline if copper levels in the Lake increase as result of a spill (Roch, et al. 1985). Returning salmon which encountered the heavy metals in the plume from the spill might incur olfactory damage or be deterred from their upstream migration depending on the concentrations of heavy metals in the water column (Goldstein, J., et al. 1999)

Slurry Pipeline Breaks and Spills: As documented in the Sections on Copper Toxicity and Pollution Pathways, slurry pipeline breaks and spills occur frequently in spite of governmental regulations and oversight. Fish and other aquatic life would be likely killed by a large spill of copper concentrate slurry into any of the 40 or more streams crossed by the slurry pipelines. For example, large numbers of Newhalen River and Lake Clark sockeye stocks could be impacted by a pipeline break which spilled copper concentrate and contaminated water into the Newhalen River during the adult spawning migration, or the smolt out migration. Rearing salmon in the Newhalen River and Lake Iliamna would be impacted by dissolved copper directly and indirectly by copper which is very toxic to the planktonic food organisms that juvenile sockeye salmon feed on (see Pebble Project Toxicity section).

Adult salmon attempting to enter the Newhalen River might be injured or killed by copper levels in the River or abort their spawning run up river. Depending on the size, time and location of a pipeline spill, a slurry pipeline break could impact thousands to hundreds of thousands of adult salmon and high value resident fish, and hundreds of thousands to millions of juvenile fish.

Industrial Development and the Public Perception of Pollution Could Impact the Marketability of Bristol Bay Salmon: Publicity surrounding a major pollution event such as the failure of one of the 750 foot high tailings dams, chronic heavy metals pollution, or just the perception that the Pebble Mine might be polluting the waters of Bristol Bay drainages is likely to harm the marketability of Bristol Bay salmon. Subsistence fishermen would likely stop fishing stocks that might be contaminated. Sport fishermen who are now attracted to the pristine but expensive salmonid fisheries of Bristol Bay might avoid areas believed to be contaminated. The economic and social cost could be very great.

Although, a comprehensive discussion of the effect of the perception of food safety on consumer's purchases is beyond the scope of this paper, the scientific literature contains many examples of how consumer's seafood purchases are affected by contamination of fish. Public reaction to news about mercury levels in tuna, a heavy metal also present in the Pebble mine area is one example of what could happen in the aftermath of news about chronic pollution or a major spill. According to a recent report in Globefish, which provides information on international fish trade, "bad publicity surrounding mercury levels in tuna has significantly reduced tuna sales in the United States, despite strenuous efforts by the industry to counter public perceptions. "Around 21% of consumers say they are "extremely concerned" about mercury in fish, up from 17% two years ago, according to a recent poll. The effective closure of all canneries on the US mainland has already dented imports of frozen whole tuna: now only around 10 000 tons, compared to 130 000 tons eight years ago. In the first nine months of 2006, imports of frozen tuna declined further, by 8%. Studies carried out recently found 19% of people ate canned tuna at least once during the previous two weeks. In 2001, this share had been 25%. The canned tuna industry is swimming upstream, hurt by health warnings of mercury contamination" (Globefish, 2006).

Reports of a massive spill of Pebble Mine tailings into the Koktuli River or Upper Talarik Creek, a slurry pipeline break spilling copper concentrate into the Newhalen River or just chronic heavy metals pollution into the salmon streams draining the mine area could trigger a similar market reaction. For example scientists who studied the public reaction to news that farmed salmon were contaminated with PCB's and dioxins, reported that, "The identification of chemical contamination in farmed salmon had an immediate impact in the press (as judged by worldwide news coverage), on the public (reduced sales of farmed salmon were reported), and on perceptions of the state of the science." (Louma, S. and R. Ragnar, 2007).

Consumers are rightfully concerned about the purity of the food they eat and concern about the safety of seafood from an area can linger long after the source of the pollution is removed. According to the International Tanker Owners Pollution Federation Limited Technical Information Paper Number 3, (ITOPF, 2004), the most serious threat of oil spills to fisheries and aquaculture activity is the economic loss arising from business interruption. "Oil on the water and the application of temporary fishing and harvesting bans may prevent normal production, or a loss of market confidence may occur leading to price reductions or outright rejection of seafood products by commercial buyers and consumers. In extreme cases the mere hint of oil contamination can affect the marketing of high-price luxury seafood even if the produce is proven to be taint-free after testing by trained sensory panels and contaminants are at background levels after exhaustive chemical analysis" (ITOPF, 2004).

6.4 Other Pebble Mine Impacts: Although not part of the mining process per se, the construction of a road and port are an essential part of the project and would result in regional economic and social changes. The construction and operation of a new power plant for the mine could have significant fisheries impacts in its own right.

Secondary Development: Depending on your perspective, one of the biggest impacts or benefits of construction of the Pebble Mine port, electric transmissions lines and access road is the secondary development what may occur as a result. The 2005 update of the ADNR Bristol Bay Area Plan For State Land, (pg. 2-37) identifies 95 mineral deposits, prospects, and occurrences within 120 miles of the port site. Most are less than 50 miles from the proposed Pebble Mine access road corridor as depicted on page 2-74 of the Bristol Bay Area Plan for State Land (ADNR, 2006). Thousands of acres of claims have been staked around the Pebble Project claims. Many more deposits are located within 120 miles of the terminus of the Pebble Mine access road, including large gold deposits in the Shotgun Hills, copper claims near Iliamna, the Kemuk Mountain iron and titanium deposit, and the Sleitat Mountain tin-tungsten-silver deposit. The fourth Mineral Resources goal on page 2-32 of the Alaska Department of Natural Resources Bristol Bay Area Plan for State Lands entitled, State Support of Mining: is "aid in the development of infrastructure such as ports, roads, railroads, and continue to provide geologic and geophysical mapping and technological support to the mining industry." (ADNR, 2005). Once transportation facilities and electric power become available, many other large mining projects may become viable, especially if the roads and transmission lines are provided by the state or public utilities. These projects could have similar impacts on fish habitat, fish, and fishermen as the Pebble Mine.

If the road and port site are open to the public it would not only reduce the cost of living for residents of the area, but would make it attractive for new people to move into the area to work in the mines and service industries. State lands designated for settlement along the road corridor at Pile River, Chekok Lake, and the Newhalen River would likely be claimed by new residents. If ferry service were established, residents of the rail belt could use the Pebble Mine access road or the state maintained Williamsport Road to access both the Kvichak River system for hunting and fishing. Road extensions to the Mulchatna drainage would allow hunters and fishermen to access that drainage. Increased demand for key species such as salmon, trout, moose and caribou and competition with local residents will likely require changes in harvest and subsistence regulations.

The New Power Plant Needed to Meet Pebble Mine Power Needs Might Have Its Own Impacts: Because there currently isn't sufficient generating capacity in South Central Alaska to provide the 300 megawatts of electricity needed for the Pebble Mine, a new power plant would have to be constructed to provide electric power. If this power were supplied by a new coal burning power plant, fueled by coal strip mined from one of Cook Inlet's coal fields, then it would have additional significant impacts on fish habitat, salmon and high value resident fish. There has also been interest the construction of a coal gasification or coal burning power plant using coal mined from the coal fields in the Chuitna River drainage near Tyonek. This project could seriously impact water quality and fish habitat in the Chuitna River drainage.

CONCLUSION: The assessment of the potential impacts of the current Northern Dynasty Mines Pebble Project Mine Proposal presented in this report is based on the scientific literature, the historical record, and expert opinion. Over 1000 documents were reviewed in the preparation of this report and the information and conclusions are derived from the 300 references cited.

Because so much conflicting information has been disseminated by proponents and opponents of the Pebble Project the reader is encouraged to refer to the scientific literature whenever there is an unanswered question regarding the potential effects of Pebble Mine.

Based on the information and the case histories available at this time, it is clear that the development of the second largest copper mine in the world, using open pit and block caving techniques proposed by NDM would physically impact a substantial amount of fish and wildlife habitat at the headwaters of the Kvichak and Nushagak River drainages. Because of the size of the mine and the nature of the ore and waste, the mine and associated tailings storage facilities would also present a substantial long term pollution threat to fish production and commercial, subsistence and sport fishing in portions of the Nushagak and Kvichak River drainages.

Bristol Bay is the largest sockeye salmon producing system remaining in the world. The Bristol Bay salmon fishery is the largest employer and the largest source of income in the region. The Kvichak River drainage has historically been the largest sockeye salmon producing system in Bristol Bay (ADNR, 1984). The Kvichak –Naknek District which includes both the Kvichak and Naknek River drainages and the Nushagak District together provided 63% of the total 2006 Bristol Bay sockeye harvest. The Kvichak river drainage (including the Alagnak River) and the Nushagak River drainage (including the Wood River system) together provided over 65 % of the total 2006 Bristol Bay sockeye escapement. The 2006 harvest of all salmon species in Bristol Bay was approximately 31 million fish. The ex vessel value was $93,935,000 to the fishermen.

Construction of the mine using open pit and block caving techniques as proposed by NDM would physically destroy a substantial amount of salmon and high value resident fish habitat in the North and South Forks of the Koktuli River and Upper Talarik Creek drainages. The tailings storage facilities would bury additional salmon and high value resident fish habitat under billions of tons of mine waste. Water appropriations for the mine would eliminate more spawning and over wintering habitat during critical summer and winter low flow periods. Construction of the 104 mile long road would fill hundreds of acres of riparian and wetlands habitat, and a percentage of the stream crossing structures would block fish passage over time. The Iniskin Bay port would impact a productive and currently undisturbed coastal and marine area. These habitat losses would reduce salmon and high value resident fish populations in affected drainages, as well as seabirds, marine mammals, and marine fish and invertebrates at the port site.

The mine and associated facilities would permanently change the wild character of the Kvichak River drainage. The road, port, and electrical transmission lines for the Pebble mine would provide access and infrastructure could support the development of other mineral claims in the Kvichak and Nushagak drainages which might not otherwise be economically viable. If developed these mines could have similar types of impacts as the proposed Pebble Project.

The sulfide ore which would be mined when exposed to water and air generates sulfuric acid which dissolves metals present in the ore, waste rock and tailings. The current information from NDM indicates that there is very little buffering capacity in the ore and treatment of the mill waste and reactive waste rock to neutralize acids is not proposed. Copper, mercury, other metals present in the ore and chemicals such as cyanide, which may be used at the mine, are toxic to fish and other aquatic life at extremely low levels. Acid mine drainage, tailings dam leaks and failures, slurry pipeline breaks, chemical spills, fugitive dust and ground water pollution which have occurred with some regularity at other mines in the United States, can carry toxic metals and mine chemicals from mines into fish streams. Acid mine drainage from much smaller copper mines than the proposed Pebble Mine, has completely eliminated salmon from formerly productive streams. Sulfide mines in wet areas have experienced significant pollution problems compared to other types of mines and mines in arid areas.

The size of the Pebble Project, as currently proposed by NDM, which would leave behind 8 billion tons or more of mine waste behind the largest earth fill dams ever constructed in the United States and a pit that may be more than 4 square miles and a mile deep when completed, means that all of the pollution problems experienced at much smaller mines could be magnified many times.

Because the mine tailings are currently proposed to be stored and not treated to neutralize acids, the tailings containment facilities present a long term threat to the Nushagak and Kvichak River drainages. Because all tailings dams leak and the mine pit is likely to fill with water and over flow, pollution control measures at the mine and the tailings storage areas will have to function and be actively maintained in perpetuity. The need for long term maintenance increases the likelihood that pollution and substantial damage to the Nushagak or Kvichak River habitat and fisheries will occur at some point over the thousands of years that everything needs to operate flawlessly. The most common causes of tailings dam failures have been earthquakes, floods, and structural failures. The location of the proposed Pebble Project Mine in a very remote, tectonically active area with high precipitation and severe weather adds to the risk.

Neither mine developers nor state and federal regulators can guarantee that the Pebble Project mine would not pollute. NEPA documents for recently permitted sulfide mines have not predicted pollution and environmental damage that occurred after the mines began operating. Mines are exempt from federal anti-pollution statutes, such as CERCLA. Experience with mines in Alaska and elsewhere demonstrate that because of permit amendments the size and operation of the mine can change significantly after the EIS is completed and initial permits are issued. Federal and state regulators have not been very successful in predicting and preventing acid mine drainage, tailings dam failures, slurry pipeline breaks, dust pollution, cyanide spills or ground water pollution at recently permitted large mines in the United States. Changes in Alaska's regulatory system and the Bristol Bay Area Plan between 2003 and 2006 reduced protection for fish habitat.

In a number of recent high profile cases where metals mines have polluted fish streams, the restoration bonds required by the mine permits have been a fraction of what the public has had to pay to treat pollution after the mining company declared bankruptcy. Alaskan mines are listed some of the largest polluters in the United States, in large part because of exemptions from federal statutes which allow mines to permanently store massive amounts of toxic mine waste after the mine is closed..

The Frazer River has frequently been used by Northern Dynasty Mines as an example of how hard rock mining and salmon habitat can coexist. It is useful to consider the current status of Frazer River salmon stocks in evaluating these claims. The Frazer River drainage once was the second largest sockeye salmon producing system in the world. It has good soils, mineral deposits and forests. As a result portions of the Frazer River watershed have been developed for mining, logging and agriculture. However, this development has had a detrimental effect on salmon habitat and production. Beginning in the early 1990's, Frazer River sockeye runs precipitously declined to such low levels that the commercial, sport and subsistence fisheries were closed completely in 2007. The outlook for a recovery looks bleak. The decline which is attributed to warming water temperatures and habitat destruction occurred in spite of a substantial public investment in state of the art salmon habitat enhancement over the last 30 years. The dramatic decline of the Frazer River system in the last two decades should be a sobering reminder for Alaskan's of how fragile salmon ecosystems may be and how little is known about how these systems can be affected by development and environmental changes.

It is my hope that this report will help answer the following important questions:

(1) Is the physical loss of fish and wildlife habitat that will result from development of the mine, construction of the access road, slurry pipelines, electrical transmission lines and port and the resulting fundamental change in the character of the area consistent with conservation of salmon in the Nushagak and Kvichak River drainages?
(2) How does the likelihood that development of the Pebble Project infrastructure (road, port, and power) will stimulate other mineral development with similar impacts in these drainages factor into TNC's decisions?
(3) In addition to the direct physical loss, what is the risk that the mine pit and underground workings might generate pollution and tailings storage facilities might fail or leak causing extensive habitat loss in the Nushagak or Kvichak River drainages during mining or at some time during the thousands of years after the mine is closed?
(4) based on past experience what is the likelihood that state and federal regulatory processes will anticipate and prevent significant environmental problems that may occur at the mine over its 40 to 70 year life span or in the thousands of years after it is closed?

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Appendix 1. Collection Data from 2004 Pebble Mine Road Corridor Fish Surveys

Stream coordinates	Coho		Sockeye		Chum	Chinook		Pink	Dolly Varden		Rainbow Trout		grayling		sculpin	stickleback
	adults	juveniles	adults	juveniles	adult	adults	juveniles	adult	adult	juvenile	adult	juvenile	adult	juvenile		
1.N59.91293																
W155.26279		20													20	
2.N59.92601																
W.155.22971																
3.N59.92886																
W155.20145										2						
4.N5992747																
W155.19458																
5.N59.92175									4							
W155.15887																
6.N59.91860																
W155.14301																
7.N59.91473																
W155.12256																
8.N59.91072																
W155.11748																
9.N59.91221		19								4						
W155.09050																
10.N59.91115																
W155.07437																
11.N59.90842										6					25	
W155.03561																
12.59.90842		6								4				4	32	
W154.94038																
13N59.90777		12													11	
W.155.27148																
14.N59.90400																
W155.24896																
15.N59.90197		32														1
W155.23792																
16.N5990531		3														15
W155.22839																
17.N59.88292		2														
W155.17679																
18.N59.87932		21					9				2	2	8			
W155.17113																
19. N59.88639															18	15
W155.02428																
20.N59.89405										100						
W155.02428																
21N59.89405															19	
W154.97673																
22.N59.89588																
W154.95325																
23. N59.90010															4	
W.15494063																
24.N59.89951															20	
W154.94038																
25N59.86399																
W154.92587																
26. N59.84462									2							
W 154.92729																
27.N59,83117										2					30	
W154.92007																
28. N59.77761				3000						1						
W153.82530																
29.N59.76044																
W153.85202																
30. N59.75839				2000												
W.153.84750																

2079

Stream coordinates	Fish Species and Numbers															
	Coho		Sockeye		Chum	Chinook		Pink	Dolly Varden		Rainbow Trout		grayling		sculpin	stickleback
	adults	juveniles	adults	juveniles	adult	adults	juveniles	adult	adult	juvenile	adult	juvenile	adult	juvenile		
31.N59.76991										1						
W153.84750																
32.N59.76869										1						
W153.82381																
33.N59.72946										3					1	
W153.80251																
34.59.71869										1						
W153.79527																
35.59.70868										4					7	
W153.74580																
36.N59.68557										8						
W153.65350																
37.N59.64527		9	3		63	1		12	10	8						
W153.52769																
38.N59.64468																
W153.51646																
39.N59.69768										5					1	
W153.59636																
40.N59.83503				100						1					25	
W.153.76364																
41.N59.82109				100						6						
W.153.64362																
42.N59.80172																
W153.59996																
43.N59.79528										7						
W153.56619																
44.N59.77565										8		1				
W153.51138																
45.N59.7319					50				15							
W153.45644																
46.N59.73463	100												1	9		
W153.45984																
47.N59.71375										3						
W153.44768																
48.N59.82681		3	50				1					2			11	
W154.88028																
49.N59.80719															19	
W154.80444																
50.N59.80555										5					22	
W154.78462																
51.N59.80440																
W154.75993																
52.N59.80082										16						
W154.70607																
53.N59.80238															11	1
W154.67198																
54.59.80865										6						
W154.67198																
55.59.80693										10						
W. 15461536																
56.N59.84211		1	7							5					7	
w154.52963																
57. N59.84969		9	100					5	3	7					3	
W154.51971																
58.N59.85029		5														
w154.45849																
59. N59.84463			13	300					2	12		2				
W154.45876																
60.N59.84669		8														
W154.43849																
61. N59.84031															15	
W154.38333																
62.N59.8395[illegible]			[illegible]													
W154.3817																
63.N59.83666			522							3					25	
W154.36778																
64.N59.81266			89							11					9	

Stream coordinates									Fish Species and Numbers							
	Coho		Sockeye		Chum	Chinook		Pink	Dolly Varden		Rainbow Trout		grayling		sculpin	stickleback
	adults	juveniles	adults	juveniles	adult	adults	juveniles	adult	adult	juvenile	adult	juvenile	adult	juvenile		
62.N59.83958			683									7			5	
W154.38171																
63.N59.83666			522							3					25	
W154.36778																
64.N59.81266			89							11					9	
W154.12366																
65.N59.28213																
W154.08099																
66.N59.080264										8						
W153.96252																
67.N59.81358										4						
W153.93198																
68.N59.80261								10								
W153.87315																
69.N59.80261			177							4					6	
W153.82471																

Appendix 2. Act 171, Wisconsin 1997 Sulfide Mining Law

293.50 Moratorium on issuance of permits for mining of sulfide ore bodies.

(1) In this section:

(a) "Pollution" means degradation that results in any violation of any environmental law as determined by an administrative proceeding, civil action, criminal action or other legal proceeding. For the purpose of this paragraph, issuance of an order or acceptance of an agreement requiring corrective action or a stipulated fine, forfeiture or other penalty is considered a determination of a violation, regardless of whether there is a finding or admission of liability.

(b) "Sulfide ore body" means a mineral deposit in which metals are mixed with sulfide minerals.

(2) Beginning on May 7, 1998, the department may not issue a permit under s. 293.49 for the mining of a sulfide ore body until all of the following conditions are satisfied:

(a) The department determines, based on information provided by an applicant for a permit under s. 293.49 and verified by the department, that a mining operation has operated in a sulfide ore body which, together with the host rock, has a net acid generating potential in the United States or Canada for at least 10 years without the pollution of ground water from acid drainage at the tailings site or at the mine site or from the release of heavy metals.

(b) The department determines, based on information provided by an applicant for a permit under s. 293.49 and verified by the department, that a mining operation that operated in a sulfide ore body which, together with the host rock, has a net acid generating potential in the United States or Canada has been closed for at least 10 years without the pollution of ground water or surface water from acid drainage at the tailings site or at the mine site or from the release of heavy metals.

(2m)

(a) The department may not base its determination under sub. (2) (a) or (b) on any mining operation that has been listed on the national priorities list under 42 USC 9605 (a) (8) (B) or any mining operation for which the operator is no longer in business and has no successor that may be liable for any contamination from the mining operation and for which there are no other persons that may be liable for any contamination from the mining operation.

(b) The department may not base its determination under sub. (2) (a) or (b) on a mining operation unless the department determines, based on relevant data from ground water or surface water monitoring, that the mining operation has not caused significant environmental pollution, as defined in s. 293.01 (4), from acid drainage at the tailings site or at the mine site or from the release of heavy metals.

(3) This section applies without regard to the date of submission of the permit application.

History: 1997 a. 171

Source: Wisconsin Department of Natural Resources,

Appendix 3. Montana Cyanide Ban CI 137 Enacted 1998

Current law states:

82-4-390. Cyanide heap and vat leach open-pit gold and silver mining prohibited.

(1) Open-pit mining for gold or silver using heap leaching or vat leaching with cyanide ore-processing reagents is prohibited except as described in subsection (2).

(2) A mine described in this section operating on November 3, 1998, may continue operating under its existing operating permit or any amended permit that is necessary for the continued operation of the mine.

The current law is actually an amended version of the citizen's initiative CI-137 that was approved by the electorate in November 1998. The 1999 legislature, through passage of SB345 (Shea), made the following amendments to the initiative language.

Section 1. Section 82-4-390, MCA, is amended to read:
"82-4-390. Cyanide heap and vat leach open-pit gold and silver mining prohibited.

(1) Open-pit mining for gold or silver using heap leaching or vat leaching with cyanide ore-processing reagents is prohibited except as described in subsection (2).

(2) A mine described in this section operating on November 3, 1998, may continue operating under its existing operating permit, but the permit may not be amended to allow its operations to be expanded or any amended permit that is necessary for the continued operation of the mine."

Section 2. Effective date. [This act] is effective on passage and approval.
This amendment effectively allowed the Golden Sunlight mine near Whitehall and the Majesty.

Source: State of Montana: Environmental Quality Council

Appendix 4. A Chronology of Polluted Related Events At The Red Dog Mine As Reported In The Anchorage Daily News 1989-2007

1. October, 7, 1989. Water containing toxic levels of zinc and other heavy metals began flowing from a seep into Red Dog Creek. Changes in ground water flow associated with mining are suspected as the sources.

2. March 21, 1990. The mines operators struggled for over a year to get the mines treatment plant operating to neutralize waste. The Red Dog tailings dam, which had been approved under the state and federal permitting process, came very close to failing. Snow melt and rainfall flowing into the mines 500 acre waste impoundment which was already full of mine waste filled the pond to overflowing. The dam, though built as permitted, was under designed to cope with the levels of effluent and precipitation encountered. To save the dam and avoid having the entire contents of the tailings impoundment flow down into the Wulik River, Teck-Cominco had to open a spillway and release polluted water. Millions of gallons of wastewater were discharged to frozen Red Dog Creek.

3. August 18, 1990. Toxic levels of zinc and other hazardous metals from the mine leaked fouling more than 20 miles of creek with milky orange stains and threatening the Wulik River one of N.W. Alaska's richest fisheries. Regulators asked Cominco to build a diversion ditch around the mine, but company isn't sure that the problem is related to their mining activities.

4. August 30, 1990. Zinc levels flowing from a seep into Red Dog Creek reach, 1,180 ppm. Company build diversion ditch around mine and pollution subsides.

5. December 5, 1990. Three trucks carrying ore overturn spilling zinc and lead concentrate onto the tundra next to the haul road.

6. March 13, 1991. EPA fines Cominco $125,000 for violating their discharge permit 134 times between May and October 1990. Company fights allegations.

7. July 7, 1991. Red Dog Mine spends $11,000,000 to clean up pollution in Red Dog Creek. To halt pollution from the mine Cominco built a plastic lined ditch to divert Red Dog Creek water around the mine, and capture water from seeps.

8. April, 1992. Mine dumps 100,000 gallons of metal contaminated water into frozen Red Dog Creek. Zinc levels reach 220 times state water quality limit, but not expected to threaten fish or humans.

9. July 14, 1997. Cominco agrees to pay 4.7 million dollars for several thousand water quality violations which occurred 1990 and 1993. According to EPA violations included metals spills, operating unpermitted sewage treatment plants and fuel spills.

10. June 3, 1998. A pump on a slurry pipeline at the mine broke spilling 200,000 gallons of zinc and lead concentrate.

11. December 14, 1999. EPA blocks Red Dog air quality permit, because of disagreement over whether Cominco should upgrade power plant to reduce air pollution.

12. September 8, 2000. The State of Alaska joins Cominco law suit to block EPA from requiring higher air quality standards at mine.

13. October 11, 2000. Ore Truck overturns spilling 30 tons of lead concentrate onto tundra.

14. October 18, 2000. ADNR rejects Cominco's request to create an air quality exclusion zone around power plant because of restriction of public access on state tidelands.

15. April 10, 2001. State of Alaska alleges that Cominco is responsible for multiple air quality violations at Red Dog mine.

16. June 21, 2001. National Park Service releases results of study showing elevated levels of lead, zinc and cadmium on vegetation along haul road. Metal levels were higher than severely polluted areas of Eastern Europe.

17. July 7 2001. Local natives ask ADNR to close the haul road because of concern that subsistence foods are being contaminated by toxic lead and cadmium dust from ore trucks

18. July 14, 2001. State rejects road closure request. ADEC says health risk isn't enough to justify closure.

19. July 18. ADEC and EPA focus on heavy metal contamination along haul road. EPA attorney describes contamination as very significant.

20. July 21, 2001. A truck hauling concentrates overturns spilling lead concentrate on tundra.

21. December 19, 2001. Red Dog mine agrees to pay $827, 000 in fines to settle State pollution complaint.

22. January 30, 2002. Cominco buys new trucks with covers to reduce dust from trucks hauling concentrate.

23. June 3, 2002. EPA releases TRI report that in 2000 the Red Dog Mine had the second largest toxic release in the U.S. Red Dog release is huge amount of waste rock containing lead and zinc deposited in tailings impoundments and upland storage areas. According to EPA the metals can leach out and contaminate ground and surface water unless properly treated.

24. July 18, 2002. Village of Kivalina claims that mine discharges are affecting their water supply and announce plans to sue Teck-Cominco.

25. July 31, 2002. Federal Appeals Court rules against Teck-Cominco and State. EPA was justified in requiring better antipollution equipment on mine generators.

26. August 24, 2002. Murkowski promises to build roads and change state laws and policies to benefit mines.

27. September 20, 2002. Village of Kivalina files suite against Red Dog Mine discharges because of concerns about water pollution and concerns about contamination of subsistence foods.

28. October 20, 2002. ADEC official tackle acid mine drainage from Alaska's mines. Red Dog and Greens Creek Mines are identified as acid generating. The bond for Greens Creek has been set at 24 million dollars and requires 30 years of monitoring. The State is 3 years away from regulating acid mine drainage at the Red dog Mine. According to Charlotte MacCay environmental coordinator for Red Dog, "Because the deposit at Red dog is highly sulfuric, the piles of waste actually smoke. When that happens, workers cover them with inert material to keep out the air and water that triggers the acid making process."

30. January 22, 2004. The Supreme Court rejects Teck-Cominco and State claims and rules that the EPA can require tighter clean air standards at Red Dog Mine.

31, February 2, 2004. Ore truck overturn spilling lead zinc concentrate.

32. June 24, 2004. State ADEC disputes independent chemists finding that between 10 and 43 percent of berries and sourdock samples along the Red Dog Mine haul road exceed the U.S.D.A.'s food safety standards for lead and cadmium.

33. June 24, 2004. Red Dog, Greens Creek, and Illinois Creek tops EPA's 2002 toxic release list. Red Dog stored 481 millions pounds of toxic chemicals on land, and released 195, 000 pounds of air emissions.

34. July 11, 2004. The Red Dog Mine works to control waste discharge, as villagers voice concerns about affect on water quality and health.

35. July 30, 2004. State officials acknowledge high concentration of lead zinc and cadmium along haul road but say that locals don't gather food in heavily contaminated areas.

36. August 10, 2004. National Parks Service Study finds that dust from trucks has contaminated thousands of acres along haul road with toxic levels of lead, cadmium and zinc.

37. October, 5, 2004. A truck hauling fuel for the Red Dog Mine spills 4000 gallons of diesel.

38. March 20, 2005. Kivalina villagers claim that vessel traffic has caused beluga whales to change migratory routes.

39. May, 12, 2005. EPA reports that releases of toxic material from the Red Dog lead zinc mine make it the nation's tops polluter in 2003.

40. November 12, 2005. Red Dog Mine Cited for water quality breach.

41. August 2, 2006. U.S. District Court Judge John Sedwick found that Teck-Cominco violated its discharge permit 618 times by pumping too much effluent or treated waste water into Red Dog Creek which flows into the Wulick River.

42. August 24, 2007. Teck Cominco, who operates the Red Dog Mine, is currently operating under a federal compliance order allowing it to exceed certain water quality standards. Several residents of the Village of Kivalina are suing Teck Cominco for water quality violations at the mine (Anchorage Daily News, 8/24/07).

Appendix 5. Fish Habitat Protection Statutes Transferred From ADF&G to ADNR by Executive Order 107

AS 41.14.840. Fishway Required.

If the deputy commissioner considers it necessary, every dam or other obstruction built by any person across a stream frequented by salmon or other fish shall be provided by that person with a durable and efficient fishway and a device for efficient passage for downstream migrants. The fishway or device or both shall be maintained in a practical and effective manner in the place, form, and capacity the deputy commissioner approves, for which plans and specifications shall be approved by the deputy commissioner upon application. The fishway or device shall be kept open, unobstructed, and supplied with a sufficient quantity of water to admit freely the passage of fish through it.

AS 41.14.870. Protection of Fish and Game.

(a) The deputy commissioner shall, in accordance with AS 44.62 (Administrative Procedure Act), specify the various rivers, lakes, and streams or parts of them that are important for the spawning, rearing, or migration of anadromous fish.
(b) If a person or governmental agency desires to construct a hydraulic project, or use, divert, obstruct, pollute, or change the natural flow or bed of a specified river, lake, or stream, or to use wheeled, tracked, or excavating equipment or log-dragging equipment in the bed of a specified river, lake, or stream, the person or governmental agency shall notify the deputy commissioner of this intention before the beginning of the construction or use.
(c) The deputy commissioner shall acknowledge receiving the notice by return first class mail. If the deputy commissioner determines that the following information is required, the letter of acknowledgement shall require the person or governmental agency to submit to the deputy commissioner:
(1) full plans and specifications of the proposed construction or work;
(2) complete plans and specifications for the proper protection of fish and game in connection with the construction or work, or in connection with the use; and
(3) the approximate date the construction, work, or use will begin.
(d) The deputy commissioner shall approve the proposed construction, work, or use in writing unless the deputy commissioner finds the plans and specifications insufficient for the proper protection of fish and game. Upon a finding that the plans and specifications are insufficient for the proper protection of fish and game, the deputy commissioner shall notify the person or governmental agency that submitted the plans and specifications of that finding by first class mail. The person or governmental agency may, within 90 days of receiving the notice, initiate a hearing under AS 44.62.370 . The hearing is subject to AS 44.62.330 - 44.62.630.

Neither the 41.14.840 Fishway Required or AS 41.14.870 mandate maintainence of fish passage, or protection of anadromous fish habitat. AS41.14.840 states "***If the deputy commissioner considers it necessary***, every dam or other obstruction built by any person across a stream frequented by salmon or other fish shall be provided by that person with a durable and efficient fishway and a device for efficient passage for downstream migrants. AS41.14.870 states**(b)** If a person or governmental agency desires to construct a hydraulic project, or use, divert, obstruct, pollute, or change the natural flow or bed of a specified river, lake, or stream, or to use wheeled,

tracked, or excavating equipment or log-dragging equipment in the bed of a specified river, lake, or stream, the person or governmental agency shall notify the deputy commissioner of this intention before the beginning of the construction or use.
(c) The deputy commissioner shall acknowledge receiving the notice by return first class mail. ***If the deputy commissioner determines that the following information is required***, the letter of acknowledgement shall require the person or governmental agency to submit to the deputy commissioner:
(1) full plans and specifications of the proposed construction or work;
(2) complete plans and specifications for the ***proper protection of fish and game*** in connection with the construction or work, or in connection with the use; and
(3) the approximate date the construction, work, or use will begin.
(d) The deputy commissioner shall approve the proposed construction, work, or use in writing unless the deputy commissioner finds the plans and specifications ***insufficient for the proper protection of fish and game***. Upon a finding that the plans and specifications are insufficient for the proper protection of fish and game, the deputy commissioner shall notify the person or governmental agency that submitted the plans and specifications of that finding by first class mail. The person or governmental agency may, within 90 days of receiving the notice, initiate a hearing under AS 44.62.370 . The hearing is subject to AS44.62.330-44.62.630. As written the deputy commissioner has the discression to determine that plans an specifications

Appendix 6. No Perpetual Care Statutes and Regulations

A. **Michigan Statute and Regulations**: Compiled Laws Annotated Currentness
Chapter 324. Natural Resources and Environmental Protection Act
Natural Resources and Environmental Protection Act (Refs & Annos)
Article III. Natural Resources Management
Chapter 3. Management of Nonrenewable Resources
Subchapter 4. Mineral Mining
Part 632. Nonferrous Metallic Mineral Mining (Refs & Annos)

→324.63209. Compliance with permit standards; conduct of reclamation activities generally; actions of permittee during period of suspension of mining operations; postclosure monitoring period; scope of reclamation and remediation; compliance with applicable tribal, state, federal, or local requirements

Sec. 63209. (1) A permittee shall comply with all other applicable permit standards under this act.

(2) A permittee shall conduct reclamation activities at a mining area in accordance with the approved mining, reclamation, and environmental protection plan.

(3) If mining operations are suspended for a continuous period exceeding 90 days, the permittee shall take actions to maintain, monitor, and secure the mining area and shall conduct any interim sloping or stabilizing of surfaces necessary to protect the environment, natural resources, or public health and safety in accordance with the permit.

(4) Subject to subsection (5), a permittee shall begin final reclamation of a mining area within 3 years of the date of cessation of mining operations and shall complete reclamation within the time set forth in the mining, reclamation, and environmental protection plan approved by the department.

(5) Upon written request of a permittee, the department may approve an extension of time to begin or complete final reclamation.

(6) A permittee shall conduct groundwater and surface water monitoring in accordance with the provisions of the permit during mining operations and during the postclosure monitoring period. The postclosure monitoring period shall be 20 years following cessation of mining, subject to the following conditions:

(a) The permittee shall provide to the department a written request to terminate the postclosure monitoring not less than 18 months before the proposed termination date and shall provide the department with technical data and information demonstrating the basis for the termination. The department shall extend the postclosure monitoring period in increments of up to 20 years unless the department determines, approximately 1 year before the end of a postclosure monitoring period or postclosure incremental monitoring period, that there is no significant potential for water contamination resulting from the mining operation.

(b) The department may shorten the postclosure monitoring period at any time upon determining that there is no significant potential for water contamination resulting from the mining operation.

(7) The department may extend or shorten the postclosure monitoring period under subsection (6) only after public notice and opportunity for a public hearing under section 63219(2). [FN1]

(8) Both the mining area and the affected area shall be reclaimed and remediated to achieve a self-sustaining ecosystem appropriate for the region that does not require perpetual care following closure and with the goal that the affected area shall be returned to the ecological conditions that approximate premining conditions subject to changes caused by nonmining activities or other natural events. Any portion of the mining area owned by the applicant may be used for any legal purposes.

(9) Compliance with the provisions of this part does not relieve a person of the obligation to comply with all other applicable tribal, state, federal, or local statutes, regulations, or ordinances.

CREDIT(S)

P.A.1994, No. 451, § 63209, added by P.A.2004, No. 449, Imd. Eff. Dec. 27, 2004.

[FN1] M.C.L.A. § 324.63219.

CROSS REFERENCES

Financial assurance requirement, see § 324.63211.

LAW REVIEW AND JOURNAL COMMENTARIES

Regulation of non-ferrous metallic mineral mining in Michigan. Eugene E. Smary and Dennis J. Donohue, 24 Mich Env LJ No. 2, p. 11 (2006).

M. C. L. A. 324.63209, MI ST 324.63209

Current through P.A.2007 No. 51

END OF DOCUMENT

MICHIGAN ADMINISTRATIVE CODE
DEPARTMENT OF ENVIRONMENTAL QUALITY (R 425.101 THROUGH R 425.602)
OFFICE OF GEOLOGICAL SURVEY
NONFERROUS METALLIC MINERAL MINING
PART 2. PERMITS

Current through 2007 Register #13 (August 1, 2007)

R 425.203 Mining Plan.

Rule 203. The mining, reclamation, and environmental protection plan required under R 201(1)(d) shall contain a plan for the proposed mining operations. The plan shall include information that demonstrates that all methods, materials, and techniques proposed to be utilized are capable of accomplishing their stated objectives in protecting the environment and public health, except that such information may not be required for methods, materials, and techniques that are widely used in mining or other industries and are generally accepted as effective. The required information may consist of results of actual testing, modeling, documentation by credible independent testing and certification organizations, or documented applications in similar uses and settings. The plan shall include, at a minimum, all of the following:

(a) A description of the type and method of mining, the expected operating life of the mine, and the anticipated rate and schedule of mining.

(b) An estimate of the number of employees required for the mining operation, and variations in the number over the life of the mine.

(c) Information depicting and describing the items listed in paragraphs (i) to (xxiv) of this subdivision that are mining activities or are part of, or associated with, mining activities. Information that is amenable to clear depiction on a map shall be shown on a map or maps of the mining area drawn to an appropriate scale on a topographic base and referenced to the nearest government-surveyed section or quarter-section lines. Other required information shall be presented, as appropriate, by cross-sections, photographs, documents, and engineering drawings.

(i) Area, thickness, and characteristics of topsoil that will be stripped, and plans for stockpiling and stabilizing topsoil until it will be used in reclamation.

(ii) Area, volumes, and characteristics of overburden and waste rock to be excavated; plans and schedules for excavating; and locations and dimensions of stockpiles and final placement areas.

(iii) Area, volumes, types, and mineralogy of ore to be excavated, and schedule of mining and stockpiling ore.

(iv) Plans for limiting access to stockpiles and storage or disposal facilities to prevent disposal of unauthorized materials.

(v) A characterization of the geochemistry of the ore, waste rock, and overburden that will be mined, and peripheral rock that will be exposed in the process of mining, and of any tailings that will be generated. The characterization shall include the following:

(A) Chemical and physical testing and modeling to predict the potential generation of acid, dissolved metals, and other related substances by reaction and leaching of the ore, waste rock, tailings, overburden, and peripheral rock.

(B) Testing and modeling methodology.

(C) A plan for monitoring the characterization during the proposed mining operation to calibrate and adjust the model and predictions.

(D) Identification of the ore, waste rock, overburden, peripheral rock, and tailings that are reactive.

(vi) Lithology and thickness of rock surrounding and overlying the ore body.

(vii) The locations, depths, and contours of open pits.

(viii) The locations and dimensions of shafts, portals, or other openings between the land surface and underground mine workings.

(ix) The areal extent, depth, and dimensions of underground workings.

(x) Types and uses of grouting of the walls of open pits and of the walls, floor, and roof of underground workings.

(xi) A plan for preventing damage to the environment or public health or safety from subsidence, caving, or collapse of underground mine workings. The plan shall contain the following:

(A) A description of any planned or intentional caving and subsidence.

(B) Provisions to prevent adverse impacts to public or private water supplies or to an aquifer in the affected area.

(C) Provisions to assure that any underground mining shall not cause material damage to structures not owned or controlled by the operator.

(D) Provisions to assure that any underground mining shall not cause material damage to natural features on lands not owned by the operator.

(xii) A description of water that will be used in the mining operations, including the source or sources of the water and intended rates and durations of pumping, diversion, or withdrawal.

(xiii) A description of water that will be stored, transferred, or discharged in the mining operations, including:

(A) The location, size, and capacities of any artificial ponds, impoundments, dewatering systems, diversions, other water control structures, and treatment facilities.

(B) The estimated volumes, rates, and water quality of discharges, and the discharge locations.

(xiv) Storage areas for equipment and vehicles.

(xv) Buildings and other facilities or structures.

(xvi) Areas for the storage and transfer of chemicals, fuel, and explosives.

(xvii) Truck and mining equipment wash down areas.

(xviii) Roads, railroads, docks, piers, and other transportation infrastructure, and provisions to prevent release of contaminants to the environment from ore or waste rock during transportation.

(xix) Beneficiation processes, materials, and activities, including the following:

(A) The types, extent, and sequence of beneficiation, including physical and chemical characterization of all materials, wastes, or products.

(B) A description of any mills, concentrators, dryers, separators, chemical reactors, filtering equipment, electrolytic chambers, flotation cells, kilns, or other beneficiation equipment.

(C) The type and amount of chemicals to be added.

(D) The types, amounts, locations, sequence, schedule, and means of waste rock and tailings disposal.

(E) Provisions to prevent release of contaminants to the environment from beneficiation equipment.

(F) Tailings transport systems, if not buried, should be designed to provide for emergency tailings conveyance or storage should a pipeline break, plug, freeze or require repairs and be made accessible for inspection, emergency repair, and maintenance. Location of emergency spill areas shall be designed to prevent contamination of surface water. If a power failure occurs, then tailing pipelines shall be self draining to the tailings area or to an emergency spill area or standby pumps and pipelines or standby power shall be provided. In some cases (such as a long pipeline over rough country), several spill areas may have to be provided.

(xx) Plans and schedules for regulating or controlling drainage of water, including surface runoff, from within the diked area of a tailings disposal area to prevent breaching of the dikes, both during and after mining. The plans and schedules shall ensure that 24-hour 100-year precipitation events do not cause releases of water that are not in compliance with the conditions of the mining permit.

(xxi) Plans and schedules for monitoring, containment, and treatment of surface runoff that has contacted, or may contact, ore, waste rock, overburden, or tailings determined to be reactive under R 425.203(c)(v). The plans shall be designed to reasonably minimize actual and potential adverse impacts on groundwater and surface water by preventing leaching or runoff of acid-forming waste products and other waste products from the mining process.

(xxii) A soil erosion and sedimentation control plan that meets the standards of part 91 of the act to effectively reduce accelerated soil erosion and sedimentation that may impact the affected area. The plan shall include, but not be limited to, all of the following:

(A) The location, description, and schedule for installing and removing all proposed temporary soil erosion and sediment control measures.

(B) A description and the location of all proposed permanent soil erosion and sediment control measures, and provisions for establishing the permanent soil erosion control measures as soon as possible after an earth change has been completed or if significant earth change activity ceases.

(C) Provisions to limit the exposed area of any disturbed land to the shortest feasible period of time.

(D) Provisions to remove sediment caused by accelerated soil erosion from runoff water before it leaves the mining area.

(E) Temporary or permanent control measures for the conveyance of water around, through, or from the area affected by mining activities to limit the water flow to a nonerosive velocity.

(F) Provisions for temporary soil erosion and sedimentation control measures before or upon commencement of the earth change activity; for maintaining the measures on a daily basis; and for removing the measures after permanent soil erosion measures are in place and the area is stabilized.

(G) Provisions for stabilizing the area with permanent soil erosion control measures as soon as possible after an earth change has been completed or if significant earth change activity ceases.

(xxiii) Plans for conducting reclamation activities concurrently with mining operations to the extent feasible.

(xxiv) Plans for inspecting, monitoring, and maintaining liners, final covers, leachate collection systems, leak detection systems, berms, and embankments, including frequency of inspections. Inspecting or monitoring shall be conducted at least monthly.

(d) A map and description of ownership of all tracts of land in the mining area and within 1320 feet of the boundary of the mining area, including all of the following:

(i) Ownership of surface rights.

(ii) Ownership of mineral rights.

(iii) Conservation easements as defined in section 2140 of the act.

(iv) Historic preservation easements as defined in section 2140 of the act.

(e) A description of measures to be taken to prevent damage to property not owned or controlled by the operator within and immediately adjacent to the mining area.

(f) Measures to minimize impacts to the volumes and rates of recharge, flow, and discharge of groundwater and surface waters in the mining area and in the affected area sufficient to accommodate seasonal and long-term variations in precipitation, water quantity, and water quality.

(g) A monitoring plan for monitoring of groundwater and surface water quality, groundwater levels, and surface water stage and discharge rates, during mining operations and during the post-closure monitoring period. The monitoring plan shall conform to existing statutes and rules, but is not required to include monitoring required under other permits.

(i) The monitoring plan shall provide for monitor wells and structures to be located at points where mining activities have a reasonable potential for measurable impact on surface water or groundwater, taking into consideration the following:

(A) Proximity to the mining activity.

(B) The potential for diffusion and dispersion.

(C) Horizontal and vertical groundwater gradients.

(D) Seasonal variations in flow.

(E) Topography, access, and other practical limitations.

(ii) The monitoring plan shall comply with the requirements of R 425.406.

(iii) The monitoring plan shall include all of the following:

(A) Number and location of monitoring wells and structures.

(B) Frequency of sampling and sampling procedure, including all of the following:

(aa) The sampling method and volume of water to be removed from each well or sampling point during sampling.

(bb) Steps taken to prevent cross contamination between samples.

(cc) Sample handling and preservation methods.

(dd) Laboratory analysis method.

(ee) Laboratory method detection level.

(ff) Quality assurance and quality control as approved by the department.

(gg) Provisions for routine monitoring to be conducted at least every 3 months.

(C) Sampling parameters, which shall include the following:

(aa) Specific conductance.

(bb) Temperature.

(cc) The hydrogen ion concentration expressed as pH.

(dd) Dissolved oxygen.

(ee) Concentrations of calcium, sodium, magnesium, potassium, and iron.

(ff) Concentrations of chloride, sulfate, and bicarbonate.

(gg) Concentrations of other total and dissolved elements and compounds that may be introduced or affected by the mining activities, as identified in the environmental impact assessment.

(D) A description of the techniques used to present and evaluate water quality monitoring data.

(E) A description of the method used to collect static water levels and present groundwater flow data. Static water level precision shall be to 0.01 foot.

(F) The depth and screened interval for each monitor well.

(G) Provisions for design, construction, and abandonment of monitoring wells and structures that comply with R 425.406(2).

(h) A treatment and containment plan that describes proposed measures to prevent contamination of groundwater and surface water from leaching of acidic water or dissolved metals.

(i) The treatment and containment plan required under this subdivision shall apply to earth materials that are determined to be reactive under R 425.203(c)(v). The plan shall describe proposed measures for the following:

(A) Design, construction, and operation of stockpiles and storage or disposal facilities for ore, waste rock, overburden, and tailings.

(B) The management of peripheral rock that has been determined in the environmental impact assessment to have the potential to contaminate groundwater or surface water.

(ii) The treatment and containment plan required under this subdivision shall account for the volume, rate, and movement of leachate that may be generated, and the influence of weather on the generation of leachate, including any adverse impacts from severe or extreme weather events.

(iii) The treatment and containment plan required under this subdivision shall meet all applicable requirements of R 425.409.

(i) A general description of blasting materials and methods.

(j) If a threatened or endangered species may be impacted, a plan to protect the threatened or endangered species that conforms to the requirements of state and federal endangered species laws.

(k) Plans to monitor, prevent, minimize, and mitigate any adverse impacts of the proposed mining operation on flora, fauna, fish or wildlife habitats, and biodiversity.

(l) Where percolation leaching is proposed as a mining activity, plans demonstrating compliance with R 425.403.

(m) A plan and schedule for inspection or monitoring, or both, of all mine related facilities at least monthly.

(n) The name and qualifications of the person or persons who prepared the plan for the proposed mining operations.

(By authority conferred on the director of the department of environmental quality by section 63203(1) of 1994 PA 451, MCL 324.63203(1))

Mich. Admin. Code R. 425.203, MI ADC R. 425.203

MI ADC R. 425.203
END OF DOCUMENT

MICHIGAN ADMINISTRATIVE CODE
DEPARTMENT OF ENVIRONMENTAL QUALITY (R 425.101 THROUGH R 425.602)
OFFICE OF GEOLOGICAL SURVEY
NONFERROUS METALLIC MINERAL MINING
PART 2. PERMITS

Current through 2007 Register #13 (August 1, 2007)

R 425.204 Reclamation Plan.

Rule 204. The mining, reclamation, and environmental protection plan required under R 425.201(1)(d) shall contain a plan for the proposed final reclamation operations, including the anticipated schedule, sequence, and duration of reclamation. The plan shall include information that demonstrates that all methods, materials, and techniques proposed to be used are capable of accomplishing their stated objectives in protecting the environment and public health, except that such information may not be required for methods, materials, and techniques that are widely used in mining or other industries and are generally accepted as effective. The required information may consist of results of actual testing, modeling, documentation by credible independent testing and certification organizations, or documented applications in similar uses and settings. The plan shall include, at a minimum, all of the following:

(a) Information depicting and describing the items listed in paragraphs (i) to (iv) of this subdivision. Information that is amenable to clear depiction on a map shall be shown on a map or maps of the mining area drawn to an appropriate scale on a topographic base and referenced to the nearest government-surveyed section or quarter-section lines. Other required information shall be presented, as appropriate, by cross-sections, documents, and engineering drawings.

(i) Final land contours.

(ii) Proposed final land use and relationship to surrounding land and land use.

(iii) Ponds, streams, wetlands, roads, dikes, drainage ditches, and soil erosion and sedimentation control structures that will remain after completion of reclamation.

(iv) Plans and schedules for stabilizing waste rock piles, settling ponds, tailings disposal facilities, overburden banks, open pit banks and walls, roads, and the plant site. The plans shall include sloping, grading, terracing, and revegetating that will prevent slumping, land or rock slides, or other slope failure and will effectively reduce accelerated soil erosion and sedimentation. The plans shall include the following:

(A) Provisions for sloping or terracing of the banks or bottoms of open pit surfaces that will be under water after cessation of mining, or other measures to prevent a hazard to public safety.

(B) Provisions for replacing topsoil from surface areas disturbed by the mining operation as appropriate for the approved final land use.

(C) Vegetation species and quantities, seedbed and planting area preparation, seeding and planting methods, mulching, fertilization, maintenance, and final density of plants.

(b) Evidence satisfactory to the department that the proposed reclamation will conform to the following minimum performance standards:

(i) Final disposition of all toxic and hazardous wastes, refuse, tailings and other solid waste shall be managed in a manner that protects the environment, natural resources and public health and safety, and in conformance with all other applicable federal and state laws and regulations.

(ii) All shafts, portals, or other openings between the land surface and underground mine workings shall be sealed in a manner that will protect the environment, natural resources, and public health and safety and in accordance with all other applicable laws and regulations.

(iii) All surface structures, infrastructure, rock stockpiles, and tailings disposal areas constructed as a part of the mining activities shall be removed, unless they are converted to an alternate use in accordance with the proposed final land use.

(iv) All disturbed surface areas shall be stabilized to prevent accelerated erosion by wind or water.

(v) All disturbed surface areas shall be revegetated with a variety of plants that are native to the area, except that non-native plants may be used for revegetation in areas where appropriate for an approved final land use that is different from the premining land use. In addition, plant species not native to the area may be used as approved by the department when necessary to provide temporary stabilization of slopes and prevention of erosion.

(vi) Both the mining area and the affected area shall be reclaimed to achieve a self-sustaining ecosystem appropriate for the region that does not require perpetual care following closure and with the goal that the affected area shall be returned to the ecological conditions that approximate premining conditions subject to changes caused by nonmining activities or other natural events. Any portion of the mining area owned by the applicant may be used for any legal purpose.

(c) Plans for monitoring of ground and surface water quality during the postclosure monitoring period.

(d) The name and qualifications of the person or persons who prepared the plan for the proposed final reclamation operations.

(By authority conferred on the director of the department of environmental quality by section 63203(1) of 1994 PA 451, MCL 324.63203(1))

Mich. Admin. Code R. 425.204, MI ADC R. 425.204

MI ADC R. 425.204

MICHIGAN ADMINISTRATIVE CODE
DEPARTMENT OF ENVIRONMENTAL QUALITY (R 425.101 THROUGH R 425.602)
OFFICE OF GEOLOGICAL SURVEY
NONFERROUS METALLIC MINERAL MINING
PART 4. MINING OPERATIONS

Current through 2007 Register #13 (August 1, 2007)

R 425.409 Treatment and containment of reactive materials.

Rule 409. An operator shall manage overburden, ore, waste rock, peripheral rock, and tailings determined to be reactive under R 425.203(c)(v) in accordance with this rule and in a manner that is designed to reasonably minimize actual and potential adverse impacts on groundwater and surface water by preventing leaching or runoff of acid-forming waste products and other waste products from the mining process.

(a) An operator shall design, construct, and operate stockpiles or storage facilities for reactive overburden, ore, waste rock, or tailings in compliance with paragraph (i) or (ii) of this subdivision.

(i) A stockpile or storage facility shall meet the following requirements:

(A) A stockpile or storage facility shall have a composite liner system comprised of a flexible synthetic membrane that is not less than 60 mils thick and a layer of at least 3 feet of compacted soil having a maximum hydraulic conductivity of 1.0 X 10-7 cm/sec.

(B) The department may approve an alternative liner system that uses other materials or designs, including modified soil liners, or technologically advanced systems only if the operator provides data to demonstrate the alternative is capable of providing equivalent or better protection as compared to the requirements under subparagraph (A).

(C) A stockpile or storage facility shall have a leachate collection system.

The system shall be designed, constructed, and operated to limit the hydraulic head at the lowest point in the system to not more than 1 foot, excluding the collection sump, after construction.

(D) A stockpile or storage facility shall have a leak detection system.

(E) The liner, leachate collection system, and leak detection system shall be tested before the placement of overburden, ore, waste rock, or tailings into the facility.

(F) A cover shall be employed to isolate the reactive overburden, ore, or waste rock from precipitation and air as soon as practicable.

(G) A registered professional engineer or other qualified individual shall certify the proper design, construction, and testing of all liners, covers, and leachate collection systems required by this paragraph. The permittee shall submit the certification to the department and shall not begin placement of ore, waste rock, overburden, or tailings in the storage facility until approved by the department.

(ii) Subject to approval of the department, an operator may utilize an alternative plan for a stockpile or storage facility for reactive overburden, ore, waste rock, or tailings. The department may approve an alternative plan only if the operator provides data that demonstrates that the alternative plan is capable of providing protection of groundwater and surface water that is equivalent to or better than that provided under paragraph (i) of this subdivision. The alternative plan shall incorporate 1 or more of the following:

(A) Measures to prevent the generation of leachate by adding a material or materials that counteract or neutralize the acid-forming or toxic characteristics of the ore, waste rock, overburden, or tailings.

(B) Measures to treat or neutralize any leachate that may be generated before it migrates outside of the storage facility.

(C) Measures to isolate the ore, waste rock, overburden, or tailings from oxygen and other oxidizing substances.

(D) Measures to isolate the ore, waste rock, overburden, or tailings from groundwater or surface water.

(b) An operator may utilize a disposal facility to manage, contain, or isolate reactive waste rock, tailings, overburden, or peripheral rock subject to approval of the department. A disposal facility may consist of a mined area that will be backfilled. The department shall not approve the plans for a disposal facility unless the operator demonstrates that the design, construction, operation, and closure of the disposal facility will reasonably minimize the actual and potential adverse impacts on groundwater and surface water by preventing leaching or runoff of acid-forming waste products and other waste products from the mining process and will not require perpetual care following closure in accordance with MCL 324.63209(8) and with R 425.204(b)(vi).

(c) A stockpile or storage or disposal facility under this rule shall be monitored in compliance with R 425.406.

(d) A permittee shall conduct and maintain grading or diking at stockpiles and storage or disposal facilities subject to this rule to assure that surface water drains away from the storage or disposal area.

(By authority conferred on the director of the department of environmental quality by section 63203(1) of 1994 PA 451, MCL 324.63203(1))

Mich. Admin. Code R. 425.409, MI ADC R. 425.409

MI ADC R. 425.409
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B. New Mexico Statute:
West's New Mexico Statutes Annotated Currentness
Chapter 69. Mines
Article 36. New Mexico Mining Act (Refs & Annos)

→§ 69-36-12. New mining operations; mining operation permit required

A. After the effective date of the New Mexico Mining Act, except as provided in Section 5 of that act, no person shall conduct a new mining operation without a permit issued by the director. Applications for permits for new mining operations operating pursuant to Section 5 of the New Mexico Mining Act shall be received by the director by December 31, 1995. The director may grant one extension for the submission of a permit application for a new mining operation for six months for good cause shown. Prior to receiving a permit for a new mining operation, an applicant shall submit an application that complies with the New Mexico Mining Act and regulation of the commission, including at a minimum, one year of baseline data as required by regulation.

B. The director shall issue the permit for a new mining operation if the director finds that:

(1) the permit application is complete;

(2) the permit application fee has been paid and the financial assurance is adequate and has been provided;

(3) reclamation in accordance with the proposed reclamation plan is economically and technically feasible;

(4) the mining operation is designed to meet without perpetual care all applicable environmental requirements imposed by the New Mexico Mining Act and regulations adopted pursuant to that act and other laws following closure; and

(5) the applicant, the operator or owner or any persons or entities directly controlled by the applicant, operator, owner or any persons or entities that directly control the applicant, operator or owner:

(a) are not currently in violation of the terms of another permit issued by the division or in violation of any substantial environmental law or substantive environmental regulation at a mining operation in the United States, which violation is unabated and is not the subject of appeal, and have not forfeited or had forfeited financial assurance required for any mining, reclamation or exploration permit in the United States; provided that a violation that occurred prior to the initiation of a legal relationship between the permit applicant and the violator shall not be considered for purposes of this paragraph; and

(b) have not demonstrated a pattern of willful violations of the New Mexico Mining Act or other New Mexico environmental statutes; provided that a violation that occurred prior to the initiation of a legal relationship between the permit applicant and the violator shall not be considered for purposes of this paragraph.

C. The permit for a new mining operation may be revoked or suspended by order of the director for violation of its terms or conditions, a regulation of the commission or a provision of the New Mexico Mining Act.

L. 1993, Ch. 315, § 12.

LIBRARY REFERENCES

Mines and Minerals k92.15.
Westlaw Key Number Search: 260k92.15.
C.J.S. Mines and Minerals § 338.

NOTES OF DECISIONS

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1. In general

The decision of whether a proposed mining activity is a new mining unit or a new mining operation subject to stricter environmental safeguards under the Mining Act must be reasonable and have a rational basis. NMSA 1978, §§ 69- 36-5, 69-36-7, subds. D, G, 69-36-12. Rio Grande Chapter of Sierra Club v. New Mexico Mining Com'n, 2002, 133 N.M. 97, 61 P.3d 806, rehearing denied. Mines And Minerals ⚷ 92.8

Under the New Mexico Mining Act, a core function like the issuance of a mining permit should not be the decision of the Director of Energy, Minerals, and Natural Resources Department alone, but should involve the Mining Commission by direct administrative review. NMSA 1978, §§ 69-36-14, subd. A, 69-36-15, subd. A. Pueblo of Picuris v. New Mexico Energy, Minerals and Natural Resources Dept., 2001, 131 N.M. 166, 33 P.3d 916, certiorari denied 131 N.M. 221, 34 P.3d 610. Mines And Minerals ⚷ 92.17

2. Rules and regulations

Mining Commission regulation which could be interpreted to exceed Commission's authority under Mining Act to require permit applicant to pay for experts hired by Commission could not be struck down on facial challenge to regulation, in light of alternative interpretation of regulation under which it complied with Act. NMSA 1978, § 69-36-9, subd. G. Old Abe Co. v. New Mexico Min. Com'n, 1995, 121 N.M. 83, 908 P.2d 776, certiorari denied 120 N.M. 828, 907 P.2d 1009. Mines And Minerals ⚷ 92.8

3. Expansion of permit--In general

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MEMORANDUM

TO: Robert Heyano, Art Nelson, Bonnie Williams
Alaska Board of Fisheries, Subcommittee on Bristol Bay Drainages

THROUGH: Jim Marcotte, ADF&G, Boards Support
VIA EMAIL: jim_marcotte@fishgame.state.ak.us

FROM: William P. Horn, counsel to Trout Unlimited
Geoffrey Y. Parker, counsel to Trout Unlimited
Roger Flynn, counsel to Trout Unlimited[2]

WPH

DATE: January 9, 2007

RE: Elevating Habitat Conservation Standards in the Bristol Bay Drainages

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I. INTRODUCTION

Higher standards for conservation of fish and wildlife resources and related habitat in the Bristol Bay region may be recommended by the Alaska Board of Fisheries and established by the Alaska Legislature. These may be in the context of a fish and game refuge or other designation requiring that prospective large scale mining projects in the region be able to demonstrate and ensure a capability to conserve water quality, instream flows and protect fish, wildlife, habitat and public uses as a precondition for state permission to proceed.

We have reviewed applicable federal and Alaska law regarding "takings" (i.e., when government action substantially diminishes property rights triggering the payment of just compensation for the "taken" rights) to determine whether proposals to elevate conservation standards imposing new regulatory constraints would constitute a taking of mining claims in the

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region. Our conclusion is that raising conservation standards now would NOT be a taking of the very limited property interests attendant to such claims.

State and federal law are very clear on this issue. The Alaska Supreme Court has held expressly that a mining claim carries with it "no right to mine" and that mining is "always contingent on State permission to mine."[3] Therefore, the State is free to impose new standards and reasonably withhold its permission (under elevated standards) to develop such claims if the applicant cannot satisfy the standards.

It is highly unlikely that any mining claim holders in the Bristol Bay region seeking to develop a large scale open pit or similar mine would be able to satisfy the myriad legal requirements to establish a taking in the event that, in the future, a claimant applies for permits that are substantially modified or reasonably denied on the basis of elevated conservation standards.

II. SUMMARY

We understand that your subcommittee will meet with Alaska Department of Natural Resources (DNR) staff on Thursday, January 11, 2007, concerning it's large mine permitting process. We also appreciate that your committee will consider higher standards for habitat conservation, and identify options, including refuge status for the Nushagak and Kvichak drainages, where a proposed large mine, of an acid-generating sulfide deposit for copper and other metals (Pebble Mine), could harm fish, wildlife, their habitats, and the subsistence, commercial and recreational uses which depended upon them.

This memorandum gives examples of higher standards and examines two issues relevant to your meeting with DNR and your considerations:

(1) What forms of higher standards would be lawful and not constitute a "taking" of the mining claims; and

(2) What forms of strengthened public and other processes related to large-mine permitting in a refuge would not constitute a "taking."

NO TAKING OF A MINING CLAIM OCCURS when the state legislature adopts higher standards under (a) the state's police power to protect public health, safety, the environment, and other public interests, (b) its property power to manage its land, or (c) state constitutional mandates to conserve fish and wildlife.[4] This is particularly true in the context of creating a

[3] *Beluga Mining Company v. State Department of Natural Resources*, 973 P.2d 570 (Alaska 1999).

[4] *See* Art. VIII, Alaska Constitution.

refuge to accomplish these ends. In fact, other specially designated areas (e.g., the Tugidak Island Critical Habitat Area) contain prior mining claims subject to higher standards.

A mining claim is a very limited property interest. It amounts to a right of a claimant to be first in line against subsequent claimants. It does not create a right to mine or preempt the State legislature or state agencies from regulating use or development of the claim under the State's police power, property power, and mandates to conserve fish and wildlife.

As long as the State relies on such established authorities and purposes, the following examples of "higher standards" would not constitute a taking, and the State is free to enact all, or similar provisions, in legislation:

(a) a "refuge" or similar designation where the legislation provides that the land shall be managed to protect (1) fish and wildlife habitats, and (2) public uses for commercial, subsistence and sport fishing, hunting and other such uses;[5]

(b) a "compatibility test" that requires that mining be compatible with refuge purposes;

(c) closure of refuge lands to new mining claims subject to valid existing rights;

(d) a prohibition of mining methods of operations that use or generate toxics harmful to human health, safety, aquatic or terrestrial life, the environment and subsistence, commercial

[5] In several respects, refuge or similar status would also affect a federal environmental impact statement (EIS) under the National Environmental Policy Act (NEPA) on a mine, in a manner favorable to conservation of fish, wildlife, habitats and public uses. In terms of environmental consequences, the EIS would have to address any inconsistency or conflict with state law creating the refuge. 40 CFR 1502.16 (2006); 40 CFR 1506.2(d). Federal consultation with ADF&G would occur earlier in the EIS process. 40 CFR 1501.2(d). Because ADF&G is the lead state agency managing state refuges (AS 16.20), it would have a stronger role in the EIS process. ADF&G would most likely be a "joint-lead agency" responsible with a federal lead agency for the preparation of an EIS. 40 CFR 1501.5. Refuge status would mean that ADF&G would have "jurisdiction by law" and elevate its role even as a "cooperating agency" in the EIS process, which would mean that ADF&G's expertise and environmental analysis would have to be used to the "maximum extent possible." 40 CFR 1501.6(a). Finally, even though an EIS would obviously be prepared for permits authorizing Pebble Mine, refuge status would be more likely to trigger a supplemental EIS on subsequent permit actions after the mine had been initially permitted. This is because refuge status affects the determination of whether an impact is "significant," which triggers an EIS. 40 CFR 1508.27. None of these effects on the NEPA process even trigger takings law, for reasons discussed herein.

and recreational uses of water, fish, game and other natural resources, or that may cause a nuisance;

(e) a prohibition of storage or disposal of waste rock and tailings that may generate sulfuric acid, dissolved metals, chemicals, compounds or materials that may cause such harms;

(f) a prohibition of storage or disposal of overburden, waste rock, tailings, or other waste in waters or riparian areas, or within a reasonable distance (say 500 feet) of waters or riparian areas;

(g) a prohibition of withdrawal of surface or subsurface water that may adversely affect the spawning, incubation, migration, rearing, or propagation of fish, and a requirement that any water appropriated be replaced;

(h) a prohibition of discharge of water from any point source or nonpoint source that does not meet water quality standards required for fish;

(i) a requirement that dams, for tailings disposal or other similar purposes, be seated to bedrock and impermeable;

(j) a requirement that any open pit or block caving be isolated hydrologically;

(k) a requirement that roads, power, and other facilities be designed, located, constructed and maintained in perpetuity to the highest standards to conserve fish, wildlife, habitat and uses dependent on them, by the mining company at its sole expense; and

(l) a requirement that transportation of ore concentrate use all reasonable methods to eliminate any risk of harmful or toxic metallic dust.

With respect to the second question, takings are NOT EVEN AN ISSUE when the legislature amends the processes -- rather than the standards -- related to permitting mining within a refuge. For example, takings law is not triggered when the legislature –

(a) requires a refuge management plan that is adopted into regulation by the Joint Board of Fisheries and Game;

(b) strengthens the role of the public or other agencies in decision making;

(c) creates public notice requirements that do not exist today;

(d) requires that information used be of the highest scientific quality;

(e) strengthens standards for judicial review of permitting; or

(f) requires particularized analysis of, for example, socio-economic impacts on subsistence, recreational and commercial uses of fish and game.

III. TAKINGS LAW

A. Introduction

Takings law arises from the Fifth Amendment to the U.S. Constitution and Article I, § 18 of the Alaska Constitution. Each provides that private property cannot be taken or damaged for public use or purposes without just compensation. Similarly, both the U.S. and Alaska Supreme Courts have recognized that overbroad government regulation that both substantially and inappropriately diminishes property rights, not limited interests, can be a taking.

The same case law prescribes the rigorous requirements which must be demonstrated by a claimant to establish successfully a takings claim. These matters are discussed in detail below.

Recently, the Legislative Affairs Agency addressed general aspects of takings law. The following is a more thorough outline of applicable takings law. Moreover, no draft legislation or specific proposal was in front of the agency, so it did not apply takings law to any specific proposals. This memorandum does so.

B. Constitutional Provisions

The "Takings" Clause of Fifth Amendment to the U.S. Constitution provides "nor shall private property be taken for public use, without just compensation." This limitation is imposed on the states, including Alaska, by the Fourteenth Amendment. *Chicago, B. & O.R. Co. v. Chicago*, 166 U.S. 226 (1897).

The Alaska Constitution contains a similar provision which specifies that "private property shall not be taken or damaged for public use without just compensation." Art. I, § 18.

C. Federal Law

The U.S. Supreme Court recognizes four kinds of takings: (1) "physical takings" where the property is physically appropriated by government for public use, such as where government takes private property for a highway; (2) a "total regulatory taking," such as where government eliminates all economically beneficial use of the land; (3) a "regulatory taking" such as where legislative or agency action to control land use "goes too far;" and (4) "land use exactum" takings, such as when government demands dedication of a conservation easement as a condition for approving a subdivision. *Lingle v. Chevron USA*, 544 U.S. 528 at 548 (2005).

Regulatory takings were first recognized in *Pennsylvania Coal Co. v. Mahon*, 260 U.S. 393 (1922), in a case substantially different from the situation at hand. At issue in that case was a privately owned, express right to remove subsurface coal in private land, where the right had been reserved by contract at the conveyance of the surface estate to a homeowner. No public land or mining claim was involved. Here, we have mere mining claims on public land that do not create any right to mine. Nevertheless, the Court concluded that a 1921 Pennsylvania law restricting the impact of coal mining on surface estates affected a taking of the specific, privately-owned coal rights. Justice Oliver Wendell Holmes penned the decision, including the famous line "if regulation goes too far, it will be recognized as a taking." *Id.* at 415. However, the decision also recognized that "Government hardly could go on if to some extent values incident to property could not be diminished without paying for every such change in the general law." *Id.* at 413; *see also Lingle* at 538.

Since *Mahon*, the Court has elaborated the particular and rigorous requirements that must be demonstrated to establish that a regulation has gone "too far":

(1) The claimant must hold an established property right or a bona fide property interest that has been taken, but "a mere unilateral expectation or an abstract need is not a property interest entitled to protection." and such expectations or needs are not sufficient to support a takings claim. *Webbs Fabulous Pharmacies, Inc. v. Beckwith*, 449 U.S. 153, 161 (1980). *Penn Central Transp. Co. v. City of New* York, 438 U.S. 103, 125 (1978); *see also Seven Up Pete Venture v. State*, 114 P.3d 1009, 1019 (Montana 2005) citing *Lucas v. South Carolina Coastal Council*, 505 U.S. 1003 (1982).

(2) The claim can arise only after a government has considered and acted to deny or amend a particular course of action or permit impacting property rights. *Palazzolo v. Rhode Island*, 533 U.S. 604 (2001); *United States v. Riverside Bayview Homes*, 474 U.S. 121, 127 (1985);

(3) Per se rules are frowned upon and a regulatory takings analysis is a factual, ad hoc inquiry that focuses on three criteria –

(a) The economic impact on the property owner;

(b) The extent of interference with the reasonable investment backed expectations of the owner; and

(c) The character of the government action. *Penn Central* at 124; *see also Palazzolo* at 617.

Regarding the necessary property right, landowners, including mining claim holders, generally have no property interest or entitlement to a permit or approval for particular action: "A cognizable property interest exists [in prospective permit approval] only when the discretion of the issuing agency is so narrowly circumscribed that approval of a proper application is virtually assured." *Gardner v. Baltimore Mayor and City Council*, 969 F.2d 63, 68 (4th Cir. 1992). Similarly, unpatented federal mining claims, like the state claims at issue in *Beluga* (supra at 2), are only a limited property interest subject to substantial governmental regulatory control, and denial of mining approval is not a compensable property interest. *Reeves v. United States*, 54 Fed. Cl. 652, 672, 674 (2002).

Takings claims are also not ripe for judicial review until there has been governmental action which is a "final and authoritative determination of the type and intensity of development legally permitted on the subject property." *MacDonald, Sommen & Frates v. Yolo County*, 477 U.S. 340, 348 (1986). A court cannot determine whether a regulation has gone "too far" unless it knows how far the regulation goes. *Id.*

The heart of a takings analysis remains governed by the three *Penn Central* criteria that continue to serve as the Court's "principal guidelines" for regulatory takings. *Lingle* at 539. Each criterion has been addressed by subsequent decisions.

In terms of economic impact (the first criterion), the Court has held a taking occurred when an owner was denied ALL use of his property. *Lucas v. South Carolina Coastal Council*, 505 U.S. 1003 (1982). However, if permit restrictions allow some uses but not others, a taking is not likely. *Penn Central* at 137. In that case, building restrictions for historic preservation purposes were quite strict but it remained possible to engage in some forms of construction and building renovation consistent with the preservation standards. This meant the owner retained some rights to his property and no taking occurred. In *Riverside Bayview Homes*, reviewing a takings challenge to wetlands conservation rules, the Court opined that the possible availability of permits consistent with conservation standards would not constitute a taking: "a requirement that a person obtain a permit before engaging in a certain use of his or her property does not in itself 'take' the property in any sense; after all the very existence of a permit system implies that permission may be granted." *Id.* at 127. The Court declined to strike down the Federal wetlands regulatory program and ruled that its limitations on development did not constitute a taking.

Even very substantial reductions in property values (i.e., economic impacts) have been found not to be takings. *Penn Central* cited two cases that reduced values 75% and 87½% without being a taking. *Id.* at 131; *Euclid v. Ambler Realty Co.*, 272 U.S. 365 (1926); *Hadacheck v. Sebastian*, 239 U.S. 394 (1915).

The character of the government action is another critical criterion. The Court's general proposition is that "State laws prohibiting contemplated uses of land have been held not to be takings when the prohibitions or restrictions are for promotion of health, safety, morals, and general welfare." *Penn Central* at 125. Government action found to protect against what it determines to be a significant threat to the common welfare "leans heavily against finding a taking." *Keystone Bituminous Coal Association v. DeBenedictis*, 480 U.S. 468, 485 (1987).

This is especially so when the restricted or prohibited activity might constitute a "nuisance."[6] A nuisance is the use of property by the owner that adversely impacts his neighbors or the community. Under the common law, all property is held under an implied obligation that the owner's use of it shall not be injurious to the community. *Keystone* at 491 citing *Mugler v. Kansas*, 123 U.S. 623 (1887). Accordingly, the Court has a "long line . . . of cases sustaining against Due Process and Takings Clause challenges the State's use of its 'police powers' to enjoin a property owner from activities akin to public nuisances." *Lucas* at 1022 citing Mugler; *see also Hadacheck; Miller v. Schoene*, 276 U.S. 272 (1928); *Goldblatt v. Hempstead*, 369 U.S. 590 (1902). State action in the form of restrictions or prohibitions to restrain uses that are tantamount to a nuisance create circumstances in which the Court will "hesitate" to find a taking. *Keystone* at 491.

States are also permitted to impose restrictions on individual property owners, or a category of property owners, to protect other interests. In a noteworthy decision, the Court denied a taking claim by landowners ordered to cut down certain ornamental trees. The State of Virginia took the action to protect its apple industry as the ornamental trees were a possible source of a plant disease that could adversely impact apple orchards: "the State had not exceeded its constitutional powers by deciding upon the destruction of one class of property [without compensation] in order to save another, which in the judgment of the legislature, is of greater value to the public." *Penn Central* at 136 citing *Miller v. Schoene*.[7] The same rationale would apply to State efforts to protect valuable commercial fishing, the recreation industry and subsistence from mining.

Lastly, governments retain authority and discretion to set new rules or limitations on land use without triggering takings: "even with respect to vested property rights, a legislature generally has the power to impose new regulatory constraints on the way in which those rights

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[6] Alaska law defines "nuisance" as a "substantial and unreasonable interference with the use and enjoyment of real property, including water." AS 09.45.255; *Parks Hiway Enterprises LLC v. CEM Leasing Inc.*, 995 P.2d 657 (Alaska 2000).

[7] An old Nevada case upheld restrictions against non-miners to facilitate the mining industry because of the value of the mining industry to that State. *Dayton Gold & Silver Mining Company v. Seawell*, 11 Nev. 394 (1876).

are used, or to condition their continued retention on performance of certain affirmative duties." *Reeves v. United States*, 54 Fed. Cl. 652, 672 (2004) citing *United States v. Locke*, 471 U.S. 84, 104 (1985). In *Reeves*, a mining company alleged that denial of its permit application to mine by the Bureau of Land Management under "non-impairment" rules, as well as designation of a National Monument that encompassed its valid mining claims, constituted a regulatory taking. The U.S. Court of Federal Claims rejected the claim.

D. <u>Alaska Law</u>

1. <u>Introduction</u> – Many features of Alaska law regarding takings mirror the U.S. Supreme Court precedents. However, the private property protection aspect of the State constitution is considered "broader" than that of the Fifth Amendment. *Anchorage v. Sandberg*, 861 P.2d 554, 557 (Alaska 1993).

Similar to federal case law, the Alaska Supreme Court also distinguishes between cases (a) where there has been a physical invasion of private property for public purposes or the destruction of all economic value and (b) regulatory takings where property rights are only diminished. *R & Y Inc. v. Municipality of Anchorage*, 34 P.3d 289, 296 (Alaska 2001).

Regulatory takings are subject to a four factor "*Sandberg*" analysis much like the *Penn Central* criterion:

(a) Character of the government action;

(b) Economic impact;

(c) Interference with reasonable investment backed expectations; and

(d) Legitimacy of the interest advanced by the regulation or land use decision. *Id.* at 557-558 citing *Penn Central.*

2. <u>Mining Claims</u> – The Alaska court has also specifically addressed the issue of State mining claims and takings. *Beluga v. State Department of Natural Resources*, 973 P.2d 570 (Alaska 1999). When the proponents of the major Beluga coal mine project failed to obtain permits to mine, they filed an unsuccessful takings claim against the Alaska Department of Natural Resources.

Factually, the Beluga mining claims were staked in 1983 and some mining permits were issued by the State in 1989. Other related permits were issued in 1990 but the final mining licenses were not timely issued, and "unable to mine its claims, Beluga abandoned them and sued the State for resulting economic losses." *Id.* at 572. The Court applied the *Sandberg* factors and rejected the claim: "The State deprived Beluga of no property right. Beluga had property rights in its claims, but it had NO RIGHT TO MINE; IT'S MINING 'RIGHTS' WERE PROSPECTIVE AND CONTINGENT..." (Emphasis added). *Id.* at 575.

Beluga also argued that it had invested millions of dollars toward developing its claims and these constituted reasonable investment backed expectations for which it should be compensated. This argument was also rejected: "Beluga's claims were always CONTINGENT on State permission to mine and assertion of adverse mining claims. Absent any demonstration to the contrary, we conclude that reasonable investors could have recognized that DNR might be delayed in granting Beluga permission to mine." (Emphasis added). *Id.* at 576.

Lastly, the mine proponents contended that they had a "contractual" right under State law and rules to mine their claims and a right to obtain the necessary permits. *Id.* at 578. This argument failed too as the Court held that Beluga had no right, contractual or otherwise, to "land use permits" and after reviewing State mining law the Court decided "no express or implied promise by the State could have created a contractual mining right." *Id.*

Although not an Alaska case, the Montana Supreme Court recently handed down a similar ruling. *Seven Up Pete Venture* (2005). The mining interests acquired State mining leases in 1986 estimated to contain 9 million ounces of gold and 20 million ounces of silver. *Id.* at 1013. The permit process commenced for mining and cyanide ore processing, and the mining company invested significant sums in permit applications and for preparation of an environmental impact statement. *Id.* at 1014-1015. During this process, Montana established new environmental standards and prohibited "open-pit mining for gold or silver using heap leaching or vat leaching with cyanide ore processing reagents." *Id.* at 1013.

When it became evident that the project could not proceed under the new standard, the mining company filed takings claims arguing (a) it had "property rights in 'the opportunity for a favorable ruling on its mining permit application'" and (b) the new ban on cyanide "preclude[d] the only economically viable" means of mining therefore affecting a total taking per *Lucas*. *Id.* at 1016.

Each of these claims was rejected. Addressing the first, the court held the "opportunity to seek a permit, which required convincing the State that this cyanide leaching project was appropriate DID NOT CONSTITUTE A PROPERTY RIGHT." (Emphasis added). *Id.* at 1019. Regarding the second, the court cited *Reeves* and *Locke* that the State had the right to "impose new regulatory constraints" and these new rules did not affect a taking. *Id.* at 1017.

3. Rights to Permits – Other cases have also addressed the purported rights or entitlements of applicants to obtain permits for land development activities. Even in situations in which a statute prescribes that a permit "shall" be issued if an application satisfies particular

standards, a government is not stripped of its discretion and authority to determine if those standards have been satisfied. *Spinnell Homes, Inc. v. Municipality of Anchorage*, 78 P.3d 692, 697-698 (Alaska 2003). In such cases, a takings claim will be denied. Alaska law, in this regard, mirrors *Gardner* (4th Cir.) and Montana (*Seven Up Pete Venture*).

4. Character of Government Action – Like the U.S. Supreme Court, the Alaska Supreme Court has held that exercise of government authority for legitimate public purposes is unlikely to result in a taking. *Sandberg* at 558 citing *Penn Central*. It specifically noted that a "'taking' may more readily be found when the interference with property can be characterized as a physical invasion by government than when interference arises from some public program adjusting the benefits and burdens of economic life to promote the common good." *Id.* citing *Penn Central* at 124.

In the environmental arena, statutes, ordinances or regulations which limit a landowner's use of his property are not a taking unless the owner has been deprived of ALL economically beneficial uses of his property. *Zerbetz v. Municipality of Anchorage*, 856 P.2d 777, 782 (Alaska 1993) citing *Lucas v. South Carolina Coastal Council*, 505 U.S. 1003 (1992). The *Zerbetz* Court held that a "conservation wetlands" designation imposed on private property was not a taking even though the designation elevated the standards for building permits. Despite the new standards, permits could still be secured by satisfying the requirements. *Id.* at 783; *see also Riverside Bayview Homes* at 127. The Court also noted that the trend in environmental law was to reject landowners' takings claims and to uphold such rules as a lawful exercise of police power. *Zerbetz* at 782.

5. Reasonable Investment Backed Expectations – This feature of the *Sandberg* analysis was specifically addressed in the *Beluga* case. However, the *Sandberg* decision reveals that the Alaska Supreme Court determined that it is not necessarily reasonable to invest millions of dollars in a project dependent on prospective government approval. *Sandberg* was an inverse condemnation claim by a housing developer seeking to recover monies it invested in a development plan that secured some initial, partial government approvals, but ultimately was abandoned by the government. Rejecting this claim, the Court held it would "have to conclude" that the initial, partial approvals "constituted some kind of 'guarantee' or 'express promise'" that the government would follow through on the project and there was "absolutely no basis for such a conclusion." *Id.* at 559. Pithily the Court noted the claimant "gambled" that necessary approvals would be secured and "they lost this gamble." *Id.* at 560. Such "gambling" was held to not constitute a reasonable investment for which compensation was warranted under Alaska law. *Id.*

A reasonable investment backed expectation must also be more than a "unilateral expectation or an abstract need." *State DNR v. Arctic Slope Reg. Corp.*, 834 P.2d 134, 140 (Alaska 1991) citing *Ruckelshaus v. Monsanto*, 467 U.S. 986 (1984). In this case, where neither

State law or regulations provided a "guarantee" or "express promise" as claimants desired (i.e., to keep commercial information (property) secret), the claimants had no "reasonable" expectation that government would provide what they desired and could not assert a takings claim. *Id.*

6. Legitimate Government Interest – The Alaska Constitution addresses expressly fish, wildlife, land and water. Fish, wildlife and waters are reserved to the people for common use. (Art. VIII, § 3). Fish and wildlife are to be utilized, developed and maintained on the sustained yield basis. (Art. VIII, § 4) The legislature shall provide for the utilization, development and conservation of all natural resources belonging to the State, including lands and waters, for the maximum benefit of its people and is to provide for the administration of the state public domain. (Art. VIII, §§ 2, 6) The constitution authorizes limited entry fisheries for resource conservation and to prevent economic distress among fishermen. (Art. VIII, § 15) These provisions, in part, have been held to grant the State the right to direct the use of its natural resources including fish and game. *Herscher v. State, Dep't of Commerce*, 568 P.2d 996 (Alaska 1977).

Title 16 of the Alaska Statutes, the Fish and Game code, including state refuges, springs from the constitutional authority of Article VIII. For that matter, so does the Board's authority under AS 16.05.251(a)(1) to recommend that the legislature designate State refuges. Conservation of fish and wildlife and their habitat, salmon spawning and rearing habitats and opportunities for public uses for commercial, sport and subsistence fishing, hunting and other public uses "in a high quality environment" are among the purposes of these areas (e.g., 16.20.033(b)(1), (2)), and the use and disposition of other resources must be consistent or compatible with these purposes (e.g., 16.20.033(b)(3)). State action consistent with these authorities clearly would advance purposes of Article VIII. *See Arctic Slope Reg. Corp.* at 143. This case also refers to a variety of other legitimate government actions including public health, physical safety, financial safety and economic welfare. *Id.* The *Sandberg* opinion expressly cited this portion of the *Arctic Slope* ruling. *Id.* at 561.

IV. ANALYSIS AND APPLICATION OF TAKINGS LAW

The application of both Federal and Alaska takings law demonstrates that action by the Alaska Legislature to "impose new regulatory constraints" (*Reeves* at 672), such as those listed at the outset, on how mining development in the Bristol Bay drainages shall proceed would not constitute a taking of any cognizable property rights held by present mining claim holders. The Legislature is free to establish a refuge or other designation which elevates applicable fish, wildlife and habitat conservation standards in the Bristol Bay region or take other actions to establish more rigorous standards under which mine permit applications would be scrutinized. Such actions would not trigger a taking of mining claims or other interests requiring just compensation under either the Takings Clause of the Fifth Amendment or Article I , § 18 of the Alaska Constitution.

Analysis of each required element for a takings claims reveals that potential plaintiffs could not carry their legally mandated burdens if they challenged State action to elevate conservation standards in the Bristol Bay region:

A. <u>No Cognizable Property Interest</u>

A mining claim is a very limited INTEREST that carries with it no right to mine and takings doctrine is only implicated when the State deprives a person a property RIGHT. *Beluga*; *Reeves*, *Penn Central*, *see also Seven Up Pete Venture*. The State retains substantial discretion to review any future permit applications, that may or may not be filed, and the applicant has no property right to have those applications approved. *Spinnell; Gardner*. The so-called "right to mine" or the "opportunity for a favorable ruling on a mining permit application" are at best mere expectancies not protected by either constitutional provision. Federal mining law, upon which Alaska's mining laws are based, confirms that there is no compensable property right to develop mining claims free of government regulation. Alaskan mining law is based upon, and very similar to, federal mining law. *Trustees for Alaska v. State*, 736 P.2d 324 (Alaska 1987).

Similarly the U.S. Department of Interior, which is charged with administering the federal mining laws on western public lands, has repeatedly held that any property right in a mining claim against the government, is contingent upon compliance with all applicable state and federal environmental and other regulatory requirements. *Great Basin Mine Watch*, 146 IBLA 248, 256 (1998) (*citing Southwest Resource Council*, 94 Interior Dec. 56, 67 (1987)) (emphasis added). *See also Clouser v. Espy*, 42 F.3d 1522, 1530 (9th Cir. 1994).

As detailed herein on state lands, the State of Alaska, like the federal government on federal public lands, has broad authority to impose new and substantial regulatory constraints on mining operations conducted on mining claims. Compliance with these requirements, and the calculation of any costs to comply with these requirements, is a prerequisite to establishing any property right against the State. Thus, a mining claimant that is unable or unwilling to comply with these requirements, or that cannot profitably develop the claims due to the imposition of these compliance costs, does not have any property right against the government.

There is also no compensable property right to operate free of government controls on mining. As detailed herein, the State of Alaska has broad regulatory authority over mining. The State is free to impose existing, or enact new, restrictions on the ability of claimants to develop their mining claims. Because a mining claimant holds his claims pursuant to, and contingent upon, compliance with all state and federal restrictions, the denial of a mine proposal based on these restrictions does not implicate a compensable property interest. Again, directly analogous caselaw from the federal and state courts is instructive.

B. Character of Government Action

Even if it could be argued that a mining claimant has a compensable property right to mine (which is not the case), government regulatory authority over mining does not constitute a taking under Alaskan or federal law.

The State possesses wide latitude and discretion to take actions to protect and promote public health and safety and has more than ample authority to take additional steps to further ensure the conservation of valuable fish and wildlife resources like those found in the Bristol Bay region. First, mining can be a public nuisance by virtue of polluted effluent discharges, dewatering of streams, release of toxics, dust and particulates, and a variety of other actions that can produce "substantial and unreasonable interference" with the State's ability to enjoy the real property, including waters, it holds in trust for its citizens. As noted above, courts "lean heavily against a finding a taking" and are "hesitant" to do so when a State restricts property rights to prevent a nuisance. *Penn Central, Keystone.*

Second, the State is allowed to take action designed to protect activities and industries it deems important even if the action restricts other classes of property owners (i.e., mining claim holders in Bristol Bay). *Miller v. Schoene.* Here, multi-million dollar commercial, sport, and subsistence fisheries are sustained by the renewable salmon resources in Bristol Bay. The Alaska Legislature is within its rights to act to protect this vital industry even if it means new restrictions on the nascent mining industry in the region.

Third, the State, like the Federal government, is authorized to impose new regulatory constraints or create new land designations encompassing existing mining claims without triggering compensable takings. *See Reeves.* This has happened repeatedly in Alaska and not resulted in any successful takings claims (e.g., mining claims within Tudigak Island State Critical Habitat Area; U.S. Borax molybdenum claims included in Misty Fiords National Monument; Orange Hill patented copper claims included in Wrangells-St Elias National Park and Preserve, etc.).

C. Economic Impact

Elevating conservation standards in all or part of the Bristol Bay drainages will have not have any direct, tangible economic impact on present holders of mining claims in the region. As the claims carry no right to mine, and State permission to mine is a matter of discretion, any economic impacts are purely speculative and cannot rise to the level of a taking. Possible future permit applicants may well be able to satisfy the new standards, in some manner, and be granted permission to mine in some fashion. This possibility means that present claimants and prospective applicants would not suffer any appreciable immediate economic impact. *Riverside Homes*.

D. Reasonable Investment Backed Expectations

As a matter of fact, it is highly speculative (i.e., a "gamble") that the State authorities, under either present standards or elevated conservation standards, would permit an enormous open pit mine, massive tailings dams and toxic sediment dumps, water diversions and withdrawals, and all of the related infrastructure (i.e., roads, bridges, powerlines, port, housing, etc.) astride two major river systems that support the world's most productive and best managed salmon fishery. It is also wholly unknown, and speculative, if any prospective mining projects in the Bristol Bay region are economically viable independent of environmental or conservation standards. The Alaska Supreme Court, in its seminal *Sandberg* ruling, stated that investing money in enterprises dependent on speculative government approvals constitutes a "gamble". This kind of gamble is not a "reasonable" investment. When a property owner takes such a risk and loses the gamble, the State is under no obligation to compensate that owner for its loss. Similarly, in the *Beluga* case, the Court indicated that "reasonable investors" could recognize that permits to mine may not be forthcoming from the State.[8] The existence of this fundamental contingency means that any such future investments in future permit applications and related enterprises would not be able to satisfy this critical requirement of takings law.

E. Legitimacy of the Interest Advanced by the Regulation or Land Use Decision

Conservation of fish, wildlife and related habitat is a completely legitimate interest to be advanced by State action. Authority for such action arises directly from the Alaska Constitution (Art. VIII), and the legislatively enacted Fish and Game Code (Title 16) conclusively establishes the legitimacy of state conservation interests as a matter of state law. The Court has found that a wide variety of actions are "legitimate," *see Arctic Slope* at 143, *Sandberg* at 558, and there is no doubt that constitutionally inspired conservation actions would totally satisfy the "legitimacy" requirement.

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[8] In this vein, the Memorandum of Understanding between Northern Dynasty and the Department of Natural Resources, by which Northern Dynasty reimburses state permitting costs, provides that Northern Dynasty expressly agrees that nothing in the agreement entitles Northern Dynasty to permits or favorable treatment at the time of permit application.

F. Proposals to Improve Processes Related to Mining Permits Do Not Trigger a Takings Issue.

Proposals to improve the processes related to mining permits do not create higher conservation standards and never trigger a takings issue because mining claims are not directly affected.

For example, a draft Jay Hammond refuge bill would require ADF&G to prepare, in consultation with DNR, a refuge management plan that could be adopted into regulation by the Joint Board of Fisheries and Game. The regulations might affect the standards for permits, but the requiring plan does not.

The draft refuge bill also would strengthen the role of the public in decision making by creating a citizen advisory body. That strengthens the role of the public, compared to DNR decision-making, but does not directly affect any mining claims.

We understand that DNR is under no statutory requirement for public notice of permits under the Anadromous Fish Act, AS 41.14.870, or the Fishways Act, AS 41.14.840. A refuge bill could require public notice for any permits related to mining in the refuge.

Similarly, DNR has no applicable statutory requirement that information used in mine permitting be of the highest quality. A refuge bill could require as much.

Legislative enactment of a refuge bill also fits squarely within Alaska administrative law regarding subsequent agency action to grant or deny permits for a mine. Alaska courts apply four standards of review for agency decisions. *Kachemak Bay Watch, Inc., v. Dept. of Natural Resources* 935 P 2d 816 (Alaska 1997). (1) For questions of law not involving agency expertise, the courts apply the "substitution of judgment" standard because when no agency expertise is involved, the courts are more equipped than agencies to interpret law. *Handley v. State, Dep't of Revenue*, 838 P.2d 1231, 1233 (Alaska 1992); *Kjarstad v. State*, 703 P.2d 1167, 1170 (Alaska 1985). (2) For questions of law involving agency expertise, Alaska courts apply the "reasonable basis" test. *Rose v. Commercial Fisheries Entry Comm'n*, 647 P.2d 154, 161 (Alaska 1982). (3) The "reasonable and not arbitrary" standard is applied to administrative regulations. *Handley*, 838 P.2d at 1233. (4) The "substantial evidence" test is applied to questions of fact. *Id.*

Creating a Jay Hammond refuge administered, as refuges are, by ADF&G in some respects and by DNR in other respects, would strengthen the former's role in any permit process. However, the standards for judicial review would remain the same, and there would be no impact on due process afforded to a prospective permit applicant.

Refuge or other legislation could also require that the best information as evidence be the basis of any permits issued for large-scale mining. Given that the Bristol Bay drainages are so important for so many reasons, we are persuaded that the Board of Fisheries should recommend to the legislature that a refuge bill requires that evidence necessary to support factual findings for mine permits within the refuge must be of the highest evidentiary standard – i.e., the "clear and convincing evidence" standard.

Finally, the written comments of Trout Unlimited (TU) on Proposal 121 include a copy of *The Economics of Wild Salmon Watersheds, Bristol Bay, Alaska* (Duffield, et al. 2006) by the economic study by the University of Montana and the University of Alaska (ISER). It quantifies the economic production from the Bristol Bay watershed for commercial, subsistence and recreational use, but stops short of addressing how Pebble or other mines might impact socio-economically those uses. A refuge bill could require particularized analysis of such socio-economic impacts.

V. <u>CIVIL AUTHORITY OF DNR VERSUS CRIMINAL AUTHORITY OF ADF&G</u>

No discussion of elevated standards would be complete without recognizing that the importance of fish and game to Alaskans prompted Alaska's lawmakers to make violations of Title 16 (the Fish and Game Code) criminal, while nearly all violations of Titles 38 and 41 (DNR statutes) are civil (except for violations of the Fishways Act (AS 41.14.840) and the Anadromous Fish Act (AS 41.14.870)). The latter authorities were transferred from ADF&G to DNR by the elimination of the former ADF&G/Habitat Division, and which we appreciate the Board at Dillingham voted unanimously to transfer back to ADF&G.

If the Board's interest in elevating standards includes enforcement, as it should, then it makes sense to have criminal penalties under consideration.

In the context of large mine permitting, recent enforcement actions demonstrate this distinction between criminal and civil penalties. On December 21, 2006, EPA announced that Coeur Alaska, Inc. had agreed to pay penalties for Clean Water Act violations at the Kensington Mine – a project now under construction per permits received through the same large mine permitting process now applicable in the Bristol Bay region.[9]

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[9] A recent, first-of-its-kind study, "Comparison of Predicted and Actual Water Quality at Hardrock Mines" (Maest, Kuipers, 2006) compares water quality predictions made at the time of permitting with outcomes at 25 representative large mines permitted in the United States during the last 30 years. The study concludes that the vast majority of large mines do not perform as predicted at the time of permitting. The full study, and a summary of it, are available at http://www.mine-aid.org/

VI. CONCLUSION

Elevating conservation standards in the Bristol Bay region, as outlined in Part II, by means of the twelve examples of higher standards would not constitute a taking. First, a mining claim is a very limited property right, is not a right to mine (mining is always contingent on state permission), amounts to only a priority over subsequent claimants, and is not sufficient to support a takings claim. Second, all of the twelve examples rest upon the State's police power, property power and constitutional mandate to conserve fish and wildlife, and those powers and authorities can be exercised without creating any per se takings. Third, under the three-prong, federal-law analysis of "regulatory" takings and the similar four-prong, state-law analysis, none of the elevated standards, if incorporated into legislation, would constitute a taking of the mining claims in question. In fact, two of the examples (refuge purposes and the compatibility test) are in existing State refuge statutes and have never constituted a taking, even in areas where prior mining claims exist (e.g., Tugidak Island Critical Habitat Area). Furthermore, other examples (seating of dams to bedrock, hydrological isolation, and replacement of water) have been suggested by DNR at public meetings on the subject of higher standards, and we agree with DNR that such standards would not constitute a taking. Fourth, and last, any legislation that strengthens the processes related to large-mine permitting, as also outlined in Part II by means of six examples, would not even raise the issue of takings.

It is a complete "red herring" to suggest that strengthened fishery conservation standards for the Bristol Bay region would cause a compensable taking of mining claims in that area.

Sustainability of Bristol Bay Salmon Fisheries

Provided to Senate Resources Committee members for the purpose of providing background information on Bristol Bay fisheries by Nunamta Aulukestai[1]
Feb. 27, 2009

Commercial fisheries have harvested wild salmon from Bristol Bay for over a century and current catches are as high as during any time period in the past.

Bristol Bay commercial salmon catches have been sustainable for over a century despite substantial shifts in climate in western Alaska during this time period.

The relative contributions of salmon from each of the major rivers in the Bristol Bay region have waxed and waned in response to the changing environment. The contributions of fish from rivers that were especially productive during certain decades were replaced by other rivers when their populations became less productive.

Thus, the long-term sustainability of Bristol Bay fisheries derives from the diversity of habitats and associated salmon populations in this region.

This effect of salmon biodiversity on fishery sustainability is analogous to a 'portfolio effect' in the stock market: while single 'hot' stocks may be very productive during short time periods, diverse stock portfolios nearly always outperform simple ones over the long term. Bristol Bay is one of the few places on Earth where its salmon habitat portfolio remains intact.

Industrial development of the pristine watersheds of Bristol Bay represents a potentially serious risk to salmon in this region because it threatens to erode the diversity of habitats and salmon populations that have been critical for fishery sustainability.

Although Bristol Bay is mostly known for the fact that it is the world's largest sockeye fishery, it also supports one of the largest Chinook (king salmon) fisheries in the world, and it is also home to many important species that rely on the seasonal pulse of salmon resources for their own sustenance (e.g., brown bears, rainbow trout; both of which support an enormous tourism industry)

[1] This document was compiled with technical support from Dr. Daniel Schindler at the University of Washington Fisheries Research Institute.

Key questions to ask about salmon habitat:

1) Where will the water come from that is needed to operate the mine? Will water need to be pirated from other watersheds beyond the proposed Pebble Mine footprint? *(it remains unclear where the water that is needed to operate the mine and treat the tailings will come from. It is also unclear whether the watershed that the proposed Pebble Mine would be situated within has enough water to support the mine. It is actually unlikely)*

2) What are the spin-off environmental effects of the supporting infrastructure for the mine? Roads and their associated dust, increased access, effects on hydrology are likely to all have important effects on natural ecosystems of this region.

3) What exactly is meant by 'no net loss' of salmon habitat? The current landscape of salmon habitat was generated by thousands of years of natural erosion processes that followed after the last glaciation. It is unclear that engineers will be able to create similarly productive habitats.

4) Where will the water come from to support such newly created habitats?

5) Heavy metal mining has a horrible environmental history – especially with respect to proper treatment and storage of wastes and tailings. Why would the proposed Pebble Mine be any different?

6) How long will it take for environmental effects of the mine to be expressed? *(environmental effects of hard rock mining are often expressed decades after a mine has begun operation. By this time, the mining company has often finished their exploitation and moved on.)*

Thus, how will the Pebble Limited Partnership guarantee the environmental precautions it claims it will be taking?

PERSPECTIVE: FISHERIES MANAGEMENT

Climate Change, Ecosystem Impacts, and Management for Pacific Salmon

Daniel E. Schindler, Xan Augerot, Erica Fleishman, Nathan J. Mantua, Brian Riddell, Mary Ruckelshaus, Jim Seeb, and Michael Webster

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ABSTRACT: As climate change intensifies, there is increasing interest in developing models that reduce uncertainties in projections of global climate and refine these projections to finer spatial scales. Forecasts of climate impacts on ecosystems are far more challenging and their uncertainties even larger because of a limited understanding of physical controls on biological systems. Management and conservation plans that explicitly account for changing climate are rare and even those generally rely on retrospective analyses rather than future scenarios of climatic conditions and associated responses of specific ecosystems. Using past biophysical relationships as a guide to predicting the impacts of future climate change assumes that the observed relationships will remain constant. However, this assumption involves a long chain of uncertainty about future greenhouse gas emissions, climate sensitivity to changes in greenhouse gases, and the ecological consequences of climate change. These uncertainties in forecasting biological responses to changing climate highlight the need for resource management and conservation policies that are robust to unknowns and responsive to change. We suggest how policy might develop despite substantial uncertainties about the future state of salmon ecosystems.

Cambio climático, impactos a nivel ecosistema y manejo del salmón del Pacífico

RESUMEN: A medida que el cambio climático se intensifica, existe un creciente interés en desarrollar modelos que reduzcan la incertidumbre en las proyecciones del clima global, y llevar estas proyecciones a escalas más finas. El pronóstico de los impactos del clima sobre los ecosistemas es más difícil de abordar y la incertidumbre asociada es aun mayor porque se tiene un entendimiento rudimentario sobre los controles físicos en sistemas biológicos. Son pocos los sistemas de manejo y conservación que consideran explícitamente el papel del clima, e incluso éstos se basan en análisis retrospectivos más que en escenarios futuros de condiciones climáticas y las correspondientes respuestas a nivel ecosistema. Al utilizar relaciones biofísicas preestablecidas como guía para predecir los impactos de cambio climáticos, se asume que dichas relaciones permanecerán constantes. Sin embargo, esta suposición implica una larga cadena de imprecisiones con respecto a la intensidad de futuras emisiones de gases de invernadero, sensibilidad climática a los cambios en estos gases, y las consecuencias ecológicas del cambio climático. La incertidumbre del pronóstico de las respuestas biológicas a un clima cambiante, resaltan la necesidad de políticas de manejo y conservación que sean suficientemente robustas a esas incógnitas y sensibles al cambio. Se sugiere cómo pueden desarrollarse tales políticas a pesar de la importante incertidumbre que existe en torno al estado futuro de los ecosistemas que albergan al salmón.

OVERVIEW OF SALMON RESPONSES TO CHANGING CLIMATE

Pacific salmon are icons of the natural and cultural heritage of coastal nations throughout the subarctic North Pacific Ocean (SNPO). Since the 1960s, scientists across all nations of the SNPO have greatly advanced understanding of Pacific salmon and their habitats. During this time period, environmental conditions of the SNPO also have shifted substantially in response to inter-decadal climate variability and longer-term warming trends (e.g., Schindler et al. 2005). Initial syntheses of these data have begun to shed light on how salmon and their ecosystems respond to changing climate.

Pacific salmon are affected by climate change across a hierarchy of coarse and fine spatial and temporal scales; each of these scales has distinct implications for development of policy that will be robust to future climate change. At the scale of the entire SNPO (Figure 1), biomass of Pacific salmon has increased substantially over the last century (Figure 2; Eggers 2009 in press), coincident with increases in global temperatures (IPCC 2007). This increased salmon production has been especially pronounced since the mid-1970s (Mantua et al. 1997; Beamish et al. 2008). However, trends in both climatic conditions and salmon production have not been uniform across the SNPO. In western North America, inter-decadal patterns of salmon production in northeastern stocks (i.e., Alaska) are out of phase with production regimes for stocks in the conterminous United States and Canada (Figure 3). This variation in production coincides with warming trends in salmon watersheds and nearshore marine waters in western North America, but cooling trends in the open waters of the interior North Pacific Ocean where most salmon feed and mature (Mantua et al. 1997; Hare et al. 1999).

At still finer spatial scales, stocks entering the ocean within 500-800 km of one another have weakly coherent responses to changes in local oceanographic conditions (Mueter et al. 2002; Pyper et al. 2005). This regional coherence in productivity is most correlated with regional variation in sea surface temperatures (Mueter et al. 2002). However, at the scale of individual populations, responses to regional shifts in climatic conditions are diverse (Figure 4; Peterman et al. 1998; Hilborn et al. 2003; Crozier and Zabel 2006; Rogers and Schindler 2008). Further, salmon species vary considerably in their responses to regional climate changes (Hare et al. 1999). Identifying features of the environment and of salmon populations that produce the diversity of salmon responses to regional climate forcing is critical because these are the scales at which most management and conservation activities operate.

Policies for managing salmon in the face of climate change must change if we hope to meet our conservation and management goals. Our ability to accurately predict climate impacts on salmon ecosystems is incomplete and unlikely to improve to the point of accounting for the regional response diversity noted above. Policies must be robust to these uncertainties rather than reliant upon prescriptive forecasts of climate and associated ecological conditions. Some such management strategies have been suggested as ways to account for climatically-driven changes in salmon production, without the need to understand the intricacies of climate impacts on salmon ecosystems (e.g., Walters and Parma 1996; Peterman et al. 2000). For example, Walters and Parma (1996) showed that a constant harvest strategy (i.e., one that exploits a constant proportion of stock each year) performs remarkably well at tracking long-term fluctuations in stock productivity, as would be caused by climate change. The information needed to develop such a strategy relies heavily on our ability to forecast year-to-year variation in abundance but does not necessar-

Figure 1. Map of the distribution of salmon in the Subarctic North Pacific Ocean (SNPO). Letters and corresponding arrows depict the location and rough spatial scales over which data from Figures 3 and 4 were summarized.

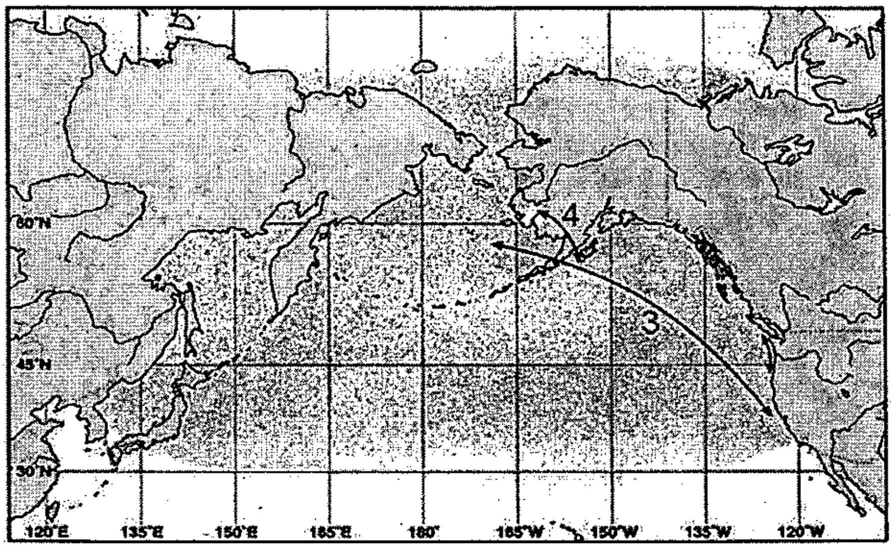
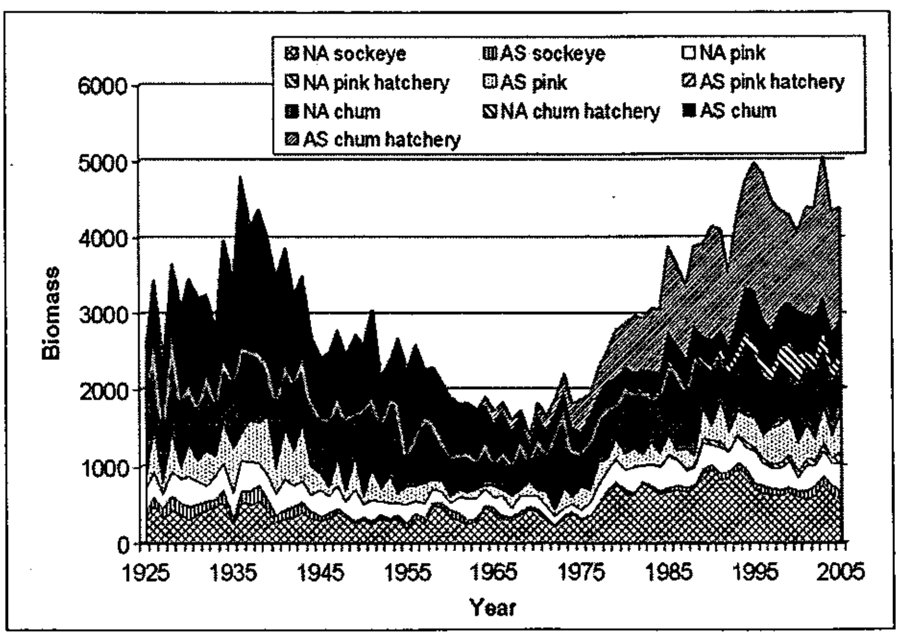


Figure 2. Total biomass (thousands of metric tons) of chum (*Oncorhynchus keta*), sockeye (*O. nerka*), and pink salmon (*O. gorbuscha*) inhabiting the SNPO (stippled area in Figure 1) from 1925–2005. Data are separated by species, continent of origin (North America [NA] versus Asia (AS), and hatchery versus wild stocks). Not all hatchery contributions are known with high certainty (e.g., Russian pink salmon) so these are combined with the wild components. Data are from Eggers (2009 in press).



ily rely on an intricate understanding of the processes causing climatically-driven variation. Given our limited predictive capacity, what information about the links between salmon and climate is useful to current policy? In particular, how might policy to address climate impacts on salmon embrace the hierarchy of spatial and temporal scales that characterize salmon responses to a changing environment?

Figure 3. Standardized anomalies of salmon harvests along the North American west coast from 1925–2005. Data were smoothed with a 5-year running mean. Abbreviations are: ch = Chinook salmon (*O. tshawytscha*), co = coho salmon, so = sockeye salmon, pi = pink salmon, BC = catch from British Columbia, US = catch from US lower 48 states, AK = catch from Alaska).

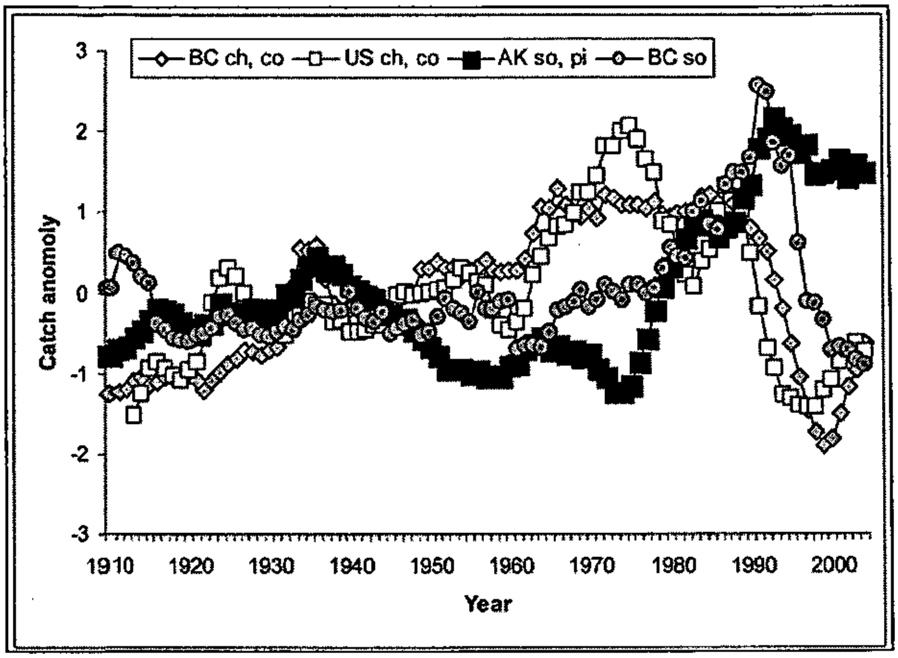
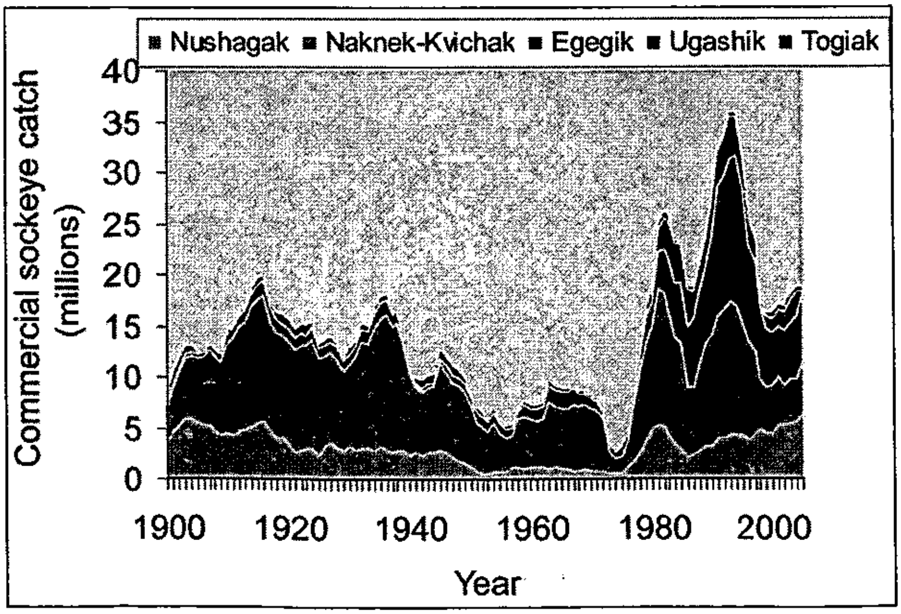


Figure 4. Sockeye salmon (*O. nerka*) commercial catch (millions of fish) from Bristol Bay, Alaska, from 1893–2006, apportioned to five fishing districts associated with the major rivers of this region (updated from Hilborn et al. 2003). Data are smoothed with a 5-year running mean.



The need for SNPO-wide salmon-climate policy

Improved salmon-climate policy is needed at all of the spatial scales described above. First, we believe that proactive policy development at the scale of the entire SNPO is needed to help minimize future climate-induced political conflicts over the use of limited prey resources by salmon from different nations of the SNPO. At the scale of the entire SNPO, increases in salmon biomass largely reflect increasing numbers of hatchery-released salmon from Eurasia (Figure 2, Eggers 2009 in press) that compete with salmon from North American rivers when they overlap in international waters (Kaeriyama and Edpalina 2004; Ruggerone et al. 2005). This surge in salmon production was concurrent with a general cooling of North Pacific offshore habitat where salmon achieve most of their growth (Mantua et al. 1997; Hare et al. 1999). If the increasing trend in biomass is dependent upon the cooling trends in this offshore ecosystem, it is not likely to persist with ongoing climate warming. Thus, the institutional expectation of the SNPO's capacity to produce salmon that has developed during the last few decades may prove overly optimistic as global atmospheric and upper-ocean temperatures continue to increase. In fact, capacity may decline if thermal characteristics of offshore habitat eventually switch trajectories and, consistent with global climate model projections, the upper ocean begins warming. More extensive use of the Arctic Ocean by Pacific salmon may partially offset any diminished capacity of the SNPO. Nevertheless, international coordination of management of the open-ocean commons used by Pacific salmon needs refinement to address potential climate-driven changes in productivity. There is currently no coordinated vision for use of the SNPO (Holt et al. 2008).

Climate policy at regional scales

At intermediate (regional) spatial scales, policies that govern maintenance of habitat quality and harvest strategies could be modified to more appropriately account for complex stock structure and variation in climate impacts on different habitats used by salmon. Multi-decadal regimes of high salmon production (Beamish et al. 1999) due to favorable

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ocean conditions may mask the erosion of freshwater and estuarine habitat quality, and within-stock biodiversity, that only become evident once productivity in the ocean decreases. For example, fisheries for Oregon coho salmon (*Oncorhynchus kisutch*) appeared to be robust and sustainable from the 1950s into the mid-1970s. During this period, hatchery programs grew rapidly and replaced wild stocks as the principal producers of juvenile coho salmon (Pearcy 1992). Intense harvest rates that seemed appropriate for hatchery stocks during periods of exceptionally high marine survival proved too high for the long-term sustainability of wild stocks. In 1977, a shift in the state of the Pacific Decadal Oscillation generated a 20-year period of unfavorable ocean conditions for Oregon coho salmon. The abundance of both hatchery and wild coho salmon adults plummeted, sending coho salmon populations and their fisheries into a decline from which they may be only beginning to recover. Accordingly, despite their knowledge that hatcheries were eroding the complex stock structure of wild coho salmon that had evolved for millennia, a 20-year period of high marine survival rates led fishery managers to mistakenly believe that large-scale hatchery production could sustain intense fisheries (Lichatowich 1999).

Further, Oregon coho salmon provide a compelling example of situations where favorable climatic conditions and high survival in one habitat (e.g., ocean) can obscure the degradation of other habitats (e.g., freshwater systems). For example, degradation of freshwater habitats can occur during periods of favorable ocean conditions that produce high marine survival rates. The degradation of freshwater habitats is only detectable once marine conditions switch back to a low productivity regime and salmon populations are more dependent on high quality freshwater habitat. Consequently, a ratchet effect can develop on population size and stock diversity as climatically-driven conditions in the ocean oscillate between periods of high and low quality (Lawson 1993).

Although within-stock diversity hinders the development of accurate and generalizable long-term forecasts of climate impacts on salmon at watershed scales, policies that protect diverse landscapes and their potential for diverse ecological responses are likely an effective means to hedge bets against future climate changes. Ecosystem and population sensitivity to changes in temperature and precipitation varies substantially across the entire latitudinal gradient that salmon occupy. The ecological and climatic factors that produce intraregional variation in population responses to changing climate (e.g., Hilborn et al. 2003; Crozier and Zabel 2006; Rogers and Schindler 2008) are poorly understood. It is useful to think of salmon landscapes as heterogeneous "filters" of climate. The environmental conditions experienced by any individual population are produced from how the overriding climate signal is expressed in their habitat, as influenced by its geomorphic, hydrologic, and ecological characteristics. We currently have a poor understanding of how landscapes filter climate signals, and how these in turn affect salmon populations. This lack of knowledge is an impediment to developing accurate predictions about the future status of specific salmon populations. However, to some extent, the regional diversity of population responses to climate change appears to derive from local adaptations of salmon populations to heterogeneity in landform and hydrologic conditions (Hilborn et al. 2003; Beechie et al. 2006; Crozier and Zabel 2006; Rogers and Schindler 2008). This response diversity imparts resilience to human social systems, such as fisheries, because they integrate across this ecological heterogeneity (Hilborn et al. 2003). Focusing regional policy on "salmon landscapes" will also be necessary to account for the range of habitats used by salmon over the course of their lives, including migratory corridors (Martin 2006). In the Pacific Northwest, where salmon landscapes are being developed most quickly, such protection of habitat may have to be especially aggressive to counteract ongoing effects of climate change (Ashley 2006).

What science can do to improve salmon-climate policy

Science can play an important role in reducing key uncertainties about climate impacts to which future policy can adapt. Areas that are particularly ripe for study and application to policy include:

- Developing quantitative models that allow projections for temperature, precipitation, and hydrologic conditions to be reliably downscaled to the watershed level. These models will facilitate exploration of the probability that regional conditions will support salmon in specific locations as climate continues to warm (Battin et al. 2007).
- Developing models that allow for integration of multiple factors influencing salmon ecosystems, including the cumulative impacts of climate change, land use, and water use on habitat, fishery harvest, and hatchery effects.
- Exploring the extent to which salmon and co-occurring organisms might adapt to ongoing climate change, thus affecting the direction and magnitude of overall ecosystem response. The role of evolution in ecological responses to anthropogenic change of Earth systems has been essentially ignored in conservation planning (Smith and Bernatchez 2007). This knowledge would inform policy decisions to invest or divest in salmon fisheries, salmon recovery, and hatchery production around the North Pacific.
- Exploring scenarios of future ocean productivity, linkages among ocean and freshwater or terrestrial conditions, and effects of changes in ocean, freshwater, or terrestrial conditions on salmon production at local, regional, and SNPO scales. This knowledge will be important for creating a management regime for cooperative use of the ecosystem services of the SNPO.
- Improving our understanding of how climate change affects the metapopulation processes important to salmon evolutionary and ecological dynamics.
- Refining genetic techniques to identify stocks, and ways to efficiently implement the data generated by those techniques, in harvest management to protect stock diversity in fisheries.

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CONCLUSIONS

Predictions of the scope and exact nature of biological responses to future climatic and habitat conditions will always be subject to considerable uncertainty. However, we can be certain that climate will continue to change and biological responses will be heterogeneous across a variety of spatial and temporal scales. We face the challenge of developing management and conservation approaches that are robust to substantial uncertainties about future conditions and capable of responding to change. Simultaneously, we must hone our ability to identify a realistic range of alternative futures. While we have focused on Pacific salmon, the issues we raise are not unique to these species. Many of these same issues will challenge policy to achieve sustained production and conservation of any wide-ranging species as global and regional climate continue to change. ⚓

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Biocomplexity and fisheries sustainability

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A classic example of a sustainable fishery is that targeting sockeye salmon in Bristol Bay, Alaska, where record catches have occurred during the last 20 years. The *stock complex* is an amalgamation of several hundred discrete spawning populations. Structured within lake systems, individual populations display diverse life history characteristics and local adaptations to the variation in spawning and rearing habitats. This biocomplexity has enabled the aggregate of populations to sustain its productivity despite major changes in climatic conditions affecting the freshwater and marine environments during the last century. Different geographic and life history components that were minor producers during one climatic regime have dominated during others, emphasizing that the biocomplexity of fish stocks is critical for maintaining their resilience to environmental change.

climate change | resilience | Pacific salmon | endangered species | biodiversity

At a time of growing concern about the sustainability of many of the world's fisheries, several stand out as providing long-term sustainable yield. Among the most prominent successes are the fisheries for sockeye salmon in Bristol Bay, Alaska (Fig. 1), that have seen record returns and catches in the last two decades. This success is due in part to several factors including (*i*) favorable ocean conditions in recent decades, (*ii*) a single, accountable management agency, and (*iii*) a well established program of limited entry to the fishery. However, the biocomplexity of the stock structure has also played an critical role in providing stability and sustainability. Here we provide evidence for the effects of biocomplexity on sustainability and emphasize that conserving biocomplexity within fish stocks is important for maintaining their resilience to future environmental change.

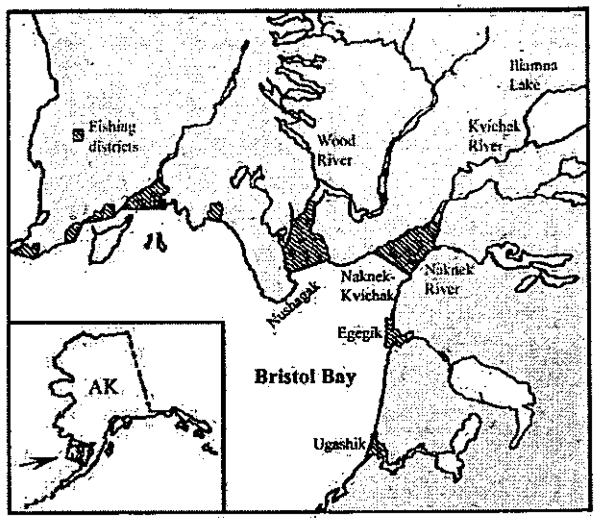

Fig. 1. Map of Bristol Bay, Alaska, showing the major lake systems producing sockeye salmon and the associated fishing districts. Figure is adapted from Minard and Meacham (37), which also gives an overview of Bristol Bay sockeye management practices.

The Biodiversity Of Bristol Bay Sockeye

Homing of Pacific salmon (*Oncorhynchus* spp.) to their natal sites results in reproductive isolation of populations, allowing natural selection to operate on heritable phenotypic traits, and the result is a wealth of distinct, locally adapted populations (1, 2). Sockeye salmon (*Oncorhynchus nerka*), for example, display a wide variety of life history types, each associated predictably with certain breeding and rearing habitats (3). The diversity of phenotypes thus reflects the adaptation of populations to the diversity of suitable habitats. Spawning by salmonid fishes generally takes place in lotic habitats, and Bristol Bay sockeye salmon spawn in streams and rivers ranging from 10 cm to several meters deep, and in substrate ranging from small gravel to cobble (4, 5). Some creeks have spring-fed ponds with much finer substrate and deeper, slowly flowing water, and these too are used for spawning. Sockeye also spawn in groundwater-fed beaches at the outwash areas of rivers and along hillsides with substantial groundwater inputs. In these habitats, sockeye may spawn from the shoreline to depths of several meters. Finally, sockeye may also spawn on the rocky beaches of low-lying islands that are too flat to develop groundwater but where wind-driven surface currents are sufficient to deliver highly oxygenated water to developing embryos buried in the coarse gravel (6).

Adult sockeye display a suite of adaptations to the diversity of spawning and incubation environments, seen repeatedly from one site to another (Table 1). First, the date of spawning reflects the long-term average thermal regime experienced by incubating eggs and the timing of food production for juvenile salmon in the spring. Simply put, the adults spawn at a date that, given the average thermal regime, will allow the embryos to complete embryonic development and emerge in time to feed on aquatic insects and zooplankton the following spring (7). Salmon spawn early (late July to mid-August) in small streams that experience cold temperatures during incubation but spawn later (late August to October) in large rivers and lakes that have substantial heat storage capacity (8).

Not only the timing of spawning but also the average size of the eggs reflects the habitat-specific features of the incubation environment. In general, salmon have very large eggs compared with other teleost fishes (9). The development of such large embryos is possible because the cold, highly oxygenated water counters the surface-to-volume constraint against large eggs and because size-selective predation (10) and competition favor large juveniles (11). Larger adult salmon have both larger and more numerous eggs than smaller salmon, but the energetic constraints on the female result in tradeoffs between egg size and egg number that are population-specific. Sockeye spawning in rocky island beaches have unusually large eggs (12). This takes advantage of the well oxygenated water and large interstitial spaces among the rocks to provide the offspring with abundant yolk to help survive the prolonged posthatching period that results from early spawning. In addition, large eggs may be less vulnerable to size-selective predation by sculpins (*Cottus* spp.) (13). In contrast to the island spawners, the eggs of females spawning in streams and rivers are of intermediate size (match-

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Abbreviations: ENSO, El Niño Southern Oscillation; PDO, Pacific Decadal Oscillation.

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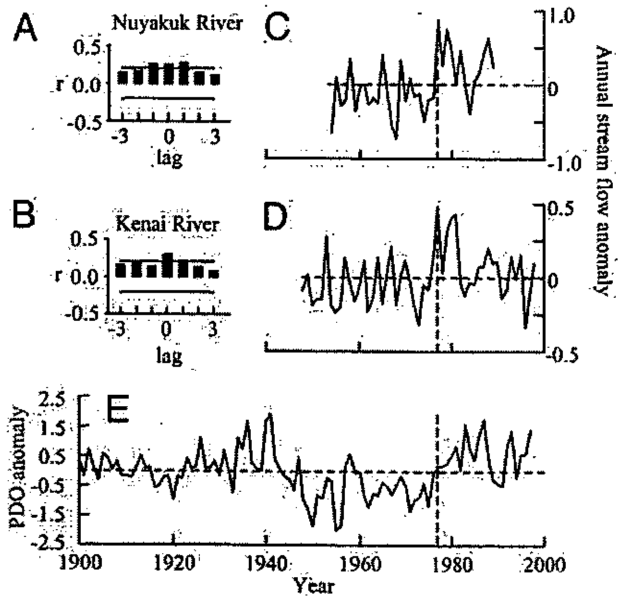

Fig. 2. Comparisons of the average annual PDO index for 1900–1998 (*E*) (ref. 26 and http://tao.atmos.washington.edu/pdo) and annual streamflow for two coastal rivers in southwestern Alaska. All time series have been normalized to the long-term mean. (*A* and *B*) The cross correlation plots (CCF) between normalized annual flow for each of the two rivers and the annual average PDO index. Lags are shown for 1-year increments. Horizontal lines on *A* and *B* mark the significance bounds ($P \leq 0.05$). Historical streamflow (annual $ft^3 \cdot s^{-1}$) is shown for the Nuyakuk River (59°56′08″ N, 158°11′16″ W, *C*) in the Upper Nushagak drainage near Dillingham, Alaska (1954–1989) and for the Kenai River at Cooper Landing, Alaska (60°29′34″ N, 149°48′28″ W, *D*) for 1948–1998.

the hydrologic conditions in sockeye spawning and nursery habitats (Fig. 2). When we use the Kenai River and the Nuyakuk River as examples, we see that climate regimes associated with positive phases of the PDO are characterized by relatively high stream flows, whereas negative phases of the PDO are associated with below-average flows (23, 25).

Temporal and spatial variation in the hydrology of spawning and nursery habitats have important implications for both the spawning success of adult sockeye and for growth and survival of juveniles during their freshwater residency. For example, access to small spawning streams by adults is impeded during years with low flows (19) whereas access to spawning habitat on lake beaches may be much less dependent on hydrologic patterns. Survival of smolts during their seaward migration may also be enhanced during periods with high flow because of reduced vulnerability to freshwater predators. In general, years with high stream flows coincide with years of favorable near-shore marine conditions such that sockeye productivity may be enhanced at several stages of their life history (25).

There is apparent coordination among several critical physical and biological conditions important to sockeye salmon biology. Nevertheless, an outstanding characteristic of the responses of Bristol Bay sockeye to climate variation is that not all populations appear to respond coherently to documented shifts in the environment. We argue that this population-specific variability in response to climate fluctuations is ultimately responsible for the resilience of the entire Bristol Bay sockeye stock.

Historical Patterns of Stock Productivity

To illustrate the importance of biocomplexity of the Bristol Bay stock complex, we have broken down the historical sockeye catch into the contributions from the three major fishing districts (Naknek/Kvichak, Egegik, and Nushagak) (Fig. 3). Before the

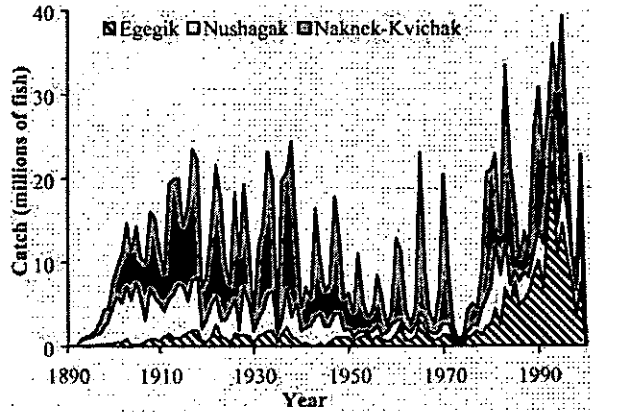

Fig. 3. Catch history of the three major fishing areas within Bristol Bay, Alaska. Contributions of the minor districts, Ugashik and Togiak, have averaged 4.6% since 1955.

1950s, we do not have estimates of the number of fish spawning in each river system and must use fishery catch as a surrogate for total run, but all major fisheries were already well developed by the early 20th century and catch is an excellent metric of total run size. We see that initially the Naknek/Kvichak was responsible for most of the sockeye production, with the Nushagak a close second and Egegik a small contributor. In the middle part of the 20th century, the importance of the Nushagak diminished, whereas Egegik remained roughly steady, and the Naknek/Kvichak dominated, driven almost exclusively by the Iliamna Lake populations. During that period, the Bristol Bay fishery was essentially a Naknek/Kvichak fishery. With the PDO regime shift of 1977 the Egegik run expanded greatly, so it was often at least as big than the Naknek/Kvichak, and the Nushagak system remained a small but steady contributor to the total fishery. In the 1990s the Naknek/Kvichak contribution declined dramatically, Egegik diminished, whereas Nushagak increased slightly to become, in some recent years, the most important fishery in Bristol Bay. Even within the Naknek/Kvichak district, the contribution of Iliamna Lake is now so small that it requires special protective fishery management to allow fishing on the Naknek populations.

Since the 1950s, visual counting towers on the major rivers leading into the lake systems have provided reliable counts of the number of fish passing through the fishery *en route* to their spawning sites. The number of recruits per spawner is the total number of adult returns from a spawning year divided by the number of fish that spawned in that brood year, and is a measure of per capita reproductive success. We calculated this for individual systems within fishing districts associated with each of the major rivers in Bristol Bay to demonstrate the temporal changes in their productivity (Fig. 4). In Fig. 4 we see the Naknek/Kvichak broken into its two dominant components; the Kvichak River–Lake Iliamna system and the Naknek River system. The Nushagak fishing district consists of three distinct lake/river systems; the Igushik, the Wood, and the Nushagak (not shown in Fig. 4). Finally the Ugashik system is the most remote of Bristol Bay's systems, located on the Alaska Peninsula.

Two features are important in Fig. 4, the absolute number of recruits per spawner and the temporal trends. The Kvichak and Wood systems have produced the fewest recruits per spawner, generally 2–4, whereas the Naknek averages ≈4, and the Egegik, Ugashik and Igushik show considerable variability but average more than Kvichak and Wood. Egegik showed the largest increase after the 1977 regime shift. This rise in survival was largely responsible for the upsurge in abundance of Egegik sockeye after the shift. The Ugashik system also showed a

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We have emphasized the importance of biocomplexity on the larger geographic scale, but similar patterns exist on ever-smaller scales within each lake system over the range of habitats and life history strategies described earlier. Within lakes, tributaries show asynchronous shifts in density and productivity, and even within tributaries we have seen habitat units affected by selective predation by bears, blockage by beaver dams, and other local processes. Our ability to measure changes in contribution at this level of biocomplexity is limited by our ability to assign the fishery catch to fine scale locations. Advances in genetic stock identification may pave the way for a high resolution analysis of the role of biocomplexity in maintenance of sustainability.

This work has lessons beyond the conservation of Pacific salmon. There is growing recognition that many marine fish stocks consist of amalgamations of several geographic components (35, 36). It would seem prudent to try to prevent loss of such stock components, including those that appear, at present, to be unproductive. This might necessitate a much finer scale of management than that which is the current norm. We believe that long-term sustainability is derived in large part from complementary patterns of productivity in different stock components. Defining the entire stock as healthy simply because a large component is doing well might lead to decline and extinction if the conditions that fostered the success of the healthy component disappear and the alternate strategy, which would have done well in the new environmental conditions, has been lost.

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Pebble Mine: Fish, Minerals, and Testing the Limits of Alaska's "Large Mine Permitting Process"

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ABSTRACT

Two foreign mining companies plan to develop one of the world's largest copper and gold mines on mining claims staked on state land in the Bristol Bay drainages. Currently, this area of southwestern Alaska produces the world's largest commercial salmon fishery, offers world-class sport fishing, and provides an important food source for local communities. The promoters of the Pebble Mine promise they will create jobs and protect the environment in their quest to recover copper, gold, and molybdenum from a large metallic sulfide deposit containing iron and other metallic sulfides. However, such sulfide ore, by its nature, generates sulfuric acid when exposed to air and water. Sulfuric acid, in turn, dissolves metals present in the host rock. The dissolved metals, such as copper, can be toxic to salmon and other fish. This Article examines the adequacy of the State's large mine permitting process and finds it insufficient to deal with large metallic sulfide mines such as Pebble. The Article then analyzes current legislative responses to the Pebble Mine and discusses their relative strengths and weaknesses. Finally, the Article argues that these legislative solutions would not rise to the level of an unconstitutional taking of the mining claims.

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I. INTRODUCTION

A proposal by two foreign companies to mine a massive, low-grade, copper and gold deposit on state land in southwestern Alaska has sparked an intense conflict between fishing and mining interests. The "Pebble Mine" would be located at the headwaters of the Kvichak (pronounced KWEE-jak) and Nushagak (pronounced NUSH-a-gak) river drainages, in the Bristol Bay drainages, which are essential habitats for Alaska's most productive salmon fisheries. Northern Dynasty Minerals Ltd. ("NDM"), a subsidiary of Hunter Dickinson,[1] and Anglo American Plc, the world's second largest mining concern,[2] plan to develop the Pebble Mine over several decades.

This Article examines: (1) current statutory standards at the heart of the State's "large mine permitting process;" (2) legislative proposals designed

1. NORTHERN DYNASTY MINERALS LTD., PEBBLE COPPER–GOLD–MOLYBDENUM PROJECT ALASKA, USA 13 (2007) [hereinafter NDM, PEBBLE COPPER], *available at* http://www.northerndynastyminerals.com/i/ndm/NDM_RobertDickinson_Nov2007.pdf. NDM and Hunter Dickinson are based in Vancouver, British Columbia. Northern Dynasty Mines, Inc., a United States subsidiary of NDM, owns the Pebble mining claims. Rio Tinto, a global mining concern based in London, England and Melbourne, Australia, has a 19.8 percent stake in NDM. RIO TINTO, STAYING STRONG IN COPPER (2006), http://www.riotinto.com/annualreview2006/5740_staying_strong_in_copper.asp. Mitsubishi bought a 6.1 percent stake in NDM in December 2007. *See* NORTHERN DYNASTY MINERALS LTD., ADVANCING AMERICA'S MOST IMPORTANT NEW MINERAL DEPOSIT 2 (2008) [hereinafter NDM, IMPORTANT NEW MINERAL DEPOSIT], *available at* http://www.northerndynastyminerals.com/i/pdf/NDM_FactSheet_Jan2008.pdf.

2. ANGLO AMERICAN PLC, ANNUAL REPORT 2006 51 (2006), *available at* www.angloamerican.co.uk/static/uploads/2006%20Annual%20Report%20Lo-Res2.pdf. Anglo American has operations in forty-five countries on seven continents. *Id.* Anglo American entered into a staged-investment agreement with NDM that gives Anglo American rights to up to fifty percent of the Pebble Mine project. Press Release, Northern Dynasty Materials Ltd., Northern Dynasty & Anglo American Establish 50:50 Partnership to Advance Pebble Project to Production (July 31, 2007) [hereinafter Advance Pebble Project to Production], *available at* http://www.pebblepartnership.com/files/July312007.pdf.

to protect the fish, game, habitat, and public uses of them in the Bristol Bay drainages; and (3) claims that current legislative proposals will result in regulatory takings that require compensation. This Article concludes that: (1) current statutory standards are vague and open to wide discretion; (2) stricter statutory standards are needed to protect fish, game, wildlife, habitat, and public uses of fish and wildlife in the Bristol Bay drainages; and (3) no such stricter standard would constitute a regulatory taking requiring the state to compensate those who hold mining claims for minerals at the proposed Pebble Mine.

II. BACKGROUND

Fishing and mining ventures have played major roles in Alaska's history. In the late nineteenth and early twentieth centuries, absentee business interests controlled Alaska's commercial fishing and mining industries.[3] One of the major players was the "Alaska Syndicate," which was a partnership formed by the Guggenheim family, whose American Smelting and Refining Company was a dominant force in the nation's hardrock mining industry,[4] and J. P. Morgan, an East Coast investment banker.[5] The Syndicate developed the Kennecott copper mine in the Wrangell Mountains north of Prince William Sound and held major interests in gold mines, the dredging, shipping, and transportation industries, as well as in Alaska's salmon canneries.[6] In Washington, D.C., the Syndicate successfully lobbied the United States Congress to oppose further extension of Alaskan home rule.[7]

Other merchants and bankers, based in San Francisco and Seattle, supplied capital and dominated Alaska's commercial salmon fishing industry and canneries.[8] Interests outside Alaska frustrated federal efforts to manage salmon harvests,[9] held tight control of the territorial Senate,[10]

3. *See, e.g.*, DANIEL NELSON, NORTHERN LANDSCAPES: THE STRUGGLE FOR WILDERNESS ALASKA 12–14 (2004).
4. IRWIN UNGER & DEBBI UNGER, THE GUGGENHEIMS, A FAMILY HISTORY 71–82 (2005).
5. Melody Webb Grauman, *Kennecott: Alaska Origins of a Copper Empire, 1900–1938*, 9 W. HIST. Q. 201 (1978).
6. *Id.* at 202. At the time, the Kennecott copper vein was the richest copper deposit in the country. *Id.*
7. CLAUS M. NASKE, A HISTORY OF ALASKA STATEHOOD 34–35 (1985).
8. *See* NELSON, *supra* note 3, at 12–13.
9. *See* JOHN H. CLARK ET AL., ALASKA DEP'T OF FISH & GAME, 12 ALASKA FISHERY RES. BULL. 1–2, THE COMMERCIAL FISHERY IN ALASKA (2006), *available at* http://www.adfg.state.ak.us/pubs/afrb/vol12_n1/clarv12n1.pdf. Between 1906

fought statehood because they feared the new state would impose taxes and limit access to fishing grounds,[11] and persuaded Congress that Alaska would remain an economic burden, demanding greater federal subsidies if it became a state.[12]

By the late 1930s, many of the high-grade mineral deposits were depleted, and the mining industry in Alaska appeared to have little future potential.[13] By the time Congress conferred statehood on Alaska in 1959, the state's commercial salmon harvests had declined from an annual average of ninety million fish in the 1930s to an annual average of forty million fish in the 1950s.[14]

The Alaska Statehood Act granted the new state authority to manage fish and game.[15] In January 1960, the new state's first governor, William A. Egan, addressed the state legislature about the need to restore the salmon fisheries:

> On January 1 of this year, Alaska's Department of Fish and Game was handed the depleted remnants of what was once a rich and prolific fishery. From a peak of three-quarters of a billion pounds in 1936, production dropped in 1959 to the lowest in [sixty] years. On these ruins of a once great resource, the department

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and 1924, forty-two bills introduced in Congress proposed a variety of means to regulate Alaskan commercial salmon fishing. *Id.* at 2. All were defeated or seriously weakened by the salmon canning industry. *Id.*

10. Richard Mauer, *Oil, a Foundation of Alaska, Works to Rebuild Its Image*, N.Y. TIMES, Nov. 29, 1989, at A1, *available at* http://query.nytimes.com/gst/fullpage.html?res=950DE0DB103CF93AA15752C1A96F948260.

11. *Id.* The canning industry also dominated the territorial legislature to prevent tax increases on canned salmon. NELSON, *supra* note 3, at 13.

12. Mauer, *supra* note 10, at A1.

13. *See* NELSON, *supra* note 3, at 22, 28.

14. CLARK ET AL., *supra* note 9, at 2–3. In 1924, the White Act, 43 Stat. 464, as amended, 48 U.S.C. §§ 221–28 (repealed), allowed the federal government to establish fishing seasons and hours, set catch limits, and regulate fishing practices, all of which improved salmon harvests. *Id.* at 2; *see* Kake Vill. v. Egan, 369 U.S. 60, 62 (1962). By 1939, harvests again declined due to, *inter alia*, industry resistance to regulation, lack of funding for federal enforcement and research, and overharvesting to meet food production goals during World War II. CLARK ET AL., *supra* note 9, at 3. When average annual harvests declined to forty million salmon, President Eisenhower declared parts of Alaska disaster areas, thereby authorizing emergency food supplies. *Id.*

15. Section 6(e) of the Alaska Statehood Act allowed the state to assume fish and wildlife management after the Secretary of the Interior certified to Congress that the Alaska State Legislature had made adequate provision for the administration, management, and conservation of fish and game "in the broad national interest." 48 U.S.C.S. prec § 21 (LexisNexis 2008).

> must rebuild. Our gain is that we can profit by studying the destructive practices, mistakes and omissions of the past. The revival of the commercial fisheries is an absolute imperative. The livelihood of thousands of fishermen and the very existence of many communities scattered along thousands of miles of continental and island coastline depends upon improvement of the fisheries. To this end we will give our best efforts.[16]

A. The Fishing Economy of the Bristol Bay Drainages

Alaska salmon populations rebounded as a result of improved state and federal management. In 1973, the Alaska Legislature enacted the Limited Entry Act to control the issuance of commercial fishing permits and thereby limit salmon harvests.[17] In 1976, Congress enacted the Magnuson-Stevens Fisheries Management and Conservation Act, which established an exclusive economic zone that extended United States jurisdiction over fisheries for 200 nautical miles beyond state waters.[18] This allowed the federal government to regulate foreign fishing vessels and reduce their harvests of Alaska-bound salmon.[19]

Most of Alaska's salmon populations are thriving today,[20] which is a stark contrast to the steep declines in other Pacific salmon stocks that resulted from habitat loss.[21] Alaska fisheries currently support lucrative commercial and sport industries, subsistence,[22] and tourism. By 2001, about 54,000 people earned all or part of their annual incomes from fishing,

16. CLARK ET AL., *supra* note 9, at 3.

17. 1973 Alaska Sess. Laws ch. 79 § 1 (codified as amended at ALASKA STAT. § 16.43.010 (2006)).

18. Pub. L. No. 94-265, 90 Stat. 331 (codified as amended at 16 U.S.C. §§ 1801, 1811 (2000)).

19. *Id.*; *see also* CLARK ET AL., *supra* note 9, at 7.

20. CLARK ET AL., *supra* note 9, at 6.

21. T.L. Slaney et al., *Status of Anadromous Salmon and Trout in British Columbia and Yukon*, FISHERIES, Oct. 1996, at 20; Willa Nehlsen et al., *Pacific Salmon at the Crossroads: Stocks at Risk from California, Oregon, Idaho, and Washington*, FISHERIES, Mar.–Apr. 1991.

22. Federal and state statutes define "subsistence" as the "customary and traditional" uses of wild renewable resources by rural Alaska residents. 16 U.S.C. § 3113 (2000); ALASKA STAT. § 16.05.940 (2006). Unlike the federal program, the state does not give preference to rural residents in administering subsistence programs on state lands. *See* McDowell v. State, 785 P.2d 1 (Alaska 1989) (holding that state statute limiting subsistence to rural residents violates Alaska Constitution).

which provided more jobs than oil, gas, mining, timber, agriculture and forestry, combined.[23]

In southwestern Alaska, the Bristol Bay drainages produce the world's largest commercial sockeye salmon fishery,[24] which is commercially the most valuable salmon species.[25] The Bristol Bay commercial sockeye salmon harvest is five-to-ten times larger than all other Alaska sockeye fisheries, combined.[26] Between 1986 and 2005, annual commercial catches of all five species of Pacific salmon in Bristol Bay averaged nearly 24 million sockeye (red), 70,000 Chinook (king), 922,000 chum, 103,000 coho (silver) and, in even years, 261,000 pink salmon.[27]

Bristol Bay accounts for one third of all earnings from commercial salmon fishing in Alaska.[28] In 2005, all salmon harvested commercially in Bristol Bay accounted for $226 million in wholesale value in the regional economy.[29] Between 1986 and 2005, commercial fishers received, in total, an average of $128 million in income from salmon caught in Bristol Bay, with sockeye salmon accounting for $125 million of that total.[30]

Between 1983 and 2003, subsistence harvests of salmon from the Bristol Bay drainages averaged about 159,000 fish, of which 125,000 were sockeye

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23. CLARK ET AL., *supra* note 9, at 21.

24. PAUL SALOMONE ET AL., ALASKA DEP'T OF FISH & GAME, 2006 BRISTOL BAY AREA ANNUAL MANAGEMENT REPORT 1, FISHERY MANAGEMENT REPORT NO. 07-22 (2007), *available at* http://www.sf.adfg.state.ak.us/FedAidPDFs/Fmr07-22.pdf.

25. Alaska Dep't of Fish and Game, Sockeye Salmon [hereinafter Sockeye Salmon], http://www.adfg.state.ak.us/pubs/notebook/fish/sockeye.php (last visited March 30, 2008).

26. *Id.*

27. SALOMONE ET AL., *supra* note 24, at 2. The Bristol Bay commercial salmon fishery provided a harvest of about twenty-six million salmon in 2005 at a value of more than $93 million. U.S. BUREAU OF LAND MGMT., BAY PROPOSED RESOURCE MANAGEMENT PLAN/FINAL ENVIRONMENTAL IMPACT STATEMENT § 3-24 (2007), *available at* http://www.blm.gov/ak/st/en/prog/planning/bay_rmp_eis_home_page.html (follow "Bay Proposed RMP and Final EIS" hyperlink; then follow "Chapter 3–Affected Environment" hyperlink). The 1985–2004 average sockeye salmon harvest for the Naknek-Kvichak district was 7.8 million fish, about thirty-three percent of the total Bristol Bay sockeye harvest. *Id.* The average sockeye salmon harvest for the Nushagak district for the same time period was four million fish, seventeen percent of the total Bristol Bay sockeye harvest. *Id.* The 2005 Naknek-Kvichak district harvest was slightly less than average at 6.7 million sockeye, while the Nushagak district harvest was higher at 7.1 million sockeye. *Id.*

28. JOHN DUFFIELD ET AL., ECONOMICS OF WILD SALMON WATERSHEDS: BRISTOL BAY, ALASKA 14 (2007), *available at* http://www.housemajority.org/coms/hfsh/trout_unlimited_report.pdf.

29. *Id.* at 16.

30. SALOMONE ET AL., *supra* note 24, at 2.

salmon.[31] Southwestern Alaska's world-class trout fisheries and plentiful king salmon attract sport anglers who annually contribute about $61 million to the state's economy.[32]

In 2005, the wild salmon watersheds in the Bristol Bay drainages generated $324 million in regional expenditures related to fish and wildlife.[33] This created an estimated 5540 full-time-equivalent jobs in Alaska. Alaska residents held more than 3400 of these jobs, with almost 1600 held by residents of the Bristol Bay area.[34]

The Bristol Bay drainages produce an average of 39 million sockeye salmon annually.[35] This is more than twice as many salmon, of all species, as the entire Columbia River drainage produced before those salmon

31. TIM SANDS, ALASKA DEP'T OF FISH & GAME, 2001–2003 OVERVIEW OF THE BRISTOL BAY SALMON FISHERY 2 (2003), *available at* http://www.cf.adfg.state.ak.us/region2/pubs/bof/rr2a0327.pdf.

32. DUFFIELD ET AL., *supra* note 28, at 15, 45.

33. *Id.* at 16.

34. *Id.* at 17. The following table reflects the distribution of jobs.

Total Full Time Equivalent (FTE) Employment in Alaska Dependent on Bristol Bay Wild Salmon Ecosystems, 2005

Sector	*Alaska Residents*			*Nonresidents*	*Total FTE jobs*
	Local residents	Non-local residents	Total Alaska		
Commercial fishing	689	667	1357	1172	2529
Commercial processing	465	449	914	796	1710
Sport fishing	288	435	723	123	846
Sport hunting	60	105	165	2	167
Wildlife viewing/ tourism	82	139	222	17	239
Subsistence	14	34	49	0	49
Total FTE jobs	1598	1829	3430	2110	5540

Id. Hunting is included because wild salmon returning from the sea perform an "ecosystem service" of nutrient recycling to support habitat functions. *See id.* at 24–26. For example, in Alaska, marine nitrogen accounts for as much as ninety percent of the nitrogen in brown bears. *See* ROBERT J. NAIMAN ET AL., RIPARIA: ECOLOGY, CONSERVATION, AND MANAGEMENT OF STREAMSIDE COMMUNITIES 184–85 (2005).

35. *See* LOWELL F. FAIR, ALASKA DEP'T OF FISH & GAME, 10 ALASKA FISHERY RES. BULL. 95, CRITICAL ELEMENTS OF KVICHAK RIVER SOCKEYE SALMON MANAGEMENT (2003), *available at* http://www.adfg.state.ak.us/pubs/afrb/vol10_n2/fairv10n2.pdf.

populations declined.[36] Historically, the Kvichak River drainage is the world's single most productive sockeye salmon watershed.[37] The Nushagak River watershed is the largest producer of the other four (Chinook, chum, coho and pink) Pacific salmon species in the Bristol Bay drainages.[38]

Furthermore, the area is home to the Mulchatna caribou herd, one of Alaska's largest herds. The Mulchatna herd numbered as many as 193,000 caribou in 1996, though the population has declined in recent years due to natural population cycles.[39] The Bristol Bay drainages also are a premier area for grizzly bear, which depend on salmon for food.[40]

B. The Proposed Pebble Mine and Its Facilities

The Pebble deposit is located at the divide between the Koktuli (pronounced KOKE-too-lee) River and the Upper Talarik (pronounced Ta-LAR-ick) Creek.[41] The Koktuli River is part of the Nushagak drainage, and Upper Talarik Creek is part of the Kvichak drainage.

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36. Before 1850, about sixteen million salmon and steelhead returned to the Columbia River basin annually to spawn. U.S. GEN. ACCOUNTING OFFICE, COLUMBIA RIVER BASIN SALMON AND STEELHEAD: FEDERAL AGENCIES' RECOVERY RESPONSIBILITIES, EXPENDITURES AND ACTIONS 1 (2002), *available at* http://www.gao.gov/new.items/d02612.pdf. Over the past twenty-five years, however, the number of salmon and steelhead returning to the Columbia River Basin has averaged around 660,000 per year. *Id.* The decline has been attributed to over-harvesting, construction and operation of hydroelectric dams, degradation of spawning habitat, increased human population, and unfavorable weather and ocean conditions. *Id.*

37. Sockeye Salmon, *supra* note 25.

38. R. ERIC MINARD, EFFORT AND CATCH STATISTICS FOR THE CHINOOK SALMON (ONCORHYNCHUS TSHAWYTSCHA) SPORT FISHERY IN THE LOWER NUSHAGAK RIVER, 1986, 1 FISHERY DATA SERIES NO. 15 (1987), *available at* http://www.sf.adfg.state.ak.us/FedAidPDFs/fds-015.pdf.

39. DIV. OF WILDLIFE CONSERVATION, ALASKA DEP'T OF FISH AND GAME, CARIBOU MANAGEMENT REPORT 24 (2001), *available at* http://www.wc.adfg.state.ak.us/pubs/techpubs/mgt_rpts/mca01-2mt_south.pdf; Interview with Jim Woolington, Wildlife Biologist, Div. of Wildlife Conservation, Alaska Dep't of Fish and Game (Mar. 14, 2008).

40. *See* ALASKA DEP'T OF FISH & GAME, BROWN BEAR MANAGEMENT REPORT 100–03 (2001), *available at* http://www.wc.adfg.state.ak.us/pubs/techpubs/mgt_rpts/mbr01_sc.pdf.

41. The proposed site of the Pebble Mine is about eighteen miles north of Iliamna Lake, nineteen miles southwest of the southern shore of Lake Clark, and about eighteen miles from the predominantly Native villages of Nondalton, Newhalen, and Iliamna. The Pebble Partnership, General Land Status Collings Proposed Route, http://www.pebblepartnership.com/images/LandStatus_D01-map.jpg (last visited Mar. 30, 2008).

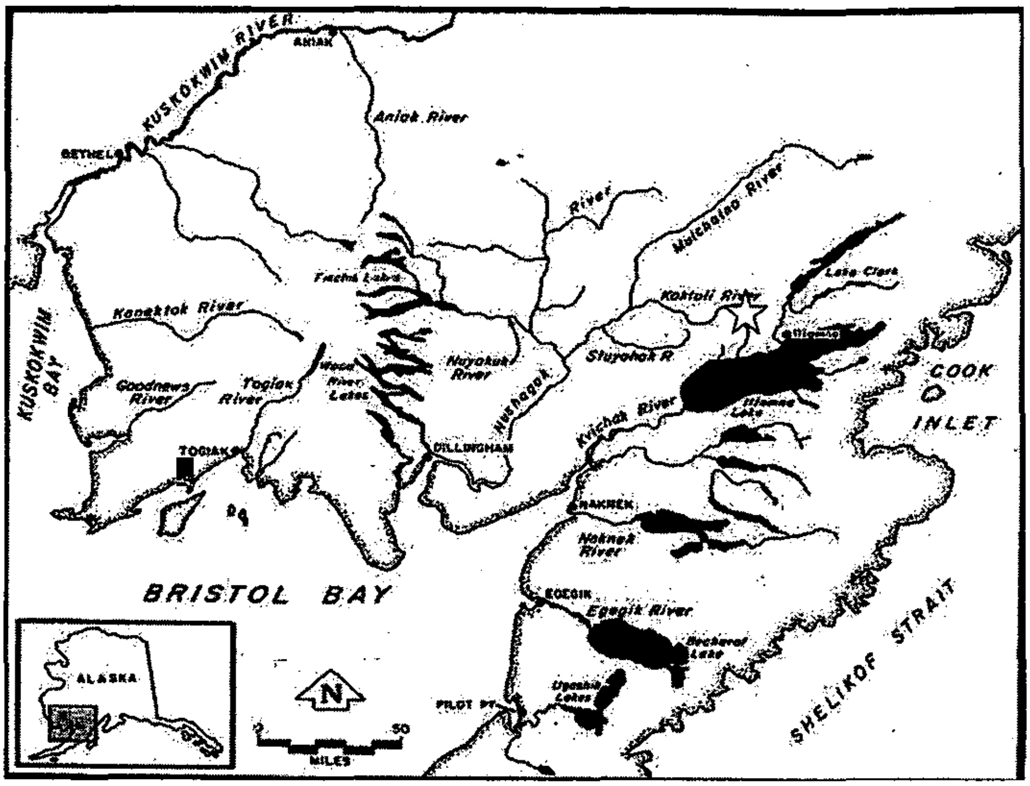

Figure 1. Schematic map of Bristol Bay watersheds. The star indicates the approximate location of the copper, gold, and molybdenum deposit comprising the proposed Pebble Mine. Map from the Alaska Department of Fish and Game.

NDM and Anglo American have asserted that the Pebble deposit "rank[s] among the world's most important accumulations of copper, gold and molybdenum."[42] NDM has asserted that Pebble is the second largest copper mineral deposit in the world and that it contains about sixty-seven billion pounds of copper, four billion pounds of molybdenum, and eighty-two million ounces of gold.[43] NDM has indicated that, on the surface, the Pebble deposit is approximately 2.65 miles by 1.7 miles.[44]

NDM divided the ore body into the "Pebble East" and "Pebble West" deposits.[45] NDM has asserted that the Pebble West deposit extends from the surface to a depth of about 2000 feet.[46] NDM also has asserted that

42. *See* Advance Pebble Project to Production, *supra* note 2.
43. NDM, PEBBLE COPPER, *supra* note 1, at 4, 11.
44. NDM, IMPORTANT NEW MINERAL DEPOSIT, *supra* note 1, at 2.
45. *Id.*
46. *Id.*

Pebble West contains 4.1 billion metric tonnes of ore and that it may develop an open pit mine.[47]

NDM has analyzed the copper, gold, and molybdenum content in three quarters (3.026 billion tonnes) of the Pebble West deposit.[48] Converting NDM's data to United States tons indicates that each *ton* contains between 6.2 *pounds* and 10.1 *pounds* of copper, 0.010 *ounces* and 0.016 *ounces* of gold, and 0.33 *pounds* and 0.46 *pounds* of molybdenum.[49] At most, about 10.6 pounds of metals would be recovered from every 2000 pounds of ore.[50] The waste-to-metals ratio would be at least 189 to one.[51] Thus, at least 99.5 percent of the deposit will be waste.[52] NDM estimated a similar yield for the remaining 1.1 billion tonnes in the Pebble West deposit.[53]

According to NDM, the Pebble East deposit is buried beneath overburden that ranges from several feet to more than 1000 feet deep at its eastern boundary.[54] NDM has estimated that the Pebble East deposit extends more than 5000 feet below the surface.[55] NDM has asserted that Pebble East contains 3.9 billion metric tonnes of ore.[56]

NDM has also predicted that concentrations of copper, gold, and molybdenum in the Pebble East deposit will be higher than at Pebble West.[57] Converting NDM's data to United States tons indicates that, in February 2008, NDM "inferred" that each *ton* of ore at Pebble East *may* contain as much as between 12.8 *pounds* and 19.2 *pounds* of copper, 0.012 *ounces* and 0.017 *ounces* of gold, and 0.73 *pounds* and 0.77 *pounds* of

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47. *Id.* at 1–2. Ore is defined as "rock that contains minerals in sufficient concentration, quantity, and value to be mined at a profit." *See, e.g.*, Climax Molybdenum, Glossary, http://www.climaxmolybdenum.com/Glossary/Glossary.htm (last visited Mar. 30, 2008).

48. NDM, IMPORTANT NEW MINERAL DEPOSIT, *supra* note 1, at 2.

49. *Id.*

50. *See id.*

51. *See id.*

52. *See id.*

53. *Id.*

54. *Id.* Overburden is defined as "rock material of little or no value that overlies an ore deposit." *See, e.g.*, Climax Molybdenum, Glossary, *supra* note 47.

55. NDM, IMPORTANT NEW MINERAL DEPOSIT, *supra* note 1, at 2.

56. Press Release, Northern Dynasty Minerals Ltd., Updated Resource Estimate Confirms Pebble East as One of the World's Most Important Copper-Gold-Molybdenum Deposits (Feb. 25, 2008) [hereinafter Updated Resource Estimate], *available at* http://www.northerndynastyminerals.com (follow "Investor Centre" hyperlink; then follow "News Releases" hyperlink; then follow "February 25, 2008").

57. *Id.*; *see also* NDM, IMPORTANT NEW MINERAL DEPOSIT, *supra* note 1, at 2.

molybdenum.[58] At most, based on NDM's estimations, less than twenty pounds of metals would be recovered from every 2000 pounds of ore mined at Pebble East.[59] The waste-to-metals ratio at Pebble East would be more than 100 to one.[60] Accordingly, more than 99 percent of all ore mined at Pebble East would be waste.[61]

Thus, if the eight billion tonnes of ore that comprise the Pebble East and Pebble West deposits are fully mined and processed, the Pebble Mine would produce more than seven billion tons of waste[62] plus waste rock that would not be processed as ore. Presumably, almost all of these wastes would be stored on state-owned public lands near the mine in perpetuity.

In 2006, NDM submitted eleven permit applications to the Alaska Department of Natural Resources (DNR).[63] Six of these applications sought to appropriate surface or groundwater from the North and South Forks of the Koktuli River and from Upper Talarik Creek.[64] The other five applications sought permits to build five massive, earthen-fill dams or embankments to contain waste from the mine.[65]

Although NDM later requested that DNR delay adjudicating the applications,[66] they provide insight into NDM's development plans. The Pebble Mine likely would include most of the following facilities:

1. An open pit mine at Pebble West that may be about 2000 feet deep and cover about two square miles and an underground mine at Pebble East that may be of comparable size and 5000 feet deep.[67]

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58. *See* Updated Resource Estimate, *supra* note 56. NDM stated that an "inferred" mineral resource is "estimated on the basis of geological evidence and limited sampling." *Id.* NDM has "reasonably assumed, but not verified" how much of the Pebble East deposit actually contains copper, gold, or molybdenum at these concentrations. *Id.*

59. *See id.*

60. *See id.*

61. *Id.*

62. *See* NDM, IMPORTANT NEW MINERAL DEPOSIT, *supra* note 1, at 2. NDM asserts that the size of Pebble East is "wide open to further expansion and delineation drilling is ongoing." *Id.* Thus, the amount of ore and corresponding waste from Pebble East could increase.

63. DIVISION OF MINING, LAND, AND WATER, ALASKA DEP'T. OF NATURAL RES., PEBBLE PROJECT [hereinafter PERMIT APPLICATIONS], http://www.dnr.state.ak.us/mlw/mining/largemine/pebble/waterapp.htm (providing hyperlinks to all available NDM permit applications) (last visited Mar. 30, 2008).

64. *Id.*

65. *Id.*

66. Letter from Michael C. T. Smith, NEPA and Permitting Manager, Northern Dynasty Mines Inc., to Thomas Crafford, Large Mine Coordinator, Alaska Dep't of Natural Res. (Oct. 12, 2006), *available at* http://www.dnr.state.ak.us/mlw/mining/largemine/pebble/2006/acmp.pdf.

2. Various stream diversion channels, wells and devices to: (a) prevent water from filling the open pit, (b) extract water that would be used for processing the ore, (c) transport ore concentrate in a slurry via pipelines, and (d) transport wastes in a slurry via pipelines.[68]
3. A mill to crush, process, and concentrate the ore extracted from the open pit and underground mines.[69]
4. Five dams or embankments composed of waste rock and earthen-fill material that together would span about nine linear miles. The three largest dams would be 740 feet high and 3 miles long, 700 feet high and 2.9 miles long, and 710 feet high and 1.3 miles long.[70] These dams and embankments would create and contain ponds that would cover at least 10 square miles and store chemically reactive, ore-processing wastes known as "tailings."[71]
5. A deep-water port in marine waters on the west side of Cook Inlet (about 200 miles southwest of Anchorage) to load the ore concentrate on ocean freighters.[72]
6. A 104-mile road to provide a transportation corridor from the mine facilities to the port.[73]

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67. *See* The Pebble Partnership, Project Status and Timeline [hereinafter Project Status and Timeline], http://www.pebblepartnership.com/pages/project-information/project-status.php (last visited March 30, 2008); NDM, IMPORTANT NEW MINERAL DEPOSIT, *supra* note 1, at 1–2.

68. *See generally*, NORTHERN DYNASTY MINES INC., PEBBLE PROJECT: APPLICATION FOR WATER RIGHT: SOUTH FORK KOKTULI RIVER at Project Description 2, 4 (2006), *available at* http://www.dnr.state.ak.us/mlw/mining/largemine/pebble/2006/swsfkorig.

69. Project Status and Timeline, *supra* note 67.

70. *See* KNIGHT PIESBOLD CONSULTING, NORTHERN DYNASTY MINES, INC., TAILINGS IMPOUNDMENT A INITIAL APPLICATION REPORT 2 (2006) (describing the dimensions of the dams or embankments) [hereinafter TAILINGS IMPOUNDMENT A REPORT], *available at* http://www.dnr.state.ak.us/mlw/mining/largemine/pebble/2006/damaap.pdf; KNIGHT PIESBOLD CONSULTING, NORTHERN DYNASTY MINES, INC., TAILINGS IMPOUNDMENT G INITIAL APPLICATION REPORT 1 (2006) [hereinafter TAILINGS IMPOUNDMENT G REPORT], *available at* http://www.dnr.state.ak.us/mlw/mining/largemine/pebble/2006/damgap.pdf.

71. The estimate that total area of the water surface in these two impoundments exceeds ten square miles is derived by summing the surface water area stated in the applications for permits to build dams or embankments described in the appendices to two reports. *See* TAILINGS IMPOUNDMENT A REPORT, supra note 70; TAILINGS IMPOUNDMENT G REPORT, supra note 70.

72. *See* NDM, PEBBLE COPPER, *supra* note 1, at 19; *see also* The Pebble Partnership, Road, Port, & Power [hereinafter Road, Port, & Power], http://www.pebblepartnership.com/pages/project-information/road-port-power.php (last visited Mar. 30, 2008).

73. *Id.*

7. Two 100-mile-long, fifteen inch-diameter pipelines that would run parallel to the road. One pipeline would be used to transport a slurry of copper ore concentrate from the mill to the port, where the slurry would be de-watered. The other pipeline would return the slurry water to the mine area.[74]
8. Four 54-inch-diameter pipelines. Three of the pipelines, totaling 70,000 feet (13.25 miles), would transport mine wastes from the mill to the waste storage facilities. The fourth pipeline, totaling 17,000 feet (3.2 miles), would reclaim water from the waste facilities and transport it to the mill.[75]
9. A 300-megawatt power plant that would be located on the Kenai Peninsula, across Cook Inlet.[76]
10. More than 100 miles of transmission lines and undersea cables to transmit electricity from the power plant on the Kenai Peninsula to the mine site.[77]

The Pebble Partnership asserts that development of the Pebble Project will generate 1000 skilled, high-wage jobs for fifty to eighty years and 2000 jobs during the project's two- to three-year construction phase.[78] The partnership claims the mine will generate tens of millions of dollars in

74. *See id.*; NORTHERN DYNASTY MINES INC., PEBBLE PROJECT: RESPONSE TO JULY 26, 2006 ADNR ANALYSIS OF APPLICATION COMPLETENESS OF JULY 7, 2006 APPLICATION FOR SURFACE WATER RIGHT: SOUTH FORK KOKTULI RIVER (2006) [hereinafter NDM, RESPONSE TO JULY 26, 2006, ADNR ANALYSIS], *available at* http://www.dnr.state.ak.us/mlw/mining/largemine/pebble/2006/swsfkfinal.pdf.

75. NDM, RESPONSE TO JULY 26, 2006, ADNR ANALYSIS, *supra* note 74, at Table 3. During operation, water would circulate between the tailings impoundments and the tailings slurry pipelines. *Id.*

76. Shane Lasley, *Mining News: Mining and Fish Can Coexist*, NORTH OF 60 MINING NEWS, Dec. 30, 2007, *available at* http://www.petroleumnews.com/pntruncate/91525336.shtml.

77. Road, Port, & Power, *supra* note 72.

78. The Pebble Partnership, Pebble Facts [hereinafter Pebble Facts], http://www.pebblepartnership.com/pages/project-information/pebble-facts1.php (last visited Mar. 30, 2008). The Pebble Mine would be in the Lake and Peninsula Borough, which extends hundreds of miles from Lake Clark National Park and Preserve to the southern tip of the Alaska Peninsula. In 2006, the Borough population was 1557 people, of whom eighty percent were Alaska Native or part Native. *See* STATE OF ALASKA, ALASKA COMMUNITY DATABASE COMMUNITY INFORMATION SUMMARIES, http://www.commerce.state.ak.us/dca/commdb/CF_CIS.htm (follow "Lake and Peninsula Borough" hyperlink in box under "Select a Community") (last visited Mar. 30, 2008). Residents of the communities nearest the Pebble Mine are all predominantly Alaska Native. *Id.* In 2006, the populations of these villages were: Nondalton (pop. 196), Newhalen (pop. 167) and Iliamna (pop. 82). *Id.*

annual tax payments to state and local governments, as well as numerous local business opportunities.[79]

C. The Pebble Mine is Likely to Generate Acid Mine Drainage

As previously noted, NDM may construct a block-cave underground mine at Pebble East and an open-pit mine at Pebble West.[80] Block cave mines often cause surface subsidence or settling.[81] Subsidence occurs as the material above the ore body, including surface and rain water, gradually moves downward to replace the ore that has been mined.[82]

Open pit and underground mines often must be dewatered to allow extraction of the ore.[83] Two methods used to dewater the mines are pumping from ground-water interceptor wells to lower the water table and pumping directly from the mine workings.[84] Dewatering can create a hydrologic cone of depression around the mine area and can prevent contamination from reaching the surrounding aquifer.[85] If pumping ceases after the mine is abandoned, the mine workings will fill partially or completely with water and may lead to uncontrolled releases of water.[86]

The host rock associated with most types of metal mining activities contains metal sulfide minerals.[87] Most of the ore at the Pebble deposit contains iron and other metallic sulfides.[88] When such sulfides are exposed

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79. Pebble Facts, *supra* note 78.

80. *Id.* Block caving is an underground mining method. Generally, the first step is to blast the ore body so it becomes fractured, creating a cavern of broken rock. *See, e.g.*, RESOLUTION COPPER MINING, BLOCK CAVING AND SUBSIDENCE, http://www.resolutioncopper.com/res/ourapproach/BlockCaveMining.pdf (last visited Mar. 30, 2008). The second step is to drill a tunnel under the broken rock cavern. *Id.* Finally, narrow-necked chutes are constructed under the cavern to funnel the ore to collection points in the tunnels. *Id.*

81. *Id.*

82. *Id.*

83. OFFICE OF SOLID WASTE, U.S ENVIRONMENTAL PROTECTION AGENCY, MINING INDUSTRY PROFILE: COPPER 1–63 (1994), *available at* http://www.epa.gov/epaoswer/other/mining/techdocs/copper/copper1b.pdf.

84. *Id.*

85. *Id.*

86. *Id.*

87. OFFICE OF SOLID WASTE, U.S. ENVIRONMENTAL PROTECTION AGENCY, TECHNICAL DOCUMENT: ACID MINE DRAINAGE PREDICTION 4 (1994) [hereinafter EPA, ACID MINE DRAINAGE PREDICTION], *available at* http://www.epa.gov/epaoswer/other/mining/techdocs/amd.pdf.

88. The predominant copper sulfide minerals in the Pebble deposit are chalcopyrite ($CuFeS_2$) and bornite (Cu_5FeS_4). *See* Press Release, Northern Dynasty Minerals Ltd., Major New Porphyry System Discovered at Pebble (Sept. 21, 2005),

to air and water, they generate sulfuric acid, which dissolves most metals, mobilizing them into solution.[89]

Prior to mining, oxidation of these sulfides and the formation of sulfuric acid is a function of natural weathering processes.[90] The oxidation of undisturbed ore bodies, which is followed by release of acid and mobilization of metals, is slow.[91] Discharge from such deposits poses little threat to receiving aquatic ecosystems.[92]

Extractions and beneficiation operations associated with mining activity increase the rate of these same chemical reactions by exposing large volumes of sulfide rock material with increased surface area to air and water.[93] This process is commonly referred to as acid mine drainage.[94] In addition to the acid contribution to surface waters, acid mine drainage may cause metals such as arsenic, cadmium, copper, silver, zinc, iron, lead, and manganese to leach from mine wastes.[95]

These leached metals cause environmental damage and are of greater concern than the acidity.[96] When dissolved metals enter surface waters, either directly or through groundwater, they become available to fish and the food chains upon which they depend.[97]

The formation of acid mine drainage, and the contaminants associated with it, have been described as the largest environmental problem facing the U.S. mining industry.[98] Mine waste rock, tailings, overburden, and mine structures such as open pits and underground workings are sources of acid mine drainage.[99] Because the factors affecting the potential for acid mine drainage are highly variable from site to site, predicting the potential for acid mine drainage is difficult, costly, and of questionable reliability.[100]

available at http://www.northerndynastyminerals.com/ndm/NewsReleases.asp?ReportID=117769; NDM, PEBBLE COPPER, *supra* note 1, at 15.

89. EPA, ACID MINE DRAINAGE PREDICTION, *supra* note 87, at 4–6.
90. *Id.* at 4.
91. *Id.*
92. *Id.*
93. *Id.* at 4.
94. *Id.* at 1.
95. *Id.* at 1, 7, 41.
96. *Id.* at 1.
97. *See generally* CAROL ANN WOODY, COPPER: EFFECTS ON FRESHWATER FOOD CHAINS AND SALMON: A REVIEW (2007), *available at* http://fish4thefuture.com/pdfs/Woody_Copper_Effects_to_Fish%20-%20FINAL2007.pdf.
98. EPA, ACID MINE DRAINAGE PREDICTION, *supra* note 87, at 1.
99. *Id.* at 1–2.
100. *Id.* at 1.

III. DISSOLVED METALS SUCH AS COPPER ARE TOXIC TO FISH

The late Jay Hammond, the popular Republican governor of Alaska from 1976 to 1982, made his home on the shore of Lake Clark, in the Bristol Bay drainages, thirty miles from the proposed Pebble Mine.[101] On July 11, 2005, two weeks before his death, he expressed his views of the Pebble Mine:

> When I was first asked about the Pebble Mine . . . I expressed this concern: that if I were asked where in Alaska would I least rather see the largest open-pit mine in the world, I can think of no more less appropriate spot than the headwaters of the Talarik Creek and Kokutli River, the drainages of two of the finest trout streams and salmon spawning areas in Alaska. But I have since modified that to where if asked that question again, I'd say there is one place I'd even less rather see it, and that's in my living room here at Lake Clark.[102]

The Pebble Partnership asserts that about ninety-five percent of the metal that Pebble Mine would produce is copper.[103] This Part focuses on the toxic effects of copper on salmon and aquatic food chains.

Copper is essential to living organisms and no fatal copper deficiencies have ever been documented for any aquatic species.[104] Yet, concentrations just above the amount required for growth and reproduction can be highly toxic to aquatic species and cause irreversible harm.[105] The exact amount of dissolved copper that is toxic to fish and aquatic food chains can be

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101. JAY S. HAMMOND, TALES OF ALASKA'S BUSH RAT GOVERNOR: THE EXTRAORDINARY AUTOBIOGRAPHY OF JAY. S. HAMMOND 294 (1994).

102. Interview by Lance Holter with Jay S. Hammond, former Governor of Alaska, in Port Alsworth, Alaska (July 11, 2005) (available upon request from authors).

103. Elizabeth Bluemink, *Jewelers Announce Opposition to Pebble Prospect's 'Dirty Gold': Companies Call for Protection of River Drainages*, ANCHORAGE DAILY NEWS, Feb. 13, 2008, at A1, *available at* http://www.adn.com/money/industries/mining/story/313462.html.

104. 1 RONALD EISLER, HANDBOOK OF CHEMICAL RISK ASSESSMENT: HAZARDS TO HUMANS, PLANTS, AND ANIMALS: METALS 138 (2000).

105. Peter V. Hodson et al., *Toxicity of Copper to Aquatic Biota*, *in* COPPER IN THE ENVIRONMENT: HEALTH EFFECTS PT. II, 307, 307–08 (Jerome O. Nriagu ed., 1979); W. Scott Hall et al., *Monitoring Dissolved Copper Concentrations in Chesapeake Bay, U.S.A.*, 11 ENVTL. MONITORING AND ASSESSMENT 33 (1988); ELSA M. SORENSEN, METAL POISONING IN FISH 235–84 (1991); EISLER, *supra* note 104, at 144–73; David H. Baldwin et al., *Sublethal Effects of Copper on Coho Salmon: Impacts on Nonoverlapping Receptor Pathways in the Peripheral Olfactory Nervous System*, 22 ENVTL. TOXICOLOGY AND CHEMISTRY 2266, 2273 (2003).

difficult to predict[106] because many factors influence toxicity including: (1) species of copper, in elemental or compound forms, and the concentration;[107] (2) water quality, including pH, temperature, hardness, salinity, suspended solids, and organics; (3) synergistic interactions of copper with other local elements; and (4) species of fish or organism, age, size, reproductive condition, and prior exposure to copper.

Salmon and organisms comprising freshwater food chains are very sensitive to heavy metals, trace elements, and other contaminants found in mine wastes.[108] Because copper is highly toxic to freshwater aquatic organisms, understanding potential lethal and sublethal effects of copper on salmon and their freshwater food chains is important to address the adequacy of the state's large mine permitting process. Both lethal and sublethal effects of copper (Cu) on salmon and their food chains have been demonstrated[109] at concentrations below the Alaska state water quality criterion for protection of freshwater species (9 micrograms Cu per liter (µg Cu/L) calculated on 100 mg/L hardness ($CaCO_3$)) and well below the human drinking water criterion of 1300 µg Cu/L.[110]

Copper has sublethal effects on salmon that can reduce the viability of populations.[111] Concentrations below the accepted criterion for aquatic life in Alaska (< 9 µg Cu/L) have produced the following documented effects on fish: (1) impairment of sense of smell (olfaction);[112] (2) interference with

106. OFFICE OF RESEARCH AND DEVELOPMENT, U.S. ENVIRONMENTAL PROTECTION AGENCY, AMBIENT AQUATIC LIFE WATER QUALITY CRITERIA FOR COPPER 1–18 (1980), *available at* http://www.epa.gov/waterscience/criteria/library/ambientwqc/copper80.pdf; EISLER, *supra* note 104, at 133; Hodson et al., *supra* note 105, at 339–481.

107. Aquatic Life Ambient Freshwater Quality Criteria–Copper 2007 Revision. 72 Fed. Reg. 7983 (Feb. 22, 2007).

108. SORENSEN, *supra* note 105, at 233; A. Dennis Lemly, *Mining in Northern Canada: Expanding the Industry While Protecting Arctic Fishes—A Review*, 29 ECOTOXICOLOGY AND ENVTL. SAFETY 229, 230–34 (1994); EISLER, *supra* note 104, at 94–95.

109. EISLER, *supra* note 104, at 144–73.

110. ALASKA ADMIN. CODE tit. 18 § 70.020(b) (2007) (incorporating by reference the DEP'T OF ENVTL. CONSERVATION, ALASKA WATER QUALITY CRITERIA MANUAL FOR TOXIC AND OTHER DELETERIOUS SUBSTANCES (2003) (stating the copper criteria for freshwater aquatic life and for human health)), *available at* http://dec.alaska.gov/water/wqsar/wqs/pdfs/70wqsmanual.pdf.

111. Baldwin et al., *supra* note 105, at 2273; EISLER, *supra* note 104, at 163–66; SORENSEN, *supra* note 105, at 269–76.

112. J. Raloff, *Aquatic Non-Scents: repercussions of water pollutants that mute smell*, SCIENCE NEWS, Jan. 27, 2007, at 59.

normal migration;[113] (3) impairment of their ability to fight disease (immune response);[114] (4) difficulties in breathing;[115] (5) disruption of osmoregulation (ability to control internal salinity of body fluids);[116] (6) impairment of ability to sense vibrations via their lateral line canals (a sensory system that helps fish avoid predators);[117] (7) impairment of brain function;[118] (8) changes in enzyme activity, blood chemistry, and metabolism;[119] and (9) delay or acceleration of natural hatch rates.[120]

Many metals toxic to aquatic life are commonly released at hard rock mining sites, and interactive effects on salmon and aquatic systems are not well studied.[121] Few studies exist on the "cocktail" effects that multiple metals have on fish and aquatic food chains. However, combined effects can be more toxic than any single element.[122] For example, copper (Cu) and zinc (Zn) often co-occur; a 6:1 ratio of soluble Zn:Cu caused additive toxicity to fish in hard water, meaning that together the elements were more toxic to fish then either alone.[123] Rainbow trout exposed to sublethal concentrations of Cu, Cu+ low concentrations of Zn, or Cu + high concentrations of Zn consistently exhibited depressed levels of lymphocytes and elevated levels of neutrophils, two white blood cell types key to immune function.[124]

Moreover, interactions among metals, such as copper and zinc, can produce more than additive effects. Mixtures of the metals cause higher rates of mortality in fish than would be expected by simply adding the

113. J.N. Goldstein et al., *Movements of Adult Chinook Salmon During Spawning Migration in a Metals-Contaminated System, Coeur d'Alene River, Idaho*, TRANSACTIONS OF THE AMERICAN FISHERIES SOCIETY 121–29 (1999); D.F. Woodward et al., *Brown Trout Avoidance of Metals in Water Characteristic of the Clark Fork River, Montana*, 52 CANADIAN JOURNAL OF FISHERIES AND AQUATIC SCIENCES 2031–37 (1995); SORENSEN, *supra* note 105, at 254, 265.

114. R.J. Baker et al., *Susceptibility of Chinook Salmon,* Oncorhynchus tshawytscha *(Walbaum), and Rainbow Trout,* Salmo gairdneri, *Richardson, to Infection with* Vibrio anguillarum *Following Sublethal Copper Exposure*, 3 JOURNAL OF FISH DISEASES 267–75 (1983).

115. SORENSEN, *supra* note 105, at 266–69.

116. *Id.* at 256–62; EISLER, *supra* note 104, at 180.

117. SORENSEN, *supra* note 105, at 253.

118. EISLER, *supra* note 104, at 163.

119. SORENSEN, *supra* note 105, at 256–62; EISLER, *supra* note 104, at 180.

120. SORENSEN, *supra* note 105, at 271.

121. EISLER, *supra* note 104, at 102–05.

122. WOODY, *supra* note 97, at 14.

123. SORENSEN, *supra* note 105, at 335–39.

124. Gail M. Dethloff et al., *Alterations in Physiological Parameters of Rainbow Trout* (Oncorhynchus mykiss) *with Exposure to Copper and Copper/Zinc Mixtures*, 42 ECOTOXICOLOGY AND ENVTL. SAFETY 253, 260 (1999).

effects of each element alone.[125] Once inside an organism, metallic elements exist in a specific form and ratio to other elements and will interact directly or indirectly based on a multitude of parameters.[126] For example, survival from egg to hatch of catfish (*Ictalurus* spp.) treated with a 1:1 ratio of Cu:Zn declined predictably under an additive model up to a concentration of ~1 ppm. With increasing concentrations, mortality rates increased synergistically at higher than predicted rates.[127] However, relatively few studies of synergistic effects exist, and the scientific understanding of such effects is still developing.

Bristol Bay salmon populations are comprised of several hundred genetically and phenotypically discrete stocks displaying different life history characteristics and local adaptations.[128] This biodiversity allows the aggregate populations to sustain their productivity, despite major changes in climatic conditions affecting the freshwater and marine environments during the last century.[129] The stability and sustainability of Bristol Bay sockeye salmon have been greatly influenced by different populations performing well at different times.[130] If managers in earlier times had decided to focus management on the most productive runs at the time, the biocomplexity that later proved important could have been lost.[131] This biocomplexity is important on small scales as well, as lakes and tributaries show asynchronous shifts in density and productivity.[132]

Long-term sustainability is derived in large part from complementary patterns of productivity in different stock components.[133] Defining the entire stock as healthy, simply because a large component is doing well, might lead to decline and extinction if the conditions that fostered success of the healthy component disappear, and the alternate strategy, which

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125. J.B. Sprague & B.A. Ramsay, *Lethal Levels of Mixed Copper-Zinc Solutions for Juvenile Salmon*, 22 J. OF THE FISHERIES RES. BD. OF CAN. 425 (1965); SORENSEN, *supra* note 105, 335–39; EISLER, *supra* note 104, at 104.

126. H.H. SANDSTEAD, EFFECTS AND DOSE-RESPONSE RELATIONSHIPS OF TOXIC METALS 511 (1976); SORENSEN, *supra* note 105, at 335.

127. Wesley J. Birge & Jeffrey A. Black, *Effects of Copper on Embryonic and Juvenile Stages of Aquatic Animals*, *in* COPPER IN THE ENVIRONMENT: HEALTH EFFECTS PART II 373, 386–88 (Jerome O. Nriagu ed., 1979).

128. Ray Hilborn et al., *Biocomplexity and Fisheries Sustainability*, 100 PROC. OF THE NAT'L ACAD. OF SCI. 6564 (2003), *available at* http://www.pnas.org/cgi/reprint/100/11/6564?ck=nck.

129. *Id.*

130. *Id.* at 6567.

131. *Id.*

132. *Id.* at 6568.

133. *Id.*

would have done well in the new environmental conditions, has been lost.[134] Conservation of a diverse "salmon stock portfolio," much like a diverse retirement portfolio, increases the likelihood of long-term sustained salmon returns into the future.

Thus, the following factors should be considered in devising state statutory standards: (1) scientific findings demonstrate toxic affects on fish below established limits for copper, (2) multiple parameters affect toxicity of copper alone and in synergistic combination with other metals, and (3) the understanding of synergistic effects is developing.

IV. STATE STATUTORY STANDARDS ARE INADEQUATE TO PROTECT FISH FROM THE PEBBLE MINE

The Alaska Department of Natural Resources (DNR) asserts that its "large mine permitting process," which depends substantially on the preparation of federal environmental impact statements ("EIS") under the National Environmental Policy Act ("NEPA"),[135] will adequately protect fish, wildlife, and public uses of fish and game from potential adverse effects of the Pebble Mine.[136]

134. *Id.*

135. 42 U.S.C. § 4321 (2000).

136. *See* OFFICE OF PROJECT MANAGEMENT AND PERMITTING, ALASKA DEP'T. OF NAT. RES., PERMITTING LARGE MINE PROJECTS IN ALASKA 5 (2006), *available at* http://www.dnr.state.ak.us/mlw/mining/largemine/lmpt_process.pdf; Press Release, Alaska Dep't of Nat. Res., Commissioner Irwin Voices Supports For Resource Development in Alaska (July 3, 2007), *available at* http://www.dnr.state.ak.us/standard/dsp_media_release.cfm?id=885&title=Commissioner%20Irwin%20Voices%20Supports%20for%20Resource%20Development%20in%20Alaska.

In 2006, a groundbreaking study[137] systematically compared predicted and actual water quality at hardrock mines operating in the United States, including in Alaska.[138] The study compared pre-mining water quality data presented in federal EISs[139] to operational and post-operational water quality data in order to assess the reliability of predictions relied upon by agency personnel making permitting decisions.[140] Four of the study's conclusions are particularly useful for assessing the adequacy of current state statutory standards. They are:

1. Actual water quality impacts are closer to potential (pre-mitigation) impacts rather than the predicted (post-mitigation) impacts stated in the EISs. The threshold inquiry for determining the environmental significance (or effect) of agency permitting decisions, e.g., for purposes of determining whether permitting the mine would "significantly affect the quality of the human environment,"[141] should be a mine's *potential* rather than *predicted* impacts.[142]

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137. JAMES R. KUIPERS ET AL., COMPARISON OF PREDICTED AND ACTUAL WATER QUALITY AT HARDROCK MINES: THE RELIABILITY OF PREDICTIONS IN ENVIRONMENTAL IMPACT STATEMENTS (2006), *available at* http://www.earthworksaction.org/pubs/ComparisonsReportFinal.pdf. For mines with potential for acid drainage or metals leaching, the study found that eighty-five percent polluted surface water and ninety-three percent polluted groundwater. *Id.* at ES-11,12. At the time of permitting, eighty-nine percent of the environmental review documents for those mines underestimated the potential of the mines to pollute. *See id.* at ES-09. Nearly all of the environmental impact statements examined by the report predicted that the mines would be able to comply with water quality standards. *Id.* at ES-8. In actuality: seventy-six percent of the mines polluted ground or surface water in excess of water quality standards, *id.* at Table ES-7b; sixty percent of mines polluted surface water severely enough to exceed water quality standards, *id.* at Table ES-5; fifty-two percent of mines polluted ground water severely enough to exceed water quality standards, *id.* at Table ES-6; seventy-three percent of mines exceeded surface water quality standards despite predicting that mitigation would result in compliance, *id.* at Table ES-5; seventy-seven percent of mines that exceeded groundwater quality incorrectly predicted that mitigation to correct problems would result in compliance, *id.* at Table ES-6. Mitigation measures failed sixty-four percent of the time. *Id.* at 192. Of the mines analyzed that polluted ground and surface water, sixty-three percent released toxic metals such as lead, mercury, cadmium, copper, nickel, or zinc. More than half of the mines released arsenic, sulfates, and cyanide. *Id.* at ES-9.

138. *Id.* at i, ES-3.

139. The National Environmental Policy Act requires a detailed EIS on "major Federal actions significantly affect[ing] the quality of the human environment." 42 U.S.C. § 4332(C) (2000).

140. KUIPERS ET AL., *supra* note 137, at ES-1.

141. 42 U.S.C. § 4332(C).

142. KUIPERS ET AL, *supra* note 137, at ES-15.

2. State and federal agencies should require a minimum and relatively consistent set of geochemical tests, for example to determine sulfide and metals content at the Pebble deposit.[143]
3. Mines with close proximity to water sources—as Pebble Mine would be—or with moderate to high acid drainage potential—as the Pebble deposit is—should undergo more scrutiny by agencies in the permitting process than mines with low inherent potential for impacting water quality.[144]
4. Failure to accurately characterize hydrological conditions can be addressed by requiring adequate characterization and conservative assumptions about water quality and quantity.[145]

Most Alaska statutes that apply to the permitting, operation, and closure of mines, and the use of lands and waters for mining-related activities, are administered by DNR. The remainder of this section summarizes the State's statutory framework and addresses whether the statutory standards[146] are adequate to protect fish, wildlife, their habitats, and the uses of fish and game from the potential impacts associated with the Pebble Mine.

Pursuant to section 27.05.010 of the Alaska Statutes, DNR is "the lead agency for all matters relating to the exploration, development, and management of mining, and, in its capacity as lead agency, shall coordinate all regulatory matters concerning mineral resource exploration, development, mining, and associated activities."[147] The statute requires all other state agencies to consult with DNR before "tak[ing] action that may directly or indirectly affect the exploration, development, or management of mineral resources."[148] Thus, section 27.05.010 provides only a standard

143. *Id.*; *see*, JAMES R. KUIPERS ET AL., PREDICTING WATER QUALITY AT HARDROCK MINES: METHODS AND MODELS, UNCERTAINTIES, AND STATE-OF-THE-ART (2006) [hereinafter KUIPERS ET AL., METHODS AND MODELS], *available at* http://www.earthworksaction.org/pubs/PredictionsReportFinal.pdf.
144. KUIPERS ET AL, *supra* note 137, at ES-15.
145. *Id.*
146. Although most state statutes relevant to mining are administered by DNR, the United States Environmental Protection Agency administers the issuance of permits under the National Pollutant Discharge Elimination System ("NPDES") because Alaska is not authorized to implement the NPDES program under section 402(b) of the Clean Water Act. 33 U.S.C. § 1342(b) (2000). *See* U.S. Environmental Protection Agency, National Pollutant Discharge Elimination System, State Program Status, http://cfpub.epa.gov/npdes/statestats.cfm (last visited Mar. 30, 2008).
147. ALASKA STAT. § 27.05.010(b) (2006).
148. *Id.*

that other agencies must consult with DNR before taking actions that "directly or indirectly affect" mining, and the statute contains no standard for DNR's role as the "lead agency" that "coordinate[s] all regulatory matters" concerning mining.

The general standard that governs DNR's management of state lands is found in section 38.04.005 of the Alaska Statutes. The statute requires DNR to "provide for maximum use of state land consistent with the public interest."[149] Without identifying any of the values to be considered in determining the public interest, the statute allows DNR wide discretion and does not specifically address fish, wildlife, or uses of them. The statute stands in stark contrast to section 16.05.020 of the Alaska Statutes, which imposes on the Alaska Department of Fish and Game (ADF&G) a duty to "manage, protect, maintain, improve, and extend the fish, game and aquatic plant resources of the state in the interest of the economy and general well-being of the state."[150]

Section 38.05.035 of the Alaska Statutes spells out powers and duties of DNR with respect to managing state lands, including its power to "approve contracts for the sale, lease, or other disposal" of state land, resources, property, or interests in them.[151] In approving these contracts, DNR must issue "a written finding that the interests of the state will be best served."[152] The statute provides eight exceptions to the requirement for a best interest finding.[153] These exceptions include: revocable permits or authorizations; mining claims;[154] mining leases;[155] leases for surface use of land or water necessary for mining operations, such as for mill sites, tailings disposal, and other mine-related facilities;[156] and permits, rights-of-way, or easements for roads, ditches, pipelines, electric transmission lines,

149. ALASKA STAT. § 38.04.005(a) (2006).
150. ALASKA STAT. § 16.05.020 (2006).
151. ALASKA STAT. § 38.05.035(e) (2006).
152. *Id.*
153. *See* ALASKA STAT. § 38.05.035(e)(6)(A)–(H).
154. *See* ALASKA STAT. § 38.05.035(e)(6)(D) (exempting approval of mineral claims under section 38.05.195 of the Alaska Statutes from the requirement in section 38.05.035(e) of the Alaska Statutes of "a written finding that the interests of the state will be best served").
155. *See* ALASKA STAT. § 38.05.035(e)(6)(E) (exempting approval of mineral leases under section 38.05.205 of the Alaska Statutes from the requirement in section 38.05.035(e) of the Alaska statutes of "a written finding that the interests of the state will be best served").
156. *See* ALASKA STAT. § 38.05.035(e)(6)(G) (exempting approval of surface uses under section 38.05.255 of the Alaska Statutes from the requirement in section 38.05.035(e) of the Alaska Statutes of "a written finding that the interests of the state will be best served").

and similar uses or improvements.[157] Thus, this "best interest" standard contains many exceptions for mining; it is also vague, does not address fish, game, habitat, or uses of them, and is open to wide discretion.

Section 38.05.255 of the Alaska Statutes, in turn, governs surface use of state lands and water by mining operations. It states that "surface uses of land or water included within a mining property by the owners, lessees, or operators shall be limited to those *necessary* for the prospecting for, extraction of, or basic processing of minerals and shall be *subject to reasonable concurrent uses*."[158] Without defining what constitutes a "necessary" use of land and water, this provision appears to give DNR wide latitude to approve use of as much land and water as it deems necessary, subject to "reasonable concurrent uses."[159]

By failing to provide an adequate definition of what would be deemed "necessary" for prospecting, extraction, and processing, the statute gives wide latitude to the agency to defer to the mining company. DNR would have difficulty deciding whether, for example, housing and sewage treatment for two thousand workers are a "necessary" use of state land when alternatives may exist on private land that would not infringe on concurrent uses. The introduction of two thousand workers into an area sparsely populated by residents in small villages could have substantial impacts on local subsistence activities far beyond the land addressed by section 38.05.255(a) of the Alaska Statutes. Also, this statute fails to provide guidance to DNR as to whether it should take cost into account in deciding whether use of state land is necessary. DNR would have no basis to decide whether it could require the mine to house its workers or provide sewerage facilities on private land, which may be significantly more expensive. This type of permitting decision could have serious regional impacts on fish, game, and uses dependent on these resources. Even the requirement that the land remain subject to "reasonable concurrent use" does not address off-site impacts that are potentially more significant.

Section 38.05.850 of the Alaska Statutes authorizes DNR to issue permits, rights-of-way, or easements on state land for uses or improvements such as roads, trails, ditches, pipelines, telephone or electric

157. *See* ALASKA STAT. § 38.05.035(e)(6)(H) (exempting approval of permits, rights-of-way, or easements for roads, ditches, pipelines, electric transmission and distribution lines, and similar uses or improvements under section 38.05.850 of the Alaska Statutes from the requirement in section 38.05.035(e) of the Alaska Statutes of "a written finding that the interests of the state will be best served").

158. ALASKA STAT. § 38.05.255(a) (emphasis added).

159. *Id.*

transmission and distribution lines, and production facilities for recovering minerals.[160] The statute requires DNR to "give preference to that use of the land that will be of greatest economic benefit to the state and the development of its resources."[161] The statute, however, does not spell out the factors that DNR should consider in making such a determination. The statute also fails to identify the intended beneficiary of the economic benefit, or in other words, whether the term "the state" refers to the state treasury, the general economy, or the citizens of Alaska.

Section 46.15.080 of the Alaska Statutes governs applications to appropriate state owned waters. Approval of an application to appropriate water must be "in the public interest."[162] In determining the public interest, section 46.15.080 requires DNR to "consider" eight criteria: (1) benefit to the applicant resulting from the proposed appropriation, (2) effect of the economic activity resulting from the proposed appropriation, (3) effect on fish and game resources and on public recreational opportunities, (4) effect on public health, (5) effect of loss of alternate uses of water that might be made within a reasonable time if not precluded or hindered by the proposed appropriation, (6) harm to other persons resulting from the proposed appropriation, (7) intent and ability of the applicant to complete the appropriation, and (8) effect upon access to navigable or public water.[163]

The requirement that DNR "consider" these eight factors is far short of a substantive standard requiring DNR to protect fish and game, and avoid, minimize, or mitigate harms and risks to fish, wildlife, and public uses of them. Also, "considering" the effects on fish is far short of a statutory standard that articulates a standard for deciding whether a certain level of harm to fish is acceptable.

Section 46.17.010 *et seq.* of the Alaska Statutes applies to permits authorizing construction of dams, such as for tailings impoundments. Dams must be designed, constructed, operated, and maintained "consistent with the protection of life and property."[164] This standard ignores fish, game, habitat, and uses of these resources. It leaves such

160. ALASKA STAT. § 38.05.850(a) (2006).
161. *Id.*
162. ALASKA STAT. § 46.15.080 (a)(4) (2006).
163. ALASKA STAT. § 46.15.080(b)(1)–(8) (2006).
164. ALASKA STAT. § 46.17.010 (2006).

matters to other statutes such as the Fishway Act[165] and the Anadromous Fish Act,[166] both discussed below.

The Alaska Coastal Management Program ("ACMP")[167] applies to state agency decisions on a proposed project located in the coastal zone, as identified by state or district coastal management plans. Section 46.40.096 of the Alaska Statutes provides that agency decisions must be reviewed for "consistency" with statewide coastal zone standards adopted under section 46.40.040 of the Alaska Statutes and the enforceable policies in an applicable district coastal management plan. In 2003, then Governor Frank Murkowski issued Executive Order 106, which transferred the ACMP from the Office of the Governor to DNR.[168] Under DNR's administration of the ACMP, the districts amended their district coastal management plans to eliminate many prior district policies that sought to balance conservation and development.[169]

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165. Currently codified as ALASKA STAT. §§ 41.14.840–.860 (2006). On February 13, 2008, Alaska Governor Sara Palin issued Executive Order 114, which effectively reversed an earlier Executive Order, changing the statutory language and restoring the administration of the Fishway Act and the Anadromous Fish Act to ADF&G. Alaska Exec. Order No. 114 (Feb. 13, 2008); *see infra* note 168 and accompanying text. The legislature, pursuant to the Alaska constitution, has sixty days to disapprove the executive order. *See* ALASKA CONST. art. 3, § 23. If the legislature does not disapprove Executive Order 114, then, effective July 1, 2008, the statute will be codified pursuant to the Executive Order as ALASKA STAT. §§ 16.05.841–.861.

166. Currently codified as ALASKA STAT. §§ 41.14.870–.900 (2006). *See supra* note 165 for description of pending change in codification and statutory language. Effective July 1, 2008, the Anadromous Fish Act may be codified as ALASKA STAT. §§ 16.05.871–.901.

167. ALASKA STAT. §§ 46.40.010–.100 (2006).

168. ALASKA STAT. §§ 46.39.010–.040 (2006); *see also* Exec. Order No. 106 (Feb. 13, 2003), *available at* http://www.legis.state.ak.us/PDF/23/EO/exor0106.pdf.

169. For example, the polices of Lake and Peninsula Borough Coastal Management Plan ("LPB-CMP") in 1996 provided:

> C-12 Mining and Mineral Processing Waste Disposal
> Mining and mineral processing activities which dispose of potentially toxic tailings or discharge processing effluents which may contain toxic materials shall ensure that:
> 1) effluents are treated to remove materials toxic to human health, fish, or wildlife prior to discharge;
> 2) tailings are treated, stored and disposed in a manner which avoids any possibility of toxic runoff to surface waters or infiltration of toxic waters into the groundwater aquifer; and
> 3) if conditions 1) and 2) cannot be achieved and satisfactorily demonstrated, all potentially toxic tailings and process waters shall be contained in a zero-discharge disposal facility or impoundment.

Section 27.19.020 of the Alaska Statutes governs reclamation of mining sites. It states that "[a] mining operation shall be conducted in a manner that prevents *unnecessary and undue degradation* of land and water resources, and the mining operation shall be reclaimed *as contemporaneously as practicable* with the mining operation to leave the site in a *stable condition*."[170] "Unnecessary and undue degradation" is defined in section 27.19.100(9) of the Alaska Statutes as "surface disturbance greater than would normally result when an activity is being accomplished by a prudent operator in usual, customary, and proficient operations of similar character and considering site specific conditions" and "includes the failure to initiate and complete reasonable reclamation."[171] This standard does not address fish and wildlife or public use of public land and is almost impossible to enforce because the terms "prudent operator," "usual, customary, and proficient," "similar," "considering site specific conditions," "failure to initiate," and "reasonable" are all open to wide interpretation and dispute.

Section 27.19.100(7) of the Alaska Statutes defines "stable condition" as "the rehabilitation, where feasible, of the physical environment of the site to a condition that allows for the reestablishment of renewable resources on the site within a reasonable period of time by natural processes."[172] Thus, reclamation to a "stable condition" is unenforceable in that it is qualified by "where feasible," which is an amorphous standard. It also does not address rehabilitation of the area to a condition approximating that which existed before the mining activity because the statute does not specifically define what constitutes "reestablishment of renewable resources." Thus, the statute allows the establishment of any renewable resources, as opposed to resources that were present before the mining activity. Similarly, reclamation "as contemporaneously as practicable" is

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LAKE AND PENINSULA BOROUGH COASTAL MANAGEMENT PLAN, ENFORCEABLE AND ADMINISTRATIVE POLICIES 16 (1996), *available at* http://www.alaskacoast.state.ak.us/Explore/EPSpdf/LakePen.pdf.

Then, under DNR's administration of the ACMP, the current Lake and Peninsula Borough Coastal Management Plan *deleted* the above policy that bears upon Pebble Mine. *See* LPB-CMP, Enforceable Policies (approved by DNR Oct. 29, 2007; federal approval pending as of Feb. 16, 2008). *See* ALASKA DEP'T OF NATURAL RES., FINAL COASTAL DISTRICT PLAN APPROVALS (2008), *available at* http://www.alaskacoast.state.ak.us/District/html/ProgressApproval.htm (last visited Mar. 30, 2008), http://alaskacoast.state.ak.us/District/FinalFinalPlans/LakePen/LPB%20policies.pdf (last visited Mar. 30, 2008).

170. ALASKA STAT. § 27.19.020 (2006) (emphases added).

171. ALASKA STAT. § 27.19.100(9) (2006).

172. ALASKA STAT. § 27.19.100(7).

open to differing interpretation and addresses the timing of restoration rather than fish or wildlife.

In addition to statutes implemented by DNR, ADF&G has some permitting authority over activities related to the proposed Pebble Mine.[173] This is because the mine and its associated facilities may trigger the Fishway Act[174] and the Anadromous Fish Act.[175]

The Fishway Act requires permits for activities that could obstruct fish passage, such as dams and culverts, in order to assure fish passage "if the commissioner considers it necessary."[176] ADF&G has discretion in determining what is "necessary," but the issue quickly gets complicated by technical matters, such as the proper design and placement of culverts to allow fish passage.[177]

The Anadromous Fish Act requires permits to assure "proper protection" for activities that use or pollute waters "specified" by the commissioner as "important" for anadromous fish such as salmon.[178] The "proper protection" standard and the discretion to determine which streams are "important" are vague, subjective, open to discretion, and lack statutory definition. Many anadromous waters remain to be identified. The state currently lists approximately 16,000 streams, rivers, and lakes in Alaska which have been specified as important for the spawning, rearing, and migration of anadromous fish.[179] Based upon thorough surveys of a few drainages, it is believed that this number represents less than fifty percent of the streams, rivers, and lakes actually used by anadromous

173. On February 13, 2008, Alaska Governor Sara Palin issued Executive Order 114, which effectively reversed former Governor Murkowski's Executive Order 107, and restored the administration of the Fishway Act and the Anadromous Fish Act to ADF&G. *See supra* notes 165, 166 and accompanying text.

174. Currently codified as ALASKA STAT. §§ 41.14.840–.860 (2006). *See supra* note 165 for description of pending change in codification and statutory language.

175. Currently codified as ALASKA STAT. §§ 41.14.870–.900 (2006). *See supra* notes 165, 166 for description of pending change in codification and staturory language.

176. ALASKA STAT. § 16.05.841 (2006) (codified as amended by Executive Order 114); *see* Alaska Exec. Order No. 114 (Feb. 13, 2008). *See supra* note 165 for description of pending change in codificiation and statutory language.

177. *See, e.g.*, Alaska Dep't of Fish & Game, Fish Passage Improvement Program, Fish Passage Inventory Projects, abstracts, http://www.sf.adfg.state.ak.us/SARR/Fishpassage/FP_inventory.cfm (last visited Mar. 30, 2008).

178. ALASKA STAT. § 16.05.871 (2006) (codified as amended by Executive Order 114); *see* Alaska Exec. Order No. 114 (Feb. 13, 2008). *See supra* note 166 for description of pending change in codificiation and statutory language.

179. Alaska Dep't of Fish & Game, Fish Distribution Database, http://www.sf.adfg.state.ak.us/SARR/FishDistrib/FDD_intro.cfm (last visited Mar. 30, 2008).

fish.[180] At least another 20,000 anadromous water bodies have not been identified or specified under the Act.[181]

Several conclusions seem inescapable. First, none of the statutes that are administered by DNR and that apply to permitting facilities related to Pebble Mine articulate clear standards for protecting fish and game, habitats, and public uses of them. Only the Water Use Act at section 46.15.080 of the Alaska Statutes mentions fish, game, and recreation (but not commercial or subsistence use).[182] The Act only requires DNR to "consider" fish, game, and recreation, rather than to protect them.[183] Furthermore, all of the applicable statutes, even the Fishway and Anadromous Fish Acts, administered by ADF&G, are subject to broad discretion.

Second, no statute requires DNR to approve the mine's plan of operation. Instead, the state process consists of a series of unrelated permits, most of which derive from statutes not tailored specifically to mining.

Third, none of the statutes specifically address modern, large scale mining, such as the Pebble Mine, that exploits massive, low-grade, ore deposits. Some of the statutes were enacted before the risks of contemporary mining of massive, low-grade, metallic sulfide ores posed to ecosystems were widely recognized.[184]

Fourth, although section 27.05.010 of the Alaska Statutes requires DNR to "coordinate" matters related to mining, no statute actually *creates* DNR's so-called "large mine permitting process." Instead, DNR's "large mine permitting process" is a *personnel action*, i.e., the selection of a staff person as a "project manager" who coordinates permit applications, agency reviews, and authorizations for large mines under pre-existing discretionary authority and vague statutes.[185]

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180. *Id.*

181. *Id.*

182. ALASKA STAT. § 46.15.080 (2006).

183. *See id.*

184. The statute that gave DNR authority over all mining activities was enacted in 1949, before Alaska was a state. *See* ALASKA STAT. § 27.05.010 (2006).

185. *See* OFFICE OF PROJECT MANAGEMENT AND PERMITTING, ALASKA DEP'T OF NATURAL RESOURCES, PERMITTING LARGE MINE PROJECTS IN ALASKA (2006), *available at* http://www.dnr.state.ak.us/mlw/mining/largemine/lmpt_process.pdf. A mining company proposing a large mine can opt to engage the process by entering into a "memorandum of agreement" with DNR, whereby the company reimburses DNR for personnel time and costs related to the permits. *Id.* at 6. This creates a potential conflict between DNR's duties to perform objective analysis and DNR's reliance on the industry to pay DNR staff to perform that analysis.

Other states have addressed the problems that arise from mining massive, low-grade deposits. Michigan and New Mexico, for example, require mines to show at the time they receive permits to operate that they will not require "perpetual care" after they close.[186] Wisconsin has imposed a moratorium on permits to mine metallic sulfides until the industry can show that a single mine in North America has operated for ten years without creating acid mine drainage and that a single mine has been closed for ten years without creating acid mine drainage.[187] To date, the industry does not appear to have been able to meet these statutory standards.[188]

V. PROPOSED LEGISLATION AIMS TO IMPROVE STATUTORY STANDARDS, BUT FURTHER TIGHTENING IS NEEDED

In response to the controversy surrounding Pebble Mine, two state legislators introduced legislation to create more stringent standards for permitting mines such as the Pebble Mine.

A. Proposed Legislation Would Establish a State Fish and Game Refuge in the Kvichak and Nushagak Drainages.

1. *Proposed Legislation.* Senator Gary Stevens (R-Kodiak), whose district includes the Kvichak drainage, introduced Senate Bill 67, which aims to permanently protect fish, wildlife, habitat, and public uses of these resources on state lands in the Kvichak and Nushagak drainages. Senate Bill 67 would designate about seven million acres of state lands and waters in these drainages as a fish and game refuge named after former governor Jay Hammond.[189]

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186. *See* MICH. COMP. LAWS § 324.63209 (2006); N.M. STAT. § 69-36-12 (2007). These standards are an effort to avoid perpetual care because once a mine requires perpetual care, the taxpayers usually end up having to cover the costs.

187. WIS. STAT. § 293.50 (2006).

188. Telephone Interview with Philip Fauble, State Mining Coordinator, Wis. Dep't of Natural Res., in Madison, Wis. (Mar. 18, 2008).

189. S.B. 67, 2007 Leg., 25th Sess. (Alaska 2007), *available at* http://www.legis.state.ak.us/PDF/25/Bills/SB0067A.pdf. As introduced, Senate Bill 67 would be codified at section 16.20.045 of the Alaska Statutes by adding a new section to the Alaska Code. The refuge still may be revised to exclude land within the Nushagak drainage, which is concomitantly south of Wood-Tikchik Park and west of the Lake and Peninsula Borough, so as to allow potential land selections of a possible future borough in the Dillingham/Nushagak area from the excluded area. Section 29.65.030 of the Alaska Statutes entitles municipal governments to select ten percent of "vacant, unappropriated, unreserved land"

The central provisions of Senate Bill 67, as in any refuge legislation, are the purposes for which the refuge is established and the "compatibility test," which is a standard that allows uses of resources not within refuge purposes to proceed if compatible with refuge purposes.[190] Accordingly, Senate Bill 67 provides:

> (b) The Jay Hammond State Game Refuge is established to protect the
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> 1. fish and wildlife habitat and populations, including the salmon and trout spawning and rearing habitat, and critical caribou, moose, and brown bear habitat;
> 2. public use of fish and wildlife and their habitat, particularly subsistence, commercial, and recreational fishing, hunting, trapping, viewing, and general public recreation in a high quality environment; and
> 3. use and disposition of other resources when the activities are not incompatible with (1) and (2) of this subsection.[191]

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within its boundary. Senate Bill 67 excludes Wood-Tikchik State Park and should be revised to exclude any state and federal lands in the Nushagak and Kvichak drainages that already are designated as parks or refuges.

190. Other refuge statutes contain compatibility tests. *See* ALASKA STAT. § 16.20.033(b)(3) (2006) (applying to the Yakataga State Game Refuge); ALASKA STAT. § 16.20.036(c) (2006) (applying to the Susitna Flats State Game Refuge); ALASKA STAT. § 16.20.037(b)(3) (2006) (applying to the Minto Flats State Game Refuge); ALASKA STAT. § 16.20.038(c) (2006) (applying to the Trading Bay State Game Refuge): ALASKA STAT. § 16.20.041(b)(3) (2006) (applying to the McNeil River State Game Refuge). *See also* 16 U.S.C. § 668dd(d) (2000) (applying to all national wildlife refuges). The compatibility test seeks to simultaneously protect fish, game, habitat, and uses of them, while protecting other uses, such as valid existing mining claims, so long as they are compatible with protecting fish, wildlife, habitats, and public uses of them. *Id.*

191. S.B. 67, 2007 Leg., 25th Sess. (Alaska 2007). Because of commercially harvested salmon, the proposed Jay Hammond refuge would probably produce more economic benefits from fish and wildlife than any national wildlife refuge in the United States. As explained in text, direct expenditures/sales in the Alaskan regional economy resulting from commercial, recreational, subsistence, and nonconsumptive use of fish and wildlife in the Bristol Bay drainages were estimated at approximately $324 million in 2005. *See* DUFFIELD ET AL., *supra* note 28, at 15. Although not all of this value is attributable to the Kvichak and Nushagak drainages, the Kvichak drainage is historically the most productive of sockeye salmon and therefore the most economically productive and the Nushagak is historically the most productive for other salmon. *See id.* at 15–16. In contrast, the total direct expenditures/sales in the regional economies from consumptive and nonconsumptive use of fish and wildlife in all 548 national wildlife refuges in the United States was estimated at almost $1.7 billion in 2006. *See* ERIN CARVER & JAMES CAUDILL, DIV. OF ECONOMICS, U.S. FISH & WILDLIFE SERVICE, BANKING ON NATURE 2006: THE ECONOMIC BENEFITS TO LOCAL COMMUNITIES OF NATIONAL WILDLIFE REFUGE

In late 2007, the Pebble Partnership issued a series of statements about its ability to develop the Pebble Mine in a manner that protects fish and wildlife and the public uses of these resources:

> "If a mine cannot be designed that protects the water, fisheries, and wildlife resources of Bristol Bay, it will not be built."[192]

> "Pebble will be . . . engineered to protect all things Alaskans value. Or it won't be built at all."[193]

> "Fish come first. We simply won't develop Pebble if it harms commercial, subsistence or sport fishing in this remarkable region."[194]

> "We simply will not develop a mine that damages Alaska's fish and wildlife."[195]

> "We will not be associated with the development of a mine that damages Alaska's Bristol Bay fishery and wildlife, or those in the communities whose livelihoods depend on those resources. If the mine cannot be developed in a way that provides proper protections, we will not build it."[196]

> "If the mine cannot be planned in a way that provides proper protections, it should not be built."[197]

VISITATION, ES-ii (2007), *available at* http://www.fws.gov/refuges/policyMakers/BankingOnNature.html.

192. The Pebble Partnership, Setting Each Piece in Place (quoting Cynthia Carroll, CEO, Anglo American). http://www.pebblepartnership.com/files/5%20Principles%20Mosaic.pdf.

193. The Pebble Partnership, Not Your Grandfather's Copper Mine, http://www.pebblepartnership.com/files/Pebble%204%20Science.pdf (last visited Mar. 30, 2008).

194. The Pebble Partnership, Fish Come First, http://www.pebblepartnership.com/files/Pebble%203%20Fish.pdf (last visited Mar. 30, 2008).

195. *Id.* (quoting Cynthia Carroll, CEO, Anglo American).

196. Cynthia Carroll, Editorial, *Pebble Partnership Promises Responsible Development*, ANCHORAGE DAILY NEWS, Dec. 1, 2007, *available at* http://dwb.adn.com/opinion/compass/story/9490777p-9401615c.html.

197. Speech by Cynthia Carroll, CEO, Anglo American plc, to Resource Development Council, in Anchorage, Alaska (Oct. 23, 2007), http://www.pebblepartnership.com/related_media/speech.pdf.

Although none of these statements addressed specific legislation, one could conclude from these statements that the Pebble Partnership may not oppose the refuge purposes and compatibility test of Senate Bill 67.

Senate Bill 67 would also close the refuge to new mining claims[198] and prohibit storage or disposal of industrial waste in the refuge.[199] Subject to the refuge purposes, closure to new mining claims, and prohibition of disposal of industrial waste, ADF&G and DNR would exercise their respective authorities over the refuge consistent with a management plan prepared by ADF&G in consultation with DNR.[200] A citizens' advisory committee, composed of representatives of subsistence users, state, municipal and tribal entities, tourism and recreation, mining and industry, and sport and commercial fishing, would assist ADF&G and DNR regarding management of the refuge.[201] Furthermore, refuge management plans are usually adopted into regulation.[202] Doing so provides an opportunity for pubic notice and comment under the Alaska Administrative Procedure Act.[203] Finally, ADF&G's overall policy statute, which requires ADF&G to "manage, protect, maintain, improve, and extend the fish, game and aquatic plant resources of the state in the interest of the economy and general well-being of the state," would apply.[204]

2. *The Legislature May Wish to Consider Several Revisions to the Refuge Bill.* First, because the Bristol Bay drainages are so valuable for fish and

198. Senate Bill 67 could be clarified to provide that the closure to new mining claims (mineral entry) is subject to valid existing rights, so as to accommodate concerns that the legislation would not otherwise protect valid existing rights. *See* S.B. 67, 2007 Leg., 25th Sess. (Alaska 2007).

199. Industrial waste is defined as:

> [A] liquid, gaseous, solid, or other waste substance or a combination of them resulting from process of industry, manufacturing trade or business, or from the development of natural resources; however, gravel, sand, mud, or earth taken from its original situs and put through sluice boxes, dredges, or other devices for the washing and recovery of the precious metal contained in them and redeposited in the same watershed from which it came is not industrial waste.

ALASKA STAT. § 46.03.900 (2006).

200. *See* S.B. 67, 2007 Leg., 25th Sess. (Alaska 2007). For example, DNR would continue to exercise authority to lease for oil and gas and permit dams for Pebble Mine and rights of way as long as such activities were compatible with refuge purposes.

201. *Id.*

202. ALASKA ADMIN. CODE tit. 5, §§ 95.500–.545 (2007).

203. ALASKA STAT. §§ 44.62.190–.290 (2006).

204. ALASKA STAT. § 16.05.020 (2006).

game production, the legislature should consider a "no perpetual care" standard to be used at the time of permitting a metallic sulfide mine. This could be similar to "no perpetual care" standards in Michigan and New Mexico mining statutes.[205] Such an amendment might read:

> *A mine for sulfide minerals or ores in the refuge shall be permitted only if the mining area and affected area, including all facilities, shall be reclaimed and remediated to achieve a naturally self-sustaining ecosystem appropriate for the area that does not require long-term or perpetual care, including treatment, and the areas shall be returned as expeditiously as possible to the ecological conditions that approximate pre-mining conditions.*

Imposing such a standard at the time of permitting would not foreclose requiring perpetual care after closure of the mine. The legislature also could require that any waste rock piles and tailings facilities be isolated hydrologically from surface and groundwater. As noted above, such hydrological isolation may be difficult due to the fracturing of rock that occurs in block caving.[206]

Second, with respect to mining metallic sulfides in the refuge, the legislature should consider adopting the "precautionary approach" of the Alaska Board of Fisheries. Such an approach is already used in its Policy for the Management of Sustainable Salmon Fisheries.[207] The precautionary

205. *See* MICH. COMP. LAWS § 324.63209 (2006); N.M STAT. § 69-36-12 (2007).
206. *See supra* note 80.
207. ALASKA ADMIN. CODE tit. 5, § 39.222 (2007). The Policy for the Management of Sustainable Salmon Fisheries adopts the precautionary approach, at ALASKA ADMIN. CODE tit. 5, § 39.222(c)(5) (2007), which provides:

> (5) in the face of uncertainty, salmon stocks, fisheries, artificial propagation, and essential habitats shall be managed conservatively as follows:
>
> (A) a precautionary approach, involving the application of prudent foresight that takes into account the uncertainties in salmon fisheries and habitat management, the biological, social, cultural, and economic risks, and the need to take action with incomplete knowledge, should be applied to the regulation and control of harvest and other human-induced sources of salmon mortality; a precautionary approach requires
>
> (i) consideration of the needs of future generations and avoidance of potentially irreversible changes;
> (ii) prior identification of undesirable outcomes and of measures that will avoid undesirable outcomes or correct them promptly;
> (iii) initiation of any necessary corrective measure without delay and prompt achievement of the measure's purpose, on a time scale

approach requires an agency to be cautious—in effect to err on the side of conservation—when information is inadequate or still developing, as in the case of synergistic effects of copper, and the absence of adequate information is not a reason to fail to take conservation measures.

Third, the legislature could clarify that the compatibility test refers to the refuge purposes and is not a part of the purposes themselves.[208] Doing so would avoid confusion between the purposes of the refuge—protecting fish, wildlife, habitat and public uses of these resources—and other potential uses, such as development of pre-existing mining claims, which would be permitted only if compatible with the purposes of the refuge. Thus, the proposed subsection 16.20.045(b) of the Alaska Statutes should be amended to be two subsections, (b) and (c), as follows:

> *(b) The Jay Hammond State Game and Wild Salmon Protection Area is established to protect the*
> *1. fish and wildlife habitat and populations, including the salmon and trout spawning and rearing habitat, and critical caribou, moose, and brown bear habitat; and*
> *2. public use of fish and wildlife and their habitat, particularly subsistence, commercial, and recreational fishing, hunting, trapping, viewing, and general public recreation in a high quality environment.*
>
> *(c) The use and disposition of other resources may be permitted when the activities are not incompatible with subsections (b)(1) and (b)(2).*

Fourth, the legislature could amend the proposed section 16.20.045(d) of the Alaska Statutes in order to focus statutory prohibitions or restrictions on the environmental issues posed by development of pre-existing mining

not exceeding five years, which is approximately the generation time of most salmon species;
(iv) that where the impact of resource use is uncertain, but likely presents a measurable risk to sustained yield, priority should be given to conserving the productive capacity of the resource;
(v) appropriate placement of the burden of proof, of adherence to the requirements of this subparagraph, on those plans or ongoing activities that pose a risk or hazard to salmon habitat or production;
(B) a precautionary approach should be applied to the regulation of activities that affect essential salmon habitat.

208. In most refuge statutes, the compatibility test is a separate subsection that refers to the refuge purposes. *See* ALASKA STAT. § 16.20.036(c) (2006) (applying to the Susitna Flats State Game Refuge); ALASKA STAT. § 16.20.038(c) (2006) (applying to the Trading Bay State Game Refuge); *see also* 16 U.S.C. § 668dd(d) (2000) (applying to all national wildlife refuges).

claims for metallic sulfide ore. By focusing in this manner, the refuge bill could address (1) sulfuric acid, acid mine drainage, toxic agents such as cyanide used in ore processing, and ammonia residues from explosives used in mining; (2) storage or disposal of industrial waste, waste rock, overburden, and tailings; and (3) withdrawal, appropriation, and diversion of surface or subsurface water. The following is suggested language that would prohibit acid mine drainage in the refuge:

> *No state agency shall issue a permit or authorization for activities that would have potential to create acid mine or acid rock drainage into surface or groundwater.*

Fifth, the legislature could implement the Kuipers-Maest procedural recommendations by requiring that permitting agencies (1) use *potential* impacts to water quality rather than *predicted* impacts to water quality when making permitting decisions,[209] (2) establish a minimum and relatively consistent set of geochemical tests to determine geochemistry and sulfide content of ore,[210] (3) impose stricter scrutiny of any potential metallic sulfide mine that is near water and has potential for acid drainage,[211] and (4) ensure hydrological conditions are adequately characterized based on conservative assumptions about water quality and quantity.[212]

Sixth, the legislature should provide longer opportunities for public comment on permits for metallic sulfide mining in the refuge. Except for the consistency findings under the Alaska Coastal Management Program and land disposals or leases under section 38.05.035(e) of the Alaska Statutes, the remainder of the state statutes implemented by DNR or ADF&G, and applicable to Pebble Mine, do not afford public notice and comment. Hence, DNR and ADF&G will depend on a federal EIS under NEPA[213] to provide notice and comment on state permits. This will occur by virtue of NEPA regulations, which require the EIS to be coordinated with state and local permits.[214] The result is that state and local permits will be adjudicated contemporaneously with federal permits. However, under NEPA regulations, the minimum comment period on a draft EIS is ninety days and on a final EIS only thirty days.[215] In the case of the Pebble Mine,

209. KUIPERS ET AL., *supra* note 137, at ES-15.
210. *Id.; see also* KUIPERS ET AL., METHODS AND MODELS, *supra* note 143.
211. KUIPERS ET AL., *supra* note 137, at ES-15.
212. *Id.*
213. 42 U.S.C. § 4321 (2000).
214. 40 C.F.R. § 1506.2 (2007).
215. 40 C.F.R. § 1506.10 (2007).

the EIS is likely to be so voluminous and complicated by issues of science, engineering, and law that it could defeat the ability of the public to comment effectively. The legislature would be wise to amend state law to give the public time to become educated about what is likely to be a very complex matter and to afford judicial review.[216] For example, the legislature could amend Senate Bill 67 to include the following:

> *Any permit, lease, compatibility determination, or authorization for facilities related to mining sulfide minerals or ores in the refuge shall be subject to a public notice and comment period of at least 180 days, after which the agency shall respond to comments in writing and with scientific or technical justification for the agency's position. Any person who participated in the public comment process may seek judicial review of the agency decision.*

Finally, the legislature should amend Senate Bill 67 to condition annual exploration permits, which generally are issued prior to applications that trigger the NEPA process, upon a duty to release and summarize environmental data as they are gathered by the Pebble Partnership. The partnership claims to have spent $55 million on environmental and socio-economic studies to assist it in developing a project plan to be submitted for governmental and public review.[217] However, no statute or regulation requires the Pebble Partnership to disclose these studies, the underlying data, protocols used to gather data, or assumptions made in designing the studies.[218] NEPA regulations provide that environmental information must

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216. The Alaska Administrative Procedure Act, *see* ALASKA STAT. § 44.62.330(a)(6) (2006), affords judicial appeal to review DNR's decisions under the Alaska Land Act, ALASKA STAT. § 38.05 *et seq.*, "where applicable." The Alaska Land Act, at § 38.05.035(l), provides for appeal to a superior court from a written finding by DNR that it is in the best interest of the state to sell, lease, or dispose of land under § 38.05.035(e)(6). However, § 38.05.035(e)(6)(A)–(H) lists eight exceptions to the requirement of a written best interest finding. These exceptions include approvals of: (1) revocable permits or authorizations; (2) mineral claims located under § 38.05.195; (3) mineral leases under § 38.05.205; (4) surface use leases (e.g., for mill sites, tailings disposal and other mine-related facilities) under § 38.05.255; and (5) permits, rights-of-way, or easements (e.g., for roads, ditches, pipelines, electric transmission lines) under § 38.05.850. Thus, a result of the exemptions in section 38.05.035(e)(6) is that many of DNR's decisions related to mining may not be subject to appeal to the courts under the Administrative Procedure Act because the decision will not depend on an approval based on a best interest finding.

217. The Pebble Partnership, Environment Overview, http://www.pebblepartnership.com/pages/environment/environment-overview.php (last visited Mar. 30, 2008).

218. For example, whenever NDM discloses the content of valuable metals in its ore (which presumably bolsters marketing the prospective mine to investors) but

be "high quality" and that "[a]ccurate scientific analysis, expert agency comments, and public scrutiny are essential."[219] Requiring disclosure to agencies and the public would help assure high quality information, improve public understanding of the issues, and facilitate more informed public scrutiny. The legislature also should require analysis of socio-economic impacts on public uses of natural resources—such as subsistence and recreational uses of fish and game—that occur substantially outside of conventionally quantifiable market transactions, such as commercial fishing.[220]

B. Proposed Legislation Would Regulate Use of State Waters in the Bristol Bay Drainages

1. *Proposed Legislation.* State Representative Bryce Edgmon (D-Dillingham), whose district includes the Nushagak drainage, introduced House Bill 134, which aims to provide additional protections for water used by salmon or for human consumption.[221] As introduced, House Bill 134 provided that, subject to exceptions for most current uses of water, a person may not "withdraw, obstruct, divert, inject, pollute, or pump" surface or ground water or "alter, destroy, displace, relocate, channel, dam, [or] convert to dry land" any water body in the Nushagak, Kvichak, Naknek, Egegik, and Ugashik river drainages—all of which flow to Bristol Bay.[222]

The House Special Committee on Fisheries revised the bill to focus on mining metallic sulfides. The committee substitute bill, CS House Bill 134, provided in part:

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does not disclose the sulfide content, then the public is put at a disadvantage for purposes of protecting public interests in fish. NDM, PEBBLE COPPER, *supra* note 1, at 4.

219. 40 C.F.R. § 1500.1 (2007).

220. *See* DUFFIELD ET AL., *supra* note 28, at 14 (providing an example of a natural resource economic study that quantifies socio-economic values for activities such as subsistence and recreation that occur substantially outside of market-transactions and the ordinary market economy).

221. H.B. 134, 2007 Leg., 25th Sess. (Alaska 2007), *available at* http://www.legis.state.ak.us/PDF/25/Bills/HB0134A.pdf. While Senate Bill 67 primarily seeks to protect fish, game, habitat, and public uses of these resources, and would be implemented by ADF&G and DNR, House Bill 134 would add a new section to the Alaska Code, section 16.10.015 of the Alaska Statutes, and would be implemented by the Alaska Department of Environmental Conservation (DEC).

222. *See* H.B. 134, 2007 Leg., 25th Sess. § 2 (Alaska 2007).

> Sec. 16.10.015. Protection of salmon streams within certain drainages affecting Bristol Bay. (a) Notwithstanding any other provision of law, a person may not withdraw, obstruct, divert, inject, pollute, or pump, either temporarily or permanently, any subsurface or surface water within the anadromous fish waters of the Bristol Bay watershed in connection with a sulfide mining operation.
> (b) Notwithstanding any other provision of law, a person may not alter, destroy, displace, relocate, channel, dam, convert to dry land, or otherwise adversely affect any portion of the anadromous fish waters of the Bristol Bay watershed in connection with a sulfide mining operation.
> (c) In addition to any other penalties, a person who violates (a) or (b) of this section, upon conviction, is punishable by a fine of not less than $100,000 a day or more than $1,000,000 a day. Each day on which a violation described in (a) or (b) of this section occurs constitutes a separate violation of (a) or (b) of this section.
> (d) In this section,
> (1) "anadromous fish waters of the Bristol Bay watershed" means the waters in the Bristol Bay watershed that are specified under [the Anadromous Fish Act] as being important for the spawning, rearing, or migration of anadromous fish;
> (2) "sulfide mining operation" means a mining operation for
> (A) antimony, arsenic, copper, iron, lead, mercury, molybdenum, nickel, palladium, platinum, silver, or zinc; or
> (B) gold associated with any of the minerals listed in (A) of this paragraph.[223]

This revision of House Bill 134 clarified that it applied solely to metallic sulfide mining operations and did not ensnare individuals engaged in relatively harmless activities. Nonetheless, to achieve its goal of protecting the Bristol Bay watershed, the legislature could further revise the legislation.

2. *Legislature Could Further Revise the Legislation.* First, the legislature should define "pollution" in a bill such as CS House Bill 134. It does not do so. Thus, to adjudicate any challenge brought in the absence of a definition,

223. Comm. Substitute for H.B. 134, 2007 Leg., 25th Sess. § 2 (Feb. 2008), *available at* http://www.legis.state.ak.us/PDF/25/Bills/HB0134B.pdf.

a court would be forced to rely on the definition of "pollution" found in section 46.03.900(20) of the Alaska Statutes. It reads as follows:

> "[P]ollution" means the contamination or altering of waters, land, or subsurface land of the state in a manner which creates a nuisance or makes waters, land, or subsurface land unclean, or noxious, or impure, or unfit so that they are actually or potentially harmful or detrimental or injurious to public health, safety, or welfare, to domestic, commercial, industrial, or recreational use, or to livestock, wild animals, bird, fish, or other aquatic life[.][224]

In defining "pollution," the bill should address issues such as acid mine drainage, toxic effects of copper at levels below state standards, synergistic effects, use of toxic agents such as cyanide, and ammonia residues, all of which may be toxic to salmon and other organisms. The bill should also address the storage or disposal of industrial waste, waste rock, overburden, and tailings, all of which can impair water quality.

Second, the legislature could rely on a *combination* of standards and restrictions or prohibitions in House Bill 134, as Senate Bill 67 does. House Bill 134 relies on prohibitions, instead of standards by which to measure a proposed activity. Relying solely on prohibitions to protect the Bristol Bay watershed from mine pollution requires the legislature to foresee *every* potential activity associated with the Pebble Mine that could harm fish populations. In contrast, Senate Bill 67 focuses first on standards—i.e., the purposes of the refuge and a compatibility test by which to evaluate *any* proposed action, foreseeable or not, that is not within refuge purposes—and then addresses prohibitions. Relying on a combination of standards and prohibitions or restrictions helps the legislature draft legislation capable of addressing unforeseeable issues.

Third, in the proposed section 16.10.015(a) of the Alaska Statutes, the legislature should clarify what it means by "any subsurface or surface water within the anadromous fish waters." The language is unclear whether it intends to protect any subsurface water from pollution and other activities related to metallic sulfide mining or only subsurface water that feeds anadromous surface water.

Fourth, instead of defining anadromous waters by reference to the Anadromous Fish Act, which dates to 1959, the legislature may wish to

224. ALASKA STAT. § 46.03.900(2) (2006).

model its definition on a more modern statute. For example, the Alaska Forest Practices Act provides:

> (1) "anadromous water body" means the portion of a fresh water body or estuarine area that
>
> (A) is cataloged under [the Anadromous Fish Act] as important for anadromous fish; or
>
> (B) is not cataloged under [the Anadromous Fish Act] as important for anadromous fish but has been determined [by ADF&G] to contain or exhibit evidence of anadromous fish in which event the anadromous portion of the stream or waterway extends up to the first point of physical blockage.[225]

The legislature could also amend House Bill 134 by incorporating the suggestions made above with respect to Senate Bill 67. The legislature could add to House Bill 134 the "no perpetual care" and "precautionary approach" standards to be used at permitting, add a more protective post-closure reclamation and restoration standard, improve public notice and opportunities for comment and public involvement, require the permitting agencies to respond to public comments, allow for judicial review, place conditions on exploration permits that require the mining company to release all scientific data when gathered, and otherwise improve regulation and permitting of metallic sulfide mines as suggested above.

Finally, the best approach to producing final legislation that protects the Bristol Bay drainages may be for the legislature to combine Senate Bill 67 and House Bill 134 and then select the most appropriate combination of standards, procedures, prohibitions and restrictions pertaining to metallic sulfide mining. Doing so would allow the legislature, the public, and the agencies to speak to both approaches and all matters at once.[226]

VI. THE PROPOSED LEGISLATION WOULD NOT CONSTITUTE A TAKING

The Takings Clause of the Fifth Amendment to the United States Constitution, made applicable to the states through the Fourteenth

225. ALASKA STAT. § 41.17.950(1) (2006).

226. No discussion of elevated standards is complete without recognizing that the importance of fish and game to Alaskans prompted Alaska's lawmakers to criminalize most violations of Title 16 of the Alaska Statutes. *See, e.g.*, ALASKA STAT. § 16.05.925(a) (2006). Nearly all violations of Title 38 (DNR statutes) are civil violations. ALASKA STAT. §§ 38.05.005–.95.300 (2006).

Amendment,[227] provides that private property shall not "be taken for public use, without just compensation."[228] The Takings Clause "does not prohibit the taking of private property, but instead places a condition on the exercise of that power."[229] In other words, it "is designed not to limit the governmental interference with property rights *per se*, but rather to secure *compensation* in the event of otherwise proper interference amounting to a taking."[230] Similarly, Article I, section 18 of the Alaska Constitution provides: "[p]rivate property shall not be taken or damaged for public use without just compensation."[231]

Proponents of Pebble Mine have asserted that, if House Bill 134 becomes law and stops the Pebble Mine project, it will constitute a taking of NDM's mining claims and require the State to compensate NDM.[232] The Legal Services Division of the Alaska Legislature advised Representative Edgmon that if, after a holder of a mining claim has acquired rights, the law is changed in such a way that "no longer allows [the holder of a mining claim] to use its land for the intended profit-making purpose, then it seems likely a taking has occurred."[233]

In analyzing whether a governmental action constitutes a taking, "the logically antecedent inquiry [is] into the nature of the owner's estate" and to ascertain whether the proscribed use interests were part of his title.[234] Thus, the threshold inquiry in this case must be into the nature of the property rights that a mining claimant holds on state-owned public land.

Mining claims are a "unique form of property." [235] Unlike ordinary private property, the government is the owner of the underlying fee title to

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227. *See* Chicago, B. & Q. R. Co. v. City of Chicago, 166 U.S. 226, 233–34 (1897).

228. *See* U.S. CONST. amend. V.

229. Lingle v. Chevron U.S.A., Inc., 544 U.S. 528, 536 (2005) (citing First English Evangelical Lutheran Church of Glendale v. County of Los Angeles, 482 U.S. 304 (1987)).

230. *First English Evangelical Lutheran Church*, 482 U.S. at 315.

231. ALASKA CONST. art. I, § 18.

232. *See, e.g., Hearing on H.B. 134 Before Alaska H. Fisheries Comm.*, 2007 Leg., 25th Sess. (Alaska 2007) (statement of Gail Phillips, Truth About Pebble), *available at* http://www.legis.state.ak.us/basis/get_minutes_comm.asp?hse=H&session=25&comm=FSH&date=20070305&time=0842. Phillips previously served as speaker of the Alaska House of Representatives. *Id.*

233. Memorandum from Brian J. Kane, Legislative Counsel, Legal Services Division of Legal and Legislative Research, Legislative Affairs Agency, State of Alaska, to Rep. Bryce Edgmon (Feb. 12, 2008) (on file with author).

234. Lucas v. S.C. Coastal Council, 505 U.S. 1003, 1027 (1992).

235. Best v. Humboldt Placer Mining Co., 371 U.S. 334, 335–36 (1963) (stating that a mining claim is a "possessory interest" that is "mineral in character" within the limits of the claim). Unless otherwise provided, the uses and interpretations of

the public domain.[236] As the owner, the government maintains broad powers over the terms and conditions upon which the public lands can be used, leased, and acquired.[237] Alaska law contains no provision for patenting a mining claim, which would convey fee-simple title.[238]

In Alaska, a "prior right" to mineral deposits on state land open to claim staking may be acquired by discovery, location, and recording.[239] The claimant has an "exclusive" right to possess and extract minerals within the boundaries of the claim.[240]

The holder of a state mining claim, however, has "no right to mine" because that right is always contingent on state permission.[241] In other words, a mining claim does not constitute an absolute right to mine; it vests in the claimant a right to exclude others who wish to mine the same minerals within the boundaries of the mining claims.[242]

For a mining claim to be valid, the discovery must ultimately pass the "marketability test."[243] This test requires the claimant to show that the minerals can be extracted at a profit.[244]

A. Legal Standards Governing Takings Analysis

In examining whether a government intrusion on private property rights constitutes a taking, several factors have particular significance. The

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federal mining law as supplemented by state law apply to sections 38.05.185–.275 of the Alaska Statutes. ALASKA STAT. § 38.05.185(c) (2006).

236. United States v. Locke, 471 U.S. 84, 104 (1985) (citing, e.g., Kleppe v. New Mexico, 426 U.S. 529, 539 (1976)).

237. *Locke*, 471 U.S. at 104.

238. *See* ALASKA STAT. §§ 38.05.185 *et seq.* (2006).

239. "Prior discovery, location, and filing, as prescribed by law, shall establish a prior right to these minerals and also a prior right to permits, leases, and transferable licenses for their extraction." ALASKA CONST. art. VIII, § 11.

240. ALASKA STAT. § 38.05.195(a). In order to maintain the claim, a claimant must comply with requirements for annual labor, pursuant to section 38.05.210 of the Alaska Statutes; annual rental, pursuant to section 38.05.211 of the Alaska Statutes; and production royalties, pursuant to section 38.05.212 of the Alaska Statutes. ALASKA STAT. § 38.05.185(a).

241. Beluga Mining Co. v. Dep't of Natural Res., 973 P.2d 570, 575–76 (Alaska 1999).

242. The right to exclude other subsequent mining claimants, however, is not a right to exclude the public at large. *See* ALASKA STAT. § 38.05.255 (2006) (providing that a holder of a mining claim has limited use of surface land and waters within the boundaries of the claim, subject to reasonable concurrent uses by the ordinary public).

243. United States v. Coleman, 390 U.S. 599, 602–03 (1968).

244. *Id.*

economic impact of the regulation on the claimant and, particularly, on the extent to which the regulation has interfered with distinct investment-backed expectations are two primary factors.[245] Also relevant is the character of the governmental action, i.e., whether it amounts to a physical invasion or merely affects property interests "through some public program adjusting the benefits and burdens of economic life to promote the common good."[246] These three factors all aim to identify regulatory actions that are functionally equivalent to a direct appropriation or ouster from private property in that each focuses on the severity of the burden that the government imposes on property rights.[247]

B. House Bill 134 and Senate Bill 67 Would Not Constitute Takings

In assessing the character of the government action, a court may more readily find a "taking" when the interference with property can be characterized as a physical invasion by government than when interference arises from some public program adjusting the benefits and burdens of economic life to promote the common good.[248] Under Alaska law, this inquiry also examines the legitimacy of the interest advanced by the regulation or land-use decision.[249]

The legislature may enact legislation that is designed to protect activities and industries it deems important, even if it thereby restricts other types of industries, without having to compensate the industry that suffers a loss as a result of the legislature's action.[250] In a wide variety of

245. Penn Cent. Transp. Co. v. City of New York, 438 U.S. 104, 124 (1978).

246. *Id.* Prior to *Pennsylvania Coal Co. v. Mahon*, 260 U.S. 393 (1922), it was generally thought that the Takings Clause reached only a "direct appropriation" of property or the functional equivalent of a "practical ouster of [the owner's] possession." Lucas v. S.C. Coastal Council, 505 U.S. 1003, 1014 (1992) (citations omitted). *Mahon* established the oft-cited maxim that, "while property may be regulated to a certain extent, if regulation goes too far it will be recognized as a taking." *Id.* (citing *Mahon*, 260 U.S. at 415).

247. Lingle v. Chevron U.S.A., Inc., 544 U.S. 528, 539 (2005).

248. *Penn Cent.*, 438 U.S. at 124.

249. Beluga Mining Co. v. Dep't of Natural Res., 973 P.2d 570, 575 (Alaska 1999). The Supreme Court of the United States rejected this prong of the analysis, stating that it "prescribes an inquiry in the nature of a due process, not a takings test, and that it has no proper place in . . . takings jurisprudence." *Lingle*, 544 U.S. at 540.

250. Miller v. Schoene, 276 U.S. 272, 279 (1928) (finding no taking where state required destruction of one owner's rust-infected cedar trees with the intent to prevent destruction of apple orchards because "the state does not exceed its constitutional powers by deciding upon the destruction of one class of property in order to save another, which, in the judgment of the legislature, is of greater value to the public").

contexts, the government may execute laws or programs that adversely affect recognized economic values.[251] "Even with respect to vested property rights, a legislature generally has the power to impose new regulatory constraints on the way in which those rights are used, or to condition their continued retention on performance of certain affirmative duties."[252] This power includes the enactment of new land designations encompassing existing mining claims.[253]

In enacting more stringent environmental regulations or establishing a refuge in the Bristol Bay drainages, the legislature would simply be adjusting the benefits and burdens of economic life to promote the common good.[254] In Alaska, the common good includes protecting the public interest in the conservation of fish, wildlife, and habitat; the protection of commercial, sport and subsistence fishing, and hunting; and other public uses "in a high quality environment."[255]

The Bristol Bay drainages support multi-million dollar commercial, sport, and subsistence fisheries. Thus, if the legislature restricts mining in the Bristol Bay drainages in an effort to protect the fisheries, it would not have to compensate the affected mining claimants if, in the judgment of the legislature, the fisheries are of greater value to the public.[256]

The legitimacy of the state interests advanced by House Bill 134 and Senate Bill 67 is supported by Article VIII of the Alaska Constitution. Article VIII: (1) requires the legislature to provide for the conservation of natural resources for the maximum benefit of the people;[257] (2) reserves fish, wildlife, and waters to the people for common use;[258] (3) provides that fish, forests, wildlife, grasslands, and all other replenishable resources are to be maintained on a sustained yield basis;[259] and (4) requires the

251. *Penn Cent.*, 438 U.S. at 124.

252. Reeves v. United States, 54 Fed. Cl. 652, 672 (2002) (quoting United States v. Locke, 471 U.S. 84, 104 (1985)).

253. *See id.* at 672.

254. *See Penn Cent.*, 438 U.S. at 124.

255. *See, e.g.*, ALASKA STAT. §§ 16.20.033(b)(1)–(2) (2006) (stating that purposes of the Yakataga State Game Refuge include protecting fish and wildlife habitat, populations, and public use).

256. *See, e.g.*, Miller v. Schoene, 276 U.S. 272, 279 (1928).

257. ALASKA CONST. art. VIII, § 2 ("The legislature shall provide for the utilization, development and conservation of all natural resources belonging to the State, including land and waters, for the maximum benefit of its people.").

258. ALASKA CONST. art. VIII, § 3 ("Whenever occurring in their natural state, fish, wildlife, and waters are reserved to the people for common use.").

259. ALASKA CONST. art. VIII, § 4 ("Fish, forests, wildlife, grasslands, and all other replenishable resources are to be utilized, developed and maintained on the sustained yield principle, subject to preferences among beneficial uses.").

legislature to provide for the administration of public lands.[260] The progeny of these constitutional authorities includes: statutes that regulate mining, such as Title 27 and sections 38.05.185–.275 of the Alaska Statutes; set aside land as refuges under sections 16.20.010–.080 of the Alaska Statutes; and the other statutes discussed herein.

The second prong of the takings analysis is the economic impact of the regulation or legislation. This test is essentially an ad hoc, factual inquiry into the circumstances of a particular case.[261]

Here, the economic losses may include the expenditures by NDM and its partners to maintain their claims so as to pass the marketability test. These losses may range from the annual rental, pursuant to section 38.05.211 of the Alaska Statutes, to the total investments by NDM and its partners in maintaining their claims prior to the passage of the legislation.[262] Any compensable economic losses would not include a right to mine, the value of the mined metals, or lost profits because a state mining claim does not bestow on its possessor a right to mine.[263] In any event, "mere diminution in the value of property, however serious, is insufficient to demonstrate a taking."[264]

The last prong of a takings analysis requires an examination of whether further regulation, such as the regulations specified in House Bill 134, or the refuge compatibility test inherent in Senate Bill 67, were part of the

260. ALASKA CONST. art. VIII, § 6 ("Lands and interests therein, including submerged and tidal lands, possessed or acquired by the State, and not used or intended exclusively for governmental purposes, constitute the state public domain. The legislature shall provide for the selection of lands granted to the State by the United States, and for the administration of the state public domain.").

261. *See, e.g.*, Kaiser Aetna v. United States, 444 U.S. 164, 175 (1979).

262. NDM claims to have invested $180 million since 2002 in exploring the mineral potential of the Pebble project. NDM, IMPORTANT NEW MINERAL DEPOSIT, *supra* note 1.

263. *See* Beluga Mining Co. v. Dep't of Natural Res., 973 P.2d 570, 575 (Alaska 1999) (stating that mining claim provides no right to mine). As a legal matter, the Supreme Court of the United States has emphasized that "[t]he loss of future profits . . . provides a slender reed upon which to rest a takings claim." Andrus v. Allard, 444 U.S. 51, 66 (1979). "Prediction of profitability is essentially a matter of reasoned speculation that courts are not especially competent to perform." *Id.* "Further, perhaps because of its very uncertainty, the interest in anticipated gains has traditionally been viewed as less compelling than other property-related interests." *Id.* This is especially true regarding the speculative profits of modern mining concerns that routinely vary their production levels, or even cease operations temporarily, in response to changes in market conditions and technology.

264. Concrete Pipe & Prods. of Cal., Inc. v. Constr. Laborers Pension Trust for S. Cal., 508 U.S. 602, 645 (1993).

investment-backed expectations of the property owner. The investment-backed expectations of a mining enterprise include the possibility of government regulation, and revisions to those regulations, because mining is always contingent on state permission.[265] Many takings challenges have failed on the ground that, while the government action caused economic harm, it did not interfere with interests that were sufficiently bound up with the reasonable expectations of the claimant to constitute "property" for Fifth Amendment purposes.[266]

Where an entity that is already subject to government regulation claims that further regulation constitutes a taking, a court is likely to reject the claim on the grounds that further regulation was part of the company's investment-backed expectations.[267] After all, "[g]overnment hardly could go on if to some extent values incident to property could not be diminished without paying for every such change in the general law."[268]

NDM and its partners invested in the Pebble Mine with the expectation that their mining activities would be regulated by, *inter alia*, DNR permitting statutes, the Anadromous Fish Act, the Fishway Act, and the

265. *See Beluga Mining Co.*, 973 P.2d at 575–76. On federal public lands, for example, any right in a mining claim is contingent upon compliance with applicable environmental and other regulatory requirements. 30 U.S.C. § 22 (2006) (stating that staking and patent of mineral claims on federal land must comply with all federal regulations). *See, e.g.*, Reeves v. United States, 54 Fed. Cl. 652, 672–73 (2002) (finding no taking where miners holding unpatented mining claims on federal land designated as wilderness study area were forced to comply with non-impairment standard); Clouser v. Espy, 42 F.3d 1522, 1529–30 (9th Cir. 1994) (mining operations must comply with Forest Service regulations to protect forest resources).

266. Penn Cent. Transp. Co. v. City of New York, 438 U.S. 104, 125–26 (1978) (citations omitted).

267. *Concrete Pipe & Prods.*, 508 U.S. at 645 (citation omitted). *See also* Usery v. Turner Elkhorn Mining Co., 428 U.S. 1, 16 (1976) (stating that legislation readjusting rights and burdens is not unlawful solely because it upsets otherwise settled expectations).

268. Pennsylvania Coal Co. v. Mahon, 260 U.S. 393, 413 (1922). Zoning laws are the classic example. *See* Gorieb v. Fox, 274 U.S. 603, 608 (1927) (providing requirement that portions of parcels be left un-built); Euclid v. Ambler Realty Co., 272 U.S. 365 (1926) (providing a prohibition of industrial use); Welch v. Swasey, 214 U.S. 91 (1909) (providing height restrictions). The Court has viewed these and other regulations as permissible governmental action even when they prohibited the most beneficial use of the property. *See Penn Cent.*, 438 U.S. at 125. Takings challenges have also been held to be without merit in a wide variety of situations where the challenged governmental actions "prohibited a beneficial use to which individual parcels had previously been devoted and thus caused substantial individualized harm." *Id.* at 125–26 (citing Miller v. Schoene, 276 U.S. 272 (1928)).

federal Clean Water Act.[269] The Kvichak and Nushagak drainages are historically important to commercial, subsistence, and recreational fishing. Hence, a developer of a massive, sulfide mineral deposit in these drainages should reasonably expect the possibility that the legislature would implement stricter statutory standards to protect these fisheries. A mine developer also would expect procedural reforms, such as adoption of a "precautionary approach" in legislation, or other suggestions discussed herein, that would refine the mine permitting process to further protect the Bristol Bay drainages and the valuable fisheries they support.[270]

In a mining venture, a reasonable investment-backed expectation would be that permission to mine might not be granted.[271] Where government approval is required but not assured for a project, any investment in that project is akin to a business gamble.[272] "A mere unilateral expectation or an abstract need" is not a property interest entitled to protection.[273]

By the time Anglo American entered into its partnership with Northern Dynasty, legislators had already introduced Senate Bill 67 and House Bill 134.[274] That the state might establish a refuge, or further protect water, must have been within the investment-backed expectations of the Pebble Partnership. Those who do business in a regulated field cannot object if the legislative scheme is buttressed by subsequent legislation or regulation.[275]

269. *See* Clean Water Act, § 402(b), 33 U.S.C. § 1342(b) (2000) (providing for the National Pollutant Discharge Elimination System); *see also* Clean Water Act § 404, 33 U.S.C. 1344 (2000) (providing for wetland dredge and fill program).

270. *See* United States v. Locke, 471 U.S. 84, 107–08 (1985) (stating that newly enacted requirements mandating that the claimants timely register prior mining claims and forfeit their claims upon failure to comply do not "take" the claims of those who fail to comply).

271. Beluga Mining Co. v. Dep't of Natural Res., 973 P.2d 570, 575–76 (Alaska 1999).

272. Anchorage v. Sandberg, 861 P.2d 554, 560 (Alaska 1993) (finding that developer who purchased land and planned housing development did not have reasonable expectations that the city government would fund access road, water, and sewer).

273. Webb's Fabulous Pharmacies, Inc. v. Beckwith, 449 U.S. 155, 161 (1980) (citing, e.g., *Penn Cent.*, 438 U.S. at 122); Dep't of Natural Res. v. Arctic Slope Regional Corp., 834 P.2d 134, 140 (Alaska 1991) (quoting Ruckelshaus v. Monsanto Co., 467 U.S. 986, 1005 (1984)).

274. *See* Advance Pebble Project to Production, *supra* note 2; S.B. 67, 2007 Leg., 25th Sess. (Alaska 2007); H.B. 134, 2007 Leg., 25th Sess. (Alaska 2007). Mitsubishi also bought into NDM after Senate Bill 67 and House Bill 134 were introduced. *See supra* note 1.

275. Concrete Pipe & Prods. of Cal., Inc. v. Const. Laborers Pension Trust for S. Calif., 508 U.S. 602, 645 (1993).

NDM and its partners claim they have invested large sums in the Pebble mine.[276] If these investors invested in the Pebble Mine with the expectation that the state would approve their plans to develop the mine, their economic losses would have been based on a "mere unilateral expectation" and would not be property interests entitled to constitutional protection.[277] In other words, these investments would have been a business gamble.[278]

Because the reasonable, investment-backed expectations of NDM and its partners were that the Pebble Mine might be subject to further regulation, NDM and its partners have no constitutionally protected interest for which they must be compensated should House Bill 134 or Senate Bill 67 be enacted into law.

VII. CONCLUSION

Heightened regulation is necessary to protect the Bristol Bay drainages and the valuable commercial, subsistence, and recreational fisheries from the risks posed by the Pebble Mine. House Bill 134 and Senate Bill 67 attempt to provide that protection, but such legislation must survive takings challenges by the mine proponents. Nonetheless, government regulation was part of the investment-backed expectations of Northern Dynasty Minerals and its partners. From the start, they had no right to mine these claims, which are on state land, because that "right" was always contingent on the state granting them permission to mine. Thus, if the Alaska Legislature enacts legislation to impose new regulatory constraints on metallic sulfide mining in the Bristol Bay drainages, its actions would not constitute a taking of property for which the state would be required to compensate the owners of the Pebble Mine claims.

276. NDM claims to have invested $180 million since 2002 in exploring the mineral potential of the Pebble project. NDM, IMPORTANT NEW MINERAL DEPOSIT, *supra* note 1.

277. *See Webb's Fabulous Pharmacies, Inc.,* 449 U.S. at 161; *see also* NDM, IMPORTANT NEW MINERAL DEPOSIT, *supra* note 1.

278. *See* Anchorage v. Sandberg, 861 P.2d 554, 560 (Alaska 1993).