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MASTER'S THESIS

The Precautionary Principle and Risk-Management in Environmental Decision-Making:

A case study of the proposed Pebble Mine in Bristol Bay, Alaska

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1 Introduction

Environmental decision-making is a process fraught with conflict and steeped in values that pit different sectors of society in battle for potentially scarce resources. The resources in question are often public goods, are linked into an ecological system and are an important part of the local landscape. All of these factors make the process of resources rights and allocation a complex political battle.

A proposed hard-rock mine in the Bristol Bay region of Alaska has brought to light the decision-making process used in issuing or denying permits needed to mine. The mine is highly controversial because of its size and proximity to the Bristol Bay watershed, an area which is known almost exclusively for its commercial and sport fishing industry, which take advantage of the large populations of a particular type of salmon indigenous to the region. The Pebble Partnership is a subsidiary created to run the proposed mine and is currently funding baseline studies to analyze the state of the current environment. Many groups are in opposition to the mine because of the risk it could pose to the ecosystem and consequently to the salmon residing in it.

What makes this case so significant is the scale of the possible consequences in debate, regarding both the size of the area involved and the number of people involved in the debate. While policy-making in the US has mostly focused on reactionary measures of regulation, occurring only after damage has been shown to happen, the case for the use of precautionary principle can be made in regard to the Pebble Mine. The precautionary principle is particularly good at recognizing uncertainties associated with data and how they can affect the decision-making process. This method also recognizes that in situations of extreme risk, precautionary measures may need to be taken in order to

prevent catastrophic or irreversible consequences. The first part of this thesis will outline the characteristics of Alaska and the Bristol Bay region, showing why Alaska and the Bristol Bay region in particular are distinctly different from the rest of the United States. The second section lays out the framework of the debate- the proposed actions, the companies involved and the opposition to the project. Thirdly, the formal mine permitting process and attempts to influence this process will be covered. The following sections analyzes the effects that the proposed mine could have on the Bristol Bay region. An analysis of the Pebble Project and the decision-making process in light of the two main methods of the decision-making, risk management and the precautionary principle follows. Finally, the thesis will conclude with a summary of the analysis made with some mentions about the implications of the outcome of the debate.

2 Alaska

On the bottom of the Alaska state license plate, the phrase “the last frontier“ captures the essence of the Alaskan mentality that gives the state its unique status within the United States. In the American experience, the frontier is place of limitless resources, vast expanses of unconquered land and limited government control. Although the ideas of a frontier society have been around since before Alaska was owned by the US, no other place in the US has held fast to these ideas quite as strongly. In the 19th century, Fredrick Jackson Turner observed that “American development has exhibited not merely an advance along a single line, but a return to primitive conditions on a continually advancing frontier line” (Turner, 2). No where else is this statement as true today as in the rural enclaves of Alaska, where subsistence living is still prominent and bartering a significant method of trade. Around the time when Alaska was purchased by the US from

Russia, Turner emphasized the continual expansion of the US kept it in continuous touch with primitive society (pg. 3). Though this statement may not be true today for most Americans, the fact remains that for the 20% of the population living in rural Alaska, numbered at just over 124,000 people, living closer to nature is not a hobby but a way of life(Wolf,1). Everyday life and economic activity alike are contingent on the behavior and functioning of natural systems and the raw resources they provide. Throughout the region's history, natural resources have made the area desirable for control by outside interests starting with the control of certain part of Alaska by Tsarist Russia. Though the resources in Alaska were valuable, harsh conditions and the distance of the region from other world centers, as well as the presence of native groups, made the area difficult and unprofitable as a colony, which were factors in the willingness by Russia to rid themselves of the land.

On March 30th 1867, the Alaskan territory was purchased from the Russian Empire. Alaska had not proved to be a successful colony for the Russians, who explored the area for the second half of the 18th century before forming permanent settlements around 1800. The Russian period of colonization was based first on fur trade, most of their efforts were concentrated in coastal areas of Alaska, the regions immense size and inhospitable terrain prevented a complete colonization. A lasting remnant of the Russian period in Alaska's history is the presence of the Orthodox Christian religion, evidence of the colonization and the religious influence that can still be seen in both the existing church congregations and the traditional Orthodox churches that remain to this day.

American influence in the area increased as they set up their own trading companies, and when the 1,518,800 km² territory was bought in 1867 many Russians

were forced to move elsewhere (“The History“). The treaty was negotiated primarily between Russian Czar Alexander II and American Secretary of State, Fredrick W. Seward, who greatly supported American expansion. At first Alaska was designated as a department, and was ruled by the US Army and Navy and the US Department of the Treasury. Only in 1884 was Alaska designated as a district, and despite the lacking infrastructure, attracted hundreds of prospective gold miners, fisherman, fish processors, fur trappers and hunters (“The History“) From 1912 to 1959, Alaska was officially a territory, and was organized into four regions. As a result of WWII conflict in Alaska, the Alaska-Canada highway was built in 1942, providing the first source of overland transportation to the rest of the United States.

On January 3rd 1959, Alaska officially became a state of the union. Popularity in granting statehood was possibly helped by the discovery of oil and the recognition of Alaska's geostrategic position (Ross, p. 52). Juneau remained the official capital, and the state was organized in boroughs instead of counties like most other US states. The vast majority of Alaskan territory is lumped together in a general “Unorganized borough”, which is essentially all of the leftover land that did not in with the other 16 boroughs. The only form of organization in this vast region are school districts and municipal governments in the towns and villages big enough to support them.

After the discovery of oil in Prudhoe Bay in the North Slope, pressures by Alaskan Natives to claim rights to their land intensified as the value of oil was recognized. In 1971, Richard Nixon signed the Alaska Native Claims Settlement Act, which collectively gave Alaskan natives 180,000 square kilometers of land and $963 million dollars to be divided up between various native corporations at the local and

village level, leading to the creation of 13 Regional Native Corporations (Ross, p. 67). The completion of the oil pipeline from Prudhoe Bay to Valdez in 1977 and the consequent establishment of the Permanent Fund, an investment which takes profits from oil and pays dividends every year to every resident of Alaska, increased income to all Alaska residents. Another notable event in Alaskan history was the 1989 Exxon-Valdez oil spill, which dumped approximately 41 Million liters of oil into Prince William Sound. A class action suit filed by residents of the area against Exxon is still in court; no payments have been made to this day.

2.1 Importance of Natural Resources

Unlike many of the other states in U.S., the Alaskan economy and population depend primarily upon natural resources as an economic driver. Oil reserves provide the state with enough revenue to send out yearly checks to each man, women and child in Alaska that average around $1,000. Fish harvesting and processing provide jobs for 54,000 people, many of whom are Alaska residents (2009 Alaska). In coastal areas, fisheries account for over 50% of private sector employment (2009 Alaska). However, fisheries are an important part of the entire economy due to their large percentage of export value. Providing 2 billion dollars a year in exports, fish products account for over half of export value in Alaska, bypassing even oil exports in revenues (2009 Alaska). Other important sources of income and tax revenue include industrial pursuits such as mining, and tourism. Tourists visit Alaska for both the pure aesthetic value of the land as well as the hunting and fishing opportunities it provides. With regard to employment, public sector jobs account for much of the full-time, non-seasonal work available outside of urban areas.

As it is evident from the data presented above, Alaska's natural resources are the driver of economic activity in Alaska. Most economic activity is focused on the extraction of renewable (fish) and non-renewable (oil) resources involving large corporations funding expensive operations to attain and process these resources. A second type of economic force is tourism, which benefits mostly small and mid sized business owners who cater to service activities. Thirdly there is the public sector, consisting of teachers as well as public officials who help to oversee the process of natural resource extraction and play a key role in environmental regulation in remote areas.

Income levels do not necessarily provide a complete picture of the resources available to the population; elements such as subsistence and the informal economy are major factors in providing income and keeping rural inhabitants from poverty. Many people, both native and non-native, depend on special hunting and fishing rights, known as Subsistence Rights, in order to feed themselves and their families. Fishing accounts for over 60% of subsistence food, making it more important than the hunting of land animals (2009 Alaska). Subsistence fishing is one of the ways that people put food on the table in areas where 20 percent of the population live below the poverty level (2009 Alaska).

Property rights that govern the use of the animals and land in Alaska are comprised of a complicated system of federal and state rules and differ greatly from property and usage rights in other states due in part to the cultural heritage of native Alaskans and the unique reliance of the state's people and businesses on the environment and natural resources it provides. The battle over land use and harvesting of animals are at the center of Alaskan politics, with various environmental groups at both national and

state level pitted against extraction-centered corporations. Various government bodies have historically had different allegiances to either protectionist environmental groups or exploitive corporate interests.

2.1.1 Subsistence Lifestyle

The rural population is comprised of around 225 communities, many of which are not connected to each other or to urban centers by roads. (Wolf. p. 1). Some communities consist only of natives of the five tribes in Alaska, while others vary, consisting of both native and non-native people, many of whom have intermarried and blurred the distinctions (look up source!). Because of the logistical and distance issues associated with rural areas, basic food staples are more expensive then in other rural American areas. Consequently, natives and non-natives alike take advantage of special access to resources of their region, referred to as "subsistence" or "subsistence rights". Subsistence, defined as "customary and traditional uses of wild resources for food, clothing, fuel, transportation, art, crafts, sharing and customary trade", is licensed by the state for primarily the rural population ("Subsistence" 2). The importance of subsistence is emphasized by the weight per capita usage of wild sources of food, which is around 375 pounds per person, though the figure for rural inhabitants is probably much higher (Wolf, 2). While natural resources have not always proved to be a reliable source of cash, the natural world provides rural citizens with other benefits that are not easily measured in monetary terms.

Not only are rural residents of Alaska more dependent on local sources of food than the rest of US, their local economies also exhibit features that have long been taken over by the market economy in the rest of the country. This type of local economy is

called a “mixed subsistence market economy” and is characterized by extended families and communities sharing their resources to obtain subsistence food, not for selling on the market but for personal use (“Subsistence“, 3). Despite the relative backwardness of these communities, some of them have been in existence for several hundred years and have managed to sustain their populations in a fast-changing world.

It would appear based on the above descriptions, that these communities were linked closely with their surrounding environment. Nature and the goods it provides are used by the population of rural Alaska directly as a food source, and also as a means of employment. For the non-native population of rural Alaska, instrumental uses of natural resources are the dominant theme, and these instrumental uses help to “structure the social life and the annual round of activity among many groups in these communities” (“Subsistence”, 8). The onset of different fishing and hunting seasons helps to structure local activities, the interdependence between individuals in obtaining these resources helps to solidify forms of social capital in the region. It is clear that natural resources are not just a way to eat and pay bills, they also play an important role in the social bonds that tie communities together.

In the 26 Bristol Bay communities, a total of 2.4 million pounds of subsistence food a year is used by the inhabitants, working out to about 315 pounds of subsistence food per person per year. The majority of subsistence foods are fish and other seafood, but hunting for game also plays a role. Harvesting different type of seafood and animals guides the “seasonal round of activities based on wild resources” (Duffield, 3). For the native population, “social life is organized around the taking and use of foods and materials that exist in the natural environment” (Vol1a, 7). Social bonds between and

within communities are also strengthened by the use and sharing of natural resources (Volla, 7). Often nuclear and extended family units are involved in acquiring and processing the resources, equipment such as nets and boats are sometimes shared with other family members, or the fruits of these activities distributed, sometimes in exchange for other resources.

Another characteristic of this way of life is the strong and unmeasured presence of an informal economy, which is useful way to obtain goods and services in places where banks do not exist and cash is difficult to obtain. (Goldsmith, 43). In small communities, large numbers of citizens trade services, share goods and make cash payments that are not reported to the IRS (Goldsmith, 43). This can partially be attributed to the lack of service businesses that normally exist in communities; regions in Alaska are simply too small and too remote to warrant service businesses (Goldsmith, 43). Another issue is that of availability of goods; in an area where stores are small and may not carry all of the goods desired by the community, trading and paying cash for these good from other people in the community is an easy solution to obtaining these goods. Overall this makes the economic activity in Alaska difficult to quantify accurately.

2.1.2 Bristol Bay

Comprised of 25 communities and approximately 7,610 people, Bristol Bay makes up a small portion of the total Alaskan population. Nonetheless, it is widely recognized as one of the key areas for Salmon fishing in the state. Commercial fishing activities have been carried out in this area for over 100 years, and while the number of salmon entering Bristol Bay's nine major rivers fluctuates significantly each year, state regulations have created a sustainable management system that will, in the absence of

external factors, continue to be a viable fishery for years to come (Marine Stewardship Council). Similar to the rest of rural Alaska, subsistence fishing is a key part of the culture in both the native and non-native populations.

Economically, Bristol Bay exhibits typical characteristics of a natural-resource based economy, which will be explained in greater detail below in order to understand the circumstances under which these communities operate. Dependence on resource extraction as well as the need for labor-intensive production methods are characteristics that influence the structure and size of the communities themselves (Flint, 3). In this case salmon fisheries are a seasonal activity which require more workers than local communities have to offer. Hence, a mass-migration of seasonal workers from around the country and even the world arrive for a short period to help with the harvesting and processing of salmon. Services and transportation for the outside workers provide a stimulus to the economy during the summer months. Other traditional perspectives emphasize the economic instability of such natural-resourced based economies, in this case the instability is comes from external factors and the nature of the resource itself (Flint, 3). Supply and demand economics influence the prices that Salmon fetch per pound each year; strong downward trends have been observed in recent years that have shocked the local economy. In addition, because the salmon is harvested sustainability, the amount of fish that are available for harvesting each year can fluctuate wildly. All of these factors show the potentially vulnerable position residents are placed in with regard to economic security. Other facets of this unique relation to the natural world help to balance out the instability of commercial resource extraction.

2.1.3 Economic Viewpoint of Bristol Bay

A unique feature of a natural-resource based economy is the complicated pattern of ownership, or lack thereof, of the resource upon which the community is dependent. In some aspects, it is possible to see the entire ecosystem of Bristol Bay, including the land, water and air as a public good. In order to qualify as a public good, the ecosystem must be shown to be non-rivalrous and non-excludable. Firstly, to be non-rivalrous, consumption of the good by one person does not take away from the consumption of the good by another. To be non-excludable, the good must be available to all, in this case everyone in the community can enjoy the benefits of the ecosystem. As an example, air to breath is both a non-rivalrous and a non-excludable resource. Public goods often do not fulfill these requirements completely, and the actual practice of accessibility to goods can be influenced by the state.

In Bristol Bay, the public goods that provide natural resources upon which the economy depends are a part of a bigger ecosystem. Some of the goods used were created underground over thousands of years and are non-renewable resources, others can be harvested every year and are considered to be renewable resources. However, the uses provided by an ecosystem go beyond that of what can be directly sold on the market. Efforts have been made to quantify the benefits of a healthy ecosystem, to break down the benefits, material and non-material, that are inherent in it. Other values of the environment are more difficult to quantify but nonetheless contribute to the economic well-being of the Bristol Bay region. Tourism often makes use of the inherent value of nature without extracting anything from it directly. It is useful to create a working definition of the word ecosystem on order to be able to break down the components contained within it and the benefits that accrued from them. A helpful archetype can be

used to break down the different products of an ecosystem into eight different categories, the benefits of which range from abstract concepts to concrete goods (Colt, 36). Firstly, I will discuss the uses and benefits of an ecosystem that are related more closely to the field of natural sciences. Ecological processes performed by the system provide services such as clean air, pollination, and climate regulation among others. Another related aspect is the benefits brought about in relation to the watershed, where the system provides for and regulates water flow and supply. The habitat created by an ecosystem is used "for resident and transient populations of animals and people" (Colt, 5) Lastly, the biodiversity inherent in an ecosystem provides for the protection, control and evolution of species. Although these ecosystem services do not provide directly for humankind, the by-products of a healthy ecosystem, or what we typically see as "natural resources", are the key elements of economic processes in a natural-resource dependent society. Natural resources as we commonly view them are consumptive benefits associated with an ecosystem, such as timber, fish, game and agriculture among others. It is these benefits that are most commonly dealt with in economics, as well as most fought over in politics in the context of a natural resource based society. The last three categories of ecosystem benefits are difficult to quantify in economic terms but nonetheless are part of the evaluation. Non-consumptive usage of an ecosystem include tourism and sightseeing, as well as teaching and research. Future and passive uses are focused on conceptual ideas of what nature means to society, what it can provide to in the future to new generations and pure aesthetic value. Attempting to align this paradigm with an economic-based cost benefit analysis proves to be a difficult task, intangible public good, however beneficial, are not easily assigned a monetary value, though such analysis have been attempted.

While the benefits of an ecosystem that supports quality public goods may be intangible and vague, the benefits of so-called common goods are not. In the paradigm used above, common goods can be seen as consumptive goods, or resources taken from an ecosystem, many of which have a marketable value. Common goods, unlike public goods, can be rivalrous, meaning that consumption of the good by one individual limits the amount of the good that is available for others to consume. One of the most commonly used examples of common goods are fish in a lake. In the absence of government regulation, anyone can take as many fish from the lake as they like, making the good non-excludable or accessible to everyone. For each fish that is taken from the lake, there is one less fish for someone else, making this good rivalrous. However, the entire range of common goods that exist in the Bristol Bay region extends far beyond a single fish species. Three other type of fish species, as well as "berries, caribou, moose, marine mammals, ptarmigan, ducks, geese and many plants" are used by the locals and are "prepared in thousands of ways – smoked, dried, baked, fried. Teas are made with herbs from the tundra. Clothes and boats used to be made from these animals as well." (Goldsmith, 37).

In an effort to preserve these valuable animal resources by harvesting them sustainably, fishing and hunting activities are limited. In the absence of such regulation, the effects of over fishing and excess hunting would lead to a situation of negative externalities, in which each individual overusing the resource creates a problem for other users because of open accessibility, the individuals who loose out on the resource receive no compensation. Although fish in the sea are a commonly used analogy, pure public goods often better characterize the situation of externalities, where the good is truly free

for all to use or exploit as is seen fit. Because natural resources and uses of the ecosystem are so important for the state of Alaska, the laws governing their ownership and usage have played a large part in the politics of state.

2.2 Property rights and land usage

The basic premise behind many of the debates in Alaskan current events today revolve around property rights: how is control of resources allocated, to whom and on what basis? These key questions are at the core of Alaskan politics, they mobilize, motivate and infuriate communities, companies and the government in a feverish bid to secure access to limited, excludable resources. In Alaska's recent history, conflict has erupted between corporate interests invested in extractive industries, and local residents dependent on a healthy environment as a source of food and water. The landmark Exxon-Mobil oil spill in Prince William Sound represents the worst case scenario of risk in an environmentally sensitive area. Oil and natural gas drilling and exploration has also created conflict over the protection of whale habitat near offshore drilling facilities, as well as the health of caribou herds residing within the Alaska National Wildlife Refuge.

One group of people in Alaska that fought hard for their rights were the Alaskan Natives. Even as Alaska gained statehood, Native's claims to land were not resolved. Before Alaska was even recognized as a territory, the Alaska Organic Act allowed Natives freedom from any disturbance on land that they were currently using or occupying. Efforts at the beginning of the 20^{th} century attempted to create Native Allotments, but few were ever claimed (Ross, 192). A few native groups declared a reservation status, but this option was not favorable to many native villages. After gaining statehood, Alaska was given 25 years to choose 102.5 million acres of land that

was not owned by the federal government or the natives (Ross, 193). The discovery of oil and increased interest in mining led to a race between the state government and natives in claiming economically valuable land. In 1963, Natives urged the Interior Secretary Steward Udall to process native claim land settlements before authorizing the state's selection of land. The Alaska Federation of Natives rallied for the cause and In 1967, state claims were suspended. Pressures from the discovery of oil and the suspension of state claims meant that native claims were suddenly a top priority. Struggles between Natives, the State government and Federal government complicated the situation of land ownership, and several different interest groups all wanted a say in how the land would be divided up and what activities would be allowed on different kinds of land. Many native groups supported some form of development over conservationism. All natives could agree that strong subsistence use rights were a priority for them. The state government also tended to be pro-development, as long as the land in question was under their jurisdiction. Meanwhile, the environmental movement both in Alaska and in the rest of the US lobbied for a more preservationist approach to land use at the federal level. Finally in 1971, Nixon signed the Alaska Native Claims Settlement Act, which allowed Native groups to select 44 million acres of land (Ross, 196). Twenty-eight Million acres of the land was appropriated to village corporations for subsistence and cultural use, the other 16 million acres were allocated to the 12 regional native corporations and could be used for profit (p. 196). Following the selection of this land, government interests at the federal and state level battled for land, and finally after years of debate, emerged with the Alaska National Interest Lands Conservation Act (ANILCA), representing a balance between preservationalism and utilization.

In 1980, the ANILCA, regarded by many as the most important piece of legislation regarding Alaskan land rights, was signed into existence (Ross, 206). This act effectively ended the idea of the open frontier by solidifying the rights of ownership and usage. A relatively democratic approach to decision-making was taken by creating the Alaska Land Use Planning Council, a group of Native, state and federal representatives, and giving them a voice in the process. While the document aimed to protect Alaska's unique landscape and biodiversity, it also created provisions for subsistence usage by rural inhabitants. Several provisions were made to allow the development of industrial activity, especially on federal lands not designated as national parks or the Arctic National Wildlife Refuge (ANWR). In 1994 the time period for land selection by natives, the state and federal government came to an end, but lawsuits, sales and other land transactions continued on. Currently around 225 million acres of Alaska are designated federal lands, 105 Million acres are state-owned, 45 million acres are Native lands and 3 million acres are privately owned (Ross, 208). Federal lands are regulated by several different departments, such as the Bureau of Land Management (BLM), the Forest Service, The National Park Service and the Fish and Wildlife Service. History has shown the National Park Service to be the most preservationist in their approach, while the BLM lies at the other end of the spectrum. With the ANILCA came an increased reliance of the lands of Alaska on national policy objectives, due to the expanse of land under federal control and changing regulations that control the usage of the land.

2.3 Commercial Interests and Industry in Alaska

Since the US acquired the territory of Alaska in 1867, outside commercial interests have played a key role in the state's development. Beginning in the late 19th and

early 20th centuries, natural resource-based industries such as copper and gold mining were influenced by large investment groups. Consequently, they were able to shape the political position of the territory because of their dominance in the territorial senate, and avoided pressures that would turn Alaska into a state due to fears of increased regulation and higher taxes. The Klondike gold rush which occurred in the 1890's introduced mining to the region, waves of prospectors seeking fortunes continued coming to the region until the 1920's. Most of the high-grade mineral deposits were exhausted in the 1930's and by the 1950's stocks of salmon had decreased greatly from their peak in the 30's. In 1959, after Alaska gained statehood, state control of the land and sea brought some sense of order to the region, and led to the 1973 limited entry permit system, as well as the 76' Magnuson-Stevens fisheries management decision. Nonetheless, industries such as fisheries, mining and oil and gas extraction provide a strong economic base for an economy of limited diversity. After the takeover of fisheries management by state agencies, populations of different types of fish generally started a trend toward healthy levels. Industrial growth in Alaska has most likely been responsible for increased living standards in rural areas in particular. Despite the many conflicts that have occurred over land use and access to natural resources from fish to oil, overall one could conclude that development in Alaska has benefited the majority of the population in one way or another. Costs in the form of environmental damage due to increased industrialization vary depending on the region in question. Some areas of Alaska, most notably the Prince William Sound region where the Exxon-Valdez oil spill occurred, have incurred high costs of industrial activities, while countless other regions may benefit from royalties from oil and gas exploration or mining. Some of the costs incurred involve mainly the

ecosystem, while other costs directly affect public health or economic value of the land.

2.4 Track Record of Mining in Alaska

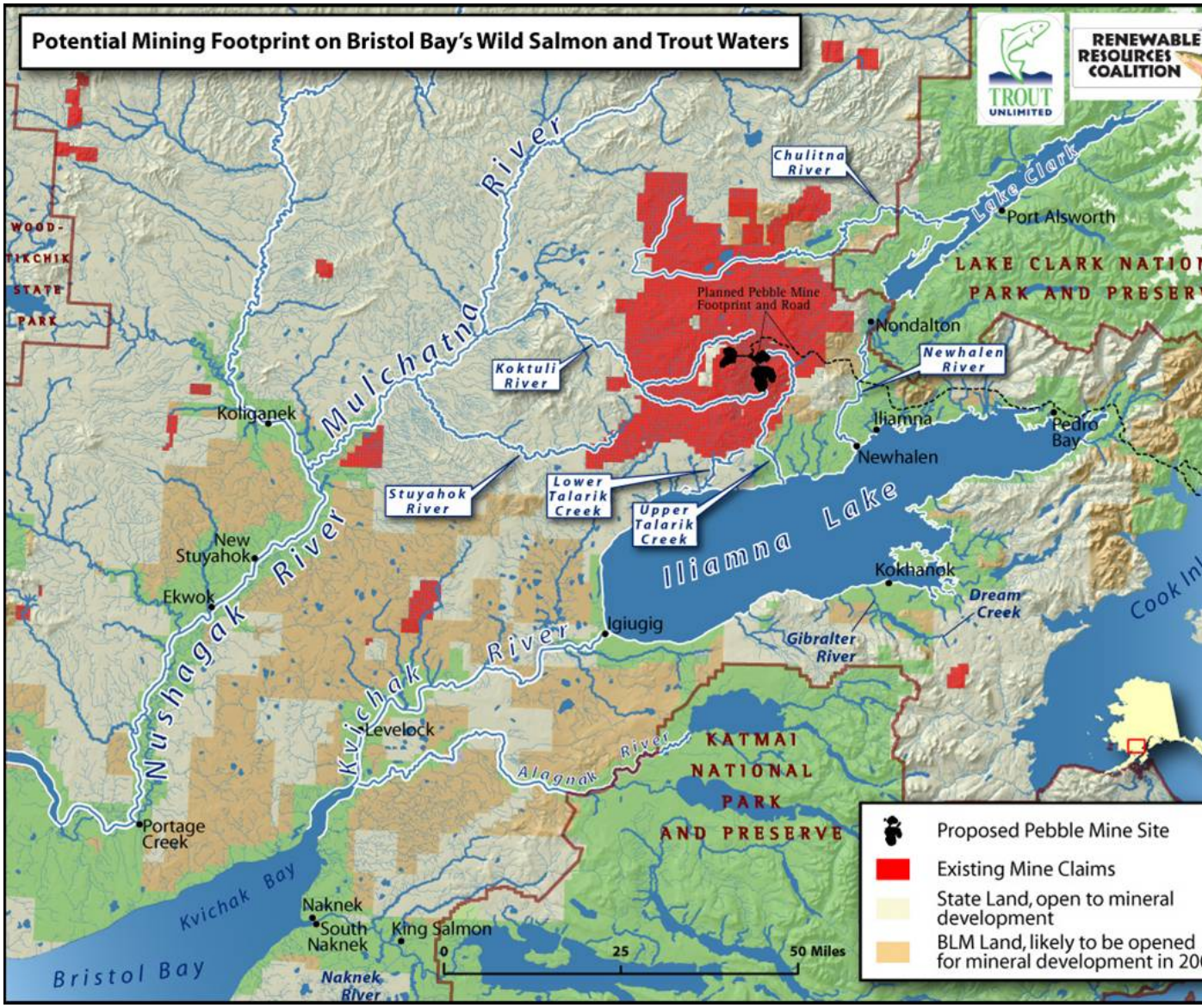
In theory, the proposed Pebble Mine would, if conducted according to the plans laid out by the Pebble Partnership, contain sufficient standards so as to ensure environmental protection. However, the skepticism of the environmental safety of the project is well-founded. As of 1997, mines are required to produce a yearly report of their release of toxic substances under the Emergency Planning and Community right to know act. The results of the report show that one of the mines in operation in Alaska, the Red Dog mine located in the far north of Alaska, has the greatest level of toxic releases of any mine in the country (“EPA Cites“). Litigation against Teck Cominco, owner of the Red Dog Mine, was initiated by native villagers accused the company of polluting native plants and berries used for subsistence. When samples of plants and berries were taken alongside nearby roads used by both the natives and the mining company, elevated levels of cadmium and lead were found. Although the company has in fact had a negative effect on the environment, there are no applicable standards the would govern the amount of lead permissible in the affected environment. Due the resolution that lead contamination was of low bioavailability (amount of metal that is able to be transferred to humans from plants), Alaska Department of Health and Human Services' Environmental Public Health Program advised “residents of Kivalina, Noatak and Point Hope should continue to eat their traditional foods without restriction” (“Alaska Community”, 5)What is noteworthy of this example is that despite the proof that mining activities had effected the surrounding environment, little protection or consideration was given to the residents dependent on the region's ecosystem as a source of food. Contamination did not occur

directly at the mine, or at the tailings storage facility, but occurred when milled ore was transported in open trucks, enabling the wind to spread the dust particles from the road into the surrounding plants. Lessons that can be learned from this example are that even if the proposed Pebble Mine itself manages to fulfill every promise set forth by the Pebble Partnership, there exist numerous points where the environment and the people and animals dependent on it are vulnerable to an environment changed by external forces. Secondly, it is important to note how uncertainty was handled in this situation. Villagers were tested for levels of toxic chemicals present in their bodies after the mine was first opened, but hadn't been tested for years when the results of the plant contamination were confirmed. Thus, it was stated that because the population in the area were healthy at that point, the low bioavailability of the type of lead present in the environment had been confirmed, however no new blood tests were carried out to confirm this assumption. (“Analysis of“).

3 The Pebble Project

A recent and ongoing controversy has remained relatively unheard of outside of Alaska, but may prove to be one of the most decisive battles between Alaskans and Corporations. The ecosystem that gives Bristol Bay its status as the sockeye salmon capital of the world could be in danger of suffering costs from industrial development. The Pebble Project, as the project has come to be known, is a bid to create North America's largest open pit mine in the Bristol Bay watershed, as well as a second underground mine. More specifically, the mine would be at the headwaters of the Kvichak and Nushagak rivers, and would be in close proximity to Lake Iliamna and Lake Clark. Large amounts of copper, gold and molybdenum have been discovered in the

area, and exploration activities have been underway since 1986. Thus far, two major mines have been planned, Pebble West, an open pit mine, and Pebble East, an area where different types of mining strategies will be used to bring minerals up from this deep deposit. In order to make the mine profitable, a large-scale project has to be undertaken. As a result of the low quality of the ore, the majority of the material mined will be waste; at Pebble West the ratio of waste to metals is 189:1, at Pebble East it is 100:1. If the estimations of the amount of ore are correct, a total of 7 billion tons of waste ore will be leftover once the project is completed (Parker).It is partially the enormous size of the mine that generates so much concern and controversy, particularly because of it's proximity to lakes and rivers that empty out into Bristol Bay. The Pebble Partnership envisions a mine that is three miles wide and several thousands of feet deep, it would be the largest pit mine in Alaska and in North America.



Map of the Bristol Bay Watershed and Pebble Mining Claims. Renewable Resources Coalition. http://www.renewableresourcescoalition.org/images/BBMap10_26.jpg

3.1 Focus of the Conflict

The basic interests of Bristol Bay residents and Pebble Project are similar: both parties would like to use natural resources available to them. Both have access to these natural resources through state and federal rights, for the most part the natural resources and land are not exclusively owned by the individual or group using them. Fishing both

commercially and for subsistence is a right granted to certain individuals by the state. Mining exploration permits, and the several permits needed at the state and federal level to begin large-scale mining operations, are granted by State and Federal government agencies. Although the Pebble Partnership leases land from the state, the right to mine on the land requires the application of additional permits.

Mining, like commercial fishing, has long been part of the historical development of Alaska. Four large mines are in operation and over 30 are in the exploration phase ("The Economic") Over 130 mine sites that have been abandoned are currently under consideration for state cleanup and reclamation funds ("Abandoned Mine"). Increases in technology have improved the environmental management capabilities of mine operators, on the other hand the scale and scope of the projects being undertaken has risen dramatically (Roth).

3.2 Construction

In order to accommodate such a large-scale mining operation, large-scale solutions for waste rock, waste water, transportation and energy are needed. Due to the remote location, considerable amounts of capital will be needed to build the infrastructure before the mining process ever beings. The construction of a 600-700 Megawatt power plant is being considered that could potentially provide low cost power to Bristol Bay residents. It would use more energy annually than the entire population of Anchorage, which is Alaska's largest city. It would be located across from Cook inlet on the Kenai peninsula and would need around 200 miles of transmission lines due to the great distance of the power plant from the mining operation, and around 50 miles of the transmission lines would need to be placed underwater in Cook Inlet. In addition, a new port to transport

minerals away from the area would need to be constructed. The current proposed site is Iniskin Bay, inside Cook Inlet which is a part of the larger Bristol Bay. In order to reach the site from the proposed port, an 86-mile road would need to be constructed, which would be in close proximity to lake Illiama and would intersect several small streams and a few major rivers. The road would have restricted access, meaning that it might not be accessible for public use, precluding any benefits for Bristol Bay residents in the form of increased infrastructure. Alongside the road would be pipelines for transporting water and concrete needed for the project. The permits that have been applied for by the Pebble Partnership for water usage total 35 billion gallons a year, which is a higher annual usage than Alaska's largest city, Anchorage (Sevier, 9). It has been suggested that in order to obtain this large volume of water, 60 miles of streams, tributaries and wetlands, vital for fish populations and the entire ecosystem, would need to be "de-watered", or drained fully or partially (Parker). Mine tailings, the liquid waste generated from the mining process, would be stored in 5 different dams and embankment constructions, in total they will cover 10 square miles and will be located in public state lands (Parker, 9).

3.3 Companies Involved

Exploration of the regions was spearheaded by Cominco Alaska Exploration (CAE) in 1986 with airplane flyovers accessing the possible minerals contained in the rocks. From 1988-1992, small-scale drilling operations were conducted, enabling CAE to estimate the volume of minerals contained at the site, which was originally called Pebble Beach. Their estimations showed 11 million ounces of gold and 3 millions tons of copper were present inside 1000 million tons of ore. After a nine-year lull, interest in the project was reestablished by Northern Dynasty Minerals, Ltd. (NDM) when they acquired

mineral rights from CAE's parent's successor company, Teck Cominco in 2001. A year later, NDM initiated new exploration efforts that are still ongoing. In 2004, the project size was more than doubled with the discovery of another site, named Pebble West. Studies also began that year by NDM to analyze the engineering that would be needed, as well as the environmental and socio-economic situation in the region. In 2007, NDM teamed up with Anglo-American, a company based on London, to form what is now known as the Pebble Partnership, with each company having a 50 percent share in the subsidiary.

3.4 Opposition Groups

Though the idea of a democratic decision-making process is one entrenched in American political thought, reality of accessibility to the political system shows a different side of the story. Although opposition groups have very little formal power over the decisions made by state and federal agencies, attempts have been made to sway public opinion on both sides of the debate. Organizations have been formed by Bristol Bay residents to fight the Pebble Mine permit process. Groups in the community that normally have conflicting viewpoints, including native organizations, commercial fisherman and sports fisherman and hunters, have expressed concern about the possible outcome of a mine in the Bristol Bay region. One of the organizations is comprised solely of natives in village corporations, called “caretakers of the land”. Another one, called the Bristol Bay Alliance, consists mainly of fisherman and business owners in the region. The Renewable Resources coalition, Stop Pebble Mine, save Bristol Bay, Our Bristol Bay and Pebble Mine Alaska are all citizen efforts to raise awareness about the issue. Some of the groups listed above are largely internet-based website initiatives, while

others are true organizations in the sense that they organize actual events related to the issue. Another organization, Earthworks, is an international group against mining that has added the Pebble Mine to their list of issues. Residents of the Bristol Bay region are largely opposed to the creation of the mine. Three different public opinion surveys were conducted, two were sponsored by groups against the Pebble Project, the third was sponsored by the Pebble Partnership itself. Unsurprisingly, the two sponsored by opponents of the project showed the majority of the population being opposed to the mine, while the study sponsored by the Pebble Partnership showed a slight majority supporting the project. Needless to say, vested interests held by each side could have influenced the formation of the questions and the decision about which areas were included in the survey. The Bristol Bay Native Corporation, which represents the interests of natives in the region, has also formally stated their opposition to the mine. Opposition to the mine can best be demonstrated by the manifold strategies that have been used to halt the development of this region. Three kinds of strategies have been used by organizations and citizens to delay progress; persuasion, litigation and legislation. Numerous environmental organizations such as the Sierra Club, Earthworks and the Renewable Resources Coalition among others have attempted to build public awareness of this issue in the national and even global arena. Websites contain powerful personal accounts and pleas against the danger that the Pebble Project could create. Several documents on the risks of mining, salmon health, ecosystem concerns and societal effects of the project have been supported by such organizations to provide a counterbalance to the Pebble Project's website and documents. Earthworks created a “no dirty gold” campaign, urging over a dozen major retails such as Tiffany and Co. to boycott gold

mined in Alaska (“Jeweler's pledge“). Tiffany and Co.'s CEO responded with a strong resolution against the project, stating that “There are places where mining does not represent the best use of resources. In Bristol Bay, we support the salmon fishery as the best bet for sustainable, long-term benefit. For Tiffany and CO., and we believe for many of our fellow retail jewelers, this means we will look to other places to source gold” (Pebble investor risk. p. 8). This approach generated considerable media coverage and several news articles in American and British newspapers covered the story. Other ways in which persuasive tactics are used are by anti-Pebble activists are through funding, publication and online access of research documents. Such documents cover various issues, some stress scientific research linking higher levels of copper to a possible decrease in Salmon spawning, while others highlight the dependence of local and native residents on fish as a food resource.

4 Permit Process

4.1 Alaska Large-Mine Permitting Process

The proposed project would be located on state-owned land, much of which is open to mining claims and exploration under the Alaskan constitution. After a claim has been staked on state or federal land, exploration activities conducted and analysis of economic and environmental feasibility are submitted, the process towards the creation of a working mine continues. Before any further construction or large-scale operations can begin, the Pebble Partnership must apply for the necessary permits required to operate a large-scale, hard rock mine. The permitting process involves agencies at both the state and federal level, and is not a single, comprehensive permit, but a combination of several state and federal permits. According to the information available on the Pebble

Partnership webpage, around 67 permits will be applied for before the construction of the mine is able to begin. Permits involve issues such as water and air quality, animal protection and construction and planning at both the state and federal level, and involve the participation of more than 10 state and federal agencies.

For the purposes of evaluating state permits, a Large Mine Permitting Team is created to coordinate between different state agencies, as well as between local and federal government. All of the documents that the Pebble Project has been compiling will be reviewed by the large mine permitting team. Baseline studies have been conducted for the Pebble Mine over the past few years about socio-economic and environmental conditions prior to the opening of the mine will provide data upon which future comparisons can be made. This data helps in the creation of detailed project plans and form an important part of the mine application process. Environmental data for the baseline studies is broken down into several specific categories that monitor detailed statistics related to the state of the ecosystem. Once the detailed studies are completed, a comprehensive Environmental Baseline Document will be complied. A detailed analysis and review of the baseline studies and proposed plans often involves experts hired from outside government agencies. Often the technical nature of the reports requires more in-depth knowledge of specific fields, for this reason third-party experts usually play a part in the analysis of the material (Crafford). In most cases, application for federal permits needed for the mine trigger the requirement for an Environmental Impact Statement (EIS) under the National Environmental Policy Act (NEPA).

Even before an application is submitted, the job of the large mine permitting team begins working with the company involved and sets up a timeline for the project

application process. After the entire application package is turned in, the Permitting Team investigates the issues that are important to all of the stakeholders affected by the decision, and analyzes and reviews the information. Often there are issues found with the application that must be solved. Finally, the team drafts authorizations, maintains the permit and assists in the monitoring process

Criticism associated with the process

The large mine permitting process has been criticized by those unfamiliar with the process and the way it actually works. From the viewpoint of the general public, the Permit Team always gives a positive response to all of the permits. Behind closed doors, permits that are denied or simply plans that do not meet expectations can be corrected by the company before and the entire project is scrapped. Giving the company a chance to correct shortcomings is part of the application process, and it means that many problems are corrected before they are ever made public. However, there are some situations in which then problems are too numerous to solve. In the past case of the proposed A-J mine for example “We worked with them quite a while until the no's killed the project," (Amstrong).

A more recent and targeted criticism of the large mine permitting process produced by a former Alaska Department of Fish and Game employee was made available online by the Renewable Resources coalition. During the administration of Governor Murkowski, several changes were made with regard to the balance of competences between state agencies that have led to a concentration of power in the Alaska Department of Natural Resources (DNR), while at the same time the staff at the Alaska Department of Fish and Game was thinned out (Trasky). Authority to follow the

Alaska coastal management program and protect wetlands and fish streams were all transferred from the Alaska Department of Fish and Game, an agency whose entire existence focuses on the protection and management of fish and wildlife, to the Alaska Department of Natural Resources. The focus of this agency is to promote economic health and increase the quality of life in Alaska through the management of state resources. The DNR consists of several divisions and are in charge of "all land, water and natural resources except for fish and game" ("About DNR"). Changes in regulation issued by the Alaska Department of Environmental Conservation, a state agency who's primary focus is supposedly the conservation, improvement and protection of state recourses for the benefits of Alaskans, have allowed the discharge of semi-treated waste wastewater from industrial activities into areas where fish spawn. These areas, called mixing zones, enable industrial activities to remain economically viable, but allowing these mixing zones in areas where fish spawn reduces the level of protection of this resource. Another possible issue is related to the source of funding for research and analysis of projects. Currently, the system is set up so that the mining company applying for permits must directly arrange all of the environmental studies, or baseline studies, that are conducted prior to the permitting process. In addition, the document claims that the salaries of state department agency individuals involved in the permitting process are paid by the mining company also (Trasky, 4). If this is the case, state employees involved in the permitting process may be under increased pressure to reach a positive decision in the interests of their own job security. If the accusations put forth in this document are correct, an unbiased, balanced method of decision-making regarding Pebble Mine and other proposed mines will be difficult to achieve (Trasky) The centralization of power

may have the effect of streamlining processes which may have been overly complex, but at the cost of lower protection for fish and wildlife in Alaska. Provided the Alaska DNR does manage resources wisely, the transfer of authority should not present a problem. While it is clear that the balance has shifted in favor of a different regulatory agency, it is hard to know if the effects will be as detrimental as this former employee claims they will be. On the other hand, an important issue is brought to the forefront of the mining debate- that is the source of knowledge and science used in the decision-making process. Because of the heavy emphasis placed on scientific data, the source and quality of the data should accompany the analysis of the decision-making process used.

4.2 Litigation

Due to the complex system of land ownership, there are several strategies that can be used to attempt to prevent the necessary permits from being issued to the Pebble Partnership. The land through which the proposed road would run crosses into the boarders of two native corporations, and five village corporations. Almost half of the length of the proposed road would run through land owned by the Bristol Bay Native Corporation (BBNC), and the group "passed a resolution denying development of the road across BBNC lands until the native corporation has received the Pebble Mine development plan and determined whether development of the mine meets their approval" (p. 8). As of 2007, around 70% of the BBNC members disapproved of the project, making it unlikely that infrastructure development will run smoothly in the development process.

Most recently a suit was filed by several native corporations along with a few prominent Alaskan residence that attempted to block the exploration efforts and

temporary water usage permits that the Alaskan Department of Natural Resources (DNR) has already issued to the Pebble Partnership. The civil suit claims that the Alaskan DNR "failed to consider the publics interest in sustaining the region's rich salmon, wildlife, and subsistence resources, which are negatively affected by exploration activities", and asked the court to order a suspension of exploration efforts immediately (Hill). Although the effort has not been successful to date, similar lawsuits questioning the legality of permits already issues and those that are being applied for could be brought into question by the public. Another recent lawsuit challenges the State of Alaska and the laws in the 2005 Bristol Bay Area Plan was initiated by several federally-recognized Alaskan tribes, many of whom reside in the watershed area of Bristol Bay. The lawsuit against the Alaskan DNR challenges the Bristol Bay Area Plan which altered the land usage of state land around the mine claim.

4.3 Legislation

Three bills were introduced into the Alaskan senate that would have greatly undermined the ability of the Pebble Project to receive the permission needed for mining. The first, House Bill 242, attempts to alter state law and place restrictions on large scale mines by requiring a five year long baseline study of conditions before mining to be submitted well before any permits are issued. It would also require the companies to prove that they would not have any effect, whether direct, indirect or cumulative, on "fish, wildlife, or commercial, subsistence or sport fishing activities, or on guiding and tourism" (Our Bristol Bay).

One bill, originating in the Senate, would have created the Jay Hammond State Refuge in the Kvichak and Nushagak drainage areas, which would have given legal

protections to wildlife located in these areas, and would have prevented new mining claims to be made in the region. The bill never made it out of the Alaska State Resources Committee. Another action aiming to protect the Bristol Bay ecosystem was initiated by two members of the Alaskan House, who proposed the House Concurrent Resolution 15. This would force the Alaska Legislative Council to access the environmental and socio-economic consequences of the Pebble mine by issuing studies from two independent bodies, the National Research Council and the National Academy of Sciences.

5 Impacts

5.1 Potential Impacts of Open-Pit Mining

While mining has the potential to generate economic wealth and jobs, the act of mining also poses the risk of undesirable consequences. The following section will explain some of the risks commonly associated with the type of mining that will be undertaken, and why they are an issue with regard to the Pebble Mine.

Like any other industrial undertaking, mining can have an effect on the environment, society and economic situation in the area it operates. Several hundred abandoned, current and proposed mine claims sites exist in Alaska. The Pebble Project is classified as a hard rock mine, which is grouped separately from other types of mines such as coal mines and oil sand mining with regard to both regulation standards and economic statistics. This separate classification enables mining to be compared to other industries in the state such as gas and oil production or commercial fishing.

The most obvious effects of hard rock mining are the aesthetic changes in the land. First and foremost, mining, especially open-pit mining, alters the physical landscape in the area. The changed landscape is not only unaesthetic; it can increase rates of erosion

and often creates large amounts of dust containing large amounts of potentially harmful wastes. Chemical changes that are not always seen with the naked eye come in the form of acidic waste and chemicals that can find their way into surrounding waters. Water contamination is one of the biggest issues with regard to mining. Degradation of water quality is an effect of mining that often lasts decades after the mine has been tapped out.

Pollution from mining often occurs as a result of the wastes products left over from the mining process, referred to as 'tailings'. Ore, which is material that contains enough minerals to make it cost-effective to process, is crushed or milled into a fine powder, then different methods can be used to obtain the desired metal from this fine powder depending on what the target mineral is. Sometimes chemicals are added that cause the desired metals to float on top of a foam that forms on the water. Other situations call for a solvent to be added that melts down the mineral. No matter methods are used, the process inherently creates leftover waste products that must be contained in large pools. The pebble mine project calls for 5 such pools, or natural earthen dams in this case, to contain tailings. Ideally, the design of these structures would prevent any leakage from occurring that would contaminate air, water or soil in the area.

5.2 Acid Mine Drainage

The process of mining inherently causes changes in the rock that is mined, characteristics of the ore help to determine in what way the chemical makeup of the rock will be affected. When ore contains certain types of elements, it creates a higher potential for runoff that could impact water in the vicinity. Acid rock drainage occurs when sulfide materials oxidize.This process occurs very slowly in nature but can be accelerated when human activities such as mining and road building bring rock to the surface, where it

begins to oxidize to due water and air exposure. This accelerated process is referred to as acid mine drainage. “Acid mine drainage is responsible for physical, chemical and biological degradation of stream habitat” (Jennings, 8). Receiving waters, where wastewater meets a natural body of water, tend to have a very low Ph as a result of the high acid content of the sediment. Ph levels effect different species of fish differently, there is a threshold at which all aquatic life is destroyed, but even slight changes in Ph dramatically effect the number and diversity of fish in an area. In the past, “fish kills” have occurred in situations where mine tailings escaped their confined areas due to storms or other accidents, killing off large numbers of fish (Jennings11). In other areas of Alaska, as well as in Canada and the Pacific Northwest, where pacific salmon also spawn, the results of acid mine drainage have shown to have decreased the number and diversity of salmon species in the streams. The nature of the deposits at the proposed pebble mine are likely to cause acid mine drainage because of the high levels of sulfide contained in the ore, as well as the size of the operation planned (Roth, 61).

Water

The biggest environmental issue facing the mining industry today is without a doubt water quality. Mining activities have polluted several bodies of water to date, and the problem does not end when mining ceases. Acidification and dissolved minerals can still be found in water systems decades after a mine has been shut down. Often, mines are not shut down so much as abandoned due to bankruptcy. With regard to the Pebble Project, water is without a doubt the key issue and the major source of controversy between locals and the Pebble Partnership. In Alaska, as in every ecosystem, clean water is a necessary element for healthy plant and animal life. Everything in the ecosystem is

linked in such a way that if one of the links in the chain is weak, the whole chain could potentially break down. Fish are directly effected by pollution, salmon always return to the same stream in which they hatched, meaning that even if a stream is polluted and will harm the fish going up that stream, a salmon's instincts will keep in going in that direction. Not only are salmon a prized fishing resource, they provide food for wildlife in the area where humans have not yet managed to disrupt the natural cycles.

When the volume of wastewater becomes too enormous, water must be disposed of in some manner. Recent changes to regulations on so called "mixing zones", where wastewater empties into a natural water source, have provoked concern amongst residents of Bristol Bay. Mixing zones are specific places where waste water is allowed to be disposed, the idea behind them is that water that is treated to some degree will be diluted, bringing levels of potential contaminants down to levels where they are not harmful. When applying for a mixing zone permit, factors such as the amount of wastewater discharged, flow of natural body of water and the state of the ecosystem, plants and animals in the area must be taken into account (Sonafrank, 2). Mixing zones are allowed because of the need of industry and wastewater treatment plants to discharge of water; without the mixing zone laws, discharge water would have to be fulfill drinking water requirements which would not be economically feasible (Sonafrank 2). Wastewater treatment plants, seafood processors and the mining industry all take advantage of mixing zone permits.

Water as a common good is needed in surrounding villages for personal use and as drinking water. Even small amounts of certain elements or a slight difference in acidity could have effects on human health. Water quality is a key issue in the mining debate;

once a water source is contaminated it is difficult to impossible to clean it, irreversibility of the damages that can be done point to the seriousness of the situation. In addition, because water is something people come into contact with and consume in their bodies every day, cumulative effects of contaminated water may produce public health risks that are unknown for many years. In any case, prediction and mitigation plans produced by the environmental impact assessment reports needed by many mines to begin the permitting process play a key role in protecting the surrounding environment. The Pebble Partnership is expected to turn in a development plan within the next few months. In addition, they will be required by the National Environmental Policy Act (NEPA) to submit a detained Environmental Impact Assessment (EIS) that will be reviewed by the federal government. NEPA is not intended to be a regulatory body with the decision to grant or deny permits, it is simply a tool used by federal and state authorities to determine the possible consequences of granting the permits necessary for the project. Inaccurate reports are not punished, it is assumed that the source of the report is non-biased and that the methods use are based on sound science. Only if the reports are incomplete and do not address certain concerns can they be challenged, sometimes leading to termination of the project.

5.3 Site-specific risks

The Pebble Project poses a particular concern for tailings storage due to it's location in Alaska. The proposed location for the mine is located on the Pacific “ring of fire”, an area with high geologic and seismic activity in coastal areas near the Pacific basin. This area of Alaska is by far the most seismically active area in the US, and is known in particular for strong and reoccurring earthquakes, with major earthquakes (over

7.0 on the Richter scale) occurring an average of every two years (AEIC). Concerns have been expressed by many experts and locals alike about the viability of earthen dams to hold potentially toxic wastes in the event of a large earthquake. Although Northern Dynasty's claim was that the dams would be built to withstand a quake up to 7.8, the mixture of contained toxic materials in a seismically and volcanically active region is an additional risk that cannot easily be calculated in a cost-benefit analysis.

5.4 Infrastructure Issues

The road needed for transportation is also a controversial issue because of the road's remote location. The proposed transportation road of around 100 miles will need to be constructed in order to connect the remote mine site with other towns. An estimated 120 rivers and steams will need to be crossed if the road is constructed according to the current plan (Hauser). Instead of building bridges across every one of these bodies of water, culverts, an enclosed metal drain, would most likely be put under the road where it intersects with streams. In the past, culverts have obstructed fish movements due to poor planning or inadequate design. In other regions of Alaska, research has shown that anywhere for 44 to 85% of culverts are impassable by all types of fish or specific species (Hauser). Initial construction and regular maintenance of the road is also an area of concern; extreme weather conditions could make road maintenance a frequent activity, and initial construction would require the use of heavy machinery.

5.5 Socio-economic effects

Mining could increase the number of jobs available to local residents in the Bristol Bay region, especially in the few small villages around Lake Iliamna. Although many locals would welcome the creation of new jobs, many are also skeptical of the

possible effects mining will have on fish, which are currently the largest source of income. Possible ecosystem disruption from mining activities will have an effect on the animals and people that depend on the healthy ecosystems. If a decline in salmon populations occurs as a result of mining activities, whether it be the construction of a road or a chemical leak into the spawning grounds, a vast majority of the Bristol Bay population will feel the effects. The region was already declared a state economic disaster area in 2002, when low fish stocks and low market prices for Sockeye Salmon devastated the local economy. If the supply of salmon available for commercial, recreational and subsistence uses were to decline, the results could trigger another economic disaster. Fluctuations in stock and prices are often seen as a reason for increased development in the area of economic activities such as mining, which create year-round, stable sources of income. Paradoxically, increases in development, especially in mining, could affect the salmon which is currently responsible, directly and indirectly, for most of the employment in the region.

Mining in Alaska employs 3,000 people, commercial fishing employs 14,000, and sports fisheries 12,000. From an employment standpoint it would appear that the fishing industry provides more jobs to Alaskans, but it must not be forgotten that these jobs are typically seasonal and are often filled by outsiders. The same could be said for mining jobs. A common fear expressed by locals near the proposed Pebble Project is that the jobs will be given to workers with specific skills who will be hired from outside the state, leaving fewer possible opportunities open to the locals. Another concern is that locals will only be hired for the temporary construction phase of the mine and will not be able to fill the full-time, long-term positions that will be made available. With regard to

industry payments to the government, taxes and licensing fees account for $13.7 million annually in the mining industry, in commercial fishing and sport fishing it is $50.4 million and $640 million respectively (Rothe, 3). Currently, the mining industry, including the royalties they pay, contribute less to public funds than either the sport fishing, commercial fishing and oil and gas extraction sectors of the economy. A similar story unfolds when comparing the amounts contributed by mining companies to the Alaska Permanent Fund, an investment tool created by the state that takes revenue from extraction industries and distributes equal portions of the interest earned on the investment every year to every man, woman and child registered as a year-round resident of Alaska. With regard to the Alaskan Permanent Fund, the mining industry has contributed $8.8 million to the permanent fund since it first began, which represents only 0.09% of the value taken from the land. (Roth, 2) By contrast, coal, oil and gas extraction have contributed a total of $5.3 billion to the fund, representing 2.8% of the value of the resources extracted (Roth, p. 2).

Because each group is interested in using a different resource, it would seem that conflict would not need to occur. However, due to the possibility that mining would affect fishing, a solution must be found that addresses the rights of each group involved. Normally, when one economic activity affects another, the company or individual producing the negative externality is somehow persuaded or restricted from pursuing the activity. In the case of mining, violations of various regulations may lead to permits being revoked, shutting down the mining activity altogether. Coase, in his paper titled “The problem of social cost”, refers to a situation similar to this one and frames the problem in a different light by asking “is the value of the fish lost greater or less than the value of the

product which the contamination of the stream makes possible" (Coase, 2). In other words, are mining interests allowed to harm fishing interests, or are fishing interest allowed to harm mining interests? In a system where there are no bargaining costs and the system of pricing works correctly, the most economically beneficial outcome for society will be reached. For example, if mining activities running at fifty-percent capacity cause the amount of fish available for commercial and subsistence fishing to drop by half and the mine is held liable, they have the choice to either construct a new system that prevents water from being polluted and poisoning the fish, or paying a fee to those involved in fishing equal to the market value of the fish killed. A regulatory approach might dictate that the mining company pays damages to fisherman, even if this is not the most economically efficient solution. Under a system with no bargaining costs, the mining company can choose the most beneficial option, which may be to improve the methods of waste water containment rather than to pay off the fisherman for their losses.

The assumptions of this theorem are not practically applicable in many cases. Property rights in this situation are not well-defined because the state is technically the owner of the land and property. In addition, bargaining costs in the form of litigation are incredibly high. In Coases theorem, the prices of each good are stable, while in real life prices for the commodities in question, fish and metal, change often and would mean that an efficient outcome could change from year to year. Nonetheless, the theorem brings up the importance of property rights and the role they play in the debate, exemplifying the need for more defined property rights in the case of public goods. In the end, if one industry effects another it will create a battle between the two industries over the amount of protection each is qualified for under law.

5.6 Societal Benefits of Mining

Job creation and royalty payment are a major benefit that the mining industry provides for the state of Alaska. In 2004, employment in the mining industry provided for around 3,000 jobs in the state, brought in over $13 million dollars in state revenue and provided an estimated 10 million in municipal/borough tax dollars. Although this is a significant amount, mining is still second to commercial fishing in terms of tax dollars collected at the state level and in the number of jobs it creates.

Framing the problem behind the risk involved is a good tool to evaluate the potential of the project in question. Mining as an industrial activity has provided society with the raw materials it needs to grow and prosper. Raw materials are important because of their potential for a multitude of uses in both high and low technology industries. Copper is used in construction of houses, gold is a valuable tradable commodity and molybdenum used in high-tech industries. The proposed Pebble Mine would provide vast quantities of each types of these metals, but at very low concentrations. These minerals probably constitute a large value to society as a whole, but the low concentrations are a cause for concern. Is more beneficial to society to mine only those deposits with higher concentrations? Is there another way of mining which does not have a potential to harm the environment? How necessary are these minerals? Are they replaceable by other materials that are more readily accessible? Another possible concern is the value of each mineral involved in the pebble project. Prices for minerals as commodities can fluctuate wildly from month to month, depending on supply and demand, which are contingent on manifold factors occurring in the world and are difficult to impossible to predict. If the prices for the target minerals drop suddenly, would the pebble partnership be able to

continue operating the mine at a profit, which, just through it's construction, has already drastically effected the environment?

While minerals are useful to society, how do fish as a natural resource measure up to minerals? Fish differ from their benefits to society because they are a renewable resource. Renewable resources can be replaced by natural processes in the environment faster than people consume the resource. Although salmon fisheries do not completely fit this guideline, with state management strategies salmon populations have remained healthy in most areas; consequently, salmon are able to be harvested every year. Theoretically, barring major climate change catastrophes and human intervention, populations of salmon will continue to be a viable food source for years to come. Not only do salmon feed locals through subsistence fishing, commercial fishing provides wild salmon for consumption throughout the world, and is one of the last wild (non-farmed) sources of salmon in the world. Minerals on the other hand, are a non-renewable resource, meaning that we can take them out of the earth faster than natural process can create them. Some mine sites can provide minerals for decades, 45 percent of all mines that were in operation in 1975 are still being mined (Kuipers, 23). The Pebble Mine is expected to provide for between 20-30 percent of the US needs of copper for 50-80 years (“Not Your“).

6 Risk-Management and the Precautionary Principle

Now that the situation has been clarified, the issue of whether or not to issue the Pebble Project the permits it needs seems to a relatively straightforward question. The situation will be judged based on scientific facts and figures that can unequivocally determine what effects, if any, the proposed mine could have on the ecosystem near the

adjacent lakes and wider Bristol Bay region. In order to understand the approach used by the large mine permitting process it is useful to look at the type of decision-making tool used by the mine permitting team; an approach called risk-management. Risk management is a decision-making tool that is heavily relied upon in American politics, the approach uses cost-benefit analysis and emphasizes sound-science and expert-based analysis above all. Risk management has many benefits as a tool in decision-making, but it has also been criticized as being inadequate for decisions involving high levels of risk and uncertainty, and for it's exclusion of social concerns and layperson views. An alternative approach to decision-making involves the use of the precautionary principle or precautionary approach. Although the relation between these two approaches has been debated, for the purposes of comparison each method will be treated as a separate concept. The precautionary approach emphasizes the need for decisions to take into account scientific uncertainty and irreversibility of possible consequences, allowing for preventative measures to be made with regard to the environment and public health in the face of uncertainty.

6.1 Usage

Risk management has traditionally been the main decision-making method characterized in environmental and public health issues in the US. However, examples of precautionary measures can be found in the US, their reasoning closely mirrors the ideas enshrined in the precautionary principle as set forth in academic literature.

While the precautionary principle has gained influence amongst Non-governmental and non-profit organizations and in academic circles, proliferation of this approach into everyday politics in the US has not occurred. Usage of the approach is limited by the

nature of politics in the US, including “limited flexibility in US regulations; the need for agencies to defend themselves in court; and the US reliance on a narrow vision for 'science-and expert-based' regulations” (Tickner, 194). As a whole, the laws that protect the environment are vague and broad. Consequently, government agencies responsible for regulation create highly-detailed orders, some of which conflict with actions being carried out by other departments. The fragmented nature of environmental protection slows down any reactionary measures to problems that occur unless they are an imminent danger. To make matters more complicated, competences in environmental protection are spread between local, state and federal government bodies creating additional conflict. Due in part to the strong separation of powers, any individual, group of company who disagrees with the legality environmental legislation has the option of taking the issue to court or challenging the issue in Congress. Historically, the courts have played a disproportionately big role in the application and legality of environmental legislation. The ability to set precedents with regard to the level of precaution versus cost-benefit analysis puts the US judicial system at the heart of disputes revolving around the levels of precaution that is able to be used in decision-making. In the case Ethyl Corp. v. Environmental Protection Agency, the District of Columbia Court of Appeals made a ruling supporting the ideals enshrined in the precautionary principle by acknowledging that a presence of scientific unknowns in a precautionary measure do not require the measure to prove causality. In other words, precautionary measures under certain circumstances do not have to prove “a rigorous step-by-step proof of cause and effect” (Tickner, 197). However, that precedent was overturned in a case where ample cause and effect was not established to necessitate occupational health standards for benzine,

emphasizing the need for scientific proof that justified action. The role of the court changed when it overturned an Environmental Protection Agency (EPA) ban on Asbestos, ruling that the "least-burdensome" option must always be chosen based on a cost-benefit analysis. More recently, the courts are requiring the EPA to conduct cost-benefit analysis when deciding on legislation regarding pollution and public health. As a result of the several outcomes in court, environmental agencies place an emphasis on scientific analysis and economic costs and benefits of various legislative options, to the effect of limiting propensity towards precautionary measures. The litigious nature of the American political system, spurred by the rights enshrined in the Bill of Rights, the original intention of which was to protect citizens from excess government interference, has produced "excessive litigiousness" that has advanced the rights of minorities, women and the environment (Lipset, 21). However, the same characteristics has created policies that are highly dependant on economic and scientific facts and figures that are more easily defended in court, which in the case of the environment can often work against protectionist measures. Currently, the system of decision-making downplays the role of unknowns and uncertainties present in scientific and economic analysis, essentially placing a high level of trust in the makers of facts. Accounting for uncertainties and recognizing the risk that they present would enable a more realistic and representative assessment of possible outcomes of various decisions.

6.2 Risk Assessment

As the dominant method of decision-making, risk-assessment is a pragmatic approach to resolving complex decisions involving uncertainties. It involves organizing and interpreting technical information for use in the decision-making process. Often, this

approach puts an emphasis on “sound-science”, which is a subjective term frequently used to describe a decision-making process based on hard science facts and figures. Another characteristic of the approach is an emphasis on cost-benefit analysis- which implies that some adverse effects are permissible if the benefits of the contested action bring about enough positive benefits to counteract the negative effects. Using cost benefit analysis in policy-making procedures has both benefits and drawbacks. An advantage of cost benefit analysis is that it can show how resources can “be used to bring about the greatest social good” (Arrow, 1). Investments can affect society in different ways, and cost-benefit analysis recognizes that sometimes the costs of an action can outweigh the benefits, and that money or effort could better be used elsewhere. On paper, cost-benefit analysis provides a balanced evaluation of the pros and cons of an action, but in reality measuring marginal costs and benefits can pose a challenge for real-world applications. In some situations, a small improvement that costs relatively little may bring about much larger benefits in proportion to the small action, an example of which would be regulations involving better fuel economy standards. In other cases, situations of marginal costs and benefits are difficult to create in real life- for instance when regulation involving pollution of a waterway is impacted, how much more beneficial is a partially polluted waterway than a heavily polluted waterway? What discount rate could be used to express that future benefit? Another complex aspect of regulation is that of fairness, although costs and benefits may be able to be calculated for society as a whole, the burden and benefits of some decisions may be disproportionately skewed towards certain groups in society, which in turn may change the desirability of that particular regulation option.

Despite the best intentions of sound science methods and cost-benefit analysis, the actual effects of a decision are fraught with uncertain outcomes. Expert-based analyses, upon which policies and decisions depend, are assumed to be accurate. It would appear that expert opinions are seldom challenged. From an outsider's perspective, science seems to produce objective, undisputable truths, but assumptions present in design research unknowingly influence the outcome of scientific research (Forsyth). Assumptions made in research design and modeling often tend to downplay the uncertainties present in a particular situation. Uncertainties pertain to a situation in which "individuals, groups, communities, cultures or everyone experiences or constructs doubt upon something that matters in view of decision-making and acting which is partially or fully possible, because scientific knowledge is perceived or portrayed as limited" (Van Asselt). Uncertainty under this broad definition encompasses a wide variety of situations in which science cannot produce predictions with one-hundred percent accuracy. Sometimes uncertainties may stem from variability associated with a situation; climate change is a situation in which there are several variables that can affect possible climate fluctuations. It is difficult to impossible to predict with one-hundred percent accuracy what the values for each one of these variables will be, which makes the reliability of the predictions made highly uncertain. In other cases it may be due to limited knowledge about a situation, especially in the case of new technologies such as genetically modified foods and the potential effects on human health.

The Environmental Protection Agency (EPA) approach with regard to risks and risk assessment asks three general questions. First and foremost, what is the source of the pollutant? Secondly, how does the pollutant find its way into the air, water, land or food

in the environment? Lastly, how are individuals coming into contact with the harm? Under the ideas in risk management, it is assumed that some levels of harm may be acceptable, especially considering the benefits of the harmful action. Action to prevent a harmful activity is not taken until after it has been proved to have harmed the environment or people. Risk management normally ignores the unknown, relying upon "sound science", or quantifiable consequences. The criticisms associated with this approach is that it takes the position of that an action or substance is innocent until proven guilty, it is by nature reactionary rather than proactive. By contrast, the precautionary principle assumes that uncertainty in the scientific realm, combined with a situation in which people and the environment are likely to be effected, is enough to justify action. Although risk-assessment is commonly cited as the other alternative to the precautionary principle, economists that support this kind of quantifiable, cost-benefit approach claim that "despite the arguments made for decades by economist, there is only limited political support for broader use of benefit-cost analysis to access proposed or existing environmental regulations. These analytical methods remain on the periphery of policy formulation" (Stavins, 16). The question of how decisions are make in the realm of environmental policies then becomes apparent. Proponents of each method claim that practical application of each method is limited. On what basis are decisions made if not the precautionary principle or cost-benefit analysis? Is it possible to separate politics from science in the policy-making process?

6.3 Uncertainty and Risk: role in decision-making process

While sound science approaches attempt to model an accurate prediction of the future under certain circumstances, the methods used are never completely accurate with

regard to actual outcomes. To further complicate the matter, conflicting material from different experts constructs uncertainty upon which opinions are formed. Uncertainty is constructed or occurs under different contexts. Firstly, a situation of uncertainty occurs when there is perceived to be a shortage of information; it is the most commonly cited form of uncertainty (Lipshitz). Generally the solution to this dilemma requires more detailed studies and analysis when the time and funding is available. Secondly, uncertainty is perceived under circumstances in which a deluge of information adds to ambivalence due to "conflicting meanings" (Lipshitz, 3). Thirdly, uncertainty is felt in situations where a lack of differentiation is presented in cases where there is no option that is more or less desirable, a term which has been coined "conflict" (Lipshitz 3).

In some cases, the solution to uncertainty is simply to gain more information about the issue, but in many situations it is simply not possible. For situations such as these, attempts have been made to statistically calculate to account for uncertainty, assigning a probability to different kinds of outcomes based on past events (Lipshitz, 5). This approach was taken by some documents in opposition to the Pebble Project some took a qualitative approach and others took a quantitative route. One example of the quantitative approach to reducing uncertainty regarding the environmental conditions that would occur around the mine site is a work that looks at other mines in North America to judge the likelihood that the Pebble mine in Bristol Bay would produce undesirable environmental conditions. The study took a sample of mines from around the United States and analyzed the proposed propensity the mine would have to worsen water quality. The premise of the article was that even if the Pebble Partnership alleged that water quality would not be affected, past experiences and events show that there is still a

high likelihood that water quality could be worsened. Another approach, assumption-based reasoning, fills in gaps of knowledge, going beyond what is known about a situation and making reasoned guesses to reduce uncertainty (Lipshitz, 5). Many websites opposing the Pebble Mine take this approach, linking together the concepts of mining with pollution, and pollution with decreases in fish populations. Although it has not been proven that if Pebble was polluting that it would reach waterways where fish spawn, environmental groups assume that if pollution occurs that fish will in fact come into contact with it. The assumption continues by claiming that when fish come into contact with toxins of any sort at any level that it will invariably kill them and lead to a population decline. In some cases it is possible to control the variables associated with the uncertainty. Variables that are able to be controlled in this situation would relate to the size of the mine in operation and also the techniques used to keep the tailings wastes in place. Although some mines have had negative effects on the ecosystem, the Pebble Partnership has claimed that improved technology will prevent tailings wastes from coming into contact with water sources, essentially lowering the odds that contamination will occur.

In some instances, decision-makers attempt to quantify uncertainty as a coping mechanism (Lipchitz, 4). This trend emphasizes the acceptance of uncertainty in the decision-making process, and is part of a second strategy of uncertainty management involving acknowledgement of uncertainties (Lipshitz, 4). Another way of acknowledging uncertainty is by creating ways to be prepared for the risks associated with unknown outcomes. Such strategies are often taken by companies that must regularly plan for activities in the long-run that are fraught with great unknowns. In the

case of the Pebble Partnership, structural approaches relating to the composition of the company itself show the way in which approaches to the project itself can be seen as a hedge against uncertain outcomes. The Pebble Partnership is a subsidiary formed by two companies, the structure of which enables the two parent companies to provide the subsidiary with ample funds, but limiting the parent companies' liability for the subsidiary. This enables the Pebble Partnership to declare bankruptcy and effectively dissolve without any negative effects on the parent company.

When all rational efforts to deal with uncertainty have been exhausted, the last option for decision-makers is to simply to suppress the uncertainty (Lipset, 5). Relying on "sound-science" and data enables the Pebble Partnership to essentially deny the possibility that the outcome of the mine is uncertain. Both the amount of copper contained in the deposit and the possible impact of mining activity on the ecosystem and social and economic status of the Bristol Bay area are uncertain. When addressing the concerns related to the project, the Pebble Partnership simply points the studies available and highlights the forthcoming studies, requesting individuals to withhold judgment until the data answer the questions ("Not Your"). There is no admission on the part of the Pebble Partnership that the data will be anything but one-hundred percent correct in its predictions, clearly showing a denial of the possibility of unknowns.

6.4 Pebble Mine through the Sound-Science Perspective

In theory, the Pebble Partnership would prevent pollution of the watershed in surrounding areas using properly constructed tailings ponds, though the Pebble Partnership has not released detailed plans of the specifics of tailing embankment structures that will be used, or how they will deal with possible leakages, the material

they have published indicates that they will “design and build tailings facilities that are able to withstand sever earthquakes, floods and other catastrophic events” (“Pebble Mine Project“). In addition, waterproof liners or water collection systems can be used to prevent any leaks from contaminating the surrounding environment (“Pebble Mine Project“).

Current methods of analysis and decision-making rely heavily on quantifiable, sound-science based modes of justification. Each phase of the mine’s development uses sound-science based methods, starting with the exploration phase where technology and sampling can be used to determine the amount of minerals present in ore. In the permitting phase, sound science plays the role of the referee. Pebble project executives have stated that they believe people should “let the data speak for itself” before making any judgments (“Red Gold“). The Northern Dynasty Data, a form of what is considered to be sound-science, is a large part of the permit application process, baseline studies and EIS statement, most of the data is created and compiled by outside consultancy firms hired by the company to perform the specific task. So expert-based is the data that even high-level policy-makers in Alaskan State government agencies cannot understand that data, and outside experts are brought in to interpret the data. This process increases the chances for error, misunderstanding and poor communication. When neither of the two most powerful stakeholders involved in the project fully understand the implications of their decisions, the role of the expert is increased dramatically. Although experts may truly be unbiased with both creation and interpretation of data, little is done to recognized the unknown variables and hence the range of potential outcomes. More than 500 scientists and experts have worked on the compilation of environmental research used in

the baseline studies and permit applications. While having a multitude of scientists would seem to increase the chances of accurate data, it could also have the effect increasing the diversity of viewpoints associated with the data. With several different interpretations of data available, it is possible that the Pebble Partnership has the option of picking and choosing between different outcome options that are presented to the various government agencies and published for public viewing. Not only does the Pebble Partnership have an influence over how the data is created because they are the sole funders of it, they also have control of the way in which the data is used and to whom and how it is presented.

6.5 Uncertainty and Water Quality Predictions

In the case of Environmental Impact Assessment for the Pebble Mine, the biggest and possibly most difficult issue will be that of water quality. Already there are conflicting opinions of the effects or lack thereof on water supplies from the scientific community. Studies on this project are usually funded by parties with an interest in pushing a particular outcome. While the Pebble Prospect is required to publish studies of this sort eventually, non-profit groups working at the local, state and national levels are pooling their resources to commission studies on many different aspects of the Pebble Project, ranging from the importance of fisheries to public opinion polls of Bristol Bay residence on their feelings about the proposed mine to the mining industries track record of producing accurate water quality predictions. Studies commissioned by both sides of the debate are conducted by independent researchers, some of them are academic professionals working at public universities and others work for private research and think-tank organizations. Studies commissioned by the Pebble Partnership tend to be highly technical in their approach. Documents assessing certain aspects of the mine

project are posted on their website, free for all to see. However, the technical nature of the documents prevents any layperson, or anyone not specialized in the field of sciences, from comprehending the reports. What is assessable to all individuals are the basic promises made by the Pebble Partnership on its webpage. The opposition also draws attention to their main points on their websites with attention-grabbing, cautionary stories and quotes. Studies commissioned by the opposition are often a result of collaborations between different environmental and local Bristol Bay organizations. The range of their studies is much wider, and the reports tend to be more reader-friendly, explaining the terminology needed to understand the report and providing examples for comparison to provide a context for the situation. Both sides make data available that enhances the validity of their prospective claims, which makes evaluation of the proposal difficult for outsiders. While the Alaska DNR and other government agencies will receive only the data sponsored by the Pebble Partnership, it would be likely that the general public will only be able to understand the data presented by the opposition organizations, leading to a polarization of opinions due to the different sources of information consumed.

The importance of clean water in areas surrounding a mine cannot be understated, yet the methods behind predicting and planning for water contamination are imprecise. In every environmental impact report the possible effects the mine could have on groundwater should be predicted. The outcome of the report itself does not determine whether or not the mine will be approved, but is meant to serve as a guideline to state and federal agencies in making their decisions to award the needed permits or to withhold them. Hence, the predictions and their accuracy play a key role in the outcome of the mine. Because there are so many factors involved in the modeling process, the impact

assessment is not meant to determine if the mine will or will not effect the environment and how much, but what the likelihood is that environmental effects will occur, both positive and negative. In the case of water contamination, many factors are taken into account. Some of those factors are inherent, meaning that they are part of the mining area itself. Proximity to water, weather patterns, and composition of the ore are part of the inherent factors that are part of the equation. The other set of variables are external, or design factors, this includes plans set forth in the proposal that express in detail how mining waste will be treated, stored, and other considerations that constitute the design and planning of the mine. Together, these variables create conditions that have either low, medium or high potential to create water exceedences. Exceedences are conditions where contaminants in water are above permissible levels. When analyzing water, the distinction between groundwater and surface water is made and analysis for each type of water is kept separate.

An evaluation focusing on the predicted and actual results of water surrounding hard-rock mines shows a high rate of inaccuracies. Baseline studies of water quality done before the mine was active were compared with water quality results from during or after the operation period to account for any existing contaminants. A case study was performed whereby 25 mines located throughout the country were chosen and evaluated on the accuracy of their predictions with relation to water exceedences. Of the 67% of mines in the study which had levels of contaminants in surface water that were higher than allowed, none of them was predicted as being a mine with “high potential” to have exccedences (Kuipers, 28) . In other words, none of the mines were considered as having a high probability of polluting surface water, but they did. Three of the 15 mines with

pollutants did not have information related to this type of potential. Seven of them had predicted a moderate potential, and 4 of them a low potential (Kuipers, 47). In this case, the severe inaccuracies show the difficulties associated with such predictions. A similar situation is made apparent by the contaminants found in ground water. Fifty-two percent of the mines in the case study had contaminants in excess of drinking water standards present in groundwater surrounding the mine (Kuipers, 168). One of Environmental Impact Assessments (EIA) predicted the presences of excceedences, two others deemed the mines to have a high potential. The majority of the mines (Kuipers, 168) predicted a moderate potential and two were labeled low potential. Although the accuracies in this area were higher, the range of predictions that all lead to the same outcome is shocking. Acid mine drainage, a process whereby the Ph of water in the area becomes too acidic for plant and wildlife, occurred in 9 of the 25 case study mines or 36%. The majority of these mines, (8 out of 9) predicted a low potential (Kuipers, 172). Clearly the predictions set forth in Environmental Impact Assessments leave much to be desired in the way of accuracy. When predictions are incorrect, the price is paid by the company and in the case of bankruptcy and a low bond amount; the price is paid by the public. An effort was made by the study to identify the different type of factors that influence predictions and secondly the reasons why predictions were not correct. The so called “failure-mode” and root cause were identified in each case where the predictions were inaccurate (Kuipers, 180). Three types of failure modes were identified in the case studies. Hydrologic and geochemical characterization together are two failure modes that account for inaccuracies associated with predictions. These are inherent factors that have more do with the pre-existing conditions of the mine site. Another type are mitigation failures, these types of

failures result from issues such as design failure and are connected with the planning of the mine structures itself. Needless to say, improvements need to be made if Environmental Impact Assessments are to be relied on as the soul source of information regarding environmental quality by decision-makers.

Although there is a standard protocol used by scientists in predicting future occurrences of acid mine drainage, uncertainties are always present. Much of the analysis depends on sampling and modeling methods, the quality of which determine the quality of the results obtained. Despite the uncertainties, the companies invested in the Pebble Partnership have claimed that they are ”committed to develop the Pebble Project in a way that will provide long-term benefits for local communities while protecting environmental values and traditional ways of life” (“Pebble Mine Project“). This vague promise fails to provide the security needed to generate support of the project by the general public. Technical studies completed by outside experts have recently been released and are accessible, in theory, to the general public. Unfortunately for those individuals or groups who are seeking further information on the risks inherent in the proposal, the nature of the reports are so technical so as to disclude understanding by those who are not experts in the field of analysis.

Sound science in the risk-management approach

Risk-management as a decision-making tool lies at the other end of the spectrum from the precautionary principle. This approach relies heavily on quantifiable, scientific facts, downplaying the role of risk, uncertainty and other non-scientific considerations, and has been criticized on many counts for sacrificing public safety and well-being. Nonetheless, the risk-management approach sometimes comes up with the same

conclusions as the precautionary principle; it just takes more time and money to get there. In the case of the Pebble Project, this is not necessarily the case. Risk-management calls for the use of "sound-science" in the decision-making process. The assumption is that science can solve all debates in the policy-making area. Quantifiable results of models and studies provide all the knowledge necessary in the decision-making process. Science refers or course only to the physical and biological sciences, excluding all disciplines involved in the social sciences. One scholar and proponent of risk communication strategies has found through his practical experiences that there is a "slippery relationship" between science and policy (Sandman). Firstly, experts can exist at extreme end of either side of the bell curve, meaning that if you want to find a scientist who believes what you believe it is probably possible. Secondly, it is naïve to believe that scientists are an island of unbiased, true knowledge. Scientists also can have their own personal ideologies which influence there research and its outcomes, sometimes that ideology can also involve money (Sandman). The absence of social sciences does not mean than the outside world has no effect on the process, in fact, research funded by a group is likely to find results in concurrence with the sponsoring group's beliefs, "because they unconsciously resolve the many intangibles in the research process in ways conducive to their funders' goals" (Sandman). Many conflicts over so-called "sound-science" are in fact entrenched in values and moral assumptions. The famous case of the Alar chemical on apples had two different "sound-science" versions of data they were relying on to push their case. When each organization was asked if they would back down if it could be proven that the other side's science was more accurate than their own, they both declined. Even the choice of battles was influenced by social preferences.

Although many another more harmful chemicals and pesticides find their way into foods, the Natural Resources Defense council chose their battle probably because apples and apple juice are products that children consume at higher rates than adults.

Another aspect to think about in a debate is the way in which it is framed by each side. Companies tend to frame the debate in terms of their own “sound science” versus the oppositions “junk science” (Sandman). Activists on the other hand, frame the issue a moral one, pitting corporate greed and lack of values against human health issues that invariably involve the young, the old, disadvantaged and minorities. Governments, when they must choose a side, tend to cite different reasons for support depending on whose camp they end up siding with. Protection is the key word for government agencies when their policies or agenda ends up on the same side as the activists, while “data” becomes the key clarification for choosing the alternative pushed by companies. Usage of the sound-science rhetoric then could point to a system that favors risk-management strategies of risk reduction rather than precautionary measures of risk reduction.

6.6 The Precautionary Principle

Protecting the environment and people from possible threats has always been a difficult challenge in the US. Competences are shared between different levels of government and distributed amongst various agencies within each level of government. Environmental and public health protection tends to be very reactionary as opposed to proactive, waiting until a problem emerges until action is taken. Historically, the burden of proof has been on the shoulders of the public, who must determine that an action is having an adverse effect on people or the environment before the action can be curtailed. Risk-assessment, “sound-science” and cost-benefit analysis approaches are the most

commonly used methods of decision-making in the US. Under the risk-assessment decision-making method, by the time a negative consequence is unequivocally determined, the damage has already been done, often with irreversible ramifications (Tickner, 1). The three main components of the precautionary principle are " threat of harm; scientific uncertainty; and preventative, precautionary action" (Tickner, 3). The presence of both a threat and uncertainty are needed to justify preventative action. In 1998, the Wingspread Conference on implementing the precautionary principle constructed a definition of the precautionary principle which is widely accepted my most proponents (Tickner,192). "When an activity raises threats of harm to human health or the environment, precautionary measures should be taken even if some cause and effect relationships are not fully established" (Tickner,192). The precautionary principle has been characterized in various ways, including "as a broad ethical standpoint, a narrow legal doctrine, specific guidance for decision-making, or as a general tool for advocacy" (Cooney, 6). Partially as a result of the large variation of terms, the precautionary principle has been criticized as being a paralyzing, risk-averting, counter-productive, right-infringing form of trade protection among other things (Tickner, 8).

Some elements of this approach to decision-making are an emphasis on democracy and transparency, which means making information about the activity readily available, and involving the public in the decision making process to some extent. Another aspect of this approach is considering every possible alternative to the proposed action. Often when people hear the precautionary principle they assume that the only way to mitigate risk is an outright ban, but other methods of conducting the activity should be considered, enabling an activity to be conducted that leads to the same benefits but using

a different method with less risks. Finally, the actor proposing or conducting the activity has the responsibility of conducting research on the effects of the action undertaken, and is ultimately responsible for the burden of proof of the activities effects.

Three different strengths of the Precautionary Principle exist in both normative literature and legislation, from weak to strong and a moderate version in between. Weak versions of the precautionary principle are welcomed because they allow, but do no require action. The general premise is that the precautionary principle may be a good tool to use in cases of high risk and uncertainty, but the requirement to take precautionary measures is not present. This leaves open the possibility that decisions can be made based on factors such as socio-economic cost, taking into account the entirety of the repercussions surrounding the decision (Cooney, 6). This type of approach can be seen in the 1992 Convention on Biological Diversity. The moderate view suggests that evidence showing a threat should allow precautionary measures to be undertaken, even when a clear causal analysis cannot be made, and is embodied in the UK Biodiversity action plan. A third approach, the so-called strong approach, uses reverses the burden of proof completely so that “actions of substances are considered 'guilty until proven innocent' rather than 'innocent until proven guilty'” (Cooney, 7). Although this approach is most often associated with environmental activist groups, it can provide a useful approach in certain situations. One example would be for protection of an endangered species, such as certain species of whales, where protective measures are already in place and in order to be allowed to kill a whale, it would most likely need to be proved first that the action would not harm the overall population. In practice, official application of the principle in all forms has been limited, it has as of yet not been used as an overarching solution to

environmental regulation in the United States. In an effort to make use of precautionary measures without having to commit to them in all aspects of environmental policy, thresholds are usually written out that enable concerns such as cost and feasibility to override strict application of the principle. In some cases, the costs of precaution may simply be too expensive, or to difficult to carry out in practice.

Critics of this approach cite the precautionary principal and it's goals as impossible to achieve and detrimental to innovation. Although the precautionary approach may call for bans, often times the solution is simply more research. Precautionary measures do not claim to completely eliminate risk, but they do attempt to eliminate unnecessary risks that are preventable. Others claim that the Precautionary Principle is unnecessary because risk-management are sufficient for decision-making, but it is important to understand that risk assessment works best only under ideal conditions when risks and benefits are known and quantifiable (Meyers). While the precautionary principle is accused of being “anti-science” in its approach, proponents argue that this approach is simply realistic in its knowledge that science cannot reduce all uncertainties in a situation (Meyers). Arguments by opponents of this approach suggest that it impedes innovation because of it's suspicious outlook on changes that cannot be proven to be positive. Another concern is the approach threatens to deprive individuals of freedom and that it may prevent development in areas where poverty is high. Some policies are criticized in this regard for being well-minded on paper but ignoring the day to day realities of the areas they effect. Often the clash of interests has pitted conservationists adhering to precaution against those promoting human development and poverty reduction, such conflicts emphasize the need to take into account the entire impacts of a

policy or lack thereof, not just on the environment but on the regions as a whole, including but not limited to it's economy and inhabitants. Criticism of the practical applications of the precautionary principal depend in part on how the decisions are make and which form, strong, moderate or weak, was used as a framework for the process (Cooney, 8).

6.7 Uncertainty, Science and Policy-making

More and more, science begins to look less sound and more vulnerable to the biases in present in every other discipline, the normative element of science cannot be erased entirely. What is certain is that when companies embrace the risk-assessment, sound-science approach, they usually end up going against everything that the precautionary principle pushes for. Although they may stand by their decision and actually believe that they are not causing harm, the thought-process by which they end up at this decision is completely the opposite of the precautionary method. The push by the opposition of the Pebble Mine for a voice in the debate follows the ideas put forth in the precautionary principle. Under the precautionary principle, democratic methods of decision making are encouraged as part of the approach. In the case of the Pebble Mine, the avenues of influence available to the public to influence the outcome of the decisions are very limited. Positions with state agencies are not chosen by a public vote, and influence over federal agencies is also impossible. Action taken by local government against state agencies has also been weakened in the past decade. Local government has shown itself in many instances to be faster adaptors to the precautionary principle than state and local levels of government. The typical American attitude of “not in my backyard” ideas of environmental and public health protection could partially explain the

propensity of local government to favor approaches leaning towards precaution with regard to these issues. On the other hand, there are those in the community who would argue that the use of the precautionary principle would deprive them of the benefits of development and the jobs and economic growth it could bring to the region. With regard to the democratic aspect of the precautionary principle, little institutionalized methods of public influence are currently available. While the Alaska DNR often has a period for public commentary after a decision has been reached, there is no legal obligation to take any of these comments into account. The practice of allowing public comments is little more than a formality and is a poor excuse for proper democratic participation of the effected public.

An additional aspect addressed in the precautionary principle is that of transparency. Transparency implies that the inputs and decision-making process should be open to the public. While the Pebble Partnership has fulfilled their promise of transparency by publishing online much of the baseline studies and the methodology used to create them, the inability of non-experts to interpret them cancels out the transfer of knowledge that is normally associated with transparency. With regard to the Alaska DNR and the large-mine permitting team, efforts were made to teach the Alaskan public about the entire permitting process through presentations and publication of the slideshow online that explains the general framework of the steps taken throughout the process, from how a mining claim is staked to the restoration process. The part missing from the presentation and other sources of information is an explanation of how the sound-science data is used in the decision-making process. All that is explained in this case it that the data is analyzed by the large mine permitting team to aid them in making the decision

whether or not to issue the particular permit associated with the data. No mention is made of a cost-benefit analysis or a precautionary approach, though the emphasis on data and sound-science points to a risk-management strategy.

Finally, the most important aspect of the precautionary principle and method, its major focus; uncertainty recognition and risk reduction, would have a strong positive impact on the permitting process of the Pebble Mine. Despite the emphasis on sound-science, data and expert analysis, uncertainties and discrepancies in knowledge cannot be eliminated. Because it cannot be proved that the mine will definitely have a negative impact on the ecosystem and fisheries, government agencies will likely have a difficult time denying permits to the Pebble Partnership. This is partially due to the need to defend decisions in court, the litigious nature of American politics and society hinders the practical application of the precautionary principle for this reason. The precautionary principle is all about taking action without the establishment of a concrete cause-effect relationship. Taking these sorts of precautionary actions would likely fail to be defendable in the court system. The stakes in this game are higher than in any past development project in the state of Alaska. High levels of risk to the ecosystem, fisheries, socio-economic and public health of the population are unfortunately not taken into account by those in power. High levels of uncertainty are not necessarily recognized by those in charge of making decisions, who can neither interpret the data nor make claims of its reliability. Unfortunately for the residents of the Bristol Bay region, the extreme levels of uncertainty and risk are not formally accounted for in the data and methodology of the permitting process. The usage of the precautionary methods as even a part of the traditional data and expert-bases analysis would be a step forward for US agencies. While

the litigious and reactionary nature of America will likely persist indefinitely, the number of situations in which litigation must be used in place of effective legislation in the first place could be decreased with the use of the precautionary principle.

7 Conclusion

Alaska, more than any other state in the US, has a history of natural resource dependency that is unequalled in any other state. This dependency on raw natural resources as the main driver for the economy has persisted to current times. In addition to the economic importance of natural resources, usage of the ecosystem and the benefits it provides are an important part of the survival, culture and economic well-being of the rural population. Bristol Bay has a special role in Alaska based on its abundance of salmon, which bring tourists and industry to the region and provide its main source of income. Recently, the mining industry has taken an interest in the region and its numerous natural resources. Concern has been expressed by both the existing fishing and tourism industries as well as the general population of the region as to the effects that mining activities would have on the region's ecosystem and fish and wildlife populations on which they are dependant. The current permitting system has been criticized for being too lenient and biased in favor of the mining companies. This has been attributed to changes in the competences assigned to different agencies from 2002-2005. The large mine permit team has the job of analyzing the data funded by the Pebble Partnership associated with the various state permits needed for the mine, and making a judgment based on the analysis of sound-science. This approach has subsequently been labeled risk-management or risk assessment. It has been emphasized that this approach fails to fulfill ideas of democracy and transparency. These concepts are part of the core ideas associated with the

precautionary principle or precautionary method, a decision-making tool which is known as an alternative to the traditional risk management approach. Uncertainties are present in this situation which cannot be resolved by additional studies. In addition, the risks of inaccurate data could come with a high price. Even when all attempts have been made to ensure the accuracy of the data presented, the propensity for risk remains high. If the Pebble-funded experts are incorrect, their mistake could bring down the entire ecosystem in a region that has been largely unaltered by human interference. By affecting the health of just one part of the ecosystem, the entire interdependent chain could fail, leading to a collapse of the salmon population which would subsequently lead to a collapse of the economic base upon which these communities are dependant. Once an ecosystem fails, the possibility for reversibility is shut off. Experiences in the Pacific Northwest region of the US, which used to have significant populations of salmon, show that once populations are disturbed the reality is that regeneration will not occur within an individual's lifetime, if ever. Pushing for the use and legality of precautionary methods would turn the tables on companies that attempt risky projects at the detriment of the local population. By allowing precautionary measures to be undertaken, the dependency on reactive litigation, which is both costly and time consuming, could be lessoned. While the battle for environmental protection may be too little to late in the case of the Pebble Project, legislation could protect the region from further mining activities. The outcome of the Pebble Project will likely set the tone for further mining claims that are currently in process in the region. What is now an area known for fishing may well turn into a prominent mining region. The fate of this particular region is still hanging in the balance, whether or not precautionary measures taking into account the uncertainties and risks

associated with the decision remains to be seen.