

Final Report

**Economic Analysis of Rail Link
Port MacKenzie to Willow, Alaska**

Phase II - Possible Rail Extension Users Analysis

By

Paul A. Metz, Ph.D., DIC, P.G,
Consulting Economic and Mining Geologist
P.O. Box 73795
Fairbanks, Alaska 99707

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Matanuska-Susitna Borough

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Executive Summary

This economic analysis examines possible business activities that will be induced or enhanced in Southcentral and Interior Alaska by the rail extension from Port MacKenzie to the Alaska Railroad mainline. The possible business activities include: coal exports, mineral aggregate (sand and gravel) exports, lime and portland cement exports, forest product exports, refined petroleum product exports and imports, the Alaska Natural Gas Pipeline logistics and metallic mineral development. This is also a preliminary investigation of the economic benefits provided by these uses and whether these benefits justify the capital investment needed to build the rail extension. The analysis does not include the coal tonnage that would likely be transported on the rail extension, if the Agrium Coal Gasification Project moves forward.

Background: Metallic and non-metallic mineral and solid fuel (coal) resource development is a major source of freight for most railroads worldwide. These bulk commodities must be transported to worldwide markets by the most economical method available. Thus, railroads either transport the materials from mines and quarries directly to manufacturing and population centers or to ocean vessels via the nearest port facilities. Alaska is no exception.

Alaska has abundant mineral and energy resources that can supply both North American and worldwide markets. In the absence of a railroad connection to the contiguous states and major manufacturing in Alaska, these resources must be exported through deepwater port facilities. Connecting the mines to the ports via railroads greatly reduces transportation costs. This increases the competitive advantage of Alaskan resources, and results in maximum returns to the State in the form of jobs, corporate income taxes, and mineral rents and royalties. Estimating the mineral and energy resource potential of Alaska is a necessary step in the planning, design, financing, and construction of infrastructure.

Part I: Part I examines possible exports and imports of products, other than metallic minerals, over the rail extension during the first ten years of rail extension operation. The analysis provides information on expected rail extension use during the first five years (2012-2017) and the second five years (2017-2022) of operation. During the first five years, 1.4 million tons of freight is expected to be annually transported over the rail extension. For the second five year period, 2.4 to 3.4 million tons are expected to be annually transported. *The five year and ten year freight tonnage projections in this investigation **may be very conservative**. These expected annual tonnages are over and above the 3.3 million tons of coal annually required for the Agrium Coal Gasification Project at Nikiski.*

Part II: Part II focuses on new metallic mineral developments that will be enabled by the proposed 25-40 mile rail extension. The Part II analysis examines the feasibility of developing one small, one large, and one medium metallic mineral deposit inland from the port over the first, second, and third decades of rail extension operation. In addition, the analysis includes a forecast of the tonnage of rail freight for each mine over the initial

mine life; the mining license taxes, royalties, and corporate income taxes expected to accrue to the State of Alaska; and the expected economic benefits that will accrue to the communities along the rail belt from the mine developments.

Metallic mineral deposits and coal in the railbelt corridor have the greatest potential for generating additional rail freight revenues and additional revenues to the State of Alaska as well as additional economic benefits to the railbelt communities. Other potential sources of rail freight loads are relatively small or short term. During the first thirty years of rail extension operation, it is expected that the annual metallic mineral development tonnages transported will be at least 365,000 tonnes in the first decade, 1.7 million tonnes in the second decade and 1.9 million tonnes during the third decade.

The expected annual rail freight revenues from metallic mineral production for the first, second, and third decades of the rail extension operation are expected to increase by \$7.8, \$33, and \$45.1 million respectively. The expected revenue streams to the State of Alaska over a sixty year period in the form of corporate income taxes, mining license taxes, and mining royalties from metallic minerals alone are estimated at \$18.1 billion or \$300 million per year. The economic benefits that will accrue to the railbelt communities from metallic mining over the same period are estimated at \$185 billion or \$3 billion per year. These amounts far exceed the estimated \$225 - \$330 million capital cost of providing the rail connection between Port MacKenzie and the rest of the Alaska Railroad system.

Conclusion: The combined Part I and Part II results of estimated metallic and non-metallic annual freight tonnages over the first thirty years of rail extension operation are conservatively expected to range up to 3.7 million tonnes in the first decade, 4.1 million tonnes in the second decade and 4.3 million tonnes in the third decade. Most of the origin or destination of the freight would be the interior of Alaska thus the average haul distances are expected to be approximately 350 miles. At an average freight rate of \$0.06 per ton mile, four million tonnes of freight per year along this route would generate annual gross revenues of \$84 million.

Introduction and Scope of Analysis

This analysis of the possible users of the rail extension from Port MacKenzie to the Alaska Railroad mainline is a preliminary investigation of the potential sources of economic benefits that would justify the capital investment needed to build the rail extension. The investigation is divided into two parts. Part I focuses on a spectrum of possible exports and imports of products, other than metallic minerals, through the port and the rail extension during the first ten years of rail extension operation. The analysis provides information on expected rail extension use during the first five years (2012-2017) and the second five years (2017-2022) of operation. This analysis does not include the 3.3 million tons of coal that would likely be transported through the port annually, if the Agrium Coal Gasification Project moves forward.

Part II focuses on new mineral developments that will be enabled by the proposed 25-40 mile rail extension. The Part II analysis examines the feasibility of developing one small, one large, and one medium metallic mineral deposit inland from the port over the first, second, and third decades of the existence of the rail extension. In addition, the analysis includes a forecast of the tonnage of rail freight for each mine over the initial mine life; the mining license taxes, royalties, and corporate income taxes expected to accrue to the State of Alaska; and the expected economic benefits that will accrue to the communities along the rail belt from the mine developments.

The potential developments reviewed in this analysis are in addition to those developments and economic benefits related to the Agrium Coal Gasification Project at Nikiski, Alaska. The company is currently examining the economic feasibility of utilizing coal gasification as an alternative to natural gas for feedstock at the company's Nikiski operations. The proposed new chemical plant would use low-sulfur coal from the Usibelli Coal Mine at Healy to produce ammonia and urea. The plant would require 3.3 million tons of coal per year. The coal will be transported by rail to Cook Inlet and then by barge to the Nikiski plant. Assuming completion of the rail extension, this coal will be transported through Port MacKenzie.

Over the past five years, bulk commodity and container cargo transported by ocean and Great Lakes vessels and by railroads in North America have increased dramatically, and this increase was not predicted by freight suppliers, transporters, and receivers. This unprecedented increase in transportation needs has been the result of rapid growth of Asian economies in general and China in particular. This economic growth has resulted in worldwide shortages of energy and mineral commodities that require the bulk transportation capabilities of large marine vessels, ports, and railroads for the efficient and cost effective movement of these materials.

*The five year and ten year projections in this investigation for the transportation requirements through Port MacKenzie via the railroad extension **may be very conservative**, depending upon future rates of economic development in India, China and the rest of Asia.*

The Final Report to Phase I of the Alaska Canada Rail Link Investigation by Boland and others (released June 19, 2007), examines the cost and benefits of extending the Alaskan rail line 1,100 miles to meet the existing Canadian rail line. The report demonstrates that the public benefits of the 1,100 mile link, discounted at 6%, exceed the capital cost of the large rail extension project. These benefits will only accrue if the Alaska/Canada rail link is connected to Alaskan ports. Assuming the Port MacKenzie extension is completed, the port with the largest potential capacity is Port MacKenzie.

PART I

Use of Port MacKenzie 2012-2022

Part I is a conservative overview analysis of the types of non-metallic minerals and materials that may be exported through Port MacKenzie during the first ten years of rail operation. The minerals and materials considered include: coal exports, mineral aggregate (sand and gravel) exports, lime and portland cement exports, forest product exports, petroleum product exports and imports, and natural gas pipeline logistics. Each overview includes: an Explanation of Business, Resources, Market Size and Market Need, Customer Analysis, Competition, and Use of Rail Extension. Part I provides an overview of the potential users of the rail extension during the first and second five year periods following its construction.

Coal Exports

Explanation of Business Port MacKenzie is well positioned to provide rail transport and port facilities for the export of coal from the Usibelli Coal Mine in Healy. The Usibelli Coal Mine is the only active coal mine and current source of coal for export from Alaska. The exports from the mine have fluctuated significantly in recent years, with a peak market of approximately one million tons to approximately 400,000 tons, with an intermediate term annual average of 750,000 tons. Currently, coal is exported through the port of Seward using a coal loading facility owned by the Alaska Railroad Corporation and currently operated by Usibelli Coal Mines, Inc.

Assuming construction of the Port MacKenzie rail extension, the use of the port for coal export would forgo the 147 additional rail miles to Seward, with a savings of around \$3 to \$8.50 per ton of coal shipped. The Metz study (2006) indicated a savings of \$8.44 per ton, assuming an average cost of freight of \$0.06 per ton mile. Even taking into account possible costs related to additional sailing time to go to Port MacKenzie rather than Seward, the transport of 80,000 tons of coal by Port MacKenzie, on a 80,000 ton vessel, could save \$180,000 to \$560,000 per trip. In addition, Port MacKenzie has the space to provide for efficient rail operations and compatible industrial uses for coal transport. Also, due to the shorter distance, lack of congestion, straighter alignment, and lower grades, higher rail velocities can be maintained using the Port MacKenzie route, resulting in shorter transport times and the possibility of higher volumes of coal being shipped than could be shipped on the alternate Seward route.

Resources Extremely large coal resources exist in Alaska (estimated in excess of 5 trillion short tons (see Flores and others, 2003), however, past market uncertainties and lack of surface transportation systems have limited the development of these coal resources. The Usibelli Mine at Healy alone has over 250 million short tons of proven coal reserves. In addition, the Chulitna Basin in

the Upper Susitna Valley contains several billion tons of coal that will also be provided access to tide water by the rail extension.

Market Size and Market Need With rapid increases in the demand for coal in China, there is a strong market for coal in the Pacific Rim. The market for the low rank and low sulfur coals from Alaska is primarily for the power generation industries in China, Taiwan, Korea and Japan. Usibelli is also investigating South American markets.

Concerns about climate change and anthropogenic carbon dioxide emission have raised some questions concerning the utilization of fossil fuels in general and coal in particular as a source of energy. Recent research in part funded by the U.S. Department of Energy has indicated that there are multiple methods that are both technologically and economically feasible to permanently sequester carbon dioxide emissions in various geologic environments. Thus zero carbon dioxide discharge coal fired power plants can be built and will remain the lowest cost fossil fuel alternative for electrical energy generation.

Customer Analysis Usibelli has expended significant managerial resources assessing potential customers in the western Pacific Rim, as well as South America. Definition of customers and their long term coal requirements is an essential step in developing export markets for coal transported through Port MacKenzie or any other port in Alaska.

Competition There is significant competition in these markets from larger tonnage mining and port operations in Australia, Indonesia and British Columbia, Canada. Potential competition to exports through Port MacKenzie exists within Alaska for the Pacific Rim markets. The North Slope Region Corporation, in cooperation with BHP, is also completing a preliminary feasibility study of the development of a 20 million ton per year coal mine at the Deadfall Syncline on the western end of the Alaska North Slope. Production of coal from this area is a longer term possibility but the coals are of a higher rank than the coals from either the Nenana Coal Field (Usibelli Coal Mine) or the Susitna-Beluga area of the Cook Inlet region.

Use of Rail Extension During the first five years, it is highly probable that from .75 to 1.25 million tons of coal could be transported annually over the rail extension. Due to the design of this relatively high speed freight rail extension, and the inherent transportation cost savings, the amount of coal transported over the extension during the second five years could be significantly larger.

Mineral Aggregate (Sand and Gravel) Exports

Explanation of Business Port MacKenzie has extensive gravel resources within the 9,000 acre industrialized area. This aggregate resource could be used by the railroad for ballast to repair and maintain their rail lines throughout the state of Alaska. After the rail extension is built, the railroad could move its annual

requirement of 100,000 tons of ballast over the rail extension to other parts of the Alaska railway during the first five years of operations. The railroad would only be using the courser aggregate materials for ballast purposes. It is assumed that such materials would be separated from other sand and gravel, as sand and gravel is sold from Port MacKenzie sources for transport by barge to other areas, such as Southwest Alaska. Ballast material could also be used from Port MacKenzie to provide for the construction of the rail extension itself. It is estimated that the rail extension will take up to \$10 million (minimum value) of ballast materials. Consequently, using cheaper ballast from Port MacKenzie should reduce the overall costs of the rail extension construction.

The existing aggregate at Port MacKenzie will also provide low cost construction materials for other economic development activities at the Port, including manufacturing facilities and power plants. The sand and gravel provides both high quality materials for the foundations of structures, as well as aggregates for portland cement concrete structures and for asphalt pavements.

Using the power plant example, the construction of a coal fired power plant at the port could lead to the need for an additional million tons per year of coal. This coal would be transported to the site via the rail extension. Thus, the existing aggregate at the site could encourage developments, which will lead to additional use of the rail extension for resource transportation.

In view of the large quantity of relatively inexpensive sand and gravel resources at Port MacKenzie, and the fact that other sand and gravel sources along the rail belt may be restricted for environmental reasons or be quite expensive, there may be occasions when sand and gravel from Port MacKenzie needs to be transported by rail north to meet construction requirements. This may be especially true for projects such as the gas pipeline from the North Slope, the gas pipeline from the Yukon flats, or a gas liquids line from a potential gas separation facility in the Fairbanks area.

Resources It is estimated that Port MacKenzie has in excess of 100 million cubic yards of aggregate resources, with much of it appropriate for sand and gravel production.

Market Size and Market Need There is a large market for sand and gravel in the Pacific Northwest and California due to decreasing local resources and the constraint on new material production sites, due to environmental and zoning restrictions. The recent demand in the Seattle/Tacoma area was in excess of 40 million tons for the SeaTac Airport expansion, repairs and related developments.

There is a continuing demand in the villages of Southwest Alaska for gravel resources, which could easily be barged from Port MacKenzie. Fluctuations and demand associated with major construction projects must also be considered when evaluating export market possibilities. The fact that there is a

demand for gravel, and that it will likely be exported from Port MacKenzie by barge, means that there will be an ongoing sand and gravel production operation. Due to this demand and the other noted uses, a certain economy of scale will apply to the Port MacKenzie sand and gravel operation, which will lead to the production of less expensive materials for projects to the north.

Customer Analysis Customer material specifications vary depending on the type of construction project, construction manager, and jurisdiction. For instance, the U.S. Army Corps of Engineers specifications for aggregates for portland cement concrete limit the clay content to 1.0% or less. The high clay content of unwashed glacial morainal deposits will not meet this specification. The large tonnage of water sorted glacial outwash gravels at Port MacKenzie are very low in clay content and will meet this specification.

Competition Aggregate producers from southern British Columbia, Canada will be significant competitors to production from Port MacKenzie for the U.S. west coast markets and Southwest Alaska villages.

Use of Rail Extension As noted above, aggregate development at Port MacKenzie could provide ballast materials for Alaska Railroad repair and maintenance needs. Such ballast materials would be transported north over the rail extension to reach the areas of maintenance and repair need. This use could amount to at least 100,000 tons per year. In addition, the existence of aggregate that can be used for supporting the development of other Port MacKenzie industrial sites will lead to the need for more resources, such as coal, to be transported to Port MacKenzie over the rail extension. Coal for a power plant, for example, could lead to an additional million tons of resource per year.

Lime and Portland Cement Exports

Explanation of Business Construction of the Port MacKenzie rail extension to tidewater will make development of major lime resources north of Fairbanks more economical. It is expected that lime would be exported across the rail extension through Port MacKenzie, for use in Southwest Alaska, in villages and cities, and major mining operations. Lime is used to help maintain water quality for waters associated with mining operations. It is noted that Red Dog Mine in Northwest Alaska currently imports lime from Vancouver, British Columbia and the proposed Donlin Creek Mine in Southwest Alaska plans to do likewise. Thus, lime from north of Fairbanks could be more economical to barge from Port MacKenzie to Southwest and Northwest Alaska than from British Columbia. It is possible that lime will be produced in kilns at the site 38 miles north of Fairbanks and transported through Port MacKenzie within the first five years of operations. It is expected that eventually cement will also be manufactured at the limestone site and exported through Port MacKenzie. The export of cement would involve the transport of much larger tonnages.

Resources Very large limestone resources occur at 38 Mile on the Elliot Highway, north of Fairbanks. These resources are the essential materials for the production of lime (calcium oxide) and portland cement (hydrated calcium and aluminum silicates). The economy of scale of lime production is as small as 100 tons per day, while the economy of scale of portland cement is at least 10 times larger. Neither of these products are produced in Alaska, thus domestic consumption is met with imports from either the contiguous states or other countries. The Globe Creek lime deposit, located approximately 38 miles north of Fairbanks, is the largest known high-quality limestone deposit in Alaska and contains an estimated 1.6 billion tons of high-purity limestone for both lime and portland cement production. Several other small lime deposits, of varying degrees of purity, are located around the state. None of these small deposits are economical for large scale production.

Market Size and Market Need The current demand for lime in interior Alaska is 100 tons per day. This is the minimum amount to justify a small kiln operation near Fairbanks. The main restriction is the cost of fuel to run such a kiln operation. With the completion of the agreement between Fairbanks Natural Gas and British Petroleum, liquified natural gas (LNG) will be available for delivery from the North Slope to the Fairbanks market via tanker trucks. These vehicles will go past the Globe Creek limestone deposit and the proposed lime production site. Thus, it is expected that a lime manufacturing plant will be in production in the near future. Initially it will serve the 100 ton per day demand that is associated with interior gold mines, such as Fort Knox and Pogo. Once the Port MacKenzie rail extension is completed, lime could be exported through Port MacKenzie to serve Southwest Alaska mines and villages, as well as Red Dog Mine. It is expected that at least part of this market demand will be met through the transport of up to 50,000 tons of lime per year through Port MacKenzie on the rail extension.

Customer Analysis Lime has approximately 18,000 different uses. In Alaska, the largest developing demand is in the processing of ore minerals, such as gold, silver, copper, lead, and zinc. Thus, the largest customer for lime will be mining operations. The largest customer for portland cement, on the other hand, is the construction industry.

Competition The production of both lime and portland cement requires large amounts of relatively low cost fuels, such as coal and natural gas. Small scale lime production is generally more competitive with natural gas as a fuel source, since lime and cement kilns fueled with coal have higher capital costs. There currently is no significant amount of lime or portland cement produced anywhere in Alaska. Portland cement demand in Alaska is less than 300,000 tons per year and is being met by foreign imports.

As noted above, lime production at Globe Creek is a function of the availability of trucked LNG to the lime production site. The LNG production

facilities on the North Slope are completed and it is currently economical for the production of lime for use at mines in the Interior and for export to Southwest Alaska, once a rail line is constructed. The production of portland cement is predicated on large volumes of gas being brought to the site by pipeline, either from Minto Flats, Yukon Flats or the North Slope.

Use of Rail Extension It is highly probable that 50,000 tons or more of lime will be annually exported across the rail extension through Port MacKenzie during the first five years of rail extension operation.

Forest Product Exports

Explanation of Business The rail extension will enhance the forest products industry in Interior Alaska and the export of products through Port MacKenzie. Forest products exports have been a major business activity of Port MacKenzie. The primary product is wood chips for Japanese, Korean, and Taiwanese markets. This low unit value commodity is very sensitive to the cost of transportation from the standing forest to the port facility. Currently transport is by truck with economic haulage distances limited to the Susitna Valley region. Large timber resources occur on State of Alaska lands, University of Alaska Trust Lands, Alaska Mental Health Trust Lands and Native Corporate Lands in the Tanana Basin (see Fairbanks Economic Development Corporation (FEDC) Prospectus, March 2007). Estimated resources in the Tanana Basin are approximately 1.6 billion board feet with an estimated sustainable yield of 30 million board feet per year. Connecting these timber resources to Port MacKenzie by the rail extension will substantially reduce transportation costs to tidewater and greatly increase the net value of forest products exports.

Resources Total available resources for harvest in the Susitna Valley and Tanana Basin exceed 1.6 billion board feet.

Market Size and Market Need A detailed market analysis has not been completed but it is highly probable that the business enterprise will be constrained by the sustainable yield rather than the Pacific Rim market. Ron Arvin, President of NPI, Inc., recently stated that the Pacific Rim markets could use more wood tonnage than Alaska can provide. (Personal Communication) Assuming sustainable production of 30 mmbf per year from each of the Susitna and Tanana Basins, an estimated rail freight tonnage of 60,000 tons per year could be achieved over the 2012-2017 time period.

Customer Analysis Currently, production from the Susitna Valley is unable to meet the need of customers in Japan, Taiwan, and Korea. The cooperative effort of the FEDC, Tanana Chiefs Conference, Alaska Division of Forestry, and Alaska Office of Economic Development has made significant contributions in fostering this economic enterprise and expanding the customer base.

Competition Port MacKenzie has made a significant investment in developing this enterprise and it is unlikely that there would be significant competition with respect to other port facilities in Alaska for forest products export activity. Significant competition does exist for the wood chip markets in Asia from southeast Alaska and British Columbia.

Any existing market plan by the Port Authority for wood chips should be coordinated with the entities listed above and revised to reflect the impacts of the rail extension from Port MacKenzie to the Alaska Railroad mainline, and Eielson AFB to Delta Junction, on transportation costs and market prices. For additional market considerations see: Jackson and McKetta, 1986; Rapp, 2003; and Sasatani and other, 2005.

Use of Rail Extension It is estimated that at least 60,000 tons of forest products will be transported over the rail extension annually during the initial five years of operations.

Petroleum Product Exports and Imports

Explanation of Business The development of petroleum storage facilities at Port MacKenzie to accommodate both exported and imported petroleum products would add additional transportation and storage capacity to the Cook Inlet area, as well as facilitate the transfer of fuels to and from interior Alaska. The rail extension is critical for the transport of fuel and is a necessary precursor to fuel tank farms at Port MacKenzie.

Resources There is a growing demand for low sulfur diesel fuel in Interior and Southwest Alaska, as a function of mineral and energy development. This demand is associated with federally mandated low sulfur fuel specifications that go into effect in 2009. The new regulations require off-road equipment (ie. mining operations) to only use low sulfur fuel. Since Flint Hills Refineries made a decision not to produce low sulfur diesel fuel in its North Pole refinery, and Conoco-Philips decided to not complete their low sulfur fuel refinery addition on the North Slope, the demand for low sulfur fuel will increase. It is expected that the rail extension will be used to transport low sulfur diesel fuel to meet Interior and North Slope demands.

In addition to optimizing production from existing wells, the oil industry is working on oil production from heavy oil resources. The very large heavy oil resources on the North Slope are approximately 34 billion barrels or roughly three times the quantity of conventional oil produced to date, thus long term production of petroleum products in Alaska is highly probable.

Market Size and Market Need Flint Hills Resources and Petro Star, Inc. currently produce approximately 10 million gallons of diesel fuel annually for

Interior Alaska markets. However, the large capital cost of converting the North Pole Refineries into low sulfur diesel fuel facilities to meet the 2009 regulations is not economic at this level of production. The low sulfur diesel fuel will be needed to replace transportation fuel and fuel for mining, construction, and oilfield support vehicles. Such fuel could be shipped north over the rail extension through Port MacKenzie. In addition, fuel suppliers have discussed the possibilities of establishing tank farms at Port MacKenzie and then shipping the fuel north by rail.

Customer Analysis Customers include Interior Alaska communities, lower Yukon and Kuskokwim River communities, and coastal communities along the Alaska Peninsula and Aleutian Islands. Low sulfur diesel for the Fort Knox Mine and a new gold deposit under development are each expected to consume 7 million gallons of diesel fuel annually, for a total of 14 million gallons. Furthermore, low-sulfur fuel could be delivered by rail to Fairbanks via Port MacKenzie for truck transport to the North Slope.

Competition Due to the limited space available, long term competition from the Port of Anchorage is not expected.

Use of Rail Extension It is estimated that 60,000 tons of low sulfur diesel fuel will be transported north from Port MacKenzie to Interior Alaska, and a similar amount to Southwest Alaska for a total of 120,000 tons of low sulfur fuel. This will begin during the first five years of operations and will continue to grow as more and more diesel fuel is sent north. In addition, fuel suppliers are considering setting up tank farms at Port MacKenzie and transporting 80,000 to 90,000 tons of fuel via the rail extension to North Slope markets.

Natural Gas Pipeline Logistics

Explanation of Business If the Alaska Highway natural gas pipeline is built, it will be necessary to transport pipe, compressor station construction materials, compressor components, construction equipment, fuel, construction camps and camp supplies from tidewater to inland locations. The most cost effective way to transport these construction materials to the construction areas is by rail, as far as possible, and then by truck the rest of the way. In March, 2007, Northern Economics completed a comparative study that assessed the ability of Southcentral ports to transport pipe for the proposed Alaska Highway natural gas line project (Burden, 2007a). The study assumed an Alaskan port would be used to transport construction materials for the portions of the pipe line running from Prudhoe Bay, 950 miles to Burwash Landing, Yukon Territory. Assuming the Port MacKenzie rail extension is built, the study concluded that Port MacKenzie would be the most cost effective port for transporting pipeline materials. Accordingly, Port MacKenzie and the rail extension would be used to transport pipeline sections and materials north.

Resources The proposed natural gas pipeline is predicated on 35 TCF of proven conventional natural gas on the Alaska North Slope. Estimated conventional resources of natural gas in the region exceed 200 TCF. Unconventional natural gas resources are estimated to be several times greater. Coal bed methane in the Barrow area alone is estimated at 44 TCF and methane hydrates on-shore are estimated at 590 TCF (Metz and others, 2005). Thus the North Slope could be producing natural gas for several hundred years even at the proposed production rate of 4.5 BCF per day for the Alaska Highway natural gas pipeline project.

Market Size and Market Need The market size for this Port MacKenzie business activity will vary pending the final pipeline route selection. However, if the Alaska Highway route is used, the Northern Economics study determined that 122,760 forty-foot long segments of pipe (joints), weighing 12.3 tons per joint, would need to be transported through Port MacKenzie and over the rail extension during a 2 year period. In addition, appropriate support materials, structures, fuel and supplies would also be transported on this route.

Customer Analysis The customer will be determined by the successful award of the contract for the construction of the pipeline. The cost of the logistics for the pipeline will be approximately five percent of the total construction cost.

Competition Assuming the Alaska Highway route is used, the ports of Seward, Whittier, Anchorage, and Port MacKenzie will compete to supply pipe and materials for the portion of the gas pipeline from Prudhoe Bay to Burwash Landing. The Northern Economics study notes that Port MacKenzie would be the port of choice, due to the lowest expense, as well as having abundant room for staging materials, and would provide the least congested rail route north.

Use of Rail Extension Under the most optimistic scenario, the natural gas pipeline will not be under construction until the end of the first five years of the operation of the rail extension. Assuming the Alaska Highway route, the Prudhoe Bay to Burwash Landing pipeline segment alone would account for about 1.6 million tons of rail freight over the first two years of pipeline construction. Additional freight tonnage of 320,000 tons would be accounted for by other construction materials, fuel and supplies.

Generally logistics account for 5 percent of the cost of major construction projects. Thus, for a \$25 billion pipeline project along the Alaska Highway route, total logistic costs are estimated at \$1.25 billion. With approximately one quarter of this route in Alaska, the Alaska portion of the logistics would account for about \$300 million. If the Alaska Railroad accounted for 100% of these logistics costs and with the Railroad's margin of approximately 12%, the net income to the railroad for the project could be as high as \$36 million. Large staging areas needed for the pipeline logistics, the shorter haul distances, lower transportation

congestion issues, and high train speeds would make Port MacKenzie the preferred port site for the project.

Other Potential Users

Other potential users include the electric companies and the US Army Alaska (USARAK). A conceptual business plan is not included herein for either electric companies or the USARAK.

Southcentral Alaska needs additional power generating capacity for its population. One option could be the development of a coal fired power plant located at Point MacKenzie. The site advantages include: the presence of extensive sand and gravel resources for the foundations of the plant, the same materials for portland cement for the structure, large amounts of space for both the plant and the storage of coal, compatible uses in the area for industrial development, eventual rail access for coal transport to the site, and potential additional markets for electrical power from other industrial developments at Port MacKenzie, such as a major petrochemical complex. A moderate size power plant would consume up to a million tons of coal per year. An expanded power plant to accommodate a major petrochemical complex would consume an estimated 9-10 million tons of coal per year. This tonnage of coal would generate up to \$25 million in revenue per year on the rail extension. A major petrochemical plant is predicated on an Alaska natural gas pipeline, which would not be completed before the end of the second five year period.

USARAK currently utilizes the Port of Anchorage for deployments of Striker Units to and from Alaska. Large logistic requirements also exist for major training exercises in Interior Alaska for other units. The railroad extension from Eielson, AFB to Fort Greely is in part predicated on these logistic requirements. Connection of Port MacKenzie to the existing Alaska Railroad mainline would be the final step in providing fairly direct, non-congested rail access from the deepwater port to the Tanana Flats and Donnelly Training Areas. These one million acre combined training areas in Interior Alaska are the largest training areas available to the Department of Defense (DOD). The estimated freight loads for DOD logistic requirements cannot be projected until finalization of the re-programming action for various units to Alaska.

Part I Summary

Table 1 is a summary of the tonnages of the various products that may be transported over the Port MacKenzie rail extension in the first and second five year periods, after the rail extension comes into operation.

Table 1. Expected tonnages of various commodities to be transported over the Port MacKenzie rail extension in the first 10 years after operations commence. These tonnages do not include the aggregate metallic mineral tonnages discussed in Part II or the annual transport of 3.3 million tons of coal associated with the Agrium Coal Gasification Project.

Product	Annual Tonnages in Years 1-5	Annual Tonnages in Years 6-10*
Coal Exports	1,000,000	1,000,000
Aggregates	100,000	100,000
Lime	50,000	50,000
Wood Chips	60,000	60,000
Petroleum Products	200,000 – 210,000	200,000 – 210,000
Natural Gas Pipeline	0	960,000**
Power Plant	0	1,000,000
USARAK Logistics	Not Available	Not Available
Total	1,410,000 – 1,420,000	3,370,000 – 3,380,000 (each of 2 yrs.) 2,410,000 – 2,420,000 (each of 3 yrs.)

*The chart does not indicate any increase in resource tonnages for certain resources during the second five year period of rail extension operation. It is likely that such resource tonnage being transported on the rail extension will increase during the second five year period.

** 960,000 tons per year of pipeline sections and other construction materials for two years.

Part I Conclusion

In the first five year period, the estimated annual freight load, not including metallic minerals, is 1.4 million tons. For the second five year period, the estimated annual tonnage is 3.4 million tons for each of two years and 2.4 million tons for each of three years.

PART II

Metallic Mineral Resource Development

Metallic and non-metallic mineral and solid fuel (coal) resource development is a major source of freight for most railroads on a worldwide basis. In addition, these bulk commodities must be transported to worldwide markets in the most economical method available. Thus railroads from mines and quarries either transport the materials directly to manufacturing centers or the materials are transferred to ocean vessels via the nearest port facilities. Alaska is no exception.

Alaska has abundant metallic and non-metallic mineral and energy resources that can supply both North American and worldwide markets. In the absence of a railroad connection to the contiguous states and major manufacturing in Alaska, these resources must be exported through deepwater port facilities. Connecting the mines to the ports via railroads greatly reduces transportation costs. This increases the competitive advantage of Alaskan resources, and in turn maximizes returns to the State of Alaska in the form of jobs, corporate income taxes, and mineral rents and royalties. Estimating the metallic mineral resource potential of Alaska is a necessary step in the planning, design, financing, and construction of infrastructure.

The reduction in transportation costs afforded by the completion of the Port MacKenzie rail extension is significant compared to rail transport costs to other bulk freight natural resource ports, such as Whittier or Seward (Metz, 2006). The cost savings allows for the development of smaller tonnage and lower grade mineral deposits, as well as speeds up development of larger and higher grade deposits. The economic feasibility of small, as well as medium to large metallic mineral deposits is examined in Part II of this investigation.

Three different metallic mineral deposit types were examined. The smallest mine under consideration would have a mine life of only 10 years, while the large and medium scale operations would have lives of 30 and 20 years respectively. The mines are assumed to come on-line in ten year intervals (1st, 2nd and 3rd decades after the rail line is completed). The small operation is planned to terminate when the large size mine comes into production in the second decade. The medium and large scale mines will have concurrent production during the third decade of development, when the medium scale mine comes into production.

Metallic Mineral Resource Potential of the Rail Belt The mineral resource potential of the railbelt was briefly described by Metz (2007). More detailed discussions of the mineral potential of Alaska in general include: Nokleberg and others (1987), Metz (1991) Goldfarb and Miller (1997), Hughes and Szumigala (2006), Szumigala and Hughes (2007). Of the 887 mineral occurrences in the 100 mile wide railbelt corridor, 50 miles each side of the rail line, in Alaska (Metz, 2007), the largest potential is associated with three major types of mineral deposits: Sedimentary Exhalative Zinc-Lead (Zn-Pb),

Kuroko Volcanogenic Massive Sulfide Copper-Zinc-Lead-Silver-Gold (Cu-Zn-Pb-Ag-Au), and Porphyry Copper-Molybdenum (Cu-Mo-Au-Ag).

These three base-metal mineral deposit types were examined for economic feasibility, volume contribution to rail freight loads, revenue generation to the State of Alaska, and the contribution of economic benefits to the communities within the railbelt. As with base-metal mineral deposits worldwide, the mines produce sulfide mineral concentrates, which are relatively low unit value but high volume products, which generally are transported by rail and ocean vessels or barges. Without these bulk transportation systems only very high grade deposits are usually developed. There are multiple mineral occurrences that fit each of these mineral deposit types near the existing railroad corridor from the Fairbanks area to the Willow area. The transportation costs of mineral concentrates from these mineral occurrences, as compared with transport through Anchorage, Whittier or Seward, will be reduced with the rail extension to tidewater at Port MacKenzie (see Metz, 2007).

Methodology for Mineral Freight and Economic Benefit Forecasts Cox and Singer (1986) provide mineral deposit model descriptions for most types of metallic mineral deposits. The descriptive models, as well as tonnage (quantity) and grade (quality) models, are based on numerous past and present producing mines worldwide. Using these models, a mine is hypothecated at one of various mineral occurrences on the north flank of the Alaska Range, just south of Fairbanks. Assuming a particular tonnage and grade distribution, a mine plan is selected for that site.

For a small scale mine with a 10 year mine life, it is assumed that a Sedimentary Exhalative deposit of median sized (fiftieth percentile of tonnage and grade of all deposits worldwide) would be developed in the Bonnifeld Mining District northeast of Healy. The development is in the first decade of the operation of the rail extension. The modeled tonnage is 22 million metric tonnes, and the modeled grades for zinc and lead are 5.6 and 2.8%, respectively. A large scale deposit (ninetieth percentile) would have a tonnage of 130 million metric tonnes and grades of 13% Zn and 7.7% Pb. Recent airborne geophysical surveys commissioned by the Alaska Division of Geological and Geophysical survey greatly increases the potential of the area, and thus a median sized deposit is a very conservative estimate for the model.

For a large scale mine with a 30 year mine life, it is assumed that a Porphyry Cu-Mo-Au-Ag deposit of large size (ninetieth percentile of tonnage and grade) is developed in the north flank of the Alaska Range. The development is in the second decade of the operation of the rail extension. The north flank of the Alaska Range is highly favorable for all three mineral deposit types.

For a medium scale mine with a 20 year mine life, it is assumed that a Kuroko Type Cu-Zn-Pb-Ag-Au deposit of large size (ninetieth percentile of tonnage and grade of all deposits worldwide) would be developed on the north flank of the Alaska Range. The development is in the third decade of the operation of the rail extension. The Greens

Creek Mine is a Kuroko type deposit and is in the ninetieth percentile in tonnage and grade.

Using the U.S. Bureau of Mines (1987) cost estimating system, as well as other mine cost data (Staff, Western Mine Engineering, Inc, 2004) and current metal prices, a preliminary mine feasibility study was completed for each of the three mineral deposit types. The cost data for a particular source year was adjusted with the Consumer Price Index (CPI). The cost data was input into a mine evaluation program entitled, “Software for Economic Evaluation” - SEE (Software Bisque and Investment Evaluations Corp, 1991).

The descriptive models for each deposit type are included in Appendices A1, B1, and C1, respectively. The input and output data for the preliminary mine feasibility study for each deposit type is included Appendices A2, B2, and C2. The cash flow output from SEE for each hypothecated mine is included in Appendices A3, B3, and C3.

Results

Table 2 is a tabulation of the estimated tonnage of mineral concentrate freight from each deposit type, the estimated tax and royalty revenue to the State of Alaska and the estimated gross metal value and thus economic benefits to railbelt communities.

Table 2. Summary of critical economic data for three major metallic mineral deposit types and their hypothecated mines.

Mineral Deposit Types	Sedimentary Exhalative Zn-Pb (only)	Porphyry Cu-Mo-Au-Ag (only)	Kuroko VMS Cu-Zn-Pb-Ag-Au + Porphyry Cu-Mo-Au-Ag
Decade of Mine Development	First	Second	Third
Mine Life	10	30	20
Estimated Annual Tonnage Of Mineral Conc.	365,000 tonnes	1,679,000 tonnes	1,879,750 tonnes
Estimated Annual Rail Freight Revenue @\$0.06/ton mile	\$7,884,000	\$36,266,400	\$40,602,600
Estimated Total State Corp. Income Taxes Over Est. Mine Life	\$115,765,030	\$4,578,331,579	\$4,967,161,643
Estimated Total State Mining License Taxes/Royalties	\$306,744,080	\$10,669,521,500	\$11,452,352,460
Estimated Gross Metal Value	\$5.8 billion	\$154.6 billion	\$167 billion

Discussion

The cash flow analysis for the three mineral deposit models indicates very large rates of return on capital. This is a function of the very large increase in base-metal and precious-metal prices in recent years. These increases in metal prices are much larger than the increases in the factor inputs to the mining process. For example, the Consumer Price Index for the period 1987 – 2007 is 183, while the metal price index for molybdenum for the same period is 955. With these high metal prices and relatively modest cost increases, total revenue and net income, as well as cash flow from modeled mine operations, are very large.

The revenue flow to the State of Alaska occurs as a maximum 9.3% state corporate income tax rate, a maximum 7% mining license tax rate and a 3% net proceeds interest (NPI) royalty rate. The mining license tax and NPI royalty are calculated on net income before state and federal income taxes (Krause and Stevens, 2006).

For the relatively small Sedimentary Exhalative deposit, the mining license and NPI royalty income to the state over the 10 year mine life is expected to exceed the capital cost of the rail extension. The total mining license and royalty revenue to the state for the three modeled deposits over the estimated sixty years of mine production is \$12.6 billion. In addition, the state would receive a maximum of \$5.5 billion in corporate income taxes from these three operations. *These are probably maximum amounts since the differential inflation between metal prices and costs of production are not expected to continue for that extended time period.* In any case the total revenue from these sources far exceeds the capital cost of the rail extension.

The McDowell Group (1999) reported on the economic benefits of the Fort Knox Mine to the Fairbanks North Star Borough. Metz (2007) noted that the accrued benefits to the Borough over the expected life of the mine are equivalent to the gross metal content of the mine at the time of the final feasibility study. Using this same argument, it is estimated that the three mineral deposits model in this investigation could contribute \$185 billion to the railbelt communities over a sixty year time period or approximately \$3 billion per year. Most of this value is predicated on the development one Porphyry Cu-Mo-Au-Ag mine in the railbelt. ***The modeled porphyry deposit in this investigation has a gross value of less than half that of the Bougainville Porphyry Cu-Mo-Au-Ag deposit, which is the largest copper deposit in the world, thus the estimated gross metal value is considered conservative.***

Part II Conclusions

Metallic mineral deposits and coal in the railbelt corridor have the greatest potential for generating additional rail freight revenues and additional revenues to the State of Alaska, as well as additional economic benefits to the railbelt communities. Other potential sources of rail freight loads are relatively small or short term. The expected revenue streams to the State of Alaska and the economic benefits to the railbelt

communities far exceed the \$225-\$330 million capital cost range of providing the rail extension between Port MacKenzie and the rest of the Alaska Railroad system.

Summary and Conclusions

The combined Part I and Part II results of estimated metallic and non-metallic mineral annual freight tonnages as well as estimated freight tonnages of other bulk commodities over the first thirty years of rail extension operation are summarized in Table 3. The estimated tonnages of railroad freight are considered conservative and are expected to range up to 3.7 million tonnes in the first decade, 4.1 million tonnes in the second decade and 4.3 million tonnes in the third decade.

Table 3. Combined Parts I and II results summary of estimated metallic and non-metallic mineral freight tonnages and freight tonnages of other bulk commodities over the first thirty years of rail extension operations.*

Product	Annual Tonnages in Years (1-5)	Annual Tonnages in Years (6-10)	Annual Tonnages in Years (10-20)	Annual Tonnages in Years (20-30)
Coal Exports	1,000,000	1,000,000	1,000,000	1,000,000
Aggregates (sand and gravel)	100,000	100,000	100,000	100,000
Lime	50,000	50,000	50,000	50,000
Wood Chips	60,000	60,000	60,000	60,000
Petroleum Products	200,000	200,000	200,000	200,000
Natural Gas Pipeline	0	960,000**	0	0
Power Plant	0	1,000,000	1,000,000	1,000,000
USARAK Logistics	Not Available	Not Available	Not Available	Not Available
Mineral Concentrates	365,000	365,000	1,679,000	1,879,750
Total	1,775,000	3,735,000	4,089,000	4,289,75

* Non-metallic freight tonnages remain the same in the second and third decade, though it is expected that these tonnages would grow significantly. Freight tonnages do not include coal tonnages associated with the Agrium Coal Gasification Project.

** Assume 960,000 tons of pipe and construction materials for each of two years during the five year period.

Most of the origin or destination of the freight would be the interior of Alaska thus the average haul distances are expected to be approximately 350 miles. At an average freight rate of \$0.06 per ton mile, four million tonnes of freight per year along this route would generate annual gross revenues of \$84 million.

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Appendix A1

Descriptive Model of Sedimentary Exhalative Zn-Pb

DESCRIPTIVE MODEL OF SEDIMENTARY EXHALATIVE Zn-Pb

DESCRIPTION Stratiform basinal accumulations of sulfide and sulfate minerals interbedded with euxinic marine sediments from sheet- or lens-like tabular ore bodies up to a few tens of meters thick, and may be distributed through a stratigraphic interval over 1,000 m. (Approximate synonyms - Shale-hosted Zn-Pb; sediment hosted massive sulfide Zn-Pb).

GENERAL REFERENCES Large (1980, 1981, 1983).

GEOLOGICAL ENVIRONMENT

Rock Types Euxinic marine sedimentary rocks including: black (dark) shale, siltstone, sandstone, chert, dolostone, micritic limestone, and turbidites. Local evaporation sections in contemporaneous shelf facies. Volcanic rocks, commonly of bimodal composition are present locally in the sedimentary basin. Tuffites are the most common. Slump breccias, fan conglomerates, and similar deposits as well as facies and thickness changes are commonly associated with synsedimentary faults.

Textures Contrasting sedimentary thicknesses and facies changes across hinge zones. Slump breccias and conglomerates near synsedimentary faults.

Age Range Known deposits are Middle Proterozoic (1,700-1,400 m.y.), Cambrian to Carboniferous (530-300 m.y.)

Depositional Environment Marine epicratonic embayments and intracratonic basins, with smaller local restricted basins (second- and third-order basins).

Tectonic Setting(s) Epicratonic embayments and intracratonic basins are associated with hinge zones controlled by synsedimentary faults, typically forming half-grabens. Within these grabens (first-order basins), penecontemporaneous vertical tectonism forms smaller basins (second-order basins) and associated rises. Smaller third-order basins (tens of kilometers) within the second-order basins are the morphological traps for the stratiform sulfides.

Associated Deposit Types Bedded barite deposits

DEPOSIT DESCRIPTION

Mineralogy Pyrite, pyrrhotite, sphalerite, galena, sporadic barite and chalcopryite, and minor trace amounts of marcasite, arenopyrite, bismuthinite, molybdenite, enargite, millerite, freibergite, cobaltite, cassiterite, vallerite, and melnikovite.

Texture/Structure Finely crystalline and disseminated, monomineralic sulfide laminae are typical. Metamorphosed examples are coarsely crystalline and massive.

Alteration Stockwork and disseminated sulfide and alteration (silicification, tourmalization, carbonate depletion, albitization, chloritization, dolomitization) minerals possibly representing the feeder zone of these deposits commonly present beneath or adjacent to the stratiform deposits. Some deposits have no reported alteration. Celsian, Ba-mucovite, and ammonium clay mineral may be present.

Ore Controls Within larger fault-controlled basins, small local basins form the morphological traps that contain the stratiform sulfide and sulfate minerals. The faults are syndimentary and serve as feeder for the stratiform deposits. Euxinic facies.

Weathering Surface oxidation may form large gossans containing abundant carbonates, sulfates, and silicates of lead, zinc, and copper.

Geochemical Signature Metal zoning includes lateral Cu-Pb-Zn-Ba sequence extending outward from feeder zone; or a vertical Cu-Zn-Pb-Ba sequence extending upward. NH_3 anomalies may be present. Exhalative chert may be interbedded with stratiform sulfide minerals; peripheral hematite-chert formations. Local (within 2 km) Zn, Pb, and Mn haloes. Highest expected background in black shales; Pb = 500 ppm; Zn = 1,300 ppm; Cu = 750 ppm; Ba = 1,300 ppm; in carbonates Pb = 9 ppm; Zn = 20 ppm; Cu = 7 ppm; Ba = 10 ppm.

Examples

Sullivan Mine, CNBC	(Hamilton and others, 1982)
Meggen Mine, GRMY	(Krebs, 1981)
Navan, Silvermines, Tynagh, IRLD	(Boyce and others, 1983; Taylor, 1984)

GRADE AND TONNAGE MODEL OF SEDIMENTARY EXHALATIVE Zn-Pb

(After W. David Menzie and Dan L. Mosier)

COMMENTS Deposits in this model include most commonly identified deposits of this type. Nevertheless, examination of the distribution of silver grade suggests the presence of two subtypes. Lead grades are significantly correlated with silver grades ($r = 0.77$, $n = 39$). Upper ten percent of deposits contain a minimum of 130 million tonnes at 13.0% Zn, 7.7% Pb, and 160 grams/tonne Ag. Total contained metal: 16.9 million metric tonnes Zn, 10.0 million metric tonnes Pb, 20.8 billion grams Ag. Gross metal value in 2007 is \$90.9 billion. Fiftieth percentile of the deposits contains 15-22 million metric tonnes at 5.6% Zn, 2.8% Pb, and 30 grams/tonne Ag. Maximum contained metal: 1.2 million metric tonnes Zn, 0.6 million metric tonnes Pb, 450 million grams Ag. Gross metal value in 2007 would be \$5.8 billion. The **fiftieth percentile tonnage and grade data is used for the cash flow analysis.**

CASH FLOW ANALYSIS

Mine Life/Mining Rate: Ten years at 2.2 million metric tonnes per year or 6,100 metric tonnes per day.

Gross Metal Value: \$5.8 billion

Gross Metal Value of Annual Production: \$580 million

Total State Corporate Income Taxes, Mining License Taxes, and Production Royalties Over Mine Life: \$ 421 million

Appendix A2

Mine Preliminary Feasibility Parameters for Median Sized Sedimentary Exhalative Zn – Pb Deposit

Mine Preliminary Feasibility

Mineral Deposit Type: Sedimentary Exhalative:

Comments, Assumptions, Specifications: Surface Mine: Open Pit; 365 days/year; 10 year mine life.

UNDEGROUND MINE MODEL STATISTICS, INPUT AND OUTPUT DATA:

Deposit Type: *Sedimentary Exhalative Lead Zinc – LIK near Red Dog*

Total Ore Tonnage: *22 million metric tonnes*

Mining Method: *Open Pit*

Beneficiation Method: *Crushing, grinding, floatation*

Extraction Rate: *95%*

Dilution/Waste Rate: *5%*

Proposed Mine Life: *10 years*

Proposed Daily Production Rate: *6,100 metric tonnes*

Maximum Ore Depth: *250 meters*

Stripping Ratio: *5:1*

Haulage Distance: *600 kilometers with 30 kilometers of new road*

Distance From Power: *On site diesel*

Pre-Production Development: *N/A*

Production Development: *N/A*

Equipment: *Front-End-Loaders, Shovels, Trucks*

Concentrate Production: *1000 metric tonnes per day; two products*

INPUT VARIABLES:

A. (For Operating Costs)

Clearing rate – ha/day: *.1 ha/day*

Burden/ Waste rate-mtpd: *27,800 mtpd*

Burden/Waste depth & haul – m: *140 m, 3,500m*

Ore rate – mtpd: *6,100 mtpd*

Ore depth & haul – m: *175m, 2,500 m*

Conveyor length & slope – km & % : *N/A*

Water needs – m³/day: *2,500 m³/day*

Drainage head and distance – m³/day, m & km: *40,000 m³/day, 200m, 1.5 km*

Concentrate (day) rate – mtpd: *1,000 mtpd*

Tails (dry) rate – mtpd: *5,100 mtpd*

Production water needs – m³/day: *5,500 m³/day (make-up)*

Portable Power needs – kW: *3,000kW*

Wastewater – L/sec: *30L/sec*

Concentrate haul – km: *600 km (360 miles)*

Employee housing – men: *400 men*

Other: *\$30,195 /day toll Dmrt*

B. (For Capital Costs)

Concentrate feeds – mtpd: 6,100 mtpd
Mill operating costs - \$/day: \$116,072
Working capital time – weeks: 13
Development time – days: 300 days stripping
Clearing needs – ha: 400 ha
Stripping needs – mt: 10 million metric tonnes
Stripping depth & haul – m: 70 m, 2,200m
Restoration area – ha: 800 ha
Contractors – 1 or 2: 2
Mine operating costs - \$/day: \$233,400
Access roads, length & width – m: 30km, 15m
Airstrip length and width – m: 1,400m, 18m
Powerline length & power – km & mW: portable
Dike & Dam needs – cm/fill: 200,000 m³
Climate/Weather factors: Severe

OUTPUT DATA

C. (For Operating Costs)

Mining Costs – \$/day: \$233,400
Mining Costs - \$/year: \$85,191,000
Mining Costs - \$/mt: \$38.26
Milling Costs - \$/day: \$116,072
Milling Costs - \$/year: \$42,366,280
Milling Costs - \$/mt: \$19.03
Infrastructure Costs - \$/day: \$132,144
Infrastructure Costs - \$/year: \$48,232,560
Infrastructure Costs - \$/mt: \$21.66
Total Operating Costs - \$/day: \$481,616
Total Operating Costs - \$/year: \$175,789,840
Total Operating Costs - \$/mt: \$78.95

D. (For Capital Costs)

MINE CAPITAL COSTS

Mine Working Capital - \$: \$18,631,043
Heavy Equipment (fixed life) - \$: \$37,626,190
Mine Rehabilitation - \$: \$13,630,572
Engr. & Const. Mgmt. - \$: \$6,023,926

Remaining Mine Capital - \$: \$44,872,273
Total Mine Capital - \$: \$120,784,000

MILL CAPITAL COSTS

Mill Working Capital - \$: \$9,265,396
Light Vehicles (short life) - \$: \$2,701,192
Remaining Mill Capital - \$: \$43,075,727
Total Mill Capital - \$: \$55,042,315

INFRASTRUCTURE CAPITAL COSTS

Buildings and Structures - \$: \$28,590,754
Remaining Infrastructure Capital - \$: \$51,234,025
Total Infrastructure Capital - \$: \$79,824,779

CONDENSED CAPITAL COSTS

Sum of Working Capital - \$: \$27,096,439
**Sum of Remaining Mine, Mill &
Infr. Costs (sum of) - \$:** \$139,182,020
**Sum of Total Mine, Mill &
Infr. Costs - \$:** \$255,651,090
Exploration Cost - \$: \$25,565,109
Overall Capital Cost - \$: \$281,216,199

Appendix A3

Cash Flow Analysis for Median Sized Sedimentary Exhalative Zn – Pb Deposit

Cash Flows

NPV	\$912,719,153		DCFROR= 74.8%	Pay Back= 1.31	MROR = 10.0%
Year	Time 0	1	2	3	
=====	=====	=====	=====	=====	
ZN REV	31,677,695	380,132,343	380,132,343	380,132,343	
PB REV	7,191,201	86,294,411	86,294,411	86,294,411	
AG REV	1,950,597	23,407,164	23,407,164	23,407,164	
GROSS REVENUE	40,819,493	489,833,919	489,833,919	489,833,919	
Total Revenue	40,819,493	489,833,919	489,833,919	489,833,919	
-SMELTING CHARGES	-2,040,975	-24,491,696	-24,491,696	-24,491,696	
-Total Smelting Cost	-2,040,975	-24,491,696	-24,491,696	-24,491,696	
-----	-----	-----	-----	-----	
Net Smelt Ret.	38,778,519	465,342,223	465,342,223	465,342,223	
-MIN LIC/NPI ROYALTY	-2,556,201	-30,674,408	-30,674,408	-30,674,408	
-Total Royalties	-2,556,201	-30,674,408	-30,674,408	-30,674,408	
-----	-----	-----	-----	-----	
Net Revenue	36,222,318	434,667,815	434,667,815	434,667,815	
-OPER COSTS	-15,257,487	-183,089,840	-183,089,840	-183,089,840	
-Total Oper Costs	-15,257,487	-183,089,840	-183,089,840	-183,089,840	
-Depreciation	-18,827,895	-35,042,142	-29,454,746	-24,248,781	
-Write Off					
-----	-----	-----	-----	-----	
Before Depltn	2,136,936	216,535,833	222,123,229	227,329,194	
% Limit	1,068,468	108,267,917	111,061,614	113,664,597	
Percent Depln	5,433,348	65,200,172	65,200,172	65,200,172	
-Depletion	-1,068,468	-65,200,172	-65,200,172	-65,200,172	
-Total D,D & A	-19,896,363	-100,242,314	-94,654,918	-89,448,953	
-----	-----	-----	-----	-----	
Taxable	1,068,468	151,335,661	156,923,056	162,129,022	
-Tax Due	-363,279	-51,454,125	-53,353,839	-55,123,867	
-----	-----	-----	-----	-----	
Net Income	705,189	99,881,536	103,569,217	107,005,154	
+Depreciation	18,827,895	35,042,142	29,454,746	24,248,781	
+Depletion	1,068,468	65,200,172	65,200,172	65,200,172	
+Write Off					
-Capital Costs	-280,416,207	-2,701,192			
-----	-----	-----	-----	-----	
Cash Flow	-259,814,655	197,422,658	198,224,136	196,454,107	
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Year	4	5	6	7	
=====	=====	=====	=====	=====	
ZN REV	380,132,343	380,132,343	380,132,343	380,132,343	
PB REV	86,294,411	86,294,411	86,294,411	86,294,411	
AG REV	23,407,164	23,407,164	23,407,164	23,407,164	
GROSS REVENUE	489,833,919	489,833,919	489,833,919	489,833,919	
Total Revenue	489,833,919	489,833,919	489,833,919	489,833,919	
-SMELTING CHARGES	-24,491,696	-24,491,696	-24,491,696	-24,491,696	
-Total Smelting Cost	-24,491,696	-24,491,696	-24,491,696	-24,491,696	
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Net Smelt Ret.	465,342,223	465,342,223	465,342,223	465,342,223	
-MIN LIC/NPI ROYALTY	-30,674,408	-30,674,408	-30,674,408	-30,674,408	
-Total Royalties	-30,674,408	-30,674,408	-30,674,408	-30,674,408	
-----	-----	-----	-----	-----	
Net Revenue	434,667,815	434,667,815	434,667,815	434,667,815	
-OPER COSTS	-183,089,840	-183,089,840	-183,089,840	-183,089,840	
-Total Oper Costs	-183,089,840	-183,089,840	-183,089,840	-183,089,840	
-Depreciation	-20,121,487	-17,288,182	-14,892,141	-12,738,645	
-Write Off					
-----	-----	-----	-----	-----	
Before Depltn	231,456,487	234,289,792	236,685,834	238,839,330	
% Limit	115,728,244	117,144,896	118,342,917	119,419,665	
Percent Depln	65,200,172	65,200,172	65,200,172	65,200,172	
-----	-----	-----	-----	-----	
Year	4	5	6	7	
=====	=====	=====	=====	=====	
-Depletion	-65,200,172	-65,200,172	-65,200,172	-65,200,172	
-Total D,D & A	-85,321,660	-82,488,355	-80,092,313	-77,938,818	
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		SEDEX CA		
Taxable	166,256,315	169,089,620	171,485,662	173,639,157
-Tax Due	-66,402,772	-67,534,394	-68,491,373	-69,351,479
Net Income	99,853,543	101,555,226	102,994,289	104,287,678
+Depreciation	20,121,487	17,288,182	14,892,141	12,738,645
+Depletion	65,200,172	65,200,172	65,200,172	65,200,172
+Write Off				
-Capital Costs		-2,701,192		
Cash Flow	185,175,203	181,342,389	183,086,601	182,226,495

Year	8	9	10	Salvage
ZN REV	380,132,343	380,132,343	380,132,343	
PB REV	86,294,411	86,294,411	86,294,411	
AG REV	23,407,164	23,407,164	23,407,164	
GROSS REVENUE	489,833,919	489,833,919	489,833,919	
Total Revenue	489,833,919	489,833,919	489,833,919	27,096,439
-SMELTING CHARGES	-24,491,696	-24,491,696	-24,491,696	
-Total Smelting Cost	-24,491,696	-24,491,696	-24,491,696	
Net Smelt Ret.	465,342,223	465,342,223	465,342,223	
-MIN LIC/NPI ROYALTY	-30,674,408	-30,674,408	-30,674,408	
-Total Royalties	-30,674,408	-30,674,408	-30,674,408	
Net Revenue	434,667,815	434,667,815	434,667,815	
-OPER COSTS	-183,089,840	-183,089,840	-183,089,840	
-Total Oper Costs	-183,089,840	-183,089,840	-183,089,840	
-Depreciation	-12,569,821	-13,076,294	-12,798,472	-24,799,628
-Write off				-27,096,439
Before Depltn	239,008,154	238,501,681	238,779,503	-24,799,628
% Limit	119,504,077	119,250,840	119,389,751	
Percent Depln	65,200,172	65,200,172	65,200,172	
-Depletion	-65,200,172	-65,200,172	-65,200,172	
-Total D,D & A	-77,769,993	-78,276,467	-77,998,644	-51,896,067
Taxable	173,807,982	173,301,508	173,579,330	-24,799,628
-Tax Due	-69,418,908	-69,216,622	-69,327,585	9,904,971
Net Income	104,389,074	104,084,886	104,251,746	-14,894,656
+Depreciation	12,569,821	13,076,294	12,798,472	24,799,628
+Depletion	65,200,172	65,200,172	65,200,172	
+Write Off				27,096,439
-Capital Costs		-2,701,192		
Cash Flow	182,159,067	179,660,160	182,250,390	37,001,410

Appendix B1

Descriptive Model of Kuroko Volcanogenic Massive Sulfide Cu–Zn–Pb–Ag–Au

DESCRIPTIVE MODEL OF KUROKO MASSIVE SULFIDE

DESCRIPTION Copper and zinc-bearing massive sulfide deposits in marine volcanic rocks of intermediate to felsic composition (Approximate synonyms Noranda type, volcanogenic massive sulfide, felsic to intermediate volcanic type).

GENERAL REFERENCES Ishihara (1974), Franklin and other (1981), Hutchinson and others (1982), Ohmoto and Skinner (1983).

GEOLOGICAL ENVIRONMENT

Rock Types Marine rhyolite, dacite, and subordinate basalt and associated sediments, principally organic-rich mudstone or shale. Pyritic and siliceous shale. Some basalt.

Textures Flows, tuff, pyroclastics, breccias, bedded sediment, and in some cases felsic domes.

Age Range Archean through Cenozoic

Depositional Environment Hot springs related to marine volcanism, probably with anoxic marine conditions. Lead-rich deposits associated with abundant fine-grained volcanogenic sediments.

Tectonic Setting(s) Island arc. Local extensional tectonic activity, faults, or fractures. Archean greenstone belt.

Associated Deposit Types Epithermal quartz-adularia veins in Japan are regionally associated but younger than Kuroko deposits. Volcanogenic Mn, Algoma Fe.

DEPOSIT DESCRIPTION

Mineralogy Upper stratiform massive zone (black ore) pyrite + sphalerite + chalcopyrite +/- pyrrhotite +/- galena +/- barite +/- tetrahedrite-tennantite +/- bornite; Lower stratiform massive zone (yellow core) pyrite + chalcopyrite (gold and silver). Gahnite in metamorphosed deposits. Gypsum/anhydrite present in some deposits.

Texture/Structure Massive (> 60 percent sulfides); in some cases, an underlying zones of ore stockwork, stringers or disseminated sulfides or sulfide-matrix breccia. Also slumped and redeposited ore with graded bedding.

Alteration Adjacent to and blanketing massive sulfide in some deposits – zeolites, monmorillomite (and chlorite?); stringer (stockwork) zone – silica, chlorite, and sericite; below stringer – chlorite and albite. Cordierite and anthophyllite in footwall of metamorphosed deposits and graphitic schist in hanging wall.

Ore Controls Toward the more felsic to of volcanic or volcanic-sedimentary sequence. Near center of felsic volcanism. May be locally brecciated or have felsic dome nearby. Pyritic siliceous rock (exhalite) may mark horizon at which deposits occur. Proximity to deposits may be indicated by sulfide clasts in volcanic breccias; Some deposits may be gravity transported and deposited in paleo depressions in the seafloor. In Japan, best deposits have mudstone in hanging wall.

Weathering Yellow, red, and brown gossans. Gahnite in stream sediments near some deposits.

Gochemical Signature Gossan may be high in Pb and typically Au is present. Adjacent to deposit – enriched in Mg and Zn, depleted in Na. Within deposits – Cu, Zn, Pb, Ba, As, Ag, Au, Se, Sn, Bi, Fe.

Examples

Kidd Creek, CNON	(Walker and others, 1975)
Mt. Lyell, AUTS	(Corbett, 1981)

GRADE AND TONNAGE MODEL OF KURKOKO MASSIVE SULFIDE

After Donald A. Singer and Dan L. Mosier

DATA REFERENCE Mosier And other (1983)

COMMENTS Includes all deposits listed by Mosier and other (1983) tat are associated with felsic or intermediate volcanic rocks. Tonnage is correlated with copper grade ($r=0.17$) and with gold grade ($r=0.19$, $n=238$) Zinc grade is correlated with lead grade ($r=0.55$, $n=184$) and with silver grade ($r=0.52$, $n= 249$). Lead grade is correlated with silver ($r=0.55$, $n=153$) and with gold grade ($r=0.34$, $n=124$). Gold and silver grades are correlated ($r=0.39$, $n=227$). Upper ten percent of the deposits contain a minimum of 18 million metric tonnes at 8.7% Zn, 3.5% Cu, 1.9% Pb, 100 grams/tonne Ag, and 2.3 grams/tonne Au. Total contained metal: 1.6 million tonnes Zn, 0.63 million tonnes Cu, 0.34 tonnes Pb, 1.8 billion grams Ag and 41.4 million grams Au. Gross value of metal in 2007 would be \$12.4 billion.

CASH FLOW ANANYSIS

Mine Life/Mining Rate: Twenty years at 0.9 million tonnes per year or 2,500 metric tonnes per day.

Gross Metal Value: \$12.4 billion

Gross Value of Annual Production: \$620 million per year

Total State Corporate Income Taxes, Mining License Taxes and Production Royalties Over Mine Life: \$ 1.2 billion

Appendix B2

Mine Preliminary Feasibility Parameters for Large Size Kuroko VMS Cu-Zn-Pb-Ag-Au Deposit

Mine Preliminary Feasibility

Mineral Deposit Type: Kuroko Type Volcanogenic Massive Sulfide (VMS)

Comments, Assumptions, Specifications: Underground Mine; Sublevel Stopping; 365 days/year; 20 year mine life.

UNDEGROUND MINE MODEL STATISTICS, INPUT AND OUTPUT DATA:

Deposit Type: *Volcanogenic Massive Sulfide – Alaska analogue is Greens Creek Mine*

Total Ore Tonnage: *18 million tonnes*

Mining Method: *Sublevel stoping*

Beneficiation Method: *Crushing, grinding, floatation*

Extraction Rate: *85%*

Dilution/Waste Rate: *15%*

Proposed Mine Life: *20 years*

Proposed Daily Production Rate: *2,500 metric tonnes*

Maximum Ore Depth: *500 meters*

Stripping Ratio: *N/A*

Haulage Distance: *600 kilometers (360 miles) with 15 kilometers (9 miles) of new road*

Pre-Production Development: *N/A*

Production Development: *N/A*

Equipment: *Jumbos, Load-Haul-Dumps, Conveyor, Drum Hoist*

Concentrate Production: *550 metric tonnes per day; three products*

INPUT VARIABLES:

A. (For Operating Costs)

Shaft sinking and face – meters/day & square meters: *N/A*

Drifting and face – meters/day & square meters: *2 m/d; 15 m².*

Raises and face – meters/day & square meters: *N/A*

Inclines and face – meters/day & square meters: *N/A*

Ore pockets/day – mtpd: *N/A*

Stope Preparation/day – stopes & square meters: *0.006; 8,000 m²*

Ore rate –mtpd: *2,500 mtpd*

Hoist depth, rate, & time-m, mtph, hr/day: *500 m, 210 mtph, 16 hrs/day*

Haul distance – meters: *650 meters*

Compressed air – cm/min: *175m³/min*

Ventilation – cm/min: *8,500 m³/min*

Conveyor length & slope – km & %: *1 km, 10 %*

Water needs – cm/day& m: *10m³/h-, 16h-s/day*

Drainage, head – cm/day & m: *1,500 m³/day, 500m*

Concentrate (dry) rate-mtpd: *550 mtpd*

Tails (day) rate-mtpd: *1950 mtpd*

Production water needs – cm/day: *2150 m³/day*

Portable Power needs – kW: *N/A*
Wastewater – L/sec: *34 L/sec*
Concentrate haul - km : *600 km (360 miles)*
Employee housing – men: *60 men*

B. (For Capital Costs)

Concentrate feeds – mtpd: *2,500, 2,300; 2,100 mtpd*
Mill operating costs - \$/day: *\$78,760/day*
Working Capital time – weeks: *13*
Development time – days: *N/A*
Shaft sinking & face – meters & square meters: *500m, 45m²*
Drifting & face – meters & square meters: *N/A*
Raises & face – meters & square meters: *750 m; 4 m²*
Inclines & face – meters & square meters: *1,500m, 15 m²*
Ore pockets – mt: *3,750 mt*
Stope preparations – stopes & square meters: *2; 8,000m²*
Dewatering; head, dys & rate – meters, dys & cm/day: *500m, 200 days, 1,500m³/day*
Rehabilitation (total tonnage) – mt: *2,500 mtpd*
Contractors – 1 or 2: *1*
Mine operating costs - \$/day : *\$165,039/day*
Access roads, length & width – km & m: *15 km, 15m*
Airstrip length & width – m : *1200m, 18m*
Townsite cost - \$: *\$3,066,879*
Powerline length & power – km & mW: *50 km, 8.2 mW*
Dike & Dam needs – cm/fill: *20,000 m²*
Climate/ Weather factors: *Severe*

OUTPUT DATA:

C. (For Operating Costs)

Mining Costs- \$/day: *\$165,039*
Mining Costs - \$/year: *\$60,239,337*
Mining Costs - \$/mt: *\$66.02*
Milling Costs - \$/day: *\$78,760*
Milling Costs - \$/year: *\$28,747,400*
Milling Costs - \$/mt: *\$31.50*
Infrastructure Costs - \$/day: *\$33,730*
Infrastructure Costs - \$/year: *\$12,311,333*
Infrastructure Costs - \$/ mt: *\$13.49*
Total Operating Costs - \$/day: *\$277,529*
Total Operating Costs - \$/year: *\$101,298,080*
Total Operating Costs - \$/mt: *\$111.01*

D. (For Capital Costs)

MINE CAPITAL COSTS

Mine Working Capital - \$: *\$13,174,188*
Heavy Equipment (fixed life) - \$: *\$8,616,619*
Mine Rehabilitation - \$: *\$2,791,215*
Engr. & Constr. Mgmt. - \$: *\$8,966,973*
Remaining Mine Capital - \$: *\$40,215,946*
Total Mine Capital Cost - \$: *\$79,764,941*

MILL CAPITAL COSTS

Mill Working Capital - \$: *\$5,454,357*
Light Vehicles (short life) - \$: *\$1,978,592*
Remaining Mill Capital - \$: *\$30,084,762*
Total Mill Capital Cost - \$: *\$37,517,712*

INFRASTRUCTURE CAPITAL COSTS

Buildings and Structures - \$: *\$16,530,036*
Remaining Infrastructure Capital - \$: *\$28,636,151*
Total Infrastructure Capital - \$: *\$45,166,187*

CONDENSED CAPITAL COSTS

Sum of Working Capital - \$: *\$18,628,545*
**Sum of Remaining Mine, Mill &
Infr. Costs (sum of) - \$:** *\$98,939,860*
**Sum of Total Mine, Mill &
Infr. Costs - \$:** *\$156,448,840*
Exploration Cost - \$: *\$15,644,889*
Overall Capital Cost - \$: *\$172,093,729*

Appendix B3

Cash Flow Analysis for Large Size Kuroko VMS Cu-Zn-Pb-Ag-Au Deposit

Cash Flows

NPV = \$1,802,629,221 DCFROR=161.7% Pay Back= 0.62 MROR = 10.0%

Year	Time 0	1	2	3
=====	=====	=====	=====	=====
ZN REV	19,107,941	229,295,286	229,295,286	229,295,286
CU REV	15,241,669	182,900,025	182,900,025	182,900,025
PB REV	1,894,637	22,735,647	22,735,647	22,735,647
AG REV	2,423,520	29,082,240	29,082,240	29,082,240
AU REV	2,759,738	33,116,850	33,116,850	33,116,850
GROSS REVENUE	41,427,504	497,130,048	497,130,048	497,130,048
Total Revenue	41,427,504	497,130,048	497,130,048	497,130,048
-SMELTING CHARGES	-2,071,375	-24,856,502	-24,856,502	-24,856,502
-Total Smelting Cost	-2,071,375	-24,856,502	-24,856,502	-24,856,502
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Net Smelt Ret.	39,356,129	472,273,546	472,273,546	472,273,546
-MIN LIC/NPI ROYALTY	-3,261,796	-39,141,548	-39,141,548	-39,141,548
-Total Royalties	-3,261,796	-39,141,548	-39,141,548	-39,141,548
-----	-----	-----	-----	-----
Net Revenue	36,094,333	433,131,998	433,131,998	433,131,998
-OPER COSTS	-8,809,547	-105,714,570	-105,714,570	-105,714,570
-Total Oper Costs	-8,809,547	-105,714,570	-105,714,570	-105,714,570
-Depreciation	-4,354,760	-8,310,330	-7,775,986	-6,952,792
-Amortization	-8,966,973			
-Write Off				
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Before Depltn	13,963,052	319,107,098	319,641,442	320,464,636
% Limit	6,981,526	159,553,549	159,820,721	160,232,318
Percent Depln	5,414,150	64,969,800	64,969,800	64,969,800
-Depletion	-5,414,150	-64,969,800	-64,969,800	-64,969,800
-Total D,D & A	-18,735,883	-73,280,130	-72,745,786	-71,922,592
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Taxable	8,548,902	254,137,298	254,671,642	255,494,836
-Tax Due	-2,906,627	-86,406,681	-86,588,358	-86,868,244
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Net Income	5,642,275	167,730,617	168,083,284	168,626,592
+Depreciation	4,354,760	8,310,330	7,775,986	6,952,792
+Depletion	5,414,150	64,969,800	64,969,800	64,969,800
+Amortization	8,966,973			
+Write Off				
-Capital Costs	-172,093,728	-1,978,592		
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Cash Flow	-147,715,569	239,032,154	240,829,069	240,549,184

Year	4	5	6	7
=====	=====	=====	=====	=====
ZN REV	229,295,286	229,295,286	229,295,286	229,295,286
CU REV	182,900,025	182,900,025	182,900,025	182,900,025
PB REV	22,735,647	22,735,647	22,735,647	22,735,647
AG REV	29,082,240	29,082,240	29,082,240	29,082,240
AU REV	33,116,850	33,116,850	33,116,850	33,116,850
GROSS REVENUE	497,130,048	497,130,048	497,130,048	497,130,048
Total Revenue	497,130,048	497,130,048	497,130,048	497,130,048
-SMELTING CHARGES	-24,856,502	-24,856,502	-24,856,502	-24,856,502
-Total Smelting Cost	-24,856,502	-24,856,502	-24,856,502	-24,856,502
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Net Smelt Ret.	472,273,546	472,273,546	472,273,546	472,273,546
-MIN LIC/NPI ROYALTY	-39,141,548	-39,141,548	-39,141,548	-39,141,548
-Total Royalties	-39,141,548	-39,141,548	-39,141,548	-39,141,548
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Net Revenue	433,131,998	433,131,998	433,131,998	433,131,998
-OPER COSTS	-105,714,570	-105,714,570	-105,714,570	-105,714,570
-Total Oper Costs	-105,714,570	-105,714,570	-105,714,570	-105,714,570

Year	4	5	6	7
=====	=====	=====	=====	=====
-Depreciation	-6,442,632	-6,479,687	-6,509,896	-6,138,910
-Amortization				
-Write Off				

	KUROKO V			
Before Depltn	320,974,796	320,937,741	320,907,532	321,278,518
% Limit	160,487,398	160,468,871	160,453,766	160,639,259
Percent Depln	64,969,800	64,969,800	64,969,800	64,969,800
-Depletion	-64,969,800	-64,969,800	-64,969,800	-64,969,800
-Total D,D & A	-71,412,431	-71,449,486	-71,479,695	-71,108,709
Taxable	256,004,996	255,967,942	255,937,733	256,308,719
-Tax Due	-102,248,396	-102,233,596	-102,221,530	-102,369,702
Net Income	153,756,601	153,734,346	153,716,202	153,939,016
+Depreciation	6,442,632	6,479,687	6,509,896	6,138,910
+Depletion	64,969,800	64,969,800	64,969,800	64,969,800
+Amortization				
+Write Off				
-Capital Costs		-1,978,592		
Cash Flow	225,169,032	223,205,240	225,195,897	225,047,726

Year	8	9	10	11
ZN REV	229,295,286	229,295,286	229,295,286	229,295,286
CU REV	182,900,025	182,900,025	182,900,025	182,900,025
PB REV	22,735,647	22,735,647	22,735,647	22,735,647
AG REV	29,082,240	29,082,240	29,082,240	29,082,240
AU REV	33,116,850	33,116,850	33,116,850	33,116,850
GROSS REVENUE	497,130,048	497,130,048	497,130,048	497,130,048
Total Revenue	497,130,048	497,130,048	497,130,048	497,130,048
-SMELTING CHARGES	-24,856,502	-24,856,502	-24,856,502	-24,856,502
-Total Smelting Cost	-24,856,502	-24,856,502	-24,856,502	-24,856,502
Net Smelt Ret.	472,273,546	472,273,546	472,273,546	472,273,546
-MIN LIC/NPI ROYALTY	-39,141,548	-39,141,548	-39,141,548	-39,141,548
-Total Royalties	-39,141,548	-39,141,548	-39,141,548	-39,141,548
Net Revenue	433,131,998	433,131,998	433,131,998	433,131,998
-OPER COSTS	-105,714,570	-105,714,570	-105,714,570	-105,714,570
-Total Oper Costs	-105,714,570	-105,714,570	-105,714,570	-105,714,570
-Depreciation	-6,015,248	-6,386,234	-7,276,867	-7,444,696
-Amortization				
-Write Off				
Before Depltn	321,402,180	321,031,194	320,140,561	319,972,732
% Limit	160,701,090	160,515,597	160,070,280	159,986,366
Percent Depln	64,969,800	64,969,800	64,969,800	64,969,800
-Depletion	-64,969,800	-64,969,800	-64,969,800	-64,969,800
-Total D,D & A	-70,985,047	-71,356,033	-72,246,667	-72,414,496
Taxable	256,432,381	256,061,395	255,170,761	255,002,932
-Tax Due	-102,419,093	-102,270,921	-101,915,202	-101,848,171
Net Income	154,013,288	153,790,474	153,255,559	153,154,761
+Depreciation	6,015,248	6,386,234	7,276,867	7,444,696
+Depletion	64,969,800	64,969,800	64,969,800	64,969,800
+Amortization				
+Write Off				
-Capital Costs		-1,978,592	-11,407,834	
Cash Flow	224,998,335	223,167,915	214,094,392	225,569,257

Year	12	13	14	15
ZN REV	229,295,286	229,295,286	229,295,286	229,295,286
CU REV	182,900,025	182,900,025	182,900,025	182,900,025
PB REV	22,735,647	22,735,647	22,735,647	22,735,647
AG REV	29,082,240	29,082,240	29,082,240	29,082,240
AU REV	33,116,850	33,116,850	33,116,850	33,116,850
GROSS REVENUE	497,130,048	497,130,048	497,130,048	497,130,048
Total Revenue	497,130,048	497,130,048	497,130,048	497,130,048

Page 2

		KUROKO V		
-SMELTING CHARGES	-24,856,502	-24,856,502	-24,856,502	-24,856,502
-Total Smelting Cost	-24,856,502	-24,856,502	-24,856,502	-24,856,502
Net Smelt Ret.	472,273,546	472,273,546	472,273,546	472,273,546
-MIN LIC/NPI ROYALTY	-39,141,548	-39,141,548	-39,141,548	-39,141,548
-Total Royalties	-39,141,548	-39,141,548	-39,141,548	-39,141,548
Net Revenue	433,131,998	433,131,998	433,131,998	433,131,998
-OPER COSTS	-105,714,570	-105,714,570	-105,714,570	-105,714,570
-Total Oper Costs	-105,714,570	-105,714,570	-105,714,570	-105,714,570
-Depreciation	-6,910,352	-6,952,792	-6,813,618	-6,232,363
-Amortization				
-Write Off				
Before Depltn	320,507,076	320,464,636	320,603,810	321,185,065
% Limit	160,253,538	160,232,318	160,301,905	160,592,533
Percent Depln	64,969,800	64,969,800	64,969,800	64,969,800
-Depletion	-64,969,800	-64,969,800	-64,969,800	-64,969,800
-Total D,D & A	-71,880,152	-71,922,592	-71,783,417	-71,202,162
Taxable	255,537,276	255,494,836	255,634,010	256,215,266
-Tax Due	-102,061,588	-102,044,637	-102,100,224	-102,332,377
Net Income	153,475,688	153,450,198	153,533,787	153,882,888
+Depreciation	6,910,352	6,952,792	6,813,618	6,232,363
+Depletion	64,969,800	64,969,800	64,969,800	64,969,800
+Amortization				
+Write Off				
-Capital Costs		-1,978,592		
Cash Flow	225,355,840	223,394,198	225,317,204	225,085,051

Year	16	17	18	19
ZN REV	229,295,286	229,295,286	229,295,286	229,295,286
CU REV	182,900,025	182,900,025	182,900,025	182,900,025
PB REV	22,735,647	22,735,647	22,735,647	22,735,647
AG REV	29,082,240	29,082,240	29,082,240	29,082,240
AU REV	33,116,850	33,116,850	33,116,850	33,116,850
GROSS REVENUE	497,130,048	497,130,048	497,130,048	497,130,048
Total Revenue	497,130,048	497,130,048	497,130,048	497,130,048
-SMELTING CHARGES	-24,856,502	-24,856,502	-24,856,502	-24,856,502
-Total Smelting Cost	-24,856,502	-24,856,502	-24,856,502	-24,856,502
Net Smelt Ret.	472,273,546	472,273,546	472,273,546	472,273,546
-MIN LIC/NPI ROYALTY	-39,141,548	-39,141,548	-39,141,548	-39,141,548
-Total Royalties	-39,141,548	-39,141,548	-39,141,548	-39,141,548
Net Revenue	433,131,998	433,131,998	433,131,998	433,131,998
-OPER COSTS	-105,714,570	-105,714,570	-105,714,570	-105,714,570
-Total Oper Costs	-105,714,570	-105,714,570	-105,714,570	-105,714,570
-Depreciation	-6,015,248	-6,386,234	-6,509,896	-6,138,910
-Amortization				
-Write Off				

Year	16	17	18	19
Before Depltn	321,402,180	321,031,194	320,907,532	321,278,518
% Limit	160,701,090	160,515,597	160,453,766	160,639,259
Percent Depln	64,969,800	64,969,800	64,969,800	64,969,800
-Depletion	-64,969,800	-64,969,800	-64,969,800	-64,969,800
-Total D,D & A	-70,985,047	-71,356,033	-71,479,695	-71,108,709
Taxable	256,432,381	256,061,395	255,937,733	256,308,719
-Tax Due	-102,419,093	-102,270,921	-102,221,530	-102,369,702
Net Income	154,013,288	153,790,474	153,716,202	153,939,016
+Depreciation	6,015,248	6,386,234	6,509,896	6,138,910
+Depletion	64,969,800	64,969,800	64,969,800	64,969,800
+Amortization				

		KUROKO V		
+Write Off		-1,978,592		
-Capital Costs				
Cash Flow	224,998,335	223,167,915	225,195,897	225,047,726

Year	20	Salvage
ZN REV	229,295,286	
CU REV	182,900,025	
PB REV	22,735,647	
AG REV	29,082,240	
AU REV	33,116,850	
GROSS REVENUE	497,130,048	
Total Revenue	497,130,048	18,628,545
-SMELTING CHARGES	-24,856,502	
-Total Smelting Cost	-24,856,502	
Net Smelt Ret.	472,273,546	
-MIN LIC/NPI ROYALTY	-39,141,548	
-Total Royalties	-39,141,548	
Net Revenue	433,131,998	
-OPER COSTS	-105,714,570	
-Total Oper Costs	-105,714,570	
-Depreciation	-5,641,436	-12,465,232
-Amortization		-18,628,545
-Write Off		
Before Depltn	321,775,992	-12,465,232
% Limit	160,887,996	
Percent Depln	64,969,800	
-Depletion	-64,969,800	
-Total D,D & A	-70,611,235	-31,093,777
Taxable	256,806,192	-12,465,232
-Tax Due	-102,568,393	4,978,614
Net Income	154,237,799	-7,486,619
+Depreciation	5,641,436	12,465,232
+Depletion	64,969,800	
+Amortization		18,628,545
+Write Off		
-Capital Costs		
Cash Flow	224,849,035	23,607,159

Appendix C1

Descriptive Model for Porphyry Cu-Mo-Au-Ag Deposit

DESCRIPTIVE MODEL OF PORPHYRY Cu-Mo-Au-Ag

DESCRIPTION Stockwork veinlets of quartz, chalcopyrite, and molybdenite in or near porphyritic intrusion. Ratio of Au (in ppm) to Mo (in percent) less than 3.

GENERAL REFERENCE Titley (1982).

GEOLOGICAL ENVIRONMENT

Rock Types Tonalite to monzogranite stocks and breccia pipes intrusive into batholithic, volcanic, or sedimentary rocks.

Textures Intrusions contemporaneous with ore commonly are porphyries with fine- to medium-grained aplitic groundmass. Porphyry texture may be restrictive to small dikes in some deposits (Brenda)

Age Range Mainly Mesozoic to Tertiary, but can be any age.

Depositional Environment High-level intrusive porphyry contemporaneous with abundant dikes, faults, and breccia pipes. Cupolas of batholiths.

Tectonic Setting Numerous faults in subduction-related volcanic plutonic arcs. Mainly along continental margins but also in oceanic convergent plate boundaries.

DEPOSIT DESCRIPTION

Mineralogy Chalcopyrite + pyrite + molybdenite. Peripheral vein or replacement deposits with chalcopyrite + sphalerite + galena +_ gold. Outermost zone may have veins of Cu-Ag-Sb-sulfides, barite, and gold.

Texture/Structure Veinlets and disseminations or massive replacement of favorable country rocks.

Alteration Quartz + K-feldspar + biotite (chlorite) +/- anhydrite (potassic alteration) grading outward to propylitic. Late white mica + clay (phyllic) alteration may form capping or outer zone or may affect the entire deposit. High-alumina alteration assemblages may be present in upper levels of the system.

Ore Controls Ore grade is, in general, positively correlated with spacing of veinlets and mineralized fractures. Country rocks favorable for mineralization are calcareous sediments, diabase, tonalite, or diorite.

Weathering Intense leaching of surface: wide areas of iron oxide stain. Fractures coated with hematitic limonite. Supergene copper as chalcocite may form blanket below leached zone. Residual soils may contain anomalous amounts of rutile.

Geochemical Signature Cu + Mo + Ag +/- W +/- B +/- Sr center; Pb, Zn, Au, As, Sb, Se, Te, Mn, Co, Ba, and Rb in outer zone. Locally Bi and Sn form distal anomalies. High S in all zones. Ratio of Au (ppm): Mo (percent) <3. Magnetic low.

EXAMPLES

Brenda, CNBC

(Soregaroli and Whiteford, 1976)

Sierrita Esperanza, USA

(West and Aiken, 1982)

GRADE AND TONNAGE MODEL OF PORPHYRY Cu-Mo

(After Donald A. Singer, Dennis P. Cox, and Dan L. Mosier)

COMMENTS These deposits are a subset of porphyry Cu-Mo deposits for which a Cu, Mo and Au grade were available. Upper ten percent of deposits contain a minimum of 2.1 billion tonnes at 0.69% Cu, 0.035% Mo, 0.043 grams/tonne Au and 4.2 grams/tonne. Ag. Total contained metal is 14.5 million tonnes Cu, 0.74 million tonnes Mo, 90.3 million grams Au, and 8.8 billion grams Ag. Gross value of metal in 2007 would be \$167 billion.

CASH FLOW ANALYSIS

Mine Life/Mining Rate Thirty years at 70 million metric tonnes per year or 200,000 metric tonnes per day.

Gross Metal Value: \$167 billion

Gross Metal Value of Annual Production: \$5.5 billion

Total State Corporate Income Taxes, Mining License Taxes, and Production Royalties Over Mine Life: \$ 16.3 billion

Appendix C2

Mine Preliminary Feasibility Parameters for Large Size Porphyry Cu-Mo-Au-Ag Deposit

Mine Preliminary Feasibility

Mineral Deposit Type: Porphyry Cu-Mo

Comments, Assumptions, Specifications: Surface Mine; Open Pit; 365 days/year; 30 year mine life.

SURFACE MINE MODEL STATISTICS, INPUT AND OUTPUT DATA:

Deposit Type: *Porphyry Cu-Mo, Alaskan Analogue - Pebble Project*

Total Ore Tonnage: *2,100 million metric tonnes*

Mining Method: *Open Pit*

Beneficiation Method: *Crushing, grinding, floatation*

Extraction Rate: *95%*

Dilution/Waste Rate: *5%*

Proposed Mine Life: *30 years*

Proposed Daily Production Rate: *200,000 metric tonnes*

Maximum Ore Depth: *600 meters*

Stripping Ratio: *1.5:1*

Haulage Distance: *600 kilometers with 50 kilometers of new road*

Distance From Power: *50 kilometers (30 miles)*

Pre-Production Development: *N/A*

Production Development: *N/A*

Equipment: *Electric Shovels, Trucks*

Concentrate Production: *5,150 metric tonnes per day; two products*

INPUT VARIABLES:

A. (For Operating Costs)

Clearing rate-ha/ day: *0.3 ha/day*

Burden/Waste rate-mtpd: *300,000 mtpd*

Burden/Waste depth & haul-m: *170 m; 5600 m*

Ore rated mtpd: *200,000 mtpd*

Ore depth and haul-m: *290 m; 3650 m*

Conveyor length & slope – km & %: *1.5 km; 6%*

Water needs – m³/day: *35,000 m³/day*

Drainage, head & distance – m³/day, m & km: *60,000 m³/day, 250m, 1.5km*

Concentrate (day) rate-mtpd: *5,150 mtpd*

Tails (dry) rate-mtpd: *195,000 mtpd*

Production water needs-m³/day: *150,000m³/day (make-up); 450,000m³/day 9(recycle)*

Portable power needs-kW: *N/A*

Wastewater- Liters/sec: *800 Liters/sec*

Concentrate haul-km: *610 km (366 miles)*

Employee housing-person camp: *1,000 employees*

B. (For Capital Costs)

Concentrate feeds – mtpd: 200,000 mtpd
Total operating costs - \$/day: \$1,486,283/day
Working capital time-weeks: 13 weeks
Development time- days: 220 days @ 500,000 mtpd
Clearing needs-ha: 1,300 ha
Stripping needs-mt: 110 million metric tonnes
Stripping depth & haul – m: 5 meters, 4,000 meters
Restoration area-ha: 4,200ha
Contractors – 1 or 2: 2
Mine operating costs- \$ / day: \$1,843,413/day
Access roads, length & width-km & m: 160 km, 15m
Airstrip length & width – m: 1,800 m, 25m
Power line length & power – km & mW: 530km, 255mW
Dike and dam needs – cm/ fill: 5,000,000 m³
Climate/Weather factors: Severe

OUTPUT DATA:

C. (For Operating Costs)

Mining Costs - \$ /day: \$2,101,491
Mining Costs - \$/year: \$767,044,215
Mining Costs - \$/mt: \$10.51
Milling Costs - \$/day: \$1,694,363
Milling Costs - \$/year: \$609,970,349
Milling Costs - \$/mt: \$8.47
Infrastructure Costs - \$/day: \$788,378
Infrastructure Costs - \$/year: \$287,757,970
Infrastructure Costs - \$/mt: \$3.94
Total Operating Costs - \$/day: \$4,584,232
Total Operating Costs - \$/year: \$1,673,244,680
Total Operating Costs - \$/mt: \$22.92

D. (For Capital Costs)

MINE CAPITAL COSTS

Mine Working Capital - \$: \$167,750,580
Heavy Equipment (fixed life) - \$: \$722,246,307
Mine Rehabilitation - \$: \$71,581,501
Engr. & Const. Mgmt. - \$: \$43,026,093
Remaining Mine Capital - \$: \$370,255,849

Total Mine Capital - \$: \$1,374,860,330

MILL CAPITAL COSTS

Mill Working Capital - \$: \$135,251,710

Light Vehicles (short life) - \$: \$9,134,026

Remaining Mill Capital - \$: \$684,233,508

Total Mill Capital - \$: \$828,619,244

INFRASTRUCTURE CAPITAL COSTS

Buildings and Structures - \$: \$176,531,836

Remaining Infrastructure Capital - \$: \$593,680,311

Total infrastructure Capital - \$: \$770,212,147

CONDENSED CAPITAL COSTS:

Sum of Working Capital - \$: \$303,002,290

**Sum of Remaining Mine, Mill &
Infr. Costs (Sum of) - \$: \$1,648,169,484**

Sum of Total Mine, Mill &

Infr. Costs - \$: \$2,973,691,721

Exploration Cost - \$: \$297,370,416

Overall Capital Cost-\$: \$3,271,074,576

Appendix C3

Cash Flow Analysis for Large Size Porphyry Cu-Mo-Au-Ag Deposit

PORCUMO

Cash Flows

NPV =18,402,414,895 DCFROR= 88.7% Pay Back= 1.11 MROR = 10.0%

Year	Time 0	1	2
MO REV	142,398,667	1,708,784,000	1,708,784,000
CU REV	302,660,738	3,631,928,850	3,631,928,850
AG REV	9,917,050	119,004,600	119,004,600
AU REV	5,259,042	63,108,500	63,108,500
GROSS REVENUE	460,235,496	5,522,825,950	5,522,825,950
Total Revenue	460,235,496	5,522,825,950	5,522,825,950
-SMELTING CHARGES	-23,011,775	-276,141,297	-276,141,297
-Total Smelting Cost	-23,011,775	-276,141,297	-276,141,297
Net Smelt Ret.	437,223,721	5,246,684,653	5,246,684,653
Net Revenue	437,223,721	5,246,684,653	5,246,684,653
-OPER COSTS	-142,114,595	-1,705,375,134	-1,705,375,134
-Total Oper Costs	-142,114,595	-1,705,375,134	-1,705,375,134
-MIN LIC/NPI ROYALTY	-31,812,090	-381,745,082	-381,745,082
-Total Sev. Ad Valor	-31,812,090	-381,745,082	-381,745,082
-Depreciation	-113,962,287	-208,221,155	-179,072,477
-Amortization	-43,026,093		
-Write Off			
Before Depltn	106,308,657	2,951,343,282	2,980,491,959
% Limit	53,154,328	1,475,671,641	1,490,245,980
Percent Depln	65,583,558	787,002,698	787,002,698
-Depletion	-53,154,328	-787,002,698	-787,002,698
-Total D,D & A	-210,142,708	-995,223,853	-966,075,175
Taxable	53,154,328	2,164,340,584	2,193,489,262
-Tax Due	-18,072,472	-735,875,799	-745,786,349
Net Income	35,081,857	1,428,464,785	1,447,702,913
+Depreciation	113,962,287	208,221,155	179,072,477
+Depletion	53,154,328	787,002,698	787,002,698
+Amortization	43,026,093		
+Write Off			
-Capital Costs	-2,932,059,847	-9,134,026	
Cash Flow	-2,686,835,282	2,414,554,612	2,413,778,088

Year	3	4	5
MO REV	1,708,784,000	1,708,784,000	1,708,784,000
CU REV	3,631,928,850	3,631,928,850	3,631,928,850
AG REV	119,004,600	119,004,600	119,004,600
AU REV	63,108,500	63,108,500	63,108,500
GROSS REVENUE	5,522,825,950	5,522,825,950	5,522,825,950
Total Revenue	5,522,825,950	5,522,825,950	5,522,825,950
-SMELTING CHARGES	-276,141,297	-276,141,297	-276,141,297
-Total Smelting Cost	-276,141,297	-276,141,297	-276,141,297
Net Smelt Ret.	5,246,684,653	5,246,684,653	5,246,684,653
Net Revenue	5,246,684,653	5,246,684,653	5,246,684,653
-OPER COSTS	-1,705,375,134	-1,705,375,134	-1,705,375,134
-Total Oper Costs	-1,705,375,134	-1,705,375,134	-1,705,375,134
-MIN LIC/NPI ROYALTY	-381,745,082	-381,745,082	-381,745,082
-Total Sev. Ad Valor	-381,745,082	-381,745,082	-381,745,082
-Depreciation	-153,926,730	-134,495,184	-121,005,103
-Amortization			
-Write Off			

Year	3	4	5
Before Depltn	3,005,637,707	3,025,069,253	3,038,559,334
% Limit	1,502,818,853	1,512,534,626	1,519,279,667
Percent Depln	787,002,698	787,002,698	787,002,698

		PORCUM0	
-Depletion	-787,002,698	-787,002,698	-787,002,698
-Total D,D & A	-940,929,428	-921,497,882	-908,007,801

Taxable	2,218,635,009	2,238,066,555	2,251,556,636
-Tax Due	-754,335,903	-893,883,782	-899,271,720

Net Income	1,464,299,106	1,344,182,773	1,352,284,915
+Depreciation	153,926,730	134,495,184	121,005,103
+Depletion	787,002,698	787,002,698	787,002,698
+Amortization			
+Write Off			
-Capital Costs			-9,134,026

Cash Flow	2,405,228,534	2,265,680,655	2,251,158,691

Year	6	7	8
=====			
MO REV	1,708,784,000	1,708,784,000	1,708,784,000
CU REV	3,631,928,850	3,631,928,850	3,631,928,850
AG REV	119,004,600	119,004,600	119,004,600
AU REV	63,108,500	63,108,500	63,108,500
GROSS REVENUE	5,522,825,950	5,522,825,950	5,522,825,950
Total Revenue	5,522,825,950	5,522,825,950	5,522,825,950
-SMELTING CHARGES	-276,141,297	-276,141,297	-276,141,297
-Total Smelting Cost	-276,141,297	-276,141,297	-276,141,297

Net Smelt Ret.	5,246,684,653	5,246,684,653	5,246,684,653
Net Revenue	5,246,684,653	5,246,684,653	5,246,684,653
-OPER COSTS	-1,705,375,134	-1,705,375,134	-1,705,375,134
-Total Oper Costs	-1,705,375,134	-1,705,375,134	-1,705,375,134
-MIN LIC/NPI ROYALTY	-381,745,082	-381,745,082	-381,745,082
-Total Sev. Ad Valor	-381,745,082	-381,745,082	-381,745,082
-Depreciation	-115,072,942	-185,584,943	-242,793,771
-Amortization			
-Write Off			

Before Depltn	3,044,491,494	2,973,979,494	2,916,770,666
% Limit	1,522,245,747	1,486,989,747	1,458,385,333
Percent Depln	787,002,698	787,002,698	787,002,698
-Depletion	-787,002,698	-787,002,698	-787,002,698
-Total D,D & A	-902,075,640	-972,587,641	-1,029,796,469

Taxable	2,257,488,797	2,186,976,796	2,129,767,968
-Tax Due	-901,641,025	-873,478,532	-850,629,326

Net Income	1,355,847,771	1,313,498,264	1,279,138,641
+Depreciation	115,072,942	185,584,943	242,793,771
+Depletion	787,002,698	787,002,698	787,002,698
+Amortization			
+Write Off			
-Capital Costs		-722,246,307	

Cash Flow	2,257,923,412	1,563,839,598	2,308,935,111

□

Year	9	10	11
=====			
MO REV	1,708,784,000	1,708,784,000	1,708,784,000
CU REV	3,631,928,850	3,631,928,850	3,631,928,850
AG REV	119,004,600	119,004,600	119,004,600
AU REV	63,108,500	63,108,500	63,108,500
GROSS REVENUE	5,522,825,950	5,522,825,950	5,522,825,950
Total Revenue	5,522,825,950	5,522,825,950	5,522,825,950
-SMELTING CHARGES	-276,141,297	-276,141,297	-276,141,297
-Total Smelting Cost	-276,141,297	-276,141,297	-276,141,297

Net Smelt Ret.	5,246,684,653	5,246,684,653	5,246,684,653
Net Revenue	5,246,684,653	5,246,684,653	5,246,684,653
-OPER COSTS	-1,705,375,134	-1,705,375,134	-1,705,375,134
-Total Oper Costs	-1,705,375,134	-1,705,375,134	-1,705,375,134

		PORCUMO	
-MIN LIC/NPI ROYALTY	-381,745,082	-381,745,082	-381,745,082
-Total Sev. Ad Valor	-381,745,082	-381,745,082	-381,745,082
-Depreciation	-218,505,534	-179,421,717	-140,782,903
-Amortization			
-Write Off			
-----	-----	-----	-----
Before Depltn	2,941,058,903	2,980,142,719	3,018,781,534
% Limit	1,470,529,451	1,490,071,360	1,509,390,767
Percent Depln	787,002,698	787,002,698	787,002,698
-Depletion	-787,002,698	-787,002,698	-787,002,698
-Total D,D & A	-1,005,508,232	-966,424,415	-927,785,601
-----	-----	-----	-----
Taxable	2,154,056,205	2,193,140,022	2,231,778,836
-Tax Due	-860,330,048	-875,940,125	-891,372,467
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Net Income	1,293,726,157	1,317,199,897	1,340,406,369
+Depreciation	218,505,534	179,421,717	140,782,903
+Depletion	787,002,698	787,002,698	787,002,698
+Amortization			
+Write Off			
-Capital Costs	-9,134,026	-374,583,791	
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Cash Flow	2,290,100,363	1,909,040,521	2,268,191,970

Year	12	13	14
=====	=====	=====	=====
MO REV	1,708,784,000	1,708,784,000	1,708,784,000
CU REV	3,631,928,850	3,631,928,850	3,631,928,850
AG REV	119,004,600	119,004,600	119,004,600
AU REV	63,108,500	63,108,500	63,108,500
GROSS REVENUE	5,522,825,950	5,522,825,950	5,522,825,950
Total Revenue	5,522,825,950	5,522,825,950	5,522,825,950
-SMELTING CHARGES	-276,141,297	-276,141,297	-276,141,297
-Total Smelting Cost	-276,141,297	-276,141,297	-276,141,297
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Net Smelt Ret.	5,246,684,653	5,246,684,653	5,246,684,653
Net Revenue	5,246,684,653	5,246,684,653	5,246,684,653
-OPER COSTS	-1,705,375,134	-1,705,375,134	-1,705,375,134
-Total Oper Costs	-1,705,375,134	-1,705,375,134	-1,705,375,134
-MIN LIC/NPI ROYALTY	-381,745,082	-381,745,082	-381,745,082
-Total Sev. Ad Valor	-381,745,082	-381,745,082	-381,745,082
-Depreciation	-124,322,649	-118,057,089	-116,978,728
-Amortization			
-Write Off			
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Before Depltn	3,035,241,788	3,041,507,347	3,042,585,709
% Limit	1,517,620,894	1,520,753,674	1,521,292,854
Percent Depln	787,002,698	787,002,698	787,002,698
-Depletion	-787,002,698	-787,002,698	-787,002,698
-Total D,D & A	-911,325,346	-905,059,787	-903,981,426

Year	12	13	14
=====	=====	=====	=====
Taxable	2,248,239,090	2,254,504,650	2,255,583,011
-Tax Due	-897,946,693	-900,449,157	-900,879,854
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Net Income	1,350,292,398	1,354,055,493	1,354,703,156
+Depreciation	124,322,649	118,057,089	116,978,728
+Depletion	787,002,698	787,002,698	787,002,698
+Amortization			
+Write Off			
-Capital Costs		-9,134,026	
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Cash Flow	2,261,617,744	2,249,981,254	2,258,684,582

Year	15	16	17
=====	=====	=====	=====
MO REV	1,708,784,000	1,708,784,000	1,708,784,000
CU REV	3,631,928,850	3,631,928,850	3,631,928,850

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	PORCUMO		
AG REV	119,004,600	119,004,600	119,004,600
AU REV	63,108,500	63,108,500	63,108,500
GROSS REVENUE	5,522,825,950	5,522,825,950	5,522,825,950
Total Revenue	5,522,825,950	5,522,825,950	5,522,825,950
-SMELTING CHARGES	-276,141,297	-276,141,297	-276,141,297
-Total Smelting Cost	-276,141,297	-276,141,297	-276,141,297
Net Smelt Ret.	5,246,684,653	5,246,684,653	5,246,684,653
Net Revenue	5,246,684,653	5,246,684,653	5,246,684,653
-OPER COSTS	-1,705,375,134	-1,705,375,134	-1,705,375,134
-Total Oper Costs	-1,705,375,134	-1,705,375,134	-1,705,375,134
-MIN LIC/NPI ROYALTY	-381,745,082	-381,745,082	-381,745,082
-Total Sev. Ad Valor	-381,745,082	-381,745,082	-381,745,082
-Depreciation	-113,946,708	-112,789,436	-163,060,130
-Amortization			
-Write Off			
Before Depltn	3,045,617,729	3,046,775,001	2,996,504,307
% Limit	1,522,808,864	1,523,387,500	1,498,252,154
Percent Depln	787,002,698	787,002,698	787,002,698
-Depletion	-787,002,698	-787,002,698	-787,002,698
-Total D,D & A	-900,949,406	-899,792,134	-950,062,827
Taxable	2,258,615,031	2,259,772,303	2,209,501,609
-Tax Due	-902,090,843	-902,553,058	-882,474,943
Net Income	1,356,524,187	1,357,219,245	1,327,026,667
+Depreciation	113,946,708	112,789,436	163,060,130
+Depletion	787,002,698	787,002,698	787,002,698
+Amortization			
+Write Off			
-Capital Costs			-731,380,333
Cash Flow	2,257,473,594	2,257,011,379	1,545,709,161

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Year	18	19	20
MO REV	1,708,784,000	1,708,784,000	1,708,784,000
CU REV	3,631,928,850	3,631,928,850	3,631,928,850
AG REV	119,004,600	119,004,600	119,004,600
AU REV	63,108,500	63,108,500	63,108,500
GROSS REVENUE	5,522,825,950	5,522,825,950	5,522,825,950
Total Revenue	5,522,825,950	5,522,825,950	5,522,825,950
-SMELTING CHARGES	-276,141,297	-276,141,297	-276,141,297
-Total Smelting Cost	-276,141,297	-276,141,297	-276,141,297
Net Smelt Ret.	5,246,684,653	5,246,684,653	5,246,684,653
Net Revenue	5,246,684,653	5,246,684,653	5,246,684,653
-OPER COSTS	-1,705,375,134	-1,705,375,134	-1,705,375,134
-Total Oper Costs	-1,705,375,134	-1,705,375,134	-1,705,375,134
-MIN LIC/NPI ROYALTY	-381,745,082	-381,745,082	-381,745,082
-Total Sev. Ad Valor	-381,745,082	-381,745,082	-381,745,082
-Depreciation	-197,744,144	-170,030,647	-153,471,644
-Amortization			
-Write Off			
Before Depltn	2,961,820,293	2,989,533,790	3,006,092,793
% Limit	1,480,910,147	1,494,766,895	1,503,046,396
Percent Depln	787,002,698	787,002,698	787,002,698
-Depletion	-787,002,698	-787,002,698	-787,002,698
-Total D,D & A	-984,746,842	-957,033,345	-940,474,342
Taxable	2,174,817,595	2,202,531,092	2,219,090,095
-Tax Due	-868,622,148	-879,690,918	-886,304,584
Net Income	1,306,195,448	1,322,840,174	1,332,785,511
+Depreciation	197,744,144	170,030,647	153,471,644
+Depletion	787,002,698	787,002,698	787,002,698
+Amortization			
+Write Off			

		PORCUMO	-71,581,501
-Capital Costs			
Cash Flow	2,290,942,289	2,279,873,519	2,201,678,352

Year	21	22	23
MO REV	1,708,784,000	1,708,784,000	1,708,784,000
CU REV	3,631,928,850	3,631,928,850	3,631,928,850
AG REV	119,004,600	119,004,600	119,004,600
AU REV	63,108,500	63,108,500	63,108,500
GROSS REVENUE	5,522,825,950	5,522,825,950	5,522,825,950
Total Revenue	5,522,825,950	5,522,825,950	5,522,825,950
-SMELTING CHARGES	-276,141,297	-276,141,297	-276,141,297
-Total Smelting Cost	-276,141,297	-276,141,297	-276,141,297
Net Smelt Ret.	5,246,684,653	5,246,684,653	5,246,684,653
Net Revenue	5,246,684,653	5,246,684,653	5,246,684,653
-OPER COSTS	-1,705,375,134	-1,705,375,134	-1,705,375,134
-Total Oper Costs	-1,705,375,134	-1,705,375,134	-1,705,375,134
-MIN LIC/NPI ROYALTY	-381,745,082	-381,745,082	-381,745,082
-Total Sev. Ad Valor	-381,745,082	-381,745,082	-381,745,082
-Depreciation	-141,924,656	-126,606,155	-116,915,336
-Amortization			
-Write Off			
Before Depltn	3,017,639,780	3,032,958,282	3,042,649,101
% Limit	1,508,819,890	1,516,479,141	1,521,324,550
Percent Depln	787,002,698	787,002,698	787,002,698
-Depletion	-787,002,698	-787,002,698	-787,002,698
-Total D,D & A	-928,927,354	-913,608,853	-903,918,034

Year	21	22	23
Taxable	2,230,637,083	2,245,955,584	2,255,646,403
-Tax Due	-890,916,451	-897,034,660	-900,905,173
Net Income	1,339,720,632	1,348,920,924	1,354,741,230
+Depreciation	141,924,656	126,606,155	116,915,336
+Depletion	787,002,698	787,002,698	787,002,698
+Amortization			
+Write Off			
-Capital Costs	-9,134,026		
Cash Flow	2,259,513,960	2,262,529,777	2,258,659,264

Year	24	25	26
MO REV	1,708,784,000	1,708,784,000	1,708,784,000
CU REV	3,631,928,850	3,631,928,850	3,631,928,850
AG REV	119,004,600	119,004,600	119,004,600
AU REV	63,108,500	63,108,500	63,108,500
GROSS REVENUE	5,522,825,950	5,522,825,950	5,522,825,950
Total Revenue	5,522,825,950	5,522,825,950	5,522,825,950
-SMELTING CHARGES	-276,141,297	-276,141,297	-276,141,297
-Total Smelting Cost	-276,141,297	-276,141,297	-276,141,297
Net Smelt Ret.	5,246,684,653	5,246,684,653	5,246,684,653
Net Revenue	5,246,684,653	5,246,684,653	5,246,684,653
-OPER COSTS	-1,705,375,134	-1,705,375,134	-1,705,375,134
-Total Oper Costs	-1,705,375,134	-1,705,375,134	-1,705,375,134
-MIN LIC/NPI ROYALTY	-381,745,082	-381,745,082	-381,745,082
-Total Sev. Ad Valor	-381,745,082	-381,745,082	-381,745,082
-Depreciation	-114,695,222	-115,088,461	-115,072,942
-Amortization			
-Write Off			
Before Depltn	3,044,869,215	3,044,475,975	3,044,491,494
% Limit	1,522,434,608	1,522,237,988	1,522,245,747
Percent Depln	787,002,698	787,002,698	787,002,698

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		PORCUMO	
-Depletion	-787,002,698	-787,002,698	-787,002,698
-Total D,D & A	-901,697,920	-902,091,159	-902,075,640
Taxable	2,257,866,517	2,257,473,278	2,257,488,797
-Tax Due	-901,791,887	-901,634,827	-901,641,025
Net Income	1,356,074,630	1,355,838,450	1,355,847,771
+Depreciation	114,695,222	115,088,461	115,072,942
+Depletion	787,002,698	787,002,698	787,002,698
+Amortization			
+Write Off			
-Capital Costs		-9,134,026	
Cash Flow	2,257,772,550	2,248,795,584	2,257,923,412

Year	27	28	29
MO REV	1,708,784,000	1,708,784,000	1,708,784,000
CU REV	3,631,928,850	3,631,928,850	3,631,928,850
AG REV	119,004,600	119,004,600	119,004,600
AU REV	63,108,500	63,108,500	63,108,500
GROSS REVENUE	5,522,825,950	5,522,825,950	5,522,825,950
Total Revenue	5,522,825,950	5,522,825,950	5,522,825,950
-SMELTING CHARGES	-276,141,297	-276,141,297	-276,141,297
-Total Smelting Cost	-276,141,297	-276,141,297	-276,141,297
Net Smelt Ret.	5,246,684,653	5,246,684,653	5,246,684,653
Net Revenue	5,246,684,653	5,246,684,653	5,246,684,653
-OPER COSTS	-1,705,375,134	-1,705,375,134	-1,705,375,134
-Total Oper Costs	-1,705,375,134	-1,705,375,134	-1,705,375,134
-MIN LIC/NPI ROYALTY	-381,745,082	-381,745,082	-381,745,082
-Total Sev. Ad Valor	-381,745,082	-381,745,082	-381,745,082
-Depreciation	-89,693,746	-65,456,302	-67,168,932
-Amortization			
-Write Off			
Before Depltn	3,069,870,691	3,094,108,135	3,092,395,505
% Limit	1,534,935,346	1,547,054,067	1,546,197,753
Percent Depln	787,002,698	787,002,698	787,002,698
-Depletion	-787,002,698	-787,002,698	-787,002,698
-Total D,D & A	-876,696,443	-852,459,000	-854,171,630
Taxable	2,282,867,993	2,307,105,437	2,305,392,807
-Tax Due	-911,777,477	-921,457,912	-920,773,887
Net Income	1,371,090,517	1,385,647,525	1,384,618,920
+Depreciation	89,693,746	65,456,302	67,168,932
+Depletion	787,002,698	787,002,698	787,002,698
+Amortization			
+Write Off			
-Capital Costs			-9,134,026
Cash Flow	2,247,786,960	2,238,106,525	2,229,656,524

Year	30	Salvage
MO REV	1,708,784,000	
CU REV	3,631,928,850	
AG REV	119,004,600	
AU REV	63,108,500	
GROSS REVENUE	5,522,825,950	
Total Revenue	5,522,825,950	303,002,290
-SMELTING CHARGES	-276,141,297	
-Total Smelting Cost	-276,141,297	
Net Smelt Ret.	5,246,684,653	
Net Revenue	5,246,684,653	
-OPER COSTS	-1,705,375,134	
-Total Oper Costs	-1,705,375,134	

		PORCUMO
-MIN LIC/NPI ROYALTY	-381,745,082	
-Total Sev. Ad Valor	-381,745,082	
-Depreciation	-33,098,226	-3,425,260
-Amortization		
-Write Off		-303,002,290
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Before Depltn	3,126,466,210	-3,425,260
% Limit	1,563,233,105	
Percent Depln	787,002,698	
-Depletion	-787,002,698	
-Total D,D & A	-820,100,924	-306,427,550
Year	30	Salvage
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Taxable	2,339,463,513	-3,425,260
-Tax Due	-934,381,727	1,368,049
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Net Income	1,405,081,786	-2,057,211
+Depreciation	33,098,226	3,425,260
+Depletion	787,002,698	
+Amortization		
+Write Off		303,002,290
-Capital Costs		
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Cash Flow	2,225,182,710	304,370,339