NOTE TO READER: This Technical Report has been re-issued on August 14, 2014 in order to reflect revisions made to the presentations in Tables 1-3, 22-1, 22-4, 22-7 and 22-8.

# Preliminary Economic Assessment Technical Report Zazu Metals Corporation, Lik Deposit Alaska, USA

Report Date: April 23, 2014
Effective Date: March 3, 2014

**Prepared for:**

Zazu Metals Corporation
350-885 Dunsmuir Street
Vancouver, BC Canada
V6C 1N5


| Qualified Persons | Company |
|---|---|
| Robert L. Matter, PE | JDS Energy & Mining, Inc. |
| Tony Loschiavo, P.Eng. | JDS Energy & Mining, Inc. |
| George Rawsthorne, P.Eng. | G.R. Rawsthorne and Associates Inc. |
| Neil N. Gow, P.Geo. | Roscoe Postle Associates, Inc. |
| Michael Travis, PE | Travis/Peterson Environmental Consulting, Inc. |




Vancouver Office
T 604.687.7545 F 604.689.5041
#860 – 625 Howe Street Vancouver, BC V6C 2T6

Kelowna Office
T 250.763.6369 F 250.763.6302
#200 – 532 Leon Avenue, Kelowna, BC V1Y 6J6

## Date and Signature Page

This report entitled Preliminary Economic Assessment Technical Report for the Lik Deposit, Alaska, USA, effective as of March 3, 2014, was prepared and signed by the following authors:

Prepared by:

*"Robert L. Matter"*
Robert L. Matter, PE

Prepared by:

*" Tony Loschiavo"*
Tony Loschiavo, P.Eng.

Prepared by:

*" George Rawsthorne"*
George Rawsthorne, P.Eng.

Prepared by:

*"Neil N. Gow"*
Neil N. Gow, PGeo

Prepared by:

*"Michael Travis"*
Michael Travis, PE

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**NOTICE**

JDS Energy & Mining, Inc. prepared this National Instrument 43-101 Technical Report, in accordance with Form 43-101F1, for Zazu Metals Corporation. The quality of information, conclusions and estimates contained herein is based on: (i) information available at the time of preparation; (ii) data supplied by outside sources, and (iii) the assumptions, conditions, and qualifications set forth in this report.

Zazu Metals Corporation filed this Technical Report with the Canadian Securities Regulatory Authorities pursuant to provincial securities legislation. Except for the purposes legislated under provincial securities law, any other use of this report by any third party is at that party's sole risk.

# 1.0 Executive Summary

## 1.1 Introduction

Zazu Metals Corporation (Zazu or the Company) commissioned JDS Energy & Mining, Inc. (JDS) to prepare this Preliminary Economic Assessment (PEA) Technical Report for the Lik Deposit (the Project), located in northwestern Alaska, United States of America (USA). This Preliminary Economic Assessment was developed in accordance with National Instrument 43-101 Standards of Disclosure for Mineral Projects (NI 43-101). JDS personnel have visited the project on several occasions, most recently on June 18, 2013.

The PEA results showed that the Lik Deposit has potential economic viability based on its zinc, lead and silver resources. All currency is stated in US dollars (US$). The economic analysis modeled for the Lik Deposit as a part of this PEA revealed a pre-tax internal rate of return (IRR) of 12.5% with a net present value assuming an interest rate of 8% ($NPV_{8\%}$) of $69.3 million and a post-tax IRR of 9.7%, with an $NPV_{8\%}$ of $25 million. The economic analysis determined the payback period to be five years pre-tax and 5.8 years after tax, into the nine-year mine life. Total capital requirements over the life of the mine were estimated at $351.7 million. Inputs into the economic analysis model included the following metal pricing:

- Zinc: $0.9242/lb (November 2013 3-year trailing average)
- Lead: $1.013/lb (November 2013 3-year trailing average)
- Silver: $19.43/oz (Kitco spot price December 30, 2013)

Zazu is a Canadian-based exploration company formed with the acquisition of an interest in the Lik zinc/lead deposit as the basis for its formation. The Company currently holds a 50% interest in the property; Teck American, Inc. (Teck) currently holds the other 50% interest. Zazu has the right to earn an additional 30% interest in the property through spending/work commitments.

Indicated and Inferred Mineral Resources, as surface mineable in-pit resources with an effective date of December 31, 2013, are shown in Table 1-1 below. Mineral Resources are reported using a 5% lead+zinc cut-off.

Additional resources, also shown in Table 1-1, may extend the pit life or be mined by underground methods, but are subject to additional study and evaluation and are not considered in this PEA. The additional resources were estimated using a 7% lead+zinc cut-off.

**Table 1-1: Total Mineral Resource Estimate, December 31, 2013, Zazu Lik Deposit**

| Location | Cut-off % Pb+Zn | Indicated Resources | | | | Inferred Resources | | | |
|---|---|---|---|---|---|---|---|---|---|
| | | Mt | % Zn | % Pb | g/t Ag | Mt | % Zn | % Pb | g/t Ag |
| **Potential Open Pit** | | | | | | | | | |
| Lik South | 5% | 16.85 | 8.04 | 2.70 | 50.1 | 0.74 | 7.73 | 1.94 | 13.4 |
| Lik North | 5% | 0.44 | 10.03 | 2.77 | 59.0 | 2.13 | 8.88 | 2.94 | 45.8 |
| ***Sub-Total*** | | ***17.29*** | ***8.09*** | ***2.70*** | ***50.3*** | ***2.87*** | ***8.59*** | ***2.68*** | ***37.5*** |
| **Additional Resource** | | | | | | | | | |
| Lik South | 7% | 0.69 | 8.04 | 3.15 | 51.0 | 0.51 | 6.97 | 1.59 | 11.3 |
| Lik North | 7% | 0.13 | 8.93 | 2.93 | 37.5 | 1.96 | 9.22 | 2.99 | 45.8 |
| ***Sub-Total*** | | ***0.82*** | ***8.18*** | ***3.12*** | ***48.9*** | ***2.47*** | ***8.76*** | ***2.70*** | ***38.7*** |
| **Total** | | **18.11** | **8.10** | **2.72** | **50.2** | **5.34** | **8.66** | **2.69** | **38.0** |

Notes:

1. CIM Definitions were followed for Mineral Resources.
2. Mineral Resources are estimated using an average long-term zinc price of $2.65/kg, lead price of $2.65/kg and silver price of $0.95/g.
3. A density value of 3.5 g/cm$^3$ (0.109 tons/ft$^3$) was used.

Mineral resources that are not mineral reserves do not have demonstrated economic viability. It includes Inferred Mineral Resources that are considered too speculative geologically to have the economic considerations applied to them that would enable them to be categorized as mineral reserves. There is no certainty that the preliminary economic assessment will be realized.

The project's current on-site facilities/assets are as follows:

- small stick-built exploration camp (±20 person capacity) with kitchen, dining and office facilities and several lesser storage-type buildings plus a core shed
- approximately 12 collapsible Weatherhaven exploration-type tents
- light equipment at the site including a small dozer, front-end loader, skid steer loader, tractor backhoe, forklift, and a Kubota side-by-side all-terrain vehicle
- ~1,200 m long gravel airstrip is located less than 1 km southwest of the camp area.

This PEA development plan is based on the following general assumptions:

- Year-round truck/shovel/loader open pit mining with an operating mine life of approximately nine years.
- A mill production throughput rate of 5,500 tonnes per day (tpd) [2.0 million tonnes per annum (tpa)].
- Operation of an on-site concentrator using crushing/grinding/flotation methods for the production of both zinc and lead concentrates.
- The construction of a 216 room mine camp and mine facilities for support of the year-round mine operations.
- Construction of a 35 km long access road to connect the mine site to the existing Delong Mountain Transportation System (DMTS).
- Transportation of concentrates and supplies along the existing DMTS and through a modified port facility near Kivalina, on the Chukchi Sea.
- Storage of concentrates at an existing port storage building for shipment during the 90-day open water season.

## 1.2 Property Description and Ownership

The Lik property is located in northwestern Alaska, approximately 145 km north of the port of Kotzebue and 22 km northwest of the Red Dog Mine held by Teck.

The Lik property initially consisted of some 296 contiguous federal mining claims all located in the U.S. Geological Survey (USGS) DeLong Mountains A-2 and A-3 quadrangle maps. In 2013, the federal mining claims were converted to a series of 47 contiguous state, Meridian Township, Range, Section, Claims (MTRSC) mining claims, administered by the State of Alaska. The geographical latitude/longitude coordinates of the Lik Deposit are approximately 68º 10’ North latitude, 163º 12’ West longitude. The Lik Deposit was broken into two contiguous areas identified as Lik South and Lik North for the original resource estimation prepared by Roscoe Postle Associates.

## 1.3 Geology and Mineralization

The Lik Deposit is hosted in the upper part of the Ikalukrok Unit of the Kuna Formation. The immediate host rocks are carbonaceous and siliceous black shale, with subordinate black chert and fine-grained limestone. There is little outcrop or exposure of the host rocks on site and as such they are interpreted to strike broadly north-south, and dip at approximately 25º to 40º to the west. The massive sulphides are overlain conformably by rocks of the Siksikpuk Formation. The sequence is overridden by allochthonous rocks that form high hills north and west of the deposits.

The mineralized sequence is cut by a number of minor faults. Recent drilling has demonstrated that several of the interpreted faults may not exist, or the movement on the fault is minor. The most significant of these faults is the Main Break Fault. While the plunge of the northern end of the Lik Deposit increases to approximately 25º to 42º, it is no longer apparent that there is a break separating the areas originally identified as Lik South and Lik North. It is also unclear whether north of the fault there is a change in deposit strike.

## 1.4 History, Exploration and Drilling

The Red Dog deposit was identified in 1970 by Mr. I. Tailleur, who was mapping in the DeLong Mountains area on behalf of the USGS. In 1975, attention was redrawn to this deposit by the U.S. Bureau of Mines, which was carrying out a mineral assessment in northwest Alaska. The 1975 announcement precipitated a staking rush throughout the DeLong Mountains.

GCO Minerals Company (GCO), in joint venture with New Jersey Zinc Company (NJZ) and WGM Inc. (WGM) (the WAK Joint Operating Agreement), was involved in the staking rush. The group carried out stream geochemical sampling and reconnaissance for color anomalies. Claims were staked in July 1976 to protect a stream geochemical anomaly on Lik Creek. Houston Oil and Minerals Exploration Company (HOMEX) replaced NJZ in the joint venture in 1976-1977.

Cominco Limited (Cominco), which is now part of Teck, staked adjacent ground. Subsequent exploration has demonstrated that the Lik deposit continues to the Teck ground where it is known as the Su deposit.

Diamond drilling commenced in 1977 and targeted a gossan with a coincident soil and electromagnetic anomaly. The first hole encountered massive lead-zinc-silver-bearing sulphides. By the end of 1977, the joint venture had completed 40 line-kilometers of ground geophysics, a soil sampling program, and ten diamond drill holes with an aggregate depth of 1,603 m. In 1978, further geological, geochemical, and geophysical surveys were carried out, together with the drilling of another 79 diamond drill holes aggregating 10,680 m. A further 14 diamond drill holes with a total depth of 4,930 m were completed in 1979 and a mineral resource was estimated.

The WAK Joint Operating Agreement joint venture continued to work in the district in the period 1980 to 1983. The joint venture held a large number of claims outside the existing Lik block and work was concentrated on other targets in some of these years; however, some diamond drilling activity continued on the Lik property. The Lik Block Agreement was signed in 1984.

In 1984, Noranda Exploration, Inc. (Noranda) optioned the Lik property. Much of the Noranda activity was concentrated in Lik North where ten diamond drill holes with an aggregate depth of 4,180.3 m were completed on four sections. Noranda also drilled holes in Lik South to delineate higher grade areas of mineralization. Noranda dropped its interest in the Lik property after a reorganization of its holdings in the United States.

Moneta Porcupine Mines Inc. (Moneta) optioned the property in 1990 and together with GCO, completed three diamond drill holes aggregating 263.4 m. The purpose of the Moneta drilling was to obtain metallurgical samples, but no records of any significant Moneta metallurgical work have been located. GCO drilled two additional diamond drill holes in 1992. There was no further drilling until Zazu acquired the property and commenced the drilling program in 2007.

There have been several mineral resource estimates in the past; however, these have been superseded by the current resource estimate in this report.

## 1.5 Metallurgical Testing and Mineral Processing

There have been five metallurgical testwork reports issued to date on the Lik ores. The most recent and comprehensive processing and metallurgical testing programs include work performed by G&T Metallurgical Services Ltd. (G&T) in Kamloops, BC, Canada, and by SGS Mineral Services (SGS) in Vancouver, BC, Canada.

Samples collected during drilling in 2007 and 2008 were composited into one Master Composite for testing at G&T in 2008, and later testing by SGS was carried out in 2010 on the remainder of the Master Composite. These key testing results have formed the basis for this economic evaluation of the Lik Deposit. Results are summarized in Table 1-2.

**Table 1-2: SGS 2010 and G&T 2008 Test Results**

| Test | Element | Feed | Lead Concentrate | | Zinc Concentrate | |
|---|---|---|---|---|---|---|
| | | Grade | Grade | Recovery | Grade | Recovery |
| SGS 2010 | Pb% | 2.83 | 52.00 | 69.10 | 1.88 | 9.70 |
| | Zn% | 9.56 | 7.39 | 2.91 | 54.60 | 83.10 |
| | Ag gpt | 37 | 55 | 5.5 | 68 | 26.6 |
| G&T 2008 | Pb% | 2.36 | 70.30 | 70.3 | 1.57 | 9.4 |
| | Zn% | 8.47 | 4.17 | 1.20 | 52.20 | 86.9 |
| | Ag gpt | 34 | 68 | 4.8 | 64 | 26.9 |
| Average Used for Mass Balance and NSR Estimates | Pb% | 2.60 | 61.15 | 69.7 | 1.73 | 9.6 |
| | Zn% | 9.02 | 5.78 | 2.06 | 53.40 | 85.0 |
| | Ag gpt | 36 | 62 | 5.2 | 66 | 26.8 |

The metallurgical flowsheet for this PEA includes conventional crushing, grinding, and flotation processing methods. Run-of–Mine (ROM) ore will be delivered to a primary crushing plant and stored in a coarse ore stockpile awaiting reclaim into the grinding circuit. Crusher ore will be reclaimed and delivered to a two-stage grinding circuit equipped with a Semi-Autogenous Grinding (SAG) mill and a ball mill in closed circuit with cyclones.

The cyclone overflow enters a pre-flotation (carbon) circuit to remove carbonaceous material before the slurry enters the lead flotation circuit. Lead flotation is accomplished in a circuit comprised a rougher stage followed by a three-stage cleaning circuit. The final concentrate is pumped to lead concentrate dewatering.

The lead rougher and cleaner tails streams are combined and enter a zinc conditioner. Conditioned slurry overflows into the zinc circuit comprised of a rougher stage followed by a three-stage cleaning circuit. The final concentrate is pumped to zinc concentrate dewatering. The zinc rougher and cleaner tails are combined with the pre-float concentrate and enter the tailings thickener for recovery of process water prior to disposal in the tailings pond. Lead and zinc concentrates are dewatered in individual circuits that each include a thickener followed by a pressure filter. Filtered concentrates are trucked to the port facility for storage and transferred to barges on a seasonal basis.

Recoveries from these modeled methods and metallurgical testing conducted to date are anticipated to be 85% of zinc to the zinc concentrate and 69.7% of the lead to the lead concentrate. Silver is also recovered and payable at times in the zinc concentrate and more significantly in the lead concentrate.

## 1.6 Mineral Resource Estimates

The subject mineral resources of this preliminary economic assessment consist only of the open pit mineable portion and are predominantly Indicated Mineral Resources with lesser quantities of Inferred Mineral Resources. A block model was developed with blocks 15.24 x 15.24 x 3.05 m high (50-ft X 50-ft X 10-ft). Grade interpolation for both the Lik South and Lik North deposits was by ordinary kriging. Interpolation was completed as a two-pass process. The 5% Pb+Zn cut-off grade is based on estimated long-term lead and zinc prices, on operating costs for the nearby Teck Red Dog Mine, and on other data. The assay database was checked and corrected for high values; only some silver assays were considered to be outliers. The density of 3.5 $g/cm^3$ (0.109 $tons/ft^3$) was used to convert volume into tonnes, based on the density results of 144 samples that were considered to be representative.

The preliminary pit shell was completed by Roscoe Postle Associates using Whittle software; zinc, lead, and silver metallurgical recoveries for the Lik deposit; assumed costs; concentrate terms; and average long-term commodities prices. The Mineral Resources are classified as Indicated and Inferred and follow Canadian Industry of Mining (CIM) definition standards for Mineral Resources. The Mineral Resources are not materially affected by any known environmental, permitting, legal, title, taxation, socio-economic, political or other relevant issues in the opinion of JDS. The estimates of Mineral Resources may be materially affected if mining, metallurgical or infrastructure factors change from those currently anticipated at the Lik Project.

Potential Indicated Mineral Resources within the preliminary open pit include 16.85 million tonnes grading 8.04% Zn, 2.70% Pb, and 50.1 g/t Ag, plus Inferred Mineral Resources of 0.74 million tonnes grading 7.73% Zn, 1.94% Pb, and 13.4 g/t Ag. Additional Indicated and Inferred Mineral Resources associated with parts of the Lik Deposit that could have the potential for underground mining are not considered in this PEA, beyond being an additional opportunity for extension of the mine life pending further evaluation of economic feasibility.

## 1.7 Sample Preparation, Analyses and Security

Zazu conducted a quality assurance and quality control (QA/QC) program and found that the reproducibility between G&T and ALS Chemex pulps was good. The QA/QC program included blanks and quartered duplicates, but the 2007 samples did not include acceptable reference samples. There were some cases of reference samples during the 2011 drilling season that had low lead values that exceeded three standard deviations and did not meet QA/QC standards. In the case of the 2011 reference samples, Roscoe Postle Associates did not consider the problems to be significant.

Due to remote location of the Project, on-site security is not considered to be a problem. Samples are transferred by company personnel and by bonded carrier. No significant security risks were encountered.

Roscoe Postle Associates is of the opinion that the analytical work completed and planned will give a reliable indication of the grades of mineralization tested in the 2007 and 2008 drilling.

## 1.8 Mineral Reserve Estimates

Mineral Reserves have not yet been estimated for the Lik Deposit. This will be a focus for the next level of study on the Lik Deposit.

## 1.9 Mining Methods

The Lik Deposit's southern portion (Lik South) is the focus of this study and will be mined using open pit, truck/shovel, and/or truck/loader mining methods. A block model has been created based on current exploration drilling and digital topography to represent the deposit. Pit optimization was carried out on the model and forms the basis to support a 5,500 metric ore tonnes-per-day open pit mining and milling operation. JDS estimated the optimized, mineable open pit Mineral Resources to be 17.1 million tonnes at estimated grades of 7.7% zinc, 2.6% lead, and 47.5 g/tonne of silver. This estimate compared favorably with the preliminary estimate made by Roscoe Postle Associates, and the JDS estimate forms the basis for this PEA.

Additional resources have been intercepted by exploration drilling to the northeast of the open pit portion of the deposit. These resources would be considered for extension of the mine life, depending on prevailing economic conditions and metal prices at that time. Access from the bottom of the pit could also facilitate underground mining of these resources at a lower production rate. Also worthy of note are the resources identified in the neighboring (contiguous) Su Deposit owned by Teck. Resource quantities in the Su Deposit have not been publicly disclosed at this time. Neither the Su Deposit nor the additional resources at the Lik Deposit are included in this PEA.

## 1.10 Project Infrastructure

The Lik Deposit is situated in a remote location with minimal existing infrastructure or services for support of the Project. Hence, on-site and off-site infrastructure to support both initial construction and ongoing operations of the mine will have to be constructed. Existing infrastructure includes a small exploration camp and a roughly 1,200 m long airstrip capable of handling larger multiple-engine airplanes using visual flight rules.

The proposed 5,500 tonne per day mill for the site will be constructed with crushing, grinding, and sequential flotation systems to produce separate lead and zinc concentrates. To support onsite mining and processing operations, waste rock storage facilities, a Tailings Management Facility (TMF), power supply, equipment repair workshop, explosives magazines, explosives emulsion facility, warehouse, engineering offices, mine dry facility, administration offices, first aid station, separate Pb and Zn concentrate storage facilities, fuel/lubricants storage and an accommodation complex will be built on site. Power generation, potable water, sewage, and wastewater treatment facilities will also be built to support the operations at the site.

The process plant and other surface facilities are strategically located so adjoining deposit(s) are not sterilized. The mine infrastructure will have additional storage capacity of materials in case of access restrictions due to weather. Arctic weather conditions have also been considered in the accommodations.

A 35 km long access road will need to be built to connect the mine site to the existing 84 km long DMTS roadway between the Teck Red Dog Mine and the DeLong Mountain Port on the Chukchi Sea. This access road in conjunction with the existing DMTS will be used for supply deliveries and haulage of concentrates from the mine to the port. Concentrates will be hauled in specialized 120 tonne (130 ton) capacity trucks and stockpiled temporarily until shipped to a smelter. The concentrate haulage and supply deliveries will be subcontracted.

Concentrates from Lik will be hauled to port in the same size vehicles currently being used by Teck in transporting the Red Dog Mine concentrates to port. The economic advantages of these large vehicles over “highway standard” trucks include reduced manpower and less traffic on the road.

The DeLong Mountain Port is owned by the Alaska Industrial Development and Export Authority (AIDEA), and is operated and maintained by Teck Red Dog Mine, which is currently the only user of the facility. NANA Regional Corporation owns the land on which all of the port facilities are built, and the National Park Service manages all of the surrounding area. Agreements with AIDEA and the Teck Red Dog Mine will be needed for the Lik Project to use their facilities and to make modifications to accommodate Lik Project shipments. Currently, the port facilities at the DeLong Mountain Port include a fuel storage tank farm for Teck Red Dog Mine, as well as a supply unloading dock area and laydown yard for supplies, mostly transported in sea-can (ISO) containers. The port also has two concentrate storage buildings, currently used by Teck Red Dog Mine, a truck dump for unloading the concentrate trucks from the mine, a conveyor system for stacking the concentrates and for conveying the concentrates to concentrate barges. The barges will transfer the concentrates to larger, deeper draft ships, which will be anchored further offshore. Dredging will be periodically required.

With current Teck Red Dog Mine concentrate production rates, JDS believes that the existing port facility has the capacity to handle the future Lik concentrate production and sea lift re-supply. Some modifications considered for the port include possible upgrading of the materials handling system, and an enlarged bulkhead dock for fuel and supplies. AIDEA is currently conducting capacity studies through consultants to confirm that sufficient capacity exists in the current concentrate storage buildings to accommodate both the Teck Red Dog Mine and Lik Project concentrates.

The present Teck Red Dog Mine lightering contractor, Foss Maritime, owns and operates the tugs and the two 5,800 tonne self-unloading barges. At least one new barge, designed for the local conditions, will likely be required to accommodate lightering of Lik Project concentrate production.

Weather conditions restrict port operations to approximately 90 days per year, thus accurate weather forecasting is a major concern for port operations. Capital is included in the estimate for off shore weather buoys to improve accuracy in timing approaching storm fronts.

Diesel will be the only fuel used for power generation and mine operations. Annual requirements are estimated at 34,000,000 liters. Included in this quantity is fuel for port power generation, as well as for contractor port and trucking operations. New port site storage will include a 28.4 million liter capacity tank farm and upgraded fuel pumping system. Fuel will be supplied by barge, likely from a refinery in Washington, within the 90-day port operational window.

An additional 60,703 $m^2$ fenced lay down area will be required to store the estimated 34,500 tonnes of annual supplies required to sustain mine operations. These supplies will be delivered by 10,500 tonne capacity barges and transferred to site by conventional tractor trailer truck units. The bulk of the supplies will be received in ISO containers.

Improvements to the existing airstrip are proposed, but the airstrip will still have restricted usage. Further study and negotiation with Teck is recommended to enable use of their existing all-weather instrumented airport, which is approximately 40 km from the Lik Project. Access to the site can also be by commercial jet flights from Anchorage followed by approximately a 45-minute trip to the Lik Project by road.

A reliable power supply at the Lik Project is essential for the year-round operations. Initial studies indicate that a multiple engine diesel generator station will provide a practical solution. For this study, based on a nominal N+2 configuration, the station will consist of eight containerized 1800rpm, 2.725mW diesel generator, sets to supply the 13.24mW base load (six engines on load, one on maintenance mode and one on stand-by mode). Exhaust gas heat exchangers on each engine exhaust will capture the waste heat for space heating of the process plant, and other occupied site buildings. Low grade heat from the engine radiators will be utilized for in-floor heating on the repair shop floor. One engine will be delivered and commissioned early and used to supply power during mine construction. Fire protection and monitoring equipment are planned.

The ammonium nitrate storage facilities, emulsion plant, and explosives storage magazine are sited to the south of the process plant site at a distance specified per appropriate guidance for safety and supplies will be delivered and stored using safety guidance methods. A small secured operating storage pad will also be built adjacent to the emulsion plant. The emulsion plant equipment and explosives-handling vehicles will be supplied by the selected explosives contractor. Three explosives storage magazines will be constructed.

## 1.11 Environment and Permitting

Travis/Peterson Environmental Consulting, Inc. (TPECI), headquartered in Anchorage, Alaska has been conducting initial baseline studies and reviews since 2008. Project environmental permitting involves both federal and state agencies. It is anticipated that the United States Army Corps of Engineers (ACOE) will be the lead NEPA agency for this project, because of the wetlands present in the project area. Cooperating agencies include the Alaska Department of Environmental Conservation (ADEC), the Alaska Department of Natural Resources (ADNR), and the Alaska Department of Fish and Game (ADF&G).

Environmental scoping will determine whether the NEPA process will involve the Environmental Assessment (EA) process or whether the Environmental Impact Statement (EIS) process will be followed. The nearest large mine, Teck Red Dog Mine, used the EIS process.

The primary differences between the EA and EIS processes are the duration and scope of public involvement. The scope of public involvement for an EIS involves an actual hearing process, whereas the EA requires public notification and comment process whereby public comments and concerns are documented and incorporated into the larger decision-making process of the project owner and lead environmental agencies. Zazu is currently preparing an EA for the Project. If the ACOE deems the project impacts to be significant, then it is anticipated that the EA will be upgraded to an EIS.

Baseline environmental data collection has included information on hydrology, cultural resources, fisheries, soils, vegetation, wetlands and meteorology. The study area included the Square Creek drainage and all of its first-order streams leading into (and including) the Wulik River drainage to the east, plus the Iklukrok Creek drainage near the Teck Red Dog Mine. Meteorological monitoring was conducted over four quarterly periods in 2011 and 2012 for wind speed, wind direction, temperature and solar radiation. Geochemical testing of mining wastes has begun, however the results are not available yet.

The Lik Deposit is located in an Arctic climate where the average summer maximum temperature is 25°C and the average winter minimum temperatures range between -30 to -35°C. The mean annual precipitation in the northwestern interior of Alaska ranges from 300 to 400 mm per year, rainfall and snow water equivalent.

Initial review of the area hydrogeology has indicated that the area is expected to be dominated by continuous permafrost. The presence of permafrost may serve in isolating groundwater from surface waters in the proposed mine area; however it was noted that groundwater springs contribute flow to many smaller streams within and surrounding the project site. The surface hydrology is quite complex with numerous creeks that drain into the Wulik River. Little to no flow occurs in streams during the winter season when precipitation accrues as snow. It is unlikely that the area will have significant wetlands due to the terrain and soil conditions, although a wetland below the existing Lik camp collects much of the basin runoff not captured in streams. The Wulik River drainage is listed as an important location for spawning, rearing or migration of fishes. The Wulik River is known for Dolly Varden fish, which is a subsistence food for the residents of Kivalina. Multiple hydrologic studies are either in progress or scheduled, including a minor and major basin analyses.

The existing port facility has a loading dock that protrudes into the Chukchi Sea. The sea bottom is flat and packed with tight sediments. The area is subjected to fierce storms and erosion.

A preliminary soil survey of the Project area was completed in 2011. The environmental management plan will include salvage of growth media during construction for future use during reclamation. Vegetation within the Project area includes mixed shrub-sedge tussock tundra with willow thickets along rivers and stream. Alpine tundra is predominant at higher elevations and ridge crests. The entire Project site is north of the Arctic tree line. The Lik Deposit and the proposed transportation routes fall within the Arctic Tundra. The eco-regions of the Arctic Tundra support Arctic char, Arctic grayling, Arctic cisco, broad whitefish, least cisco, Dolly Varden, salmon, wolves, Arctic foxes, grizzly bears, caribou, muskoxen, Dall sheep, shorebirds, ducks, geese, swans, songbirds, and other animals. It is anticipated that large numbers of caribou could come in contact with the development area, Dall sheep may be present, as well as muskoxen, moose and grizzly bears.

Future development of the mine facilities, haul road, and expanded port facility may affect a range of terrestrial habitat types and aquatic habitat types and wildlife species. An environmental management system will be developed to reduce or mitigate environmental impacts and to establish a monitoring program. In addition, a reclamation and closure plan is currently in development. For the purpose of this PEA, it was assumed that closure would be carried out in less than one year, and that all waste rock and tailings can be managed in unlined facilities.

## 1.12 Capital and Operating Costs

Capital and operating costs have been estimated by JDS based upon similarly located, recently constructed projects and experience with similar constraints encountered at the Lik Project. Where remoteness and access were considerations, adjustments were made to approximate those impacts on costs.

The Life-Of-Mine (LOM) capital costs for the Lik Project have been estimated at $351.7 million, with $324.7 million in pre-production capital and $27.0 in sustaining capital. A 20% contingency on direct costs is included in the above estimates.

The estimate is based on 2013 US dollars with no escalation. Project development is based on a 24-month schedule, including major construction at site taking place over 18 months. Sustaining capital is carried over operating Years 1 through 9 and includes closure costs incurred in Year 10. The accuracy of the engineering cost is estimated at +25/5%.

## 1.13 Economic Analysis

The economic analysis performed by JDS with tax review concurrence from Pricewaterhouse Coopers (PwC) was based on several assumptions that are considered appropriate for the PEA level of study represented by this report. Key assumptions include:

- Alaska Industrial Development and Export Authority (AIDEA) assistance in funding a significant portion of the access road and port improvements. The funding assistance would take into account other potential resource development in the area to justify annual costs amortized over a 30-year period.
- Port capacity studies (currently on-going) of existing infrastructure will show that existing capacity, along with proposed improvements in weather and oceanic condition forecasting, will be sufficient to manage the additional concentrate produced from Lik.

The key economic criteria are based on the following revenue and cost assumptions.

Revenue Assumptions

- 2 million tonne per annum milling rate
- Zinc recovery of 85% to zinc concentrate (53.4% zinc concentrate grade)
- Lead recovery of 69.7% to lead concentrate (61.1% lead concentrate grade)
- Silver recovery of 26.75% to the zinc concentrate and 5.2% to the lead concentrate
- Metals prices:
    - Zinc: $0.9242/lb (November 2013 3-year trailing average)
    - Lead: $1.013/lb (November 2013 3-year trailing average)
    - Silver: $19.43/oz (Kitco spot price December 30, 2013)
- Teck percent of ownership at time of production yet to be determined, all economics are based on the total project performance
- Revenue is recognized in the year the concentrate is produced

Cost Assumptions

- Pre-production period of two years
- Mine life of nine years
- Life of mine capital: $351.7 million
- Average operating cost over the life of mine: $67.66 per tonne milled
- 1% Net Profits Interest (NPI) payments to GCO Minerals Company by the Project.

Zazu owes a 2% Net Proceeds Interest (NPI) to GCO Minerals Company. The amount is based upon Zazu's yet to be determined percentage ownership in the project. This cost is noted here for disclosure, but has not been included in the economic analysis because Zazu's ownership position will likely change as the site moves toward development. This NPV will be further detailed in the next level of study.

The results of the economic analysis modeled for the Lik Deposit show a pre-tax IRR of 12.5% with an $NPV_{8\%}$ of $69.3 million and a post-tax estimated IRR of 9.7% with an $NPV_{8\%}$ of $25 million (Table 1-3).

Mineral resources that are not mineral reserves do not have demonstrated economic viability. The mineral resources used in developing the economic model for this PEA include inferred resources that are considered too speculative geologically to have the economic considerations applied to them that would enable them to be categorized as mineral reserves. There is no certainty that the preliminary economic assessment will be realized.

**Table 1-3: Summary of Results for NSR Parameter Metal Pricing (Zn @ $0.92/lb; Pb @ $1.01/lb; Ag @$19.43/oz)**

| Summary of Results | Unit | Value |
|---|---|---|
| **Concentrate Production** | | |
| Zn Concentrate Produced | LOM dry kt | 2,088.4 |
| Average Zn Concentrate Produced | dry kt/a | 233.9 |
| Zn Production | Mlbs | 2,090.2 |
| Average Zn Production | Mlbs/a | 234.1 |
| Ag in Zn Concentrate | LOM koz | 443.5 |
| Average Ag in Zn Concentrate | koz/a | 49.7 |
| Pb Concentrate Produced | LOM dry kt | 498.1 |
| Average Pb Concentrate Produced | k dry t/a | 55.8 |
| Pb Production | Mlbs | 638.1 |
| Average Pb Produced | klbs/a | 71.5 |
| Ag in Pb Concentrate | LOM koz | 523.1 |
| Average Ag in Pb Concentrate | koz/a | 58.6 |
| LOM NSR | $M | 1,787 |
| | $/t milled | 104 |
| Operating Costs | LOM $M | 1,159 |
| | $/t milled | 67.66 |
| Zn Cash Cost (Net of By-Products) | $/lb | 0.63 |
| Pb Cash Cost (Net of By-Products) | $/lb | 0.04 |
| **Capital Costs** | | |
| Pre-Production Capital | $M | 286.2 |
| Pre-Production Contingency | $M | 38.5 |
| **Total Pre-Production Capital Costs** | **$M** | **324.7** |
| | **$/t milled** | **18.95** |
| Sustaining & Closure Capital | $M | 27.0 |
| **Total Sustaining & Closure Capital Costs** | **$M** | **27.0** |
| **Total Capital Costs (incl. Contingency)** | **$M** | **351.7** |
| Average Operating Cashflow During Production | $M | 68.7 |
| **Pre-Tax NPV$_{8\%}$** | **$M** | **69.3** |
| **Pre-Tax IRR** | **%** | **12.5%** |
| **Pre-Tax Payback Period** | **Years** | **5.0** |
| **After-Tax NPV$_{8\%}$** | **$M** | **25.0** |
| **After-Tax IRR** | **%** | **9.7%** |
| **After-Tax Payback Period** | **Years** | **5.8** |

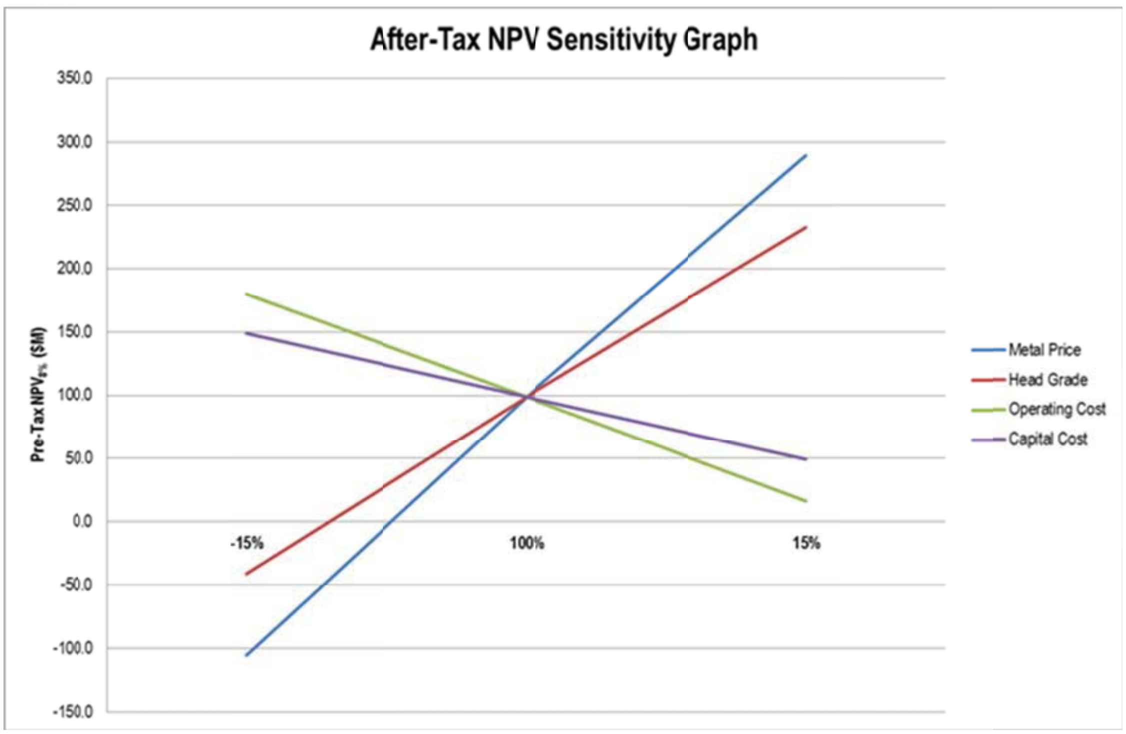
## 1.14 Interpretation and Conclusions

The Lik project reflects a positive economic analysis result based upon the key operational assumptions and modelled metal prices of Zinc: $2.04/kg; Lead: $2.23/kg; Silver: $0.68/g.

Mineral resources that are not mineral reserves do not have demonstrated economic viability. The mineral resources used in developing the economic model for this PEA include inferred resources that are considered too speculative geologically to have the economic considerations applied to them that would enable them to be categorized as mineral reserves. There is no certainty that the preliminary economic assessment will be realized.

Sensitivity to the zinc price is high as modeled, and a small price fluctuation produces significant swings in both the rate of return and the net present value of the Lik project. Optimizing the economic outcome of mining the Lik Deposit will be directly tied and dependent upon both the zinc and lead prices at the time of mining and the smelter contracts that Zazu will be able to negotiate at the time production is initiated. The sensitivity graph below shows the impacts of fluctuations in the price of zinc while lead and silver prices are kept steady.

**Figure 1-1: After Tax NPV Sensitivity Graph**




Revenue attributed to each metal is approximately 70% Zn, 29% Pb and 1% Ag.

Capital cost of infrastructure for the project as modelled is critical and reliant on partial funding/financing by state agencies set up to help develop natural resources in Alaska.

Zazu conducted a QA/QC program and found that the reproducibility between G&T and ALS Chemex pulps was good. The QA/QC program included blanks and quartered duplicates, but the 2007 samples did not include acceptable reference samples. Roscoe Postle Associates is of the opinion that the analytical work completed and planned will give a reliable indication of the grades of mineralization tested in the 2007 and 2008 drilling.

The Lik site is relatively conducive to the development of a mining operation. Although the site is located in a remote area in an Arctic climate, the logistics and climate challenges have been successfully reduced or mitigated at other mining operations, and the proposed mine plan has taken these challenges into account.

Space, though not abundant, is more than sufficient by current estimates to support mining and waste storage of identified potential resources. Existing topography and efficient site layout offers the opportunity to control and manage waters within the drainage of the proposed Tailings Management Facility (TMF). As a result, fresh make-up process water requirements are minimised. Once collected in the TMF, treatment of impacted waters is simplified and the captured water can be treated and recycled back to the ore concentration process in the mill, reducing the need for additional make-up water from a fresh water source.

Environmental impacts related to the waste rock and storage facilities are manageable. Testing is underway to identify rock types that will require specialized storage design and/or management. There are no insurmountable environmental or permitting issues identified that could preclude the development of the Lik Deposit.

## 1.15 Recommendations

JDS recommends that Zazu conduct the following activities to advance the project to the pre-feasibility design level:

- Move forward with discussions with Teck regarding synergies that can be realized to make their combined development and operation of the Lik Deposit more efficient and cost effective.
- Concentrate sales agreements (smelter contracts) and shipping costs should be investigated in greater detail so that costs can be more accurately estimated for future levels of study. The cost of the access road was estimated based on a narrower roadway than was originally proposed, with the placement of pull-outs to facilitate larger vehicles to pass each other. This would also result in less of an environmental liability. Further design needs to be evaluated on this basis.
- A cooperative approach to the use of the port facilities should be discussed and negotiated between Teck, Zazu, AIDEA, Foss Maritime, and NANA so that the absolute minimum port footprint and infrastructure expansion can be determined to facilitate the additional concentrates produced from the Lik Deposit. This scenario is beneficial to all parties involved.

- Further foundation drilling and geotechnical work for the site facilities, waste storage facilities, and tailings storage facilities should also proceed at this point to determine with additional certainty the site layout, material types and quantities required, and the geotechnical requirements of the waste and tailings storage facilities. The hydrogeological investigation should be advanced also for both water supply and in-pit flows characterization.
- Roscoe Postle Associates recommended that the QA/QC program include pulp sample splits to an independent laboratory to check the integrity of the database.
- Optimizations costs should be revised based on the latest information provided in this PEA, to include road and port maintenance operating costs.
- Develop a more detailed pit design with ramps located to further optimize haulages to both the concentrator/mill and the waste storage facilities. Additionally, the preliminary tailings storage facility design should be prepared.
- Review access road alignment options and make final selection on both the routing and the typical dimensions, road width in particular.
- Continue the collection of environmental data required to advance the permitting process and initiate plan review with the Department of Natural Resources – Large Mines Group.
- Review and confirm details/assumptions regarding planned contracts with AIDEA and NANA for construction of the access road connecting Lik to the existing DMTS and for improvements and use of the port facilities near Kivalina so that the financial impacts are clear.
- Proceed with additional metallurgical testwork to optimize recoveries and optimize the economic returns of the project.
- Investigate smelter contracts and conduct a marketing study.

The preparation of a Pre-Feasibility Study will be the next level of study providing that Zazu has successful negotiations with Teck, AIDEA, and NANA that provide sufficient cost certainty to confirm or improve current modeling assumptions.

A total of $5.9 million for recommended work programs has been estimated to advance the project to a Pre-Feasibility Study.

# 2.0 Introduction

## 2.1 Basis of Technical Report

JDS Energy & Mining, Inc. (JDS) was commissioned by Zazu Metals Corporation (Zazu) to prepare an Technical Report at the PEA level of study for the Lik Project located approximately 145 km north-northeast of Kotzebue Alaska, in the United States of America (USA).

The purpose of this Technical Report is to provide a PEA of the Lik Project in support of the public disclosure of information regarding the Lik Project by Zazu. This Technical Report was developed in accordance to NI 43-101 Standards of Disclosure for Mineral Projects (NI 43-101)

Roscoe Postle Associates, Inc. (RPA) prepared the resource model and the geologic interpretation to produce the block model that incorporates all of the useable drilling data accumulated to date. This block model was provided to JDS and forms the basis for the mine modeling and cost estimating performed by JDS, the results of which are presented in this PEA level technical report.

## 2.2 Scope of Work

JDS was commissioned by Zazu to conduct the development of this PEA Technical Study to include updated technical site information, integrate the new block model containing new drilling results and to incorporate an estimate of the effect of taxes on the project economics.

This technical study is the culmination of work by several consultants independent of Zazu, who have significant knowledge and have been closely involved in the Lik project. JDS has performed significant portions of this assessment and directed the development of this report with the support of RPA, Travis Peterson Environmental Consulting, Inc. (TPECI), and EBA Engineering Consultants, Ltd. (EBA).

The PEA is preliminary in nature. Mineral resources that are not mineral reserves do not have demonstrated economic viability. This includes inferred mineral resources that are too speculative geologically be categorized as mineral reserves. There is no certainty that the economic estimates modeled, on which this preliminary economic assessment is based, will be realized.

## 2.3 Qualifications and Responsibilities

The consultants who prepared this PEA are specialists in the fields of geology, exploration, mineral resources estimation and classification, open pit mining, metallurgical processing, processing design, capital and operating cost estimation and mineral economics. None of the consultants or any associates employed in the preparation of this report have any beneficial interest in the Lik Project. The consultants are not insiders, associates or affiliates of Zazu. The consultants are being paid a fee for their work in accordance with normal professional consulting practice.

The following individuals, by virtue of their education, experience and professional association, are considered Qualified Persons (QPs) as defined in the NI 43-101 standard and are members in good standing of appropriate professional institutions. The QPs are responsible for specific sections as follows below, and for information from their sections used in the executive summary, and have a shared responsibility for section 27.

- Robert Matter, PE, is responsible for sections 1-3, 18, 19, 22-26 and shares responsibility for sections 5, 21, and 27.
- Antonio Loschiavo, P.Eng., is responsible for sections 15, 16 and 21 (except for 21.2 and 21.2.4, 21.7,21.8)
- George Rawsthorne, P.Eng., is responsible for sections 13 and 17 and shares responsibility for section 21.
- Michael Travis, PE, is responsible for sections 20 and shares responsibility for section 27.
- Neil Gow, P.Geo., is responsible for sections 4, 6-12,14 and shares responsibility for sections 5 and 27.

The Certificates of Authors are provided in Appendix A.

## 2.4 Site Visit

JDS has conducted several visits to the Lik site, as has RPA, TPECI and EBA. The most recent site visit that JDS took part in was on June 18, 2013 and included representatives from TPECI, and EBA, to evaluate a potential access road bridge crossing location, tailings storage facility location, and the area being proposed for the mill, camp, office and shop facilities.

## 2.5 Units and Currency

Unless otherwise specified or noted, the units used in this technical report are metric. Every effort has been made to clearly display the appropriate units being used throughout this technical report. Currency is in United States Dollars (USD or US$).

## 2.6 Sources of Information

Site visits by JDS personnel were carried out by Robert L. Matter, PE in 2011 and again on June 18, 2013. Other JDS personnel involved in the development of this report have also visited the site.

Discussions have been held on numerous occasions with the following Zazu personnel:

- Mr. Gil Atzmon, Chief Operating Officer
- Mr. Matt Ford, President
- Mr. Ralf Langner, Chief Financial Officer
- Mr. Joe Britton, Alaska Operations Manager.

The above Zazu personnel have provided documentation relevant to the development of this report.

Pit slope angles contained in the geotechnical report, 2011 Geotechnical Site Investigation & Geotechnical Pre-Feasibility Study for Proposed Open Pit at the Lik Deposit, produced by EBA Engineering Consultants, Ltd., dated December 2011, were used by JDS for the pit modeling and optimizations fo this PEA.

JDS is responsible for sections 1 through 3, 13, 15 through 19, and 21 through 26 and shares responsibility for sections 5 and 27.

TPECI is responsible for section 20 and shares responsibility for section 27.

RPA is responsible for section 4, 6 through 12, 14 and shares responsibility for sections 5 and 27.

All tables and figures are sourced from JDS, unless otherwise indicated.

## 2.7 Units of Measure, Calculations & Abbreviations

**Table 2-1: Units of Measure & Abbreviations**

| | |
|---|---|
| ' | Foot |
| " | Inch |
| µm | Micron (micrometer) |
| Amp | Ampere |
| Ac | Acre |
| Ag | Silver |
| Au | Gold |
| Cfm | Cubic feet per minute |
| cm | Centimeter |
| Cu | Copper |
| d/a | Days per annum |
| dmt | Dry metric tonne |
| ft | Foot |
| $ft^3$ | Cubic foot |
| g | Gram |
| h | Hour |
| ha | Hectare |
| hp | Horsepower |
| In | Inch |
| kg | Kilogram |
| km | Kilometer |
| $km^2$ | Square kilometer |
| KPa | Kilopascal |
| kt | Thousand tonnes |
| Kw | Kilowatt |
| KWh | Kilowatt hour |
| L | Liter |
| lb or lbs | Pound(s) |
| m | Meter |
| M | Million |
| $m^2$ | Square meter |
| $m^3$ | Cubic meter |
| mi | Mile |
| min | Minute |
| mm | Millimeter |
| MPa | Mega Pascal |
| mph | Miles per hour |
| Mt/a | Million tonnes per annum |
| Mt | Million tonnes |
| °C | Degree Celsius |
| oz | Troy ounce |
| ppb | Parts per billion |
| ppm | Parts per million |
| s | Second |
| t | Metric tonne |
| t/d | Tonnes per day |
| t/h | Tonnes per hour |
| US$ | US dollars |
| V | Volt |
| W | Watt |
| wmt | Wet metric tonne |

## Abbreviations & Acronyms

| | |
|---|---|
| % or pct | Percent |
| AAS | Atomic absorption spectrometer |
| ABA | Acid base accounting |
| ADIS | Automated Digital Imaging System |
| amsl | Above mean sea level |
| ANFO | Ammonium Nitrate/Fuel Oil |
| AP | Acid potential |
| ARD | Acid rock drainage |
| BC | British Columbia |
| BIF | Banded iron formation |
| BLS | Barren leach solution |
| Btu | British Thermal Unit |
| BWI | Ball work index |
| $CaCO_3$ | Calcium carbonate |
| CAPEX | Capital costs |
| CAT | Caterpillar |
| CIC | Carbon-in-Column |
| CIL | Carbon-in-Leach |
| CIM | Canadian Institute of Mining |
| CIP | Carbon-in-Pulp |
| CLU | Change of land-use authorization |
| CPM | Critical path method |
| CRM | Certified reference material |
| Cu eq | Copper equivalent |
| CV | Coefficient of variation |
| DO | Dissolved oxygen |
| Elev | Elevation above sea level |
| ESIA | Environmental-Social Impact Assessment |
| ETF | Exchange traded fund |
| FA/grav | Fire assay with gravimetric finish |
| FEL | Front-end loader |
| FLOT | Flotation |
| FS | Feasibility Study |
| GMV | Gross metal value |
| GPS | Global positioning system |
| H:V | Horizontal to vertical |
| HDPE | High density polyethylene |
| HVAC | Heating, ventilation and air conditioning |
| ICP-MS | Inductively coupled plasma mass spectrometry |
| ID2 | Inverse distance square |
| IMSS | Social security |
| IRA | Inter-ramp angles |
| IRR | Internal rate of return |
| ISN | Payroll tax |
| ISRMR | In-situ rock mass rating |
| JDS | JDS Energy & Mining Inc. |
| LOM | Life of mine |
| MARC | Maintenance and repair contract |
| MIBC | Methyl isobutyl carbinol |

| | |
|---|---|
| ML/ARD | Metal leaching/acid rock drainage |
| MSE | Mechanically stabilized earth |
| N,S,E,W | North, South, East, West |
| NI 43-101 | National Instrument 43-101 |
| NN | Nearest neighbour |
| NAG | Non potentially acid generating |
| NP | Neutralization potential |
| NPV | Net present value |
| NSOX | North, South Oxide |
| NSR | Net Smelter Return |
| NZ | North Zone |
| Ø | Diameter |
| OEM | Original equipment manufacturer |
| OK | Ordinary Kriging |
| OPEX | Operating costs |
| PA | Preliminary Assessment |
| PAG | Potentially acid generating |
| PAX | Potassium Amyl Xanthate |
| PFS | Prefeasibility Study |
| PLS | Pregnant leach solution |
| PM | Project management |
| POX | Pressure oxidation |
| PPM | Project procedures manual |
| QA/QC | Quality Assurance/Quality Control |
| QMS | Quality Management System |
| RC | Reverse circulation |
| RFS | Rock Storage Facility |
| ROM | Run-of-the-mill |
| RQD | Rock quality designation |
| S.G. | Specific gravity |
| SAG | Semi-autogenous grinding |
| STP | Sewage treatment plant |
| SZ | South Zone |
| TOX | Tizate Oxide |
| TSF | Tailings storage facility |
| UPS | Uninterrupted power system |
| UTM | Universal Transverse Mercator |
| Vulcan | Maptek Vulcan TM |
| Whittle | Gemcom Whittle- Strategic Mine Planning TM |
| X,Y,Z | Cartesian Coordinates, also Easting, Northing and Elevation |

# 3.0 Reliance on Other Experts

This technical report has been conducted by JDS for Zazu. The information, conclusions, opinions, and estimates within this report are based upon:

- Information available to JDS at the time of preparation of this report
- Assumptions, conditions, and estimations as set forth in this report
- Data, reports, and other information provided by Matthew Ford, President of Zazu, Ralf Langner, CFO of Zazu, and Joe Britton, VP – Exploration of Zazu.

JDS has relied upon claim ownership information and agreements between Zazu and Teck for the Lik Project, provided by Matthew Ford and Joe Britton of Zazu during the preparation of this report (December 2013 through February 2014).

JDS was provided with a boundary agreement between Teck and Zazu provided by Joe Britton, VP - Exploration of Zazu (January 7, 2014), and the theoretical State of the Alaska Mining Claim boundary, based upon applicable theoretical section corners provided by Lounsbury & Associates, Inc. (January 17, 2014).

RPA was provided with a copy of a title search by the law firm Guess & Rudd of Anchorage, Alaska which RPA reviewed in 2010. This title search confirmed the ownership of the Lik property by Zazu.

JDS has relied upon Ralf Langner, CFO of Zazu for company financial information used in estimating the impact of taxes and royalties on the project economics. This information was provided to JDS during the tax estimation and modeling process in January and February 2014.

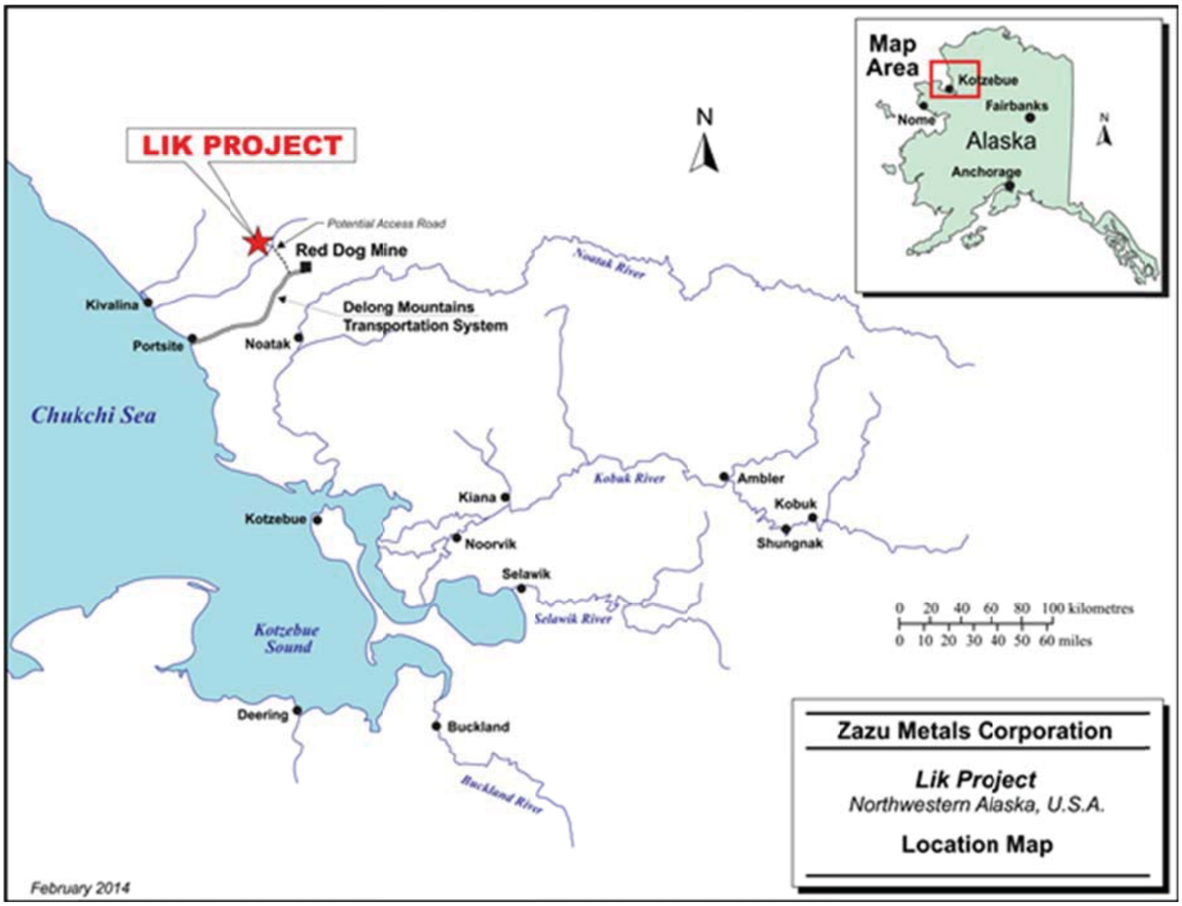
PricewaterhouseCoopers (PwC) performed a review of the tax implications of the economic model for the Lik Project developed by JDS and provided a letter dated February 25, 2014 describing the general scope of their review and their general concurrence with JDS' economic modeling of the applicable taxes.

# 4.0 Property Description and Location

## 4.1 Location

The Lik property is located in northwestern Alaska, 145 km north of the port of Kotzebue and 22 km northwest of the Red Dog project held by Teck American, Inc. (Teck). The geographical coordinates of the Lik deposit are approximately 163°12' W longitude and 68°10' N latitude. The location of the property is shown in Figure 4-1.

**Figure 4-1: Location Map**



## 4.2 Property Claims

The Lik property consists of 47 contiguous state Meridian, Township, Range, Section Claims (MTRSC) mining claims (Table 4-1). The contiguous claims have been grouped together for the purpose of working and operating the same under a common plan of development for the benefit of all of the claims. The claims cover an area of approximately 2,460 ha.

The claims are located in the vicinity of the southwestern DeLong Mountains in the Wulik River drainage, approximately in the below-described protracted Townships, Ranges, and Sections, Kateel River Meridian, State of Alaska.

**Table 4-1: Claim Locations**

| Name of Claim Block | Approximate Location (Kateel River Meridian) | Located within the USGS Quadrangle Map(s) Indicated Below |
|---|---|---|
| LIK-MTR | T.32N., R.20W<br>Sections 1-4, 9-16, & 22-24 | DeLong Mountains A-2 & A-3 |
| | T.32N., R.19W<br>Section 6 | DeLong Mountains A-2 |

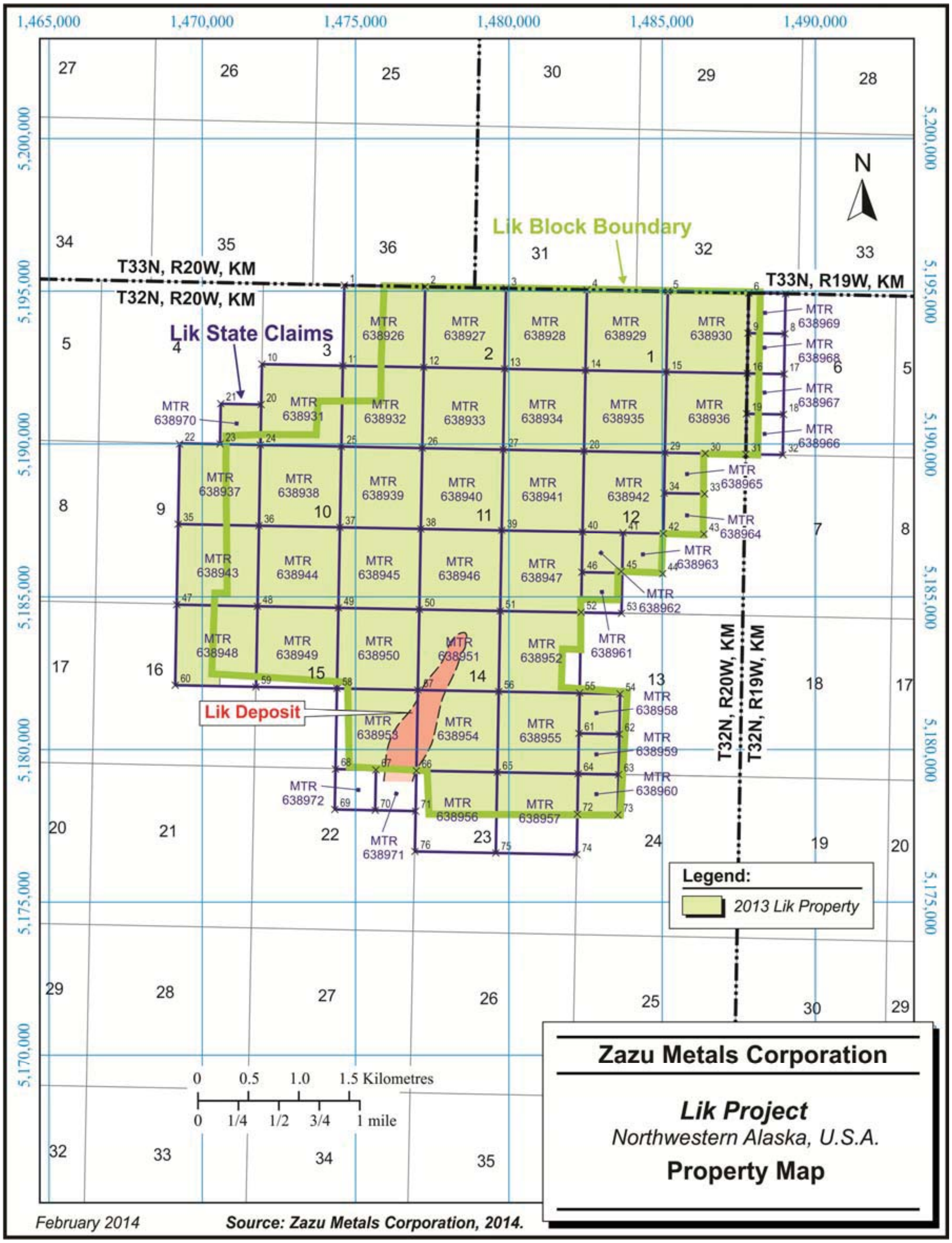
All 47 claims in this exhibit are owned by Zazu and Teck. The claim names, ADL serial numbers, claim sizes, and document numbers for the 47 Lik claims are listed in Table 4-2. A property map is shown in Figure 4-2.

**Table 4-2: State of Alaska MTRSC Claims Certificate of Location Recorded In Barrow Recording District**

| Claim Names | ADL Serial Number | Claim Size (acres) | Document No. |
|---|---|---|---|
| LIK-MTR1 | 638926 | 160 | 2001-001013-0 |
| LIK-MTR2 | 638927 | 160 | 2001-001014-0 |
| LIK-MTR3 | 638928 | 160 | 2001-001015-0 |
| LIK-MTR4 | 638929 | 160 | 2001-001016-0 |
| LIK-MTR5 | 638930 | 160 | 2001-001017-0 |
| LIK-MTR6 | 638931 | 160 | 2001-001018-0 |
| LIK-MTR7 | 638932 | 160 | 2001-001019-0 |
| LIK-MTR8 | 638933 | 160 | 2001-001020-0 |
| LIK-MTR9 | 638934 | 160 | 2001-001021-0 |
| LIK-MTR10 | 638935 | 160 | 2001-001022-0 |
| LIK-MTR11 | 638936 | 160 | 2001-001023-0 |
| LIK-MTR12 | 638937 | 160 | 2001-001024-0 |
| LIK-MTR13 | 638938 | 160 | 2001-001025-0 |
| LIK-MTR14 | 638939 | 160 | 2001-001026-0 |
| LIK-MTR15 | 638940 | 160 | 2001-001027-0 |
| LIK-MTR16 | 638941 | 160 | 2001-001028-0 |
| LIK-MTR17 | 638942 | 160 | 2001-001029-0 |
| LIK-MTR18 | 638943 | 160 | 2001-001030-0 |
| LIK-MTR19 | 638944 | 160 | 2001-001031-0 |
| LIK-MTR20 | 638945 | 160 | 2001-001032-0 |
| LIK-MTR21 | 638946 | 160 | 2001-001033-0 |
| LIK-MTR22 | 638947 | 160 | 2001-001034-0 |
| LIK-MTR23 | 638948 | 160 | 2001-001035-0 |
| LIK-MTR24 | 638949 | 160 | 2001-001036-0 |
| LIK-MTR25 | 638950 | 160 | 2001-001037-0 |
| LIK-MTR26 | 638951 | 160 | 2001-001038-0 |
| LIK-MTR27 | 638952 | 160 | 2001-001039-0 |
| LIK-MTR28 | 638953 | 160 | 2001-001040-0 |
| LIK-MTR29 | 638954 | 160 | 2001-001041-0 |
| LIK-MTR30 | 638955 | 160 | 2001-001042-0 |
| LIK-MTR31 | 638956 | 160 | 2001-001043-0 |
| LIK-MTR32 | 638957 | 160 | 2001-001044-0 |
| LIK-MTR33 | 638958 | 40 | 2001-001045-0 |
| LIK-MTR34 | 638959 | 40 | 2001-001046-0 |
| LIK-MTR35 | 638960 | 40 | 2001-001047-0 |
| LIK-MTR36 | 638961 | 40 | 2001-001048-0 |
| LIK-MTR37 | 638962 | 40 | 2001-001049-0 |
| LIK-MTR38 | 638963 | 40 | 2001-001050-0 |
| LIK-MTR39 | 638964 | 40 | 2001-001051-0 |
| LIK-MTR40 | 638965 | 40 | 2001-001052-0 |
| LIK-MTR41 | 638966 | 40 | 2001-001053-0 |
| LIK-MTR42 | 638967 | 40 | 2001-001054-0 |
| LIK-MTR43 | 638968 | 40 | 2001-001055-0 |
| LIK-MTR44 | 638969 | 40 | 2001-001056-0 |
| LIK-MTR45 | 638970 | 40 | 2001-001057-0 |
| LIK-MTR46 | 638971 | 40 | 2001-001058-0 |
| LIK-MTR47 | 638972 | 40 | 2001-001059-0 |

*MTRSC – Meridian, Township, Range, Section Claims refer to State of Alaska mining claims.

**Figure 4-2: Property Map**



## 4.3 Land Tenure

The Lik property is subject to the terms of the Lik Block Agreement dated October 17, 1984, as amended by letter agreement in 1993. A short form of the Lik Block Agreement was recorded on January 22, 1998, at Book 95, Pages 331 to 370, Barrow, Alaska, Recording office.

On June 28, 2007, Zazu purchased GCO Minerals Company's (GCO) entire 50% interest in the Lik property (and GCO's interest in the Lik Block Agreement) for $20 million. This interest is subject to a 2% net proceeds interest (NPI) payable by Zazu. GCO also retains a 1% NPI in the Lik property, which was conveyed to GCO by WGM Inc. on April 7, 1997.

Under the Lik Block Agreement, Zazu also holds the right to earn 60% of the 50% interest held by Teck Resources Inc. (Teck) (being a further 30% interest) provided that it spends approximately $40 million (being the initial $25 million required amount under the Lik Block Agreement, adjusted for inflation indexing and escalations). Should Zazu earn such additional 30% interest, Teck has a one-time option to convert its remaining 20% interest in the property to a 2% net smelter royalty (NSR).

Initially, the Lik property was staked as federal claims (shown as the Lik Block Boundary – Figure 4-2 above). Subsequently, the property was included in the area that passed from the United States Federal Government to the State of Alaska and Zazu had the option of relinquishing the federal claims and holding mineral rights under the state claims. Zazu opted to convert the claims to state claims in 2013. The new claims were then surveyed. As part of the transfer of federal to state claims, the Lik property was enlarged slightly to the west.

The southern and eastern property boundaries have also been surveyed to avoid potential property conflicts with adjacent properties. In these areas, Teck's claims are contiguous with the Lik property. The Lik deposit continues on to the Teck ground where it is known as the Su deposit. Independent of any claim position, Zazu and Teck have a boundary agreement (the 2010 Zazu/Teck Boundary Line Agreement) negotiated to avoid any potential conflicts. The location of the deposit, relative to the property boundaries, is shown in Figure 4-2. There are no existing tailings ponds, waste dumps, or mine workings on the property at the present time. Zazu considers that there is sufficient space available within the claims to include waste dumps and tailings ponds in the future.

Once Zazu converted the property to state claims, surface rights to the area passed from the United States Federal Government to the State of Alaska.

State claims require the payment of an annual rental. The required rental is not a fixed rate, but varies based on a number of factors. The rental formulae are set out in Table 4-3. The annual rental for the Lik property is US$14,150.

**Table 4-3: Rental for Alaskan State Claims**

| Date | Standard Amount (US$) | Quarter Section Amount (US$) |
|---|---|---|
| On or before September 1, 2003 | 170 | 680 |
| On or Before August 3, 2009 | 70 | 280 |
| On or Before September 1, 2009 or later | 35 | 140 |

Property holders are also required to perform assessment work with the amount dependent on the area of the state claims. Assessment credits may be carried forward for a maximum of four years. If required, payments may be made in lieu of work to allow retention of the property. Zazu management has advised that the company holds two further years of assessment credits without completing any further work.

In December 2007, Messrs. Perkins and Lyle of Guess & Rudd, Law Offices in Anchorage, Alaska, completed an Updated Title Report for the Lik Property (Perkins and Lyle, 2007). The report confirmed ownership of the Lik property by Zazu.

# 5.0 Accessibility, Climate, Local Resources, Infrastructure and Physiography

## 5.1 Topography, Elevation and Vegetation

The project site is located within the western Brooks Range of Alaska, which is the northernmost extension of the Rocky Mountain range. In particular, the DeLong Mountains are host to the Lik deposit and possess steep angular summits of sedimentary and metamorphic rock draped with rubble and scree (Nowacki, 2001). To the west and east, the topography becomes less rugged including more flat-topped mountains flanked by stepped slopes reflecting emerging bedrock conditions.

High-energy streams and rivers are found within narrow ravines with steep headwalls that etch a deeply incised, dendritic pattern into the surrounding terrain (Nowacki, 2001). Many braided streams and rivers with highly variable seasonal discharge, clear, cold water, and abundant arctic char, and arctic grayling. Lakes are not typical in this part of the Brooks Range. Smaller streams typically freeze to the stream bottom causing large *aufeis* formations throughout the winter and early spring.

The Lik deposit sits at approximately 243 to 274 meters above sea level (masl) within the northwestern interior of Alaska.

Vegetation within the project area includes mixed shrub-sedge tussock tundra with willow thickets along rivers and streams (Nowacki, 2001). Alpine tundra is predominant at higher elevations and ridge crests. For south facing slopes, and low mountain slopes areas are comprised of sedge tussocks and shrubs including dwarf birch and a variety of willow species. The entire project site is north of the Arctic treeline.

## 5.2 Accessibility

Access to the property is by air to a company-built airstrip located on the property. Charter flights may be arranged from a number of sites in northwestern Alaska. The town of Kotzebue is located approximately 145 km from the deposit. Kotzebue is a seaport and is serviced by a regular air service from Anchorage. It is the center for access to the nearby Red Dog zinc-lead-silver mine operated by Teck. The city of Anchorage is located about 950 km to the southeast of the deposit.

## 5.3 Climate

Climatic data for the Lik deposit area are not available. The nearest location for which climatic data are available is the town of Kotzebue. As Kotzebue is adjacent to the ocean, the climatic data may not be entirely reliable as an indicator for conditions near the Lik deposit.

The average annual temperature at Kotzebue is -5.8°C. The average maximum temperature is -2.3°C and the average minimum temperature is -9.3°C. Seasonal extremes probably range between 25°C in summer and -50°C in winter.

There is on average 22.8 cm of rain per year and snowfall of 1.2 m per year. Snowfalls are not extreme, but blowing snow may form significant drifts. Strong winds are a problem in most parts of Alaska.

Currently, diamond drilling is possible at Lik between about June 1 and October 1 annually. An existing constraint is water; the drills and the camp use surface water.

## 5.4 Local Resources

There are no local resources adjacent to the Lik deposit. The Red Dog Mine is located about 22 km southeast of the deposit. It is expected that concentrates would be moved along the access road from near the Red Dog Mine to the port on the Chukchi Sea. This road, the Delong Mountains Transportation System (DMTS) road, is owned by the state of Alaska and is available for use by other industrial users.

The port has a shipping season of about 100 days. The current concentrate storage at the port site is at capacity and further storage facilities would have to be constructed if the Lik deposit came into production.

The largest town site in the vicinity of Lik is Kotzebue, about 145 km south of the deposit. Facilities at Kotzebue include a regional hospital, hotel accommodations, schools, and a domestic airport with daily jet services to Anchorage.

## 5.5 Infrastructure

There is an exploration camp and airstrip located near the Lik deposit. The airstrip is approximately 1,300 m long and 30 m wide. The strip is gravel surfaced and is capable of handling large, multi-engine planes. The airstrip will require grading and levelling prior to being used for construction purposes when higher traffic and larger aircraft will be utilized.

## 5.6 Physiography

The exposures of the Lik deposit are located at approximately 245 masl. West of the deposit, the land rises steeply to peaks approximately 700 masl. To the southeast, the land slopes down to the Wulik River where the bottom of the valley is about 215 masl. As noted above, there are no improvements on the Lik property. The supply of electric power, workforce accommodation, and other facilities will have to be developed. There is sufficient space for tailings and waste rock disposal. In all likelihood, there is sufficient water available for any proposed processing.

At the adjacent Red Dog site, permafrost is reported to be developed to depths of approximately 60 m.

Locally, there is vegetation on the property classified as woody tundra and consisting of lichen, various grasses, and low brush made up of willow, dwarf birch, dwarf evergreen shrubs, and alder.

# 6.0 History

The Red Dog deposit was identified in 1970 by Mr. I. Tailleur, who was mapping in the De Long Mountains area on behalf of the United States Geological Survey (USGS). In 1975, attention was redrawn to this deposit by the U.S. Bureau of Mines, which was carrying out a mineral assessment in northwest Alaska. The 1975 announcement precipitated a staking rush throughout the De Long Mountains.

## 6.1 Prior Ownership

GCO, in joint venture with New Jersey Zinc Company (NJZ) and WGM Inc. (WGM) (the WAK Joint Operating Agreement), was involved in the staking rush. The group carried out stream geochemical sampling and reconnaissance for color anomalies. Claims were staked in July 1976 to protect a stream geochemical anomaly on Lik Creek. Houston Oil and Minerals Exploration Company (HOMEX) replaced NJZ in the joint venture in 1976-1977.

Cominco Limited (Cominco), which is now part of Teck, staked adjacent ground. Subsequent exploration has demonstrated that the Lik deposit continues onto the Teck ground, where it is known as the “Su deposit.”

## 6.2 Past Exploration

Diamond drilling commenced in 1977 and targeted a gossan with a coincident soil and electromagnetic anomaly. The first hole encountered massive lead-zinc-silver-bearing sulfides. By the end of 1977, the joint venture had completed 40 line-kilometers of ground geophysics, a soil sampling program, and ten diamond drill holes with an aggregate depth of 1,603 m. In 1978, further geological, geochemical, and geophysical surveys were carried out, together with the drilling of another 79 diamond drill holes aggregating 10,680 m. An additional 14 diamond drill holes with a total depth of 4,931.1 m were completed in 1979 and a mineral resource was estimated.

The WAK Joint Operating Agreement joint venture continued to work in the district in the period 1980 to 1983. The joint venture held a large number of claims outside the existing Lik block and work was concentrated on other targets in some of these years; however, some diamond drilling activity continued on the Lik property. The Lik Block Agreement was signed in 1984.

In 1984, Noranda Exploration, Inc. (Noranda) optioned the Lik property. Much of the Noranda activity was concentrated in the Lik North area where ten diamond drill holes with an aggregate depth of 4,180.3 m were completed on four sections. Noranda also drilled holes in the Lik South deposit to delineate higher grade areas of mineralization. Noranda dropped its interest in the Lik property after a reorganization of its holdings in the United States.

Moneta Porcupine Mines Inc. (Moneta) optioned the property in 1990 and together with GCO, completed three diamond drill holes aggregating 263.4 m. The purpose of the Moneta drilling was to obtain metallurgical samples, but no records of any significant Moneta metallurgical work have been located. GCO drilled two additional diamond drill holes in 1992. There was no further drilling until Zazu acquired the property and commenced the drilling program in 2007.

There have been several mineral resource estimates in the past; however, these have been superseded by the current resource estimate in this report.

## 6.3 Historical Production

There has been no historical production from the Lik deposit.

# 7.0 Geological Setting and Mineralization

The following description of geological setting has been assembled from published information that is cited where appropriate.

## 7.1 Regional Geology

The regional geology of the Western Brooks Range area is structurally complex. The sedimentary rocks of the area have been disrupted by thrust sheets or allochthons (Dumoulin et al., 2004) (Figure 7-1). The Lik deposit and the other zinc-lead deposits of the Brooks Range, including Red Dog, are hosted in the Kuna Formation of the Lisburne Group. The stratigraphic section is shown in Figure 7-2. In the Western Brooks Range, the Lisburne Group includes both deep and shallow water sedimentary facies and local volcanic rocks. The rocks have been extensively disrupted by thrusting. The deep-water facies of the Lisburne Group, the Kuna Formation, is exposed chiefly in the Endicott Mountains and the structurally higher Picnic Creek allochthons.

In the Red Dog plate of the Endicott Mountains allochthon, the Kuna Formation consists of at least 122 m of thinly interbedded calcareous shale, calcareous spiculite, and bioclastic supportstone (the Kivalina Unit) overlain by 30 m to 240 m of siliceous shale, mudstone, calcareous radiolarite, and calcareous lithic turbidite (the Ikalukrok Unit). The Ikalukrok Unit in the Red Dog plate hosts all of the known massive sulfide deposits in the area. The Ikalukrok Unit is carbonaceous, is generally finely laminated, and contains siliceous sponge spicules and radiolarians. Based on conodonts and radiolaria, the Kuna Formation is Osagean to Chesterian (late Early to Late Mississippian). The unit is thought to have formed in slope and basin settings characterized by anoxic or dysoxic bottom water.

The structural complexity of the Western Brooks Range resulted from Mesozoic convergence followed by further shortening in the Tertiary period. Young (2004) notes that the reconstructed Kuna Basin is a 200 km by more than 600 km feature.

Figure 7-1: Regional Geology

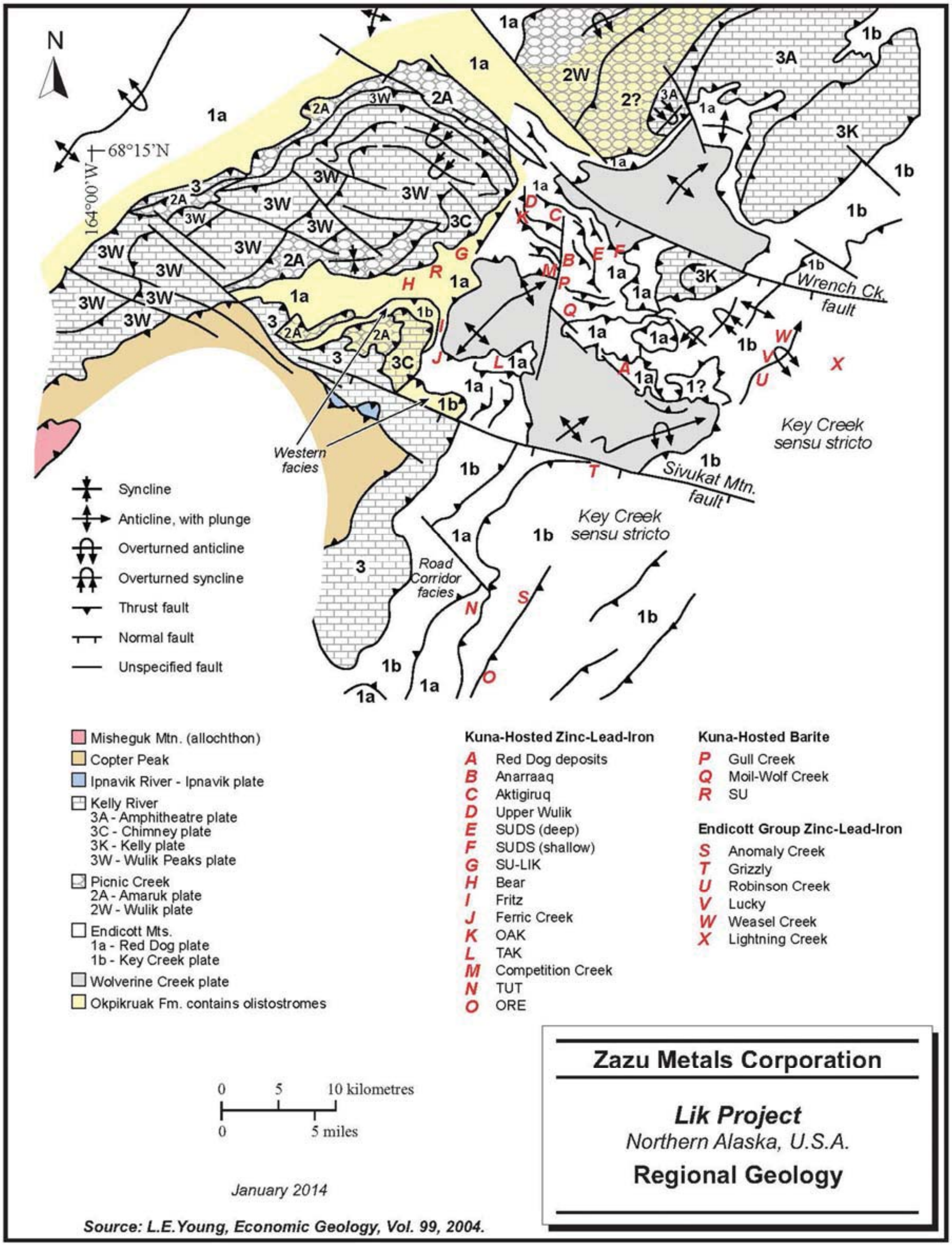
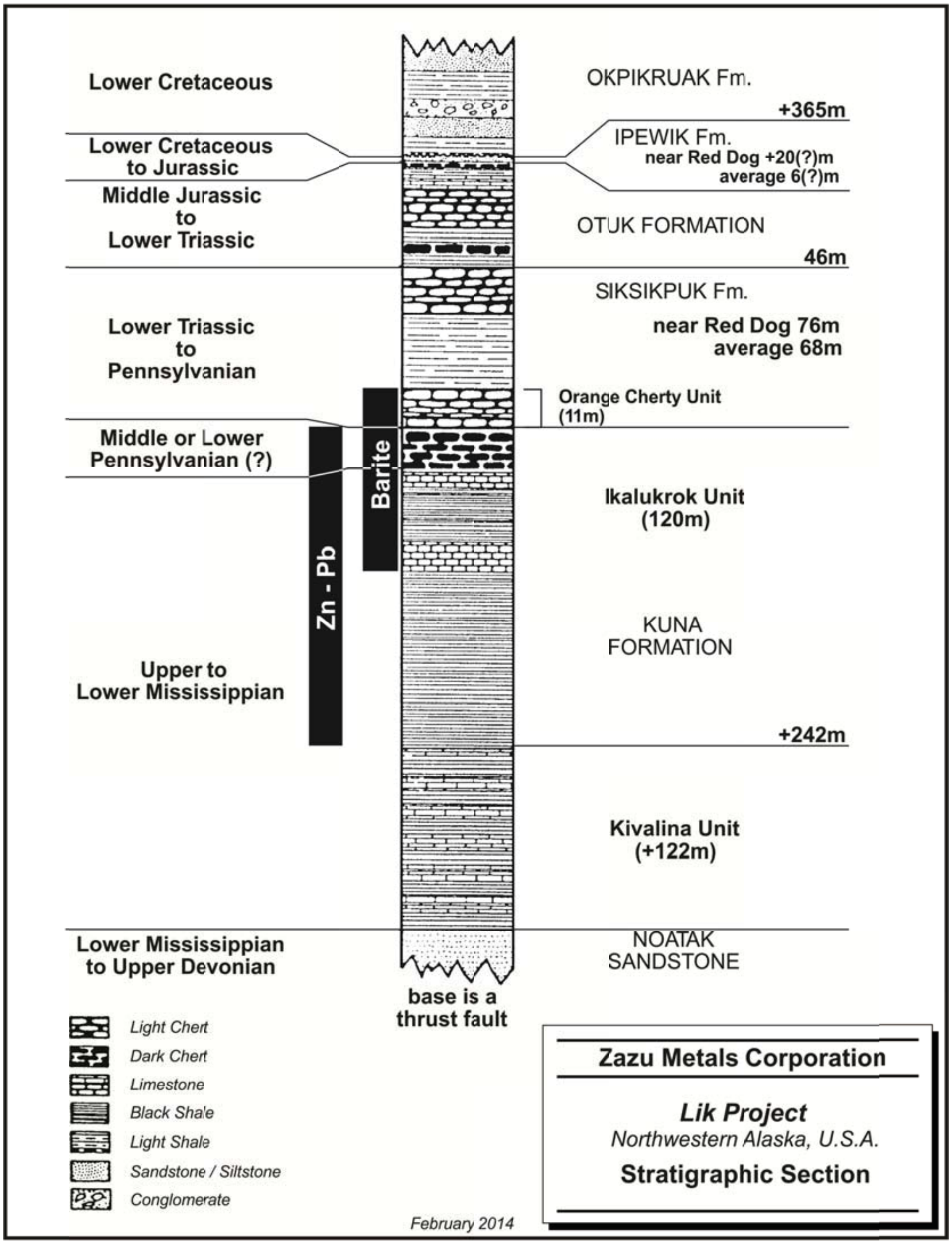


**Figure 7-2: Stratigraphic Section**



## 7.2 Local Geology

The Lik deposit is hosted in the Red Dog plate of the Endicott Mountains allochthon (Young, 2004). The term "allochthon" describes an assemblage of stratigraphically related rocks that overlies a large displacement thrust fault. The stratigraphically lowest rocks within the Red Dog plate belong to the Kayak Shale. The top of the Kayak Shale is interbedded with rocks of the Kuna Formation.

The Kuna Formation is divided into two units, the Kivalina Unit and the Ikalukrok Unit. In a district sense, the Kivalina Unit is up to 122 m thick and may have been deposited in a local fault-bounded depression. It includes laminated, black calcareous shale and thick-bedded, grey micritic limestone, grainstone, and packstone. The Ikalukrok Unit varies in thickness across the district from 29 m to greater than 240 m. The unit has been divided into a lower laminated black shale subunit and an upper medium- to thick-bedded black chert subunit.

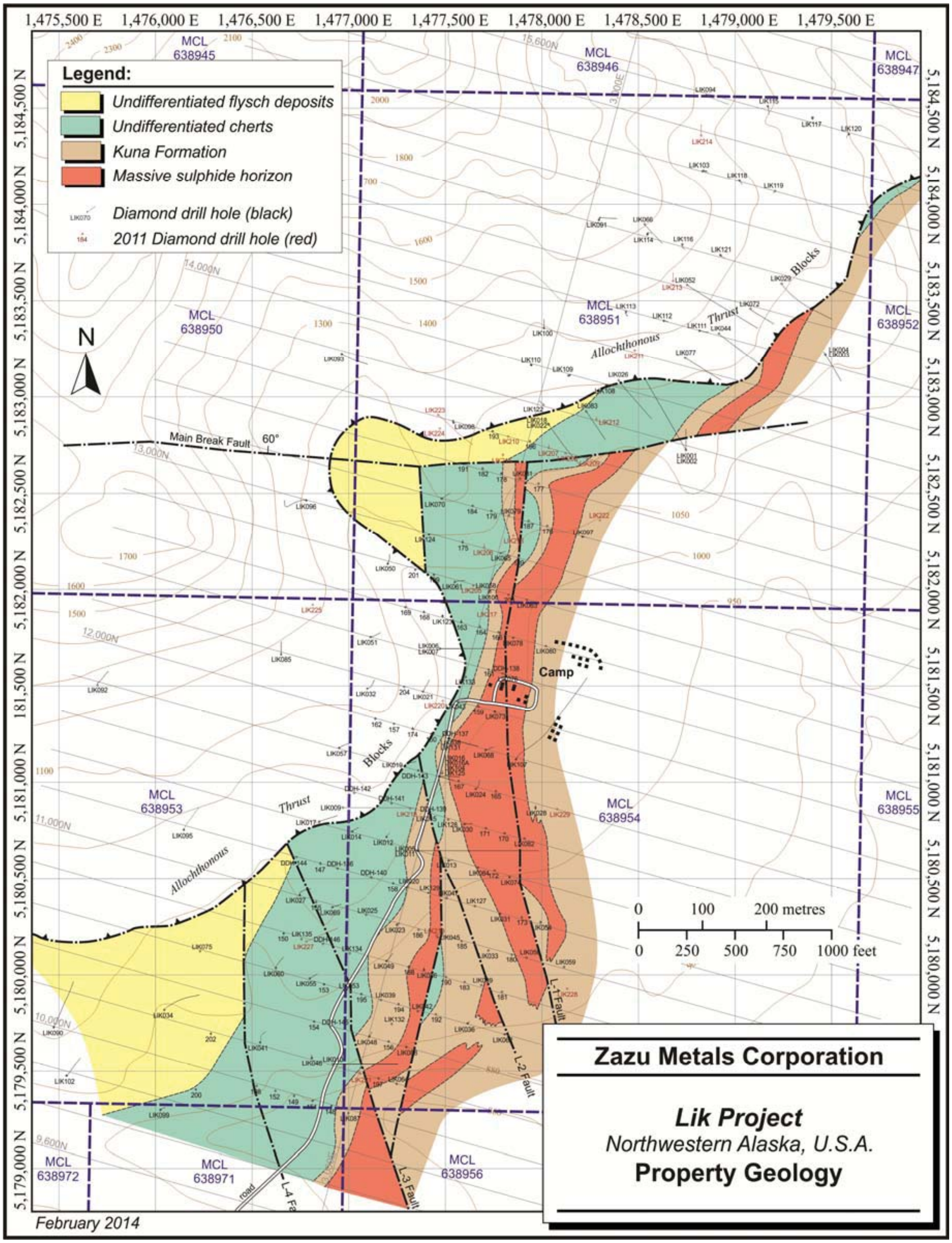
The shale is siliceous and carbonaceous and has reported mean concentrations of 74% to 77% $SiO_2$ and greater than 4% Corg. Distal to proximal carbonate turbidite is an important component of the shale subunit.

## 7.3 Property Geology

The Lik deposit is hosted in the upper part of the Ikalukrok Unit of the Kuna Formation. At Lik, the immediate host rocks are carbonaceous and siliceous black shale, with subordinate black chert and fine-grained limestone. These rocks strike broadly north-south and dip at approximately 25° to 40° to the west (Figure 7-3). Figure 7-3 is based on interpretation as there is very little exposure in the deposit area. The massive sulfides are overlain conformably by rocks of the Siksikpuk Formation. The sequence is overridden by allochthonous rocks that form high hills north and west of the deposits.

The mineralized sequence is cut by a number of minor faults. Recent drilling has demonstrated that several of the interpreted faults may not exist, or the movement on the fault is minor. The most significant of these faults is the Main Break Fault (Figure 7-3). While the plunge of the northern end of the Lik deposit increases to approximately 25° to 42°, it is no longer apparent that there is a break separating the Lik South and Lik North deposits. It is also unclear whether there is a change in strike north of the fault, or whether the change is more apparent due to topography.

**Figure 7-3: Property Geology**



There is another group of steeper faults that tend to strike northerly or northwesterly and which are interpreted as being both normal and reverse with throws of up to 100 m. The drilling in 2008 appears to demonstrate that several of these faults are non-existent or more minor than previously interpreted.

## 7.4 Mineralization

The Lik deposit is a stratiform zinc-lead-silver deposit. The deposit is continuous outside the Lik property onto the adjacent Su property to the south held by Teck. The southern continuation of the Lik deposit is referred to as the Su deposit.

Within the Lik property, the deposit is divided into two parts. The main part of the deposit within the existing claims is referred to as the Lik South deposit. Previously, the boundary between the Lik South and Lik North deposits was defined by the Main Break Fault.

Recent work appears to show that the fault does not exist, or its effects are very minor. The division into two parts is maintained and the boundary is taken as Section 13800N for this report. As presently tested, the largest lens, the A Lens of the Lik South deposit, is approximately 1,100 m long and 600 m wide and much of it is flat-lying. It contains the bulk of the tonnage in the Lik South area. The second largest lens, B Lens, is approximately 500 m long, up to 200 m wide, and averages approximately 120 m wide. The R Lens is approximately 400 m north-south, 100 m east-west, and up to 5 m thick and lies about 6 m above the A Lens. Mineralization in the Lik South deposits has been tested down dip to a depth of approximately 150 m to 200 m.

The Lik North deposit is approximately 700 m long and 350 m wide. As with the Lik South deposit, mineralization is interpreted as occurring in a number of lenses, with most of the mineralization present in a single lens referred to as the North Lens in this report. The North Lens plunges at about 25° to 42° and has been tested down dip to a depth of about 300 m.

The deposits strike broadly northerly and dip westerly at approximately 25° to 40°. The mineralization comprises irregular, stratiform lenses. The mineralogy of the sulfides is simple and comprises pyrite, marcasite, sphalerite, and galena, with rare tetrahedrite, bournonite, and boulangerite. Gangue minerals include quartz (as chert), clay minerals, carbonate, and barite. Noranda recognized six different ore types in its logging of drill core (Scherkenbach et al., 1985). Sulfide grain sizes and grades vary between different ore types. Maximum sphalerite grain size is about 100 µm. Figure 7-3 shows the locations of the drill hole collars and the sections included in this report. Typical drill sections for the Lik South and Lik North deposits are shown in Figures 7-4, 7-5, and 7-6.

Typical grades of mineralized intersections within the Lik deposit are listed in Table 7-1.

**Table 7-1: Typical Mineralized Intersections**

| Hole No | From (m) | To (m) | Length (m) | Zn% | Pb% | Ag (g/t) |
|---|---|---|---|---|---|---|
| 5 | 54.56 | 78.79 | 24.23 | 19.72 | 6.27 | 126.5 |
| 16 | 80.16 | 94.49 | 14.33 | 21.67 | 7.01 | 230.4 |
| 21 | 129.54 | 135.33 | 5.79 | 7.07 | 1.88 | 8.6 |
| 24 | 40.87 | 50.14 | 9.27 | 11.09 | 1.44 | 51.1 |
| 31 | 21.49 | 34.75 | 13.26 | 9.07 | 2.69 | 6.9 |
| 38 | 45.90 | 63.67 | 17.86 | 8.13 | 1.80 | 48.0 |
| 38 | 70.53 | 87.75 | 17.22 | 8.92 | 2.08 | 28.8 |
| 43 | 35.66 | 40.69 | 5.03 | 17.66 | 3.62 | 8.6 |
| 43 | 60.96 | 80.28 | 19.32 | 9.07 | 2.49 | 47.7 |
| 55 | 114.0 | 125.88 | 11.89 | 8.15 | 2.42 | 205.7 |
| 68 | 32.31 | 53.43 | 21.12 | 13.34 | 2.85 | 56.9 |
| 79 | 15.85 | 31.33 | 15.48 | 9.14 | 2.66 | 37.0 |

## 7.5 Significant Mineralized Zones

Previous work by GCO claimed that sulfides were deposited in four distinct cycles. The cycles were believed to have been developed close to the likely hydrothermal source of the mineralizing fluids. Individual cycles were interpreted as being quite thin near the margins of the deposit and the thickest accumulation in a single cycle noted to date is approximately 13.7 m. This interpretation is not considered valid by either Zazu or RPA. The more recent drilling has shown that fine-grained and coarse-grained sulfides are interbedded. Banding is variably developed. Higher grades occur in different levels of the sulfide lenses. Locally, the sulfides appear to be structurally distorted. At least some of the mineralization is cut by debris flows and is considered primary, while other textures apparent in the core appear to indicate that mineralization is at least partly diagenetic or post-diagenetic.

While brecciated sulfides are common in high-grade areas, they do not form a large percentage of the overall sulfide mass. Individual breccia zones vary in thickness from a few centimeters to a few meters. The origin of the brecciation is not clear, but at least some of it is judged to be primary.

**Figure 7-4: Cross Section 10,600N**

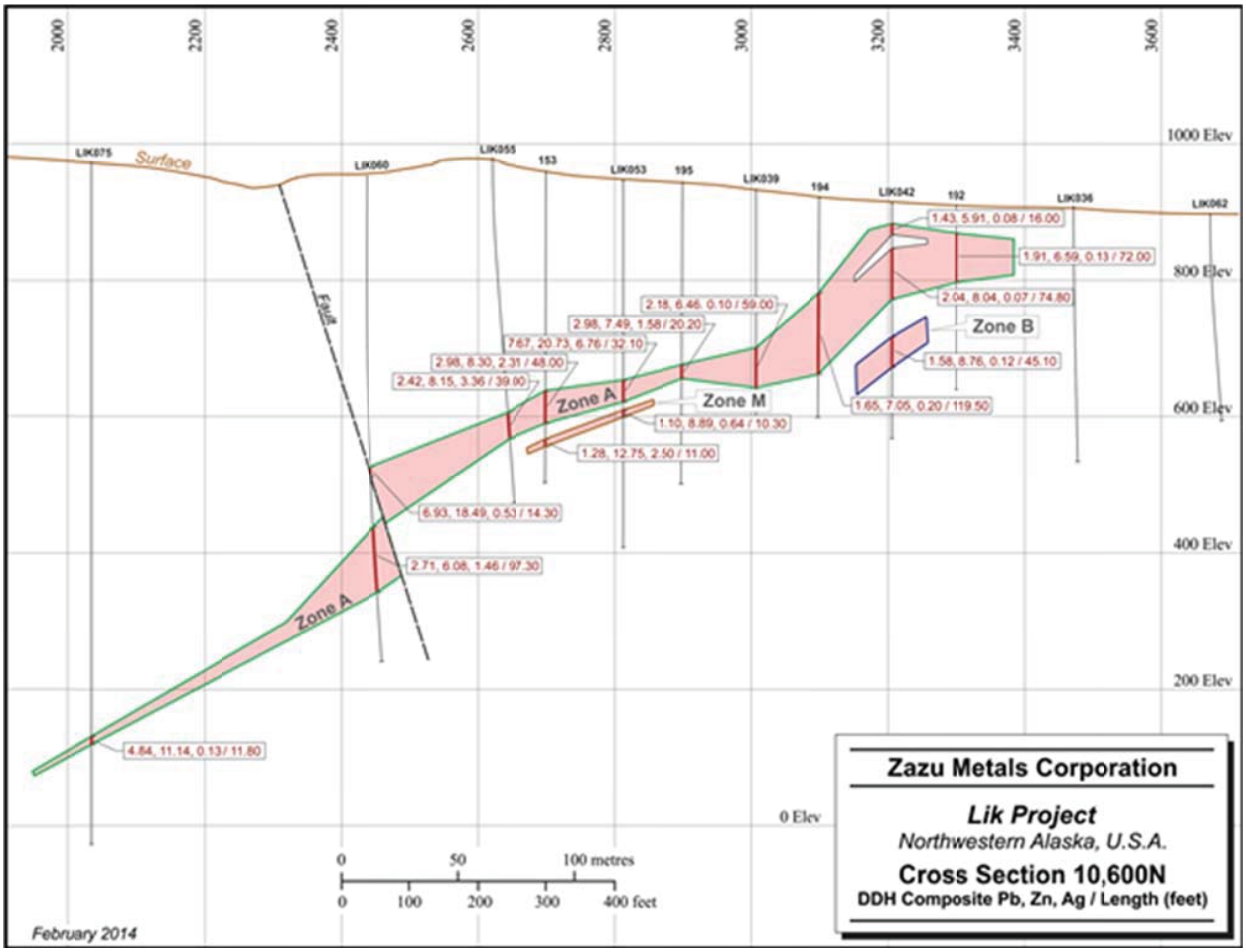
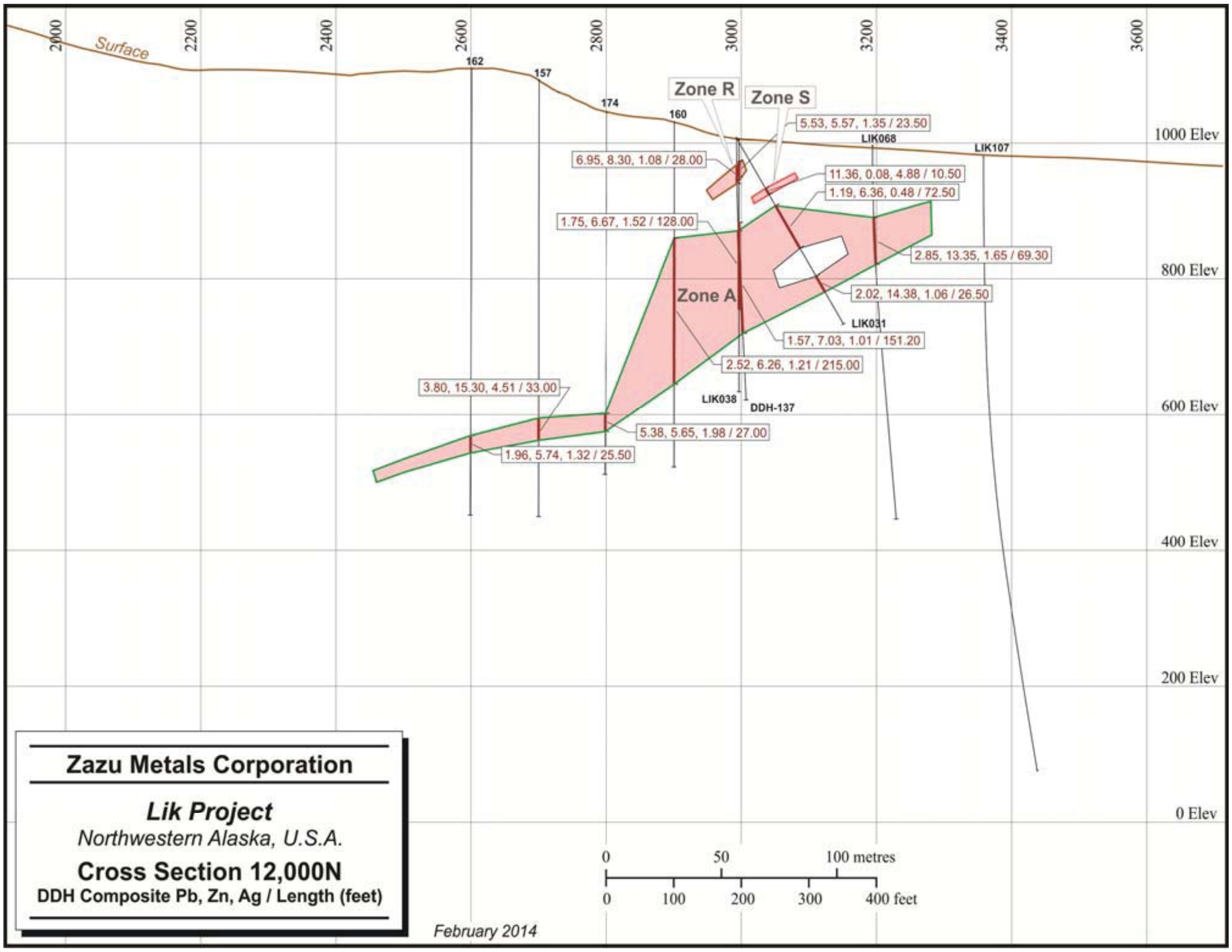
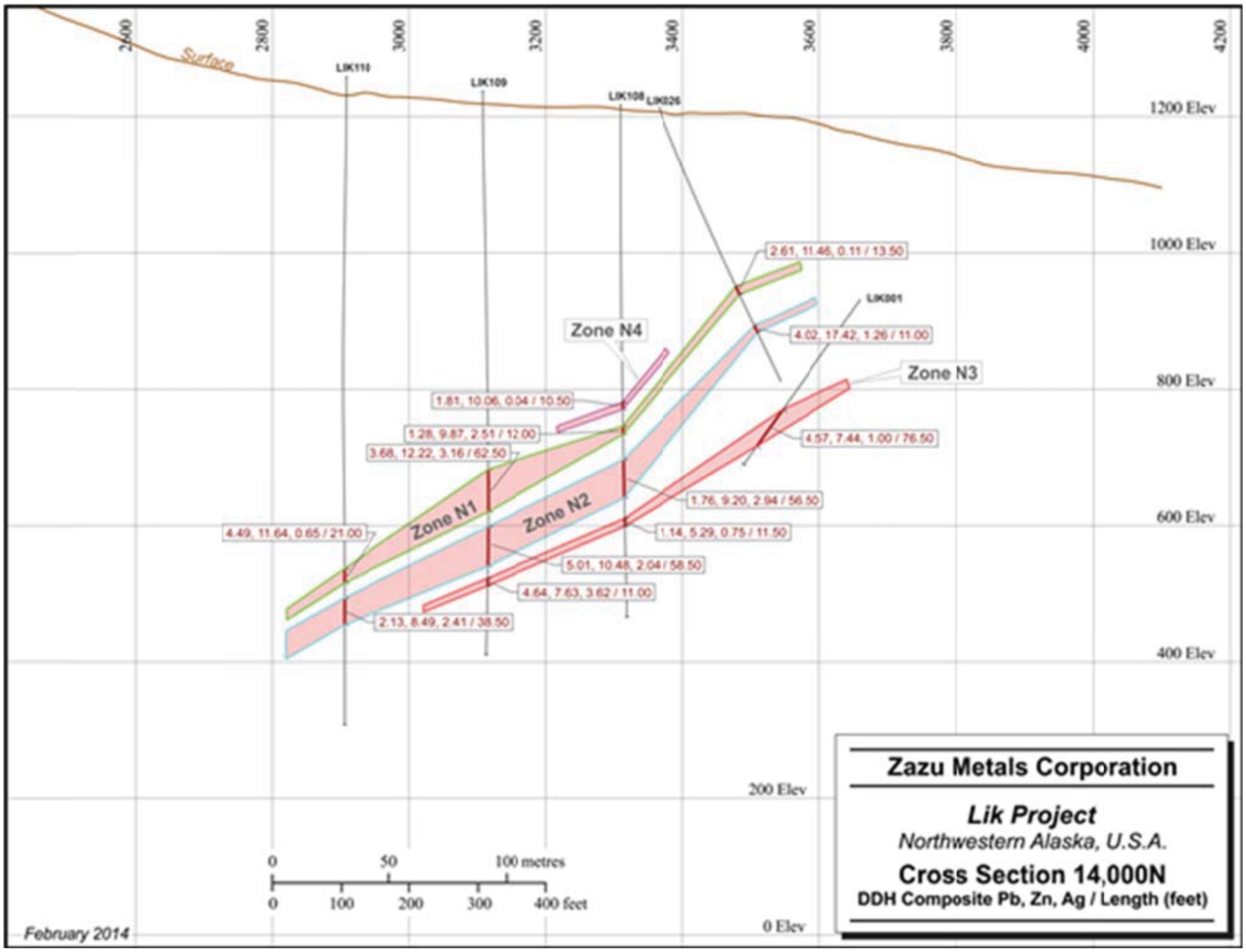


**Figure 7-5: Cross Section 12,000N**



### Figure 7-6: Cross Section 14,000 N



# 8.0 Deposit Types

The Lik deposits are examples of a large group of deposits broadly referred to as sediment-hosted zinc-lead-silver deposits. Cox and Singer (1992) described the deposit type as follows:

> *Stratiform basinal accumulations of sulfide and sulfate minerals interbedded with euxinic marine sediments form sheet- or lens-like tabular bodies up to a few tens of meters thick and may be distributed through a stratigraphic interval over 1,000 m.*

The model covers a large group of deposits that have been divided into subtypes, including Broken Hill-type, Mount Isa-type, and others. Water depth of the host units may be variable, the rock types are variable, and the depositional environment may vary from lacustrine to deep water marine.

Historically, the deposits have been regarded as syngenetic, but recent studies appear to demonstrate that many of the deposits are diagenetic. In the case of Red Dog, evidence that the deposits are partially syngenetic and partially diagenetic has been described by Moore et al (1986).

Typically, metallurgical recovery is affected by post-depositional events. Deposits subjected to higher metamorphic grades typically have higher metallurgical recoveries; however, the post-depositional events may dismember the deposit and lower the quality of the recoverable zinc concentrate.

# 9.0 Exploration

Controlled- and natural-source audio-frequency magnetotelluric (CSAMT and NSAMT) surveys were completed by Zonge Engineering & Research Organization, Inc. (Zonge Engineering) in June and July 2008. Tensor CSAMT and NSAMT data were acquired at 61 m (200 ft) station intervals over six lines for a total of about 8 km (26,400 ft). The primary objective of the survey was to trace mineralization and geological structure from the known drill-tested areas north into undrilled terrain north of the existing Lik North deposit. To achieve this objective, two orthogonal transmitter bipoles were located 5 km south-southeast of the survey area so that nearly orthogonal source-field orientations were generated over the survey area.

While a number of trends were recognized (Scott et al, 2010), the surveys do not appear to have identified continuations of mineralization.

In 2010, Teck completed a helicopter-borne time domain electromagnetic (HTEM) geophysical survey of that part of the Brooks Range area that included the Lik property. The raw results of the survey within the Lik property were given to Zazu by Teck. These data were processed, but the information was considered not to show any noticeable relationship to the drill-tested mineralization and no final interpretation was obtained by Zazu. The HTEM data are considered by RPA to contribute very little to the exploration results.

Zazu has not completed any surface exploration programs since 2011.

# 10.0 Drilling

## 10.1 Summary

The drilling to date on the Lik Project is summarized in Table 10-1. The drill hole plan is shown in Figure 10-1 and typical drill hole sections for the Lik South and Lik North deposits are shown in Chapter 7 as Figures 7-4, 7-5, and 7-6. RPA considers that the Lik property is an advanced property for the purposes of NI 43-101.

**Table 10-1: Diamond Drilling Campaigns**

| Year | Number of Holes | Aggregate Depth (m) | Company |
|---|---|---|---|
| 1977 | 10 | 1,603.3 | Managed by WGM |
| 1978 | 79 | 10,680.2 | Managed by WGM |
| 1979 | 14 | 4,931.1 | Managed by GCO |
| 1980 | 3 | 202.1 | Managed by GCO |
| 1983 | 1 | 835.2 | Managed by GCO |
| 1984 | 6 | 1,643.5 | Managed by GCO |
| 1985 | 16 | 4,883,1 | Managed by Noranda |
| 1987 | 1 | 696.5 | Managed by GCO |
| 1990 | 3 | 263.4 | Managed by Moneta |
| 1992 | 2 | 283.5 | Managed by GCO |
| 2007 | 11 | 1,394.1 | Managed by Zazu |
| 2008 | 57 | 6,830.0 | Managed by Zazu |
| 2011 | 24 | 3,811.4 | Managed by Zazu |
| Total | 229 | 38,201.2 | |

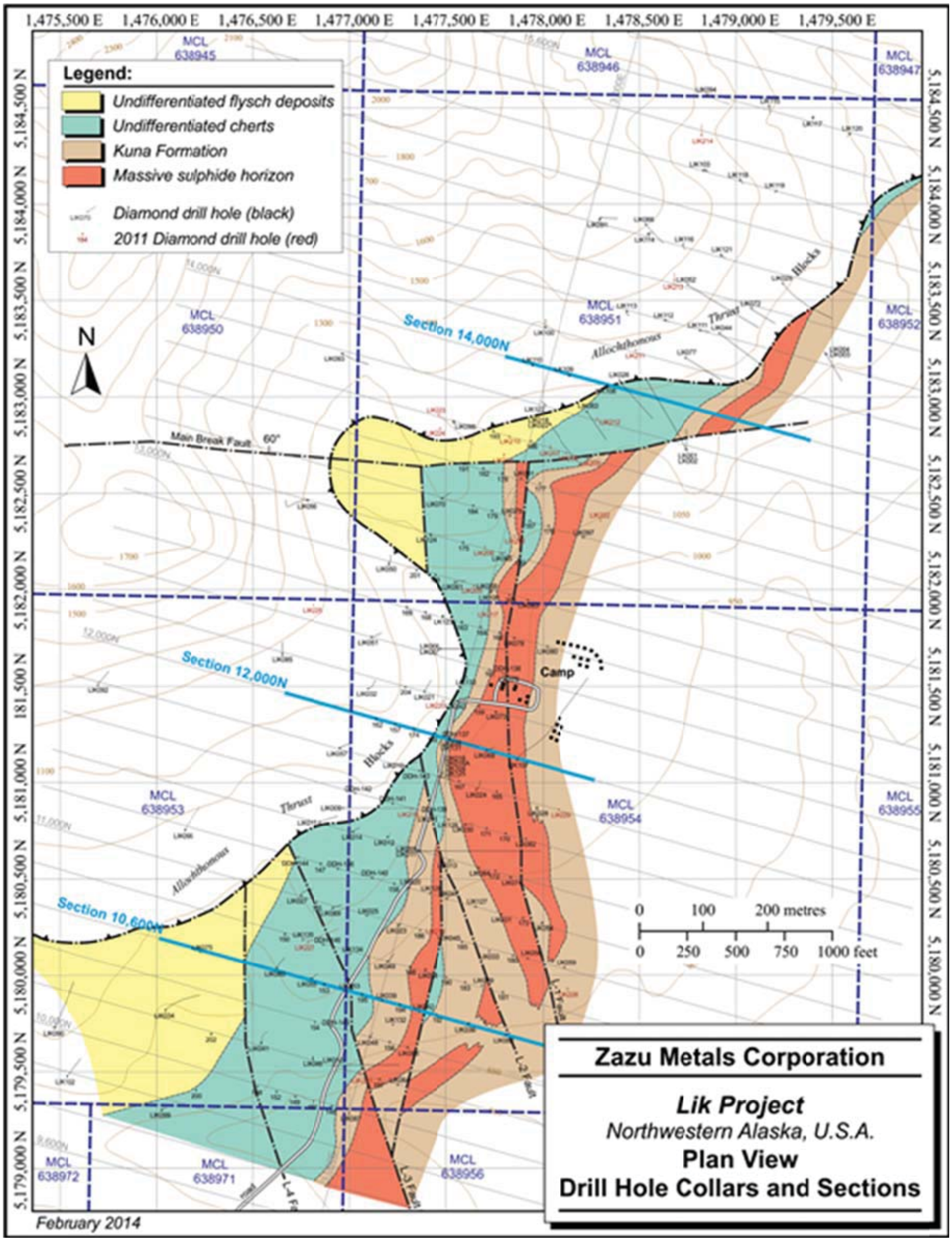
Note: There are some minor discrepancies in year-to year figures.

Information about the drilling and sampling procedures on the Lik property from 1977 to 2007 is limited. RPA has briefly summarized the information in the reports during the period with the exception of the three holes drilled by Moneta in 1990 as no records were available to RPA.

Since acquiring the Project, Zazu has completed three drilling programs, in 2007, 2008 and 2011, which are discussed in the following section.

No drilling has been completed on the Lik property since 2011.

**Figure 10-1: Plan View – Drill Hole Collars and Sections**



## 10.2 Type and Extent

### 10.2.1 Drilling Campaigns Prior to the Zazu Acquisition

***Drilling by WGM 1977-1978***

WGM carried out the initial diamond drilling campaigns on the Lik property (Frederickson et al., 1979). Reports by WGM do not name the drill contractor. All holes were collared with NQ sized drill bits but six holes required reduction to BQ size because of ground conditions. Core recoveries were not discussed. At the end of the WGM drilling, the general shape of the Lik South part of the deposit had been outlined and the overall grade of the deposit had been determined. Most of the diamond drill core for the WGM drilling is stored on the Lik property and is in good condition. A small amount of the diamond drill core from the initial year of drilling was observed by RPA in a hanger at the Anchorage airport. The small portion of the drill core which contains diagenetic marcasite oxidizes rapidly. The bulk of this marcasite is on the margins of lead-zinc mineralization and the higher grade mineralization remains in re-usable condition.

***Drilling by GCO (1979-1984, 1987, 1992)***

GCO completed a number of drilling campaigns as manager of the joint venture (Kennedy et al., 1979, Kennedy and Hicks, 1984). The name of the drill contractor was not included in the report but typically core was drilled to obtain NQ size core with reductions to BQ size and rarely to AQ, if required. Core recoveries were typically high (89% in 1979). The objectives of this drilling were to complete the fill-in drilling in Lik South and to test the limit of the deposit down dip. The GCO drill core is stored on the Lik property and is in good condition.

***Drilling by Noranda (1985)***

Noranda completed a drilling program in 1985. The report by Scherkenbach et al. (1985) makes no mention of the drilling procedures or core recoveries. As noted above, Noranda completed some fill-in drilling on Lik South, but much of the Noranda drilling also tested the down-plunge portion of Lik North. The core from the Noranda campaign is stored on the Lik property.

### 10.2.2 Zazu Drilling Campaigns

***2007 And 2008 Drilling***

Zazu completed two programs of drilling during the 2007 and 2008 summer field seasons, both of which were designed to confirm and expand the the Lik South deposit. To facilitate the drilling, Zazu purchased a diamond drill rig and contracted with an independent diamond driller to operate and maintain the drill rig. The arrangement worked satisfactorily in 2007. In 2008, Zazu extended the program and obtained a second drill that worked under the same agreement.

The purpose of the 2007 program was to confirm previous drilling results, commence infill drilling, and obtain samples for more detailed metallurgical samples. A total of 11 holes were drilled with an aggregate length of 1,394 m. At the end of the 2007 drilling campaign, it was apparent that there were gaps in the previous testing and areas where there was potential for expansion of the mineral resources. The 2008 program was designed to improve the understanding of the Lik South deposit.

A total of 57 holes were drilled in 2008 with an aggregate length of 6,830 m. All of the 2008 diamond drilling was HQ-size core, and core recoveries were typically very high. At the end of 2008, most of the Lik South deposit had been tested on lines spaced at 200 ft with holes spaced at about 100 ft.

### *2011 Drilling*

Zazu completed further diamond drilling in the 2011 field season on both Lik North and South. The drilling in 2011 had a number of objectives (Table 10-2) and the location data for the drill holes is shown in Table 10-3.

Three diamond drill holes were completed to test the Lik North deposit with the objective to improve the understanding of this deposit. A further seven diamond drill holes were completed essentially to improve the understanding of the northeast corner of the Lik South deposit. The interpretation of the boundary between the Lik South and Lik North deposits changed as further data were acquired.

Zazu also completed seven diamond drill holes to provide material for enhanced metallurgical testing. The geotechnical drilling (seven holes) was designed to provide data relating to pit slope stability and included some condemnation drilling.

**Table 10-2: 2011 Drilling Objectives**

| Drill Hole ID | Objectives | Aggregate Depth (m) |
|---|---|---|
| DDH 205 to DDH 214 | Exploration | 1,997.81 |
| DDH 215 to DDH 221 | Metallurgical Holes | 712.93 |
| DDH 222 to DDH 229 | Geotechnical Drilling | 1,100.64 |

Diamond drilling was carried out using a drill rig owned by Zazu but manned under contract. The drill moves were facilitated by helicopter.

**Table 10-3: 2011 Diamond Drill Holes**

| Hole ID | Easting | Northing | Length (m) | Azimuth (°) | Dip (°) |
|---|---|---|---|---|---|
| DDH-205 | 1477645 | 5182019 | 152.4 | 0 | -88.6 |
| DDH-206 | 1477701 | 5182216 | 165.51 | 0 | -87.7 |
| DDH-207 | 1478036 | 5182735 | 165.51 | 0 | -87.7 |
| DDH-208 | 1478123 | 5182708 | 61.42 | 0 | -89.6 |
| DDH-209 | 1478236 | 5182684 | 67.67 | 0 | -89 |
| DDH-210 | 1477826 | 5182794 | 114 | 0 | -89.4 |
| DDH-211 | 1478481 | 5183242 | 237.74 | 0 | -89.8 |
| DDG-212 | 1478283 | 5182882 | 146.91 | 0 | -88.2 |
| DDH-213 | 1478679 | 5183602 | 334.98 | 0 | -87.6 |
| DDH-214 | 1478824 | 5184358 | 551.69 | 0 | -88.5 |
| DDH-215 | 1477798 | 5182698 | 107.29 | 0 | -88.5 |
| DDH-216 | 1477852 | 5182279 | 104.85 | 0 | -89.7 |
| DDH-217 | 1477716 | 5181899 | 92.05 | 0 | -89.2 |
| DDH-218 | 1477319 | 5180863 | 86.26 | 0 | -89.1 |
| DDH-219 | 1477454 | 5180203 | 52.73 | 0 | -89.3 |
| DDH-220 | 1477487 | 5181423 | 137.77 | 0 | -90 |
| DDH-221 | 1477059 | 5179486 | 131.98 | 0 | -88.6 |
| DDH-222 | 1478300 | 5182361 | 167.64 | 0 | -90 |
| DDH-223 | 1477463 | 5182906 | 246.89 | 127.9 | -72.7 |
| DDH-224 | 1477472 | 5182836 | 36.58 | 0 | -90 |
| DDH-225 | 1476814 | 5181921 | 213.36 | 0 | -90 |
| DDH-227 | 1476780 | 5180173 | 137.16 | 68.8 | -66.1 |
| DDH-228 | 1478132 | 5179928 | 137.16 | 0 | -90 |
| DDH-229 | 1478080 | 5180860 | 161.85 | 0 | -90 |
| **Total** | | | **3,811.40** | | |

All of the drilling completed during 2011 was HQ size. Core recoveries were typically very high, close to 100% in most cases. Downhole surveys were completed on a regular basis typically every 61 m (200 ft) and at the bottom of the hole. Zazu brought in a surveyor to carry out a collar location survey before the end of the drilling season.

## 10.3 Procedures

The core obtained from the Lik deposit during the 2007, 2008, and 2011 drilling campaigns was logged on site at the Lik camp. The entire core containing sulfide mineralization was sawn using diamond saws and half of the core was sent for assay.

At Lik, there is local diagenetic marcasite associated with the margins of the higher grade mineralization and within some of the lower grade mineralization. This material oxidizes rapidly, breaking up the core and rendering samples inappropriate for metallurgical testing. Once core was placed in sample bags, the air was evacuated and replaced with nitrogen.

The samples were sent to Kotzebue, Alaska, by charter plane and then by licensed carrier to Anchorage, Alaska. The samples were stored under refrigeration in Anchorage until the end of the drilling campaign. Finally, the samples were dispatched to G&T Metallurgical Services Ltd. (G&T) of Kamloops, BC, Canada. As well as completing metallurgical testing, G&T crushed and analyzed the samples.

The 2008 and part of the 2011 diamond drill core was not required for metallurgical testing, and core from exploration drill holes was handled normally. Sawn samples were bagged and boxed on site and dispatched to a facility of ALS Laboratory Group (ALS Chemex) located in Fairbanks, Alaska, for sample preparation. The pulps were analyzed at ALS Chemex Fairbanks.

Core was typically sampled in 1.52 m (5 ft) intervals. As the deposit would be mined by open cast methods, Zazu considered that this type of sampling was more appropriate. Notwithstanding the absence of economic mineralization, all massive and high sulfide areas were sampled. Mineralization is sufficiently coarse and high grade to be recognized visually, and thus, visual methods were used to select sample boundaries and lengths.

Of the 1,905 original samples collected in 2008, 1,006 samples were five-foot long. Of the 583 original samples collected in 2011, 394 samples were 1.52 m (5 ft) long. Short samples were noted adjacent to areas where grade changed sharply, with the shortest samples being one foot (0.30 m) long. The majority of the other samples were 5.5 ft (1.68 m) long and only few were longer, up to 7.5 ft (2.29 m).

Recovery was typically excellent in core seen on site by RPA. An examination of the core logs showed that core recovery in sulphide areas was generally very high.

RPA considers the mineralization at Lik to be appropriately logged and sampled. It is not evident that logging or sampling is leading to any bias in the sample results.

There are no known drilling, sampling or recovery factors that could materially impact the accuracy and reliability of the drilling and sampling results. Further, RPA considers that the drilling results for the work completed to date is satisfactory for the estimation of Mineral Resources.

# 11.0 Sample Preparation, Analyses and Security

## 11.1 General

The Lik camp is located in an isolated area of Alaska. Access is typically by charter airplane through Kotzebue. Core was logged and sampled on site. Samples are despatched by bonded carrier through Kotzebue airport. RPA considers that security has been maintained in the handling of samples.

## 11.2 Drilling by WGM (1977-1978)

Core was split using diamond saws and sample sizes varied from 0.30 m to 6.10 m with an average sample length of 1.39 m (Frederickson et al., 1979). Samples were bagged and sent to Bondar-Clegg in Fairbanks, AK. Samples were assayed for lead, zinc and silver. Initially, all samples were assayed for cadmium, but values were generally found to be low and only samples with greater than 5% Pb+Zn were analyzed later in the season. The assay method is not discussed, but was probably atomic absorption spectrometry (AAS).

The inclusion of reference samples is not mentioned, but 65 assay duplicates were sent from Bondar-Clegg to the independent metallurgical laboratory used by the joint venture. The results of the duplicate assays were not discussed.

## 11.3 Drilling by GCO (1979-1984, 1987, 1992)

Core was logged on site and sampling completed using diamond saws. All samples were sent to Bondar-Clegg in Vancouver, BC for analysis. Assay protocols are not discussed. The available reports include no mention of any Quality Assurance and Quality Control (QA/QC) procedures.

## 11.4 Drilling by Noranda (1985)

The report by Scherkenbach et al. (1985) makes no mention of the analytical laboratory or whether any QA/QC procedures were carried out.

## 11.5 Zazu 2007 Analyses

The 2007 Lik samples were dispatched to G&T, an ISO 9001:2000 certified laboratory for precious metals and base metals. As well as completing the analyses for a range of elements, G&T also carried out a program of metallurgical testing. Zazu transferred pulps from G&T to ALS Chemex in Vancouver for check analysis as part of the QA/QC. Reproducibility between G&T and ALS Chemex was found to be good. Zazu is not responsible for any part of the sample preparation or analysis.

G&T prepared the Zazu samples using its SMS21 Preparation Method. The major steps in this protocol were:

- Samples were received, identified, and labelled
- Samples were passed through a jaw crusher to reduce the core to >10 mesh
- Samples were passed through a cone crusher until +99% of the sample was -10 mesh
- Samples were riffled to cut a sample of about 500 g
- This material was treated in a ring pulverizer so that all of the material was <100 microns
- A pulp of 250 g was sent for analysis

The material was then treated using the AMS08 protocol for analysis. Major steps included:

- Samples were dissolved using an aqua regia digestion
- The samples were analyzed using inductively coupled plasma (ICP) analysis

The QA/QC procedures employed by Zazu included the use of blanks (unmineralized core from outside of the mineralized zone) and quartered duplicates. Zazu was unable to obtain acceptable reference samples for the 2007 field season and reference samples were not included as part of the 2007 QA/QC program.

## 11.6 2008 and 2011 Analyses

Samples from the 2008 and 2011 summer drilling campaigns were sent to the preparation facilities of ALS Chemex located in Fairbanks, Alaska. At Fairbanks, the samples were treated using Sample Preparation Package – PREP-31. This is a standard sample preparation protocol. The following steps were followed for the Zazu samples:

- LOG-22 – Each sample was logged into the tracking system and a bar code was attached to the sample. Each sample was weighed and dried.
- CRU-31 – Each sample was finely crushed so that more than 70% of each sample was passing 2 mm.
- SPL-21 – Samples were split using a riffle splitter.
- PUL-31 – A 250 g sample was split out and pulverized so that greater than 85% of each sample was passing 75 µm.

The pulps were analyzed at ALS Chemex in Fairbanks with over-limit samples transferred to an ALS Chemex facility located in North Vancouver, British Columbia. The ALS Chemex facility in North Vancouver has received ISO 17025 accreditation from the Standards Council of Canada under CAN-P-4E (ISO/IEC 17025:2005), the General Requirements for the Competence of Testing and Calibration Laboratories, and the PALCAN Handbook (CAN-P-1570).

The basic analyses for each sample, ME-OG62, included:

- ASY-4A01 – four acid digestion. A 0.4 g sample of the pulp was digested in 100 mL of nitric, perchloric, hydrofluoric, and hydrochloric acids for 180 minutes at 220ºC and then evaporated to incipient dryness. Hydrochloric acid and de-ionized water were added for further digestion and the sample was heated. The sample was cooled to room temperature and transferred to a 100 mL volumetric flask.
- ICP-AES - The resulting solution was diluted to volume with de-ionized water, homogenized, and the solution was analyzed by inductively coupled plasma-atomic emission spectrometry (ICP-AES).

This protocol has an upper limit of 1,500 ppm Ag, 20% Pb, and 30% Zn and a lower limit of 1 ppm Ag, 0.01% Pb, and 0.01% Zn.

In cases where lead values exceeded the upper limits of the analytical procedure, volumetric titration with EDTA (Ethylene Diamine Tetraacetic Acid) was used. This methodology has an upper limit of 100% Pb. An examination of the assay datafile for the original Lik samples shows that two of the original lead samples assayed greater than 20% Pb and were re-assayed by volumetric titration. In cases where the zinc values exceeded the upper limits of the ICP-AES methodology, volumetric titration with EDTA and using Xylenol orange as an indicator was used. In both cases, a 0.4 g to 1.0 g prepared sample was digested using a four acid digestion.

In 2011, Zazu dispatched the original drill samples sent for analysis together with a further 30 blank samples, 32 reference samples, and 19 core duplicate samples. An assessment of the QA/QC results indicates that:

- Blank samples gave low results, indicating that intersample contamination was not a problem in 2011.
- Core duplicate samples gave acceptable reproducibility.
- Zazu inserted eight different reference samples during the 2011 drilling season sourced from CDN Resource Laboratories Ltd. of Vancouver. Generally, the reference samples gave acceptable results, although several of the low lead values exceeded the three standard deviation level and are considered to have failed. It is recommended that Zazu pursue these matters with the laboratory. RPA considers that the minor problems experienced do not invalidate the mineral resource model developed in this report.

RPA is of the opinion that the sample preparation, security, and analytical procedures completed to date have been carried out to industry standards.

The Lik camp is an isolated fly-in facility. On-site security is not considered to be a major problem. Samples are transferred by company personnel to Kotzebue, Alaska, and are transported to the laboratory by bonded carrier. No significant security risks are apparent to RPA.

# 12.0 Data Verification

RPA has completed several site visits, data verification studies, and previous NI 43-101 reports on the Lik property. The results of the data verification work are summarized in this section. As noted in Section 11 of this report, Zazu maintained a satisfactory QA/QC program during all of its drilling campaigns.

## 12.1 2007

RPA completed check sampling of diamond drill core from the 2007 drilling as part of a verification process during a property visit in September 2007. Eight samples of quartered core were collected and the samples were returned to the SGS Canada laboratory in Toronto in the custody of the RPA representative. Details of the samples collected are set out in Table 12-1.

**Table 12-1: RPA Check Samples 2007**

| Hole ID | Sample ID | From (m) | To (m) | Length (m) |
|---|---|---|---|---|
| DDH-139 | 462151 | 26.52 | 28.04 | 1.52 |
| DDH-143 | 462152 | 75.29 | 76.81 | 1.52 |
| DDH-143 | 462153 | 81.39 | 82.91 | 1.52 |
| DDH-143 | 462154 | 85.96 | 87.48 | 1.52 |
| DDH-143 | 462155 | 90.53 | 92.05 | 1.52 |
| DDH-143 | 462156 | 101.19 | 102.71 | 1.52 |
| DDH-136 | 462157 | 99.67 | 100.89 | 1.22 |
| DDH-136 | 462158 | 100.89 | 102.41 | 1.52 |

The check samples were dispatched to Toronto for analysis. The results of the analyses by SGS Canada and their comparison with G&T sample results are shown in Table 12-2.

**Table 12-2: 2007 Check Sample Comparison**

| RPA Sample ID | SGS Results | | G&T Sample Results | |
|---|---|---|---|---|
| | Zn% | Pb% | Zn% | Pb% |
| 462151 | 0.05 | 0.07 | 0.92 | 0.76 |
| 462152 | 0.20 | 0.04 | 0.55 | 0.22 |
| 462153 | 7.98 | 10.00 | 21.50 | 14.20 |
| 462154 | 3.55 | 0.63 | 1.65 | 8.96 |
| 462155 | 9.13 | 1.06 | 10.70 | 1.68 |
| 462156 | 3.55 | 0.63 | 4.52 | 0.86 |
| 462157 | 1.09 | 0.60 | 1.02 | 0.51 |
| 462158 | 3.09 | 1.26 | 3.90 | 0.82 |

One of the samples showed significant variation between the SGS value and the G&T value, and RPA recommended further assaying to determine whether there was a problem with these data.

Diamond drill collar positions and core storage buildings were inspected during the RPA visit.

One of the objectives of the 2007 drilling was to twin several of the previous holes with the purpose of confirming the earlier work. Three of the holes completed were twin holes of earlier drilling. Of the holes drilled, DDH 137 twinned DDH 38, DDH 138 twinned DDH 76, and DDH 139 twinned DDH 15.

Results of these twin holes are shown in Table 12-3.

**Table 12-3: Results of Twin Holes**

| Hole ID | From (m) | To (m) | Length (m) | Pb% | Zn% |
|---|---|---|---|---|---|
| DDH-137 | 4.88 | 16.92 | 12.04 | 3.38 | 7.72 |
| | 34.14 | 76.50 | 42.36 | 1.67 | 6.49 |
| DDH-38 | 11.89 | 17.37 | 5.48 | 7.61 | 6.52 |
| | 45.90 | 87.75 | 41.85 | 1.72 | 7.42 |
| DDH-138 | 7.01 | 32.61 | 25.60 | 2.44 | 8.20 |
| DDH-76 | 10.36 | 33.99 | 23.63 | 1.48 | 9.49 |
| DDH-139 | 29.56 | 46.02 | 16.46 | 2.13 | 8.95 |
| DDH-15 | 31.09 | 28.16 | 17.07 | 2.69 | 10.44 |

Overall, these twinned holes appear to show reasonable correlation. The higher intersections in holes DDH 137 and DDH 38 are markedly different because of core loss in the upper part of DDH 38. The depth differences between DDH 137 and DDH 38 for the lower intersection may reflect hole deviation. When individual assays are examined, there is correlation between the higher grade areas in the various twinned holes.

It should be noted that diamond drilling and sampling has been carried out and supervised by different companies including WGM, GCO, Noranda, and Moneta.

## 12.2 2008

Further verification sampling was completed during the 2008 field visit. A further eight samples of quartered core were collected, with the samples coming from two different holes. The samples were selected to cover a number of different grades. The verification samples were dispatched to SGS Laboratories in Toronto. Samples for base metals were assayed using the ICP90Q protocol (sodium peroxide fusion with ICP-AES analysis), while silver was assayed using FAG323. The locations of the verification sampling are listed in Table 12-4 and the results are tabulated in Table 12-5.

**Table 12-4: RPA Check Samples, 2008**

| Hole ID | Sample ID | From (m) | To (m) | Length (m) |
|---|---|---|---|---|
| 179 | 553393 | 74.07 | 75.59 | 1.52 |
| 179 | 553394 | 78.64 | 80.16 | 1.52 |
| 179 | 553395 | 80.16 | 81.69 | 1.53 |
| 179 | 553396 | 86.26 | 87.78 | 1.52 |
| 182 | 553397 | 64.47 | 64.92 | 0.45 |
| 182 | 553398 | 64.92 | 66.45 | 1.53 |
| 182 | 553399 | 86.72 | 87.78 | 1.06 |
| 182 | 553400 | 89.31 | 90.83 | 1.52 |

**Table 12-5: 2008 Check Sample Comparison**

| RPA Sample ID | SGS Results | | | ALS Sample Results | | |
|---|---|---|---|---|---|---|
| | Zn% | Pb% | Ag ppm | Zn% | Pb% | Ag ppm |
| 553393 | 13.20 | 6.26 | <3 | 11.30 | 4.82 | 3 |
| 553394 | 8.14 | 1.16 | <3 | 7.11 | 1.02 | 2 |
| 553395 | 9.38 | 3.80 | <3 | 7.11 | 1.02 | 2 |
| 553396 | 9.49 | 0.93 | 60 | 10.50 | 0.62 | 46 |
| 553397 | 6.94 | 4.64 | 114 | 6.40 | 4.01 | 110 |
| 553398 | 7.30 | 3.10 | 60 | 7.14 | 2.26 | 103 |
| 553399 | 11.60 | 2.70 | 138 | 11.00 | 2.92 | 153 |
| 553400 | 25.30 | 9.10 | 400 | 23.60 | 8.37 | 427 |

The verification sampling completed by RPA shows a slight bias for base metals (zinc is 7% higher overall, lead is 17% higher overall) in the SGS samples and a slight bias towards silver (9%) in the ALS samples.

RPA recommended that Zazu routinely send a number of pulps to an independent laboratory. This would serve as another check of the integrity of the database.

## 12.3 2011

RPA completed check sampling of diamond drill core from 2011 as part of a verification process for samples from the drill campaign during a property visit in September 2011. Nine samples of quartered core were collected and the samples were sent to ALS Chemex in Fairbanks. Details of the samples collected are set out in Table 12-6.

**Table 12-6: RPA Check Samples, 2011**

| Hole ID | Sample ID | From (m) | To (m) | Length (m) |
|---|---|---|---|---|
| DDH 139 | 462151 | 26.52 | 28.04 | 1.52 |
| DDH 143 | 462152 | 75.29 | 76.81 | 1.52 |
| DDH 143 | 462153 | 81.39 | 82.91 | 1.52 |
| DDH 143 | 462154 | 85.96 | 87.48 | 1.52 |
| DDH 143 | 462155 | 90.53 | 92.05 | 1.52 |
| DDH 143 | 462156 | 101.19 | 102.71 | 1.52 |
| DDH 136 | 462157 | 99.67 | 100.89 | 1.22 |
| DDH 136 | 462158 | 100.89 | 102.41 | 1.52 |

The locations of a number of the 2011 drill hole collars were visited in the field. The drill hole collar sites are well marked.

**Table 12-7: 2011 Check Sample Comparison**

| RPA Sample ID | Check Results | | | Initial Results | | |
|---|---|---|---|---|---|---|
| | Zn% | Pb% | Ag ppm | Zn% | Pb% | Ag ppm |
| 3801 | 9.51 | 2.06 | 1 | 8.84 | 2.08 | 1 |
| 3802 | 6.55 | 1.81 | 98 | 4.79 | 4.07 | 53 |
| 3803 | 10.05 | 2.18 | 30 | 13.90 | 0.80 | 52 |
| 3804 | 13.15 | 1.78 | 52 | 10.80 | 0.93 | 47 |
| 3805 | 9.34 | 2.38 | 32 | 10.35 | 1.99 | 27 |
| 3806 | 6.30 | 1.16 | 35 | 8.75 | 2.93 | 54 |
| 3807 | 16.75 | 4.00 | 106 | 19.45 | 3.87 | 115 |
| 3808 | 15.15 | 5.77 | 119 | 15.85 | 5.77 | 130 |
| 3809 | 0.17 | 0.20 | 6 | 0.33 | 0.12 | 2 |

There is reasonable correlation between these two sets of analyses, which should be considered as core duplicates.

RPA is of the opinion that the data is adequate for the preparation of an updated Mineral Resource estimate.

# 13.0 Metallurgical Testing

## 13.1 Summary

There have been five testwork reports issued to date on the Lik ores included in Section 27, References.

Two other test programs between 1978 to 1980 were mentioned in the Scott Wilson RPA report entitled, "Technical Report and Mineral Estimate on The Lik Deposit, Northern Alaska USA" (May 13, 2009). The first completed at Colorado School of Mines was considered unreliable due to oil contamination of the sample; the second at Dawson Metallurgical Laboratories was halted due to oxidation of the sample.

In addition to the above, a small testing program is in progress on a sample of G&T 2013, Period 2 (Years 3, 4 & 5) at BGRIMM in China. BGRIMM had success in eliminating the pre-float circuit and increasing recoveries at the Cu/Pb/Zn Wolverine Mine owned by Yukon Zinc Corporation. The Lik ores are similar to Wolverine in that there is sufficient carbonaceous material present to complicate the Cu and Pb sulfide circuits. The small test program was initiated to determine if they could achieve similar results for the Lik ore as they have done on Wolverine.

This section summarizes the significant results reported to date.

## 13.2 H. Hartjens 1981 Program

Table 13.1 contains the data reported by Scott Wilson RPA for the tests directed by H. Hartjens and does not include Si or $SiO_2$ analyses; as a result no concerns over the silicate levels in the zinc concentrates where raised. The data is consistent with subsequent programs on different composites.

## 13.3 G&T 2008 Program

In 2007-2008, samples from 13 drill holes were composited into one master composite for preliminary investigations at G&T Laboratories in Kamloops. This composite was used in the 2008 program at G&T and subsequently moved to SGS in Vancouver where the 2010 and 2011 SGS programs where completed. Two cycle tests where completed (Tests 21 & 22). Test 22 was rejected based on the poor results reportedly due to poor operation of the lead flotation, causing high rejection of lead to the zinc circuit /concentrate.

Test 21 recovery and concentrate grades are in a reasonable range for ores of this type, with lead recoveries to the lead concentrate of 70.3% at a grade of 70.3% Pb, and zinc recoveries to the zinc concentrate at 86.9% at a grade of 52.2% Zn.

**Table 13-1: H. Hartjens 1981 Program**

| Test 26 | Element | Feed Grade | | Lead Conc | | Zinc Conc | |
|---|---|---|---|---|---|---|---|
| | | Assayed | Calculated | Grade | Recovery | Grade | Recovery |
| Composite 6a | Pb % | 1.80 | 1.77 | 62.80 | 78.00 | 0.94 | 5.80 |
| | Zn % | 8.20 | 8.28 | 6.00 | 1.60 | 57.20 | 75.70 |
| | Ag oz/ton | 1.70 | 1.66 | 4.57 | 6.10 | 3 | 18 |

| Test 28 | Element | Feed Grade | | Lead Conc | | Zinc Conc | |
|---|---|---|---|---|---|---|---|
| | | Assayed | Calculated | Grade | Recovery | Grade | Recovery |
| Composite 2a-6a (1:2) | Pb % | 4.30 | 4.05 | 68.00 | 86.40 | 0.79 | 5.50 |
| | Zn % | 16.00 | 15.59 | 7.20 | 2.40 | 59.10 | 86.90 |
| | Ag oz/ton | 3.80 | 3.68 | 19.06 | 26.60 | 5.54 | 34.50 |

| Test 27 | Element | Feed Grade | | Lead Conc | | Zinc Conc | |
|---|---|---|---|---|---|---|---|
| | | Assayed | Calculated | Grade | Recovery | Grade | Recovery |
| Composite 7a | Pb % | 1.10 | 1.09 | 56.80 | 72.90 | 0.63 | 3.90 |
| | Zn % | 4.50 | 4.55 | 4.00 | 1.30 | 58.00 | 86.40 |
| | Ag oz/ton | 1.10 | 1.14 | 4.44 | 5.50 | 3.22 | 19.10 |

**Table 13-2: G&T 2008 Report**

| Test | Element | Feed | Lead Con | | Zinc Conc | |
|---|---|---|---|---|---|---|
| | | Grade | Grade | Recovery | Grade | Recovery |
| Test 21 | Pb% | 2.36 | 70.3 | 70.30 | 1.57 | 9.4 |
| | Zn% | 8.47 | 4017 | 1.2 | 52.20 | 86.9 |
| | Ag g/t | 34 | 68 | 4.8 | 64 | 27 |
| Test 22 | Pb% | 2.60 | 76.70 | 59.5 | 3.99 | 23.9 |
| | Zn% | 8.78 | 2.53 | 0.6 | 45.1 | 80.0 |
| | Ag g/t | 33 | 64 | 3.9 | 55 | 26.0 |

The silica level in the zinc concentrate was 10.1%, which is well above penalty levels. This level of silicate would make the zinc concentrate difficult to market, as well as attract associated penalties.

It was noted that the presence of carbonaceous material could be complicating lead flotation, and G&T recommended future testing should include a pre-flotation step to assess the impact of removing this material prior to lead flotation.

## 13.4 SGS 2010 Program

The remainder of the master composite from the 2008 program at G&T was moved to SGS in Vancouver and used in follow-up programs to confirm G&T results as well as to address the high levels of silicate in the zinc concentrate. The program consisted of 13 tests, the last being a cycle test (LCT 1). The results of the cycle test from this SGS program are compared with G&T Test 21, completed on the same master composite in Table 13.3 below.

**Table 13-3: SGS 2010 and G&T 2008 Cycle Test Comparison**

| Test | Element | Feed | Lead Con | | Zinc Conc | |
|---|---|---|---|---|---|---|
| | | Grade | Grade | Recovery | Grade | Recovery |
| SGS 2010 | Pb% | 2.83 | 52.00 | 69.10 | 1.88 | 9.70 |
| | Zn% | 9.56 | 7.39 | 2.91 | 54.60 | 83.10 |
| | Ag g/t | 37 | 55 | 5.5 | 68 | 26.6 |
| G&T 2008 | Pb% | 2.36 | 70.30 | 70.3 | 1.57 | 9.4 |
| | Zn% | 8.47 | 4.17 | 1.20 | 52.20 | 86.9 |
| | Ag g/t | 34 | 68 | 4.8 | 64 | 26.9 |
| Average Used for Mass Balance and NSR Estimates | Pb% | 2.60 | 61.15 | 69.7 | 1.73 | 9.6 |
| | Zn% | 9.02 | 5.78 | 2.06 | 53.40 | 85.0 |
| | Ag g/t | 36 | 62 | 5.2 | 66 | 26.8 |

Both of the cycle tests reported above are within the expected range for this ore, with one exception. The lead concentrate grade in G&T test 21 at 70.3% Pb is high compared to 52.0% for SGS LCT 1 at similar levels of recovery 70.3% (G&T) and 69.1%.

The 2010 SGS report notes that the master composite sample was stored for two years prior to being moved to SGS. Even though the sample was in cold storage, it might have oxidized, which would contribute to the difference in metallurgical response.

Silicate level in the zinc concentrate was lowered from 10.1% $SiO_2$ (G&T 2008) to 6.0% $SiO_2$ for LCT 1 (SGS 2010)

The average results of two cycle tests (G&T 2008 and SGS 2011) were used to estimate the mass balance and calculate the NSR used for mine modeling and financial analysis. The average values are considered a reasonable estimation of expected metallurgy at this level of study.

In summary, the average lead concentrate grade is estimated at 61.2% Pb containing 69.7% of lead in the feed and the average zinc concentrate grade is estimated at 53.4% Zn containing 85.0% of zinc in the feed.

Concerns over the potential oxidation of the sample resulted in an additional short program at SGS in 2011 to assess the level of oxidation if any, as well as to confirm previous test results at G&T and SGS for the master composite. The results of the three programs on the master composite compare well and the sample does not appear to have oxidized in cold storage. The level of experience of the operator performing the test appears to be a major factor in reproducibility.

## 13.5 SGS 2011 Program

Zazu commissioned JDS to review the 2009 Scott Wilson RPA Report. Part of this review included a follow-up program at SGS to confirm the findings from the master composite reported by SGS in 2010.

The test program included five tests including two cycle tests. The initial cycle tests were discarded due to the inexperience of the operator. The second cycle test performed by the same operator as the 2010 test yielded comparative results to the previous cycle test in the SGS 2010 program.

The results of this program confirming the results of the previous 2010 SGS program (see Table 13-3) are summarized in Table 13.4.

**Table 13-4: SGS 2011 Confirmation Tests**

| Test | Element | Feed | Lead Con | | Zinc Conc | |
|---|---|---|---|---|---|---|
| | | Grade | Grade | Recovery | Grade | Recovery |
| LCT2 | Pb% | 2.57 | 51.2 | 69.9 | 1.76 | 9.18 |
| | Zn% | 9.14 | 6.54 | 2.52 | 56.40 | 82.80 |
| | Ag g/t | 37.00 | 67.00 | 6.32 | 76.00 | 27.60 |

Silicate levels were reported at 6.0% $SiO_2$.

No further testing on the master composite has been carried out.

## 13.6 G&T 2013 Flotation Program

Based on the recommendations in the JDS 2010 report, a drill program was completed in 2010 to supply fresh metallurgical samples for further testing of the Lik deposit. The metallurgical holes where planned to provide material representative of three periods over the mine life.

- Period 1 (representing expected mill feed for Years 1 and 2)
- Period 2 (representing expected mill feed for Years 3, 4 and 5)
- Period 3 (representing expected mill feed for Year 6 to end of mine).

The combined program consisted of 33 tests including four cycle tests: two on Period 1 Composite (Test 13 & 18) and one each on Period 2 & 3 (Test 25 & 24, respectively). The first cycle test on Period 1 Composite (Test 13) was completed without a pre-flotation stage, the remainder of the cycle tests were completed with a pre-flotation stage prior to lead flotation. Note that based on the poorer metallurgy of the Period 2 Composite, the cycle test for Period 3 was completed before the test for Period 2; the test numbers reflect the sequencing of the tests.

The results of the cycle tests are summarized in Table 13.5.

**Table 13-5: G&T 2013 Period Composites**

| Test | Element | Feed | Preflot Concentrate | | Lead Concentrate | | Zinc Concentrate | |
|---|---|---|---|---|---|---|---|---|
| | | Grade | Grade | Recovery | Grade | Recovery | Grade | Recovery |
| Test 13 Period-1 Compo No Pre-flot | Pb% | 3.16 | | | 52.30 | 76.30 | 1.82 | 8.70 |
| | Zn% | 10.90 | | | 9.17 | 3.90 | 59.60 | 82.60 |
| | Ag g/t | 72 | | | 197 | 12.5 | 141 | 29.3 |
| Test 18 Period 1-Compo | Pb% | 3.04 | 2.44 | 4.20 | 54.70 | 75.90 | 1.72 | 10.10 |
| | Zn% | 10.70 | 10.20 | 4.90 | 5.30 | 2.10 | 52.80 | 88.10 |
| | Ag g/t | 73 | 60 | 4.3 | 204 | 11.90 | 132 | 32.40 |
| Test 25 Period 2-Compo | Pb% | 2.89 | 2.35 | 7.40 | 53.10 | 61.40 | 2.28 | 10.20 |
| | Zn% | 9.28 | 9.95 | 9.70 | 4.47 | 1.60 | 51.40 | 71.70 |
| | Ag g/t | 25.00 | 23.00 | 8.3 | 44.00 | 5.8 | 42 | 21.6 |
| Test 24 Period 3-Compo | Pb% | 1.84 | 1.68 | 5.90 | 76.60 | 59.50 | 1.98 | 10.80 |
| | Zn% | 7.07 | 7.60 | 7.00 | 1.84 | 0.40 | 56.40 | 80.50 |
| | Ag g/t | 28 | 28 | 6.4 | 80 | 4.2 | 52 | 18.8 |

### 13.6.1 Period 1 Composite

The Period 1 results, with and without pre-flotation, are similar for the lead concentrates at 54.7% Pb and 75.9% recovery and 52.3% Pb and 76.3%, respectively.

The zinc grades vary from 52.6% Zn to 59.6% Zn with recoveries of 88.1% and 82.6%, respectively. For higher grade concentrates the recovery would normally be expected to be lower, which is true in this case between cycle tests without and with pre-flotation.

The silver recovery to the zinc concentrate ranges between 29.3% and 32.4%, which is considerably higher than the lead concentrate range of 8.7% to 10.1%. This result puts the majority of the recovered silver in the zinc concentrate where higher silver deductions are charged by the smelters.

The silicate levels recorded in the zinc concentrates are 2.7% SiO2 for Test 13 and 7.7% $SiO_2$ for Test 18. These results suggest that more investigation is needed in this area to stabilize and reduce $SiO_2$ level below 5%.

### 13.6.2 Period 2 Composite

The results from the cycle test on the Period 2 composite were significantly poorer that for Period 1.

- The lead concentrate grade is 53.1% Pb containing 61.4% of lead in the feed.
- The zinc concentrate grade is 51.4% Zn containing 71.7% of zinc in the feed.

Silver grade in the lead and zinc concentrates was 44 g/t and 42 g/t, with recoveries of 5.8% and 21.6%, respectively.

In order to identify if the poor metallurgy was localized in one area, subsamples were identified from the residual Period 2 drill core and composites for further testing. These tests are planned after the ongoing tests on the Period 2 composites are completed at BGRIMM Laboratory in China.

### 13.6.3 Period 3 Composite

The results from the cycle test on Period-3 Compo were poorer than for Period-1, but better than Period-2:

- The lead concentrate grade is 76.6% Pb containing 59.5% of lead in the feed.
- The zinc concentrate grade is 56.4% Zn containing 80.5% of zinc in the feed.

Silver grade in the lead and zinc concentrates was 80 g/t and 52 g/t, with recoveries of 4.2% and 18.2%, respectively.

Additional subsample compos have been prepared for Period-3 for follow up testing.

The testwork on the Period 2 and 3 Subsample Compos is recommended to further the understanding of the Lik metallurgy and to assist with the location of holes for the next drill program.

## 13.7 G&T 2013 Comminution Testwork

G&T completed a series of comminution tests on seven separate composites taken from the drill core received in September 2011.The test data was used by JKTech to produce an SMC test analysis report, included with the G&T 2013 Report.

The composites tested where made up of material designated as Massive Sulfide and Semi-Massive Sulfide for each of the three periods (Years 1 & 2, Years 3, 4 & 5, and Years 6, 7 & 8). The seventh composite evaluated containing Low Grade Sulfide material to establish a baseline for possible dilution material.

A summary of the G&T data and the JKTech SMA test analysis is included in Table 13-6 for reference.

**Table 13-6: Comminution Data G&T 2013 in Imperial Units**

| Sample ID | Sample Description | Bond Ball Wi (kWh/ton) | Bond Rod Wi (kWh/ton) | Crushing Wi (kWh/ton) | Abrasion Index (lbs/kWh) | SMC (A x b) | PLI-UCS (MPa) |
|---|---|---|---|---|---|---|---|
| Compo 1 | Semi Massive Sulfide (Yrs 1&2) | 14.8 | 13.6 | 9.3 | 0.10 | 48.0 | 110 |
| Compo 2 | Semi Massive Sulfide (Yrs 3,4&5) | 14.8 | 14.5 | 6.0 | 0.23 | 54.3 | 82 |
| Compo 3 | Semi Massive Sulfide (Yrs 6,7&8) | 12.7 | 12.3 | 6.1 | 0.12 | 75.9 | 81 |
| Compo 4 | Semi Massive Sulfide (Yrs 1&2) | 11.6 | 12.7 | 7.6 | 0.16 | 66.3 | 84 |
| Compo 5 | Semi Massive Sulfide (Yrs 3,4&5) | 12.2 | 13.6 | 8.4 | 0.16 | 46.7 | 113 |
| Compo 6 | Semi Massive Sulfide (Yrs 6,7&8) | 13.7 | 13.5 | 12.7 | 0.17 | 46.0 | 102 |
| Compo 7 | Semi Massive Sulfide (Yrs 1&2) | 12.6 | 12.3 | 6.2 | 0.17 | 67.3 | 61 |

**Table 13-7: Comminution Data G&T 2013 in Metric Units**

| Sample ID | Sample Description | Bond Ball Wi (kWh/t) | Bond Rod Wi (kWh/t) | Crushing Wi (kWh/t) | Abrasion Index (lbs/kWh) | SMC (A x b) | PLI-UCS (MPa) |
|---|---|---|---|---|---|---|---|
| Compo 1 | Semi Massive Sulfide (Yrs 1&2) | 16.3 | 15.0 | 10.3 | 0.10 | 48.0 | 110 |
| Compo 2 | Semi Massive Sulfide (Yrs 3,4&5) | 16.3 | 16.0 | 6.6 | 0.23 | 54.3 | 82 |
| Compo 3 | Semi Massive Sulfide (Yrs 6,7&8) | 14.0 | 13.6 | 6.7 | 0.12 | 75.9 | 81 |
| Compo 4 | Semi Massive Sulfide (Yrs 1&2) | 12.8 | 14.0 | 8.3 | 0.16 | 66.3 | 84 |
| Compo 5 | Semi Massive Sulfide (Yrs 3,4&5) | 13.5 | 15.0 | 9.3 | 0.16 | 46.7 | 113 |
| Compo 6 | Semi Massive Sulfide (Yrs 6,7&8) | 15.1 | 14.9 | 14.0 | 0.17 | 46.0 | 102 |
| Compo 7 | Semi Massive Sulfide (Yrs 1&2) | 13.9 | 13.6 | 6.8 | 0.17 | 67.3 | 61 |

### 13.7.1 Bond Ball Mill work index

The bond ball mill Work Index ranges from a low of 12.8 kWh/ton (compo 4) to a high of 16.3 kWh/ton (compos 1 & 2). This range is considered to indicate low to medium hard ore.

### 13.7.2 Bond Rod Mill Work Index

The bond Rod Mill Work Index ranges from a low of 13.6 kWh/ton (compo 7) to a high of 16.0 kWh/ton (compo 2). This range is considered to indicate low to medium hard ore for rod mill operation.

### 13.7.3 Bond Crushing Work Index

The Bond Crushing Work Index ranges from a low of 6.6 kWh/ton (compo 2 & 3) to a high of 14.0 kWh/ton (compo 6). This range is considered to indicate low to medium hard ore for crusher operation.

### 13.7.4 Bond Abrasion Index

The Bond Abrasion Index ranges from a low of 0.10 (compo 1) to a high of 0.17 (compo 6). This range is considered to be moderately abrasive.

### 13.7.5 SMC (SAG Mill Comminution) Tests

The SMC tests (A x b values) ranged from 46 (compo 6) to 76 (compo 3), where lower values indicate higher resistance to breakage. Based on comparison to the JK data base medial of 47, these ores are considered to be moderately resistant to breakage in a SAG mill.

### 13.7.6 UCS (Unconfined Compressive Strength) Tests

The seven compos with unconfined compressive strength ranged from 61 MPa (compo 7) to 113 MPa (compo 5) with an average of 91 MPa.

## 13.8 Mark Richardson – Contract Services Report (MRCS)

MRCS completed a report including preliminary equipment sizing and power estimates for two options a) a SABC circuit, SAG Mill / Ball mill circuit with pebble crushing and b) a SAG Mill / Ball mill circuit without pebble crushing.

MRCS completed an equipment estimate for the requirements to process 6,000 Mt/d of Lik ore from a feed size of 150 mm to 40 µm with:

- Highest ball mill work index of 16.3 kWh/t
- Hardness (A x b) of 46).

### 13.8.1 SAG Mill

One 24 ft diameter (inside shell) by 8ft (EGL) with a 2600 kW motor operating at 76.9% critical 12% ball charge drawing 2170 kW.

### 13.8.2 Ball Mills

Two 16 ft diameter (inside shell) by 26 ft (EGL) with a 2970 kW motor operating at 73.1% critical 34% ball charge, drawing 2190 kW.

### 13.8.3 Pebble Crusher

No load power assumed at 35 kW.

The total estimated specific energy is 29.4 kWh/t (26.7 kWh/ton) for the SABC circuit.

## 13.9 Mineralogy

Lik mineralogy based on QSCAM analysis is detailed in the following subsections.

### 13.9.1 Master Composite Sample

The master composite sample was estimated to contain 43% pyrite, 31% quartz, 15% sphalerite, and 3% galena (SGS 2010).

Lead mineralization was predominantly galena. However, the 15% to 19% of the contained lead reported to be in non-sulfide forms would not be expected to respond well to conventional flotation. At a $K_{80}$ sizing of 76 µm galena liberation was estimated to be about 60%.

Zinc mineralization was predominantly sphalerite. A small amount (3%) of the zinc present was contained in oxide and carbonate minerals. Sphalerite liberation at a $K_{80}$ of 76 µm is poor, at an estimated 33%. The unliberated sphalerite was equally distributed between binaries with gangue and as structurally complex multiphase particles.

Pyrite mainly in the euhedral form was the dominant sulfide mineral at 43%.

Silver was present in the Master Composite assayed at 35 g/t.

### 13.9.2 Period Composites

Lead mineralization was predominantly galena. However, the 15% to 19% of the contained lead reported to be in non-sulfide forms would not be expected to respond well to conventional flotation. Galena liberation for a $K_{80}$ sizing of 36 µm is considered well liberated at 65%, 725 and 75% for the three period samples, respectively. Unliberated galena was mainly locked in multiphase structures with some interlocking with other sulfide minerals.

Zinc mineralization was predominantly sphalerite. A small amount of a zinc iron oxide mineral (franklinite) was detected in the samples. Sphalerite liberation for a $K_{80}$ sizing of 36 µm is considered well liberated at 61%, 605 and 63% for the three period samples, respectively. Unliberated sphalerite was mainly locked in binary non-sulfide gangue or in multiphase structures.

Pyrite was the dominant sulfide mineral in all composites ranging in content from 36% to 39%.

Silver was present in all three period composite ranging from 26 to 75 g/t.

# 14.0 Mineral Resource Estimates

## 14.1 General Statement

RPA has estimated the Mineral Resources of the Lik deposits by constructing a block model of the mineralized zones. Table 14-1 summarizes the Mineral Resources of the Lik deposit effective as of December 31, 2013.

Overall, there were only minor changes between the previous estimate dated February 28, 2009 (Scott et al., 2010) and the current estimate. The difference results from the incorporation of the 2011 drilling, which altered the interpretation of the Lik South – Lik North boundary, and the higher long-term metal prices used in 2013, which expanded the Whittle pit to include larger portions of the Lik North deposit that had previously been expected to be mined by underground methods. No drilling has been carried out by Zazu on the Lik Project since 2011.

**Table 14-1: Mineral Resource Estimate – December 31, 2013**

| Location | Cut-off % Pb+Zn | Indicated Resources | | | | Inferred Resources | | | |
|---|---|---|---|---|---|---|---|---|---|
| | | Mt | % Zn | % Pb | g/t Ag | Mt | % Zn | % Pb | g/t Ag |
| **Potential Open Pit** | | | | | | | | | |
| Lik South | 5% | 16.85 | 8.04 | 2.70 | 50.1 | 0.74 | 7.73 | 1.94 | 13.4 |
| Lik North | 5% | 0.44 | 10.03 | 2.77 | 59.0 | 2.13 | 8.88 | 2.94 | 45.8 |
| ***Subtotal*** | | ***17.29*** | ***8.09*** | ***2.70*** | ***50.3*** | ***2.87*** | ***8.59*** | ***2.68*** | ***37.5*** |
| **Potential Underground** | | | | | | | | | |
| Lik South | 7% | 0.69 | 8.04 | 3.15 | 51.0 | 0.51 | 6.97 | 1.59 | 11.3 |
| Lik North | 7% | 0.13 | 8.93 | 2.93 | 37.5 | 1.96 | 9.22 | 2.99 | 45.8 |
| ***Subtotal*** | | ***0.82*** | ***8.18*** | ***3.12*** | ***48.9*** | ***2.47*** | ***8.76*** | ***2.70*** | ***38.7*** |
| **Total** | | **18.11** | **8.10** | **2.72** | **50.2** | **5.34** | **8.66** | **2.69** | **38.0** |

Notes:
1. CIM Definitions were followed for Mineral Resources.
2. Mineral Resources are estimated using an average long-term zinc price of US$1.20/lb, lead price of US$1.20/lb and silver price of US$27/oz.
3. A density value of 3.5 g/cm$^3$ (0.109 tons/ft$^3$) was used.

In order to fulfil the mineral resource requirement of "reasonable prospects of economic extraction," the open pit portion of the Mineral Resource estimate reported in Table 14-1 is the part of the block model that was constrained within a preliminary open pit shell. The preliminary pit shell was completed by RPA using Whittle software, zinc, lead, and silver metallurgical recoveries for the Lik deposit, assumed costs, concentrate terms, and average long-term commodities prices. The Mineral Resources are classified as Indicated and Inferred and follow Canadian Industry of Mining (CIM) Definition Standards for Mineral Resources and Mineral Reserves adopted on November 27, 2010 (CIM Definitions).

The southern part of the Lik deposit occurs near surface and is considered to have potential for open pit mining. The mineralization in the northern part and at depth in the south is considered to have potential for underground mining. The Mineral Resource estimate has been completed using Gemcom Gems 6.3 software using a conventional approach including 3D solid modeling and block modeling.

## 14.2 Database

The database for the current resource estimate consists of 223 diamond drill holes totaling 37,833.0 m. This drill hole database excludes historic holes that have collar and survey data but no assay data. Details of the recent drilling campaigns are set out in Section 10.0, Drilling, while older diamond drilling programs are discussed under Section 6.0, History.

Zazu supplied data to RPA in MS Excel spreadsheets that included collar, survey, and assay files. Validation revealed no errors in the database. Previous work on the Lik property used the NAD 27 coordinate system. Zazu is converting the database to the NAD 83 coordinate system for future work.

The primary sources of density information on the Lik deposit is from 1985 Scherkenbach et al. report and the 2008 G&T report. Scherkenbach et al. (1985) included 62 density determinations from three diamond drill holes. All of these samples were analyzed for zinc, lead, silver, barium, copper, and mercury. Scherkenbach et al. (1985) relied on density values for samples with Zn+Pb greater than 5%.

Some 35 density values for samples for which Pb+Zn were greater than 3% were available. The 2008 G&T metallurgical report included some 300 density determinations. Of these, 144 were for samples for which Pb+Zn were greater than 3%. The average of these values was close to 3.5 g/cm$^3$ (0.109 tons/ft$^3$) and this value was used in the RPA estimate to convert volume into tonnes.

Density is affected by the amounts of pyrite and silica in each sample. Iron values are available for the G&T work but not for the earlier work. The correlation between zinc and iron values is poor.

## 14.3 Geological Interpretation and 3D Solids

All of the drilling by Zazu in 2007 and 2008 targeted the Lik South deposit. RPA digitally plotted the drill holes for the Lik deposits on drill sections at 200 ft (61 m) intervals corresponding to the spacing of most of the drill sections in the field. Both grid east-west and grid north-south sections were plotted. Zazu provided an interpretation of the deposit based on previous work completed on the deposit. RPA reviewed the previous interpretation and made adjustments for the new drilling completed in the summer of 2011. The results of the 2011 drilling have not changed the interpretations of various lenses significantly. The most important changes are that the Lik South deposit has been extended to the northeast, while drilling in Lik North confirmed the existing interpretation and extended the mineralization to depth.

Base metal mineralization at Lik appears to occur in a number of lenses. The bulk of the Lik South mineralization is interpreted as being in two lenses, with the A Lens being the larger, while the bulk of the Lik North mineralization is interpreted as occurring in a single lens, the N Lens.

Previous interpretations of the Lik South deposit involved a number of north-south faults that divided the mineralization into several fault blocks. The drilling in 2008 and 2011 appears to demonstrate that most of these faults are either less significant or non-existent.

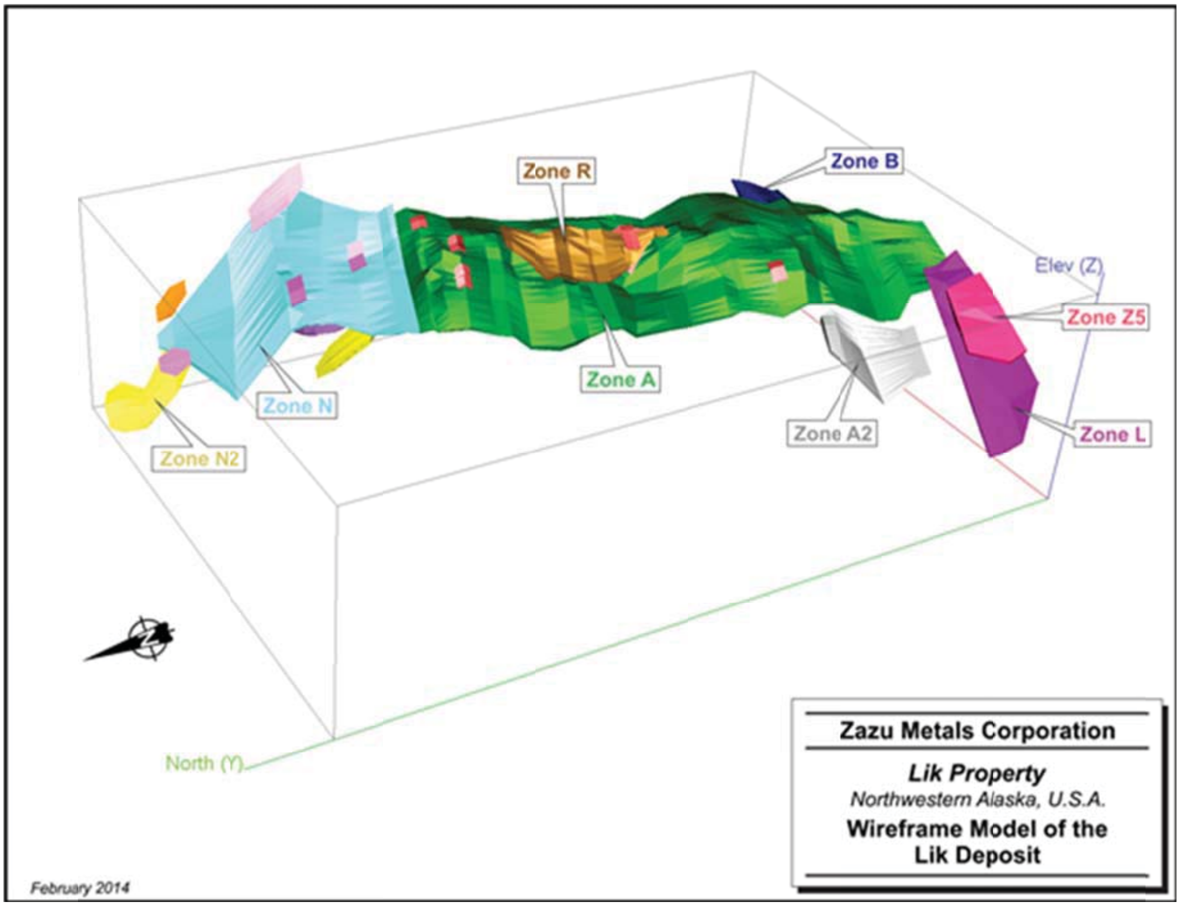
In previous interpretations, the Lik South deposit has been separated from the Lik North deposit by an east-west fault, the Main Break Fault. The recent drilling appears to demonstrate that this fault is less significant than previously interpreted. The A Lens and the N Lens may be continuous, although there is a change in plunge or dip of the mineralization at about the interpreted position of the Main Break Fault. This change in attitude is more akin to a sharp flexure or hinge rather than a fault.

It is noted that the massive sulfides provide more continuity than the wall rocks, for which the geology is complex and it is difficult to interpret much continuity in the enclosing rocks.

While the bulk of the sulfide is interpreted as being part of the A Lens in Lik South and the N Lens in Lik North, there are a number of other sulfide lenses. These are interpreted as lying both above and below the major lenses. The lenses above the A Lens in Lik South are important, as they would have to be mined in an open pit to access the larger A Lens. Higher costs would apply to the mining of smaller lenses located below the A Lens.

A wireframe model was developed from the interpretations prepared on sections and is shown in Figure 14-1. The wireframe model for Lik South was constructed at a minimum grade of 3% Pb+Zn, while the wireframe model for Lik North was constructed at a minimum grade of 7% Pb+Zn. There is a portion of Lik North that lies within the preliminary Whittle pit shell which, if re-wireframed at 3% Pb+Zn, would not differ significantly from that at the 7% minimum. The wireframed mineralized domains were used to constrain interpolation of grades using drill hole assay composites within the wireframes.

**Figure 14-1: Wireframe Model of the Lik Deposit**




## 14.4 Cut-Off Grade for Mineral Resources

As noted above, the Lik deposit divides into two parts: the Lik South deposit, which is considered amenable to open pit mining, and the deeper Lik North deposit, which is likely to require underground mining.

To report resources, RPA has used a cut-off grade of 5% Pb+Zn for potential open pit resources within the preliminary Whittle pit. RPA has used a cut-off grade of 7% for the potential underground resources. Since the Lik South deposit wireframe model was developed using a minimum grade of 3% Pb+Zn, potential underground resources at a 7% Pb+Zn cut-off are reported only for areas that display continuity and grades that are reflective of potential underground mining selectivity.

The 5% Pb+Zn cut-off grade is based on estimated long-term lead and zinc prices, on operating costs for the Red Dog Mine (Cinits, 2007), and on other data. The average long-term metal prices selected were US$1.20/lb zinc and US$1.20/lb lead. The Red Dog Mine is an open pit base metal mine in the same geographic area as the Lik deposit and the operating costs at Red Dog are considered to be a preliminary benchmark for a potential open pit operation at Lik.

For the portion of the Lik North deposit, with potential for underground mining, all of the blocks within the 7% Lik North wireframe is reported as Mineral Resources to avoid mixing of blocks above and below 7% Pb+Zn. The 7% Pb+Zn cut-off for potential underground mineral resources is based on assumed costs for underground mining in northern Alaska.

## 14.5 Compositing and Statistics

The Lik assay database was checked for high values. While there are a few assays of both lead and zinc that are considered to be outlier values, there were too few high values to materially affect the average grade. For this reason, no cutting of high values was carried out on the lead and zinc assays. There were a number of high silver assays that were considered to be outlier values and these assays were capped prior to compositing at 320 g/t Ag.

Basic statistics for drill hole assays for the Lik South and Lik North deposits are listed in Tables 14-2 and 14-3, respectively. Only assays within the mineralized wireframes are included.

**Table 14-2: Statistics of Drill Hole Assays – Lik South**

| Statistic | Length (m) | % Pb | % Zn | g/t Ag | g/t Ag Capped |
|---|---|---|---|---|---|
| N | 2,414 | 2,414 | 2,414 | 2,414 | 2,414 |
| Mean | 1.28 | 2.62 | 7.97 | 48.35 | 45.25 |
| Median | 1.43 | 1.47 | 6.32 | 21.94 | 21.94 |
| Max. Value | 4.57 | 35.39 | 42.80 | 1,445.14 | 320.00 |
| Standard Deviation | 0.50 | 3.15 | 6.77 | 82.68 | 58.61 |
| Coefficient of Variation | 0.39 | 1.17 | 0.86 | 1.63 | 1.24 |

**Table 14-3: Statistics of Drill Hole Assays – Lik North**

| Statistic | Length (m) | % Pb | % Zn | g/t Ag | g/t Ag Capped |
|---|---|---|---|---|---|
| N | 360 | 360 | 360 | 360 | 360 |
| Mean | 1.12 | 3.16 | 9.37 | 48.24 | 47.92 |
| Median | 1.07 | 2.05 | 8.75 | 28.63 | 28.63 |
| Max. Value | 3.05 | 36.45 | 39.15 | 420.69 | 320.00 |
| Standard Deviation | 0.47 | 3.70 | 6.31 | 52.73 | 50.76 |
| Coefficient of Variation | 0.42 | 1.19 | 0.69 | 1.14 | 1.11 |

RPA composited assays into 3.05 m (10 ft) intervals down hole inside the mineralized wireframes, starting with the first assay down hole within the wireframe. Basic statistics for the composites are shown in Tables 14-4 and 14-5 and include composites of all lengths.

**Table 14-4: Statistics of Drill Hole Composite Assays – Lik South**

| Statistic | Length (m) | % Pb | % Zn | g/t Ag |
|---|---|---|---|---|
| N | 1,141 | 1,141 | 1,141 | 1,141 |
| Mean | 2.73 | 2.64 | 7.73 | 46.23 |
| Median | 3.05 | 1.82 | 6.74 | 27.20 |
| Max. Value | 3.05 | 23.88 | 35.64 | 320.00 |
| Standard Deviation | 0.75 | 2.58 | 5.33 | 54.00 |
| Coefficient of Variance | 0.28 | 0.96 | 0.68 | 1.15 |

**Table 14-5: Statistics of Drill Hole Composite Assays – Lik North**

| Statistic | Length (m) | % Pb | % Zn | g/t Ag |
|---|---|---|---|---|
| N | 143 | 143 | 143 | 143 |
| Mean | 2.55 | 3.09 | 8.86 | 43.79 |
| Median | 3.05 | 2.60 | 8.73 | 30.22 |
| Max. Value | 3.05 | 13.59 | 21.93 | 265.96 |
| Standard Deviation | 0.90 | 2.44 | 4.41 | 44.43 |
| Coefficient of Variation | 0.35 | 0.79 | 0.49 | 0.98 |

Composites less than 0.9 m (3 ft) were excluded from the variography. Statistics for the composited data with the small composites removed are shown in Tables 14-6 and 14-7. The similarity of the data set out in Table 14-4 compared to those in Table 14-6, and in Table 14-5 compared to those in Table 14-7, indicates that the elimination of the small composites did not affect the overall integrity of the composited database.

**Table 14-6: Statistics of Lik South Drill Hole Composite Assays with Composites less than 0.9 m Removed**

| Statistic | Length (m) | % Pb | % Zn | g/t Ag |
|---|---|---|---|---|
| N | 1,066 | 1,066 | 1,066 | 1,066 |
| Mean | 2.89 | 2.65 | 7.81 | 47.03 |
| Median | 3.05 | 1.85 | 6.81 | 28.83 |
| Max. Value | 3.05 | 23.88 | 35.64 | 320.00 |
| Standard Deviation | 0.45 | 2.56 | 5.28 | 54.40 |
| Coefficient of Variation | 0.16 | 0.96 | 0.67 | 1.15 |

**Table 14-7: Statistics of Lik North Drill Hole Composite Assays with Composites less than 0.9 m Removed**

| Statistic | Length (m) | % Pb | % Zn | g/t Ag |
|---|---|---|---|---|
| N | 126 | 126 | 126 | 126 |
| Mean | 2.83 | 3.06 | 8.93 | 44.39 |
| Median | 3.05 | 2.65 | 8.91 | 30.18 |
| Max. Value | 3.05 | 13.59 | 21.93 | 265.96 |
| Standard Deviation | 0.51 | 2.33 | 4.40 | 45.03 |
| Coefficient of Variation | 0.18 | 0.76 | 0.49 | 0.99 |

## 14.6 Variography and Kriging Parameters

RPA produced variograms using the 3.05 m (10 ft) composites within the mineralized domains, except for composites of 0.9 m (3 ft) or less. Variograms were reasonably well developed for the Lik South deposit, but not well developed for Lik North due to limited composite data. Downhole variograms were used to determine the nugget effect, which is 28% of the sill for zinc, 38% for lead, and 10% for silver. Directional variograms within the plane of the Lik South mineralized zones gave different ranges of influence for along strike, down dip, and perpendicular to dip directions, as shown in Table 14-8.

**Table 14-8: Variogram Ranges – Lik South**

| Metal | Range | | |
|---|---|---|---|
| | Along Strike ft (m) | Down Dip ft (m) | Across Dip ft (m) |
| Zn | 40 (12.2) | 100 (30.5) | 40 (12.2) |
| Pb | 64 (19.5) | 100 (30.5) | 54 (16.5) |
| Ag | 67 (20.4) | 90 (27.4) | 40 (12.2) |

The parameters for the Lik South variograms were used for block grade interpolation in both Lik South and Lik North mineralized domains.

## 14.7 Block Model and Grade Interpolation

A block model was developed with blocks 15.24 x 15.24 x 3.05 m high (50-ft X 50-ft X 10-ft). Grade interpolation for both the Lik South and Lik North deposits was by ordinary kriging using the variogram parameters described in the previous section. Interpolation was completed as a two-pass process. The first pass used search parameters of 60.96 x 60.96 x 7.62 m to cover drill hole spacing of mostly 30.48 x 60.96 m Blocks required a minimum of two composites and a maximum of 12 composites. A second pass with a search of 182.88 x 182.88 x 15.24 m and minimum and maximum composite limits of one and 12 composites, respectively, were used to interpolate any blocks not interpolated in the first pass. Figures 14-2 to 14-4 are three sections that illustrate the block model.

**Figure 14-2: Block Model Section 10,600N**

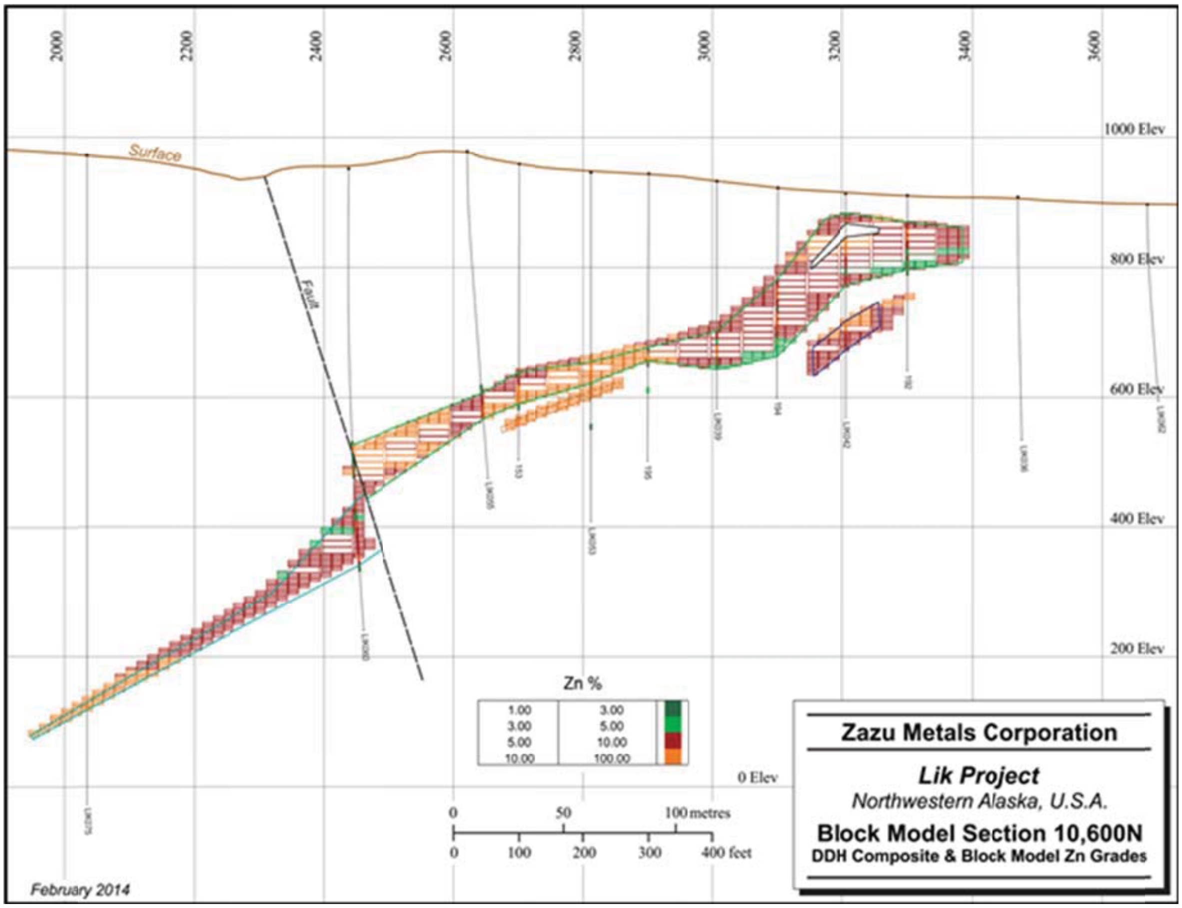


Figure 14-3: Block Model Section 12,000N

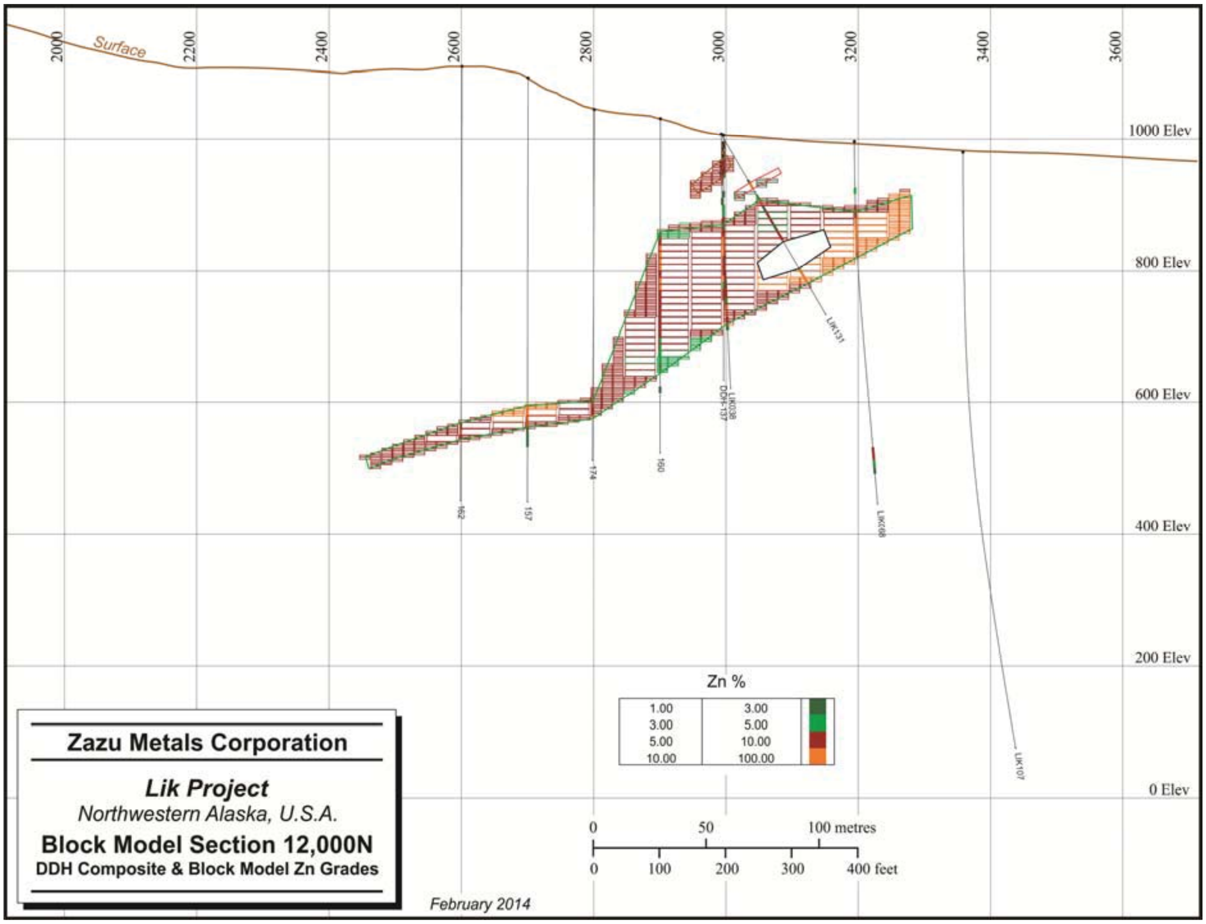
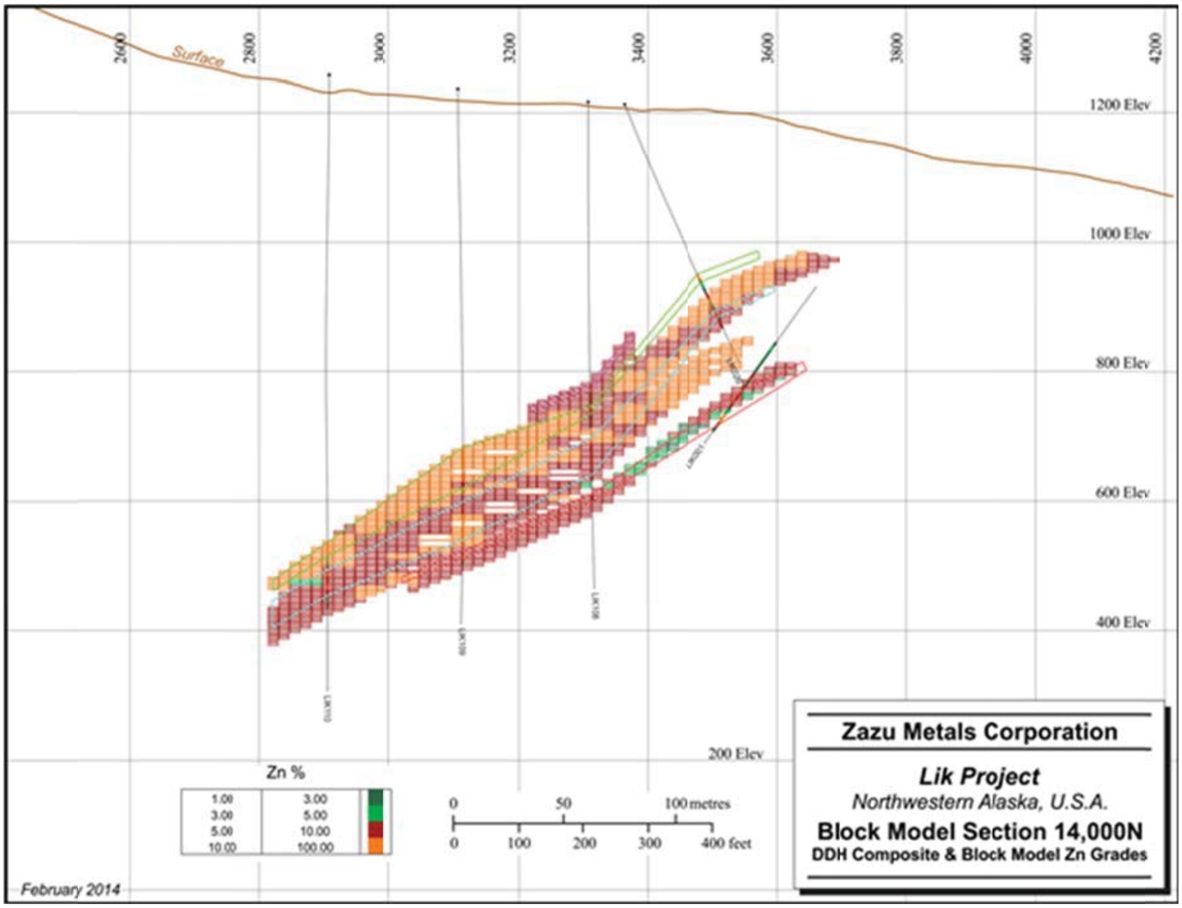


**Figure 14-4: Block Model Section 14,000N**

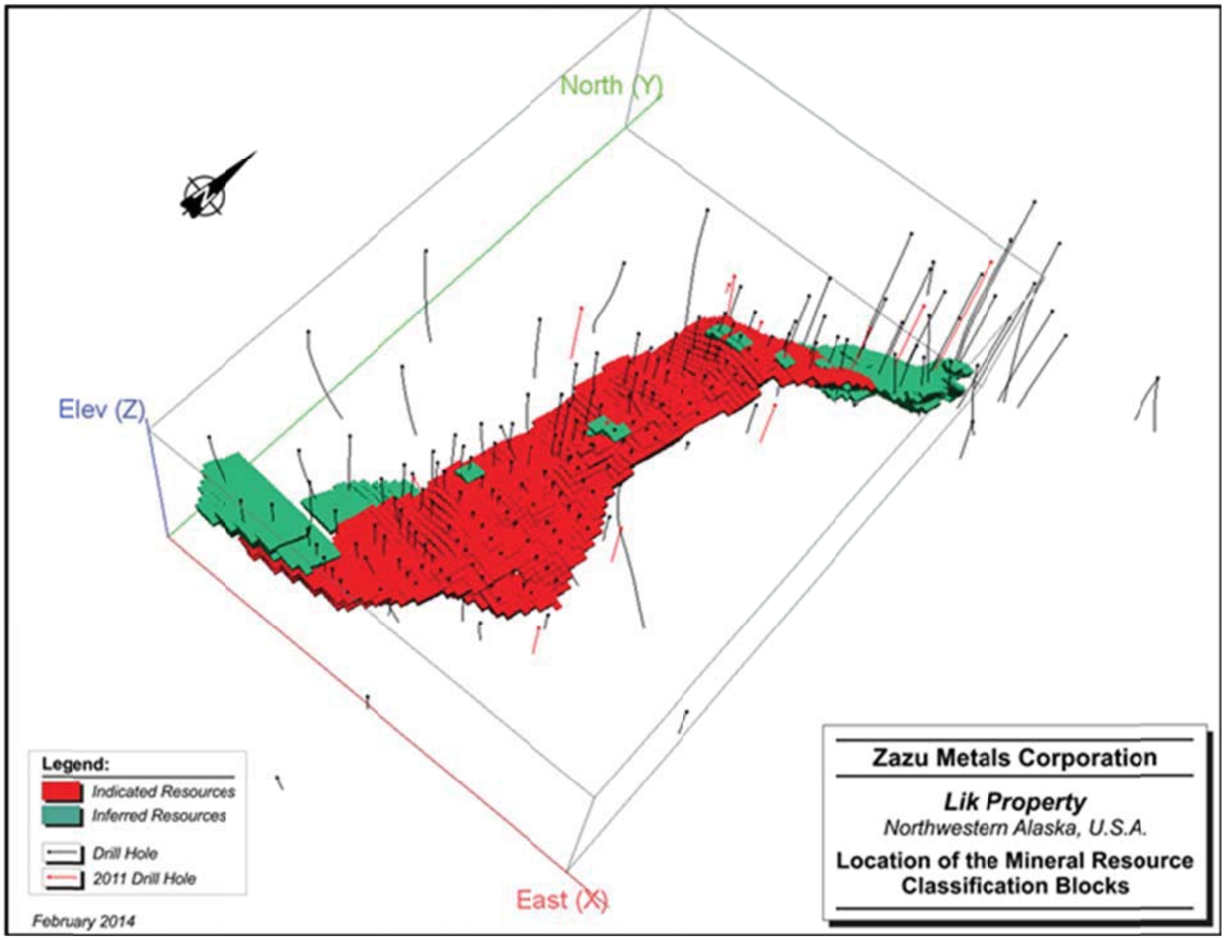



## 14.8 Classification of Mineral Resources

A significant amount of diamond drilling has been completed on the Lik deposit. Drilling has been carried out on 200 ft (60.96 m) sections in the Lik South area, with holes mainly spaced at 100 ft (30.48 m) along section lines. The major part of the Lik South deposit is comparatively well tested and is considered to be an Indicated Mineral Resource. The portions outside this central area in the Lik South deposit, where drill holes are more widely spaced or where lenses are tested by only a few holes, are classified as Inferred Mineral Resource. Drill holes at Lik North are more widely spaced in general than at Lik South, and Lik North is therefore primarily classified as an Inferred Mineral Resource. A portion of the Lik North deposit that occurs within the preliminary pit shell is classified as an Indicated Mineral Resource.

Figure 14-5 shows the locations of the Mineral Resource classification blocks.

**Figure 14-5: Location of the Mineral Resource Classification Blocks**




## 14.9 Block Model Validation

RPA validated the ordinary kriging block model as follows:

- Visual inspection and comparison of block grades with drill hole composite and assay grades
- Statistical comparison of the grades of blocks and composites
- Check of ordinary kriging block model results by inverse distance squared ($ID^2$).

Basic statistics for block model block grades for the Lik South and Lik North deposits are listed in Tables 14-9 and 14-10, respectively. Only assays within the mineralized wireframes are included.

**Table 14-9: Statistics of Block Grades – Lik South**

| | ID$^2$ | | | Ordinary Kriging | | |
|---|---|---|---|---|---|---|
| **Statistic** | **% Pb** | **% Zn** | **g/t Ag** | **% Pb** | **% Zn** | **g/t Ag** |
| Mean | 2.49 | 7.50 | 43.81 | 2.48 | 7.48 | 43.71 |
| Median | 2.18 | 7.17 | 39.47 | 2.24 | 7.27 | 41.07 |
| Max. Value | 14.21 | 28.31 | 244.41 | 11.60 | 20.91 | 221.71 |
| Standard Deviation | 1.54 | 2.82 | 35.81 | 1.38 | 2.45 | 33.47 |
| Coefficient of Variation | 0.62 | 0.38 | 0.82 | 0.56 | 0.33 | 0.77 |

**Table 14-10: Statistics of Block Grades – Lik North**

| | ID$^2$ | | | Ordinary Kriging | | |
|---|---|---|---|---|---|---|
| **Statistic** | **% Pb** | **% Zn** | **g/t Ag** | **% Pb** | **% Zn** | **g/t Ag** |
| Mean | 2.97 | 9.00 | 41.84 | 2.99 | 8.95 | 41.47 |
| Median | 2.89 | 8.89 | 36.73 | 2.92 | 8.89 | 38.98 |
| Max. Value | 10.36 | 18.78 | 214.64 | 9.62 | 18.78 | 200.78 |
| Standard Deviation | 1.29 | 2.92 | 31.59 | 1.18 | 2.61 | 29.01 |
| Coefficient of Variation | 0.43 | 0.32 | 0.75 | 0.40 | 0.29 | 0.70 |

A comparison of the ordinary kriging and ID$^2$ results is shown in Table 14-11. The results from the two different methods are very close, at least in part, due to the fact that the Lik drill holes to date are not clustered.

**Table 14-11: Grade Comparison, ID$^2$ vs. Ordinary Kriging**

| Resource Classification | ID$^2$ | | | | Ordinary Kriging | | | |
|---|---|---|---|---|---|---|---|---|
| | **Mt** | **% Zn** | **% Pb** | **g/t Ag** | **Mt** | **% Zn** | **% Pb** | **g/t Ag** |
| Indicated | 18.11 | 8.12 | 2.72 | 50.3 | 18.11 | 8.10 | 2.72 | 50.2 |
| Inferred | 5.34 | 8.72 | 2.69 | 38.1 | 5.34 | 8.66 | 2.69 | 38.1 |

In the opinion of RPA, the ordinary kriging block model provides a reasonable estimate of the Lik Mineral Resources at this stage.

## 14.10 Mineral Resources

In order to comply with the CIM Definitions of “reasonable prospects for economic extraction”, RPA prepared a preliminary Whittle pit shell using the estimated costs and parameters shown in Table 14-12. Most of the resource in the Lik South and a portion of the resource in Lik North areas appear to have reasonable potential for open pit mining. Lik North and portions of Lik South at depth appear to have reasonable potential for underground mining.

**Table 14-12: Preliminary Whittle Pit Shell Parameters**

| Design Parameter | Value Used |
|---|---|
| Zinc Price | US$1.20/lb |
| Lead Price | US$1.20/lb |
| Silver Price | US$27.00/oz |
| Mining Cost – Open Pit | US$3.31/t |
| Process + G&A Cost | US$49.60/t |
| Zinc Recovery | 85% |
| Lead Recovery | 70% |
| Silver Recovery | 30% |
| Offsite Costs, Zinc Concentrate | US$0.45/lb |
| Offsite Costs, Lead Concentrate | US$0.30/lb |
| Pit Slopes | 45° maximum |

The Mineral Resource estimate for the Lik deposit, effective as of December 31, 2013, is set out in Table 14-1

To report resources, RPA has used a cut-off grade of 5% Pb+Zn for potential open pit resources within the preliminary Whittle pit. RPA has used a cut-off grade of 7% for the potential underground resources. Since the Lik South deposit wireframe model was developed using a minimum grade of 3% Pb+Zn, potential underground resources at a 7% Pb+Zn cut-off are reported only for areas that display continuity and grades that are reflective of potential underground mining selectivity.

Table 14-14 shows the sensitivity of the potential open pit Lik South and North Mineral Resources to variations in cut-off grade.

**Table 14-13: Sensitivity of the Lik South & North Potential Open Pit Mineral Resource Estimate to Variation In Cut-Off Grade**

| Cut-off % Pb+Zn | Indicated Mineral Resources | | | | Inferred Mineral Resources | | | |
|---|---|---|---|---|---|---|---|---|
| | Mt | % Zn | % Pb | g/t Ag | Mt | % Zn | % Pb | g/t Ag |
| 7% | 15.92 | 8.36 | 2.82 | 51.7 | 2.69 | 8.78 | 2.78 | 37.5 |
| 5% | 17.29 | 8.09 | 2.70 | 50.3 | 2.87 | 8.59 | 2.68 | 37.5 |
| 3% | 17.42 | 8.06 | 2.69 | 50.1 | 2.88 | 8.57 | 2.68 | 37.4 |

Table 14-15 shows the sensitivity of the potential underground Mineral Resources to variations in the cut-off grade.

**Table 14-14: Sensitivity of the Lik South & North Potential Underground Mineral Resource Estimate to Variation in Cut-off Grade**

| Cut-off % Pb+Zn | Indicated Mineral Resources | | | | Inferred Mineral Resources | | | |
|---|---|---|---|---|---|---|---|---|
| | Mt | % Zn | % Pb | g/t Ag | Mt | % Zn | % Pb | g/t Ag |
| 9% | 0.60 | 8.87 | 3.69 | 54.7 | 1.84 | 9.53 | 3.06 | 45.2 |
| 8% | 0.68 | 8.57 | 3.48 | 52.4 | 2.23 | 9.04 | 2.84 | 41.4 |
| 7% | 0.82 | 8.18 | 3.12 | 48.9 | 2.47 | 8.76 | 2.70 | 38.7 |

In RPA's opinion, Tables 14-14 and 14-15 demonstrate that the Lik Mineral Resources are not particularly sensitive to changes in the cut-off grades in the ranges shown.

## 14.11 Comparison to Previous Estimate

A comparison of the current and previous Mineral Resource estimates is summarized in Table 14-16.

**Table 14-15: Mineral Resource Comparison**

| Estimate | Cut-off % Pb+Zn | Indicated Resources | | | | Inferred Resources | | | |
|---|---|---|---|---|---|---|---|---|---|
| | | Mt | % Zn | % Pb | g/t Ag | Mt | % Zn | % Pb | g/t Ag |
| **December 31, 2013** | | | | | | | | | |
| Lik South | 5% | 17.54 | 8.04 | 2.72 | 50.1 | 1.25 | 7.42 | 1.80 | 12.6 |
| Lik North | 5-7% | 0.56 | 9.78 | 2.81 | 54.2 | 4.09 | 9.04 | 2.96 | 45.8 |
| **Subtotal** | | **18.11** | **8.10** | **2.72** | **50.2** | **5.34** | **8.66** | **2.69** | **38.0** |
| | | | | | | | | | |
| **February 28, 2009** | | | | | | | | | |
| Lik South | 5% | 18.74 | 8.08 | 2.62 | 52.8 | 1.23 | 6.80 | 2.12 | 35.0 |
| Lik North | 7% | | | | | 5.18 | 9.65 | 3.25 | 50.7 |
| **Subtotal** | | **18.74** | **8.08** | **2.62** | **52.8** | **6.41** | **9.1** | **3.03** | **47.7** |

In addition to incorporating the 2011 drilling, the current estimate differs from the previous estimate in the following areas:

- Slight adjustments to wireframe shapes
- Capped silver grades
- Updated classification of the Mineral Resources
- Increase in open pit resources within a preliminary pit shell
- Decrease in underground resources outside the pit shell, due to the application of a more selective approach to isolated blocks, to better reflect a reasonable prospect of economic extraction.

# 15.0 Mineral Reserve Estimates

JDS has not developed a mineral reserve estimate for the Lik Project as part of this PEA. Significant additional data collection and technical work is required to elevate the technical confidence of the project to a level consistent with mineral reserve estimation, in accordance with the CIM Code.

JDS is not aware of any previous mineral reserve estimates on the Lik deposit that have been completed in accordance with an international reporting code.

# 16.0 Mining Methods

Mine design and planning for the Lik project is based on the RPA resource model, as detailed in Section 14 of this report. Mine planning and optimization results are based solely on indicated and inferred resources for zinc, lead and silver. There is no measured resource within the block model.

This section outlines the parameters and procedures used to perform pit optimization and subsequent mine planning work for the Lik project.

## 16.1 Overview

The deposit will be a conventional, open pit, truck-and-shovel operation. A mill feed of approximately 5,500 t/d is planned over a nine-year mine life. There will be a small quantity of pre-strip material in Year -1, with a full production ramp-up in year 1. The throughput rate in Year 1 was reduced to 80% of full capacity to reflect mill construction and start-up time.

A net smelter return (NSR) model was developed for zinc, lead and silver in Maptek Vulcan™ software then transferred into Geovia Whittle™ pit optimization software. Using the Lerchs-Grossman (LG) algorithm, the optimization performs a series of nested shells by varying revenue factors. The ultimate pit and phases were then selected and used to develop the life of mine plan (LOM).

The waste rock, acid base accounting and ARD/ML testing is underway and was not yet available at the time of this study; the next level of study will include management of waste as it is categorized.

Table 16-1 shows the key results from the LOM plan. Waste material mined and associated strip ratio includes pre-stripping activities in Year -1.

**Table 16-1: LOM Plan Key Results**

| Description | Units | Value |
|---|---|---|
| Ore Material Mined | tonnes | 17.13 |
| Average Zinc Grade | % | 7.6 |
| Average Lead Grade | % | 2.6 |
| Average Silver Grade | g/t | 47.5 |
| Average NSR | $/t | 95.7 |
| Waste Material Mined | tonnes | 87.0 |
| Strip Ratio | w:o | 5.1 |
| Milling Rate | t/d | 5,500 |
| Mine Life | Years | 10 |

## 16.2 Block Value Calculation

### 16.2.1 Block Model

The mineral resource for the Lik Project was completed by RPA and documented in Section 14, which forms the basis of the NSR model and open pit optimizations. The block model was provided by RPA in an ASCII format with a 50ft-(X) by 50ft-(Y) by 10ft-(Z) (15.24 m x 15.24 m x 3.05 m) block size.

### 16.2.2 Block Value

The block value was developed using an NSR block model script in Maptek Vulcan™ software. The NSR (US$/ton) value was calculated for each block of the resource model and stored in the model. These parameters for the NSR calculation are summarized in Table 16-2. Note that the NSR calculation was in short tons due to the block model having been provided in feet then converted to meters for this report.

**Table 16-2: NSR Parameters**

| Parameter | Unit | US$ |
|---|---|---|
| Zn Price* | US$/lb | 0.9242 |
| Pb Price** | US$/lb | 1.013 |
| Ag Price*** | US$/oz | 19.43 |
| **Zn Concentrate** | | |
| Zn Recovery | % | 85 |
| Ag Recovery | % | 26.75 |
| Zn Conc. Grade | % | 53.40 |
| Zn Payable | % | 85 |
| Ag Payable | % | 70 |
| Zn Deductions | % | 8 |
| Ag Deductions | oz/dmt | 3.5 |
| Zn Treatment Charge | US$/dmt | $170.00 |
| Zn Price Participation (based on Zn price of US$1000/mt) | US$/dmt | $103.75 |
| Zn Penalties – SiO2 Conc Grade | % | 6.03 |
| Zn Penalties – SiO2 (US$1.50 per 1% over 2.5%) | US$/dmt | 5.30 |
| **Pb Concentrate** | | |
| Pb Recovery | % | 69.70 |
| Ag Recovery | % | 5.17 |
| Pb Conc. Grade | % | 61.15 |
| Pb Payable | % | 95 |
| Ag Payable | % | 95 |
| Pb Deductions | % | 3 |
| Ag Deductions | g/dmt | 50 |
| Pb Treatment Charge | US$/dmt | $165.00 |
| Pb Price Participation (based on Pb price of US$1000/mt) | US$/dmt | $74.00 |
| Ag Refining | US$/oz | $0.78 |
| **Concentrate Handling Costs** | | |
| Haul Cost (Mine to Port) | US$/dmt | $13.73 |
| Port Costs | US$/dwt | 21.04 |
| Ocean Freight | US$/dmt | 60.00 |
| Moisture Content | % | 8 |
| Insurance (of NIV) | % | 0.15 |
| Losses (of NIV) | % | 0.42 |

*Zn Price: Lesser of (November three year rolling average $0.9242 or Kitco price of $0.9566) as of December 30th, 2013.
**Pb Price: Lesser of (November three year rolling average $1.013 or Kitco price of $1.013) as of December 30th, 2013. *** Ag Price: Kitco Spot price as of December 30th, 2013. Source: JDS, 2014.

## 16.3 Geotechnical

Pit wall slope recommendations were provided in a December 2011 drawing by EBA, *"2011 Geotechnical Site Investigation & Geotechnical Pre-Feasibility Study for Proposed Open Pit at the Lik Deposit."*

### 16.3.1 Optimization Wall Slopes

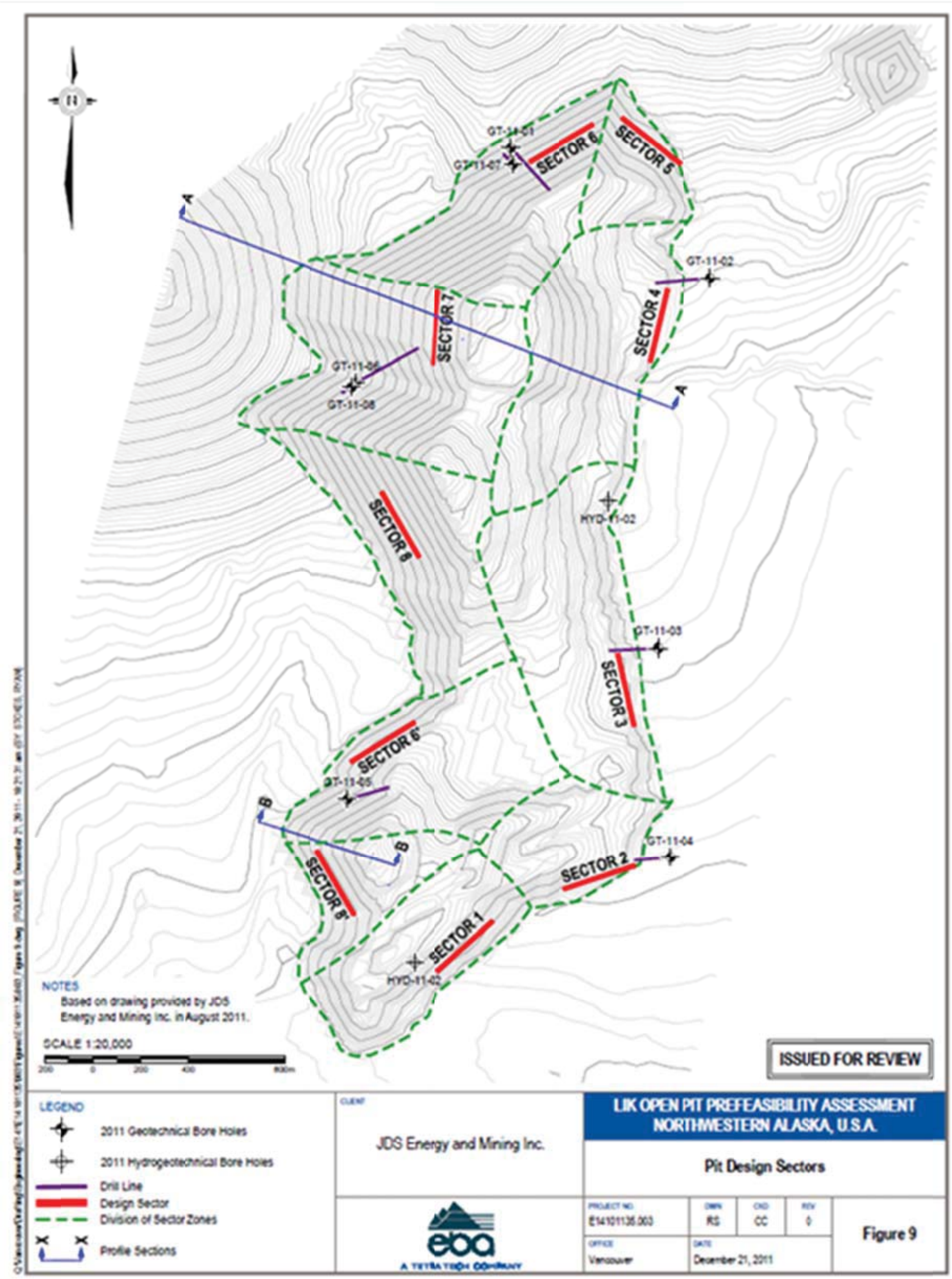
Table 16-3 shows the Whittle™ optimization overall wall slope parameters by sector.

**Table 16-3: Whittle Optimization Overall Wall Slope Parameters**

| Overall Slope Angles for Whittle™ | Unit | Angle |
|---|---|---|
| Sector 1 | degrees | 45 |
| Sector 2 | degrees | 45 |
| Sector 3 | degrees | 41 |
| Sector 4 | degrees | 41 |
| Sector 5 | degrees | 45 |
| Sector 6 | degrees | 45 |
| Sector 7 | degrees | 43 |
| Sector 8 | degrees | 45 |
| Sector 6' | degrees | 45 |
| Sector 8' | degrees | 45 |

Due to the natural terrain of the deposit, Sectors 1 through 4 are in the lowest part of the topography and the shallowest part of the deposit. These are proposed as the main ramp location and therefore should be included in the overall slope angle.

**Figure 16-1: Open Pit Prefeasibility Assessment**



## 16.4 Open Pit Optimization

### 16.4.1 Optimization Parameters

The NSR model was then transferred into Geovia Whittle™ software. In addition to the NSR parameters defined in Table 16.2 above, parameters outlined in Table 16.4 were estimated using the limited information available. No capital costs were considered at the time of this study. Optimizations were run using indicated and inferred mineral resources.

**Table 16-4: Pit Optimization Parameters**

| Parameter | Unit | Value |
|---|---|---|
| NSR Value | US$ | calculated |
| Processing and G&A Cost | US$/t ore | $38.58 |
| Mining Cost | US$/t mined | $3.31 |
| Mining Dilution | % | 5% |
| Discount Rate | % | 10% |
| Pit Slopes | degrees (°) | variable |

Source: JDS, 2014

### 16.4.2 Optimization Results

Series of nested shells were generated using a revenue factor as a function of NSR(US$/sT). The line graphs in Figure 16-2 represent the best- and worst-case value scenarios for each shell by varying revenue factors.

The best-case graph plots discounted values based on the mining performed shell by shell; the worst-case graph plots discounted values based on the mining performed bench by bench. This gives a representation of where the optimized pit shell lies for each best- and worst-case curve. Note that the optimization results are reported in short tons.

The revenue factor ranged from 0.3 to 2.0, with a 0.02 step size increment. The discounted value of each pit shell was estimated using a discount rate of 10%. The tabulation of data from Figure 16-2 is shown in Table 16-5.

**Figure 16-2**: **Optimization Results**

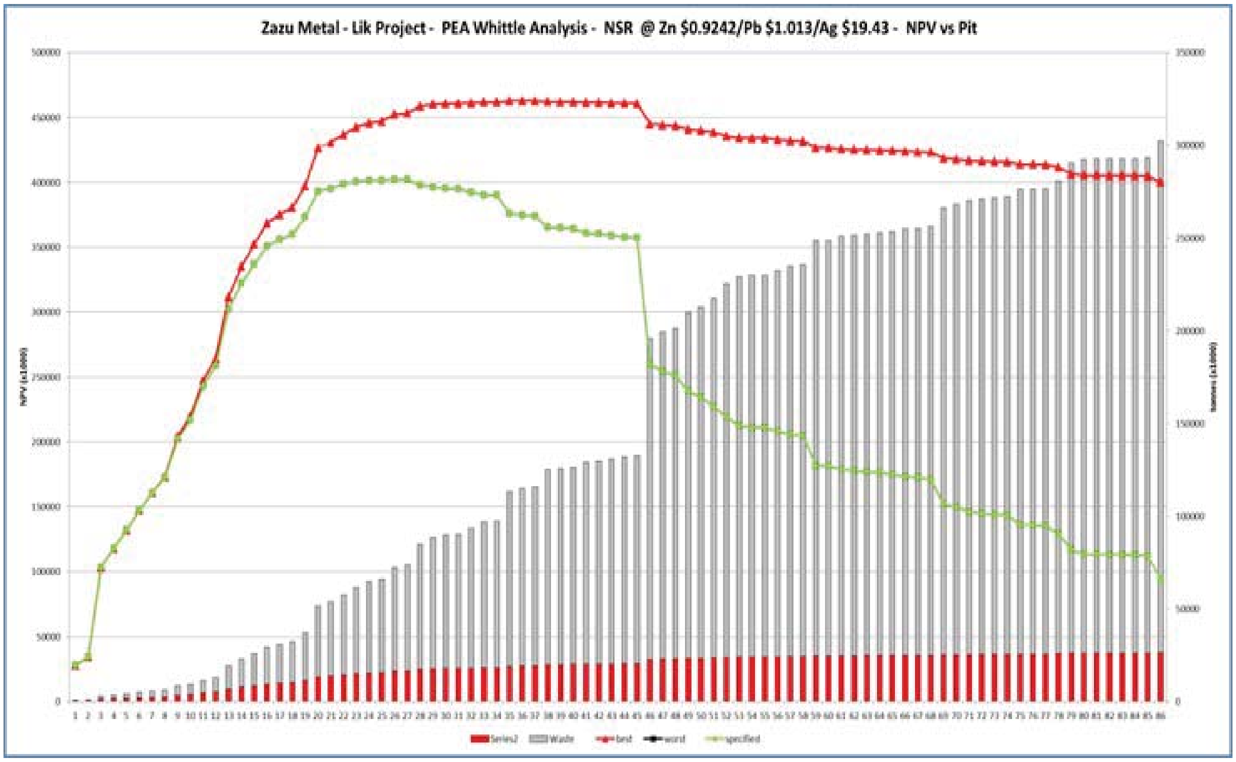


**Table 16-5: Whittle Optimization Results**

| Pit Shell (#) | Revenue Factor | Rock Tonnes (x1000) | Ore Tonnes (x1000) | Strip Ratio (W:O) | NSR Grade ($/sT) | ZN Grade (%) | PB Grade (%) | AG Grade (oz/sT) | DCF Best (x1000) | DCF Specified (x1000) | DCF Worst (x1000) | Mine Life (yrs) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | 0.30 | 638 | 222 | 1.87 | 155.88 | 13.31 | 4.86 | 3.15 | 28,118 | 28,118 | 28,118 | 0.14 |
| 2 | 0.32 | 821 | 289 | 1.84 | 151.93 | 12.81 | 4.87 | 3.01 | 34,389 | 34,389 | 34,389 | 0.18 |
| 3 | 0.34 | 3,224 | 988 | 2.26 | 142.42 | 12.70 | 4.11 | 2.57 | 103,370 | 103,370 | 103,370 | 0.65 |
| 4 | 0.36 | 3,716 | 1,207 | 2.08 | 138.37 | 12.36 | 3.99 | 2.43 | 118,137 | 118,137 | 118,137 | 0.77 |
| 5 | 0.38 | 4,294 | 1,448 | 1.96 | 134.29 | 11.93 | 3.93 | 2.33 | 132,116 | 132,116 | 132,116 | 0.90 |
| 6 | 0.40 | 5,009 | 1,717 | 1.92 | 130.51 | 11.58 | 3.83 | 2.22 | 147,461 | 147,456 | 147,456 | 1.04 |
| 7 | 0.42 | 5,597 | 1,960 | 1.86 | 127.14 | 11.27 | 3.74 | 2.15 | 160,893 | 160,693 | 160,693 | 1.18 |
| 8 | 0.44 | 6,240 | 2,235 | 1.79 | 123.46 | 10.88 | 3.68 | 2.06 | 173,181 | 172,584 | 172,584 | 1.32 |
| 9 | 0.46 | 8,379 | 2,870 | 1.92 | 118.28 | 10.39 | 3.55 | 1.97 | 204,451 | 202,304 | 202,304 | 1.71 |
| 10 | 0.48 | 9,368 | 3,338 | 1.81 | 114.01 | 9.96 | 3.47 | 1.83 | 219,898 | 216,800 | 216,800 | 1.94 |
| 11 | 0.50 | 11,301 | 4,088 | 1.76 | 109.20 | 9.54 | 3.33 | 1.73 | 247,284 | 243,057 | 243,057 | 2.34 |
| 12 | 0.52 | 12,943 | 4,651 | 1.78 | 106.35 | 9.30 | 3.23 | 1.67 | 264,588 | 258,988 | 258,988 | 2.63 |
| 13 | 0.54 | 19,233 | 6,290 | 2.06 | 101.45 | 8.87 | 3.08 | 1.62 | 311,689 | 302,204 | 302,204 | 3.45 |
| 14 | 0.56 | 22,981 | 7,332 | 2.13 | 98.87 | 8.66 | 2.98 | 1.58 | 335,299 | 322,383 | 322,383 | 3.93 |
| 15 | 0.58 | 25,930 | 8,142 | 2.18 | 97.09 | 8.53 | 2.91 | 1.56 | 352,284 | 336,885 | 336,885 | 4.30 |
| 16 | 0.60 | 29,179 | 9,012 | 2.24 | 95.31 | 8.41 | 2.82 | 1.49 | 368,466 | 350,693 | 350,693 | 4.70 |
| 17 | 0.62 | 30,774 | 9,478 | 2.25 | 94.28 | 8.33 | 2.79 | 1.46 | 375,327 | 356,006 | 356,006 | 4.90 |
| 18 | 0.64 | 32,292 | 9,874 | 2.27 | 93.46 | 8.27 | 2.76 | 1.45 | 380,653 | 360,110 | 360,110 | 5.06 |
| 19 | 0.66 | 37,030 | 10,948 | 2.38 | 91.58 | 8.13 | 2.68 | 1.38 | 397,348 | 373,439 | 373,439 | 5.65 |
| 20 | 0.68 | 51,507 | 13,093 | 2.93 | 90.11 | 7.96 | 2.67 | 1.38 | 426,791 | 393,021 | 393,021 | 6.70 |
| 21 | 0.70 | 53,781 | 13,523 | 2.98 | 89.59 | 7.91 | 2.65 | 1.37 | 430,826 | 395,183 | 395,183 | 6.89 |
| 22 | 0.72 | 57,290 | 14,170 | 3.04 | 88.80 | 7.85 | 2.62 | 1.35 | 436,854 | 398,688 | 398,688 | 7.19 |
| 23 | 0.74 | 61,626 | 14,759 | 3.18 | 88.40 | 7.82 | 2.60 | 1.35 | 442,645 | 400,833 | 400,833 | 7.47 |
| 24 | 0.76 | 64,619 | 15,175 | 3.26 | 88.04 | 7.79 | 2.59 | 1.34 | 445,912 | 401,680 | 401,680 | 7.66 |
| 25 | 0.78 | 65,745 | 15,330 | 3.29 | 87.90 | 7.78 | 2.59 | 1.34 | 446,957 | 401,698 | 401,698 | 7.72 |
| 26 | 0.80 | 72,442 | 16,182 | 3.48 | 87.17 | 7.74 | 2.54 | 1.31 | 452,506 | 402,471 | 402,471 | 8.16 |
| 27 | 0.82 | 73,767 | 16,354 | 3.51 | 87.01 | 7.73 | 2.54 | 1.31 | 453,414 | 402,114 | 402,114 | 8.23 |
| 28 | 0.84 | 84,973 | 17,237 | 3.93 | 87.07 | 7.70 | 2.56 | 1.35 | 458,845 | 397,893 | 397,893 | 8.66 |
| 29 | 0.86 | 88,555 | 17,542 | 4.05 | 86.99 | 7.69 | 2.55 | 1.35 | 460,235 | 396,324 | 396,324 | 8.81 |
| 30 | 0.88 | 89,923 | 17,671 | 4.09 | 86.92 | 7.69 | 2.55 | 1.36 | 460,663 | 395,304 | 395,304 | 8.86 |
| 31 | 0.90 | 90,271 | 17,717 | 4.10 | 86.86 | 7.68 | 2.55 | 1.36 | 460,757 | 395,003 | 395,003 | 8.88 |
| 32 | 0.92 | 93,420 | 17,936 | 4.21 | 86.85 | 7.67 | 2.55 | 1.36 | 461,265 | 392,297 | 392,297 | 8.99 |
| 33 | 0.94 | 97,188 | 18,166 | 4.35 | 86.89 | 7.68 | 2.55 | 1.36 | 461,806 | 390,172 | 390,172 | 9.10 |
| 34 | 0.96 | 97,476 | 18,202 | 4.36 | 86.84 | 7.67 | 2.55 | 1.36 | 461,840 | 389,985 | 389,985 | 9.11 |
| 35 | 0.98 | 113,254 | 19,111 | 4.93 | 86.98 | 7.67 | 2.56 | 1.39 | 462,766 | 376,020 | 376,020 | 9.56 |
| 36 | 1.00 | 115,084 | 19,232 | 4.98 | 86.94 | 7.67 | 2.55 | 1.39 | 462,800 | 374,881 | 374,881 | 9.62 |
| 37 | 1.02 | 115,814 | 19,285 | 5.01 | 86.91 | 7.67 | 2.55 | 1.39 | 462,772 | 374,122 | 374,122 | 9.64 |
| 38 | 1.04 | 125,267 | 19,955 | 5.28 | 86.52 | 7.66 | 2.52 | 1.36 | 462,165 | 365,221 | 365,221 | 9.97 |
| 39 | 1.06 | 125,723 | 19,992 | 5.29 | 86.49 | 7.66 | 2.52 | 1.35 | 462,119 | 364,798 | 364,798 | 9.98 |
| 40 | 1.08 | 126,341 | 20,039 | 5.30 | 86.45 | 7.65 | 2.52 | 1.35 | 462,029 | 364,235 | 364,235 | 10.00 |
| 41 | 1.10 | 129,179 | 20,188 | 5.40 | 86.44 | 7.65 | 2.52 | 1.35 | 461,623 | 360,884 | 360,884 | 10.08 |
| 42 | 1.12 | 129,616 | 20,216 | 5.41 | 86.42 | 7.65 | 2.52 | 1.35 | 461,542 | 360,464 | 360,464 | 10.09 |
| 43 | 1.14 | 130,840 | 20,283 | 5.45 | 86.40 | 7.64 | 2.52 | 1.35 | 461,287 | 359,073 | 359,073 | 10.12 |
| 44 | 1.16 | 132,009 | 20,354 | 5.49 | 86.35 | 7.64 | 2.52 | 1.35 | 461,013 | 357,894 | 357,894 | 10.15 |
| 45 | 1.18 | 132,625 | 20,400 | 5.50 | 86.30 | 7.64 | 2.52 | 1.35 | 460,836 | 357,344 | 357,344 | 10.17 |
| 46 | 1.20 | 195,878 | 22,773 | 7.60 | 87.37 | 7.74 | 2.54 | 1.35 | 445,062 | 259,765 | 259,765 | 11.36 |
| 47 | 1.22 | 199,304 | 22,916 | 7.70 | 87.38 | 7.74 | 2.55 | 1.35 | 444,110 | 254,287 | 254,287 | 11.43 |
| 48 | 1.24 | 201,326 | 23,010 | 7.75 | 87.35 | 7.74 | 2.54 | 1.35 | 443,484 | 251,276 | 251,276 | 11.47 |
| 49 | 1.26 | 209,665 | 23,330 | 7.99 | 87.40 | 7.75 | 2.55 | 1.36 | 440,959 | 239,138 | 239,138 | 11.63 |
| 50 | 1.28 | 212,799 | 23,445 | 8.08 | 87.42 | 7.75 | 2.55 | 1.36 | 439,973 | 234,503 | 234,503 | 11.69 |
| 51 | 1.30 | 217,347 | 23,614 | 8.20 | 87.44 | 7.74 | 2.55 | 1.36 | 438,482 | 227,254 | 227,254 | 11.77 |
| 52 | 1.32 | 225,286 | 23,984 | 8.39 | 87.26 | 7.73 | 2.55 | 1.35 | 435,583 | 219,047 | 219,047 | 11.95 |
| 53 | 1.34 | 229,191 | 24,120 | 8.50 | 87.29 | 7.73 | 2.55 | 1.35 | 434,273 | 212,320 | 212,320 | 12.02 |
| 54 | 1.36 | 229,872 | 24,151 | 8.52 | 87.27 | 7.73 | 2.55 | 1.35 | 434,031 | 211,369 | 211,369 | 12.03 |
| 55 | 1.38 | 229,999 | 24,161 | 8.52 | 87.25 | 7.73 | 2.55 | 1.35 | 433,977 | 211,219 | 211,219 | 12.03 |
| 56 | 1.40 | 232,628 | 24,289 | 8.58 | 87.16 | 7.72 | 2.54 | 1.34 | 432,876 | 208,297 | 208,297 | 12.10 |
| 57 | 1.42 | 234,833 | 24,370 | 8.64 | 87.15 | 7.72 | 2.54 | 1.34 | 432,032 | 205,967 | 205,967 | 12.13 |
| 58 | 1.44 | 235,645 | 24,408 | 8.65 | 87.12 | 7.72 | 2.54 | 1.34 | 431,685 | 204,713 | 204,713 | 12.15 |
| 59 | 1.46 | 248,646 | 24,790 | 9.03 | 87.24 | 7.73 | 2.55 | 1.34 | 426,712 | 181,682 | 181,682 | 12.34 |
| 60 | 1.48 | 248,766 | 24,798 | 9.03 | 87.22 | 7.73 | 2.55 | 1.34 | 426,652 | 181,512 | 181,512 | 12.34 |
| 61 | 1.50 | 250,896 | 24,895 | 9.08 | 87.15 | 7.72 | 2.54 | 1.34 | 425,702 | 178,968 | 178,968 | 12.39 |
| 62 | 1.52 | 251,579 | 24,922 | 9.09 | 87.14 | 7.72 | 2.54 | 1.34 | 425,411 | 177,865 | 177,865 | 12.40 |
| 63 | 1.54 | 252,168 | 24,956 | 9.10 | 87.09 | 7.72 | 2.54 | 1.34 | 425,110 | 177,115 | 177,115 | 12.42 |
| 64 | 1.56 | 252,871 | 24,987 | 9.12 | 87.07 | 7.72 | 2.54 | 1.34 | 424,777 | 176,273 | 176,273 | 12.43 |
| 65 | 1.58 | 253,570 | 25,018 | 9.14 | 87.04 | 7.71 | 2.54 | 1.34 | 424,445 | 175,137 | 175,137 | 12.44 |
| 66 | 1.60 | 254,821 | 25,065 | 9.17 | 87.01 | 7.71 | 2.54 | 1.34 | 423,855 | 173,241 | 173,241 | 12.47 |
| 67 | 1.62 | 255,336 | 25,092 | 9.18 | 86.98 | 7.71 | 2.54 | 1.34 | 423,585 | 172,704 | 172,704 | 12.48 |
| 68 | 1.64 | 256,111 | 25,117 | 9.20 | 86.97 | 7.71 | 2.54 | 1.34 | 423,225 | 171,225 | 171,225 | 12.49 |
| 69 | 1.66 | 266,427 | 25,366 | 9.50 | 87.07 | 7.72 | 2.54 | 1.34 | 418,680 | 152,026 | 152,026 | 12.62 |
| 70 | 1.68 | 268,137 | 25,434 | 9.54 | 87.02 | 7.71 | 2.54 | 1.34 | 417,830 | 149,873 | 149,873 | 12.65 |
| 71 | 1.70 | 270,271 | 25,488 | 9.60 | 87.02 | 7.71 | 2.54 | 1.33 | 416,855 | 146,034 | 146,034 | 12.68 |
| 72 | 1.72 | 271,247 | 25,532 | 9.62 | 86.97 | 7.71 | 2.54 | 1.33 | 416,333 | 144,784 | 144,784 | 12.70 |
| 73 | 1.74 | 271,811 | 25,555 | 9.64 | 86.95 | 7.71 | 2.54 | 1.33 | 416,040 | 144,008 | 144,008 | 12.71 |
| 74 | 1.76 | 272,182 | 25,571 | 9.64 | 86.94 | 7.71 | 2.53 | 1.33 | 415,839 | 143,549 | 143,549 | 12.71 |
| 75 | 1.78 | 276,125 | 25,654 | 9.76 | 86.98 | 7.71 | 2.54 | 1.33 | 414,003 | 136,091 | 136,091 | 12.76 |
| 76 | 1.80 | 276,244 | 25,660 | 9.77 | 86.97 | 7.71 | 2.54 | 1.33 | 413,934 | 135,962 | 135,962 | 12.76 |
| 77 | 1.82 | 276,623 | 25,676 | 9.77 | 86.95 | 7.70 | 2.54 | 1.33 | 413,721 | 135,243 | 135,243 | 12.76 |
| 78 | 1.84 | 280,766 | 25,815 | 9.88 | 86.85 | 7.70 | 2.53 | 1.32 | 411,534 | 129,183 | 129,183 | 12.83 |
| 79 | 1.86 | 290,501 | 26,153 | 10.11 | 86.58 | 7.67 | 2.53 | 1.33 | 406,464 | 117,020 | 117,020 | 13.00 |
| 80 | 1.88 | 292,530 | 26,203 | 10.16 | 86.57 | 7.67 | 2.53 | 1.33 | 405,406 | 113,423 | 113,423 | 13.03 |
| 81 | 1.90 | 292,596 | 26,207 | 10.16 | 86.57 | 7.67 | 2.53 | 1.32 | 405,367 | 113,347 | 113,347 | 13.03 |
| 82 | 1.92 | 292,622 | 26,212 | 10.16 | 86.56 | 7.67 | 2.53 | 1.32 | 405,347 | 113,310 | 113,310 | 13.03 |
| 83 | 1.94 | 292,652 | 26,213 | 10.16 | 86.55 | 7.67 | 2.53 | 1.32 | 405,327 | 113,276 | 113,276 | 13.03 |
| 84 | 1.96 | 292,830 | 26,220 | 10.17 | 86.55 | 7.67 | 2.53 | 1.32 | 405,219 | 113,054 | 113,054 | 13.03 |
| 85 | 1.98 | 293,348 | 26,240 | 10.18 | 86.52 | 7.67 | 2.53 | 1.32 | 404,900 | 112,325 | 112,325 | 13.04 |
| 86 | 2.00 | 302,430 | 26,421 | 10.45 | 86.57 | 7.67 | 2.53 | 1.33 | 400,141 | 94,601 | 94,601 | 13.13 |

## 16.5 Mine Planning

### 16.5.1 Pit Shell Selection & Mine Design

The key focus of the preliminary assessment was to maximize the open pit resources and to show '*reasonable potential for economic extraction'*. Therefore, pit shell 36, where the revenue factor is equal to 1, was selected for mine planning.

A detailed mine design was not completed for this study, but mining will be performed on 30 ft (9.15 m) benches and 200 ft (60 m) mining widths. A series of shells were analyzed, and shells 10 and 22 where selected for mine planning.

### 16.5.2 Cut-Off Grade

An NSR cut-off calculation is based on; mining, milling and G&A costs. These are shown in Table 16-6.

**Table 16-6: NSR Cut-off Calculation**

| | |
|---|---|
| Mining | US$3.31/t mine |
| Milling and G&A | US$38.58/t ore |
| NSR Mining Pit Rim Cut-off | US$41.89/t (Mine & Mill) |
| NSR Milling Pit Rim Cut-off | US$38.58/t (Mill Only) |

Two NSR cut-off calculations were determined for the mine production schedule. To maximize a higher value during the mine life, a mining cut-off was applied and any material between the milling and mining cut-off would be stockpiled and processed at the end of mine life. Due to the small quantity of material (~33,600 tonnes) between the milling and mining cut-off, only the milling cut-off numbers was factored into scheduling.

### 16.5.3 Mine Production Schedule

The mining production schedule was developed based on a maximum mill capacity of approximately 5,500 t/d. The Lik project mine life is 10 years, including one year of pre-stripping followed by nine years of production. The throughput rate in Year 1 was reduced to 80% of full capacity to reflect mill construction and start-up/commissioning time. Table 16.7 below, outlines the mine production schedule by year.

**Table 16-7: Mine Production Schedule by Year**

| Year | Resources (Mt) | Zn (%) | Pb (%/t) | Ag (g/t) | NSR ($/t) | Waste (Mt) | Total (Mt) | S.R. (W:O) |
|---|---|---|---|---|---|---|---|---|
| -1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 1 | 1.60 | 8.60 | 3.47 | 62.58 | 114.39 | 5.64 | 7.23 | 3.53 |
| 2 | 2.00 | 9.46 | 2.99 | 58.29 | 115.95 | 11.33 | 13.33 | 5.68 |
| 3 | 2.00 | 7.62 | 2.48 | 57.24 | 94.99 | 11.18 | 13.17 | 5.60 |
| 4 | 2.00 | 7.00 | 2.37 | 31.73 | 87.24 | 11.35 | 13.34 | 5.69 |
| 5 | 2.00 | 7.10 | 2.15 | 27.96 | 85.38 | 10.82 | 12.82 | 5.42 |
| 6 | 2.00 | 7.05 | 2.18 | 33.58 | 85.49 | 11.31 | 13.31 | 5.67 |
| 7 | 2.00 | 7.22 | 2.43 | 51.55 | 91.21 | 11.22 | 13.22 | 5.62 |
| 8 | 2.00 | 7.16 | 2.15 | 37.69 | 86.68 | 11.57 | 13.57 | 5.80 |
| 9 | 1.57 | 7.97 | 3.02 | 75.51 | 106.09 | 2.33 | 3.89 | 1.48 |
| Total | 17.13 | 7.66 | 2.55 | 47.45 | 95.72 | 86.96 | 104.09 | 5.07 |

During the mine scheduling exercise, the goal was to mine the highest-grade material first, while deferring the pre-stripping requirements until later. This would allow for early payback and to help improve the economics of this deposit. Only 0.21 Mt will be required to be moved during pre-striping. The level of organics that will need to be moved is unknown at the time of this study. It is JDS opinion that a majority of the pre-stripping requirements are likely to be associated to the removal of organics.

## 16.6 Mine Waste Rock Management

Over the life of mine, the open pit will produce approximately 87 Mt of waste rock. At the time of this study, the waste rock acid-base accounting information was not available; therefore, all waste rock has been categorized as NAG waste rock.

## 16.7 Mine Equipment

This operation will be a conventional, open pit, truck-and-shovel operation. JDS prefers conventional, proven 90-tonne class trucks, 12.5 $m^3$ class hydraulic shovels and front-end wheel-loaders for open pit loading and hauling. The front-end wheel loader is preferred for its mobility and ability to manage ore loading, while the hydraulic-shovel will be mainly used for waste loading.

Blast-hole track-mounted drills, either rotary drilling or down-the-hole (DTH), are planned for the project. Due to the size of the operation, all equipment on site will be diesel powered.

### 16.7.1 Mine Equipment Parameters

The mine will operate 24 hours per day, 365 days per year. Equipment is expected to have long-term mechanical availability of 85%. Utilization has been assumed to be 85%. This gives approximately 6,329 gross operating hours per year.

### 16.7.2 Mine Equipment Requirements

Major mine equipment has been estimated based on the equipment parameters above. They are listed in Table 16-8 below.

**Table 16-8: Major Mine Equipment Requirements**

| Equipment Type | Initial | Ultimate |
|---|---|---|
| Crawler-mounted, rotary tri-cone, 7-7/8" (200 mm) dia. | | 1 |
| Crawler-mounted, down-the-hole, 6.5" (165 mm) dia. | 1 | 1 |
| Diesel, 16 $yd^3$ (12.5 $m^3$) hydraulic shovel | 1 | 1 |
| Diesel, 16 $yd^3$ (12.5 $m^3$) wheel loader | | 1 |
| 100-ton (90-tonne) class haul truck | 1 | 8 |
| D10-class track dozer | 1 | 2 |
| 16H-class grader | 1 | 1 |

Support mine equipment will consist of:

- Small excavator
- Mechanical trucks
- Service & lube truck
- Welding trucks
- Fuel truck
- ANFO truck
- Small crane
- Zoom boom
- Tire handler
- Ambulance
- Fire truck
- Flat decks
- Snow plow
- Bus
- Crew van
- Pickups

## 16.8 Explosives

Explosives will be supplied by a single service provider, using conventional heavy ANFO and delivered by an on-site mixing truck to the blast hole.

Blast design is based on 30 ft (9.15 m) benches, using powder factors ranging between 0.21 and 0.28 kg/t. Over the life of mine, the project will use approximately 26 Mkg of ammonium nitrate (AN) with an average use of 3.3 Mkg per year during Years 2 through 8.

The project will use conventional blasting products: nonels, detonating cords, delays and boosters.

A pre-shear product is considered for the northeast wall and included in the operating cost of the project. The pre-shear would allow for a steeper wall, which in turn would help in lowering life-of-mine waste movement. The pre-shear needs to be further examined during the next stage of the study.

Mine operations personnel will be responsible for the blasting pattern design and for tie-ins.

## 16.9 Mine Personnel

The management staff, technical personnel and mine crews will operate on two 12-hour shifts per day, 365 days per year. This will require four mining and maintenance crews. Crews will work a standard rotation of two weeks on, two weeks off. Personnel requirements are estimated based on the peak number of equipment units operating. Peak mine personnel requirements are summarized in Tables 16-9 to Table 16-12.

**Table 16-9: Mine Operations Personnel Summary**

| Position | Quantity | Schedule | Hourly/Salary |
|---|---|---|---|
| Mine Superintendent | 1 | 2x2 DS | Salary |
| Mine Shift Foreman | 4 | 2x2 D/N | Hourly |
| Mine Trainer | 1 | 2x2 DS | Hourly |
| Mine Clerk | 1 | 2x2 DS | Hourly |
| Driller | 8 | 2x2 DS | Hourly |
| Blaster | 2 | 2x2 DS | Hourly |
| Blasting Helper | 2 | 2X2 DS | Hourly |
| Shovel/Loader Operator | 8 | 2x2 D/N | Hourly |
| Truck Driver | 28 | 2x2 D/N | Hourly |
| Support Equipment Operators | 4 | 2x2 D/N | Hourly |
| Mine Services | 6 | 2x2 D/N | Hourly |
| Mine Operations Total | 65 | | |

**Table 16-10: Mine Maintenance Personnel Summary**

| Position | Quantity | Schedule | Hourly/Salary |
|---|---|---|---|
| Maintenance General Foreman | 1 | 2x2 DS | Salary |
| Maintenance Planner/Shift Foreman | 1 | 2x2 DS | Salary |
| Heavy Equipment Mechanic | 20 | 2x2 D/N | Hourly |
| Mechanics and Welders | 15 | 2x2 D/N | Hourly |
| Services – Fuel & Lube | 4 | 2x2 D/N | Hourly |
| Tireman | 2 | 2x2 D/N | Hourly |
| Labourer/Trainee | 4 | 2x2 D/N | Hourly |
| Mine Maintenance Total | 47 | | |

**Table 16-11: Technical Services Personnel Summary**

| Position | Quantity | Schedule | Hourly/Salary |
|---|---|---|---|
| Chief Engineer | 1 | 2x2 DS | Salary |
| Production Engineer | 2 | 2x2 DS | Salary |
| Grade Control Geologist | 2 | 2x2 DS | Salary |
| Mine Geologist | 1 | 2x2 DS | Salary |
| Sampler | 2 | 2x2 DS | Salary |
| Surveyor | 2 | 2x2 DS | Salary |
| Rodman | 2 | 5x2 | Salary |
| Technical Services Total | 12 | | |

**Table 16-12: Total Mine Personnel Summary**

| Team | Personnel |
|---|---|
| Operations | 65 |
| Maintenance | 47 |
| Technical Services | 12 |
| Total Mine Personnel | 193 |

# 17.0 Process Description

## 17.1 Introduction

The planned processing facilities have been designed to process the lead/zinc/silver ROM ore from the Lik deposit at a nominal throughput of 5,480 t/d (2.0 Mt/a). The testwork discussed in Section 13.0, as well as the most recent mine production schedule, provided the basis for the preliminary process design.

Lead-, zinc- and silver-bearing Lik ore will be crushed, ground and floated to produce lead and zinc concentrates. The concentrates will be separately dewatered and hauled by truck to the port facility where it will be stored and seasonally shipped to suitable smelters.

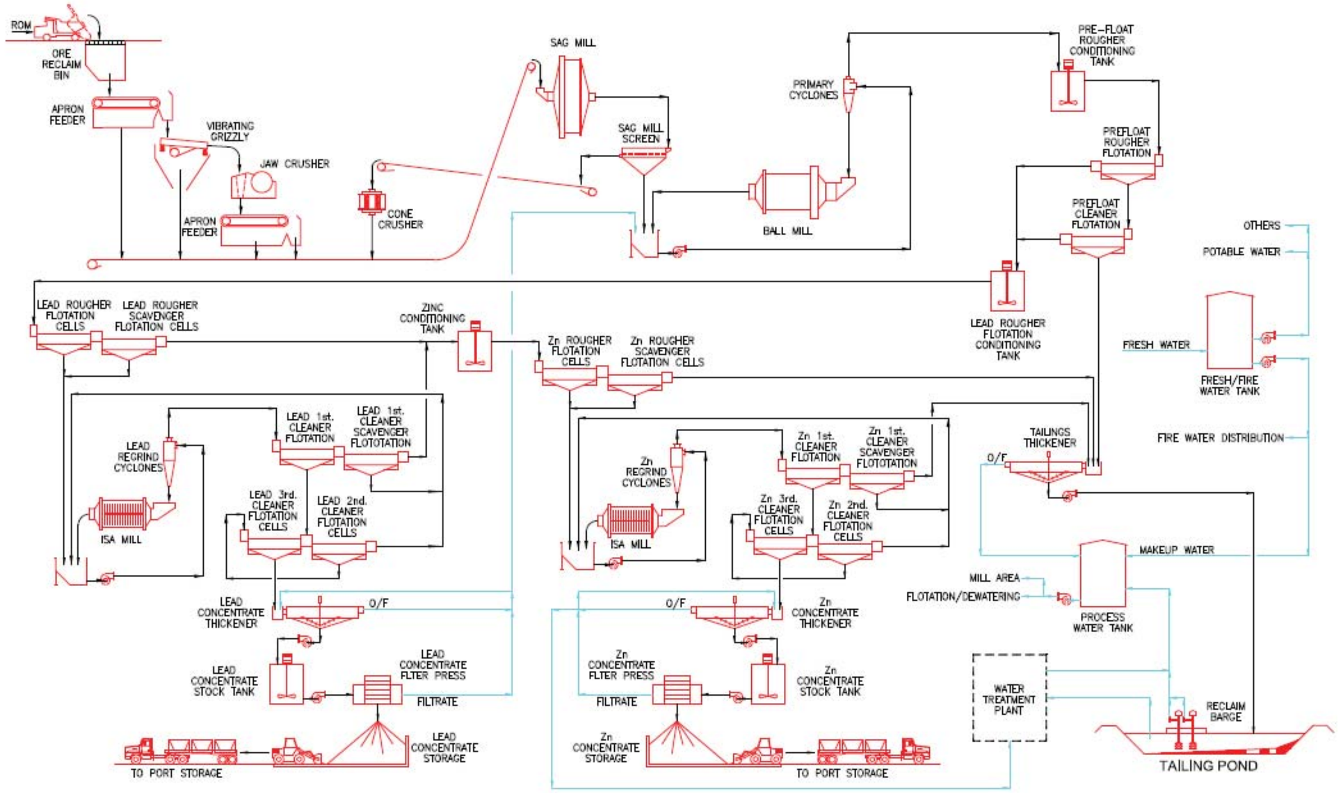
The average production rates of dry lead and zinc concentrate will be approximately 153 t/d or 56,000 t/a, and 641 t/d or 234,000 t/a, respectively.

The 5,500 t/d process plant will consist of the following unit operations and facilities:

- ROM material receiving and primary crushing
- Coarse ore stockpile
- Coarse plant feed material stockpile reclaim facilities
- SAG mill incorporating a pebble crushing circuit
- Ball mill grinding circuit incorporating cyclones for classification
- Carbon pre-flotation
- Pb rougher, cleaner flotation including a regrinding circuit
- Zn rougher, cleaner flotation including a regrinding circuit
- Pb concentrate dewatering
- Zn concentrate dewatering
- Tailings dewatering and tailings storage facilities
- Water treatment plant
- Process water reclamation
- Reagent preparation facilities
- Utilities

The simplified flowsheet is shown in Figure 17.1.

**Figure 17-1: Simplified Flow Sheet**



## 17.2 Plant Design

### 17.2.1 Major Design Criteria

The concentrator has been designed to treat lead, zinc-bearing material at the rate of 5,500 t/d (nominal 2,000,000 t/a). The major design criteria are outlined in Table 17-1.

**Table 17-1: Major Design Criteria**

| Criteria | Unit | Value |
|---|---|---|
| Overall Plant Feed - Design (Ave) | Mt/d | 5480 |
| Operating Year | d | 365 |
| Primary Crushing Circuit Utilization | % | 50 |
| Primary Crushing Circuit Availability | % | 75 |
| Primary Crushing Circuit Throughput Rate (Operating) | t/h | 543 |
| Grinding, Flotation Circuits Availability | % | 92 |
| Grinding and Flotation Feed Rate (Operating) | t/h | 248 |
| Bond Crushing Work Index, design | kWh/t | 14.0 |
| Bond Ball Mill Work Index, design | kWh/t | 16.3 |
| Specific Gravity Feed | - | 3.35 |
| Moisture Content Feed | % | 5.0 |
| SAG Mill Feed Size, 80% Passing | mm | 150 |
| Flotation Feed Size, 80% Passing | µm | 40 |
| Lead Ro Concentrate Regrind, 80% Passing | µm | 15 |
| Zinc Ro Concentrate Regrind, 80% Passing | µm | 10 |
| Ball Mill Circulating Load | % | 250 |
| Lead Head Grade, Average | Pb, % | 2.55 |
| Zinc Head Grade, Average | Zn, % | 7.66 |
| Silver Head Grade, Average | Ag g/t | 43 |
| Lead Recovery to Lead Concentrate, Design | % | 69.7 |
| Lead Concentrate Grade | Pb, % | 61.15 |
| Silver Recovery to Lead Concentrate | % | 5.2 |
| Lead Concentrate Silver Grade | Ag g/t | 77 |
| Zinc Recovery to Zinc Concentrate, Design | % | 85.0 |
| Zinc Concentrate Grade | Zn, % | 53.4 |
| Silver Recovery to Zinc Concentrate | % | 26.8 |
| Zinc Concentrate Silver Grade | Ag g/t | |

The process design parameters are based on testwork results obtained by G&T, particularly from test programs performed in 2008. Data from the SGS Lakefield test report completed during 2009 was also incorporated in the design where applicable.

The grinding circuit preliminary design was based on the MRCS estimate and a Bond work index of 14.8 kWh/t obtained from the G&T 2013 testwork.

The lead and zinc flotation circuits designed based on the flotation testwork results reported by G&T in 2008 and SGS in 2010.

### 17.2.2 Operating Schedule and Availability

The processing plant will be designed to operate on the basis of two 12-hour shifts per day, for 365 days per year at 92% availability. The primary crusher will operate one 12-hour shift per day at 75% availability. These utilizations will allow for sufficient downtime for scheduled and unscheduled maintenance of the crushing and process plant equipment. The crushing circuit will also have enough capacity to allow for increased throughput if required.

## 17.3 Process Plant Description

### 17.3.1 Primary Crushing

The crushing circuit will reduce the mined material from a nominal top size of 850 mm to a product size $P_{80}$ of 150mm in preparation for grinding. The primary crushing circuit comprises the following equipment:

- ROM feed hopper
- Oversize rock breaker
- Vibrating grizzly
- Jaw crusher
- Apron feeder
- Conveyor belts, metal detector
- Belt magnet
- Dust collection system.

Haul trucks will bring ROM plant feed material the crushing plant. The material will be dumped from the trucks into a crusher feed hopper. The delivery area will be equipped with a coarse rock breaker to handle oversized material. The feed hopper will have a nominal capacity of couple of truckloads of plant feed material to allow for the simultaneous delivery of truckloads. The ROM material will be reclaimed from the feed hopper using an apron feeder and will be transferred to the primary jaw crusher.

The crushed material will be transferred by a conveyor to the coarse ore stockpile.

The primary crushing and conveyor drop points will be equipped with a dust collection system to control fugitive dust that will be generated during crushing and during conveyor loading and transportation of the crushed material.

### 17.3.2 Coarse Ore Stockpile and Reclaim

The coarse ore stockpile will be a production surge facility that will allow for a steady feed of material to the process plant.

The major equipment and facilities in this area includes:

- Coarse rock stockpile
- Reclaim apron feeders
- Conveyor belts c/w metal detectors and belt weigh scale
- Dust collection system.

The coarse ore stockpile will have a live capacity of 5,500 tonnes. The material will be reclaimed from this stockpile by two apron feeders. The apron feeders will feed the SAG mill feed conveyor which in turn will feed the SAG mill. The SAG feed conveyor will be equipped with a belt weigh scale.

The coarse ore stockpile and reclaim area will be equipped with a dust collection system to control fugitive dust that will be generated during conveyor loading and the transportation of feed material.

### 17.3.3 Grinding Circuit Operation

The grinding circuit will reduce the size of the crushed material to a product size $P_{80}$ of 40 µm. The grinding process will be a two-stage operation with the SAG mill followed by one ball mills in closed circuit with the cyclones. A pebble crusher will be included in closed circuit with the SAG mill to handle coarse pebbles from the SAG mill discharge screen. The grinding circuit will process ore at an operating rate of 248 tonnes per hour.

The grinding circuit will include the following main items of equipment:

- SAG mill
- Pebble crusher
- Two ball mills
- Mill discharge pump box
- Cyclone feed slurry pumps
- Cyclone cluster
- Mass flow meter
- Grinding area sump pump

Water and lime will be added to the SAG mill feed as required, and to maintain the slurry density at 74% solids. The SAG mill will operate at a critical speed of 76.9% with a nominal 12% ball load.

Discharge from the SAG mill will be directed to a vibrating screen. Undersize from the screens will be discharged to the cyclone feed pump box, and oversize material (15-25% of new feed) will be sent to the pebble crusher by conveyor. The crushed material from the pebble crusher will be returned to the SAG mill.

SAG mill discharge will combine with the ball mill discharge in the cyclone feed pump box. Slurry from the cyclone feed pump box is pumped to a cyclone clusters. Process makeup water and the required reagent will also be added to the cyclone feed pump box.

The cyclone underflow will gravity-flow to the ball mill feed chute, while the overflow will gravity-flow to the bulk rougher flotation bank. The cyclone clusters will have a cut size of $P_{80}$ of 40 µm, and the circulation load to the individual ball mill circuits will be 250%. The ball mills will operate at a critical speed of 73.1% with 34% ball loading.

### 17.3.4 Carbon Pre-flotation

The overflow from both hydrocyclones in grinding circuit will feed to carbon pre-flotation circuit to remove the organic carbon from the ore prior to lead rougher flotation. Carbon pre-flotation circuit includes rougher and cleaner stages. Carbon pre-flotation cleaner concentrate containing most of the organic carbon will be discharged to the tailings thickener and the carbon pre-flotation rougher and cleaner tails, which contains the valuable minerals, will feed to the lead (Pb) rougher flotation circuit.

### 17.3.5 Lead Flotation

#### *Lead Rougher Flotation*

The carbon pre-flotation rougher and cleaner tails, which conclude the feed to the lead rougher flotation, will be conditioned in the lead rougher flotation conditioning tank. The flotation reagents will include lime, zinc sulfate, promoter 3418A and methyl isobutyl carbinol (MIBC).

The lead rougher flotation circuit consists of eight flotation tank cells (six rougher and two rougher scavenger). The concentrate from the rougher and rougher scavengers are combined and sent to the regrind circuit. The rougher scavenger tail will be forwarded to Zinc flotation conditioner tank.

#### *Lead Regrinding Circuit*

The lead rougher concentrate will be reground to a particle size of $P_{80}$ of 10 µm in a regrind mill complete with a cyclone cluster. The overflow from the cyclones will gravity-flow to the lead cleaner circuit, the underflow of the cyclones will feed to the regrinding mill for further regrind.

Lime and sodium cyanide will be added in the regrinding circuit.

***Lead Cleaner flotation***

The lead regrind cyclone overflow will be cleaned in three cleaner stages. The first stage of cleaner flotation includes four convention cells. The 1st cleaner concentrate will be fed to the 2nd cleaner and the 2nd cleaner concentrate feeds the 3rd cleaner flotation circuit. For the 2nd and 3rd cleaner stages, three conventional cells and four conventional cells will be used, respectively. The 1st cleaner flotation tailings will be further floated in two cleaner scavenger flotation cells. The concentrate product from the 1st cleaner scavenger flotation will be sent to the lead regrinding cyclone feed pump box, and the tailings will be advanced to the zinc flotation circuit. The tailings from the 2nd and 3rd cleaner flotation stages will be returned to the head of the preceding cleaner circuit. The final lead concentrate will be sent to the lead concentrate thickener.

### 17.3.6 Zinc Flotation

The tailings from lead rougher scavenger and lead 1st cleaner scavenger will conclude the feed to the zinc flotation circuit. The slurry will be conditioned in the zinc conditioning tank prior to flotation. The flotation reagents will include lime, copper sulfate, SIPX, and MIBC.

***Zinc Rougher flotation***

The zinc rougher flotation circuit consists of one bank of eight rougher tank cells and an additional bank of four rougher scavenger tank cells. The concentrate from the rougher and rougher scavengers will combine and report to the zinc regrinding circuit. The rougher scavenger tails will be transferred to the tailings thickener for thickening prior to being discharged to the tailings facility.

***Zinc Regrinding Circuit***

The zinc rougher concentrate will be reground to a particle size of $P_{80}$ of 8 µm in a regrind circuit consisting of mill in closed circuit with a cyclone cluster. The overflow from the cyclone cluster gravity-flows to the zinc cleaner circuit, while the underflow of the cyclones will be recycled back to the regrind mill.

Process water will be added to the regrind cyclone feed pump box to adjust the feed to the cyclones as required.

***Zinc Cleaner flotation***

The zinc regrind cyclone overflow will be cleaned in three cleaner stages. The first stage of cleaner flotation includes four tank cells. The 1st cleaner concentrate will advance to 2nd cleaner circuit and 2rd cleaner concentrate will advance to the 3rd cleaner circuit for a final stage of cleaning to produce the 3rd cleaner concentrate. The 1st cleaner flotation tailings will be further floated in a scavenger circuit. The concentrate product from the 1st cleaner scavenger flotation will be sent to the regrinding cyclone feed pump box, and the tailings will be sent to the tailings thickener. The tailings from the 2nd and 3rd cleaner flotation stages will be returned to the head of the preceding cleaner flotation circuit. The final zinc concentrate will be sent to the zinc concentrate thickener.

The same reagents used in the rougher flotation circuit will be used in the cleaner circuit, with the addition of promoter 3418A.

### 17.3.7 Lead and Zinc Concentrate Dewatering

The lead and zinc concentrate will be thickened to 65% solids in separate concentrate thickeners. Thickener underflow will be pumped to the respective concentrate stock tanks prior to being filtered. The lead thickener overflow will be recycled to grinding circuit, while zinc thickener overflow will be transferred to water treatment or directly to the process water tank for recycle to the process.

The thickened underflows from the lead and zinc thickeners will be pumped from the stock tanks to dedicated lead and zinc pressure filter presses, for further dewatering to a target moisture content of 8%. The filter presses operate under batch conditions. Filtrates will flow to the filtrate collection tanks, and will subsequently be pumped to the respective concentrate thickeners. The dewatered lead and zinc concentrates will be transferred to individual lead and zinc stockpiles by conveyor.

The concentrates will be reclaimed from the stockpiles onto trucks for transfer to the storage facility at the port from which it is reclaimed to barges and transferred to ocean going ships on a seasonal basis. The average dry lead concentrate production rate is estimated to be approximately 159 t/d (58,161 t/a), with an expected average grade of 61.2% Pb. The average dry zinc concentrate production rate is estimated to be approximately 668 t/d (243,849 t/a), with an expected average grade of 53.4% Zn.

### 17.3.8 Tailings Management

Zinc flotation tailings (rougher scavenger and cleaner 1 scavenger tails) plus the carbon pre-flotation cleaner concentrate containing organic carbon material will be directed to a tailings thickener and thickened to 55% solids. The tailings thickener overflow is pumped to the process water tank, and the underflow is pumped to the tailings pond where it will settle to an estimated 70% solids. Barged centrifugal pumps will reclaim water from the tailings pond to the process water tank.

### 17.3.9 Reagent handling

The reagents used at the mill site will include:

- Flotation: sodium isopropyl xanthate (SIPX), methyl isobutyl carbinol (MIBC), copper sulfate ($CuSO_4$), zinc sulfate ($ZnSO_4$), lime ($Ca(OH)_2$), sodium cyanide (NaCN), Aero 633 & 3418A
- Concentrate dewatering and tailing thickener: flocculent
- Water treatment: lime and flocculent.

All the reagents will be prepared in a containment area in a separate reagent preparation and storage area. The reagent storage tanks will be equipped with level indicators and instrumentation to ensure that spills do not occur during operation. Appropriate ventilation and fire and safety protection will be provided at the facility.

The liquid reagents (including MIBC, Aero 633,3418A) will be added in the undiluted form to various process circuits via individual metering pumps.

All the reagents received in solid form (including SIPX, NaCN, $CuSO_4$, and ZnSO4) will be mixed with fresh water to required solution strength in their respective mixing tanks, and stored in separate holding tanks before being metered to the process at the required addition points.

Slaked lime will be prepared onsite from bulk lime storage bins. Lime will be slaked, diluted to a 20% solids milk of lime slurry, and distributed to various addition points through a closed pressure loop.

### 17.3.10 Assay and Metallurgical Laboratory

The assay laboratory will be equipped with necessary analytical instruments to provide routine assays for the mine, process, and environmental departments.

The metallurgical laboratory will be fully equipped with all necessary laboratory equipment and instruments, and will undertake necessary testwork to monitor the metallurgical performance and to improve the process efficiency on a daily basis.

### 17.3.11 Water Supply

Two separate water supply systems will be provided to support the operation: a fresh water system and a process /recycle water system.

#### *Fresh Water Supply System*

Fresh water will be supplied to a storage tank from the water treatment plant and local drainage runoff areas and wells.

Fresh water will be used primarily for fire water emergency use, cooling water for mill motors and mill lubrication systems, reagent preparation and gland seal water. By design, the fresh water tank will provide at least 2 hours of firewater in an emergency. The expected fresh water needed for processing is 353 US gallons per minute.

***Process Water Supply System***

Process water will consist primarily of tailings thickener overflow, reclaimed water from the TSF, and treated water from water treatment plant. The major process water source is the tailings thickener overflow (2,010 US gallons per minute) followed by the reclaim water from the TSF (361 US gallons per minute). The need for treating process water from the zinc circuit prior to entering the process water system requires testing to determine the need and method of treatment.

All recycle water will be directed to a process water storage tank other than the lead concentrate thickener overflow. Process water from the storage tank will be distributed as required to areas not serviced on a priority basis by fresh water. A preliminary estimate of the process water requirements are provided on the overall mass and water balance.

### 17.3.12 Air Supply

Plant air service systems will supply air to the following areas:

- Flotation circuits – Low pressure air blowers for flotation cells.
- Lead and zinc filtration circuits – High pressure air for concentrate dewatering filters.
- Crushing circuit – High pressure air for the dust suppression (fogging) systems and other services by an air compressor
- Plant service air – High pressure air for various services from dedicated air compressors
- Instrument air requirements – Instrument air will be supplied from the plant air compressors, dried and stored in a dedicated air receiver prior to distribution.

# 18.0 Project Infrastructure

## 18.1 General

The Lik project is located in a remote area with minimal supporting infrastructure and services. Hence, both on-site and off-site infrastructure to support construction and operations will have to be included in project development.

## 18.2 Off-Site Services and Facilities

To connect the mine to the nearest land/sea access it will be necessary to build a road from the site to connect with AIDEA Delong Mountain Transportation System (DMTS) road and port facilities that service Teck Corporation's Red Dog mine. At present, a small airstrip suitable for short takeoff and landing (STOL) aircraft is in place at the Lik mine site.

An understanding with AIDEA and Red Dog will have to be reached regarding capital and operating costs for the modifications required to the DMTS.

### 18.2.1 Access Road

The DMTS 52 mile long, 30 ft wide all-weather gravel road connects the Red Dog mine to port facilities. Preliminary studies were carried out by Lounsbury & Associates Inc. (SW-RPA Report, April 2010) on optional road routes to connect Lik to the DMTS. Four options were considered, as shown in Figure 18-1. All the routes infringe on Sate and Alaska Industrial Development & Export Authority (AIDEA) lands.

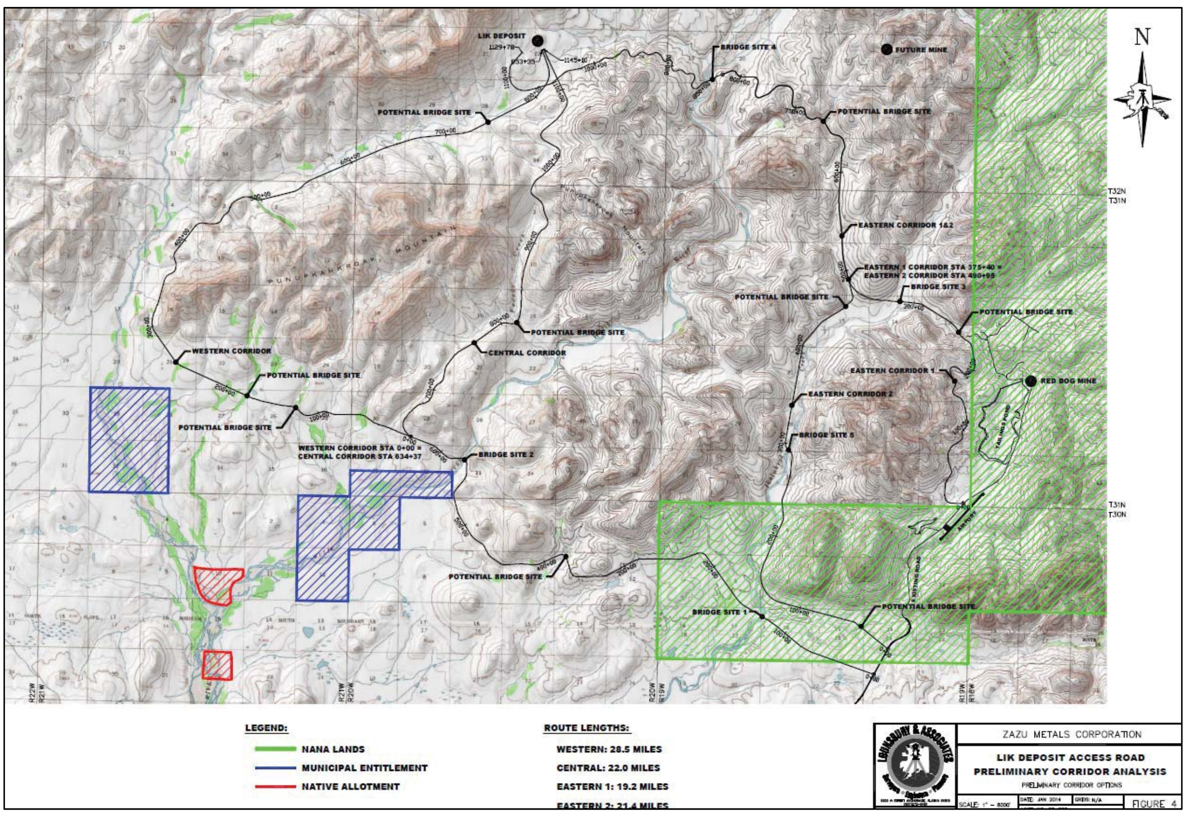
From the map, the selected 8.5 m wide gravel road, option E2, was subject to further study in November 2013 to rationalize the alignment and restrict the grade to 4%. The 35 km long route includes several bridge crossings including the most significant bridge crossing the Walik River and joins the DMTS road 9 km southwest of Red Dog. The total distance to port from the Lik property is approximately 106 km.

The above design parameters will permit the use 120 tonne haulage trucks to move the concentrate to port.

Lounsbury estimates a capital cost at $80.73M with an estimated annual operating cost of $200,000.

JDS has made a few modified a few of the access road design assumptions for a narrower, single lane road with turnouts and has estimated the cost more in the range of $45 million. This rework will require more detailed design and cost estimation in the next level of study.

**Figure 18-1: Road Alternatives Map**



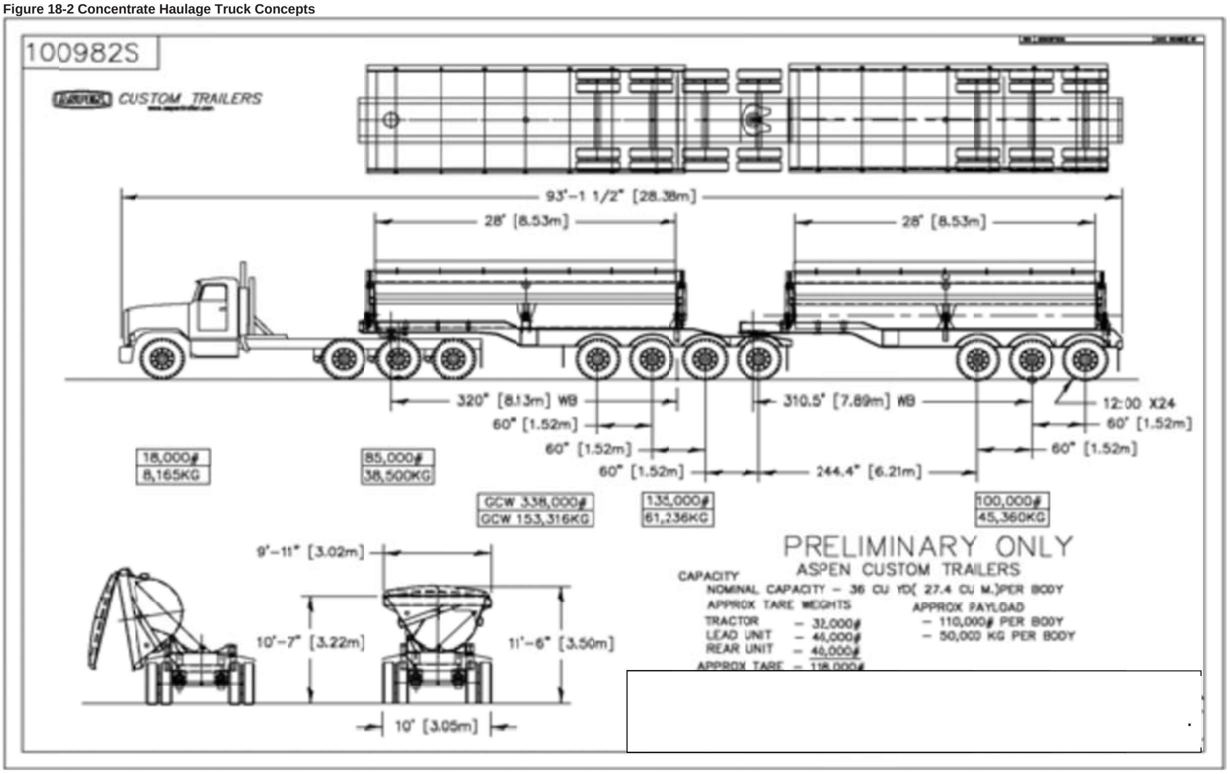
### 18.2.2 Concentrate Haulage

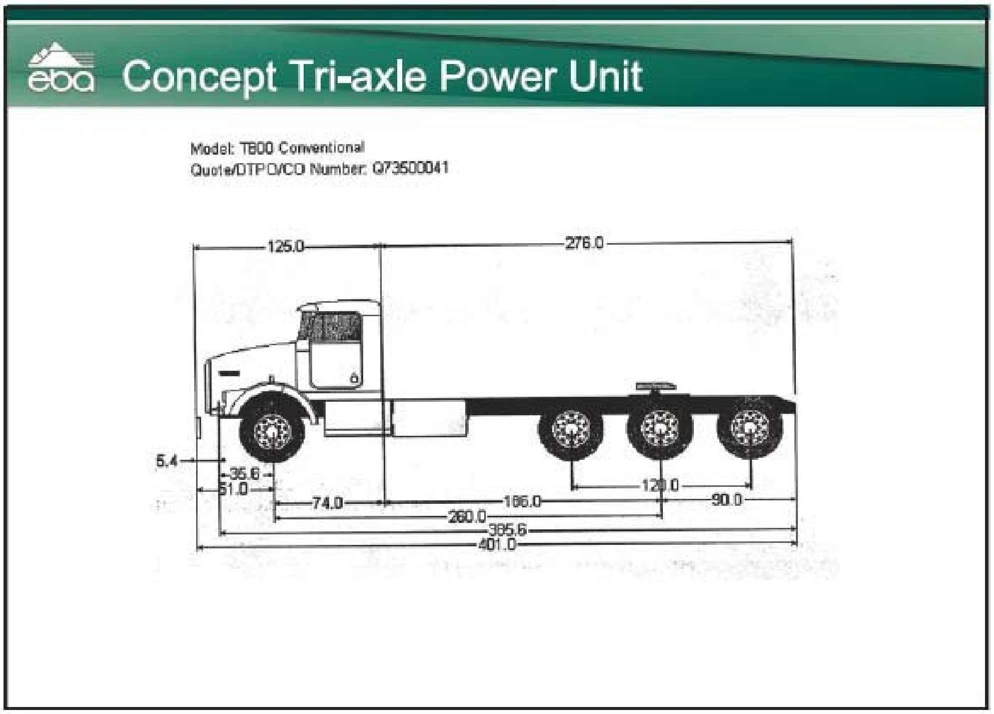
Past and present Red Dog concentrate haulage operations have proven that specialized, large 120 tonne capacity vehicles have significant advantages over “highway standard” trucks in the haulage scenario associated with the Lik concentrates.

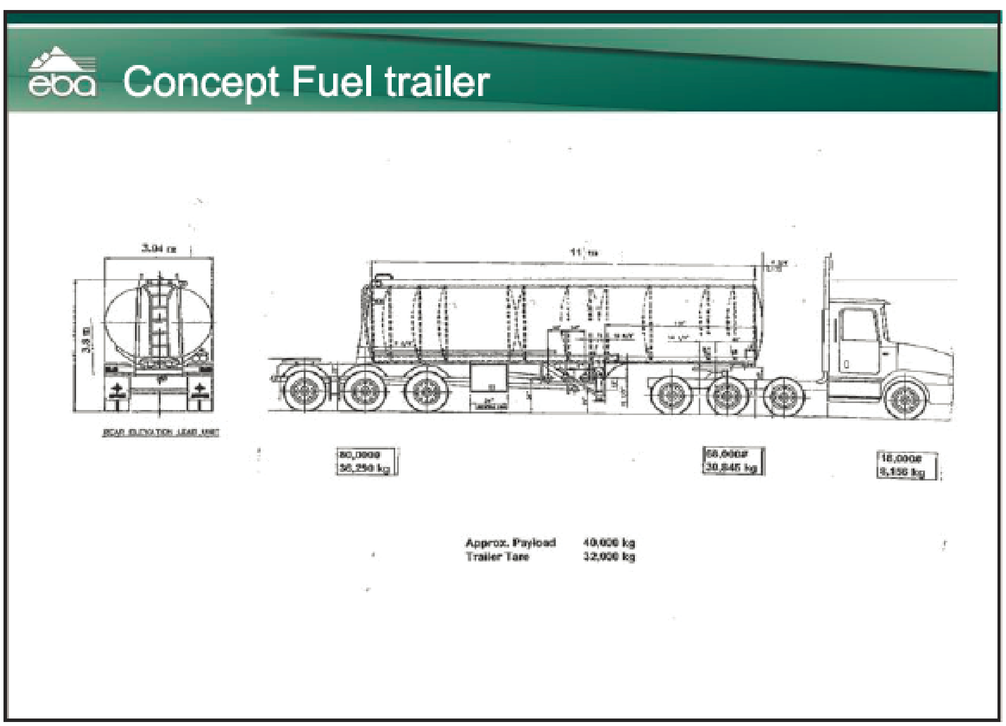
The economic advantages of the larger trucks include reduced manpower, equipment numbers and traffic on the road (2,344 trips at 120 tonnes per load vs. 3,860 trips at 85 tonnes). Also, contracting out the haulage has proven to be economic.

For these reasons, haulage of concentrates to port is based on utilizing the 120 tonne units as presently used by Red Dog. Haulage costs have been quoted by the present Red Dog contractor, NANA Lynden, at $12.454 per (wet) ton with fuel supplied by Lik.

**Figure 18-2 Concentrate Haulage Truck Concepts**




eba
Concept Tri-axle Power Unit
Model: T800 Conventional
Quote/DTPO/CO Number: Q73500041
125.0
276.0
5.4
35.6
51.0
74.0
186.0
120.0
90.0
260.0
385.6
401.0


eba
Concept Fuel trailer
3.04 m
3.8 m
11 m
80,000#
36,290 kg
68,000#
30,845 kg
18,000#
8,150 kg
Approx. Payload 40,000 kg
Trailer Tare 12,000 kg

### 18.2.3 DMTS Port Facility

PND Engineers, Inc.'s report, "*Capacity Analysis for the Delong Mountain Port Facility in Support of Developing the Lik Deposit*" (October 2010) provided a summary of existing conditions and suggested alternative modifications required to accommodate Lik.

Studies supported by AIDEA/Zazu are ongoing.

The facility is owned by AIDEA and is operated and maintained by Teck, currently the only user of the facility.

The onshore infrastructure includes a truck dump, two concentrate storage buildings (CSBs), a materials handling conveyor/surge system, a fuel storage tank farm, a supply laydown area, maintenance facilities, a power station, water and sewage treatment plants, an accommodations camp and offices.

The offshore concentrate loading facility is made up of three 20 m diameter sheet piled mass filled closed cells in parallel, spaced to extend 500 feet out to sea to accommodate the loaded 5 m draft of the concentrate barges. These barges transport and transfer the concentrates to larger ships anchored further offshore in deeper water.

Barge loading can be carried out on either side of the concentrate loadout dock. No physical changes are anticipated to be required to accommodate the concentrates from Lik.

A fixed swivel, luffing, telescopic ship loader is mounted between the two outer piles and is fed by the load out conveyor system. Loading can be achieved from either side of this dock.

Dredging in the area of concentrate barge load out facility is sometimes required.

The existing bulkhead dock is used to unload mine supplies and fuel. To allow for the additional Lik traffic and to eliminate any interference with future increased concentrate load-out operations, the width of the face of the dock needs to be doubled.

Weather conditions restrict port operations to approximately 90 days per year. While Teck is in charge of the port operation, Fednav control overseas shipping and Foss Maritime own and operate the tugs and self-unloading concentrate barges. NANA Corporation owns the land surrounding all of the present facilities.

***On Shore Port Operations with Zazu Lik***

The existing port facility, with modifications, has the capacity to handle the additional Lik concentrate production. As outlined in the PND October 2010 report, the truck dump, concentrate storage, fuel storage, laydown facilities, conveyor/surge system and port load-out facilities adequately accommodate the Red Dog production. To accommodate the Lik concentrates and supplies, assuming financing arrangements are reached with AIDEA, NANA and Teck, the infrastructure can be combined into one system.

Required modifications to the port infrastructure will include allotment of space for Lik concentrate storage within the existing concentrate storage buildings, along with possible upgrades to the existing truck dump, materials handling systems, power generation, camp ancillaries and possibly the construction of some additional office space. Present camp accommodation capacity should be adequate for any additional manpower required to support the modifications resulting from the additions to manage the concentrates and supplies from Lik. Order of magnitude capital for the anticipated port infrastructure modifications is estimated at $2.5million. Additional manpower requirements will be minimal.

An ideal situation would be one in which Teck assumes responsibility for shipping both theirs and Lik's concentrate production. Such an agreement would be advantageous to both Teck and Zazu. It should be noted that Teck is currently a 50% owner of the Lik property which should help promote interest in sharing the facilities and responsibilities.

### *Concentrate Storage for Lik*

The adequacy of the existing CSB's at the port site to accommodate both Teck's Red Dog Mine and the Lik concentrates during the non-shipping portion of the year is currently being re-evaluated. The Lik site will require additional concentrate storage facilities to be constructed. These have been accounted for in the capital estimates for Lik.

Concentrate storage facilities will be required at both the mine site and the port. Thought was given to reversing the Red Dog set up of having four months' storage at the mine and eight months' at the port (i.e., eight months' storage at site and four months' at the port); however, this idea needs further study. For the present it has been assumed that sufficient concentrate storage will be available to accommodate both the Teck Red Dog Mine and the Lik concentrates.

### *Port Materials Handling Systems*

Theoretically, the existing load-out materials handling system has the capacity, over the 90-day climate-driven operating window of the port, to move roughly twice the tonnage presently exported. However, in practice, weather issues hinder seamless operations. In an effort to decrease the barge loading time, a study by Agra (*DMTS Concentrate Storage and Handling Capacity Study)* in 1999 concluded that the 1,800 ton-per-hour capacity conveyors could be upgraded to move 20% more product. The requirement for such a modification is part of the ongoing port capacity work commissioned by Zazu, in conjunction with AIDEA/NANA. The results will be accounted for in the next level of study.

### 18.2.4 Maritime Operations

***Concentrate Barges***

The present Red Dog lightering contractor, Foss Maritime, owns and operates the tugs and the two 5,800 t self-unloading barges.

The present barging operation is manpower intensive, requires extensive marine support, and is somewhat unsuitable for the weather/sea conditions. Turnaround is slow, requiring some seven hours cycle time to move one load from concentrate storage building to barge to ship and barge return to loading dock to receive the next load.

Although well maintained the transfer barges have the following limitations:

- They are not self-propelled. A tug is required for propulsion with additional tugs being required for maneuvering and mooring. During the site visit in July 10, 2010, four tugs were in full-time attendance supporting the unloading of one concentrate barge. A fifth tug was at anchor with the other barge.
- The discharge boom on each barge, is arranged for either port or starboard operation (location of the operator cabin and boom rest), hence there is no flexibility in loading or unloading as each barge is restricted to operate on the side configured.
- The barge reclaim bucket elevator and discharge boom has insufficient elevation to reach over the side of “Panamax” vessels while empty. Ships have to be ballasted until they are partially loaded. This also restricts operating to a sea swell exceeding three feet. This is a major concern as the majority of vessels chartered today are “Panamax” ships.
- The unloading rate, depending on boom angle, averages approximately 1,800 t/h. Unloading is assisted by front-end loaders (FELs) in the barges.
- Barges have been in service for some 20 years. The useful barge life has not yet been determined.

To accommodate the Lik concentrates, the lightering contractor will need at least one more barge of similar capacity. For efficiency, the new barge(s) should be self-propelled with a material handling system suitable to operate in sea states typical for the area. Including capital for new equipment, lightering costs are estimated by Lynden NANA at $17.35/t (wet), with fuel supplied by Lik.

Foss marine declined to quote on lightering citing their contractual obligations to Teck at Red Dog Mine.

***Ship Charters***

Presently, Fednav is responsible for the chartering and loading of the ships. From the 2010 Shipping Season Schedule, ships arrive every three days through the shipping season. It was reported that at times up to five ships are waiting to be loaded. Three ships were at anchor awaiting loading during our site visit on July 9, 2010.

Upgrading the on shore facilities, along with additional barging capacity (if deemed warranted by the ongoing capacity study) will provide the required facilities to accommodate the efficient export of Lik concentrates.

***Weather Reporting***

The onsite Foss Maritime supervisor makes the decision on when ships can be safely loaded. The decisions are based on the NOAA National Weather Service as well as weather forecasts provided by a private company. Reports are received twice per day. Accuracy of the forecasts, particularly with regards the arrival time of storm fronts, is not reliable and hence is an issue for go/no-go decisions.

It has been suggested that navigation buoys, placed at intervals out to sea, could provide real time wave and wind speed information to the port operations. This “local” Information would be a more reliably forecast of when storm fronts are expected to reach the port .Such accurate weather forecast information would certainly positively influence the “go/no-go” decision making process.

A $1M capital allowance has been included to support this purpose.

### 18.2.5 Annual Resupply Requirements

***Fuel***

Diesel will be the only fuel used on site for power generation and mine operations. Annual requirements are estimated at approximately 34,000,000 litres. Included in this quantity is fuel for port power generation as well for contractor port and trucking operations.

Based on the recharging cycle, new port site storage will include a 263 L capacity tank farm and upgraded fuel pumping system. Fuel from Alaskan refineries will be supplied by barge within the 90 day operational window typical for the port.

Crowley Marine Services estimate fuel delivered to port at $1.03/L and Lynden NANA estimate $0.03017/L to deliver the fuel from port to site. Hence, diesel delivered to site is estimated to cost $1.06/L. Allowance has been made for fuel that will be used by the trucking contractor.

*Annual Materials Re-Supply (Sea Lift)*

An additional 15 acre fenced cold laydown area will be required to store the estimated 34,500 t of annual supplies required to sustain mine operations. These supplies will be delivered in three shipments by 30 X 121 m barges and transferred to site by conventional tractor trailer truck units. The bulk of the supplies will be received in ISO containers. Lynden NANA estimated $18.39/t to transport cargo from the port to the mine site.

Pricing excludes fuel which will be supplied by Lik.

Crowley Marine Service's budget costs for each sea-lift shipment is $1.75 million plus $15,000 per day demurrage in excess of four days in port. Assembled empty containers from the previous sea lift, along with items no longer required on site, will provide backhaul loads for the barges.

While the existing barge bulkhead dock is theoretically adequate to handle requirements of both mines, to avoid congestion with this operation and the loading out of concentrates, the dock will be extended to accommodate two 121 m long barges. Capital for this work is included in the port estimate.

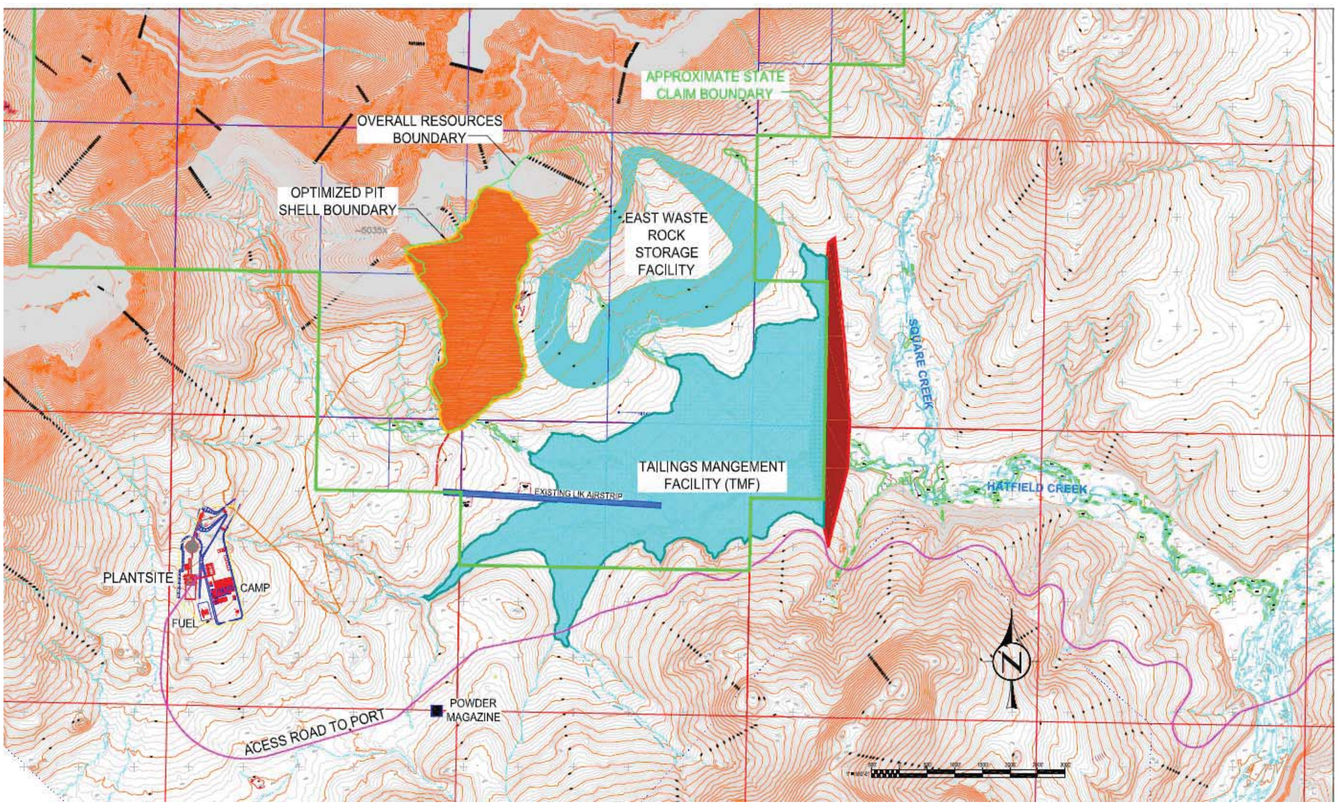
## 18.3 On-Site Infrastructure

To support on-site mining and processing operations a power supply, equipment repair workshop, explosives magazines, explosives emulsion facility, warehouse, engineering offices, mine dry, administration offices, first aid station, concentrates storage (Pb and Zn divided), fuel/lubricants storage and an accommodation complex will have to be built on-site. Also required is an all-weather airstrip capable of handling shift changes as well as serving as the alternative access to the site.

### 18.3.1 Site Plan

The proposed layout of the facilities to exploit the Lik resource is shown on Drawing, Figure 18-3. The layout takes into account the footprint required for waste dumps and the tailings storage facility. The process plant and other surface facilities are strategically located to allow for the possible future development of the adjoining Su deposit.

**Figure 18-3: Overall Site Plan**



### 18.3.2 Tailings Management Facility

The design captures the life of mine tailings, and all site runoff and is located so as not to interfere with flows of Square Creek.

It is recognized that if the on-site airstrip is to remain in use, future earthworks will be necessary to maintain the runway above the level of the deposited tailings, plus freeboard to account for containment of storm water.

It has been assumed that a significant portion of the material needed for construction of the TMF will come from pre-stripping and stripping operations of the pit. This is reflected in a relatively low cost estimate for the construction of the TMF.

Geotechnical studies are underway to confirm the suitability of the site.

### 18.3.3 Airstrip

The present plan is to upgrade and widen the existing private airstrip at the Lik site. Costs include allowances for high intensity strip lighting along with a locator beacon, VHS radio and a GPS guidance system. The proposed strip is only suitable for “short take-off and landing” (STOL) aircraft with “restricted loading” and its location in the valley, limits operations to “visual only flight rules” (VFR).

Given that the proposed all-weather access road to Lik is approximately 40 km from the sealed Red Dog aerodrome, further study and negotiation with Teck - Red Dog is recommended to enable Lik to use this existing all-weather instrumented facility for air access. The advantage of using commercial jet flights from Anchorage, followed by an approximately 45-minute trip to the site by road would be safer, more reliable, and competitive with the overall costs of the restricted on-site strip operation.

### 18.3.4 Power Supply

A reliable power supply at the Lik site is essential for the year-round operations. Initial studies indicate that a multiple engine diesel generator station will provide a practical solution. For this study, based on a nominal N+2 configuration the station will consist of eight containerized 1,800 rpm, 2.725 MW diesel generator sets to supply the 13.24 MW base load (six engines on load, one on maintenance and one on standby). The specified engine generator sets and switch gear are designed to operate virtually un-manned.

Exhaust gas heat exchangers on each engine exhaust system will capture the waste heat for space heating of the process plant, and other occupied site buildings. Low grade heat from the engine radiators will be utilized for in-floor heating on the repair shop floor. One engine will be delivered and commissioned early and used to provide the power supply needed during construction.

Given the multiple engine configuration, no additional emergency generation capacity will be required on site.

Allowing for fuel and preventative maintenance power generation costs are estimated at approximately $0.27/kWh.

Alternative power generation facilities, which should be considered in future project development, include larger base load engines housed in a building and diesel-fired gas turbines. Given the base case scenario mine life, economics would preclude alternative power sources such as wind turbines.

### 18.3.5 Fuel Storage

To provide a buffer for delays in delivery from the port, one 11 ML fuel tank plus tankage for ancillary lubricants and fluids will be built within a bermed and lined tank farm in-line with current Spill Prevention Control and Countermeasures (SPCC) best management practices. Loading and unloading pumping facilities will be included.

### 18.3.6 Accommodations

A 216-room, self-contained accommodation complex including kitchen, dining and recreation facilities will be required initially to facilitate construction and then retained for ongoing operations. The camp will be of modular construction specified suitably for the artic conditions at Lik. Also supplied as part of the camp supply will be modular units built for the engineering offices, mine dry, administration offices and first aid-station.

A potable water treatment plant, sewage treatment plant and high temperature incinerator will complete the camp complex facilities.

The fully equipped environmental laboratory will be located in the camp complex office area and be designed to serve during both the construction and operations phases of the project.

Estimated capital cost for the complex, extrapolated from a similar recent artic project is $23 M. Similarly, contractor catering costs are estimated at $60.00/person/day.

### 18.3.7 Waste Disposal

Inert non-combustible waste will be buried in designated areas within the waste dumps.

Combustible waste will be collected and assembled in a vermin proof facility for batch incineration. Any waste deemed as unsuitable for on-site incineration or incorporation into the waste dumps will be collected and appropriately stored for shipment to licensed off-site facilities for disposal.

### 18.3.8 Water Supply

A water reservoir will be constructed on or adjacent to the plant site. At this time, site geotechnical and hydrological conditions are still being investigated. Indications are that an adequate supply of fresh water for the site will not be a problem; however, formal confirmation is yet to be established.

### 18.3.9 Warehousing

The annual sea lift re-supply cycle means that extensive warehousing facilities will be required for both weather-proof and cold storage. An estimate for a 30 X 60 m insulated building along with a 10 acres leveled, fenced cold storage area is included for this purpose. Commodities not requiring heated storage will be used as required, directly from the received ISO containers.

### 18.3.10 Concentrates Storage

To allow for weather and unforeseen circumstances when truck transport is not possible, separated undercover storage for some 15,000 tonnes of Pb and 75,000 tonnes of Zn concentrates will be required at the Lik mine site. Product will be moved in and out of the building by a front-end loader.

### 18.3.11 Work Shop

An insulated heated building complete with offices, service/repair bays, wash bay, overhead gantry cranes and warehousing for day use, lubricants and spare parts is required to provide mechanical, electrical and instrumentation services to maintain the fleet of mobile mining and miscellaneous site vehicles and equipment. Based on similar recent projects, the four bay facilities are estimated to cost $13.5 million.

### 18.3.12 Fire Protection

Fire hydrants will be located on the perimeter of each building. Smoke detection will be provided in all buildings including electrical rooms. Hand held hose stations will be provided within occupied work areas. Sprinkler systems will be provided for all areas of the camp and offices.

The modular power station will be supplied complete with fire detection and fire-fighting facilities.

All site fire detection/fighting will be monitored year-round.

### 18.3.13 HVAC

Occupied work areas will be heated by energy supplied predominantly from waste heat recovered from the diesel generators. An emergency boiler is included to provide heating of the camp facilities.

Reverse cycle air conditioning will be provided for the camp accommodations, offices and electrical rooms.

### 18.3.14 Explosives

Annual supplies will be delivered to site via the annual sea lift. The components that make up the explosives will be shipped in separate containers on separate barges.

***Ammonium Nitrate Storage***

Ammonium nitrate requirements will be supplied in supersacs and shipped to site in ISO containers. At site, a ground-level pad will be prepared for the containers to be stacked in rows. The contents of each container will be used throughout the year as needed.

A small operating storage pad will also be built adjacent to the emulsion plant.

Trade-off studies performed for other similar projects have shown benefits from the use of supersacs over bulk storage from both safety and economic points of view.

The size of the storage pad will be designed for approximately 3,000 t of ammonium nitrate. The smaller operating storage pad adjacent to the emulsion plant will hold approximately 500 t.

The ammonium nitrate storage facilities, emulsion plant, and explosives storage magazine are sited to the south the process plant site, with separation distances in accordance with the guidelines set out in the “MSHA Code of Federal Regulations-30 CFR. Part 1-90. Minerals Resources Department, Department of Labor Mine Safety & Health Regulations.”

***Bulk Emulsion Plant***

The emulsion plant equipment and explosives handling vehicles will be supplied by the explosives contractor. The design of plant building and fixed equipment is in line with facilities used at other remote mines.

***Explosives Storage Magazines***

Three explosives storage magazines will be constructed. A rock fill berm will be constructed adjacent to each magazine, per the requirements of the above MSHA Code. The magazines will separately hold boosters, delays, detonating cords, detonating caps, and other explosives accessories.

### 18.3.15 Fuel Storage

Fuel storage at the mine-site will be used to store and dispense fuel for the on-site power generation facility, mining fleet, and support vehicles and equipment. All mobile equipment on-site will be diesel powered so that only diesel fuel will require tankage/storage.

# 19.0 Market Studies and Contracts

## 19.1 Market Studies

At this time, no market studies have been completed as the zinc and lead concentrates to be produced at Lik are anticipated to be of a quality that can be readily sold in the open market. General concentrate terms and parameters were used in the economic analysis of the project. The details of these terms can be found in Section 22 of this report.

## 19.2 Contracts

No contractual arrangements for concentrate trucking, port usage, shipping, smelting or refining exist at this time. Furthermore, no contractual arrangements have been made for the sale of zinc or lead concentrate at this time.

## 19.3 Royalties

The project is subject to a Net Profit Interest royalty of 1%. This was accounted for in the economic analysis of the project. An additional 2% net proceeds interest royalty is owed to GCO by Zazu, based on the percentage of ownership held by Zazu. Since the level of Zazu's ownership during development has not yet been defined, the royalty is being disclosed here, but has not been incorporated into the economic model.

## 19.4 Metal Prices

The base and precious metal markets benefit from terminal markets around the world (London, New York, Tokyo, Hong Kong) and fluctuate on an almost continuous basis. Historical metal prices for zinc, lead and silver are shown in Figures 19-1 through 19-3. These figures demonstrate the change in metal price from 1998 through to January 2014.

**Figure 19-1: Average Zinc Price as at January 31, 2014**

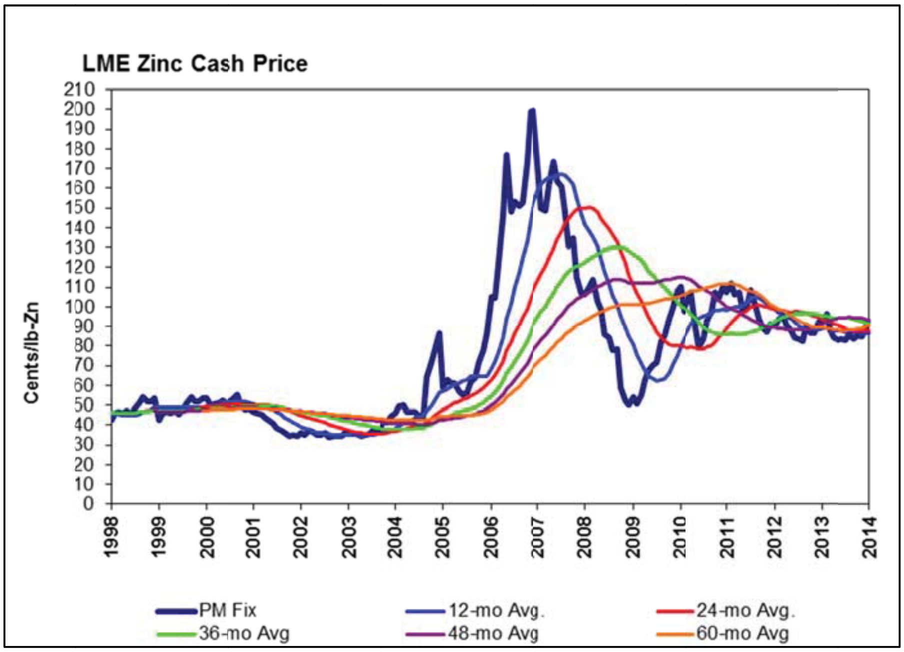



**Figure 19-2: Average Lead Price as at January 31, 2014**

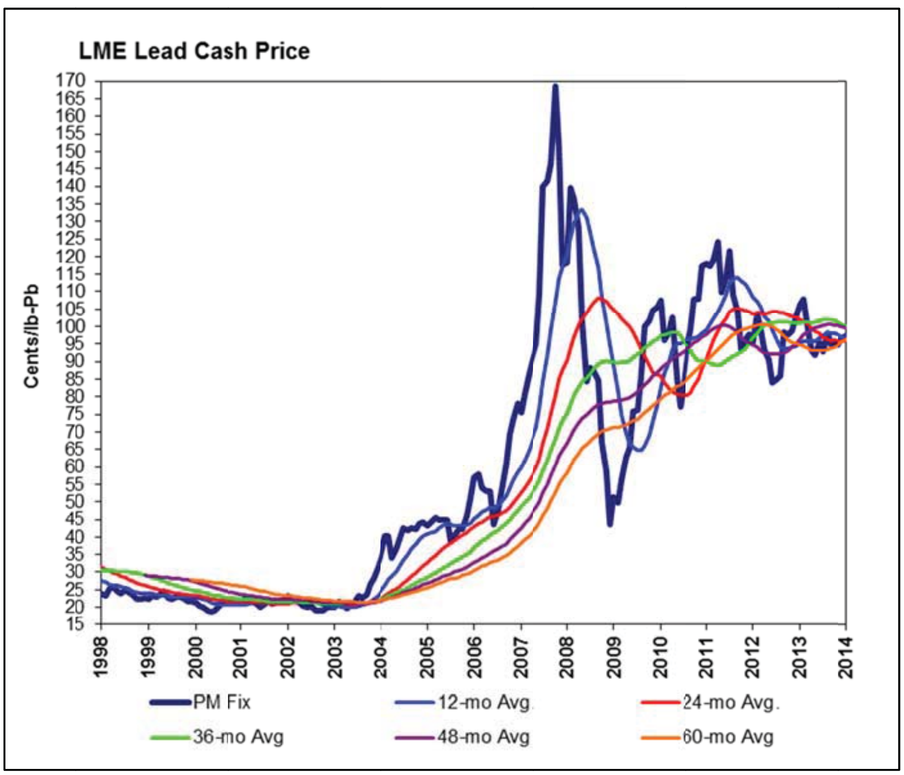


**Figure 19-3: Average Silver Prices as at January 31, 2014**

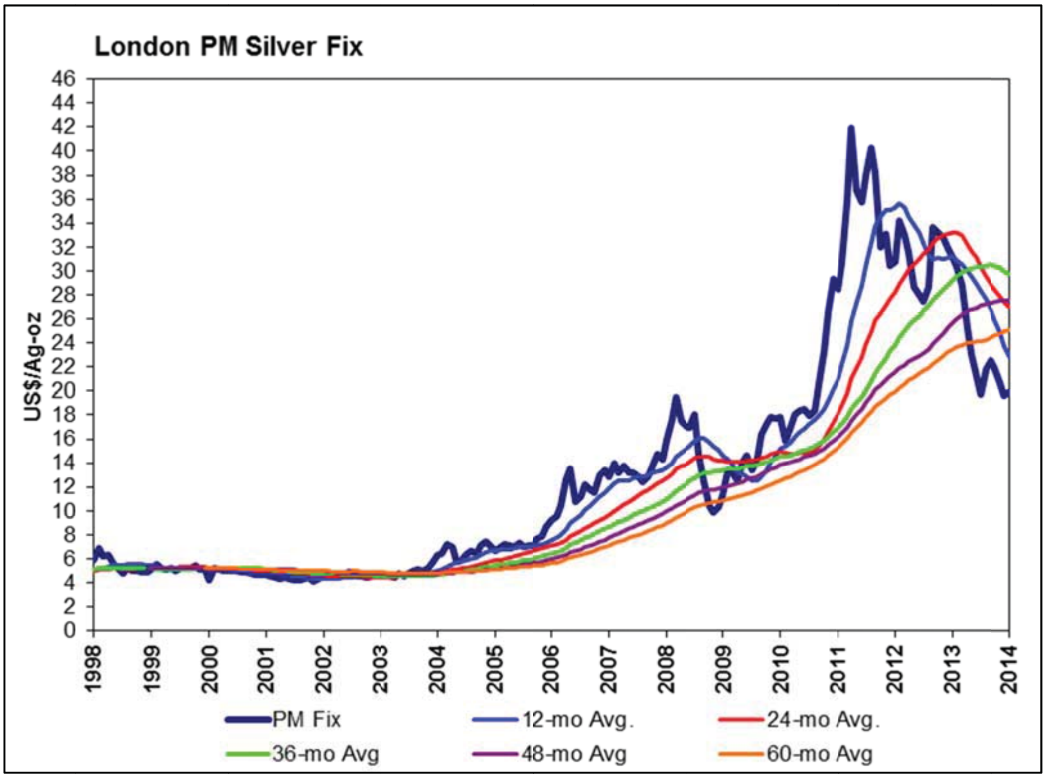



Table 19-1 outlines the metal prices, used in the various scenarios of the economic analysis. Three-Year trailing average prices are as at December 30, 2013. NSR Assumption pricing is based on three-year trailing average prices for both zinc and lead. Silver pricing for the NSR Assumption scenario is based on the spot price as at December 30, 2013. The Forward Pricing scenario utilizes the forward price of zinc as published by Bloomberg on January 31, 2014 and utilizes the same prices as the NSR Assumptions scenario for both lead and silver.

In addition to these two scenarios, the project was tested at various metal prices. These results can be found in the sensitivity analysis section of this report. NSR assumption pricing was used to develop the mine plan.

**Table 19-1: Metal prices Used in Economic Analysis Scenarios**

| Parameter | Units | NSR Assumptions | Forward Zinc Price |
|---|---|---|---|
| Zinc Price | US$/lb | 0.92 | 1.00 |
| Lead Price | US$/lb | 1.01 | 1.01 |
| Silver Price | US$/oz | 19.43 | 19.43 |

# 20.0 Environmental Studies, Permitting and Social or Community Impact

## 20.1 Objectives

Zazu selected Travis/Peterson Environmental Consulting, Inc. (TPECI) as the environmental consultant for the Lik deposit environmental baseline studies. The baseline studies were the first step of the environmental permitting process as dictated by the National Environmental Policy Act (NEPA). The main objective of the baseline studies was to characterize the biological, physical, and human environment of the project. TPECI evaluated the project in accordance with federal and state acts and regulations.

## 20.2 Site Description

### 20.2.1 Lik Deposit Project Area

The Lik deposit is located in the Wulik River valley approximately 18.4 km northwest of the Red Dog Mine in the DeLong Mountains, Alaska (Figure 20-1). The DeLong Mountains are within the western Brooks Range approximately 136 km north-northeast of Kotzebue and about 752 km northwest of Fairbanks. The Lik deposit is situated approximately 68°10’12.00” north latitude and -163°11’20.40” west longitude. The Lik deposit sits at approximately 243 to 274 masl within the northwestern interior of Alaska.

The greatest seasonal temperature contrast between seasons is found in the central and eastern portion of the continental interior. In this area, summer heating produces average maximum temperatures around 25°C with extreme readings around 35°C. In winter, the lack of sunshine lowers temperatures to -40°C and colder for up to two or three weeks at a time. Average winter minimums are -30°C to -35°C.

Mean annual precipitation in the northwestern interior ranges from 300 to 400 mm per year, rainfall and snow water equivalent.

Local stream hydrology is dominated by the Arctic climate. Winters last up to seven months, during which little to no flow occurs even in larger streams and precipitation accrues as snow. Permafrost is considered continuous throughout much of the region north of the Arctic Circle, except on some south facing slopes. According to the updated 2008 map of Permafrost Characteristics of Alaska, there is a greater than 90% occurrence of continuous permafrost in the western Delong Mountains region of the Brooks Range and north of the Arctic Circle. Surficial geology greatly affects permafrost characteristics because of differences in topography, soil texture (which affects moisture and thermal properties) and hydrology.

The proposed development sits among the headwaters of the Wulik River (Figure 20-2). The Wulik River is also fed by Ikalukrok Creek, which drains the area developed by the Red Dog Mine. The Wulik River discharges into the Chukchi Sea at Kivalina.

**Figure 20-1: Location & Vicinity**

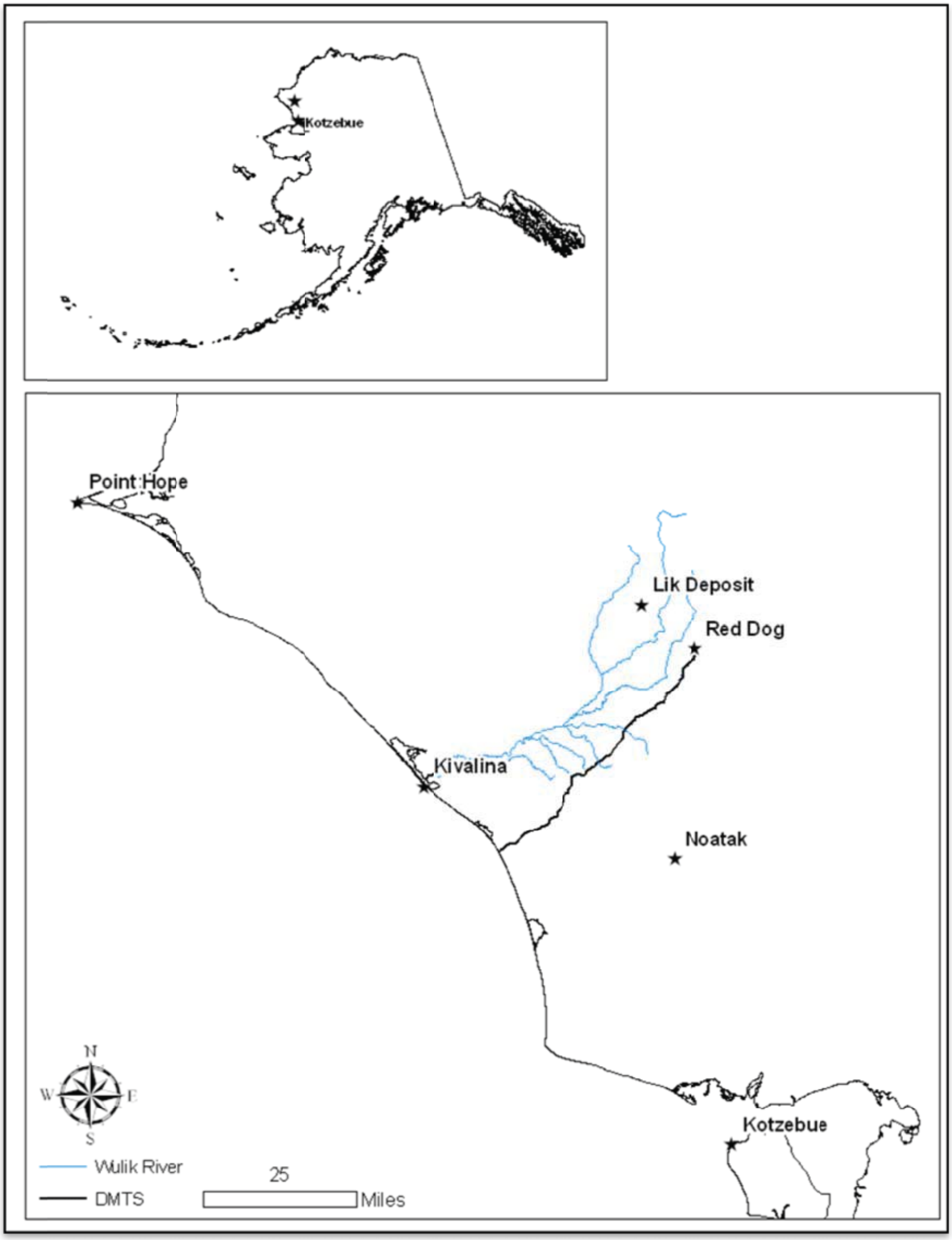
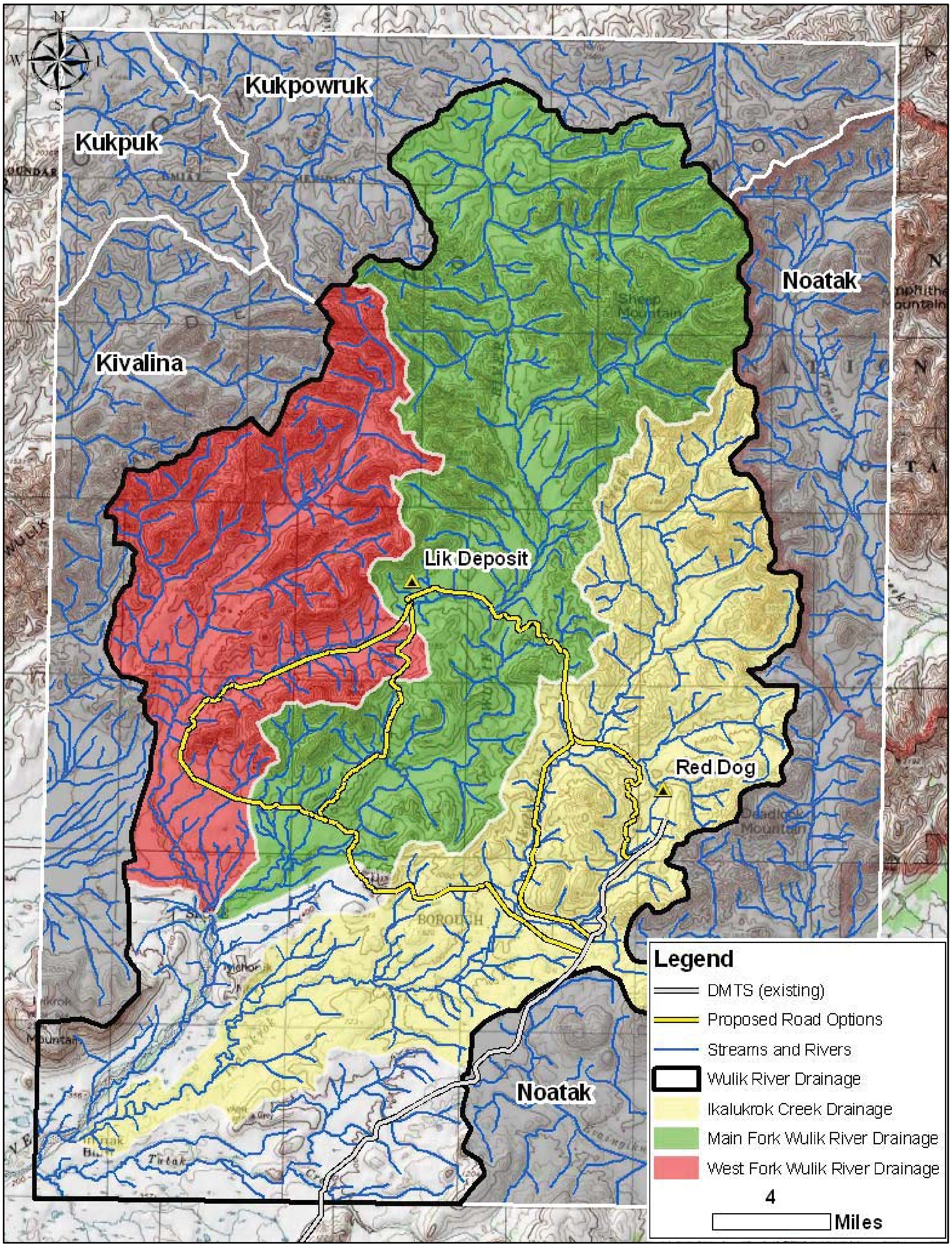


**Figure 20-2: Wulik River Drainage and DMTS**



The Lik deposit is situated within the Northwest Arctic Borough (NWAB) and will require a development permit. All mining claims are administered by the State of Alaska, Department of Natural Resources (ADNR) Large Mines Group. Final mine plan design approval will be via the ADNR Large Mines Group.

The ADNR and NANA Regional Corporation will need to be consulted to obtain a right of way approval for the haul road. Any wetlands that will receive fill will be coordinated through the United States Army Corps of Engineers (USACE) and through the State of Alaska Department of Environmental Conservation (ADEC) for wetlands permitting.

### 20.2.2 Lik Deposit Infrastructure

The Lik deposit is remote and isolated from surface transportation. Currently, minimal infrastructure exists at the Lik deposit. Facilities include a 1,219 m gravel airstrip and exploration camp.

### 20.2.3 Transport Haul Road Corridor

The proposed 35 km haul road corridor follows the Square Creek drainage to the Wulik River and travels east and south to connect to the existing Delong Mountain Transportation System (DMTS) south of the Red Dog Mine (Figure 20-2). The DMTS consists of a 83.2 km, approximately 9.1 m wide, all-weather industrial haul road, The DMTS road, designed to accommodate multiple users, leads from the mining district that includes the Red Dog Mine to a port site located on the Chukchi Sea, about 19.2 km south of Kivalina village.

The Alaska Industrial Development/Export Authority (AIDEA) owns the DMTS.

### 20.2.4 Port Facility

The DMTS port consists of a shallow dock, offshore conveyor concentrate loading facility, fuel distribution and storage systems, and support camp.

## 20.3 Jurisdiction, Applicable Laws and Regulations

### 20.3.1 Lead and Cooperating Agencies and Agency Involvement

TPECI anticipates the United States Army Corps of Engineers (ACOE) will be the lead NEPA agency for this project because of the wetlands present in the project area. Cooperating agencies include the Alaska Department of Environmental Conservation (ADEC), the Alaska Department of Natural Resources (ADNR), and the Alaska Department of Fish and Game (ADF&G).

Environmental Scoping will determine whether the NEPA process will involve the Environmental Assessment (EA) process or the Environmental Impact Statement (EIS) process will be followed. The nearest large mine, Red Dog Mine, used the Environmental Assessment process. The primary difference between the EA and EIS processes is duration and scope of public involvement. The scope of public involvement for an EIS involves an actual hearing process whereas the EA requires public notification and comment process whereby public comments and concerns are documented and incorporated into the larger decision making process of the project owner and lead environmental agencies.

### 20.3.2 Federal Environmental Assessment Process

Currently an EA is in progress for this project. Zazu anticipates the lead agency will be the USACE which regulates all jurisdictional wetlands and Waters of the United States. If the USACE deems the project impacts as significant, TPECI will upgrade the EA to an EIS.

### 20.3.3 Environmental Permitting

Overall project environmental permitting involves both federal and state agencies. Federal permitting involves the USACE for any wetlands associated permits. The State of Alaska permitting process is described below.

### 20.3.4 ADNR Large Mine Permitting Process

The ADNR Large Mines group will oversee the bulk of environmental permitting for the project. The larger permitting process will be activated once the project owner submits a memorandum of agreement to the ADNR for project cost recovery. The unified permitting process incorporates all State of Alaska regulatory permits for the following:

- Water use
- Land use
- Dam safety
- Waste disposal – solid waste, domestic waste, landfill waste
- Camp permits
- Fish and game Title 16 fish habitat permits
- Air quality.

A current timeline for this task has not yet been defined.

### 20.3.5 Biophysical Environment Baseline Studies

Environmental baseline data collection began for the Lik project in 2008 and continued through 2013. Data collection has included hydrology, water quality, cultural resources, fisheries, soils, vegetation, wetlands, and meteorology.

### 20.3.6 Study Areas Assessment Overview

The Lik project study area included the Square Creek drainage and all of its first order streams and leading into and including the Wulik River drainage to the east, and the Ikalukrok Creek drainage near the Red Dog Mine.

### 20.3.7 Meteorology and Air Quality

HMH Consulting, LLC performed the meteorological monitoring program over four quarterly periods from July 2011 through June 2012. Meteorological monitoring data collection adhered to the minimum data completeness criteria of ≥90% valid for hourly data per monitoring quarter as set forth in Chapter 5, Sections 3 and 4 of the U.S. EPA Meteorological Monitoring Guidance for Regulatory Modeling Applications (EPA/454/R-99-005).

Baseline field monitoring included a 10 m aluminum tower meteorological station situated just southeast of Lik camp. The sensors on the met station measured horizontal wind speed, wind direction, standard deviation of wind direction, vertical wind speed, standard deviation of vertical wind speed, 10-meter height temperature, 2 m height temperature, and solar radiation.

Average wind speed at the measurement site was 2.45 m/sec with a predominant wind direction out of the northeast. Quarterly wind directions varied slightly but remained predominantly aligned with the valley and is a typical behavior exhibited by valley wind flows.

The upper and lower temperature profiles recorded at the monitoring site are reasonable for a location within the Arctic Circle. The summer months were predominantly cool or mild with a considerable amount of variation in temperature throughout each month. July temperatures ranged from near freezing to above 20°C.

Based on the Noatak monitoring station records, which includes sky cover, the higher temperature measurements were recorded during days with clear weather. During the fourth quarter of 2011 and first quarter of 2012, there were many sustained periods of very cold temperatures with little diurnal variation, due to lack of solar heating as the days became shorter.

In many cases, the coldest wintertime records also correspond to clear weather, which is very reasonable considering that surface heat is lost to space during clear weather as opposed to being absorbed and reemitted by clouds. There were some cold wintertime temperatures (ranging from approximately -20°C to -23°C) recorded during periods of annual maximum wind velocity; however, these cold temperatures are relatively warm in comparison to the annual minimum of -40°C.

Total measured precipitation for the month of June, 2012 was 17 mm, total for the month of July, 2012 was 207 mm, for August, 2011 was 511 mm and for September, 2012 was 82 mm. In 2013, precipitation data was retrieved for June 2013 at 12 mm and for part of July 2013 at 34 mm. Precipitation is assumed to be in rain form unless air temperature data indicate snow producing conditions. For the purposes of this report, all precipitation measurements are assumed as rain.

### 20.3.8 Hydrology

Ward and Olson (1980) described the Wulik River as clear and fast, with riffles and pools in the mountains, and wide and slow with deep pools on the coastal plain. Surface water in the Lik project area is characterized by fluctuating streams that drain to the Wulik River. There are no lakes and ponds in the project area drainages. Ponds and wetlands are more abundant once Ikalukrok Creek and the Wulik River leave the DeLong Mountains to the south and west. In the mountainous Lik area, water storage is limited. Wetlands are generally limited to the areas immediately surrounding the stream channels.

Stream discharge and water quality data were recorded for the Lik Environmental Baseline study at 18 gaging stations from 2008 through 2013. There was no field program during 2010.

Water quality in the Wulik River and Ikalukrok Creek, and Square Creek basins is typically characterized by cold, clear streams having near neutral to alkaline pH, relatively high conductivity that generally increases throughout the summer as melt runoff decreases. Stream flow is typically highest in early summer then decreases throughout the summer usually reaching base flow conditions by September just prior to freeze up.

Stream hydrology sampling sites were selected to establish baseline data downstream of potential road crossings, in particular the east route and to establish baseline data downstream of any areas that may be impacted by mining and associated development. Baseline data was also sought in visibly mineralized streams within the deposit and road corridor area.

Tributaries of the Wulik are characterized by quick responses to precipitation meaning that discharge responds rapidly to storm events and hydrographs of storm events have steep rising and falling limbs with a short period of peak flow.

According to Ward and Olson, average precipitation in the area was 50 cm per year with most of the precipitation coming in the summer months. Ward and Olson claimed that groundwater storage was limited due to the continuous permafrost.

### 20.3.9 Hydrogeology

USGS maps indicate that the Lik deposit sits at approximately 275 to 290 masl. Surrounding peaks range from about 549 to 850 masl. The Wulik River flows at elevations of about 198 to 213 masl.

The smaller streams in the Lik project area can be characterized by heavy spring *aufeis* deposits. Groundwater springs contribute flow to the many smaller streams within and surrounding the project site.

### 20.3.10 Aquatic Resources and Water Quality

There are no lakes within or near the project area. However, the project area is situated within a freshwater stream ecosystem dominated by oligotrophic streams and rivers. Many of the streams located in the Lik deposit area are unlikely to have significant areas of wetlands associated with them because of the terrain and soil conditions. Many of the mountainous streams have limited basin storage capacity. Since wetlands provide storage, their presence in the steepest parts of the watershed is minimal. The discharge slope below Lik camp is a wetland that collects much of the basin runoff not captured in streams.

### 20.3.11 Estuarine Ecosystems

The Lik deposit is approximately 144 km from the nearest coastline estuarine ecosystem. The existing port facility has a loading dock that protrudes several hundred feet into the Chukchi Sea. The sea bottom is flat and packed with tight sediments. This area is subjected to fierce storms and erosion.

### 20.3.12 Fish and Fish Habitat

The Lik project is in the Wulik River drainage, which lies within the Chukchi Sea sub-area of the Northwest/North Slope Management Area. The entire Wulik River, including both the main stem and the West Fork, plus the lower reaches of Ferric Creek, Square Creek (also known as Hatfield Creek and Lower Lik Creek), Sunday Creek, and an unnamed nearby creek are listed in the ADF&G Catalog of Waters Important for the Spawning, Rearing or Migration of Anadromous Fishes and its associated Atlas (the Catalog and Atlas, respectively; ADF&G, 2005).

The Wulik River is important to fishes (especially Dolly Varden) of several river systems, including the Noatak and Kivalina rivers. In fact, ADF&G reports (e.g. Scanlon, 2008) use the term “Kotzebue-area” Dolly Varden, to reflect the fact that those fish move among those various river systems. Much of the fisheries data for the Wulik River system were gathered in relation to the Red Dog mine; that is, they focus on Ikalukrok Creek, and the lower Wulik River below its confluence with Ikalukrok Creek.

Anadromous Dolly Varden make their first seaward migration at age 3 or age 4, and after moving to sea in the spring to feed during the summer, they return to freshwater each winter.

Upon reaching sexual maturity at ages 6 - 9, they return to their home river to spawn. Each fall, nonspawning Dolly Varden return to freshwater to overwinter in mixed-stock aggregations (Scanlon, 2008). Most Norton Sound Dolly Varden are summer spawners and may (1) overwinter in their natal stream, move upstream to spawning areas in summer, and move back downstream to overwintering areas until the following spring when they migrate out to sea; or (2) they might overwinter in non-natal streams, migrate out to sea in the spring, and move directly to their natal streams to spawn. A genetics study, funded through the U.S. Fish and Wildlife Service (USF&WS) Office of Subsistence Management also found that the Wulik River provides overwintering habitat to Dolly Varden from many river systems (Crane, DeCicco, Spearman, & Wenburg, 2005).

The Wulik River is also well known as an excellent fishing destination for large Dolly Varden. The river is about 144 km long and enters the Chukchi Sea through Kivalina Lagoon near the village of Kivalina. Dolly Varden from the Wulik River are heavily used for subsistence by the residents of Kivalina. During the most recent five-year period for which data are available (2001-2005), estimated sport fishing effort has averaged about 500 angler-days.

Sport fishing occurs throughout the open water period, but the majority of effort and harvest occurs during late August and September when Dolly Varden return from the sea to winter in the river (Scanlon, 2008). There is very little fisheries information on streams in the area of the Lik site, or on the myriad smaller streams that might be crossed by the three possible Lik transportation corridors, apart from data collected by Graystar Pacific Seafood Ltd between 2008 up to the present.

Recent data from Graystar Pacific Seafood Ltd showed that small Dolly Varden were the only species captured or observed in 2013 and those fish were more abundant in September, and less abundant in July. Adult Dolly Varden were observed in upper Hatfield Creek in September 2013, which corroborates similar observations from September 2011 (sport angler) and September 2012 (Graystar).

### 20.3.13 Soils

A preliminary soil survey of the Lik project area was completed in 2011. Survey sites consisted of points along the future road corridor and within the footprint of the mine development and tailings facilities.

Pursuant to existing mining regulation, growth media will be required for the mine site and associated infrastructure, including the road corridor. Available growth media should be salvaged during construction and stockpiled until required at the end of mining.

Growth media for mine land reclamation encompasses a widely divergent range of materials that includes organic materials to weathered rock. Ultimately, the primary criterion for growth media is that it possesses qualities that enable plant growth (i.e. top soil, peat, and sand).

The soils of the DeLong Mountains have been mapped at a reconnaissance scale by the U.S Department of Agriculture, Soil Conservation Service (USDA, 1979). The reconnaissance survey was performed at a scale of 1:500,000 aerial photograph interpretation, with limited ground survey activity. Hence, the resulting mapping is an identification of soils associations correlated to geomorphic features. The soils of the western DeLong Mountains primarily consist of soils from five of the soil orders:

1. Gelisols
2. Inceptisols
3. Spodosols
4. Mollisols
5. Entisols.

### 20.3.14 Ecosystem Mapping

The project site is situated within the western Brooks Range of Alaska, which is the northernmost extension of the Rocky Mountain range. In particular, the DeLong Mountains are host to the Lik deposit and possess steep angular summits of sedimentary and metamorphic rock draped with rubble and scree (Nowacki, 2001). To the west and east, the topography becomes less rugged including more flat-topped mountains flanked by stepped slopes reflecting emerging bedrock conditions.

High energy streams and rivers are found within narrow ravines with steep headwalls that etch a deeply incised, dendritic pattern into the surrounding terrain (Nowacki, 2001). Many braided streams and rivers are present with highly variable seasonal discharge, clear, cold water, abundant arctic char, and arctic grayling.

Lakes are not typical in this part of the Brooks Range. Smaller streams typically freeze to the stream bottom causing large *aufeis* formations throughout the winter and early spring.

During summer months, the larger aufeis formations provide refuge from heat and mosquitoes for migrating caribou herds. The area supports caribou, musk ox, arctic ground squirrels, a variety of birds of prey, including peregrine falcons, wolves, and grizzly bears.

Permafrost is contiguous in most parts of this region excepting some southerly hill slopes. The dry climate here has short, cool summers and long, cold winters (Nowacki, 2001).

### 20.3.15 Vegetation

Vegetation within the project area includes mixed shrub-sedge tussock tundra with willow thickets along rivers and streams (Nowacki, 2001). Alpine tundra is predominant at higher elevations and ridge crests. For south facing slopes, and low mountain slopes areas are comprised of sedge tussocks and shrubs including dwarf birch and a variety of willow species. The entire project site is north of Arctic tree line.

### 20.3.16 Wildlife

The following sections discuss habitat, early wildlife studies in the Lik area, current wildlife information, project specific wildlife data, and rare and endangered species in the project area. The Lik deposit and the proposed transportation routes fall within the Arctic Tundra Division, near the border of the Brooks Foothills and Brooks Range eco-regions according to the classification system of Spencer et al (2002). As such, the region is characterized by open, wind-swept lands with precipitation less than 50 cm per year, cool summer temperatures, little to no tree growth, and continuous permafrost. The eco-regions of the Arctic Tundra Division support Arctic char, Arctic grayling, Arctic cisco, broad whitefish, least cisco, Dolly Varden, salmon, wolves, Arctic foxes, grizzly bears, caribou, muskoxen, Dall sheep, shorebirds, ducks, geese, swans, songbirds, and other animals(Spencer et al., 2002).

One of the three avian and small mammal study areas was near Lik Camp, and large mammals were studied over broader areas. With respect to large mammals, Douglass et al. (1980) concluded that large numbers of caribou could come in contact with the development area, even though it is on the periphery of the Western Arctic Caribou Herd range at the time; Dall sheep summer north of Lik camp and may winter on the mountains closer to Lik camp; muskoxen occur at low densities since their reintroduction at Cape Thompson; moose are common in riparian habitats of most drainages of the area; and grizzly bears are common and will probably suffer the most from human encounters when the human density increases or if mining activities occur in grizzly bear denning areas.

According to Roseneau (1979), caribou would be most impacted by activity in the Lik region during four activity-related periods. From late April to early June, spring migration brings caribou near the proposed activity in the Western DeLong Mountains. Fall migration passes the Lik region from mid-September through early October. Early winter movements near Lik occur from very late October through mid- to late November.

Migratory periods are longer than mentioned above, but the above time ranges describe the periods of greatest contact between caribou and the project area.

Troy (1980) reported on the non-raptorial birds in the mineral development area of the DeLong Mountains. The most commonly seen birds are as follows: Lapland longspur, white-crowned sparrow, tree sparrow, redpolls, savannah sparrow, black turnstone, gray-cheeked thrush, fox sparrow, American robin, whimbrel, American golden plover, long-tailed jaeger, Wilson’s warbler, bar-tailed godwit, and semipalmated plover. The highest densities of non-raptorial birds were found in riparian shrublands and shrublands, followed by tussock shrublands, exposed alluvium, and mat cushion.

Moose recolonized and expanded their range through game management area 23 from the 1920s through the 1940s (Dau, 2008). Moose census activity for the unit was not located particularly near the Lik deposit or proposed transportation routes; however, moose harvest in the Wulik and Kivalina drainages has been low, but steady over the 20 years between 1983 and 2002 (Dau, 2004a; Dau, 2008). An estimated 10 moose were harvested by residents of Kivalina in 2006-2007 and an estimated six moose were taken by residents of Noatak in the same year (Dau, 2008).

## 20.4 Environmental Survey and Anticipated Impacts

### 20.3.17 First Analysis from Previous Studies

The Lik deposit is located on Federal Lands within the DeLong Mountains, approximately 193 km northeast of Kotzebue, Alaska. Development in the area includes the construction and maintenance of a camp facility. There are four above-ground storage tanks that provide for a total maximum of 22,712.5 L of diesel fuel stored on site. A Spill Prevention and Countermeasure Control plan has been prepared for the tank farm in 2008 by TPECI (TPECI, 2008).

Due to the preliminary status of exploration at this site, there have been very few previous environmental reports of the area. A comprehensive EA is currently in the development phase as are acid rock drainage, major basin, and minor basin environmental studies.

### 20.3.18 Design of the Environmental Survey and Anticipated Impacts of the Project

The EA currently in development for the Lik deposit study area will present the planned action, alternative actions, as well as the current state and anticipated impacts to the surrounding physical, ecological, and socioeconomic environment. The purpose in the preparation of this document is to provide government agencies as well as any affected individuals information from which to evaluate and provide input for the proposed actions.

## 20.4 Environmental Management

Future development of the mine facilities, haul road, and expanded port facility may affect a range of terrestrial habitat types and aquatic habitat types and wildlife species. Mining operations may have impacts on air quality at the mine site and along the gravel haul road due to increased haul traffic. The scope and nature of the Environmental Management System (EMS) will be related to the nature, scale, and complexity of the future mine development at Lik. The following is an example of an EMS that would be implemented for this project:

- Implementing an environmental monitoring program concurrent with the development and operation of the Lik deposit
- Development and management of an audit system for the EMS to ensure compliance
- Preparation and publishing of quarterly monitoring reports
- Submittal of all quarterly monitoring reports to the ADEC.

## 20.5 Tailings and Waste Rock Management

### 20.5.1 Tailings and Management Facilities (TMF) Design Basis

The preliminary site layout is underway, as is a study to determine the expanded tailings capacity of the area and a road route and waste rock facility.

### 20.5.2 Tailings Management Facility Design

The TMF is still in the design phase. Preliminary plans have located a site south of the mill area by the airstrip, along with associated infrastructure such as an access road.

### 20.5.3 Waste Rock Management

The waste rock management facility is currently in the design phase. Additionally studies of the areas drainage and the acid rock drainage properties are in development.

### 20.5.4 Waste Rock Disposal

The waste rock management facility is currently in the design phase. Final plans will depend on the results of area drainage studies, acid rock drainage studies, and the final mine design plan, all of which are currently in development.

### 20.5.5 Hydrogeology

Due to the Lik deposit location at 68°N longitude, the area is expected to be dominated by continuous permafrost. John Williams (1970) wrote on the relationship between permafrost and groundwater in Alaska. Williams estimated that in Kotzebue, south of Lik, permafrost was continuous from depths of 5.8 to 72.5 m. As found by Williams, permafrost can limit the utility of an aquifer through the freezing of any available water in that layer.

Permafrost can also serve as a confining layer, but if permafrost extends to great depth, accessing aquifers below may be impractical. Presence of permafrost may serve in isolating groundwater from surface waters in the proposed mine area. The presence, condition, and ice-richness of the permafrost in the area would need to be evaluated prior to determining the impact of permafrost in the area.

Base flow in late winter (April 2009 sampling event) is expected to reflect shallow groundwater conditions. Additional data includes in situ measurements at one open spring on Ikalukrok Creek and several drilled pressure ridges.

Comprehensive information on hydrogeologic conditions of the area will be included in the Environmental Assessment, which is scheduled to be completed in February 2016.

### 20.5.6 Hydrology

The Hydrology of the Lik study area is quite complex as numerous creeks provide drainage of the area into the Wulik River. The Environmental Assessment for this project will include the baseline environmental data collected from streams within the project footprint. Additionally, a minor basin analysis is scheduled to be completed in January 2015, and a major basin analysis to include a Hydrology Report, Break up Study, and a Hydrology/Scour report is scheduled to be completed in August 2014.

### 20.5.7 Water Management

Water Management practices will be developed once a greater understanding of the hydrologic and hydrogeologic properties of the area is achieved. Drainage studies, as well as the Environmental Assessment, and the major and minor basin studies are all in the development phase.

## 20.6 Remediation and Mine Closure Requirements

The reclamation and closure plan is currently in development. This plan is scheduled to be completed in February 2016.

### 20.6.1 Remediation Pre-Planning

The reclamation and closure plan is currently in development. The plan is scheduled to be completed in February 2016.

### 20.6.2 Objectives and Scope of the Remediation, and Mine Closure Plan

The mine closure plan will be constructed to meet the requirements of the Alaska Department of Environmental Conservation (Alaska DEC) and will include long term plans as necessary to address long term environmental impacts at the site.

### 20.6.3 Proposed Approach to Remediation and Mine Closure

The mine closure plan will identify any potential long term environmental issues which warrant continued monitoring as indicated or required by the Alaska DEC or other Government Agencies.

### 20.6.4 Post Closure Monitoring and Treatment

The mine closure plan will include plans for long-term monitoring as directed by the Alaska DEC or other Government Agencies.

### 20.6.5 Estimated Closure Costs

As stipulated in the current Alaska mining law, a rehabilitation plan will have to be prepared. The rehabilitation and restoration plan will be developed in conjunction with the ADNR Large Mines Permitting Group. The economic analysis of a mining project will have to take into account the costs required for mine closure.

Preliminary closure plan costs were based on the rehabilitation of the tailings disposal area and the waste rock disposal area. The preliminary cost estimate of the rehabilitation and closure plan is based on the re-sloping and re-vegetation of the tailings storage facility and the re-vegetation of the top and berms of the waste rock dumps, which usually represents the largest proportion of rehabilitation costs.

# 21.0 Capital and Operating Costs

## 21.1 Capital Cost Summary

The capital cost (CAPEX) estimate includes the costs required to design and engineer, procure equipment, provide on/off-site infrastructure and contract construction services to operate the mine, as well as costs for sustaining and closing the site. These costs are summarized in Table 21-1.

**Table 21-1: Summary of Life of Mine Capital Costs**

| Description | Total US$M |
|---|---|
| Pre-production Capital | 324.7 |
| Sustaining/Closure | 27.0 |
| **Total Capital Costs** | **351.7** |

## 21.2 Basis of Capital Estimate

The CAPEX for the Zazu Preliminary Economic Assessment study was estimated and prepared by JDS from a combination of information that developed for previous projects with similar constraints as well as information JDS developed specifically for the Lik project. The estimate is based on 2013 US dollars with no escalation.

Project development is based on a 24-month schedule, including major construction at site taking place over 18 months.

At the planned 5,500 tonne-per-day feed to the process plant, the mine life is estimated at 9 years, plus a less than 1 year period for mine closure, based on contemporaneous reclamation.

Costs for major equipment and buildings relating to the process plant, on-site and off-site infrastructure were based on a combination of quotations and estimates received for this project, proposals from past similar projects, and JDS in-house data and experience.

Civil, concrete, structural steel, process tanks, electrical and instrumentation bulk quantities were estimated by JDS from the drawings with pricing based on current in-house cost information. Structural steel, tank steel, electrical hardware and instrumentation supply pricing was all based on recent quotations for similar projects in North America. Piping allowances were applied by JDS, commensurate with the plant areas and type of equipment being installed.

Construction and installation costs were estimated using data from previous project and/or in-house experience for contractor construction in North America.

A composite labour rate for mining pre-production capital costs has been developed for the estimate, based on known local wages, with factors added to include for employee benefits, supervision and overtime, based on 12-hour shifts.

The sustaining capital is carried over operating Years 1 through 9 and includes closure costs incurred in Year 10.

Based on the degree of engineering, the input accuracy of this estimate is in the order of +25/5%.

## 21.3 Direct Capital Costs

Pre-production capital costs were estimated to develop the property from detailed engineering to start-up. Pre-production capital cost allocation is shown in Figure 21-1 and summarized in Table 21-2.

**Figure 21-1: Pre-Production Capital Cost Allocation**

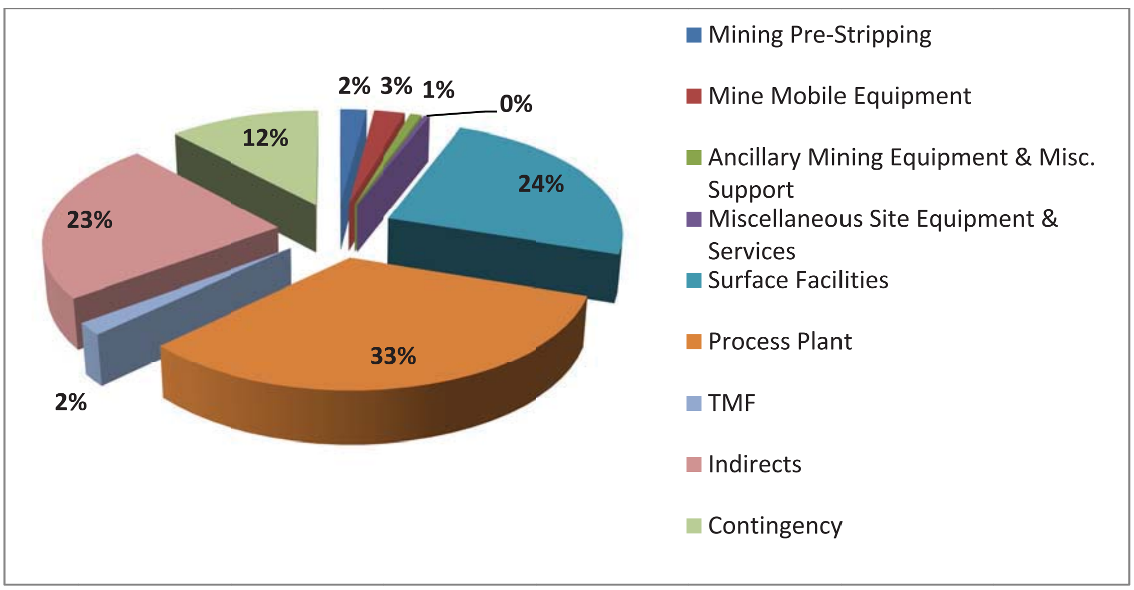


**Table 21-2: Summary of Pre-Production Capital Costs**

| Description | Total Cost ($M) |
|---|---|
| Mining Pre-Stripping | 6.7 |
| Mine Mobile Equipment | 8.2 |
| Ancillary Mining Equipment & Misc. Support | 2.9 |
| Miscellaneous Site Equipment Services | 1.5 |
| **Surface Facilities** | |
| Civil Works and Site Roads | 1.3 |
| Explosives Magazines & storage facilities | 1.3 |
| Power Station | 27.9 |
| Camp, Admin, Mine Dry WT/ST, Incinerator | 23.0 |
| Truck Shop | 13.0 |
| Shop Tools - Electrical/Inst | 0.1 |
| Shop Tools - Mechanical | 0.4 |
| Shop Scaffolding | 0.1 |
| Tank Farm | 0.3 |
| On-Site Concentrate Storage | 10.0 |
| Airstrip Upgrade & Instrumentation | 1.3 |
| **Subtotal Surface Facilities** | **78.5** |
| **Process Plant** | |
| Civil Works | 1.5 |
| Process Buildings | 4.5 |
| Primary Crushing | 4.5 |
| Crushed Ore Stockpile | 4.5 |
| Grinding & Classification | 24.0 |
| Flotation | 18.0 |
| Filtration | 14.0 |
| Reagent Mixing | 2.5 |
| Piping & Electrical | 33.1 |
| **Subtotal Process Plant** | **106.6** |
| **TMF** | |
| Site Preparation | 0.5 |
| Tailings Facility | 4.0 |
| Mechanical & Electrical | 1.3 |
| **Subtotal TMF** | **5.8** |
| **Indirect Costs** | |
| Construction Indirects | 15.4 |
| Freight | 22.7 |
| Capital Spares & Initial Fills | 2.9 |
| Commissioning & Startup | 2.0 |
| Construction Equipment | 5.0 |
| EPCM | 23.1 |
| Owner's Costs | 5.0 |
| **Subtotal Indirect Costs** | **76.1** |
| **Subtotal - Pre-Contingency** | **286.2** |
| **Contingency** | **38.5** |
| **Total Capital** | **324.7** |

## 21.4 Open Pit Mining Capital Costs

### 21.4.1 Mining Pre-Strip

The estimate covers pre-production mine open pit development prior to commencement of mining operations and is summarized in Table 21-3.

**Table 21-3: Mining Pre-Strip Cost in Year -1**

| Direct Mining Cost Categories | Cost ($M) |
|---|---|
| Load & Haul | 2.4 |
| Drill & Blast | 0.9 |
| Mine General | 2.5 |
| Mine Maintenance | 0.8 |
| **Total Mining Costs Year -1** | **6.7** |

### 21.4.2 Mining Equipment

Requirements for the Lik project are based on the JDS Mine Plan for the 5,500 t/d open pit mining operation as summarized in Section 16.

Primary mobile equipment costs are based on budgetary quotes received for this project and/or recent quotations from similar projects and are estimated at $8.2 million.

### 21.4.3 Mine Support Equipment

Mining support equipment would be purchased. Estimates are based on budgetary quotations from other projects and/or JDS in-house experience. Mine support equipment is estimated at $2.9 million.

Costs include the following items:

- Explosives delivery and support trucks
- Fuel and lube trucks
- Mobile maintenance support equipment
- Mine site and haul road support equipment
- Mine communication systems and mobile radios
- Light crew vehicles.

## 21.5 Process Plant

The estimate is based on the flow sheet design and equipment list prepared by JDS for the 5,800 t/d peak plant operation. To verify up-to-date process plant equipment costs, budget estimates were sought and received from a supplier for key long delivery items including the crusher and grinding mills. The quoted costs have been incorporated into the estimate.

The unit rates used for concrete, structural steel, tankage, etc., was derived from current JDS database costs. Piping, electrical, and instrumentation costs are based on industry recognized ratios of equipment and building area.

Due regard was taken to account for additional warehousing required to accommodate the annual sea lift of supplies as well as the site-specific concentrate storage requirements.

Power requirements were based upon the process, mine, and site estimated power loading. A budget quotation was received for a modular multiple engine diesel generation station that was based on an N+2 configuration, to ensure reliability in the remote arctic environment.

## 21.6 Tailing Management Facility and Surface Facility

Costs for the TMF and surface facility are estimated at $5.8 million. The tailing facility costs are relatively low and are based on the assumption that the facility will be built using the waste rock from the pre-strip and stripping operations, pending suitable characterization of these materials.

## 21.7 Underground Mining Capital Costs

Underground capital cost was not evaluated as part of the scope for this PEA.

## 21.8 Operating Costs

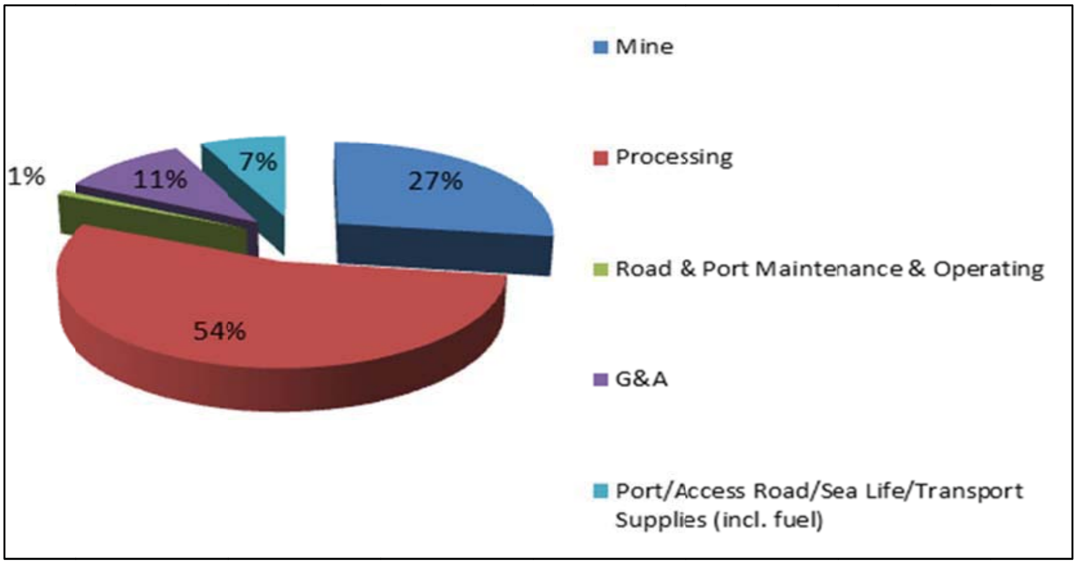
### 21.8.1 Summary of Operating Costs

Operating costs for the Lik project have been estimated by incorporating both off-site and on-site infrastructure as related to the mine plan and processing schedule. Costs for the major areas are summarized in Table 21-4 and Figure 21-2.

**Table 21-4: Summary of Operating Costs**

| Description | LOM Total (US$M) | US$/t processed |
|---|---|---|
| Mining | 315.6 | 18.42 |
| Processing | 629.2 | 36.72 |
| Road & Port Maintenance & Operating | 10.5 | 0.61 |
| G&A | 121.8 | 7.11 |
| Port/Access Road/Sea Lift/Transport Supplies (incl. fuel) | 82.4 | 4.81 |
| **Total Operating Costs** | **1,159.4** | **67.66** |

**Figure 21-2: Operating Cost Allocation**




### 21.8.2 Basis of Operating Costs Estimate

Operating costs were estimated based on the following criteria:

- All costs are shown as 2013 dollars.
- Escalation has not been considered.
- Site operations will be conducted 24 hours per day, 365 days per year based on 12-hour shifts using a work schedule of 14-days on and 14-days off. Non-shift employees were calculated on a 48-hour work week.
- Personnel requirements were developed by JDS based on experience in the mining industry in North American remote mine-camp scenarios. Labour costs have been based on a total employee compliment of 330 people.
- Regional labour rates, in US dollars, were provided by Zazu. Allowances for supervision, employee benefits and overtime have been built into the final rates used.

- Mine equipment maintenance costs are based on supplier advice and JDS industry knowledge. Fuels, lubricants, and explosive prices have been estimated using recent budgetary quotations. Consumption rates have been calculated based on experience with similar projects.
- Process plant reagent usage rates were estimated from the process testwork and reports done by others. Spare parts and consumable requirements were based on JDS experience with other similar projects.
- Electrical power costs were based on vendor budget quotes for natural gas fired reciprocating engine generator sets.

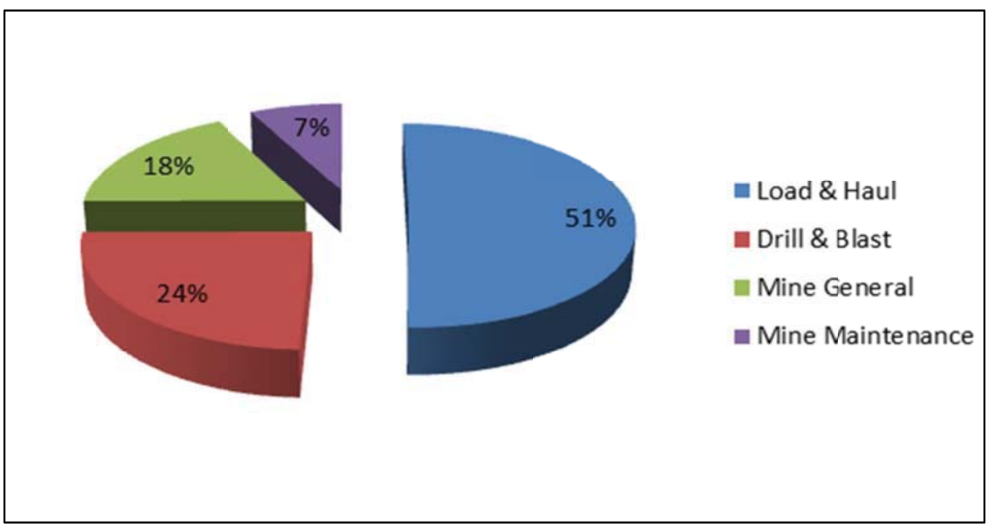
### 21.8.3 Mining Operating Costs

Mining operating costs have been estimated for a nine-year operating mine life. Costs exclude pre-stripping, which has been capitalized as described in Section 21.1.1 of this report. A summary of LOM operating costs by activity are shown in Table 21-5. Mine operating cost allocation is shown in Figure 21-3.

**Table 21-5: Summary of Life of Mine Operating Cost by Activity**

| By Activity | (US$) | (US$/t mined) | (US$/t processed) |
|---|---|---|---|
| Load & Haul | $159,296,998 | $1.53 | $9.30 |
| Drill & Blast | $77,116,769 | $0.74 | $4.50 |
| Mine General | $55,669,491 | $0.53 | $3.25 |
| Mine Maintenance | $23,480,000 | $0.23 | $1.37 |
| **Life of Mine Operating Costs** | **$315,563,258** | **$3.03** | **$18.42** |

**Figure 21-3: Mining Operation Cost Allocation during Production**



### 21.8.4 Process Operating Costs

Process operating costs totaling $36.74/t have been developed for a 2.0 Mt/a facility. Costs have been developed based on the following:

- Employee total costs of $4.67/t for a total of 82 are based on industrial norms for similar size and type of process facilities and wages based on published data for Alaska with overheads and overtime allowances based on industry accepted levels for fly-in operations.
- Steel consumption and costs are based on industrial standards and in-house data totaling $3.68/t.
- Reagent costs at $11.97/t are based on locked cycle test projected consumptions and updated pricing.
- An allowance of $0.77/t is included for miscellaneous operating supplies and services
- An allowance of $1.86/t is used based on in house data for general operating and maintenance supplies and consumables covering filter cloth, vehicles, small tools and motors, water treatment and other miscellaneous expenses.
- Assay and Metallurgical laboratories allowance is estimate to be $0.20/t based on similar operations.
- Power costs of $13.59/t based on a unit power cost of $0.248 kWh.

The process operating costs are summarized in Table 21-6.

**Table 21-6: Process Operating Costs**

| Area | | Annual Cost (US$/Year) | Unit Cost (US$/t) |
|---|---|---|---|
| **Employees** | **#** | | |
| Operating Staff | 11 | $1,443,736 | $0.73 |
| Operating Labour | 32 | $3,282,240 | $1.64 |
| Metallurgical Lab & Quality Control | 11 | $1,199,240 | $0.61 |
| Maintenance Staff | 8 | $1,104,936 | $0.55 |
| Maintenance Labour | 20 | $2,283,840 | $1.15 |
| **Subtotal Employees** | **82** | **$9,313,992** | **$4.67** |
| **Supplies & Consumables** | | | |
| Steel | | $8,102,674 | $3.68 |
| Reagents | | $23,869,173 | $11.97 |
| Other Consumables & Supplies | | $1,548,800 | $0.77 |
| Laboratory Supplies | | $396,000 | $0.20 |
| Sub Total - Operating Supplies & Consumables) | | $33,160,672 | $16.62 |
| Maintenance Supplies (Allowance) | | $3,718,000 | $1.86 |
| **Total Supplies & Consumables** | | **$36,878,672** | **$18.48** |
| **Power Supply** | **kWh/t** | | |
| Power Supply - Mill | 49.62 | $27,098,111 | $13.59 |
| **Total Power** | | **$27,098,111** | **$13.59** |
| **Total Process Plant** | | **$73,290,775** | **$36.74** |

## 21.9 General & Administration Operating Cost Details

Costs include all off-site and on-site activities, including allowances for external assays, insurance, recruitment, travel and employee transportation, etcetera. The summary of costs is shown in Table 21-7, averaged over the life of mine. The costs take into account full G&A staffing during the first year of operation, with production limited to approximately 80% capacity.

**Table 21-7: Distribution of G&A Costs**

| Description | Annual Cost US$M | US $/t processed |
|---|---|---|
| G&A Labour | 2.5 | 1.27 |
| G&A Expenses | 11.7 | 5.84 |
| **Total** | **14.2** | **7.11** |

## 21.10 Road and Port Maintenance Operating Cost Details

Road and port maintenance and operating costs are estimated at a life-of-mine cost of $10.5 million ($0.61/t). This includes the proposed 35 km haul road corridor that follows the Square Creek drainage to the Wulik River and travels east and south to connect to the existing Delong Mountain Transportation System (DMTS) south of the Teck Red Dog Mine. Road maintenance costs were estimated based on an assumed sharing of most of the DMTS portion of the road with Teck with an assumed usage proration, while Zazu would maintain the entirety of the narrower and shorter Lik access road.

## 21.11 Fuel, Supplies Transport, Sea-Lift, Access Road & Port Operating Cost Details

The fuel, supplies transport, sea-lift, access road & port are estimate life of mine cost and summarized in Table 21-8.

**Table 21-8: Summary of Fuel, Supplies, Sea-Lift, Access Road & Port**

| Description | (US$) | (US$/t processed) |
|---|---|---|
| Fuel & Supplies Transport | $1,534,430 | $0.09 |
| Annual Supply Sea-Lift | $48,933,198 | $2.86 |
| Access Road | $30,172,871 | $1.76 |
| Port | $1,722,992 | $0.10 |
| **Life of Mine Operating Costs** | **$82,363,492** | **$4.81** |

## 21.12 G&A Personnel

Included are all site supervision and support personnel required to administer the operation, as shown in Table 21-9.

**Table 21-9: G&A Personnel**

| Position | Quantity | Schedule | Hourly/Salary |
|---|---|---|---|
| General Manager | 1 | | Salary |
| HR Manager | 1 | | Salary |
| HR Clerk | 1 | | Hourly |
| Payroll Supervisor | 1 | | Salary |
| Purchaser | 1 | | Salary |
| IT Technician | 2 | | Salary |
| Environmentalist | 1 | | Salary |
| Environmental Technician | 2 | | Salary |
| Safety & Training Officer | 1 | | Salary |
| Warehouse Supervisor | 1 | | Salary |
| Nurse/First Aid | 2 | | Hourly |
| Warehouse | 4 | | Hourly |
| Security | 4 | | Hourly |
| General Clerks | 2 | | Hourly |
| **Total** | **25** | | |

# 22.0 Economic Analysis

## 22.1 Introduction

An engineering economic model was developed to estimate annual cash flows and sensitivities of the project. Pre-tax estimates of project values were prepared for comparative purposes, while after-tax estimates were developed and are likely to approximate the true investment value. It must be noted, however, that tax estimates involve many complex variables that can only be accurately calculated during operations and, as such, the after-tax results are only approximations.

Sensitivity analyses were performed for variations in metal prices, grades, operating costs, capital costs, and discount rates to determine their relative importance as project value drivers.

This technical report contains forward-looking information regarding projected mine production rates, construction schedules and forecasts of resulting cash flows as part of this study. The mill head grades are based on sufficient sampling that is reasonably expected to be representative of the realized grades from actual mining operations. Factors such as the ability to obtain permits to construct and operate a mine, or to obtain major equipment or skilled labour on a timely basis, to achieve the assumed mine production rates at the assumed grades, may cause actual results to differ materially from those presented in this economic analysis.

This preliminary economic assessment is preliminary in nature. The results of the economic analysis performed as a part of this PEA are based in part on inferred mineral resources. Inferred mineral resources are considered too speculative geologically to have the economic considerations applied to them that would enable them to be categorized as mineral reserves, and there is no certainty that the preliminary economic assessment will be realized.

The estimates of capital and operating costs have been developed specifically for this project and are summarized in Section 21 of this report (presented in 2013 dollars). The economic analysis has been run with no inflation (constant dollar basis).

Please refer to Appendix B for the 9-year mine plan.

## 22.2 Assumptions

Two metal price cases were evaluated to better understand the value drivers in each scenario. All costs, metal prices and economic results are reported in US dollars (USD). Both cases have identical LOM plan tonnage and grade estimates (Table 22-1). On-site and off-site costs and production parameters were also held constant for each scenario evaluated.

**Table 22-1: LOM Plan Summary for all Cases**

| Category | Units | Value |
|---|---|---|
| Mine life | Years | 9 |
| Total Ore | Mt | 20.8 |
| Total Waste | Mt | 105.7 |
| Strip Ratio | waste:mill feed | 5.1 |
| **Total Mined** | **Mt** | **126.5** |
| Plant Throughput | t/d | 6,400 |
| **LOM Ore Head Grade** | | |
| Zn | % | 7.7 |
| Pb | % | 2.6 |
| Ag | oz/t | 1.38 |
| **Production** | | |
| Zn Concentrate Produced | LOM dry kt | 2,088.4 |
| Average Zn Concentrate Produced | dry kt/a | 233.9 |
| Zn Production (payable) | Mlbs | 2,090 |
| Average Zn Production (payable) | Mlbs/a | 234 |
| Pb Concentrate Produced | LOM dry kt | 498.1 |
| Average Pb Concentrate Produced | dry kt/a | 55.8 |
| Pb production (payable) | Mlbs | 638 |
| Average Pb Production (payable) | Mlbs/a | 71.5 |
| Ag in Zn Concentrate | LOM koz | 444 |
| Average Ag in Zn Concentrate | koz/a | 50 |
| Ag in Pb Concentrate | LOM koz | 523 |
| Average Ag in Pb Concentrate | koz/a | 59 |

Other economic factors common to all three cases include the following:

- Discount rate of 8% (sensitivities using other discount rates have been calculated for each scenario)
- Closure cost of $5M
- Nominal 2014 dollars
- Revenues, costs, taxes are calculated for each period in which they occur rather than actual outgoing/incoming payment
- Working capital calculated as three months of operating costs in Year 1 (including mining, processing, G&A, port and road maintenance costs)
- Results are presented on 100% ownership and do not include management fees or financing costs
- Exclusion of all pre-development and sunk costs (i.e. exploration and resource definition costs, engineering fieldwork and studies costs, environmental baseline studies costs, etc.).

Table 22-2 outlines the metal prices, used in the various scenarios of the economic analysis. Three-Year trailing average prices are as at December 30, 2013. NSR Assumption pricing is based on three-year trailing average prices for both zinc and lead. Silver pricing for the NSR Assumption scenario is based on the spot price as of December 30, 2013. The Forward Pricing scenario utilizes the forward price of zinc as published by Bloomberg on January 31, 2014 and utilizes the same prices as the NSR Assumptions scenario for both lead and silver.

In addition to these two scenarios, the project was tested at various metal prices. These results can be found in the Sensitivity Analysis section (Section 21-8) of this report. NSR assumption pricing was used to develop the mine plan.

**Table 22-2: Metal Prices used in Economic Analysis Scenarios**

| Parameter | Units | NSR Assumptions | Forward Zinc Price |
|---|---|---|---|
| Zinc Price | US$/lb | 0.92 | 1.00 |
| Lead Price | US$/lb | 1.01 | 1.01 |
| Silver Price | US$/oz | 19.43 | 19.43 |

## 22.3 Revenues & NSR Parameters

Mine revenue is derived from the sale of concentrate into the international marketplace. No contractual arrangements for concentrate smelting or refining exist at this time. Details regarding the terms used for the economic analysis can be found in the Market Studies Section 19 of this report. Revenues from concentrate production were assumed to begin in 2015 and end in 2023, in line with the nine-year mine life.

Table 22-3 indicates the NSR parameters that were used in the economic analysis. Figure 22-1 shows a breakdown of the amount of concentrate produced during the mine life – a total of 2,539 dry kt of zinc concentrate and 606 dry kt of lead concentrate are produced during the mine life.

**Table 22-3: NSR Parameters Used in Economic Analysis for Both Scenarios**

| | | |
|---|---|---|
| **Recoveries** | | |
| **Zn Concentrate** | | |
| Zn Recovery | % | 85 |
| Ag Recovery | % | 27 |
| **Pb Concentrate** | | |
| Pb Recovery | % | 70 |
| Ag Recovery | % | 5 |
| **Smelter Terms** | | |
| Zn Concentrate Grade | % | 53.4 |
| Moisture Content | % | 8.00 |
| Zn Payable | % | 85.00 |
| Zn Min. Deduction | %/Zn tonne | 8 |
| Zn TC | $/dry tonne | 170.00 |
| Zn Price Participation | $/dry tonne | 50.75 |
| SiO2 Penalty | $/dry tonne | 5.30 |
| Zn Transport Mine to Port | $/tonne | 13.73 |
| Port & Road Fee | $/tonne | 21.04 |
| Ocean Freight | $/tonne | 60.00 |
| Insurance (of NIV) | % | 0.15 |
| Losses | % | 0.42 |
| Ag Payable | % | 70 |
| Ag Min. Deduction | oz/dry tonne | 3.5 |
| Ag RC | $/pay oz | 0.00 |
| Pb Concentrate Grade | % | 61.2 |
| Pb Payable | % | 95.00 |
| Pb Min. Deduction | %/Pb tonne | 3.00 |
| Pb TC | $/dry tonne | 165.00 |
| Pb Price Participation | $/dry tonne | 10.40 |
| Pb Penalty | $/dry tonne | 0.00 |
| Pb Transport Mine to Port | $/tonne | 13.73 |
| Port & Road Fee | $/tonne | 21.04 |
| Ocean Freight | $/tonne | 60.00 |
| Insurance (of NIV) | % | 0.15 |
| Losses | % | 0.42 |
| Ag Payable | % | 95 |
| Ag Min. Deduction | Oz | 1.5 |
| Ag RC | $/pay oz | 0.78 |

**Figure 22-1: Concentrate Production by Year**

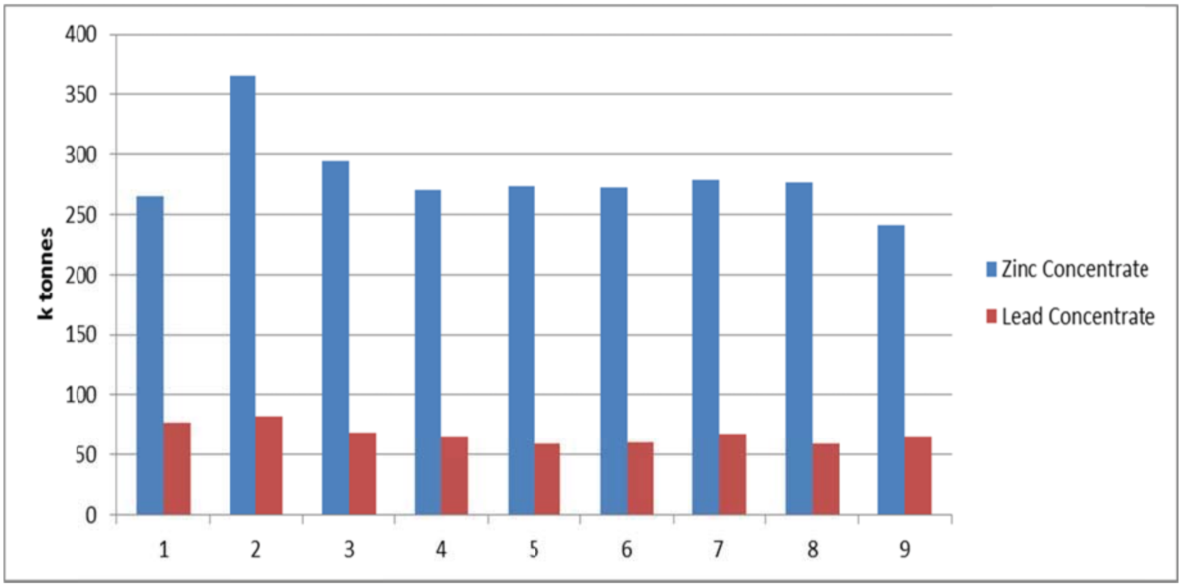



Table 22-4 shows the amount of payable metal for the project. Figure 22-2 and Figure 22-3 demonstrate that the breakdown of LOM NSR (net of royalty payments) for the NSR Assumptions Case amounted to $1,751 million. Royalties amount to $2.8 million. Royalties were calculated as 1% of Net Profit Interest for the entire mine life.

**Table 22-4: LOM Payable Metal Production**

| Concentrate | Unit | Value |
|---|---|---|
| Zinc | LOM k dry tonnes | 2,088.4 |
| | LOM NSR $M | 1,263.0 |
| Lead | LOM k dry tonnes | 498.1 |
| | LOM NSR $M | 523.7 |
| **Total NSR** | **LOM NSR $M** | **1,786.8** |

Figure 22-2: NSR by Payable Metal

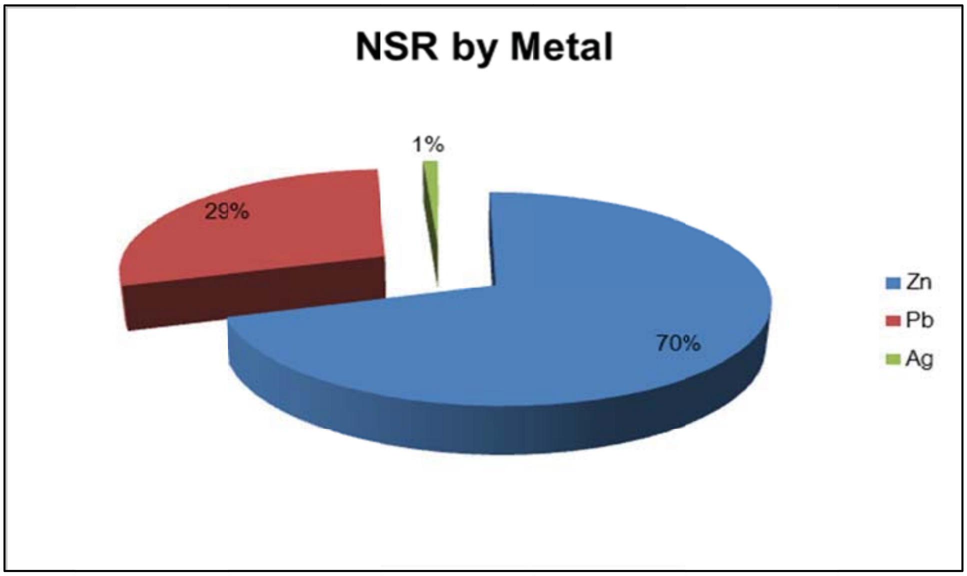
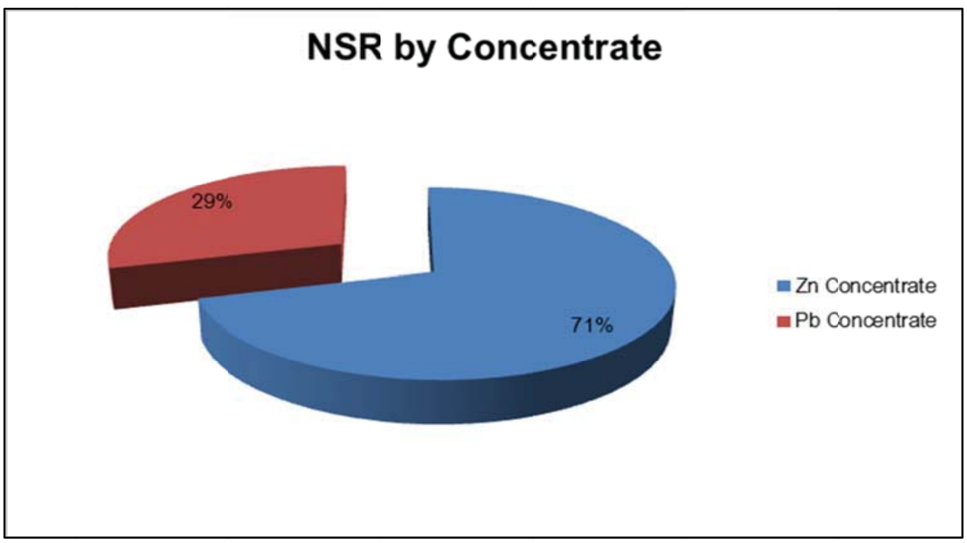



Figure 22-3: NSR by Concentrate



## 22.4 Summary of Capital Cost Estimate

During pre-production (assumed to be 2013 and 2014), the initial capital costs amount to $324.7 million. This includes costs for site development, processing plant, on-site infrastructure, camp construction, pre-production operating costs, etc.

A 20% contingency on direct costs was included in the initial capital costs.

Sustaining and closure capital cost estimates amount to $27.0 million and were assumed to occur from 2016 to 2024 with a majority of these costs for mine equipment. A breakdown of the sustaining and capital costs is shown in Table 22-5 and Figures 22-4 and 22-5.

Closure costs amount to $5.0 million and were assumed to occur in 2024.

Details on the capital costs can be found in Section 21 of this report.

**Table 22-5: Summary of LOM Capital Costs**

| Capital Costs | Pre-Production | Sustaining & Closure | Total | % of Total |
|---|---|---|---|---|
| Pre-Stripping | 6.7 | 0.0 | **6.7** | 2% |
| Mine Equipment | 11.2 | 22.0 | **33.2** | 9% |
| Direct Costs | 192.3 | 0.0 | **192.3** | 55% |
| Construction Indirects | 15.4 | 0.0 | **15.4** | 4% |
| Freight | 22.7 | 0.0 | **22.7** | 6% |
| Capital Spares & Initial Fills | 2.9 | 0.0 | **2.9** | 1% |
| Commissioning & Startup | 2.0 | 0.0 | **2.0** | 1% |
| Construction Equipment | 5.0 | 0.0 | **5.0** | 1% |
| EPCM | 23.1 | 0.0 | **23.1** | 7% |
| Owners costs | 5.0 | 0.0 | **5.0** | 1% |
| Closure | 0.0 | 5.0 | **5.0** | 1% |
| Subtotal | 286.2 | 27.0 | **313.2** | 89% |
| Contingency (20% of Direct Costs) | 38.5 | 0.0 | **38.5** | 11% |
| **Total Pre-Production Capital Costs** | **324.7** | **27.0** | **351.7** | **100%** |

**Figure 22-4: Breakdown of Pre-Production Capital Costs**

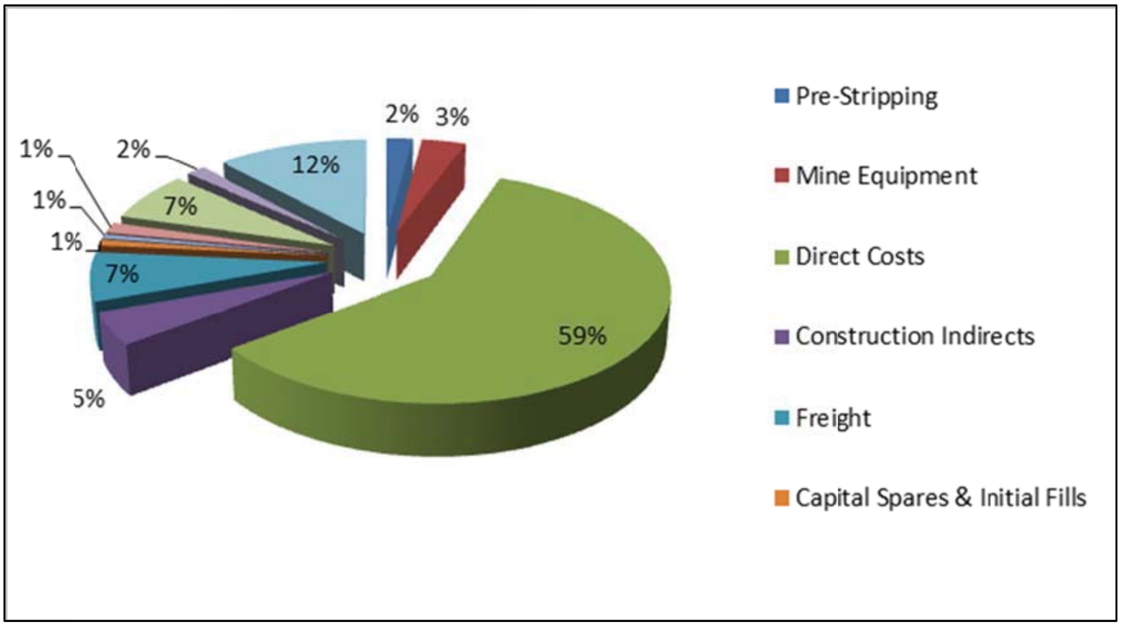
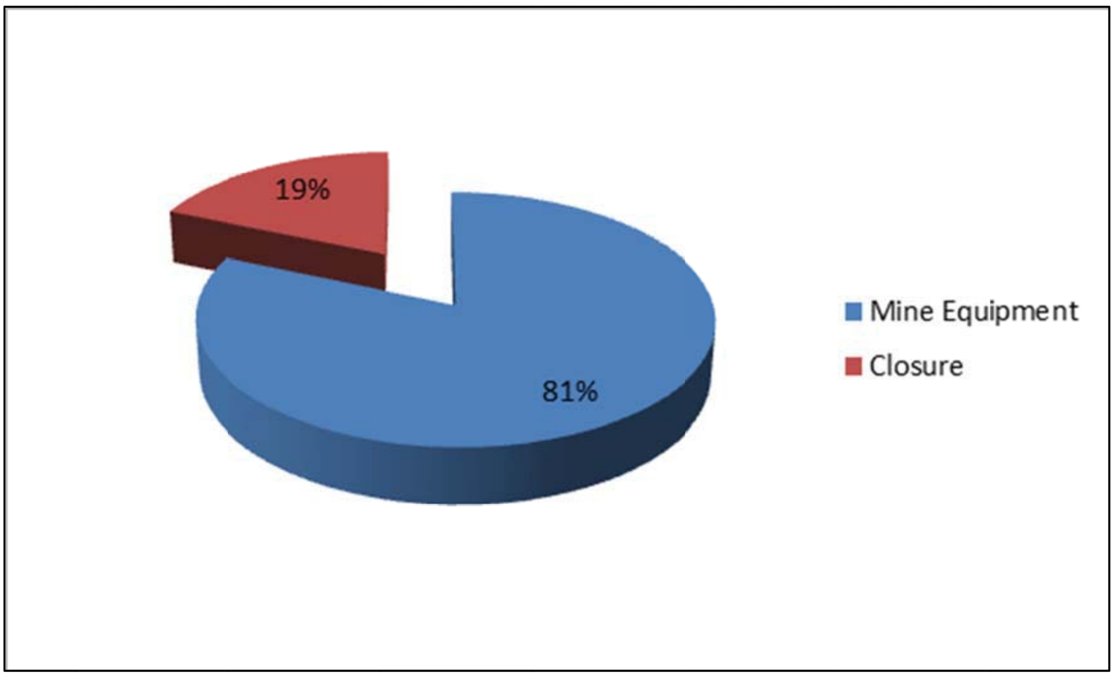



**Figure 22-5: Breakdown of Capital Expenditures during Production**



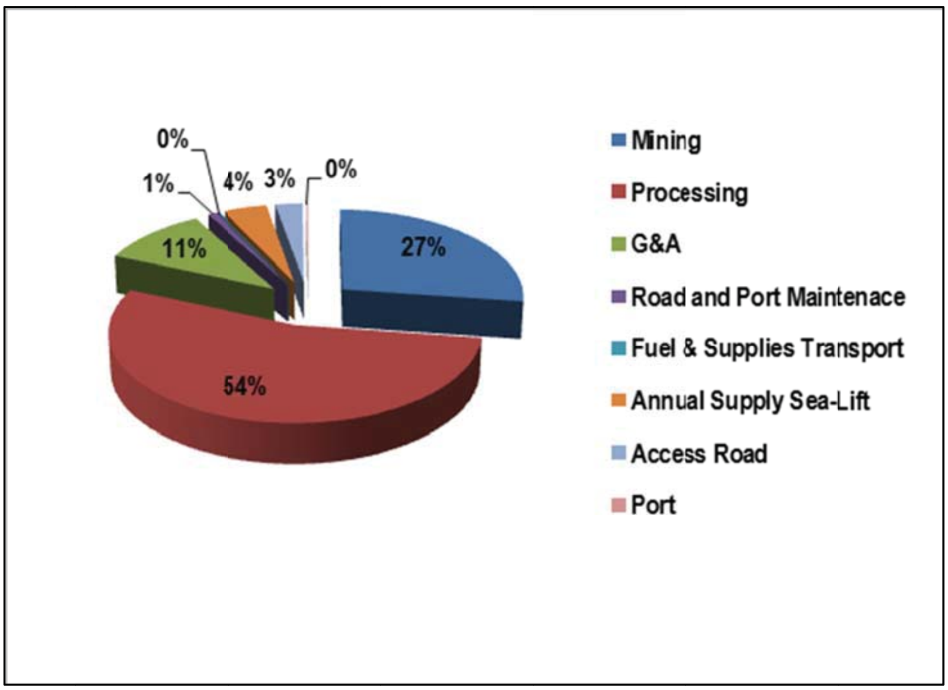
## 22.5 Summary of Operating Cost Estimates

Total LOM operating costs amount to $1,159.4 million. The total LOM operating costs translate to an average cost of $67.66/tonne milled. A breakdown of these costs is outlined in Table 22-6 and Figure 22-6.

**Table 22-6: Operating Costs**

| OPEX | LOM $M | $/t milled |
|---|---|---|
| Mining | 315.6 | 18.42 |
| Processing | 629.2 | 36.72 |
| G&A | 121.8 | 7.11 |
| Road and Port Maintenance | 10.5 | 0.61 |
| Fuel & Supplies Transport | 1.5 | 0.09 |
| Annual Supply Sea-Lift | 48.9 | 2.86 |
| Access Road | 30.2 | 1.76 |
| Port | 1.7 | 0.10 |
| **Total OPEX** | **1,159.4** | **67.66** |

**Figure 22-6: Breakdown of Operating Costs**



## 22.6 Taxes

The project has been evaluated on an after-tax basis to provide a more indicative value of the potential project economics. Zazu commissioned PwC in Vancouver, BC to review a tax model for the post-tax economic evaluation of the project with the inclusion of applicable US Federal and State income taxes. The tax calculations also assume appropriate depreciation for each of the capital cost class. Total taxes for the life of the project amount to $70.9 million.

The following major assumptions were used in the preparation of taxes for the Lik project for use in the economic model:

- Tax calculations are based on 100% ownership of the Lik Project.
- All taxes are paid in the year incurred.
- Withholding taxes on repatriation to Canadian parent are not considered as all after tax profits are assumed to remain in the US subsidiary.
- All sales are recognized in the year of production.
- Cash requirements to fund the project are provided by equity.
- Any tax losses generated will be carried forward (no carryback has been assumed).
- Applicable tax jurisdictions are IRS and Alaska income tax codes and Alaska code substantially follows IRS code.
- No consideration is given to other taxes that may apply including but not limited to state sales taxes, municipal taxes, property taxes.

Other assumptions were used in the technical preparation of taxes for the purpose of the economic model. All assumptions were deemed valid and appropriate by PwC for the purposes of this report.

## 22.7 Economic Results

The project is economically viable with an after-tax internal rate of return (IRR) of 9.7% and a net present value 8% ($NPV_{8\%}$) of $25.0 million using the metal prices utilized to prepare the mine plan. In addition, another scenario was evaluated utilizing a forward-looking zinc price for the life of mine.

Table 22-7 and Table 22-8 summarize the economic results of each scenario evaluated.

The scenario utilizing the forward-looking zinc price resulted in the highest performance and project value due to the highest metal prices of all three scenarios.

Figures 22-7 through 22-9 show the projected cash flows for the project used in the different scenarios of the economic analysis.

**Table 22-7**: **Summary of Results for NSR Parameter Metal Pricing (Zn @ $0.92/lb; Pb @ $1.01/lb; Ag @$19.43/oz)**

| Summary of Results | Unit | Value |
|---|---|---|
| **Concentrate Production** | | |
| Zn Concentrate Produced | LOM dry kt | 2,088.4 |
| Average Zn Concentrate Produced | dry kt/a | 233.9 |
| Zn Production | Mlbs | 2,090.2 |
| Average Zn Production | Mlbs/a | 234.1 |
| Ag in Zn Concentrate | LOM koz | 443.5 |
| Average Ag in Zn Concentrate | koz/a | 49.7 |
| Pb Concentrate Produced | LOM dry kt | 498.1 |
| Average Pb Concentrate Produced | k dry t/a | 55.8 |
| Pb Production | Mlbs | 638.1 |
| Average Pb Produced | klbs/a | 71.5 |
| Ag in Pb Concentrate | LOM koz | 523.1 |
| Average Ag in Pb Concentrate | koz/a | 58.6 |
| LOM NSR | $M | 1,787 |
| | $/t milled | 104 |
| Operating Costs | LOM $M | 1,159 |
| | $/t milled | 67.66 |
| Zn Cash Cost (Net of By-Products) | $/lb | 0.63 |
| Pb Cash Cost (Net of By-Products) | $/lb | 0.04 |
| **Capital Costs** | | |
| Pre-Production Capital | $M | 286.2 |
| Pre-Production Contingency | $M | 38.5 |
| **Total Pre-Production Capital Costs** | **$M** | **324.7** |
| | **$/t milled** | **18.95** |
| Sustaining & Closure Capital | $M | 27.0 |
| **Total Sustaining & Closure Capital Costs** | **$M** | **27.0** |
| **Total Capital Costs (incl. Contingency)** | **$M** | **351.7** |
| Average Operating Cashflow During Production | $M | 68.7 |
| **Pre-Tax $NPV_{8\%}$** | **$M** | **69.3** |
| **Pre-Tax IRR** | **%** | **12.5%** |
| **Pre-Tax Payback Period** | **Years** | **5.0** |
| **After-Tax $NPV_{8\%}$** | **$M** | **25.0** |
| **After-Tax IRR** | **%** | **9.7%** |
| **After-Tax Payback Period** | **Years** | **5.8** |

**Table 22-8: Summary of Results for Forward Metal Pricing Scenario (Zn @$1.00/lb; Pb @$1.01/lb; Ag @ $19.43/oz)**

| Summary of Results | Unit | Value |
|---|---|---|
| **Concentrate Production** | | |
| Zn Concentrate Produced | LOM dry kt | 2,088.4 |
| Average Zn Concentrate Produced | dry kt/a | 233.9 |
| Zn Production | Mlbs | 2,090.2 |
| Average Zn Production | Mlbs/a | 234.1 |
| Ag in Zn Concentrate | LOM koz | 443.5 |
| Average Ag in Zn Concentrate | koz/a | 49.7 |
| Pb Concentrate Produced | LOM dry kt | 498.1 |
| Average Pb Concentrate Produced | k dry t/a | 55.8 |
| Pb Production | Mlbs | 638.1 |
| Average Pb Produced | klbs/a | 71.5 |
| Ag in Pb Concentrate | LOM koz | 523.1 |
| Average Ag in Pb Concentrate | koz/a | 58.6 |
| LOM NSR | $M | 1,944 |
| | $/t milled | 113 |
| Operating Costs | LOM $M | 1,159 |
| | $/t milled | 67.66 |
| Zn Cash Cost (Net of By-Products) | $/lb | 0.63 |
| Pb Cash Cost (Net of By-Products) | $/lb | -0.21 |
| **Capital Costs** | | |
| Pre-Production Capital | $M | 286.2 |
| Pre-Production Contingency | $M | 38.5 |
| **Total Pre-Production Capital Costs** | **$M** | **324.7** |
| Sustaining & Closure Capital | **$/t milled** | 27.0 |
| **Total Sustaining & Closure Capital Costs** | $M | **27.0** |
| **Total Capital Costs (incl. Contingency)** | **$M** | **351.7** |
| Average Operating Cashflow During Production | **$M** | 86.3 |
| **Pre-Tax NPV$_{8\%}$** | $M | **170.8** |
| **Pre-Tax IRR** | **$M** | **18.6%** |
| **Pre-Tax Payback Period** | **%** | **3.6** |
| **After-Tax NPV$_{8\%}$** | **Years** | **99.1** |
| **After-Tax IRR** | **$M** | **14.4%** |
| **After-Tax Payback Period** | **%** | **4.5** |

**Figure 22-7: Annual After-Tax Cash Flows utilizing NSR Mine Planning Parameters**

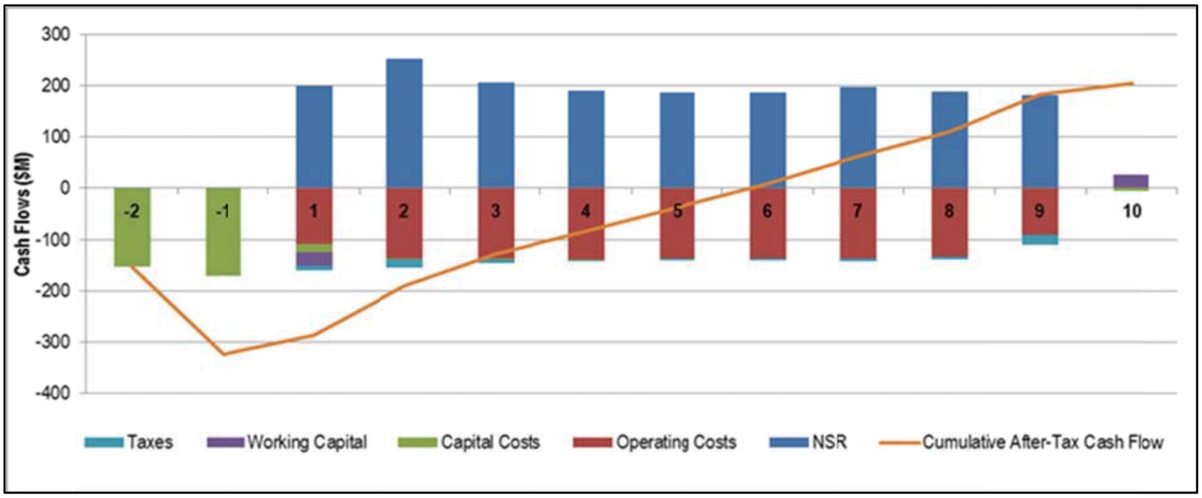



**Figure 22-8: Annual After-Tax Cash Flows for Three-Year Trailing Average Metal Price Scenario**

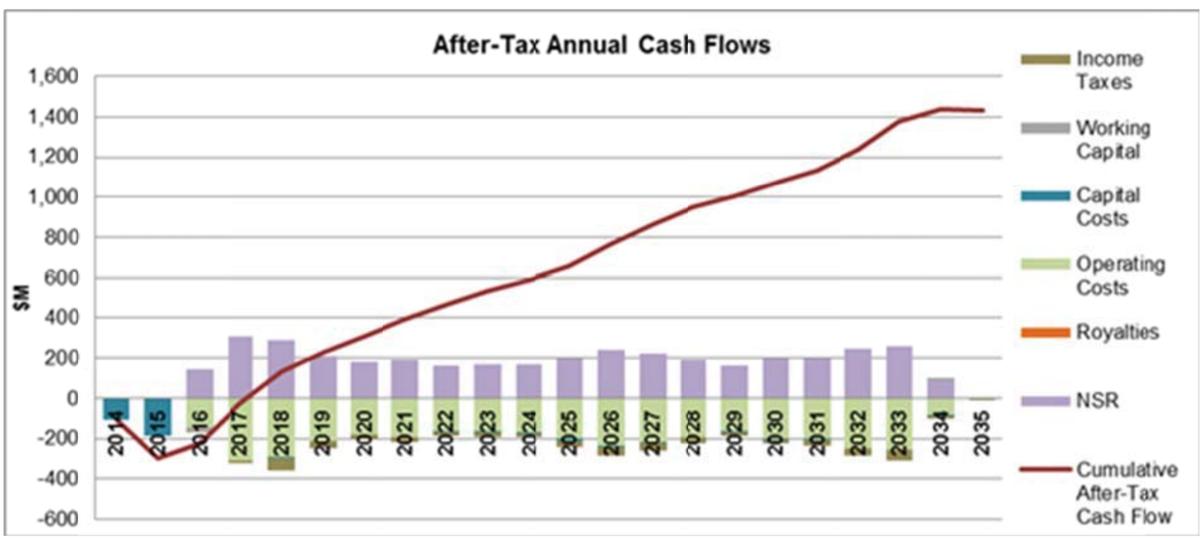
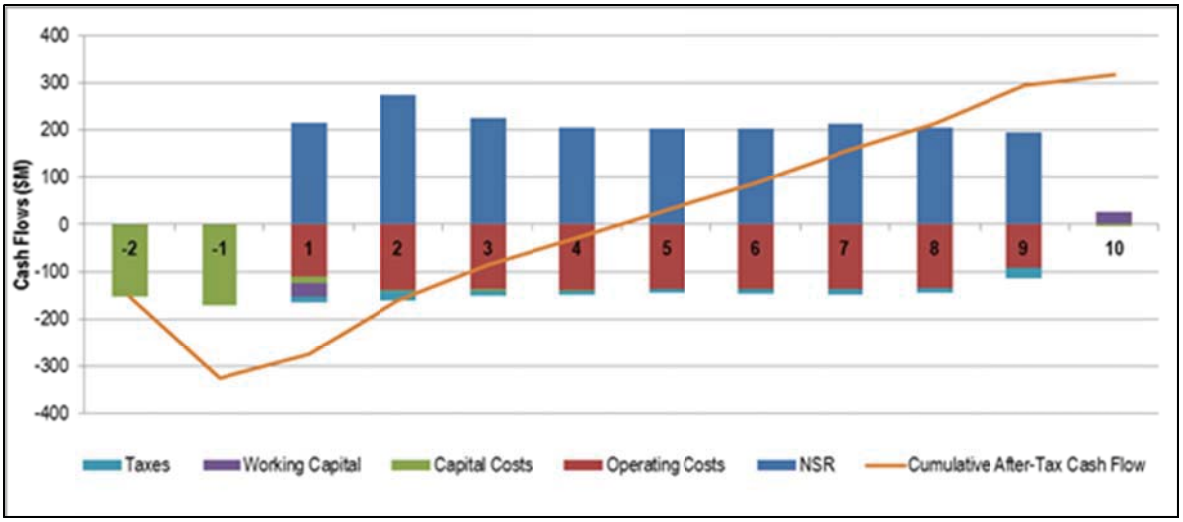


**Figure 22-9: Annual After-Tax Cash Flows for Forward Zn Price Scenario**




## 22.8 Sensitivities

A sensitivity analysis was performed on each of the metal pricing scenarios to determine what factors most affected the project economics. The analysis revealed that the project is most sensitive to metal prices, followed by head grades and operating costs. The project showed the least sensitivity to capital costs.

Table 22-9 and Table 22-10, along with Figures 22-10 and 22-11, outline the results of the sensitivity tests performed on after-tax $NPV_{8\%}$ for each of the metal price scenarios evaluated.

In addition, various scenarios were evaluated showing the project's sensitivity to zinc price only.

**Table 22-9: Sensitivity Results for NSR & Mine Planning Parameters (Zn @ $0.92/lb; Pb @ $1.01/lb; Ag @ $19.43/oz)**

**After-Tax $NPV_{8\%}$ ($M)**

| Variable | -15% | 100% | +15% |
|---|---|---|---|
| Head Grade | -113.2 | 25.0 | 149.1 |
| Metal Prices | -184.8 | 25.0 | 205.6 |
| Operating Costs | 106.6 | 25.0 | -62.4 |
| Capital Costs | 75.0 | 25.0 | -24.9 |

**Figure 22-10: Sensitivity Results for NSR & Mine Planning Parameters (Zn @ $0.92/lb; Pb @ $1.01/lb; Ag @ $19.43/oz)**

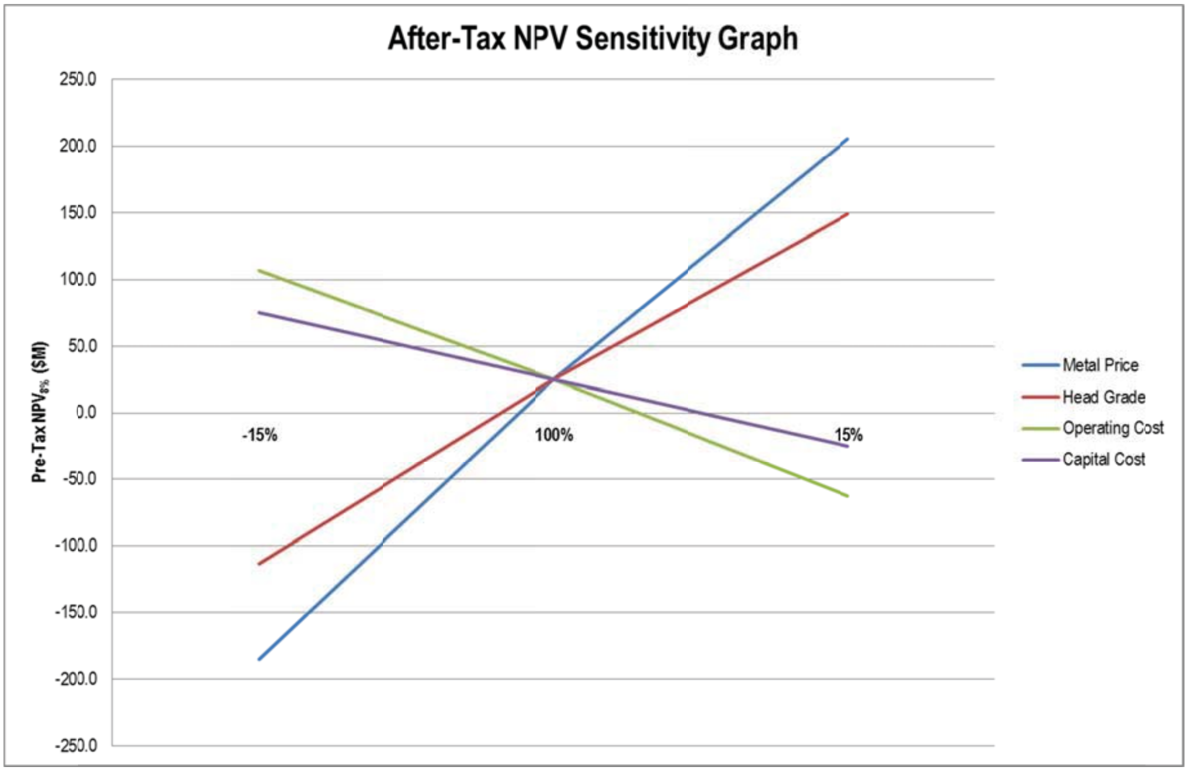



**Table 22-10: Sensitivity Results for Forward Zinc Price (Zn @ $1.00/lb; Pb @ $1.01/lb; Ag @ $19.43/oz)**

**After-Tax $NPV_{8\%}$ ($M)**

| Variable | -15% | 100% | +15% |
|---|---|---|---|
| Head Grade | -40.8 | 99.1 | 232.8 |
| Metal Price | -105.7 | 99.1 | 289.2 |
| Operating Costs | 179.6 | 99.1 | 16.3 |
| Capital Costs | 149.0 | 99.1 | 49.1 |

**Figure 22-11: Sensitivity Results for Forward Zinc Price (Zn @ $1.00/lb; Pb @ $1.01/lb; Ag @ $19.43/oz)**

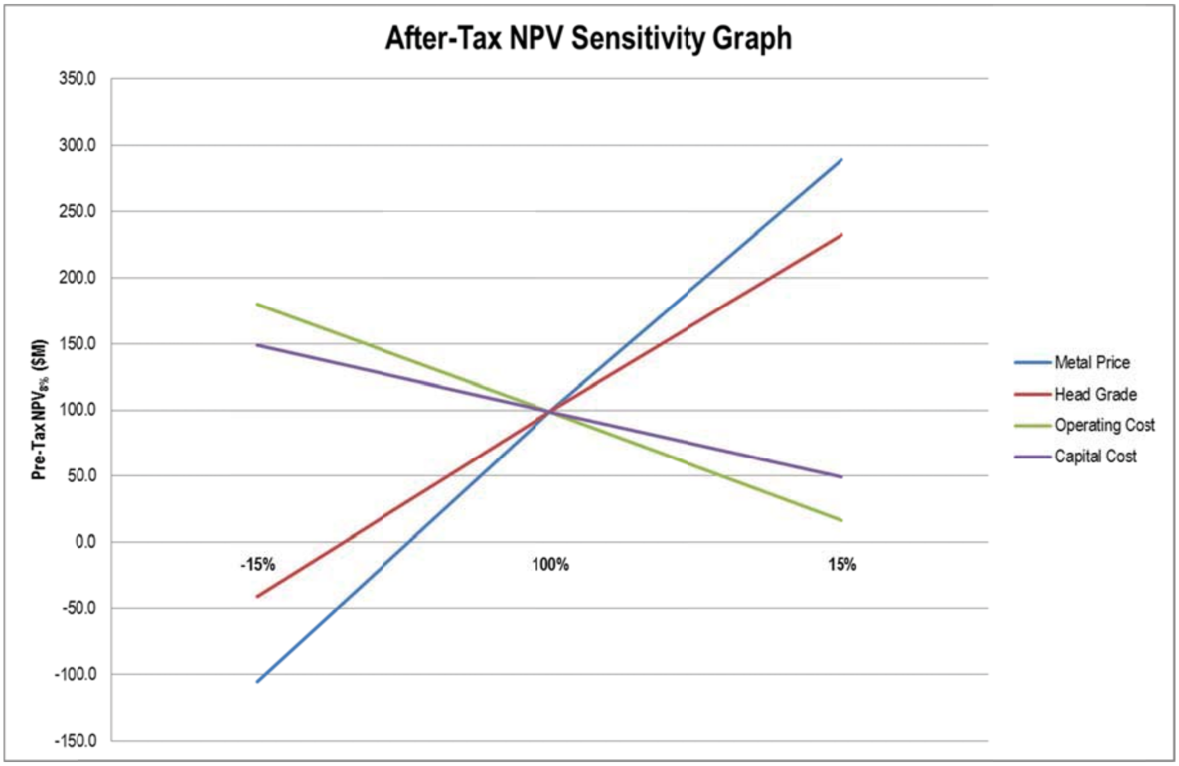



Table 22-11 shows the economic results of the project using various zinc prices and maintaining lead price at $1.01/lb and silver price at $19.43/oz. The sensitivity test shows that the project's break-even zinc price is approximately $0.90/lb.

The project was also tested under various discount rates. The results of these tests for each of the metal pricing scenarios are demonstrated in Table 22-12 and Table 22-13.

**Table 22-11: Project Sensitivity to Zn Price (maintaining Pb @ $1.01/lb; Ag @ $19.43/oz)**

| Zn Price Sensitivity | After-Tax $NPV_{8\%}$ | After-Tax IRR | After-Tax Payback (Yrs) |
|---|---|---|---|
| 0.90 | 1 | 8.10% | 6.3 |
| 0.92 | 25 | 9.70% | 5.8 |
| 0.95 | 50.5 | 11.30% | 5.3 |
| 1.00 | 99.1 | 14.40% | 4.5 |
| 1.05 | 147.2 | 17.20% | 3.9 |
| 1.10 | 195.2 | 20.00% | 3.4 |

**Table 22-12: Discount Rate Sensitivity for NSR & Mine Planning Parameters (Zn @ $0.92/lb; Pb @ $1.01/lb; Ag @ $19.43/oz)**

| Discount Rate | Pre-Tax NPV ($M) | After-Tax NPV ($M) |
|---|---|---|
| 0% | 273.0 | 204.8 |
| 5% | 130.5 | 79.0 |
| 7% | 88.1 | 41.6 |
| 8% | 69.3 | 25.0 |
| 10% | 35.7 | -4.5 |

**Table 22-13: Discount Rate Sensitivity for Forward Zinc Price (Zn @ $1.00/lb; Pb @ $1.01/lb; Ag @ $19.43/oz)**

| Discount Rate | Pre-Tax NPV ($M) | After-Tax NPV ($M) |
|---|---|---|
| 0% | 428.9 | 317.7 |
| 5% | 248.8 | 165.0 |
| 7% | 194.8 | 119.4 |
| 8% | 170.8 | 99.1 |
| 10% | 127.9 | 62.8 |

# 23.0 Adjacent Properties

Teck has an adjoining deposit named the Su deposit, which lies to the southwest of the Lik deposit. An agreement is in place with Teck, who is a joint owner of a portion of the Lik deposit, as to where the dividing line is between the two connected deposits. There has been no NI 43-101 compliant technical study or resource estimation performed on Teck's Su deposit.

# 24.0 Other Relevant Data and Information

At the time of this report no other relevant data and information was encountered.

# 25.0 Interpretations and Conclusions

## 25.1 Results

RPA estimated a potential indicated mineral resource of 16.85 Mt grading 8.04% Zn, 2.70% Pb, and 50.1 g/t Ag, plus an inferred mineral resources of 0.74 Mt grading 7.73% Zn, 1.94% Pb, and 13.4 g/t Ag in Lik South. There are additional Indicated and inferred mineral resources (see Table 1-1) that are not considered in this PEA, but which, pending further evaluation, might represent an opportunity to extend the mine life after the depletion of Lik South.

JDS has reviewed the Lik Deposit data at a PEA level of study and has concluded that under the base case assumptions, the project has potential economic viability. The base case scenario has utilized a zinc price of $0.92/lb, a lead price of $1.01/lb and a silver price of $19.43/oz.

The Lik Deposit has been evaluated on the basis of an open pit truck/shovel/loader mine that produces and processes 2 Mt of ore per annum. The saleable products produced will be both zinc and lead concentrates from the life of mine open pit mineral resource estimated at 17.1 Mt grading at 7.7% Zn, 2.6% Pb and 47.5 g/t Ag.

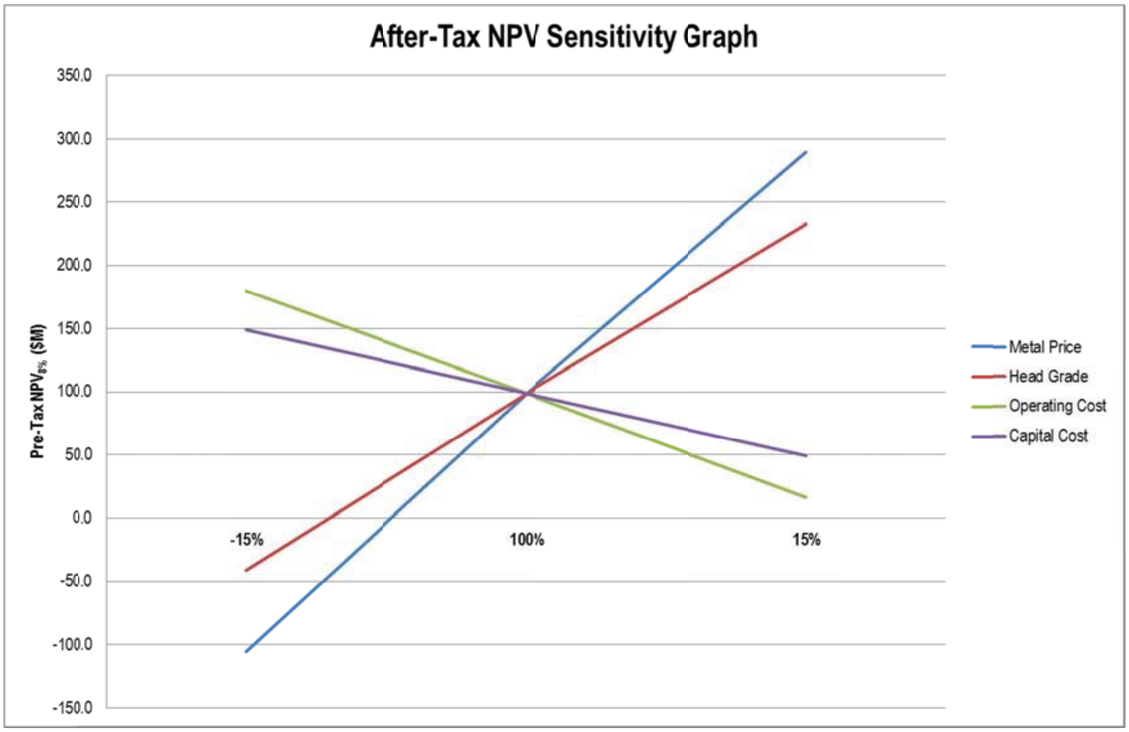
A 5,500 t/d concentrator plant, tailings facility, diesel generation power station, truck shop, offices, mine dry, fuel storage facility, and camp will be built on the project site to facilitate year-round mine operations.

## 25.2 Projected Economic Outcomes

The results of the economic analysis, based on all the drilling data and associated mine modeling and cost estimations for the Lik deposit, reflect a pre-tax IRR of 12.5% with an $NPV_{8\%}$ of $69.3 million and a post-tax estimated IRR of 9.7% with an $NPV_{8\%}$ of $25 million. The payback period based on the economic analysis is five years in the pre-tax scenario and 5.8 years in the after-tax scenario.

The Lik deposit as modeled is very sensitive to changes in metals prices, for example in the sensitivity table below, a change in zinc price from $0.92/lb to $1.00/lb increases the after-tax NPV8% from $69.3 to $148 million. See Figure 25-1 for further zinc sensitivity estimates.

**Figure 25-1: After-Tax NPV Sensitivity Graph**




The Lik site is relatively conducive to the development of a mining operation. Space, though not abundant, is more than sufficient by current estimates to support mining and waste storage of identified potential resources. Existing topography and efficient site layout offers the opportunity to control and manage waters within the drainage of the proposed Tailings Management Facility (TMF). As a result, fresh makeup process water requirements are minimized. Once collected in the TMF, treatment of impacted waters is simplified and the captured water can be treated and recycled back to the ore concentration process in the mill, reducing the need for additional makeup water from a fresh source.

Acid rock drainage (ARD) and metal leaching (ML) issues related to the waste rock and storage facilities are manageable. Testing is underway to identify rock types that will require specialized storage design.

## 25.3 Foreseeable Impacts of Risks

There are no insurmountable environmental or permitting issues identified that could preclude the development of the Lik deposit. The fluctuation of world zinc and lead prices is a risk to the Lik Project and virtually any zinc/lead mine currently working toward a development plan.

# 26.0 Recommendations

JDS recommends that Zazu follow a priority-driven path forward that reduces risks associated with elements of the plan that are perceived to have the greatest degree of uncertainty first, and capitalize on all opportunities to improve the project fundamentals as early in the planning and development process as possible.

Key steps in proceeding with planning for development of Lik are as follows:

- Proceed with geotechnical and hydrogeological investigation work for the mill foundation, tailings dam, water supply/reservoir sizing, and waste dump locations to verify stability and determine material types, quantities, capacities and associated cost.
- Continue with geotechnical program for data collection and evaluation needed for a detailed pit design.
- Revise optimized costs based on the latest information provided in this PEA, including road and port maintenance operating costs.
- Develop a more detailed pit design with ramps located to further optimize haulages to both the concentrator/mill and the waste storage facilities.
- Review access road alignment options and make final selection on both the routing and the typical dimensions, road width in particular.
- Continue the collection of environmental data required to advance the permitting process and initiate plan review with the Department of Natural Resources – Large Mines Group.
- Review and confirm details/assumptions regarding planned contracts with AIDEA and NANA for construction of the access road connecting Lik to the existing DMTS and for improvements and use of the port facilities near Kivalina so that the financial impacts are clear.
- Investigate in greater detail the costs associated with shipping from the port near Kivalina to several potential off-takers/smelters to clearly understand the impacts on the project economics as they relate to each.
- Proceed with additional metallurgical testwork to optimize recoveries and optimize the economic returns of the project.
- Prepare a prefeasibility study based upon the review of results of the work described above.

The costs shown in Table 26-1 are for recommended work and are not included in the economic analysis developed for this technical report. Some of the recommended work program elements are not considered crucial for the development of a prefeasibility level study and may have to be considered for a subsequent study.

**Table 26-1: Recommended Work Cost Estimates**

| Area | Price |
|---|---|
| Continuation of Geotechnical and Hydrological Investigations | $200,000 |
| Drilling in Support of geotechnical investigations | $900,000 |
| Camp Costs in Support of Drilling | $500,000 |
| Helicopter Support for Drilling | $300,000 |
| Fuel, Transport, and Travel in Support of Drilling | $300,000 |
| Preliminary Tailings Storage Facility Design (Dam) | $75,000 |
| Investigate Road, Port, and Shipping Costs | $50,000 |
| Pit Phase and Ramp Design | $60,000 |
| Investigate Smelter Contracts | $50,000 |
| Marketing Study | $40,000 |
| Additional Metallurgical Process Optimization | $100,000 |
| Prefeasibility Study | $1,800,000 |
| Camp and Equipment Maintenance | $60,000 |
| Environmental and Permitting Work | $1,000,000 |
| Contingency | $500,000 |
| **Total** | **$5,935,000** |

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# Appendix A – Qualified Persons Certificates

**CERTIFICATE OF AUTHOR**

I, Robert L. Matter, PE do hereby certify that:

1. I am currently employed as a Mining Engineer with JDS Energy & Mining, Inc. with an office at 2015 West River Road, Tucson, Arizona, USA ;
2. This certificate applies to the technical report entitled "Preliminary Economic Assessment Technical Report, Zazu Metals Corporation, Lik Deposit, Alaska, USA", with an effective date of March 3, 2014 prepared for Zazu Metals Corporation.;
3. I am a Professional Mining Engineer (P.E. 37372) registered with the Arizona Board of Technical Registration. I am a graduate of the Montana College of Mineral Science and Technology (Montana Tech) with a Bachelor of Science degree in Mining Engineering (1993). I have worked in the Mining Industry during summer breaks while in school since 1987 and continuously after my graduation from Montana Tech in 1993. I have worked in production and technical positions in mines in Canada and held progressively responsible positions including senior technical positions in companies in the United States. I have been a consultant for over 10 years and have performed mine planning, cost estimation, mine reclamation planning and oversight, scheduling and technical reporting for mining operations in Canada, the United States, and Africa.
4. I have read the definition of "qualified person" set out in National Instrument 43-101 (NI 43-101) I certify that by reason of my education, affiliation with a professional association (as defined in NI 43-101) and past relevant work experience, I fulfill the requirements to be a "qualified person" for the purposes of NI 43-101.
5. I have visited the Lik project site several times, with the most recent visit taking place on June 18, 2013;
6. I am responsible for Section numbers 1-3, 18, 19, 22-26 and share responsibility for Sections 5, 21 and 27.
7. I am independent of the Issuer applying the test set out in Section 1.5 of NI 43-101.
8. I have had prior involvement with the property that is the subject of the Preliminary Economic Assessment Technical Report of the Lik Project; I have taken part in mine planning, infrastructure planning and cost estimating as an independent consultant for Zazu previously.
9. As of the date of this certificate, to the best of my knowledge, information and belief, this technical report contains all scientific and technical information that is required to be disclosed to make the technical report not misleading;
10. I have read NI 43-101, and the sections of the Technical Report for which I am responsible have been prepared in accordance with NI 43-101 and Form 43-101F1.

Effective Date: March 3, 2014
Signing Date: April 23, 2014
*{"Original Signed and Sealed"}*
*"Robert L. Matter"*

**CERTIFICATE OF AUTHOR**

I, Antonio (Tony) Loschiavo, P.Eng. do hereby certify that:

1. I am currently employed as a Senior Mining Engineer with JDS Energy & Mining, Inc. with an office at Suite 860 – 625 Howe Street, Vancouver, British Columbia, V6C 2T6, Canada ;
2. This certificate applies to the technical report titled "Preliminary Economic Assessment Technical Report, Zazu Metals Corporation, Lik Deposit, Alaska, USA", with an effective date of March 3, 2014 prepared for Zazu Metals Corporation.;
3. I am a graduate of University of British Columbia with a B.A.Sc in Mining & Mineral Process Engineering, 1998. I have practiced my profession continuously since 1998; My relevant experience includes more than 15 years experience in mining operations, project studies and engineering. I have held senior mine planning and technical mine positions in Canada. I've worked as a consultant for over 6 years and have performed optimization, mine planning, scheduling, cost estimation and economic analysis work for a significant number of projects, throughtout Canada, USA, Latin & South America.
4. I have not visited the Lik project site;
5. I am responsible for Sections numbers 15, 16 and 21 (except for 21.2 & 21.2.4, 21.7 and 21.8);
6. I am a Professional Engineer (License#: 39436) with the Association of Professional Engineers and Geoscientists of British Columbia;
7. I have read the definition of "qualified person" set out in National Instrument 43-101 (NI 43-101) and certify that by reason of my education, affiliation with a professional association (as defined in NI 43-101) and past relevant work experience, I fulfill the requirements to be a "qualified person" for the purposes of NI 43-101. I am independent of the Issuer and related companies applying all of the tests in Section 1.5 of the National Instrument 43-101;
8. I have not had prior involvement with the property that is the subject of the Preliminary Economic Assessment Technical Report of the Lik Project;
9. As of the date of this certificate, to the best of my knowledge, information and belief, this technical report contains all scientific and technical information that is required to be disclosed to make the technical report not misleading;
10. I have read NI 43-101, and the sections of the Technical Report for which I am responsible have been prepared in accordance with NI 43-101 and Form 43-101F1.

Effective Date: March 3, 2014

Signing Date: April 23, 2014

*{"Signed and Sealed"}*

*"Antonio Loschiavo, P.Eng"*

G.R. RAWSTHORNE AND
ASSOCIATES INC.
BOX 1988
SQUAMISH, B.C. V8B 0B4
604-898-9061 fax 604-898-9003

**CERTIFICATE OF AUTHOR**

I, George Rawsthorne, P.Eng. do hereby certify that:

1. I am currently the President and a Principal Engineer with G. R. Rawsthorne & Associates located at 40503 Thunderbird Ridge in Squamish B.C. contracted as a Metallurgical Specialist with JDS Energy & Mining, Inc. with an office at Suite 860 – 625 Howe Street, Vancouver, British Columbia, V6C 2T6, Canada ;
2. This certificate applies to the technical report titled "Preliminary Economic Assessment Technical Report, Zazu Metals Corporation, Lik Deposit, Alaska, USA", with an effective date of March 3, 2014 prepared for Zazu Metals Corporation;
3. I am a Professional Process Engineer (P.Eng. # 143091) registered with the association of Professional Engineers, Geologists of British Columbia. I am also a member of the Canadian Institute Of Mining and Metallurgy and the Society of Mining Engineers of the AIME. I am a graduate of Queen's University in Chemical Engineering (1966). I have been involved in the process and mining industry since 1966 and have practiced my profession continuously since graduation. I have held senior metallurgical production and technical positions in 5 operating mines in Canada. I have worked as a consultant for over 30 years and have performed testwork planning and supervision, mill design and startup, plant optimization, financial analysis and project management, as a Qualified Person, for a significant number of engineering studies and technical reports, plus plant design in Canada, Asia, Latin America and Russia.
4. I have read the definition of "Qualified Person" set out in National Instrument 43-101 (NI 43-101) and certify that by reason of my education, affiliation with a professional association (as defined in NI 43 101) and relevant work experience, I fulfill the requirements to be a Qualified Person" for the purposes of NI 43-101.
5. I have not visited the Lik project site;
6. I am responsible for Sections numbers 13, 17, and share responsibility for Section 21.
7. I am independent of the Issuer applying the test set out in Section 1.5 of NI 43-101.
8. I have not had prior involvement with the property that is the subject of the Preliminary Economic Assessment Technical Report of the Lik Project.
9. As of the date of this certificate, to the best of my knowledge, information and belief, this technical report contains all scientific and technical information that is required to be disclosed to make the technical report not misleading;
10. I have read NI 43-101, and the sections of the Technical Report for which I am responsible have been prepared in compliance with NI 43-101 and Form 43-101F1.

Effective Date: March 3, 2014
Signing Date: April 23, 2014

*{"Original Signed and Sealed"}*
*"George Rawsthorne, P.Eng"*

## NEIL N. GOW

I, Neil N. Gow, P.Geo., as an author of this report entitled Preliminary Economic Assessment Technical Report, Zazu Metals Corporation, Lik Deposit, Alaska, USA", prepared for Zazu Metals Corporation and dated March 3, 2014, do hereby certify that:

1. I am Associate Principal Geologist with Roscoe Postle Associates Inc. of Suite 501, 55 University Ave Toronto, ON M5J 2H7.

2. I am a graduate of University of New England, Armidale, NSW, Australia, in 1966 with a Bachelor of Science degree in Geological Sciences.

3. I am registered as a Professional Geologist in the Province of Ontario (Reg. #433). I have worked as a geologist for a total of 47 years since my graduation. My relevant experience for the purpose of the Technical Report is:
   - Review and report as a consultant on numerous exploration and mining projects around the world for due diligence and regulatory requirements.
   - VP and Director of an exploration branch of a major Australian mining company in Canada.
   - Senior Geologist with a major Australian mining company in charge of base metal and uranium exploration in the Northern Territory of Australia, bauxite exploration in southeast Asia and parts of Africa, nickel exploration in New Caledonia.
   - Senior Mine Geologist in charge of exploration and reserve estimation programs at a large base metal mine in NSW, Australia.

4. I have read the definition of "qualified person" set out in National Instrument 43-101 ("NI 43-101") and certify that by reason of my education, affiliation with a professional association (as defined in NI 43-101) and past relevant work experience, I fulfill the requirements to be a "qualified person" for the purposes of NI 43-101.

5. I visited the Lik property on October 11, 2006, September 11, 2007, August 20 to 21, 2008, and August 19 to 21, 2011.

6. I am responsible for Section 4, Sections 6 to 12, 14 and share responsibility for Sections 5 and 27 of the Technical Report.

7. I am independent of the Issuer applying the test set out in Section 1.5 of NI 43-101.

8. I have had prior involvement with the property that is the subject of the Preliminary Economic Assessment Technical Report of the Lik Project. I completed Technical Reports on the Lik property in August 2007 and April 2010.

9. I have read NI 43-101, and the Technical Report has been prepared in compliance with NI 43-101 and Form 43-101F1.

10. At the effective date of the Technical Report, to the best of my knowledge, information, and belief, the sections for which I am responsible in the Technical Report contain all scientific and technical information that is required to be disclosed to make the Technical Report not misleading.

Effective Date: March 3, 2014
Signing Date: April 23, 2014

**(Signed & Sealed) "*Neil N. Gow*"**

Neil N. Gow, P.Geo.

Travis/Peterson
Environmental Consulting, Inc.

Michael D. Travis, P.E.
Principal
3305 Arctic Boulevard, Suite 102
Anchorage, Alaska 99503

Phone: (907) 522-4337
Fax: (907) 522-4313

Laurence A. Peterson
Operations Manager
329 2nd Street
Fairbanks, Alaska 99701

Phone: (907) 455-7225
Fax: (907) 455-7228

**CERTIFICATE OF AUTHOR**

I, Michael Travis, PE do hereby certify that:

1. I am currently employed as a Principal with Travis/Peterson Environmental Consulting, Inc. (TPECI) with an office at 3305 Arctic Blvd., Suite 102, Anchorage, Alaska 99503;

2. This certificate applies to the Technical Report titled, "Preliminary Economic Assessment Technical Report, Zazu Metals Corporation, Lik Deposit, Alaska, USA", with an effective date of March 3, 2014 prepared for Zazu Metals Corporation;

3. I am a Professional Engineer (No. 8048) certified by the State of Alaska Board of Registration for Architects, Engineers, and Land Surveyors and I am a Certified Environmental Professional (No. 02645) certified by the National Association of Environmental Professionals. I am a graduate of University of Alaska with a Bachelor of Science in Fisheries Biology (May 1980) and a Master of Science in Environmental Quality Science (September 1986). I have practiced my profession continuously since 1981. I have worked as a consultant for NANA Corporation representing their interests at the Red Dog Mine. This experience enabled me to evaluate the Lik Project environmental issues.

4. I have been working on the Lik Project since December, 2007. I have visited the Lik project site multiple times. My most recent visits were the weeks of June 22, 2013 and July 13, 2013;

5. I am responsible for Section 20 and share responsibility for Section 27 of the Technical Report;

6. I have read the definition of "qualified person" as defined in National Instrument (NI) 43-101 and certify that by reason of my education, affiliation with a professional association (as defined in NI 43-101), and past relevant work experience, I fulfill the requirements to be a "qualified person" for the purposes of NI 43-101. I am independent of the Issuer and related companies applying all of the tests in Section 1.5 of the NI 43-101;

7. I have had prior involvement with the property that is the subject of the Preliminary Economic Assessment Technical Report of the Lik Project. I supervised TPECI involvement which included developing the Environmental Assessment to fulfill the National Environmental Policy Act, State and Federal environmental permitting, and field programs to collect environmental baseline data;

8. As of this certificate date, to the best of my knowledge, information, and belief, this Technical Report contains all scientific and technical information that is required to be disclosed to ensure the technical report is not misleading; and

9. I have read NI 43-101, and the sections of the Technical Report for which I am responsible. I believe these sections were prepared in accordance with NI 43-101 and Form 43-101F1.

Effective Date: March 03, 2014
Signing Date: April 23, 2014
{Original Signed and Sealed}
*Michael Travis, P.E.*

# Appendix B – Economic Analysis 9-Year Mine Plan

Zazu - Lik Project

| All units in Imperial | Source | Unit | LOM | 2013 (-2) | 2014 (-1) | 2015 (1) | 2016 (2) | 2017 (3) | 2018 (4) | 2019 (5) | 2020 (6) | 2021 (7) | 2022 (8) | 2023 (9) | 2024 (10) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| METAL PRICES | | | | | | | | | | | | | | | |
| Zn | link | $/lb | 0.9242 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 |
| Pb | link | $/lb | 1.013 | 1.01 | 1.01 | 1.01 | 1.01 | 1.01 | 1.01 | 1.01 | 1.01 | 1.01 | 1.01 | 1.01 | 1.01 |
| Ag | link | $/oz | 19.43 | 19.43 | 19.43 | 19.43 | 19.43 | 19.43 | 19.43 | 19.43 | 19.43 | 19.43 | 19.43 | 19.43 | 19.43 |
| PRODUCTION (Based on short tons) | | | | | | | | | | | | | | | |
| Tons | link | tons | 18,887,642 | | | 1,760,000 | 2,200,000 | 2,200,000 | 2,200,000 | 2,200,000 | 2,200,000 | 2,200,000 | 2,200,000 | 1,727,641 | 0 |
| Waste | link | tons | 95,851,879 | | 229,093 | 6,212,165 | 12,488,955 | 12,322,369 | 12,509,845 | 11,926,726 | 12,471,059 | 12,371,089 | 12,756,716 | 2,563,862 | 0 |
| Total Mined | calc | tons | 114,739,520 | | 229,093 | 7,972,164 | 14,688,956 | 14,522,369 | 14,709,845 | 14,126,726 | 14,671,059 | 14,571,089 | 14,956,716 | 4,291,503 | 0 |
| Throughput Rate | calc | stpd | 5,797 | | 0 | 4,822 | 6,027 | 6,027 | 6,027 | 6,027 | 6,027 | 6,027 | 6,027 | 4,733 | 0 |
| Strip Ratio | link | w:o | 5.1 | | | 3.5 | 5.7 | 5.6 | 5.7 | 5.4 | 5.7 | 5.6 | 5.8 | 1.5 | |
| HEAD GRADE | | | | | | | | | | | | | | | |
| Zn | link | % | 7.66% | | | 8.60% | 9.46% | 7.62% | 7.00% | 7.10% | 7.05% | 7.22% | 7.16% | 7.97% | 0.00% |
| Pb | link | % | 2.55% | | | 3.47% | 2.99% | 2.48% | 2.37% | 2.15% | 2.18% | 2.43% | 2.15% | 3.02% | 0.00% |
| Ag | link | oz/stons | 1.4 | | | 1.83 | 1.70 | 1.67 | 0.93 | 0.82 | 0.98 | 1.50 | 1.10 | 2.20 | 0.0 |
| NSR CALCULATION | | | | | | | | | | | | | | | |
| Zn Concentrate | | | | | | | | | | | | | | | |
| Recovery to Zn Concentrate | input | % Zn | 85.0% | 85% | 85% | 85% | 85% | 85% | 85% | 85% | 85% | 85% | 85% | 85% | 85% |
| | input | % Ag | 26.8% | 26.75% | 27% | 27% | 27% | 27% | 27% | 27% | 27% | 27% | 27% | 27% | 27% |
| Metal in Zn Concentrate | calc | Zn tons | 1,229,555 | 0 | 0 | 128,685 | 176,896 | 142,432 | 130,961 | 132,732 | 131,920 | 135,091 | 133,844 | 116,995 | 0 |
| | calc | Zn lbs | 2,459,110,512 | 0 | 0 | 257,369,041 | 353,791,240 | 284,863,912 | 261,921,823 | 265,464,000 | 263,840,484 | 270,182,644 | 267,687,574 | 233,989,792 | 0 |
| | calc | Ag oz | 6,992,992 | 0 | 0 | 859,334 | 1,000,471 | 982,549 | 544,671 | 479,989 | 576,463 | 884,814 | 646,879 | 1,017,822 | 0 |
| Pull Factor | calc | | 8.3 | 0 | 0 | 7 | 7 | 8 | 9 | 9 | 9 | 9 | 9 | 8 | 0 |
| Zn Concentrate Grade | input | % Pb | 53.40% | 53.40% | 53.40% | 53.40% | 53.40% | 53.40% | 53.40% | 53.40% | 53.40% | 53.40% | 53.40% | 53.40% | 53.40% |
| | calc | oz/t Ag | 3.00 | 0.0 | 0.0 | 3.6 | 3.0 | 3.7 | 2.2 | 1.9 | 2.3 | 3.5 | 2.6 | 4.6 | 0.0 |
| Zn Concentrate Produced | calc | tons | 2,302,538 | 0 | 0 | 240,982 | 331,265 | 266,727 | 245,245 | 248,562 | 247,042 | 252,980 | 250,644 | 219,092 | 0 |
| Moisture Content | link | % | 8% | 8% | 8% | 8% | 8% | 8% | 8% | 8% | 8% | 8% | 8% | 8% | 8% |
| Minimum Deduction | link | %/Zn ton | 8% | 8% | 8% | 8% | 8% | 8% | 8% | 8% | 8% | 8% | 8% | 8% | 8% |
| Zn Payable | link | % | 85.00% | 85.00% | 85.00% | 85.00% | 85.00% | 85.00% | 85.00% | 85.00% | 85.00% | 85.00% | 85.00% | 85.00% | 85.00% |
| Zn payable based on min. deduction | calc | % | 45% | 45% | 45% | 45% | 45% | 45% | 45% | 45% | 45% | 45% | 45% | 45% | 45% |
| Zn payable based on % | calc | % | 45% | 45% | 45% | 45% | 45% | 45% | 45% | 45% | 45% | 45% | 45% | 45% | 45% |
| Payable Zn in Zn Concentrate | calc | Zn lbs | 2,090,243,935 | 0 | 0 | 218,763,685 | 300,722,554 | 242,134,325 | 222,633,550 | 225,644,400 | 224,264,411 | 229,655,247 | 227,534,438 | 198,891,324 | 0 |
| | calc | Zn tons | 1,045,122 | 0 | 0 | 109,382 | 150,361 | 121,067 | 111,317 | 112,822 | 112,132 | 114,828 | 113,767 | 99,446 | 0 |
| Revenues - Zn in Zn Concentrate | calc | $ | 1,931,803,445 | 0 | 0 | 202,181,398 | 277,927,785 | 223,780,543 | 205,757,927 | 208,540,555 | 207,265,169 | 212,247,380 | 210,287,328 | 183,815,361 | 0 |
| Payable Ag in Zn Concentrate | calc | oz | 443,465 | 0 | 0 | 65,917 | 0 | 94,947 | 0 | 0 | 0 | 57,086 | 0 | 225,514 | 0 |
| Ag Payable | input | % | 70% | 70% | 70% | 70% | 70% | 70% | 70% | 70% | 70% | 70% | 70% | 70% | 70% |
| Ag min. deduction | input | oz | 3.18 | 3.18 | 3.18 | 3.18 | 3.18 | 3.18 | 3.18 | 3.18 | 3.18 | 3.18 | 3.18 | 3.18 | 3.18 |
| Revenues - Ag in Zn Concentrate | calc | $ | 8,616,520 | 0 | 0 | 1,280,771 | 0 | 1,844,823 | 0 | 0 | 0 | 1,109,188 | 0 | 4,381,737 | 0 |
| Zn Treatment Charge | input | $/dry ton | 154.22 | 154.22 | 154.22 | 154.22 | 154.22 | 154.22 | 154.22 | 154.22 | 154.22 | 154.22 | 154.22 | 154.22 | 154.22 |
| | calc | $ | 355,106,610 | 0 | 0 | 37,165,246 | 51,089,045 | 41,135,629 | 37,822,688 | 38,334,195 | 38,099,752 | 39,015,588 | 38,655,289 | 33,789,178 | 0 |
| Ag Refining Charge | input | $/payable oz | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| | calc | $ | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Transport Cost - Zn Concentrate | input | $/dry ton | 85.98 | 85.98 | 85.98 | 85.98 | 85.98 | 85.98 | 85.98 | 85.98 | 85.98 | 85.98 | 85.98 | 85.98 | 85.98 |
| | calc | $ | 197,961,491 | 0 | 0 | 20,718,532 | 28,480,640 | 22,931,903 | 21,085,036 | 21,370,186 | 21,239,491 | 21,750,043 | 21,549,187 | 18,836,473 | 0 |
| Zn Price Participation | input | $/dry ton | 46.04 | 46.04 | 46.04 | 46.04 | 46.04 | 46.04 | 46.04 | 46.04 | 46.04 | 46.04 | 46.04 | 46.04 | 46.04 |
| | calc | $ | 106,007,954 | 0 | 0 | 11,094,729 | 15,251,322 | 12,279,985 | 11,290,992 | 11,443,689 | 11,373,702 | 11,647,101 | 11,539,543 | 10,086,891 | 0 |
| Penalties | input | $/dry ton | 4.80 | 4.80 | 4.80 | 4.80 | 4.80 | 4.80 | 4.80 | 4.80 | 4.80 | 4.80 | 4.80 | 4.80 | 4.80 |
| | calc | $ | 11,060,526 | 0 | 0 | 1,157,588 | 1,591,273 | 1,281,254 | 1,178,066 | 1,193,997 | 1,186,695 | 1,215,221 | 1,203,999 | 1,052,434 | 0 |
| Insurance | input | %NIV | 0.15% | 0.15% | 0.15% | 0.15% | 0.15% | 0.15% | 0.15% | 0.15% | 0.15% | 0.15% | 0.15% | 0.15% | 0.15% |
| | calc | $ | 1,905,425 | 0 | 0 | 199,989 | 272,273 | 221,995 | 201,572 | 204,298 | 203,048 | 209,593 | 206,009 | 186,648 | 0 |
| Losses | input | %NIV | 0.42% | 0.42% | 0.42% | 0.42% | 0.42% | 0.42% | 0.42% | 0.42% | 0.42% | 0.42% | 0.42% | 0.42% | 0.42% |
| | calc | $ | 5,335,190 | 0 | 0 | 559,970 | 762,365 | 621,586 | 564,401 | 572,034 | 568,535 | 586,860 | 576,825 | 522,615 | 0 |
| Zn NSR in Zn Concentrate | calc | $ | 1,254,426,248 | 0 | 0 | 131,285,344 | 180,480,866 | 145,308,191 | 133,615,172 | 135,422,156 | 134,593,946 | 137,822,973 | 136,556,477 | 119,341,123 | 0 |
| Ag NSR in Zn Concentrate | calc | $ | 8,616,520 | 0 | 0 | 1,280,771 | 0 | 1,844,823 | 0 | 0 | 0 | 1,109,188 | 0 | 4,381,737 | 0 |
| Total Zn NSR | calc | $ | 1,263,042,767 | 0 | 0 | 132,566,115 | 180,480,866 | 147,153,014 | 133,615,172 | 135,422,156 | 134,593,946 | 138,932,161 | 136,556,477 | 123,722,860 | 0 |
| | calc | $/dry ton | 549 | | | | | | | | | | | | |
| Pb Concentrate | | | | | | | | | | | | | | | |
| Recovery to Pb Concentrate | input | % Pb | 69.7% | 69.70% | 70% | 70% | 70% | 70% | 70% | 70% | 70% | 70% | 70% | 70% | 70% |
| | input | % Ag | 5.2% | 5% | 5% | 5% | 5% | 5% | 5% | 5% | 5% | 5% | 5% | 5% | 5% |
| Metal in Pb Concentrate | calc | Pb tons | 335,839 | 0 | 0 | 42,514 | 45,812 | 38,023 | 36,382 | 33,045 | 33,434 | 37,239 | 32,978 | 36,411 | 0 |
| | calc | Pb lbs | 671,677,086 | 0 | 0 | 85,027,697 | 91,624,893 | 76,046,115 | 72,763,742 | 66,089,200 | 66,868,527 | 74,477,427 | 65,956,547 | 72,822,938 | 0 |
| | calc | Ag oz | 1,351,543 | 0 | 0 | 166,084 | 193,362 | 189,898 | 105,269 | 92,768 | 111,414 | 171,009 | 125,023 | 196,716 | 0 |
| Pull Factor | calc | | 35.2 | 0 | 0 | 25 | 29 | 35 | 37 | 41 | 40 | 36 | 41 | 29 | 0 |
| Pb Concentrate Grade | input | % Pb | 61.15% | 61.15% | 61.15% | 61.15% | 61.15% | 61.15% | 61.15% | 61.15% | 61.15% | 61.15% | 61.15% | 61.15% | 61.15% |
| | calc | oz/t Ag | 2.42 | 0.0 | 0.0 | 2.4 | 2.6 | 3.1 | 1.8 | 1.7 | 2.0 | 2.8 | 2.3 | 3.3 | 0.0 |
| Pb Concentrate Produced | calc | tons | 549,204 | 0 | 0 | 69,524 | 74,918 | 62,180 | 59,496 | 54,039 | 54,676 | 60,897 | 53,930 | 59,545 | 0 |
| Moisture Content | link | % | 8% | 8% | 8% | 8% | 8% | 8% | 8% | 8% | 8% | 8% | 8% | 8% | 8% |
| Minimum Deduction | link | %/Pb ton | 3% | 3% | 3% | 3% | 3% | 3% | 3% | 3% | 3% | 3% | 3% | 3% | 3% |
| Pb Payable | link | % | 95.00% | 95.00% | 95.00% | 95.00% | 95.00% | 95.00% | 95.00% | 95.00% | 95.00% | 95.00% | 95.00% | 95.00% | 95.00% |
| Pb payable based on min. deduction | calc | % | 58% | 58% | 58% | 58% | 58% | 58% | 58% | 58% | 58% | 58% | 58% | 58% | 58% |
| Pb payable based on % | calc | % | 58% | 58% | 58% | 58% | 58% | 58% | 58% | 58% | 58% | 58% | 58% | 58% | 58% |
| Payable Pb in Pb Concentrate | calc | Pb lbs | 638,093,232 | 0 | 0 | 80,776,313 | 87,043,649 | 72,243,809 | 69,125,555 | 62,784,740 | 63,525,101 | 70,753,556 | 62,658,720 | 69,181,791 | 0 |
| | calc | Pb tons | 319,047 | 0 | 0 | 40,388 | 43,522 | 36,122 | 34,563 | 31,392 | 31,763 | 35,377 | 31,329 | 34,591 | 0 |
| Revenues - Pb in Pb Concentrate | calc | $ | 646,388,444 | 0 | 0 | 81,826,405 | 88,175,216 | 73,182,978 | 70,024,187 | 63,600,941 | 64,350,927 | 71,673,352 | 63,473,283 | 70,081,155 | 0 |
| Payable Ag in Pb Concentrate | calc | oz | 523,076 | 0 | 0 | 61,459 | 79,899 | 94,257 | 17,578 | 13,262 | 30,093 | 78,089 | 44,055 | 104,385 | 0 |
| Ag Payable | input | % | 95% | 95% | 95% | 95% | 95% | 95% | 95% | 95% | 95% | 95% | 95% | 95% | 95% |
| Ag min. deduction | input | oz/dmt | 1.46 | 1.5 | 1.5 | 1.5 | 1.5 | 1.5 | 1.5 | 1.5 | 1.5 | 1.5 | 1.5 | 1.5 | 1.5 |
| Revenues - Ag in Pb Concentrate | calc | $ | 10,163,374 | 0 | 0 | 1,194,151 | 1,552,445 | 1,831,408 | 341,531 | 257,687 | 584,704 | 1,517,268 | 855,989 | 2,028,191 | 0 |
| Pb Treatment Charge | input | $/dry ton | 149.69 | 149.69 | 149.69 | 149.69 | 149.69 | 149.69 | 149.69 | 149.69 | 149.69 | 149.69 | 149.69 | 149.69 | 149.69 |
| | calc | $ | 82,209,321 | 0 | 0 | 10,406,890 | 11,214,348 | 9,307,597 | 8,905,854 | 8,088,929 | 8,184,314 | 9,115,599 | 8,072,693 | 8,913,099 | 0 |
| Ag Refining Charge | input | $/payable oz | 0.78 | 0.78 | 0.78 | 0.78 | 0.78 | 0.78 | 0.78 | 0.78 | 0.78 | 0.78 | 0.78 | 0.78 | 0.78 |
| | calc | $ | 406,535 | 0 | 0 | 47,766 | 62,098 | 73,256 | 13,661 | 10,307 | 23,388 | 60,691 | 34,240 | 81,128 | 0 |
| Transport Cost - Pb Concentrate | input | $/dry ton | 85.98 | 85.98 | 85.98 | 85.98 | 85.98 | 85.98 | 85.98 | 85.98 | 85.98 | 85.98 | 85.98 | 85.98 | 85.98 |
| | calc | $ | 47,218,045 | 0 | 0 | 5,977,339 | 6,441,113 | 5,345,945 | 5,115,198 | 4,645,987 | 4,700,772 | 5,235,668 | 4,636,661 | 5,119,360 | 0 |
| Pb Price Participation | input | $/dry ton | 9.43 | 9.43 | 9.43 | 9.43 | 9.43 | 9.43 | 9.43 | 9.43 | 9.43 | 9.43 | 9.43 | 9.43 | 9.43 |
| | calc | $ | 5,179,480 | 0 | 0 | 655,671 | 706,544 | 586,412 | 561,101 | 509,631 | 515,641 | 574,315 | 508,608 | 561,557 | 0 |
| Penalties | input | $/dry ton | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| | calc | $ | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Insurance | input | %NIV | 0.15% | 0.15% | 0.15% | 0.15% | 0.15% | 0.15% | 0.15% | 0.15% | 0.15% | 0.15% | 0.15% | 0.15% | 0.15% |
| | calc | $ | 782,308 | 0 | 0 | 98,899 | 106,955 | 89,552 | 83,655 | 75,906 | 77,267 | 87,307 | 76,616 | 86,151 | 0 |
| Losses | input | %NIV | 0.42% | 0.42% | 0.42% | 0.42% | 0.42% | 0.42% | 0.42% | 0.42% | 0.42% | 0.42% | 0.42% | 0.42% | 0.42% |
| | calc | $ | 2,190,461 | 0 | 0 | 276,918 | 299,475 | 250,745 | 234,234 | 212,536 | 216,348 | 244,458 | 214,524 | 241,224 | 0 |
| Pb NSR in Pb Concentrate | calc | $ | 513,988,309 | 0 | 0 | 65,066,359 | 70,113,325 | 58,189,140 | 55,685,246 | 50,577,584 | 51,172,225 | 56,990,320 | 50,472,789 | 55,721,321 | 0 |
| Ag NSR in Pb Concentrate | calc | $ | 9,756,839 | 0 | 0 | 1,146,385 | 1,490,347 | 1,758,152 | 327,870 | 247,379 | 561,316 | 1,456,578 | 821,749 | 1,947,064 | 0 |
| Total Pb NSR | calc | $ | 523,745,148 | 0 | 0 | 66,212,743 | 71,603,672 | 59,947,292 | 56,013,117 | 50,824,964 | 51,733,541 | 58,446,898 | 51,294,538 | 57,668,384 | 0 |
| | calc | $/dry ton | 954 | | | | | | | | | | | | |
| Total Zn NSR | link | $ | 1,263,042,767 | 0 | 0 | 132,566,115 | 180,480,866 | 147,153,014 | 133,615,172 | 135,422,156 | 134,593,946 | 138,932,161 | 136,556,477 | 123,722,860 | 0 |
| Total Pb NSR | link | $ | 523,745,148 | 0 | 0 | 66,212,743 | 71,603,672 | 59,947,292 | 56,013,117 | 50,824,964 | 51,733,541 | 58,446,898 | 51,294,538 | 57,668,384 | 0 |
| Total NSR | calc | $ | 1,786,787,915 | 0 | 0 | 198,778,858 | 252,084,537 | 207,100,306 | 189,628,288 | 186,247,120 | 186,327,486 | 197,379,059 | 187,851,015 | 181,391,245 | 0 |
| Royalties (NSR tied) | calc | $ | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Total NSR (Net of Royalties) | calc | $ | 1,786,787,915 | 0 | 0 | 198,778,858 | 252,084,537 | 207,100,306 | 189,628,288 | 186,247,120 | 186,327,486 | 197,379,059 | 187,851,015 | 181,391,245 | 0 |
| OPERATING COSTS | | | | | | | | | | | | | | | |
| Mine | input | $/ton | 2.76 | 0.00 | 0.00 | 3.61 | 2.73 | 2.69 | 2.78 | 2.77 | 2.70 | 2.69 | 2.44 | 2.84 | 0.00 |
| | calc | $ | 315,563,258 | | | 28,789,736 | 40,173,125 | 39,039,254 | 40,829,216 | 39,176,431 | 39,637,340 | 39,261,874 | 36,480,452 | 12,175,830 | |
| Processing | input | $/ton | 33.31 | 0.00 | 0.00 | 33.31 | 33.31 | 33.31 | 33.31 | 33.31 | 33.31 | 33.31 | 33.31 | 33.31 | 0.00 |
| | calc | $ | 629,173,240 | | 0 | 58,628,003 | 73,285,026 | 73,285,018 | 73,285,018 | 73,285,018 | 73,285,028 | 73,285,016 | 73,285,018 | 57,550,096 | 0 |
| Maintenance & Operating (Road/Port) | input | $/ton | 0.56 | | | 0.66 | 0.53 | 0.53 | 0.53 | 0.53 | 0.53 | 0.53 | 0.53 | 0.68 | 0.00 |
| | calc | $ | 10,497,321 | | | 1,166,369 | 1,166,369 | 1,166,369 | 1,166,369 | 1,166,369 | 1,166,369 | 1,166,369 | 1,166,369 | 1,166,369 | |
| G&A | input | $/ton | 6.45 | 0.00 | 0.00 | 6.45 | 6.45 | 6.45 | 6.45 | 6.45 | 6.45 | 6.45 | 6.45 | 6.45 | 0.00 |
| | calc | $ | 121,780,745 | 0 | 0 | 11,347,846 | 14,184,812 | 14,184,812 | 14,184,812 | 14,184,812 | 14,184,812 | 14,184,812 | 14,184,812 | 11,139,212 | 0 |
| Fuel & Supplies Transport | input | $ | 1,534,430 | | 72,043 | 144,879 | 168,894 | 167,988 | 169,347 | 168,101 | 168,441 | 168,327 | 168,781 | 137,630 | |
| Annual Supply Sea-Lift | input | $ | 48,933,198 | | | 5,437,022 | 5,437,022 | 5,437,022 | 5,437,022 | 5,437,022 | 5,437,022 | 5,437,022 | 5,437,022 | 5,437,022 | |
| Access Road | link | $ | 30,172,871 | | | 3,352,541 | 3,352,541 | 3,352,541 | 3,352,541 | 3,352,541 | 3,352,541 | 3,352,541 | 3,352,541 | 3,352,541 | |
| Port | link | $ | 1,722,992 | | | 191,444 | 191,444 | 191,444 | 191,444 | 191,444 | 191,444 | 191,444 | 191,444 | 191,444 | |
| Total Operating Costs | calc | $ | 1,159,378,055 | 0 | 72,043 | 109,057,841 | 137,959,234 | 136,824,448 | 138,615,769 | 136,961,738 | 137,422,997 | 137,047,405 | 134,266,438 | 91,150,143 | 0 |
| | calc | $/ton | 61.38 | | | | | | | | | | | | |
| Net Operating Income | calc | $ | 627,409,860 | 0 | -72,043 | 89,721,018 | 114,125,304 | 70,275,858 | 51,012,519 | 49,285,382 | 48,904,489 | 60,331,654 | 53,584,577 | 90,241,102 | 0 |
| CAPITAL COSTS | | | | | | | | | | | | | | | |
| Pre-Stripping | link | $ | 6,655,801 | | 6,655,801 | | | | | | | | | | |
| Mine Equipment | link | $ | 33,151,977 | | 11,177,696 | 15,734,281 | 1,560,000 | 3,120,000 | 1,560,000 | 0 | 0 | 0 | 0 | 0 | 0 |
| Direct Costs | link | $ | 192,335,000 | 96,167,500 | 96,167,500 | | | | | | | | | | |
| Construction Indirects | link | $ | 15,386,800 | 7,693,400 | 7,693,400 | | | | | | | | | | |
| Freight | link | $ | 22,746,278 | 11,373,139 | 11,373,139 | | | | | | | | | | |
| Capital Spares & Initial Fills | link | $ | 2,863,856 | 1,431,928 | 1,431,928 | | | | | | | | | | |
| Commissioning & Startup | link | $ | 2,000,000 | 1,000,000 | 1,000,000 | | | | | | | | | | |
| Construction Equipment | link | $ | 5,000,000 | 2,500,000 | 2,500,000 | | | | | | | | | | |
| EPCM | link | $ | 23,080,200 | 11,540,100 | 11,540,100 | | | | | | | | | | |
| Owners costs | link | $ | 5,000,000 | 2,500,000 | 2,500,000 | | | | | | | | | | |
| Closure | link | $ | 5,000,000 | | | | | | | | | | | | 5,000,000 |
| | link | $ | 0 | | | | | | | | | | | | |
| Total Pre-Contingency Capital Costs | link | $ | 313,219,911 | 134,206,067 | 152,039,563 | 15,734,281 | 1,560,000 | 3,120,000 | 1,560,000 | 0 | 0 | 0 | 0 | 0 | 5,000,000 |
| Contingency (20% of Direct Costs) | calc | $ | 38,467,000 | 19,233,500 | 19,233,500 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Total Capital Costs | calc | $ | 351,686,911 | 153,439,567 | 171,273,063 | 15,734,281 | 1,560,000 | 3,120,000 | 1,560,000 | 0 | 0 | 0 | 0 | 0 | 5,000,000 |
| *Pre-Production* | *link* | *$* | ***324,712,630*** | *153,439,567* | *171,273,063* | *0* | *0* | *0* | *0* | *0* | *0* | *0* | *0* | *0* | *0* |
| *Sustaining* | *link* | *$* | ***26,974,281*** | *0* | *0* | *15,734,281* | *1,560,000* | *3,120,000* | *1,560,000* | *0* | *0* | *0* | *0* | *0* | *5,000,000* |
| Working Capital | calc | $ | 0 | | | 27,264,460 | | | | | | | | | -27,264,460 |
| Net Pre-Tax Cash Flow | calc | $ | 275,722,949 | -153,439,567 | -171,345,106 | 46,722,276 | 112,565,304 | 67,155,858 | 49,452,519 | 49,285,382 | 48,904,489 | 60,331,654 | 53,584,577 | 90,241,102 | 22,264,460 |
| Cumulative Pre-Tax Cash Flow | calc | $ | | -153,439,567 | -324,784,673 | -278,062,397 | -165,497,093 | -98,341,235 | -48,888,715 | 396,667 | 49,301,156 | 109,632,810 | 163,217,387 | 253,458,489 | 275,722,949 |
| Estim.1% Net Profits Interest-Royalty | calc | $ | 2,757,229 | 0 | 0 | 0 | 0 | 0 | 0 | 3,967 | 489,045 | 603,317 | 535,846 | 902,411 | 222,645 |
| Net Pre-Tax Cash Flow after NPI | calc | $ | 272,965,720 | -153,439,567 | -171,345,106 | 46,722,276 | 112,565,304 | 67,155,858 | 49,452,519 | 49,281,416 | 48,415,445 | 59,728,338 | 53,048,731 | 89,338,691 | 22,041,816 |
| Cumulative Pre-Tax Cash Flow after NPI | calc | $ | | -153,439,567 | -324,784,673 | -278,062,397 | -165,497,093 | -98,341,235 | -48,888,715 | 392,700 | 48,808,145 | 108,536,482 | 161,585,213 | 250,923,904 | 272,965,720 |
| Pre-Tax Payback | calc | Years | 5.0 | | | | | | | | | | | | |
| Pre-Tax IRR | calc | % | 12.53% | | | | | | | | | | | | |
| Pre-Tax NPV | calc | $ | 69,287,450 | | | | | | | | | | | | |
| Taxes | link | $ | 70,921,064 | 0 | 0 | 9,290,209 | 15,256,003 | 6,386,367 | 3,193,849 | 3,548,767 | 3,376,935 | 6,227,784 | 4,944,212 | 18,696,938 | 0 |
| Net After-Tax Cash Flow | calc | $ | 204,801,885 | -153,439,567 | -171,345,106 | 37,432,067 | 97,309,301 | 60,769,491 | 46,258,670 | 45,736,615 | 45,527,554 | 54,103,870 | 48,640,365 | 71,544,164 | 22,264,460 |
| Cumulative After-Tax Cash Flow | calc | $ | | -153,439,567 | -324,784,673 | -287,352,606 | -190,043,305 | -129,273,814 | -83,015,144 | -37,278,528 | 8,249,026 | 62,352,896 | 110,993,261 | 182,537,425 | 204,801,885 |
| After-Tax Payback | calc | Years | 5.8 | | | | | | | | | | | | |
| After-Tax IRR | calc | % | 9.67% | | | | | | | | | | | | |
| After-Tax NPV | calc | $ | 25,034,328 | | | | | | | | | | | | |