APPENDICES

APPENDIX C-12

TAILINGS STORAGE FACILITY DESIGN CONCEPT

EXECUTIVE SUMMARY

The Jervois Base Metal Project is being developed by KGL Resources Limited (KGL). The target commodity is copper with subordinate lead, zinc, gold and silver associated with a large sediment-hosted mineral system that has been the subject of substantial historical exploration.

KGL commissioned Knight Piésold Pty Ltd (KP) to provide engineering services as part of the pre-feasibility study (PFS).

The PFS study report undertaken by KP was completed and issued in June 2014. Subsequently KGL has undertaken optimisation studies for the project which has resulted in an increase in mine life and process throughput.

The project area is arid with dry, hot summers and short, dry winters. Mean annual rainfall is 296 millimetres and falls mainly between November and March. Summers are hot with average maxima in the high thirties reducing to low twenties at night, and winters are mild with daily maxima in the mid-twenties cooling to around 5° Celsius at night.

PROJECT DESCRIPTION

The Jervois Base Metal Project (the Project) is approximately 380 kilometres north-east of Alice Springs in Central Australia, off the Plenty Highway. The nearest occupied communities are Bonya and Harts Range.

The Project contains a significant and high-grade copper resource, as well as silver, gold, lead and zinc in several deposits. The ore would be mined by open cut and underground methods and processed to a concentrate on site. The concentrate would then be trucked via the Plenty and Stuart Highways to the current rail freight terminal in Alice Springs, and then onto Darwin and/or Adelaide by rail. An option to shorten the road haulage being investigated by KGL involves the construction of a rail siding adjacent to the Adelaide to Darwin rail line north of Alice Springs on the Ghan Railway Line where it crosses the Plenty highway.

The Project footprint is estimated at 970 hectares of which a significant portion has been disturbed by historic mining activities. The operations will focus upon optimising the recovery of the currently estimated copper resource of 25.2 Mt. The operations are anticipated to produce approximately 87 Mt of waste rock and 20 Mt of tailings over a concept mine plan of 15 years. The rate of mining is influenced by the Processing Plant capabilities which currently allows for Run of Mine feed of up to 1.6 Mtpa, producing 150,000 tonnes of base metal concentrate per annum.

Mining operations at the Project area will be split between three operational areas (refer number):

- Reward;
- Bellbird; and
- Rockface.

Mining at Reward and Bellbird is both open cut and underground, whilst Rockface is underground only. Ore from all three mining areas will be trucked to the ROM stockpile for processing at the plant.

Mine infrastructure will include pits, waste rock landforms, tailings storage facilities, topsoil stockpiles, haul roads, heavy vehicle parking areas, ROM pads and fuel storage areas. The Processing Plant will include associated water tanks, workshops, fuel facilities, concentrate load out facility, mobile equipment, power plant, air and water supply facilities and storage areas.

Other infrastructure associated with the project will include laydown areas, production and monitoring bores, a magazine and explosives store, an accommodation camp, administration buildings, new sediment catchment dams, access and haul roads, monitoring and supply bores, power generation and supply facilities, workshops, hardstands and laydown areas. Proposed infrastructure will be located over previously disturbed mine infrastructure areas wherever feasible.

Once approved, it is anticipated that construction will commence in 2019, with mining and commissioning occurring in approximately 2020. It is currently anticipated that three will be up to 360 people employed to facilitate the construction requirements and up to 300 for the proposed project operations.

TAILINGS CHARACTERISTICS

A sample of Rougher Flotation tailings was tested to provide density and water release design parameters for the TSF design. The sample is a non-plastic Sandy SILT and was classified as ML. The P_{80} is approximately 120 µm. The grading indicates that liquefaction of the tailings material under earthquake loading will need to be considered.

Based on physical testing of the sample, behaviour characteristics were predicted for the tailings. The discharge percent solids was nominated at around 55% during the life of operation. At this percent solids, the expected water release would be around 35% of the water in slurry, not accounting for rainfall and evaporation. The underdrainage recovery potential would be high, up to around 10 – 15%, depending on the extent of the underdrainage collection system and basin conditions. Following PFS optimisation studies the process design parameters were amended and three tailings streams are to be produced from processing of Primary Copper, Transition Copper, and Primary Lead/Zinc ore. These tailings streams each have independent tailings properties, throughputs and scheduling. For the purposes of the PFS Update, tailings design parameters for each tailings stream were interpolated from the results of the testing carried out for the PFS and apportioned according to the process design schedule. A typical achievable density of 1.2 t/m^3 is expected for the early phase of the project increasing to 1.4 - 1.45 t/m^3 during the later stages. The interpretation is based on a target percent solids for the three tailings streams of between 57% and 62%, and will vary if significant changes in the design percent solids occur.

Results suggest that tailings from sulphide ore samples will have moderate S values of around 1%S, but are still likely to be PAF. Tailings showed enrichment in a suite of metals/metalloids including Ag, Bi, Be, Cd, Co, Cs Cu, Fe, Mn, Pd S Mo, Se TI, W and Zn. Some mobilisation of Cd, Co, Cu SO_4, Mn and Zn can be expected during the lag period.

Results indicate that the following preliminary segregation criteria based on total S only could be used for routine classification:

NAF: ≤ 0.4%S

PAF > 0.4%S

Tailings from fresh ore processing are expected to be PAF, and the proposed TSF will require management to prevent ARD. The TSF will require a secure low permeability base to prevent leaching of process water and oxidation products during operations, and is likely to require an infiltration control cover system for closure. The potential for paste backfill of tailings into underground workings should be assessed to help reduce the inventory of tailings requiring surface management.

The tailings samples were classified as Potentially Acid Forming (PAF). Therefore, specific controls will be required in relation to the acid formation potential of the tailings. However, additional testing such as an acid buffering characteristic curve (ABCC) should be undertaken to better understand the acid formation potential of the tailings. The tailings recorded a moderate number of element enrichments, with silver, bismuth, molybdenum, phosphorous and lead all found to be highly enriched, and boron, copper, sulphur, selenium and uranium found to be significantly enriched. Further, cobalt, copper, lead, manganese, nickel, sulphur and zinc exceed guideline values, indicating that a basic store and release cover system will be required on closure to isolate the tailings from the environment.

This will comprise the following nominal design concepts:

- A low permeability layer over the surface of the tailings to reduce water movement into and out of the tailings.
- A store and release layer to provide water storage after storms for later use by vegetation or evaporation removal.
- A topsoil layer integrated into the surface of the store and release layer for vegetation growth.
- Thickness of layers to be determined based on material selection and climatic conditions.

Management of the facility should also incorporate operational measures to reduce dust generation. Dust monitoring should also be undertaken around the tailings storage facility during operations.

The tailings solids were found to contain certain elements which are readily soluble in water. On the basis of a brief comparison with the water quality data from the Jervois Camp bore it is considered that an engineered low permeability liner will be required throughout the basin area in each cell.

TAILINGS STORAGE FACILITY DESIGN

The design parameters adopted for the TSF design are summarised in Table E1.

Table E1: TSF design parameters

Design Parameter	Design Value
Process Plant Commissioning	2020
Ore Throughput	1.6 Mtpa
Concentrate Production	150,000 tpa
Concept mine plan	15 years
TSF Capacity	20 Mt
Tailings Density (Initial-Final)	1.2 t/m^3 - 1.45 t/m^3
Tailings Beach Slope	1.25 %

The severity of damage and loss resulting from a dam failure together with the assessed population at risk are used to determine the consequence category. Based on a severity level of Major and a PAR of ≥1 to <10 the resulting consequence category is “High C”. The design criteria applicable to this category are drawn from the ANCOLD “Guidelines on Tailings Dams” and are summarised in Table E2.

Table E2: ANCOLD design criteria summary

Guideline Requirement	Description of requirements	Guideline Reference
Extreme storm storage	1 in 100 year AEP 72 hour duration storm with no release, evaporation or decant.	ANCOLD 2012 Table 4
Contingency freeboard	Wave run-up associated with a 1:10 AEP wind velocity and an additional freeboard of 0.5 m	ANCOLD 2012 Table 5
Spillway capacity	1 in 100,000 year Annual Exceedance Probability (AEP) design flood with freeboard allowance to suit wave run-up for 1:10 AEP wind velocity	ANCOLD 2012 Table 6
Design earthquake loading	OBE 1 in 1,000 year MDE 1 in 10,000 year Post Closure MCE	ANCOLD 2012 Table 7
Stability minimum factor of safety	Long term drained 1.5 Short term undrained • Downstream 1.5 • Upstream 1.3 • Post Seismic 1.0 – 1.2	ANCOLD 2012 Table 8
Dam safety/ inspection frequency	Inspection by Dam Designer or equivalent qualified Engineer - Annual inspections. Routine inspections – daily to 3 times per week	ANCOLD 2012 Tables 9 and 10

The TSF will consist of two cells and will be constructed using mine waste and local borrow. The embankments will be constructed downstream for the first two stages and upstream for subsequent stages, except for the eastern perimeter embankment of Cell 2 which is proposed to be constructed entirely downstream (due to the proximity of the Processing Plant and the corresponding consequence category). The basin area will have a composite liner to achieve an appropriate level of seepage control. The low permeability compacted composite liner comprising HDPE and soil liner will be located below the operating supernatant pond locations and in the Stage 1 basin area.

The design incorporates a basin underdrainage system to reduce seepage, increase tailings densities, and improve the geotechnical stability of the TSF. The underdrainage system drains by gravity to a collection tower located at the lowest point in the TSF basin. Supernatant water will be removed from each cell of the TSF via a central decant tower abstraction system. Solution recovered from the decant system will be pumped back to the plant for re-use in the process circuit.

Tailings will be discharged into each cell of the facility by sub-aerial deposition methods from all embankments by means of spigots located at regularly spaced intervals, in order to locate the supernatant pond centrally around the decant towers. The active tailings beach will be regularly rotated around the perimeter of the TSF to promote de-watering of the tailings.

The water balance for the project is negative during most of the life of mine, however it may turn slightly positive towards the end of the mine life, depending on the groundwater volumes encountered during mining. The supernatant pond stays at minimum size all the time, and consequently ponding of water against the external embankments is unlikely to occur under any storm event, and a spillway should not be required.

Process make-up water will be required throughout the operation although the quantity required will vary between the wet and dry seasons. Due to the low rainfall in the project area under average conditions, the benefit of storing wet season run-off in the TSF cells prior to commissioning is negligible.

A comprehensive monitoring programme will be developed to monitor for any potential problems. The monitoring will include survey pins to check embankment movements, piezometers in the embankment and monitoring bores downstream of the embankment. The piezometers and bores will be monitored monthly for water levels and quarterly for water quality.

SEISMIC DESIGN PARAMETERS

Given the design proposal to raise the TSF upstream from Stage 3 onwards, and the liquefaction potential of the tailings, the following seismic design parameters are recommended:

- OBE – 0.075g
- MDE – 0.09g
- MCE – 0.1g

Detailed stability analyses will be carried out in accordance with ANCOLD guidelines as part of the TSF design in order to determine the sensitivity of the TSF design geometry to the design parameters and to ensure the technical robustness of the adopted design.

A diversion channel will be constructed to the east of the eastern perimeter of the TSF to divert water towards the catchment to the south.