2.2 Project Alternatives

Yukon Zinc sees no feasible alternative to Wolverine Project. The project is the principle asset of YZC and although there are other mineral deposits in the Finlayson District, YZC does not own any interest in them and therefore cannot effect the evaluation of the possible co-development with the Wolverine deposit. Similarly, it is not possible to consider the potential addition of other deposits that may be discovered through exploration. Given the current and future global market for zinc, the proposed project is the best available option to achieve the business goals of the company.

Yukon Zinc has assessed a number of alternatives in coming to the proposed design of the Wolverine Project. The alternatives considered include the various ways that the project could be implemented or carried out, including alternative locations in the project area, routes and methods of development, implementation, and mitigation.

Examining the main project alternatives involved answering the following three questions:

1. What alternatives are technically and economically feasible?
2. What are the environmental effects associated with the feasible alternatives?
3. What is the rationale for selecting the preferred alternative?

Throughout the Wolverine Project design process, various mining concepts were developed, analyzed, refined and eventually focused down to preferred alternatives. This section describes alternatives that were considered by YZC, and the rationale for selecting the preferred alternative.

The decisions made by YZC for the purposes of project design and mine planning are based on limited, pre-feasibility level information. Nevertheless, this information provides a reasonable basis for detailed design.

2.2.1 Mining Method

Underground mining is the only feasible means of extracting the Wolverine deposit.

The Project Description Report (PDR; Gartner Lee Ltd. 2004) presented drift and fill mining as the primary mining method. All workings would be laterally driven, that is parallel to the strike of the ore. Two scales of mining would be used:

1. mining would begin with large equipment and wide spans starting at the footwall of the deposit with ore in the back
2. mining would proceed upward from the initial lift towards the hangingwall.

For the final stope lifts that expose the hangingwall, the mining width would be reduced to 3.5 m and small equipment employed.

YZC believed more appropriate mining methods were possible, and early in the 2005 advanced exploration program conducted an assessment of alternate mining methods. A combination of two methods were selected:

1. an adjusted drift and fill mining method using herringbone primary and secondary panels
2. uphole slashing, done from a drift located in the waste of the footwall beneath the ore (Section 2.5: Mine Plan)

The main advantages of the preferred approach are:

- Enhanced safety and mine stability as workers would always be located beneath ore backs that are more solid than hangingwall waste rock.
- More flexible mining due to increasing the number of active headings with herringbone panels.
- More complete recovery of the resource as thinner mineralized zones could be extracted.

2.2.2 Main Ramp Location

The main ramp has been located in the hangingwall of the deposit, which is not the usual practice; a footwall ramp location is more typical. In the Wolverine mine, most waste rock is of poor quality (particularly the footwall rhyolite) and will be difficult to support.

The hangingwall has two solid exhalite units: the EXCP and the EXMT (Section 2.5: Mine Plan). Both will be used to contain the main ramp. Diamond drill drifts will be located primarily in the EXMT units.

2.2.3 Underground Conveyor Haulage

Conveyor haulage usually presents a reasonable alternative to diesel truck haulage for ore and waste. This is not considered to be viable for the Wolverine project due to the poor quality ground in the mine. Access development will need to be more flexible than a conveyor drift would allow, as it will have to change direction regularly to follow the more competent rock units.

2.2.4 Backfill

There were three backfill system options considered for the mine: cemented rock fill (CRF), hydraulic classified sand fill, and paste backfill. The PDR presented CRF as the proposed backfill method with an unspecified surface quarry used to generate approximately 1.7 Mt of fill. The CRF option was rejected for the following reasons:

- Additional surface disturbance would be required to provide aggregate suitable for use as CRF fill.
- The byproducts of mining, namely waste rock and tailings, are not used as fill materials therefore the tailings pond would be much larger.
- CRF is very difficult to place in small headings and requires multiple handling, precise placement with small equipment and packing to achieve tight fills.
- It is labour-intensive.

- Additional equipment would be required for quarrying, surface haulage, underground haulage, fill placement, and packing.
- Higher power and propane costs would be incurred due to increased ventilation flow requirements.
- Due to all the above considerations, it is more costly to place than tailings-based fill systems.

Paste backfill was selected in favour of hydraulic classified sandfill for the following reasons:

- Sandfill bleeds cement in it's decant water and can fouls the de-watering system. Paste backfill does not decant.
- A paste pour does not have a hydrostatic head and therefore does not require strong fill bulkheads.
- Smaller quantities of cement binder are required than sandfill fills since it is a more homogenized processed product.
- Sandfill operations have a tendency to be fill-starved because only the coarsest fraction of fill is used. The amount of fill the mill is capable of producing is usually very close to that required by the mine on a daily or annual basis. A very large and costly coarse sand storage tank would be required.
- Strength gain occurs faster than other fills, allowing more flexible scheduling.

2.2.5 Ore Processing

Conventional flotation will be employed by YZC to process the ore, as there is no viable alternative. However, prior to flotation, YZC will use a dense media separation plant to reduce the feed to the mill.

Dense media separation (DMS) uses the difference in density between the ore and waste to separate mineralized and unmineralized rock in a dense liquid. This process is placed between crushing and grinding, reducing the grinding and flotation tonnages and the associated energy consumption. The incorporation of a DMS plant also allows more aggressive mining methods and a more complete recovery of the orebody by mining narrower thicknesses.

2.2.6 Waste Rock Disposal

In spring 2005 the waste rock location as described in the PDR was relocated to an area southeast of the portal. The existing waste rock pad location was selected for the following reasons;

- it is located in the Go Creek catchment
- it is a natural saddle shape, making water collection easy
- it was relatively close to the portal
- the overburden is largely clay.

The existing facility has adequate capacity for the waste rock generated from pre-development during the construction phase (Section 2.7: Waste Rock Disposal), and as such, no alternative to the existing infrastructure were examined. During the operations phase, waste rock will be disposed of through a combination of underground backfill and disposal in the tailings facility.

2.2.7 Tailings Disposal

Sub-aqueous disposal of liquid tails (slurry) was selected for the property. An alternative method involving the on-land disposal of dry tails in paste form was assessed. Advantages of paste tails disposal are:

- A tailings dam does not have to be constructed, removing a significant capital cost item.
- Water does not have to be managed to prevent the oxidation of potentially acid generating materials.

The disadvantages of this option are:

- Dust can be generated from the pile.
- Pumping is more difficult and expensive than for a liquid tails.
- Operating costs are higher due to the pumping and, potentially, the need to add minimal cement to the tails to retain its form as paste.

The most significant reasons for selecting sub-aqueous disposal of liquid tails is that there is ample surface water to maintain year-round cover and that YZC prefers to adopt proven technology rather than embark on a pioneer project. While numerous operations have elected to select paste tails disposal in favour of sub-aqueous disposal, these are primarily gold operations with benign tails, not acid-generating massive sulphides.

2.2.8 Tailings Facility Location

There are numerous interdependencies among facilities that tended to dictate the order in which they would be located. YZC relocated the tailings facility based on results of site surveys, test pits and reviews of past work. Klohn Crippen conducted an assessment of potential tailings facility (TF) locations in 2004 and two locations were assessed in 2005 for geotechnical and hydrogeological considerations (Figure 2.2-1).

Figure 2.2-1 Tailings Facility Site Location Alternatives (Vol. 2)

Tailings Facility 1 is in the valley of Go Creek, while TF 2 is located in a smaller valley approximately 500 m east of TF 1. TF 1 would cover a larger area and would create a valley impoundment within the upper reach of Go Creek, which would necessitate the re-location of the airstrip. In addition to a having a smaller footprint, TF 2 is the preferred location for the following reasons:

- The dam will be easier to construct as it has a narrower base on the valley floor (the dam largely follows a ridge line), and is not near the wetlands in the valley floor.
- The catchment area is significantly less, and less water management will be required.

- Portions of the TF 1 location are outside of YZC’s claim boundaries, requiring the acquisition of additional claims or permission for surface use.

YZC's closure objective is to design and manage the tailings facility to enable the site to be left without requirements for long-term water treatment.

2.2.9 Water Treatment Technology

YZC evaluated the treatment alternatives based upon after-treatment water quality, environmental performance (including waste streams and energy requirements), operating feasibility in a remote northern environment, and economics. As a result of these evaluations, YZC proposes to treat minewater discharge through a combination of settling ponds and hydroxide/sulphide precipitation for metals removal within a treatment plant.

A number of alternative methods were considered for the water treatment plant, including high density sludge (HDS), lime neutralization, reverse osmosis, activated silica gel, biological treatment and activated carbon. The HDS method was selected because it is robust, it is reasonably affordable, has minimal sludge production with near stable sludge quality and is easy to fine tune once constructed.

The HDS process has many advantages over other lime precipitation systems. The most important of these is a substantial reduction in sludge volume resulting from an increase in sludge density. Typical HDS plants can densify the influent from 2% to 30% solids resulting in reduction of the volume of sludge produced by over 95% compared to conventional neutralization plants. The resulting reduction in sludge disposal costs increases the cost effectiveness of the process. In addition to reduced sludge volume and superior sludge density, there is an increase in sludge stability, both chemically and physically. Within a few days of deposition, the sludge can drain to in excess of 50% solids. The sludge produced by a HDS process can be co-deposited with tailings. Other advantages of the HDS process include:

- a high quality effluent is produced
- the process is easily automated
- HDS is a proven technology
- operating plants consist of standard equipment available from many competitive manufactures, which reduces the need for large spare parts inventories
- lower neutralization costs are achieved compared to conventional lime treatment

2.2.10 Camp Location

The existing exploration camp was not considered and will remain an exploration camp only. Three alternatives were considered for the camp location.

- North of the existing airstrip, on the east side of Go Creek
- North of the existing airstrip, on the west side of Go Creek
- Above the portal on the exploration access road

YZC selected the east side of Go Creek as the preferred site for the camp. YZC assumes that the differences in the three locations, from an economic and technical perspective, would be minimal so other factors, such as view and potential for noise (primarily from haulage trucks), were considered.

The site on the west side of Go Creek would be closer to the main haulage road and therefore not as quiet.

The main disadvantages of the location west of the portal was its location within the Wolverine Creek watershed, distance from the airstrip, and the small width of YZC claims in the area.

All sites are approximately equal with respect to transporting personnel to the industrial complex, but the chosen site has the advantage that personnel can walk to or from the airstrip when departing or arriving; additional transportation will not be necessary.

2.2.11 Power Supply

The Wolverine project will require a continuous power supply generate 10 MW of power for the industrial complex, the camp and supporting facilities. The type of the energy sources used in the operation will have an immediate impact on the capital requirement and the on-going cost of the project. The three energy sources considered for the project and their limitations are as follows:

- Connection to the Main Grid - the connection to the existing Yukon power grid will require a high voltage line from Faro, an approximate distance of 150 km. Based on the high initial capital investment and the short duration (12 years) of the operation this option is not considered viable.
- Natural gas power generation - previous studies of other mines have indicated that the natural gas and diesel based power generation systems have comparable reliability. However, the diesel generators seem to be 5% to 10% more efficient than natural gas. Natural gas turbines are economical for processes that require high heat or where natural gas supplies, such as pipelines and wells, are nearby. Since there are no gas sources in the area of the project and the diesel-based system provides higher efficiency, the natural gas power generation is not considered viable.
- Hydropower generation - generally hydropower provides the environmentally cleanest operation with the lowest operating cost structure. There are disadvantages; however, such as very high initial capital cost investment, long payback period and complex regulatory requirements with a possible four to five year approval period. This option is not considered viable.

2.2.12 Site Access Road Location

In July and August 2005, YZC commissioned two road construction firms to conduct assessments of two road access options between the Robert Campbell Highway and the Wolverine Project site (Figure 2.2-2). The northern portion from the RCH to Bunker Creek at approximately 10 km is the same for both alignments, then they diverge. (Section 2.11: Transportation). The Light Creek route trends southwest along the ridge, while the Money Creek route trends south along the west side of Money Creek.

Figure 2.2-2 Preferred and Alternate Road Routes (Vol. 2)

The assessment included air photo and map reviews, and paper route projections. Helicopter reconnaissances and selective ground truthing was conducted. The key design and assessment requirements that were considered included:

- land tenure
- the avoidance of environmentally sensitive areas such as streams, and wildlife critical habitat areas
- alignment gradient and length
- the presence of permafrost
- the presence of bedrock and blasting requirements

Based on these assessments, YZC selected the Light Creek route alignment over the Money Creek route for the following reasons:

- It is approximately 10 km shorter distance and therefore minimizes the disturbance footprint.
- B-train concentrate trucks will have to travel a shorter distance, reducing the potential for wildlife encounters.
- It is located above the valley floor and has less fisheries values and stream crossings than the Money Creek route.

Both options provide an opportunity to control inadvertent access onto the mine access road and during the mine’s construction and operational life through a gated section at the highway.