Yukon
Economic Development

CONFIDENTIAL DRAFT

Projected Yukon and British Columbia Mining Sector Activity Arising from the Development of the Alaska-Canada Rail Link

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Section 1

Summary of Results & Methodology

This study was undertaken to estimate Alaska-Canada Rail Link shippable base metal concentrates and coal tonnage and estimate capital and operating costs. This study complements earlier work undertaken by Gartner Lee, Ltd (GL). Results between the two studies point to convergence between 0.5 and 1.7 million tons (MT) base metals shipped annually. Divergent projections for coal reflect differing treatment of BC's Klappan mountain coal. Analysis of the massive Crest iron ore deposit yields a substantially large shipment potential for iron ore pellets to overseas markets.

	Yukon Gov't Study	*Gartner Lee - Conservative*	*Gartner Lee - Optimistic*
Base Metals	1,650,054	630,000	1,540,000
Coal	14,102,182	920,000	3,860,000
Iron Ore	28,000,000	-	15,000,000
Total	43,752,236	1,550,000	20,400,000

Research work underpinning this Yukon government study was focused on estimating the tonnage of base metal concentrates and coal that could be shipped from prospective Yukon and BC mines to tidewater ports, with a portion of the journey undertaken on the proposed Alaska-Canada Rail Link (ACRL).

Iron ore, coal and base metal mines rely on relatively inexpensive rail transportation to competitively supply global markets as transportation can account for one-quarter to one-half of total costs.[1] Conversely, across Canada, 293 million tonnes of crude and fabricated minerals were shipped in 2003 on Canadian railways and loaded at Canadian ports, representing 60% of total rail revenue freight and 75.1% of total port volume.[2] These shipments accounted for over half of rail revenues and 60% of total port volume.[3] In Canada, it is difficult to overstate the symbiotic relationship between railroads and mines.

Iron ore is the largest single commodity loaded at Canadian ports, followed by crude petroleum and then coal.[4] This study further emphasizes the dependence on coal and iron ore tonnage in achieving revenue requirements for a northern rail system.

A key question addressed in this study is: **To what extent would the ACRL result in increased mining activity in Yukon and BC?** This paper explains spreadsheet analysis employed in addressing this question and presents study results in terms of:

[1] Gordon R. Peeling President and Chief Executive Officer, Mining Association of Canda; www.reviewcta-examenltc.gc.ca/Submissions-Soumissions/May3/Mining%20Association%20of%20Canada.pdf
[2] P.30, Mining Association of Canada, Facts and Figures 2004
[3] PricewaterhouseCoopers 2003 Mining Report
[4] *op. cit.* Mining Association of Canada p. 31

- US tons and miles of shippable coal and base metals (limited in this case to copper, lead and zinc) that provide rail and port revenues; and
- Annualized operating costs and capital expenditures for related mining activities, denominated in U.S. dollars.[5]

The economic impact of ACRL-induced mining activity is addressed by Informetrica, Ltd.[6] Output data from this study was designated as input data for the Informetrica study. In reference to the ACRL, mining is the most intensely affected economic sector, however, it is not the only sector of impact. In the broader ACRL study, Informetrica has evaluated the incremental economic impacts of other industries such as tourism, forestry and transportation.

Values presented in this document are in U.S. dollars and tons (2,000 pounds).

1.1 Methodology

For this study, four approaches were developed in estimating ACRL rail shippable mineral and coal tonnage for the purpose of subsequent economic impact analysis. Tier I analysis, previously undertaken by QGI Consulting Ltd. of Edmonton, estimated shippable tons (inbound and outbound materials) for rail revenue purposes. This study presents the results of Tier II, Tier III, BC historical analysis and a brief study of the Crest Iron Ore deposit. Background, scope and intent of these approaches are as follows:

1. ***Tier II.***[7] Gartner Lee Ltd. undertook an extensive and detailed analysis of known mineral deposits in Yukon and BC, analyzing the potential for a mine start to occur along with the estimated tonnage of ACRL-shippable base metals and coal.[8] Mineral deposits (i.e., prospective mines) were included or excluded from the Gartner Lee study based on the net ore value and operating expense. To be viable, net ore value of a deposit had to exceed twice the operating expense or opex (opex does not include transportation, capital cost or profit). Tier II analysis in this study used Gartner Lee deposit data and assessed inclusion/exclusion based on opex and transportation costs in relation to benchmark data.[9] Beyond providing a second data set for purposes of analytical rigour, this competitiveness approach avoids the need to forecast metal and coal prices.

[5] Initial Tier II data submitted to the ACRL study team included start up and mine life data unique to each mine site. Tier II estimates in this report (p.) reflect an average production over a set 20 year lifecycle.
[6] Informetrica Ltd., Alaska-Canada Rail Link Strategic Environmental Assessment: Canadian Economic Impacts Final Report D1.c (Aug. 2006)
[7] Tier I data was initially developed as a commercially viable activity with application of more rigorous criteria than this Tier II focus on "economic" viability.
[8] 2006. Traffic Data Development for Mineral Resources—Work Package A2(a) for Alaska-Canada Rail Link Study. Gartner Lee Ltd. Data from Work Package A2(a) is applied throughout this document as it provides an exceptional amount of relevant, detailed and well-researched information.
[9] This study also allowed for a modest expansion of *mineable reserves* (i.e., the portion of a mineral deposit that can be economically mined) was calculated. The expansion of mineable reserves was proposed on account of reduced transportation costs that theoretically enable mining companies to "dig deeper" and engage in larger scale production that consequently generates a second-round reduction in per unit costs.

2. ***Tier III.*** A Yukon Geological Survey (YGS) database was applied in estimating the potential for future discoveries of base metals within a distance that is close enough (150 km or 93 miles) to ensure access to the ACRL. Over several years, YGS has estimated the number of undiscovered deposits based on existing data and expert opinion (with proscribed confidence intervals). As Tier II presents known deposits and Tier III addresses undiscovered deposits, the two data sets can be viewed as unique and therefore potentially summative. Given that Tier II addresses known deposits while Tier III reflects undiscovered deposits, it is likely that Tier II-related mining activity would occur prior to Tier III.

3. ***Comparative BC Historical Analysis.*** British Columbia historical production mineral of copper, lead, zinc and coal was analyzed in estimating Yukon output on a rail distance equivalence basis.[10] This analysis was undertaken for cross-reference and validation purposes for Tier II and Tier III estimations.

4. ***Crest Iron Ore Competitiveness Analysis.*** A separate preliminary analysis was undertaken on the Crest iron ore deposit in north-eastern Yukon. With a potential mineral reserve of 20 to 30 billion ton reserve, Crest could be the second largest undeveloped iron ore deposit in the world (second to El Mutún in Bolivia). A brief comparative analysis was applied to Crest and the IOC Carol Lake mine in Labrador to undertake a preliminary screeing of its ability to competitively and sustainably supply Asian markets.

1.1 Key Findings

Tier II Analysis[11]

- Although a rail extends north to Prince George and a small leg connected Whitehorse to Skagway, Alaska up to 1982, Yukon and northern BC mines have limited access to competitively-priced transportation options. Although current and potentially high future metal prices may continue to rejuvenate some mining operations in the region, a key aspect of long term competitiveness and viability is low transportation costs.
- Annually, Tier II mines (data set does not include Crest) collectively benefit through an estimated $216 million in transportation cost savings if the ACRL were to be built (cost savings for rail versus trucking). It was estimated that the viability of Yukon and northern BC region mines analyzed in this study is questionable without rail transportation. This does not exclude the possibility for mines to achieve temporal viability when market prices are high.
- 2.72 million short tons (MT) of coal and base metal concentrates (lead, zinc, copper) from Yukon mineral and coal deposits[12] could be shipped from the Territory to

[10] This approach relies on rough geological comparability and the existence of rail transport in BC during the period of historical analysis. In brief, historical BC mineral shipments are correlated to regional rail mileage and prorated for shipments arising from ACRL mileage: 620 miles in Yukon and 630 miles in northern BC.

[11] The spread sheet applied in this analysis can be edited to alter numerous variables such as years of extraction, to filter in and out mine site data, and to adjust various criteria.

[12] Some mineral deposits are not well characterized or evaluated.

Pacific ports and onward to global markets for a 20-year period pending completion of the ACRL.[13] Of this tonnage, base metals account for 1.17 MT (29% of total Canadian base metal shipments) with coal shipments accounting for the residual amount of 1.55 MT.[14]

- BC mine sites with access to the ACRL could ship 480 thousand MT of base metals and 12.6 MT coal.
- Yukon and BC figures sum to 1.65 MT of shippable base metals or 41% of 2005 Canadian production. Coal from the two jurisdictions amounted 14.1 MT or 22% of 2005 Canadian production. The combined annual tonnage of shippable base metal concentrates and coal amounts to 15.8 MT.
- BC coal accounts for 80% of this total figure warranting targeted analysis of assumptions and calculations applied in both this Yukon government (YG) study and the Gartner Lee document. [15]
- These volumes entail 805 million ton miles of rail transit for Yukon and 3.9 billion ton miles for BC. Given a sliding breakdown of rail transportation costs, this tonnage could amount to US$137 million annual rail revenue.[16]
- Estimated annual operating costs (opex) for all mines included in the Tier II analysis amounts to $1.3 billion. Estimated capital costs amount to $2.4 billion.

Tier III Analysis

- This evaluation focused on the region in Yukon that lies within 150 km (93 miles) of the ACRL tracks, forming a 300 km or 186 mile corridor. It was estimated that 547 thousand tons of Yukon base metal concentrates from undiscovered mineral deposits in this region could be shipped by the ACRL annually for 50 years with a corresponding figure of 454 tons from BC mines over the same timeframe.[17]

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[13] All measurements are conducted in U.S. dollars and short tons.

[14] In referencing base metals in this report, reference is made only to copper, lead and zinc. Unless otherwise noted, reference is made to concentrates rather than refined metals; copper concentrate is estimated at 25% pure copper while lead and zinc are estimated at 50% pure. Sources for percentage of Canadian supply—US Geological Survey and Statistics Canada: http://minerals.usgs.gov/minerals/pubs/commodity/ and http://mmsd1.mms.nrcan.gc.ca/mmsd/data/2006/06MTLY05.pdf

[15] Unlike most estimates, this value of coal shipments from BC diverges considerably from the Gartner Lee study. Although a transportation competitiveness assessment was undertaken for coal deposits, an operating cost assessment was not. Beyond the transportation cost test, this YG study applied a basic default inclusion for valuable anthracite coal deposits; all are found at the Mt. Klappan in BC (i.e., Lost Fox, Hobbit-Broatch, Summit, and Groundhog). If the Gartner Lee assumption of a consistent 6:1 stripping ratio is correct, then these mines would likely be excluded from the analysis, bringing the total shippable volume of coal and base metal from BC and Yukon to 3.2 MT. Future analysis should target the viability of these mines as collectively they account for 80% of total tonnage for projected mineral traffic on the ACRL from Yukon and BC.

[16] Rail rates: 1.9 U.S. cents per ton mile for over 500 miles; 2.2 cents per ton mile between 400 and 500 miles; 2.5 cents per ton mile between 300 and 400 miles; 3.5 cents per ton mil between 200 and 300 miles; 6 cents per ton mile between 100 and 200 miles; and 10 cents per mile between 0 and 100 miles.

[17] Estimations at 50% confidence interval (interval corresponds and is supported by secondary BC comparative data). Values are based on Yukon data and extrapolated to BC on the basis of a near identical rail distance coverage for the two regions and with application of 300 km wide rail corridor (i.e., 150 km on each side of rail tracks). It is estimated that shippable BC mineral concentrates will amount to 83% of Yukon volumes based on ratio of concentrates from mine sites with rail access in Yukon as presented in Tier II analysis.

- A cumulative probability distribution was developed. A 50% probability value was selected based on practical considerations.[18]
- Combined, the two jurisdictions could ship one million MT each year for 50 years from yet-to-be-discovered copper, lead and zinc deposits.
- If the timeframe for mining this region is reduced to 30 years, the total annual tonnage from Yukon and BC increases to 1.67 MT, representing 41% of total annual Canadian production of copper, lead and zinc concentrates in 2005.[19]

Comparative BC Historical Analysis

- British Columbia's historical production data for lead, zinc, copper and coal from 1929 to 2001 were combined with rail coverage ratios in this analysis. The results of this comparative analysis were supportive of the Tier III estimate of one million tons of annual production with roughly an equal split between Yukon and BC tonnage.[20]
- This comparative analysis suggests that between 8 and 15 MT of shippable coal in the rail-servicing corridor of the ACRL is conceivable. These figures correspond to a mineral extraction period of 36.5 and 20 years, respectively.[21]

Crest Iron Ore Deposit

- Through the ACRL, the Crest mine could reduce its annual transportation costs by $1.4 billion.
- The Crest iron ore deposit is projected to annually produce 28 million metric tons of shippable iron ore pellets based on open pit mining and the development of 4 pelletizing plants, conceivably located in Carmacks, Yukon. Initial projections are for a mine life of up to 400 years.
- As the deposit is at least 560 rail miles (900 km) inland, viability has always been a question. In 1965, Canadian National Railways and Crest Exploration Co. (then a division of Chevron) undertook a detailed analysis—*Yukon Iron Ore Railway Feasibility*—examining potential rail routes to the Crest deposit.[22] Chevron currently owns the lease on the Crest deposit.
- Preliminary capital investment requirements for the Crest mine site and pelletizing facility is estimated at $3.1 billion. This is comprised of $1.42 billion in the mine and milling facility and equipment and $1.68 billion for the construction of 4 pellet plants (at $420 million each). Additional capital investment in dedicated rail and potentially in port infrastructure could add an additional $6.3 billion investment. Additional rail traffic, partnerships and contributions could defray capital costs.

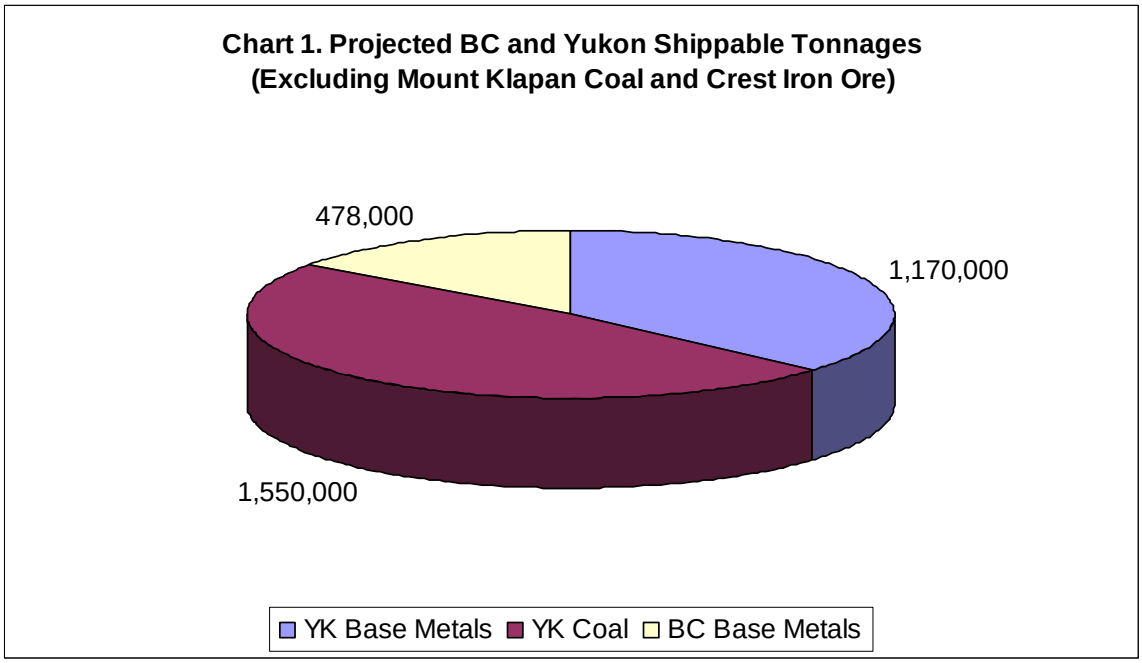
[18] Estimated deposits at the 95% percentile were deemed to be too low (relative to known data) while values at the lower end of the distribution were considered to be too high.
[19] This is reflected in the first tab of the associated spreadsheet analysis.
[20] Analysis applied 73 years of historical mining with a key assumption that the same mines could be mined in one-half the time given modern technology and infrastructure.
[21] Interpretation of this is as follows: 73 years of historical mining in BC is condensed to one-half the time for a contemporary or modern mining scenario to arrive at 36.5 years of extraction. If this period of extraction is further reduced to 20 years, then an annual extraction rate of 15 MT coal is achieved. Annual production (tons) based on historical BC mineral production and existing rail coverage (2750 miles—subject to verification) provides a rail mile-based equivalent that can be compared to the ACRL (maintaining an estimated 630 miles in BC and 620 miles in Yukon).
[22] 1965. Yukon Iron Ore Railway Feasibility prepared by CN Railways in co-operation with Crest Exploration Limited for the Government of Canada (J.L Charles—Consulting Engineer, CNR)

- Annual mine and mill operating costs for Crest are estimated at $590 million. Operating costs per ton of producing iron ore pellets are estimated at $32 (includes mining, milling and pelletizing).
- The Crest deposit is believe to be the second largest iron ore deposit in the world and, as such, has strategic value that may extend beyond its economic value. A supply chain investment could ultimately mobilize the Crest mine given the importance of garnering security of supply in this highly concentrated industry sector.

Section 2 Prospective Rail Tonnage

Charts 1 and 2 illustrate shippable tonnage estimates from the Tier II analysis and analysis of the Crest Iron Ore deposit. Both Crest Iron Ore and BC coal represents a large portion of total tonnage potential. BC coal tonnage is entirely on account of Mount Klappan mines (Lost Fox, Hobbit Boatch, Summit and Groundhog).

Chart 1. Projected BC and Yukon Shippable Tonnages (Excluding Mount Klapan Coal and Crest Iron Ore)



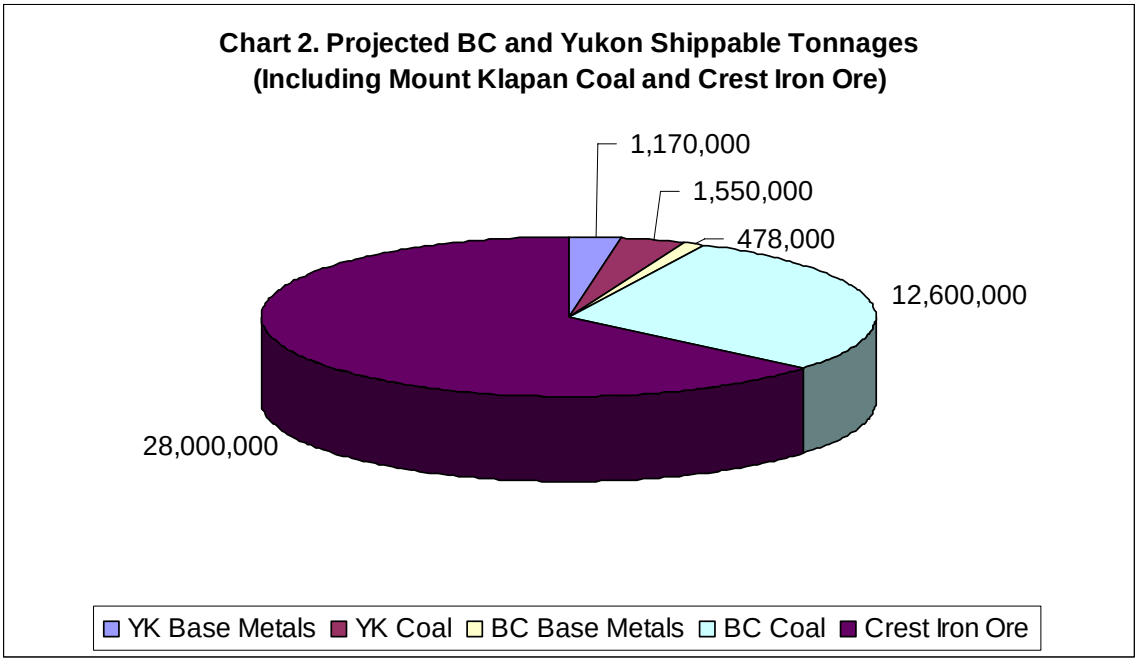
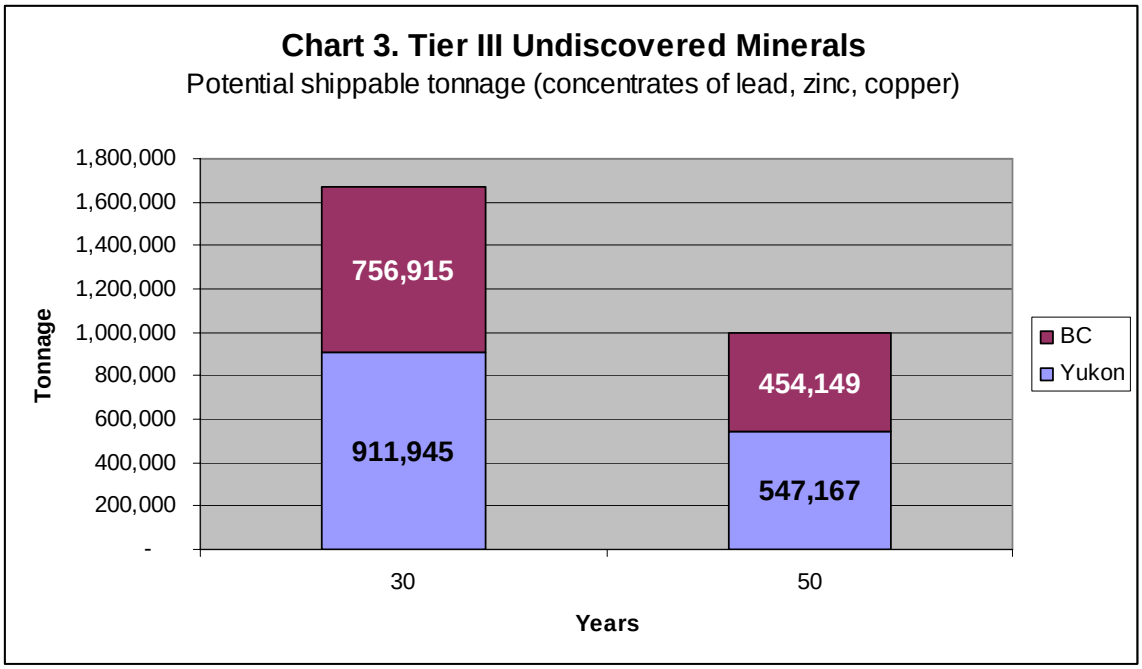


Chart 3 presents annual shippable tons of yet-to-be discovered base metals in Yukon and BC. If these deposits were to be mined over a 30-year period, approximately 1.7 MT of annual shippable base metals would be anticipated. Alternately, if these deposits were to be mined out over 50 years, 550 thousand tons could be shipped annually from Yukon with 450 tons shipped from BC mines.[23]

Chart 3. Tier III Estimations of Yet-to-be-Discovered Base Metals in Yukon and BC



[23] BC tonnages were estimated based on the ratio of Yukon to BC tonnages developed in Tier II.

BC historical mineral production data was analyzed and applied as a point of reference for Tier II and III results as mineralogical similarities between Yukon and BC are observed. This comparative analysis examined rail mileage and mineral production in BC based on historical data from 1929 to 2001. The ratio of BC mineral production to rail mileage was calculated and this ratio was applied in deriving a crude estimate of potential production for the ACRL-impacted mining areas in BC and Yukon.

As modern technologies have considerably improved mining productivity, it was assumed that the years expended in mining the historical tonnage would be reduced. One approach applied a doubling of the pace of extraction, thus the 73 years of extraction was undertaken in 36.5 years. Another approach was to mine and ship the equivalent volume in 20 years. The results of these supplemental approaches are presented in Tables 1 and 2.

Table 1. Comparative BC Historical Analysis Estimations (36.5 years to mine)

	Tons Base Metals	Tons Coal	Total (tons)
Yukon Conversion	509,769	4,051,308	4,561,077
BC Region Conversion	517,991	4,116,652	4,634,643
Total Yukon and BC tons	1,027,760	8,167,961	9,195,721

Table 2. Comparative BC Historical Analysis (36.5 years to mine)

	Base Metals	Coal	Total
Yukon Conversion	930,329	7,393,638	8,323,966
BC Northern Region Conversion	945,334	7,512,890	8,458,224
Total Yukon and BC tons	1,875,663	14,906,528	16,782,191

2.2 Comparison of Results

A comparison of the Gartner Lee results and the approaches applied in this study is presented below.[24] All data reflects combined Yukon and BC tonnages (scale is altered to better present base metal tonnages).

[24] Each Yukon and BC mine in the Gartner Lee study was evaluated based on estimated, unique mine life. The un-weighted average mine life in the GL study was between 14 and 15 yrs (excludes Crest). The associated spreadsheet for this study applied an average mine life to each lump sum total production (years are denoted in Chart 3). This estimated mine life (or period of extraction) is editable. Data forwarded to Informetrica included mine life estimates along with proposed start-up dates. These are not reported in this study.

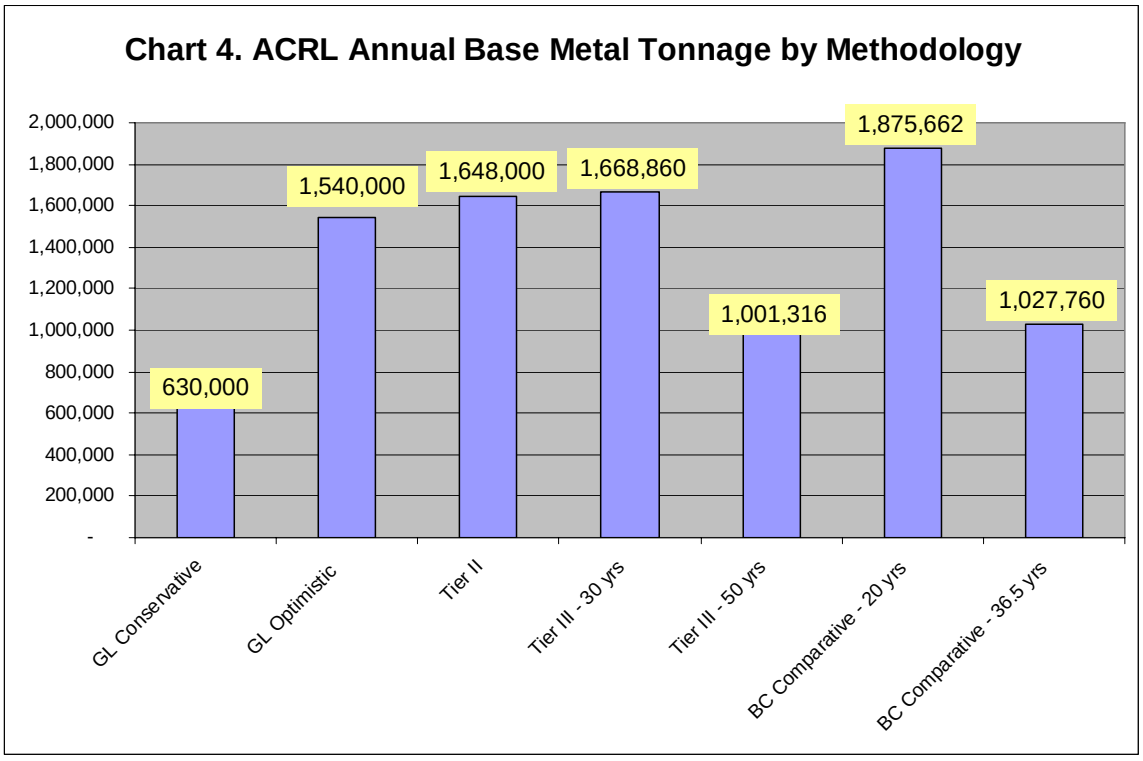
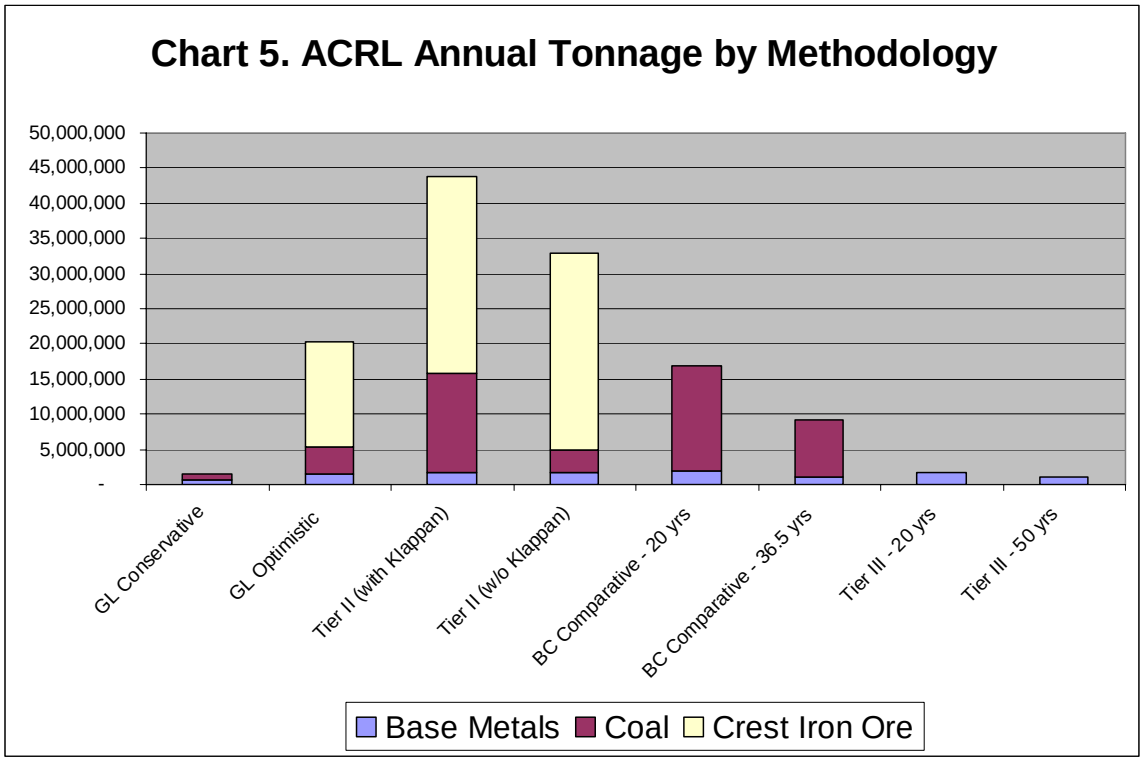


Chart 4 highlights a degree of convergence in estimates for shippable base metal concentrates between one and two million MT. Results from Tier II analysis suggest approximately 1.6 MT shippable base metal concentrates could be anticipated from year zero to 20 based on known deposits, with roughly the same 1.6 MT continuing from year 20 to year 50, based on yet-to-be-discovered mineable deposits. Conversely, Chart 5 reveals that estimated tons of shippable coal tonnage by methodology is more variable.



This study applied a transportation cost test for coal as well as a test based on the quality of the deposit.[25] A critical decision point in evaluating coal shipments arises in the case of Klappan Mountain mines in BC. Given its proximity to the ACRL, it may be anticipated that Klappan coal could be shipped by rail to Ridley Island (Prince Rupert port) for export to Asia. Based on BC historical data, 6 MT of shippable coal is projected while Gartner Lee estimates an optimistic scenario would amount to 3.9 MT shippable coal. To be explicit with this data, values reflected above are presented in numerical form in Table 3.

Table 3. ACRL Tonnage by Methodology

	Base Metals	*Coal*	*Crest Iron Ore*
GL Conservative	630,000	920,000	
GL Optimistic	1,540,000	3,860,000	15,000,000
Tier II (with Klappan)	1,648,000	14,150,000	28,000,000
Tier II (without Klappan)	1,648,000	3,197,540	28,000,000
Tier III - 30 yrs	1,668,860		
Tier III - 50 yrs	1,001,316		
BC Comparative - 20 yrs	1,875,662	14,906,528	
BC Comparative - 36.5 yrs	1,027,760	8,167,961	

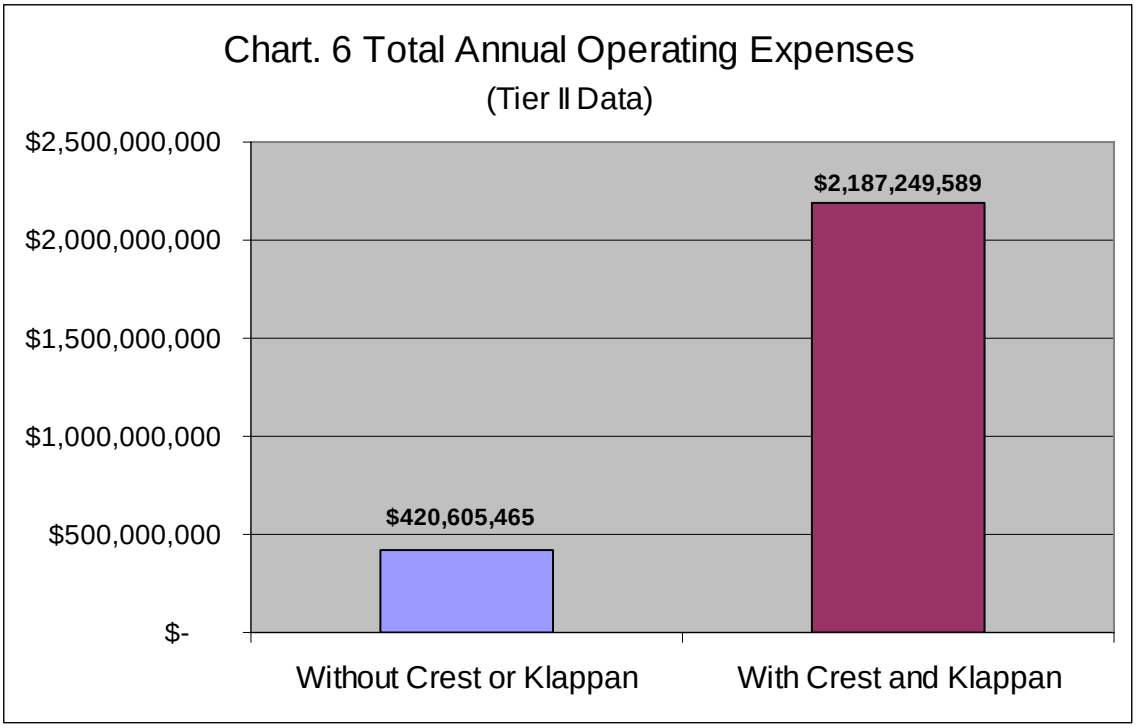
[25] More rigorous analysis was applied to base metals than coal on account of available data. Beyond assessing transportation costs, this study applied the status of coal (i.e., metallurgical was shipped and thermal was not). This study did not include Bonnet Plume coal in the shippable amount on this basis.

Section

3 Valuations

As Yukon and BC mines begin operations, capital will be expended and operating costs incurred. These investments and expenses create positive local and external economic impacts (modeled and estimated by Informetrica). Charts 6 and 7 illustrate the impacts of the ACRL on operating expenditures and capital investments as well as the impacts of including or excluding key mines from the analysis.[26]

Given the size of Crest and Klappan deposits, total operating and capital expenses from ACRL-induced mines are presented with and without inclusion. A potential of $2.2 billion could be expended annually on operational expenses such as salaries, fuel and electricity, repairs, etc. when included and $420 million where they are excluded. Capital expenditures with Crest and Klappan included amounts to $5.3 billion and $1.6 billion when excluded.



[26] Analysis relied on Western Mine Engineering, Ltd data extracted from: Volume 1. Mining Cost Service (2006) and Gartner Lee study results.

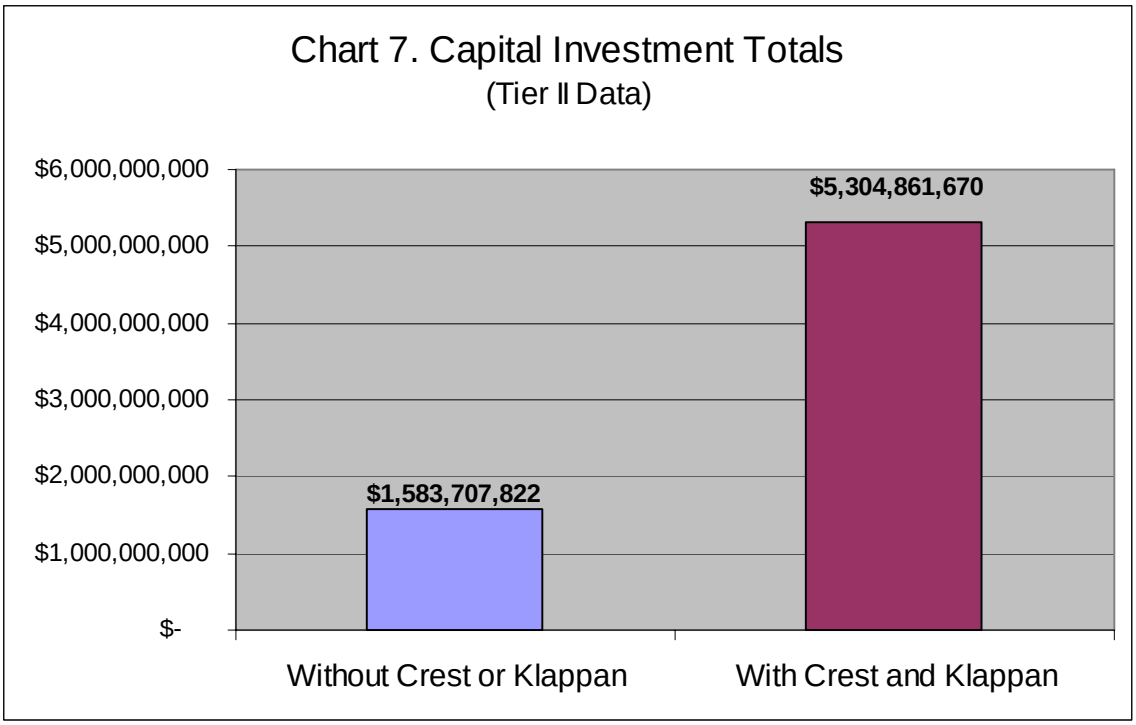
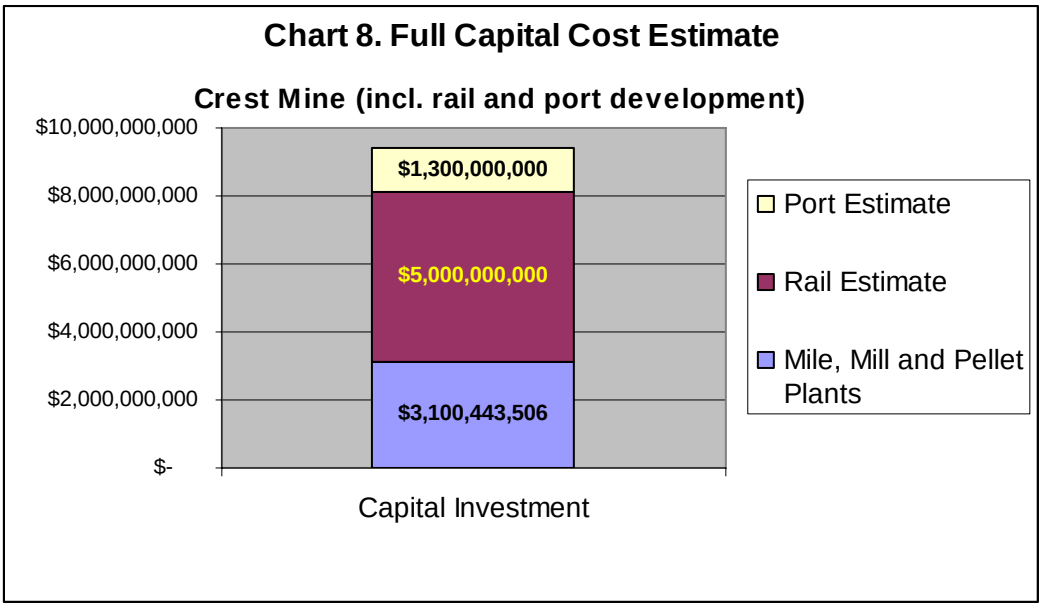
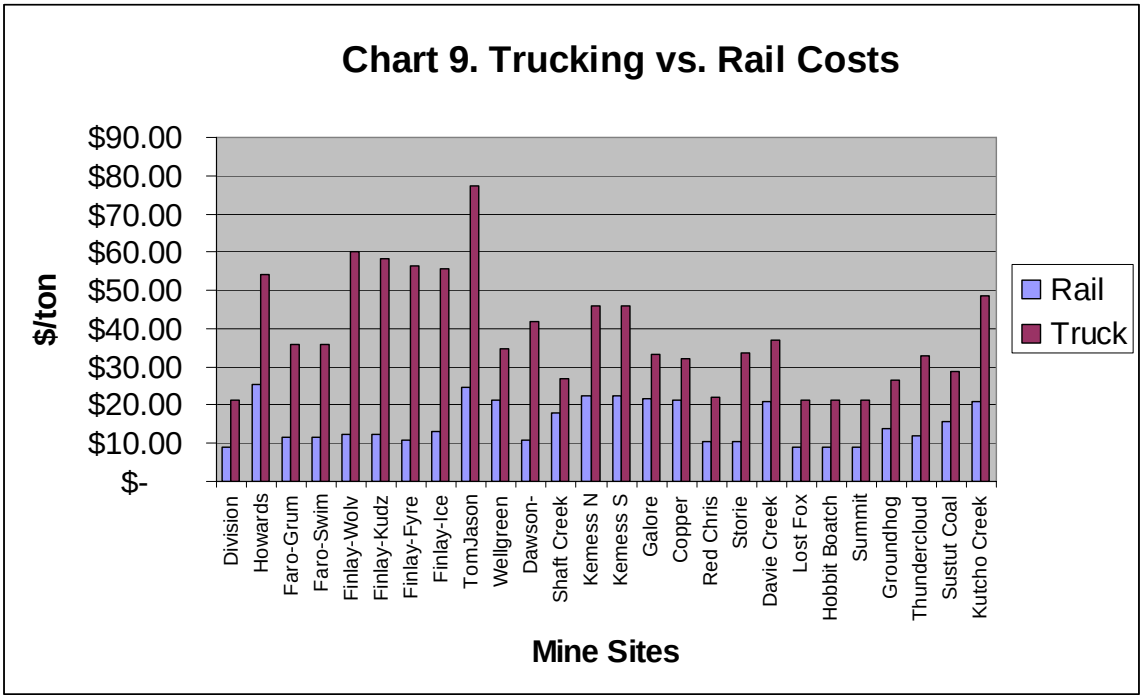


Chart 8 illustrates the capital investment impact of infrastructural projects if Crest bears full infrastructural investment costs.



3.1 Transportation Cost Differentials and Implied Value of Rail

A railroad would reduce cost structures for many northern industries, most notably the mining sector. Chart 9 illustrates calculated costs for truck versus rail transportation for all mines (included and excluded) as per Tier II analysis.[27]



Through access to rail, ACRL-induced mines will benefit through a reduced cost structure and improved economies of scale, providing a corresponding increase in production occurs. From Tier II and Tier III analysis as well as a separate analysis of the Crest deposit, various value estimates can be attached to the development of the ACRL. These are summarized as follows:

- Mines that are proposed to be operational (through Tier II analysis) enjoy transportation cost savings of $216,335,000 through access to the ACRL. At 10% discount rate over 20 years of shipping Tier II tonnage, net present value is calculated at $1.84 billion.
- As Tier III analysis proposes a continuation of Tier II volumes for 30 years (extending the study period from 20 to 50 years), this value gain can be roughly projected to last 50 years. NPV over a 50-year period (capturing Tier I and II transport savings) at the same 10% discount rate is $2.3 billion.

[27] Trucks were evaluated at US$0.105 per running mile while rail applied the ton-mile pricing structure presented in the QGI Report: Logistics Evaluation for Mineral Resources; Work Package: A-2 (D) for the ACRL study.

- The benefit to the Crest mine amounts to $1.38 billion annually or $11.7 billion NPV over 20 years. Extending this valuation to 50 years brings the NPV value to $13.65 billion.
- The following chart presents the value of payments, if mines were to agree to pay a portion of this transportation savings (beyond basic rail rate; see footnote 15). The table should be interpreted as follows: where mines contribute 25% of the truck-rail differential (e.g., to assist in covering capital costs) for 50 years, NPV of the contribution amounts to $3.98 billion. This indicates the net present value of cost savings for access to rail transport. Unless mines are forced to make an additional payment to infrastructure (above basic shipping charge), this value would accrue to prospective mining operations.

Table 4. Value of Transportation Savings
NPV by Percentage Allocation and Total Year

	25%	50%	75%	100%
20 yrs-Tier II	$ 460,465,706	$ 920,931,411	$ 1,381,397,117	$ 1,841,862,823
20 yrs-Crest	$2,930,467,049	$5,860,934,098	$ 8,791,401,147	$11,721,868,197
20 yr Total	$3,390,932,755	$6,781,865,510	$10,172,798,265	$13,563,731,019
50 yrs-Tier II & III	$ 567,659,576	$1,135,319,152	$ 1,702,978,727	$ 2,270,638,303
50 yrs-Crest	$3,412,793,762	$6,825,587,524	$10,238,381,285	$13,651,175,047
50 yr Total	$3,980,453,338	$7,960,906,675	$11,941,360,013	$15,921,813,350

Another difference between private rail and public road transportation is the differential impact on public road maintenance expenditures. Although these are can be partially captured through user fees or tariffs, the following chart portrays the potential value of public expenditure savings based on proposed annual mining production ton-miles. Though the cost per ton mile of maintenance is not know, it could amount to $203 million where each ton-mile cost is determined to be 1 cent or one-half billion where maintenance costs are 2.5 cents per ton-mile of coal or base metal concentrates.

Table 5. Cost Savings per Ton Mile at Variable Rates

Ton-Miles	Rates >>	$ 0.01	$ 0.025	$ 0.05	$ 0.10
4,322,515,813	Tier II Data	$ 43,225,158	$ 108,062,895	$ 216,125,791	$ 432,251,581
16,009,840,000	Crest Data	$ 160,098,400	$ 400,246,000	$ 800,492,000	$ 1,600,984,000
20,332,355,813	Totals	$ 203,323,558.13	$ 508,308,895.32	$ 1,016,617,790.64	$ 2,033,235,581.27

Substantial public sector value lies in potential tax revenues that are a subject of analysis in the aforementioned Informetrica study. Other factors, such as royalty payments, the potential to limit highway trucking congestion are additional value considerations of a developed ACRL.

Section 3

Appendices

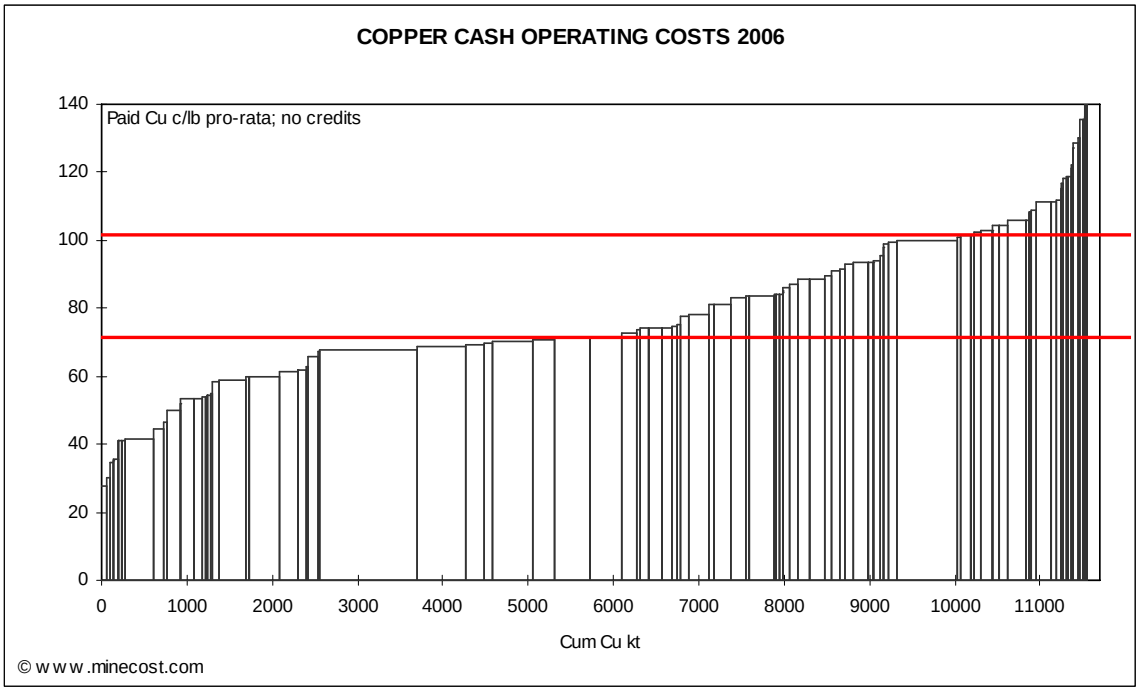
This study focused on assessing the potential for a railroad traversing Yukon and BC to stimulate mining sector activity within Yukon and BC. The remainder of this document further explains the quantitative assessment that was undertaken to determine the tonnage of mining production (i.e., concentrates) that would be shipped by rail from Yukon and BC mine sites to selected ports along with related investment and operational expenses. Also included are references, explanatory notes and assumptions applied in estimating inputs (Tier 2 and Tier 3 data) for the AlCan Rail Link Study.

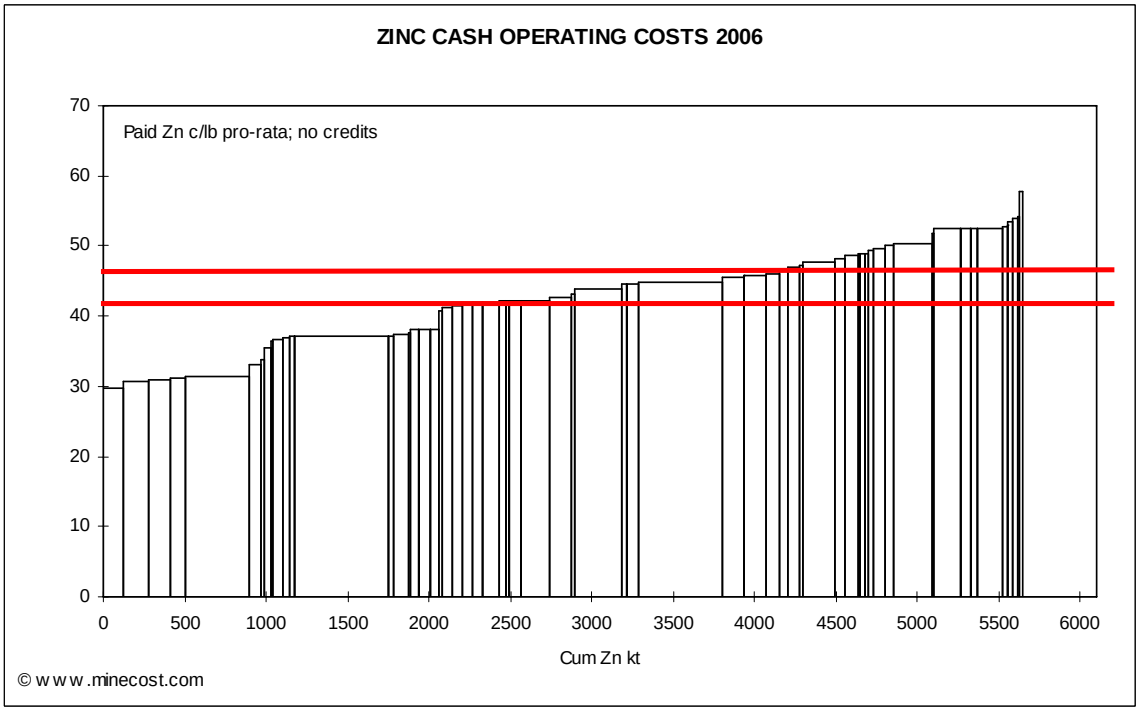
This analysis was conducted by the Yukon Department of Economic Development and the Department of Mines, Energy and Resources deals with **economic and geological information only**. Issues of a social and environmental nature are not considered in this analysis but are the subject of parallel and subsequent discussion and analyses. Units applied in this study are short tons and U.S. dollars.

A.3.1 Key Assumptions and Applications

1. Gartner Lee data on individual mine sites were applied for all mines analyzed in this report. Adjustments were made to the Crest mine from 60% recovery to 70% recovery on account of productivity re-evaluation.
2. Screening of mines based on transportation costs was as follows: Competitive benchmark set at 20 miles trucking distance to rail and 300 miles transport on rail. This amounted to $12.60. Study of ocean freight rates concluded Yukon has $4.64 shipping rate advantage (over average rates paid by Brazil, Chile and Australia to Shanghai). This amount was credited to Yukon mines to arrive at $17.24 competitive benchmark shipping cost. A 20% margin of error was credited to elevate the competitive benchmark to $20.69. Yukon mines that incur greater than this amount were screened out.[28]
3. Screening of **base metal** mines based on operating costs was as follows: Opex was calculated based on Gartner Lee estimates and estimates derived from *Western Mine Engineering Ltd.*'s Mining Cost Service. These three expense estimates were evaluated for the focal mining material (i.e., zinc/lead or copper) to derive a US dollar per pound estimated cost (pro-rated to value of focal metal). These estimates were contrasted with global cost opex values as provided through *World Mine Cost Data Exchange Inc.* (minecost.com). Yukon and BC mines with an opex value exceeding two-thirds of operational mines as reported by World Mine Cost Data Exchange were screened out. Mines operating within the top one-third of world mines were noted. An example of a cost chart is provided below with red lines demarcating one-third and two-third levels.

[28] One mine that exceeded this bench market was not screened out because operational costs were the lowest among the mines and the mine is working on additional steps to reduce transportation costs.





4. A mineable reserve expansion factor was applied in this study. The rationale was that the ACRL would lower the cost structure of the mine, enabling additional resource extraction. The difference between mineable reserve and mineral resource was affected by the distance between the mine and the ACRL. Mines that were between zero and 93 miles and more (>150 km) were rated as 100% and 0% impacted, respectively. Without a cost function to apply in the analysis, the impact percentage was multiplied by 20% to arrive at a reserve expansion amount.

The twenty percent figure arises from an assumption that 50% of the expansion potential (i.e., difference between reserve and resource) would be of adequate grade to mine and that 40% of this amount would be impacted by transportation cost reductions. This approach led to a 7% increase in mineable reserve tonnage.

5. Distances were estimated for anticipated minesite to highway routing as well as anticipated road and rail routing. Gartner Lee maps and scales were applied in estimating distances.
6. QGI rail costing was applied as follows: 1.9 U.S. cents per ton mile for over 500 miles; 2.2 cents per ton mile between 400 and 500 miles; 2.5 cents per ton mile between 300 and 400 miles; 3.5 cents per ton mile between 200 and 300 miles; 6 cents per ton mile between 100 and 200 miles; and 10 cents per mile between 0 and 100 miles.

A.3.2 Introduction to Accompanying Spreadsheet

The following notes relate to numbered tabs in the underlying spreadsheet document (EcDev Tier II and III Final July 29.xls). Identification of column and row values is provided cell comments in the spreadsheet.

1. Global Production – provides overview of global base metal production based on 2005 production of refined copper, lead, and zinc. Global production values are Worksheet is taken from US Geological Survey, Mineral Commodity Summaries, January 2006.
   http://minerals.usgs.gov/minerals/pubs/commodity/zinc/zinc_mcs06.pdf
   http://minerals.usgs.gov/minerals/pubs/commodity/lead/lead_mcs06.pdf

2. Tier 2 – through analysis and filtering, worksheet provides estimates of potential rail volumes from selected mines in Yukon and BC along with operating and capital expenses. Gartner Lee Study (Work Package A2(a)), *Traffic Data Development for Mineral Resources* applied extensively throughout development of Tier 2 data.

3. Tier 3 – provides estimation of undiscovered minerals across Yukon. Key contributions from Geoff Bradshaw (Yukon Geological Survey) with reference to Survey staff (Dept. of Energy, Mines and Resources) and partners who developed a large mineral tract database for application in estimating mineral deposit potential across Yukon.

4. Base Metals & Coal – BC comparison – provides a comparison of mineral and coal extraction in BC and Yukon. Values for Yukon are compared to BC after adjusting for variations in size. Not that this worksheet should only be applied as secondary evidence for findings in Tier 2 and 3 analyses. Data from BC Ministry of Energy, Mines and Petroleum Resources; key contributor: Ken Galambos.

5. Abridged Reserves – the mass of mineable reserves is linked to mineral prices and cost structures. As metal prices rise or costs drop, mineable reserve expands (i.e.,

it becomes economical to dig deeper). On average, mineable reserves were estimated to increase 7.6% on account of reduced transportation costs and lower unit costs through economies of scale factors.

6. Minesite Evaluation – presents minesite data such as abridged reserves, total shippable volumes, daily tons, operating expenses and capital costs.

7. Opex & Capex (i.e., operating expenses and capital expenses) – Matrix table of operating expenses and capital costs at various production levels (tons per day milled at minesite). Provides data from Western Mine Engineering Ltd., *Mining Cost Services* and Gartner Lee Work Package A2(a). Data from WME is interpolated and presented in matrix form (links daily tonnage and stripping ratios with operating and capital costs).

8. Refined Metal Cost Test – estimates pro rata costs of production in terms of US dollars per pound of refined metal (does not include smelting). Gartner Lee (A2(a)) data provides deposit grade estimates and recovery rates and is combined with opex estimates from WME. Purpose of developing these costs is they are comparable to data provided in tabs 11 and 12 (Cu and Zn) that presents world mining costs on same basis.

9. Transportation – Transportation costs and distance (manually estimated) from mines to selected ports by truck and rail. Costing basis provided by QGI Inc.

10. Transport Test – Estimates of global shipping costs are applied in comparison to Yukon and BC mine costs. Where local mines are 20% higher than global benchmark, mines are excluded from analysis.

11. Cu – Copper costs for various global mining operations. Red bars indicate cost levels for mines within the top 33% and 67% of most competitive mines (on cost per pound of refined metal production basis…as per Tab 8).

12. Zn – Same as Tab 11.

13. Crest Deposit is examined for cost competitiveness.

14. Comparison between different study results is presented.

A.3.3 Mine Inclusion/Exclusion Status & Rationale

Yukon Deposits

CREST
Status: Included
Rationale: Comparative assessment with the largest iron ore mine in Canada that is and has been operation for several decades (i.e., Carol Lake mine owned by the Iron Ore Company of Canada).

DIVISION
Status: Included
Rationale: Export potential coal and competitive transportation.

HOWARDS PASS
Status: Included
Rationale: Per unit value could have the deposit being developed with or without a railroad. Additional rail spur proposed by developer.

GRUM
Status: Included
Rationale: Competitive operating and transportation costs.

SWIM
Status: Included
Rationale: Competitive operating and transportation costs.

FETISH (Wolverine)
Status: Included
Rationale: Despite the short mine life of the deposit, the location relative to future rail development would prompt additional exploration and expansion of known reserves.

TAG (Kudz Ze Kayah)
Status: Included
Rationale: Competitive operating and transportation costs.

FYRE
Status: Included
Rationale: Competitive operating and transportation costs.

ICE
Status: Included
Rationale: Competitive operating and transportation costs.

TOM/JASON
Status: Excluded
Rationale: Non-competitive transportation costs could preclude the development of deposits.[29]

[29] For prospective mines with this rationale, anticipated costs with rail development were still above criterion threshold values.

WELLGREEN
Status: Excluded
Rationale: Non-competitive transportation costs could preclude the development of deposits.

MINTO
Status: Included
Rationale: Competitive operating and transportation costs.

CASINO
Status: Excluded
Rationale: Volumes of concentrate shipped from a porphyry copper deposit would be small.[30]

CASH
Status: Excluded
Rationale: Volumes of concentrate shipped from a porphyry copper deposit would be small.

RED MOUNTAIN
Status: Excluded
Rationale: Volumes of concentrate shipped from a porphyry molybdenum deposit would be small.

LOGTUNG
Status: Excluded
Rationale: Volumes of concentrate shipped from a porphyry tungsten deposit would be small.

MACTUNG
Status: Excluded
Rationale: Volumes of concentrate shipped from a tungsten deposit would be small.

GRIZZLY
Status: Excluded
Rationale: The high cost of underground mining in conjunction with the moderate value of the ore could preclude the development of the deposit at present.

SULPETRO
Status: Excluded
Rationale: Distance to tide water accompanied by the low unit value of the product could preclude the development of the deposit.

[30] Mines with this stated rationale were potentially viable, however, they constituted a relatively small shippable volume and were excluded from impact results.

Bonnet Plume Coal
SPACESHIP
Status: Excluded
Rationale: Distance to tide water accompanied by the low unit value of the product could preclude development of the deposit.

British Columbia Deposits

SCHAFT CREEK
Status: Included
Rationale: Competitive operating and transportation costs.

KEMESS NORTH
Status: Included
Rationale: Competitive operating and transportation costs.

KEMESS SOUTH
Status: Included
Rationale: Competitive operating and transportation costs.

GALORE CREEK
Status: Excluded
Rationale: Competitive operating costs but non-competitive transportation costs could preclude development of mine.

COPPER CANYON
Status: Excluded
Rationale: Non-competitive operating costs and non-competitive transportation costs could preclude development of mine.

RED CHRIS
Status: Excluded
Rationale: Competitive transportation costs but non-competitive operating costs could preclude development of mine.

STORIE
Status: Excluded
Rationale: Volumes of concentrate shipped from a porphyry molybdenum deposit would be small

DAVIE CREEK MOLY.
Status: Excluded
Rationale: Volumes of concentrate shipped from a porphyry molybdenum deposit would be small and non-competitive transportation costs.

MOUNT KLAPPAN (LOST-FOX)
Status: Included

Rationale: High-quality coal and competitive transportation costs.

MOUNT KLAPPAN (HOBBIT-BROATCH)
Status: Included
Rationale: High-quality coal and competitive transportation costs.

MOUNT KLAPPAN (SUMMIT)
Status: Included
Rationale: High-quality coal and competitive transportation costs.

MOUNT KLAPPAN (GROUNDHOG)
Status: Included
Rationale: High-quality coal and competitive transportation costs.

THUNDERCLOUD
Status: Excluded
Rationale: Competitive transportation costs, however, coal may not be exportable.

SUSTUT COAL
Status: Excluded
Rationale: Competitive operating costs but non-competitive transportation costs could preclude development of mine.

KUTCHO CREEK
Status: Excluded
Rationale: The cost of open pit mining in conjunction with the value of the ore preclude the development of the deposit at present.

DISCOVERY
Status: Excluded
Rationale:

PANORAMA NORTH
Status: Excluded
Rationale:

TULSEQUAH CHIEF
Status: Excluded
Rationale: Truck haul to Skagway is not substantially further than (undeveloped) road to Tintina trench.