

ALASKA CANADA RAIL LINK PROJECT

FEASIBILITY STUDY REPORT

**INFRASTRUCTURE COST ESTIMATES
FOR FULL RAIL ROUTE INVESTMENT**

WORK PACKAGE B3(a)

April 2006

REVISED June 2006*

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1.1 Introduction

The work Packages B1(d), B1(e) and B1(g) identified the technically feasible mainline rail routes in BC and Yukon. For an assumed project traffic of about 10 million revenue tons per year, we have identified other basic infrastructure and ancillary facilities needed, to start and run a railway operation. These include sidings for pass and meet, intermediate and home terminals with buildings and shops, communication and power needed for the dispatching of trains and wayside communication, etc. The main track and support structures have been estimated based on CTA/FRA Class 4 track standards (60 mph freight and 70 mph for passenger) and right-of-way standards compatible with mainline operations, through mountainous terrain, providing a safe and reliable right of way. These standards have been identified in work packages B1(d) and B1(e). The unit prices, developed with the help of other experienced construction engineering personnel reflect the prices one would have to pay in the present marketplace, under the following conditions:

- Railway construction practice (foot print of an operating railway is narrower than a major highway such as the Trans Canada).
- The project is of a major undertaking with nearly 1200 miles of new construction in virgin territory. Economies of scale has been given due consideration.
- Federally regulated railways have the freedom to invite both union and non-union contractors to construct the railway, while meeting certain regulatory obligations.
- The final design and construction practice would respect and recognize restrictions imposed in environmentally sensitive locations.
- All unit prices and cost estimates in this report are in US\$.

1.2 Track and Roadbed Standards

See Work Packages B1(d) and B1(e).

1.3 Unit Prices

The unit prices used in this study represent costs at the time of this study (2005 – 2006) as well as rail industry practice and marketplace. The remoteness of the project location has been addressed through a regional factor, at the final stage of estimating.

The primary purpose of this is to compare the cost of construction and maintenance of the alternate routes.

The selection of premium materials such as premium rails and concrete ties for the track structure are based on the life cycle costs, for moderate to heavy tonnage traffic.

The unit prices include cost of performance bond, liability insurance, mobilization, demobilization, and site clean-up to meet environmental conditions. Allowance for access road construction has been identified in the earthwork and rock excavation unit prices. For construction and estimating purposes, right-of-way widths of 100 feet, 150 feet and 200 feet has been assumed. Land purchase costs are not included in the estimate, as it is assumed that most of the land required for the railway right-of-way would be government or crown land.

Based on the projected railway grade profile and the existing ground profile along the route segments, the terrain encountered was subdivided into the following categories and railway carrying structural units, and prices developed to meet the standards:

- Average construction – per mile
- Heavy construction – per mile
- Extra heavy construction – per mile
- Organics – per mile
- Permafrost – per mile
- Rock cuts – per mile
- Erosion rip rap protection – per mile
- Tied back retaining walls – average height of 20 feet - per foot
- Bridge pipes (multiplate culverts- 6 to 7 feet in diameter) – per foot
- Highway grade crossings with flashing lights and bell - each
- Highway railway conflict in tight locations – per mile
- Bridges over major rivers – concrete piers with steel superstructure – per foot
- Steel tower bridges on concrete footings over 300 feet high – per foot
- Steel tower bridges between 300 and 200 feet high – per foot
- Steel tower bridges between 200 and 100 feet high- per foot
- Steel tower bridges between 100 and 50 feet high – per foot
- Steel tower bridges less than 50 feet high – per foot
- Railway overpass structures – per foot
- Highway overpass structures – square foot
- Flumes, rock and snow sheds –per foot
- Unlined rock tunnels < 2 miles – per foot
- Unlined rock tunnels > 2 < 5 miles – per foot
- Unlined rock tunnels > 5 miles – per foot
- Mainline track – per mile
- 7200 foot long mainline sidings and back tracks every 30 miles – per mile
- Communication and power line – per mile
- Hot box and dragging equipment detectors every 75 miles - each
- Home terminal with facilities every 300 miles - each
- Intermediate terminal with facilities every 150 miles - each
- Fuelling facilities at one home terminal - each

All of the unit prices have been checked against past and present railway construction project prices in BC to ensure they are valid within a reasonable variation.

Notes on Unit Prices:

- Unit prices for earth works, rock works, sub-ballast, and rock rip rap have been derived from recent construction prices in BC and adjusted to reflect the project conditions and marketplace. They have been rounded to the nearest dollar.
- Steel tower bridge unit prices per foot are determined from a step function model assembled and validated over many years from railway bridge construction costs and detailed estimating, by railway bridge engineers. This provides a unit price per foot for different bridge heights, within a reasonable variation, acceptable to this level of study. Bridges estimated for E-85 Cooper Loading.
- The bridges over major rivers were also determined from a similar model, but show a smaller variation in unit prices with height due to greater uncertainty of subsurface and river flow conditions. This model has been used and validated for this cost estimate. Bridges estimated for E-85 Cooper Loading.
- Tunnel unit prices have been developed from five rock tunnel projects constructed on BCR/CN and CP railways in the 1980's. These were further compared to detailed rock tunnel cost estimates completed during the 1980's of 17 rock tunnels in the BC Fraser/Thompson canyon. These prices have been updated to reflect the 2006 marketplace. For rock tunnels over five miles, an allowance has been made for some roof shotcrete, bolting and a ventilation shaft.
- Mainline track, passing tracks, back tracks, R&D tracks, hot box and dragging equipment detectors and grade crossing estimates are compatible with Canadian Class 1 railway unit prices, but adjusted to reflect the marketplace. All prices include material, labour, installation, work equipment, work train, and typical railway overheads for benefits and supervision.

The communication and power unit price and estimate reflect a power and fibre optic cable being buried simultaneously in the railway right-of-way at the end of construction. This would provide a secure and reliable communication system for train operations for the expected traffic levels of this project.

1.4 Route Segment Cost Estimates

At the final stage of estimating, a regional construction factor was applied (one for northern BC of 1.1 and one for Yukon of 1.2) to cover costs related to transport of material, labor, construction camp set up and catering, and general support of project.

Given the quantities developed along each route segment for each of the construction items, total costs were developed by multiplying the unit prices by the estimated quantities. To the total, a contingency of 25% was added to mitigate all of the unknown factors at this stage of this desk top engineering feasibility study. To this total, a 2% environmental mitigation cost was added to mitigate against environmental issues

imposed through regulatory and public hearings. This total was assumed to be the total construction cost of the route segment. A 3% cost was added for preliminary engineering and environmental studies to be conducted prior to application for environmental and regulatory approval. To this was added 3% for owner's overview control costs and 12% for final engineering design and project management during construction of the total project. The construction cost including the engineering, environmental, control and project management costs would be considered to be the total cost of the project and should be used in any business case analysis.

1.5 40 Year Capital Replacement and Right-of-Way Cost Estimate Prediction for Each Route Segment in BC and Yukon

Assumptions used in this cost estimate prediction are:

- 10 MRT (Million Revenue Tons) per year converted to 19 MGT (Million Gross Tons) per year.
- A 3% per year compounded growth in traffic over a 40 year period.
- General rail and track degradation models used by Class 1 freight railroads.
- Life of premium 136lb CWR rail in tangent track under moderately heavy axle loads is about 1 BGT (Billion Gross Tons).
- Right-of-way stabilization costs are based on historical annual costs for railway subdivisions in mountainous terrain.

Table 1: Cost Estimate for Fort Nelson to Watson Lake

**ALCAN Rail Link Construction Cost
In 2006 US\$ converted from Cdn\$
at the following exchange rate.**

Exchange Rate:	Cdn\$1.00 = US\$0.85
	BC South Unit Cost
	Units US\$/Unit

Track - 136# CWR w/ Hardwood or Concrete Ties

Track Construction - material & labour	mile	\$969,000
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Embankment Grade & Sub-ballast

Average	mile	\$789,000
Heavy	mile	\$1,269,000
Very Heavy	mile	\$3,087,000
Rock cuts	mile	\$3,454,000
Organics	mile	\$1,850,000
Permafrost	mile	\$1,177,000

Tunnel Construction

Rock - Unlined < 2 miles each	feet	\$6,800
Rock - Unlined > 2 miles each	feet	\$6,375

Embankment Protection Structures

Rip Rap Protection - 3 ft wide.	mile	\$936,000
Tied Back Retaining Walls	feet	\$2,550
Flumes, Rock/Snow sheds	feet	\$3,400

Railway Bridge Structures Over Water/Debris

Steel Bridges/Trestles		
Less than 50 ft high	feet	\$8,500
50 to 100 ft high	feet	\$11,050
100 to 200 ft high	feet	\$12,750
200 to 300 ft high	feet	\$14,450
More than 300 ft high	feet	\$16,150
Bridge over Major River	feet	\$23,800
Bridge Pipes (multiplates)	feet	\$1,275

Highway-Railway Intersections

Grade Separation Structures		
Railway Bridge <50'H Over Hwy	feet	\$8,500
Railway Bridge >50'H Over Hwy	feet	\$11,050
2-Lane Hwy Bridge Over Rwy	feet	\$9,180
4-Lane Hwy Bridge Over Rwy	feet	\$15,300
Highway/Railway Conflict - Relocation	mile	\$10,200,000
Grade Crossings & Signals	No.	\$191,250

Main Track Construction Cost - Jct to Jct per Manual Drawing

Mileage Adjustment

\$5.573 M	335.0 Mi	\$1,866.905 M	
0.30%	1.0 Mi	5.573 M	included above

Main Track Construction Cost - Jct to Jct per Computer Drawing

Add Portion of Route on Other Segment

Total Route Main Track Costs

336.0 Mi	\$1,872.478 M	\$1,872.478 M
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Communications, Power, & Detectors

Communication & power	mile	\$161,500
Hot Box & Dragging Equipment Detectors	No.	\$204,000

336	\$59.690 M
4	\$0.898 M

Sidings and Terminals

Mainline sidings & back tracks	No.	\$3,381,000
Home Terminal & facilities	LS	\$33,957,000
Fueling facilities	LS	\$2,550,000
Inter. Terminal & facilities	LS	\$9,582,000

10	\$37.191 M
1	\$37.353 M
1	\$2.805 M
1	\$10.540 M

Total Route Construction Costs

Contingencies & Environmental Mitigation

Contingencies	25%	
Environmental Mitigation	2%	Costs + Contingencies

Sub Total

Engineering & Environmental Studies

Eng. Environmental Study & Approval	3%
Owner Overview Costs	3%
Engineering & Project Mgmt	12%

	\$2,020.955 M
	\$555.763 M
\$505.239 M	
\$50.524 M	
	\$2,576.718 M
	\$463.810 M
\$77.302 M	
\$77.302 M	
\$309.206 M	

Total Estimated Route Cost

Average Cost per Mile

\$9.049 M

Fort Nelson to Watson Lake	
336	Route Miles
1.10	BC North Cost Factor
Quantity	Total Cost - Million US\$

335	\$357.077 M	\$358.143 M
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137.5	\$119.336 M	\$655.223 M
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74.0	\$103.297 M
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50.1	\$170.125 M
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65.3	\$248.101 M
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6.1	\$12.414 M
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0.0	
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		\$74.273 M
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10,560	\$74.052 M
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		\$20.744 M
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7.62	\$7.846 M
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1,056	\$2.962 M
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2,640	\$9.874 M
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		\$759.587 M
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3,740	\$34.969 M
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5,364	\$65.199 M
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6,890	\$96.632 M
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656	\$10.427 M
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19,521	\$511.060 M
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27,835	\$39.039 M
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		\$4.508 M
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341	\$3.443 M
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minor	
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5	\$1.052 M
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Table 2: Cost Estimate for Minaret to Watson Lake via Dease Lake

ALCAN Rail Link Construction Cost			Minaret to Watson Lake		
In 2006 US\$ converted from Cdn\$ at the following exchange rate.			Route Miles		
Exchange Rate: Cdn\$1.00 = US\$0.85			1.10 BC North Cost Factor		
BC South Unit Cost			Quantity	Total Cost - Million US\$	
	Units	US\$/Unit			
Track - 136# CWR w/ Hardwood or Concrete Ties				\$403.976 M	
Track Construction - material & labour	mile	\$969,000	380	\$405.042 M	
Embankment Grade & Sub-ballast				\$1,031.499 M	
Average	mile	\$789,000	7.1	\$6.162 M	
Heavy	mile	\$1,269,000	110.1	\$153.689 M	
Very Heavy	mile	\$3,087,000	150.4	\$510.713 M	
Rock cuts	mile	\$3,454,000	95.5	\$362.843 M	
Organics	mile	\$1,850,000	0.4	\$0.814 M	
Permafrost	mile	\$1,177,000	0.0		
Tunnel Construction				\$613.015 M	
Rock - Unlined < 2 miles each	feet	\$6,800	7,920	\$59.242 M	
Rock - Unlined > 2 miles each	feet	\$6,375	79,200	\$555.390 M	
Embankment Protection Structures				\$446.549 M	
Rip Rap Protection - 3 ft wide.	mile	\$936,000	7.945	\$8.180 M	
Tied Back Retaining Walls	feet	\$2,550	145,860	\$409.137 M	
Flumes, Rock/Snow sheds	feet	\$3,400	8,131	\$30.410 M	
Railway Bridge Structures Over Water/Debris				\$804.914 M	
Steel Bridges/Trestles					
Less than 50 ft high	feet	\$8,500	9,318	\$87.123 M	
50 to 100 ft high	feet	\$11,050	18,865	\$229.304 M	
100 to 200 ft high	feet	\$12,750	16,306	\$228.692 M	
200 to 300 ft high	feet	\$14,450	6,414	\$101.951 M	
More than 300 ft high	feet	\$16,150	2,625	\$46.633 M	
Bridge over Major River	feet	\$23,800	1,969	\$51.548 M	
Bridge Pipes (multiplates)	feet	\$1,275	44,055	\$61.787 M	
Highway-Railway Intersections				\$97.362 M	
Grade Separation Structures					
Railway Bridge <50'H Over Hwy	feet	\$8,500	1,450	\$13.558 M	
Railway Bridge >50'H Over Hwy	feet	\$11,050	1,332	\$16.190 M	
2-Lane Hwy Bridge Over Rwy	feet	\$9,180	381	\$3.847 M	
4-Lane Hwy Bridge Over Rwy	feet	\$15,300			
Highway/Railway Conflict - Relocation	mile	\$10,200,000	5.5	\$61.710 M	
Grade Crossings & Signals	No.	\$191,250	11	\$2.314 M	
Main Track Construction Cost - Jct to Jct per Manual Drawing			\$8.964 M	380.0 Mi	\$3,406.279 M
Mileage Adjustment			-0.26%	-1.0 Mi	-8.964 M
Main Track Construction Cost - Jct to Jct per Computer Drawing				379.0 Mi	\$3,397.315 M
Add Portion of Route on Other Segment			\$5.573 M	13.0 Mi	\$72.449 M
Total Route Main Track Costs				392.0 Mi	\$3,469.764 M
Communications, Power, & Detectors					\$70.761 M
Communication & power	mile	\$161,500	392	\$69.639 M	
Hot Box & Dragging Equipment Detectors	No.	\$204,000	5	\$1.122 M	
Sidings and Terminals					\$143.219 M
Mainline sidings & back tracks	No.	\$3,381,000	12	\$44.629 M	
Home Terminal & facilities	LS	\$33,957,000	2	\$74.705 M	
Fueling facilities	LS	\$2,550,000	1	\$2.805 M	
Inter. Terminal & facilities	LS	\$9,582,000	2	\$21.080 M	
Total Route Construction Costs					\$3,683.744 M
Contingencies & Environmental Mitigation					\$1,013.030 M
Contingencies	25%			\$920.936 M	
Environmental Mitigation	2%	Costs + Contingencies		\$92.094 M	
Sub Total					\$4,696.774 M
Engineering & Environmental Studies					\$845.419 M
Eng. Environmental Study & Approval	3%			\$140.903 M	
Owner Overview Costs	3%			\$140.903 M	
Engineering & Project Mgmt	12%			\$563.613 M	
Total Estimated Route Cost					\$5,542.193 M
Average Cost per Mile				\$14.138 M	

Table 3: Cost Estimate for Watson Lake to Carmacks

ALCAN Rail Link Construction Cost			Watson Lake to Carmacks	
In 2006 US\$ converted from Cdn\$				
at the following exchange rate.				
Exchange Rate:		Cdn\$1.00 = US\$0.85		
			Route Miles	
			Yukon Cost Factor	
			Quantity	Total Cost - Million US\$
Track - 136# CWR w/ Hardwood or Concrete Ties				
Track Construction - material & labour	mile	\$969,000	403	\$468.608 M
Embankment Grade & Sub-ballast				
Average	mile	\$789,000	92.8	\$87.863 M
Heavy	mile	\$1,269,000	150.9	\$229.791 M
Very Heavy	mile	\$3,087,000	101.8	\$377.108 M
Rock cuts	mile	\$3,454,000	23.4	\$96.988 M
Organics	mile	\$1,850,000	6.3	\$13.986 M
Permafrost	mile	\$1,177,000	27.8	\$39.265 M
Tunnel Construction				
Rock - Unlined < 2 miles each	feet	\$6,800	0	
Rock - Unlined > 2 miles each	feet	\$6,375	0	
Embankment Protection Structures				
Rip Rap Protection - 3 ft wide.	mile	\$936,000	7.65	\$8.592 M
Tied Back Retaining Walls	feet	\$2,550	0	
Flumes, Rock/Snow sheds	feet	\$3,400	2,746	\$11.204 M
Railway Bridge Structures Over Water/Debris				
Steel Bridges/Trestles				
Less than 50 ft high	feet	\$8,500	4,724	\$48.185 M
50 to 100 ft high	feet	\$11,050	12,434	\$164.875 M
100 to 200 ft high	feet	\$12,750	4,724	\$72.277 M
200 to 300 ft high	feet	\$14,450	2,133	\$36.986 M
More than 300 ft high	feet	\$16,150		
Bridge over Major River	feet	\$23,800		
Bridge Pipes (multiplates)	feet	\$1,275	28,478	\$43.571 M
Highway-Railway Intersections				
Grade Separation Structures				
Railway Bridge <50'H Over Hwy	feet	\$8,500	984	\$10.037 M
Railway Bridge >50'H Over Hwy	feet	\$11,050		
2-Lane Hwy Bridge Over Rwy	feet	\$9,180	433	\$4.770 M
4-Lane Hwy Bridge Over Rwy	feet	\$15,300		
Highway/Railway Conflict - Relocation	mile	\$10,200,000	19.5	\$238.680 M
Grade Crossings & Signals	No.	\$191,250	27	\$6.197 M
Main Track Construction Cost - Jct to Jct per Manual Drawing				
Mileage Adjustment			403.0 Mi	\$1,958.983 M
Main Track Construction Cost - Jct to Jct per Computer Drawing				
Add Portion of Route on Other Segment			0.0 Mi	0.000 M
Total Route Main Track Costs				
			403.0 Mi	\$1,958.983 M
Communications, Power, & Detectors				
Communication & power	mile	\$161,500	403	\$78.101 M
Hot Box & Draggng Equipment Detectors	No.	\$204,000	5	\$1.224 M
Sidings and Terminals				
Mainline sidings & back tracks	No.	\$3,381,000	12	\$48.686 M
Home Terminal & facilities	LS	\$33,957,000	2	\$81.497 M
Fueling facilities	LS	\$2,550,000	1	\$3.060 M
Inter. Terminal & facilities	LS	\$9,582,000	2	\$22.997 M
Total Route Construction Costs				
			\$2,194.548 M	
Contingencies & Environmental Mitigation				
Contingencies	25%			\$548.637 M
Environmental Mitigation	2%	Costs + Contingencies		\$54.864 M
Sub Total				
			\$2,798.049 M	
Engineering & Environmental Studies				
Eng. Environmental Study & Approval	3%			\$83.941 M
Owner Overview Costs	3%			\$83.941 M
Engineering & Project Mgmt	12%			\$335.766 M
Total Estimated Route Cost				
			\$3,301.697 M	
Average Cost per Mile				
			\$8.193 M	

Table 5: Cost Estimate for Carmacks to Beaver Creek via Nisling River

ALCAN Rail Link Construction Cost			Carmacks to Beaver Creek		
In 2006 US\$ converted from Cdn\$ at the following exchange rate.					
Exchange Rate: Cdn\$1.00 = US\$0.85					
BC South Unit Cost			Route Miles		
			Yukon Cost Factor		
	Units	US\$/Unit	Quantity	Total Cost - Million US\$	
Track - 136# CWR w/ Hardwood or Concrete Ties					\$263.645 M
Track Construction - material & labour	mile	\$969,000	218.1	\$253.607 M	
Embankment Grade & Sub-ballast					\$389.357 M
Average	mile	\$789,000	76.9	\$72.809 M	
Heavy	mile	\$1,269,000	46.9	\$71.419 M	
Very Heavy	mile	\$3,087,000	26.8	\$99.278 M	
Rock cuts	mile	\$3,454,000	1.0	\$4.145 M	
Organics	mile	\$1,850,000	55.5	\$123.210 M	
Permafrost	mile	\$1,177,000	2.6	\$3.672 M	
Tunnel Construction					\$529.111 M
Rock - Unlined < 2 miles each	feet	\$6,800			
Rock - > 5 miles each	feet	\$9,563	44,352	\$508.966 M	
Embankment Protection Structures					\$14.150 M
Rip Rap Protection - 3 ft wide.	mile	\$936,000	1.09	\$1.224 M	
Tied Back Retaining Walls	feet	\$2,550	528	\$1.616 M	
Flumes, Rock/Snow sheds	feet	\$3,400	2,640	\$10.771 M	
Railway Bridge Structures Over Water/Debris					\$395.229 M
Steel Bridges/Trestles					
Less than 50 ft high	feet	\$8,500	5,659	\$57.722 M	
50 to 100 ft high	feet	\$11,050	1,804	\$23.921 M	
100 to 200 ft high	feet	\$12,750			
200 to 300 ft high	feet	\$14,450			
More than 300 ft high	feet	\$16,150			
Bridge over Major River	feet	\$23,800	9,925	\$283.458 M	
Bridge Pipes (multiplates)	feet	\$1,275	9,856	\$15.080 M	
Highway-Railway Intersections					\$0.716 M
Grade Separation Structures					
Railway Bridge <50'H Over Hwy	feet	\$8,500			
Railway Bridge >50'H Over Hwy	feet	\$11,050			
2-Lane Hwy Bridge Over Rwy	feet	\$9,180			
4-Lane Hwy Bridge Over Rwy	feet	\$15,300			
Highway/Railway Conflict - Relocation	mile	\$10,200,000			
Grade Crossings & Signals	No.	\$191,250	3	\$0.689 M	
Main Track Construction Cost - Jct to Jct per Manual Drawing			\$7.304 M	209.7 Mi	\$1,531.587 M
Mileage Adjustment			3.96%	8.3 Mi	60.623 M
Main Track Construction Cost - Jct to Jct per Computer Drawing					\$1,592.208 M
Add Portion of Route on Other Segment			\$5.761 M	15.0 Mi	\$86.415 M
Total Route Main Track Costs				233.0 Mi	\$1,678.625 M
Communications, Power, & Detectors					\$45.889 M
Communication & power	mile	\$161,500	233	\$45.155 M	
Hot Box & Dragging Equipment Detectors	No.	\$204,000	3	\$0.734 M	
Sidings and Terminals					\$83.706 M
Mainline sidings & back tracks	No.	\$3,381,000	7	\$28.400 M	
Home Terminal & facilities	LS	\$33,957,000	1	\$40.748 M	
Fueling facilities	LS	\$2,550,000	1	\$3.060 M	
Inter. Terminal & facilities	LS	\$9,582,000	1	\$11.498 M	
Total Route Construction Costs					\$1,808.218 M
Contingencies & Environmental Mitigation					\$497.260 M
Contingencies	25%			\$452.055 M	
Environmental Mitigation	2%	Costs + Contingencies		\$45.205 M	
Sub Total					\$2,305.478 M
Engineering & Environmental Studies					\$414.985 M
Eng. Environmental Study & Approval	3%			\$69.164 M	
Owner Overview Costs	3%			\$69.164 M	
Engineering & Project Mgmt	12%			\$276.657 M	
Total Estimated Route Cost					\$2,720.463 M
Average Cost per Mile					\$11.676 M

Table 6: Cost Estimate for Watson Lake to Whitehorse via Alaska Highway

ALCAN Rail Link Construction Cost			Watson Lake to Whitehorse	
In 2006 US\$ converted from Cdn\$				
at the following exchange rate.				
Exchange Rate:		Cdn\$1.00 = US\$0.85		
		BC South Unit Cost		
	Units	US\$/Unit	Quantity	Total Cost - Million US\$
Track - 136# CWR w/ Hardwood or Concrete Ties				
Track Construction - material & labour	mile	\$969,000	312	\$362.794 M
Embankment Grade & Sub-ballast				
Average	mile	\$789,000	42.7	\$40.428 M
Heavy	mile	\$1,269,000	170.5	\$259.637 M
Very Heavy	mile	\$3,087,000	78.2	\$289.684 M
Rock cuts	mile	\$3,454,000	4.3	\$17.823 M
Organics	mile	\$1,850,000	15.3	\$33.966 M
Permafrost	mile	\$1,177,000	1.0	\$1.412 M
Tunnel Construction				
Rock - Unlined < 2 miles each	feet	\$6,800	0	
Rock - Unlined > 2 miles each	feet	\$6,375	0	
Embankment Protection Structures				
Rip Rap Protection - 3 ft wide.	mile	\$936,000	0.285	\$0.320 M
Tied Back Retaining Walls	feet	\$2,550	4,330	\$13.250 M
Flumes, Rock/Snow sheds	feet	\$3,400	528	\$2.154 M
Railway Bridge Structures Over Water/Debris				
Steel Bridges/Trestles				
Less than 50 ft high	feet	\$8,500	9,826	\$100.225 M
50 to 100 ft high	feet	\$11,050	3,757	\$49.818 M
100 to 200 ft high	feet	\$12,750	2,789	\$42.672 M
200 to 300 ft high	feet	\$14,450		
More than 300 ft high	feet	\$16,150		
Bridge over Major River	feet	\$23,800	5,577	\$159.279 M
Bridge Pipes (multiplates)	feet	\$1,275	14,403	\$22.037 M
Highway-Railway Intersections				
Grade Separation Structures				
Railway Bridge <50'H Over Hwy	feet	\$8,500	295	\$3.009 M
Railway Bridge >50'H Over Hwy	feet	\$11,050		
2-Lane Hwy Bridge Over Rwy	feet	\$9,180	148	\$1.630 M
4-Lane Hwy Bridge Over Rwy	feet	\$15,300		
Highway/Railway Conflict - Relocation	mile	\$10,200,000	19.0	\$232.560 M
Grade Crossings & Signals	No.	\$191,250	19	\$4.361 M
Main Track Construction Cost - Jct to Jct per Manual Drawing				
Mileage Adjustment			312.0 Mi	\$1,637.059 M
			2.0 Mi	10.494 M
Main Track Construction Cost - Jct to Jct per Computer Drawing				
Add Portion of Route on Other Segment			314.0 Mi	\$1,647.553 M
Total Route Main Track Costs			314.0 Mi	\$1,647.553 M
Communications, Power, & Detectors				
Communication & power	mile	\$161,500	314	\$60.853 M
Hot Box & Dragging Equipment Detectors	No.	\$204,000	4	\$0.979 M
Sidings and Terminals				
Mainline sidings & back tracks	No.	\$3,381,000	9	\$36.515 M
Home Terminal & facilities	LS	\$33,957,000	1	\$40.748 M
Fueling facilities	LS	\$2,550,000	1	\$3.060 M
Inter. Terminal & facilities	LS	\$9,582,000	1	\$11.498 M
Total Route Construction Costs				
Contingencies & Environmental Mitigation				
Contingencies	25%			\$450.302 M
Environmental Mitigation	2%	Costs + Contingencies		\$45.030 M
Sub Total				\$2,296.538 M
Engineering & Environmental Studies				
Eng. Environmental Study & Approval	3%			\$68.896 M
Owner Overview Costs	3%			\$68.896 M
Engineering & Project Mgmt	12%			\$275.585 M
Total Estimated Route Cost				
Average Cost per Mile				
				\$8.630 M

Table 7: Cost Estimate for Whitehorse to Beaver Creek via Alaska Highway

ALCAN Rail Link Construction Cost			Whitehorse to Beaver Creek	
In 2006 US\$ converted from Cdn\$				
at the following exchange rate.				
Exchange Rate:		Cdn\$1.00 = US\$0.85		
		BC South Unit Cost		
	Units	US\$/Unit	Quantity	Total Cost - Million US\$
Track - 136# CWR w/ Hardwood or Concrete Ties				\$381.398 M
Track Construction - material & labour	mile	\$969,000	325.5	\$378.491 M
Embankment Grade & Sub-ballast				\$659.188 M
Average	mile	\$789,000	26.1	\$24.711 M
Heavy	mile	\$1,269,000	166.2	\$253.089 M
Very Heavy	mile	\$3,087,000	69.2	\$256.344 M
Rock cuts	mile	\$3,454,000	5.3	\$21.967 M
Organics	mile	\$1,850,000	24.0	\$53.280 M
Permafrost	mile	\$1,177,000	31.7	\$44.773 M
Tunnel Construction				\$123.463 M
Rock - Unlined < 2 miles each	feet	\$6,800	2,640	\$21.542 M
Rock - Unlined > 2 miles each	feet	\$6,375	13,200	\$100.980 M
Embankment Protection Structures				\$26.917 M
Rip Rap Protection - 3 ft wide.	mile	\$936,000	0	
Tied Back Retaining Walls	feet	\$2,550	0	
Flumes, Rock/Snow sheds	feet	\$3,400	6,547	\$26.712 M
Railway Bridge Structures Over Water/Debris				\$688.905 M
Steel Bridges/Trestles				
Less than 50 ft high	feet	\$8,500	26,345	\$268.719 M
50 to 100 ft high	feet	\$11,050	2,871	\$38.069 M
100 to 200 ft high	feet	\$12,750	6,070	\$92.871 M
200 to 300 ft high	feet	\$14,450	1,476	\$25.594 M
More than 300 ft high	feet	\$16,150		
Bridge over Major River	feet	\$23,800	7,546	\$215.514 M
Bridge Pipes (multiplates)	feet	\$1,275	28,031	\$42.887 M
Highway-Railway Intersections				\$9.884 M
Grade Separation Structures				
Railway Bridge <50'H Over Hwy	feet	\$8,500	328	\$3.346 M
Railway Bridge >50'H Over Hwy	feet	\$11,050		
2-Lane Hwy Bridge Over Rwy	feet	\$9,180	295	\$3.250 M
4-Lane Hwy Bridge Over Rwy	feet	\$15,300		
Highway/Railway Conflict - Relocation	mile	\$10,200,000		
Grade Crossings & Signals	No.	\$191,250	14	\$3.213 M
Main Track Construction Cost - Jct to Jct per Manual Drawing				\$5.761 M
Mileage Adjustment			0.77%	325.5 Mi \$1,875.352 M
Main Track Construction Cost - Jct to Jct per Computer Drawing				\$1,889.755 M
Add Portion of Route on Other Segment			2.5 Mi	14.403 M included above
Total Route Main Track Costs				\$1,889.755 M
			328.0 Mi	\$1,889.755 M
Communications, Power, & Detectors				\$64.545 M
Communication & power	mile	\$161,500	328	\$63.566 M
Hot Box & Dragging Equipment Detectors	No.	\$204,000	4	\$0.979 M
Sidings and Terminals				\$95.878 M
Mainline sidings & back tracks	No.	\$3,381,000	10	\$40.572 M
Home Terminal & facilities	LS	\$33,957,000	1	\$40.748 M
Fueling facilities	LS	\$2,550,000	1	\$3.060 M
Inter. Terminal & facilities	LS	\$9,582,000	1	\$11.498 M
Total Route Construction Costs				\$2,050.178 M
Contingencies & Environmental Mitigation				\$563.799 M
Contingencies	25%			\$512.545 M
Environmental Mitigation	2%	Costs + Contingencies		\$51.254 M
Sub Total				\$2,613.977 M
Engineering & Environmental Studies				\$470.515 M
Eng. Environmental Study & Approval	3%			\$78.419 M
Owner Overview Costs	3%			\$78.419 M
Engineering & Project Mgmt	12%			\$313.677 M
Total Estimated Route Cost				\$3,084.492 M
Average Cost per Mile				\$9.404 M

Table 10: Cost Comparison and Engineering Properties of Route Segments

Alaska Canada Railway Alternate Route Assessment Summary - Yukon & BC Segments								Other Alternate Routes in BC Not in Study	
Corridor Description Issues	Watson Lake to Carmacks via Rob.Campbell	Carmacks to Alaska Border via Yukon & Ladue R.	Carmacks to Beaver Creek via Nisling River	Watson Lake to Whitehorse along Alaska Hwy.	Whitehorse to Beaver Creek along Alaska Hwy.	Fort Nelson to Watson Lake	Minaret to Watson Lake via (BCR grade)	MacKenzie to Watson Lake via Rocky Mountain trench Route	Hazleton to Watson Lake via Nass, Klappen River, & Dease Lake.
Construction Miles	403	223	233	314	328	336	392	435	497
Tunnels	None	None	8.4 miles	2.2 miles	0.5 mile	None	16.5 miles	None	None
Highway conflict	High	Low	Low	Very high	Moderate	Moderate	Moderate	Low	Moderate
Profile Grades									
General Grade	Low	Low	Steep	Low	Moderate	Moderate	Very Steep	Gentle	Moderate
Max. Grade	0.7% EB & WB	0.7% EB & WB	1.5%WB 0.7% EB	0.7% EB & WB	1.0% EB & WB	0.7% WB 1.0% EB	2.5% EB & WB	0.5% EB & WB	1.0% EB & WB
Alignment Curves									
1 to 3 deg. Curves	88 miles - 22 %	48 miles - 22%	37 miles - 16%	74 miles - 24%	55 miles - 17%	32 miles - 10%	90 miles - 23%	89 miles - 20 %	118 miles - 24%
4 to 6 deg. Curves	24 miles - 6%	29 miles - 13%	15 miles - 6%	31 miles - 10%	13 miles - 4%	79 miles - 24%	57 miles - 15%	21 miles - 5%	55 miles - 11%
All Curves	112 miles - 28%	77 miles - 35%	52 miles - 22 %	105 miles - 34%	68 miles - 21%	111 miles - 33%	147 miles - 38%	110 miles - 25%	174* miles - 35%
Track/Train Dynamics Outcome									
Rail Wear	Low	Moderate	Low	Moderate	Low	Very High	High	Low	Moderate
Fuel Consumption	Low	Low	High	Low	Moderate	Moderate	Very High	Low	Moderate
Operating Cost	Low	Low	High	Medium	Medium	Medium	Very High	Low	Medium
Risk Ranking									
Seismic Activity	Moderate	Moderate	Moderate	Low	Low	Low	Low	Low	Low
Nat. Disasters	Moderate	Moderate	Moderate	Moderate	Moderate	Moderate	High	Moderate	Moderate
Capital Construction Costs									
Total (Million \$)	\$3,301.70	\$2,014.57	\$2,720.46	\$2,709.92	\$3,084.49	\$3,040.53	\$5,542.19	\$3,262.47	\$3,952.64
Per Mile (Million \$)	\$8.19	\$9.03	\$11.68	\$8.63	\$9.40	\$9.05	\$14.14	\$7.50	\$7.95

* Revised June 2, 2006

Table 11: Cost Comparison of Full Rail Routes from Alaska to BC

ALCAN Rail Link - Route Cost Estimates
In Million US\$

Route Segment \ Rail Route	Delta Jct Ladue Border Carmacks Watson Lake Fort Nelson	Delta Jct Beaver Creek Carmacks Watson Lake Fort Nelson	Delta Jct Beaver Creek Whitehorse Watson Lake Fort Nelson	Delta Jct Ladue Border Carmacks Watson Lake MacKenzie	Delta Jct Beaver Creek Carmacks Watson Lake MacKenzie	Delta Jct Beaver Creek Whitehorse Watson Lake MacKenzie	Delta Jct Ladue Border Carmacks Watson Lake Hazelton	Delta Jct Beaver Creek Carmacks Watson Lake Hazelton	Delta Jct Beaver Creek Whitehorse Watson Lake Hazelton
1. Delta Jct to Ladue Border	\$1,047.65			\$1,047.65			\$1,047.65		
1. Delta Jct to Beaver Creek		\$1,169.02	\$1,169.02		\$1,169.02	\$1,169.02		\$1,169.02	\$1,169.02
Ladue Border to Carmacks	\$2,014.57			\$2,014.57			\$2,014.57		
Beaver Creek to Carmacks		\$2,720.46			\$2,720.46			\$2,720.46	
Beaver Creek to Whitehorse			\$3,084.49			\$3,084.49			\$3,084.49
Carmacks to Watson Lake	\$3,301.70	\$3,301.70		\$3,301.70	\$3,301.70		\$3,301.70	\$3,301.70	
Whitehorse to Watson Lake			\$2,709.92			\$2,709.92			\$2,709.92
Watson Lake to Fort Nelson	\$3,040.53	\$3,040.53	\$3,040.53						
Watson Lake to MacKenzie				\$3,262.47	\$3,262.47	\$3,262.47			
Watson Lake to Hazelton							\$3,952.64	\$3,952.64	\$3,952.64
Total Route Cost	\$9,404.44	\$10,231.71	\$10,003.96	\$9,626.39	\$10,453.65	\$10,225.90	\$10,316.55	\$11,143.82	\$10,916.07
Total Route Miles	1,162	1,182	1,188	1,261	1,281	1,287	1,323	1,343	1,349
Cost per Mile	\$8.09	\$8.66	\$8.42	\$7.63	\$8.16	\$7.95	\$7.80	\$8.30	\$8.09
2. 3rd Party Cap. Cost	\$816.17	\$816.17	\$816.17	\$52.28	\$52.28	\$52.28	\$0.00	\$0.00	\$0.00
3. Miles to Pr. George	1,678	1,698	1,704	1,377	1,397	1,403	1,613	1,633	1,639
3. Miles to Pr. Rupert	2,139	2,159	2,165	1,838	1,858	1,864	1,494	1,514	1,520

Notes:

1. Costs from Alaska Consultants
2. CN costs to upgrade to Class 3 or 4 track
3. From Delta Junction Alaska

Table 12: Capital and Right-of-Way Costs Over 40 Years for Each Route Segment

Estimated Capital replacement & ROW costs over 40 year life for Rail Route segments in BC & Yukon

Assume 10 MRT converted to 19 MGT per route segment

Assume 3% growth in traffic each year over a forty year period

Route Description	Fort Nelson to Watson Lake	Minaret to Watson Lake	Watson Lake to Carmacks	Carmacks to Ladue border	Carmacks to Beaver Creek	Watson Lake to Whitehorse	Whitehorse to Beaver Creek
Plant Summary							
Route Miles	336	392	403	223	233	314	328
Rail Replacement - 40 yr	537	634	433	283	292	385	340
Route Curve Miles	33.10%	37.60%	27.90%	34.60%	22.20%	33.40%	20.60%
Very heavy -Miles	50.10	150.40	101.80	83.00	26.80	78.20	69.20
Miles of Rock Cut	65.30	95.50	23.40	10.60	1.00	4.30	5.30
Miles of Rip Rap	7.62	79.40	7.65	48.46	1.09	0.28	0.00
No. of Turnouts	24	36	34	18	20	24	26
Grade Xings	5	11	27	3	3	19	14
Miles of Rock Tunnel	2	17	0	0	8.4	0	3.0
Maximum Grade	1.0%	2.5%	0.7%	0.7%	1.5%	0.7%	1.0%

Alternate BC Routes Not included in this Study	
Mackenzie to Watson Lake	Hazelton to Watson Lake
435	497 **
22.70%	32.40%

Capital Cost Items	Costs	Costs	Costs	Costs	Costs	Costs	Costs
Rail replacement	\$206,745,000	\$244,090,000	\$181,692,000	\$118,860,000	\$122,640,000	\$161,637,000	\$142,758,000
Tie replacement	\$0	\$0	\$0	\$0	\$0	\$0	\$0
Track surfacing	\$104,522,880	\$121,943,360	\$136,762,080	\$75,677,280	\$79,070,880	\$106,559,040	\$111,310,080
Undercut & Ballast	\$130,653,600	\$152,429,200	\$170,952,600	\$94,596,600	\$98,838,600	\$133,198,800	\$139,137,600
Rail profile grinding	\$18,431,179	\$24,718,832	\$13,653,064	\$11,076,484	\$7,332,891	\$14,540,433	\$7,920,595
Bridge/Deck replacement	\$0	\$0	\$0	\$0	\$0	\$0	\$0
Slope/rock stabilisation	\$68,818,933	\$155,906,667	\$81,352,000	\$67,657,600	\$17,966,400	\$52,844,800	\$47,680,000
Rehab. Turnouts	\$7,465,920	\$11,198,880	\$11,538,240	\$6,108,480	\$6,787,200	\$8,144,640	\$8,823,360
Rehab. Grade Xings	\$110,000	\$242,000	\$648,000	\$72,000	\$72,000	\$456,000	\$336,000
Total	\$536,747,512	\$710,528,938	\$596,597,984	\$374,048,444	\$332,707,971	\$477,380,713	\$457,965,635
Cost/MGT/mile/year	\$1,130	\$1,282	\$1,047	\$1,186	\$1,010	\$1,075	\$987

Costs	Costs
\$607,362,960	\$755,599,410 **
\$987 *	\$1,075 *

Note:

Replacement costs estimated using rail & track degradation models & ROW costs estimated using historical costs for mountainous terrain.

* Assumed

** Revised June 2, 2006

1.6 *Comments on Cost Estimate of Selected Route Segments and Total Route*

- Cost estimates of the route segments represent only one alignment projected, to meet the location engineering standards as agreed to in the meeting of November 2005. Refinement to the selected route has not been done, due to lack of time and also being outside the scope of the term of reference.
- Based on past feasibility railway location studies, the initial projected alignment could be realigned and refined with the help of more detailed mapping, aerial photos interpretation, and field validation, to reduce the costs and still meeting the locations and engineering standards. This may tend to lengthen the railway in order to mitigate major obstacles of impediments, but overall could achieve a reduction of about 5% to 10% in the total construction cost.
- Of the seven route segments studied in BC and Yukon, the cost of six segments fall within a range of \$8.19 to \$11.68 million per mile, with an average of \$9.33 million per mile. The segment from Minaret to Watson Lake via Dease Lake cost estimate is \$14.14 million per mile.
- The alternate route segments studied in 1969 were Mackenzie (near Prince George) to Watson Lake and Hazelton via Dease Lake to Watson Lake. The standards were reviewed and construction costs re-estimated in 2006 dollars. The construction costs are \$7.5 and \$7.95 million per mile, respectively. The original estimates were adjusted using construction cost index and allowance to reflect the standards of this study as compared to 1969.
- The construction cost of the segment from Minaret to Watson Lake appears to be very high as compared to the other route segments. The maximum ruling grade is 2.5% and is outside the limits of the standards set in this study. This results in very high fuel consumption and long-term operating costs. Based on this present information, it is recommended that this segment should be excluded from the ALCAN Railway Corridor Study. However, this segment at the projected location could be constructed to a much lower branch line track and right-of-way standards at a substantial lower cost, to meet any local traffic demands.
- Based on the engineering properties (grade profile, ground profile, and alignment) of the route, difficulty of construction, capital construction cost per mile, and future capital and maintenance cost, our ranking by priority is as follows:
 1. Ranking No.1 – Route from Mackenzie, BC via Sifton Pass to Watson Lake, Carmacks, Ladue River Alaska border and to Delta Junction, Alaska. This route is most promising for traffic destined to central and southern USA.

2. Ranking No.2 – Route from Hazelton BC, via Dease Lake to Watson Lake, Carmacks, Ladue River Alaska border and to Delta Jct., Alaska. This route is the shortest to west coast tidewater ports and most attractive for traffic destined to the far east, eliminating nearly 600 operating miles.
3. Ranking No.3 – Route from Mackenzie BC via Sifton Pass to Watson Lake, Whitehorse, Beaver Creek, and to Delta Jct., Alaska, along the Alaskan Highway.
4. Ranking No.4 - Route from Hazelton BC, via Dease Lake to Watson Lake, Whitehorse, Beaver creek, and to Delta Jct., Alaska, along the Alaskan Highway.

The remaining routes are ranked lower and could be constructed to mainline standards, with some revisions in grade and alignment. Market forces should drive the route selection process.