ALASKA – CANADA RAIL LINK

STRATEGIC ENVIRONMENTAL ASSESSMENT

Biophysical Assessment Component

Submitted to Macleod Institute

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up-dated July 7, 2006.

HDR

IRIS environmental systems inc.

Introductory Note

The information provided in this document, a step accomplished toward compiling the Strategic Environmental Assessment, is an integrated summary drawn from two sources:

- "Alaskan Bio-Physical Assessment for the Alaska Canada Rail Link Project", HDR Engineering Inc., June 2006.

- "Biophysical Assessment – Canada", IRIS Environmental Systems Inc., June 2006, up-dated July 2006.

These reports, respectively, deal with strategic environmental issues on the U.S. and Canadian sides of the potential rail link as determined within the time frame and resources available for this study. This integrated summary is organised by way of Scenario; that is, sub-corridors that make up a perceived portion of the Study Area that offer sub-corridor choice in strategically planning for an Alaska-Canada rail link, are grouped as a Scenario.

The reader will note that the content of this summary varies to a degree, in format, terminology and emphasis. This is a reflection of the respective regulatory regimes and consequent state of environmental management practice that exist on either side of the international border. In addition, the relative proportion of the study area in Canada demands a broader perspective.

Annexes to this document, also reflective of the foregoing, deal with qualitative and sustainability issues such as air quality and emissions, relative fuel efficiency, noise and vibration, climate change adaptation, and sub-surface features that, essentially, are common to all the possible rail link scenarios.

1.0 STUDY AREA

Figure 1. Alaska Canada Rail Link; Sub-corridor Rail Links

Source: Gartner Lee Limited

HDR

Legend

- Highway
- Rail Corridors
- International Boundary
- Link Terminus

Rail Link Definition

A Delta Junction to Tanacross
B Tanacross to Carmacks (via Ladue River)
C Tanacross to Beaver Creek (via AK Hwy)
D Beaver Creek to Carmacks
E Beaver Creek to Whitehorse (via AK Hwy)
F Carmacks to Whitehorse
G Whitehorse to Skagway
H Carmacks to Watson Lake
I Whitehorse to Watson Lake
J Watson Lake to Fort Nelson
K Watson Lake to Mackenzie
L Watson Lake to Minaret
L1 Watson Lake to Eaglenest Creek to Hazelton

ALASKA CANADA RAIL LINK

Sub-Corridor Rail Links

The following Tables, information therein referenced in the foregoing map of the Study Area, identify the links that make up all possible combinations for joining the existing Alaskan and Canadian rail systems. Table 1. groups these links by Scenario, each illustrated by way of quantitative and qualitative indicator in the following section.

Table 1. Links Identified, Described by Scenario.

Link Designation	Description	Scenario #
A	Delta Junction to Tanacross	1
B	Tanacross to Carmacks (via Ladue River)	1
C	Tanacross to Beaver Creek (via Alaska Highway)	1
D	Beaver Creek to Carmacks	1
E	Beaver Creek to Whitehorse (via Alaska Highway)	1
F	Carmacks to Whitehorse	2
G	Whitehorse to Skagway	2
H	Carmacks to Watson Lake	3
I	Whitehorse to Watson Lake	3
J	Watson Lake to Fort Nelson	4
K	Watson Lake to Mackenzie	4
L	Watson Lake to Minaret	4
L1	Watson Lake to Eaglenest Creek to Hazelton	4

Table 2. ACRL Potential Link Combinations

Endpoints		Link Sequence
Delta Junction	Carmacks	A-B
		A-C-D
Carmacks	Whitehorse	F
Delta Junction	Whitehorse	A-B-F
		A-C-D-F
		A-C-E
Carmacks	Skagway	F-G
Delta Junction	Skagway	A-B-F-G
		A-C-D-F-G
		A-B-E-G
Carmacks	Watson Lake	H
		F-I
Whitehorse	Watson Lake	I
Delta Junction	Watson Lake	A-B-H
		A-C-D-H
		A-B-F-I
		A-C-D-F-I
		A-C-E-I
Watson Lake	Fort Nelson	J
Delta Junction	Fort Nelson	A-B-H-J
		A-C-D-H-J
		A-B-F-I-J
		A-C-D-F-I-J

		A-C-E-I-J
Watson Lake	Mackenzie	K
Delta Junction	Mackenzie	A-B-H-K
		A-C-D-H-K
		A-B-F-I-K
		A-C-D-F-I-K
		A-C-E-I-K
Watson Lake	Minaret	L
Delta Junction	Minaret	A-B-H-L
		A-C-D-H-L
		A-B-F-I-L
		A-C-D-F-I-L
		A-C-E-I-L
Watson Lake	Hazelton	L1
Delta Junction	Hazelton	A-B-H-L1
		A-C-D-H-L1
		A-B-F-I-L1
		A-C-D-F-I-L1
		A-C-E-I-L1

3.0 Integrated Summary, Quantitative and Qualitative Indicators

Table 3. below, provides a detailed summary of the important biophysical issues in all sub-corridors of the Study Area, grouped by Scenario, as determined within the timeframe and resources available for this Study.

Regarding induced development, primary potential developments are in the mining sector. Current and near –to-medium term potential developments are identified in two categories: “assisted” mines are those where development will proceed with or without a rail link, but if a rail link is built would most likely shift current plans to truck materials and product to constructing and utilising a spur line connecting to the ACRL; “dependent” mines are those that would most likely proceed if a rail link were built.

Table 3. Integrated Bio-Physical Matrix – Summary, Quantitative and Qualitative Indicators

Note: Shaded indicators and information by sub-corridor supported and detailed in Alaskan Bio-physical Assessment Report; non-shaded indicators and information by sub-corridor supported and detailed in Strategic Environmental Assessment, Biophysical Assessment – Canada Report.

SCENARIO ONE	**Parks and Special Management Areas**	**Threatened and Endangered Species**	**Wildlife/ Waterfowl**	**Special Waste/ Spill/Derailment Potential Hazard**	**Waterways/ Water Quality** **Wetlands**	**Vegetation**	**Induced Development**
	Designated Ecologically Sensitive and or Biodiverse Areas	**SARA Schedule 1 Species**	**Potential Wildlife Movement Corridors**	**Spill/Derailment Potential Hazard**	**Water Bodies (Lakes, Rivers, Streams)** **Fisheries**	**Surface Disturbance** **Potential Land Use Issues**	**Induced Development (Mining)**
SUB-CORRIDORS (Links)							
Delta Junction to Tanacross (stand-alone, common to remaining sub-corridors	(1) State Forest; (3) Native Villages; ANCSA Land; (4) Game Management Units; (3) Controlled Use Areas; (3) Trails; (4) State Parks; (1) Scenic Byway; (1) State Range; (1) Military Reservation	(1) Federally threatened - Lynx; (7) Species of special concern - Northern Goshawk, American Peregrine Falcon, Arctic Peregrine Falcon, Olive-sided Flycatcher, Gray-cheeked Thrush, Townsend's Warbler, Blackpoll Warbler	(5) Caribou herd locations; Tanana River anadromous fish stream; fisheries; migratory area for 186 bird species	(4) CERCLA sites, (21) UST sites, (9) RCRA sites, and (94) contaminated sites in Tanacross, Fort Greely, and Delta Junction. There are sensitive areas (water bodies, wildlife habitat, and areas of human settlement) within the corridor that are vulnerable to hazardous waste spills.	(9) rivers, (37) creeks, (26) lakes, (3) sloughs, (3) rapids, and (1) flat. The Tanana River is the only navigable stream in the study corridor. There are no Wild and Scenic rivers in the corridor. Water quality is monitored in (1) creek and (2) lakes. (5) rivers, (3) creeks, and (12) lakes support aquatic farming. Floodplains are associated with water bodies within this corridor. Approximately 58 percent of segment consists of NWI	The greatest percentages of vegetative land cover within the corridor are Alpine tundra, forests, and shrubs. The rail alignment will potentially disrupt the functions of the vegetation including the support of wildlife through fragmentation.	Unknown

SCENARIO ONE	Parks and Special Management Areas Designated Ecologically Sensitive and or Biodiverse Areas	Threatened and Endangered Species SARA Schedule 1 Species	Wildlife/ Waterfowl Potential Wildlife Movement Corridors	Special Waste/ Spill/Derailment Potential Hazard Spill/Derailment Potential Hazard	Waterways/ Water Quality Wetlands Water Bodies (Lakes, Rivers, Streams) Fisheries	Vegetation Surface Disturbance Potential Land Use Issues	Induced Development Induced Development (Mining)
SUB-CORRIDORS (Links)							
					delineated wetlands. NRCS Farmed wetland data was not available.		
Tanacross to North of Beaver Creek to Carmacks via Ladue River	(1) State Forest; (2) Native Villages; ANCSA Land / Trading Center; (1) Game Management Unit; (1) Controlled Use Area; (7) Trails; (1) State Park; (1) Coast Guard Station	(1) Federally threatened - Lynx; (7) Species of special concern - Northern Goshawk, American Peregrine Falcon, Arctic Peregrine Falcon, Olive-sided Flycatcher, Gray-cheeked Thrush, Townsend's Warbler, Blackpoll Warbler	(3) Caribou herd locations; Tetlin National Wildlife Refuge; Tanana River anadromous fish stream; salmon fisheries; migratory area for 186 bird species	(3) CERCLA sites, (24) UST sites, (3) RCRA sites, (20) LUST sites in Tok (of which 7 are currently open), and (19) contaminated sites in Tanacross, Tetlin, and Tok. There are sensitive areas (water bodies, wildlife habitat, and areas of human settlement) within the corridor that are vulnerable to hazardous waste spills.	(6) rivers, (10) creeks, and (16) lakes. The Tanana River is the only navigable stream in the study corridor. There are no Wild and Scenic rivers in the corridor. Water quality is monitored in (2) creeks and (1) lake. (2) rivers and (5) lakes support aquatic farming. Floodplains are associated with water bodies within this corridor. Wetlands are likely located in the study corridor; however, NWI and farmed wetland information is not available.	The greatest percentages of vegetative land cover within the corridor are Alpine tundra, forests, and shrubs. The rail alignment will potentially disrupt the functions of the vegetation including the support of wildlife through fragmentation.	Unknown
	Nordenskiold Habitat Protection Area	Peregrine Falcon,	Frenchman Lakes Corridor	35% of alignment is curves	90% of route within 1km of a water	55% of route requires heavy or	Potential but not near to

SCENARIO ONE	Parks and Special Management Areas	Threatened and Endangered Species	Wildlife/ Waterfowl	Special Waste/ Spill/Derailment Potential Hazard	Waterways/ Water Quality Wetlands	Vegetation	Induced Development
	Designated Ecologically Sensitive and or Biodiverse Areas	**SARA Schedule 1 Species**	**Potential Wildlife Movement Corridors**	**Spill/Derailment Potential Hazard**	**Water Bodies (Lakes, Rivers, Streams)** **Fisheries**	**Surface Disturbance** **Potential Land Use Issues**	**Induced Development (Mining)**
SUB-CORRIDORS (Links)							
	4,168 ha of protected areas within corridor	Woodland Caribou		Low gradient	body Major Rivers: Tatchun, Yukon, Selwyn, & White 20 significant crossings	very heavy construction Recreation areas and highway corridors, proposed Carmacks to Stewart Crossing transmission line	medium term.
Tanacross to Beaver Creek via Alaska Highway	(1) State Forest; (3) Native Villages; ANCSA Land / Trading Center; (1) Game Management Unit; (7) Trails; (1) State Park; (1) Coast Guard Station	(1) Federally threatened - Lynx; (7) Species of special concern - Northern Goshawk, American Peregrine Falcon, Arctic Peregrine Falcon, Olive-sided Flycatcher, Gray-cheeked Thrush, Townsend's Warbler, Blackpoll Warbler	(3) Caribou herd locations; Tetlin National Wildlife Refuge; Tanana River anadromous fish stream; salmon fisheries; migratory area for 186 bird species	(4) CERCLA sites, (27) UST sites, (6) RCRA sites, (26) LUST sites in Tok (of which 7 are currently open) and Northway(of which 6 are currently open), and (19) contaminated sites in Tanacross, Tetlin, and Tok. There are sensitive areas (water bodies, wildlife habitat, and areas of human settlement) within the corridor that	(9) rivers, (18) creeks, (58) lakes, and (1) slough. The Tanana River is the only navigable stream in the study corridor. There are no Wild and Scenic rivers in the corridor. Water quality is monitored in (3) creeks and (3) lakes. (2) rivers and (5) lakes support aquatic farming. Floodplains are associated with water bodies within this corridor. Approximately 80 percent of segment	The greatest percentages of vegetative land cover within the corridor are Alpine tundra, forests, and shrubs. The rail alignment will potentially disrupt the functions of the vegetation including the support of wildlife through fragmentation.	Unknown

SCENARIO ONE	Parks and Special Management Areas	Threatened and Endangered Species	Wildlife/ Waterfowl	Special Waste/ Spill/Derailment Potential Hazard	Waterways/ Water Quality Wetlands	Vegetation	Induced Development
	Designated Ecologically Sensitive and or Biodiverse Areas	**SARA Schedule 1 Species**	**Potential Wildlife Movement Corridors**	**Spill/Derailment Potential Hazard**	**Water Bodies (Lakes, Rivers, Streams) Fisheries**	**Surface Disturbance Potential Land Use Issues**	**Induced Development (Mining)**
SUB-CORRIDORS (Links)							
				are vulnerable to hazardous waste spills.	consists of NWI delineated wetlands. NRCS Farmed wetland data was not available.		
Beaver Creek to Carmacks via Nisling River	Nordenskiold Habitat Protection Area 2,584 ha of protected areas within corridor	Peregrine Falcon, Woodland Caribou, Wood Bison	Nisling River Corridor Migratory waterfowl in Wellesley basin	22% of alignment is curves Steep gradient	56.6 % of route within 1km of a water body Major Rivers: Yukon, Nisling, Donjek, & White 21 significant crossings	31.6% of route requires heavy or very heavy construction	Potential but not near to medium term.
Beaver Creek to Whitehorse via the Alaska Highway	Kluane National Park, Kuane Game Sanctuary 462,329 ha of protected area within corridor 27% of route within protected areas	Peregrine Falcon, Woodland Caribou, Wood Bison	Burwash Uplands to Alsek River Valley Shakwak trench flyway	21% of alignment is curves Low gradient	40% of route within 1km of a water body Major Rivers: Yukon, Takhini, Mendenhall, Aishihik, Jarvis, Slims, Donjek, Klondike, & White 36 significant crossings	71.8% of route requires heavy or very heavy construction National Park and Game Sanctuary	Potential but not near to medium term.

SCENARIO TWO	Designated Ecologically Sensitive and or Biodiverse Areas	SARA Schedule 1 Species	Potential Wildlife Movement Corridors	Spill/Derailment Potential Hazard	Water Bodies (Lakes, Rivers, Streams) Fisheries	Surface Disturbance Potential Land Use Issues	Induced Development (Mining)
SUB-CORRIDORS (Links)							
Carmacks to Whitehorse	Nordenskiold Habitat Protection Area 7,847 ha of protected areas within corridor	Peregrine Falcon, Woodland Caribou	--	--	63.7% of route within 1km of a water body Major Rivers: Nordenskiold River Lakes: Fox Lake 12 significant crossings	Klondike Highway Corridor, private lands	Division Mountain, Minto; both assisted.
Whitehorse to Skagway via Carcross*	Chilkoot Pass National Historic Site 12,770 ha of protected area within corridor	Peregrine Falcon, Woodland Caribou	Lewes & Watson River valleys	Bennett Lake an area of concern	66.8% of route within 1km of a water body Lakes: Lewes & Bennett Lakes 4 significant crossings	Expected to minimal if existing corridor is followed Follows existing corridor with summer use	Potential but not near to medium term.

*Note: Alaskan portion of Whitehorse to Skagway Link (Link G) - Potential environmental effects of constructing an additional rail 20.5 inches (52.0 centimeters) outside of one of the existing rails are likely minimal. The improvements would likely take place within existing right-of-way. The largest risk to the further development and design of the improvements is the railroad's historic status and restrictions associated with the status. The White Pass and Yukon Railroad does not appear at this time to be subject to a Section 4(f) evaluation since it is not specifically listed on the Federal Register of Historic Places. However, the railroad may be eligible for listing on the Federal Register; its surrounding areas are listed on the National Register.

SCENARIO THREE	Designated Ecologically Sensitive and or Biodiverse Areas	SARA Schedule 1 Species	Potential Wildlife Movement Corridors	Spill/Derailment Potential Hazard	Water Bodies (Lakes, Rivers, Streams) Fisheries	Surface Disturbance Potential Land Use Issues	Induced Development (Mining)
SUB-CORRIDORS (Links)							
Whitehorse to Watson Lake via the Alaska Highway	Blue/Dease Rivers Ecological Reserve, Nasutlin River National Wildlife Area 6,545 ha of protected area within corridor	Woodland Caribou	Squanga Lake to Teslin River Teslin Lake outflow	34% of alignment is curves Low gradient	64.8% of route within 1km of a water body Major Rivers: Little Rancheria, Tootsie, Swift, Morley, Teslin & Yukon 31 significant crossings	79.7% of route requires heavy or very heavy construction Alaska Highway Corridor Alaska Gas pipeline corridor	Howard's Pass, assisted.
Carmacks to Watson Lake	Nordenskiold Habitat Protection Area 3,166 of protected area within corridor	Peregrine Falcon, Woodland Caribou	Frenchman Lakes, Finlayson River, & French River corridors	28% of alignment is curves Low gradient	62.6% of route within 1km of a water body Major Rivers: Frances, Puchitua, Ketza & Lapie Lakes: Little Salmon, Finlayson, Frances, & Simpson Lakes 41 significant crossings	62.7% of route requires heavy or very heavy construction Klondike & Robert Campbell Highway intersection	Wolverine, assisted. Fyre, Kudz Ze Kaya, Grum, Ice, Swim; all dependent.

SCENARIO FOUR	Designated Ecologically Sensitive and or Biodiverse Areas	SARA Schedule 1 Species	Potential Wildlife Movement Corridors	Spill/Derailment Potential Hazard	Water Bodies (Lakes, Rivers, Streams) Fisheries	Surface Disturbance Potential Land Use Issues	Induced Development (Mining)
SUB-CORRIDORS (Links)							
Watson Lake to Fort Nelson	Multiple protected areas including Liard Hot Springs & Liard River Corridor Provincial Parks 90,575 ha of protected area within corridor 21.14% of route within protected areas	Woodland Caribou, Wood Bison, Hotwater Physa	--	34% of alignment is curves Low - moderate gradient	55.5% of route within 1km of a water body Major Rivers: Muskwa, Dunedin, Liard, Grayling, Deer, Smith, Rabbit, Kechika, & Dease 33 significant crossings	36.9% of route requires heavy or very heavy construction Alaska Highway Corridor Multiple protected areas	Potential, but not near to medium term.
Watson Lake to Mackenzie	Multiple protected areas including Omineca, Dune Za Keyih, & Denetiah Provincial Parks 310,509 ha of protected area within corridor 1.77% of route within protected areas	Woodland Caribou	Kechika & Finlay Rivers, Rocky Mountain Trench	25% of route is curves Gentle gradient	38.1% of route within 1km of a water body 53 significant crossings	Crosses Dune Za Keyih, & Denetiah Provincial Parks Interaction with multiple protected areas	Potential, but not near to medium term.
Watson Lake to Minaret via BDR Extension Rail Bed	Multiple protected areas including Spatsizi Headwaters, Spatsizi Plateau, & Stikine River Provincial Parks 187,675 ha of protected area within corridor 4.42% of route within protected areas	Woodland Caribou	Dease, Stikine, & Klappan River valleys	38% of alignment is curves Very steep gradient	38.1% of route within 1km of a water body Major Rivers: Mosque, Duti, Kluatan, Spatsizi, Stikine, Tansilla, Dease, Cottonwood, French, & Blue	68.6% of route requires heavy or very heavy construction Crosses Stikine Provincial Park Interaction with multiple protected areas	Potential, but no near to medium term.

SCENARIO FOUR	Designated Ecologically Sensitive and or Biodiverse Areas	SARA Schedule 1 Species	Potential Wildlife Movement Corridors	Spill/Derailment Potential Hazard	Water Bodies (Lakes, Rivers, Streams) Fisheries	Surface Disturbance Potential Land Use Issues	Induced Development (Mining)
SUB-CORRIDORS (Links)							
					Lakes: Dease Lake Construction along Skeena River		
Eaglenest Creek to Hazelton	Multiple protected areas including Spatsizi Headwaters & Spatsizi Plateau Provincial Parks 84,225 ha of protected area within corridor 1.77% of route within protected areas	Woodland Caribou	Skeena, Klappan, Nass, & Kispiox River valleys	Approximately 1/3 curves Moderate gradient	23.9% of route within 1km of a water body Major Rivers: Skeena, Klappan, Nass, & Kispiox	Interaction with multiple protected areas, crosses large areas of wilderness	Kerness North and South; assisted. Lost Fox, Hobbit Boatch, Summit, Ground Hog Coalfield; all dependent.

4.0 Potential Biophysical Effects

This section provides a summary of the four scenarios from a biophysical perspective providing the reader an overview that can be used to refine the scope of subsequent work that will be required at the next level of route definition and planning. As would be expected with a project of this magnitude and potential cost, planning and route selection will be an iterative process.

As noted in Table 5. there are key biophysical data gaps and they are large enough to merit significant additional investigation. Furthermore, the information gaps along each sub-corridor are large enough to suggest proceeding with caution from a biophysical perspective. The biophysical data for each sub-corridor needs to be brought up to a common base standard to effectively contribute to the selection of a preferred routing. A number of issues raised in this assessment could have substantial time and cost implications that would affect project economics. Further, the development, costing and implementation of effective management and mitigation efforts will require such biophysical data.

Finally, Table 6., following, offers further qualitative commentary on “hot spots” in the study area, designed to flag significant ssues for consideration at this level of strategic consideration.

Table 5. Summary Net Potential Biophysical Effects, Data Gaps, by Scenario,

Note: Shaded information by sub-corridor supported and detailed in Alaskan Bio-physical Assessment Report; non-shaded information by sub-corridor supported and detailed in Strategic Environmental Assessment, Biophysical Assessment – Canada Report.

SCENARIOS	NET BIOPHYSICAL EFFECT	DATA GAPS
Scenario One (Links)		
Delta Junction to Tanacross (standalone, common to remaining sub-corridors) (Link A)	Potential impacts to a State Forest, State Parks, a State Range, Game Management Units, Controlled Use Areas, Trails, Scenic By-way, Military Reservation, Aboriginal land, 1 T&E Species, 7 Species of Concern, Caribou herd locations, an anadromous fish stream, fisheries, migratory bird areas, other wildlife habitat and sensitive vegetation, 128 existing special waste sites, 79 water bodies including a navigable stream and aquatic farms, wetlands, and floodplain. There is also a potential hazard for a special waste spill/derailment, noise and vibration effects, thawing of permafrost, and beneficial air quality affects.	Additional air quality modeling, detailed noise and vibration elevations, field investigations, NWI and NRCS wetlands delineations, FEMA floodplain delineations (except for Delta Junction), consultation to determine aboriginal sensitive areas, issues, and concerns, hydrologic/hydraulic surveys, mapping, and modeling, earthquake and volcano hazards, additional studies on permafrost and geologic features, recorded T&E species locations, field investigations and studies on known potential special waste sites, induced development, and all other traditional environmental knowledge.

SCENARIOS	NET BIOPHYSICAL EFFECT	DATA GAPS
Tanacross to North of Beaver Creek to Carmacks via Ladue River (Link B)	Potential impacts to a State Forest, State Park, Game Management Unit, Controlled Use Area, Trails, Coast Guard Station, Aboriginal land, 1 T&E Species, 7 Species of Concern, Tetlin National Wildlife Refuge, Caribou herd locations, an anadromous fish stream, fisheries, migratory bird areas, other wildlife habitat and sensitive vegetation, 69 existing special waste sites, 32 water bodies including a navigable stream and aquatic farms, wetlands, and floodplain. There is also a potential hazard for a special waste spill/derailment, noise and vibration effects, thawing of permafrost, and beneficial air quality affects.	Additional air quality modeling, detailed noise and vibration elevations, field investigations, NWI and NRCS wetlands delineations, FEMA floodplain delineations (except for Delta Junction), consultation to determine aboriginal sensitive areas, issues, and concerns, hydrologic/hydraulic surveys, mapping, and modeling, earthquake and volcano hazards, additional studies on permafrost and geologic features, recorded T&E species locations, field investigations and studies on known potential special waste sites, induced development, and all other traditional environmental knowledge.
	Majority of route within 1 km of water bodies, surface disturbance due to construction requirements, greater relative spill/ derailment potential hazard. Aesthetics, land use conflicts Minto to Carmacks with proposed power line routing east side of Klondike Highway, Tantalus Bluff.	Effect of potential induced development. Traditional environmental knowledge. Climate change adaptation.
Tanacross to Beaver Creek via Alaska Highway (Link C)	Potential impacts to a State Forest, State Park, Game Management Unit, Trails, Coast Guard Station, Aboriginal land, 1 T&E Species, 7 Species of Concern, Tetlin National Wildlife Refuge, Caribou herd locations, an anadromous fish stream, fisheries, migratory bird areas, other wildlife habitat and sensitive vegetation, 82 existing special waste sites, 86 water bodies including a navigable stream and aquatic farms, wetlands, and floodplain. There is also a potential hazard for a special waste spill/derailment, noise and vibration effects, thawing of permafrost, and beneficial air quality affects.	Additional air quality modeling, detailed noise and vibration elevations, field investigations, NWI and NRCS wetlands delineations, FEMA floodplain delineations (except for Delta Junction), consultation to determine aboriginal sensitive areas, issues, and concerns, hydrologic/hydraulic surveys, mapping, and modeling, earthquake and volcano hazards, additional studies on permafrost and geologic features, recorded T&E species locations, field investigations and studies on known potential special waste sites, induced development, and all other traditional environmental knowledge.
Beaver Creek to Carmacks via Nisling River (Link D)	Three SARA Schedule 1 species, over half the route within 1 km of a water body, relatively greater spill/ derailment potential hazard. Permafrost, migratory birds (wetlands), potential for rare plants, roadless wilderness area.	Effect of induced development. Traditional environmental knowledge. Climate change adaptation. Lack of specific biophysical information on Nisling River drainage (candidate for Special Management Area).
Beaver Creek to Whitehorse via Alaska Highway (Link E)	Direct impact on Kluane National Park and Kluane Game Sanctuary, wildlife corridor from Kluane National Park, relatively high number of significant river crossings, highest potential for surface disturbance of all sub-corridors. Permafrost, seismic, migratory birds (Pickhandle Lakes), Chisana caribou, land use conflicts (Kluane National Park at Slims River), spruce beetle at Haines Junction (enhanced fire risk), bison, elk, rare plants (Takhini Valley), routing at Whitehorse.	Effect of Induced development Traditional environmental knowledge Climate change adaptation.

SCENARIOS	NET BIOPHYSICAL EFFECT	DATA GAPS
Scenario Two (Links)		
Carmacks to Whitehorse (Link F)	Majority of route within 1 km of a water body Nordenskoild wetlands, Braeburn elk, Fos Lake (land use conflicts, aesthetics, soils and grades, routing at Whitehorse and Yukon River crossing.	Wildlife corridor, surface disturbance, water body crossings, spill/ derailment potential hazard, induced development with two assisted mines identified, extent of effect unknown. Traditional environmental knowledge. Climate change adaptation.
Whitehorse to Skagway via Carcross (Link G)*	Majority of route within 1 km of a water body. Routing at Whitehorse, Yukon River crossing, Southern Lakes caribou, Lewes Lake, Carcross, Bennet Lake proximity to waterbody.	Wildlife corridors, spill/ derailment potential hazard, effect of potential induced development, traditional environmental knowledge, climate change adaptation.
Scenario Three (Links)		
Whitehorse to Watson Lake via the Alaska Highway (Link I)	Land use conflicts with Alaska Highway and pipeline corridors, majority of route within 1 km of a water body, relatively high number of significant river crossings, highest potential for surface disturbance of all sub-corridors, greater relative spill/ derailment potential hazard. Yukon River crossing and wetlands, Marsh Lake land use conflicts, Squanga Lake whitefish, Johnson Crossing Teslin River crossing, Teslin Lake Nisutlin Bay (waterfowl, grades, routing), Rancharia (aesthetics, bull trout, caribou), laird River crossing.	Induced development with one assisted mine identified; extent of effect unknown. Traditional environmental knowledge Climate change adaptation
Carmacks to Watson Lake (Link H)	Majority of route within 1 km of a water body, relatively high number of significant river crossings, relatively high potential for surface disturbance. Routing at Carmacks, aesthetics, Yukon River crossing, raptors, Little Salmon Lake, migratory flyway, routing at Watson Lake.	Induced development with one assisted and five dependent mines identified; extent of effect unknown. Wildlife corridors. Climate change adaptation. Traditional environmental knowledge
Scenario Four (Links)		
Watson Lake to Fort Nelson (Link J)	Direct impact on protected areas, three SARA Schedule 1 species, over half the route within 1 km of a water body, relatively high number of significant river crossings, relatively greater spill/ derailment potential hazard. Laird River crossing, Liard Hotsprings and Corridor Park aesthetics and multiple wildlife conflicts, unusual boreal forest bird and plant diversity.	Wildlife corridors, climate change adaptation. Effect of potential induced development Traditional environmental knowledge
Watson Lake to Mackenzie (Link K)	Direct impact on protected areas, land use conflicts with protected areas, potentially high number of significant water body crossings. Roadless wilderness, important wildlife migration corridor, Kechika River drainage and Rocky Mountain trench hold multiple wildlife habitat interests including Denetiah and Dune Za Keyih provincial parks.	Wildlife corridors, surface disturbance, water body crossings, spill/ derailment potential hazard, effect of potential induced development, traditional environmental knowledge, climate change adaptation.

SCENARIOS	NET BIOPHYSICAL EFFECT	DATA GAPS
Watson Lake – Minaret via BCR Extension rail bed (Link L)	Direct impact on protected areas, land use conflicts with protected areas, construction along Skeena River, relatively high potential for surface disturbance, highest relative spill/ derailment potential hazard among all sub corridors. Aesthetics. Dease Lake, Stikine and Klappen Rivers, Skeena River headwaters, proximity to Spatzizi Wilderness Park, multiple wildlife concerns.	Wildlife corridors, climate change adaptation. Effect of potential induced development Traditional environmental knowledge
Eaglenest Creek – Hazelton (Link L1)	Direct impact on protected areas. Kiespiox, Nass, Skeena Rivers high fisheries and recreational value, encroachment into roadless valleys with high wilderness values, duplication of existing unfinished railbed.	Wildlife corridors, surface disturbance, water body crossings, spill/ derailment potential hazard, climate change adaptation. Induced development with two assisted and four dependent mines identified; extent of effect unknown. Traditional environmental knowledge

*Note: Alaskan portion of Whitehorse to Skagway Link (Link G) - Potential environmental effects of constructing an additional rail 20.5 inches (52.0 centimeters) outside of one of the existing rails are likely minimal. The improvements would likely take place within existing right-of-way. The largest risk to the further development and design of the improvements is the railroad's historic status and restrictions associated with the status. The White Pass and Yukon Railroad does not appear at this time to be subject to a Section 4(f) evaluation since it is not specifically listed on the Federal Register of Historic Places. However, the railroad may be eligible for listing on the Federal Register; its surrounding areas are listed on the National Register.

Table 6. Summary of SEA Level Biophysical Hotspots by Scenario

SCENARIOS	CORRIDOR HOTSPOTS
Scenario One	
Delta Junction to Tanacross (standalone, common to remaining sub-corridors)	See Annex 1, following for discussion on Alaskan sub-corridor.
Tanacross to North of Beaver Creek to Carmacks (via Ladue River)	See Annex 1, following, for discussion on Alaskan sub-corridor. In Yukon: Aesthetics, land use conflicts Minto to Carmacks with proposed power line routing east side of Klondike Highway, Tantalus Bluff
Tanacross to Beaver Creek to Carmacks (via Nisling River)	See Annex 1, following, forf discussion on Alaskan sub-corridor. In Yulon: Permafrost, migratory birds (wetlands), lack of biophysical information on Nisling River drainage, candidate SMA, potential for rare plants, roadless wilderness area
Tanacross to Beaver Creek to Whitehorse along the Alaska Highway	See Annex I, following, for discussion on Alaskan sub-corridor. In Yukon: Permafrost, seismic, migratory birds (Pickhandle Lakes), Chisana caribou, major land use conflicts Kluane National Park at Slims River, Spruce beetle at Haines Junction, Bison & Elk, rare plants Takhini Valley, routing at Whitehorse
Scenario Two	
Carmacks to Whitehorse	Nordenskiold wetlands, Braeburn elk, Fox Lake (land use conflicts, aesthetics, soils and grades, routing at Whitehorse and Yukon River crossing
Whitehorse to Skagway via Carcross	Routing at Whitehorse, Yukon River crossing, Southern lakes caribou, Lewes Lake, Carcross, Bennett Lake
Scenario Three	
Whitehorse to Watson Lake (via the Alaska Highway)	Yukon River crossing & wetlands, Marsh Lake land use conflicts, Squanga Lake whitefish, Johnson Crossing Teslin River crossing), Teslin Lake Nisutlin Bay (waterfowl, grades, routing) Rancheria (aesthetics, bull trout, caribou), Liard River crossing
Carmacks to Watson Lake	Routing at Carmacks, aesthetics, Yukon River crossing, raptors, Little Salmon Lake, migratory flyway, routing at Watson Lake
Scenario Four	
Watson Lake to Fort Nelson	Liard River Crossing, Liard River Hotsprings & Corridor Park, aesthetics and multiple wildlife conflicts, unusual boreal forest bird/plant diversity

SCENARIOS	CORRIDOR HOTSPOTS
Watson Lake to Mackenzie	Roadless wilderness, important wildlife migration corridor, Kechika River drainage & Rocky Mountain trench have multiple wildlife habitat interests including Denetiah and Dune Za Keyih provincial parks,
Watson Lake – Minaret via BCR Extension rail bed	Aesthetics, Dease Lake, Stikine & Klappan Rivers, Skeena River headwaters, proximity to Spatzizi Wilderness park, multiple wildlife concerns
Eagle nest Creek – Hazelton	Kispiox, Nass, Skeena rivers have high fisheries and recreation values, encroachment into roadless valleys with high wilderness values, duplication of existing unfinished rail bed

ANNEX 1

Alaskan Bio-physical Assessment – Qualitative Component

1.1 Air Quality

The U.S. Environmental Protection Agency (EPA) has established National Ambient Air Quality Standards (NAAQS) for six criteria pollutants to protect the public from health hazards associated with air pollution. These six criteria pollutants include: carbon monoxide (CO), ozone, nitrogen dioxide, sulfur dioxide, particulate matter (PM) (including coarse - PM_{10} and fine particulate - $PM_{2.5}$), and lead.

The Federal Clean Air Act and state law in Title 44, Chapter 46, and Title 46, Chapter 3 and Chapter 14, establish the duties of the Division of Air Quality for controlling and mitigating air pollution (for the six criteria pollutants) and for conserving the clean air within most locations of Alaska.

Alaskans periodically experience threatening air pollution from natural events including forest fires, volcanic eruptions, and high wind glacial dust storms. While no one can control these types of pollution, the Division of Air Quality provides health advisories and suggested protective actions to be taken during these events.

1.1.1 Affected Environment

The Division of Air Quality focuses on monitoring larger communities (populations greater than 10,000) to cover the largest possible population exposure. Air quality is not currently monitored since the population of the communities within the study area are less then the criteria. The nearest location to the study area that is monitored is Fairbanks, Alaska. Fairbanks' air quality is monitored for CO levels and $PM_{2.5}$. In addition to CO and $PM_{2.5,}$ Alaska also monitors for PM_{10}. Air quality information for the state is reported annually.

1.1.2 Potential Affects

In order to assess the potential impacts on air quality of the proposed ACRL, a preliminary evaluation was performed to estimate the amounts of air pollutant emissions that would be generated by locomotive traffic along either of the alternative rail routes from Delta Junction to the Alaska-Canada International Boundary. Because the trip distance for either alignment is approximately the same, it was assumed that locomotive emissions would be roughly the same with either alignment. To compare the locomotive emissions with those of a "no-action" alternative, emission estimates were also made for a scenario where no rail line is constructed, and freight would be transported by trucks. For all alternatives, emissions estimates were made for the first full year of operation, assumed to be 2015.

For the locomotive emissions analysis, the calculation methodology is based on the following:

- Sulfur dioxide emissions are based on mass-balance for diesel fuel containing 15 ppm of sulfur by weight (maximum allowed starting before 2015).
- CO and volatile organic compound (VOC) emissions are based on current EPA Tier II emission standards, as listed in EPA Publication EPA420-F-97-051, December 1997 since the Tier III standards are not yet available.

- Nitrogen oxides (NOx) and PM emissions factors are assumed to be 10% of the Tier II factors, based on EPA's stated intentions to reduce locomotive NOx and PM emissions for new (Tier III) locomotive emissions by 90%.

Locomotive emission factors in grams/gallon were multiplied by total estimated annual fuel use in gallons (5,661,115 gallons (21,429,651 liters) in 2015, based on an ongoing energy analysis which assumes a fuel consumption rate of 2.0 Gal/KGTM) to calculate annual pollutant emissions from locomotives traveling along the proposed rail segment.

For the truck emissions analysis, the calculation methodology is based on the following:

- Emissions of the above listed pollutants were obtained using the EPA's MOBILE6.2 emissions model, for heavy-duty diesel vehicles (HDDVs) assumed to be traveling at 55 miles/hour (88 kilometers/hour).
- Highway length was assumed to be the same as rail segment length (195.5 miles (314.6 kilometers)).
- The national default vehicle registration (age) distribution was used for MOBILE6.2 projections.
- Trucks were assumed to haul 45 tons (41 metric tons) per load, with 100% of the trucks full in one direction, and a 60%/40% full/empty split assumed in the other direction.
- Estimated rail freight movement of 14.48 million gross tons (13.14 million gross metric tons), and 75% freight proportion (10.86 million net tons (9.85 million net metric tons)), were converted, based on the above truck loading, to 301,686 truck trips per year.

Based upon estimated gross ton-miles of freight to be carried during the first full year of operation (2015), a comparison of the rail alternative with the truck alternative was performed, in terms of emission factors in tons per year for Nitrogen Oxides (NO_x), Carbon Monoxide (CO), Particulate Matter (PM), Volatile Organic Compounds (VOCs), and Sulfur Dioxide (SO_2). These air pollutant emissions comparisons are shown below.

Table 1. Estimated Pollutant Emissions (2015)

Pollutant	Rail Alternative (tons/yr)	Truck Alternative (tons/yr)
NO_x	38.00	288.00
CO	83.00	39.00
PM*	2.10	7.00
VOCs	31.00	13.00
SO_2	0.30	0.86

Note: * Includes both $PM_{2.5}$ and PM_{10}, however, all are expected to be in the PM_{10} size range

For either of the proposed rail corridor routes, the ACRL would in general help to reduce emissions of NOx, PM_{10}, and SO_2, in comparison to transporting freight along the corridor by trucks. While somewhat higher emissions of CO and VOCs are shown for the rail alternative, the rail emissions estimates do not account for expected reductions in these pollutants due to anticipated Tier III emissions standards, which are not yet quantified by EPA.

1.1.3 Mitigation Statement

Avoidance and minimization measures will be implemented where prudent and feasible. An Erosion Control Plan is recommended that outlines procedures for minimization of pollutants discharged during construction activities.

1.2 Noise and Vibration

The sources of railroad noise include the locomotive noise emissions (engine casing, air intake and exhaust areas), the wheel/rail interaction, and the rattling noise from empty cars. New locomotives must meet EPA noise emission performance standards; EPA does not inspect aged locomotives. There is no other regulatory mechanism for reducing noise emissions from locomotives.

Federal Railroad Administration (FRA) safety regulations address wheel and rail maintenance. Railroad operators are required to maintain tracks and wheels in accordance with these safety standards. Maintenance on tracks and wheels also reduces noise emissions, and improves fuel economy. As with locomotive noise emissions, there is no other regulatory mechanism for reducing noise emissions from wheel/rail interaction. Some work has been done evaluating the application of a lubricant to the rail, to reduce noise emissions. However use of this approach has been largely limited to sections of curved track where flange squeal is an issue. Safety concerns limit the use of this practice.

Empty freight cars tend to rattle when rolling down the track because the dampening effects of their cargo are absent. For obvious economic reasons, railroad operators like to minimize the number of empty cars they transport. However on occasion it is a necessity.

1.2.1 Affected Environment

Noise and vibration-sensitive receptors are generally associated with residential areas and some types of industries that are sensitive to vibration. Potentially sensitive areas of this nature within the study corridors would likely be located within or in close proximity to the following Census-designated Areas:

• Delta Junction • Deltana • Fort Greely • Dry Creek • Dot Lake • Dot Lake Village	• Tanacross • Tok • Tetlin • Northway Junction • Northway Village • High Cache	• Northway • Nabesna Village • Kathakne • Charlieskin Village

Specific noise and vibration sensitive receptors will be identified during subsequent more detailed studies, as well as the impacts on these receptors and potential mitigation.

1.2.2 Potential Affects

Noise from freight train passbys can be in the range of 90 to 100 dBA at 100 feet (30 meters) from the tracks. When the locomotive horn is used at grade crossings, horn noise can reach 110 dBA at 100 feet (30 meters). These loud sounds can be audible far from the rail line if background noise levels are low. In urban areas, where background noise levels are higher, train noise does not stand out quite as much because the background noises mask train noise at distances far from the track. It is reasonable to assume that freight train passby noise will be audible for several hundred feet (meters) from the rail line in areas where background noise is low, which will be the case through the majority of the potential ACRL corridors.

Similarly, ground-borne vibration from freight train passbys may also be perceivable for a few hundred feet (meters) from the rail line. Certain soil conditions and shallow bedrock are two factors that affect how well ground-borne train-induced vibrations travel through the ground and; therefore, how ground-borne vibrations attenuate (weaken) with increasing distance from the rail line.

1.2.3 Mitigation Statement

Avoidance and minimization measures will be evaluated where impacts occur. As part of the avoidance strategies, attempts may be made to locate the rail alignment away from sensitive receptors. Potential noise attenuation strategies are listed below:

1.2.3.1 Path Treatments

Placing a physical barrier between the source and the noise sensitive area is a typical noise attenuation strategy for outdoor noise control. Earthen berms are often used, especially when construction projects have excess earthwork from excavation activities. However, they require wide footprints (due to their sloped sides) and often there isn’t adequate room for them.

The most common and practical method of outdoor noise control is through the construction of noise walls between the source and the noise sensitive area. Noise walls require less space to erect, due to their narrower footprint (compared with berms). Noise walls are also available in prefabricated sizes and lengths.

1.2.3.2 Receiver Treatments

It is possible to reduce noise levels by treating the noise sensitive area. This approach is a common mitigation strategy for airport noise, but not common for highway or railroad noise abatement. Common treatments include retrofitting homes with new acoustical windows, insulation in walls and attics, central air conditioning, or when possible, treating roof vents to reduce noise propagation inside the structure. Average costs are approximately $40,000 per home to mitigate using receiver treatment strategies. For economic reasons, this approach is often not considered reasonable or feasible for mitigating highway and rail noise problems.

1.2.3.3 Other Options

Another potential treatment is a quiet zone. The Federal Railroad Administration (FRA) outlined the requirements for quiet zones, in which locomotive horns and whistles are not routinely sounded. To compensate for the absence of the horns, Supplemental Safety Measures (SSMs) must be implemented to warn on-coming pedestrians, cyclists, and motorists that a train is approaching the grade crossing. Potential SSMs include four- quadrant gate systems, gates with median barriers, conversion to one-way street, and temporary or permanent closure of the crossing.

1.3 Farmland

The U.S. Department of Agriculture (USDA), National Agriculture Statistics Service states that the Upper Tanana Valley from Fairbanks to Delta Junction (near the Link A corridor) produces much of the state's barley and oats, as well as hay, potatoes, milk, greenhouse plants and vegetables. According to the USDA - Natural Resource Conservation Service (NRCS), Delta Junction Service Center, the study area does not encompass prime farmland, unique farmland, or farmland of statewide significance.

Potential affects to prime and unique farmland are not anticipated since there is no protected farmland within the study area. If future investigations or surveys identify protected farmland, additional analysis will be required.

1.4 Geological/Seismic Features and Permafrost

The geologic features that were identified for the study area include bedrock geology and surficial geology. In addition, glaciers, mining, seismic activity, volcanoes and permafrost areas were addressed, and Conservation Districts identified.

1.4.1 Affected Environment

The project area is located at the convergence of three physiographic provinces: the Alaska Range to the south, the Yukon-Tanana upland to the north, and the Northway-Tanana lowland in the middle. The proposed segments generally follow the Tanana River and the Ladue River to the Canadian Border.

1.4.1.1 Link A (Delta Junction to Tanacross)

The Link A corridor is located in the Northway-Tanana lowland, which contains the northeasterly flowing Tanana River. The corridor generally follows the Tanana River floodplain. At lower elevations near the Tanana River, the project area is underlain by various glacial outwash, alluvial deposits and floodplain formations. At higher elevations, the project area contains mountainous bedrock and coarse and fine rubble. The entire area is also underlain by permafrost. At lower elevations, both lowland and upland areas contain permafrost. Permafrost in these areas varies in thickness. Higher elevations contain mountainous areas underlain by discontinuous permafrost. The occurrence of permafrost should be investigated in detail during the design process.

Link A is also in the general vicinity of several active and dormant volcanoes. The dormant Prindle volcano is located approximately 62 miles (100 kilometers) to the northeast and the Wrangell range volcanoes are located approximately 62 miles (100 kilometers) to the south. The Wrangell range contains nine volcanoes, two of which are considered active. A number of earthquakes have occurred approximately 46 miles (75 kilometers) south of the project corridor area.

There are no large mining facilities in the project area; however, mineral deposits are located thoughout the study area. It is unknown how many of those deposits will be extracted through mining operations if the rail alignment is constructed or is not constructed.

No active glaciers are located in the proposed corridor. However, glaciers are located at higher elevations that are the source of several tributaries to the Tanana River.

1.4.1.2 Link B (Tanacross to Carmacks (via Ladue River) - Alaskan Portion)

The Alaska portion of Link B generally follows the Tanana River floodplain. Lower elevations in this area are underlain by various glacial outwash, alluvial deposits and floodplain formations. At higher elevations, the project area contains mountainous bedrock and coarse and fine rubble. The eastern portion of this segment follows the Ladue River to the Canadian Border. This area contains mountain alluvium and coluvium, coarse and fine rubble. The entire area contains permafrost. At lower elevations, both lowland and upland areas contain permafrost. Permafrost in these areas varies in thickness. Higher elevations contain mountainous areas underlain by discontinuous permafrost. The occurrence of permafrost should be investigated in detail during the design process.

The Alaska portion of Link B is also in the vicinity of several active and dormant volcanoes. Prindle Volcano is located approximately 17 miles (28 kilometers) north of the proposed alignment. A number of earthquakes have occurred approximately 37 to 74 miles (60 to120 kilometers) south of the project corridor area.

There are no large mining facilities in the project area; however, mineral deposits are located thoughout the study area. It is unknown how many of those deposits will be extracted through mining operations if the rail alignment is constructed or is not constructed.

No active glaciers are located in the proposed corridor. However, glaciers are located at higher elevations that are the source of several tributaries to the Tanana River.

1.4.1.3 Link C (Tanacross to Beaver Creek (via Alaska Highway) - Alaskan Portion)

The Alaska portion of Link C generally follows the Tanana River floodplain. At lower elevations, the proposed alignment is underlain by various glacial outwash, alluvial deposits and floodplain formations. East of Northway Junction this corridor encounters floodplain deposits and an eloian sand dune formation. The last 14 miles (22 kilometers) of the corridor follow the Chisana River to the Canadian border. Geology in this area ranges from mountain alluvium and coluvium to coarse and fine rubble in the floodplain formation of the Chisana River. At higher elevations, the project area contains mountainous bedrock and coarse and fine rubble. The entire area contains permafrost. At lower elevations, both lowland and upland areas contain permafrost of varying thickness. Higher elevations contain mountainous areas underlain by discontinuous permafrost. The occurrence of permafrost should be investigated in detail during the design process.

The Alaska portion of Link C is also in the vicinity of several active and dormant volcanoes, being located approximately 75 miles (120 kilometers) northeast of the Wrangell range. The Wrangell range contains nine volcanoes, two of which are considered active. A number of earthquakes have also occurred approximately 37 to 43 miles (60 to 70 kilometers) south of the project corridor area.

There are no large mining facilities in the project area; however, mineral deposits are located thoughout the study area. It is unknown how many of those deposits will be extracted through mining operations if the rail alignment is constructed or is not constructed.

No active glaciers are located in the proposed corridor. However, glaciers are located at higher elevations that are the source of several tributaries to the Tanana River.

1.4.2 Potential Affects

Construction of the proposed ACRL would impact the existing topography and soils. The impacts will vary according to the placement of the proposed right-of-way. If the right-of-way is placed in the river valleys, the topography is relatively level and fewer cuts and fills would be necessary. If the proposed right-of-way is placed in the adjacent mountainous uplands, extensive cut and fill would be required.

If the right-of-way is located near the rivers, it may need extra stability if located in alluvial, permafrost soils. Extra stability may also be required if the right-of-way is located near fault lines. If the right-of-way is located in upland bedrock mountainous areas, blasting may be required.

A cumulative affect of the proposed ACRL is gradual warming or thawing of the permafrost layers. Frozen permafrost makes a good foundation as long as it remains frozen. When thawed, these soils can change into soft slurry with very little strength for supporting a structure and foundation failure can result (Siefert, 1994). As the soils become unstable from the thawing the ground sinks and there is potential for deep pits, sinkholes, and hummocks to form. Different soil types also react differently to permafrost. Solid rock, gravel and sand normally contain very little ice. Fine grain soils such as silt, clay or peat typically have high ice content. These soils are susceptible to settling when permafrost melts and heaving when moisture moves to a frozen layer. The rate at which permafrost thaws is dependent on several factors (soil types, global warming, other developments that lie on permafrost, etc.). Since several factors including global warming cannot be controlled, it needs to be considered in the project design.

1.4.3 Mitigation Statement

1.4.3.1 Permafrost

Permafrost occurs in discontinuous patches throughout the project area. Local variation in climate, soils, vegetation, relief, snow cover, and slope aspect appear to control the occurrence and depth of permafrost. Permafrost can also be influenced by soil type, vegetation, topography, snow cover, and slope aspect.

Construction in these areas requires specific knowledge about permafrost and specialized building techniques (Siefert, 1994). The occurrence and depth of permafrost should be investigated in detail in the proposed corridors. The proposed design should take into account the depth and locations of permafrost. Engineers who are experienced with Arctic building issues should characterize and design the proposed corridor and account for permafrost areas in the design of the proposed railroad.

When frozen, permafrost is virtually impermeable (Siefert 1994). This can result in drainage difficulties because the amount of runoff is increased and the amount of water infiltrating the ground is decreased. This phenomenon should be taken into account when designing site drainage for the proposed railroad.

1.4.3.2 Seismic Risk

Earthquake and volcano hazards should be identified in more detail during the design process. The rail line should be designed in accordance with the earthquake risk of the area.

ANNEX II

COMMENTARY, BIOPHYSICAL SUSTAINABILITY - CANADA

1.1 Rail Compared to Alternative Transportation Mode

In terms of biophysical sustainability, the ACRL as the rail mode is comparable to the alternative modes of marine and trucking freight transportation. We use land and space use, greenhouse gas emissions, energy efficiency and fuel consumption as indicators of sustainability, where less of each is the desirable target.

1.2 Land (Space) Use

While marine transport by and large does not compete for land and space use, its shipping routes are often confined, especially in fjord coastline of British Columbia and Alaska. For large bulk carriers, this confinement can pose elevated risk of accidents, as evidenced by the Exxon Valdez. Marine transport requires extensive land-based port infrastructure. Roads are large consumers of land and space. Compared to marine and rail transport, accident risk is relatively high, but involves significantly less material. Railways occupy relatively narrow ribbons, with physical constraints linked to the types of locomotives used, the gradient, curvature, and load capacity. The biophysical effect is less pervasive than a road in terms of pollution, congestion, land use and infrastructure.

1.3 Climate Change Implications

Typically, 89 percent of GHG Emissions from railways originate from locomotives, with minor contributions from refrigeration, fire systems and power (Canadian Pacific Railway 2005). From a 13,800-mile rail network, CPR generated between 2,500,000 and 2,700,000 tonnes of CO_2 equivalent, and averaged between 15 and 20 CO_2 equivalent kg/1000 GTM. Although rail currently carries approximately 60 percent of surface goods by volume in Canada, its contribution to total GHG emissions is low at 4 percent. In its Options Paper, the Transportation Climate Change Task Force notes that GHG emissions associated with rail are less than 20 grammes per tonne-kilometre, while that for trucking was more than 100 grammes. Transport Canada (1999) compared them as follows:

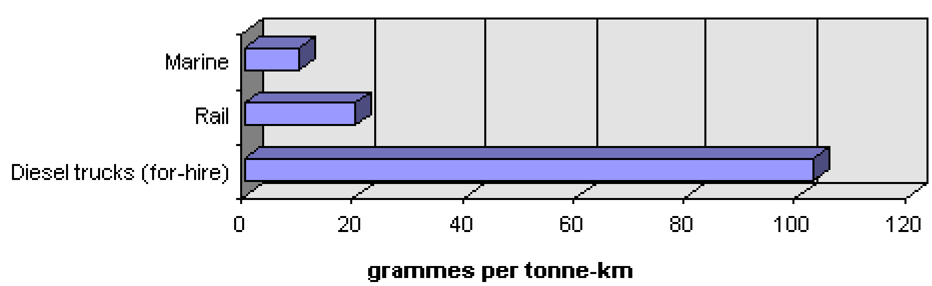

Figure 1. GHG freight emissions per tonne-kilometre by mode, 1997 (Transport Canada (1999).

Rail emissions are affected by a variety of factors: the age of the train, the type of fuel used, load capacity, maintenance of the engine and driving technique. Emission of smog-causing nitrogen oxides (NOX) are also a concern. Canadian railways have signed a memorandum of understanding with Environment Canada that provides for a maximum NOX emission of 115 kilotonnes per year. If railway traffic grows due to diversion from other more emission-intensive modes, such as road transport, the permissible emission limits might be increased.

In terms of the way in which climate change could affect the Project, the most prominent in current thinking is the deterioration of permafrost as temperatures increase with global warming, with resultant effects on rail bed integrity, the increase in number and extent of forest fires in Yukon and northern British Columbia and, related to the latter, changes in precipitation patterns that could affect slope slippage and vegetation patterns. An increase in forest fires and changes in vegetation patters could also alter wildlife corridors and ranges; moreover, these could have an effect on watersheds with a consequent effect on fisheries.

1.4 Energy Efficiency and Fuel Consumption

Marine transport is the most energy efficient; while, on average, large trucks (more than 14970 Kg) use 9.2 times as much energy as rail per tonne-kilometre. Intercity tractor-trailer trucks use five times as much energy per tonne-kilometre as rail (Railway Association of Canada 2001):

Mode	Fuel Consumption
Rail	455 ton-miles per gallon
Trucking	105 ton-miles per gallon

Source: Brown and Hatch (2002)

1.5 The ACRL In Its Overall Corridor

Infrastructure such as rail will provide opportunities for resource development that would otherwise not take place in Yukon, the key consideration being access to markets from remote northern sites. A major infrastructure project such as the ACRL therefore has the potential to influence an extended landscape beyond the immediate vicinity of its route (see below). Analysis of the overall corridor within which the ACRL would lie is therefore relevant to the SEA.

In Yukon and northern British Columbia, sub-corridor options exist for the ACRL to be introduced to a number of areas devoid of infrastructure and essentially all sustained human activity. Even where such infrastructure exists, many will hold that such areas would be considered “wilderness”. At the time writing, it is unknown whether the state of the environment in the overall corridor has been subject to any landscape monitoring to determine whether “wilderness values” are being maintained. Evidence is accumulating of the trend in northern Canada towards a changing landscape as the effects of climate change are felt. The rate of change is unknown, but is generally projected to be appreciable over the next four or five decades, within the life of an operating ACRL. It is beyond the resources of the current review to analyze the potential implications; however, a reasonable scenario for Yukon and northern British Columbia involves increased risk of forest fire, a reduction in permafrost layer, and alterations in precipitation and vegetation patterns, all with significant implications for a railway line.

A key consideration for the Project will be whether it selects a corridor with an existing road, thus mitigating the effects of creating access into an otherwise “wilderness” area. Even though such a choice is consistent with established environmental management practice for minimizing the biophysical impacts of linear developments, science-based risk analysis may reveal that the impacts of using a corridor without existing access are less than those with existing access. An example may be an ACRL option paralleling the Alaska Highway through Kluane National Park where, despite the presence of the Highway, the railway may place at risk a number of ecologically sensitive areas, thus suggesting a “wilderness” alternative as being preferable. This potential situation underscores the need for detailed biophysical information collection and analysis during the planning and design stage such that the comparative trade-offs can be appreciated in decision-making.

In terms of landscape permanence, common to all parts of the ACRL overall corridor is the risk of forest fire due to climate change. Presence of the operating ACRL will, due to increased access, exacerbate this risk. Permafrost will be commonly encountered by the ACRL, particularly in Yukon. Owing to the possibility of thawing and terrain movement, permafrost presents a potential railway integrity issue underscored by biophysical risk due to derailment. Therefore, special attention to rail bed structure design to maintain insulation of the permafrost layer will be necessary, coupled with assiduous inspection and maintenance during the operations phase. Further, alterations to precipitation patterns and vegetation patterns over the life of the rail line due to climate change, and consequent potential effects on fisheries, wildlife corridors and ranges, strongly suggest that final design parameters need to be sensitive to these effects, with the establishment of strong baseline data and information as management and mitigation measures during the construction and operation of the rail line should include significant resources to monitor and adjust to such changes. The relative reduction in emissions inherent in rail line transport goes to the cause of climate change. However, climate change is occurring at an accelerated rate in the project area; it is issues of climate change adaptation that the rail line will need to manage during its duration. Further, the rail line offers a focus for ongoing research and applied research activities on climate change adaptation.

Sustainability assessment requires that the life of the Project be considered along with the prospect of decommissioning and abandonment. Given the volumes of earth moving and positioning involved in its construction, the grade for a railway through mountainous areas such as those in Yukon and northern British Columbia will become a permanent, prominent feature of the landscape. Restoration of the landscape prior to the ACRL, if this were to be a desired objective of reclamation for abandonment, would be likely to cause as much disturbance as its original construction, and may negate any ecological adaptation that may have taken place. The grade is therefore likely to remain into the foreseeable future. However, the integrity of the grade in relation to maintenance and protection of biophysical environmental quality will be a continuing impact management task.

1.6 The ACRL as a Sustainable Railway

To be sustainable in biophysical environmental terms, the ACRL will need to consider a variety of issues, design criteria and actions that seek to attain the goal. Since it will be introduced to a landscape largely devoid of equivalent infrastructure, and, by virtue of its presence, may induce significant other activity, the full extent of the development potential and its impacts must be envisaged. As the Project moves from concept to realization it will involve a series of decision stages, corresponding to standard Project development. It is important to note that resolution of issues relating to biophysical impacts is critically dependent on acceptance of preferred alternatives, reasonably presented, through public consultation and negotiation.

At the Project Concept stage, sustainability features are best considered as part of the pre-feasibility and feasibility study. Typically, these might be concerned with the fundamental operating concept, in the same way that economic and social considerations affect the method of taking the concept to a blueprint. Much remains to be developed in terms of an ACRL design and operational strategy. For this SEA, in the text below we list examples that are most relevant during analysis of the Project Concept, and best considered at the Pre-Feasibility and Feasibility Stages:

- Selection of single or double track options in relation to minimizing the overall land use footprint of the Project.
- Width of the right-of-way in relation to minimization of clearing and grading and related effects on habitat.
- Length of trains in relation to stopping capability in mountainous terrain, and potential for derailment and spillage.
- Evaluation of alternative scenarios for train frequency, length and weight in relation to the need for deeper ballast and borrow pits, thus causing greater terrain disturbance.
- Size of locomotives and cars and their weight in relation to the need for different bridge and culvert structures affecting hydrology and fisheries.
- Design grade, wherein the lower the grade, the greater the need for cut and fill to achieve it, thus increasing the terrain footprint of the railway, and potentially lengthening culverts with attendant impacts on fish passage.
- Operating (design) speed, wherein faster speed requires less curvature, in turn requiring greater potential topographical conflict and surface disturbance in areas of high relief, and raising the potential for wildlife collisions.
- Maximum curvature (radius), wherein the lower the maximum radius, the more likely the terrain impact, but the lower the risk of derailment and risk of spillage.
- Deciding whether access for construction will be along the right-of-way, or whether subsidiary access will be necessary, proceeding on the principle that minimizing access requirements will reduce impacts, particularly on fish and wildlife populations and their habitat.
- Readiness to implement a “no net loss” policy with regard to fish and wildlife habitat, and compensate in kind for residual impacts, particularly at watercourse crossings for fish habitat, and for wildlife habitat in valley bottom situations where rail grade is achieved most easily, and where habitats may be fragmented and habitat effectiveness may be compromised.
- Readiness to incorporate climate change adaptation considerations in final design, construction and operation phases of the project.