MAXHAMISH PIPELINE PROJECT

APPLICATION FOR A PROJECT APPROVAL CERTIFICATE

Prepared for:

PARAMOUNT RESOURCES LTD.

By:

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in association with:

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EXECUTIVE SUMMARY

Paramount Resources Ltd. (Paramount) is applying to the British Columbia Environmental Assessment Office for a Project Approval Certificate that would allow Paramount and its partner Berkley Petroleum Corp. (Berkley) to construct, own and operate a sweet residue gas pipeline.

This application identifies potential environmental, social, cultural, heritage, and health effects associated with the proposed Paramount Maxhamish project. The application also identifies the measures to be adopted by Paramount and its consultants and contractors, to prevent or mitigate adverse effects, and to maximize local and regional benefits.

Paramount has completed the necessary activities required under the *Environmental Assessment Act*. Paramount believes that approval of the application will provide the following benefits:

1. Paramount will invest an estimated $25 million in British Columbia, spend $3.5 million per year for operations and maintenance, and provide future employment for eight full-time employees and additional contract staff in the northeast region;

2. The Maxhamish project will create socio-economic benefits including an estimated 110 person-years of direct, indirect, and induced employment in the region (340 person-years provincially), direct household income of at least $4.7 million in the region, estimated indirect and induced household income totalling $9.1 million provincially; as well as increased revenue to the producers and the province;

3. The proposed pipeline route follows existing or proposed corridors for more than 95% of its length, thereby reducing potential environmental, social, economic, cultural, and heritage effects;

4. Routing along the Liard Highway right-of-way will improve the line of sight for vehicle traffic and reduce the risk of animal collisions;

5. An aerial pipeline crossing of the Fort Nelson River will be constructed to minimize instream activities. This structure has been designed to accommodate additional pipelines to minimize future instream activities.

6. The Maxhamish project will encourage further exploration and development in the gas supply area; and

7. This application concludes that **no significant adverse effects** are likely to result from the Maxhamish Project.

Paramount requests the approval of the Maxhamish Project Approval Certificate Application in a timely manner to allow construction to begin in early November 1999. Early approval will help encourage local employment and business opportunities.

PROJECT RATIONALE

The proposed 164 kilometre pipeline would connect the proposed Paramount Maxhamish gas plant located in 36-I/94-O-14 to a tie-in and sales point located on the Westcoast Energy Inc. (WEI) pipeline system immediately south of the Fort Nelson gas plant at b-85-G/94-J-10. This processing and transportation system will tie-in sweet gas reserves from a field southeast of Fort Liard, Northwest Territories, as well as potential Paramount wells within British Columbia.

The Maxhamish project will allow Paramount to tie-in their Fort Liard, Maxhamish, and British Columbia sweet gas reserves into the WEI transmission system and to market produced natural gas liquids (NGL) in Taylor. The nearest facility with suitable processing capability is located more than 200km away. The supply basin for the Maxhamish plant is relatively unexplored and holds significant potential for future recoverable gas reserves of over 142 $10^9 m^3$.

The Maxhamish residue gas pipeline will initially transport processed natural gas from the pool discovered with the F-36 well in the Northwest Territories. No additional gas sources have been committed to the Maxhamish project at this time, but Paramount is continuing discussions with other producers in this area. A volume of 3,000 $10^3 m^3/d$ has been utilized as the design basis for the Maxhamish residue gas pipeline.

PROJECT DESCRIPTION

The 323.9 mm OD (12 inch) pipeline will be designed for an initial flow rate of 3,000 $10^3m^3/d$ (106 mmscfd) and a maximum pressure of 13,100 kPa (1,900 psig). Although the pipeline will transport sweet gas initially, it will be designed for sour service to enhance future flexibility. Five automatic shut-down valves will be installed at strategic locations along the right-of-way.

The installed capital cost of the Paramount Maxhamish residue gas pipeline is estimated to be approximately $40.8 million. Additional capital expenditures of about $20 million are required for the gas plant and access road in British Columbia. Annual operating costs for the residue gas pipeline and associated field facilities are projected to be $3.5 million.

The 164.4km pipeline route follows existing or proposed linear corridors for more than 95% of its length. An 18 m-wide right-of-way will be required for construction. This area will be reduced by sharing 6m to 11m of temporary workspace on adjacent rights-of-way. Additional temporary workspace will be required for sidehills, bends, timber deck sites, and foreign line, road, and watercourse crossings.

No expansion to existing infrastructure is required for the project to proceed.

Intermediate to large watercourse crossings include the Fort Nelson and Muskwa rivers and d'Easum (Maxhamish) Creek. Aerial crossings of the Fort Nelson River and one d'Easum Creek crossing are proposed. The Fort Nelson River crossing structure consists of a two span bridge with an overall length of 243.8 m. The pipeline will be attached to a road bridge across d'Easum Creek at kilometre post (KP) 4.3. Horizontal directionally-drilled (HDD) crossings of the Muskwa River and second d'Easum Creek crossing are proposed. A 1.1 kilometre-long HDD crossing of the Muskwa River together with its unstable south bank is planned. Paramount plans to attempt an HDD crossing of d'Easum Creek at KP 20, despite the high risk of failure indicated by experience gained during recent construction of the AEC West Maxhamish pipeline. Paramount proposes an open-cut crossing of this watercourse if the HDD is not successful.

Paramount wishes to place the proposed facilities in service by April 1, 2000. In order to meet this commitment, Paramount proposes to start construction of the camp, facilities, and pipeline in November 1999 upon receipt of all necessary regulatory approvals. Pipeline construction will be conducted by two 60-person crews working over a 100+ day period and is scheduled to be complete by March 2000. An additional 10 contractors will be used as inspectors (*i.e.*, environmental, quality assurance). Pipeline construction crews will be based in two temporary camps to be located and operated by the pipeline contractor(s). The construction crew for the Fort Nelson River bridge will be based in the gas plant camp, and the crew for the Muskwa River HDD will obtain commercial accommodation in Fort Nelson.

ISSUES SCOPING AND CONSULTATION

Paramount consulted with local, regional, provincial and federal stakeholders to describe the project and identify concerns and issues. The intent of the public consultation program was to promote awareness and understanding of the project, seek input in identifying and resolving concerns and issues, seek local knowledge, and advise of opportunities for local contractors, suppliers and employment.

Project information packages describing the gas supply development area, gathering system, gas battery and processing plant, access roads and residue gas pipeline have been widely distributed. Potentially affected trappers and guide outfitters have received written notification and information describing the project and the construction schedule, so plans to minimize disruption to their winter activities can be made.

Paramount has personally contacted area residents, local, regional, provincial and federal government officials, and other resource developers, in addition to the local First Nations. An afternoon and evening Open House was held in Fort Nelson on July 21, 1999 to provide interested parties with the opportunity to obtain additional information and share their ideas or concerns. Notice of this Open House and the proposed project was provided in the *Fort Nelson News*, *BC Gazette*, *Decho Drum*, *NWT News North*, notices on the radio, and printed flyers posted in the community.

Where appropriate, Paramount representatives have continued discussions with local and regional individuals and groups to identify and resolve potential issues. Representatives of the Oil and Gas Commission and Ministry of Forests accompanied Paramount representatives on route overflights to orient themselves and identify site-specific issues. Paramount has also had numerous meetings with residents of the community of Fort Liard to discuss opportunities and concerns.

Paramount will continue their communication process through the life of the project via ongoing consultation and follow-up on issues.

ENVIRONMENTAL AND RESOURCE USE ASSESSMENT

A multi-disciplinary environmental assessment was conducted for this application to identify the potential biophysical effects associated with the proposed project. This assessment was conducted by a team of independent technical specialists using environmental indicators and established methods. Information obtained from field investigations, recent environmental assessments, published literature, and specialist knowledge was used to identify the potential effects associated with the residue gas pipeline and other field facilities. Mitigative measures to prevent or reduce potential adverse effects, and any remaining residual effects were also identified.

Potential environmental effects associated with the Maxhamish residue gas pipeline were evaluated by project team members using specific definitions provided in Section 4.1.1. Among other factors, these definitions describe the geographic extent (local, sub-regional, regional), duration (immediate, short-term, medium-term, long-term), direction (positive, neutral, negative), and magnitude (nil, low, medium, high) of potential environmental effects (see Section 4.4.1). A summary table of all potential biophysical effects is included in Section 7 of the document.

Potential effects on terrain and soils are limited to direct disturbance areas. With the implementation of standard construction techniques, residual effects of clearing and surface disturbance on terrain and soils due to construction and operation of the Maxhamish residue gas pipeline are anticipated to be negative in direction, local in extent, long-term in duration and continuous in frequency, but low to medium in magnitude. The probability of effects is high, but they are reversible in the long-term. Because standard construction practices are involved, confidence in this assessment is considered high.

Potential effects on soils, vegetation, wildlife, and aquatic resources depend on the activity or species being considered. Anticipated effects are positive (*e.g.*, beneficial for certain species), while others are concluded to be neutral (no net benefit or gain), or negative (net loss to the resource). The anticipated spatial extent ranges from local (within the area disturbed by the pipeline) to regional (beyond 1.5 km of the pipeline), and short- to long-term in duration. With two exceptions, potential environmental effects were concluded to be of low magnitude. Medium to high magnitude effects on Arctic grayling and fish habitat could occur as a result of overfishing and, where trenchless crossing methods are not feasible, open cut crossings of streams with high fisheries values. It is recommended that government monitor this population and implement harvest restrictions if appropriate.

No significant adverse residual environmental effects are considered to be likely.

SOCIO-ECONOMIC EVALUATION

Potential economic benefits and social issues associated with all aspects of the Maxhamish Project were evaluated by an independent specialist. The Northern Rockies Regional District (NRRD) was selected as the study area for the socio-economic assessment and northeast British Columbia was defined as the region. These geographic areas were chosen because the proposed project could have measurable effects on existing socio-economic conditions in these areas.

The socio-economic evaluation considered potential effects on employment, rural residences, household income, municipal services, and regional transportation infrastructure. Socio-economic effects were evaluated using the same definitions as the environmental assessment (Section 4.4.1). Mitigation measures that could reduce or eliminate adverse socio-economic effects were identified and the significance of residual effects was evaluated. A summary table of all potential socio-economic effects is included in Section 7 of the document.

Potential construction related socio-economic effects are considered to be positive (*e.g.*, income, employment) to negative (*e.g.*, increased road traffic), sub-regional in extent, short-term, and low to moderate in magnitude.

Potential effects during operations vary with the effect being considered. They ranged from positive (*e.g.*, employment opportunities) to negative (*e.g.*, increased road traffic), local to sub-regional in extent, short- to long-term in duration, and low to medium in magnitude.

Overall, no significant adverse socio-economic effects are considered to be likely.

ARCHAEOLOGICAL AND HERITAGE IMPACT ASSESSMENT

An Archaeological Impact Assessment was conducted for the proposed pipeline right-of-way. The assessment was conducted by an

archaeologist, assisted by representatives of the Fort Nelson and Prophet River First Nations. One archaeological site was located along the existing highway corridor. This site is considered to be of limited interpretive value and no further work is recommended.

No historic sites were encountered within or adjacent to the proposed pipeline right-of-way.

FIRST NATIONS

The proposed residue gas pipeline route traverses the traditional territory of the Fort Nelson First Nation and the Prophet River First Nation. Each has received information packages describing the proposed development, and follow-up meetings have been held to discuss the project in person. Paramount also attended the Petitot First Nations Gathering held in early August and made a presentation describing the project.

Representatives of both First Nations attended Informational Open Houses, and community representatives were given the opportunity to review maps and associated alignment sheets to identify any traditional land use sites. Land Use Coordinators from each First Nation were consulted to determine appropriate methods and areas for studies of traditional land use.

To date, neither the Fort Nelson nor Prophet River First Nation has expressed any major issues or concerns about the proposed development. Representatives of both First Nations expressed interest in business and employment opportunities.

Representatives of the Fort Nelson and Prophet River First Nations participated in a reconnaissance of the entire route to identify traditional use structures and sites. In addition, interviews were done with Fort Liard residents who traditionally use the Maxhamish area. Eleven cabin sites, four camp sites, one large beaver dam, and a crossing of the Old Fort Nelson Trail were identified during this reconnaissance. Only one cabin, the beaver dam, and crossing of the Old Fort Nelson Trail will be intersected by the proposed right-of-way. There are no specific subsistence use areas in conflict with the proposed residue gas pipeline.

Paramount will work with the Fort Nelson First Nation and cabin owner to relocate or avoid the cabin. Paramount will consult with government and Prophet River representatives to identify the most appropriate solution for the beaver dam. The Old Fort Nelson Trail is now used as a winter logging road and no mitigation is recommended.

No significant adverse effects on traditional aboriginal hunting, fishing, or trapping areas or structures are anticipated.

LIST OF ABBREVIATIONS AND TERMS

$10^3m^3/d$	Thousand cubic metres per day.
10^6m^3	Million cubic metres.
AAC	Annual allowable cut.
AEC	AEC West.
AIA	Archaeological Impact Assessment.
ALR	Agricultural Land Reserve.
asl	Above sea level.

Bellhole	A hole excavated for equipment to work in; *e.g.* during boring.
Borrow pit	Extraction location for subsoil or gravel.
BWBS	Boreal black and white spruce biogeoclimatic unit.
CCMC	Canadian Chopstick Manufacturing Company.
CEAA	Canadian Environmental Assessment Act.
Containment berm	Subsoil berm constructed around a structure to prevent migration of accidental fluid spills.
COSEWIC	Committee on the Status of Endangered Wildlife in Canada.
CPWCC	Canadian Pipeline Water Crossing Committee.
CSA	Canadian Standards Association.
DFO	Fisheries and Oceans Canada.
Ditch plug	Temporary, non-excavated gaps in the trench; provide animal and vehicle crossings and erosion protection at watercourse crossings.
Diversion berm	Subsoil berm constructed to divert runoff from the right-of-way onto adjacent vegetated soil; prevents erosion on steep slopes.
EAO	British Columbia Environmental Assessment Office.
EPP	Environmental Protection Plan.
ERP	Emergency Response Plan.
FISS	Fisheries Information and Summary System.
GIS	Geographic Information System.

GPS	Global Positioning System.
GRP	Ground-Penetrating Radar.
ha	Hectare.
HDD	Horizontal Directional Drill.
km	Kilometres.
KP	Kilometre Post; pipeline distances from start to end.
kPa	Kilopascals.
LRMP	Land and Resource Management Plan.
m	Metre.
mm	Millimetre.
m^3	Cubic metre.
MELP	British Columbia Ministry of Environment, Lands and Parks.
mmscfd	Million cubic feet per day at 15° C and 101.325 kPa.
MOE	British Columbia Ministry of Environment (now MELP).
MOF	British Columbia Ministry of Forests.
MOP	Maximum operating pressure.
MOTH	British Columbia Ministry of Transportation and Highways.

MU	BC Management Unit.
NEB	National Energy Board.
NGL	Natural gas liquids.
NPS	Nominal Pipe Size.
NRRD	Northern Rockies Regional District.
NTS	National Topographic System.
OD	Outside diameter (of pipe).
OGC	British Columbia Oil and Gas Commission.
OHV	Off highway vehicle.
OSB	Oriented strand board.
PAS	Protected Areas Strategy.
PRRD	Peace River Regional District.
Raw gas	Gas with water vapour removed.
Residue gas	Sales specification gas (NGLs and water removed).
Rock-shield	A protective covering applied to a pipeline to prevent damage; used in areas of bedrock and coarse backfill materials.
Rollback	Removed vegetation (slash) that is "rolled back" onto ROW; limits erosion and/or access.
RMZ	Resource Management Zone.

ROW	Right-of-way.
Salvage	Save for future use(s).
Secondary containment	Impervious structure used to prevent migration of liquid in event primary container fails/leaks.
Silt fence	Structure used to slow water velocity and prevent erosion and sediment movement into watercourses.
Sediment trap	Semi-circular earthen berm used to prevent surface run-off from introducing sediments into watercourse.
TCPL	TransCanada PipeLines.
TSA	Timber supply area.
TSIL	Terrain survey intensity level.
UNBC	University of Northern British Columbia.
WCB	Workers Compensation Board.
WEI	Westcoast Energy Inc.
WHMIS	Workplace Hazardous Materials Information System.
WSC	Water Survey of Canada.

CONCORDANCE TABLE

BC Guidelines for Preparation of an Application for Project Approval Certificate	**Paramount Maxhamish Project Application**

Subject	EA Act Provision	Section
I. PROJECT A. PROJECT DESCRIPTION		
Identification of proponent and particulars	Section 7(2)	1.1.1
Project description outlining major components	Section 7(2)(a)	1.1, 2.1, 2.2
On and offsite facilities	Section 7(2)(c)	2.2, 2.3
Construction plan and timetable	Section 7(2)(d)	2.1.3
Expansion needed to public works	Section 7(2)(e)	1.1, 5.3.2.3
B. PROJECT PURPOSE		
Describe the need or demand the project will fill: - Include any discussion of justification requirements relevant to each sector; - This could include an alternatives analysis	Section7(2)(a)	2.1.2
C. LEGISLATIVE AND POLICY CONTEXT FOR PROJECT		
Describe any land use plans completed and relevant to the project area.	Section 7(2)(h)	4.3.6
Outline to the best of the ability of the proponent whether there is an expectation of a CEAA trigger.	Bilateral Agreement	2.7
Describe any emergency plans in effect for project area and site, and outline the lead agencies for these.	None	2.5, 5.3.2.2
Describe approvals required of proponent in addition to the project approval certificate, prior to the project being operational.	None	2.7

II. EFFECTS IDENTIFICATION AND ASSESSMENT A. EXISTING INFORMATION AND SETTING		
Describe the current situation regarding the following effects:	Section 7(2)(b)	
Environmental		4.3
Economic		5.2.1
Social		5.2.1
Health		5.2.1
Cultural		5.2.1
Heritage		6.2.1
First Nations		6.3.1, 4.3.6.8
B. IDENTIFY ISSUES AND POTENTIAL EFFECTS OF PROJECT		
Identify the issues associated with the project.	Section 7(2)(m)	3.2, 4.2
Describe the potential effects of the project relying on the categories listed above; include the methodology used to make predictions.	Section 7(2)(f)	4.4, 4.5, 5.3.2, 6.3.2
Rate the significance of the predicted effects.	Directed by Section 19 test	4.4, 5.3.2, 6.3.2, 7.2, 7.3,
Undertake an assessment of the cumulative effects if it appears necessary to meet the needs of the CEAA.	Bilateral Agreement	4.5
C. MITIGATION MEASURES AND MONITORING		
Based on the assessment in B above, and on a categorization of the effects, describe the proposals to reduce adverse effects. This may require consideration of options.	Section 7(2)(m)	4.4, Appendix A

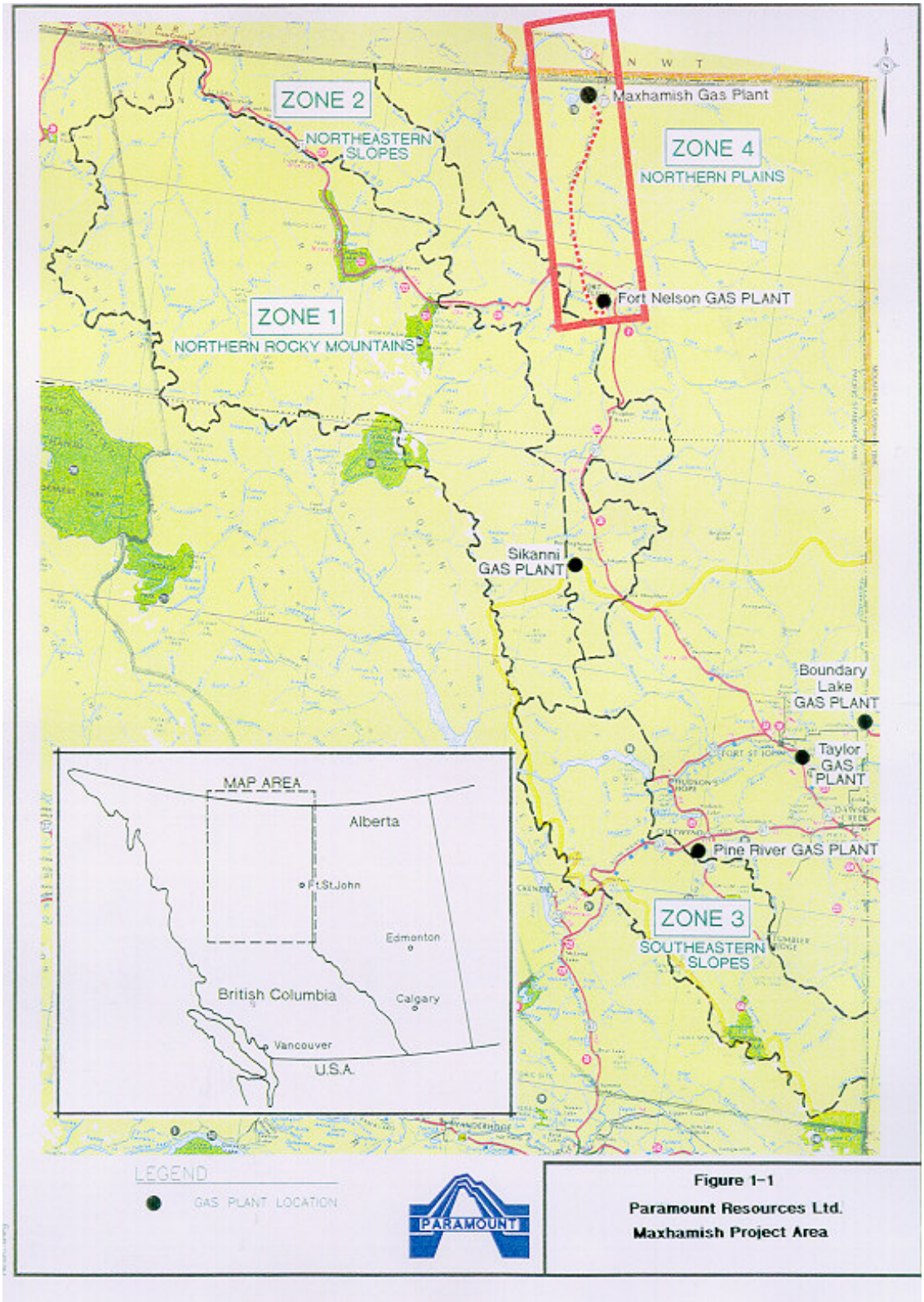
Include description of existing emergency planning context if relevant and not covered under Part I-C above and consider emergency measures needed at site.	Bilateral Agreement	2.5, 5.3.2.2
III. INFORMATION DISTRIBUTION AND CONSULTATIONS		
Provide notification and information to the public from an early stage in the planning and ensure public input into the identification and resolution of concerns and issues.	Section 7(2)(i) and (j)	3.0, 3.2.2, 3.2.4, Appendix B
Ibid, pertaining to identified First Nations in the project area.	Section 7(2)(k) and (l)	6.3.3, 3.0, 3.2.1, 6.2.1, Appendix B
Provide information on discussions undertaken with ministries or agencies of the BC government about the effects of the project.	Section 7(2)(m) and (n)	3.0, 3.2.1, Appendix B

1. INTRODUCTION

Paramount Resources Ltd. (Paramount) and its partner Berkley Petroleum Corp. (Berkley) propose to construct, own and operate a sweet residue gas pipeline to connect the proposed Paramount Maxhamish gas plant to the Westcoast Energy Inc. (WEI) pipeline system near the WEI Fort Nelson gas plant (Figure 1-1). This processing and transportation system will tie-in sweet gas reserves from a field southeast of Fort Liard, Northwest Territories, the Maxhamish field near the British Columbia-Northwest Territories border, as well as potential British Columbia wells.

An application for the proposed Paramount Maxhamish Gas Plant has been made to the British Columbia Oil and Gas Commission and approval has been received. A pipeline proposed by Shiha Energy Transmission Ltd. that will carry raw gas to the Maxhamish facility is the subject of another application submitted to the National Energy Board.

This application to the British Columbia Environmental Assessment Office requests a Project Approval Certificate which will allow Paramount to proceed with the Maxhamish project as proposed below.



1.1 Project Overview

The reviewable portion of the Maxhamish project consists of a residue gas pipeline. This 164 kilometre (km) pipeline will transmit sweet natural gas from the Paramount Maxhamish gas plant located in 36-I/94-O-14 to a tie-in and sales point located on the WEI pipeline system immediately south of the WEI Fort Nelson gas plant at b-85-G/94-J-10.

The 323.9 mm OD (NPS 12) pipeline will be designed for an initial flow rate of 3,000 $10^3m^3/d$ (106 mmscfd) and a maximum pressure of 13,100 kPa (1,900 psig). The route follows existing linear corridors for more than 95% of its length. An 18 metre (m)-wide right-of-way will be required for construction. This area will be reduced by sharing 6 m to 11 m of temporary workspace on adjacent rights-of-way. Intermediate to large river crossings include d'Easum Creek and the Fort Nelson and Muskwa rivers. Additional temporary workspace will

be required for sidehills, bends, timber deck sites, and foreign line, road, and watercourse crossings.

Paramount wishes to place the proposed facilities in service by April 1, 2000. In order to meet this commitment, Paramount proposes to start construction of the camp, facilities, and pipelines in November 1999 upon receipt of all necessary regulatory approvals. Pipeline construction will be conducted by two contractor crews and is scheduled to be complete by March 2000.

Other field facilities in British Columbia subject to other review and approval processes include existing and proposed well sites, a raw gas pipeline, gathering lines, and the Maxhamish gas plant that will remove natural gas liquids to meet WEI sales gas specifications. This plant will be connected to the Fort Liard Highway by a new all-weather access road. No expansion to existing infrastructure is required for the project to proceed.

The total capital cost of the Paramount Maxhamish residue gas pipeline is estimated at approximately $40.8 million. The total capital cost of other Maxhamish gas processing project facilities and activities in British Columbia and the Northwest Territories is approximately $39.5 million. Annual operating costs for British Columbia facilities are expected to be $3.5 million.

Temporary remote camps will be established by pipeline contractors. Operations staff will be housed in an on-site dormitory at the plant and will be transported from Fort Nelson to the site via bus on a weekly or bimonthly rotation. Accommodation for the facility construction crew and Fort Nelson River bridge construction crew will be provided at the gas plant camp.

1.1.1. Applicant Name and Contact

Paramount is an established publicly-traded petroleum producer that has been active in the Fort Liard area over the last twenty years. Paramount has approximately 160 employees. Its headquarters are located at 4000, 350 - 7 Avenue S.W., Calgary, Alberta.

Communication regarding the Maxhamish Project should be sent to:

Paramount Resources Ltd.
Suite 4000, 350 - 7 Avenue S.W.
Calgary, Alberta T2P 3W5
Attention: Mr. Wayne Rousch

Telephone: (403) 290-3645
Facsimile: (403) 290-3614

1.2 Application Overview

The Application for a Project Approval Certificate has been prepared pursuant to requirements of the British Columbia Environmental Assessment Process (EAO 1995). This application describes the proposed Maxhamish residue gas pipeline and other gas processing facilities and activities. It also discusses issues that were identified during discussions with the BC Environmental Assessment Office, local residents, local, regional, provincial and federal government agencies, First Nations, and interested groups and individuals. The application also identifies the potential biophysical and socio-economic effects and describes the proposed mitigation measures.

[Figure -1.Paramount Resources Ltd. Maxhamish Gas Processing Project Area. - 81/2 X 11 colour map from Little Rock]

The document is divided into the following main sections:

2. Project Description — Description of the proposed Maxhamish project and facilities, including the project rationale and schedule;

3. Issues Scoping and Consultation — Summary of information provided to the public and government contacts, and the proposed program for further information distribution and public consultation;

4. Environmental Assessment — Description of the existing environmental setting, potential effects of construction and operation, and the mitigation and monitoring measures to prevent or reduce potential effects;

5. Socio-Economic Evaluation — Description of the existing social, economic, cultural, and health setting; potential effects of construction and operation; and mitigation and monitoring measures to prevent or reduce potential effects;

6. Archaeological and Heritage Impact Assessment — Description of the existing heritage conditions in the study area, potential effects of construction and operation, and the mitigation and monitoring measures to prevent or reduce potential effects; and

7. Conclusions — Summary of issues identified during consultation and project assessment, the mitigative measures to be employed, anticipated positive and negative residual effects, monitoring programs, and the proposed program for further information distribution and public consultation.

8. References.

To facilitate review by technical specialists, pertinent maps and project information is included in the environmental assessment (Section 4) and socio-economic evaluation (Section 5).

1.2.1 Project Team and Responsibilities

Paramount retained a multi-disciplinary team to prepare the Maxhamish Project application. The team consisted of Paramount staff and independent technical specialists. Team responsibilities were as follows:

Project Approval Certificate Application
Salmo Consulting Inc., Calgary (Salmo; prime consultant)

- document editing and production
- waste management
- cumulative effects

Pipeline Design Engineering
Paramount Resources Ltd., Calgary
Cimarron Engineering Ltd., Calgary (Cimarron)
Associated Engineering Alberta Ltd., Edmonton (Associated)

Air Quality
E2 Environmental Alliance Inc., Calgary (E2)

Terrain
Geo-Engineering (MST) Ltd., Calgary (Geo-Engineering)

Soils, Vegetation, and Wildlife
Golder Associates Ltd., Calgary (Golder)
Wildlife & Company Ltd., Calgary (Wildlife Co.)

Fisheries
Diversified Environmental Services, Fort St. John (Diversified)
Golder Associates Ltd., Calgary

Archaeology and Heritage Resources and Traditional Aboriginal Use
Fedirchuk, McCullough and Associates Ltd., Calgary (FMA)

Socio-Economic and Land and Resource Use Evaluation
Ramsay & Associates Consulting Services Ltd., Calgary (Ramsay)

Public Consultation
Paramount Resources Ltd., Calgary

2. PROJECT DESCRIPTION

This section describes the proposed Paramount Maxhamish residue gas pipeline and associated gas processing project. It begins with a discussion of the gas supply and availability for the project, the project rationale, and the construction schedule and estimated capital and operating costs (Sections 2.1.1 to 2.1.3). Information on the proposed residue gas pipeline route and design is provided in Section 2.2, along with a discussion of other Maxhamish gas processing project facilities and activities. Overviews of proposed waste management, emergency response, and abandonment procedures are presented in Section 2.4 through 2.6 respectively.

2.1 Project Location and Scope

The Paramount Maxhamish pipeline consists of a 164 km pipeline that will transmit sweet natural gas from the Paramount Maxhamish gas plant located northeast of Maxhamish Lake near the British Columbia-Northwest Territories border to a tie-in on the WEI system immediately south of the Fort Nelson gas plant. This pipeline is part of a processing and transportation system that will tie-in sweet gas reserves from a field southeast of Fort Liard, Northwest Territories as well as the Maxhamish field near the British Columbia-Northwest Territories border.

Figure 2-1 shows the proposed project area and existing roads and pipeline rights-of-way. The 323.9 mm OD (12 inch) pipeline originates at the Maxhamish gas plant outlet, located approximately 10 km northeast of Maxhamish Lake at 36-I/94-O-14. The residue gas pipeline ends at a sales point on the WEI pipeline system at b-85-G/94-J-10. Paramount has routed the residue gas pipeline to follow existing or proposed rights-of-way for more than 95% of its length (see Section 2.2.1).

The route crosses fifty-seven watercourses including the Fort Nelson and Muskwa Rivers, d'Easum, Deszen, Tsinhia, Stanolind, Cridland, Donaldson, and Pebble creeks, and numerous unnamed creeks. Aerial crossings of the Fort Nelson River and one d'Easum Creek crossing are proposed. The Fort Nelson River crossing structure consists of a two span bridge with an overall length of 243.8 m. The pipeline will be attached to a road bridge across d'Easum Creek at kilometre post (KP) 4.3. Horizontal directionally-drilled (HDD) crossings of the Muskwa River and second d'Easum Creek crossing are proposed. A 1.1 kilometre-long HDD crossing of the Muskwa River together with its unstable south bank is planned. Paramount plans to attempt an HDD crossing of d'Easum Creek at KP 20, despite the high risk of failure indicated by experience gained during recent construction of the AEC West Maxhamish pipeline. Paramount proposes an open-cut crossing of this watercourse if the HDD is not successful.

Associated facilities in British Columbia include existing and proposed well sites, a raw gas pipeline, gathering lines, and the Maxhamish gas plant that will remove natural gas liquids to meet WEI sales gas specifications. This gas plant will be connected to the Fort Liard Highway by a new all-weather access road.

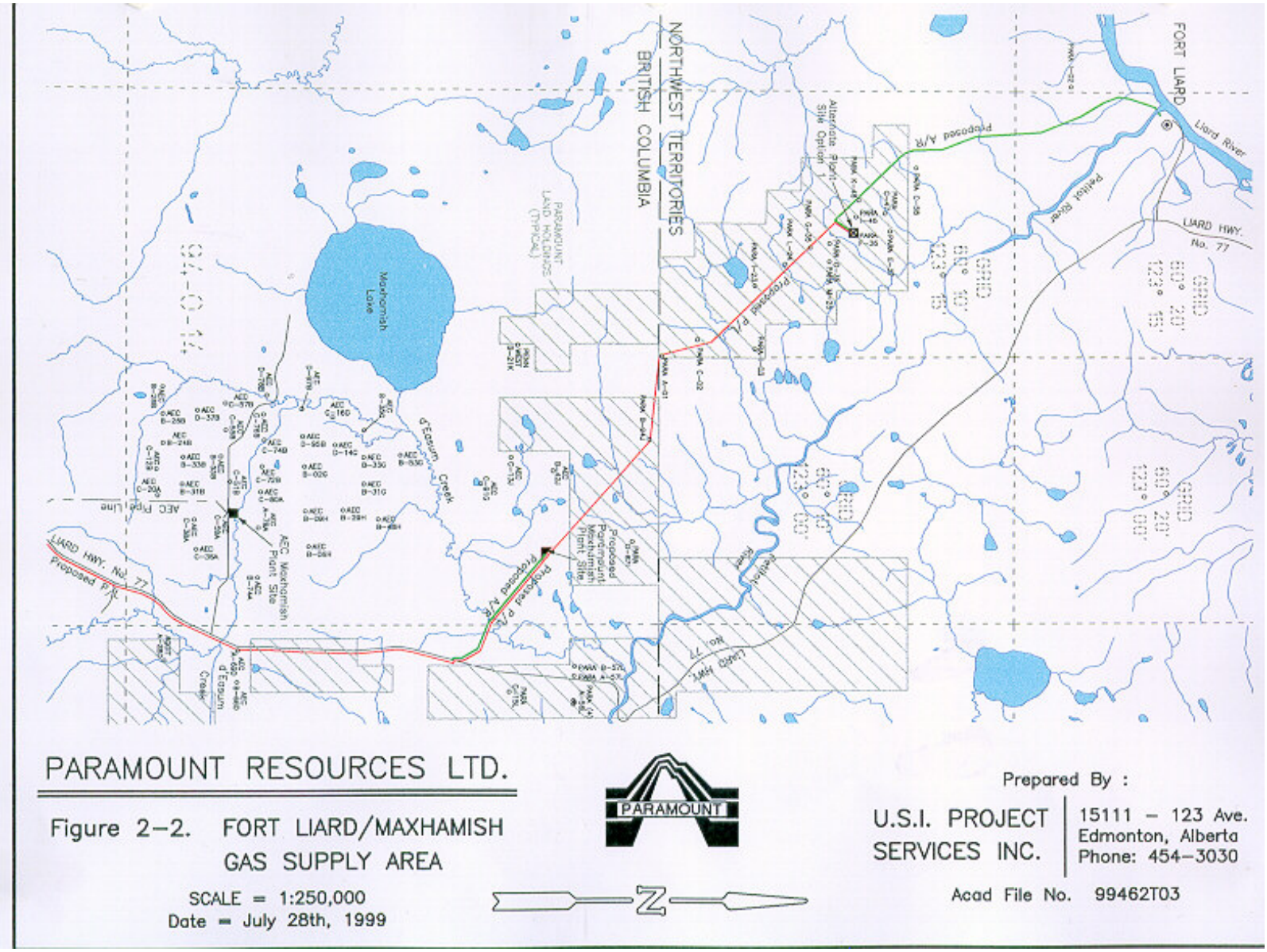
2.1.1 Gas Supply and Availability

The natural gas supply area for the Paramount Maxhamish gas processing project is shown on Figure 2-2. The core natural gas reserves include the pool associated with the F-36 well in the Northwest Territories southeast of the community of Fort Liard. Paramount estimates current marketable gas reserves of at least 7,080 10^6m^3. These reserves are sufficient to maintain a production rate of 3,000 $10^3m^3/d$.

The supply basin for the Maxhamish plant is relatively unexplored and holds significant potential for future recoverable gas reserves of over 142 10^9m^3. AEC West (AEC) is the only other producer in the Maxhamish area, and Paramount is involved in ongoing discussions for future development opportunities with them.

The Maxhamish residue gas pipeline will initially transport processed natural gas from the pool discovered with the F-36 well in the Northwest Territories. No additional gas sources have been committed to the Maxhamish Project at this time, but Paramount is continuing discussions with other producers in this area. A volume of 3,000 $10^3m^3/d$ has been utilized as the design basis for the Maxhamish residue gas pipeline.

As the existing established reserves decline, it is anticipated that available capacity will be filled with production from new discoveries within the supply basin. Ongoing drilling will maintain natural gas deliverability in the supply area.



2.1.2 Project Rationale

The Maxhamish gas processing project will allow Paramount to tie-in their Fort Liard and Maxhamish sweet gas reserves into the WEI transmission system and to market produced natural gas liquids (NGL) in Taylor. The nearest facility with suitable processing capability is located more than 200 km away.

Paramount has discussed gas processing and transportation opportunities with WEI, AEC, TransCanada PipeLines (TCPL), and other operators in the Fort Liard and Maxhamish areas. Other project alternatives considered by Paramount included:

1. Construction of a residue gas pipeline from a gas plant located at the Paramount Fort Liard F-36 well site in the Northwest Territories. This alternative was rejected because it had lower flexibility for connecting potential sweet gas reserves located on Paramount land holdings south of the Northwest Territories/British Columbia border. Future connection of reserves from this area would require gathering line(s) north to the plant site, counter to the southern flow of the proposed residue gas pipeline.
2. Construction of a residue gas pipeline from a gas plant located on an existing Paramount well site at b-57-L/94-O-15. This alternative site is cleared and accessible by road from the Liard Highway, but was rejected because it is not central to Paramount's land holding, would increase required gathering line length, and would require pipeline crossings of d'Easum Creek in a reach which is incised and has unstable slopes.
3. Construction of a residue gas pipeline from the proposed Paramount Maxhamish gas plant to a tie-in and sales point on the WEI Beaver River pipeline immediately north of the Fort Nelson River, near the AEC Maxhamish tie-in location. This option was rejected because a commercially acceptable agreement for the use of WEI transmission facilities could not be negotiated.

2.1.3 Construction and Operations

Paramount will construct and own the residue gas pipeline and associated facilities. The raw gas pipeline connecting to the Maxhamish gas plant will be constructed and owned by Shiha Energy Transmission Ltd.

2.1.3.1 Schedule and Workforce

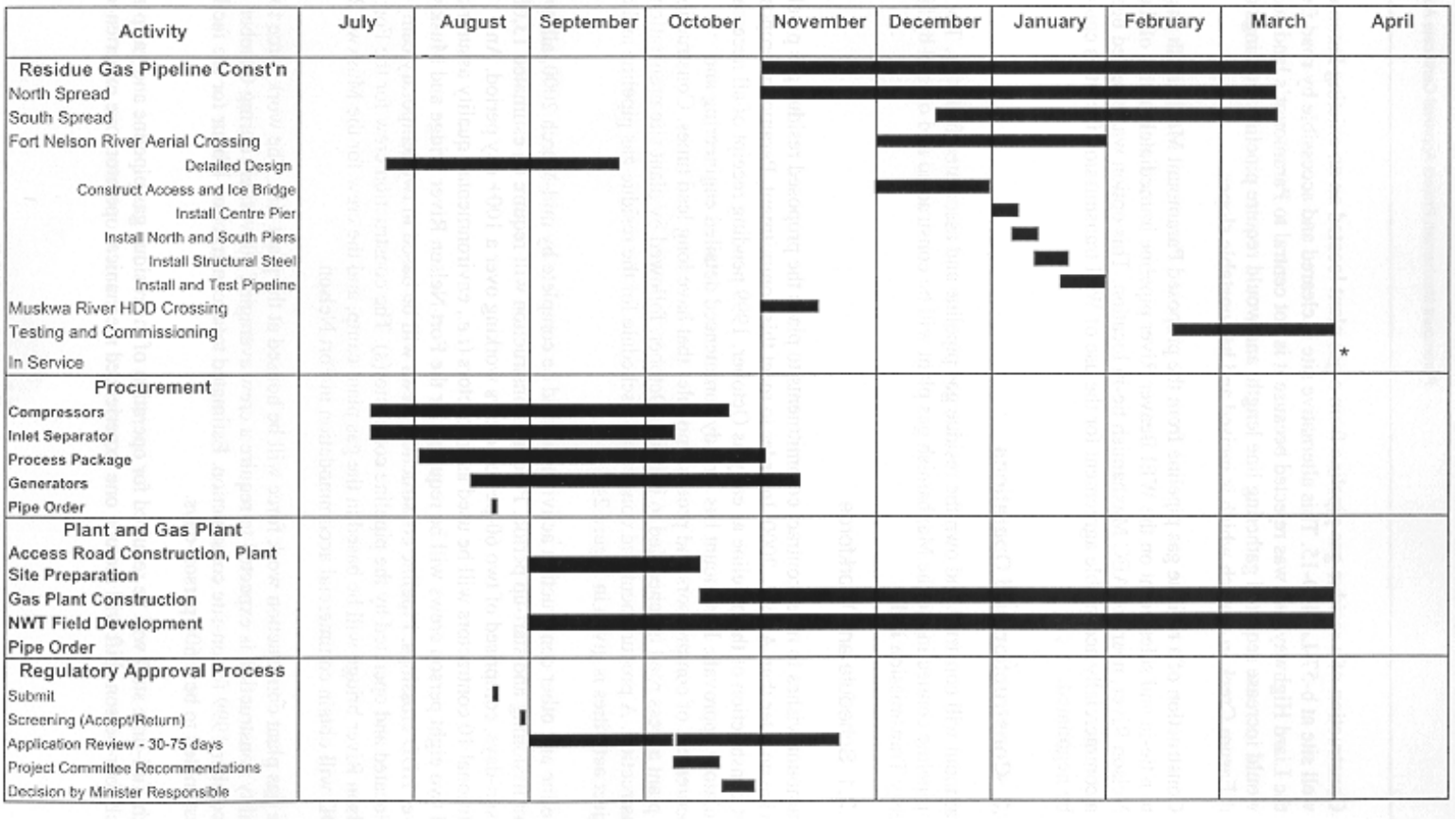
Paramount wishes to meet contract commitments to place the proposed residue gas pipeline in service no later than April 1, 2000. In order to meet this commitment, Paramount proposes to start construction of the pipeline as early as October, 1999 pending receipt of all necessary regulatory approvals. Paramount has already commenced detailed engineering and procurement of compressors and process modules that have long lead times. Construction of the plant access road is scheduled to begin in October, followed by plant site preparation and construction. A procurement and construction schedule for the residue gas pipeline and other project activities is given in Figure 2-3.

Pipeline and other construction activities should be complete by mid-March 2000, allowing a commissioning and start-up period. Pipeline construction will require an estimated 13,000 person-days, comprised of two 60-person crews working over a 100+ day period. An additional 10 contractors will be used as inspectors (*i.e.*, environmental, quality assurance), and two eight person crews will be required for the Fort Nelson River bridge and Muskwa River HDD crossings. Pipeline construction crews will be based in two temporary camps to be located and operated by the pipeline contractor(s). The construction crew for the Fort Nelson River bridge will be based in the gas plant camp, and the crew for the Muskwa River HDD will obtain commercial accommodation in Fort Nelson.

The gas plant construction work force will be housed at the plant site. The work force for facility construction is expected to require a crew averaging 40 workers during October - December 1999 for on-site construction. Estimated total construction labour for the facilities is estimated to be 3,600 person-days.

Eight full-time staff will be required for operation of the residue gas pipeline and gas plant. Each four-person shift will include one experienced mechanical operator, one experienced instrumentation operator, and two roustabouts/trainee operators. Five full-time truck drivers will also be dedicated to the gas plant. All staff will be housed in a camp at the Maxhamish gas plant on a continuous basis with cross over shifts used to ensure operating continuity. Contractors will be used for maintenance and plant turnarounds.

Figure 2-3. Procurement and construction schedule for the Paramount Maxhamish project.



2.1.3.2 Capital and Operating Costs

The installed capital cost of the Paramount Maxhamish residue gas pipeline is estimated to be approximately $40.8 million. Additional capital expenditures of about $20 million are required for the gas plant and access road in British Columbia. A breakdown of capital costs for the pipeline and other field facilities is provided in Table 2-1.

TABLE 2-1
CAPITAL COST ESTIMATE FOR THE PROPOSED
PARAMOUNT MAXHAMISH PROJECT.

Item	Estimated Capital Cost (without GST)	Estimated Expenditures in BC
COSTS – B.C.		
Residue Gas Line		
- Materials	$15,930,000	$ 110,000
- Construction	21,080,800	20,000,000

- Engineering, Management, Right-of-way & Fees	2,184,000	253,500
- PST (7%)	1,183,560	1,183,560
- Overhead	$407,784	$ 0.00
TOTAL – Residue Gas Line	**$40,786,144**	**$21,547,060**
Gas Plant, Camp, and Road		
- Major Equipment	$10,100,000	$ 36,000
- Materials	2,387,000	139,500
- Construction Labour	5,695,000	3,235,000
- Engineering, Management, Land & Fees	404,000	$5,000
- PST (7%)	874,100	874,100
- Overhead	$ 198,600	$ 0.00
TOTAL – Gas Plant	$19,658,700	$4,289,600
TOTAL COSTS – B.C.	$60,444,844	$25,836,660
TOTAL COSTS – NWT	$19,832,445	

This cost estimate includes the following:

- Applications, approvals, permits, and environmental studies;
- Purchase of pipe for the residue gas pipeline;
- Gas plant site preparation, equipment, utilities, storage facilities, electrical, camp, and access road; and
- Start-up and commissioning.

All of the estimated Maxhamish residue gas pipeline capital cost can be sourced in Canada, and approximately $21.5 million of pipeline

capital costs can be sourced in the region to existing, qualified contractors. Over 65% of total project costs will be spent in Canada, and up to $4.3 million of plant expenditures can be sourced in northeast British Columbia.

Taxes payable to the British Columbia government as a result of construction of the Maxhamish project include:

	Provincial Sales Tax (7%)	Personal Income Taxes
Pipeline	$1,183,560	$463,893
Gas Plant	874,100	146,492
TOTAL	$2,057,660	$610,385

Annual British Columbia operating costs are estimated to be $3.5 million, all of which can be sourced locally. Annual operating costs include:

Operating and maintenance salaries/wages	$ 0.9 million/year
Materials and subcontracts	$ 1.4 million/year
Taxes	$ 1.2 million/year
Insurance, other	$ 1.2 million/year

The breakdown of estimated annual taxes payable to the British Columbia government as a result of operation of the Maxhamish project is outlined below:

Provincial Sales Tax (7%)	$ 58,000
Fuel Tax	446,000
Personal Income Tax	99,205

Property Tax:

Pipelines[1]	544,320
Gas Plant	$ 71,750
TOTAL ANNUAL	$1,219,275

Notes: All tax calculations are in 1999 Canadian dollars, based on 1999 tax information provided by the Province of British Columbia.
[1] Includes residue and raw gas pipelines.

2.2 Residue Gas Pipeline

The Maxhamish residue gas pipeline will be owned and operated by Paramount and will be designed, constructed and operated in accordance with the appropriate standards established by the Canadian Standards Association (CSA) as well as applicable provincial requirements.

The residue gas pipeline is designed to transport dry natural gas at an initial flow rate of 3,000 $10^3m^3/d$ (106 mmscfd) and a maximum pressure of 13,100 kPa (1,900 psig). Although the pipeline will transport sweet gas initially, it will be designed for sour service to enhance future flexibility. Five automatic shut-down valves will be installed at strategic locations along the right-of-way. Technical details of the proposed residue gas pipeline are summarized in Table 2-2.

TABLE 2-2
TECHNICAL DETAILS OF THE MAXHAMISH RESIDUE GAS PIPELINE

Size:	323.9 mm OD (12 inch)	Corrosion Protection	
Start Point:	Proposed Paramount Maxhamish gas plant at 36-I/94-O-14	• External Coating • Impressed Current • Smart Pig Capable	Yes Yes Yes
End Point:	Existing WEI Ft. Nelson Mainline at b-85-G/94-J-10	• CP Surveys • Corrosion Inhibition	Yes No
Type	Residue Gas Pipeline	• Corrosion Monitoring	Yes
Wall Thickness (mm)	Regular: 9.5 Heavy Wall: 11.1 (in wet areas and adjacent to residences)	Over Pressure Protection • Upstream • Downstream	HPSD* HPSD*

Grade (Mpa)	Regular: 414 Heavy Wall: 359 (in wet areas and adjacent to residences)	Leak Detection • Upstream • Downstream	LPSD** Check Valve
Service	Sour Gas	Scheduled Construction Period	November 1999 to March 2000
MOP (kPa)	13,100		
Material	Steel		
Specification (CSA)	Sour Spec. Cat. I ERW	Minimum Depth of Cover (mm)	1,200
Right-of-way Width	18 m including shared temporary workspace on adjacent rights-of-way. Shared workspace ranges from 6 m to 12 m. Additional temporary workspace will be required for sidehill, bends, timber deck sites, and foreign line, road, and watercourse crossings.		
Notes: * HPSD—High Pressure Shut Down ** LPSD—Low Pressure Shut Down (The pipeline will be shut down automatically if the pipeline pressure exceeds or falls below set limits)			

Specific design standards and requirements are:

Pipeline Design	• CAN/CSA Z662-96 "Oil and Gas Pipeline Systems" • Government of British Columbia, "The Rules and Regulations Governing Oil and Gas Pipelines" (latest edition)
Line Pipe	• CAN/CSA Z245.1-95
Valves	• CAN/CSA Z245.15-96"
Fitting	• CAN/CSA Z245.11-96
Flanges	• CAN/CSA Z245.12-96

Note:
Where pipeline materials suitable for sour gas service are required, the CSA 245 series specifications for sour service application or (National Association of Corrosion Engineers) MR01-75 (latest edition) will be specified.

These design specifications will be equal to or greater than those required by CSA and the provincial rules and regulations. Initial pipeline quality will be met through selection of the appropriate pipe, including appropriate pipe diameter, wall thickness, grade, and material. In addition to methane, sweet natural gas may contain gaseous hydrocarbons (butane, propane, ethane).

The carbon steel pipeline will be protected against external corrosion by an external coating of extruded polyethylene. This will be supplemented with impressed current cathodic protection. The pipeline will be monitored with regular cathodic protection surveys to confirm adequacy of the program. Corrosion inhibitor will not be used unless the pipeline is turned to sour service.

2.2.1 Route Selection

Routing control points for the Maxhamish residue gas pipeline were the start point at the Maxhamish gas plant site, the delivery point immediately south of the WEI Fort Nelson gas plant, and the Fort Nelson and Muskwa rivers. The initial route was selected by Paramount based on the following routing criteria:

- Follow existing roads, pipelines, and clearings where feasible.
- Minimize pipeline length to reduce the total area of disturbance and capital costs.
- Minimize clearing.
- Cross watercourses at or near right angles where required.
- Cross roads and foreign lines at or near right angles.
- Avoid geotechnically unstable slopes, muskeg, and wetlands where feasible.
- Avoid residences and public facilities where feasible.

Representatives from Salmo, Geo-Engineering, and Golder conducted a ground and aerial route reconnaissance of the proposed alignment on June 21 and 22, 1999 and identified possible route alternatives based on this reconnaissance and review of available biophysical information. Further route evaluation and refinement was conducted by Paramount representatives.

Two other routing options were evaluated and rejected:

1. An alternative pipeline route south from the Paramount Maxhamish gas plant to connect to the AEC Maxhamish pipeline right-of-way approximately 15 km south of the plant site. This route would then parallel the AEC Maxhamish pipeline to the point where it joins the Liard Highway, and then follow the preferred route to Fort Nelson. This option is shorter than the preferred route but was rejected because it crosses an area of extensive muskeg and wetlands.

2. An alternative pipeline route following the Slocan haul road from a point near KP 130 where it leaves the WEI Beaver River pipeline corridor, and heads south, thereby avoiding residential and agricultural lands northwest of Fort Nelson. This haul road rejoins the WEI pipeline corridor on the north bank of the Muskwa River crossing at KP 151. This option was rejected because it is longer, crosses more muskeg, requires an additional 6 m of clearing along the right-of-way, and because landowner agreement was obtained to continue paralleling the WEI pipeline alignment (see Biophysical Alignment Sheet No. 15; Appendix A).

[Photograph 2-1. Origin of the residue gas pipeline at the proposed Maxhamish plant site.]

[Photograph 2-2. Proposed route along the Liard Highway; AEC pipeline right-of-way to right (west).]

[Photograph 2-3. Fort Nelson River crossing from the north.]

[Photograph 2-4. WEI pipeline right-of-way and Slocan winter haul road corridor from west.]

[Photograph 2-5. Muskwa River crossing location and Prophet River confluence from south.]

The proposed route is described below with reference to photographs and Biophysical Alignment Sheets included in Appendix A.

The northern 7.6 km parallels a permanent access road that will be constructed by Paramount from the Liard (No. 77) Highway to the Maxhamish gas plant (Biophysical Alignment Sheets 1 and 2). This section of the route will consist of a 10 m-wide easement adjoining the northern edge of the road right-of-way. Photograph 2-1 shows the plant site and adjacent area.

At the Liard Highway junction, the pipeline will cross the road bed and parallel the east side of the highway for approximately 79 km to a point just north of the Fort Nelson River (Biophysical Alignment Sheets 2 through 10). This section will consist of a 7-m wide right-of-way; 11 m of shared workspace on the adjacent highway right-of-way will be utilized during construction. Photograph 2-2 shows the Liard Highway from the north, and the recently constructed AEC Maxhamish pipeline right-of-way paralleling the west edge of the highway. Minor route deviations may be required to avoid borrow pits excavated during construction of the Liard Highway.

Just north of the Fort Nelson River, the route turns west and crosses the highway and WEI Beaver River pipeline right-of-way. The residue gas pipeline route then parallels the west side of the WEI alignment, and deviates west to cross the Fort Nelson River approximately 100 m downstream of the WEI crossing (Photograph 2-3; Biophysical Alignment Sheet 10).

South of the Fort Nelson River, the right-of-way continues along the west side of the WEI pipeline across the Liard Highway and Alaska Highway to the crest of the Muskwa River north approach slope. Most of this segment is situated in a variable width treed buffer between the WEI right-of-way and the Slocan winter log haul road to the west (Photograph 2-4). Northwest of Fort Nelson, this alignment traverses agricultural land and Agricultural Land Reserve lands (Biophysical Alignment Sheets 10 through 16). This segment will consist of a 12 m wide permanent right-of-way and 6 m of shared temporary workspace on the WEI right-of-way.

North of the Muskwa River, the route crosses to the east side of the WEI right-of-way and deviates approximately 100 m downstream (east) to parallel the WEI crossing of the Muskwa River (Biophysical Alignment Sheets 16). This segment will consist of a 12 m wide permanent right-of-way and 6 m of shared temporary workspace on the WEI right-of-way and 18 m wide permanent right-of-way on the new cut segment, excluding the south approach slope which will be drilled. Photograph 2-5 shows the Muskwa River crossing.

South of the Muskwa River, the route follows the east edge of the WEI right-of-way along a narrow ridge between the Muskwa and Fort Nelson rivers (Biophysical Alignment Sheets 16 and 17). The route returns to the west side of the WEI line south of a beaver dam, and leaves the WEI pipeline when it swings east to the north end of the Fort Nelson gas plant. The residue gas pipeline right-of-way continues southeast, crosses the Alaska Highway, and ties into the Fort Nelson transmission line at the south side of the plant site. Where the WEI right-of-way is paralleled, Paramount will require a 12 m wide permanent right-of-way and utilize 6 m of shared temporary workspace.

2.2.2 Pipeline Construction and Commissioning

Pipeline construction will involve standard procedures including surveying, clearing, grading, hauling, stringing, welding, trenching, lowering-in, backfilling, pressure testing, clean up, and restoration. The pipeline will be pneumatically tested, but water obtained from approved sources will be used for hydrostatic testing of short, critical sections (*e.g*. watercourse and highway crossings).

Routine pipeline construction will be conducted by two crews of approximately 60 persons working over a 100+ day period and at least two watercourse crossing crews. One pipeline crew will start work in the north, and the other will start work in the south. An additional 10 contractors will be used as inspectors (*i.e*., environmental, quality assurance). Construction crews will be based in two temporary camps to be located and operated by the pipeline contractor(s). The eight person construction crew for the horizontal directionally-drilled (HDD) Muskwa River crossing will be based in Fort Nelson, and the eight person construction crew for the aerial crossing of the Fort Nelson River will be based at the permanent camp at the Paramount Maxhamish gas plant site.

Construction truck traffic will occur primarily in daylight. Pipeline-related traffic will be relatively constant during the construction period, and is estimated to average 30 return trips per day between the camp and construction site, with a peak of 50 return trips. Additional traffic associated with pipe and equipment hauling from Fort St. John and Alberta will consist of 250 trips during the construction period, or approximately 3 trips per day.

Subject to receipt of regulatory approval, right-of-way clearing is scheduled to commence in fall 1999 on the northern segment of the line

that parallels the Liard Highway and gas plant access road. Construction prior to freeze-up is also desirable on agricultural and Agricultural Land Reserve lands near Fort Nelson. Winter construction will be required for the segment paralleling the WEI pipeline right-of-way between the Fort Nelson River and the WEI Fort Nelson gas plant.

Additional temporary working space for construction will be required for sidehills, sharp bends, timber decking and slash storage sites, and at road, foreign pipeline and watercourse crossings. The locations and dimensions of extra working areas are not currently known, but it is assumed that this will comprise an additional 10% of the total right-of-way area. Existing cleared areas and adjacent rights-of-way will be used to minimize new clearings for temporary working space requirements wherever possible.

Specific environmental protection measures to be employed during pipeline construction are summarized on the Biophysical Alignment Sheets in Appendix A and the Environmental Protection Plan in Appendix D.

2.2.2.1 Watercourse Crossings

Fisheries investigations of all 57 watercourse crossings were conducted consistent with federal and provincial standards to identify the sensitivity of aquatic habitat and species in along the route. In addition, geotechnical investigations were conducted at the Fort Nelson and Muskwa river crossings to evaluate the technical feasibility of directionally-drilled crossings of these watercourses. Site-specific data and proposed protection measures for watercourse crossings are summarized on the Biophysical Alignment Sheets in Appendix A. General protection measures are included in the Environmental Protection Plan in Appendix D.

Most (45) watercourses were concluded to have nil or low fisheries values at the crossing site. Twelve of these watercourses, however, were concluded to have moderate or high potential for downstream impacts. Paramount proposes to cross all 45 watercourses using conventional open cut techniques with log or snow fill for vehicle crossing. The final decision on the appropriate crossing techniques for flowing waterbodies will be made on-site at the time of construction by the Environmental Inspector, in consultation with the Oil and Gas Commission Land and Habitat Protection Officer. Factors to be considered include flow conditions at the time of construction, potential for downstream impacts, and the presence of beaver dams and downstream impoundments that prevent downstream impacts.

Five small watercourses were concluded to have moderate fisheries values (KP 5.1, 24.2, 67.1, 128.6, and 148.3) If flow is present, Paramount proposes to cross these watercourses using trenchless techniques and existing/temporary bridges or ice bridges. The final decision on the appropriate crossing techniques for flowing waterbodies will be made on-site at the time of construction by the Environmental Inspector, in consultation with the Oil and Gas Commission Land and Habitat Protection Officer.

Pipeline crossings of seven large and intermediate watercourses with high fisheries value will be constructed under separate contracts by specialized crews using trenchless techniques and existing/temporary bridges or ice bridges. These include proposed bored crossings of d'Easum Creek (KP 20), Stanolind Creek (KP 105.3 and 112.0), and Cridland Creek (KP 128.4) and Muskwa River (KP 151). Additional information on construction techniques for d'Easum Creek (KP 4 and 20), Fort Nelson River (KP 90), and Muskwa River (KP 151) crossings is provided below.

d'Easum Creek

The proposed residue gas pipeline right-of-way crosses d'Easum Creek in two locations, one at KP 4.3 along the gas plant access road, and one at KP 20 along the Liard Highway. This creek is considered to have high fisheries values (Section 4.3.5), and trenchless crossings are proposed. The preferred option at the KP 4.3 crossing is to attach the pipeline to the plant access road bridge to be constructed by Paramount. The clear span vehicle bridge will be constructed during fall based on design schematics provided in Appendix F.

Paramount plans to attempt an HDD crossing of d'Easum Creek at KP 20, despite the high risk of failure indicated by experience gained during recent construction of the AEC West Maxhamish pipeline. Paramount proposes an open-cut crossing of this watercourse if the HDD is not successful.

Fort Nelson River

Paramount has concluded that the risk of failure for an HDD crossing of the Fort Nelson River is unacceptably high because of site geotechnical conditions. Site-specific data for the crossing site could not be obtained due to the lack of access. Information collected from ground penetrating radar (GPR) surveys, boreholes drilled on the winter road alignment to the east, and borehole information from the Liard Highway bridge suggests that the floodplain areas close to the channel are underlain by a fairly thick alluvial sand-gravel sequence, generally overlaying clay till that contains thick coarse gravel lenses.

Paramount therefore proposes to construct an aerial pipeline crossing over the Fort Nelson River. Design and construction details and drawings for the Fort Nelson River aerial crossing are included in Appendix F. The structure and construction plan were designed to minimize effects on flow, navigation, and riparian and instream habitat.

The proposed aerial crossing consists of a two span bridge with an overall length of 243.8 m. A steel truss superstructure containing the gas pipeline and walkway will be supported by a bridge pier near the centre of the river channel and bridge abutments located outside the stream channel on the north and south banks. The abutments and instream pier will consist of a steel-walled jacket, supported by driven steel pipe piles and filled with concrete. Construction will begin in January to facilitate access, minimize ground disturbance, and allow equipment to work from the ice. The Northern Bridge and Pile Ltd. construction crew will be housed at the gas plant camp site.

Channel profiles show that the deepest portion of the channel is located south of the instream pier location. Hydrology data indicate that under normal winter flow conditions, the proposed instream pier location will be dry or have less than 25 cm of water.

Site work will be minimized because most components will be prefabricated and trucked to the site. Access to the site will be along the pipeline right-of-way, primarily from the north. Construction will begin in late December or early January with construction of an ice bridge across the river and installation of abutment piles on the north and south banks.

Once ice bridge access is available, the centre pier will be constructed by cutting through the ice at the pier location. If flow is present under the ice, a caisson pipe will be placed on the river bed to contain any substrate disturbance and the first pile pipe will be driven inside the caisson to refusal. The water will then be pumped out, the caisson pipe removed, and the hole in the ice enlarged to accept a prefabricated pier ‘diaphragm’ that is enclosed on the bottom and sides and contains sleeves for the remaining piles. The first prefabricated pier section will be installed over the driven pile and set on the bottom. Remaining piles will then be driven through the diaphragm to refusal. Because the diaphragm is enclosed, disturbance of the substrate will be minimized and contained.

Once all piles are in place, additional diaphragm and pile sections will be welded on until the required pier height is reached. The diaphragm and pile pipes will then be filled with concrete. The superstructure will then be erected using a crane and temporary scaffolding supported on the ice. The pipeline will be strung, welded, tested, and installed on the superstructure after the pier, abutments, and superstructure have been completed. The installed crossing section will be retested after the north and south ends have been tied in.

Muskwa River

Based on a field drilling program and geotechnical review, Paramount proposes a 1.1 km HDD crossing of the Muskwa River and the unstable south approach slope. The preferred approach shown on the schematic included in Appendix F is to drill from an entry point on the cleared flat on the north bank of the river to an exit point at the top of the slope on the south bank. An aerial crossing will be constructed if the HDD crossing is not successful.

The north bank is accessible by an all-weather road and the entry point is on a level, cleared field. Once a pilot hole has been established, the hole will be reamed to enlarge it so that the pipe can be pulled through.

The pipe string will be strung, welded and tested on the south bank along the existing right-of-way prior to being pulled through the hole. Temporary workspace will be required on the crest of the south shore at the exit point and on the pipe setup area. Access to the exit point and pipe set up area will be via the existing WEI right-of-way, which is winter access only. This area will be cleared prior to pipeline construction to allow the HDD to proceed.

Construction of the Muskwa River HDD crossing will commence immediately upon receipt of necessary approvals. The drilling crew will be housed in Fort Nelson.

2.3 Other Field Activities

Several other activities will occur concurrent with construction of the Maxhamish residue gas pipeline. Construction of the Paramount Maxhamish gas plant, raw gas pipeline, and facilities to process and tie-in raw gas reserves in the Northwest Territories occur between August 1999 and March 2000. Additional exploration and development is required in the Fort Liard and Maxhamish fields. Paramount could drill up to 9 additional wells in British Columbia during the winter drilling season to provide natural gas for this project. Estimated drilling and completion expenditures are $16 million.

2.4 Waste Management

The construction, operation, and eventual reclamation and site restoration of the proposed Maxhamish gas processing project will generate a variety of wastes. These will be managed according to a waste management plan stressing waste minimization, reuse, recycling, recovery, and, when required, treatment and disposal. The waste management program will use strategies and principles consistent with prudent oil and gas practices and which meet or exceed evolving regulatory requirements including the B.C. Industrial Pollution Prevention Program, *Waste Management Act, Oil and Gas Production Waste Control Regulation*, and Oil and Gas Handbook, and Environmental Operating Guidelines for the British Columbia Upstream Petroleum Industry (CAPP 1993).

2.4.1 Construction Wastes

Pipeline construction waste streams will consist primarily of: household garbage materials; pipe tape and coating; spent welding rods; used wood materials from shipping, staking, and supports; scrap metal; used geotextile and plastic; cardboard and paper associated with shipping materials; used motor and lube oils and filters; empty paint, solvent and adhesive containers; and batteries. No hazardous waste materials are likely to be generated during pipeline construction.

Where feasible, Paramount's construction contractor will segregate waste streams to ensure that materials can be reused, recycled, or disposed of. Disposal of materials will be consistent with regional landfill and provincial regulatory requirements.

2.4.2 Camp Wastes - Construction and Operations

Solid and liquid domestic waste streams from the 60 man construction camps and the permanent operations camp will be treated and disposed of according to *Ministry of Health Industrial Camp Regulations*, the *Sanitation and Operation of Food Premises Regulations*, and regional landfill disposal requirements. To avoid attracting bears and other animals, putrescible waste will be incinerated on a daily basis in a system compatible with Ministry of Environment, Lands and Parks guidelines (MELP 1994a). All residue will be transported along with non-combustible wastes to the Fort Nelson regional landfill.

2.4.3 Operational Wastes

Various solid and liquid industrial and oilfield wastes will be generated during the projected operational life of the proposed Maxhamish gas processing project. These wastes will be transported to appropriate treatment facilities or temporarily stored on-site (prior to shipping off-site for treatment) according to provincial transportation and storage requirements applicable at the time. An engineered on-site temporary chemical and waste storage facility will be present at the Paramount Maxhamish gas plant for this purpose. All waste materials will be chemically characterized and classified to determine the optimum handling and disposal practices.

2.5 Emergency Response Plan and Preparedness

Paramount will design the Maxhamish residue gas pipeline and associated facilities to prevent potential emergency situations from occurring. The design will meet or exceed all applicable Canadian Standards Association (CSA) standards, prudent oil and gas industry design guidelines and practices, and federal and provincial regulatory requirements.

Paramount will prepare an emergency response and implementation plan to ensure that Maxhamish employees and contractors respond effectively to emergency situations in the unlikely event that they occur. This will maximize protection of the health and safety of the public, Paramount employees, and contractors.

Emergency response plans will be developed in consultation with local and provincial response agencies according to requirements outlined in the *CAN/CSA-Z731-95 Emergency Planning for Industry*. Paramount representatives contacted the Municipal Emergency Response Coordinator based in Fort Nelson and determined that an emergency response plan has been developed for the Town, but not the Regional District. Paramount’s Emergency Response Plan will be registered with the Town, and will include the provincial toll free emergency reporting number. In the event of an emergency the Town will be contacted and would activate their emergency response support system as required.

In order to ensure an effective response in the event of an emergency associated with the Maxhamish pipeline or field facilities, Paramount will develop and maintain an effective training program with project operations personnel and contractors which will include conducting regular mock emergency training exercises.

Paramount will amend its corporate Environmental Response Plan to include Maxhamish facilities to ensure that proper emergency measures are in place. The objective of the plan is to ensure that personnel are familiar with environmental regulations, waste management, spill response and containment and reporting requirements.

2.6 Abandonment and Reclamation

2.6.1 Objectives

At the end of the useful life of the proposed Maxhamish gas processing facilities (not specified, but currently estimated at >20 years), Paramount will review the options, issues, and regulatory requirements for decommissioning and abandonment of the residue gas pipeline. Options could include abandonment in place, or transfer of ownership for continued service.

Factors that will be considered include current and future land use(s); pipeline corrosion and associated ground subsidence; soil and groundwater contamination; watercourse, road, and utility crossings; erosion control and reclamation; post-abandonment responsibilities; ownership and liability; and cost (Pipeline Abandonment Steering Committee 1996).

Paramount's decommissioning and abandonment plan will comply with the regulatory standards of the day, in consultation with stakeholders having an interest in the land and facilities. At minimum, the residue gas pipeline will be purged of gas and cleaned to satisfy concerns regarding soil and groundwater contamination. The right-of-way reclamation objective will be to return the plant site and pipeline rights-of-way to a condition suitable for its initial land use (forest regeneration or agriculture). Paramount will consider modifications requested by government agencies to address specific habitat or land use goals.

2.6.2 Plans and Procedures

Environmental protection measures that will be adopted by Paramount are described in the Environmental Protection Plan included in Appendix D. To maintain long-term productivity of the right-of-way on mineral soils, the trenchline will be ripped to an appropriate depth and frozen material (snow, duff, and topsoil) from ripping activities will be salvaged on the working side. Subsoil will be stored on the spoil side This ripped material will be respread during clean-up. No surface salvage will be conducted on organic soils outside the Agricultural Land Reserve. Where organic soils are underlain by mineral subsoil within trench depth, the mineral spoil will not be allowed to become admixed with organic spoil.

Original drainage patterns will be re-established after construction to the extent feasible. Silt traps and diversion berms will be placed at regular intervals along rights-of-way in order to minimize soil erosion until appropriate vegetation can re-establish. Where necessary, the upper slopes of these berms will be reinforced with slash or sandbags. Diversion ditches or berms will be installed at the base of all slopes adjacent to wetlands. Slope stability and erosion will be monitored and managed throughout the operational period of the pipeline.

Following construction and clean up, slash will be rolled back on level and gently sloping areas along the pipeline right-of-way to minimize erosion and encourage regeneration of native species from the seed bank and adjacent areas. Clean-up and seeding of riparian areas will be initiated as soon as possible following construction to stabilize soils on creek banks and approaches. The seed mix for watercourse and wetland banks and approaches will be developed in consultation with Ministry of Forests and Ministry of Transportation and Highways representatives.

Approximately 12.5 km of the residue gas pipeline right-of-way is within the British Columbia Agricultural Land Reserve (ALR). Paramount has conducted a pre-disturbance survey of these lands and submitted an application to the Provincial Agricultural Land Commission for a special use of these lands. Most ALR lands along the route are forested and topsoil depth is usually less than 15 cm. In these areas, a minimum of 15 cm of duff and mineral soil will be salvaged from the trench area. Stripping depth will be increased if a visible transition is observed during construction. In areas of shallow organic deposits, the entire depth of organics, to a maximum depth of 40 cm, will be stripped and stockpiled prior to construction.

Additional environmental protection measures for the Maxhamish residue gas pipeline are described in Section 4.4, the Biophysical Alignment Sheets in Appendix A, and the Environmental Protection Plan in Appendix D.

2.7 Approvals

Licences, permits, and approvals will be required in addition to the Project Approval Certificate for construction and operation of the

Maxhamish residue gas pipeline. A list of approvals that may be required is provided in Table 2-3.

Environmental assessment per the *Canadian Environmental Assessment Act* (CEAA) is required when, among other provisions, a federal authority issues a permit, licence or approval for a project.

TABLE 2-3
LICENCES, PERMITS, AND APPROVALS THAT MAY BE REQUIRED FOR THE MAXHAMISH RESIDUE GAS PIPELINE.

Possible Licence, Permit, or Approval	**Issuing Agency and Requirements**
PL 101 per *Pipelines Act.*	Oil and Gas Commission: Approval to construct a pipeline.
Temporary Permit for Use of Crown Land per Sect. 14 of the *Land Act*	Assets and Land Corporation/Oil and Gas Commission/Ministry of Forests: Permission to construct on pipeline easement and temporary workspace.
Surface Lease for Crown Land per *Land Act*	Assets and Land Corporation/Oil and Gas Commission/Ministry of Forests: Tenure for use of pipeline easement based on as-built survey.
Licence to Cut under the *Forests Act.*	Ministry of Forests: Provides authority for clearing and specifies merchantable timber salvage requirements.
Special Case Use under Section 44 of the *Agricultural Land Commission Act, B.C. Reg. 313/78.*	Agricultural Land Commission: Approval to use land in the ALR for other than farm use; requires soil survey, topsoil salvage, and reclamation measures.
Compliance with *Industrial Camp Health Regulations, Safe Drinking Water Regulation, Sanitation and Operation of Food Premises Regulation*, and *Sewage Disposal Regulation.*	Ministry of Health: Operation of industrial camps of less than 100 persons.
Leave to Open per the *Pipeline Act*	Oil and Gas Commission: Approval to operate a pipeline.
Approval for Short Term Use of Water per *Water Act Sect. 8.*	Oil and Gas Commission/Environment Land, and Parks: Provides authority to remove water for testing, camp, or other use.
Approval for Proposed Works and Changes In and About a Stream under *Water Act Sect. 9 Regulation.*	Oil and Gas Commission/Environment Land, and Parks: Provides authority for bridge construction, ice bridge construction, road watercourse crossing, pipeline watercourse crossing.
Permit per *Sect. 5.1 Navigable Waters Protection Act.*	Canadian Coast Guard: Provides authority to construct bridge, road, or pipeline crossing of navigable watercourse. Potential CEAA trigger.

Authorization under *Fisheries Act Sect. 35(2)*.	Fisheries and Oceans: Authorization for harmful alteration, disruption or destruction of fish habitat. Potential CEAA trigger.
Permit under *Wildlife Act Sect. 9*	Ministry of Environment, Lands and Parks: Permission to remove beaver dam.
Fuel storage approval per *Fire Services Act*.	Ministry of Municipal Affairs, Office of the Fire Commissioner: Required for onsite storage of more than 22.5 liters of fuel and onsite fuel dispensing.
Approval per *Heritage Conservation Act Sect. 12*	Oil and Gas Commission: Required to excavate or alter sites of archaeological or historical significance.
Road Use Permit	Ministry of Forests: Required to use Forest Service Road.

3. ISSUES SCOPING AND CONSULTATION

Paramount Resources Ltd. has been active in the Northwest Territories and northern British Columbia since the early 1980's, and have openly discussed their activities with local residents since that time. Following the decision to develop the Maxhamish/Fort Liard gas fields, Paramount initiated a public consultation program to provide interested parties with a description of the proposed Maxhamish project and identify any potential concerns and issues.

This section describes the communication activities undertaken by Paramount and the project team and summarizes the environmental and socio-economic issues identified during consultation. Section 3.1 describes the process through which key issues were identified, and the action taken or proposed by Paramount to address these issues. The section includes a table that summarizes the consultation efforts, issues identified, and current status. Section 3.2 describes the consultation process undertaken for each of four stakeholder groups: First Nations; interested public; local, regional, provincial, and federal government; and other resource users. Section 3.3 outlines Paramount's proposed program for ongoing public consultation.

3.1 Issues Scoping

Paramount used various sources to first identify key stakeholders for the Maxhamish project. These sources included the Environmental Assessment Office, the Oil and Gas Commission, provincial Ministries, local leaders of Fort Nelson, and key consultants with previous experience in northeast British Columbia. Pre-Open House consultations were held with directly affected landowners, local, regional, and provincial government representatives, resource users, and members of special interest groups including First Nations.

Project information packages describing the gas supply development area, gathering system, gas battery and processing plant, access roads and residue gas pipeline have been widely distributed. Paramount has personally contacted area residents, local and regional government officials, and other resource developers, in addition to the local First Nations. An afternoon and evening Open House was held in Fort Nelson on July 21, 1999 to provide interested parties with the opportunity to obtain additional information and share their ideas or concerns. Potentially affected trappers and guide outfitters have received written notification and information describing the project and the construction schedule, so plans to minimize disruption to their winter activities can be made.

The intent of the public consultation program was to promote awareness and understanding of the project, seek input in identifying and resolving concerns and issues, seek local knowledge, and advise of opportunities for local contractors, suppliers and employment. Paramount will continue their communication process through the life of the project via ongoing consultation and follow-up on issues.

Table 3-1 summarizes the consultation activities and issues that have been raised relating to the Paramount Maxhamish project. This table also identifies the action taken to resolve or address identified issues.

3.2 Consultation Program

3.2.1 First Nations

The proposed residue gas pipeline route traverses the traditional territory of the Fort Nelson First Nation and the Prophet River First Nation. Paramount forwarded a letter to the Chief of each First Nation, describing the proposed development, and enclosing a map showing the locations of the gas processing facility, access, and pipeline routes. Paramount representatives held follow-up meetings with the Chief, Councillors, and Administrator to discuss the project in person. A Paramount representative also attended the Petitot First Nations Gathering held in early August and made a presentation describing the project.

Land Use Coordinators from both First Nations (Ken Barth Fort Nelson First Nation; Brian Wolf and Robin Tsakoza of Prophet River First Nation) were consulted to determine appropriate methods and areas for studies of traditional land use. Community representatives were given the opportunity to review maps and associated alignment sheets to identify any traditional land use sites.

During the weeks of July 26 and August 2, 1999, helicopter reconnaissance was conducted with representatives identified by each First Nations along the entire length of the proposed residue gas pipeline route. These overflights were conducted to assist in their understanding of the proposed project, identify known traditional use sites, and discuss measures to avoid or reduce potential effects.

Representatives of both First Nations attended the Open House held in Fort Nelson on July 21, 1999. In addition, First Nation representatives assisted with heritage and archaeological field studies on the entire route.

To date, neither the Fort Nelson nor Prophet River First Nation has expressed any major issues or concerns about the proposed development. As indicated in Table 3-1, First Nation representatives expressed interest in business and employment opportunities and identified 16 traditional land use sites in the vicinity of the pipeline right-of-way. Consultation with two members of the Fort Nelson First Nation is still outstanding because they have been travelling and unavailable.

3.2.2 Public Consultation

Paramount’s surface land manager met personally with directly affected landowners and occupants to discuss the project and associated land issues. No outstanding concerns have been identified.

TABLE 3-1
PARAMOUNT MAXHAMISH PROJECT NOTIFICATION
AND ISSUES IDENTIFICATION SUMMARY.

CONTACT	METHODS	ISSUES	STATUS
FIRST NATIONS			
Fort Nelson First Nation	Letter, meetings, route overflight, Open House, Petitot Gathering.	Employment and business opportunities; traditional land use sites; public input.	Interested companies and skills identified; traditional use sites and mitigation measures identified; follow up with 2 individuals and Land Use Coordinator requested.

Prophet River First Nation	Letter, meetings, route overflight, Open House, Petitot Gathering.	Employment and business opportunities; traditional land use sites; public input.	Traditional use sites and mitigation measures identified.
Fort Liard First Nation	letter, meetings, Open House	Employment and business opportunities; traditional land use sites; public input	Traditional land use work completed – no sites identified.
RESIDENTS AND PUBLIC			
Directly affected landowners	Personal, Open House	Compensation	Verbal consents received, written consent will be obtained.
Area residents, general public, businesses	Notices, Radio Spots, Open House.	Business and employment opportunities; economic boost; state of main highway; watercourse crossing techniques.	Interested companies and skills identified; ongoing consultation program will provide requested updates.
FEDERAL and PROVINCIAL GOVERNMENT			
MLA, Peace River	Meeting.	Project overview.	Support for application; regular updates continue to be provided.
Ministry of Energy and Mines for Northern Development	Meeting.	Project overview.	Support for application; regular updates continue to be provided.
Energy and Mines	Meetings, phone.	Plant and infrastructure optimization.	Continue discussions with other area operators.
Oil and Gas Commission	Meetings, route overflight, phone.	Protection of sensitive environmental features, watercourse crossings, effect of Fort Nelson River aerial crossing on flow and fish; potential conflict with marten study.	Site-specific environmental issues identified, winter construction of Fort Nelson River bridge crossing will protect flow and fish; potential conflict with marten study in area immediately south of Fort Nelson River.
Northern Development Commission	Meeting.	Project overview.	Support for application; regular updates continue to be provided.

FEDERAL and PROVINCIAL GOVERNMENT (cont.)			
Ministry of Forests	Meetings, phone.	Effect on Growth & Yield plots and plantations; cruise required for Logging Plan; need to resolve conflict with Slocan on haul road.	Growth and yield plots and plantations will be avoided or compensated; timber cruise initiated on pipeline route; negotiations with Slocan complete.
Ministry of Transportation and Highways	Meeting, phone.	Introduction of noxious weeds; share right-of-way; 90° , bored highway crossings; maintain drainages; widening highway corridor will improve line-of-sight lines and traffic safety.	Agreement to use temporary workspace on Liard Highway right-of-way, agreements will be obtained for highway crossings; reclamation and drainage control will meet MOTH standards.
Ministry of Environment, Lands and Parks	Meetings, phone.	Access development, protection of sensitive wildlife features (swans, wildlife trees).	No sensitive sites or features identified on right-of-way during wildlife studies.
Ministry of Agriculture	Phone.	No grazing lease issues.	N/A.
Small Business, Tourism and Culture	Meetings, phone	Heritage Assessment methodology, Inspection Permit Application, culturally modified trees.	Permit issued. Archaeological Impact Assessment completed and submitted, no culturally modified trees found.
Assets and Land Corp.	Phone.	McConachie Creek Crown subdivision.	Right-of-way agreements will be obtained prior to construction.
Agricultural Land Commission	Phone.	ALR Application for non-farm use	Fieldwork completed and application submitted. Surface salvage to be implemented.
Department of Fisheries and Oceans (DFO)	Meeting, phone.	Potential CEAA trigger exists for watercourse crossings, effect of Fort Nelson River aerial crossing on fish and fish habitat.	Evaluation of Fort Nelson River and d'Easum Creek bridge crossings completed and submitted for review.
DFO Coast Guard	Meeting, phone.	Potential CEAA trigger exists for watercourse crossings, effect of bridge and other crossings on navigation.	Navigation considered in bridge design, evaluation of Fort Nelson River and d'Easum Creek bridge crossings completed and submitted for review, table summarizing channel characteristics included in application.

LOCAL GOVERNMENT / COMMUNITY			
Fort Nelson Chamber of Commerce, Fort Nelson News	Meeting, Open House, phone.	Business opportunities; local benefits, Highway 77 improvements.	Interested companies identified; ongoing consultation program will provide requested updates.
Town of Fort Nelson / Northern Rockies Regional District	Phone, meetings	Keep town informed; local business opportunities; contractor selection process; Highway 77 improvements.	Interested companies and skills identified; ongoing consultation program will provide requested updates, highway upgrading not required for project.
Fort Nelson Fire Department, RCMP, Hospital	Phone, meetings.	No infrastructure additions needed to accommodate the project. Town Emergency Response Plan in place.	Paramount to prepare Emergency Response Plan and file with Town.
RESOURCE USERS			
Trappers	Letter, Open House.	No issues to date.	Ongoing consultation.
Guide Outfitters	Letter.	No issues to date.	Ongoing consultation.
Fort Liard Residents	Meetings, Open House.	No issues with pipeline alignment.	Ongoing consultation.
Westcoast Energy Inc.	Meetings, letter, phone.	Right-of-way sharing.	Up to 6 m temporary workspace available south of Fort Nelson River, no commercially viable opportunities for infrastructure sharing.
AEC West	Meetings, letter, phone.	Infrastructure sharing.	No commercially viable opportunities identified.
Slocan Group	Meetings, phone.	Work and right-of-way adjacent to haul road; logging schedule; woodlands operations; road/traffic.	Survey has confirmed that there is no route overlap and Paramount activities should not conflict with winter haul.

To inform all adjacent landowners, area residents, and other interested parties of the proposed project, Paramount placed a map and notice in local papers and the British Columbia Gazette describing the project and showing the pipeline route and field facility locations. This announcement was placed in the *Fort Nelson News* on July 14 and 21; the *Decho Drum* on July 22 and 29; NWT, *News North* on July 19 and 26; and the *BC Gazette* on July 29 and August 5. A contact name, phone/fax numbers, and e-mail address was provided to accommodate questions or comments on the project. A copy of the advertisement is provided in Appendix B.

Paramount representatives also met with the local Chamber of Commerce in June and July to introduce the proposed project and discuss available services. Of particular interest was information with regard to employment and business opportunities.

On July 21, 1999 Paramount hosted a public Open House in the town of Fort Nelson between 2:00 and 8:00 p.m. During the week of July 5, 1999, notices of the Open House were posted in numerous locations in the town, and provided to the Chamber of Commerce who distributed it to its members. Ads were also placed in the Fort Nelson News on July 14 and 21, and ten radio spots were run between July 14 and 21 announcing the Open House and inviting interested parties to attend. On July 28, 1999 Paramount hosted an Open House in the community of Fort Liard between 7:00 and 10:00 p.m.

During the Open Houses, Paramount engineering, consultation, and land representatives were on hand to discuss project details, including routing and siting, construction schedules, business and employment opportunities. The Fort Nelson Open House was attended by 91 people, representing at least 56 organizations and companies. Open House attendees were asked to complete a questionnaire to identify their interests and concerns. The Fort Liard Open House was attended by 53 people.

None of the Open House attendees expressed negative comments about the proposed project, but all were interested in additional information, particularly relative to business and employment opportunities. The only environmental issue raised related to construction procedures for watercourse crossings. The following questions/issues were raised repeatedly:

- Opportunities for local business and employment;
- Boosting long-term local economy; and
- Maintenance and upgrading of the main highway to enhance tourism and industrial development projects.

Information about timing and nature of contractor, service, and supplier opportunities was included in Information Packages, and provided to people who attended the Open House.

The condition of the main highway is beyond the scope of the Maxhamish project, and highway or infrastructure upgrades are not required to accommodate proposed construction and operation activities. However, Ministry of Transportation and Highways representatives indicated that clearing for the Maxhamish project would improve sight lines along the Highway and could help reduce wildlife/vehicle collisions.

The Fort Nelson Chamber of Commerce, the Town of Fort Nelson/Northern Rockies Regional District, and the Fort Nelson News also raised the issue of business and employment opportunities. The general feeling in the area is that the Fort Nelson area has missed out on petroleum development opportunities in the past, and look at the proposed Maxhamish project as a positive development.

3.2.3 Government

Discussions with provincial, federal, local and regional government agencies commenced in mid-June, and are ongoing. Provincial officials from Energy and Mines, Environmental Assessment Office, Ministry Responsible for Northern Development and Oil and Gas Commission were notified initially to introduce the project and obtain information about provincial issues, application requirements, and the review process.

Regional representatives from these agencies and the Ministries of Transportation and Highways; Forests; Environment, Lands and Parks; and the Assets and Land Corporation and Agricultural Land Commission were consulted regarding regional and site-specific issues and conditions and the application and review process.

Federal officials from the Department of Fisheries and Oceans, Canadian Coast Guard, and the National Energy Board were contacted to discuss federal areas of responsibility and associated regulatory issues, specifically fisheries and navigable waters.

Project information was also provided to representatives of the Town of Fort Nelson and the Northern Rockies and Peace River Regional Districts during meetings and telephone conversations. Information with regard to infrastructure (*e.g*. roads, landfills), regional skills and services, and emergency response plans was obtained from local, regional, provincial, and federal government representatives.

Government representatives outlined study, mitigation, and approval requirements for construction and operation of the proposed residue gas pipeline and field facilities. Representatives noted that many potential issues had been addressed by following existing linear corridors. Environmental issues included the construction procedures for watercourse crossings; the need to identify and protect sensitive sites and

features such as trumpeter swan lakes, wildlife movement corridors, heritage sites, and wildlife trees; and measures to reclaim disturbed areas and avoid introduction of noxious weeds.

Other issues related to road crossings; use of shared workspace; confirmation of merchantable timber volumes with a formal timber cruise; and mitigation of effects on plantation areas, growth and yield plots, and Slocan timber hauling activities.

3.2.4 Other Resource Users

Paramount sent notification letters to the head offices of oil and gas resource developers and pipeline companies active in the area to introduce the project, outline their proposed schedule and seek any comments. In addition, companies with existing gas processing and transportation infrastructure were approached at the outset to discuss various development options. Once Paramount made the decision to develop their own infrastructure, companies with adjacent leases or corridors were approached to discuss right-of-way sharing opportunities.

Registered trappers and guide outfitters potentially affected by the pipeline route were identified and sent a notification letter describing the project, outlining the proposed construction schedule and enclosing an Information Package. The Information Package included a map showing the facility location and pipeline route (Appendix B). Paramount and its representatives also worked with the Prophet River and Fort Nelson First Nations and residents of Fort Liard to identify traditional aboriginal hunting, fishing, or trapping areas and structures.

Forestry companies active in the area were notified about the proposed project, and discussions were held regarding exact locations of woodland operations, regeneration areas, road use, and traffic issues.

Energy companies contacted during the notification process have raised no issues. WEI has agreed to allow Paramount to utilize up to 6 m of temporary workspace on WEI's existing gas pipeline right-of-way south of the Fort Nelson River.

Slocan Group representatives expressed concern that the proposed pipeline alignment along the west edge of the WEI right-of-way could affect their winter timber haul and plans to widen the haul road. They requested that the pipeline alignment be moved to parallel the east edge of the WEI right-of-way. Paramount's position was that this is a less favourable alternative because the WEI pipeline is located near the east side of the right-of-way. As a result, shared workspace would not be available, the residue gas pipeline right-of-way would need to increase from 12 m to 18 m in width, and an incremental area of about 30 ha would need to be cleared. Paramount completed a survey that demonstrates that there is sufficient room for the proposed 12 m right-of-way between the WEI and Slocan easements. Slocan representatives subsequently withdrew their objection to the proposed route.

To date, no issues have been raised by guide outfitters or trappers potentially affected by construction/operation of the Maxhamish residue gas pipeline.

3.3 Ongoing Consultation Activities

Paramount has made a commitment to First Nations, and other groups and individuals to continue communications regarding the Maxhamish project. Consultation will continue to be maintained through correspondence, a newsletter, telephone calls, personal contacts, and formal and informal meetings.

Landowners and other key contacts have been provided the name and phone number of a Paramount representative, and have been invited to call collect to share information or voice concerns.

Paramount will prepare advertisements notifying area residents that the application has been submitted to the Environment Assessment Office (EAO) for review and that copies are available for viewing in Fort Nelson, Fort St. John, and Victoria. Paramount will solicit feedback on the application from the general public as well as the other key stakeholders identified above.

The successful pipeline and gas plant contractors will be announced in the Fort Nelson News. This will provide an opportunity for interested contractors, suppliers, service companies and skilled trades people to contact the contractors to offer their services directly to them.

A newsletter will provide regular updates on the progress of the project and inform recipients of upcoming events of interest in connection with the proposal. This newsletter will be sent to all residents in the area using direct mail contracted through Canada Post.

4. ENVIRONMENTAL ASSESSMENT

This section provides information on the potential physical and biological effects of the proposed Maxhamish project. It begins with a discussion of the assessment scope and methods (Section 4.1), and then describes the environmental issues identified during the consultation process (Section 4.2). An overview of existing information and the current biophysical setting is provided in Section 4.3–this focuses on anticipated issues identified by the public, First Nations, government representatives, and Project Team members. The potential effects of the Maxhamish residue gas pipeline and the mitigative measures to be employed to prevent or reduce these effects are described in Section 4.4. Potential cumulative effects of this project and other disturbance sources are described in Section 4.5.

4.1 Assessment Scope and Methods

The Project Team identified in Section 1.2.1 undertook the environmental assessment of the proposed Paramount Maxhamish project. Preliminary work was initiated in mid June 1999 to evaluate project alternatives, identify pertinent data sources, and define required data collection programs. Consultation with local residents and government, First Nations and public representatives was initiated in late June to identify biophysical issues and confirm proposed study methods. Fieldwork was conducted in early to mid July when conditions were appropriate for soil, vegetation, and aquatic surveys.

4.1.1 Study Area Boundaries

Biophysical study areas were selected to reflect the anticipated zone of influence for each potential impact and pathway. The study area boundary for each biophysical component was defined as the largest zone of influence applicable to that component (Table 4-1). A map of the Maxhamish project area is included as Figure 4-1.

A 3-km wide corridor centred on the proposed right-of-way was selected as the terrestrial study area for the pipeline right-of-way. This zone of influence has been used in other terrestrial environmental assessments in northeast British Columbia (*e.g.*, WEI 1994a,b; WGSI 1995; Salmo *et al*. 1996). It is based on scientific literature that indicates that temporary disturbance effects on large mammals extend for 1 km or less in forested areas with limited line of sight (Antoniuk 1994; WGSI 1995). Most long-term effects on habitat and wildlife habitat capability are confined to the disturbed area along the right-of-way, or an area within 500 m that may be affected for species that require interior forest habitats.

Potential effects on soils, archaeological and heritage resources are confined to the disturbed area along the right-of-way.

Long-term pipeline-related effects on aquatic resources are largely associated with changes to habitat in the immediate crossing area, and downstream sedimentation from construction and chronic erosion. Most sediment appears to be deposited within 500 m of the construction site

(Macdonald and Bjornson 1993). This zone of influence is recognized in the habitat survey requirements specified by MELP and DFO (DFO/MOE 1989; MELP 1994b) which require habitat mapping to at least 200 m below the proposed crossing.

TABLE 4-1
BIOPHYSICAL STUDY AREAS USED FOR THE
PARAMOUNT MAXHAMISH PROJECT ASSESSMENT.

Biophysical Component	**Study Area 'Radius'**
Aquatic Habitat and Fisheries	500 m below stream crossing sites
Terrain and Soils	Disturbed areas

Vegetation	1.5 km from pipeline right-of-way
Wildlife	1.5 km from pipeline right-of-way
Archaeological and Heritage Resources	Disturbed areas

4.2 Environmental Issues List

Potential biophysical issues associated with construction and operation of the proposed Maxhamish project were identified by the study team from a number of sources. These included:

- Consultation with public, First Nations, and government representatives in Fort Nelson, Fort Liard, Fort St. John, Prophet River, Prince George, and Victoria;
- Recent environmental assessments from the region (Antoniuk 1994; WGSI 1995; Salmo *et al*. 1996, 1997; TERA 1998);
- Review of environmental assessment guidelines prepared by the British Columbia Environmental Assessment Office (EAO 1995);
- Published literature on impact sources and effects; and
- Project team knowledge of existing resources and likely effects.

Identified issues were used to focus the environmental assessment on topics that were relevant to the Maxhamish project as proposed, or that were of concern to affected stakeholders and residents. These issues are summarized in Table 4-2.

TABLE 4-2
ENVIRONMENTAL ISSUES IDENTIFIED FOR THE
PARAMOUNT MAXHAMISH PROJECT

Environmental issues identified for the Paramount Maxhamish project.

Environmental Issue	**Project Phase**	
	Construction	Operation
Waste Management		
• Management of camp and construction wastes	X	X
Soils		
• Loss of soil capability	X	X

• Erosion and slumping	X	X
Vegetation		
• Alteration/loss of rare plant communities	X	X
• Inadvertent wildfires		X
Wildlife		
• Habitat alteration and loss	X	X
• Reduced habitat effectiveness	X	X
• Increased access	X	X
• Project-related mortalities	X	X
• Effect on species at risk	X	X
• Effect on sensitive habitat (licks, movement corridors, trumpeter swan nesting, and wildlife trees)	X	X
• Recreational activities of contractors and staff	X	X
• Cumulative effects		X
Aquatic Resources		
• Sedimentation from instream activities and right-of-way runoff	X	
• Riparian and instream habitat alteration and loss	X	X
• Contamination from spills	X	X
• Recreational activities of contractors and staff	X	X

• Effects on navigation	X	
• Cumulative effects		X
Resource Use		
• Loss of timber resources and disruption of timber hauling	X	X
• Disruption of trapping	X	X
• Disruption of recreational and subsistence pursuits	X	X
• Disruption of traditional aboriginal uses	X	

4.2.1 Environmental Indicators

Evaluation of project-related effects was restricted to representative environmental indicators. This widely accepted approach has been adopted because it is not practical to consider all possible effects on each resource or species (Beanlands and Duinker 1983). The environmental indicators selected for the Maxhamish project assessment and the rationale for their selection are provided in Table 4-3.

TABLE 4-3
ENVIRONMENTAL INDICATORS USED FOR THE
PARAMOUNT MAXHAMISH PROJECT ASSESSMENT.

Environmental Indicator	**Rationale for Selection**
Vegetation Unit	Bounded areas with specific climatic, terrain, soils, and vegetation conditions; used to identify sensitive areas, quantify areal extent of terrestrial disturbances, and potential effects on vegetation and wildlife.
Red- and Blue-Listed Wildlife Species (Cape May warbler, Bay-breasted warbler, Philadelphia vireo, Northern goshawk, Northern long-eared myotis, Bison)	Species of provincial management concern because of very low or questionable population status (Red- or Blue-Listed).
Wildlife Species of Regional Management Concern (Pine marten, Elk, Moose, Woodland caribou)	Species of regional concern because of economic or recreational importance, low or questionable population status or habitat loss.

Fisheries Habitat Capability	Established habitat survey procedures exist; allows seasonal and life-history stage sensitivity to be identified and assessed.
Arctic grayling	Important regional sport fish; spring spawner; sensitive to overfishing.
Total Cleared Area	Numerical indicator of sub-regional forest loss and fragmentation. Used to assess potential combined effect of proposed Maxhamish project and existing sub-regional clearing.
Access Density (km right-of-way/km^2)	Numerical indicator of sub-regional habitat effectiveness; relationships between access density and habitat effectiveness have been developed for some large mammals. Used to assess potential combined effect of proposed Maxhamish project and existing sub-regional access development.

4.3 Environmental Setting

This section describes existing biophysical conditions in the Maxhamish project environmental study area to provide a context for the environmental assessment that follows in Section 4.4 and 4.5.

Each biophysical component begins with a general overview based on available regional information and pertinent technical references. A more detailed description of the Maxhamish project environmental study area follows. This site-specific discussion utilizes data from field investigations and other pertinent sources and emphasizes the environmental issues and indicators described above.

4.3.1 Climate and Meteorology

Climate Normals are available for the Fort Nelson meteorology station for the period 1961-1990 (Environment Canada 1998). The following discussion of climate and meteorology in the Maxhamish project area is based on Climate Normals and DeLong *et al*. (1991).

The Fort Nelson region is characterized by a northern continental climate with long, very cold winters and short growing seasons. During the winter months, conditions are dominated by arctic air masses. However occasional intrusions of warm maritime air can result in periods of rapid warming.

The mean annual daily temperature is –1.1ºC. Daily maximum temperatures can exceed 20ºC in April through October, but monthly average temperatures remain below 0ºC for five months of the year (November through March), and above 10ºC for only three months of the year (June through August). The extreme recorded minimum temperature is –51.7ºC and temperatures below freezing have been recorded in all months except July. The ground freezes deeply for a large part of the year and discontinuous permafrost is present in the region, but none has been identified along the route.

Annual precipitation averages 448.5 mm, with 68% falling as rain. Extreme daily rainfall is 80.5 mm during August, but high intensity events have also been recorded in May, June, and July. On average, snow cover is present in September through April.

Winds are generally light, averaging 7 km/hr. Extreme hourly winds averaging 45 to 72 km/hr occur from the west, northwest, and southwest during all months of the year.

4.3.2 Terrain and Soils

Landform mapping and terrain classification for the proposed pipeline route was carried out by means of air photo interpretation, on 1:15 000 scale colour air photos flown in 1997, using the system described by Howes and Kenk (1988). Limited ground truthing was carried out during an on-ground and helicopter-supported route reconnaissance undertaken in company with other project team members on June 21 and 22, 1999. In terms of terrain survey intensity level (TSIL), the work was carried out at TSIL D (B.C. Forest Service and B.C. Environment 1995, Table 1).

Terrain stability ratings were assigned during the mapping exercise. The classification presented in B.C. Forest Service and B.C. Environment (1995, Table 3) was used. This employs a five-class rating scheme, ranging from I (low) to V (high), to reflect the likelihood of landslide initiation following right-of-way development or clearing. However, due to the prevalence of gently sloping low-relief terrain along most of the pipeline route, where Class I and II ratings are assigned, stability ratings are not shown on the alignment sheets (Appendix A). Local terrain segments assigned ratings of Class III or greater are identified and discussed in Section 4.3.2.3.

Soil investigations were also undertaken along the proposed route. At each vegetation sampling site, a soil pit was excavated to an average depth of 40 cm and further probed to an average depth of 80 cm. Soils in the study area had a high water content at the time of survey (July 12-16, 1999) and classification of moisture regime relied heavily on an assessment of texture, terrain, and vegetation cover in addition to other soil parameters. Soil classification was completed in accordance with the standards and guidelines established in the Canadian System of Soil Classification (Agriculture Canada 1987). Additional soil investigations were undertaken on Agricultural Land Reserve lands crossed by the right-of-way using the protocol defined in General Order 293/95 (Agricultural Land Commission 1995).

Summary information on the terrain units encountered in the Maxhamish project area is provided below in Section 4.3.2.1. More specific data on the pipeline right-of-way are presented in Sections 4.3.2.2.

4.3.2.1 Regional Setting

Physiographically, the regional study area is located within the Fort Nelson Lowland subdivision of the Alberta Plateau, in turn part of the Interior Plains. Topographic conditions are relatively homogeneous, comprising a succession of gently sloping to undulating moraine areas and muskeg-infilled terrain depressions, with occasional bedrock-controlled uplands. Greater relief and steeper slopes exist along several small meltwater channels and at the larger watercourse crossings. Elevations along the pipeline range from about 600 m asl on the bedrock-controlled uplands to less than 300 m asl at the Fort Nelson and Muskwa river crossings.

According to Taylor and Stott (1968) and Stott (1982), the study area is underlain by bedrock of Upper and Lower Cretaceous age. These units comprise: Dunvegan Formation conglomerate; sandstone and shale; Sikanni Formation sandstone, siltstone and shale; and Fort St. John Group and Buckinghorse Formation marine shales with minor siltstone and sandstone. Bedrock is exposed locally along incised river and creek valleys in the area but was not observed close to the proposed pipeline or plant site. However, Dunvegan Formation occurs at shallow depth in several areas along the pipeline route north of the Fort Nelson River.

Although Mathews (1980) has mapped the area at a reconnaissance level, the surficial geology of this part of northeast British Columbia is not well known. Landforms and surficial deposits within the project area, as mapped from air photos, are shown on the Biophysical Alignment Sheets in Appendix A. Gently sloping to undulating, locally ridged, moraine (till) areas and level to depressional organic bogs and veneers (muskeg) are predominant, with some moraine-veneered bedrock uplands. Less widespread are alluvial silt-sand-gravel floodplains and terraces along the rivers and larger creeks, and colluvium, on meltwater channel walls and along the river and more incised creek valleys. A small outwash-esker complex, consisting of glaciofluvial sand and gravel, is traversed at the north end of the project.

Evidence of landslide activity in the area is limited, based on air photo interpretation and field observations. Thus, active instabilities appear to be confined to the major river valleys, where large translational failures affect the valley walls. As well, small slumps likely also exist locally along the meltwater channels and more incised creeks/drainages.

The regional study area is located within the southern fringe of the discontinuous permafrost zone. Perennially frozen ground is anticipated to be sporadically distributed and shallow (Crampton 1978). It occurs in thick muskeg areas and, where present, is generally degrading (*i.e.* slowly melting).

Soils occurring in the study area are dictated by soil parent materials and topographic position. Most of the right-of-way is characterized by a silty loam to silty clay loam matrix with a low coarse fragment content. Organic parent materials are also present throughout the study area, in poorly drained, low-lying level to depressional landscapes. Additional information on these deposits and associated soils is provided below.

Till Parent Materials

Glacial till deposits occupy gently sloping mid- to lower-slope positions, and level plateaus within the study area. Soils forming from till parent materials are variable, largely dependent on topographic position and drainage. They include a mosaic of brunisolic, luvisolic, gleysolic, and regosolic profiles. Orthic Gleysols, Orthic Gray Luvisols, Dark Gray Luvisols, and Orthic Dystric Brunisols are the most common profiles identified within the low-relief morainal landscape.

Orthic Gleysol

Gleysolic profiles dominate glacial till deposits across much of the low-relief morainal landscape. Orthic Gleysols are imperfectly drained soils with slow to moderate perviousness, occurring in level to slope toe landscape positions. Often the profiles are overlain by a thick, up to 40 cm, layer of moss under a mature black spruce forest canopy. Profiles are characterized by subsoil (Bg) horizon which is gleyed gray to olive gray in colour, with distinct yellowish brown mottles, and a silty loam texture. The till parent material (Cg horizon) is very dark grayish brown and silty loam. Some profiles were characterized by a black, loamy topsoil (Ah) horizon up to 7 cm thick, and sometimes containing charred wood fragments indicative of past fires in the area.

Orthic Gray Luvisol

Luvisolic soil profiles are moderately well to well drained, occurring on east to northeast aspect slopes of generally less than 5%. Profiles are characterized by a thin, ‘mor’ LFH layer overlying a silty, brown to pale brown Ae horizon. The subsoil (Bt) horizon is yellowish brown, clay loam, with a subangular blocky structure and friable consistency. The till parent material (C horizon) is very dark grayish brown, silty clay loam in texture and massive. Typically the coarse fragment composition is less than 5%, and any gravels or cobbles present tend to be located at the boundary of the Bt and C horizons.

Dark Gray Luvisol

Luvisolic profiles are moderately well to occasionally imperfectly drained and occur in association with very gentle southwest-facing slopes. The profiles are characterized by a moss surface layer, up to 15 cm thick, overlying a very dark grayish brown, silty clay loam, Ah or Ahe horizon. The underlying Ae horizon is pale brown and silty in texture, followed by a clay to clay loam, dark grayish brown Bt horizon. The parent material (C) horizon is mainly silty loam, very dark gray, and with no coarse fragments present. In some cases the C horizon is weakly gleyed.

Orthic Luvic Gleysol

On lower slope and level landscapes luvisolic soils are often subject to imperfect drainage conditions and become characterized by gleyed and/or mottled subsoil and parent material horizons. The resultant profiles are typically characterized by a surface covering of moss, up to 20 cm thick and overlying a silty loam, light brownish gray Ae horizon. The subsoil (Btg or Btgj) horizon is dark grayish brown to olive gray, and has a clay loam to silty clay loam texture. Faint mottles are common and clay skins may be present. The parent material is dark gray, relatively free of coarse fragments, and has a silty loam to silty clay loam texture.

Orthic Dystric Brunisol or Eutric Brunisols

Brunisolic soils occurring on till parent materials occupy well-drained, largely east-facing, very gentle slopes (<3%). Typically these profiles occur under coniferous forest cover and they are characterized by thin surface layer of mosses/lichens or LFH materials ($\leq$ 5 cm), overlying a very shallow to absent topsoil (Ah or Ahe) horizon. The subsoil (Bm) horizon is a characteristic yellowish brown, silty loam texture, friable to firm, and with a poorly developed structure. The glacial till parent material (C horizon) is variable grayish brown to olive brown, silty loam in texture, and massive. The lighter-colour of the C horizon, when compared to the luvisolic and gleysolic profiles, is attributed to drainage conditions. Occasionally profiles are characterized by the presence of a light-coloured, silty eluvial (Ae) horizon, hence their designation as Eluviated Dystric Brunisols.

Cumulic Regosol

Cumulic Regosols occur on terrace bench locations in valleys of the major rivers. Soil textures range from coarse sandy loam to silt loam. They are made up of dark gray silt loam and loam horizons (Ck) and grayish brown sandy loam horizons whose exact arrangement and thickness vary considerably according to the depositional history of the alluvium. All horizons are moderately calcareous. These soils are moderately well drained and moderately permeable.

Organic Parent Materials

Organic deposits occur in association with level to depressional basins within the study area, where peaty organic materials have built up and form the basis for the development of organic soils. Within the study area, organic parent materials often occur as a blanket overlying silty clay loam or clay till or lacustrine deposits. Where these mineral materials are encountered at a depth of less than 60 cm, soils are classified as peaty-phase gleysols rather than true organic soils. These peaty phase profiles are more commonly encountered in the study area than deeper organic profiles.

Orthic Gleysol, peaty phase
Orthic Gleysols occurring in poorly drained depressional areas are distinguished from Orthic Gleysols in imperfectly drained landscapes by the degree of gleying in the profile and the presence of a thick sequence of organic layers above the mineral surface. Typically these soils occur in association with stunted black spruce, pine, and bog birch communities. Profiles are characterized by variable moss and organic horizons (Of, Om, and Oh) at the surface, but which are less than 60 cm in total depth. The mineral (Cg) horizon is typically a very dark grayish brown, with distinct olive brown mottles. The mineral soil is dominantly clay but may also be silty loam when such profiles occur near the margin of the depressional area. During the time of the survey (July 12-16, 1999) water was encountered at or near the surface of the profile.

Terric Humic Fibrisol
These shallow organic soils have a surface layer of relatively undecomposed moss, sedge and root remains that overlay a black layer of well-decomposed organic material. The mineral soils underneath is a dark silty gray clay. The depth of the organic material varies from 61 to 122 cm and free water lies at or near the surface all year round.

Terric Mesisol
Profiles are characterized by a sequence of organic horizons (Of, Om, Oh) with a total depth of approximately 70 cm. The underlying mineral soil (Cg) was identified as very dark gray with a clay texture. These soils are very poorly drained with water at the profile surface and standing water was often noted.

4.3.2.2 Pipeline Route

As noted, the pipeline study area is predominantly characterized by level to gently undulating (moraine) and level to depressional (muskeg) areas, with some moderate- to steep-sided, flat-topped, bedrock-controlled uplands. Elevations along the pipeline range from about 425 m asl at the Paramount Maxhamish gas plant, to about 600 m asl on the bedrock-controlled uplands, to less than 300 m asl at the river crossings, to about 400 m asl at the Fort Nelson gas plant site. Slopes are mostly in the 5 to 10 degree range, or less. Greater relief and steeper slopes occur along the edges of the bedrock uplands, at the river crossings and along incised meltwater channels and creek/drainage valleys.

Pertinent geotechnical and terrain information for the residue gas pipeline route is noted on the Biophysical Alignment Sheets included in Appendix A.

Bedrock of Upper and Lower Cretaceous age underlies the study area. According to Taylor and Stott (1968) and Stott (1982):

- Fort St. John Group marine shale, with minor siltstone/sandstone, underlies the initial route segment, between the gas plant and the south crossing of d'Easum Creek.
- South from d'Easum Creek, at KP 19, to about KP 62, the pipeline traverses Dunvegan Formation sandstone, conglomerate and shale.
- Fort St. John Group and Buckinghorse Formation (marine shale, with minor siltstone/sandstone) underlie the route between about KP 62 and 109.
- From KP 109 to 133 approximately, where the alignment crosses a prominent upland area to the northwest of Fort Nelson, Sikanni Formation sandstone, siltstone and shale underlies the right-of-way.
- The final route segment, south from about KP 133 to the Fort Nelson gas plant, traverses Buckinghorse Formation marine shale and minor sandstone.

No bedrock exposures were observed close to the proposed pipeline route. As noted however, air photo interpretation and field observations indicate Dunvegan Formation strata, including conglomerates and sandstones, occur at shallow depth in several areas, along the edges and on top of bedrock-controlled uplands, between KP 32 and 73 approximately. Shallow bedrock (Sikanni Formation) may also be encountered locally on the upland northwest of Fort Nelson.

The alignment sheets (Appendix A) show the distribution of landforms and surficial materials, as mapped from air photos. The pipeline route is subdivided for discussion into segments within which terrain/surficial geology conditions are similar. In summary:

- Between the plant site and the Liard Highway, poorly drained organic bog and veneer is mostly traversed, with some short ground moraine (till) and outwash-esker sections. d'Easum Creek is crossed at about KP 4.6.
- The alignment next follows the Liard Highway south to the Fort Nelson River, a distance of nearly 82 km. Ground moraine and

moraine-veneered bedrock is predominant, with short organic bog/veneer, colluvial slopewash and alluvial floodplain segments. d'Easum and Tsinhia creeks are crossed, at about KP 19 and 66, along with a number of unnamed tributaries.

- At the Fort Nelson River crossing, the route is offset approximately 100 m downstream of the existing WEI pipeline crossing. The valley is about 2.6 km wide and 40 m deep, with sand-gravel terraces and an extensive valley bottom floodplain on the north bank. The river channel was 240 m wide and over 6 m deep at time of survey. The moderately sloping south valley approach is about 40 m high.
- South from the river for about 42 km, the pipeline is mostly routed between the WEI pipeline and a Slocan winter road. It traverses level to depressional organic bog/veneer terrain for the most part, with some, locally fairly extensive, ground moraine sections. Stanolind Creek, a major tributary and Cridland Creek are crossed, at about KP 104.6, 109.2 and 127.9 respectively.
- Continuing south to the Muskwa River, a distance of nearly 18 km, the pipeline follows the WEI alignment, the Slocan road having diverged from the corridor. It crosses ground moraine predominantly, with some short moraine veneer and muskeg sections. McConachie, Donaldson, and Pebble creeks are crossed, at about KPs 133.9, 140.2 and 148.0, along with the Alaska Highway.
- The Muskwa River valley is 1,800 m wide and 100 m deep in the crossing area, where the WEI alignment is, again, paralleled. The 190 m wide, up to 3 m deep, channel is bounded by level inactive floodplain/low terrace areas in the valley bottom, and the south valley wall is affected by an active translational landslide.
- South to the Fort Nelson gas plant, the alignment parallels the existing WEI pipeline, mostly traversing organic bog and veneer with short ground moraine sections. Colluvial terrain is encountered at the crossings of several incised drainages, all tributaries of the Fort Nelson River.

Landslide activity is limited, with active instabilities apparently confined to the major river valleys and isolated moderate- to steep-sided meltwater channels and incised creek/drainage valleys. With respect to terrain stability, most of the latter route segments, identified on the alignment sheets, were assigned a Class III rating. The south approach slope at the Muskwa River crossing is an exception, and a Class V terrain stability rating was assigned. In this area, the entire valley wall is affected by a large translational landslide, as well as a variety of smaller and shallower instabilities.

"Speckled bog", generally indicative of degrading permafrost, is visible within several thick muskeg areas, and perennially frozen ground may be present within other bogs crossed by the pipeline. However, excepting the initial route segment, between the gas plant and the Liard Highway, the route parallels existing linear disturbances, *i.e.* the WEI pipeline and/or Slocan winter road, in all these areas. As permafrost is expected to have degraded within the existing disturbed areas, it is unlikely extensive bodies of frozen ground will be encountered within these right-of-way segments, if at all. No frozen layers, continuous permafrost, or soil profile horizons with a high ice content were encountered at any of the locations that where assessed.

Dominant soils occurring along the proposed pipeline route have been previously described for the region. Soils occurring on glacial till deposits are relatively stone free. Organic soils are categorized into two groups: soils with peat veneer overlying mineral materials; and soils with an organic deposit depth in excess of 60 cm.

Most Agricultural Land Reserve lands are forested, and topsoil depth is usually less than 15 cm. Poorly drained organic Terric Fibric Mesosols, Rego Humic Gleysols, and Terric Humic Fibrisols dominate. Orthic Gray Luvisols and Cumulic Regosols are present on moderately and gently sloping land.

4.3.3 Vegetation

4.3.3.1 Regional Setting

The Maxhamish project area lies within the Taiga Plains Ecoprovince, and two Ecoregions; smaller scale divisions of the landscape based primarily on similar physiography and hydrology. The Fort Nelson Lowland Ecoregion encompasses the watershed of the Muskwa, Prophet, and Fontas rivers which are at the source of the Fort Nelson River. The Etsho Plateau Ecoregion lies north of the Fort Nelson Lowland and encompasses Maxhamish Lake and extends into Northwest Territories on the west side of the Petitot River (MELP 1994a).

Under a different classification scheme, the project lies entirely within the Moist Warm subzone of the Boreal White and Black Spruce Biogeoclimatic zone (BWBSmw; Meidinger and Pojar 1991). Biogeoclimatic zones are large geographic areas influenced by the same regional climate, while subzones are areas with a distinct climax plant association. In the Maxhamish project area, drainage patterns and fire history are two important factors that affect vegetation communities.

The Etsho Plateau is dominated by poorly drained wetlands (50-70%) characterized by open, slow growing conifer-dominated stands of predominately black spruce. Better-drained upland sites support white spruce, balsam poplar, and aspen mixedwood stands. The Fort Nelson Lowland is characterized by closed mixed stands of trembling aspen, balsam poplar, white birch, white spruce, black spruce,

lodgepole pine, and balsam fir. Poorly drained wetlands (bog and fens) comprise about 30% of the Ecoregion and are covered by black spruce and tamarack.

4.3.3.2 Pipeline Route

Vegetation communities of the proposed Maxhamish residue gas pipeline route were delineated using 1:30 000 black and white and colour aerial photographs prior to field reconnaissance. Fieldwork, conducted between July 12 and 16, 1999, was used to ground truth and sample representative areas, as well as identify any potentially sensitive or unique vegetation communities. The field program concentrated on gathering information at representative sites on and adjacent to the proposed pipeline corridor. Areas were accessed on foot, via helicopter, and vehicle transport; sample sites are shown on Biophysical Alignment Sheets in Appendix A.

Prior to the field survey, the status of rare plants in British Columbia (Douglas *et al.* 1998 and BCDC 1998) and COSEWIC lists were reviewed. A list of potential rare plant species was assembled, with inclusions based on previously recorded locations and preferred habitat. Further, an examination of herbarium specimens, for listed rare plants, was completed prior to the fieldwork. During the field survey, samples that could not be identified in the field were collected and compared to herbarium samples for positive identification.

Vegetation sampling concentrated on two main tasks: mapping vegetation types on the proposed route, and describing the species within the representative vegetation types. An incidental survey for rare plants was also conducted as part of this field program.

The vegetation description for each sample site investigated included; plot location, date, general vegetation, terrain features, and significant slopes. At each representative area, several sites with different vegetation covers were sampled. A general walk through was conducted to assess the area, followed by the selection of a "typical site" or plot. For each plot, the collective cover of all trees, shrubs, forbs, graminoids, mosses and lichens was determined. Each observed species was then listed, and community dominants determined. A structural description of the vegetation community, using height and diameter measurements, was also determined. All unknown species were collected and the voucher sample later identified. Weed and rare plant potential were also noted as part of the field investigation.

Vascular Plants with Special Conservation Status

A list of rare and endangered vascular species compiled for the project area is included in Table 4-4. This list is based on data from Douglas *et al.* (1998), the Conservation Data Centre Tracking List for the Fort Nelson Forest District (1998) and the Committee on the Status of Endangered Wildlife in Canada (COSEWIC) list. The final list was adjusted to reflect those habitats actually present along the project route. Wetland habitats have the highest potential for rare plants; over 70% of the listed plants have some type of bog, marsh, meadow, shoreline or riverbank listed as its preferred habitat.

Vegetation communities intersected by the proposed pipeline right-of-way are noted on the Biophysical Alignment Sheets included in Appendix A. Dominant community types are described below.

Black Spruce Dominated Communities

Black spruce dominated vegetation communities have topography and moisture regimes that result in an edaphic imposed climax of black spruce. They typically occur in level to depressional areas with submesic to hygric moisture regimes. The dominant tree cover is black spruce, with sparse, scattered tamarack throughout. Trees form an open canopy composed of trees that vary in height (2-10 m) and diameter (1.8-11.5cm). The understory is composed of short shrubs dominated by Labrador tea and including other species such as: cinquefoil, sweet gale, leather leaf, bog laurel, and small black spruce and tamarack. Dwarf shrubs such as lingonberry, crowberry, small bog cranberry, alpine bearberry and forbs such as cloudberry, three-leaved solomon’s-seal and round-leaved sundew are distinct plant species that characterize this community. An accumulating moss ground cover, dominated by peat and feather moss, underlies other vegetation. In transition areas between upland and lowland complexes, including small ridges or knolls in lowlands, drainage is sufficient to prevent the stunted tree growth characteristic of the lowland black spruce community. These areas continue to be dominated by black spruce, but plant species more characteristic of upland sites are present, which results in vegetation with elements of both upland and lowland communities. Depending on the canopy closure, scattered clumps of tall alder or willow (4-7 m in height) can occupy 2 to 5% of the total cover. Scattered forbs and short shrubs typically cover 5 – 10 % of the area and include: low bush cranberry, prickly rose, bunchberry, and palmate-leaved colt’s-foot. These moderately well drained sites generally have an understory dominated (60 to 80%) by feather, stairstep, and knight’s plume mosses.

Mixedwood Upland Communities

Mixedwood Uplands have gentle to moderate slopes with subxeric to mesic moisture regimes. There is a natural progression of this forest through various seral stages over time, and all stages are encountered along the pipeline. The tree canopy is composed of a variable mixture of deciduous and coniferous trees with each tree type representing from 10 - 90% cover. The most common mixedwood association is white spruce with trembling aspen. However black spruce, white birch, balsam poplar and lodgepole pine are present in varying proportions, sometimes replacing trembling aspen or white spruce as the dominant canopy species.

TABLE 4-4
VASCULAR PLANTS WITH SPECIAL CONSERVATION STATUS
THAT MAY OCCUR IN THE
PARAMOUNT MAXHAMISH PROJECT AREA.

Scientific Name	Status	Common Name	Habitat
Astragalus umbellatus	BLUE	Tundra Milk Vetch	Moist to wet sites
Botrychium crenulatum	BLUE	Dainty Moonwort	Moist grassy riverbanks
Carex bicolor	BLUE	Two-colored Sedge	Moist to wet meadows
Carex heleonastes	BLUE	Hudson Bay Sedge	Bogs
Carex lapponica	BLUE	Lappland Sedge	Wet bogs and open bog forests
Carex maritima	BLUE	Curve-Spike sedge	Mesic meadows and rocky slopes
Carex membranacea	BLUE	Fragile Sedge	Bogs shorelines and wet meadows
Carex sychnocephala	BLUE	Many Headed Sedge	Wet places and open woodland meadows
Castilleja gracillima	BLUE	Slender Paintbrush	Wet meadows and marshes
Cicuta virosa	BLUE	European Water Hemlock	Marshes ponds and lakeshores
Eriophorum vaginatum ssp. spissum	BLUE	Sheathed Cotton-Grass	Bogs marshes and wet meadows
Euphrasia arctica var disjuncta	BLUE	Arctic Eyebright	Wet sites and bogs
Galium labradoricum	BLUE	Northern Bog Bedstraw	Marshy ground moist woods bogs
Gilia capitata var capitata	RED	Globe Gilia	Dry sites in lowlands, montane
Glyceria pulchella	BLUE	Slender Manna-Grass	Ponds and ditches
Impatiens capensis	BLUE	Touch-Me-Not	Wet woodlands

Juncus arcticus spp alaskanus	BLUE	Arctic Rush	Tidal flats and lake margins
Juncus stygius ssp americanus	BLUE	Bog Rush	Wet margins of bogs and marly seepages
Liparis loeselii	RED	Loesel's Liparis	Fens, moist thickets and bogs
Luzula rufescens	BLUE	Rusty Wood-Rush	Bogs, marshes, and river bars
Malaxis paludosa var brachypoda	BLUE	One Leaved Malaxis	Treed bog
Oxytropis jordalli ssp davisii	BLUE	Jordall's Locoweed	Mesic forest openings, gravelly sites and meadows
Oxytropis maydelliana	BLUE	Maydell's Locoweed	Moist to mesic meadows
Pingicula villosa	BLUE	Hairy Butterwort	Bogs and ponds
Pinus banksiana	BLUE	Jack Pine	Dry sites
Polemonium caerleum ssp amydalinum	BLUE	Tall Jacob's Ladder	Wet to moist swamps and meadows
Salix petiolaris	BLUE	Meadow Willow	Wet thickets
Salix raupii	RED	Raup's Willow	Gravel floodplains and treed bogs
Salix serissima	BLUE	Autumn Willow	Wet thickets meadows and fens
Sarracenia purpurea ssp purpurea	BLUE	Pitcher Plant	Bogs

1 Prov. List:
Red List = Any indigenous species or subspecies (taxa) considered to be Extirpated, Endangered, or Threatened in British Columbia.
Blue List = Any indigenous species or subspecies (taxa) considered to be Vulnerable in British Columbia.

An established shrub layer, representing 40 – 80% of the cover, is composed of a mixture of willow, alder, low-bush cranberry, prickly rose, buffaloberry, currant, red osier dogwood, twining honeysuckle, and small white spruce. A lush and diverse forb community is also present and accounts for 20-60% of the cover. Common forbs include bunchberry, dewberry, twinflower, bishop's-cap, wintergreen, colt's-foot, lungwort, fireweed, baneberry, sarsaparilla, bedstraw, aster, and strawberry. Moss cover, initially present on decaying stumps and logs, increases as conifer cover increases.

As a stand matures, the deciduous component of the mixedwood begins to die out and is replaced by white spruce. The dense shrub layer is gradually replaced by an understory of balsam fir and cover associated with the shrub layer - alder, low-bush cranberry, currant and rose decreases. Common forbs in conifer-dominated mixedwood include twinflower, bog cranberry, wintergreen, bishop's cap, dewberry, running club-moss, and colt's-foot. Stair-step, feather and knight's plume mosses dominate the ground cover. Large diameter deadfall is common and arboreal lichen cover ranges from medium to high.

Riparian Communities

Vegetation communities adjacent to larger watercourses, waterbodies, and wetlands follow a general pattern of vegetation banding beginning with a graminoid (grass and sedge) community immediately adjacent to the watercourse. Graminoid cover is progressively replaced by herbs, shrubs, and trees. The composition and width of these communities is dependent on a variety of factors including surrounding topography, and the duration and amount of water saturation. Distinctive riparian communities are present adjacent to crossings of small to large streams (see Section 4.3.5.2).

The floodplain of the Fort Nelson River supports a distinctive vegetation community traversed by the pipeline right-of-way. This community consists of old growth stands of very tall, large diameter balsam poplar situated on the river's terraced floodplain. Understory shrubs (60 to 80% cover) include tall rough alder, as well as red-osier dogwood, low-bush cranberry, currants, wild raspberry, and rose. A lush forb community composed of ostrich fern, horsetail, enchanter's nightshade, bedstraw, touch-me-not, baneberry, bishop's cap and dewberry is present. White spruce is beginning to establish in the understory.

Tall willow and alder stands, 5 to 7 m in height, line the channels of ephemeral watercourses crossed by the pipeline. This community has a variable understory. Currants and dogwood shrubs, horsetails, sedges, and ferns are characteristic of small upland draws and depressions. In poorly drained lowlands, a distinctive graminoid community dominated by large sedges is present.

Right-of-way Intersects

The dominant vegetation communities on most of the proposed residue gas pipeline route are Black Spruce dominated lowlands and Mixedwood Uplands. A summary of the length of each vegetation unit intersected by the residue gas pipeline right-of-way is provided in Table 4-5.

TABLE 4-5
LENGTH OF VEGETATION COMMUNITIES (KM) INTERSECTED BY THE
PARAMOUNT MAXHAMISH PIPELINE.

Vegetation Type	Vegetation Community	Total Length Intersected (km)
Mixedwood	Aspen (Aw)	1.6
Mixedwood	Aspen/Birch (Aw/Bw	5.6
Mixedwood	Aspen/Birch/White spruce (Aw/Bw/Sw)	4.0
Mixedwood	Aspen/White spruce/Lodgepole pine (Aw/Sw/Pl)	8.9
Mixedwood	Aspen/White spruce (Aw/Sw) and complexes	46.6
Mixedwood	Aspen/White spruce/Black spruce (Aw/Sw/Sb)	8.6
Mixedwood	White spruce/Birch (Sw/Aw)	4.2

Mixedwood	White spruce/Birch/Lodgepole pine (Sw/Aw/Pb)	5.2
Mixedwood	White spruce/Birch/Lodgepole pine (Sw/Aw/Pl)	10.0
	Sub-Total	**94.7**
Lowland	White spruce/Birch (Sw/Bw)	11.6
Lowland	Black spruce/Lodgepole pine/White spruce/Aspen (Sb/Pl/Sw/Aw)	7.8
Lowland	Black spruce/Tamarack/Lodgepole pine (Sb/Lt/Pl)	1.3
Lowland	Black spruce/Tamarack (Sb/Lt)	25.7
Lowland	Black spruce/Closed shrub (Sb/Sc)	7.9
	Sub-Total	**54.3**
Riparian	White spruce/Black spruce (Sw/Sb)	0.5
Riparian	Balsam poplar/Birch/White spruce (Pb/Aw/Sw)	2.0
Riparian	Closed shrub (Sc)	0.6
Riparian	Water	0.3
	Sub-Total	**3.4**
Riparian	Clearing	0.7
Disturbed	Pit/ponds	1.4

Disturbed	Road/Pipeline	0.6
Disturbed	Cut	7.5
Agricultural	Field	1.8
	SUB-TOTAL	**12.0**
	TOTAL	**164.4**

Lowland and transition Black Spruce communities are intersected on about 33% (54km) of the route and Mixedwood Uplands occur on about 58% (95km) of the pipeline. Disturbed areas such as clearings, abandoned borrow pits, and cutblocks comprise about 6% of the (10.2km) alignment, and cleared farm land represents approximately 1% (1.8km). Riparian communities associated with watercourses, wetlands, and waterbodies are present along 2% (3.4km) of the line.

4.3.4 Wildlife Resources

4.3.4.1 Regional Setting

Despite a harsh climate, the BWBS Biogeoclimatic zone supports a relatively diverse wildlife fauna. Moose are distributed throughout and large carnivores such as black bear and gray wolf are relatively common. Frequent forest fires have created a variable-aged forest mosaic. Deciduous forests provide productive habitats for ungulates, a wide variety of birds, including warblers, thrushes, vireos, and flycatchers, and a variety of small mammals including snowshoe hare and deer mouse. Coniferous forests provide habitat for: furbearers such as marten, lynx, and red squirrel; small mammals including northern red-backed vole; and birds such as spruce grouse, Northern goshawk, Boreal chickadee, and Great gray owl. Wetlands, waterbodies, and watercourses support beaver, muskrat, mink, waterfowl and shorebirds (DeLong *et al.* 1991).

Wildlife with Special Conservation Status

The BC Conservation Data Center (1 November 1998) lists 18 taxa of wildlife (5 mammals and 13 birds) on the rare vertebrate tracking list (excluding fish) for the Fort Nelson Forest District. Based on known species distribution, 16 of these species may occur in the Maxhamish project area (Table4-6). Two bird species on the tracking list are not expected to occur in the pipeline project area: Nelson's Sharp-tailed sparrow (*Ammodramus caudacutus*); and Black-throated green warbler (*Dendroica virens*) (Enns and Siddle 1996; Fraser *et al*. 1999). With the exception of wood bison (Red List), other mammals on the tracking list in the project area are on the provincial Blue List. Bird species on the tracking list that are expected to occur in the project area include 3 Red-Listed, 7 Blue-Listed, and 1 on the Yellow List. Harlequin duck (*Histrionicus histrionicus*) is a species of regional management concern in the Fort Nelson Forest District, however, there does not appear to be suitable habitat in the project area (personal observations; P. Johnstone pers. comm. 14 July 1999).

In addition to species with special conservation status, a number of wildlife in the project area are of regional management concern in the Fort Nelson District; these include pine marten (*Martes americana*), elk (*Cervus elaphus*), moose (*Alces alces*), woodland caribou (*Rangifer tarandus*), and Northern goshawk (*Accipiter gentilis*). Pine marten are an important furbearer in northeastern British Columbia while elk, moose, and woodland caribou are hunted for sport and subsistence. Northern goshawk is a species that may be sensitive to habitat fragmentation and disturbance.

Wildlife field investigations consisting of both aerial and ground surveys were conducted along the proposed pipeline route between July 12 and 16, 1999 in conjunction with soil and vegetation studies. Representative habitat types, all river crossings, and many smaller watercourse crossings were assessed for wildlife sign which included potential and observed den sits, scats, tracks, ungulate activity, stick nests, and passerine bird species seen or heard. A compilation of wildlife field observations is included in Appendix C. Pertinent site-specific notes are also included on the Biophysical Alignment Sheets in Appendix A.

TABLE 4-6
WILDLIFE WITH SPECIAL CONSERVATION STATUS
THAT MAY OCCUR IN PARAMOUNT MAXHAMISH PROJECT AREA.

Common Name	Latin Name	COSEWIC[1]	Prov. Status[2]	Prov. List[3]
Mammals				
Wood bison	Bison bison athabascae	Threatened	S1	Red
Grizzly bear	Ursus arctos	Vulnerable	S3	Blue
Wolverine	Gulo gulo luscus subspp.	Vulnerable	S3	Blue
Fisher	Martes pennanti	NC	S3	Blue
N. Long-eared myotis	Myotis septentrionalis	NC	S2S3	Blue
Birds				
Short-eared owl	Asio flammeus	Vulnerable	S2N, S3n	Blue
American bittern	Botaurus lentiginosus	NC	S3B, SZN	Blue
Trumpeter swan	Cygnus buccinator	NAR	S3S4B, S4N	Blue
Bay-breasted warbler	Dendroica castanea	NC	S2B, SZN	Red
Cape May warbler	Dendroica tigrina	NC	S2B, SZN	Red
Sandhill crane	Grus canadensis	NAR	S3B, SZN	Blue
Bald eagle	Haliaeetus leucocephalus	NAR	S4	Yellow
Surf scoter	Melanitta perspicillata	NC	S3B, SZN	Blue

Philadelphia vireo	Vireo philadelphicus	NC	S3S4B	Blue
Connecticut warbler	Oporornis agilis	NC	S2B,SZN	Red
Canada warbler	Wilsonia canadensis	NC	S3S4B	Blue
	16 taxa listed			

1 COSEWIC Status: Committee on the Status of Endangered Wildlife in Canada, April 1999. Threatened = a species likely to become endangered if limiting factors are not reversed; Vulnerable = a species of special concern because of characteristics that make it particularly sensitive to human activities or natural events. NAR = not at risk, NC = not in any category.

2 Prov. Rank: Provincial (S) rank is identified as follows: 1 – critically imperiled because of extreme rarity or because of some factor(s) making it especially vulnerable to extirpation or extinction; 2 – Imperiled because of rarity or because of some factor(s) making it vulnerable to extirpation or extinction; 3 – Rare or uncommon, may be susceptible to large-scale disturbances.

Rank Qualifiers for avian species: B – breeding occurrences of mobile animals; N - non-breeding occurrences of mobile animals; Z – occurs in the province but as a diffuse, usually moving population, difficult or impossible to map static occurrences;

3 Prov. List:
Red List = species or subspecies designated as Threatened or Endangered under the *BC Wildlife Act*; species or subspecies that are candidates for legal designation as Endangered or Threatened; species or subspecies that have been extirpated, but were once part of the natural fauna of BC.
Blue List = Vulnerable taxa that could become candidates for the Red List in the foreseeable future; taxa generally suspected to be vulnerable because information is too limited to allow designation in another category.
Yellow List = Taxa that are considered to be secure in BC; they are managed at the habitat level by managing for a diversity of habitats in the province.

The following subsections contain summaries of ecological information, habitat associations, and management issues for wildlife species of concern in the project area.

Ungulates

Elk
Elk have been identified in northeastern British Columbia as a species of regional concern. Based on a review of rare or occasional sightings of elk in this part of the province, elk do not occur in the project area except in very low numbers (MELP nd.). The overall habitat capability for this species in the project area has been identified as Class 4 – 25-5% of provincial level (MELP 1994a).

Moose
Moose utilize a wide variety of habitat types in the boreal forest region, however, they are primarily associated with early succession mixed forests, riparian corridors and secondary drainages, and seasonally with wetland habitats. They are primarily browsers of deciduous leaves and twigs; willow and dogwood are highly preferred forage species. The overall habitat capability for moose in the project area has been rated Class 4 – 25-5% of the provincial level (MELP 1994a). Based on a review of the wildlife distribution mapping conducted by the Province of British Columbia (MELP nd.), the density of moose in the Maxhamish project area is expected to be 1 moose / 10-260km 2.

During field investigations a cow moose with twins was observed on the south side of the Muskwa River and moose tracks and pellets were present at a number of other locations along the proposed pipeline route. It is estimated that 12 moose are harvested per year (1990-

98) in Management Unit 7-55 (north of Fort Nelson River), while approximately 133 are harvested per year (1990-98) in Management Unit 7-49 (south of Fort Nelson River) (Summary Statistics, Hunter Harvest and Effort, MELP, Wildlife Branch).

Woodland Caribou

Woodland caribou have also been identified in the Fort Nelson Forest District as a species of management concern. Historically, woodland caribou ranged across the entire boreal region, their populations characterized by low density and traditional movement patterns that are adaptive in an environment with poor concealment from predators (Bergerud *et al*. 1984). Woodland caribou occupy a range of habitat conditions, but prefer lowland habitats which are a mosaic of open and closed black spruce forest on poorly drained soils (see review by Eccles *et al*. 1991). Based on wildlife distribution mapping in northeastern British Columbia, few woodland caribou occur in the project area. The relative abundance in the project area has been estimated to be 1 caribou per 25-250km 2 (MELP nd.). The overall habitat capability in the project area has been identified as Class 3 – 50-25% of the provincial level (MELP 1994a).

The project is located in both Management Units 7-55 (north of Fort Nelson River) and 7-49 (south of Fort Nelson River). Sport hunting licences are sold in this area for male caribou with 5-point antlers and the hunting season lasts from 1 September until 30 September. Approximately 1 caribou per year has been harvested from Management Unit 7-49 (1990-98), and no caribou were harvested from MU 7-55 during the 1990-1996 period for which records are available (Summary Statistics, Hunter Harvest and Effort, MELP, Wildlife Branch).

Wood Bison

Historically, wood bison ranged throughout northeastern British Columbia and southwestern Northwest Territories. Currently, the primary populations are in the Yukon, Northwest Territories, northern Alberta and northeastern British Columbia. Four small herds now occupy isolated areas of northeastern British Columbia and bordering Northwest Territories (Cannings *et al*. 1999). The Hay-Zama herd (approx. 100 animals) in northwestern Alberta frequently crosses the border with British Columbia. Other small herds include the Etthithun Lake herd, near the Alberta border, the Beaver River-La Biche River herd (northwest side of Liard River and sharing the border with Northwest Territories) and the Aline Lake herd (near mile 496 along the Alaska Highway). Potential threats to the species include disease transmission and genetic contamination if bred with Plains or hybrid bison. The population trend appears to be stable with more re-introductions to northeastern British Columbia planned.

Wood bison use primarily wet meadows in winter when they typically form large aggregations. They remain in large groups in open habitats during spring and summer. However during fall they disperse into smaller groups and occupy mixedwood forests during the rutting season (mid-July to October). No bison or sign were observed in the Maxhamish project area during field investigations. The overall habitat capability for this species in the Fort Nelson district has been rated Class 3 (50-25% of provincial level; MELP 1994a).

Carnivores/Furbearers

Grizzly Bear

While grizzly bears are found in about 80% of British Columbia, the distribution and relative abundance of grizzly bear is considered low in the northeastern area of the province (1 grizzly per 140-1000km 2) (MELP – wildlife distribution mapping). The overall habitat capability for this area has been estimated as Class 5 – 5-0.1% of the provincial level (MELP 1994a). Grizzly bears are affected primarily by habitat loss from human settlement and developments (Cannings *et al*. 1999). Direct human-caused mortality from hunting, poaching and defense of property and livestock are the major threats to the species. Habitat loss and fragmentation from road building and developments in river valley corridors are also important concerns for conservation of the species.

Wolverine

Historically wolverine ranged across northern North America and they continue to occur in north and west Yukon, Northwest Territories and British Columbia (Hatler 1989). The wolverine is a wide-ranging carnivore (daily movements may exceed 30km), however its biology is poorly understood (Cannings *et al*. 1999). Food availability, primarily ungulates in the form of carrion are important in the diet, particularly in winter. Natal dens are strongly associated with proximity to cover and northeasterly slopes that generally receive increased snow cover (Hatler 1989). The number of wolverines harvested among traplines in Region 7 (Peace) averaged about 2.1 per year for the decade (1988-97) (Wild Fur Harvest records, Ministry of Environment, Wildlife Branch, Victoria). Primary threats to wolverine include human activity and habitat alterations. In particular, wolverines appear to be reluctant to cross active transportation corridors (see Hatler 1989). Design of leave-strips and highway corridors are important considerations needed for the conservation of this species (Cannings *et al*. 1999).

Fisher

Fisher occur in all northern biogeoclimatic zones in the province of British Columbia (Banci 1989, Cannings *et al*. 1999). Fisher are associated with a diversity of forest types, primarily with coniferous or mixedwood forests with closed canopies. Fisher also frequent ecotones and edges between different habitat types, although dense forests in late seral stages provide optimum habitat for this species. The

species are not as dependent on mature forests as marten (Banci 1989). Fisher are opportunistic predators and have a diverse diet, preying primarily on birds, small mammals, hares, porcupines and carrion selected on the basis of availability. Large diameter trees, including riparian cottonwood provide cavities for natal dens. The number of fisher taken during the trapping season in this area of northeastern BC is relatively few, averaging about 2 animals per trapline for the decade 1988-98 (Wild Fur Harvest records, Ministry of Environment, Wildlife Branch, Victoria). While there is a general lack of information on abundance and population trend, primary threats for fisher include logging and access development, which increases their vulnerability to over-trapping.

Marten
Marten are widely distributed across the forested regions of northern British Columbia. Marten are small, arboreal carnivores that are closely associated with mixed deciduous and mature coniferous forests in the BWBS (Meidinger and Pojar 1991). Microtine rodents (primarily red-backed voles) are the primary prey species, although red squirrel and snowshoe hare are also important sources of food. Marten are active year round and require insulated dens during winter when not active. Den sites are typically associated with coarse, down woody debris (Lofroth and Steventon nd.). Large scale habitat capability (1:250,000) in this area has been rated Class 3 – 50-25% of provincial level (BC Environment, Peace Region GIS section, 1999). Marten are highly prized as a furbearer, and their populations generally follow fluctuations in prey availability. Numerically, marten dominate the total fur harvest in Region 7, with an average of about 313 taken each year for the decade 1988-98 (Wild Fur Harvest records, Ministry of Environment, Wildlife Branch, Victoria). Primary threats to the species include habitat removal from logging and access development that can result in over-trapping.

Other Mammals of Management Concern

Northern Long-eared Myotis
The northern long-eared myotis (bat) is widely but sparsely distributed across boreal forests of northern eastern British Columbia (Cannings *et al*. 1999). This is one of the rarest and least known bats in the province. The bat emerges at dusk from day roosts to hunt at a height of 1-3m for insects over small ponds and forest clearings. The species is non-migratory and overwinters in hibernacula alone or in small groups. The primary threat to this species is logging since the Northern long-eared myotis require mature and old trees for day roosts and nursery colonies. The species is also susceptible to human disturbances at winter hibernacula. Locations of hibernacula in the area are unknown.

Birds

Short-eared Owl
The short-eared owl nests in open treeless areas including range land, low-arctic tundra and forest clearings (Fraser *et al*. 1999). It is considered rare in northeastern British Columbia and is migratory, only occurring during the breeding season, April to October. No Short-eared owls were observed during the field survey. Threats to this species include disturbance at nest sites and intensive grazing around wetland areas. Habitat fragmentation can have an indirect effect by accentuating fluctuations of microtine prey populations.

American Bittern
This species occurs in lowland marshes in lakes, ponds and rivers primarily in south and central interior British Columbia and in the lower Fraser Valley (Campbell *et al*. 1990a). Undiscovered breeding sites may exist further north in lowland river valleys. Most, if not all, wetlands inspected during the reconnaissance field survey appeared unsuitable as American bittern breeding habitat. Loss of breeding habitat due to drainage of wetlands and sensitivity of prey species to run-off of agricultural chemicals are considered threats to this species.

Trumpeter Swan
This species nests in a wide variety of ponds, lakes, freshwater marshes, and occasionally rivers. Important parameters for suitable nesting habitat include: at least 100-m for take-off; stable levels of shallow, unpolluted water; accessible forage; emergent vegetation; a suitable nest substrate such as a beaver house; and low levels of human disturbance (Fraser *et al*. 1999). Trumpeter swans on suitable breeding lakes were observed during the field survey (Appendix C) and appear to breed in small numbers throughout the study area. Trumpeter swan were observed on 3 small lakes; KP26 (unnamed lake 1.3km east of the proposed gas plant site), KP74 (2.1km west of the proposed right-of-way on Tsinhia Lake), and KP100 (unnamed lake 700m east of the proposed right-of-way). All of these lakes are presumed to be nesting areas, although juveniles were observed only with one pair (KP100). Swans migrate south, probably to the Fraser delta area, in winter. Although the breeding population in British Columbia appears to be expanding, it was estimated to be only 100 pairs in 1995 (Fraser *et al*. 1999). Breeding habitat is easily protected, due to the visibility of this species and its strong public appeal, but disturbance during nesting should be minimized.

Bay-breasted Warbler
This species occurs primarily in stands of mature and old growth white spruce including stands within forest composed of birch, balsam poplar, willow and alder (Fraser *et al*. 1999). Large riparian stands may be particularly important. The Bay-breasted warbler only occurs in

northeastern British Columbia during the mid-May to end of August breeding season. A male was heard singing, and the male and female subsequently observed mid-height in a mixedwood habitat with mature white spruce and balsam poplar along the Liard Highway north of Stanolind Creek and south of the Fort Nelson River. Significant threats to this species are loss and fragmentation of breeding habitat due to industrial and agricultural development. The Bay-breasted warbler is subject to cowbird parasitism. Budworm control may reduce prey availability and negatively affect breeding success.

Cape May Warbler

This species breeds in mature white spruce forest or stands of mature white spruce within balsam poplar, aspen and birch forests (Fraser *et al*. 1999). Cape May warblers breed and forage high in the canopy and are only present in northeastern British Columbia from mid-May to the end of August. This species was not detected during the field survey (Appendix C). Significant threats to this species are loss and fragmentation of breeding habitat due to industrial and agricultural development. However the Cape May warbler is relatively unsusceptible to cowbird parasitism. Budworm control may reduce prey availability and negatively affect breeding success.

Sandhill Crane

This species breeds in isolated bogs, marshes, swamps and meadows with heavy emergent growth (Fraser *et al*. 1999). Wetlands used for nesting tend to be secluded and free from human disturbance. In British Columbia nesting wetlands are greater than 2-ha in size and tend to be surrounded by a narrow strip of meadow leading into coniferous forest. The Sandhill crane is migratory and only occurs in northeastern British Columbia during the April to September nesting season. A pair of adults were observed flying below the helicopter at approximately KP43, north of d'Easum Creek and may be nesting at a small lake 900m east of the proposed right-of-way. Population size in northeastern British Columbia is unknown. Loss of breeding habitat due to drainage of wetlands and logging of adjacent forest cover are threats although clearcuts have been used for nesting in other areas. Sandhill cranes are sensitive to human disturbance.

Bald Eagle

This species breeds primarily in coniferous forest near lakes, large rivers and marshes. Large trees are an important habitat component and the nest usually has an unobstructed view of the surrounding landscape. The Bald eagle is only a local breeder in northeastern British Columbia (Campbell *et al*. 1990b). A nest was observed during the field survey on an unnamed lake approximately 600m east of the proposed alignment along the Liard Highway (Biophysical Alignment Sheet 8, Appendix A). This is the only known nest site in the study area (P. Johnstone, pers. comm.). The nest was on the northwest shore of the lake and contained two juveniles in dark plumage (2nd down). The Bald eagle is migratory and is only present in the study area during the protracted breeding season, March to November. Human disturbance is the primary threat to this species.

Surf Scoter

This species nests on freshwater lakes surrounded by spruce forests, mixedwood forests, or muskeg (Fraser *et al*. 1999). The Surf scoter in British Columbia is known to nest only in a few lakes in the northeastern portion of the province. It is migratory and winters along the Pacific coast. The species was not detected during the field survey, although many lakes were not approached closely due to the presence of Trumpeter swans. Surf scoter breeding sites may be susceptible to disturbance and adjacent logging.

Philadelphia Vireo

This species breeds in deciduous stands and thickets of aspen and balsam poplar along the edges of coniferous forests in northeastern British Columbia (Fraser *et al*. 1999). It is migratory and only occurs in the province during the breeding season, mid-May to August. Two individuals were observed during the July 1999 field survey in deciduous scrub at the edge of a mature riparian spruce forest, approx. KP130 (similar location as Bay-breasted warbler sighting). The habitat type was mixedwood with mature white spruce and balsam poplar. The Philadelphia vireo's preference for second-growth stands suggests that logging is not a threat except where conversion to agricultural use occurs.

Canada Warbler

In northeastern British Columbia this species breeds in birch, aspen, white spruce and balsa poplar forests on steep slopes with a tangled understory of shrubs especially young birch and red-osier dogwood (Fraser *et al*. 1999). It is migratory and only occurs in the province during the breeding season, late-May to August. The species was observed on the south side of the Muskwa River during the field survey (Appendix C). The habitat type was associated with the shrublands in the oxbow formation. Riparian Canada warbler habitat may be threatened by hydroelectric development as well as vegetation control spraying programs.

Northern Goshawk

This species breeds in dense coniferous, mixedwood and deciduous forests (Campbell *et al*. 1990b). It occurs uncommonly in British Columbia and is partly migratory. Numbers and breeding effort appears to fluctuate with prey population cycles, particularly varying hare. Northern goshawks were observed during an overflight at approximately KP 52. At the time, it was thought the bird was a female that may have flushed from a nest. This species may be susceptible to disturbance and fragmentation of the dense forest stands it prefers for

breeding. Researchers active in the study area during 1996, during a low in the varying hare cycle, found very few Northern goshawks and no active nests (P. Johnstone, pers. comm.).

Connecticut Warbler
In British Columbia this species nests in trembling aspen forests or aspen/spruce mixedwood with a dense shrubby understory generally less than 3 m high (Fraser *et al*. 1999). It is migratory and is only present in northeastern British Columbia during the breeding season, June to August. The Connecticut warbler appears to be uncommon and local in the province. No Connecticut warblers were seen or heard during the mid-July field reconnaissance. Harvest of its aspen habitat, increased cowbird parasitism due to fragmentation, and herbicide applications are potential threats to this species.

4.3.4.2 Habitat Suitability Assessment

Habitat suitability assessments were developed for 18 different habitat types and 21 species of management concern in the project area. These capability ratings are summarized for mammals in Table 4-7 and birds in Table 4-8. Note that the habitat types for wildlife are slightly different than those provided for vegetation in Section 4.3.3.

A four-class rating system appropriate for an intermediate knowledge of habitat use was applied: High Suitability = 100-76% of provincial level; Moderate Suitability = 75-26%; Low Suitability = 25-1%; and Nil Suitability = 0% (MELP 1999). One of the habitat types in the project area, "Developed" (represented by a few locations along the route such as an active gravel pit and existing facilities), has no habitat value and consequently was not rated. Suitability ratings were generated solely on the basis of habitat characteristics observed in the field and have not been modified to reflect existing disturbance effects from the shared right-of-way corridors such as the Liard Highway and existing WEI pipeline.

Table 4-9 provides a summary of habitat suitability classes intercepted by the proposed alignment for each species. This summary highlights the species most likely to be directly or indirectly affected by pipeline construction.

Species with the greatest susceptibility to impact from pipeline construction are those that have High and Moderate habitat suitability overlapping extensive areas (>10%) of the proposed pipeline alignment. With the exception of bison and Northern goshawk, all wildlife in this category are migratory. Bison have no established herds in this area, but ranged through this area historically. Northern goshawk are known to overwinter infrequently in northeastern British Columbia (Campbell *et al*. 1990b).

Based on habitat suitability, six species of management concern are most likely to be affected by construction of the Maxhamish project. These include:

1. *Cape May warbler* (migratory, mature forest interior) - 57% of the route traverses High and Moderate habitat suitability.

2. *Bay-breasted warbler* (migratory, mature forest interior) - 57% of the route traverses High and Moderate habitat suitability.

3. *Philadelphia vireo* (migratory, young aspen, edges) - 57% of the route traverses High and Moderate habitat suitability.

4. *Northern goshawk* (partial migratory, mixed forest, edges) - 58% of the route traverses High and Moderate habitat suitability.

5. *Northern long-eared myotis* (local migration to hibernacula, mature forest and edges) - 49% of the route traverses High and Moderate habitat suitability.

6. *Bison* (no established herds in the project area) - 63% of the route traverses High and Moderate habitat suitability.

TABLE 4-7
HABITAT SUITABILITY RATINGS FOR MAMMAL SPECIES
OF SPECIAL MANAGEMENT CONCERN IN THE
PARAMOUNT MAXHAMISH PROJECT AREA.

Habitat Type	Dist.	%	Bison	Moose	Elk	Caribou	Grizzly	Wolverine	Fisher	Marten	Long-eared Myotis
Aspen (Aw)	7.2	4.4	M	L	L	L	L	L	M	L	M
Aspen/Birch/White spruce (Aw/Bw/Sw)	4.0	2.4	M	L	L	L	L	L	M	M	H
Aspen/White spruce complexes (Aw/Sw)	38.6	23.5	M	M	L	L	L	L	M	M	H
Aspen/White spruce/Black spruce complexes (Aw/Sw/Sb)	8.6	5.3	H	M	L	L	L	L	L	L	H
Aspen/White spruce/Lodgepole pine complexes (Aw/Sw/Pl)	22.8	13.9	H	L	L	L	L	L	L	L	L
Field	1.8	1.1	H	M	M	L	L	L	L	L	H
Developed	1.2	0.7	----	----	----	----	----	----	----	----	----
Meadow/Open Shrub (Md/So)	0.7	0.4	H	L	M	L	L	L	L	L	L
Balsam Poplar/ Aspen/White spruce (Pb/Aw/Sw)	2.0	1.2	L	H	M	L	M	L	M	M	H
Lodgepole pine;Black & white spruce/Aspen (Pl/Sb/Sw/Aw)	1.3	0.8	M	L	L	M	L	L	L	L	L
Black spruce/ Tamarack/White spruce (Sb/Lt/Sw)	26.7	16.3	L	L	L	M	L	L	L	L	L
Black spruce/ Tamarack/Lodgepole pine (Sb/Lt/Pl)	7.8	4.8	L	L	L	M	L	L	L	L	L

Black spruce/Closed shrub/White spruce/ Open shrub/Tamarack (Sb/Sc/Sw/So/Lt)	8.6	5.3	L	L	L	M	L	L	L	L	L
Closed shrub/Water	1.4	0.9	L	L	L	L	L	L	L	L	L
Open shrub (So)	0.6	0.4	M	M	L	L	L	L	L	L	L
Meadow	7.5	4.6	M	M	M	L	L	L	L	L	M
White spruce/Aspen/ Closed shrub (Sw/Aw/Sc)	10.4	6.4	M	M	L	L	L	L	M	M	M
White spruce/Black spruce/Closed shrub (Sw/Sb/Sc)	12.1	7.4	L	L	L	L	L	L	L	L	L
Water	0.4	0.2	L	L	L	L	L	L	L	L	L
Total	163.7	100									

4 Class Rating System: High (H), Moderate (M), Low (L) and Nil (N)

- High (H) = 100-76% of provincial level (equivalent to six-Class rating 1)
- Moderate (M) = 75-26% of provincial level (equivalent to six-Class ratings 2-3)
- Low (L) = 25-1% of provincial level (equivalent to six-Class ratings 4-5)
- Nil (N) = no habitat capability (equivalent to six-Class rating 6)

TABLE 4-8
HABITAT SUITABILITY RATINGS FOR BIRD SPECIES OF
SPECIAL MANAGEMENT CONCERN IN THE
PARAMOUNT MAXHAMISH PROJECT AREA.

Habitat Type	Dist.	%	BAEA	AMBI	SACR	TRUS	SUSC	SEOW	NOGO	BBWA	CMWA	COWA	PHVI	CAWA
Aspen (Aw)	7.2	4.4	N	N	N	N	N	N	H	N	N	H	H	H
Aspen/Birch/White spruce (Aw/Bw/Sw)	4.0	2.4	N	N	N	N	N	N	H	L	L	M	H	H
Aspen/White spruce complex (Aw/Sw)	38.6	23.5	N	N	N	N	N	N	H	M	M	M	H	M

Aspen/White spruce/Black spruce complex (Aw/Sw/Sb)	8.6	5.3	N	N	N	N	N	N	H	M	M	L	M	L
Aspen/White spruce/Lodgepole pine complex (Aw/Sw/Pl)	22.8	13.9	N	N	N	N	N	N	H	M	M	M	M	L
Field	1.8	1.1	N	L	M	N	N	M	L	N	N	N	N	N
Developed	1.2	0.7	----	----	----	----	----	----	----	----	----	----	----	----
Meadow/Open Shrub (Md/So)	0.7	0.4	N	N	L	N	N	L	L	N	N	N	N	N
Balsam Poplar/ Aspen/White spruce (Pb/Aw/Sw)	2.0	1.2	N	N	N	N	N	N	H	M	M	L	M	M
Lodgepole pine/ Black & white spruce/Aspen (Pl/Sb/Sw/Aw)	1.3	0.8	N	N	N	N	N	N	M	L	L	N	L	N
Black spruce/ Tamarack/White spruce (Sb/Lt/Sw)	26.7	16.3	N	N	N	N	N	N	L	L	L	N	N	N
Black spruce/ Tamarack/Lodge-pole pine (Sb/Lt/Pl)	7.8	4.8	N	N	N	N	N	N	L	N	N	N	N	N
Black spruce/ Closed shrub/ White spruce/Open shrub/Tamarack (Sb/Sc/Sw/So/Lt)	8.6	5.3	N	N	N	N	N	N	L	N	N	N	N	N
Closed shrub/ Water	1.4	0.9	N	L	L	N	N	N	L	N	N	N	N	N
Open shrub (So)	0.6	0.4	N	N	L	N	N	L	L	N	N	N	N	N
Meadow	7.5	4.6	N	N	L	N	N	L	L	N	N	N	N	N

White spruce/ Aspen/Closed shrub (Sw/Aw/Sc)	10.4	6.4	N	N	N	N	N	N	M	H	H	L	M	N
White spruce/ Black spruce/ Closed shrub (Sw/Sb/Sc)	12.1	7.4	N	N	N	N	N	N	L	M	M	N	N	N
Water	0.4	0.2	N	N	N	N	N	N	N	N	N	N	N	N
Total	163.7	100												

1: BAEA=Bald eagle; AMBI=American bittern; SACR=Sandhill crane; TRUS=Trumpeter swan; SUSC=Surf scoter; SEOW=Short-eared owl; NOGO=Northern goshawk; BBWA=Bay-breasted warbler; CMWA=Cape May warbler; COWA=Connecticut warbler; PHVI=Philadelphia vireo; CAWA=Canada warbler.

4-Class Rating System:

- High (H) = 100-76% of provincial level (equivalent to six-Class rating 1);
- Moderate (M) = 75-26% of provincial level (equivalent to six-Class ratings 2-3);
- Low (L) = 25-1% of provincial level (equivalent to six-Class ratings 4-5);
- Nil (N) = no habitat capability (equivalent to six-Class rating 6)

TABLE 4-9
WILDLIFE HABITAT SUITABILITY CLASSES
INTERCEPTED BY THE PARAMOUNT MAXHAMISH PIPELINE.

Common Name	% of Alignment within each of 4 Suitability Classes				**Total Percent**
	High	**Moderate**	**Low**	**Nil**	
Bison	21	42	36	1	100
Moose	2	41	57	1	100
Elk	0	7	92	1	100
Caribou	0	27	72	1	100
Grizzly bear	0	1	98	1	100
Wolverine	0	0	99	1	100
Fisher	0	38	61	1	100
Marten	0	34	65	1	100

N. Long-eared myotis	34	15	50	1	100
Bald eagle	0	0	0	100	100
American bittern	0	0	3	97	100
Sandhill crane	0	1	6	93	100
Trumpeter swan	0	0	0	100	100
Surf scoter	0	0	0	100	100
Short-eared owl	0	1	5	94	100
Northern goshawk	51	7	41	1	100
Bay-breasted warbler	6	51	19	24	100
Cape May warble	6	51	19	24	100
Connecticut warbler	4	40	134	43	100
Philadelphia vireo	30	27	1	42	100
Canada warbler	7	25	19	49	100

Based on habitat suitability assessments, it is apparent that the proposed Maxhamish project will primarily affect Low suitability habitat for thirteen species of concern, including:

1. *Grizzly bear*: With the exception of riparian corridors at the Fort Nelson and Muskwa Rivers that represent only about 1% of the route rate Moderate, habitat in the project area has Low suitability.

2. *Wolverine*: All habitats in the project area for this species are considered to have Low suitability.

3. *Elk*: Most habitat types traversed by the proposed alignment have Low suitability for this species.

4. *Bald eagle*: All habitat types traversed by the proposed alignment have Nil suitability, no nests or lake shore habitat are affected by the proposed alignment.

5. *American bittern*: All habitats traversed by the proposed alignment are Nil or Low suitability.

6. *Sandhill crane*: With one exception noted, all habitat types traversed by the proposed alignment have Nil or Low suitability (Mw rated Moderate suitability with 1% of the proposed alignment).

7. *Trumpeter swan*: All habitat types traversed by the proposed alignment have Nil suitability, important habitats for swans are greater than 1 km from the proposed alignment based on pre-planning.

8. *Surf scoter*: All habitat types traversed by the proposed alignment have Nil suitability for this species.

9. *Short-eared owl*: With one exception noted, all habitat types traversed by the proposed pipeline alignment have Nil or Low suitability (Mw rated Moderate with 1% of the proposed alignment).

10. *Woodland caribou*: No High suitability habitat is encountered by the proposed pipeline route and 72% of the proposed alignment traverses Low habitat suitability.

11. *Fisher*: Approximately 60% of the proposed route traverses Low habitat suitability for fisher and no High suitability habitat is encountered.

12. *Pine marten*: Approximately 65% of the proposed route traverses Low habitat suitability for marten and no High suitability habitat is encountered.

13. *Moose*: About 40% of the alignment traverses Moderate habitat suitability and only 1% of the alignment encounters High habitat suitability.

Important Wildlife Habitat

The following vegetation communities are considered to provide High suitability habitat important for wildlife species of management concern in the project area:

- Mature aspen (Aw), aspen mixedwood [aspen/birch/spruce (Aw/Bw/Sw) and Aw/Sw] and Spruce mixedwood with closed shrub (Sw/Aw/Sc). These are important habitat types for migratory songbirds (Bay-breasted warbler, Cape May warbler, Connecticut warbler, Philadelphia vireo and Canada warbler), Northern goshawk and Northern long-eared myotis;
- Mature mixedwood habitats, riverine cottonwoods (Pb/Aw/Sw), riparian Wet meadows (Mw) with drainage complexes (which tend to be in limited supply), and dry meadows with open shrub (Md/So), provide High and Moderate habitat values for moose, elk, Northern long-eared myotis, and bison.
- Small lakes (in limited supply) for breeding pairs of Trumpeter swan, Surf scoter, Bald Eagle, American bittern and Sandhill crane.

4.3.5 Aquatic Resources

4.3.5.1 Regional Setting

The Paramount Maxhamish project occurs within the Taiga Plains ecoprovince of northeastern British Columbia. The project area is entirely within the Liard River watershed, a sub-basin of the Mackenzie River system. The 164 km route spans several major Liard River sub-basins including the Petitot River, Fort Nelson River, and Muskwa River watersheds. With the exception of the Muskwa River mainstem, all drainage courses crossed along the project route originate on the lowlands and low-lying plateaus of the Taiga Plains. Drainage patterns were identified from 1:250 000 and 1:50 000 scale NTS maps, and from provincial 1:20 000 scale digital TRIM data.

Northern parts of the regional study area are drained by d'Easum and Emile creeks and tributaries, into the Petitot River, which flows into the Liard River at Fort Liard. The Fort Nelson River, directly or via the Muskwa River and tributaries, drains the southern part. The Fort Nelson River flows into the Liard River at Nelson Forks.

Hydrogeology

No regional hydrogeology data have been located. It is anticipated, however, that a regional groundwater flow system underlies the study area, that is recharged in the Foothills and Rocky Mountains to the west and discharges further east on the Plains. Local groundwater tables are frequently a subdued replica of the terrain, with flows taking place between upland recharge areas and discharge zones along valley bottoms and in terrain depressions.

Hydrology and Water Quality

The Fort Nelson River originates at the confluence of the Sikanni Chief and Fontas rivers, about 80 km southeast of Fort Nelson, and for most of its length flows as an underfit stream along the floor of a very large former meltwater channel. From its source, the mainstem first flows northwest to the Muskwa River confluence, at Fort Nelson; tributaries include Elleh and Klua creeks. Then, it continues north and west for about 150 km, before flowing into the Liard River at Nelson Forks (in the order of 55 km downstream from the proposed Paramount crossing). Primary tributaries, within the reach downstream from Fort Nelson include Kiwigana and Snake rivers, Cridland,

Tsinhia, Stanolind, Tsoo and Capot-Blanc creeks, and a large number of smaller named and unnamed creeks.

The Muskwa River crossing is located a short distance downstream from the confluence of the Muskwa and Prophet rivers near Fort Nelson. The Muskwa River flows into the Fort Nelson River about 11 km downstream of the proposed crossing site. Primary tributaries of the Muskwa River, which originates in the Muskwa Ranges, about 150 km southwest of the crossing, include the Tuchodi, Chiscka and Tetsa rivers, and a large number of named and unnamed creeks.

Long-term flows have been recorded on both rivers by the Water Survey of Canada (WSC). For the Fort Nelson River, two WSC stations, 10CC001 (Fort Nelson River at Fort Nelson, 1961-1978) and 10CC002 (Fort Nelson River above Muskwa River, 1978 to present), are gauged. Records for the Muskwa River, at WSC station 10CD001 (Muskwa River near Fort Nelson) date from 1945.

Stream networks generally meander extensively at low to very low gradients. Smaller streams and tributaries carry relatively low levels of suspended sediment, but are high in organic stain resulting in tanic colouration. The lower mainstems of larger rivers, such as the Fort Nelson and Liard carry significant sediment loads.

Comprehensive water quality data are not available for surface water bodies in this area. Tera (1998) obtained limited water quality data for five streams in the Petitot and Fort Nelson River sub-basins. They concluded that water quality was typical of northern boreal streams draining peatlands. Nutrient levels were low, indicating that these streams have relatively poor productivity. Several heavy metal concentrations (aluminum, cadmium, chromium, copper, iron, lead, zinc) exceeded Canadian Water Quality Guidelines for the protection of freshwater aquatic life at one or more sites (CCME 1996).

Fisheries Resources

Existing fisheries data within this portion of the Liard drainage system is limited. Eighteen species of fish are known to occur within the lower Fort Nelson, lower Petitot and lower Muskwa river drainages combined. These include: Arctic grayling, northern pike, inconnu, goldeye, walleye, burbot, lake whitefish, bull trout, mountain whitefish, slimy sculpin, longnose sucker, white sucker, largescale sucker, lake chub, longnose dace, flathead chub, trout-perch, finescale dace and brook stickleback (FISS 1999). In addition, Maxhamish Lake supports populations of arctic cisco, lake cisco, least cisco, and spottail shiner which are considered unique within the region. Site-specific data for 18 watercourses north of the Fort Nelson River were collected by Tera (1998) for the AEC Maxhamish pipeline.

Fluvial aquatic habitats within the Taiga Plains generally fall into either of two distinct categories: extremely low-gradient, low-velocity, streams dominated by marsh habitats with substrates composed of soft silt and organic debris, or slightly higher gradient, moderately-incised streams containing pool/riffle habitats with a significant proportion of granular substrates.

The first category of stream generally occurs on the poorly drained, organic terrain of low-lying plateaus. These slow, unconfined streams flow at gradients of less than 1% and have low hydraulic energy. As a result, stream substrates are normally 100% soft fines, silt and organics. Stream channels are often discontinuous through intervals of muskeg seepage. Beaver activity is extensive, sometimes resulting in a continuous series of dams and large impoundments. These low-grade, marsh-like habitats have been found to support high densities of finescale dace and brook stickleback, which survive as isolated resident populations. Both these species are capable of withstanding the anoxic conditions which make these streams unsuitable for other fish species. Seasonal access to these areas, and movement within them, is restricted by discontinuous stream channels, seepage areas and multiple impasses created by semi-permanent beaver dams. As a result, there is generally no seasonal use by other species residing in higher-quality habitats of downstream reaches. Resident finescale dace and brook stickleback populations depend on beaver impoundments to successfully overwinter.

The second category of stream is defined by slightly higher gradients, usually between 1% and 2%. These streams are generally incised into the outer portion of the plateau and flow directly into larger rivers or major tributaries. Due to higher gradients, these streams have much higher hydraulic energy and contain gravel, cobble and boulder substrates as a result of down-cutting and scouring. Higher gradient and a higher degree of confinement, contribute to better defined channels and fewer migrational barriers. As a result, these streams are often used on a seasonal basis by species which migrate upstream in spring or early summer and then move downstream to overwinter.

Arctic grayling are normally the most common seasonal inhabitant in these higher gradient streams. Juvenile grayling often move into the upper portions of relatively small tributaries where suitable rearing habitat is present and accessible. They commonly exist in association with slimy sculpin populations, while a variety of other ‘sport’ and ‘non-sport’ species occupy middle- and lower-reach habitats.

Other seasonal inhabitants of small, accessible streams within the project area include burbot, northern pike, lake chub, longnose sucker, white sucker, longnose dace and slimy sculpin.

Within the project corridor, inconnu, goldeye, walleye, trout-perch, flathead chub, and lake whitefish are likely confined to the Fort Nelson River mainstem, while bull trout and mountain whitefish appear to be restricted to the Muskwa River mainstem.

Arctic grayling

Arctic grayling (*Thymallus arcticus*) were selected as an aquatic indicator because of their importance for subsistence and recreational fishing, are abundant and widely distributed in higher gradient streams of the Maxhamish project area, and because they are sensitive to overfishing (Nelson and Paetz 1992).

Arctic grayling have a broad distribution within the Taiga Plains and Boreal Plains ecoprovinces, which lie to the east of the Rocky Mountain Foothills. They are often widespread and abundant in drainage systems where barriers do not exist. Adults overwinter in large streams or lakes, migrating upstream in April and May to spawn in smaller, gravel- and cobble-bottomed streams. Juvenile and sub-adult fish from the 0+ to 3+ age classes are often sampled at relatively high densities within headwaters and small tributaries that are seasonally accessible to them. Although, adult fish migrate downstream to large systems as fall water temperatures decline, some overwintering of young-of-the-year and yearling grayling may occur in upstream habitats.

4.3.5.2 Pipeline Route

The proposed pipeline route crosses 57 watercourses. The watercourse names and crossing locations are shown on Biophysical Alignment Sheets included in Appendix A. A summary of fisheries and habitat data is provided below and in Table 4-10.

TABLE 4-10
SUMMARY OF CHANNEL AND FISHERIES DATA
FOR THE PROPOSED PARAMOUNT MAXHAMISH PIPELINE.

No.	Stream Name	Approx. KP	Species Present	Width/ depth (m)	FPC Stream Class	Comments
1	Trib to d'Easum Cr	0.7	-	<3/-	NCD	Muskeg seepage; discontinuous channel - no fisheries concerns
2	Trib to d'Easum Cr	1.1	-	<3/-	NCD	Muskeg seepage; discontinuous channel - no fisheries concerns
3	d'Easum Creek	4.3	GR, LSU, WSU, BB, CCG, LND, TP	37/0.16-0.6	S2	High quality rearing and spawning for "sport" and "non-sport" species.
4	Trib to d'Easum Cr	5.1	(GR)	1.3/0.14	S4	Accessible seasonal rearing habitat for juvenile GR and BB downstream of crossing.
5	Trib to d'Easum Cr	8.8	-	<3/-	NCD	Muskeg seepage; no visible channel

6	Trib to d'Easum Cr	9.2	-	<3/-	NCD	No visible channel
7	Trib to Emile Cr	11.6	FDC BSB		S6	FDC BSB only. No seasonal access or suitable habitat for other species. Extensively beaver impounded, very low flow, not sensitive,
8	Trib to Emile Cr	16.8	-	<3/-	NCD	Muskeg seepage; no visible channel
9	d'Easum Creek	20.0	GR BB CCG LKC FDC	15.0/ 0.46	S2	High quality rearing habitat for "sport" and ' non-sport" species.
10	Trib to d'Easum Cr	24.2	GR BSB	4.3/0.36	S3	Seasonal rearing habitat for arctic grayling,
11	Trib to d'Easum Cr	26.3	-	<3/-	NCD	No definable drainage; no visible channel
12	Trib to d'Easum Cr	29.5	-	<3/-	NCD	No definable drainage; no visible channel
13	Trib to d'Easum Cr	30.3	-	<3/-	NCD	No definable drainage; no visible channel
14	Trib to Deszen Cr	31.9	-	<3/-	NCD	Ephemeral seepage; no visible channel (Tera 1998 - #18)
15	Trib to Deszen Cr	32.8	-	<3/-	NCD	Ephemeral seepage; no visible channel (Tera 1998 - #17)
16	Trib to Deszen Cr	33.5	-	<3/-	NCD	Ephemeral seepage; no visible channel (Tera 1998 - #16)
17	Trib to Deszen Cr	34.0	-	<3/-	NCD	Ephemeral seepage; no visible channel (Tera 1998 - #15)

18	Trib to Deszen Cr	37.8	-	<3/-	NCD	No definable drainage; no visible channel
19	Deszen Creek	38.7	-		S6	Dry/intermittent; no suitable fish habitat present (Tera 1998 - #14)
20	Trib to Tsinhia Lake	39.8	-	<3/-	NCD	Ephemeral seepage; no visible channel (Tera 1998 - #13)
21	Trib to Tsinhia Lake	41.5	-		S6	Dry/intermittent; no suitable fish habitat present (Tera 1998 - #12)
22	Trib to Tsinhia Lake	42.8	-		S6	Dry/intermittent; no suitable fish habitat present (Tera 1998 - #11)
23	Trib to Tsinhia Lake	46.0	-	<3/-	NCD	Ephemeral seepage; no visible channel (Tera 1998 - #10)
24	Trib to Tsinhia Lake	48.0	-	<3/-	NCD	Ephemeral seepage; discontinuous channel, stagnant beaver pond on proposed ROW resulting from 36" highway culvert plugged by beavers. (Tera 1998 - #9)
25	Trib to Tsinhia Cr	52.3	-	<3/-	NCD	Ephemeral seepage; no visible channel (Tera 1998 - #8)
26	Trib to Tsinhia Cr	53.9	-	<3/-	NCD	Ephemeral seepage; discontinuous channel; no fisheries potential. Not sensitive. (Tera 1998 - #7)

27	Tsinhia Creek	67.1	LSU WSU CCG LKC	8.2/0.59	S2	Suitable habitat for northern pike and juvenile burbot, in addition to forage species. (Tera 1998 -#6)
28	Trib to Tsinhia Cr	68.6	-	<3/-	NCD	Ephemeral seepage; no visible channel
29	Trib to Capot-Blanc	70.6	-	<3/-	NCD	Ephemeral seepage; no visible channel (Tera 1998 - #5)
30	Trib to Kiwigana Cr	72.7	-		S6	Dry/intermittent; no suitable fish habitat present. Not sensitive. (Tera 1998 - #4)
31	Trib to Kiwigana Cr	74.3	BSB FDC	2.45/ 0.2	S6	Suitable habitat for resident BSB/FDC; no potential for seasonal use by other species. Not sensitive. (Tera 1998 - #3)
32	Trib to Fort Nelson R	86.3	(BSB)		S6	Dry/intermittent east of highway; beaver impoundment west of highway. Low potential for BSB. Not sensitive. (Tera 1998 - #1)
33	Trib to Fort Nelson R	86.8	-	<3/-	NCD	No visible channel
34	Trib to Fort Nelson R	88.9	-		S6	Ephemeral channel within Fort Nelson River flood plain; stagnant beaver impoundment east of proposed right-of-way; dry west of ROW.
35	Fort Nelson River	90.2	IC, LW, NP, WA, GE, BB,LSU, WSU, FHC, LKC, LND, TP		S1	All species assumed present
36	Trib to Fort Nelson R	96.8	FDC	1.5/0.28	S6	Suitable only for FDC and BSB. Marsh habitat with soft silt substrates and very low flow; not sensitive.

37	Trib to Fort Nelson R	98.4	FDC	1.8/0.42	S6	Suitable only for FDC and BSB. Marsh habitat with soft silt substrates and very low flow; not sensitive.
38	Stanolind Creek	105.3	GR NP	10.6/ 0.43	S2	High quality GR spawning and rearing.
39	Trib to Stanolind Cr	112.0	GR	7.4/0.40	S2	High quality GR spawning and rearing.
40	Trib to Stanolind Cr	119.1	-	<3/-	NCD	Seepage; no visible channel.
41	Trib to Stanolind Cr	119.3	-	0.9/0.35	S6	Ephemeral; no suitable seasonal habitat present
42	Trib to Cridland Cr	124.4	-	<3/-	NCD	Muskeg seepage; no visible channel.
43	Cridland Creek	128.4	BSB (GR)	9.3/0.94	S2	Suitable rearing habitat for GR, NP and a variety of "non-sport" species.
44	Trib to Cridland Cr	128.6	GR BSB	2.4/0.48	S3	Suitable seasonal rearing habitat for arctic grayling.
45	Trib to Cridland Cr	130.0	-	<3/-	NCD	Muskeg seepage; no visible channel.
46	Trib to Cridland Cr	131.3	-	<3/-	NCD	Muskeg seepage; no visible channel.
47	McConachie Cr	134.2	FDC BSB WSU	2.2/0.25	S6	Suitable for resident FDC, BSB and WSU. GR recorded in lower reach but no seasonal access to crossing site due to low-grade marsh habitat and beaver activity in upper reaches.
48	Donaldson Cr	141.2	-		S6	Muskeg seepage; discontinuous channel. No fisheries potential.

49	Trib to Muskwa R	143.2	-		S6	Dry/intermittent; stagnant beaver impoundments. No fisheries potential
50	Trib to Muskwa R (Pebble Cr)	148.3	LSU WSU FDC LKC	8.9/0.30	S2	Limited potential for seasonal use by GR, NP and BB.
51	Muskwa R	150.8	BT, GR, MW, LSU, LGS, BB, LKC, FHC, LND, CCG		S1	All species assumed present
52	Trib to Prophet R	151.3	-		S6	Stagnant ponds on Muskwa R floodplain; low potential for BSB, FDC, WSU.
53	Trib to Fort Nelson R	152.6	-		S6	Beaver impoundment on WEI ROW; muskeg seepage upstream. Low potential for BSB FDC; no historical access due to gradient downstream.
54	Trib to Prophet R	155.1	NFC	1.3/0.19	S6	Beaver impoundment on WEI ROW; muskeg seepage upstream. Low potential for BSB FDC; no historical access due to gradient downstream.
55	Trib to Fort Nelson R	160.4	NFC		S6	Beaver impoundment on WEI ROW; muskeg seepage upstream, no visible channel downstream. Low potential for BSB FDC; no access due to gradient and highway culvert downstream.
56	Trib to Fort Nelson R	161.1	-	<3/-	NCD	Muskeg seepage; no visible channel.
57	Trib to Fort Nelson R	163.2	NFC	2.1/0.23	S3	Limited potential for seasonal use by GR from Ft Nelson R. Access currently limited by WEI water intake, and highway culvert and beaver activity. Potential BSB FDC habitat upstream of crossing.

BB=burbot; BSB=brook stickleback; BT=bull trout; CCG=slimy sculpin FDC=finescale dace; FHC=Flathead chub; GE=goldeye; GR=arctic grayling; LGS=Largescale sucker; LKC=lake chub; LSU=longnose sucker; LW=Lake whitefish; NFC=no fish captured NP=northern pike; MW=mountain whitefish; TP=Trout-perch; WA=Walleye; WSU=white sucker.

All small watercourses crossed by the right-of-way were assessed or visually inspected by Diversified Environmental Services (Diversified) between July 13 and 23, 1999 (Diversified 1999, Appendix C). Detailed habitat and fish sampling data were collected at all watercourse crossings where a definable stream channel and surface flow were present. Where possible one 200 metre sample section straddling the proposed crossing site was evaluated on each stream with potential fisheries value. Watercourses with potential fisheries values were visually inspected, by helicopter, for up to 5 km downstream to ensure that sample sites were representative and that no unique or sensitive habitat features occurred immediately downstream of proposed crossings. Sampling results are included in Appendix C.

Fisheries and habitat information at proposed crossings of lower d'Easum Creek, Fort Nelson River, and Muskwa River was collected by Golder between July 11 and 14, 1999 (Golder 1999). The minimum length of stream examined was at least ten times the measured bankfull width. Sampling results for these three watercourses are also included in Appendix C.

The northern most section of the residue gas pipeline is situated in the Petitot River sub-basin. The initial 7.6 km segment that parallels the access road from the Maxhamish gas plant to its junction with the Liard Highway crosses d'Easum Creek and several minor tributaries. The d'Easum Creek crossing at KP 4.3 is considered to have high fisheries value due to the presence of high quality spawning, nursery, and rearing habitat at and downstream of the crossing site, as well as the presence of Arctic grayling and several non-sport species. One other tributary at KP 5.1 is concluded to have moderate fisheries value as seasonal rearing habitat (Table 4-10; Diversified 1999 in Appendix C).

Between KP 7.6 and 38 the route parallels the Liard Highway and crosses d'Easum Creek, Deszen Creek, and thirteen small watercourses. Most of these watercourses have no or low fisheries value, but the d'Easum Creek crossing at KP 20 has high fisheries value and d'Easum Creek tributary crossing at KP 24.24 has moderate fisheries value. Near KP 38, the alignment crosses the height-of-land between the Petitot and Fort Nelson River sub-basins (Table 4-10; Diversified 1999 in Appendix C).

The residue gas pipeline right-of-way crosses Tsinhia Creek and fourteen small watercourses between KP 38 and the Fort Nelson River mainstem at KP 90.2. Tsinhia Creek has moderate fisheries values; all other watercourses have no or low fisheries value (Table 4-10; Diversified 1999 in Appendix C).

The Fort Nelson River near the proposed crossing site is a large, warm, turbid watercourse that provides migration, rearing and feeding habitat for a variety of species. Average channel width is 242 m and unstable, erosional banks are present on both banks at the crossing site. Substrates in the 2.5 km sampling section are dominated by fine sediments and potential spawning habitat is very limited for most fish species, particularly sport fish. Channel depths at the crossing site were 2 m to 4.5 m and depth and turbidity provided the only overhead cover. Fish species known to occur in the lower Fort Nelson River include inconnu, lake whitefish, northern pike, walleye, goldeye, burbot, longnose sucker, white sucker, flathead chub, lake chub, longnose dace, and trout-perch. The actual distribution of these fish species within the Fort Nelson River and their specific use of habitat in the vicinity of the crossing is unknown (Golder 1999 in Appendix C).

Between the Fort Nelson River and Muskwa River at KP 151, the residue gas pipeline route generally parallels the existing WEI Beaver River right-of-way and intersects Stanolind, Cridland, McConachie, Donaldson, and Pebble creeks and ten small watercourses. High fisheries values are present in Stanolind Creek at KP 105.34, a tributary to Stanolind Creek at KP 112, and Cridland Creek at KP 128.4. A tributary to Cridland Creek at KP 128.6 and Pebble Creek at KP 148.3 have moderate fisheries values; remaining watercourses have low or no fisheries potential (Table 4-10; Diversified 1999 in Appendix C).

Like the Fort Nelson River, the Muskwa River is a large, warm, turbid watercourse that provides migration, rearing and feeding habitat for a variety of species. Average channel width is 193 m and at the crossing site, the south bank is steeply sloping while the north bank is relatively shallow. Bank erosion potential is high, particularly on the south bank. Substrates in the 2.3 km sampling section are dominated by fine sediments and potential spawning habitat is very limited for most fish species, particularly sport fish. Channel depths at the crossing site were 1 m to 3.5 m and overhead and instream cover was absent. Fish species known to occur in the Muskwa River include Arctic grayling, bull trout, mountain whitefish, burbot, longnose sucker, largescale sucker, flathead chub, lake chub, longnose dace, and

slimy sculpin. Several of these species are not adapted to warm, turbid rivers and their presence in the pipeline study area is likely restricted to migration and overwintering periods (Golder 1999 in Appendix C).

The southern segment of the residue gas pipeline route follows a narrow plateau between the Prophet and Fort Nelson rivers. This segment crosses six small watercourses with nil or low fisheries potential (Table 4-10; Diversified 1999).

4.3.6 Land and Resource Use

This section describes existing land and resource management plans that apply to the Maxhamish project area along with a description of existing resource users. Other uses include agriculture (Section 4.3.6.2), forestry (Section 4.3.6.3), energy resources (Section 4.3.6.4), trapping, guiding and outfitting (Section 4.3.6.5), tourism and outdoor recreation (Section 4.3.6.6), protected areas (Section 4.3.6.7), and traditional and subsistence uses (Section 4.3.6.8).

4.3.6.1 Land and Resource Management Planning

Land and resource management objectives for the Maxhamish study area are provided in the Fort Nelson Land and Resource Management Plan (LRMP). The plan covers an area of 98,000 km^2 and was developed over four years by a working group comprised of local, regional and provincial interests and agency staff representing a wide range of values including access, agriculture, biodiversity, energy, forestry, guide outfitting, minerals, outdoor recreation and tourism, soil, transportation and utility corridors, trapping and visual quality. All these values are addressed in the plan objectives, strategies and recommendations.

The LRMP divides the land base into thirty seven Resource Management Zones (RMZs) grouped into four categories:

1. Enhanced Resource Development (representing 36% of the land base);
2. General Resource Development (representing 24% of the land base);
3. Muskwa-Kechika Special Management (representing 29% of the land base); and
4. Protected Areas (representing 11% of the land base).

The plan also identifies three levels of management direction:

1. General Management Direction;
2. Category Management Direction; and
3. RMZ Specific Direction.

There are no unresolved issues in the plan and no job losses are anticipated because of it. The plan should result in stability for all resource-based industries, creation of seven protected areas, a recommended planning framework for the Muskwa-Kechika Special Management area and an improved outlook for recreational activities and wildlife (Fort Nelson LRMP 1997).

4.3.6.2 Agriculture

There is approximately 46,000 hectares (ha) of Agricultural Land Reserve (ALR) within the Fort Nelson LRMP area. Most of it is located in the McConachie Creek and Jackfish Creek Crown agricultural subdivisions and adjacent to the Alaska Highway near the Town of Fort Nelson. There are in excess of 50 agricultural leases in this area. An estimated 8,000 ha of land has been cleared and broken in the Fort Nelson area, of which an estimated 3,000 acres is being actively farmed. According to the 1996 census, only 15 people in the study area listed agriculture as their primary occupation but many more people participate in agricultural activities on a part-time basis (T. Pittman, pers. comm. 1999).

Current agricultural enterprises in the Fort Nelson area are small in size (up to 250 ha) and function in a non-intensive fashion. They includes 12 cattle ranches with about 400 animals, four bison ranches with 150-200 animals, forage (alfalfa, clover and mixed grasses) and coarse grain (oats and barley) production as well as honey, berry and vegetable production (Fort Nelson LRMP 1997). In addition, there are 21 Crown land grazing tenures held by ranchers and guide outfitters in the Fort Nelson LRMP area (ARA Consulting *et al.* 1996).

Agricultural land development has been on the upswing in recent years, mainly in the McConachie Creek Crown subdivision. However, it has been hampered by the terms and conditions of the agricultural leasehold agreements making ownership of the land and economic viability of agricultural activities a long-term goal for most leaseholders (T. Pittman, pers. comm. 1999).

4.3.6.3 Forestry

Forestry when taken together with wood manufacturing, logging, and other related activities, is the second largest industry in Fort Nelson. The service industry is the largest employer but because it encompasses many unrelated sectors in the local economy, the forest industry is really the single largest employer in the area (Synergetix 1999a).

The Fort Nelson Timber Supply Area (TSA) overlaps the Fort Nelson LRMP area and covers an area of 8,270,660 ha. However, much of the land base cannot be used as productive forest land for a variety of reasons including non-existent or unproductive forest cover, alienated land, or private land. According to a 1993 timber supply review only 781,486 ha in the TSA are available for coniferous timber harvesting and 472,716 ha for deciduous timber harvesting. The current total annual allowable cut (AAC) in the Fort Nelson TSA is set at 1,500,000 m^3. This TSA includes an AAC of 600,000 m^3 for coniferous timber and an AAC of 900,000 m^3 for deciduous timber. The primary coniferous timber harvested in the TSA is spruce and the main deciduous timber species is aspen (ARA Consulting *et al*. 1996).

Slocan is the major forest sector employer in Fort Nelson and it holds approximately 90% of the timber harvest apportionment in the Fort Nelson TSA. It operates two divisions: the Tackama Division which includes a sawmill, veneer and plywood plants; and the Polarboard Division, which produces oriented strand board (OSB). The OSB plant is the largest facility of its kind in the province.

In addition to the Slocan, there are several small-sale sawmills operating in Fort Nelson. The Canadian Chopstick Manufacturing Company (CCMC) operated in Fort Nelson from 1990 to 1997. Although the chopstick manufacturing plant is not operational, CCMC continues to maintain the plant facilities, equipment, Forest Licence and deciduous AAC (700,000 m^3) in the hope that the plant will reopen when market and operating conditions improve.

Forestry has been, and will continue to be, a cornerstone of the Fort Nelson economy. However, there are some limitations to growth including a lack of adequate road infrastructure, distant markets and high rail transportation costs, unresolved First Nations issues, and restrictive government policies. At the same time, there are opportunities for greater diversification in manufacturing of value-added wood products (Synergetix 1999a).

4.3.6.4 Energy Resources

Northeast British Columbia has been the focus of energy exploration and development since the 1950’s and it is the only area of the province presently producing oil and natural gas. These northeast oil and gas fields are located within the huge Western Canada Sedimentary Basin, which also underlies all of Alberta and the southern half of Saskatchewan. Since de-regulation of gas markets during the mid-1980s, exploration for and discoveries of natural gas in northeast British Columbia have increased sharply. Although the largest discoveries have been in the Fort St. John and Dawson Creek LRMP areas, where gas processing and transportation infrastructure is more developed, the Fort Nelson LRMP area has also been active. Less thoroughly explored than areas to the south, it has the potential for significant new discoveries, and it contains significant volumes of natural gas reserves which are not yet tied into infrastructure.

Within the Fort Nelson LRMP area there are 41 established oil and gas fields with Clarke Lake, Helmet, Yoyo, and Sierra fields accounting for about 22% of the province’s total gas production. However, these fields have been producing for over 25 years and are depleting rapidly. The presence of gas gathering, processing and transmission infrastructure will enable new natural gas pools to be brought into production.

One of the newer areas of active exploration and development is the Maxhamish field. There are currently an estimated 35 gas wells and another 15 potential wells linked to this field. In addition to Paramount, one of the key energy players in this area is the Alberta Energy Company (AEC). During the last 18 months, AEC has constructed a gas plant southeast of Maxhamish Lake as well as a pipeline to transport gas from the plant to a tie in point on the WEI sour gas pipeline near the Fort Nelson River.

The outlook for further energy exploration and development in northeast British Columbia and the Fort Nelson area appears to be very encouraging. Petroleum activity has been a mainstay of the local economy and about 14% of town residents directly depend on the petroleum industry for their livelihood. A 1998 report prepared for the Canadian Association of Petroleum Producers, WEI and BC Energy and Mines by KPMG indicated that the North American demand for both oil and natural gas is expected to continue to grow. Long term industry projections are that both oil and gas prices will increase with natural gas prices projected to increase at a slightly faster rate. In combination with other factors instituted to encourage petroleum development, it is assumed that energy investment in the Fort Nelson area will be stimulated (Synergetix 1999a).

4.3.6.5 Trapping, Guiding and Outfitting

The diverse landscapes within the study area provide habitat to a variety of commercially harvested furbearer species that include marten, lynx, mink, beaver, muskrat, weasel, wolf, and fisher. About 90 registered traplines or portions of traplines cover the entire Fort Nelson LRMP area.

A 1994 estimate of total gross revenue from trappers in this area was $638,700 with an estimated net revenue of $269,300 (estimates provided by MELP nd.). More recently, the commercial trapping industry has been in decline due to deteriorating fur markets. Contributing to the slumping market conditions is a negative public perception of trapping in many large urban centres worldwide. To non-native trappers this activity is a part-time pursuit used to supplement other income. Among First Nation communities, trapping plays a larger role. It is a source of income and country food and it has deep roots in aboriginal culture (Ramsay 1975). Among First Nations communities, registered traplines are often held by entire families as well as individuals (ARA Consulting *et al*. 1996).

Some 15 guide outfitting businesses have been allocated areas within the Fort Nelson LRMP area where they can undertake their activities with non-resident hunters and fishermen. Only the most northern portion of the region (north of the confluence of the Fort Nelson and Liard Rivers) has not been allocated for guide outfitting. The guide outfitting industry is well established and it makes an important contribution to the local economy and the backcountry tourism industry in the Fort Nelson LRMP area. In 1994, non-resident hunters spent an estimated 3,061 days hunting within the Fort Nelson LRMP area. The primary species hunted included moose, elk, wolf, and grizzly bear but black bear, caribou, and mountain sheep are also hunted by non-residents (ARA Consulting *et al*. 1996). Although guided hunts and fishing experiences have been the traditional source of income for this industry, some guiding-outfitters have expanded and diversified their operations in recent years to include guided hikes, trail rides, and wildlife viewing during the summer months (Fort Nelson LRMP 1997).

4.3.6.6 Tourism and Outdoor Recreation

The tourism industry is a complex service industry consisting of sectors including accommodation, food and beverage, transportation, retail trade, some government services, and other services. This industry can be grouped into four categories: touring vacation travelers, adventure and recreation, industry or business travelers and work crews, and events and conferences. Fort Nelson’s tourism industry represents about 15% of the local economy but only about 6% of Fort Nelson residents depend on it solely for a living (Synergetix 1999a).

The touring vacation market is the most visible of the four tourism categories in Fort Nelson. It consists of people travelling the Alaska Highway in motor homes, buses, campers, and vehicles en route to and from the Yukon and Alaska. Fort Nelson is a major stopover point and also serves as an entrance and departure point for visitors traveling to and from the Northwest Territories via the Liard Highway (Highway 77). Based on available data it is estimated that in the order of 144,000 rubber tire visitors travel through the region each year between April and September (Ibid).

The adventure and recreation category is a growing tourism market that includes people interested in soft adventure, hunting and fishing, sightseeing, native culture and eco-tourism opportunities. These people are attracted to this region by the unspoiled wilderness, scenic values, variety and abundance of wildlife, and the range of outdoor recreation opportunities. Summer/fall outdoor recreation activities enjoyed by visitors and local residents alike include hiking, camping, fishing, hunting, jet boating and river rafting, horseback riding, wilderness canoeing and kayaking. Winter outdoor recreation activities include snowmobiling and cross-country skiing on Crown land in the Fort Nelson area.

Within the Fort Nelson LRMP area there are 8 provincial parks as well as 12 Forest Service Recreation Sites; most are located along the Alaska Highway (ARA Consulting *et al*. 1996).

Year round business and industry travelers that visit Fort Nelson and the region for a few days or an extended period of time (in the case of work crews) make an important contribution to the local economy through provision of their services as well as contributing to the revenues of the tourism hospitality businesses. These visitors, represent the energy, forestry, government, legal, health and construction sectors (Synergetix 1999a).

Fort Nelson has hosted many major sporting events and conferences over the past 10 years. The community has the hospitality services, regional infrastructure and an earned reputation for hosting such events. However, due to the demands placed on the hospitality services during the summer and winter by holiday and business/industry travelers, the preference is to schedule these events during the shoulder seasons (Ibid).

4.3.6.7 Protected Areas

In 1992, the Protected Areas Strategy (PAS) was created to coordinate British Columbia's protected areas program and objectives. The main goal of the PAS was to protect 12% of the province's land by 2000.

Within the Fort Nelson LRMP area approximately 11% (1,051,000 ha) of the land base has been proposed as protected area. The category (protected area) contains LRMP zones proposed for protection designation due to natural, cultural, heritage and/or recreational values as defined by the PAS. Logging, energy, mining and hydroelectric exploration and development are prohibited in these areas under the *Park Act*.

There are 7 Goal 1 Resource Management Zones and 13 Goal 2 sites identified in the protected area category. All the proposed protected areas stand alone as functioning units within the Fort Nelson LRMP area. The 7 Goal 1 sites are:

- Denetiah (97,200 ha)
- Klua Lakes (28,600 ha)
- Liard River Corridor (81,900 ha)
- Maxhamish Lake (27,600 ha)
- Northern Rocky Mountains (635,900 ha)
- Thinatea (19,500 ha) and
- Wokkpash (37, 500)

The 13 Goal 2 sites are small, covering a combined total of 8,500 ha (Fort Nelson LRMP 1997)

4.3.6.8 Traditional and Subsistence Use

The proposed Maxhamish pipeline route passes through the traditional territories of the Fort Nelson First Nation and the Prophet River First Nation. Residents from Fort Liard also hunt, trap and fish in the area. Land Use Coordinators Ken Barth of Fort Nelson First Nation, and Brian Wolf and Robin Tsakoza of Prophet River First Nation were consulted to determine their traditional use areas and study methods. Community representatives were given the opportunity to review maps and associated alignment sheets, and a helicopter reconnaissance was conducted along the proposed route with representatives of both First Nations to identify any traditional land use sites. These sites may include: sites of cultural significance such as camping, trapping, fishing or hunting locales, cabins, burial sites, historic trails, mineral licks, berry picking areas, medicinal plant collection locations, or areas identified as cultural landmarks or spiritual significance.

Site locations were identified during the overflight and locations were recorded using a GPS. Three traditional sites were also identified during the course of the Archaeological Impact Assessment (see Section 6), and included in the results of the traditional land use consultation.

Fort Nelson First Nation

Representatives from Fort Nelson First Nation included Bill Badine, William Dettieh and Shirley Ross. Both Bill Badine and William Dettieh actively trap and hunt in the vicinity of the development area, and have cabins in the vicinity. The entire length of the proposed residue gas pipeline route were examined during the overflight from the Maxhamish gas plant site to the terminus immediately south of the WEI gas plant.

A total of 15 traditional land use sites were identified in the vicinity of the Maxhamish pipeline right-of-way, including 11 cabin sites and 4 camping areas (Table 4-11). The majority of the sites were either of recent or current use. Camping areas appeared to be hunting/trapping camps, as tent frames, stoves, beaver stretching racks, etc. were observed. Sites in the immediate vicinity of the proposed right-of-way included 7, 9, 10, 11, 12, 13, 14, and 15. From the air, it appeared that only Site 10, Harry Dickie's cabin, was in potential conflict with the proposed right-of-way (Biophysical Alignment Sheet 7, Appendix A).

TABLE 4-11
TRADITIONAL USE SITES IDENTIFIED FOR THE
PARAMOUNT MAXHAMISH PROJECT.

No.	Site Type	First Nation Affiliation	Family Affiliation	Location	
				UTM	Longitude and Latitude (° ‘ ")
1	Cabin	Fort Nelson	Harry Dickie	10VDA 903 669	59 14 36/123 10 07
2	Cabin	Fort Nelson	Manny Gairdner	10VDA 878 795	59 21 23/123 12 49
3	Cabins	Fort Nelson	Bill Badine, Robert Badine	10VDB 895 027	59 33 54/123 11 08
4	Cabins	Fort Liard	George Deneron	10VDB 013 399	59 53 57/122 58 35
5	Cabin	Fort Liard	William Betthale	10VDB 024 381	59 52 58/122 57 23
6	Camping Area	Fort Liard	William Betthale	10VDB 024 381	59 52 58/122 57 23
7	Cabin	Fort Liard	Nap Bertrand	10VDB 013 314	59 49 20/122 58 34
8	Cabins	Fort Liard	Philip Bertrand	10VDB 007 281	59 47 34/122 59 14
9	Cabins	Fort Liard	Philip Bertrand	10VDB 966 204	59 43 27/123 03 33
10	Cabin	Fort Nelson	Harry Dickie	10VDA 877 905	59 27 20/123 12 55
11	Cabin	Fort Nelson	Willie Dettieh	10VDA 833 825	59 23 01/123 17 33
12	Cabin	Fort Nelson	Jimmy and Mary Dettieh	10VDA 833 825	59 23 01/123 17 33
13	Camping Area	unknown	Unknown	10VDB 010 285	59 47 46/122 58 56
14	Camping Area	unknown	Unknown	10VDB 011285	59 47 46/22 58 50

15	Camping Area	unknown	Unknown	10VDA 945 098	59 37 41/123 5 51

Prophet River First Nation

Representatives from Fort Nelson First Nation included Brian Wolf and Robin Tsakoza. The proposed pipeline route from the Fort Nelson River crossing to the terminus near the WEI gas plant was examined by helicopter.

No specific traditional land use sites were identified during the overflight. However, the presence of a large beaver dam was observed on the existing WEI right-of-way south of Stanolind Creek (Biophysical Alignment Sheet 13, Appendix A), along with a crossing of the Old Fort Nelson Trail.

Fort Liard Residents

Interviews were done with residents who traditionally use the Maxhamish area. No specific traditional use sites were identified along the proposed alignment.

4.4 Potential Effects and Mitigation

The following sections describe the potential effects of the proposed Maxhamish project on environmental resources in the area. Each section begins with discussions of pipeline-related effects based on the project information provided in Section 2. The mitigative measures to be used to prevent or reduce these effects are then described, along with a summary of the combined residual project-related effects. Predicted residual effects include all pipeline-related activities.

The possible cumulative effects of project activities and other disturbance sources in the Maxhamish development area are considered separately in Section 4.5.

4.4.1 Assessment Methodology

Potential environmental effects associated with the Maxhamish residue gas pipeline were identified and assessed by Project Team members using a consistent process. In the first step, potential project-related disturbances for the selected environmental indicators were defined. Next, the degree of spatial and temporal overlap was considered for each of these interactions. An assessment of the environmental significance of these effects after application of mitigative measures was then made by comparing predicted effects to established objectives or scientific criteria. The degree of confidence in the assessment was also considered.

Specific definitions were adopted to explain the predicted extent, magnitude, direction, duration, and confidence of potential environmental effects for the environmental indicators. These definitions are based on the approach proposed by Duval and Vonk (1991) have been used in other environmental assessments in northeast British Columbia and Alberta (Salmo *et al*. 1996, 1997; Alliance 1997).

Direction

Positive: net benefit to the resource.
Neutral: no net benefit or loss to the resource.
Negative: net loss to the resource.

Geographic Extent (Scope)

Local: confined to the area directly disturbed by the project (pipeline right-of-way; temporary workspace; facility site; access road)
Sub-regional: beyond the local scope but within the assessment study area boundaries specified for each discipline or indicator.
Regional: between the sub-regional and regional boundary specified for each discipline or indicator.
Provincial: extending beyond regional or administrative boundaries, but confined to the province being considered.
Interprovincial: extending beyond British Columbia.

Duration

Immediate: 2 days or less.
Short-term: between 2 days and 1 year.
Medium-term: between 1 and 10 years.
Long-term: greater than 10 years.

Magnitude

Nil: no change anticipated.
Low: disturbance predicted to be somewhat above typical background conditions and concentrations, but within established or accepted protective standards (*e.g.*, provincial Level A or federal Desirable air quality objectives), or to cause no detectable change in biological, social, or economic parameters.
Medium: disturbance predicted to be above background conditions or concentrations but well within established criteria or scientific effects thresholds (*e.g.*, provincial Level B or federal Acceptable air quality objectives), or to cause a detectable change in biological, social, or economic parameters.
High: disturbance predicted to exceed established criteria or scientific effects thresholds associated with potential adverse effects (*e.g.*, provincial Level C or federal Tolerable air quality objectives), or to cause a detectable change in biological, social, or economic parameters beyond range of natural variability or social tolerance.

Frequency

Continuous: effect will occur continually over assessment period.
Isolated: effect confined to specified period (*e.g.* construction).
Periodic: effect occurs intermittently but repeatedly over assessment period (*e.g.* routine maintenance activities and flaring).
Occasional: effect occurs intermittently and sporadically over assessment period (*e.g.* road kills and unscheduled maintenance).
Accidental: effect occurs rarely over assessment period.

Probability of Occurrence

Low: unlikely.
Medium: possible or probable.
High: certain.

Level of Confidence

Low: Based on incomplete understanding of cause-effect relationships and incomplete data pertinent to study area.
Moderate: Based on good understanding of cause-effect relationships using data from elsewhere or incompletely understood cause-effect relationships using data pertinent to study area.
High: Based on good understanding of cause-effect relationships and data pertinent to study area.

Permanence

Reversible in short-term: effect can be reversed in one year or less.
Reversible in medium-term: effect can be reversed in more than 1 year but less than 10 years.
Reversible in long-term: effect can be reversed in more than 10 years.
Irreversible: effects are permanent.

Significance

Significant Adverse Effect: Medium or High probability of permanent or long-term effect of High magnitude that cannot be technically or economically mitigated or compensated and is inconsistent with regional plans or exceeds established or assumed guidelines, standards, criteria or thresholds for the indicator being considered.
Significant Positive Effect: Medium or High probability of permanent or long-term positive effect of High magnitude.
Unknown: Potential significance cannot be defined with existing information or knowledge.
Not Significant Adverse Effect: All other negative effects.

Not Significant Positive Effect: All other positive effects.

These definitions are referenced in the assessments provided below for each biophysical component.

4.4.2 Terrain and Soils

Terrain mapping conducted for the project identifies surficial deposits and sensitive features along the Maxhamish pipeline right-of-way. Pertinent information is presented on the alignment sheets included in Appendix A. Potential effects on surficial materials and soils are described below, along with a description of the measures to be used to reduce these effects, and the anticipated impacts that would occur following application of these mitigative measures.

4.4.2.1 Potential Effects

The pipeline right-of-way is underlain by bedrock of Upper and Lower Cretaceous age. As detailed in Section 4.3.2.2, these strata comprise, depending on location: Dunvegan Formation (conglomerate, sandstone and shale), Sikanni Formation (sandstone, siltstone and shale), or Fort St. John Group and Buckinghorse Formation (marine shale, with minor siltstone and sandstone). As shown on the alignment sheets, level to gently undulating moraine, gently to moderately, locally steeply, sloping moraine-veneered bedrock, and level to depressional organic bog and veneer are the dominant surficial materials. Glaciofluvial outwash, alluvial floodplain and terrace, and colluvial slopewash deposits are encountered locally.

Soil conditions associated with the pipeline right-of-way have been previously described (Section 4.3.2.2). On upland areas, soil profiles are moderately drained and characterized by a dominantly silty loam texture overlying a silty clay loam to clay loam texture glacial till. The soil and surficial deposits (within 75 cm of the profile surface) in moraine areas are relatively stone free. Organic soils in low-lying areas are often poorly or imperfectly drained.

Potential impacts on terrain and soil resources are associated with clearing, grading, grubbing, trenching, backfilling, and vehicle traffic. Terrain concerns relate to: presence of shallow bedrock; terrain instability; and permafrost. Potential soil concerns are: subsoil and topsoil mixing and loss of productivity; compaction, rutting and pulverization; contamination from spills, and erosion. These potential concerns are discussed below relative to the Maxhamish pipeline route.

Shallow Bedrock

If bedrock is encountered during grading or trenching activities, ripping or blasting may be required for pipeline installation. Where the right-of-way is cut into a steep slope, it may not always be feasible to restore pre-existing terrain contours following construction.

Terrain Instability

Pipeline construction can reactivate pre-existing terrain instabilities or create fill instability during or following construction. Areas of unstable terrain are avoided during pipeline routing whenever possible, and fill instability can be avoided or reduced by recontouring cuts to stable angles, maintaining surface and subsurface drainage patterns, and managing erosion.

Permafrost

Disturbance of permafrost can result in melting and subsequent subsidence, and erosion. Degradation can also increase the stress or installed pipe, or allow it to float to the surface. Permafrost degradation can be reduced or avoided by constructing in previously disturbed terrain, minimizing right-of-way width, and installing surface insulation materials to maintain ground temperatures.

Some permafrost terrain is traversed but mostly in areas where existing linear disturbances are closely paralleled. Since frozen ground is expected to have degraded in these disturbed areas, it is unlikely extensive permafrost bodies will be encountered within these route segments. No permafrost has been detected in probes of muskeg areas.

Mixing and Loss of Productivity

Provincial government representatives have expressed concern about the effects of petroleum activities and other land uses (*e.g.*, roads) on the soil base, and the ultimate effects that soil degradation may have on land base productivity.

Loss of soil productivity can result from the mechanical movement, removal, or burial of soil materials during clearing and construction and contamination from spills. Soil degradation is associated with the redistribution or loss of soil nutrients due to exposure of unfavorable subsoil or spoil materials, mixing of subsoil and topsoil materials, and changes in surface and subsurface water movement. The risk of soil degradation is affected by slope aspect, complexity and angle; soil depth to features such as bedrock, unfavorable subsoil conditions and water table; soil chemistry; and the presence of carbonates.

Topsoil is the organic-enriched upper soil layer, designated as Ah or Ahe horizon, which is the seedbed for most vegetation growth. It is typically differentiated from the subsoil by a darker colour and by the presence of humus. Within the study area, however, the topsoil layer also consists of or is dominated by a lighter-coloured, less fertile Ae horizon. The topsoil material (Ah, Ahe, and/or Ae), when combined with the surface leaf litter (LFH) layer is the zone of most importance to vegetation growth.

Compaction, Rutting, and Pulverization

Site factors determining risk of compaction, rutting, and pulverization include texture, coarse fragments, moisture regime, forest floor H horizon >20 cm, and organic soil.

Compaction results from the movement of heavy vehicles and equipment over the soil. Compacted soils have a reduction in air and water spaces and, hence, the soil's ability to retain water is reduced. Furthermore, compacted soils can impede root penetration and air exchange with the atmosphere. Compacted soils can cause surface water ponding and reduced through-flow, and a reduction in soil productivity. Silty loam, silty clay loam, and clay loam soils found along the right-of-way are at a high risk for soil compaction under non-frozen conditions.

Heavy vehicle and equipment movements may also result in soil pulverization where the soil structure is broken down, leaving the soils at high risk for erosion.

Rutting of surface horizons often occurs in association with both compaction and pulverization. Where the depth of surface rutting exceeds topsoil depths, there is a risk of topsoil and subsoil mixing which can cause a loss of soil fertility, as previously discussed. The risk is high in areas where soils are characterized by shallow topsoil depths, such as the proposed pipeline route.

Erosion

Clearing and grading associated with right-of-way preparation will remove the stabilizing vegetative mat, leaving the ground surface temporarily exposed to erosion. Soil erosion can cause impacts such as soil loss, nutrient loss, and lower productivity. The risk of soil erosion is related to climatic conditions (rainfall intensity and duration, snowmelt), topographic conditions (slope angle, aspect, length, and complexity), and soil properties (organic matter content, texture, structure, coarse fragment content, and restricting perviousness). The risk of soil erosion is typically low for forest soils when surface organic layers are intact, but increases rapidly once the protective vegetation, forest floor organic mat, and slash are removed.

Fine-textured mineral soils found along the right-of-way are highly susceptible to water erosion. As noted, most of the pipeline alignment traverses low-relief terrain, encountering moraine (till) and muskeg deposits that have been assigned Class I and II terrain stability ratings. Class III ratings are assigned to a number of typically short, moderately to steeply sloping segments, at the river and incised creek/drainage crossings and along the edges of the bedrock-controlled uplands.

4.4.2.2 Mitigation and Residual Effects

Established construction procedures are available to deal with potential terrain and soil effects. Specific mitigative measures for pipeline construction and operation are provided on the alignment sheets (Appendix A) and in the Environmental Protection Plan prepared for this project (Appendix D).

Shallow Bedrock, Terrain Instability, and Permafrost

Dunvegan Formation sandstones and conglomerates, and possibly the Sikanni Formation sandstones, present a concern for ditchline excavation, and likely will require blasting, at least locally. Areas of shallow bedrock have been identified on the Biophysical Alignment Sheets. Consideration should be given to use of "rockshield", or similar, within these segments The remaining bedrock formations, mostly comprising shale and siltstone, should be rippable.

The proposed pipeline alignment mostly traverses low relief terrain and, as a result, avoids areas of active and inactive instability and minimizes sidehill sections. An exception is the south valley wall at the Muskwa River crossing, where a large translational landslide is traversed. An HDD crossing passing beneath the Muskwa River and instability on the south approach slope is proposed to mitigate this concern. With the exception of deep organic deposits, surficial materials in the project area have good bearing capacity, particularly in a frozen state, to support equipment.

Although no permafrost has been detected, small bodies of frozen material could be encountered where new right-of-way traverses degrading permafrost terrain, *e.g.* the "speckled" bog areas between the gas plant and the Liard Highway. Heavy wall pipe will be used in deep muskeg areas to address possible thaw settlement concerns. In addition, drainage control will be established to ensure water does not pond or flow over areas with ice-rich soil.

With application of these mitigative measures, potential terrain effects of pipeline construction and operation are anticipated to be: neutral to negative in direction; low magnitude; medium- to long-term and continuous duration and frequency; and reversible in medium- to long-term. The probability of these effects is medium and confidence in the assessment is moderate. Effects are anticipated to be not significant.

Mixing, Loss of Productivity, Compaction, Rutting, Pulverization, Spills

In the project area, the upper 10 to 15 cm is considered to be the favorable growing medium. Below this depth leached or undesirable soil material and soil parent material is typically encountered. A distinct colour change from brown to yellowish brown and gray was noted in most profiles, but a colour change between upper and lower soil horizons was not always evident.

To maintain land base productivity, Paramount will strip and salvage topsoil in the area of the trench and areas where grading is required. The surface stripping and topsoil salvage width will be increased at bellholes and sharp sidebends. Organic soils on Agricultural Reserve Lands, will be stripped to a minimum depth of 40 cm. Stripping depth will be increased if deeper surface horizons are observed. Stripped surface material will be stockpiled separately from spoil and respread over disturbed areas following construction. A layer of snow will be left in place on the spoil side to minimize topsoil/subsoil mixing during backfilling.

Most clearing and construction activity for the Maxhamish project will occur when soil and subsoil materials are frozen, which greatly reduces the risk of compaction, rutting, and pulverization. If required snow will be bladed off or packed on the work side to increase frost penetration in winter and snow will be graded over the travel lane to improve driving conditions.

In the event of wet or thawed soils, construction alternatives (such as snow harvesting, placement of corduroy or mats, or night-time vehicle movements) will be adopted, equipment travel will be suspended, or construction will be postponed to minimize disturbance to soil and terrain.

The Environmental Protection Plan prepared for the Maxhamish project includes specific measures to prevent and respond to accidental spills.

With application of these mitigative measures, potential effects of pipeline construction and operation on soils productivity and loss are anticipated to be: negative in direction; low magnitude; short- to long-term duration; isolated to continuous frequency; and reversible in medium- to long-term. The probability of these effects is high and confidence in the assessment is high. Effects are anticipated to be not significant.

Erosion

Trench breakers, diversion berms, and subdrains will be used to avoid or reduce erosion on Class III terrain (short, moderately to steeply sloping segments, at the river and incised creek/drainage crossings and along the edges of the bedrock-controlled uplands) and other points along the right-of-way as appropriate. Surface diversion berms will be installed at appropriate intervals to deflect flowing water onto adjacent undisturbed vegetation. If appropriate, slash will be rolled back onto the right-of-way and compacted with the tracks of a bulldozer to impede water movement. Final designs for these structures will not be developed until the right-of-way has been graded and surface conditions can be assessed.

Fine-textured soils are common along the pipeline right-of-way and they are highly susceptible to water erosion, even on low slopes, when the protective vegetation cover is removed during construction. Following clean-up, slash will be rolled back on the right-of-way to minimize surface runoff and provide microhabitat for revegetation by native species. If necessary, short-term erosion control such as erosion mats may be required to minimize the risk of erosion until the protective vegetation mat is re-established.

Regular aerial and ground surveys of the pipeline right-of-way will take place during the operations phase to identify any areas with chronic erosion problems so that remedial measures can be implemented.

With application of these mitigative measures, potential effects of pipeline construction and operation on surface erosion are anticipated to be: negative in direction; low to medium magnitude; short- to long-term duration; isolated to continuous frequency; and reversible in medium- to long-term. The probability of these effects is high and confidence in the assessment is high. Effects are anticipated to be not significant.

4.4.3 Vegetation

Vegetation mapping conducted for the project identifies vegetation communities intersected by the Maxhamish pipeline right-of-way. Pertinent information is presented on the alignment sheets included in Appendix A. Potential effects on vegetation communities are described below, along with a description of the measures to be used to reduce these effects, and the anticipated impacts that would occur following application of these mitigative measures.

4.4.3.1 Potential Effects

Potential effects of pipeline construction, reclamation, and operation include loss or alteration of significant plant communities; loss of rare plant species, merchantable timber, and vegetation important to wildlife; and introduction of insect pests, and exotic and weed species.

Significant Plant Communities

A distinctive riparian vegetation community in the floodplain of the Fort Nelson River will be traversed by the proposed route. This community consists of old growth stands of very tall, large diameter balsam poplar with a well developed understory situated on the terraced floodplain. Clearing and right-of-way disturbance will reduce the extent of this community. In addition, several communities intersected by the right-of-way are considered to have high suitability for several wildlife species of concern.

Plant Species of Concern

Thirty plant species of concern may occur along the proposed pipeline route. Three species are red-listed and the remainder are blue-listed. Most are associated with riparian habitat. Pipeline construction and reclamation could result in the loss of individuals or local populations of these species.

Merchantable Timber

Merchantable coniferous and deciduous timber will be harvested during pipeline construction. In addition, harvested nonmerchantable timber that has the potential to become merchantable will be lost or removed from one cutting cycle. Indirect loss of timber can occur from fire and spruce beetle infestations. Spruce beetle infestation has increased dramatically since 1991, and Ministry of Forests wishes to prevent the further spread of this pest. Most spruce beetle adults disperse to new areas in early to mid-June, and spruce slash provides these dispersing adults with an attractive, nonresistant medium that may allow them to be introduced to new areas more rapidly.

Weeds and Exotics

Noxious weeds and exotic species may be introduced into forest or agricultural areas by equipment and post-construction reclamation programs.

4.4.3.2 Mitigation and Residual Effects

Specific mitigative measures for pipeline construction and operation are provided on the alignment sheets (Appendix A) and in the Environmental Protection Plan prepared for this project (Appendix D).

Table 4-12 identifies the total area of each vegetation community that will be cleared for the Maxhamish residue gas pipeline. Potential effects on vegetation have been minimized by paralleling existing rights-of-way and sharing workspace for more than 95% of the proposed route. The use of shared workspace will reduce total cleared area by over 130 ha, or approximately 45%, based on the required 18 m right-of-way.

Significant Plant Communities and Species of Concern

From a purely botanical perspective, the communities traversed by the pipeline right-of-way are well represented in the region and construction is not expected to affect community viability or distribution. Habitats with a high potential to support species of concern have been avoided to the extent possible. No areas meriting avoidance or rerouting were identified during botanical surveys.

Winter construction can be conducted on a protective snow buffer, which will minimize ground disturbance and encourage regeneration of native species. By restricting ground disturbance to the surveyed right-of-way and conducting construction operations during the dormancy period for most vascular plant species, impacts to sensitive plant species have been further minimized.

Paramount will minimize grading and grubbing as much as feasible, especially in riparian habitat adjacent to wetlands and watercourse crossings. Hand cutting will be adopted where appropriate to further minimize disturbance in sensitive areas.

With application of these mitigative measures, potential effects of pipeline construction and operation on significant plant communities and species are anticipated to be: negative in direction; low magnitude; medium- to long-term duration; continuous frequency; and reversible in long-term. The probability of these effects is high and confidence in the assessment is high. Effects are anticipated to be not significant.

Merchantable Timber

Coniferous and deciduous merchantable timber stands intersected by the Maxhamish pipeline will be harvested and salvaged according to standards identified in the Logging Plan prepared for the project and the Licence to Cut issued by the Ministry of Forests.

Construction during the winter season will reduce the risk of fire. A Fire Contingency Plan complying with the Forest Fire Prevention and Suppression Regulation will be implemented in the event of a wild fire.

TABLE 4-12
AREA OF VEGETATION COMMUNITIES TO BE CLEARED
BY THE PARAMOUNT MAXHAMISH PIPELINE.

Vegetation Type	Vegetation Community	Total Cleared Area (ha)
Mixedwood	Aspen (Aw)	1.12
Mixedwood	Aspen/Birch (Aw/Bw)	5.56
Mixedwood	Aspen/Birch/White spruce (Aw/Bw/Sw)	5.28
Mixedwood	Aspen/White spruce/Lodgepole pine (Aw/Sw/Pl)	7.88
Mixedwood	Aspen/White spruce (Aw/Sw) and complexes	46.34
Mixedwood	Aspen/White spruce/Black spruce (Aw/Sw/Sb)	6.02
Mixedwood	White spruce/Birch (Sw/Aw)	5.04

Mixedwood	White spruce/Birch/Lodgepole pine (Sw/Aw/Pb)	3.64
Mixedwood	White spruce/Birch/Lodgepole pine (Sw/Aw/Pl)	8.4
	Sub-Total	**89.3**
Lowland	White spruce/Birch (Sw/Bw)	13.99
Lowland	Black spruce/Lodgepole pine/White spruce/Aspen (Sb/Pl/Sw/Aw)	7.66
Lowland	Black spruce/Tamarack/Lodgepole pine (Sb/Lt/Pl)	0.91
Lowland	Black spruce/Tamarack (Sb/Lt)	28.61
Lowland	Black spruce/Closed shrub (Sb/Sc)	6.33
	Sub-Total	**57.5**
Riparian	White spruce/Black spruce (Sw/Sb)	0.45
Riparian	Balsam poplar/Birch/White spruce (Pb/Aw/Sw)	2.37
Riparian	Closed shrub (Sc)	0.72
Riparian	Water	0.36
	Sub-Total	**3.9**
Disturbed	Clearing	0.7
Disturbed	Pit/ponds	0.98
Disturbed	Road/Pipeline	0.72
Disturbed	Cut	2.16

Agricultural	Field	7.3
	SUB-TOTAL	**11.9**
	TOTAL	**162.5**

With application of these mitigative measures, potential effects of pipeline construction and operation on merchantable timber are anticipated to be: neutral to negative in direction; local in extent; low magnitude; long-term duration; continuous frequency; and reversible in medium- to long-term. The probability of these effects is high and confidence in the assessment is moderate. Effects are anticipated to be not significant.

Weeds and Exotics

To minimize the introduction of weeds and exotics, slash rollback will be used on level and gently sloping areas to encourage revegetation from the soil seed bank and adjacent areas. A seed mix comprised of native species or an approved alternative will be used on riparian areas. Only certified seed will be used to prevent introduction of species considered to be noxious under the British Columbia *Weed Control Act*. All construction equipment will arrive on the right-of-way in a clean condition to minimize the risk of weed introduction.

Based on the mitigation measures described above, effects of pipeline construction and operation associated with introduction of weeds and exotics is anticipated to be: negative in direction; local to sub-regional in extent; low to medium magnitude; long-term duration; continuous frequency; and reversible in medium-term to irreversible. Effects are considered to be not significant. The probability of these effects is medium and confidence in the assessment is high.

4.4.4 Wildlife Resources

Pertinent site-specific wildlife information is presented on the alignment sheets included in Appendix A. Potential effects on wildlife are described below, along with a description of the measures to be used to reduce these effects, and the anticipated impacts that would occur following application of these mitigative measures.

4.4.4.1 Potential Effects

Assessment of impacts are focused on wildlife species that have been identified as most susceptible to project-related effects. In general, pipeline construction projects can impact wildlife resources through: habitat loss or alteration; reduced habitat effectiveness; habitat fragmentation; and direct animal mortalities.

Habitat Loss or Alteration

Habitat loss refers to the removal of habitat currently being utilized by wildlife species and is associated with clearing for permanent facilities where revegetation will not occur for the life of the project. Physical clearing will contribute to reduced habitat effectiveness for some species (see Habitat Effectiveness discussion below).

Habitat alteration refers to a change in biophysical conditions that may or may not affect the medium- to long-term capability of the habitat to support wildlife species. During right-of-way preparation, it results from removal of existing vegetative structure, revegetation of a different vegetation community, and disruption of soil structure within graded or trenched areas.

Reduced Habitat Effectiveness

Habitat effectiveness refers to a short- or long-term effect on wildlife use of available habitat, rather than the capability of the habitat itself. Habitat effectiveness is reduced where sensory disturbance, predation pressures, or other factors reduce the attractiveness and associated

use of otherwise suitable habitat by wildlife. The intense activities associated with pipeline construction can result in reduced habitat effectiveness in the vicinity of construction activity. After construction, on-going activities associated with operations can continue to result in reduced habitat effectiveness on a localized scale, particularly where road or rights-of-way within the project area are used for hunting and other recreational activities as well as maintenance and operational traffic and overflights.

Habitat Fragmentation

Habitat fragmentation refers to a process whereby large continuous areas of habitat are either reduced in area or divided into two or more fragments, that may become isolated from adjacent usable habitat (Wilcove *et al*. 1986; Primack 1993). A reduction in habitat area can affect population size and viability, while isolation can affect dispersal and immigration rates. The creation of increased edge areas can also alter the distributions and predation pressure for some species, particularly those preferring interior forest blocks with limited edge area. All three processes result from habitat loss/alteration and reduced habitat effectiveness, and all three processes can reduce the long-term sustainability of wildlife species.

For smaller wildlife species which predominantly utilize habitats with dense overstory cover (*e.g.*, red squirrel, marten), widening of existing corridors may be a deterrent to movements between habitats on either side, and additional clearing for the residue gas pipeline right-of-way may increase this impact. Marten in forested areas appear to avoid open areas greater than 100 m in width during winter, and wide corridors may act as barriers or filters (Nietfeld *et al.* 1985; Jalkotzy *et al*. 1997). This form of habitat fragmentation could contribute to localized population segregation.

Direct Animal Mortalities

Direct animal mortalities may result from the physical disruption of dens, the abandonment of dens (and young-of-the-year) by adults disturbed by construction activities, and from vehicle/animal collisions.

The legal harvest of wildlife by project workers can also represent an additional wildlife mortality source related to the project. However, Paramount will implement and strictly enforce a no hunting/no firearms policy for project workers which will eliminate this potential impact.

4.4.2.2 Mitigation and Residual Effects

Specific mitigative measures for pipeline construction and operation are provided on the alignment sheets (Appendix A) and in the Environmental Protection Plan prepared for this project (Appendix D).

The discussion of mitigation measures and residual effects provided below begins with a discussion of pertinent project factors that pertain to all species. Potential effects on each wildlife indicator species are then described, followed by a general discussion of effects on other wildlife species.

Habitat Loss or Alteration

New permanent above-ground facilities associated with the project will be spatially restricted, being limited to valve assemblies contained entirely on the right-of-way, and the abutments for the bridge crossing of the Fort Nelson River. The physical footprint of above-ground facilities will be less than 1 ha, and no critical habitat features are associated with them.

For this project, new clearing for the right-of-way will generally represent the transition of about 89 ha of Mixedwood Upland and Black Spruce (deciduous and coniferous dominated) communities to a persistent grass and low-shrub community. Total clearing for the pipeline has been reduced by over 130 ha by utilizing shared temporary workspace to the extent possible.

Habitat Effectiveness

Because of the fall and winter (November to March) construction schedule planned for this project, the sensitive reproductive period (i.e., May to mid-July) for most wildlife species will be avoided, as will the general residency period of most migratory species occupying the region (*e.g.*, migratory passerines, waterfowl). Late winter construction may occur at a period when food resources are limiting for some wildlife species (and stored energy resources are low), and when mobility can be difficult because of deep snow accumulations. However, most of the pipeline parallels existing corridors where vehicle traffic already occurs and some habituation may have occurred.

Several studies have shown that clearing and corridor development can have negative effects on breeding success by causing nest abandonment and increased predation (Hockin *et al*. 1992), and habitat effectiveness adjacent to disturbed areas could be affected during subsequent summer breeding periods.

Habitat Fragmentation

The proposed pipeline has been routed immediately adjacent to existing cleared corridors along most of its length and will not create a marked increase in edge area at the local, sub-regional or regional scale. Consequently, there is little reason to predict that pipeline development will contribute to habitat fragmentation.

Construction of the Maxhamish residue gas pipeline will increase the width of the Liard Highway corridor from 60 m to 67 m for approximately 24 km from the point where the access road ties into the highway south to the AEC pipeline tie-in point. Between this point and the Fort Nelson River valley, the combined highway/right-of-way corridor will increase from 78 m to 85 m over a distance of approximately 54 km. South of the Fort Nelson River, the combined WEI/Paramount right-of-way corridor width will increase from 18 to 30 m over a distance of approximately 74 km. Approximately 34 km of this corridor will be separated from the existing Slocan haul road by a variable-width treed buffer.

Direct Animal Mortalities

With a winter construction schedule, the potential for deaths associated with young abandonment will be low. However, bears will be residing in subterranean overwintering dens during that period and could be exposed to localized mortalities from clearing and grading activities.

Road kills by project vehicles are also a possibility for a number of species. Although such wildlife deaths will be unlikely along the actual right-of-way where vehicle speeds will be slow, vehicle traffic along the Liard Highway will increase during the construction season, and could contribute additional mortality. Currently, it is estimated that during the peak construction period, an average of 30 return trips per day could occur from the combined traffic of construction crews. However, during operations, it is unlikely that traffic loads will change significantly from existing levels.

The potential effect of each of these impacts is assessed below for each wildlife indicator species, where appropriate. As previously discussed, species with greatest susceptibility to the impacts of pipeline construction are those with High and Moderate suitability habitats occurring over an extensive area of the alignment. These species have been identified as three migratory songbirds (Cape May warbler, Bay-breasted warbler, Philadelphia vireo), the Northern goshawk and the Northern long-eared myotis. Table 4-13 summarizes the residual impacts on these wildlife species of concern. Bison, which were included in this list have no established populations in the project area and therefore are unlikely to be subject to any impacts by the proposed project.

Bay-breasted and Cape May Warbler

Habitat Loss or Alteration
The habitat suitability assessment for Bay-breasted and Cape May warbler indicated similar habitat affinities for both species so they are considered together. Approximately 103 ha (93.7 km x 10 m average right-of-way m + 10% extra working space) of Cape May/Bay-breasted warbler habitat may be cleared for the construction of the proposed Paramount pipeline, mostly consisting of aspen and spruce-dominated mixedwood. This habitat loss and alteration represents a small percent of the 49,200 ha of habitat available in the 3 km-wide local study area centered on the proposed pipeline route.

Localized clearing required for the pipeline right-of-way is not considered to be of significance for either species, as the affected habitats are well represented in the region. Impacts are predicted to be local, long-term, negative, low magnitude, and not significant.

TABLE 4-13
PREDICTED LEVEL OF RESIDUAL IMPACTS TO
KEY WILDLIFE SPECIES IN THE PROJECT AREA FROM
CONSTRUCTION AND OPERATION OF THE PROPOSED PIPELINE.

Species	Extent	Duration	Direction	Magnitude	Confidence

Cape May and Bay-breasted Warbler					
Habitat Loss/Altered	Local	Long-term	Negative	Low	High
Reduced Habitat Effectiveness	Sub-regional	Long-term	Negative	Low	High
Habitat Fragmented	Nil	Nil	Nil	Nil	Nil
Mortalities	Regional	Long-term	Negative	Low	High
Combined Effects	Regional	Long-term	Negative	Low	High
Philadelphia Vireo					
Habitat Loss/Altered	Local	Long-term	Negative-Positive	Low	High
Reduced Habitat Effectiveness	Sub-regional	Long-term	Negative	Low	High
Habitat Fragmented	Nil	Nil	Nil	Nil	Nil
Mortalities	Regional	Long-term	Negative	Low	High
Combined Effects	Regional	Long-term	Negative-Positive	Low	High
Northern Goshawk					
Habitat Loss/Altered	Local	Long-term	Negative-Positive	Low	High
Reduced Habitat Effectiveness	Sub-regional	Long-term	Negative	Low	High
Habitat Fragmented	Nil	Nil	Nil	Nil	Nil
Mortalities	Regional	Long-term	Negative	Low	High

Combined Effects	Regional	Long-term	Negative	Low	High
N. Long-eared Myotis					
Habitat Loss/Altered	Local	Long-term	Negative-Positive	Low	Moderate
Reduced Habitat Effectiveness	Sub-regional	Long-term	Negative	Low	Moderate
Habitat Fragmented	Nil	Nil	Nil	Nil	Moderate
Mortalities	Nil	Nil	Nil	Nil	Moderate
Combined Effects	Sub-regional	Long-term	Negative-Positive	Low	Moderate

Reduced Habitat Effectiveness
Bay-breasted and Cape May warblers could potentially be subjected to elevated levels of human and mechanical disturbance during pipeline operation, however, neither species will be directly impacted by construction, assuming a winter construction period. In new cut sections, negative effects on breeding success could occur adjacent to the right-of-way during the operations phase. The impacts of pipeline operation on reduced habitat effectiveness are likely to be sub-regional, long-term, negative, low magnitude and not significant.

Habitat Fragmentation
Although habitat fragmentation could potentially affect habitat use and nesting densities of forest nesting species such as the Bay-breasted warbler and Cape May warbler, fragmentation is not considered to be an important consideration based on the magnitude and pattern of clearing planned for the proposed pipeline. Blockage of movements is not an important consideration as birds are mobile and can easily cross pipeline right-of-way openings. Impacts are predicted to be nil for all criteria.

Direct Mortality
Fall and winter construction will avoid the nesting period and thus will not directly encounter or impact active bird nests along the pipeline routing. Some vehicle mortality could occur during the operations phase, and this negative effect could be long-term, regional, of low magnitude, and not significant.

Combined effects on Bay-breasted and Cape May warbler from the Maxhamish project are anticipated to be: negative in direction; regional in extent; low magnitude; long-term duration; continuous frequency; reversible in long-term, and not significant. The probability of these effects is medium and confidence in the assessment is high.

Philadelphia Vireo

Habitat Loss or Alteration
Approximately Approximately 103 ha (93.7 km x 10 m average right-of-way m + 10% extra working space) of Philadelphia vireo habitat may be cleared for the construction of the proposed pipeline, mostly consisting aspen and spruce-dominated mixedwood. This habitat loss and alteration represents a small percent of the 49,200 ha of available habitat in the 3 km-wide local study area centered on the proposed pipeline route. Localized clearing required for the pipeline right-of-way is not considered to be of significance as the affected habitats are well represented in the region. Impacts are predicted to be local, long-term, negative to positive, of low magnitude, and not significant.

Reduced Habitat Effectiveness
Philadelphia vireo could potentially be subjected to elevated levels of human and mechanical disturbance during pipeline operation, however, this species will not be directly impacted by winter construction. In new cut sections, negative effects on breeding success could occur adjacent to the right-of-way during the operations phase. The impacts of pipeline operation on reduced habitat effectiveness are likely to be sub-regional, long-term, negative, low in magnitude, and not significant.

Habitat Fragmentation
Although habitat fragmentation could potentially affect habitat use and nesting densities of Philadelphia vireo, fragmentation is not considered to be an important consideration at the level and pattern of clearing planned for the proposed pipeline. Blockage of movements is not a consideration as birds are mobile and can easily cross relatively narrow openings. Impacts are predicted to be nil for all assessment criteria.

Direct Mortality
Fall and winter construction will avoid the nesting period and thus will not directly encounter or impact active bird nests along the pipeline routing. Occasional vehicle mortality could occur during the operations phase, and this negative effect could be long-term, regional, low magnitude, and not significant.

Combined effects on Philadelphia vireo from the Maxhamish project are anticipated to be: positive to negative in direction; regional in extent; low magnitude; long-term duration; continuous frequency; reversible in long-term and not significant. The probability of these effects is medium and confidence in the assessment is high.

Northern Goshawk

Habitat Loss or Alteration
Approximately 105 ha (95.4 km x 10 m average right-of-way m + 10% extra working space) of habitat for this species may be cleared for the construction of the proposed residue gas pipeline, mostly consisting aspen and spruce-dominated mixedwood and riparian poplar. This habitat loss and alteration represents a small percent of the 49,200 ha in the 3 km-wide local study area centered on the proposed pipeline route. Localized clearing required for the pipeline right-of-way is not considered to be of significance for the goshawk, as it tends to nest near water bodies, which in turn are not impacted by the alignment. Impacts are predicted to be local, long-term, positive to negative , low magnitude and not significant. The direction may have a positive aspect to it because Northern goshawk rely on forest openings for prey.

Reduced Habitat Effectiveness
Northern goshawks could potentially be subjected to elevated levels of human and mechanical disturbance during pipeline operation, however, it will not be directly impacted by construction, assuming a winter construction period. In new cut sections, negative effects on breeding success could occur adjacent to the right-of-way during the operations phase. The impacts of pipeline operation on reduced habitat effectiveness are likely to be sub-regional, long-term, negative, low magnitude, and not significant.

Habitat Fragmentation
Although habitat fragmentation could potentially affect Northern goshawk nesting densities, fragmentation is not considered to be an issue at the level and pattern of clearing planned for the proposed pipeline. Blockage of movements is not a consideration as birds are mobile and can easily cross relatively narrow openings. Impacts are predicted to be nil for all criteria.

Direct Mortality
Fall and winter construction will avoid the nesting period and thus will not directly encounter or impact active bird nests along the pipeline routing. Occasional vehicle mortality could occur during the operations phase, and this negative effect could be long-term, regional, low in magnitude, and not significant.

Combined effects on Northern goshawk from the Maxhamish project are anticipated to be: positive to negative in direction; regional in extent; low magnitude; long-term duration; continuous frequency; reversible in long-term, and not significant. The probability of these effects is medium and confidence in the assessment is high.

Northern long-eared Myotis

Habitat Loss or Alteration
Approximately 89 ha (80.6 km x 10 m average right-of-way m + 10% extra working space)of High and Moderate suitability habitat would be cleared for the construction of the proposed Paramount pipeline, mostly consisting of aspen-spruce mixedwood and riparian poplar

stands. This habitat loss and alteration represents a small percent of the 49,200 ha in the 3 km-wide local study area centered on the proposed pipeline route. Although the ecology of this species is poorly understood, localized clearing required for the pipeline right-of-way is not considered to be of significance for this species, as the affected habitats are well represented in the region. Impacts are predicted to be local, long-term, negative to positive, of low magnitude, and not significant.

Reduced Habitat Effectiveness
Northern long-eared myotis could be subjected to elevated levels of human and mechanical disturbance during pipeline operation, however, similar to migratory birds (this bat is migratory) it will not be directly impacted by construction, assuming a fall/winter construction period. In new cut sections, negative effects on breeding success could occur adjacent to the right-of-way during the operations phase. The impacts of pipeline operation on reduced habitat effectiveness are likely to be sub-regional, long-term, negative, low in magnitude, and not significant.

Habitat Fragmentation
Although habitat fragmentation could potentially affect habitat use and densities of forest species such as the Northern long-eared myotis, fragmentation is not considered to be an important consideration at the level and pattern of clearing planned for the proposed pipeline. Blockage of movements is not a consideration as bats are mobile and use openings in the forest for feeding. Impacts are predicted to be nil for all criteria.

Direct Mortality
The proposed construction schedule will avoid the breeding period and thus will not directly encounter or impact this species along the pipeline routing. Because of their crepuscular and nocturnal behavior, bats are not likely to be affected by human presence and disturbance during subsequent breeding periods, and are not likely to be affected by road collisions. Such effects are predicted to be **nil** for all assessment criteria.

Combined effects on Northern long-eared myotis from the Maxhamish project are anticipated to be: positive to negative in direction; sub-regional in extent; low magnitude; long-term duration; continuous frequency; reversible in long-term, and not significant. The probability of these effects is medium and confidence in the assessment is moderate.

Other Wildlife Species

Habitat Loss or Alteration
The proposed pipeline development represents localized changes to existing habitats that will not measurably affect local carrying capacities for any species. The amount of clearing for the project has been reduced by routing the pipeline along existing cleared corridors for the majority of its length. Such habitat alteration does not represent the elimination of habitat values, as does habitat loss for permanent facilities, but rather a localized change in habitat values. It is widely recognized that many forest species will use forest openings and edge areas as foraging sites, as these features frequently offer high quality forage sources in close proximity to cover. Consequently, its unlikely that the localized habitat disturbance from right-of-way development will measurably affect the sustainability of local species, particularly when the right-of-way will be allowed to regenerate and succession occurs to shrub and saplings.

The wildlife habitats of greatest localized value intercepted by the proposed alignment are the mature mixedwood stands, including the riparian corridors. As a protective measure, the right-of-way width and temporary workspace requirements will be minimized in these areas, and grading and grubbing on the right-of-way will be reduced to the degree possible.

As noted previously, most of the proposed alignment (62%) traverses Low and Nil habitat suitability for moose. In addition, sharing existing corridors for winter construction with limited clearing is not likely to increase the impact on this species beyond existing levels. With compensating management practices such as the possibility of a corridor sanctuary along the Liard Highway, the direction of impact for this species could be positive with additional seral vegetation produced.

Of greater concern is the potential for right-of-way preparation or ditching operations to encounter and destroy a localized habitat feature of significance to a local wildlife sub-population (*e.g.*, mineral lick). No such features were identified during wildlife, traditional land use, or reconnaissance studies conducted for the Maxhamish project.

Reduced Habitat Effectiveness
Habitat effectiveness for key species has not been identified as an important issue because of the winter construction schedule (all of the key species are migratory). Operational activities could result in reduced habitat effectiveness around activity centers and areas of new cut, although the numbers of wildlife affected will not be significant at the regional scale.

Species that reside in the construction area will likely demonstrate some displacement away from the right-of-way during construction. As discussed previously, most of the pipeline route parallels existing right-of-way where vehicle traffic already occurs, and the amount of new right-of-way is relatively limited.

Habitat Fragmentation

Because the proposed pipeline alignment is mainly routed along existing cleared corridors, construction and operation will not fragment large blocks of undisturbed habitat. However, the Liard Highway corridor presumably acts as a partial or complete movement barrier to some small mammals. While is generally recognized that routing along existing rights-of-way minimizes overall effects, a widened corridor could contribute to the magnitude and probability of these effects. It is recommended that Paramount discuss possible mitigative measures with representatives of the Ministries of Transportation and Highways and Forests, and the Oil and Gas Commission. One option is placement of brush piles to provide cover in areas of suitable marten habitat.

Direct Mortalities

Although mortality rates from vehicle/animal collisions are expected to be low, there is no way to confidently predict such rates or their ramifications to local wildlife populations. One expected benefit of widening the Liard Highway corridor is that it will increase the line of sight and thereby reduce vehicle collisions.

Current collision rates are considered to be low, but all vehicle/animal incidents will be reported to the Paramount Environmental Inspector to allow the issue to be monitored, to assist with identification of movement corridors, and to assist planning of future projects in the area.

It is also recommended that the reclamation mix used for the project not contain forage species such as legumes that could attract wildlife and increase the risk of mortality. Paramount proposes slash rollback to encourage natural regeneration on level and gently sloping areas. An appropriate reclamation mix should be developed and approved by Ministry of Forests and Ministry of Transportation and Highways for watercourses, approach slopes, and erosion-prone areas.

To minimize the risk of mortality during the construction phase, it is recommended that a traffic control plan be developed to minimize the number of return trips. Signage for "wildlife crossings" should be considered if early winter wildlife movements become apparent. Construction staff will be directed to adhere to posted speed limits and to yield to wildlife on the right-of-way and roads.

With these mitigative measures, combined residual effects on wildlife of regional management concern are expected to be negative to positive in direction, local to regional in extent, short- to long-term in duration and isolated to continuous in frequency, depending o the species and activity considered. Probability is medium to high, and they are reversible in the short- to long-term. Because project activities are mainly confined to previously disturbed areas and represent a relatively small incremental disturbance, both all effects are considered to be of low magnitude and not significant effects. Confidence in this assessment is moderate.

4.4.5 Aquatic Resources

Pertinent site-specific aquatic information is presented on the alignment sheets included in Appendix A. Potential effects on fish and fish habitat are described below, along with a description of the measures to be used to reduce these effects, and the anticipated impacts that would occur following application of these mitigative measures.

4.4.5.1 Potential Effects

Potential impacts from pipeline crossing construction include: direct disturbance or alteration of instream and bank habitats at the crossing site; introduction of fine sediments to the watercourse resulting in effects on fish health; sediment deposition in sensitive downstream habitats; and introduction of contaminants to the watercourse from construction equipment. In addition, permanent crossing structures can affect navigation and construction activities can affect navigation during the construction period.

The occurrence and magnitude of potential impacts depend on the crossing technique as well as the characteristics of the watercourse that relate to sensitivity. These include the habitats present at the crossing site, habitats present downstream of the site, the fish species present, and the use of the available habitats by various life stages to satisfy their life history requirements.

Increased sediment loads can have sub-lethal and lethal effects on fish. Sediment deposition can modify the availability and suitability of habitat for spawning, overwintering, and rearing by altering substrate composition (Newcombe and MacDonald 1991; Anderson *et al*. 1996).

4.4.6.2 Mitigation and Residual Effects

Table 4-14 provides a summary of watercourses crossed by the Maxhamish pipeline, the sensitivity of these watercourses, and the crossing and mitigation measures proposed for each site.

TABLE 4-14
SUMMARY OF WATERCOURSE SENSITIVITY AND
CROSSING METHODS FOR THE PARAMOUNT MAXHAMISH PIPELINE.

No.	Stream Name	Approx. KP	Fisheries Values	Species Present	Protection Recommended	Water/Vehicle Crossing Method and Notes
1	Trib to d'Easum Cr	0.7	nil	-	no	Open cut/Snow or log fill.
2	Trib to d'Easum Cr	1.1	nil	-	no	Open cut/Snow or log fill.
3	d'Easum Creek	4.3	high	GR, LSU, WSU, BB, CCG, LND, TP	yes	Aerial crossing/Road bridge
4	Trib to d'Easum Cr	5.1	mod	(GR)	yes	Trenchless or approved alternative/Road.
5	Trib to d'Easum Cr	8.8	nil	-	no	Open cut/Snow or log fill.
6	Trib to d'Easum Cr	9.2	nil	-	no	Open cut/Snow or log fill.
7	Trib to Emile Cr	11.6	low	FDC BSB	no	Open cut/Snow or log fill.,
8	Trib to Emile Cr	16.8	nil	-	no	Open cut/Snow or log fill.
9	d'Easum Creek	20.0	high	GR BB CCG LKC FDC	yes	Trenchless with open-cut alternative/Highway bridge.
10	Trib to d'Easum Cr	24.2	mod	GR BSB	yes	Trenchless or approved alternative/Highway.

11	Trib to d’Easum Cr	26.3	nil	-	no	Open cut/Snow or log fill.
12	Trib to d’Easum Cr	29.5	nil	-	no	Open cut/Snow or log fill.
13	Trib to d’Easum Cr	30.3	nil	-	no	Open cut/Snow or log fill.
14	Trib to Deszen Cr	31.9	nil	-	no	Open cut/Snow or log fill.
15	Trib to Deszen Cr	32.8	nil	-	no	Open cut/Snow or log fill.
16	Trib to Deszen Cr	33.5	nil	-	no	Open cut/Snow or log fill.
17	Trib to Deszen Cr	34.0	nil	-	no	Open cut/Snow or log fill.
18	Trib to Deszen Cr	37.8	nil	-	no	Open cut/Snow or log fill.
19	Deszen Creek	38.7	nil	-	if flow	Open cut or approved alternative/Snow or log fill.
20	Trib to Tsinhia Lake	39.8	nil	-	no	Open cut/Snow or log fill.
21	Trib to Tsinhia Lake	41.5	nil	-	if flow	Open cut or approved alternative/Snow or log fill.)
22	Trib to Tsinhia Lake	42.8	nil	-	if flow	Open cut or approved alternative/Snow or log fill.
23	Trib to Tsinhia Lake	46.0	nil	-	no	Open cut/Snow or log fill.
24	Trib to Tsinhia Lake	48.0	nil	-	no	Open cut/Snow or log fill.
25	Trib to Tsinhia Cr	52.3	nil	-	no	Open cut/Snow or log fill.
26	Trib to Tsinhia Cr	53.9	nil	-	no	Open cut/Snow or log fill.

27	Tsinhia Creek	67.1	mod	LSU WSU CCG LKC	yes	Trenchless or approved alternative/Temp. Bridge or highway.
28	Trib to Tsinhia Cr	68.6	nil	-	no	Open cut/Snow or log fill.
29	Trib to Capot-Blanc	70.6	nil	-	no	Open cut/Snow or log fill.
30	Trib to Kiwigana Cr	72.7	nil	-	if flow	Open cut or approved alternative/Snow or log fill.
31	Trib to Kiwigana Cr	74.3	low	BSB FDC	if flow	Open cut or approved alternative/Snow or log fill.
32	Trib to Fort Nelson R	86.3	low	(BSB)	if flow	Open cut or approved alternative/Snow or log fill.
33	Trib to Fort Nelson R	86.8	nil	-	no	Open cut/Snow or log fill.
34	Trib to Fort Nelson R	88.9	nil	-	no	Open cut/Snow or log fill.
35	Fort Nelson River	90.2	high	IC, LW, NP, WA, GE, BB,LSU, WSU, FHC, LKC, LND, TP	yes	Aerial crossing/Ice or existing bridge.
36	Trib to Fort Nelson R	96.8	low	FDC	no	Open cut/Snow or log fill.
37	Trib to Fort Nelson R	98.4	low	FDC	no	Open cut/Snow or log fill.
38	Stanolind Creek	105.3	high	GR NP	yes	Trenchless or approved alternative/Temp. or Ice bridge.
39	Trib to Stanolind Cr	112.0	high	GR	yes	Trenchless or approved alternative/Temp. or Ice bridge.
40	Trib to Stanolind Cr	119.1	nil	-	no	Open cut/Snow or log fill.

41	Trib to Stanolind Cr	119.3	nil	-	if flow	Open cut or approved alternative/Snow or log fill.
42	Trib to Cridland Cr	124.4	nil	-	no	Open cut/Snow or log fill.
43	Cridland Creek	128.4	high	BSB (GR)	yes	Trenchless or approved alternative/Temp. or Ice bridge.
44	Trib to Cridland Cr	128.6	mod	GR BSB	yes	Trenchless or approved alternative/Temp. or Ice bridge.
45	Trib to Cridland Cr	130.0	nil	-	no	Open cut/Snow or log fill.
46	Trib to Cridland Cr	131.3	nil	-	no	Open cut/Snow or log fill.
47	McConachie Cr	134.2	low	FDC BSB WSU	if flow	Open cut or approved alternative/Snow or log fill.
48	Donaldson Cr	141.2	nil	-	no	Open cut/Snow or log fill.
49	Trib to Muskwa R	143.2	nil	-	if flow	Open cut or approved alternative/Snow or log fill.
50	Trib to Muskwa R	148.3	mod	LSU WSU FDC LKC	yes	Trenchless or approved alternative/Temp. or Ice bridge.
51	Muskwa R	150.8	high	BT, GR, MW, LSU, LGS, BB, LKC, FHC, LND, CCG	yes	HDD or approved alternative/Temp. or Ice bridge.
52	Trib to Prophet R	151.3	low	-	no	Avoided by HDD. Alternate open cut/Snow or log fill.

53	Trib to Fort Nelson R	152.6	low	-	If flow	Open cut or approved alternative/Snow or log fill. seepage upstream. Low potential for BSB FDC; no historical access due to gradient downstream.
54	Trib to Prophet R	155.1	low	NFC	If flow	Beaver impoundment on WEI ROW; muskeg seepage upstream. Low potential for BSB FDC; no historical access due to gradient downstream.
55	Trib to Fort Nelson R	160.4	low	NFC	If flow	Beaver impoundment on WEI ROW; muskeg seepage upstream, no visible channel downstream. Low potential for BSB FDC; no access due to gradient and highway culvert downstream.
56	Trib to Fort Nelson R	161.1	nil	-	no	Open cut/Snow or log fill.
57	Trib to Fort Nelson R	163.2	low	NFC	yes	Limited potential for seasonal use by GR from Ft Nelson R. Access currently limited by WEI water intake, and highway culvert and beaver activity. Potential BSB FDC habitat upstream of crossing.

BB=burbot; BSB=brook stickleback; BT=bull trout; CCG=slimy sculpin; FDC=finescale dace; FHC=Flathead chub; GE=goldeye; GR=arctic grayling; LGS=Largescale sucker; LKC=lake chub; LSU=longnose sucker; LW=Lake whitefish; NFC=no fish captured; NP=northern pike; MW=mountain whitefish; TP=Trout-perch; WA=Walleye; WSU=white sucker.

Most (45) watercourses were concluded to have nil or low fisheries values at the crossing site. However, twelve of these watercourses were concluded to have moderate or high potential for downstream impacts. Five small watercourses were concluded to have moderate fisheries values (KP 5.1, 24.2, 67.1, 128.6, and 148.3). Seven watercourses were considered to have high fisheries values, including d'Easum Creek (KP 4.3 and 20), Fort Nelson River (KP 90.2), Stanolind Creek (KP 105.3), tributary to Stanolind Creek (KP 112.0), Cridland Creek (KP 128.4) and Muskwa River (KP 150.8).

Additional information on proposed construction techniques for d'Easum Creek (KP 4.3 and 20), Fort Nelson River, and Muskwa River crossings is provided below, followed by a general discussion of other crossings.

d'Easum Creek

The proposed crossings for d'Easum Creek (KP 4.3 and 20) are considered sensitive due to the aquatic habitats present at and downstream of the crossing site, as well as the fish species and life stages found to be present in the study area.

The KP 4.3 crossing occurs in a habitat type known to provide nursery and rearing habitat for Arctic grayling and longnose sucker, as well as habitat for forage fish species. Fry and juvenile Arctic grayling were captured at the crossing site and adult Arctic grayling were present immediately downstream of the crossing. Potential spawning habitat for Arctic grayling, suckers and other species requiring clean, gravel substrates is also present at the proposed crossing and in habitats downstream of the crossing.

A clear span design with an overall length of 48.8 m will be installed across d'Easum Creek for the access road and the residue gas pipeline will be attached to this bridge. Design schematics are included in Appendix F. The bridge structure will be steel plate girders with a solid precast concrete deck. Bridge abutments will consist of driven steel pipe piles located well outside the wetted perimeter of the channel. Spill-through abutment fill above and behind the natural banks will be protected with filter fabric and riprap.

Potential effects on navigation in d'Easum Creek at KP 4.3 have been minimized through the use of a clear span bridge with a minimum clearance of 1.5 m during a 200 year flood. This will also allow debris passage at high flows.

Effects on fish or fish habitat in d'Easum Creek at the KP 4.3 site are not anticipated with the proposed bridge construction plan and protection measures provided in the Environmental Protection Plan. Instream activities will not occur during pipeline construction and the bridge will be used for all equipment crossings. Potential effects on riparian habitat and instream habitat due to sediment input will be minimized by placing bridge abutments outside the bankfull channel, restricting disturbance on the stream banks and approach slopes, and by reclaiming disturbed areas as quickly as feasible using an approved cover crop and seed mix.

At the KP 20 crossing site, d'Easum Creek has high quality rearing and moderate quality spawning habitat for Arctic grayling, burbot and northern pike, and moderate quality overwintering habitat for juvenile sport fish and is considered to have high fisheries values.

Paramount plans to attempt an HDD crossing of d'Easum Creek at KP 20, despite the high risk of failure indicated by experience gained during recent construction of the AEC West Maxhamish pipeline. Paramount proposes an open-cut crossing of this watercourse during the winter construction season if the HDD is not successful. An HDD crossing will avoid effects on instream and riparian habitat.

If an open cut crossing is required in d'Easum Creek at KP 20, this would result in elevated suspended sediment levels in the water column and increased deposition of sediment on downstream substrates. Temporary and permanent erosion control measures will be implemented to reduce erosion on watercourse banks and approach slopes. Potential effects are anticipated to be negative, sub-regional in extent, immediate to short-term in duration and isolated in frequency, of high magnitude, and reversible in short- to medium-term. The probability of effects is medium and the level of confidence is high. Effects on instream and riparian habitat are concluded to be not significant.

Fort Nelson River

The aquatic habitats present at the proposed crossing for the Fort Nelson river are typical for the watercourse within the region and are not considered sensitive to disturbance. Habitats at the crossing and further downstream are heavily dominated by fine sediments and are, also, not considered to be sensitive to sedimentation.

The proposed crossing for this river is considered sensitive due to the fish species assemblage potentially using the area. A number of fish species reported for the lower Fort Nelson River in the region of the proposed crossing could potentially be present at the crossing site, although the actual distribution of these fish species within the Fort Nelson River is unknown. Similarly, the specific use of habitat in the study area for various life history requirements such as migration, spawning, nursery, rearing and adult feeding is also not known. However, the potential exists for use of this section of river by numerous species including sensitive sport species at other times of the year.

Paramount conducted geotechnical studies at the proposed crossing location and concluded that the risk of failure for an HDD crossing of the Fort Nelson River is unacceptably high because of site conditions. Paramount therefore proposes to construct an aerial pipeline crossing over the Fort Nelson River. Design and construction details and drawings for the Fort Nelson River aerial crossing are included in Appendix F. The structure and construction plan were designed to minimize effects on flow, navigation, and riparian and instream habitat.

The proposed aerial crossing consists of a two span bridge with an overall length of 243.8 m. A steel truss superstructure containing the gas pipeline and walkway will be supported by a bridge pier near the centre of the river channel and bridge abutments located outside the stream channel on the north and south banks. The abutments and instream pier will consist of a steel-walled jacket, supported by driven steel pipe piles and filled with concrete. Construction will begin in January to facilitate access, minimize ground disturbance, and allow equipment to work from the ice.

Channel profiles show that the deepest portion of the channel is located south of the instream pier location. Hydrology data indicate that under normal winter flow conditions, the proposed instream pier location will be dry or have less than 25 cm of water.

Site work will be minimized because most components will be prefabricated and trucked to the site. Access to the site will be along the pipeline right-of-way, primarily from the north. Construction will begin in late December or early January with construction of an ice bridge across the river and installation of abutment piles on the north and south banks.

Once ice bridge access is available, the centre pier will be constructed by cutting through the ice at the pier location. If flow is present under the ice, a caisson pipe will be placed on the river bed to contain any substrate disturbance and the first pile pipe will be driven inside the caisson to refusal. The water will then be pumped out, the caisson pipe removed, and the hole in the ice enlarged to accept a prefabricated pier 'diaphragm' that is enclosed on the bottom and sides and contains sleeves for the remaining piles. The first prefabricated pier section will be installed over the driven pile and set on the bottom. Remaining piles will then be driven through the diaphragm to refusal. Because the diaphragm is enclosed, disturbance of the substrate will be minimized and contained.

Once all piles are in place, additional diaphragm and pile sections will be welded on until the required pier height is reached. The diaphragm and pile pipes will then be filled with concrete. The superstructure will then be erected using a crane and temporary scaffolding supported on the ice. The pipeline will be strung, welded, tested, and installed on the superstructure after the pier, abutments, and superstructure have been completed.

Effects on fish or fish habitat in the Fort Nelson River are not anticipated with the proposed bridge construction plan and protection measures provided in the Environmental Protection Plan. As described above, instream activities will be minimized during bridge construction and an ice bridge will be used for all equipment crossings. Potential effects on riparian habitat and instream habitat due to sediment input will be minimized by placing bridge abutments outside the bankfull channel, restricting disturbance on the stream banks and approach slopes, and by reclaiming disturbed areas as quickly as feasible using an approved cover crop and seed mix.

Potential effects on navigation have been minimized through the use of a clear span bridge with a minimum clearance of 3m during a 200 year flood. This will also allow debris passage at high flows.

Muskwa River

The aquatic habitats present at the proposed Muskwa River crossing are typical for the watercourse within the region and are not considered sensitive to disturbance. Habitats at the crossing and further downstream are dominated by fine sediments and are not considered to be sensitive to sedimentation. Unstable banks are present at the proposed crossing site.

Based on a field drilling program and geotechnical review, Paramount proposes a 1.1 km HDD crossing of the Muskwa River and the unstable south approach slope. The preferred approach shown on the schematic included in Appendix F is to drill from an entry point on the cleared flat on the north bank of the river to an exit point at the top of the slope on the south bank. An aerial crossing will be constructed if the HDD crossing is not successful.

The north bank is accessible by an all-weather road and the entry point is on a level, cleared field. Once a pilot hole has been established, the hole will be reamed to enlarge it so that the pipe can be pulled through. The pipe string will be strung, welded and tested on the south bank along the existing right-of-way prior to being pulled through the hole.

Effects on navigation, fish, or fish habitat in the Muskwa River are not anticipated with the proposed HDD crossing plan and protection measures provided in the Environmental Protection Plan. Potential effects on riparian habitat and instream habitat have been minimized by extending the drill under the south bank, and use of a cleared field for the entry and rig setup area.

Other Crossings

A number of protection measures will be adopted to reduce potential effects on stream and riparian habitat. These measures are described in the Environmental Protection Plan in Appendix D. These include provisions to maintain buffers along watercourses, minimize disturbance associated with grading, grubbing, and temporary workspace, implementation of erosion control measures, and recontouring and revegetation as soon as possible.

Most (45) watercourses were concluded to have nil or low fisheries values at the crossing site. Paramount proposes to cross all 45 watercourses using conventional open cut techniques with log or snow fill for vehicle crossing. The final decision on the appropriate

crossing techniques for flowing waterbodies with potential for downstream effects will be made on-site at the time of construction by the Environmental Inspector, in consultation with the Oil and Gas Commission Land and Habitat Protection Officer. Factors to be considered include flow conditions at the time of construction, potential for downstream impacts, and the presence of beaver dams and downstream impoundments that prevent downstream impacts.

If flow is present, Paramount proposes to cross these watercourses with moderate fisheries values (KP 5.1, 24.2, 67.1, 128.6, and 148.3) using trenchless techniques and existing/temporary bridges or ice bridges. The final decision on the appropriate crossing techniques will be made on-site at the time of construction by the Environmental Inspector, in consultation with the Oil and Gas Commission Land and Habitat Protection Officer.

Pipeline crossings of seven large and intermediate watercourses with high fisheries value will be constructed under separate contracts by specialized crews using trenchless techniques and existing, temporary, or ice bridges. These include proposed bored crossings of d'Easum Creek (KP 20), Stanolind Creek (KP 105.3), tributary to Stanolind Creek (KP 112.0), Cridland Creek (KP 128.4) and Muskwa River (KP 151).

Potential effects on navigation are not anticipated because construction will occur during the winter when navigation is not possible.

Based on the mitigation measures described above, potential effects on instream and riparian habitat associated with smaller watercourse crossings are anticipated to be negative, local in extent, immediate to short-term in duration and isolated in frequency, and reversible in the medium-term. The probability of effects is medium and the level of confidence is **high**. Effects on instream and riparian habitat are concluded to be not significant.

Open cut watercourse crossings and erosion can result in elevated suspended sediment levels in the water column and increased deposition of sediment on downstream substrates. Crossing techniques will minimize sediment input during construction, and temporary and permanent erosion control measures will be implemented to reduce erosion on watercourse banks and approach slopes. With implementation of best efforts, some erosion will occur, and potential effects are anticipated to be neutral to negative, sub-regional in extent, immediate- to long-term in duration and isolated, periodic or continuous in frequency, and reversible in short- to medium-term. The probability of effects is medium and the level of confidence is high. Effects on instream and riparian habitat are concluded to be not significant.

Arctic Grayling

Arctic grayling are widely distributed in the Maxhamish project area and could be affected by a number of stream crossings. As noted above, protection measures proposed for construction are considered to be adequate to mitigate effects on grayling habitat. However, the access road into the gas plant will provide access to a previously remote grayling sub-population. Because grayling are susceptible to angling pressure, this could affect the sub-population inhabiting d'Easum Creek.

Potential effects on Arctic grayling associated with increased angling pressure are anticipated to be negative, sub-regional to regional in extent, long-term in duration, continuous in frequency, medium in magnitude, reversible in the medium-term and not significant. The probability of effects is medium and the level of confidence is high. Government monitoring of populations in this system is recommended to avoid overfishing.

4.4.6 Land and Resource Use

This section discusses potential pipeline and facility-related effects on land and resource use in the Fort Nelson LRMP area. Mitigation measures are identified along with the significance of residual effects.

4.4.6.1 Impacts, Mitigation, and Residual Effects

Fort Nelson LRMP

The Maxhamish residue gas pipeline route passes through portions of three resource management zones (RMZs): the Etsho RMZ, River Corridor East RMZ and the Fort Nelson RMZ. It is entirely within Oil and Gas Guideline Zone 4.

The Etsho and Fort Nelson RMZs fall within the Enhanced Resource Development Category where the intent is to provide for intensive development of such resources as natural gas, timber, and minerals. The objectives and strategies for managing other resource values in

these RMZs will be applied in a way that recognizes the resource development priority of the zone. The River Corridor East RMZ falls within the General Resource Development Category. This zone is to be managed for a wide array of resource values and uses. Guidelines for non-extractive resource values will be integrated with resource development activities.

Management objectives for Oil and Gas Environmental Guideline Zone 4 are to minimize development of new access, prevent fragmentation of habitat, sustain biodiversity, prevent sedimentation of fish habitat, and respect treaty rights and aboriginal wildlife, fisheries, and wilderness values (MELP 1994b).

Construction and operation of Maxhamish sweet gas residue pipeline are consistent with the intent and objectives of the Enhanced Resource Development and General Resource Development Categories, the three RMZs that fall within these categories, and Oil and Gas Environmental Guidelines. As a result, with the construction practices identified in this document, the effects of the Maxhamish project on the Fort Nelson LRMP are expected to be neutral, local, long-term, continuous, low in magnitude, and reversible in the long-term, with no significant adverse effects.

Agriculture

ALR lands that will be traversed by the pipeline are located within the McConachie Creek Crown subdivision, and the area between Highway 97 and the border between Block B 94-J-15 and Block J 94-J-10, located near Fort Nelson. The McConachie Creek subdivision contains parcels of ALR land of varying size that have been leased for agricultural purposes. Once the terms of the agricultural lease are met, the leaseholder can purchase the land from the Crown. At the present time, some of the parcels have been purchased from the Crown while others are held under a leasehold agreement (E. Gowman pers. comm. 1999).

Approximately 15 parcels of land within the subdivision will be affected by the pipeline ROW. Within these parcels the pipeline right-of-way will pass through forested land as well as land that has been cleared but not cultivated. All affected landowners and leaseholders have been contacted by Paramount and made aware of the Maxhamish project and the proposed pipeline construction schedule. No concerns have been raised.

At the time of construction all merchantable timber harvested on the right-of-way will be salvaged and decked for the landowner. Topsoil will be salvaged and replaced on both mineral and organic soils. The pipeline contractor will replace any fencing and gates that are removed or damaged during pipeline construction. In addition, Paramount will make a one-time pipeline easement payment to all affected landowners and leaseholders which is based on appraised value of agricultural land in the area. During operation of the pipeline the only potential effect on agricultural activity would be associated with changes in soil productivity. Paramount will compensate affected landowners

Taking into consideration these mitigation and compensation measures, the effect of pipeline construction on agricultural activity in the McConachie Creek subdivision is expected to be neutral, local, short- to medium-term, low in magnitude, isolated to continuous and reversible in the medium-term. These are considered not significant.

Forestry

The harvesting of merchantable timber in the province is based on annual volume allocations without the provision of land tenure. The Slocan Group holds approximately 90% of the timber harvest allocations in the Fort Nelson TSA. Stumpage is paid to the Ministry of Forests for all merchantable timber removed on Crown land.

Paramount will pay stumpage for all merchantable coniferous and deciduous timber removed from its pipeline right-of-way. The proposed pipeline right-of-way will follow the east side of the Liard Highway (Highway 77) right-of-way coming in close proximity to or crossing several Ministry of Forests growth and yield plots that are within 100 m of the highway. Discussions are underway between Paramount and the Ministry of Forests to determine if these plots would be directly affected. If the plots are directly impacted by the pipeline right-of-way the right-of-way may be rerouted to avoid the plot(s) or compensation paid for relocation and re-establishment of the plot(s).

Near KP 76 and 78, the right-of-way will border or contact the edge of two Ministry of Forests forest plantations. If the plantations are disturbed, stumpage compensation would be paid to the Ministry of Forests for the disturbed area.

At KP 116, south of Stanolind Creek the pipeline right-of-way will pass close to a Slocan forest plantation. The plantation borders the west of Slocan’s winter road while the Maxhamish pipeline route parallels the east side of the winter road next to the WEI right-of-way. As a result, this plantation should not be affected. Further south near the Muskwa River crossing (KP 151), there are several forest plantations

belonging to Ministry of Forests and Slocan. If a Ministry of Forest plantation is directly impacted by the pipeline right-of-way a stumpage fee will paid for trees removed within the disturbance area. Alternatively, if a Slocan plantation is encountered, they will apply to the Ministry of Forests to have the right-of-way removed from their forest regeneration obligations within the plantation (pers. comm. D. Tofte, 1999).

Based on the mitigation and compensation measures described above, the effects of construction and operation of the Maxhamish project on forestry in the Fort Nelson TSA will be neutral, local, long-term, continuous, low in magnitude, reversible in the long-term, and not a significant adverse effect.

Energy Resources

There has been energy exploration and development in the Fort Nelson LRMP area since the mid 1950's and it continues today at an accelerated pace today due to some significant new natural gas discoveries in the region.

Paramount has received permission to use 6 metres of the WEI pipeline right-of-way for access and temporary workspace during construction of the Maxhamish pipeline. After construction, the WEI right-of-way will be recontoured and reclaimed to minimize erosion and encourage natural regeneration.

Once the Maxhamish pipeline and field facilities are operational they will add to the energy infrastructure in the region and this will further support and enhance natural gas exploration and development in the Maxhamish gas field and the Fort Nelson LRMP area. As a result, effects of the Maxhamish project are expected to be neutral to positive, local to regional in extent, short- to long-term, low in magnitude, isolated (construction) to continuous (operations), reversible in the long-term, and not significant. It will not have significant adverse consequences for any individual energy companies of the energy sector in the region.

Trapping, Guiding and Outfitting

There are an estimated 90 registered traplines in the Fort Nelson LRMP area but only the 12 registered traplines listed below would be affected by construction of the proposed pipeline.

- 755T001
- 749T007
- 755T003
- 749T008
- 755T005
- 749T009
- 755T006
- 749T011
- 749T003
- 749T012
- 749T004
- 748T003

In descending order, the primary furbearer species harvested on these 12 registered traplines over the past 10 years have been marten, beaver, lynx, mink, weasel, squirrel, and muskrat.

Potential trapper concerns including loss or damage to traps, snares and cabins, obstruction of trails, construction noise and visual impacts, fragmentation of furbearer habitat, dispersion of furbearers, improved public and hunter access have been addressed by the pipeline routing and other mitigation measures discussed here.

The loss or damage to traps, snares and cabin and the obstruction of trails will be avoided by early contact with trappers. Written notification of the Maxhamish project has already been sent out to all affected trappers. Each trapper will be provided with a project overview, maps, a project construction schedule, and the name of a Paramount representative to contact if they have any project-related concerns. This early notification will enable the trappers to relocate traps and snares in advance of construction. If traps and snares have to be relocated in order to avoid disturbance resulting from construction of the pipeline, the affected trapper would be compensated for the inconvenience of moving his/her equipment to a new location.

Slash, non-merchantable timber and stumps from the right-of-way will be rolled back along selected areas of the pipeline. Breaks in the rollback will be provided to maintain existing trapper access points.

Potential effects on furbearers were discussed in Section 4.4.4. A potential concern is that the new pipeline and access road corridor to the

gas plant will provide public access into currently inaccessible areas and may adversely affect trapping in the area. Paramount will keep this trapper informed of their development plans and identify appropriate measures to avoid or reduce potential effects on fur harvest. Paramount will consider compensation for any demonstrated effects on fur harvest.

In summary, the construction and operation of the pipeline could have a negative effect on affected registered traplines but it would be local to sub-regional in extent, short- to medium-term in duration, continuous, low in magnitude, reversible in the long-term, and not a significant adverse effect.

Only two designated Guide Outfitting areas (749N999 and 748N999) will be directly affected by the residue gas pipeline. Approximately 90 km of the 164 km pipeline is north of the Fort Nelson River where no lands have been allocated to any guide outfitters. Within Guide Outfitter area 749N999 the Maxhamish pipeline route will follow the WEI right-of-way for a distance of 56 km. In Guide Outfitter area 748N999, the right-of-way would follow the WEI pipeline for a distance of less than 2 km. Given that the WEI sour gas pipeline right-of-way will be paralleled through the two designated Guide Outfitter areas and because only 7 metres of new pipeline right-of-way will be required, the amount of wildlife habitat affected will be very limited. Furthermore, new public access and fragmentation of wildlife habitat are not issues because the WEI pipeline corridor already exists. Any wildlife displacement that occurs in the immediate vicinity of pipeline construction activity would be short term in duration.

As was the case with registered trappers, the two affected guide outfitters will be contacted well in advance of pipeline construction and provided with an information package that includes a map of the pipeline route, construction schedule, and the name of a Paramount representative that they can contact if they have questions or concerns. If the affected guide outfitter uses existing trails that cross the pipeline right-of-way they will be asked to identify the locations so that breaks can be left in the rollback along the right-of-way at these locations. As a result, pipeline construction and operation is expected to have a negative, local to sub-regional in extent, short-term in duration, continuous, low in magnitude, reversible in the long-term, and not significant.

Tourism and Outdoor Recreation

Tourism in the Fort Nelson LRMP area can be grouped into four categories: the touring vacation traveler; adventure and recreation; industry and business travelers and work crews; and events and conferences. The Maxhamish project should only affect the industry or business travelers and work crews category and the impact will be positive because of expenditures made by construction crews, consultants, and company representatives while they are in the region. Given the Maxhamish project construction schedule (fall and winter months), the limited touring travelers and adventure recreation tourists on the Liard Highway and the timing of these tourism activities (April to September) there should be no effect on these tourism categories.

It is acknowledged in the Fort Nelson LRMP that resource development drives the economy in the region but the plan also recognizes that maintaining visual quality and aesthetic values along highway corridor landscapes in the region is an important objective. The Maxhamish pipeline right-of-way will border the east side of the Liard Highway right-of-way, incorporating several existing borrow pits within its boundaries while the AEC pipeline right-of-way borders the west side of the highway. Clearing effects on the aesthetics or scenic value of the highway landscape is expected to be neutral or positive because the amount of cleared land and the tree line along either side of the Liard Highway will be more uniform. Furthermore, additional cleared land on the east side of the highway will improve sight lines for motor vehicles which could help to prevent motor vehicle/wildlife collisions on this highway.

As a result, the net effect of the Maxhamish project on tourism is expected to be neutral or positive, sub-regional, short-term, low in magnitude, continuous, reversible in long-term, and not significant.

Residents in the Fort Nelson LRMP area participate in a wide range of outdoor recreation activities including camping, hiking, fishing, hunting, boating, off highway vehicle use (OHV), snowmobiling and cross-country skiing. These activities are carried out in the Fort Nelson area and throughout the Fort Nelson LRMP area. Given the location and timing of construction of the Maxhamish project, the only outdoor recreation activity that may be temporarily affected is winter snowmobiling. Fort Nelson area residents use existing trails, powerline, pipeline and seismic corridors for snowmobiling during the winter months. It is possible that a portion of the WEI pipeline right-of-way in the McConachie Creek area is used by local snowmobilers. Because 11 metres of this right-of-way will be used as temporary workspace during winter pipeline construction it would be signed as off limits to local snowmobilers at that time. However, given the hundreds of kilometres of snowmobile trails in area to choose from, the potential temporary loss of a small portion of the WEI pipeline right-of-way this winter should not result in any noticeable impact on snowmobiling in the Fort Nelson area.

The proposed Maxhamish pipeline and gas plant will be located about 14 km northeast of Maxhamish Lake Provincial Park. This 668 ha Class A park, located along a portion of the east shoreline of Maxhamish Lake, is open to the public but no services or infrastructure (i.e. roads, camp sites, toilets, water well, garbage pick up) are provided. The main recreation activities at the park are fishing/ice fishing and

camping. Park users make the 14 km trip from the Liard Highway to the lake on seismic lines, small trails and a portion of AEC's winter road using OHVs in the summer and snowmobiles in the winter (N. Quail pers. comm. 1999). Given the distance separating the gas plant and pipeline from the park, no project-related effects are anticipated.

Protected Areas

Within the Fort Nelson LRMP seven Goal 1 Resource Management Zones and thirteen Goal 2 sites have been identified as potential protected areas under the plan. The 27,600 ha Maxhamish Lake Protected Area is the nearest protected area to the Maxhamish project. It is 10 km from the start of the pipeline at the gas plant. This protected area encompasses Maxhamish Lake and all lands within at least one kilometre of the shoreline. This area includes the Maxhamish Lake Provincial Park, six recreational lease lots with cabins located on the south side of the lake and several freehold lots with cabins on the west and north side of the lake that belong to residents of Fort Liard (N. Quail pers. comm. 1999). This area has been given protective status because it is an ecological and geographic representation of the Etsho Plateau. It has high wildlife value due to waterfowl, pike, walleye as well as cisco and spottail shiners which are considered unique to this area. In addition, this area has significant historical and current use by the Slavey and Beaver cultures of the Fort Nelson and Fort Liard First Nations (Fort Nelson LRMP 1997).

Given the distance separating the protected area from the Maxhamish project, the project will not affect this protected area. British Columbia Parks Department in the Peace-Liard District will monitor exploration and development in the Maxhamish gas field to ensure that these activities and access associated with them do not encroach on the Maxhamish Lake Protected Area (N. Quail pers. comm. 1999).

Traditional and Subsistence Use

Eleven cabin sites, four camp sites, one beaver dam, and a crossing of the Old Fort Nelson Trail were identified during traditional use studies. One cabin, the beaver dam, and the crossing of the Old Fort Nelson Trail will be directly affected by the proposed route. To avoid damaging the cabin the pipeline right-of-way will be rerouted around it or the cabin will be moved off the right-of-way by the contractor to a nearby location selected by the affected individual. Paramount has tried unsuccessfully to contact the owner of the cabin directly but are continuing their efforts to work with Fort Nelson representatives to reach him. Paramount will consult with government and Prophet River representatives to identify the most appropriate solution for the beaver dam. The Old Fort Nelson Trail is now used as a winter logging road and no mitigation is recommended.

If cabin sites are being used during pipeline construction, residents will be exposed to noise from heavy equipment and construction-related activities for several weeks this winter. This impact is unavoidable but temporary.

No specific subsistence use areas will conflict with the proposed project, and effects on subsistence use are not anticipated. With these mitigative measures, potential effects on traditional and subsistence use are anticipated to be neutral to negative, local, short-term, isolated, reversible in short-term, and not significant.

4.5 Cumulative Effects

Cumulative impacts can occur when more than one impact source affects a resource, when one action results in multiple effects on a resource, or when similar small-scale events happen repeatedly in time or space (Ross 1994). This section considers the combined effects of the proposed Maxhamish project area, when added to past, present, and other proposed activities in the project area.

4.5.1 Assessment Methodology

There is no prescribed or generally accepted methodology for cumulative effects assessment in British Columbia or Canada, and a number of approaches have been adopted (Antoniuk 1994; Kennedy 1994; Shoemaker 1994; Hegmann and Yarranton 1995; WGSI 1995; Alliance 1997). The approach adopted here has been used in a previous application for a Project Approval Certificate (Salmo *et al*. 1996).

Potential cumulative effects of the Maxhamish project were evaluated using two sub-regional indicators, total clearing and access density, to assess potential cumulative effects on vegetation and wildlife. Both were estimated from a 1:50 000 photomosaic of the 94-O-14 map sheet prepared from 1996 aerial photography. This map sheet, which includes an 820 km 2 area, was selected because it includes the Paramount Maxhamish development area, where a variety of activities in addition to the proposed residue gas pipeline are expected to occur.

This approach provides a regional or landscape level analysis that supplements the local and sub-regional analysis described in Section 4.4,

and is consistent with recommendations to evaluate potential effects at multiple levels (Klopatek 1988, Risser 1988, Noss 1990; Council of Environment Quality 1993). The pattern of patches and other manmade features determine the suitability of the landscape for different species (Jalkotzy *et al.* 1997).

Total clearing was estimated to assess potential effects on forest resources and forest fragmentation. Access density estimates are considered to be an acceptable indicator of cumulative effects for large mammals such as elk and grizzly bear (Lyon 1983, 1984; Mace and Manley 1993).

Existing Disturbance

A total of 757 km of seismic lines and 24 km of roads were present on the 94-O-14 map sheet in 1996. This translates to an average road density of 0.029 km/km 2 and an average combined corridor density of 0.95 km/km 2. Because the current road network is restricted to the east half of the map sheet, a more realistic estimate of average road density is 0.6 km/km 2, in the east half only. Similarly, because approximately 123 km 2 of the map sheet is covered by water, a more realistic estimate average combined corridor density is 1.12 km/km 2. Additional winter roads and seismic lines have undoubtedly been constructed since 1996, but more current data were not located.

Approximately 1,558ha was cleared in 1996, representing approximately 2% of the map sheet. AEC and Paramount have been exploring for, and developing petroleum reserves in this area since 1996, and 39 well sites (assumed to be 2.25ha per site), 1 plant site (assumed to be 9 ha), and 5km of pipeline (18m right-of-way) have been developed, representing estimated additional clearing of 88 ha, 9 ha, and 9 ha, respectively. On this basis, approximately 1,664 ha, or 2.4% of the map sheet has been cleared.

Planned Disturbance

Additional activities proposed by Paramount for the Maxhamish project include clearing for the Maxhamish gas plant and adjacent working area (18.2 ha), construction of a permanent access road with associated borrow pits and temporary camp (29.5 ha), and drilling of up to 10 exploration and development wells (27.5ha estimate based on 2.25ha per site plus 5km of winter road with 10m right-of-way). These activities would increase total cleared area to approximately 1,740 ha, or 2.5% of the map sheet.

Road construction will increase total road length in the area to 31.4km, or an average access density of 0.076 km/km^2 on the east half of the map sheet.

Construction of the proposed residue gas pipeline will result in incremental clearing of 7.4 ha, which represents less than 0.01% of the map sheet and 0.4 % of existing cleared area.

4.5.1.1 Potential Cumulative Effects

Consideration of cumulative environmental effects has received increasing interest over the last twenty years. It is now recognized that the combined effects of unrelated individual projects or activities can result in aggregate effects that may be different in nature or extent from the effects of the individual activities (FEARO 1994). For example, activities with no immediate (short-term) effects have potential to cause cumulative impacts that may not become apparent until after the disturbance has continued for some time. Conversely, disturbances that cause immediate effects may not necessarily generate cumulative effects over time (Contant and Wiggins 1991; Riffell *et al.* 1996).

Access density is used as a numerical indicator of sub-regional and regional habitat effectiveness and fragmentation, and relationships between access density and habitat effectiveness have been developed for some large mammals. Road access densities greater than 0.62km/km2 may affect habitat effectiveness for species such as elk and wolf (Jalkotzy *et al.* 1997), and road densities of 2.5 km/km 2 have been documented to increase sediment yield by 2.6 to 4 times (Cederholm *et al.* 1981).

Theoretical models suggest that >50-60% habitat loss is threshold for ecological effects for interior forest species and other habitat specialists (Wilcove *et al.* 1986, Lee and Gosslink 1988, Laurence and Yensen 1991, With and Crist 1995). In addition to direct effects of habitat loss and alteration, clearing and road development can affect physical processes such as water and sediment yield. Measurable effects on stream flow have been observed to occur when greater than 20% of a watershed is cleared in less than 10 years (McGurk and Fong 1995). In addition, sediment accumulation was observed to increase when total roaded area exceeded 2.5% of basin area (Cederholm *et al.* 1981).

4.5.1.2 Mitigation and Residual Effects

Existing, incremental and planned clearing and corridor development are predicted to result in levels of habitat loss, alteration, and access development that are well within theoretical and observed cumulative effects thresholds for sensitive species. Potential cumulative effects associated with the Maxhamish residue gas pipeline have been minimized by following existing cleared corridors wherever appropriate to do so.

Potential cumulative effects associated with the Paramount Maxhamish residue gas pipeline are predicted to be negative for sensitive (interior) species and neutral to positive for species that favour disturbed, or edge habitats at the sub-regional scale. The duration of cumulative effects will be long-term and continuous because they will persist throughout the operations phase, but magnitude will be low. Cumulative effects associated with clearing and access development are reversible in the long-term. The probability of occurrence is high, and level of confidence in the assessment is moderate. On this basis, potential cumulative effects are concluded to be not significant.

5. SOCIO-ECONOMIC EVALUATION

This section provides an assessment of the socio-economic effects associated with the proposed Maxhamish project. It begins with an overview of the existing socio-economic conditions in the Fort Nelson area that includes the proposed residue gas pipeline. This is followed by a discussion of the pipeline construction and operating costs, schedules and workforce requirements and the potential project effects on identified issues and socio-economic conditions in the study area. Mitigative measures that could enhance positive effects and prevent or reduce negative project-related effects are then described, along with a summary of the residual project-related effects. Predicted residual effects include the effect of the pipeline and associated field activities. Table 5-4 at the end of the section summarizes all potential project-related effects, proposed mitigation and the significance of predicted residual effects.

5.1 Assessment Scope and Methods

The socio-economic assessment process and criteria were similar to that described in Section 4 and involved: issues scoping; study area boundary definition; collection of baseline data; identification of potential effects and mitigative measures; and evaluation of the residual effects.

The first step in the assessment was scoping potential project-related socio-economic issues. A list of potential socio-economic issues was compiled from a number of sources including interviews with provincial, regional and municipal government representatives, community service providers, affected landowners, First Nations, local businesses and industries, feedback received from more than 85 people that attended the Fort Nelson Open House, and professional experience.

The following socio-economic issues were identified:

- effects of the project on local businesses, employment (aboriginal and non-aboriginal) and household income;
- effects of the project on municipal services (community services, landfill, fire protection);
- effects of the project on regional transportation infrastructure (traffic, maintenance, roads and rights-of-way); and
- effects of the project on rural residences (noise, visual, access, safety).

Next, the spatial and temporal boundaries within which the socio-economic issues would be assessed was determined. The Northern Rockies Regional District (NRRD) was selected as the study area for the socio-economic assessment and Northeast British Columbia was defined as the region. These geographic areas were chosen because the proposed residue gas pipeline and associated activities could have measurable effects on existing socio-economic conditions in these areas. In order to satisfy the socio-economic requirements of the *British Columbia Environmental Assessment Act*, project-related economic effects are also discussed in the context of the province as a whole.

The temporal boundaries for the socio-economic assessment were the construction and operations phases of the Maxhamish project. The temporal boundaries were further refined in the criteria used to determine the significance of residual effects (see section 4.4.1 for details).

Once the geographic boundaries were established, information pertaining to existing socio-economic conditions within the study area was compiled. Published and unpublished information was collected from provincial, regional and municipal government agencies, community services, First Nations and the forest products industry. Personal interviews were conducted with representatives from these government agencies, community services and local industries to fill data gaps and update baseline socio-economic information. Information on the proposed Maxhamish pipeline was provided by Paramount Resources.

Potential interactions between identified socio-economic issues and project components/activities during the construction and operations phases were analyzed to determine potential positive and negative effects. The identification and assessment of potential adverse socio-economic effects was based on professional experience, consultation with other experts and review of relevant literature. Mitigation measures that could reduce or eliminate adverse socio-economic effects were identified and the significance of residual effects were measured using a number of specific criteria. These criteria and their definitions (see Section 4.4.1) have been used consistently throughout this report to explain the predicted extent, magnitude, direction, duration, and confidence of potential socio-economic effects.

5.2 Description of the Study Area Without the Project

This section describes existing socio-economic conditions in the study area in terms of population trends, employment and income, municipal services, and regional transportation infrastructure.

5.2.1 Socio-Economic Conditions in the Project Area

Population Trends

In 1996, the census population in the NRRD study area was 6,072 compared to a population base of 5,210 in 1991 and 5,142 in 1986 (Synergetix 1999b). B.C. Statistics estimates that by 2011 the population in the region will increase to over 8,000 people. The forestry and energy sectors are mainstays of the regional economy and as such they directly affect the population base in the study area. During the period from 1986 to 1991 when

global forest products and energy markets were weak population growth in the study area was very limited (1% growth). However, during the period from 1991 to 1996 global forest product and natural gas prices were peaking and population in the study area increased by 16% (ARA Consulting Group *et al*. 1996). The study area population is very young with over 93% of the residents under the age of 55 and 29% under the age of 15 (Ibid).

The Town of Fort Nelson is the largest community in the region and it accounts for more than 70% of the study area population. Fort Nelson's population grew from 3,800 in 1991 to 4,400 in 1996 - an increase of 15% (Synergetix 1999b). Outside of Fort Nelson the study area population is scattered among a handful of rural subdivisions near Fort Nelson, several small unincorporated settlements along the Alaska Highway, four First Nation Reserves, and a few farms and ranches.

Employment and Income

From 1991 to 1996 the labour force in the study area grew from 2,770 to 3,320, an increase of 20%. As illustrated in Table 5-1 the NRRD's service industry division employed the largest number of people in 1996 followed by manufacturing. The service industry division includes all government, community and private services (municipal and provincial government, health, education, accommodation, food, beverage and business services). The manufacturing industrial division includes the Tackama saw mill/plywood mill, the Slocan OSB mill and the Canadian Chopstick Manufacturing Plant.

TABLE 5-1
COMPARISON OF STUDY AREA LABOUR FORCE ACTIVITY
BY INDUSTRIAL DIVISION 1991 – 1996.

	1991	**1996**	**% Change**
Labour Force	2770	3320	19.9%
Primary	230	235	2.2%
Manufacturing	630	865	37.3%
Construction	155	255	64.5%
Transportation, Comm. & Utilities	370	395	6.8%
Trade	360	400	11.1%
Finance, Insurance and Real Estate	40	95	137.5%
Services	985	1055	7.1%

Source: Synergetix Consulting Inc., 1999b

Between 1991 and 1996, all industrial divisions showed growth in labour force. The finance, insurance, and real estate division showed the most significant growth during this period although actual employment in this division is quite small compared to other divisions. However, by 1997, Fort Nelson began to experience a general slow down in its economy that is typical after a period of accelerated growth. In April 1997, the Canadian Chopstick Manufacturing Company Ltd. (CCMC) closed its plant putting 192 people out of work. The Slocan operations and other employers in the area were able to hire some of the displaced workers but about 20% of the CCMC employees left the community (Synergetix 1999b). Since 1997, global markets for lumber and plywood have declined, resulting in the downsizing of 140 workers at the Tackama sawmill/plywood mill (Fort Nelson News 1999). In addition, declining gas volumes at WEI's Fort Nelson Gas Plant is resulting in some downsizing of the plant workforce.

Income levels in Fort Nelson and elsewhere in the study area, with the exception of the First Nation Reserves, were higher than the Provincial average. Similarly, unemployment rates in the study area, excluding the First Nation Reserves, were substantially lower. The average total income of persons

reporting income was $28,156 in Fort Nelson and $33,279 in the remainder of the study area excluding the First Nation Reserves. On the First Nation Reserves, the average total income of persons reporting income was $8,336 (Synergetix 1999b).

Non-aboriginal people in the study area are dependent upon employment income rather than other forms of income. Forestry (including logging, pulp and paper, sawmill and other wood manufacturing) generates the greatest income dependency in the region followed by petroleum extraction and processing and the public sector (education, health, and government; Ibid). Income dependency is the percentage of after-tax income that is attributed to each industrial sector.

Municipal Services

Municipal services in the study area are concentrated in the Town of Fort Nelson. Fort Nelson is the largest community in the study area with a population of 4,400. Because the town functions as a regional transportation hub and service center and an Alaska Highway stopover destination, it offers a range of commercial and community services that would only be expected in a community with a larger population base. It offers an assortment of retail stores and service businesses. Temporary visitor accommodation available in town includes 9 hotels and motels with a total of 445 rooms. In addition, there are two bed and breakfasts and a 160-site campground in town that will accommodate visitors with tents, trailers and recreation vehicles (Visitor Information Centre 1999).

Educational services in Fort Nelson and throughout the study area are administered by School District No. 81. It oversees the operations of three elementary schools and one secondary school in Fort Nelson as well as a school in Toad River that offers kindergarten to Grade 12 education (S. Scott pers. comm. 1999). Post-secondary education is provided at the Fort Nelson Campus of Northern Lights College. The college offers a variety of university transfer courses, continuing education courses, special interest courses, and vocational training courses but no apprenticeship training (E. Sehn pers. comm. 1999).

A partnership arrangement between the Northern Lights College and the University of Northern British Columbia (UNBC) is in place whereby UNBC shares the Northern Lights Campus facilities in Fort Nelson. This arrangement provides students with an opportunity to complete studies in several undergraduate and graduate degree programs including applied degrees through cooperative education.

Medical services in the study area are provided at the Ft. Nelson General Hospital. This fully accredited hospital has 25 active care beds, emergency, outpatient and laboratory facilities, three resident doctors and a staff of 60 people (J. Mann pers. comm. 1999). Other medical and health facilities in Fort Nelson includes two medical clinics, a drugstore, two dental clinics, public health and mental health facilities, a women’s resource centre, drug and alcohol programs, counselling services, child/youth programs, and several support organizations.

Law enforcement in the study area is provided by the Fort Nelson RCMP Detachment. The detachment has a staff of 16 with 3 highway patrol constables, 11 law enforcement constables and 2 office staff (P. Snow pers. comm. 1999).

Fort Nelson has a 24-hour fire department that provides fire protection to town and rural residents as well as industrial facilities from Mile 285 to Mile 311 on the Alaska Highway. The fire department is staffed with 6 full time firemen and 25 volunteer fire fighters. The fire hall is equipped with pumper and tanker trucks, a rescue van, and utility vehicle (P. Bailey pers. comm. 1999). BC Ambulance Service operates three ambulances out of Fort Nelson. In addition, there are two commercial ambulances in Fort Nelson that service industries in the area (J. Mann pers. comm. 1999).

The town has numerous indoor and outdoor recreation facilities that support a wide range of seasonal and year round sports and leisure activities. The facilities include ball diamonds, tennis courts, golf course, indoor swimming pool, a full service recreation complex with a curling rink, arena and community hall, a library, performing arts and movie theatre, racquet ball courts and fitness centre, and cross country ski trails.

The town’s water supply is the Muskwa River and a new water treatment plant supplies treated water to residents of the town, nearby rural subdivisions, and the Fort Nelson First Nation Reserve. A sewage treatment facility (aerated lagoons) which serves town residents is operating at capacity and plans are underway to expand the facility in 2000, assuming capital funding can be obtained (P. Bailey pers. comm. 1999). The town and NRRD are about to open a new landfill that will accept solid waste, controlled waste and demolition, land clearing and construction waste but not special waste or contaminated soils (NRRD 1999). However, a new commercial landfill near Fort Nelson that can accept contaminated hydrocarbon soils and other special wastes is scheduled to open in September, pending receipt of the necessary permits from the province (C. Wright pers. comm.).

5.2.2 Regional Transportation Infrastructure

The study area is well serviced by road, rail, and air. The Alaska Highway (Highway 97) provides the main north-south and east-west road access to and through the region for local, commercial, and tourist traffic. South from Fort Nelson, the Alaska Highway provides motor vehicle access to other regions of the provinces and direct highway linkages to Alberta and other provinces. West and north of Fort Nelson, the Alaska Highway provides access to the Yukon Territory and Alaska. The Liard Highway (Highway 77) provides access between the study area and the Northwest Territories. Historically, this highway has primarily been used by vehicles travelling between Fort Nelson and Fort Liard. However, recent energy exploration and development activities near the British Columbia/Northwest Territories border has resulted in a significant volume of industrial traffic on this highway over the past two winters (J. Mayer pers. comm. 1999). Nevertheless, the condition of this all-weather gravel road resulting from inadequate maintenance and upgrading is viewed as an impediment to efficient access from Fort Nelson to the Northwest Territories and a major constraint to

trade and economic development between the two jurisdictions (Synergetix 1999a).

De-regulation in the trucking industry has enabled the larger trucking companies with outlets in Fort Nelson to spread the cost of trucking to and from the study area over their entire system. This reduces transportation costs to study area industries and commercial businesses. However, the rates charged by smaller independent truckers based in the study area more closely reflect the direct costs related to operating in the north because they have a smaller client base over which to spread these costs (Ibid). Greyhound provides daily north-south passenger and freight service to Fort Nelson.

Rail service to Fort Nelson is provided by BC Rail. In recent years BC Rail began to consider the rail infrastructure between Fort St. John and Fort Nelson as part of its entire system rather than an isolated "extension". This change has resulted in reduced rail transportation costs to/from the study area because the capital and maintenance costs associated with this section of rail infrastructure are now spread over the entire system (Ibid).

The Fort Nelson Airport provides daily commercial passenger and freight connections to international and transcontinental routes via Fort St. John, Prince George, Vancouver, Edmonton, and Calgary. The airport is served by Canadian Regional Airlines and Central Mountain Air. Additional air service is provided by several charter helicopter and fixed wing aircraft companies operating out of the airport.

5.3 Description of the Study Area With the Project

5.3.1 Project Characteristics

This section describes the estimated construction costs, construction work schedule and workforce as well as operating costs and workforce for the proposed Paramount Maxhamish project.

5.3.1.1 Construction Costs

The capital cost of the Maxhamish residue gas pipeline is estimated at $40.8 million. A breakdown of capital costs for the pipeline and field facilities is provided in Table 5-2. These cost estimates include:

- applications, approvals, permits and environmental studies;
- purchase of pipe and construction of the residue gas pipeline;
- gas plant site preparation, equipment and utilities, storage facilities, electrical, on-site camp, access road and assembly/installation of plant modules, vessels and equipment; and
- start-up and commissioning.

TABLE 5-2
CAPITAL COST ESTIMATE FOR THE PROPOSED
PARAMOUNT MAXHAMISH PROJECT.

Item	Estimated Capital Cost (without GST)	Estimated Expenditures in BC
COSTS – B.C.		
Residue Gas Line		
- Materials	$ 15,930,000	$110,000
- Construction	21,080,800	20,000,000
	2,184,000	253,500
- Engineering, Management, ROW & Fees	1,183,560	1,183,560
- PST (7%)	$407,784	$ 0.00
- Overhead	**$40,786,144**	**$21,547,060**
TOTAL – Residue Gas Line		

Gas Plant, Camp, and Road	$10,100,000	
- Major Equipment	2,387,000	$36,000
- Materials	5,695,000	139,500
- Construction Labour	404,000	3,235,000
- Engineering, Management, Land & Fees	874,100	5,000
- PST (7%)	$198,600	874,100
- Overhead	**$19,658,700**	$ 0.00
		$4,289,600
TOTAL – Gas Plant		
TOTAL COSTS – B.C.	**$60,444,844**	**$25,836,660**
COSTS – NWT		
Well Dehydration	$ 450,000	$0.00
Gathering System	3,008,735	$0.00
Gas Battery and Road	10,541,900	$0.00
Office	80,310	$0.00
Raw Gas Gathering Pipeline	$ 5,751,500	$0.00
TOTAL COSTS – NWT	**$19,832,445**	**$0.00**

In addition to the residue gas pipeline and gas plant, which are located in the study area, there are other upstream activities and facilities in the Northwest Territories that are associated with the Maxhamish project. They include well sites, access road and bridge, a gas battery/office/camp and a pipeline to transport raw gas from the battery to the gas plant in British Columbia. The capital costs for the upstream activities, facilities and infrastructure is estimated at $19.8 million bringing the total estimated cost for the Maxhamish project to $80.2 million.

It is estimated that approximately $21.5 million of the pipeline capital cost and $4.3 million of field facility capital costs could spent be in the province, almost entirely in northeast British Columbia.

Contractors, materials and services required for construction of the residue gas pipeline are available in Fort Nelson and elsewhere in northeast British Columbia. Non-labour items that could be sourced in the study area include:

- cement, sand, gravel and topsoil;
- fuels and lubricants;
- vehicle rentals, parts and repairs;
- heavy equipment parts and supplies;
- welding, electrical and safety supplies;
- passenger and freight transportation; and
- construction waste disposal.

Major items that are not manufactured in British Columbia include pipe, large valves and fittings, and gas measuring equipment. These supplies and materials would be sourced elsewhere. Overall, it is estimated that up to $21.5 million or 53% of the pipeline capital expenditures could be made in British Columbia.

To the extent possible, contractors, services and labour required for construction of the residue gas pipeline and field facilities will be sourced in the study area, northeast British Columbia, or elsewhere in the province. Selection of contractors and service companies will depend on the timing of regulatory approvals, availability, capability and competitiveness of qualified companies (union and non-union) in Fort Nelson and northeast British Columbia, as well as the availability of workers with necessary skills and experience.

Paramount used its public consultation process to raise awareness about the Maxhamish project among native and non-native contractors, suppliers, service companies, and individuals in the study area. Information about timing and nature of contractor, service, and supplier opportunities was provided to people who attended the Open House in Fort Nelson on July 21, 1999. In addition, newspaper announcements of the selected pipeline and gas plant contractors will be posted in the Fort Nelson newspaper. This will provide an opportunity for interested study area contractors, suppliers,

service companies and skilled trades people to contact the successful contractors and offer their services directly to them.

5.3.1.2 Construction Schedule

To meet contract commitments Paramount intends to have the proposed residue gas pipeline in service by April 1, 2000. Pending receipt of all the necessary regulatory approvals, construction of the residue gas pipeline will start in October, 1999 and be completed by mid March, 2000. This would allow time for start-up and commissioning.

Paramount has already initiated detailed engineering and procurement of compressors and prefabricated process modules for the gas plant because these project activities and components require long lead times. Construction of the 7.6 km plant access road is scheduled to begin in September 1999. This will be followed by plant site preparation, plant construction and pipeline tie-in.

5.3.1.3 Construction Workforce

The residue gas pipeline will be constructed in two spreads (north and south) over a 100-day period starting in early November 1999. The two spreads will be constructed simultaneously with crews of 60 workers per spread. An additional 10 contract personnel will be used as inspectors (environmental, quality assurance) and two eight person crews will be required for the Fort Nelson River bridge and Muskwa River HDD crossings. Pipeline construction crews will be based in two temporary camps while working on the pipeline. The location of the camps will be determined by the pipeline contractors. The construction crew for the Fort Nelson River bridge will be based in the gas plant camp, and the crew for the Muskwa River HDD will obtain commercial accommodation in Fort Nelson.

If receipt of regulatory approvals allows an extended construction season, opportunities for smaller local subcontractors including logging, clearing, slashing and grubbing work, will be enhanced.

The range of skills required for pipeline construction work includes:

- Slashers and powersaw operators;
- Welders and welders helpers;
- Truck and bus drivers;
- Operators (skidder, backhoe, bulldozer, excavator);
- Labourers; and
- Supervisors/Inspectors (engineering, surveyors, x-ray specialists, foremen, spread bosses).

Pipeline contractors and trades people with these skills are present in northeast British Columbia and many of the skills could be sourced from within the study area.

Gas plant and access road construction will require an average of 40 workers over at least a 90 day period from October through December, 1999. The construction workforce will peak at approximately 60 workers. It is likely that local contractors could be retained for plant site clearing, earth moving, road grading and road and yard graveling. Most of the required gas plant construction skills are available in northeast British Columbia and the ones that are not available in sufficient quantity (quality assurance, crane operators, instrument mechanic) could be filled from other regions in the Province. The plant construction workforce will live in a camp at the plant site throughout the construction period.

5.3.1.4 Operating Costs

Annual British Columbia operating costs for the Maxhamish project are estimated at $3.5 million. All operating and maintenance expenditures will be retained in British Columbia and most expenditures would be made within the study area. The operating and maintenance costs include:

- Operations and maintenance salaries/wages $0.9 million per year
- Materials and subcontracts $1.4 million per year
- Taxes, insurance, and other $1.2 million per year

5.3.1.5 Operations Workforce

A staff of eight full-time employees working in two four-person shifts will operate the Maxhamish residue gas pipeline and field facilities. Each shift will include one experienced mechanical operator, one experienced instrumentation operator and two roustabouts/trainee operators. In addition, there will be five full-time truck drivers dedicated to the gas plant. During each 7 or 14 day shift, the staff and truck drivers will live in a full-service camp at the gas plant site. At shift change, the incoming staff will be bused from Fort Nelson to the gas plant and outgoing staff will make the return trip to town. Contractors will be used for all pipeline and plant maintenance and turnarounds and these trades people will be sourced in northeast British Columbia, where available.

5.3.2 Impacts and Proposed Mitigation Measures

This section discusses the effects of the residue gas pipeline and field facilities on socio-economic issues and conditions in the study area during construction and operations phases. Mitigation measures are identified along with the significance of residual effects.

5.3.2.1 Economic Effects (Expenditures, Employment and Income)

As discussed in Section 5.3.1.1, it is estimated that in the order of $26 million of Maxhamish project capital costs will be spent in British Columbia - largely in the study area and elsewhere in the northeast region. The residue gas pipeline will account for more than 80% of the project capital expenditures made within the province.

As shown in Table 5-3, direct on site construction employment associated with the pipeline and gas plant is estimated at 85 person-years. Indirect and induced employment in the study area and elsewhere in the region totals 110 person-years. However, in reality indirect employment in the region may be somewhat lower due to modular construction of the plant whereby most supplies and materials are purchased prior to the modules arriving at the plant site. At the provincial level, total employment generated (direct, indirect and induced) is estimated to be 340 person-years.

Direct household income in the Study Area is estimated at $4.7 million. However, given the amount of overtime work anticipated on the project at an inflated wage rate, direct household income could be as much as 50% above the average household income for this type of work.

Indirect and induced household income at the provincial level is estimated at $6.1 million and $3.0 million respectively. Induced household income at the provincial level was calculated by applying the average wage for induced employment to the mid range of induced employment multipliers with and without a safety net. Indirect and induced household income in the study area/region was not provided because indirect and induced employment was estimated using an employment multiplier that rolled indirect and induced person-years together.

TABLE 5-3
ESTIMATES OF DIRECT, INDIRECT, INDUCED EMPLOYMENT
AND HOUSEHOLD INCOME ARISING FROM
CONSTRUCTION OF THE MAXHAMISH PROJECT.

Type of Impact	**Direct (On-Site) (1)**	**Indirect (Study Area) (2) (4)**	**Induced (Study Area) (3)**	**Indirect All of B.C. (5)**	**Induced All of B.C. (6) (7)**	**Total B.C.**
Pipeline Employment Person-Years	65	85	rolled into indirect employment	140	70	275
Household Income ($ 000s)	$3,575	N. A.	N.A.	$5,040	$2,520	$11,135
Plant Employment Person-Years	20	25	rolled into indirect employment	30	15	65
Household Income ($ 000s)	$1,100	N.A.	N.A.	$1,080	$540	$2,720

* Notes to Table

1. Direct impacts generally represent the employment and income received by on-site construction workers.
2. Indirect impacts represent the employment and income received by off-site project suppliers.
3. Induced impacts represent re-spending of personal income that is earned either directly or indirectly.
4. Indirect and induced employment in the study area/region are rolled together because a single multiplier was used.
5. Indirect impacts for all of BC include indirect impacts in the study area/region.
6. Induced impacts for all of BC include induced impacts in the study area/region.
7. Induced employment and household income impacts for all of BC represent the middle of the range of induced employment (with and without a safety net)

Numbers have been rounded

Sources:

Capital cost data used in calculations was provided by Paramount Resources.

British Columbia Local Area Economic Dependencies and Impact Ratios (1995) was used to calculate indirect and induced employment in the study area/region.

Provincial Economic Multipliers and How To Use Them (1996) was used to calculate direct, indirect and induced employment at the provincial level.

Statistics Canada, Average Weekly Earnings, Catalogue #72-002 was used to calculate household income

Paramount will directly employ eight full-time staff to operate the gas plant and residue gas pipeline. These employees will live at the gas plant during their rotating work schedule but their primary residence will be within the study area. As discussed in Section 5.3.1.4, annual operations and maintenance expenditures for the Maxhamish project in British Columbia are estimated at $3.5 million. These expenditures will be spent almost entirely within the study area on wages and benefits, supplies, materials, contract maintenance services and municipal taxes.

The direct employment and annual operating and maintenance expenditures will generate indirect and induced employment and income in the study area and elsewhere in the province but they have not been calculated here, as they are less extensive than the impacts arising from construction activities. Yet, it is recognized that when this employment and expenditures are considered over the life of the project, they are actually more significant than employment and income associated with construction activities.

5.3.2.2 Effects on Municipal Services

Medical Services

Given the potential for pipeline construction-related accidents and injuries and in accordance with Workers Compensation and British Columbia Health guidelines, there will be trained personnel, equipment and vehicles at the pipeline work sites to provide emergency medical treatment and transportation to the Fort Nelson General Hospital as necessary. In the event of an accident resulting in life threatening injuries the worker(s) would be transported to the Fort Nelson General Hospital for stabilization prior to being airlifted to the closest major trauma centre.

The Fort Nelson General Hospital routinely handles industrial accidents and WCB cases in its emergency and outpatient facilities. The Maxhamish project is not expected to noticeably affect the hospital’s facilities and human resources or cause delays and disruption to level of medical service presently enjoyed by area residents (J. Mann pers. comm. 1999). As a result, the impact of the Maxhamish pipeline on medical facilities and services is expected to be sub-regional, short-term, isolated, low in magnitude and not significant.

Law Enforcement and Public Safety

The Fort Nelson RCMP Detachment was contacted to provide an overview of the Maxhamish project and to identify any effects that the project might have on law enforcement and public safety in the study area. The detachment has monitored energy sector activity over the past decade and it has not resulted in any significant law enforcement or public safety concerns. During the past two years AEC has drilled wells and constructed a gas plant and pipelines in the Maxhamish Lake area. This activity brought non-local drilling crews, construction workers, and incremental traffic to the study area

but it did not result in a significant increase in crime or motor vehicle accidents. Considering the size of the Maxhamish project, the brief construction schedule, small work crews, and the provision of construction camps, an increase in motor vehicle accidents and policing is not anticipated (P. Snow pers. comm. 1999). As a result, project-related effects are expected to be sub-regional, short-term, isolated, low in magnitude and not significant.

Fire Protection and Emergency Response

Each pipeline spread will have a water truck and construction workers trained in first aid and fire fighting. An emergency response plan will be developed for the pipeline work sites and this information will be shared with the Fort Nelson Fire Department and Emergency Response Coordinator. Once the pipeline and field facilities are operational and a permanent fire protection and Emergency Response Plan has been developed, it will be provided to the Town of Fort Nelson, the Fort Nelson Fire Chief and the Emergency Response Coordinator and arrangements made for evacuation support if and when necessary. As a result, the impact on Fort Nelson fire protection and emergency response plan should be, sub-regional, short- to long-term, low in magnitude, accidental and not significant.

Landfill Requirements

Construction of the pipeline and field facilities will generate construction waste, camp garbage, and other non-hazardous solid waste. Disposal of these wastes as well as spent fuel, oil and lubricant containers will be the responsibility of the pipeline contractor(s). The NRRD/Town of Fort Nelson are in the process of opening a new landfill site that could accept the non-hazardous construction waste and garbage produced during pipeline and gas plant construction (P. Bailey pers. comm. 1999). In addition, a new commercial landfill that accepts special wastes and hydrocarbon contaminated soils is expected to open this fall at a location near Fort Nelson. The landfill operator is already licensed to transport special waste materials (C. Wright pers. comm. 1999).

It is recommended that construction contractors contact the NRRD, the commercial landfill operator, and a licensed waste transportation company prior to construction to discuss the type and quantity of garbage and waste that could be produced, the locations and hours of operation of the landfills, as well as tipping and hauling fees. Given the capacity of the new landfill sites and the receptiveness of the NRRD and commercial landfill operator to accepting pipeline construction-related waste, waste disposal will not be an issue *i.e.* project-neutral, sub-regional, short-term, isolated, low in magnitude and not a significant effect.

During the operations phase, pipeline and facility solid waste, special waste, and camp garbage will be minimal but the same waste disposal procedure and landfill sites would be used. The impact is expected to be project-neutral, sub-regional, long-term, periodic, low in magnitude and not a significant effect.

5.3.2.3 Effects on Road and Rail Infrastructure

Pipeline and field facility construction will not necessitate modifications, upgrading or expansion to the existing road network in the study area and all road bans and size/weight restrictions will be adhered to by construction traffic. In general, pipeline-related traffic will use the Alaska Highway, the Liard Highway and a number of local roads in the study area to access the pipeline work sites. The pipe for the residue gas pipeline will be transported to Fort Nelson by BC Rail. From there it will be trucked via the Alaska Highway and Liard Highway, local roads and the WEI pipeline right-of-way to designated stockpile locations along the pipeline. The roads used at any given time during pipeline construction will depend on where the construction activity is taking place. The pipeline contractor will monitor the condition of the Liard Highway and local roads during pipeline construction in the area. Snow plowing and grading will be done and water will be applied as necessary.

Due to safety concerns, extensive one-way winter logging traffic, and long term road improvement plans of the Slocan Group, Paramount will not seek shared use of Slocan’s winter haul road or the road right-of-way which parallel the proposed pipeline right-of-way south of the Fort Nelson River. Paramount will utilize the WEI right-of-way in this area for access to its pipeline and for temporary workspace during pipeline construction.

Paramount will acquire a permit from the Ministry of Transportation and Highways for access and temporary use of 11 metres of the Liard Highway right-of-way during pipeline construction. In addition, permits will be acquired from the Ministry for the nine pipeline crossings of provincial highways and local roads. All highway and local road crossings will be bored, minimizing disruption of traffic movement on the affected roads. As necessary road use and crossing agreements will be sought from industries that built roads in the study area if the pipeline crosses or pipeline-construction vehicles use these roads.

An estimate of pipeline-related traffic is presented below:

- daily personnel traffic (buses, cars and light trucks) 20 return trips/day
- light trucks (hot shot, local transport services) 8 return trips/day

- large trucks (pipe, valves, borrow material) 250 return trips over 100 days

Other traffic will be associated with field facility construction. Due to the size and weight of prefabricated gas plant modules, large vessels, compressor and other major plant equipment these items will be trucked to the plant site via Alberta and Northwest Territories highways and only a short stretch of the Liard Highway near the British Columbia/Northwest Territories border. Special road permits will be obtained from the Ministry of Transportation and Highways to transport oversized/overweight loads over the short distance on the Liard Highway within British Columbia. Construction workers, small supplies and site preparation/ access road/bridge materials will be transported to site from Fort Nelson via the Alaska and Liard Highways. Gravel and borrow material required for the plant site and access road will be sourced as close to these locations as possible.

Estimated traffic volumes to the gas plant and access road are as follows:

- personnel traffic (cars and light trucks, buses) 12 return trips/week
- light trucks (hot shot and local transport service) 4 return trips/day
- large trucks (site preparation, road & bridge materials) 80 return trips/day in September and October
- large trucks (modules, vessels, major equipment) 25 return trips in November/December

To summarize, pipeline and field facility construction traffic should have very little impact on the transportation infrastructure in the study area and the region. The effects could be negative, sub-regional to interprovincial in extent, short-term, isolated, low in magnitude and not a significant adverse effect on regional transportation infrastructure.

During operation of the pipeline and gas plant, Paramount staff will live in an on site camp at the gas plant during their one- or two-week shift. As a result, average daily traffic to and from the plant site is not expected to exceed 5 vehicles per day and this would have no effect on the regional transportation infrastructure.

5.3.2.4 Effects on Quality of Life

Quality of life is used here in reference to the potential effect of pipeline-related activities on people living in the McConachie Creek agricultural subdivision near Fort Nelson. The pipeline is expected to traverse approximately 15 subdivision parcels and make four road crossings (one crossing of Pioneer Way and three crossings of McConachie Road) within the subdivision. At the Pioneer Way crossing, the pipeline right-of-way will pass within 100 metres of four residences. Due to the three road crossings and the proximity of the pipeline to four homes the issues of road access/egress, increased traffic and motor vehicle safety, dust, noise and visual impacts are addressed here.

Pioneer Way and McConachie Road provide access and egress to the McConachie Creek subdivision and the pipeline construction activities in this area will temporarily increase traffic on these roads during the short-term. This is unavoidable but it can be mitigated by using the pipeline right-of-way as a transportation corridor for heavy pipeline construction equipment and pipe. Spread crews will be transported to and from the work sites in crew cabs, buses and vans to reduce traffic on local roads. All road crossings within the McConachie Creek subdivision will be bored rather than open cut. This will help to ensure that access/egress and motor vehicle safety are maintained and traffic disruptions are minimized.

Dust on local gravel roads and the pipeline right-of-way is not expected to be a problem because most of the construction activity is scheduled during the winter months. However, the contractor will monitor the situation to ensure that fugitive dust does not become a problem on local roads and the right-of-way for nearby homes. The contractor will also ensure that local roads used by during pipeline construction are left in the same condition as they were in prior to the pipeline activity in the area.

Construction-related noise will be unavoidable at the four residences located in close proximity to the pipeline right-of-way when construction work is taking place in the immediate area. However, this impact will be temporary lasting two weeks at the most. The people living in these homes as well as all others that own or lease agricultural parcels that would be directly impacted by the pipeline have been contacted by a Paramount representative. They were given an Information Package that describes the project as well as pipeline construction schedule. No project-related concerns were raised

by any of these people. One homeowner that lives within 100 metres of the pipeline right-of-way asked if the trees between his property and the right-of-way could be left untouched. Paramount has agreed to this request and will ensure that the pipeline contractor leaves a border of trees between the pipeline right-of-way and the four homes that are located less than 100 metres away.

Once operational, the pipeline should have no effect on the quality of life of people living in the McConachie Creek subdivision.

In summary, the effect of pipeline construction-related activities on quality of life in the McConachie Creek subdivision is expected to be negative, local to sub-regional, short-term, isolated and low to medium in magnitude but not a significant adverse effect.

6. ARCHAEOLOGICAL, HERITAGE, AND FIRST NATIONS ASSESSMENT

This section summarizes archaeological and heritage overview and impact assessments conducted for the proposed Paramount Maxhamish project. The complete Archaeological Impact Assessment (AIA) as required by the British Columbia Archaeology Branch is included in Appendix E.

6.1 Objectives and Scope of Work

The primary objectives of the Archaeological Impact Assessment were to:

- Inventory historical resource sites within the proposed development zone;
- Evaluate the significance of individual sites identified;
- Forecast the nature and magnitude of site-specific impacts; and
- Design an acceptable site-specific mitigation program that would significantly eliminate adverse impacts to identified sites prior to construction.

The scope of work for Archaeological Impact Assessments undertaken by Fedirchuk McCullough & Associates (FMA) consists of the following study components:

- Record Review to identify previously recorded sites which could be affected by the proposed development project and to determine the nature of the data base for the area;
- Aerial Reconnaissance to evaluate potential for heritage resources based on visual inspection of the immediate environment in remote areas;
- Ground Reconnaissance to relocate, in the field, historical resource sites which were previously recorded, as well as to identify and record any additional sites within the development zone. Site discovery is to be based on surficial inspection of exposures and subsurface testing, using a conventional shovel testing program, of potential site areas lacking suitable exposures.
  Deep testing using a backhoe or auger may be undertaken in localities of high site potential associated with good depositional characteristics;
- Site Evaluation to evaluate the nature of the existing resource data base, the quantify and quality of observable remains (*e.g.* site condition, content, uniqueness, and complexity), and the potential of the site to contribute to public enjoyment and education. Sites are to be evaluated by inspection of fortuitous exposures or by a standard shovel testing program.

Additional controlled assessment may be conducted when a site is perceived to contain potentially significant cultural material. In the event that such potentially significant sites concealed by sediments are encountered, the need for further evaluation is satisfied through either an extensive systematic subsurface testing program, a controlled excavation program, or a backhoe testing program.

- Impact Assessment to delineate the magnitude of forecasted impacts to the identified historical resource sites and to recommend site-specific mitigative measures commensurate with the assigned value of the site.

6.2 Archaeological Impact Assessment Summary

6.2.1 Archaeological and Historical Setting

Evidence in support of the notion that First Nations heritage is of great antiquity has been recovered from the Charlie Lake Site, British Columbia in the form of Clovis projectile points, radiocarbon-dated to ca. 10,400 years ago (Appendix E). Approximately 150 km northwest of Fort St. John, two Clovis point bases as well as Scottsbluff, Plainview, Lerma, and a later possible Salmon River projectile point and a microblade core were also recovered at the Pink Mountain Site.

The archaeological sequence for the proposed development area is largely based on the cultural materials excavated at Fisherman Lake, Northwest Territory (Appendix E), adjacent to Ft. Liard. The earliest evidence of human occupation found at Fisherman Lake has been associated with the Cordilleran Tradition, characterized by leaf-shaped projectile points and the Northern Plano Tradition (7000 – 4000 B.C.) characterized by large, lanceolate spear points. The latter is viewed as a northerly expansion of plains hunters.

Approximately 4000 B.C. a significant change occurs in the assemblages from Fisherman Lake, with the appearance of microblade technology,

lanceolate, stemmed, and notched projectile points, scrapers made from large core remnants, side blades, burins, drills, engravers, and grooved sandstone abraders. Unique to this tradition is the presence of extensive workshops identified with the Julian Technology, a bifacial reduction procedure associated with Julian Chert, a specific quality of chert the source of which, to date, has not been identified.

Succeeding components are viewed as representing the gradual development of the Athabaskan culture, as observed among the Slave people at the time of contact. This tradition, initially visible at approximately 2000 B.C., is characterized by a variety of and many notched forms of projectile points. Components relating to the contact period contain mixtures of European trade goods such as clay pipes and lithic tools.

Fish comprised approximately half the native diet (Appendix E), and large populations gathered around a "fish lake" during summer and fall. These semi-permanent settlements were also used as a base for hunting parties and collection of roots and berries. Large game animals including moose, bear, elk, woodland bison, and woodland caribou were utilized as well as smaller animals, mostly rabbit.

A model of the economic pattern of the Slave Indians has been development by Fedirchuk (nd) based on ethnographic literature and fieldwork among the Slave Indians of Fisherman Lake. In this model, large multicomponent base camps would be located at the edge of lakes and would contain a wide variety of tool types. Faunal remains would reflect year-round utilization and secondary butchering. Sites radiating from the base camps would be expected to contain a more restricted range of tool types and faunal materials at kill sites and hunting camps would bear evidence of primary butchering.

Fort Nelson was founded in 1805 by North West Company, and subsequently destroyed by local natives in 1813. It was abandoned until 1865 when it was rebuilt by the Hudson’s Bay Company on a new location across the river and adjacent to the present Town of Fort Nelson.

Fort Nelson remained in relative isolation until the Klondike gold rush, at which time two overland routes from Edmonton were promoted: one via Fort St. John and the other from Peace River Crossing (Appendix E). They were however little more than poorly defined trails and virtually impassable. It was not until the 1920s a well-established pack trail existed between Fort Nelson and Fort St. John. When the Alcan (Alaska) Highway from Dawson Creek to Fairbanks, Alaska was completed in 1943, Fort Nelson was effectively placed on a major communication route.

6.2.2 Resource Inventory and Evaluation

The record review of the Provincial Heritage Register of British Columbia indicated there were no previously recorded sites located within or adjacent to the proposed development area.

Archaeological Resources

Two members from each of the Fort Nelson and Prophet River First Nations, identified as stakeholders in the development area, worked in consultation with two qualified archaeologists during the AIA. Although an elder reported the presence of a scaffold burial in the general area south of the Fort Nelson River, careful examination of the proposed right-of-way conducted on two different occasions revealed no evidence that this burial is located within or adjacent to the proposed pipeline alignment.

Areas of moderate to high archaeological potential were identified during ground reconnaissance. In total, 483 shovel tests were excavated along the proposed right-of-way. All tests proved negative for heritage resources. As the proposed pipeline parallels existing pipelines and roads for the majority of its length, there were numerous exposures that offered high visibility for near-surface sites. One new heritage resource site was identified in this manner.

Cultural material consisting of three black banded chert flakes was recovered from an existing road cut (site MT1). Visual assessment as well as shovel testing of the site did not reveal any additional resources. Because of the sparse nature of the cultural material, the site is considered to be of limited interpretive value and no further work is recommended at the location.

Historic Sites

No historic sites were encountered within or adjacent to the proposed pipeline right-of-way. The alignment does cross the Fort Nelson Trail, south of the Muskwa River, which has been associated with the overland route from Edmonton via Fort St. John. The trail is now used as a winter logging road and bears no resemblance to the original pack trail.

6.2.3 Mitigation and Residual Effects

Mitigation of the identified heritage resource site has been achieved through the recording of the site and collection of cultural material.

Since heritage resources are non-renewable, the residual effects on these resources always reflects a loss of data in the form of *in situ* information, however, inventory and data collection contributes to the Provincial database. The residual effects on heritage resources will therefore be neutral, provincial, nil in magnitude, isolated, of low probability, irreversible, and not significant adverse or positive effect.

6.3 First Nations

6.3.1 Regional and Area Overview

The proposed Maxhamish pipeline route traverses the traditional territories of the Fort Nelson First Nation and the Prophet River First Nation. The traditional territory of the Fort Liard Indian Band also extends into the region (Fort Nelson LRMP 1997), and residents from Fort Liard (Acho Dene Koe) hunt, trap, and fish in the Maxhamish project area.

The Fort Nelson and Prophet River First Nations are member Bands of the Treaty 8 Tribal Association, with a combined total population (on and off reserve) of approximately 700 to 800 individuals (ARA Consulting *et al.* 1996). Information on the pre-contact and historical setting of the Slavey First Nations traditional territory is provided in Appendix E (FMA 1999).

Until the early 1960s, members of the Fort Nelson First Nation resided in areas that reflected traditional activities and locations. However, because these areas were not designated as reserve, most Band members subsequently relocated to reserve lands. Some members did not move to reserve lands and continue to practice a traditional lifestyle. Fort Nelson First Nation's largest reserve is located adjacent to the community of Fort Nelson. Its population is estimated at more than 550 (Fort Nelson LRMP 1997). Many members on reserve continue to actively engage in traditional hunting and trapping activities, maintaining registered traplines and occupying cabins located within the traditional territory at different times throughout the year.

The Prophet River First Nation community is located approximately 100 km south of Fort Nelson and the Band population is estimated at 150-200 individuals, about 80 of which live on reserve (ARA Consulting *et al.* 1996).

The resource sector is the basis for the majority of First Nation economic activities in the Fort Nelson area, including forestry, fire fighting, petroleum exploration and production, trapping, guiding, and packing. Members of both the Fort Nelson and Prophet River First Nations are employed in forestry-related work and oil and gas contract work (ARA Consulting *et al.* 1996). Many Fort Nelson First Nation members actively hunt and trap within the traditional territory during different times of the year. Among First Nation communities, registered traplines are often held by entire families (ARA Consulting *et al*. 1996).

The Fort Liard River Band are signatory to Treaty 11 signed in the NWT in 1921, but have no allocated reserve (Fort Nelson LRMP 1997). In 1998, the population in Fort Liard was 529. Traditional hunting, fishing, and trapping activities have formed the economic foundation for the community, but tourism, highway construction and maintenance, fire fighting, and petroleum development are becoming increasingly important.

While income levels in Fort Nelson and elsewhere in the study area were higher than the Provincial average, on the First Nation Reserves, the average total income of persons reporting income was $8,336 (Synergetix 1999b).

6.3.2 First Nations Impact Assessment

6.3.2.1 Issues Scoping

Following the decision to develop the Maxhamish/Fort Liard gas fields, Paramount forwarded a letter to the Chief of each First Nation, describing the proposed development, and enclosing a map showing the locations of the gas processing facility, access, and pipeline routes. Paramount representatives held follow-up meetings with the Chief, Councillors, Administrator or other designated representatives to discuss the project in person. A Paramount representative also attended the Petitot First Nations Gathering held in early August and made a presentation describing the project.

At the request of elected First Nation officials, FMA worked with Land Use Coordinators from the Fort Nelson and Prophet River First Nations to determine appropriate methods and areas for studies of traditional land use. Community representatives from these groups were given the opportunity to review maps and associated alignment sheets to identify any traditional land use sites. In addition, helicopter reconnaissance of traditional use areas along the proposed pipeline route was conducted with designated representatives from these First Nations. Representatives of both Fort Nelson and Prophet River First Nations attended the Open House held in Fort Nelson on July 21, 1999. In addition, First Nation representatives assisted with heritage and archaeological field studies on the entire route (see Appendix E).

The Acho Dene Koe requested that a community elder direct a traditional use study in conjunction with an independent consultant. This study consisted of formal interviews with ten Fort Liard residents who traditionally use the Maxhamish area. Fort Liard First Nation representatives and community members also attended the Open House in Fort Liard on July 28, 1999.

6.3.2.2 Effects on Traditional and Subsistence Use

Traditional use sites may include: sites of cultural significance such as camping, trapping, fishing or hunting locales, cabins, burial sites, historic trails, mineral licks, berry picking areas, medicinal plant collection locations, or areas identified as cultural landmarks or spiritual significance.

Potential effects on traditional use areas and sites include: loss or damage to traps, snares and cabins; obstruction of trails; construction noise and visual impacts; damage to wildlife licks, dens, and springs; direct or indirect loss of vegetation; disturbance of animals; and improved public and

hunter access which may affect trapping or hunting success.

As noted earlier, Paramount representatives worked directly with affected First Nations to identify traditional use sites, areas, and structures. A summary of these investigations is provided below for each group, along with the mitigative measures recommended to avoid or minimize effects on traditional and subsistence land use.

Fort Nelson First Nation

FMA worked with Fort Nelson First Nation Land Use Coordinator Ken Barth to determine appropriate methods and areas for studies of traditional land use. Community representatives Bill Badine, William Dettieh, and Shirley Ross participated in a helicopter reconnaissance of the Fort Nelson traditional use area with FMA during the weeks of July 26 and August 2, 1999. Both Bill Badine and William Dettieh actively trap and hunt in the Maxhamish project area, and have cabins in the vicinity.

The entire length of the proposed residue gas pipeline route was surveyed from the Paramount Maxhamish gas plant site to the terminus immediately south of the WEI gas plant during the overflight. The objectives of the overflight were to identify known traditional use sites, discuss measures to avoid or reduce potential effects, and help First Nations representatives understand the proposed project. Site locations identified during the overflight were recorded using a GPS.

Two traditional sites were identified during the course of the Archaeological Impact Assessment (see Appendix E), and included in the results of the traditional land use consultation. At least five of the registered traplines crossed by the proposed pipeline route are held by members of the Fort Nelson First Nation.

A total of 15 traditional land use sites were identified in the vicinity of the Maxhamish pipeline right-of-way, including 11 cabin sites and 4 camping areas (see Table 6-1). The majority of the sites were either of recent or current use. Camping areas appeared to be hunting/trapping camps, as tent frames, stoves, beaver stretching racks, etc. were observed. Locations in the immediate vicinity of the proposed right-of-way included sites 7, 9, 10, 11, 12, 13, 14, and 15. Based on the route reconnaissance and ground survey, it appears that only Site 10, Harry Dickie’s cabin, is in potential conflict with the proposed right-of-way (Biophysical Alignment Sheet 7, Appendix A).

Many of the potential impacts to traditional and subsistence activities have been addressed by the pipeline routing and other mitigation measures discussed in Sections 4 and 5. Direct and indirect vegetation and habitat loss has been minimized by following existing or proposed corridors where disturbance has already occurred, and by utilizing temporary workspace on adjacent rights-of-way.

The loss or damage to traps, snares and cabin and the obstruction of trails will be avoided by early contact with trappers. Written notification of the Maxhamish project has already been sent out to all affected trappers, and each trapper will be provided with a project overview, maps, a project construction schedule, and the name of a Paramount representative to contact if they have any project-related concerns. This early notification will enable the trappers to relocate traps and snares in advance of construction. If traps and snares have to be relocated in order to avoid disturbance resulting from construction of the pipeline, the affected trapper would be compensated for the inconvenience of moving his/her equipment to a new location. Breaks in the rollback will be provided to maintain existing trapper access points. Paramount will consider compensation for any demonstrated effects on fur harvest.

TABLE 6-1
TRADITIONAL USE SITES IDENTIFIED BY THE FORT NELSON FIRST NATION
FOR THE PARAMOUNT MAXHAMISH PROJECT.

No.	Site Type	First Nation Affiliation	Family Affiliation	Location UTM	Location Longitude and Latitude (° ‘ ")
1	Cabin	Fort Nelson	Harry Dickie	10VDA 903 669	59 14 36/123 10 07
2	Cabin	Fort Nelson	Manny Gairdner	10VDA 878 795	59 21 23/123 12 49

3	Cabins	Fort Nelson	Bill Badine, Robert Badine	10VDB 895 027	59 33 54/123 11 08
4	Cabins	Fort Liard	George Deneron	10VDB 013 399	59 53 57/122 58 35
5	Cabin	Fort Liard	William Betthale	10VDB 024 381	59 52 58/122 57 23
6	Camping Area	Fort Liard	William Betthale	10VDB 024 381	59 52 58/122 57 23
7	Cabin	Fort Liard	Nap Bertrand	10VDB 013 314	59 49 20/122 58 34
8	Cabins	Fort Liard	Philip Bertrand	10VDB 007 281	59 47 34/122 59 14
9	Cabins	Fort Liard	Philip Bertrand	10VDB 966 204	59 43 27/123 03 33
10	Cabin	Fort Nelson	Harry Dickie	10VDA 877 905	59 27 20/123 12 55
11	Cabin	Fort Nelson	Willie Dettieh	10VDA 833 825	59 23 01/123 17 33
12	Cabin	Fort Nelson	Jimmy and Mary Dettieh	10VDA 833 825	59 23 01/123 17 33
13	Camping Area	unknown	Unknown	10VDB 010 285	59 47 46/122 58 56
14	Camping Area	unknown	Unknown	10VDB 011285	59 47 46/22 58 50
15	Camping Area	unknown	Unknown	10VDA 945 098	59 37 41/123 5 51

Ken Barth, Land Use Coordinator for Fort Nelson First Nation has requested that Manny Gairdner be consulted because his trapline is in the area, and Harry Dickie be consulted because of the location of his cabin. Paramount has sent information packages to both trappers, and has attempted, unsuccessfully, to contact them directly to discuss the project. Paramount will continue to work with the Band to meet with these trappers, inform them of the development plans, and identify appropriate measures to avoid or reduce potential effects on fur harvest. To avoid damaging the cabin the pipeline right-of-way will be rerouted around it or the cabin will be moved off the right-of-way by the contractor to a nearby location selected by Mr. Dickie.

If cabin sites are being used during pipeline construction, residents will be exposed to noise from heavy equipment and construction-related activities intermittently over several weeks this winter. This impact is unavoidable but temporary.

No specific subsistence use areas will conflict with the proposed project, and effects on subsistence use in the Fort Nelson traditional lands are not anticipated. With these mitigative measures, potential effects on traditional and subsistence use are anticipated to be neutral to negative, local, short-term, isolated, reversible in short-term, and not significant.

Prophet River First Nation

FMA worked with Prophet River First Nation Land Use Coordinators Brian Wolf and Robin Tsakoza to determine appropriate methods and areas for studies of traditional land use. Brian Wolf and Robin Tsakoza participated in a helicopter reconnaissance of the Prophet River traditional use area with FMA during the weeks of July 26 and August 2, 1999.

The proposed residue gas pipeline route from the Fort Nelson River to the terminus immediately south of the WEI gas plant was surveyed during the overflight. The objectives of the overflight were to identify known traditional use sites, discuss measures to avoid or reduce potential effects, and help First Nations representatives understand the proposed project. Site locations identified during the overflight were recorded using a GPS.

One historical site was identified during the course of the Archaeological Impact Assessment (see Appendix E), and included in the results of the traditional land use consultation.

No specific traditional land use sites were identified during the overflight. However, the presence of a large beaver dam was observed on the existing WEI right-of-way south of Stanolind Creek (Biophysical Alignment Sheet 13, Appendix A), along with a crossing of the Old Fort Nelson Trail just north of KP 158 (Biophysical Alignment Sheet 17, Appendix A).

Prophet River First Nation representatives recommended that the route be altered to avoid the beaver dam, or if this is not possible, that the dam be drained in summer before construction occurs. No recommendations were made regarding the Old Fort Nelson Trail.

Paramount will consult with government and Prophet River representatives to identify the most appropriate solution for the beaver dam, as draining the dam in summer prior to construction is unlikely to be approved. The Old Fort Nelson Trail is now used as a winter logging road and no mitigation is recommended.

No specific traditional or subsistence use areas of the Prophet River First Nation will conflict with the proposed project, and effects on traditional or subsistence use are not anticipated.

Fort Liard Residents

Interviews were done with residents who traditionally use the Maxhamish area by a community elder in conjunction with an independent consultant. Interviews with ten Fort Liard residents followed an interview guideline and were conducted over a nine day period. No specific traditional use sites were identified along the proposed Maxhamish residue gas pipeline alignment and effects on traditional or subsistence use by Fort Liard residents are not anticipated.

6.3.3 First Nations Consultation Activities

Paramount has used a variety of consultation methods to provide affected First Nations with the opportunity to understand activities and potential effects associated with the Maxhamish project proposal and to identify measures that would reduce or avoid negative effects.

As described in Section 3, and summarized in Table 6-2, consultation methods included:

- formal written notification of the project;
- provision of maps and an information package describing the project;
- numerous meetings and telephone conversations between Paramount and First Nation representatives to discuss business and employment opportunities, traditional uses and sites, and potential environmental effects;
- participation in archaeological field investigations;
- involvement of Land Use Officers and designated community representatives in studies to identify traditional use sites, areas, and structures; and
- public Open Houses held in Fort Nelson and Fort Liard.

To date, neither the Fort Nelson nor Prophet River First Nation has expressed any major issues or concerns about the proposed development. As indicated in Table 6-2, First Nation representatives expressed interest in business and employment opportunities and identified 16 traditional land use sites in the vicinity of the pipeline right-of-way. Consultation with two members of the Fort Nelson First Nation is still outstanding because they have been travelling and unavailable. Paramount will also consult with government and Prophet River representatives to identify the most appropriate solution for the beaver dam located near KP 158.

No issues were identified by the Acho Dene Koe in their traditional use study.

Paramount has made a commitment to First Nations, and other groups and individuals to continue communications regarding the Maxhamish project. Consultation will continue to be maintained through correspondence, a newsletter, telephone calls, personal contacts, and formal and informal

meetings.

TABLE 6-2
PARAMOUNT MAXHAMISH FIRST NATIONS
PROJECT NOTIFICATION AND ISSUES IDENTIFICATION SUMMARY.

Group	Representative	Contact By	Date	Regarding	Identified Issues
Fort Nelson First Nation	Chief Liz Logan, Band Councillors, Administrator; Land Use Coordinator	Paramount, FMA	June 21, 23, 25, July 7, 21, 26-30, August 6-9, 1999	Input into archaeological assessment, notification Letter, map showing location of proposed development, public input	Business and employment opportunities; traditional land use work with band reps; cabins along east side of Liard Highway; possible tree burial site; list of local services; ongoing consultation with Land Use Coordinator and 2 trappers
Prophet River First Nation	Chief Lisa Wolf, Administrator, Land Use Coordinator	Paramount, FMA	June 30, July 21, 29 1999	Notification Letter, map showing location of proposed development, input into archaeological assessment, public input	Traditional Land use work with Band reps; job opportunities; effect on beaver dam near KP 158.
Acho Dene Koe (Fort Liard) First Nation	Chief Harry Deneron, Council, elders, Land Use Coordinator	Paramount, Golder, Wildlife	June 1, 20, 22, 23, 29, July 21, 28 1999	1999-2000 development plans, traditional knowledge study, notification letter, map showing location of proposed development; subsistence harvest, public input	Business and employment opportunities; traditional land use work with band representatives completed; estimated subsistence moose harvest about 24/yr; caribou harvest too few to register; 3-4 elk taken annually; key species are furbearers - beaver, muskrat, fisher, lynx and marten, keep trappers notified;
Petitot Gathering	First Nations from BC, Alberta, and NWT	Paramount	August 4-6, 1999	Paramount presentation on Maxhamish project.	Business and employment opportunities; no new issues.
Affected Trappers		Written Notification, Open House	July 19, 21, 28 1999	Project Notification; Open House	None to date.

7. CONCLUSIONS

7.1 Summary Of Issues

A summary of the biophysical and socio-economic issues and potential effects resulting from the proposed Maxhamish project is provided in Table 7-1. These issues were identified during consultation with local residents, representatives from all levels of government, First Nations, and the general public in the Fort Nelson area.

More detailed information on the issues scoping and consultation process is provided in Section 3 and Appendix B.

7.2 Potential Effects and Mitigation

Table 7-1 also identifies the enhancement, mitigation, and monitoring programs to be employed by Paramount, consultants, and contractors to address each issue or concern. Conclusions on the spatial extent, direction, magnitude, and duration of residual effects are provided based on the assessment methodology and definitions provided in Section 4.4.1. Finally, the table provides conclusions on the likelihood of significant adverse potential impacts.

As shown in this table, numerous environmental and socio-economic concerns and issues were identified during consultation. Paramount had already incorporated a number of design features and operating strategies to prevent or reduce potential negative effects and enhance anticipated positive effects.

7.2.1 Environmental and Resource Use Effects

A comprehensive environmental assessment was conducted for this application to identify the potential biophysical effects associated with the proposed project. This assessment was conducted by a team of independent technical specialists using environmental indicators and established methods. Information obtained from field investigations, recent environmental assessments, published literature, and specialist knowledge was used to identify the potential effects associated with the residue gas pipeline and other field facilities. Mitigative measures to prevent or reduce potential adverse effects, and any remaining residual effects were also identified.

Specific environmental protection measures to be employed for the Maxhamish residue gas pipeline project are described by topic in Section 4.4, noted on Biophysical Alignment Sheets in Appendix A, and described in the Environmental Protection Plan in Appendix D.

Environmental effects were evaluated using specific definitions provided in Section 4.4.1. These definitions describe the spatial extent (local, sub-regional, regional), duration (immediate, short-term, medium-term, long-term), direction (positive, neutral, negative), magnitude (nil, low, medium, high), frequency (isolated, continuous, periodic, occasional, accidental), probability (low, medium, high), and level of confidence (low, moderate, high).

Potential effects on terrain and soils are limited to direct disturbance areas. With the implementation of standard construction techniques, residual effects of clearing and surface disturbance on terrain and soils due to construction and operation of the Maxhamish residue gas pipeline are anticipated to be negative, local, long-term, and continuous, but of low to medium magnitude. The probability of effects is high, but they are reversible in the long-term. Because standard construction practices are involved, confidence in this assessment is considered high.

Potential effects on soils, vegetation, wildlife, and aquatic resources depend on the activity or species being considered. Anticipated effects are positive (*e.g.*, beneficial for certain species), while others are concluded to be neutral (no net benefit or gain), or negative (net loss to the resource). The anticipated spatial extent ranges from local (within the area disturbed by the pipeline) to regional (beyond 1.5 km of the pipeline) in extent, and short- to long-term in duration. With two exceptions, potential environmental effects were concluded to be of low magnitude. Medium to high magnitude effects on Arctic grayling and fish habitat could occur as a result of overfishing and, where trenchless crossing methods are not feasible, open cut crossings of streams with high fisheries values. It is recommended that government monitor this population and implement harvest restrictions if appropriate.

No significant adverse residual environmental effects are considered to be likely.

7.2.2 Socio-Economic Effects

From a socio-economic perspective, the proposed Maxhamish project will consist of a short period of relatively intense activity during pipeline construction. The socio-economic evaluation considered potential effects on employment, rural residences, household income, municipal services, and regional transportation infrastructure. Potential effects were evaluated using the same definitions as the environmental assessment (Section 4.4.1). The Northern Rockies Regional District (NRRD) was selected as the study area for the socio-economic assessment and Northeast British Columbia was defined as the region. These geographic areas were chosen because the proposed project could have measurable effects on existing socio-economic conditions in these areas.

Potential construction related socio-economic effects were concluded to be positive (*e.g.*, income, employment) to negative (*e.g.*, increased road traffic), sub-regional in extent, short-term, and low to moderate in magnitude.

Potential effects during operations vary with the effect being considered. They range from positive (*e.g.*, employment opportunities) to negative (*e.g.*, increased road traffic), local to sub-regional in extent, short- to long-term in duration; all are anticipated to be low in magnitude.

No expansion to existing infrastructure is required for the project to proceed. Overall, no significant adverse residual socio-economic effects are considered to be likely.

7.2.3 Cultural, Heritage, and First Nation Effects

An archaeological overview and impact assessment study to assess potential effects on heritage and archaeological resources has been completed. Representatives from the Fort Nelson and Prophet River First Nations provided field assistants for the archaeological investigations.

One new heritage resource site (Temporary number MT1) was identified during the Archaeological Impact Assessment. The site is considered to be of limited interpretive value and no further work is recommended at the location.

No historic sites were encountered within or adjacent to the proposed pipeline right-of-way. The alignment does cross the Fort Nelson Trail, but the crossing location is now used as a winter logging road and bears no resemblance to the original pack trail.

Representatives of the Fort Nelson and Prophet River First Nations participated in a reconnaissance of the entire route to identify traditional use sites and Fort Liard elders who have traditionally used the area were interviewed. Seventeen traditional use features were identified along the proposed pipeline right-of-way, but only one cabin, one beaver dam, and a crossing of the Old Fort Nelson Trail will be directly affected by the proposed right-of-way. Paramount will work with the affected individual to avoid or relocate the affected cabin, and will consult government representatives to identify the most appropriate solution for the beaver dam. No mitigation is recommended for the crossing of the Fort Nelson Trail, as it is now used as a winter logging road.

No significant effects on traditional aboriginal hunting, fishing, or trapping areas or structures are anticipated.

7.2.4 Health Effects

Construction and operation of the Maxhamish residue gas pipeline is unlikely to have any direct effects on human health. Effects could occur as a result of accidental events during construction and operations. The magnitude and extent of accidental events cannot be predicted, but Paramount will prepare an Emergency Response Plan and register it with the Town of Fort Nelson so that any emergency response efforts can be coordinated.

7.2.3 Consultation and Issues Resolution

Paramount has made a commitment to local residents, First Nations, and interested individuals, businesses, and groups to provide ongoing information on the status and schedule of the Maxhamish project. A variety of communication methods will be used to encourage participation.

7.3 Application Conclusions

Paramount has completed the necessary activities required under the *Environmental Assessment Act*. Paramount requests the approval of the Maxhamish Project Approval Certificate Application in a timely fashion to allow construction to begin in November 1999. Paramount believes that approval of the application will provide the following benefits:

1. Paramount will invest an estimated $25 million in British Columbia, spend $3.5 million per year for operations and maintenance, and provide future employment for eight full-time employees and additional contract staff in the northeast region;
2. The Maxhamish project will create socio-economic benefits including an estimated 110 person-years of direct, indirect, and induced employment in the region (340 person-years provincially), direct household income of at least $4.7 million in the region, estimated indirect and induced household income totalling $9.1 million provincially; as well as increased revenue to the producers and the province;
3. The proposed pipeline route follows existing or proposed corridors for more than 95% of its length, thereby reducing potential environmental, social, economic, cultural, and heritage effects;
4. Routing along the Liard Highway right-of-way will improve the line of sight for vehicle traffic and reduce the risk of animal collisions;
5. An aerial pipeline crossing of the Fort Nelson River will be constructed to minimize instream activities. This structure has been designed to accommodate additional pipelines to minimize future instream activities.
6. The Maxhamish project will encourage further exploration and development in the gas supply area; and
7. This application concludes that **no significant adverse effects** are likely to result from the Maxhamish Project.

TABLE 7-1
PARAMOUNT MAXHAMISH RESIDUE GAS PIPELINE
ENVIRONMENTAL ISSUES LIST AND SUMMARY OF EFFECTS, MITIGATION AND MONITORING.

ISSUE	IMPACT ASSESSMENT INDICATORS (refer to Section 4.4.1 for definitions)								MITIGATION and MONITORING MEASURES
	Geographic Extent	Magnitude	Duration/ Frequency	Direction	Permanence	Probability	Confidence	Significance	(see also EPP in Appendix D)
Terrain and Soils									
Shallow bedrock, terrain instability and permafrost	Local	Low	Long-term	Neutral to negative	Reversible in medium- to long-term	Medium	Moderate	Not significant	Site-specific measures include directional drilling below unstable slope at Muskwa R., use of a ‘rock-shield’; install trench breakers, diversion berms and/or subdrains; heavy-wall pipe in deep muskeg.
Loss of soil productivity, compaction, rutting, and pulverization, and contamination	Local	Low	Short- to long-term/ Isolated to continuous	Negative	Reversible in medium- to long-term	High	High	Not significant	Topsoil will be salvaged; along with upper 40 cm of organic soils on ALR lands; winter construction minimizes risk of compaction, etc.; construction alternatives will be implemented for wet or thawed soils; spill contingency measures in EPP.

Erosion on slopes and right-of-way	Local	Low-Medium	Short- to long-term/ Isolated to continuous	Negative	Reversible in medium- to long-term	High	High	Not significant	Surface and trench erosion control measures and revegetation o be implemented on moderate to steep slopes and other areas as required; slash rollback on level and gently sloping areas; reclamation on steeper slopes; aerial and ground surveys during operations to identify any chronic erosion problems.
Vegetation									
Alteration/loss of significant communities and rare plants	Local	Low	Medium- to long-term/ continuous	Negative	Reversible in medium- to long-term	High	Moderate	Not significant	Significant habitats avoided where possible; use of shared workspace minimizes clearing requirements; winter construction will minimize ground disturbance; grading and grubbing will be minimized where feasible.
Loss of merchantable timber	Local	Low	Long-term/ continuous	Neutral to negative	Reversible in long-term	High	High	Not significant	Timber cruise being conducted to for Logging Plan; merchantable timber will be salvaged; winter construction minimizes risk of fire; Fire Contingency Plan developed.

Introduction of weeds and exotics	Local to sub-regional	Low to medium	Long-term/ continuous	Negative	Reversible in medium term to irreversible	Medium	High	Not significant	Natural regeneration on level and gently sloping areas; a native reclamation seed mix is recommended on moderate to steeply sloping areas and watercourse approach slopes, approved mix of certified seed will be used; construction equipment will be clean on arrival.
Wildlife									
Bay-breasted and Cape May warbler	Regional	Low	Long-term/ continuous	Negative	Reversible in long-term	Medium	High	Not significant	Use of shared workspace minimizes clearing requirements; paralleling existing corridors minimizes habitat fragmentation; winter construction will minimize mortality.
Philadelphia vireo	Regional	Low	Long-term/ continuous	Negative to Positive	Reversible in long-term	Medium	High	Not significant	Use of shared workspace minimizes clearing requirements; paralleling existing corridors minimizes habitat fragmentation; winter construction will minimize mortality.

Northern goshawk	Regional	Low	Long-term/ continuous	Negative	Reversible in long-term	Medium	High	Not significant	Use of shared workspace minimizes clearing requirements; paralleling existing corridors minimizes habitat fragmentation; winter construction will minimize mortality.
Northern long-eared myotis	Sub-regional	Low	Long-term/ continuous	Negative	Reversible in long-term	Medium	High	Not significant	Use of shared workspace minimizes clearing requirements; paralleling existing corridors minimizes habitat fragmentation; winter construction will minimize mortality.
Combined effect – other species of regional management concern	Local to Regional	Low	Long-term/ Isolated to continuous	Negative to Positive	Reversible in long-term	Medium to High	Moderate	Not significant	Use of shared workspace minimizes clearing requirements; paralleling existing corridors minimizes habitat loss and fragmentation; consider placing brush piles along Liard Highway to facilitate animal crossings.
Loss of sensitive habitat features (licks, nest sites, wildlife trees)	Local	Nil	Nil	Nil	Nil	Nil	Nil	Not significant	No sensitive features identified along route during reconnaissance, wildlife, or traditional use studies.

Aquatic Resources

Effect of watercourse crossings on instream and riparian habitat	Local	Low-High	Short-to medium-term/ Isolated-continuous	Negative	Reversible in medium-term	Medium	High	Not significant	Trenchless crossings or approved alternative technique for high and moderate sensitivity streams, open-cut alternative for d'Easum Ck. KP 20; open cut or approved alternative for low and nil sensitivity streams, maintain buffers along watercourses, minimize disturbance, implementation of erosion control measures, recontouring and revegetation as soon as possible.
Aquatics (cont.)									
Sedimentation from crossings and runoff from right-of-way	Sub-regional	Low	Immediate to long-term	Neutral to negative	Reversible in short- to long-term	Medium	High	Not significant	Implementation of erosion control measures, recontouring and revegetation as soon as possible.
Combined effects on Arctic grayling	Sub-regional	Medium	Long-term/ continuous	Negative	Reversible in medium-term	Medium	High	Not significant	Recommended that government monitor populations and institute catch limits if appropriate.
Effects on navigation	Nil	Nil	Nil	Nil	Nil	Nil	Nil	Nil	Winter construction will avoid effects. Fort Nelson and d'Easum bridge crossings designed to accommodate navigation.
Land and Resource Use									

Compatibility with land use plans and protected areas	Local	Low	Long-term	Neutral	Reversible in long-term	High	High	Not significant	Maxhamish project is consistent with management objectives in LRMP and Oil and Gas Guideline Zone 4; route follows existing right-of-way through major river corridors; no protected areas affected by route.
Effects on agriculture	Local	Low	Medium-term/ continuous	Neutral	Reversible in medium-term	Medium	High	Not significant	Topsoil will be salvaged; upper 40 cm of organic soils on ALR lands; winter construction minimizes risk of compaction, etc.; salvage merchantable timber; repair/replace fencing and gates.
Effects on forest plantations, plots, and forest harvest activities	Local	Low	Long-term/ continuous	Neutral	Reversible in long-term	High	High	Not significant	Salvage merchantable timber; pay stumpage fees; minor reroutes or compensation for intersected plantations and growth/yield plots.
Effects on energy resource sector	Local - Regional	Low	Short- to Long-term/ Isolated-continuous	Neutral-positive	Reversible in long-term	High	High	Not significant	Shared temporary workspace will be reclaimed; project does not limit or affect other petroleum operations and will provide future opportunities.

Effects on trapping	Local to sub-regional	Low	Short- to Medium-term	Negative	Reversible in long-term	Medium	High	Not significant	Use of shared workspace minimizes clearing requirements; paralleling existing corridors minimizes habitat fragmentation; trail access will be maintained, early notification; compensation if loss occurs.
Effects on guide outfitting	Local to sub-regional	Low	Short-term	Negative	Reversible in long-term	Medium	High	Not significant	Use of shared workspace minimizes clearing requirements; paralleling existing corridors minimizes habitat fragmentation; winter construction avoids guiding period, early notification.
Effects on tourism	Sub-regional	Low	Short-term/ continuous	Neutral-Positive	Reversible in long-term	High	High	Not significant.	Route along Liard Highway will increase line of sight; construction timing will not affect tourism.
Effects on outdoor Recreation	Nil	Nil	Nil	Nil	Nil	High	High	Not significant	Construction timing; shared workspace.
Effects on traditional and subsistence Use	Local	Low	Short-term/ Isolated	Neutral-Negative	Reversible in long-term	High	High	Not significant	Traditional use survey done with representatives of Fort Nelson and Prophet River First Nations; one cabin is located on right-of-way; Paramount will work with affected individual to relocate cabin or reroute right-of-way; one beaver dam identified,

									will be avoided or removed.
Cumulative environmental effects	Sub-regional	Low	Long-term/ continuous	Negative-positive	Reversible in long-term	Medium	High	Not significant	Use of shared workspace minimizes clearing requirements; paralleling existing corridors minimizes habitat fragmentation.
Socio-Economic Effects									
Effects on Employment & Income	Sub-regional to provincial	Sub-regional - high Provincial-low	Short-term	Positive	Isolated-Long-term	Medium	High	Significant –Not significant	Local benefits will be consideration in contract award.
Effects on Municipal Services	Sub-regional	Low	Short-term to long term	Neutral to negative	Isolated and periodic	High	High	Not significant	Local and regional representatives will be kept informed of project plans and schedules.
Effects on Regional Transportation Infrastructure	Sub-regional to Interprov.	Low	Short-term	Negative	Isolated	High	High	Not significant	Road crossing & use agreements.
Effects on Quality of Life	Local to sub-regional	Low - Medium	Short-term	Negative	Isolated	High	High	Not significant	Advance landowner contact, leave forest cover, car pooling/busing.
Cultural and Heritage Effects									
Effects on Archaeological Resources	Provincial	Nil	Long-term	Neutral	Isolated	Low	High	Not significant	Mitigation complete; cultural material recovered and recorded.
Effects on Historic Sites	Local	Nil	Long-term	Neutral	Isolated	Low	High	Not significant	N/A

Health Effects

Effects on Health	Local	Low -High	Long-term/ Accidental	Negative	Reversible to Irreversible	Unlikely - High	High	Not Significant	Only potential effect associated with accident during construction or operation; health infrastructure considered to be adequate. Probability of high magnitude effect considered to be unlikely.

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8.1 Personal Communications

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Category	Details
Terrain/Soils	Ground Moraine: till, Undulating · Org. Bog: peat, Level, local permafrost · Ground Moraine: till, Undulating to hummocky · Organic Bog and Veneer (peat), minor Ground Moraine (till), Level to Undulating, local permafrost · Alluvial Floodplain: sand–gravel · Organic Bog, minor Veneer: peat, Level · Outwash
Vegetation and Wildlife	Bw/Aw/Sw/Pl · 4 Trumpeter Swans 1.3km NE of Plant Site · #6 Wildlife/Veg Sample Site · Sw/Sb patch of Sb/So · Sb/Lt/Aw · Sw/Sb · Sb/Lt · Pb/Sw/Aw · Aw/Sw/Pl (T) · Aw/Sw
Aquatics/Hydrology	#1 Trib. to d'Easum Creek NCD · #2 Trib. to d'Easum Creek NCD · #3 d'Easum Creek GR, LSU, WSU, BB, CCG, LND, TP · #4 Trib. to d'Easum Creek (GR)
Heritage Resources and Land Use	
Traditional Knowledge	

Legend:

Proposed Pipeline Route

Kilometre Posting (approximate) — Km 46

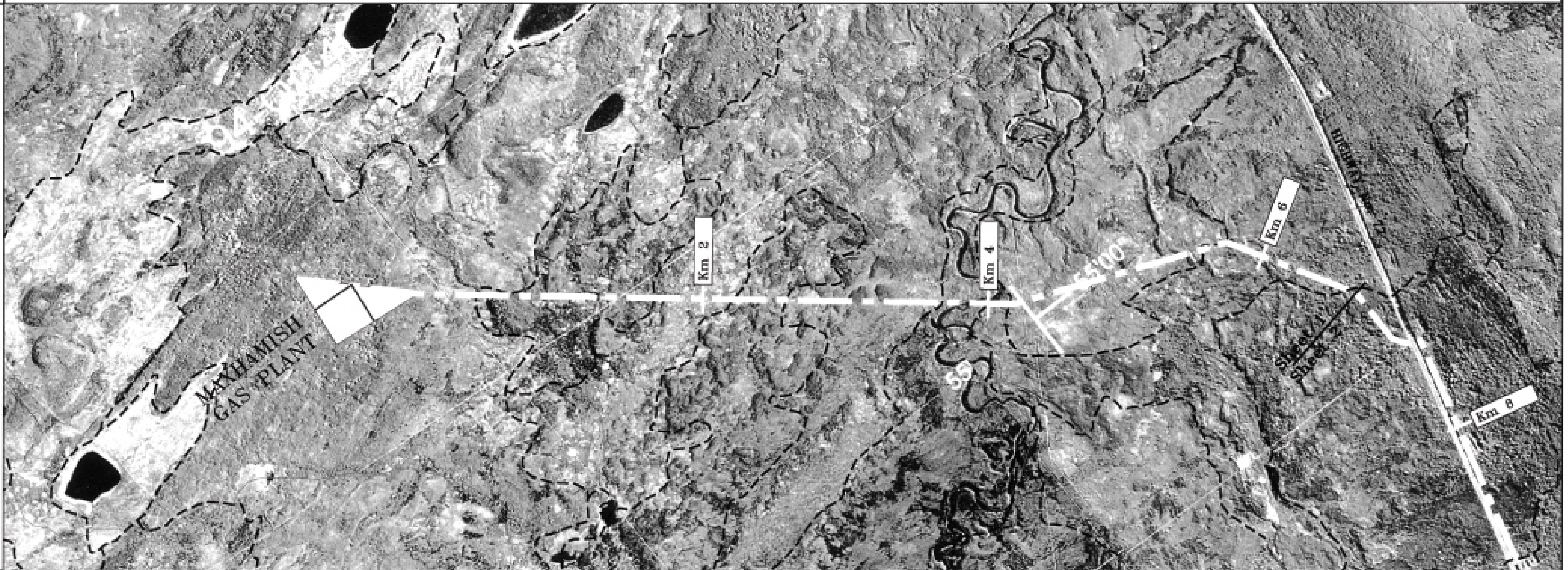
Matchline — Sheet 1 / Sheet 2

VEGETATION

- Aw – Aspen
- Bw – Birch
- Sw – White Spruce
- Sb – Black Spruce
- Sc – Closed Shrub
- So – Open Shrub
- Lt – Tamarack
- Pb – Balsam Poplar
- Pl – Lodgepole Pine
- Fb – Balsam Fir
- Complex – Mixture of types in small area
- T – Trace
- W – Water
- Mw – Wet Meadow
- Md – Dry Meadow
- Dev. – Developed

AQUATICS

- NCD – Non-Classified Drainage
- GR – Arctic Grayling
- BB – Burbot
- LSU – Longnose Sucker
- WSU – White Sucker
- CCG – Slimy Sculpin
- NP – Northern Pike
- FDC – Finescale Dace
- LND – Longnose Dace
- BSB – Brook Stickleback
- LKC – Lake Chub
- TP – Trout-Perch
- BT – Bull Trout
- MW – Mountain Whitefish
- LW – Lake Whitefish
- FHC – Flathead Chub
- LGS – Largescale Sucker
- WA – Walleye
- IC – Inconnu
- GE – Goldeye



Category	Details
Environmental Issues	Watercourse · Watercourse · High Fisheries Values · Moderate Fisheries Values
Mitigation * – Water/Equipment Crossings – Erosion Control – Other	Open Cut/Snow or Log Fill · Open Cut/Snow or Log Fill · Trenchless Crossing/Bridge See Crossing Detail Design · Trenchless or Approved Alternative if Flow/ Existing Road

* Refer to Environmental Protection Plan for General Mitigation Measures

PARAMOUNT RESOURCES LTD. · Golder Associates

BIOPHYSICAL ALIGNMENT SHEET
PARAMOUNT MAXHAMISH RESIDUE GAS PIPELINE

PHOTO DATE: June 1996 · DRAWN: VS · CHECKED: TC · DATE: 17 AUG. 1999 · SCALE: 1:30,000

Sheet 1 of 17

Terrain/Soils	Outwash: Sand–gravel Hummocky to Ridged; Ground Moraine (till), Minor Organic Veneer (peat): Level to Undulating; Meltwater Channel; Ground Moraine: till, Undulating; Organic Bog: peat, Level, local permafrost; Ground Moraine, minor Veneer: till, local shallow, bedrock, Level to Undulating; Organic Bog: peat, Level, local permafrost; Ground Moraine: till, Undulating
Vegetation and Wildlife	Aw/Sw; Wildlife/Veg Sample Site #7; Sb/Sw; Aw/Bw; Aw/Sw; Aw/Sw Sb patches; Aw/Sw Md/So; Sw/Sb/Mw/So/Sc Veg Sample Site; Aw/Sw; Sb/Lt Pl on High spots; Aw/Sw; Sb/Sc; Aw/Sw
Aquatics/Hydrology	#5 Trib. to d'Easum Creek NCD; #6 Trib. to d'Easum Creek NCD; #7 Trib. to d'Easum Creek FDC, BSB
Heritage Resources and Land Use	Liard Highway Crossing; Abandoned Pit; Abandoned Pit; Abandoned Pit
Traditional Knowledge	

Legend:

Proposed Pipeline Route

Kilometre Posting (approximate) Km 46

Matchline Sheet 1 / Sheet 2

VEGETATION

Aw – Aspen
Bw – Birch
Sw – White Spruce
Sb – Black Spruce
Sc – Closed Shrub
So – Open Shrub
Lt – Tamarack
Pb – Balsam Poplar
Pl – Lodgepole Pine
Fb – Balsam Fir
Complex – Mixture of types in small area
T – Trace
W – Water
Mw – Wet Meadow
Md – Dry Meadow
Dev. – Developed

AQUATICS

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BB – Burbot
LSU – Longnose Sucker
WSU – White Sucker
CCG – Slimy Sculpin
NP – Northern Pike
FDC – Finescale Dace
LND – Longnose Dace
BSB – Brook Stickleback
LKC – Lake Chub
TP – Trout-Perch
BT – Bull Trout
MW – Mountain Whitefish
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FHC – Flathead Chub
LGS – Largescale Sucker
WA – Walleye
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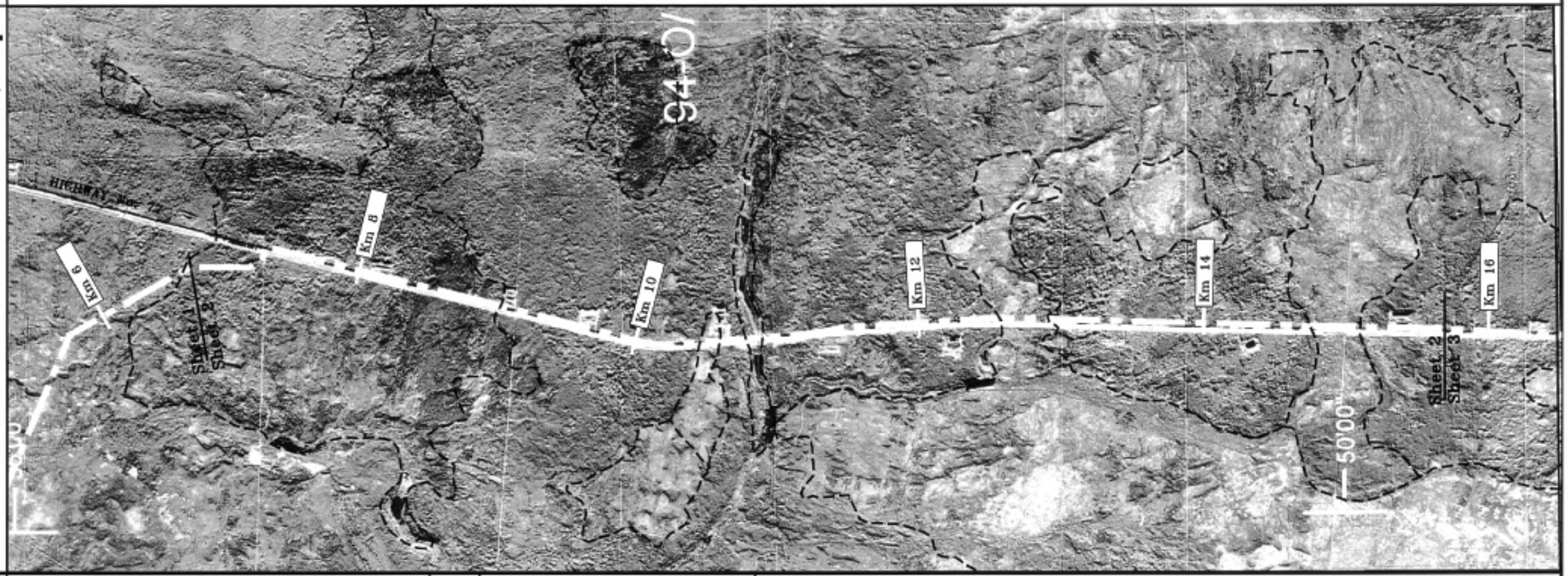

Environmental Issues	Watercourse; Watercourse; Watercourse Erosion-Prone Slopes
Mitigation * – Water/Equipment Crossings – Erosion Control – Other	Open Cut/Snow or Log Fill; Open Cut/Snow or Log Fill Erosion Control

* Refer to Environmental Protection Plan for General Mitigation Measures

PARAMOUNT RESOURCES LTD. | Golder Associates

BIOPHYSICAL ALIGNMENT SHEET
PARAMOUNT MAXHAMISH RESIDUE GAS PIPELINE

REFERENCE: SURVEY DATA SUPPLIED BY UNIVERSAL SURVEYS INC. AIR PHOTO MOSAIC SUPPLIED BY DMR RESOURCE SURVEYS. PHOTO DATE: June 1998

DRAWN: VS | DATE: 17 AUG. 1999 | SCALE: 1:30,000
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Sheet 2 of 17

Terrain/Soils	Ground Moraine (till), Minor Organic Bog (peat): Level to Undulating Organic Veneer: Shallow peat over till, Level Ground Moraine: till, Undulating Meltwater Channel Ground Moraine (till) and Organic Veneer (peat): Level to Undulating Alluvial Floodplain Organic Veneer (peat), minor Ground Moraine (till): Level to Undulating Ground Moraine: till, Undulating
Vegetation and Wildlife	Aw/Sw Pl (T) Sw/Sb Sb/Lt Pair Sandhill Cranes 1,300m E of Row Sb/Sc Sw/Sb/Sc So Aw/Sw Mw/W Sb/Lt(T) Aw/Sw/Sc/Pl (T) Patches of Sb/Lt Sample Site H Sample Site #9 Aw/Bw
Aquatics/Hydrology	#8 Trib. to Emile Creek NCD #9 d'Easum Creek GR,BB,CCG,LKC,FDC #10 Trib. to d'Easum Creek GR,BSB
Heritage Resources and Land Use	Abandoned Pit Abandoned Pit Abandoned Pit
Traditional Knowledge	

Legend:

Proposed Pipeline Route

Kilometre Posting (approximate) Km 46

Matchline Sheet 1 / Sheet 2

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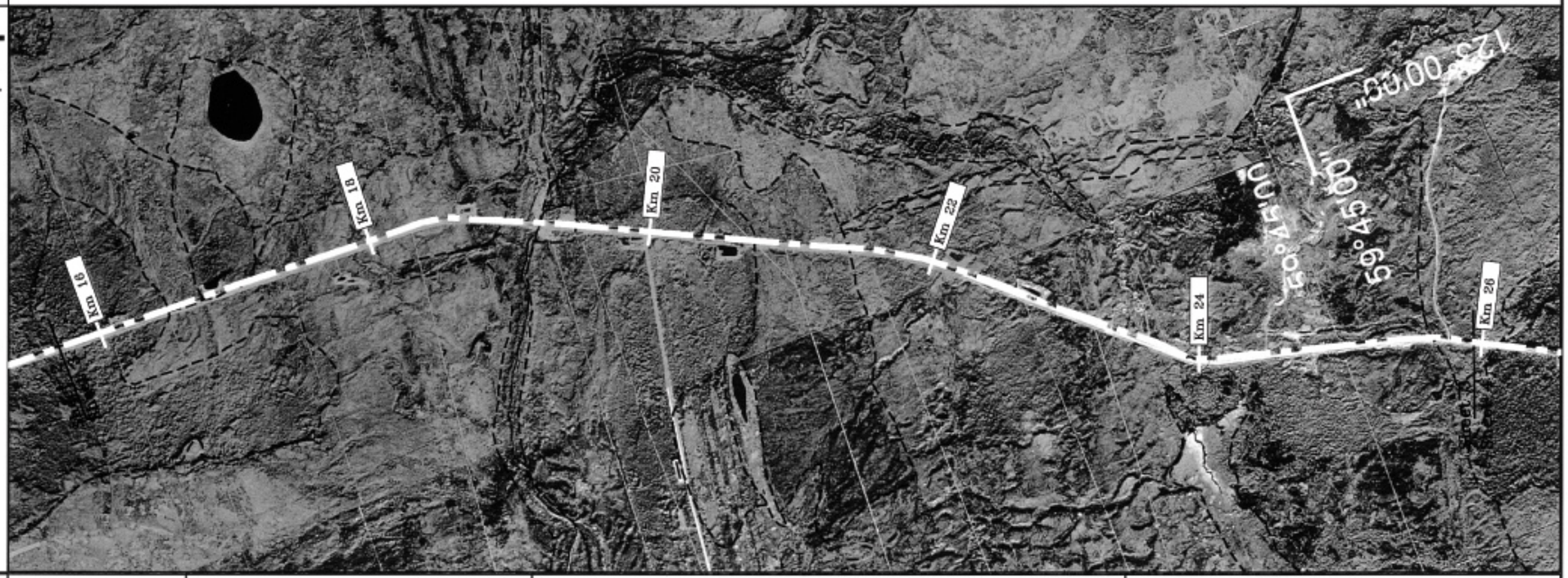
BT – Bull Trout
MW – Mountain Whitefish
LW – Lake Whitefish
FHC – Flathead Chub
LGS – Largescale Sucker
WA – Walleye
IC – Inconnu
GE – Goldeye



Environmental Issues	Watercourse	High Fisheries Values Erosion-Prone Slopes Moderate Fisheries Values
Mitigation * – Water/Equipment Crossings – Erosion Control – Other	Open Cut/Snow or Log Fill	Trenchless or Approved Alternative/ Existing Bridge Erosion Control Trenchless or Approved Alternative Temp. or Ice Bridge

* Refer to Environmental Protection Plan for General Mitigation Measures

PARAMOUNT RESOURCES LTD. | Golder Associates

BIOPHYSICAL ALIGNMENT SHEET
PARAMOUNT MAXHAMISH RESIDUE GAS PIPELINE

REFERENCE: SURVEY DATA SUPPLIED BY UNIVERSAL SURVEYS INC. AIR PHOTO MOSAIC SUPPLIED BY TERRA RESOURCE SERVICES PHOTO DATE: June 1998

DRAWN: RFM	DATE: 17 AUG. 1999	SCALE: 1:30,000	Sheet 3 of 17
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Terrain/Soils

Ground Moraine: till, Undulating

Ground Moraine, minor Veneer: till, local shallow bedrock, Undulating

Ground Moraine (till) and Organic Veneer (peat): Level and Undulating – Ridged
Moraine Veneer, minor Ground Moraine: till, some shallow bedrock, Undulating

Vegetation and Wildlife

Aw/Bw/Sw | Sw/Sb/Pl (T) | Mature Mixed Wood Forest: Aw/Sw | Sw/Fb/Aw/Bw/Pb | Wildlife/Veg Sample Site #10 | Aw/Bw | Sw/Aw/Bw/Pb/Fb | Aw/Sw | Sw | Pl/Sb/Sw/Aw | Wildlife/Veg Sample Site #11 | Sw/Pl | Aw/Pl/Sw

Aquatics/Hydrology

#11 Trib. to d'Easum Creek NCD

#12 Trib. to d'Easum Creek NCD

#13 Trib. to d'Easum Creek NCD

#14 Trib. to Dezsen Creek NCD

#15 #16 #17 Tribs. to Dezsen Creek NCD

Heritage Resources and Land Use

Abandoned Pit

Abandoned Pit

Abandoned Pit

AEC Maxhamish Pipeline parallels Hwy on W side

Abandoned Pit

Traditional Knowledge

Legend:

Proposed Pipeline Route

Kilometre Posting (approximate) Km 46

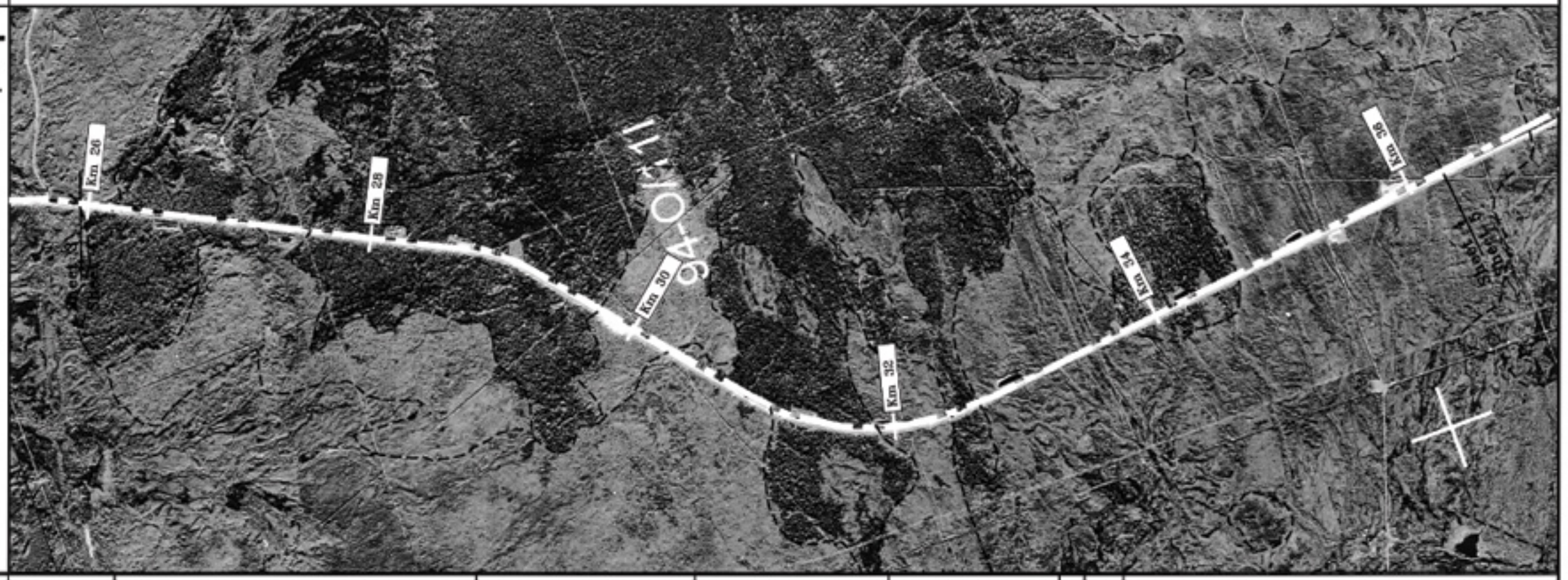
Matchline Sheet 1 / Sheet 2

VEGETATION

Aw – Aspen
Bw – Birch
Sw – White Spruce
Sb – Black Spruce
Sc – Closed Shrub
So – Open Shrub
Lt – Tamarack
Pb – Balsam Poplar
Pl – Lodgepole Pine
Fb – Balsam Fir
Complex – Mixture of types in small area
T – Trace
W – Water
Mw – Wet Meadow
Md – Dry Meadow
Dev. – Developed

AQUATICS

NCD – Non-Classified Drainage
GR – Arctic Grayling
BB – Burbot
LSU – Longnose Sucker
WSU – White Sucker
CCG – Slimy Sculpin
NP – Northern Pike
FDC – Finescale Dace
LND – Longnose Dace
BSB – Brook Stickleback
LKC – Lake Chub
TP – Trout-Perch
BT – Bull Trout
MW – Mountain Whitefish
LW – Lake Whitefish
FHC – Flathead Chub
LGS – Largescale Sucker
WA – Walleye
IC – Inconnu
GE – Goldeye



Environmental Issues

Watercourse | Watercourse | Watercourse | Watercourse | Watercourses

Shallow Bedrock: Ripping or Local Blasting may be Required

Mitigation *

- Water/Equipment Crossings
- Erosion Control
- Other

Open Cut/Snow or Log Fill | Open Cut/Snow or Log Fill | Open Cut/Snow or Log Fill | Open Cut/Snow or Log Fill | Open Cut/Snow or Log Fill

* Refer to Environmental Protection Plan for General Mitigation Measures

PARAMOUNT RESOURCES LTD. | Golder Associates

BIOPHYSICAL ALIGNMENT SHEET
PARAMOUNT MAXHAMISH RESIDUE GAS PIPELINE

PHOTO DATE: June 1998

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REVIEWED:

Sheet 4 of 17

Terrain/Soils

Alluvial Floodplain — Moraine Veneer, Minor Ground Moraine (till), some shallow bedrock, Undulating

Moraine Veneer, Minor Ground Moraine: till, some shallow rock, Undulating

Alluvial Floodplain

Organic Veneer (peat), minor Ground Moraine (till): Level to Undulating

Vegetation and Wildlife

Aw/Sw/Pl

Sw/Aw/Pl

Wildlife/Veg Sample Site #12 — Aw

Sw/Sb

Sb/Sc

Sb/Lt (T) (W) Sc

Aquatics/Hydrology

#18 Tributary to Deszen Creek NCD

#19 Deszen Creek

#20 Tributary to Tsinhia Lake NCD

Tribs. to Tsinhia Lake #21

#22

Heritage Resources and Land Use

Abandoned Pit

Abandoned Pit

Abandoned Pit

Site MT1

Abandoned Pit

Abandoned Pit

Abandoned Pit

Traditional Knowledge

Legend:

Proposed Pipeline Route

Kilometre Posting (approximate) Km 48

Matchline Sheet 1 / Sheet 2

VEGETATION

Aw – Aspen
Bw – Birch
Sw – White Spruce
Sb – Black Spruce
Sc – Closed Shrub
So – Open Shrub
Lt – Tamarack
Pb – Balsam Poplar
Pl – Lodgepole Pine
Fb – Balsam Fir
Complex – Mixture of types in small area
T – Trace
W – Water
Mw – Wet Meadow
Md – Dry Meadow
Dev. – Developed

AQUATICS

NCD – Non-Classified Drainage
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MW – Mountain Whitefish
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FHC – Flathead Chub
LGS – Largescale Sucker
WA – Walleye
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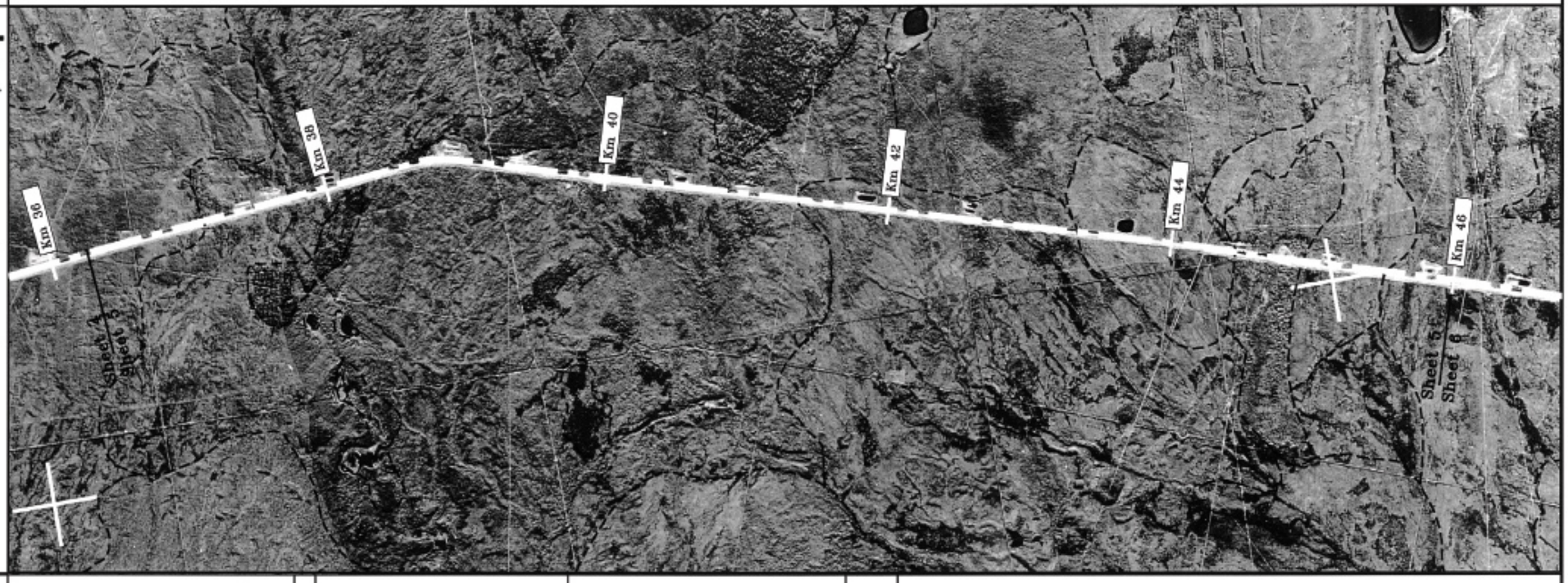

Environmental Issues

Watercourses

Watercourses

Watercourses
Erosion-Prone Slopes

Shallow Bedrock: Ripping or Blasting may be Required

Mitigation *

- Water/Equipment Crossings
- Erosion Control
- Other

Open Cut/Snow or Log Fill

Trenchless or Approved Alternative if Flow/ Temp. or Ice Bridge

Open Cut/Snow or Log Fill

Isolate if Flow/ Temp. or Ice Bridge
Erosion Control

* Refer to Environmental Protection Plan for General Mitigation Measures

PARAMOUNT RESOURCES LTD.

Golder Associates

BIOPHYSICAL ALIGNMENT SHEET
PARAMOUNT MAXHAMISH RESIDUE GAS PIPELINE

REFERENCE: SURVEY DATA SUPPLIED BY UNIVERSAL SURVEYS INC. AIR PHOTO MOSAIC SUPPLIED BY TERRA RESOURCE SERVICES
PHOTO DATE: June 1996

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DATE 17 AUG. 1999

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Sheet 5 of 17

Terrain/Soils

Organic Veneer (peat), minor Ground Moraine (till): Level to Undulating — Meltwater Channel — Ground Moraine (till), minor Organic Veneer (peat): Level to Undulatind — Ground Moraine and Veneer: till, some shallow bedrock, Undulating — Meltwater Channel — Ground Moraine (till), Minor Organic Veneer (peat): Level to Undulating — Meltwater Channel — Ground Moraine, Minor Veneer: till, local shallow, bedrock, Undulating

Vegetation and Wildlife

Sb/Lt (W) | Sb/Sc | Mw/W | Aw/Sc (DV) | Aw/Sw | Sc (drow) Aw/Sw | Md (DV) | Aw/Sw/Pl | Aw/Bw | Aw/Sw | Wildlife/Veg Sample Site #13 Sb/Lt | Sw/Sb | Sc Sb/Lt | Aw/Sw

Aquatics/Hydrology

#23 Trib. to Tsinhia Lake NCD

#24 Trib. to Tsinhia Lake NCD

#25 Trib. to Tsinhia Lake NCD

#26 Trib. to Tsinhia Lake NCD

Heritage Resources and Land Use

Abandoned Pits

Abandoned Pits

Abandoned Pit

Pit

Traditional Knowledge

Legend:

Proposed Pipeline Route

Kilometre Posting (approximate) Km 46

Matchline Sheet 1 / Sheet 2

VEGETATION

Aw – Aspen
Bw – Birch
Sw – White Spruce
Sb – Black Spruce
Sc – Closed Shrub
So – Open Shrub
Lt – Tamarack
Pb – Balsam Poplar
Pl – Lodgepole Pine
Fb – Balsam Fir
Complex – Mixture of types in small area
T – Trace
W – Water
Mw – Wet Meadow
Md – Dry Meadow
Dev. – Developed

AQUATICS

NCD – Non-Classified Drainage
GR – Arctic Grayling
BB – Burbot
LSU – Longnose Sucker
WSU – White Sucker
CCG – Slimy Sculpin
NP – Northern Pike
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LND – Longnose Dace
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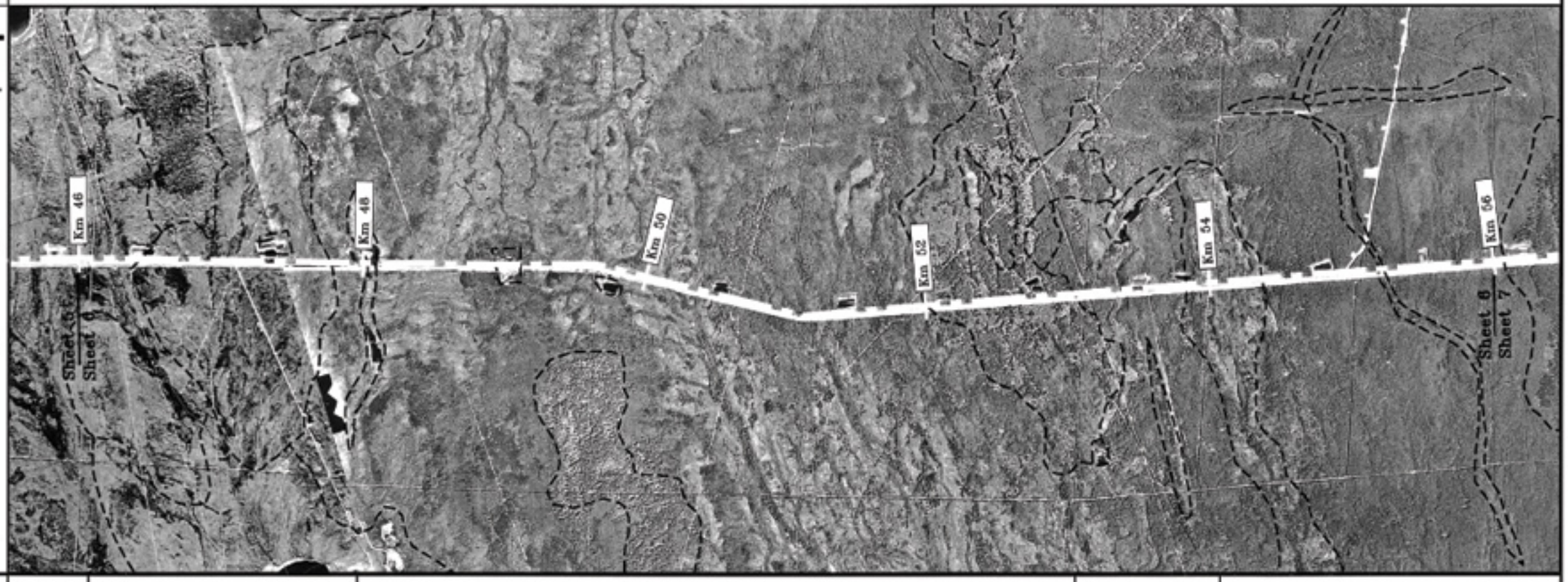
LKC – Lake Chub
TP – Trout-Perch
BT – Bull Trout
MW – Mountain Whitefish
LW – Lake Whitefish
FHC – Flathead Chub
LCS – Largescale Sucker
WA – Walleye
IC – Inconnu
GE – Goldeye



Environmental Issues

Watercourse — Watercourse — Watercourse — Watercourse

Mitigation *

- Water/Equipment Crossings
- Erosion Control
- Other

Open Cut/Snow or Log Fill — Open Cut/Snow or Log Fill — Open Cut/Snow or Log Fill — Open Cut/Snow or Log Fill

* Refer to Environmental Protection Plan for General Mitigation Measures

PARAMOUNT RESOURCES LTD. | Golder Associates

BIOPHYSICAL ALIGNMENT SHEET
PARAMOUNT MAXHAMISH RESIDUE GAS PIPELINE

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PHOTO DATE: June 1998

Sheet 6 of 17

Terrain/Soils	Ground Moraine, minor Veneer: till, local shallow bedrock, Undulating
Vegetation and Wildlife	Sb/Lt | Aw/Sw | Sb/Sc | Aw/Sw | Sw/Sb | Aw/So | Sw/Sb | Sb/Lt | Aw/Sw | Sb/Lt | Sw/Sb
Aquatics/Hydrology	
Heritage Resources and Land Use	Abandoned Pit; Abandoned Pit; Abandoned Pit; AEC P/L Const'n Camp
Traditional Knowledge	Cabin

Legend:

Proposed Pipeline Route

Kilometre Posting (approximate) Km 46

Matchline Sheet 1 / Sheet 2

VEGETATION

Aw – Aspen
Bw – Birch
Sw – White Spruce
Sb – Black Spruce
Sc – Closed Shrub
So – Open Shrub
Lt – Tamarack
Pb – Balsam Poplar
Pl – Lodgepole Pine
Fb – Balsam Fir
Complex – Mixture of types in small area
T – Trace
W – Water
We – Wet Meadow
Wd – Dry Meadow
Dev. – Developed

AQUATICS

NCD – Non-Classified Drainage
GR – Arctic Grayling
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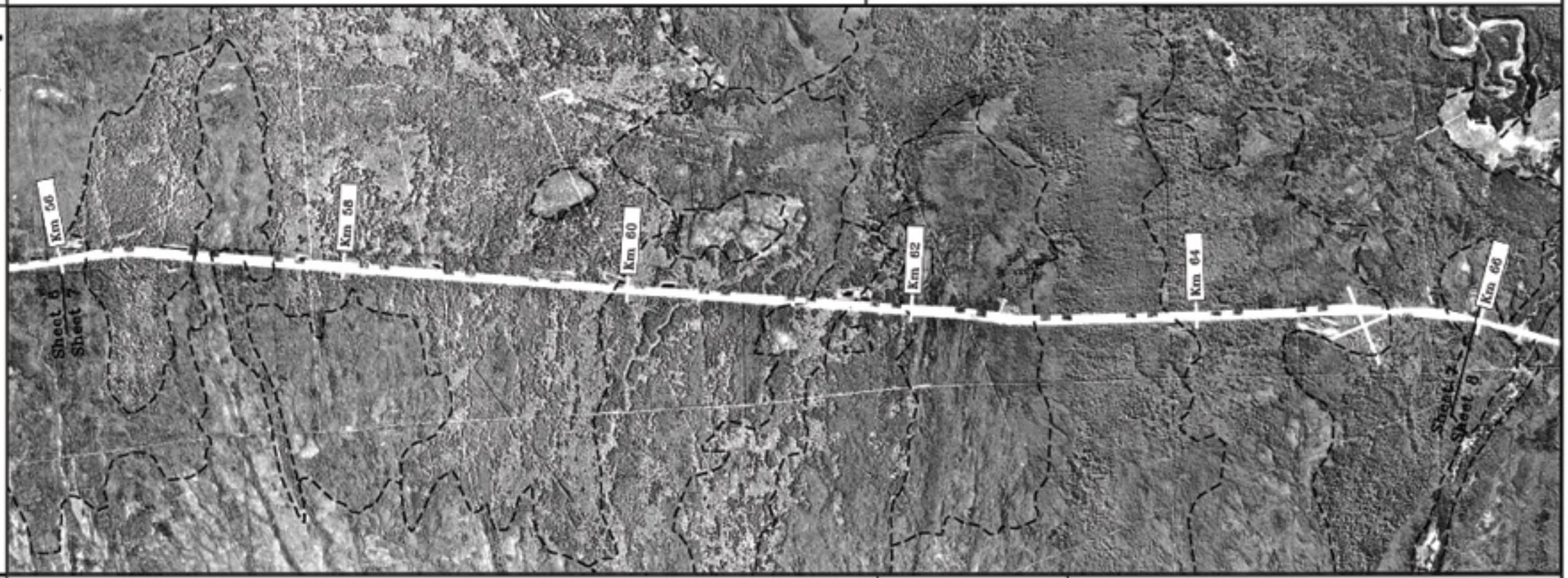
TP – Trout-Perch
BT – Bull Trout
MW – Mountain Whitefish
LW – Lake Whitefish
FHC – Flathead Chub
LCS – Largescale Sucker
WA – Walleye
IC – Inconnu
GE – Goldeye



Environmental Issues	Shallow Bedrock
Mitigation * – Water/Equipment Crossings – Erosion Control – Other	Relocate Cabin/Reroute

* Refer to Environmental Protection Plan for General Mitigation Measures

PARAMOUNT RESOURCES LTD. | Golder Associates

BIOPHYSICAL ALIGNMENT SHEET
PARAMOUNT MAXHAMISH RESIDUE GAS PIPELINE

PHOTO DATE: June 1998 | DRWN: VS | CHKD: TC | DATE: 17 AUG. 1999 | SCALE: 1:30,000

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Terrain/Soils

Gro. Moraine, min. Veneer: till, loc. shallow bed, Undulating | Alluvial Floodplain — Ground Moraine: till, Undulating | Colluvial Veneer — Moraine Veneer, minor Ground Moraine: till, some shallow bedrock, Level to Undulating | Colluvial Veneer | Ground Moraine: till, Undulating | Ground Moraine (till), minor Organic Veneer (peat), Level to Undulating | Alluvial Floodplain — Organic Veneer: peat, Level — Ground Moraine: till, Undulating

Vegetation and Wildlife

Sw/Sb | Sb/Sc | Aw/Sw | Sw/Aw | Sb/Lt | Mw | Sb/Sc | Aw/Sw — Aw/Bw | Sw/Pl/Aw/Sc/Mw (patches) | Trumpeter Swan pair & nest on West Side of Lake | Sb/Lt Pl | Aw/Bw cut block | Aw/Sw Pl (T) | Cut

Bald Eagle Nest Fledglings 600m N of Row

Aquatics/Hydrology

#27 Tsinhia Creek LSU,WSU,COG,2KC

#28 Trib. to Tsinhia Creek NCD

#29 Trib. to Capot-Blanc Creek NCD

#30 Trib. to Kiwigana Creek

#31 Trib. to Kiwigana Creek BSB,FDC

Heritage Resources and Land Use

Abandoned Pit

Abandoned Pit

Abandoned Pit

Replanted Cutblock

Traditional Knowledge

Legend:

Proposed Pipeline Route

Kilometre Posting (approximate) Km 65

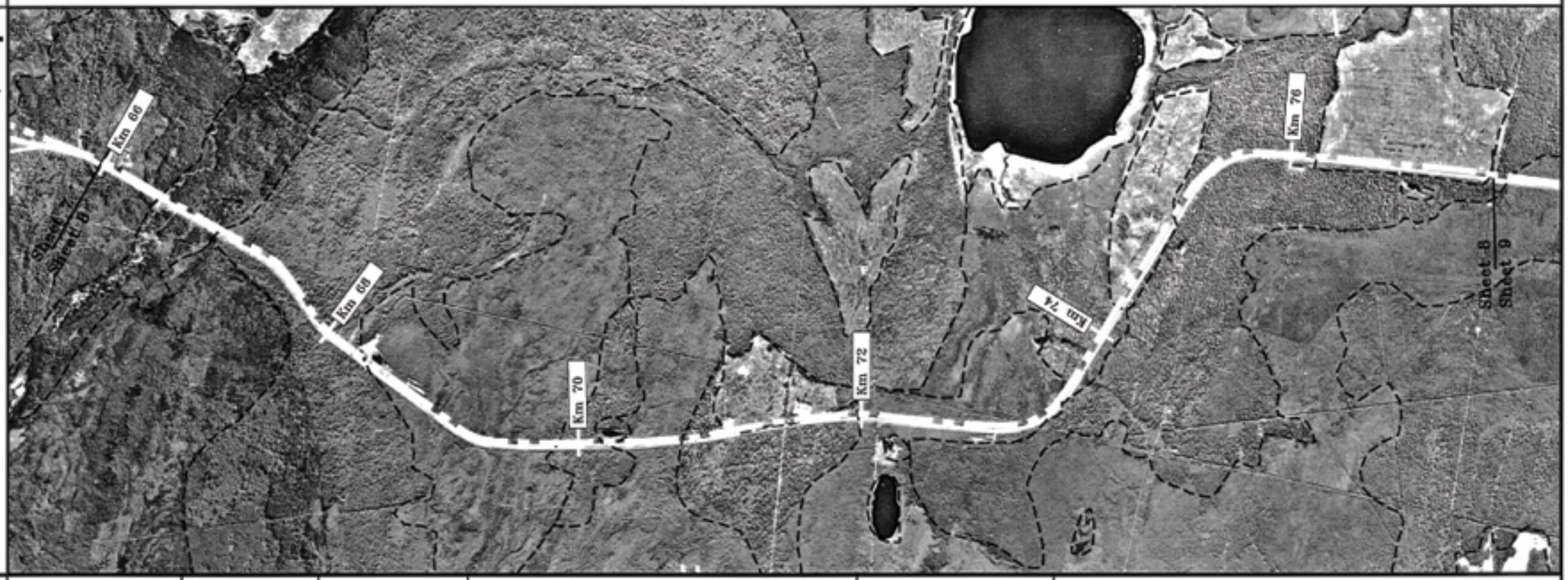
Matchline Sheet 1 / Sheet 2

VEGETATION

Aw – Aspen
Bw – Birch
Sw – White Spruce
Sb – Black Spruce
Sc – Closed Shrub
So – Open Shrub
Lt – Tamarack
Pb – Balsam Poplar
Pl – Lodgepole Pine
Fb – Balsam FV
Complex – Mixture of types in small area
T – Trace
W – Water
Mw – Wet Meadow
Md – Dry Meadow
Dev. – Developed

AQUATICS

NCD – Non-Classified Drainage
GR – Arctic Grayling
BB – Burbot
LSU – Longnose Sucker
WSU – White Sucker
COG – Slimy Sculpin
NP – Northern Pike
FDC – Finescale Dace
LND – Longnose Dace
BSB – Brook Stickleback
LKC – Lake Chub
TP – Trout-Perch
BT – Bull Trout
MW – Mountain Whitefish
LW – Lake Whitefish
FHC – Flathead Chub
LGS – Largescale Sucker
WA – Walleye
IC – Inconnu
GE – Goldeye



Environmental Issues

Moderate Fisheries Values

Watercourse Erosion-Prone Slopes

Watercourse

Shallow Bedrock: Ripping or Local Blasting may be Required

Watercourse Erosion-Prone Slopes

Watercourse

Mitigation *

- Water/Equipment Crossings
- Erosion Control
- Other

Trenchless or Approved Alternative/Temp. or Ice Bridge

Open Cut/Snow or Log Fill

Open Cut/Snow or Log Fill

Trenchless or Approved Alternative if Flow/ Temp. or Ice Bridge

Trenchless or Approved Alternative if Flow/ Temp. or Ice Bridge

* Refer to Environmental Protection Plan for General Mitigation Measures

PARAMOUNT RESOURCES LTD.

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BIOPHYSICAL ALIGNMENT SHEET
PARAMOUNT MAXHAMISH RESIDUE GAS PIPELINE

PHOTO DATE: June 1998

VS | TC | 17 AUG. 1999 | 1:30,000

Sheet 8 of 17

Terrain/Soils	Colluvial Apron: slopewash, gently sloping; Ground Moraine: till, Undulating; Organic Veneer: Shallow peak, Level; Ground Moraine: till, Undulating
Vegetation and Wildlife	Cut; Aw/Sw; Sb/Lt; Cut; Aw/Sw (P); Mw/W/Dev; Aw/Sw Pl (T); Mw/W/Dev; Aw/Sw Pl (T); Aw/Sw; Sb
Aquatics/Hydrology	#32 Trib. to Fort Nelson R. BSB
Heritage Resources and Land Use	Replanted Cutblock; Abandoned Pit; Abandoned Pit; Abandoned Pit
Traditional Knowledge	

Legend:

Proposed Pipeline Route

Kilometre Posting (approximate) Km 46

Matchline Sheet 1 / Sheet 2

VEGETATION

Aw – Aspen
Bw – Birch
Sw – White Spruce
Sb – Black Spruce
Sc – Closed Shrub
So – Open Shrub
Lt – Tamarack
Pb – Balsam Poplar
Pl – Lodgepole Pine
Fb – Balsam Fir
Complex – Mixture of types in small area
T – Trace
W – Water
Mw – Wet Meadow
Md – Dry Meadow
Dev. – Developed

AQUATICS

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WSU – White Sucker
CCC – Slimy Sculpin
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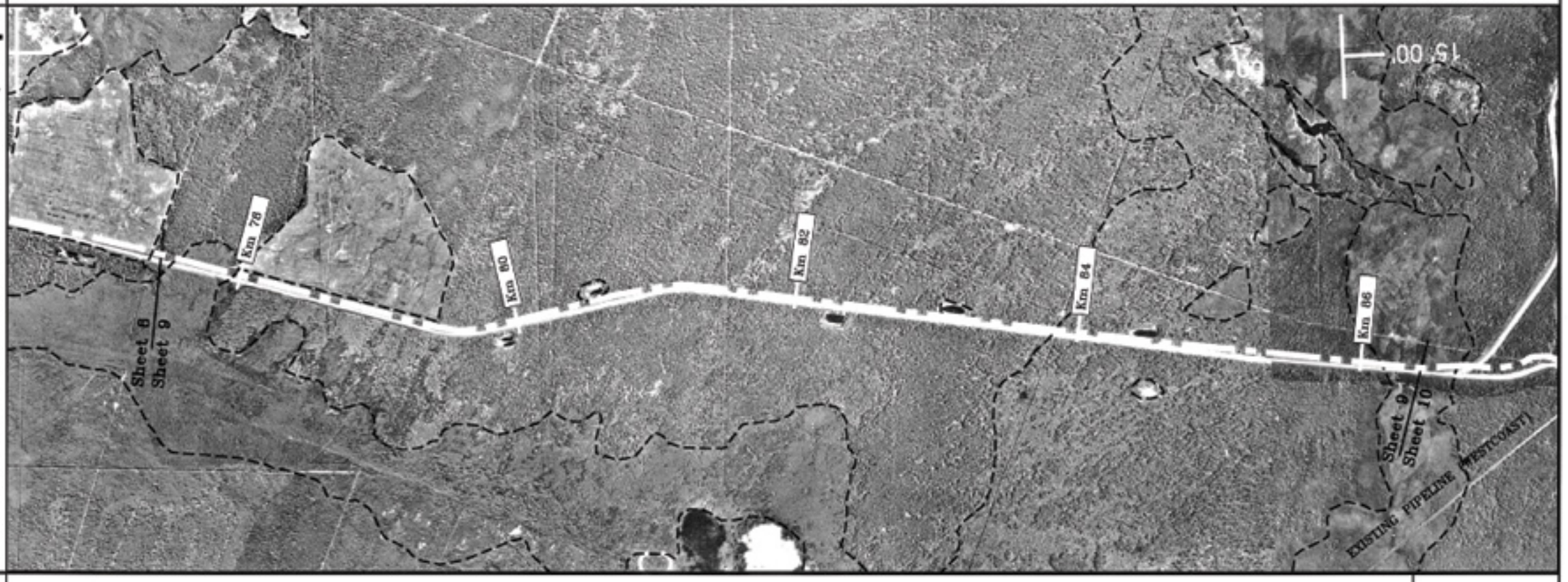
FDC – Finescale Dace
LND – Longnose Dace
BSB – Brook Stickleback
LKC – Lake Chub
TP – Trout-Perch
BT – Bull Trout
MW – Mountain Whitefish
LW – Lake Whitefish
FHC – Flathead Chub
LDS – Longscale Sucker
WA – Walleye
IC – Inconnu
GE – Goldeye



Environmental Issues	Watercourse
Mitigation * – Water/Equipment Crossings – Erosion Control – Other	Trenchless or Approved Alternative if Flow/Temp Temp. or Ice Bridge

* Refer to Environmental Protection Plan for General Mitigation Measures

PARAMOUNT RESOURCES LTD. | Golder Associates

BIOPHYSICAL ALIGNMENT SHEET
PARAMOUNT MAXHAMISH RESIDUE GAS PIPELINE

PHOTO DATE: June 1996 | DRAWN: VS | DESIGN: TC | REVISED: - | DATE: 17 AUG. 1999 | SCALE: 1:30,000

Terrain/Soils

Ground Morsine: till, Undulating | Alluvial Terrace: Sand and gravel, Level | Colluvial Slopewash | Alluvial Floodplain: Sand and gravel, Level | Ground Moraine (till), Minor Organic Veneer (peat): Level to Undulating | Organic Bog: peat, Level | Ground Moraine: till, Undulating | Organic Bog and Veneer: peat, local shallowpeat, Level

Vegetation and Wildlife

Aw/Sw | Sc | Aw/Sw | Gravel Pit (active) | Dev | Aw/Sw | Wildl./Veg Sample Site #14, K | Sw/Sb | Pb/Aw/Sw Mature Pb | Pb/Sw/Aw | W | Pb/Sw/Aw | Aw/Sw local Sb patches | Sb/Lt/Bw/Aw/Sw | Wildlife/Veg Sample Site #15, L

Aquatics/Hydrology

#33 Trib. to Fort Nelson R. NCD | #34 Trib. to Fort Nelson R. | #35 Fort Nelson R. IC,LW,NP,WA,GE,BB,LSU, WSU,FHC,LKC,LND,TP | #36 Trib. to Fort Nelson R. FDC

Heritage Resources and Land Use

Liard Highway Crossing | Liard Highway Crossing

Traditional Knowledge

Legend:

Proposed Pipeline Route

Kilometre Posting (approximate) Km 46

Matchline Sheet 1 / Sheet 2

VEGETATION

Aw – Aspen
Bw – Birch
Sw – White Spruce
Sb – Black Spruce
Sc – Closed Shrub
So – Open Shrub
Lt – Tamarack
Pb – Balsam Poplar
Pl – Lodgepole Pine
Fb – Balsam Fir
Complex – Mixture of types in small area
T – Trace
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Mw – Wet Meadow
Md – Dry Meadow
Dev. – Developed

AQUATICS

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MW – Mountain Whitefish
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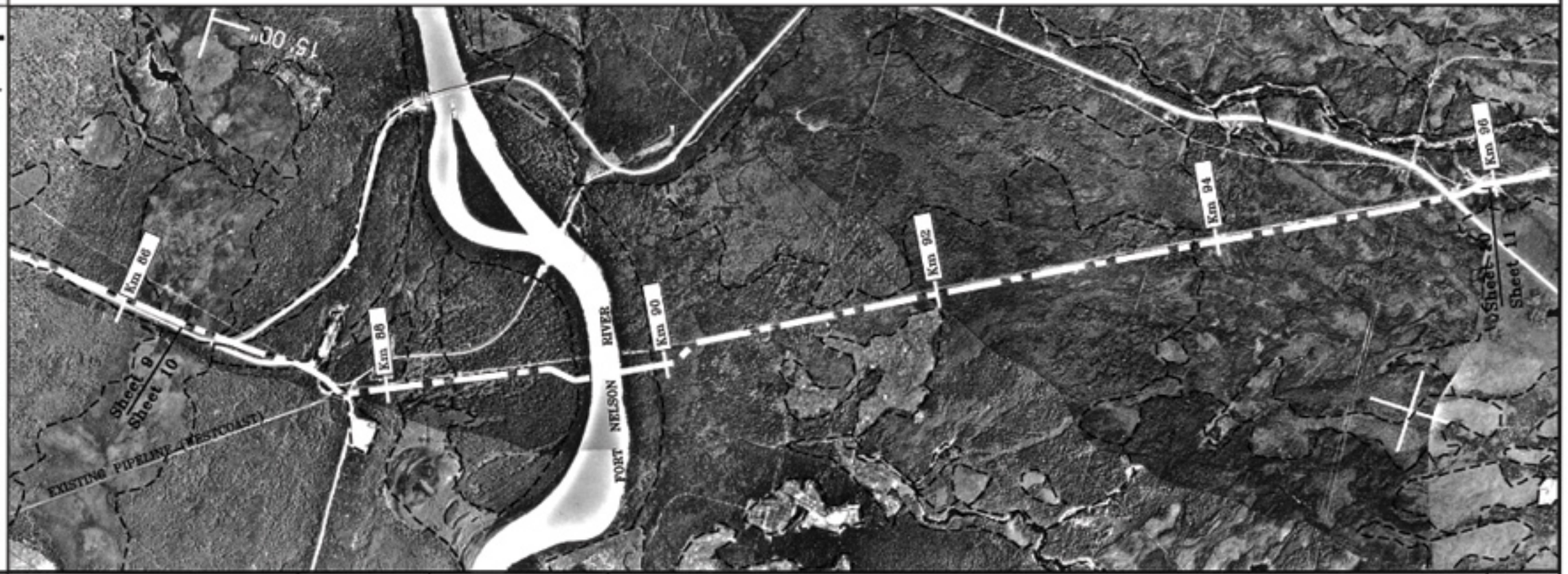
FHC – Flathead Chub
LCS – Largescale Sucker
WA – Walleye
IC – Inconnu
GE – Goldeye



Environmental Issues

Watercourse | Watercourse | High Fisheries Values | Watercourse

Erosion-Prone Slopes

Mitigation *

- Water/Equipment Crossings
- Erosion Control
- Other

Open Cut/Snow or Log Fill | Open Cut/Snow or Log Fill | Trenchless Existing or Ice Bridge See Crossing Detail Design | Open Cut/Snow or Log Fill

Erosion Control

* Refer to Environmental Protection Plan for General Mitigation Measures

PARAMOUNT RESOURCES LTD. | Golder Associates

BIOPHYSICAL ALIGNMENT SHEET
PARAMOUNT MAXHAMISH RESIDUE GAS PIPELINE

DRAWN: VS	DATE: 17 AUG. 1999	SCALE: 1:30,000	Sheet 10 of 17
DESIGN: TC	ACAD FILE:	DGN FILE:	
REVIEW: -			

PHOTO DATE: June 1998

Terrain/Soils	Alluvial Floodplain — Organic Bog: peak, Level; Organic Bog and Veneer: peak, local shallow till, Level; Organic Veneer: peat, some shallow till, Level; Ground Moraine: till, Undulating; Ground Moraine: till, Undulating; Alluvial Flood. Silt and Sand; Org. Veneer (peat), minor Ground Moraine (till): Level to Undulating; Organic Bog: peat, Level
Vegetation and Wildlife	Sb/Lt/Aw/Bw; Sb/So; Sc/W; Sb/Lt (T)/Aw; Sc; Sw/Sb; Sb/Lt; Sw/Sb; Sb/Lt; Aw/Sw; Sb/Lt/Aw; Aw/Sw; Sw/Aw; Wildl./Veg. Sample Site #16 Bb Warbler Philadelphia Vireo Sb/Lt/So; Sb/Sw
Aquatics/Hydrology	#36 Trib. to Fort Nelson River FDC; #37 Trib. to Fort Nelson River FDC; #38 Stanslind Creek GR, NP
Heritage Resources and Land Use	
Traditional Knowledge	

Legend:

Proposed Pipeline Route

Kilometre Posting (approximate) Km 46

Matchline Sheet 1 / Sheet 2

VEGETATION

Aw – Aspen
Bw – Birch
Sw – White Spruce
Sb – Black Spruce
Sc – Closed Shrub
So – Open Shrub
Lt – Tamarack
Pb – Balsam Poplar
Pl – Lodgepole Pine
Fb – Balsam Fir
Complex – Mixture of types in small area
T – Trace
W – Water
Wa – Wet Meadow
Md – Dry Meadow
Dev. – Developed

AQUATICS

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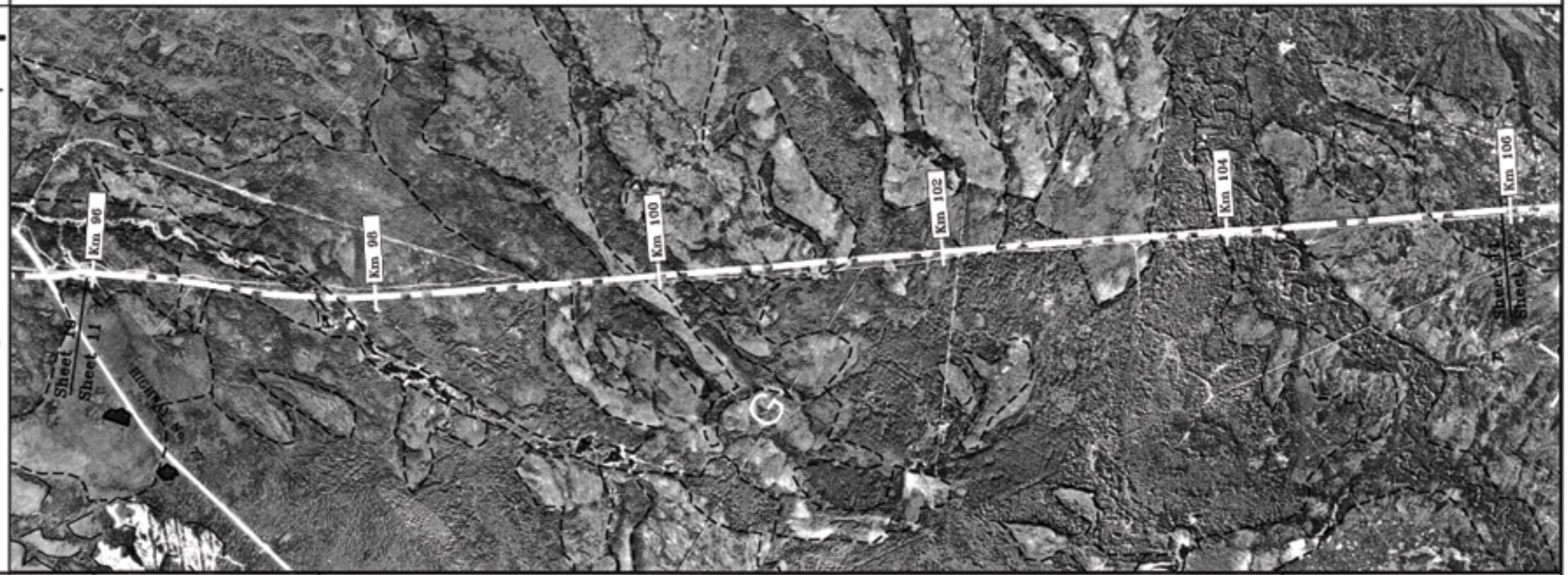
LKC – Lake Chub
TP – Trout-Perch
BT – Bull Trout
MW – Mountain Whitefish
LW – Lake Whitefish
FHC – Flathead Chub
LSS – Largescale Sucker
WA – Walleye
IC – Inconnu
GE – Goldeye



Environmental Issues	Watercourse; Watercourse; High Fisheries Values
Mitigation * – Water/Equipment Crossings – Erosion Control – Other	Open Cut/Snow or Log Fill; Open Cut/Snow or Log Fill; Trenchless or Approved Alternative/Temp. or Ice Bridge Trench Breakers

* Refer to Environmental Protection Plan for General Mitigation Measures

PARAMOUNT RESOURCES LTD. | Golder Associates

BIOPHYSICAL ALIGNMENT SHEET
PARAMOUNT MAXHAMISH RESIDUE GAS PIPELINE

REFERENCE: SURVEY DATA SUPPLIED BY UNIVERSAL SURVEYS INC. AIR PHOTO IMAGES SUPPLIED BY IMAGE RESOURCE SERVICES (PHOTO DATE) June 1999

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Terrain/Soils

Organic Bog (peat), minor Ground Moraine (till): Level to Undulating

Organic Bog (peat), Minor Ground Moraine (till): permafrost (in Bog), Level to Undulating

Organic Bog (peat), minor Ground Moraine (till): Level to Undulating

Alluvial Floodplain: Silt and Sand

Organic Bog (peat), Minor Ground Moraine (till): Level to Undulating

Ground Moraine: till, Undulating

Vegetation and Wildlife

Sb/Sa/Lt patches of open Sb

Sb/Lt

Sw/Aw

Sb/Lt/Pl (T) complex

Wildlife/Veg Sample Site #17

Sw/Aw/Sc

Sb/Lt/Pl complex

Sb/Lt(T)/Pl

Sb/Lt/Pl complex

Aw/Sw

Wildlife/Veg Sample Site #18

Aw/Bw

Aquatics/Hydrology

#39 Trib. to Stanolind Creek GR

Heritage Resources and Land Use

Traditional Knowledge

Legend:

Proposed Pipeline Route

Kilometre Posting (approximate) Km 46

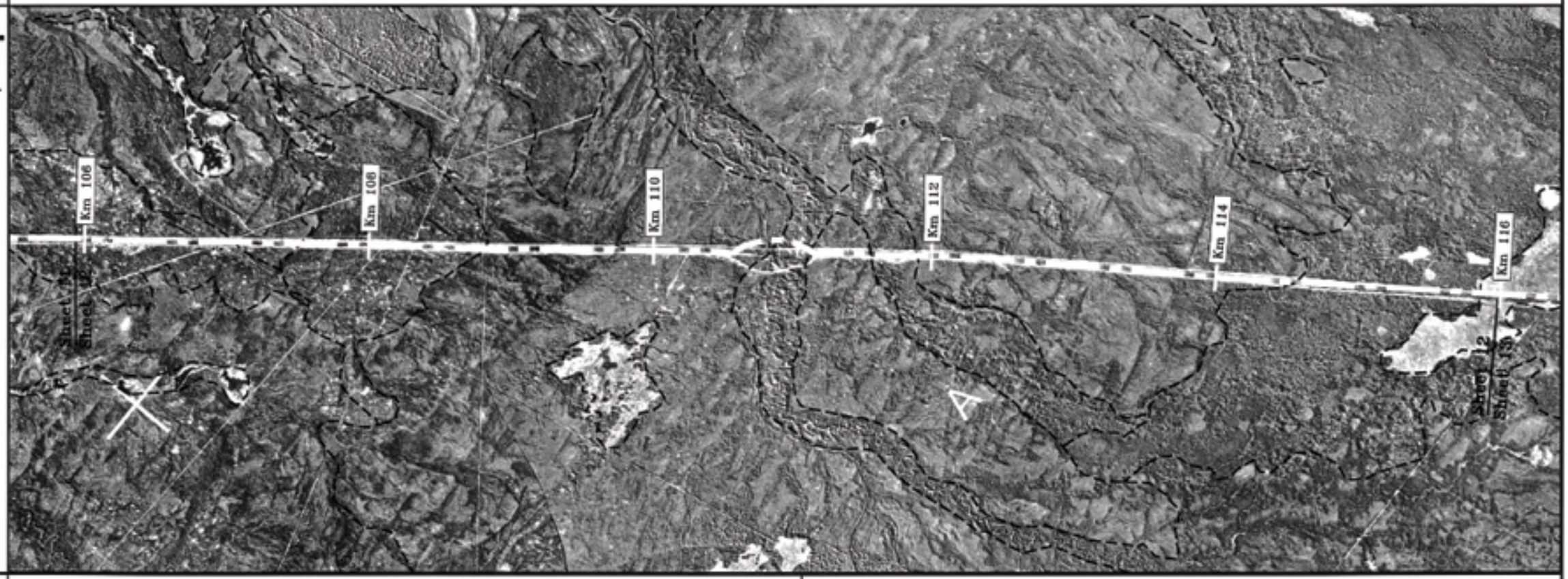
Matchline Sheet 1 / Sheet 2

VEGETATION

Aw – Aspen
Bw – Birch
Sw – White Spruce
Sb – Black Spruce
Sc – Closed Shrub
So – Open Shrub
Lt – Tamarack
Pb – Balsam Poplar
Pl – Lodgepole Pine
Fb – Balsam Fir
Complex – Mixture of types in small area
T – Trace
W – Water
Ww – Wet Meadow
Wd – Dry Meadow
Dev. – Developed

AQUATICS

NCD – Non-Classified Drainage
GR – Arctic Grayling
BB – Burbot
LSU – Longnose Sucker
WSU – White Sucker
CCC – Slimy Sculpin
NP – Northern Pike
FDC – Finescale Dace
LND – Longnose Dace
BSB – Brook Stickleback
LKC – Lake Chub
TP – Trout-Perch
BT – Bull Trout
MW – Mountain Whitefish
LW – Lake Whitefish
FHC – Flathead Chub
LCS – Longscale Sucker
WA – Walleye
IC – Inconnu
GE – Goldeye



Environmental Issues

High Fisheries Values

Mitigation *

- Water/Equipment Crossings
- Erosion Control
- Other

Trenchless or Approved Alternative/Temp. or Ice Bridge Trench Breakers

* Refer to Environmental Protection Plan for General Mitigation Measures

PARAMOUNT RESOURCES LTD.

Golder Associates

BIOPHYSICAL ALIGNMENT SHEET
PARAMOUNT MAXHAMISH RESIDUE GAS PIPELINE

PHOTO DATE: June 1999

VS | TC | 17 AUG. 1999 | 1:30,000

Sheet 12 of 17

Terrain/Soils

Ground Moraine: till, Udulating | Organic Bog, Minor Veneer: peat, local shallow till, Level | Ground Moraine: till, Undulating | Organic Bog: peat, Level | Ground Moraine: till, Undulating

Vegetation and Wildlife

Sw/Aw | Aw/Bw | Aw/Sw | Sb/Lt (T)/Sw | Aw/Sw/Bw (T) | Wildl./Veg Sample Site #20 | Wildl./Veg Sample Site #19 | Sb/Lt | Aw/Sw

Aquatics/Hydrology

Tribs. to Stanolind Creek NCD #40 #41

#42 Trib. to Cridland Creek NCD

Heritage Resources and Land Use

Traditional Knowledge

Beaver Dam

Legend:

Proposed Pipeline Route

Kilometre Posting (approximate) Km 46

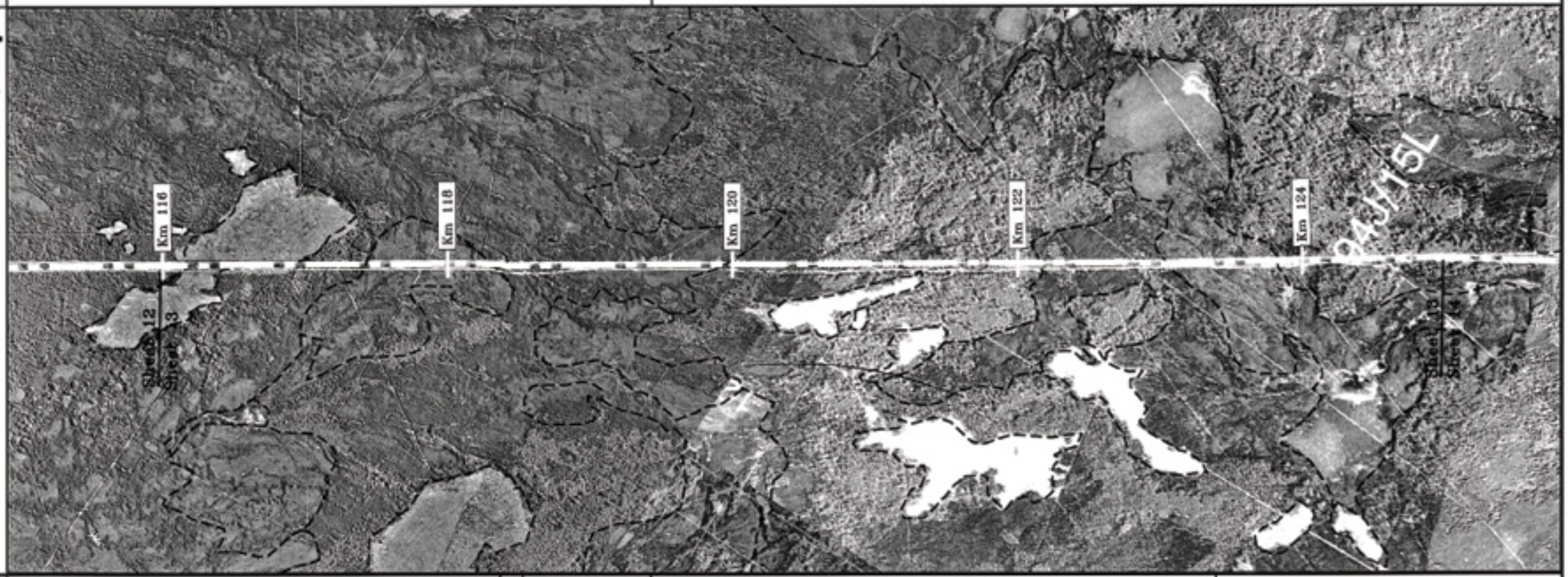
Matchline Sheet 1 / Sheet 2

VEGETATION

Aw – Aspen
Bw – Birch
Sw – White Spruce
Sb – Black Spruce
Sc – Closed Shrub
So – Open Shrub
Lt – Tamarack
Pb – Balsam Poplar
Pl – Lodgepole Pine
Fb – Balsam Fir
Complex – Mixture of types in small area
T – Trace
W – Water
Mw – Wet Meadow
Md – Dry Meadow
Dev. – Developed

AQUATICS

NCD – Non-Classified Drainage
GR – Arctic Grayling
BB – Burbot
LSU – Longnose Sucker
WSU – White Sucker
CCG – Slimy Sculpin
NP – Northern Pike
FDC – Finescale Dace
LND – Longnose Dace
BSB – Brook Stickleback
LKC – Lake Chub
TP – Trout-Perch
BT – Bull Trout
MW – Mountain Whitefish
LW – Lake Whitefish
FHC – Flathead Chub
LSS – Largescale Sucker
WA – Walleye
IC – Inconnu
GE – Goldeye



Environmental Issues

Watercourses | Beaver Dam | Watercourse

Mitigation *

- Water/Equipment Crossings
- Erosion Control
- Other

Open Cut/Snow or Log Fill

Trenchless or Approved Alternative if Flow/ Temp. or Ice Bridge

Open Cut

* Refer to Environmental Protection Plan for General Mitigation Measures

PARAMOUNT RESOURCES LTD. | Golder Associates

BIOPHYSICAL ALIGNMENT SHEET
PARAMOUNT MAXHAMISH RESIDUE GAS PIPELINE

PHOTO DATE: 1987 & 1994 | DRWN: VS | CHKD: TC | DATE: 17 AUG. 1999 | SCALE: 1:30,000

Terrain/Soils

Ground Moraine: till, Undulating | Organic Bog: peat, Level / Alluvial Floodplain | Organic Bog: peat, Level | Alluvial Floodplain | Organic Veneer: peat, some shallow till, Level | Organic Bog, minor Veneer: peat, local shallow till, Level | Org. Veneer (peat), minor Ground Moraine (till), Level to Undulating | Ground Moraine (till), minor Org Bog (peat): Lev. to Und. | Alluvial Floodplain | Organic Veneer: peat, some shallow till, Level | Ground Moraine: till, Undulating

Vegetation and Wildlife

Aw/Sw/Bw | Sb/Lt | Sw | Sb/Lt (Sc) | Aw/Sw | Sb/Lt | Aw/Sw | Sb/Sc | Aw/Bw | Aw/Sw | Sw/Sb | Md (Dev) | Aw/Sw

Aquatics/Hydrology

#43 Cridland Creek BSB (GR) | #44 Trib. to Cridland Creek GR, BSB | #45 Trib. to Cridland Creek NCD | #46 Trib. to Cridland Creek NCD | #47 McConachie Creek

Heritage Resources and Land Use

Agricultural Land Reserve | Agricultural Land Reserve

Traditional Knowledge

Legend:

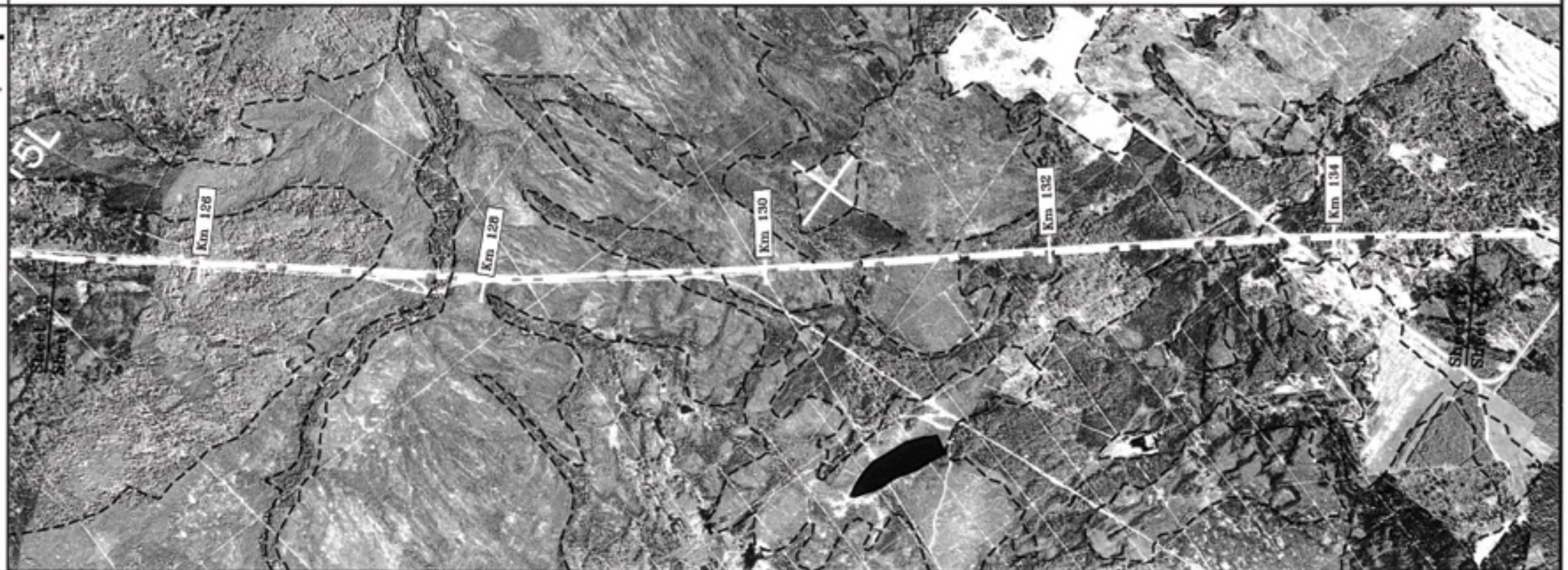
Proposed Pipeline Route

Kilometre Posting (approximate) Km 46

Matchline Sheet 1 / Sheet 2

VEGETATION
- Aw – Aspen
- Bw – Birch
- Sw – White Spruce
- Sb – Black Spruce
- Sc – Closed Shrub
- So – Open Shrub
- Lt – Tamarack
- Pb – Balsam Poplar
- Pl – Lodgepole Pine
- Fb – Balsam Fir
- Complex – Mixture of types in small area
- T – Trace
- W – Water
- We – Wet Meadow
- Md – Dry Meadow
- Dev. – Developed

AQUATICS
- NCD – Non-Classified Drainage
- GR – Arctic Grayling
- BB – Burbot
- LSU – Longnose Sucker
- WSU – White Sucker
- CCG – Slimy Sculpin
- NP – Northern Pike
- FDC – Finescale Dace
- LND – Longnose Dace
- BSB – Brook Stickleback
- LKC – Lake Chub
- TP – Trout-Perch
- BT – Bull Trout
- MW – Mountain Whitefish
- LW – Lake Whitefish
- FHC – Flathead Chub
- LCS – Largescale Sucker
- WA – Walleye
- IC – Inconnu
- GE – Goldeye



Environmental Issues

High Fisheries Values Ditchline | Moderate Fisheries Values Erosion | Watercourse | Watercourse | Watercourse

Mitigation *
- Water/Equipment Crossings
- Erosion Control
- Other

Trenchless or Approved Alternative/Temp. or Ice Bridge Trench Breakers | Open Cut/Snow or Log Fill | Open Cut/Snow or Log Fill | Trenchless or Approved Alternative if Flow/ Temp. or Ice Bridge

Strip Duff & Mineral Soil to 15cm or Colour Change if Deeper; Organic to 40cm ROW and Temporary Workspace

* Refer to Environmental Protection Plan for General Mitigation Measures

PARAMOUNT RESOURCES LTD. | Golder Associates

BIOPHYSICAL ALIGNMENT SHEET
PARAMOUNT MAXHAMISH RESIDUE GAS PIPELINE

PHOTO DATE: 1997 & 1994 | DRAWN: VS | CHECKED: TC | DATE: 17 AUG. 1999 | MAP: 1:30,000

Sheet 14 of 17

Terrain/Soils	Ground Moraine: till, Undulating; Organic Bog: peat, Level; Ground Moraine: till, Undulating; Organic Bog: peat, permafrost, Level; Ground Moraine, minor Veneer: till, some shallow bedrock, Undulating
Vegetation and Wildlife	Sw/Aw; Md (Dev); Aw/Sw; Md (Dev); Aw/Bw/Sw/Pl (T); Aw/Sw Pl (T); Farm Fields (Md) (Hay); Aw/Sw Pl (T); Md (Dev); Aw/Sw; Sb/Lt; Sw/Sb; Aw/Sw; Md (Dev)
Aquatics/Hydrology	#48 Donaldson Creek; #49 Trib. to Muskwa River
Heritage Resources and Land Use	Agricultural Land Reserve
Traditional Knowledge	

Legend:

Proposed Pipeline Route

Kilometre Posting (approximate) Km 48

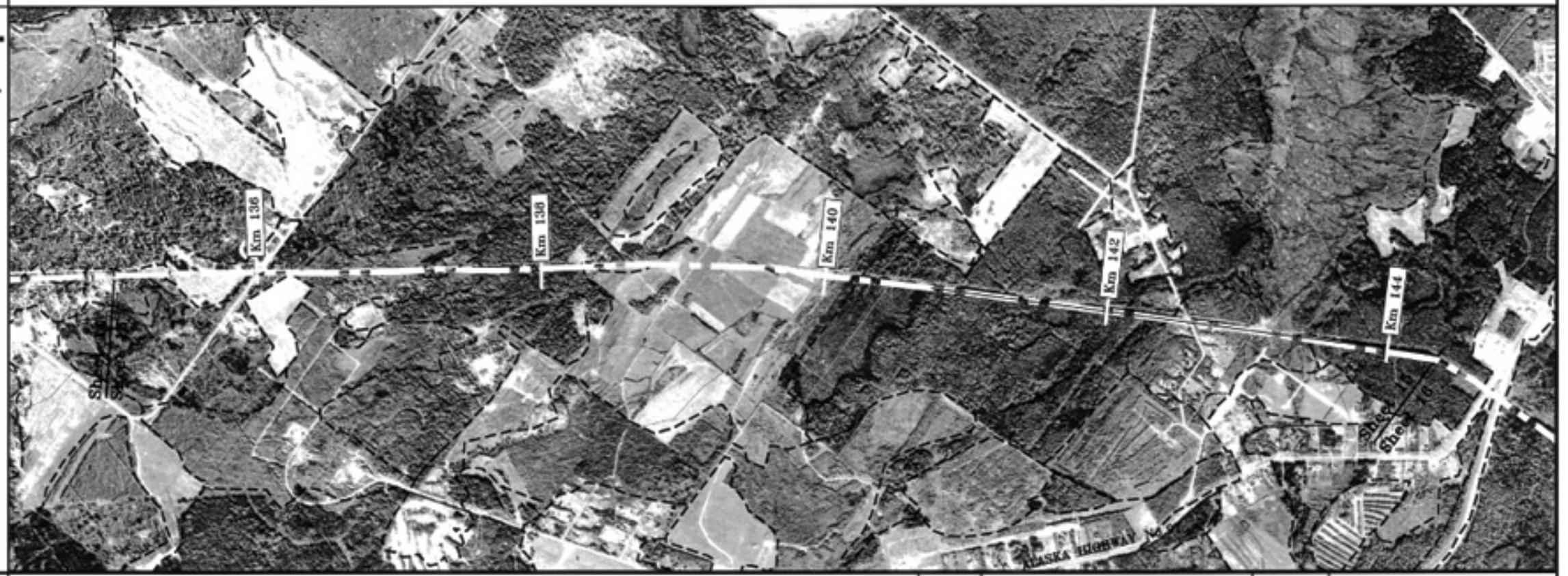
Matchline Sheet 1 / Sheet 2

VEGETATION

Aw – Aspen
Bw – Birch
Sw – White Spruce
Sb – Black Spruce
Sc – Closed Shrub
So – Open Shrub
Lt – Tamarack
Pb – Balsam Poplar
Pl – Lodgepole Pine
Fb – Balsam Fir
Complex – Mixture of types in small area
T – Trace
W – Water
Me – Wet Meadow
Md – Dry Meadow
Dev. – Developed

AQUATICS

NCD – Non-Classified Drainage
GR – Arctic Grayling
BB – Burbot
LSU – Longnose Sucker
WSU – White Sucker
CCG – Slimy Sculpin
NP – Northern Pike
FDC – Finescale Dace
LND – Longnose Dace
BSB – Brook Stickleback
LKC – Lake Chub
TP – Trout-Perch
BT – Bull Trout
MW – Mountain Whitefish
LW – Lake Whitefish
FHC – Flathead Chub
LCS – Largescale Sucker
WA – Walleye
IC – Inconnu
GE – Goldeye



Environmental Issues	Watercourse; Watercourse; Local Permafrost
Mitigation * – Water/Equipment Crossings – Erosion Control – Other	Open Cut/Snow or Log Fill; Trenchless or Approved Alternative if Flows/ Temp. or Ice Bridge

Strip Duff & Mineral Soil to 15cm or Colour Change if Deeper; Organic to 40cm on ROW and Temporary Workspace

* Refer to Environmental Protection Plan for General Mitigation Measures

PARAMOUNT RESOURCES LTD. | Golder Associates

BIOPHYSICAL ALIGNMENT SHEET
PARAMOUNT MAXHAMISH RESIDUE GAS PIPELINE

PHOTO DATE: 1994

DRAWN VS | CHECKED TC | REVIEWED -

DATE: 17 AUG. 1999 | SCALE: 1:30,000

Sheet 15 of 17

Terrain/Soils

Ground Moraine, minor Veneer: till, some shallow bedrock, Undulating | Org. Ven. | Colluvial Slopewash: over till and bedrock, moderately sloping | Colluvial Slopewash Ground Moraine: till, Undulating | Alluvial Floodplain: Sand and grav., Lev. | Landslide: colluvial slopewash, moderately to steeply sloping | Ground Moraine: till, Undulating | Organic Bog: ped., permafrost, Level | Organic Bog: ped., Level | Org. Bog (peat) and Gro. Moraine (till): Level to Undulating

Vegetation and Wildlife

Aw/Sw | Dev | Aw/Sw | Sw/Sb | Pb/Sw | Sw/Aw | Aw/Sw | Pb/Sw | Md (Dev) | W | So | Pb/Sw/Aw | Sb/Lt/Sc | W/Sc | Aw/Sw

Aquatics/Hydrology

#50 Pebble Creek LSU,WSU,FDC,LKC

#51 Muskwa R. BT,CR,MW,LSU,LCS, BB,LKC,FHC,LND,CCG

#52 Trib. to Prophet R.

#53 Trib. to Fort Nelson R.

Heritage Resources and Land Use

Alaska Highway Crossing | Agricultural Land Reserve (ALR) | Agricultural Land Reserve (ALR) | ALR | ALR

Traditional Knowledge

Legend:

Proposed Pipeline Route

Kilometre Posting (approximate) Km 46

Matchline Sheet 1 / Sheet 2

VEGETATION

Aw – Aspen
Bw – Birch
Sw – White Spruce
Sb – Black Spruce
Sc – Closed Shrub
So – Open Shrub
Lt – Tamarack
Pb – Balsam Poplar
Pl – Lodgepole Pine
Fb – Balsam Fir
Complex – Mixture of types in small area
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W – Water
Mw – Wet Meadow
Md – Dry Meadow
Dev. – Developed

AQUATICS

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CR – Arctic Grayling
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BT – Bull Trout
MW – Mountain Whitefish
LW – Lake Whitefish
FHC – Flathead Chub
LCS – Largescale Sucker
WA – Walleye
IC – Inconnu
GE – Goldeye

Environmental Issues

Moderate Fisheries Values Erosion-Prone Slopes | High Fisheries Values | Watercourse | Unstable Slope | Watercourse

Mitigation •
- Water/Equipment Crossings
- Erosion Control
- Other

• Refer to Environmental Protection Plan for General Mitigation Measures

Strip Duff & Mineral Soil to 15cm or Colour Change if Deeper; Organic to 40cm on ROW and Temporary Workspace

Trenchless of Isolate Temp. of Ice Bridge | Erosion Control

Trenchless or Approved Alternative/Existing or Ice Bridge See Crossing Detail Design

Open Cut/Snow or Log Fill

Trenchless or Approved Alternative if Flow/Temp. or Ice Bridge

Strip Duff & Mineral Soil to 15cm or Colour Change if Deeper; Organic to 40cm on ROW & Temp. Workspace

PARAMOUNT RESOURCES LTD. | Golder Associates

BIOPHYSICAL ALIGNMENT SHEET
PARAMOUNT MAXHAMISH RESIDUE GAS PIPELINE

PHOTO DATE: 1994

DRWN: VS | DATE: 17 AUG. 1999 | SCALE: 1:30,000

CHECKED: TC

Sheet 16 of 17

Terrain/Soils	Colluvial Slopewash; Organic Bog and Veneer: peat, some shallow till, Level; Organic Bog: peat, permafrost, Level; Ground Moraine: till, Undulating; Alluvial Floodplain; Organic Bog (peat), minor Ground Moraine (till): Level to Undulating; Colluvial Slopewash; Ground Moraine: till Undulating
Vegetation and Wildlife	Aw/Sw/Pl (T); Aw/Sw; Sb/Lt; Sb/Lt; Sb/Lt; Aw/Sw; Dev/So; Aw/So; Sb/Lt; Sb/Lt; Sw/Sb; Dev/Dn
Aquatics/Hydrology	#54 Trib. to Prophet R.; #55 Trib. to Fort Nelson R.; #56 Trib. to Fort Nelson R. NCD; #57 Trib. to Fort Nelson R.
Heritage Resources and Land Use	Alaska Highway Crossing
Traditional Knowledge	

Legend:

Proposed Pipeline Route

Kilometre Posting (approximate) Km 46

Matchline Sheet 1 / Sheet 2

VEGETATION

Aw – Aspen
Bw – Birch
Sw – White Spruce
Sb – Black Spruce
Sc – Closed Shrub
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Pl – Lodgepole Pine
Fb – Balsam Fir
Complex – Mixture of types in small area
T – Trace
W – Water
Mw – Wet Meadow
Md – Dry Meadow
Dev. – Developed

AQUATICS

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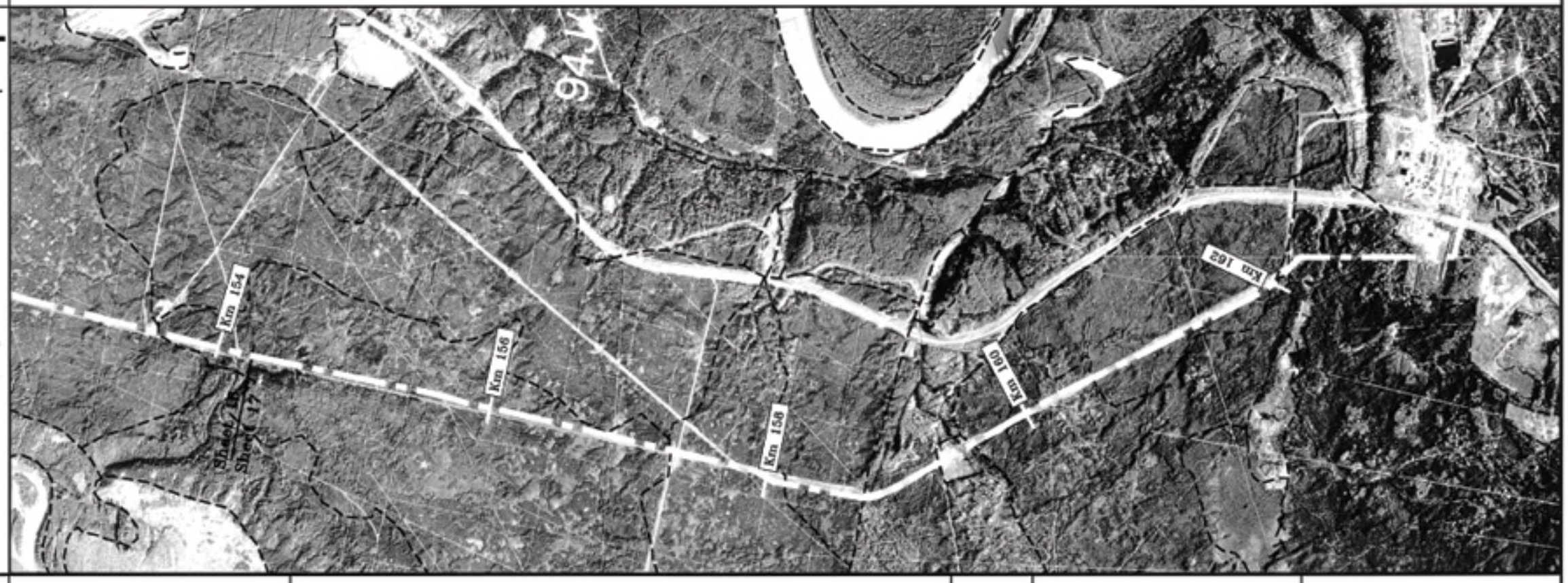
GR – Arctic Grayling
BB – Burbot
LSU – Longnose Sucker
WSU – White Sucker
SSC – Slimy Sculpin
NP – Northern Pike
FDC – Finescale Dace
LND – Longnose Dace
BSB – Brook Stickleback
LKC – Lake Chub
TP – Trout-Perch
BT – Bull Trout
MW – Mountain Whitefish
LW – Lake Whitefish
FHC – Flathead Chub
LCS – Largescale Sucker
WA – Walleye
IC – Inconnu
GE – Goldeye



Environmental Issues	Watercourse Beaver Dam; Watercourse Erosion-Prone Slopes; Watercourse Erosion-Prone Slopes
Mitigation * – Water/Equipment Crossings – Erosion Control – Other	Trenchless or Approved Alternative if Flow/Temp. of Ice Bridge; Trenchless or Approved Alternative if Flow/Temp. of Ice Bridge Erosion Control; Open Cut/Snow or Log Fill; Trenchless or Approved Alternative if Flow/Temp. of Ice Bridge Erosion Control

* Refer to Environmental Protection Plan for General Mitigation Measures

PARAMOUNT RESOURCES LTD.

Golder Associates

BIOPHYSICAL ALIGNMENT SHEET
PARAMOUNT MAXHAMISH RESIDUE GAS PIPELINE

PHOTO DATE: 1994

DRAWN: VS | DATE: 17 AUG. 1999 | SCALE: 1:30,000

CHECKED: TC

REVIEWED: -

Sheet 17 of 17

PARAMOUNT RESOURCES LTD.

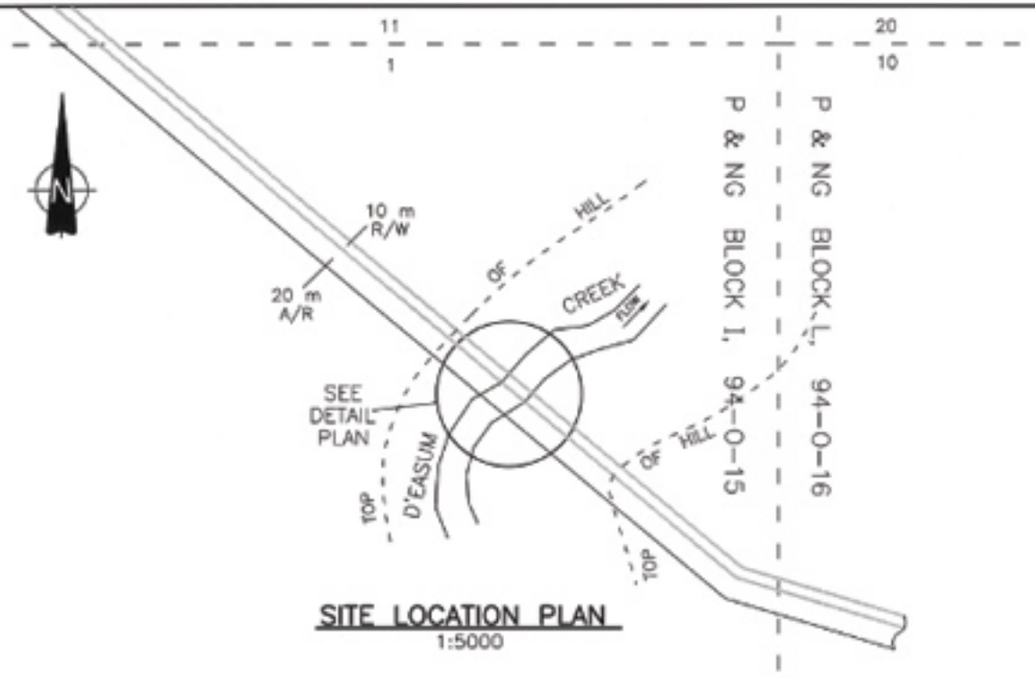
NORTHERN BRIDGE & PILE LTD.

D'EASUM (MAXHAMISH) CREEK CROSSING

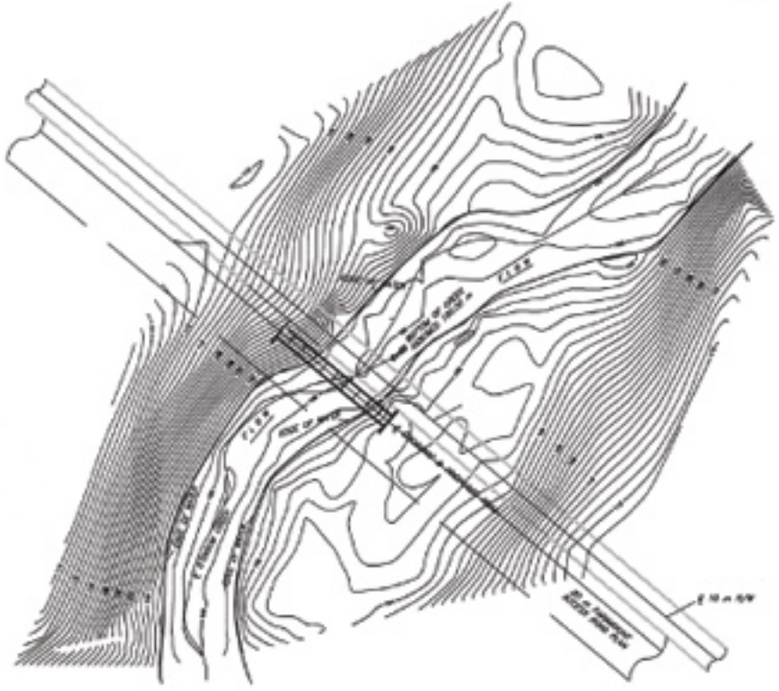
SECT. 1, P & NG BLOCK I, 94-0-15

ASSOCIATED ENGINEERING

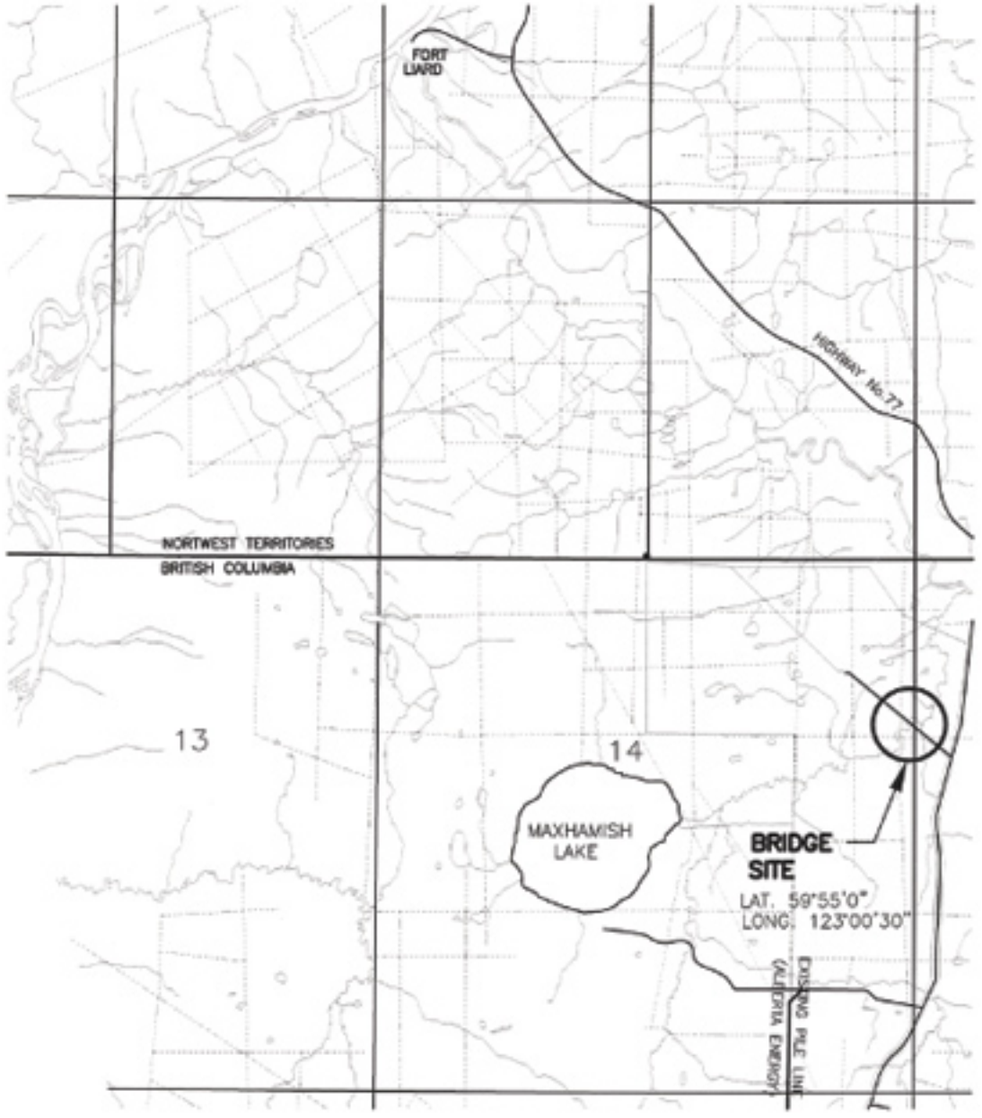
DRAWING SCHEDULE			
DRAWING No.	DESCRIPTION	REV.	DATE
3695-SK-101	LOCATION PLAN	B	99/08/17
3695-SK-102	GENERAL ARRANGEMENT	B	99/08/17
3695-SK-103	SITE PLAN	B	99/08/17
3695-SK-104	PROFILES - SHT 1	B	99/08/17
3695-SK-105	PROFILES - SHT 2	B	99/08/17
3695-SK-106	PROFILES - SHT 3	B	99/08/17



SITE LOCATION PLAN
1:5000



DETAIL PLAN
1:2000



MAP PLAN
1:300000

REV	DATE Y	M	D	REVISION DESCRIPTION	ENG	DWN
A	99	07	30	ISSUED FOR APPROVAL	RSR	FZ
B	99	08	17	ISSUED FOR REVIEW	RSR	FZ

PARAMOUNT RESOURCES LTD.

NORTHERN BRIDGE AND PILE LTD.

D'EASUM (MAXHAMISH) CREEK CROSSING
LOCATION PLAN

ASSOCIATED ENGINEERING

DESIGN:	TA
CHECK:	SR
DRAWN:	AR
DATE:	JULY 1999
SCALE:	AS SHOWN
JOB No.	993695
DWG. No.	3695-SK-101
	B

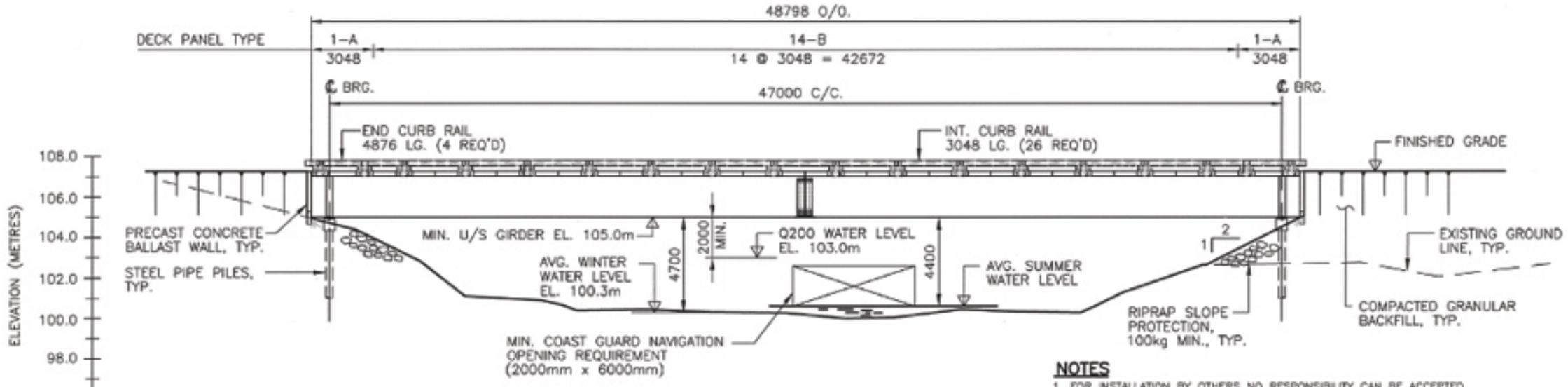
ALL DRAWINGS SUPERCEEDED PRIOR TO REVISION →

X-REF. ATTACHMENTS:

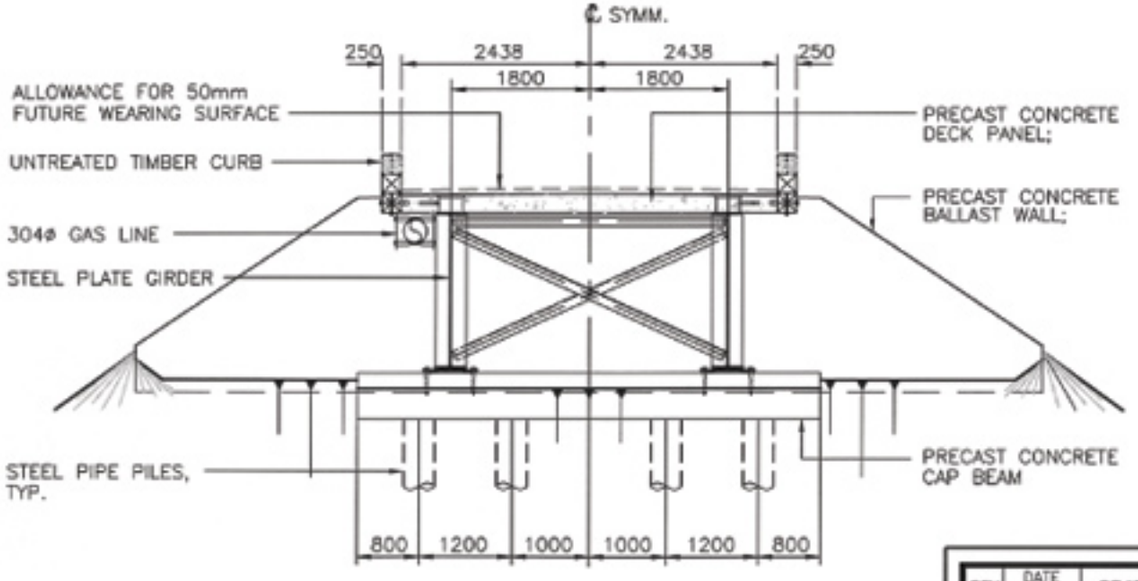
AUTOCAD DRAWING No. 3695SK102.DWG

NORTH END

SOUTH END



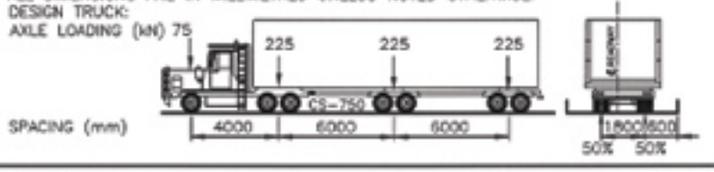
ELEVATION
1:200



SOUTH ABUTMENT ELEVATION
1:75

NOTES

1. FOR INSTALLATION BY OTHERS NO RESPONSIBILITY CAN BE ACCEPTED FOR WORK BY OTHERS.
2. DESIGN: CAN/CSA-S6-88 (MODIFIED).
3. LOADING: CS750 (76,453kg. G.V.W.)
   OCCASIONAL OVERLOAD: L150 (136,025kg. G.V.W.) a=150, DIST.=50/50, D.L.A.=0.1
4. FATIGUE: 500,000 CYCLES (CS750 LOADING)
5. STEEL: CSA G40.21M GRADE 350AT CAT. 3 (PLATE)
   GRADE 350A (SECTIONS)
   FABRICATE GIRDERS AS FRACTURE CRITICAL MEMBERS.
6. WELDING: CSA W59 6 F.W. U/N. X-RAY TENSION FLANGE BUTT WELDS, FIELD WELDERS CERTIFIED TO CSA W47.
7. PIPE: ASTM A252 GRADE 2.
8. STUDS: ASTM A108 GRADE 1020.
9. BOLTS: ASTM A325 TYPE 3 M22 U/N. JOB INSPECTION TORQUE 810Nm.
10. HARDWARE: GALVANIZED CSA G164, BOLTS ASTM A307 GALV.
11. COAT STEEL SUBSTRUCTURE WITH ONE COAT BITUMINOUS PAINT PRIOR TO BACKFILLING.
12. CONCRETE: CAN3 A23.1 EXPOSURE CLASS C1, f'c = 35MPa @ 28 DAYS.
13. PRECAST CONCRETE: CSA A23.4-94 BY CSA CERTIFIED PLANT.
14. REINFORCING: CSA G30.18M GRADE 400.
15. GROUT: INSTALL IN ACCORDANCE WITH MANUFACTURERS INSTRUCTIONS.
16. BEARING: OZONE RESISTING NATURAL RUBBER, GRADE 5 TO CAN/CSA-S6-88 60 DUROMETER.
17. TIMBER: SPF ROUGH SAWN No.2 OR BETTER, UNTREATED.
18. ALL DIMENSIONS ARE IN MILLIMETRES UNLESS NOTED OTHERWISE.
19. DESIGN TRUCK:



REV	DATE Y	M	D	REVISION DESCRIPTION	ENG	DWN
A	99	07	30	ISSUED FOR APPROVAL	RSR	FZ
B	99	08	17	ISSUED FOR REVIEW	RSR	FZ

PARAMOUNT RESOURCES LTD.

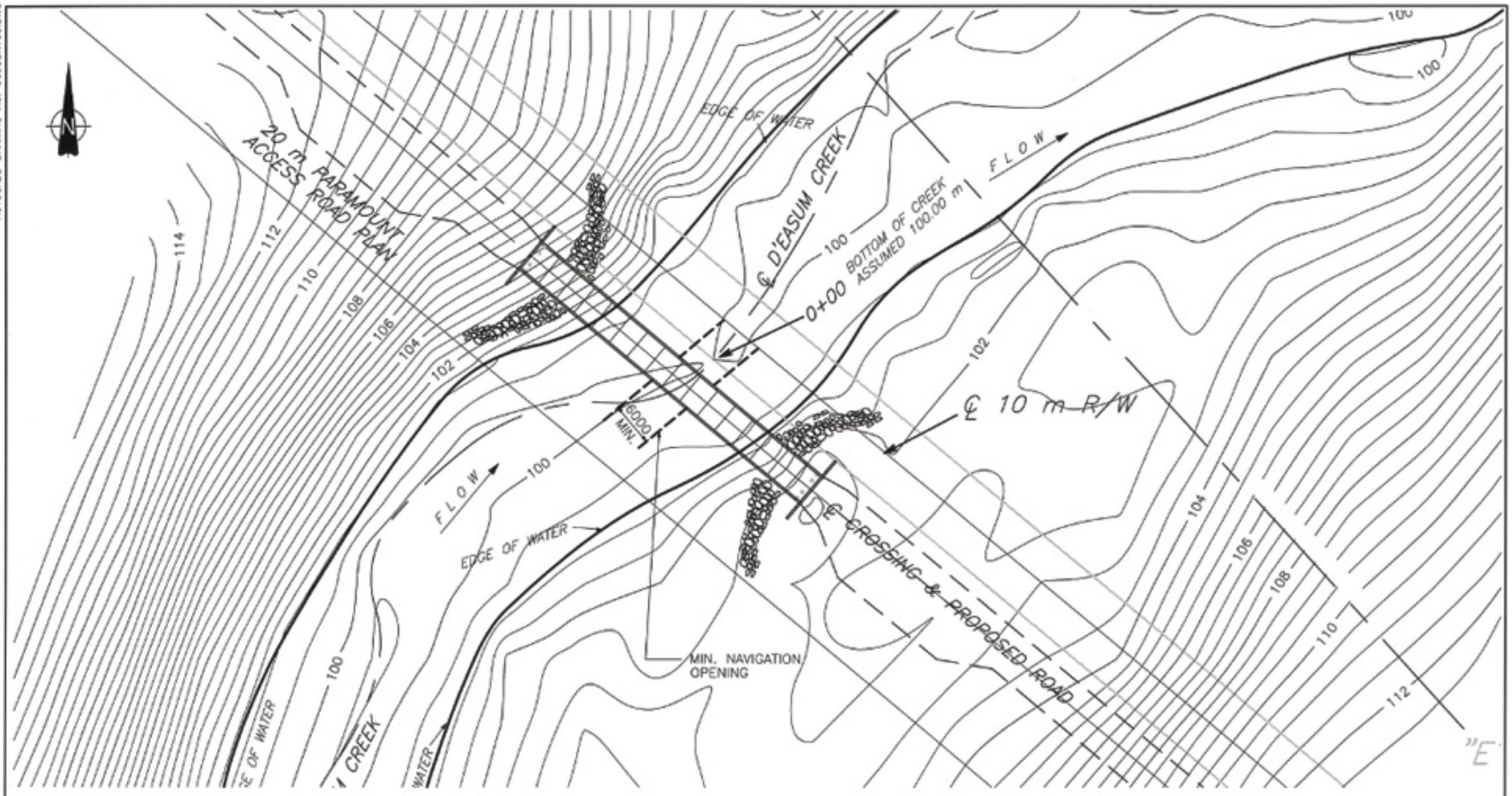
NORTHERN BRIDGE AND PILE LTD

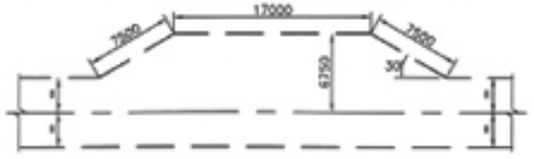
D'EASUM (MAXHAMISH) CREEK CROSSING
PROPOSED GENERAL ARRANGEMENT

ASSOCIATED ENGINEERING

DESIGN:	TA
CHECK:	SR
DRAWN:	AR
DATE:	JULY, 1999
SCALE:	AS SHOWN
JOB No.	993695
DWG. No.	3695-SK-102
	B

ALL DRAWINGS SUPERCEEDED PRIOR TO REVISION





TYPICAL PULLOUT DETAIL
1:500

NOTE:
PULLOUT SHALL BE PROVIDED AT ENDS OF BRIDGE TO SUIT ROAD DESIGN. (BY OTHERS)

REV	DATE Y	M	D	REVISION DESCRIPTION	ENG	DWN
A	99	07	30	ISSUED FOR APPROVAL	TA	FZ
B	99	08	17	ISSUED FOR REVIEW	RSR	FZ

PARAMOUNT RESOURCES LTD.

NORTHERN BRIDGE AND PILE LTD.

D'EASUM (MAXHAMISH) CREEK CROSSING
SITE PLAN

ASSOCIATED ENGINEERING

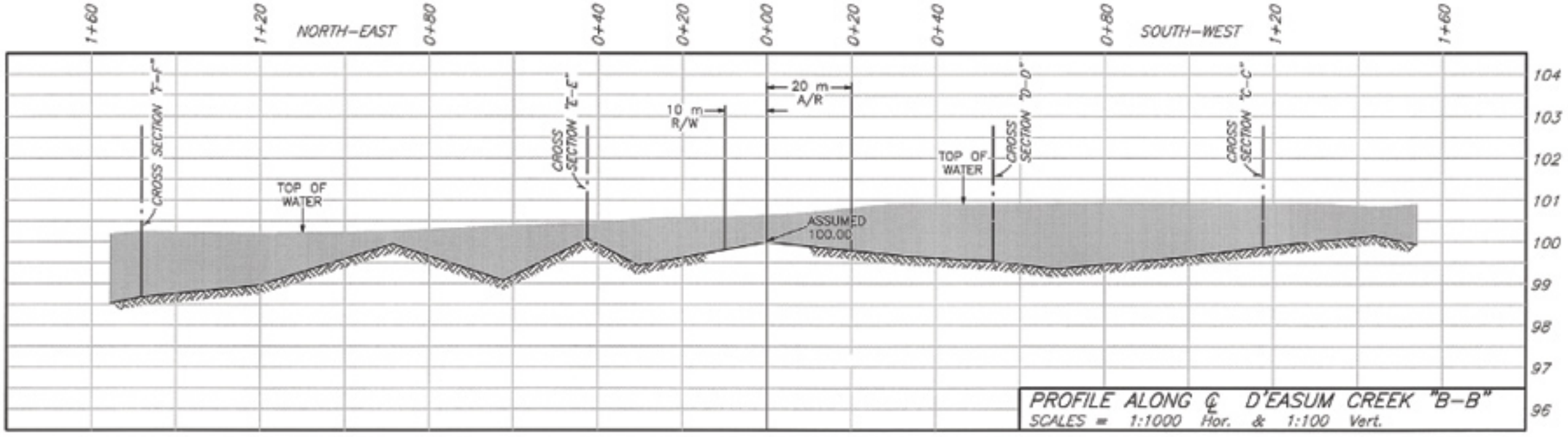
ALL DRAWINGS SUPERCEEDED PRIOR TO REVISION

DESIGN: TA	
CHECK: SR	
DRAWN: AR	
DATE: JULY 1999	
SCALE: 1:500	
JOB No. 993695	
DWG. No. 3695-SK-103	B

AUTOCAD DRAWING No. 3695SK103.DWG

X-REF. ATTACHMENTS:

AUTOCADD DRAWING No. 3695SK104.DWG



REV	DATE Y	M	D	REVISION DESCRIPTION	ENG	DWN
A	99	07	30	ISSUED FOR APPROVAL	TA	FZ
B	99	08	17	ISSUED FOR REVIEW	RSR	FZ

PARAMOUNT RESOURCES LTD.

NORTHERN BRIDGE AND PILE LTD.

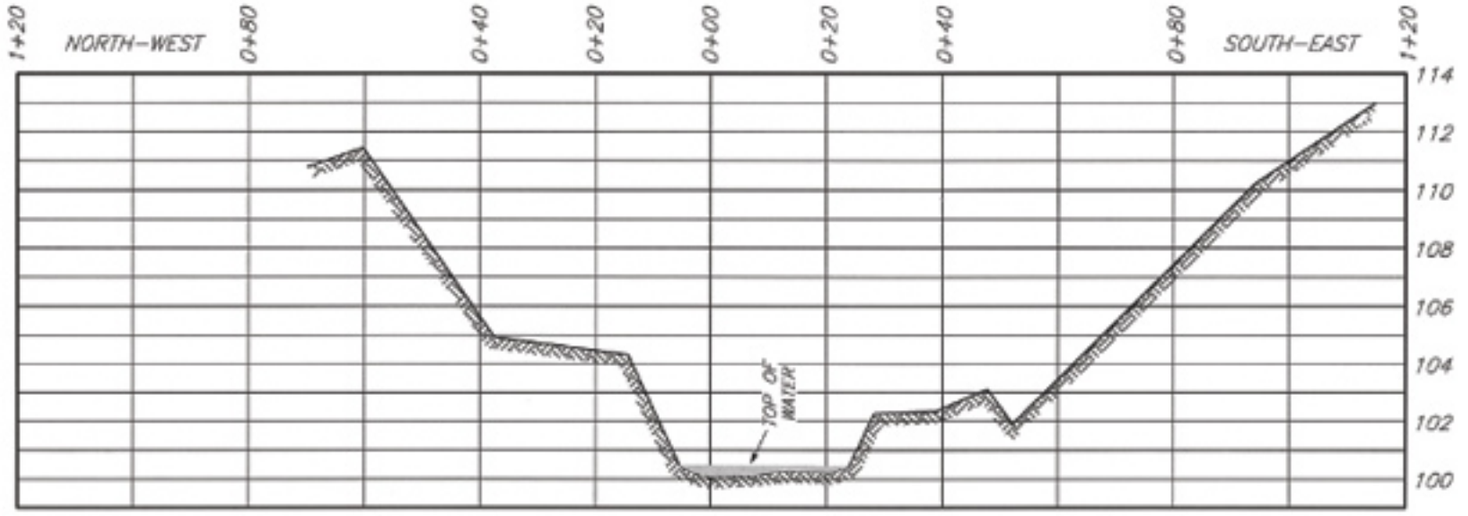
D'EASUM (MAXHAMISH) CREEK CROSSING
PROFILES – SHT 1

ASSOCIATED ENGINEERING

DESIGN: TA	
CHECK: SR	
DRAWN: AR	
DATE: JULY 1999	
SCALE: AS SHOWN	
JOB No. 993695	
DWG. No. 3695-SK-104	B

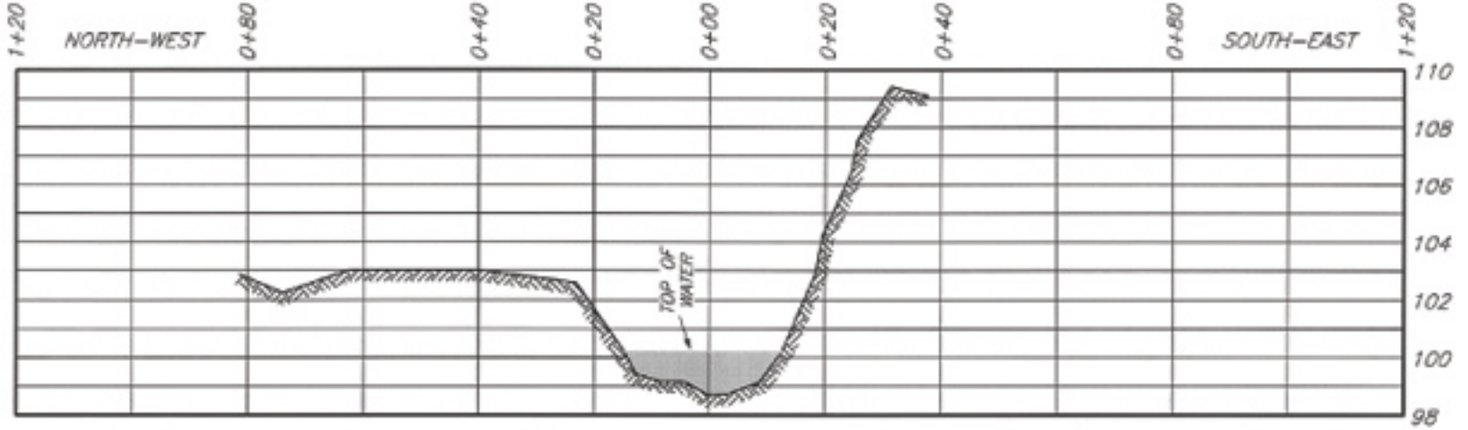
ALL DRAWINGS SUPERCEEDED PRIOR TO REVISION

X-REF. ATTACHMENTS:



CROSS SECTION at 42.6 m NORTH-EAST "E-E"

SCALES = 1:1000 Horizontal and 1:200 Vertical



CROSS SECTION at 148.1 m NORTH-EAST "F-F"

SCALES = 1:1000 Horizontal and 1:200 Vertical

REV	DATE Y	M	D	REVISION DESCRIPTION	ENG	DWN
A	99	07	30	ISSUED FOR APPROVAL	TA	FZ
B	99	08	17	ISSUED FOR REVIEW	RSR	FZ

PARAMOUNT RESOURCES LTD.

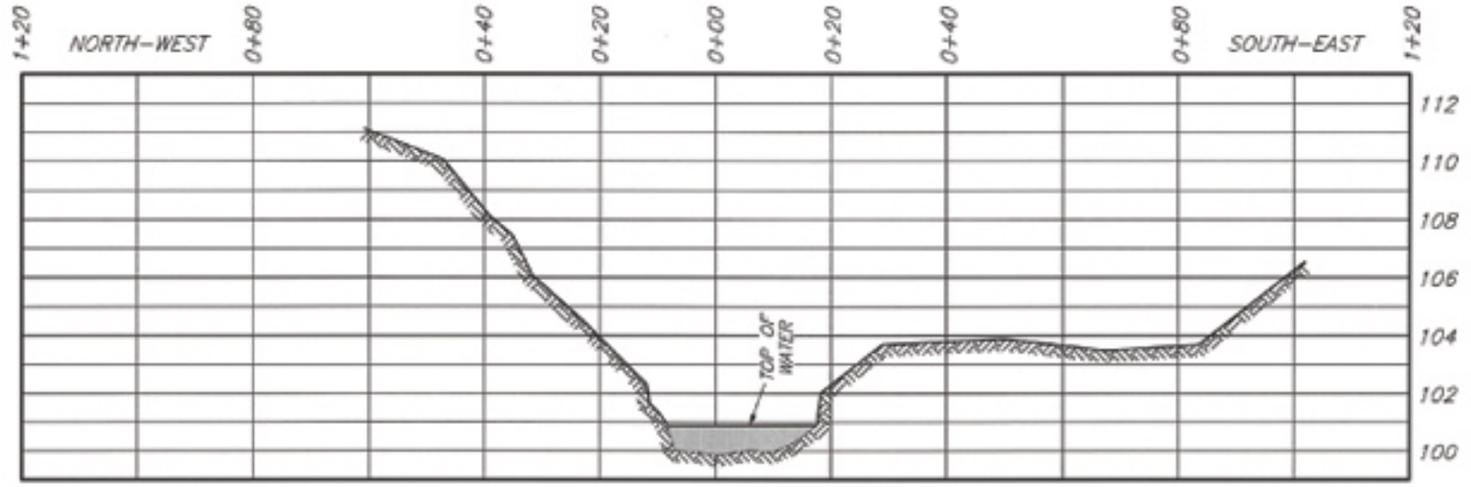
NORTHERN BRIDGE AND PILE LTD.

D'EASUM (MAXHAMISH) CREEK CROSSING
PROFILES - SHT 2

ASSOCIATED ENGINEERING

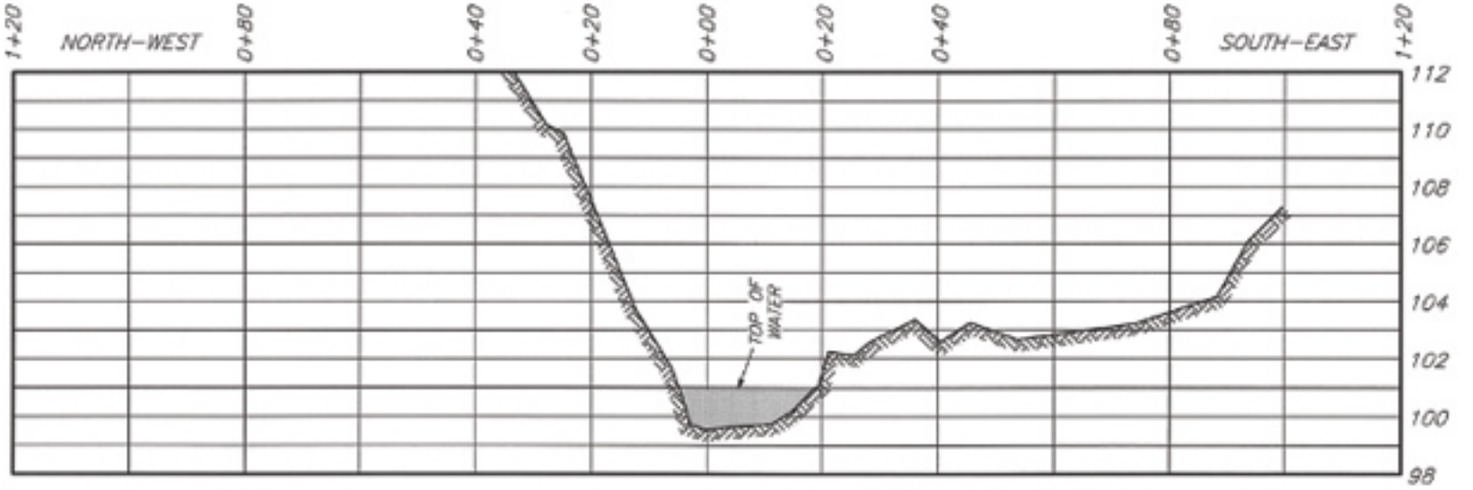
ALL DRAWINGS SUPERCEEDED PRIOR TO REVISION

DESIGN:	TA
CHECK:	SR
DRAWN:	AR
DATE:	JULY 1999
SCALE:	AS SHOWN
JOB No.	993695
DWG. No.	3695-SK-105
	B



CROSS SECTION at 117.5 m SOUTH-WEST "C-C"

SCALES = 1:1000 Horizontal and 1:200 Vertical



CROSS SECTION at 53.6 m SOUTH-WEST "D-D"

SCALES = 1:1000 Horizontal and 1:200 Vertical

REV	DATE Y	M	D	REVISION DESCRIPTION	ENG	DWN
A	99	7	30	ISSUED FOR APPROVAL	TA	FZ
B	99	08	17	ISSUED FOR REVIEW	RSR	FZ

PARAMOUNT RESOURCES LTD.

NORTHERN BRIDGE AND PILE LTD.

D'EASUM (MAXHAMISH) CREEK CROSSING
PROFILES - SHT 3

ASSOCIATED ENGINEERING

ALL DRAWINGS SUPERCEEDED PRIOR TO REVISION →

DESIGN: TA	
CHECK: SR	
DRAWN: AR	
DATE: JULY 1999	
SCALE: AS SHOWN	
JOB No. 993695	
DWG. No. 3695-SK-106	B

PARAMOUNT RESOURCES LTD.

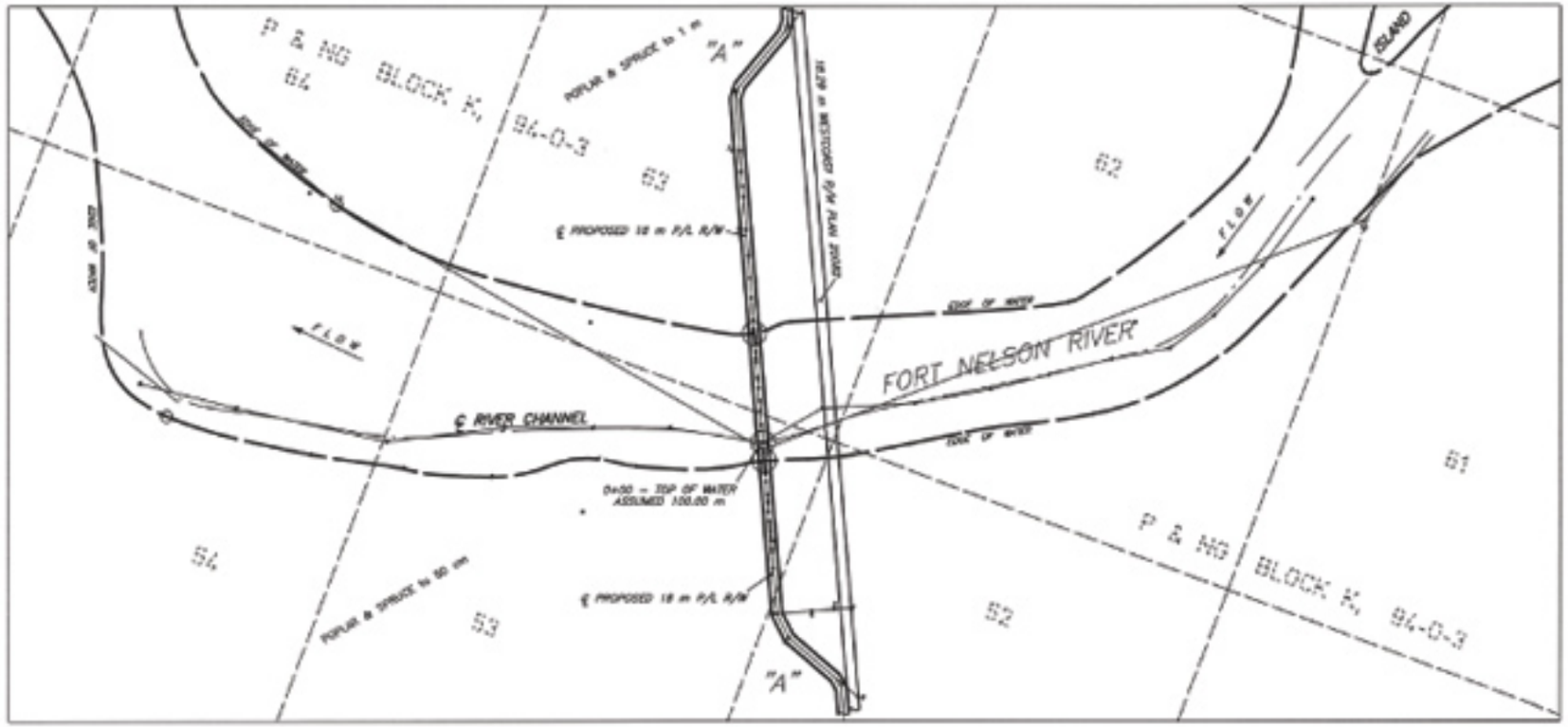
NORTHERN BRIDGE & PILE LTD.

FT. NELSON RIVER
PIPELINE CROSSING
SECT. 53 & 63, P & NG BLOCK K, 94-0-3

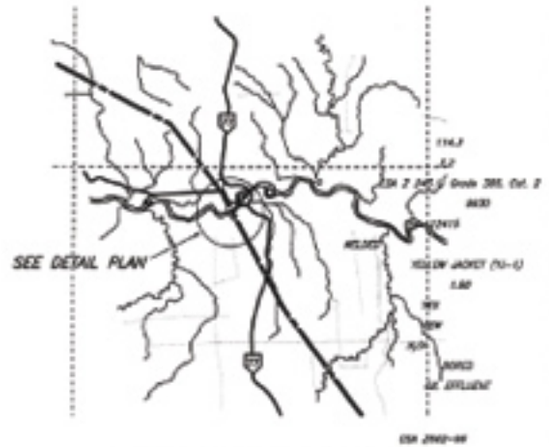
ASSOCIATED ENGINEERING

DRAWING SCHEDULE			
DRAWING No.	DESCRIPTION	REV.	DATE
3695-SK-201	DETAIL AND LOCATION PLANS	B	99/08/17
3695-SK-202	PROFILE	B	99/08/17
3695-SK-203	SECTIONS	B	99/08/17

AUTOCADD DRAWING No. 3695SK201.DWG



DETAIL PLAN – 1:5000



LOCATION PLAN – 1:250,000

X-REF. ATTACHMENTS:

REV	DATE Y	M	D	REVISION DESCRIPTION	ENG	DWN
A	99	7	23	ISSUED FOR REVIEW	TA	AR
B	99	8	17	ISSUED FOR REVIEW	TA	FZ

PARAMOUNT RESOURCES LTD

NORTHERN BRIDGE AND PILE LTD

FT. NELSON RIVER PIPELINE CROSSING
DETAIL AND LOCATION PLANS

ASSOCIATED ENGINEERING

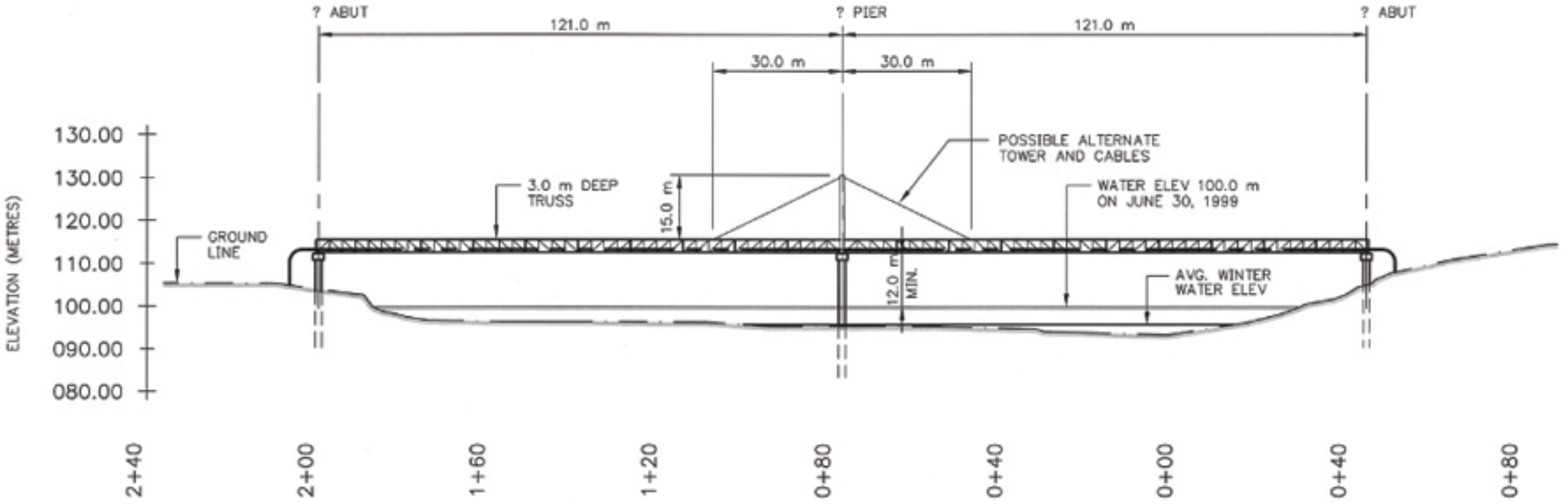
DESIGN:	TA
CHECK:	SR
DRAWN:	LP
DATE:	JULY, 1999
SCALE:	AS SHOWN
JOB No.	993695
DWG. No.	3695-SK-201

B

ALL DRAWINGS SUPERCEEDED PRIOR TO REVISION

AUTOCADD DRAWING No. 3695SK202.DWG

X-REF, ATTACHMENTS:



PROFILE ALONG PROPOSED CROSSING

1:1000

NOTES

1. DESIGN: CAN/CSA-S6-88 (MODIFIED).
2. LOADING: 300 mm DIA. GAS PIPELINE, WIND AND SNOW LOADING.
3. FATIGUE: 500,000 CYCLES.
4. STEEL: CSA G40.21M GRADE 350AT CAT. 3 (PLATE)
   GRADE 350W (SECTIONS)
   FABRICATE GIRDERS AS FRACTURE CRITICAL MEMBERS.
   PAINT: SHOP BLAST TO SSPC-SP6, PRIMER MC-MIOMASTIC 3 MIL DFT
   TOPCOAT MC-FERROX 3 MIL DFT BY WASSER
5. WELDING: CSA W59 6 F.W. U/N. X-RAY TENSION FLANGE BUTT WELDS.
   FIELD WELDERS CERTIFIED TO CSA W47.
6. PIPE: ASTM A252 GRADE 2.
7. STUDS: ASTM A108 GRADE 1020.
8. BOLTS: ASTM A325 TYPE 3 M22 U/N. JOB INSPECTION TORQUE 810Nm.
9. HARDWARE: GALVANIZED CSA G164, BOLTS ASTM A307 GALV.
10. COAT STEEL SUBSTRUCTURE WITH ONE COAT BITUMINOUS PAINT PRIOR TO BACKFILLING.
11. CONCRETE: CAN3 A23.1 EXPOSURE CLASS C1, f'c = 35MPa @ 28 DAYS.
12. PRECAST CONCRETE: CSA A23.4-94 BY CSA CERTIFIED PLANT.
13. REINFORCING: CSA G30.18M GRADE 400.
14. GROUT: INSTALL IN ACCORDANCE WITH MANUFACTURERS INSTRUCTIONS.
15. BEARING: OZONE RESISTING NATURAL RUBBER, GRADE 5 TO CAN/CSA-S6-88
    60 DUROMETER.
16. ALL DIMENSIONS ARE IN MILLIMETRES UNLESS NOTED OTHERWISE.

REV	DATE Y	M	D	REVISION DESCRIPTION	ENG	DWN
A	99	7	23	ISSUED FOR REVIEW	TA	AR
B	99	8	17	ISSUED FOR REVIEW	TA	FZ

PARAMOUNT RESOURCES LTD

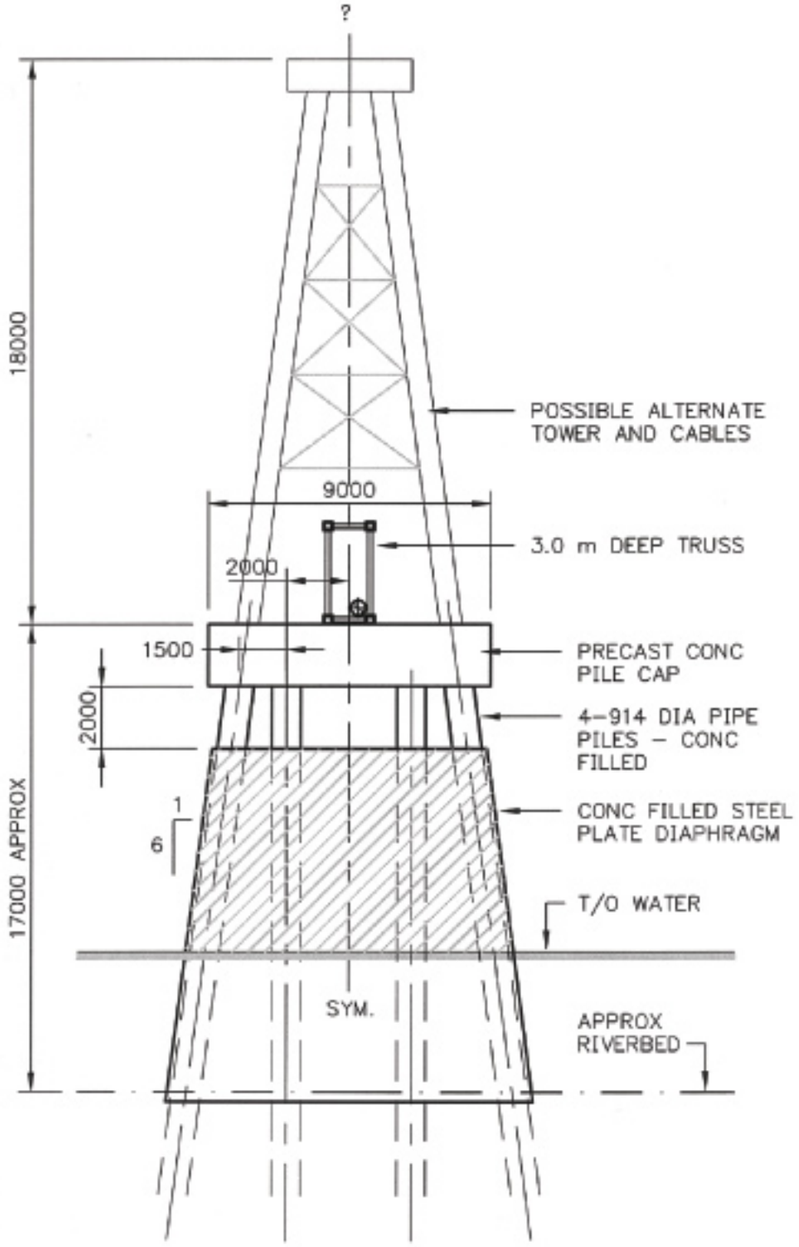
NORTHERN BRIDGE AND PILE LTD

FT. NELSON RIVER PIPELINE CROSSING
PROPOSED GENERAL ARRANGEMENT

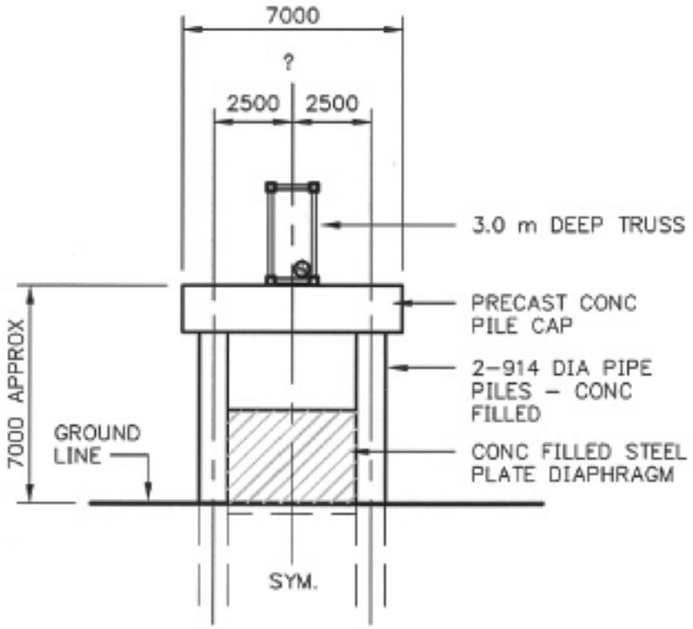
ASSOCIATED ENGINEERING

DESIGN:	TA
CHECK:	SR
DRAWN:	LP
DATE:	JULY, 1999
SCALE:	1:1000
JOB No.	993695
DWG. No.	3695-SK-202
	B

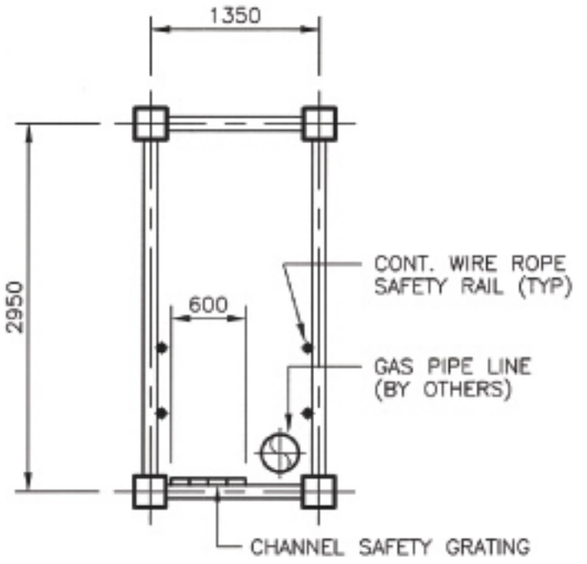
ALL DRAWINGS SUPERCEEDED PRIOR TO REVISION →



PIER ELEVATION
1:200



ABUTMENT ELEVATION
1:200



SECTION THROUGH TRUSS
1:50

REV	DATE Y	M	D	REVISION DESCRIPTION	ENG	DWN
A	99	7	23	ISSUED FOR REVIEW	TA	AR
B	99	8	17	ISSUED FOR REVIEW	TA	FZ

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NORTHERN BRIDGE AND PILE LTD

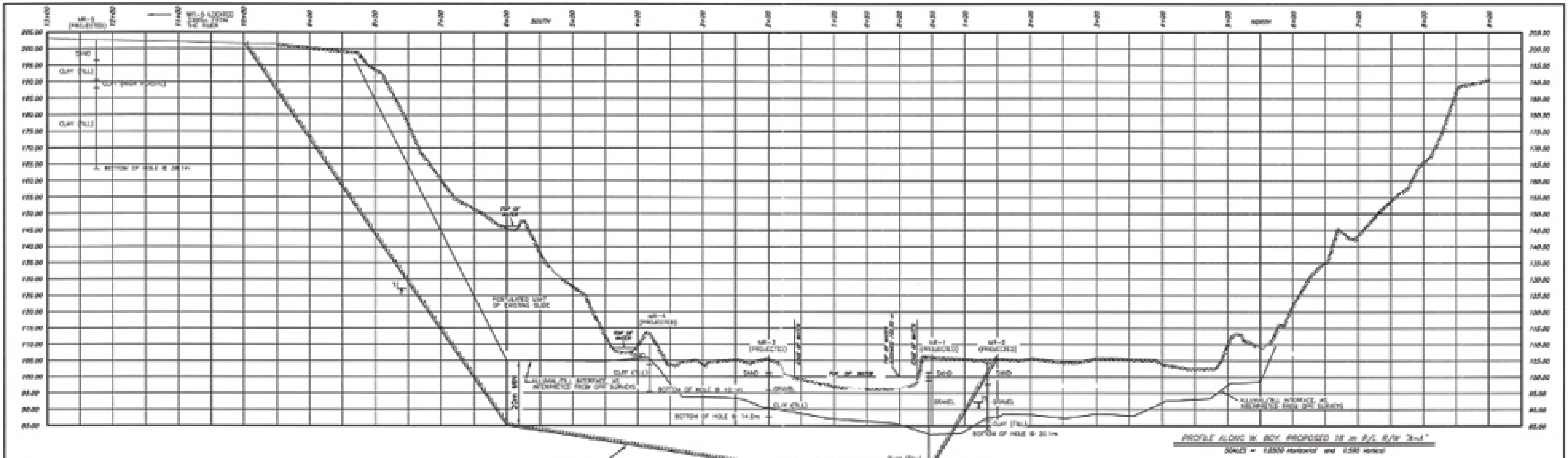
FT. NELSON RIVER PIPELINE CROSSING
SECTIONS

ASSOCIATED ENGINEERING

DESIGN: TA	
CHECK: SR	
DRAWN: LP	
DATE: JULY, 1999	
SCALE: AS SHOWN	
JOB No. 993695	
DWG. No. 3695-SK-203	B

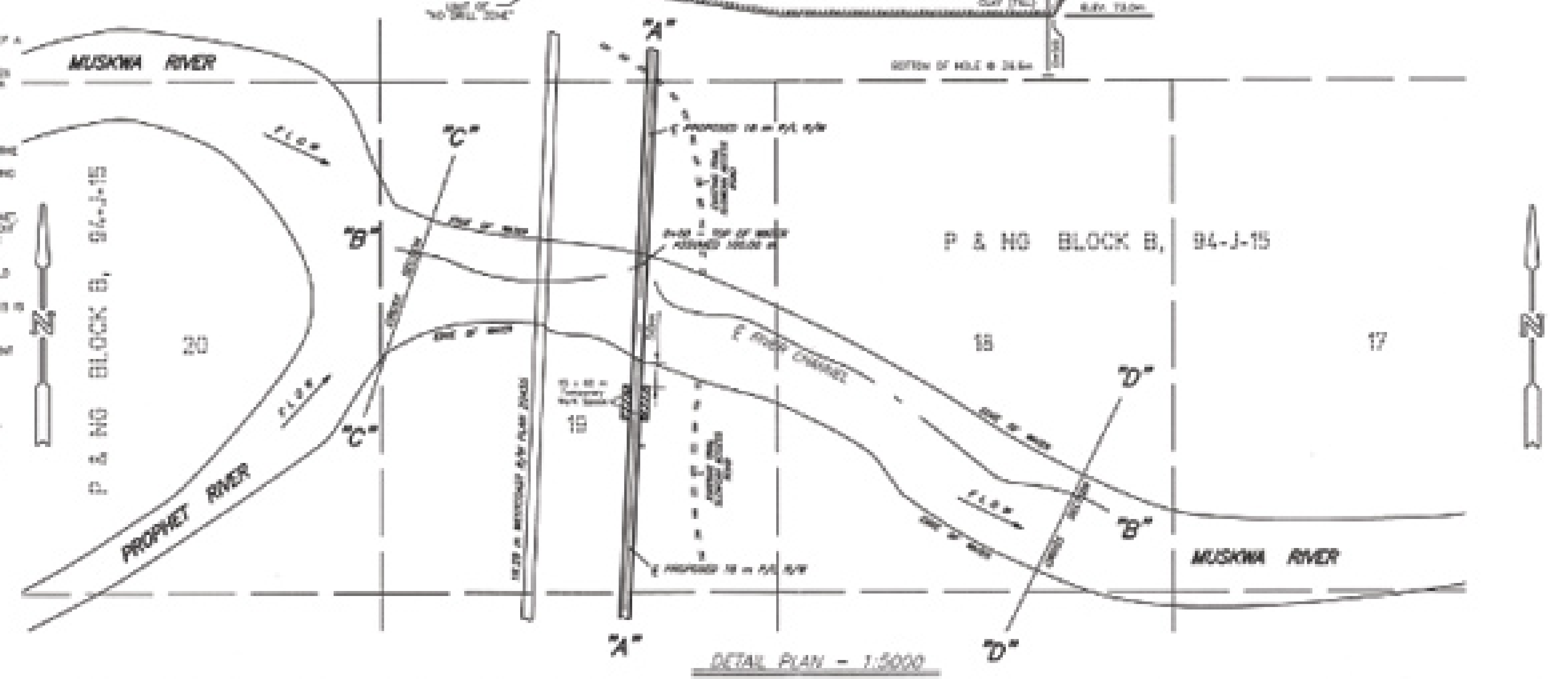
ALL DRAWINGS SUPERCEEDED PRIOR TO REVISION

X-REF. ATTACHMENTS:



NOTES:

1. SUBSURFACE CONDITIONS ARE BELIEVED TO BE FAVOURABLE FOR THE CONSTRUCTION OF A DIRECTIONALLY DRILLED CROSSING BASED ON THE BOREHOLE DATA AVAILABLE.
2. SOIL STRATIGRAPHY SHOWN IS BASED ON AN EXTRAPOLATION OF DATA FROM BOREHOLES DRILLED ALONG THE EXISTING SLOGAN WINTER ROAD, COMBINED WITH INTERPRETED DATA FROM A GROUND PENETRATING RADAR SURVEY ALONG THE PROPOSED PARAMOUNT RIGHT-OF-WAY WITHIN THE VALLEY BOTTOM. HOWEVER, SOME VARIATION IN GROUND CONDITIONS ALONG THE LENGTH OF THE BORE SHOULD BE EXPECTED.
3. RECOMMENDED "NO DRILL ZONE", AS SHOWN, HAS BEEN ESTABLISHED ON THE BASIS OF A MINIMUM 10 M VERTICAL COVER BENEATH THE POSTULATED UPPER SURFACE OF THE CLAY (TILL) BELOW THE CHANNEL AND ACTIVE FLOODPLAIN OBTAINED, 10 M BELOW SURVEYED CHANNEL THALWEG AND 20 M BELOW THE POSTULATED LIMIT OF THE EXISTING SOUTH APPROACH SLOPE SLIDE AREA.
4. ENTRY AND EXIT POINTS HAVE BEEN SHOWN ALONG A 3H:1V ALIGNMENT. THE ACTUAL DIRECTIONAL DRILL PATH MAY VARY BUT WILL BE LOCATED OUTSIDE THE "NO DRILL ZONE" AND MAY INCORPORATE GREATER VERTICAL/HORIZONTAL OFFSETS AND FLATTER ENTRY/EXIT ANGLES THAN SHOWN, AS DETERMINED BY THE DIRECTIONAL DRILLING CONTRACTOR FOR GEOMETRY AND/OR POTENTIAL FLUID LOSS CONSIDERATIONS.
5. AS INDICATED IN THE TEXT, BOREHOLE MR-5, DRILLED ON THE SOUTH UPLAND, COULD NOT BE POSITIONED CLOSER THAN 2200 M FROM THE VALLEY CREST DUE TO ACCESS RESTRICTIONS. A SIMILAR SUBSURFACE STRATIGRAPHY IS EXPECTED IN THE HDD EXIT AREA, HOWEVER THE ACTUAL GROUND CONDITIONS SHOULD BE CONFIRMED ONCE ACCESS IS AVAILABLE AND PRIOR TO MOBILIZING THE DIRECTIONAL DRILL TO THE SITE.
6. IT IS RECOMMENDED THAT THE HDD CONTRACTOR INDEPENDENTLY EVALUATE THE FEASIBILITY OF DRILLING THE CROSSING AND CONFIRM THE SUITABILITY OF HIS EQUIPMENT AND PROPOSED CONSTRUCTION PROCEDURES AGAINST ACTUAL GROUND CONDITIONS.
7. DESIGN OF A SOUTH APPROACH DIRECTIONAL DRILL WILL NEED TO ACCOMMODATE THE GEOMETRY OF THE LANDSLIDE THAT AFFECTS THE SLOPE, AND MAINTAIN AN ADEQUATE SET BACK FROM THIS FEATURE.
8. GPR INTERPRETATION SHOWS CONDITIONS ALONG PROPOSED PARAMOUNT RIGHT OF WAY. BOREHOLES, AS SHOWN, WERE LOCATED ALONG THE WINTER ROAD ALIGNMENT.
9. IT WOULD BE PRUDENT TO CONFIRM SUBSURFACE CONDITIONS IN THE EXIT AREA FOR A SOUTH APPROACH HDD, I.E. CLOSER TO THE VALLEY CREST.



NOTE

U.S.I. PROJECT SERVICES INC. and its employees take NO RESPONSIBILITY for the location of any underground conduits, pipes or other facilities, whether shown on or omitted from this plan.

PARAMOUNT RESOURCES LTD.

PIPE SPECIFICATIONS

1. OUTSIDE DIAMETER : 323.9 mm
2. WALL THICKNESS : 11.10 mm
3. PIPE SPEC'S : CSA Z245 Spec. Grade 359, Cat. I
4. MAX. OPERATING PRESSURE : 12100 kPa
5. TEST PRESSURE : 18240 kPa
6. JOINTS : WELDED
7. PROTECTIVE COATING : YELLOW JACKET
8. MINIMUM DEPTH COVER : 2.00 metres
9. CATHODIC PROTECTION : YES
10. VALVES AND FITTINGS : NEW
11. DESIGN CAPACITY : N/A
12. METHOD OF INSTALLATION : BORED
13. PIPE WILL TRANSPORT : NATURAL GAS
14. ALL MATERIALS ARE NEW
15. PIPE WILL BE DESIGNED AND CONSTRUCTED IN ACCORDANCE WITH CSA Z662-96

PARAMOUNT RESOURCES LTD.

PLAN SHOWING

PROPOSED PIPE LINE CROSSING

of

MUSKWA RIVER

within Unsurveyed Crown Land

SECTION 19, P & NG BLOCK B, 94-J-15

U.S.I. PROJECT SERVICES INC.

DATE : July 8 th, 1999
DRAWN BY : CAP
CHECKED BY : Pb

Revised – July 10th, 1999