APPENDIX A1

ALBERTA PACIFIC FOREST INDUSTRIES INC. (AlPac) ATHABASCA PULP MILL

Description of Project

Location:	Athabasca County, Alberta
Type:	Bleached Kraft Pulp Mill - Hardwood and Softwood

Process

Regulators:	Alberta Environmental Protection, Joint Federal-Provincial Review Panel.
Guiding Legislation:	Federal: Navigable Waters Protection Act, Canadian Environmental Protection Act, Environmental Assessment Act and Review Process. Provincial: Water Resources Act, Clean Air Act, Clean Water Act, Wilderness Areas, Ecological Reserves and Natural Areas Act.
Public Issues:	Effluents including cumulative effects on the Athabasca River system, water quality and fishing, timber harvesting on reserve lands, hunting fishing, trapping, emissions, socio-economic impacts, navigable waters.
Regulatory Direction:	In 1990, the Review Panel recommended against proceeding partly due to the lack of CEA, but AEP approved the project with some adjustments.
Dates:	1989: EIA submitted; 1990: Panel Report; 1990: Decision to approve.

Approach

Issues:	Identification of main environmental, community and economic impacts; identification of main issues of concern to governments; identification of issues of concern to members of the affected communities; description of the measures adopted to address concerns, minimize or eliminate possible negative impacts of the project, and enhance favourable effects of the project.
Assessment Methods:	CEA was not done except for modelling of projected BOD (biological oxygen demand) concentrations; modelling for some air and water quality issues.

Contribution to Practice and Implementation of CEA

Implementation of CEA was moved forward during the public process surrounding the proposal. The issue was raised at public hearings, thus raising awareness of CEA issues.

ALBERTA PACIFIC FOREST INDUSTRIES INC. (AlPac):

ATHABASCA PULP MILL

1.0 Description of Project

Project: Bleached Kraft Pulp Mill in the County of Athabasca in northeastern Alberta. The mill is intended to process both hardwoods and softwoods.

Proponent: Alberta Pacific Forest Industries Inc. (AlPac)

Dates: 1989: EIA submitted; 1990: Panel report; 1990: Decision.

2.0 Process

2.1 Regulators

- A joint federal-provincial panel appointed to review proponent's EIA
- Alberta Environmental Protection

Note: The panel's terms of reference included reviewing cumulative effects of effluent on the Peace-Athabasca River system, and most of the information on cumulative effects was in fact presented by government researchers rather than by the proponent.

2.2 Guiding Legislation

Federal

- Canada Navigable Waters Act
- Canadian Environmental Protection Act
- Canadian Environmental Assessment Act

Alberta

- Water Resources Act
- Clean Air Act
- Clean Water Act
- Wilderness Areas, Ecological Reserves and Natural Areas Act

2.3 Intervenors and Public Issues

Over 250 individuals or groups attended the hearings and the panel received over 750 written submissions. Intervenors included individuals, environmental groups, community groups, industry and federal and provincial governments. Most intervenors opposed the project (3, page 12).

Many intervenors were concerned about the cumulative effects of all the pulp mills on the Athabasca River. AlPac originally stated its position on cumulative effects assessment as follows:

> The public raised questions about the cumulative effects of other users of this and other area rivers and demanded information and studies which were not Alberta-Pacific's responsibility (3, page 9).

The principal issues identified by the panel as arising from the public consultation process were (3, page 20):

- Effluent discharge to the Athabasca River including cumulative effects on the Peace-Athabasca River systems and resulting impacts on downstream water quality and on fisheries
- Effects of timber harvesting on Indian reserve lands including those on hunting, trapping and fishing as well as socio-economic concerns
- Effects of the mill on the area surrounding the proposed site including matters such as the site selection criteria, emissions to the atmosphere and socio-economic impacts
- Other matters, some within the terms of reference (such as possible effects on navigable waters) and others outside the terms of reference (such as recycling).

2.4 Regulatory Direction

The review panel recommended that the proposed project not proceed based largely on the lack of a cumulative effects assessment for the Athabasca River. Alberta Environmental Protection approved the proposed project after the proponent made some adjustments to the pulping process.

For existing developments in the area, the panel recommended that monitoring programs be established and scientific research studies be undertaken on cumulative effects. The Northern River Basins Study (NRBS) subsequently (1996) recommended that no further pulp mills be approved on the Athabasca River.

3.0 Approach to CEA

3.1 Issue Identification

The proponent listed several general issues including (1, page 1.4):

- Identification of the main environmental, community and economic impacts of construction and operation of the proposed mill
- Identification of the main environmental, community and economic issues of concern to municipal governments and provincial government departments and agencies
- Identification of the issues of concern to members of affected communities by means of the public consultation program; and
- Identification of the measures adopted to:
  1) address the concerns of the public and government departments;
  2) minimize or eliminate possible negative impacts of the project; and
  3) enhance favourable effects of the project.

3.2 VEC and Indicator Selection

The assessment focussed on effluent discharged into the Athabasca River, and its potential impacts on water quality and fish. Logging required to support the mill was not included in the EIA terms of reference and therefore habitat losses due to logging operations were not assessed. Important species were identified using the Management Indicator Species evaluation scheme and ranked on the basis of the following criteria:

- Political importance
- Economic importance based on trapping and guiding
- Subsistence hunting value
- Recreational hunting value
- Non-consumptive recreational importance
- Ecological importance
- Ecological vulnerability

Ten species groups (e.g., birds, mammals, and amphibians) were ranked and the top ranked species for each group identified as follows (1, page 4.41):

- Dabbling ducks
- Great grey owl
- Ruffed grouse
- Loggerhead shrike
- Snowshoe hare
- Lynx
- Beaver
- Moose

3.3 Spatial Bounding

Separate study regions were delineated for each type of potential impact (1, page 1.8), as follows:

Potential Impacts	Study Area Boundary
Aquatic impacts	350 km downstream of the mill, to Fort McMurray
Atmospheric impacts	10 km radius of the mill, where maximum effects were expected to occur
Terrestrial impacts	8 km radius of the proposed site which included the main mill site and the water supply and effluent disposal facilities
Socio-economic impacts	County of Athabasca and Improvement Districts 17 and 18
Secondary impacts	A few tens of kilometres along road and rail access routes

3.4 Temporal Bounding

Impacts were assessed for construction of the mill and a snapshot of operational conditions. No life span for the mill was identified.

3.5 Included Projects

The assessment primarily focussed only on the proposed mill. Little baseline information, which would indicate the impacts of other projects on the river, was presented. However, biological oxygen demand (BOD) was identified as a cumulative issue, particularly in light of the existing and proposed pulp mills present on the Athabasca. Other upstream pulp mill operators on the river at the time included Weldwood Forest Products, Alberta Newsprint Company Ltd., Millar Western Pulp Ltd., and Alberta Energy Company Ltd.

3.6 Assessment Methods

Modelling was used for some air and water quality parameters but generally the proponent did not consider cumulative effects (with the exception of BOD).

3.7 Impact Characterization

Projected BOD concentrations were modelled, taking into account both theoretical considerations and actual measurements, and including the effects of all present and potential future pulp mills discharging into the Athabasca River at full current licence requirements (1, page 4.4). The results indicated that under low flow scenarios, BOD levels would still remain within Alberta Environment objectives.

Other impacts of effluent (suspended solids and colour) were estimated based on predicted characteristics of the effluent.

Chlorinated organic compounds were also of concern to intervenors and the public. Estimates of the concentrations of these compounds in the river under various scenarios were presented, but no information on how these estimates were arrived at is provided (1, page 4.9). The proponent also conducted some small-scale experiments on the breakdown of chlorinated organic compounds in water filled vessels. This approach was criticized by the panel as not representing *in situ* conditions.

Estimates of dioxin concentrations in the river were presented based on expected concentrations in the effluent. In its supplemental information, the proponent referred to a model for predicting dioxin concentrations at various levels in the aquatic food chain downstream of the mill. The model was criticized by the panel on the grounds that the levels of dioxin predicted in fish were 450 times lower than actually observed and identified a better model. The proponent also indicated several measures it will be taking to reduce dioxin loads (1, page 4.11).

Bacteria, off-flavours (tainting), nutrients, metals, sulphates, odour, phenols, sodium, chloride, ammonia, water temperature and toxicity were all discussed briefly and found to have no significant impacts (1, page 4.16-4.17). In most cases, the proponent referred to other studies that had been conducted elsewhere, or on the Athabasca River to support the finding of no significant impact. In some cases (e.g., phosphorous), background concentrations were reported (which would include contributions from upstream effluent). However, some of the data presented pre-dated developments on the river. The proponent stated its intention to monitor for these parameters during operation of the mine.

Local residents also expressed concern about contamination of groundwater surrounding the mill. The proponent concluded that the possibility of groundwater contamination was very low because of the containment measures being taken but they committed to monitoring the groundwater.

Atmospheric impacts of concern primarily related to sulphur emissions and deposition. However, the proponent also addressed potential impacts of chlorine and oxides of nitrogen emissions, odour and fogging. Background data on air quality in the area was extrapolated from previous studies. Maximum ground and treetop levels of emissions

from the stack were modelled using Alberta Environmental Protection's STACKS computer model under worst case scenarios (both in terms of emissions and meteorological conditions). Modelling was conducted for H_2S, SO_2, Cl and ClO_2, NO_x and particulates. All predictions were estimated to be below current guidelines and therefore to have no impact. Modelling was conducted for the emissions of the proposed facility only.

Sulphur deposition rates were also modelled and predicted to have a small incremental acidification in the most sensitive forest soils. No impacts on vegetation are predicted as a result of air emissions. Vegetation cleared for the project and rights of way was deemed to be typical of the area, and no rare or endangered plant species were identified. Therefore no impact was predicted.

The proponent commented that no wildlife inventories of the region were available but assessed the importance of wildlife species in the area using the Management Indicator Species evaluation scheme (see VECs and indicator selection) (1, page 4.39).

Alberta Environmental Protection asked the proponent to provide supplemental information on cumulative impacts on the Peace-Athabasca Delta. In responding, the proponent cited recent fisheries population studies of the river and its delta (carried out on behalf of Suncor Inc.) which indicated that no tainting by chemical accumulations had been detected. The proponent concluded there were no impacts from activities on the river and that the proposed mill was unlikely to have an impact.

3.8 Significance of Cumulative Effects

Predicted impacts on water and air quality were compared with guidelines and objectives. In general, if the guidelines were not exceeded, the impact was concluded to be insignificant. The proponent did not attribute significance to the impact of effluent on fisheries, commenting that insufficient baseline information existed but that they would commit to a monitoring program. None of the habitat losses associated with project construction were deemed significant.

Dioxin concentrations in the Athabasca River were estimated, but the proponent commented that there were no models available to evaluate the potential for uptake by fish (1, 4.12). The proponent quoted a study of fish tested in several provinces (it is not clear that the Athabasca was one of the rivers tested) which did not find significant levels of dioxins in fish and concluded that it was reasonable to assume that dioxin uptake in fish below the mill would not be of concern.

With regards to human and livestock health, the proponents presented a review of available information on health effects associated with pulp mills. No health effects were expected because all emissions were expected to be below current guidelines. However, the proponent did not take cumulative effects into account when reaching this conclusion (1, page 4.35).

3.9 Future Management Options

The proponent committed to several monitoring programs (e.g., water quality, concentrations of chemicals in fish).

4.0 Contribution to Practice and Implementation of CEA

Implementation of CEA was moved forward considerably during the public process surrounding the AlPac proposal. Although the proponent did not deal with cumulative effects in its proposal, the issue was raised in the hearings and addressed to some extent by data presented by government. The process raised awareness of the issues associated with CEA, including questions about responsibility and jurisdiction.

References:

1. Alberta Pacific Forest Industries Inc. Environmental Impact Assessment. Bleached Kraft Mill: Main Report. May 8, 1989.

2. Alberta Pacific Forest Industries Inc. Environmental Impact Assessment. Alberta Environment Questions and Answers. November 16, 1989.

3. Environmental Impact Assessment Review Board. The Proposed Alberta- Pacific Pulp Mill: Report of the EIA Review Board. March 1990.

APPENDIX A2

AMOCO CANADA PETROLEUM LTD., NORCEN ENERGY RESOURCES LTD., OCELOT ENERGY INC., PETRO-CANADA RESOURCES, SCEPTRE RESOURCES LTD., SHELL CANADA LIMITED, TALISMAN ENERGY INC. MONKMAN / GRIZZLY VALLEY GAS FIELDS

Description of Project

Location:	Northeastern British-Columbia, 140 km southwest of Ft. St. John
Type:	Natural Gas Field Development

Process

Regulators:	B.C. Ministry of Environment, Lands and Parks.
Guiding Legislation:	None (although the Pine River plant expansion approval was submitted before the NEB).
Public Issues:	This was not a public process.
Regulatory Direction:	N/A
Dates:	1994: EIA submitted.

Approach

Issues:	Access creation and management, sulphur emissions, effects on fish (Arctic grayling, bull trout), sedimentation, effects on wildlife (caribou and moose), effects of roads/trails on wolf predation success, cumulative effects of all disturbances.
Assessment Methods:	Use of a semi-quantitative approach, spatial and temporal overlap and zones of influence. Combined overlap from all disturbances used to represent cumulative impacts over the complete study area.

Contribution to Practice and Implementation of CEA

Assessing potential effects of many associated projects using the same resource before individual project approvals. A company-led initiative to address cumulative impacts and regional development initiatives.

AMOCO CANADA PETROLEUM LTD. and others

MONKMAN / GRIZZLY VALLEY GAS FIELDS

1.0 Description of Project

Project: Gas field to supply a processing plant located within the 5000 km^2 Monkman/Grizzly Valley in the Rocky Mountain Eastern Slopes of British Columbia. The projects included construction of gathering lines to the plant, wells, dehydration plants and associated infrastructure such as roads.

Proponent: Amoco Canada Petroleum Ltd., Norcen Energy Resources Ltd., Ocelot Energy Inc., PetroCanada Resources, Sceptre Resources Ltd., Shell Canada Ltd. and Talisman Energy Inc.

Dates: 1994: EIA submitted.

2.0 Process

2.1 Regulators

- British Columbia Ministry of Environment, Lands and Parks (MELP)

2.2 Guiding Legislation

The assessment was performed not as an EIA but as an "Environmental Protection Strategy". It was intended that study results would aid decision-makers in evaluating potential cumulative effects of continued gas development.

MELP initiated the study following a request by Westcoast Energy to expand their Pine River Gas Plant to accommodate new product to be delivered by seven other energy operators in the Monkman field. MELP requested that proponents work together to assess environmental effects over the entire production area, and to suggest initiatives to minimize those effects.

2.3 Intervenors and Public Issues

No intervenors were involved.

2.4 Regulatory Direction

Information gathered as a result of the study served to inform subsequent policy development. The study was intended as a resource to be used in establishing disturbance thresholds, identifying sensitive areas for key resources, and ensuring that mitigation, monitoring and research be focussed on significant environmental issues. For example, the Ministry of Energy, Mines and Public Resources issued the B.C. Oil and Gas Handbook in 1995, providing energy operators with guidelines for minimizing and mitigating environmental effects.

3.0 Approach to CEA

3.1 Issues Identification

The proponents identified a number of issues, including:

- Access creation and management (e.g., along seismic lines)
- Sulphur emissions
- Effects on fish (Arctic grayling, bull trout)
- Sedimentation
- Effects on caribou and moose populations
- Effects of roads/trails on wolf predation success, and
- Effects on non-energy resource uses (e.g., forestry, sport fishing, hunting, trapping, grazing, non-consumptive recreation).

3.2 VECs and Indicator Selection

A total of eleven parameters were assessed under two categories:

Physical parameters:

- Ambient SO_2 and S deposition
- Soil pH
- Aquatic buffering capacity
- Stream sediment load
- Primitive recreation opportunities

Wildlife habitat and populations:

- Poplar
- Arctic grayling
- Bull trout
- Caribou
- Moose

3.3 Spatial Bounding

The assessment focussed on any development directly related to Westcoast Energy's proposed 1993 expansion of the Pine River plant. The projects were located in 11 gas catchment areas for delivery to a single pipeline linking them with the Pine River Gas Plant, causing the proponents to study the entire area (8,000 km^2).

3.4 Temporal Bounding

1983 – 1998: all gas exploration and development activities in relation to the Pine River Gas Plant that had occurred in the past 10 years or could occur in the following 5 years.

3.5 Included Projects

Projects were included if they were directly related to the gas field under review. Logging and mining were not included (although acknowledged) as no quantitative data was available to adequately describe them for assessment purposes.

3.6 Assessment Methods

The assessment of cumulative effects was conducted for air quality, soils, vegetation, fisheries and aquatic habitat, wildlife and wildlife habitat, and recreation (1). Environmentally sensitive areas were also mapped.

The assessment framework used a semi-quantitative approach, which provided an "audit trail" in which, for each decision made, the data, assumptions and analysis were clearly explained for later examination (2). The framework followed five steps:

1. Identify VECs

2. Identify project-related disturbances and likely mitigation success

3. Identify possible interactions between environmental components and the disturbances, and estimate spatial and temporal overlap of the effects

4. Evaluate significance of residual effects

5. Prepare an audit trail

Finally, combined overlap from all disturbances was used to represent cumulative effects over the complete study area. As specific exploration and production plans for the future period (1993 to 1998) were not available, a "regional development scenario" approach was used to describe anticipated activities. The scenario approach included determining quantitative limits or thresholds for certain development activities in terms of appropriate indicating units for three periods: existing, minimum, and maximum development. Limits or thresholds were determined for the following: kilometres of seismic lines; kilometres of roads; kilometres of pipelines; number of dehydrating plants; and number of wells (3).

Sulphur stack emissions were modelled to predict air quality at known and hypothetical locations to estimate distances at which ambient short-term SO_2 levels may be exceeded.

The assessment considered wildlife interactions among representative species, disturbance sources and habitat. Spatial and temporal overlaps were estimated for each source of disturbance during the assessment period.

3.7 Impact Characterization

Air quality (e.g., SCREEN) and deposition (e.g., ADEPT) models were performed for existing and future wells and facilities to establish a Zone of Influence for sulphur emissions. A standard level of sediment loading was assumed during construction for a generalized project description of three road stream crossings per km and one pipeline stream crossing per 7 km.

Spatial and temporal overlaps were estimated between each indicator species and various project disturbances for both habitat and population. For example, for caribou, disturbances were cumulative sulphur emissions, cumulative clearing, alienation disturbances, mortality on roads, hunting, predation, and physical barriers. As an example of overlap, hunting caused a 22 to 33% spatial overlap and a 16-100% temporal overlap.

It was concluded that most of the Arctic grayling and bull trout populations would be affected by sediment and increased fishing pressures. The effect could extend to threatening population recovery within one generation.

3.8 Significance of Cumulative Effects

Four questions were posed to assess significance on physical systems and biological species. The line of inquiry was based on the following (2):

- Is there an increase in the project's direct effect in combination with effects of other projects?
- Is the resulting effect unacceptable?
- Is the effect permanent?
- If not permanent, how long before recovery from the effect?

The greatest effects were determined to arise from soil erosion and access creation. Sediment could be important in 10 to 40% of the study area during peak construction periods. New right-of-ways would create access to one-third of the caribou population and all of the moose population, thereby increasing their susceptibility to poaching and leading the proponents to conclude that indirect effects on these ungulates would be more significant than direct loss of habitat.

3.9 Future Management Options

Management options were summarized in an Environmental Protection Plan (EPP). Mitigation techniques included routine industrial mitigation practices, project re-design, re-routing and scheduling changes. These combined efforts were intended to reduce the likelihood that environmentally sensitive areas or valued resources would be adversely affected. The proponents agreed to develop an "Environmental Issues Report" for future projects.

4.0 Contribution to Practice and Implementation of CEA

The study provides an example of regional, multipartite reviews which can serve to highlight general trends and provide information that may guide future decisions regarding practical regional thresholds, mitigation, monitoring and research. Despite knowledge of specific plans, using scenarios allowed proponents to define a "generic" project and examine its potential effects.

References:

1. Antoniuk, T. M. Environmental Protection Strategies for Development of the Monkman/Grizzly Valley Gas Fields. Prepared by Salmo Consulting for Amoco Canada Petroleum Company Ltd., Norcen Energy Resources Limited, Ocelot Energy Inc., Petro-Canada Resources, Sceptre Resources Ltd., Shell Canada Ltd. and Talisman Energy Inc., Calgary, Alberta. 1994a.

2. Duval, W. and P. Vonk. A Semi-Quantitative Procedure for Preparation of Initial Environmental Evaluations and Assessment of Potential Impact Significance. Axys Environmental Consulting Ltd., Vancouver. 1994.

3. Antoniuk, T. M. Cumulative Effects of Natural Gas Development in Northeast BC. In Cumulative Effects Assessment in Canada: From Concept to Practice. Papers from the 15th Symposium Held by the Alberta Society of Professional Biologists. Edited by A.J. Kennedy, Alberta Society of Professional Biologists, pp. 239-252. 1994b.

APPENDIX A3

AMOCO CANADA PETROLEUM COMPANY LTD.
PRAIRIE ROSE: LINEAR ALPHA OLEFINS (LAO) PLANT

Description of Project

Location:	Joffre, Alberta (near Red Deer)
Type:	Chemical Processing Facility

Process

Regulators:	Alberta Energy and Utilities Board, Alberta Environmental Protection.
Guiding Legislation:	Oil and Gas Conservation Act, Environmental Protection and Enhancement Act, Water Resources Act.
Public Issues:	Increased local traffic and housing during construction, effects of long-term, low-level chemical emissions on human health and the environment, regional population, noise and light pollution, increased rail traffic, aesthetics, regional economy and employment.
Regulatory Direction:	Decision pending.
Dates:	1997: EIA submitted.

Approach

Issues:	Air quality, surface water quality and quantity, soil and groundwater, human health, noise, traffic and socio-economic issues.
Assessment Methods:	Air emissions were modelled. Quantitative analysis was undertaken for surface water, soil, groundwater, noise, human health and traffic, with modelling also being used for traffic. A quantitative and qualitative approach was taken for socio-economic effects.

Contribution to Practice and Implementation of CEA

The EIA is unusual in that the proposal has been considered almost entirely in the context of existing and proposed neighbouring developments. This is at least partially because the document is intended as an extension of the EIAs done by Union Carbide and NOVA with respect to their proposed polyethylene plant expansion in Joffre.

AMOCO CANADA PETROLEUM COMPANY LTD.:

PRAIRIE ROSE: LINEAR ALPHA OLEFINS (LAO) PLANT

1.0 Description of Project

Project: 375 kt/yr Linear Alpha Olefins (LAO) processing plant and ancillary facilities adding to NOVA's plant at Joffre, Alberta. The project will coincide with the construction of NOVA's and Union Carbide's polyethylene facilities.

Proponent: Amoco Canada Petroleum Company Ltd. (Amoco).

Dates: 1996: EIA submitted.

2.0 Process

2.1 Regulators

- Alberta Energy & Utilities Board
- Alberta Environmental Protection

2.2 Guiding Legislation

Alberta

- Oil and Gas Conservation Act
- Alberta Environmental Protection and Enhancement Act
- Water Resources Act

2.3 Intervenors and Public Issues

The proponent consulted with stakeholders and communities who may be directly affected by the LAO project. The proponent's public consultation strategy focussed on creating a direct working relationship with local stakeholders, and involving them throughout the project from the planning phase onwards. Several local residences were used as monitoring sites and involved directly with the EIA process. Regular meetings and open houses were held and newsletters frequently circulated. Public

consultation was also undertaken with the involvement of NOVA and Union Carbide where cumulative effects issues were concerned (1).

The following cumulative effects issues were raised as a result of the public consultation process:

- Construction and operations traffic on local roads;
- Construction workforce housing;
- Effects of long-term, low-level chemical emissions on human health and environment;
- Cumulative regional population projections;
- Cumulative noise and light pollution;
- Increased rail traffic;
- Aesthetics; and
- Effects on regional economy and employment (1, page 12).

2.4 Regulatory Direction

Decision pending as of February 1998.

3.0 Approach to CEA

3.1 Issue Identification

Much of the EIA focussed on incremental and cumulative impacts involving Amoco, NOVA and Union Carbide as a result of the proximity of these developments. CEA issues were discussed separately in relation to air quality, surface water quality and quantity, soil and groundwater, human health, noise, traffic, and socio-economics. Issues were identified through public consultation, professional knowledge and the application of appropriate provincial guidelines.

3.2 VEC and Indicator Selection

The proponent did not use VECs or indicator species in its EIA. Nor were vegetation and wildlife components included in the EIA, although some aspects of these variables were analysed in EIA sections on air quality, surface water, soils and human health.

3.3 Spatial Bounding

Separate study areas were delineated for each type of potential impact, as follows:

Potential Impacts	Study Area Boundary
Traffic	5 km radius, including highway 11 corridor in Red Deer and sections of highway 595
Noise	2.5 km radius
Air quality	10 km radius
Surface water	Local, 9.5 km portion of the Red Deer river above and below water intake; regional, Red Deer River from Dixon dam to Drumheller
Soil and groundwater	Local, plant site; regional, 3 km radius
Human health	Local, nearest residences; regional, several local communities. Adjacent communities which might be affected were determined through discussions with residents, existing plant employees and community leaders.

3.4 Temporal Bounding

- 1997 - baseline
- 1998-2000 - construction and commission
- 2025 - minimum life span (2050 if upgraded)

3.5 Included Projects

A number of adjacent and regional industrial developments were considered in this study, including:

- Nova Chemicals Ltd.
- Union Carbide Canada Inc.
- Agrium fertilizer plant
- K&C Silviculture
- Canadian Roxy (NUMAC Energy)
- Amoco

3.6 Assessment Methods

CEA assessment methods varied depending on discipline-specific approaches, although quantification and modelling analyses were emphasized. Linkage diagrams were used to identify cumulative effects with respect to water quality/quantity and human health. Quantitative modelling was relied upon to assess cumulative issues pertaining to air quality, noise, lighting, traffic and socio-economics.

3.7 Impact Characterization

Due to the close proximity of various NOVA/Union Carbide existing and proposed developments, the proponent's EIA contained a cumulative component throughout. Quantitative methods were emphasized, and modelling output frequently used, as follows:

Potential Impacts	Impact Characterization
Air quality	Diffusion of combined emissions plumes from all proposed and existing sources within the study area were modelled. Simulations were specific to agents which were suspected to have health implications. Models included normal operating conditions, upset conditions and the effects of fugitive emissions.
Surface water quality and quantity	Numerical analysis was conducted for the project's additional contributions on NOVA's existing and proposed facilities. Analyses included cumulative fluid waste disposal, suspended solids, inorganic and organic compounds, metals, nutrients and toxicity.
Soil and groundwater	Quantitative analysis was performed for cumulative effects on potable subsurface water, deep aquifers, near-surface ground water and shallow soil.
Human health	A quantitative approach evaluated potential contaminant pathways and exposure risk for humans, livestock and wildlife. The analysis was an addition to more detailed ecological risk assessment work conducted previously for NOVA's ethylene expansion. Findings addressed key stakeholder issues.
Noise	Noise impacts were quantitatively evaluated and

Potential Impacts	Impact Characterization
	compared to government directives based on a combined Amoco, Nova and Union Carbide scenario. Study involved monitoring and predicting noise levels at 10 local residences during combined construction and operation phases.
Traffic	Quantitative and modelling analysis was conducted for existing and predicted traffic volumes at peak times during the combined construction and operation phases. Analysis included both local traffic not associated with the Joffre site and ancillary traffic associated with the Joffre Site. A similar analysis was conducted for rail traffic.
Socio-economic	A quantitative and qualitative study of the combined effects of Amoco, NOVA and Union Carbide was conducted for the local and regional study area during the combined construction and operation phases. The study involved elements of emergency response planning, policing, recreation, utilities, family services, housing, commercial services, land use, communication and quality of life. Estimates of workforce demand and type were also made by direct Amoco employment and in combination with NOVA and Union Carbide.

3.8 Significance of Cumulative Effects

The significance of cumulative effects was often evaluated in the context of government guidelines and regulations. Individual disciplines such as human health, traffic and socio-economics used standard criteria (direction, severity, extent, frequency and duration) where appropriate. Severity was not defined specifically.

3.9 Future Management Options

Amoco, NOVA, Union Carbide and the Alberta government are taking part in a long-term study of low-level ethylene exposure to crops and vegetation caused by all neighbouring industrial developments.

As a member of the Canadian Chemical Producers' Association (CCPA), the proponent has adopted the Responsible Care program which calls for continuous improvement in health, safety and environmental management. The proponent has implemented a Safety, Health and Environmental Management System (SHEMS) and associated programs throughout its operations (1, page 5).

4.0 Contribution to Practice and Implementation of CEA

The Prairie Rose project has been considered almost entirely in the context of existing and proposed neighbouring developments. The EIA is partially intended to be an extension of previous EIAs conducted by NOVA and Union Carbide, (1, page 2)

References:

1. Amoco Canada Petroleum Company Limited. Project Prairie Rose Proposed Linear Alpha Olefins (LAO) Project Plant at Joffre, Alberta. Environmental Impact Assessment September 1997.

APPENDIX A4

CARDINAL RIVER COALS LTD.
CHEVIOT COAL MINE

Description of Project

Location:	Near Hinton, Alberta
Type:	Open Pit Coal Mine

Process

Regulators:	Alberta Energy and Utilities Board, Alberta Environmental Protection, Department of Fisheries and Oceans, Canadian Environmental Assessment Agency.
Guiding Legislation:	Provincial: Alberta Environmental Protection and Enhancement Act, Coal Conservation Act, Energy Resources Conservation Act. Federal: Canadian Environmental Assessment Act, Fisheries Act.
Public Issues:	Outstanding public issues included: selection of road and powerline routes around Cadomin, Cardinal River drainage and spiritual ties to the land, former town site of Mountain Park and cemetery.
Regulatory Direction:	Decision not reviewed.
Dates:	1997: EIA submitted; 1997: Decision to approve.

Approach

Issues:	Issues identified through consultation and expert opinion. Representative VECs were chosen, including mammalian carnivores and other wildlife.
Assessment Methods:	Numerical modelling for impacts with federal or provincial guidelines (e.g., water and air quality). Comprehensive field studies were carried out to characterize the baseline, especially for wildlife components. Results were then modelled and compared with regional planning goals and policy.

Contribution to Practice and Implementation of CEA

Cumulative effects of the project on wildlife were addressed extensively and models used to predict effects on wildlife that were not utilized in the other assessments reviewed. Future management options for other activities, and regional initiatives, including funding for compensation of non-mitigable effects were suggested.

CARDINAL RIVER COALS LTD.:

CHEVIOT COAL MINE

1.0 Description of Project

Project: A surface coal mine and coal processing plant. This mine is intended to be productive for about 20 years, producing 3.2 million tonnes annually beginning in 1999.

Proponent: Cardinal River Coals Ltd. (CRC)

Dates: 1985: Original disclosure; 1996: EIA submitted; 1997: Decision.

2.0 Process

2.1 Regulators

A joint federal / provincial review panel reviewed the application.

- Alberta Energy and Utilities Board
- Alberta Environmental Protection
- Department of Fisheries and Oceans/ Canadian Environmental Assessment Agency

2.2 Guiding Legislation

Federal

- Canadian Environmental Assessment Act
- Fisheries Act

Alberta

- Coal Conservation Act
- Alberta Environmental Protection and Enhancement Act
- Energy Resources Conservation Act

In addition, the application was carried out under the disclosure requirements of the Coal Development Policy for Alberta (1976). The Coal Development Policy is intended to ensure efficient use of coal resources in the province in a manner that avoids irreparable harm to the environment and with satisfactory reclamation of disturbed land.

2.3 Intervenors and Public Issues

The location of the proposed mine near the border of Jasper National Park resulted in the participation of numerous intervenors. CRC began a consultation program before preparing the application and attempted to address public concerns by making changes to the planning of the mine where relevant. However, several issues remained unresolved upon preparation of the application:

- Selection of a road and powerline route around Cadomin
- Cardinal River drainage and spiritual ties to the land
- Former town site of Mountain Park and cemetery access

2.4 Regulatory Direction

Decision not reviewed.

3.0 Approach to CEA

3.1 Issue Identification

Issues were identified through a combination of consultation with stakeholders and regulators, and expert opinion.

3.2 VECs and Indicator Selection

VECs were defined by CRC as those environmental attributes associated with the proposed project development, which have been identified to be of concern by either the public, government, or the professional community (4, page A-13). Table 2-2 in the application provides a listing of the VECs chosen, and the source for selection criteria (EIA Terms of Reference, Public Consultation and Professional Concerns). VECs are divided into atmospheric impacts, aquatic impacts, terrestrial impacts, recreational aspects, economic impact assessment and historical resources.

In evaluating the effects of the project on VECs, the application considered the EIA Terms of Reference, study boundaries, cumulative effects and significant effects. CRC was directed in the terms of reference to assess cumulative, regional, temporal and spatial aspects in terms of the significance of impacts.

In terms of choosing VECs for cumulative effects assessment, CRC states that cumulative effects assessment was constrained by available resources such that:

> Because of administrative, ecological/socio-economic and technical boundary constraints, CRC acknowledges that it does not have the time, technical and economic resources to carry out cumulative effects studies for all anthropogenic sources or address all cumulative effects assessment factors which could influence all impacted VECs. As a result, the Company elected to carry out cumulative effects studies only on selected VECs. Criteria for the selection of specific VEC cumulative effects studies were based on either professional opinion, public concern, or government agency interest in particular study disciplines.

Grizzly bears, wolves and cougars were the indicator species chosen because there is an established quantitative methodology for cumulative assessment and because they serve as both indicator and umbrella species (3). Grizzly bear was believed to be an appropriate indicator species because previous studies had found that protecting the habitat of grizzly bears, wolves and lynxes also resulted in habitat protection for 403 additional species.

3.3 Spatial Bounding

Spatial study areas were defined for each of the disciplines studied. Study boundary criteria are presented in Table 2-3 of the application (adapted from Barnes et al. 1993).

Definitions of Spatial Boundaries
International
National
Provincial
Regional
Local
Lease Area

For mammalian carnivores, the spatial study area chosen centred on the Cheviot mine but covered about 3000 km^2. The study area was considered adequate to account for the large home range of these species.

3.4 Temporal Bounding

Temporal boundaries were identified as lasting approximately 50 years, concomitant with the life of the mine. Impacts were assessed at the construction phase, operation and abandonment phases. In addition, impacts were classified according to duration or frequency (see table below) (4, page A-19).

Definitions of Temporal Boundaries
Year Round
Seasonal
Occasional
Cyclical
Periodic

CRC chose two temporal boundaries: 1) conditions immediately after the mine was projected to cease operations; and 2) conditions projected to 100 years after the mine was projected to cease operations. The 100-year time frame was chosen because:

> ... if sufficient habitat for carnivores is not established within that time frame, including adequate forest cover requirements, the effect of the development action is likely unmitigable (3, page iii).

3.5 Included Projects

Other activities and projects in the area considered in the cumulative effects assessment are:

- Weldwood of Canada Limited: timber harvesting and road access
- Sundance Forests Industries: timber harvesting and road access
- Alexis First Nation: recreational use
- Cardinal Divide and Muskiki Lake Natural Area: recreational access
- Cadomin Cave and Grave Flats: recreational access
- Other industries in the area: Inland cement quarry, Luscar Sterco, Obed Mountain coal and Gregg River Resources (coal), natural gas exploration, development and production
- Possible future projects: Manalta's Mercoal and McLeod River mines (which received approval and may go ahead when market conditions dictate)

3.6 Assessment Methods

CRC carried out comprehensive data collection and surveys to characterize the baseline environment where data was unavailable (4, page A-21). In addition, the proponents relied on the planning and land use management decisions for the area outlined in the Integrated Regional Plan for the Coal Branch Area (1990).

The cumulative effects assessment for carnivores serves as a focus of this project review. A Cumulative Effects Model was used to assess the impacts of the development on mammalian carnivores.

3.7 Impact Characterization

Impacts were characterized on the basis of magnitude of impact, geographic extent, duration and frequency, degree to which impacts are reversible or irreversible, ecological context and the presence of environmental standards, guidelines or objectives for assessing the impact along the lines suggested by CEAA (1994).

Baseline characterization of mammalian carnivores was largely based on pre-existing data and population trends. Data was severely limited for some species (including cougars, bobcats, black bears and river otters) and this was identified as a constraint to the analysis.

The effects of development on grizzly bear and wolves were used to assess the impacts of development. The model was developed in the United States in the 1980s and has been tested and used as a planning tool to help maintain threatened grizzly bear populations in the US. Local parameters were applied to the model and original research collected over one field season to connect regional habitat data for grizzly bear and wolf. The habitat data, and data on regional developments was entered into a GIS database. Since a validated model does not exist for wolves, existing data was used to create a preliminary model.

Impacts on cougars and thirteen other carnivores' species were analysed through a cumulative effects regional assessment perspective.

3.8 Significance of Cumulative Effects

The following table is adapted from the CRC application which, in turn, relied upon the Canadian Environmental Assessment Agency (1994).

Impact Characterization	Determination of Significance
Magnitude	Significant if effects are major or catastrophic or can trigger or contribute to cumulative

Impact Characterization	Determination of Significance
	effects
Geographic extent	Widespread effects may be significant whereas localized effects may not be
Duration and frequency	Long terms and / or frequent adverse effects may be significant. Future adverse effects should also be taken into account
Reversibility/ irreversibility	Reversible effects may be less significant than irreversible effects
Ecological context	Adverse effects may be more significant if they occur in regions that have already been affected by human activities or are ecologically fragile with little resilience to imposed stresses
Presence of environmental standards, guidelines or objectives for assessing the impact	Levels of adverse environmental effects which exceed guidelines or standards may be significant

This approach to determining significance was used throughout the EIA, although CRC points out that caveats were made at various points depending on the confidence in evaluating impacts.

Although in some cases, individual consultants employed by CRC concluded that some impacts were significant, CRC commented (citing CEAA (1994 b): the determination of whether an environmental impact is significant will be considered only after taking into account any mitigation measures (4, page A-27).

Insignificant impacts were defined as those which (4, page A-28):

- Occur in a localized manner over a short period (similar to natural variation) and have no measurable effects on the integrity of the population as a whole
- Have a negligible effect on communities of very short duration, are localized and similar to natural variations

Regarding impact of duration; '*long'* referred to effects occurring after completion of mining and abandonment, and *'short'* referred to effects occurring within the development phase. Major effects were those which required mitigation and have widespread or regional implications or have a long-term nature or high visual or ecological effects (4, page A-29).

In terms of effects of the development on mammalian carnivores, the regional study area was first divided into areas according to habitat suitability and habitat effectiveness. Habitat effectiveness is defined as:

> ... a measure of an area's potential usefulness to a species after factoring in the negative influences of human developments and activities (page v).

Bear management units were identified which roughly corresponded to the size of a female grizzly's home range. The models used assigned numerical values to the bear management units based on habitat suitability and effectiveness. The effects of the project were analysed using the same model. If the numerical value decreased significantly as a result of the project, the effect was labelled as significant.

3.9 Future Management Options

The cumulative effects assessment for mammalian carnivores concluded that the project would likely have a significant adverse effect on populations in the area (3). They suggest that careful regional level planning is required to:

> ... identify and protect blocks of high quality, effective, carnivore habitat, and ensure connection of these areas with travel corridors usable by carnivores (3, page viii).

Challenges in implementing this approach include the already fragmented nature of the habitat in the area due to existing development. Suggested approaches to addressing this problem include dispersing transient human activities (such as mining and logging) over space and time and the creation of a Cheviot Mine Compensation Package to compensate for unmitigable losses of carnivores and their habitat (3, page ix). Further studies on population trends, identification of critical habitat, and management strategies to decrease negative influence of human activities were proposed.

4.0 Contribution to Practice and Implementation of CEA

The application included recommendations for future management of resources in the area, including the establishment of a fund for compensation for non-mitigable losses.

References:

1. Alberta Energy and Utilities Board. Decision 97-08- Cheviot Coal Project. 1997.

2. Alberta Forestry, Lands and Wildlife. Integrated Regional Plan for the Coal Branch Area. 1990.

3. BIOS Environmental Research and Planning Associates Ltd. Cheviot Mine Project: Specific and Cumulative Environmental Effects Analysis for mammalian Carnivores, January 1996.

4. Cardinal River Coals Ltd. Cheviot Mine Application. Volumes II and II. February, 1996.

APPENDIX A5

COGEMA RESOURCES INC.
MIDWEST URANIUM MINES

Description of Project

Location:	Northern Saskatchewan, near Wollaston Lake
Type:	Underground Uranium Mine

Process

Regulators:	Environment Canada, Natural Resources Canada, Atomic Energy Control Board, Saskatchewan Ministry of Environment and Resource Management, Joint Federal – Provincial Review Panel on Uranium Mining Development.
Guiding Legislation:	Provincial: Environmental Assessment Act, Public Enquiries Act. Federal: Atomic Energy Control Act, Environmental Assessment and Review Process Guidelines Order, Nuclear Safety and Control Act, Uranium and Thorium Mining Regulations.
Public Issues:	The primary environmental issues of public concern were highway transportation of uranium ores and potential leakage from tailings into waterways.
Regulatory Direction:	The Joint Panel recommended approval of the mine in 1997 with some recommendations for long term monitoring and a contingency fund for mitigation. Regulatory direction is pending.
Dates:	1995: EIA submitted; 1997 Report of Joint Panel.

Approach

Issues:	The proponent, public consultation and the Joint Review Panel identified Issues. Issues included occupational health and safety, transportation and biophysical impacts.
Assessment Methods:	A regional monitoring program is in effect in the area to monitor cumulative effects of uranium mining. The proponent submitted baseline information from the monitoring program to support modelling studies.

Contribution to Practice and Implementation of CEA

A regional cumulative effects monitoring program which includes representatives from the provincial and federal government agencies, academic agencies and the proponent itself, the Cumulative Effects Monitoring Working Group.

COGEMA RESOURCES INC.:

MIDWEST URANIUM MINES

1.0 Description of Project

Project: Underground uranium mine in Northern Saskatchewan near Wollaston Lake.

Proponent: Cogema Resources Inc.

Dates: 1995: EIA submitted; 1997: Decision.

2.0 Process

2.1 Regulators

- Environment Canada
- Natural Resources Canada
- Atomic Energy Control Board (AECB)
- Saskatchewan Ministry of Environment and Resource Management

Note: A joint Federal-Provincial Review Panel on Uranium Mining Development in Northern Saskatchewan was struck to advise the regulators.

2.2 Guiding Legislation

Federal

- Atomic Energy Control Act
- Environmental Assessment and Review Process Guidelines Order (EARPGO)
- Nuclear Safety and Control Act
- Uranium and Thorium Mining Regulations

Provincial

- Environmental Assessment Act
- Public Enquiries Act

2.3 Intervenors and Public Issues

Intervenors included individuals, AECB, NGOs such as the Canadian Coalition for Nuclear Responsibility, the Canadian Nuclear Association and representatives of the governments of Canada (Environment Canada, Natural Resources Canada, Health Canada), Saskatchewan and the North West Territories.

Highway transportation of uranium ores (specifically, the risks associated with accidents, spills and ground fires) was one of the issues of most concern to intervenors. Concerns about the potential for leakage from tailings to contaminate waterways and water bodies was also a concern.

2.4 Regulatory Direction

The panel's mandate was to advise government on the acceptability of the proposed facility. The federal and provincial governments on the advice of the panel rejected an earlier proposal for the same ore body by a different proponent. The new proposal apparently addressed many of the earlier concerns and the panel recommended it be approved, although it expressed reservations (particularly with regard to tailings management). Among other things, the panel recommended long term monitoring of tailings (in perpetuity) and that a Uranium Mining Contingency Fund be established for use in the event that adverse impacts become apparent in the future.

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3. Approach to CEA

3.1 Issue Identification

The panel was first struck in 1991 to review proposals for uranium mines in Northern Saskatchewan and therefore has a history of dealing with environmental issues associated with uranium mining. Issues were identified through public consultation and expertise of the panel, proponent and consultants.

The main issues examined included occupational health and safety, transportation and biophysical impacts.

3.2 VEC and Indicator Selection

The cumulative effects monitoring program focussed on air, soil, lichen, blueberry, spruce needles, caribou, spruce grouse, water, depositional sediments, macrophytes, benthos and fish. Each of the VECs was monitored for concentrations of metals, radionuclides and other physical and chemical parameters.

3.3 Spatial Bounding

Cumulative impacts were assessed for all existing and potential uranium mines for effects on humans residing at Wollaston, Hatchet and Black Lakes during operation of the mine. A further assessment was carried out for cumulative effects after decommissioning which considered the effects of the mining and milling operation on the local environment.

3.4 Temporal Bounding

Much of the assessment was carried out for the two years of mine development and six years of operation. However, the panel recommended monitoring in perpetuity, mentioning the potential impacts of glaciation in the next ice age.

3.5 Included Projects

The cumulative effects of all of the uranium mines in the area were assessed.

3.6 Assessment Methods

The proponent submitted baseline information, modelling studies and described monitoring programs.

3.7 Impact Characterization

Modelling was conducted for arsenic concentrations in receiving bodies of water. However, the panel pointed out that there was uncertainty as to the amount of arsenic present in tailings and therefore it had difficulty in determining concentrations in receiving bodies of water.

Potential environmental impacts on human health and VECs were also modelled. However, the panel commented that Health Canada had expressed concern that the assumptions were not conservative enough because they substituted southern foods for country foods and may not have accounted for other dietary differences such as the consumption of organ meats.

3.8 Significance of Cumulative Effects

Modelling of arsenic concentration in receiving waters indicated the possibility of exceeding both Saskatchewan Surface Water Quality Objectives and Canadian Water Quality Guidelines. The panel recommended that no licence for tailings disposal be granted until it could be demonstrated that exceeding these guidelines was unlikely.

3.9 Future Management Options

The panel stressed the need for monitoring data to support modelling. Saskatchewan Environment and Resource Management and the AECB responded by setting up a Cumulative Effects Monitoring Working Group (CEMWG) with representatives from Saskatchewan Health, Environment Canada, Department of Fisheries and Oceans, Saskatchewan Research Council, University of Saskatchewan toxicology, Canadian Cooperative Wildlife Health Centre, Saskatchewan Northern Uranium Mines Monitoring Secretariat, and Terrestrial and Aquatic Environmental Managers Ltd. The group has developed a cumulative effects monitoring model and is conducting field observations to verify the model.

In addition, the panel recommended that a Uranium Contingency Fund be established to manage potential future impacts.

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4. Contribution to Practice and Implementation of CEA

The creation of the Cumulative Effects Monitoring Working Group to monitor future impacts is an effective way of gauging the effects of regional development.

References:

1. Report of the Joint Federal – Provincial Panel on Uranium Mine Developments in Northern Saskatchewan. Midwest Uranium Mine Project: Cumulative Observations. November 1997.

APPENDIX A6

COLUMBIA BASIN TRUST and COLUMBIA POWER CORPORATION KEENLEYSIDE DAM and POWER PROJECT

Description of Project

Location:	West of Castlegar, British Columbia, at the southern reach of the Upper Arrow Reservoir
Type:	Hydroelectric Dam

Process

Regulators:	British Columbia Ministry of Energy, Mines and Petroleum Resources (MELP), Department of Fisheries and Oceans (DFO).
Guiding Legislation:	British Columbia Environmental Assessment Act, Canadian Environmental Assessment Act.
Public Issues:	Effects on fisheries.
Regulatory Direction:	Decision pending. Project Committee Report being finalized (February 1998) before submission to the MELP and DFO Ministers.
Dates:	1997: EIA submitted.

Approach

Issues:	Defined a framework to guide the assessment of cumulative effects; identified direct and indirect (i.e., cumulative effects) early during scoping; identified future projects; included spatial bounds south of the U.S.-Canada border.
Assessment Method:	Use of inter-governmental workshops to establish CEA framework.

Contribution to Practice and Implementation of CEA

Collaborative development of a CEA framework.

COLUMBIA BASIN TRUST AND COLUMBIA POWER CORPORATION:

KEENLEYSIDE DAM AND POWER PROJECT

1.0 Description of Project

Project: 150 MW hydro-electric generation facility at the existing Hugh Keenleyside Dam on the Columbia River watershed in south-central British Columbia, and a transmission line to an existing electrical substation near the Canada-U.S. border. The existing dam was built in 1969 to create a larger reservoir and control flooding. The dam is located at the outfall of the Lower Arrow Reservoir which extends 235 km northward to Revelstoke, B.C. This outfall flows into the Columbia River Drainage Basin, in which numerous other dams already exist.

Proponent: Columbia Basin Trust and Power Corporation

Dates: 1995: Notification filed; 1997: EIA submitted.

2.0 Process

2.1 Regulators

- B.C. Ministry of Energy, Mines and Petroleum Resources
- Department of Fisheries and Oceans

Note: A Project Committee composed of members representing federal, provincial and local governments and directly affected First Nations designed the review process. Joint proceedings were conducted pursuant to the Canada-B.C. Agreement for Environmental Assessment Cooperation.

2.2 Guiding Legislation

Federal

- Canadian Environmental Assessment Act (screening provisions)
- Fisheries Act

Provincial

- Environmental Assessment Act

2.3 Intervenors and Public Issues

Issues were identified during a public consultation session. For each issue, the likelihood of an effect, of a residual effect and of a cumulative effect was determined. Key issues identified included fish entrainment and compensation, increases in water temperature, First Nations' fishing use and CEA scope.

2.4 Regulatory Direction

Decision pending as of February 1998.

3.0 Approach

3.1 Issues Identification

Regional issues and effects were identified during public consultations and focussed on water quality; reduced total gas pressure, fish entrainment, thermal changes, in-stream flow needs, effects on fish populations and harvesting of fish; effects of altered reservoir levels and effects of a transmission line (1).

3.2 VECs and Indicator Selection

The assessment included VECs and indicators for both aquatic and terrestrial components of the project. Principle indicators for aquatic issues included total gas pressure, flow volumes, water temperature, changes to fish populations and fish harvesting, and alteration of riparian habitat. Principle indicators for terrestrial issues included area of cleared land and effects on First Nation's traditional land use.

3.3 Spatial Bounding

The study area selected by the Project Committee extended approximately 260 km between the U.S. border and Revelstoke, and varied between 10 and 40 km along both sides of the Upper and Lower Arrow Reservoir (following topographic height-of-land). The decision to terminate the southern boundary at the U.S. border (about 40 km south of the dam) reflects the boundaries of jurisdiction within which Canadian regulators may exercise project conditions, regardless of the ecological reality of the linkage between the dam and downstream waters. The assessment study areas for each environmental component examined varies according to the effect examined.

3.4 Temporal Bounding

The temporal bounds included the consideration of conditions at the time of the construction of the dam in the 1960s through to the present.

3.5 Included Projects

Only approved projects or those already under formal regulatory review were accepted for inclusion as future projects. Projects were selected that had an actual or potential ability to interact with the proposed project within the Columbia Basin, including several dams upstream and downstream of the project within the regional study area, along with pipelines, roads, recreational and residential development and other industrial and resource extraction activities. The projects were categorized by time as past, future and ongoing.

Cumulative effects were evaluated for four scenarios:

- Conditions just prior to construction of Keenleyside Dam
- Existing conditions
- Existing conditions with Keenleyside Dam, and
- Conditions created by selected future projects (specified as those which may interact to the same effect as the Keenleyside project).

3.6 Assessment Methods

A workshop with federal, provincial and First Nations participants was convened to establish a CEA framework for the assessment, summarized as follows:

1. Which direct effects of the project under review are relevant?
2. Which other projects have effects to which these direct effects could contribute incrementally?
3. What is the geographic scope of the assessment regarding direct effects?
4. What is the temporal scope of the assessment regarding direct effects?
5. What is the overall scale of the cumulative effects likely to be?
6. What mitigation could minimize or address the cumulative effects?
7. What are the residual cumulative effects and their significance?

The workshop participants identified a preliminary list of direct environmental effects and determined how indirect effects (i.e., cumulative effects) could also be identified at an early stage in the assessment.

Effects were first assessed to determine the likelihood that any residual local effects had the potential to accumulate further in the region. A screening table was used in which each potential effect (as identified earlier in the EIA) was rated according to the following criteria: direct or indirect, mitigation available, compensation applied, residual effect, significance, certainty, spatial extent and potential as a cumulative effect.

3.7 Impact Characterization

Three effects resulting from power plant operations (altered total gas pressure on fish stocks, altered flow diversion and turbines on fish entrainment, and altered thermal regimes) and three effects due to the transmission line (changes to forestry, changes to wildlife habitat, and visual quality) were examined.

Each effect was examined qualitatively, citing quantitative data when available to further explain the assessment (e.g., volume flows through other dams, discharge rates of certain constituents, area cleared and removed from timber harvesting). This approach allowed a qualitative review of trends in the region and a determination of the relative contribution caused by the proposed project and other projects in the region. Finally, an overall residual effect of the proposed project was determined and mitigation and compensation discussed. A matrix was provided that identified which of 22 projects and activities in the region contribute to the seven types of cumulative effects examined.

3.8 Significance of Cumulative Effects

The proponent largely determined significance by concluding that the proposed project would add only small incremental effects. For example, it stated that loss of wildlife habitat would constitute only a small fraction of total available habitat in the region and loss of forest harvesting land base would represent only a small fraction of the total available in the region. With respect to Total Gas Pressure (TGP), the proponent determined that the proposed project would reduce TGP and therefore cause positive effects on all aquatic species to the U.S. border and beyond.

3.9 Future Management Options

Considerable reliance was placed on local mitigation and compensation to offset any cumulative effects. For example, enhanced fish production in the reservoir was suggested as a means to prevent potential fish losses

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4.0 Contribution to Practice and Implementation of CEA

The development of a query-based CEA framework assists in providing a flexible and general approach to assessments.

References:

1. Keenleyside Project Committee (KPC). Columbia Power Corporation Keenleyside 150 MW Powerplant Project: Amended Requirements for the Completion of the Project Report. 1997.

APPENDIX A7

EAGLE TERRACE INC.
EAGLE TERRACE SUB-DIVISION

Description of Project

Location:	Canmore, Alberta
Type:	New Residential Sub-Division

Process

Regulator:	Town of Canmore, Environmental Assessment Review Committee.
Guiding Legislation:	Town of Canmore General Municipal Plan.
Public Issues:	Loss of critical wildlife winter habitat, obstruction of regional wildlife movements, loss of recreational lands, continuing loss of montane ecosystem.
Regulatory Direction:	Incorporation of wildlife movement corridors into project design to mitigate effects on wildlife movements.
Current Assessment Status:	Approved.
Dates:	1996: EIA submitted; 1997 Decision to approve.

Approach

Issues:	Characterizing extent of continued loss of wildlife habitat in mountain valley and effects on wildlife movements, plus loss of natural areas valued by local residents for recreational use.
Assessment Methods:	Calculation of incremental land lost (direct and indirect) using a GIS due to changes between successive development scenarios.

Contribution to Practice and Implementation of CEA

Use of GIS for trend analysis and examination of a future scenario which did not include the project.

EAGLE TERRACE INC.:

EAGLE TERRACE SUBDIVISION

1.0 Description of Project

Project: 67 ha residential subdivision adjoining existing subdivisions in the town of Canmore, Alberta. Approximately 60 units and a small commercial and service area along an existing access road would be built in the first phase. The project is located in a relatively undisturbed montane valley slope between extensively disturbed urban areas. The project design incorporates environmental easements to maintain some natural features of the area.

Proponent: Eagle Terrace Inc.

Dates : 1994: Notification filed; 1996: EIA submitted; 1996: Decision.

2.0 Process

2.1 Regulators

- Environmental Assessment Review Committee, an independent citizens' advisory body which previewed the application to ensure that the assessment met the information and quality requirements as expected by Council
- Town Council

2.2 Guiding Legislation

Municipal

- Terms and conditions prescribed by the Town of Canmore, guided by the planning principles of the General Municipal Plan.

Note: Although the assessment was not specifically governed by provincial or federal statutes, it generally followed typical requirements laid out in the Alberta Environmental Protection and Enhancement Act.

2.3 Intervenors and Public Issues

Concerns were raised about the "nibbling loss" of wildlife habitat in the mountain valley, and the obstruction of wildlife movement corridors as developments continue to advance up the lower slopes of the Bow River valley. Continued growth in tourism has increased demand for resident and visitor facilities, resulting in development pressures for more housing. Loss of recreational opportunity (i.e., access and use) was also of concern to local residents.

Various members of the public had the opportunity to express their concerns at an informal town hall meeting, including local residents, business interests and environmental groups.

2.4 Regulatory Direction

The proponent was directed to incorporate an undisturbed strip of land passing through the development as a wildlife corridor. This condition was part of a larger initiative to facilitate wildlife movements around Canmore and throughout the Bow Valley (leading to the creation of a committee that researched and reported on available corridors).

3.0 Approach to CEA

3.1 Issue Identification

Regional issues focussed on the loss of natural areas valued by local residents for recreational use and as areas representative of the Rocky Mountain montane ecosystem (1). Displacement of wildlife; specifically large ungulates and carnivores was of great public concern. Effects on water were deemed negligible.

3.2 VEC and Indicator Selection

Three wildlife species were chosen as indicators:

- Elk
- Wolf, and
- Swainson's Thrush

Elk was used to assess ungulate use and to serve as an ecological indicator of early feral habitat use. Wolf was used to assess large-carnivore use and to serve as an ecological indicator of regional wildlife movements between Banff National Park and areas east of the Park. Swainson's Thrush was used to assess songbird use and to serve as an ecological indicator of localized forest habitat fragmentation.

3.3 Spatial Bounding

The study area boundaries were defined by an ecosite map of the valley that included all projects of concern which contributed substantially to habitat change and provided an adequate regional representation of natural habitat conditions.

3.4 Temporal Bounding

The scenarios used to assess incremental changes caused by developments in the valley defined the temporal bounds. The four scenarios were as follows:

- Pristine: conditions prior to extensive human development (i.e., approximately year 1800);
- Existing conditions (i.e., 1995);
- Future conditions that are predicted to occur, but without the project under review (a number of years ahead); and
- Future conditions that are predicted to occur with the project under review.

3.5 Included Projects

The GIS analysis considered direct and indirect habitat changes due to highways and major roads, a railroad, the Town urban core, outlying subdivisions and settlements, and industrial activity (e.g., aggregate mining).

3.6 Assessment Methods

The assessment method was based on the calculation of available habitat in the valley between successive development scenarios. This approach provided information about incremental habitat loss for key wildlife indicators.

3.7 Impact Characterization

Ecosites (classifications of vegetation-landscape association that categorize an area based on its soils, drainage, and vegetation characteristics) were used to create a habitat base map that provided input into a GIS. The map defined a regional study area of approximately 17,000 ha, which extended west from Canmore to the boundary of Banff National Park, and east to the eastern edge of the Rocky Mountains. Twenty-four ecosites were interpreted, based on their suitability for

providing basic wildlife habitat requirements (e.g., cover, forage), into three habitat suitability ratings (low, moderate and high) for both summer and winter.

The Eagle Terrace site was mapped together with existing developments, foreseeable projects (i.e., those under application for approval or approved), and various roads, railways and other infrastructure. To represent habitat loss due to sensory disturbances such as noise and light, an "alienation buffer" was defined for each indicator species.

Development scenarios were defined by a combination of habitat suitability and level of development to represent human and natural environmental conditions as a "snapshot in time". Four scenarios described changes in the valley, as follows:

- "Pristine", represented current valley conditions with all developments removed;
- "Current", represented the existing Bow Valley with its current settlements, roads and other developments;
- "Reasonably Foreseeable", included all developments in the "Current" scenario plus projects already under construction or for which there was considerable likelihood that they would proceed; and
- "Full Build", added the proposed development to the “Reasonably Foreseeable” scenario.

Direct habitat loss (due to overlap disturbances on the habitat suitability map), indirect habitat loss (due to the alienation buffers), and total or “effective” loss (i.e., direct and indirect) were determined for summer and winter habitat conditions. The difference in habitat loss between each scenario was calculated. The final calculation therefore provided an indication of the relative contribution of Eagle Terrace to changes in the valley. This contribution could also be compared to changes that had already occurred due to other projects.

3.8 Significance of Cumulative Effects

It was determined that the proposed project would contribute a small loss of montane and wildlife habitat relative to the losses that had previously occurred. In general, existing developments contributed to a loss of 21% or 2789 ha of montane ecosite (in an area of approximately 17,000 ha), while the proposed development represented a habitat loss of 2%. A large proportion of the most important habitat (i.e., high suitability in winter) had been lost to previous development.

Habitat loss has caused ungulates to avoid the mountain benchlands for winter refuge, carnivores to avoid the valley corridor for regional movements, and nesting songbirds to avoid the area generally.

3.9 Future Management Options

A number of mitigation measures were recommended, adopting many of the conditions imposed by the Natural Resources Conservation Board's earlier Three Sisters Resort decision. Concerns related to wildlife were addressed at a regional level and the proponent was required to incorporate wildlife movement corridors and provide linkages with other corridors throughout the valley.

Following the Three Sisters Resort proceeding, the Town of Canmore had initiated several activities to address environmental implications of continued human population growth. However, to ensure that subsequent developments acknowledge regional corridors and incorporate design features supporting their ongoing viability, the Town continues to address each development on a case by case basis.

4.0 Contribution to Practice and Implementation of CEA

The Eagle Terrace CEA, a Bow Valley regional-level assessment, examined cumulative effects on a larger scale and over a longer period of time than had any previous assessment in the region. The GIS spatial analysis technique allowed trends to be determined. Professional judgement was used to interpret mapping results and predict long-term implications for wildlife populations. Such an approach has increasingly found acceptance amongst assessment practitioners in examining changes on terrestrial ecosystems.

In addition, the CEA included a future scenario which excluded the proposed development thus allowing the proponent to isolate environmental impacts specifically related to the project.

References:

1. Eagle Terrace Inc. Area Structure Plan, Technical Report, Volume 1: Environmental Impact Assessment. Prepared by Axys Environmental Consulting Ltd. for Eagle Terrace Inc., Canmore, Alberta. 1996.

APPENDIX A8

EXPRESS PIPELINE LTD. (ALBERTA ENERGY COMPANY AND TRANS-CANADA PIPELINES) EXPRESS PIPELINE

Description of Project

Location:	Southern Alberta, between Hardisty and U.S. border
Type:	Crude Oil Pipeline

Process

Regulators:	National Energy Board, Canadian Environmental Assessment Agency.
Guiding Legislation:	National Energy Board Act, Canadian Environmental Assessment Act
Public Issues:	Loss and fragmentation of native prairie, upstream/downstream effects, loss of rare and endangered plant species or communities, introduction of weeds, effects on provincially and nationally important environmentally sensitive areas, effects on wildlife (habitat loss and fragmentation, sensory disturbances, mortality).
Regulatory Direction:	Approval conditions regarding local mitigation, rerouting, rescheduling; acknowledgement of cumulative effects concerns and implementation issues due to lack of thresholds.
Current Assessment Status:	Decision not reviewed.
Dates:	1995: EIA submitted; 1996: Hearing and Decision to approve.

Approach

Issues:	Degree of consideration of cumulative effects required under Acts, requirement to consider upstream effects, contribution to global effects (i.e., greenhouse gases), effectiveness of reclamation techniques to restore disturbed areas to original condition.
Assessment Methods:	Ecosite classification along pipeline right-of-way, threshold approach for air quality and no net loss for fish, a qualitative approach for wildlife based on landscape ecology and species biology.

Contribution to Practice and Implementation of CEA

Importance of applying local mitigation to minimize regional effects. Questions of whether proponents can be held responsible for unacceptable loss of VEC on a regional scale and implications of reclamation which is not fully effective in highly sensitive areas.

EXPRESS PIPELINE LTD.
(ALBERTA ENERGY COMPANY AND TRANS-CANADA PIPELINES):

EXPRESS PIPELINE

1.0 Description of Project

Project: Oil pipeline extending 435 km from Hardisty in southeastern Alberta to the U.S. border (there connecting with another pipeline in Montana). The project also included associated components, such as interconnect terminals, storage tanks and pump stations.

Proponent: Alberta Energy Company Ltd. and TransCanada Pipelines Ltd. (Express)

Dates: 1995: Notification and EIA filed; 1996: Decision issued.

2.0 Process

2.1 Regulators

- National Energy Board
- Canadian Environmental Assessment Agency

Note: A joint panel was convened to conduct public hearings.

2.2 Guiding Legislation

Federal

- Canadian Environmental Assessment Act
- National Energy Board Act

2.3 Intervenors and Public Issues

Various environmental organizations intervened in the proceedings. Concerns included consideration of upstream and downstream activities not directly associated with the project under review and pipeline routes through northern fescue grasslands.

2.4 Regulatory Direction

The panel attached 41 conditions to its approval, some of which related to local cumulative effects concerns along the pipeline right-of-way. The panel concluded that habitat fragmentation should not result in significant adverse effects on wildlife with adequate implementation of mitigation measures for wildlife, vegetation and soils. Effects on air quality, especially greenhouse gas emissions, were considered negligible due to the implementation of standard mitigation measures. One panel member dissented, stating that the assessment provided inadequate evidence regarding effects on vegetation and wildlife and cumulative effects and that acceptance of mitigation measures preempted a more thorough assessment of effects.

3.0 Approach to CEA

3.1 Issue Identification

The proposed project was routed through two grassland eco-regions in an area currently undergoing extensive agricultural and oil and gas activity. Intervenors raised concerns about cumulative regional habitat loss and native prairie fragmentation. Also, the proposed project crossed two major rivers which raised concerns regarding sediment loading and effects on fish.

The proponent did not explicitly address cumulative effects in the assessment. However, it did consider the likelihood that the proposed project would cause local effects which could lead to regional effects.

3.2 VEC and Indicator Selection

VECs of most concern from a cumulative effects point of view were plant and wildlife species. In general, VECs included migratory birds, fish, plants and wildlife listed on the COSEWIC rare and endangered species list. The assessment focussed on VECs which were deemed to be vulnerable based on their listed status and the degree to which local impacts may have adversely affected populations. Eight rare plant species were identified. Wildlife species of management concern along the route included eight mammals, fifteen birds and nine reptiles.

3.3 Spatial Bounding

Separate study areas were delineated for each type of potential impact, as follows:

Potential Impacts	Study Area Boundary
Other Projects	100 km wide corridor along the pipeline right-of-way.
Environmental concerns Other land-use issues	1.6 km right-of-way corridor (used for routing the pipeline alignment). The actual width within which disturbance occurs during construction is approximately 25 to 30 m.
Wildlife	500 m buffer along the right-of-way plus: • local, the right-of-way; • sub-regional, 1.6 km corridor and • regional, beyond the corridor

Special attention was paid to species of regional significance and to possible reproductive habitats along the right-of-way (e.g., burrowing owl). Areal extent of habitat loss was calculated.

3.4 Temporal Bounding

- 3 years from project construction, representing the time in which direct impacts were most severe.
- 5 – 10 years anticipated period in which major grasses reestablish themselves.
- 10 to 20 years anticipated period in which other grasses and non-vascular plants recover.

3.5 Included Projects

The proponents considered various other projects, activities, and landscape features, including railways, roads, grazing ranges, environmentally sensitive areas, agricultural lands, and other energy projects (particularly other pipelines).

3.6 Assessment Methods

Local effects were assessed for various environmental components, including land use, soils, vegetation, fisheries, wildlife, archeological, palaeontological and heritage resources and environmentally sensitive areas.

The significance of residual, local, direct effects was first established, an approach which recognized several routing considerations such as avoidance of environmentally sensitive areas and local mitigation issues such as reclamation of

soils and vegetation in native prairie. These measures were collectively intended to reduce local effects and the likelihood of regional effects (including “nibbling loss” of wildlife habitat and rare plant communities/species).

Effects on wildlife species were ranked by direction of effect, scope, magnitude and duration.

Assessment methods included qualitative discussion of effects contributed by various past, existing and future projects, quantitative assessment if thresholds and modelling tools were available (e.g., air quality, noise) and the use of mapped features and an “ad-hoc” committee approach, in which various individuals were contacted to provide information from which types of potential cumulative effects could first be identified.

3.7 Impact Characterization

Cumulative effects was implicitly addressed in various ways, beginning with the recognition that certain local effects could lead to cumulative regional effects. For example, although the proponent anticipated effects on some provincially or nationally rare species, it argued that a rare plant species is not so distributionally localized as to be eliminated by a single pipeline right-of-way. The proponent also attempted to maximize use of existing access routes, thereby reducing the effects of road proliferation. The only long-term effects identified would be those impacting air quality, loss of habitat at pump stations and noise from stations.

3.8 Significance of Cumulative Effects

Without thresholds for many of the VECs, and without provincial land use objectives and guidelines, the proponent suggested that it would be difficult if not impossible to adequately assess cumulative effects and their significance.

In its deliberations on the proposed project, the Panel identified three requirements that must be met before they would consider cumulative effects (Priddle et al. 1996, p. 187):

1. An environmental effect from the project itself must be demonstrated;
2. The environmental effect must be demonstrated to operate cumulatively with the environmental effects from other projects or activities; and
3. Other projects or activities must not be hypothetical and have been, or will be, carried out.

These requirements were developed to provide guidance as a consequence of the Panel’s deliberation on whether associated projects (in this case, upstream and downstream projects) should be considered. The Panel further stated that “A

'cumulative effects' analysis of the project should be based on the results of scientific investigation and systematic analysis, and should be presented to the Panel in a manner that allows a meaningful evaluation of the cumulative effects" (p. 188).

In summary, before a cumulative effect could be considered significant, there had to be a measurable environmental effect, any such effects had to act cumulatively, and any such cumulative effects would have to be likely.

The proponent contended that cumulative effects on native prairie were not significant given that most of the project disturbance would be local to the pipeline right-of-way and mitigable since the proposed project consisted of buried pipeline and any disturbed soils and vegetation along the right-of-way would be reclaimed. The proponent expected 80% of the vegetative composition of the right-of-way to be similar to pre-disturbance conditions within five years, and full recovery of the different botanical components to occur within 20 years. No long-term substantial effects on wildlife were expected as a result of clearing or fragmentation.

Although the ecological attributes of the Sage Creek Environmentally Sensitive Area were acknowledged, the proponent argued that the area had already undergone grazing pressures that were not representative of the type of "pre-development" conditions favoured by intervenors. This is an example of "effects masking", in which the effects of a project may be hidden amongst the effects caused by an existing dominant land use. Frequently the existing use had not been subjected to the same level of scrutiny as required for a proposed project.

3.9 Future Management Options

The proponent established an advisory committee to direct reclamation and to monitor activities regarding effects on native prairie. A reclamation plan was created for each eco-region crossed by the pipeline and a further vegetation inventory was planned to assist in better designing reclamation requirements and in identifying rare communities and species.

4.0 Contribution to Practice and Implementation of CEA

The proponent raised two important cumulative effects questions. First, whether a proponent can, in the absence of any upper limit or acceptable threshold of disturbance, be singly held accountable for unacceptable loss of a VEC on a regional scale. Second, if mitigation (i.e., reclamation in this case) is not fully effective, is there the possibility that in highly sensitive areas (e.g., native prairie), full recovery will never occur on a regional basis?

References:

1. Priddle, R., A. Côté-Verhaaf, R.D. Revel and G.M. Lewis. Express Pipeline Project: Report of the Joint Review Panel. Prepared for the National Energy Board and Canadian Environmental Assessment Agency. National Energy Board, Calgary, Alberta. 1996.

APPENDIX A9

IMPERIAL OIL RESOURCES LTD.
COLD LAKE EXPANSION PROJECT

Description of Project

Location:	Cold Lake, Alberta
Type:	In-Situ Oil Sands

Process

Regulators:	Alberta Environmental Protection (AEP), Alberta Energy and Utilities Board (AEUB).
Guiding Legislation:	Alberta Environmental Protection and Enhancement Act, Energy Resources Conservation Act, Oil and Gas Conservation Act, Oil Sands Conservation Act, Hydro and Electrical Act.
Public Issues:	Environmental: Changes to air quality, changes to surface and groundwater quality, decreases in surface water levels, loss of wildlife habitat, reduced opportunities for fishing and other resource harvesting (especially trapping), increased road access; Socio-economic: Employment opportunities.
Regulatory Direction:	Decision pending.
Dates:	1997: EIA submitted.

Approach

Issues:	Determination of extent of activities in other nearby projects, integration of results from assessment of various environmental components.
Assessment Methods:	The Focussed Environmental Assessment process provided an overall framework. All analysis was based on the use of Impact Models for each environmental component assessed. GIS or other modelling was used with qualitative discussion based on quantitative results and professional judgement.

Contribution to Practice and Implementation of CEA

Use of Impact Models and GIS to determine degree by which local effects may lead to regional cumulative effects.

IMPERIAL OIL RESOURCES LTD.:

COLD LAKE EXPANSION PROJECT

1.0 Description of Project

Project: Expansion of an existing *in situ* oil sands operation west of Cold Lake, Alberta. Bitumen product is extracted using the Cyclic Steam Stimulation process in which steam is injected into the ground for extended periods of time, followed by an extraction of the heated product. The project includes the construction of new well pads, pipeline corridors, access roads, transmission line and a central processing plant. Production is expected to increase from approximately 14,900 m^3/d to more than 20,000 m^3/d within a few years of operation.

Proponent: Imperial Oil Resources Ltd. (Esso)

Dates: 1996: Notification filed; 1997: EIA submitted.

2.0 Process

2.1 Regulators

- Alberta Energy and Utilities Board
- Alberta Environmental Protection

2.2 Guiding Legislation

- Alberta Environmental Protection and Enhancement
- Energy Resources Conservation Act
- Hydro- Electric and Energy Act
- Oil and Gas Conservation Act
- Oil Sands Conservation Act

2.3 Intervenors and Public Issues

The proponent conducted public consultations with local and regional stakeholders prior to and during the preparation of the EIA. Stakeholders included aboriginal groups, rights holders in the project vicinity and non-governmental groups. Concerns (issues) were identified for various environmental components. Issues especially

relevant to cumulative effects included: acidic deposition, long-range [air] transport of pollutants, greenhouse gas emissions, long-term water balance in the region, water quality, effects on fish and fishing, effects on old-growth forest, loss of wildlife habitat and proliferation of road access.

2.4 Regulatory Direction

Decision pending as of February 1998.

3.0 Approach to CEA

3.1 Issue Identification

The proponent addressed issues which potentially caused impacts beyond the local study area, including (1, page 2).

- Acidic deposition
- Odours
- Greenhouse gas emissions
- Lowering of lake water levels
- Contamination of water
- Depletion of aquifers
- Contamination of fish
- Increased harvest pressures on fish
- Loss of vegetation through land clearing
- Effects of airborne deposition on vegetation
- Loss, sensory alienation and fragmentation of wildlife habitat
- Direct wildlife mortality due to increased traffic and hunting harvest
- Decreased opportunities for resource harvesting (fish, traditional plants, hunting, timber, trapping)
- Increased road access, and
- Visual effects

Issues were identified from both public consultation and during the proponent's first assessment workshop in which "interaction matrices " were used. These matrices, correlating environmental components to various project activities, identified the likelihood of an effect occurring and ranked the degree to which an effect may be substantial enough to deserve further examination in a more detailed assessment (i.e., the EIA and CEA).

3.2 VEC and Indicator Selection

VECs were selected based on ranking systems developed for each environmental component. The rankings prioritized the VECs to identify candidates for further detailed assessment. Depending on the results of the EIA, some of these VECs carried forward to the CEA. Most of the VECs were also used as indicators on which the assessment effort was focussed. VECs used in the CEA included the following:

- Emitted gases transported over long distances (e.g., NO_x, SO_2)
- Combined water volume withdrawals
- Water quality constituents affecting drinking water standards
- Sport fish species
- Vegetation ecosites
- Moose
- Black bear
- Lynx
- Fisher
- Timber harvest areas
- Fur bearers
- Game species
- New road access, and
- Recreational enjoyment

3.3 Spatial Bounding

A separate local and regional study area was identified for each environmental component although, in some cases, the same study was chosen for more than one component. Generally, spatial boundaries were based on existing jurisdictional boundaries or boundaries of the watershed surrounding the project. Effects were examined at local, combined (i.e., all project components) and regional scales, resulting in a regional study area that included several other large projects.

3.4 Temporal Bounding

As the proposed project will be implemented in phases and has an expected operational life of up to thirty years, the proponent chose a similar timeframe to establish a future temporal bound for the CEA. In all, three temporal bounds were identified:

- “Past”, representing regional conditions prior to the proposed major heavy-oil development in the region (i.e., pre-1979);
- “Existing”, which included the proponent’s current operations and other existing projects in the region (e.g., other oil sands projects, forestry); and
- “Reasonably Foreseeable”, which included all future projects with or awaiting regulatory approval.

3.5 Included Projects

Five energy developments surrounding the proposed project were identified as having the potential to cause an effect on the VECs highlighted in the proponent's EIA. The boundaries, size and general operational activities of each development were first determined and mapped. Further specific information regarding operational parameters was requested in a questionnaire sent to each operator in the area although the information returned was generally quite limited.

3.6 Assessment Methods

A Focussed Environmental Assessment (FEA) Process formed the basis for both the EIA and CEA. Three workshops (issues scoping, assessment and mitigation) provided a forum for practitioners to address various assessment issues. The FEA also made use of impact models to describe important cause and effect relationships between the proposed project and its surrounding environment.

Nine major environmental resource components were examined, including air systems, surface water quantity, surface water quality, groundwater, aquatic resources, soils and terrain, vegetation, wildlife, and resource use.

The potential effects of the proposed project were assessed in two ways. First, the combined effects from various activities directly associated with the project such as pads, roads, and processing facilities were assessed. The nature and extent of these effects were evaluated in the EIA as part of the assessment of project-specific impacts. Secondly, cumulative regional effects beyond the proposed expansion area were assessed in the CEA for both the proposed project and all other existing and reasonably foreseeable projects.

Within the CEA framework, potential effects on each environmental component were assessed using the most appropriate approach as decided by the assessor. This included, to varying degrees, a mix of quantitative analysis and qualitative discussion.

Upset events (i.e., accidents) were examined separately in two "upset scenarios" in which conditions were modelled as "worst-case" and potential effects examined using impact models for each scenario.

3.7 Impact Characterization

The proponent relied on results from a total of 35 Impact Models completed in the EIA. The models assessed effects on each of nine environmental components. These models generally dealt with local effects; however, some models had regional implications "built-in" due to the wide extent of the effects. In the latter case, conclusions indicated by the models served as the basis for further assessment at a regional scale in the CEA (which consisted of a chapter in one of the volumes of the

application). The Impact Model itself constituted a substantial portion of the assessment approach for some cumulative effects. Due to the close cause and effect relationships between different environmental components (e.g., water quality and aquatic resources), many Impact Models were "linked" together so that the output (i.e., results) from one model provided input into another.

The assessment of cumulative effects involved various degrees of quantitative analysis and qualitative discussion. Qualitative analysis was conducted if a quantitative technique was not available or if the proponent determined that a qualitative discussion was adequate in the circumstances. In all cases, interactions with various other projects were considered if results from the Impact Model indicated a possibility of other than local effects. Temporal development scenarios were explicitly used in the assessment of effects on wildlife.

The following summarizes the assessment approach used for each environmental component:

Potential Impacts	Impact Characterization
Air quality	Dispersion and acidic deposition modelling was used in a 23 km x 23 km area surrounding the project. This area included a number of other major oil sands projects and other infrastructure. Maximum predicted concentrations within the study area were determined for existing sources and the proposed project. Air quality levels were compared to regulated levels using recognized air quality models.
Surface water quality	Various users in affected watersheds made comparison of water volume withdrawals.
Surface water quantity	Predicted local contaminant was compared to regulated levels.
Groundwater	The location and rate of groundwater extraction was determined for various regional users of groundwater and a water balance used to determine effects on surface waters.
Aquatic Resources	Effects on fish were examined due to changes in regional water levels, water quality and increased level of fishing activity.
Soil and terrain	Cumulative effects was not an issue because the effects are local and land must be fully reclaimed.
Vegetation	The amount of clearing due to the proposed and other projects within the regional study area was determined, and compared to potential impacts caused by the proposed project.

Potential Impacts	Impact Characterization
Wildlife	Wildlife was assessed by examining total clearing (providing a measure of gross cumulative habitat loss), access density (providing an indicator of habitat fragmentation) and potential for secondary effects from improved access, and changes in VEC habitat suitability and availability in relation to current and pre-development conditions within the regional study area. A GIS was used to calculate habitat changes for the four indicator species.
Resource use	The proponent identified other areas in the region offering equivalent or better opportunity for similar resource activity, highlighted agents of change and regional trends, qualitatively assessed capability of alternative areas to offset present and future losses due to the project or provide acceptable alternative resource use opportunities, and qualitatively assessed the incremental effects of the proposed project on the same resource uses that may be affected by the other projects and activities.

3.8 Significance of Cumulative Effects

The significance of residual effects was not explicitly stated in the CEA. Instead, appropriate mitigation measures were identified and probable residual effects discussed. Explicit recognition of significance occurred in the examination of each impact model in the EIA. This determination was based on consideration of a number of attributes regarding significance, including direction, scope, duration, frequency, and magnitude of the effect.

In general, the proponent deemed that proposed mitigation measures would result in no significant local and direct effects. An indication of the uncertainty associated with the significance conclusion was provided through the use of a “Confidence” attribute, which reflected the degree to which the assessor was confident that the data and analysis provided an accurate result.

Significance for cumulative effects was not deemed useful as regional thresholds were not available against which to compare direct changes due to the project. The only exceptions to lack of regional thresholds were air and water quality, in which case the assessment demonstrated the degree to which the proposed and other projects contributed to an increase in levels from those stipulated by the air quality guidelines.

3.9 Future Management Options

The proponent expects mitigation of local effects to contribute substantially to reducing or eliminating cumulative regional effects. In some cases, however, specific regional mitigation measures were recommended, including a regional access management plan and regional co-ordination amongst administrative bodies of land use. Such efforts would assist in practically meeting the objectives already in place as defined in the region's Integrated Resource Plan.

4.0 Contribution to Practice and Implementation of CEA

Using an FEA assessment framework allowed cumulative effects assessments to be treated as an extension of results from the EIA.

Professional judgement was often used to provide the final interpretation of assessment results regarding overall regional and long-term implications on VECs. Extensive use of quantitative analysis (i.e., air models, water volumes, spatial changes to vegetation and habitat) considerably improved the final conclusions made by assessment practitioners.

References:

1. Imperial Oil Resources Ltd. (IORL). Cold Lake Expansion Project, Volume 2, Part 1: Biophysical and Resource Use Assessment. Prepared by Axys Environmental Consulting Ltd. for Imperial Oil Resources Ltd., Calgary, Alberta. 1997a.

2. Imperial Oil Resources Ltd. (IORL). Cold Lake Expansion Project, Volume 2, Part 2: Impact Model Descriptions. Prepared by Axys Environmental Consulting Ltd. for Imperial Oil Resources Ltd., Calgary, Alberta. 1997b.

APPENDIX A10

MANALTA COAL LTD.
MERCOAL PROJECT

Description of Project

Location:	Near Hinton, Alberta
Type:	Open Pit Coal Mine

Process

Regulators:	Energy Resources Conservation Board, Alberta Environmental Protection.
Guiding Legislation:	Coal Conservation Act, Land Surface Conservation and Reclamation Act.
Public Issues:	Most important public issues included: design and layout of mine, coal processing plant (including tailings management and water supply), land use conflicts, suitability of conceptual development and reclamation plans, social and economic considerations.
Regulatory Direction:	The mine was approved by the ERCB in 1983. Decision not reviewed.
Dates:	1982: EIA submitted; 1983: Decision.

Approach

Issues:	Issues were identified through baseline field studies, which were designed in consultation with the regulators and other stakeholders. Broad environmental issues/ parameters were identified: climatology and air quality, groundwater, hydrology, fisheries and aquatic ecology, geology, soils, vegetation, wildlife and forestry.
Assessment Methods:	The assessment did not explicitly examine cumulative effects. However, extensive field studies to support modelling of some parameters resulted in an indirect consideration of cumulative effects.

Contribution to Practice and Implementation of CEA

This was an early assessment, which was not required to address cumulative effects.

MANALTA COAL LTD.:

MERCOAL PROJECT

1.0 Description of Project

Project: Surface coal mining project near Edson and Hinton in west central Alberta.

Proponent: Manalta Coal Ltd.

Dates: 1982: EIA submitted; 1983: Decision.

2.0 Process

2.1 Regulators

- Energy Resources Conservation Board (ERCB)
- Alberta Environmental Protection

2.2 Guiding Legislation

- Coal Conservation Act
- Land Surface Conservation and Reclamation Act

Note: Cumulative effects assessment was not formally required by legislation until the new Alberta Environmental Protection and Enhancement Act came into effect in 1992. However, the proponent addressed environmental impacts in the context of regional issues.

2.3 Intervenors and Public Issues

Intervenors included individuals, representatives of the towns of Hinton and Edson, the Yellowhead Regional Planning Commission, Smallboys Camp (Metis settlement), ERCB staff and the Province of Alberta.

The main issues raised by the application included (1, page 8):

- Design and layout of the mine
- Coal processing plant (including tailings management and water supply)
- Land use conflicts

- Suitability of conceptual development and reclamation plans
- Social matters
- Economic considerations

2.4 Regulatory Direction

The mine was approved by the ERCB.

3.0 Approach to CEA

3.1 Issue Identification

The proponent initiated biophysical baseline studies prior to submitting its EIA (2 page 27). It developed a detailed field program after consultation with the public and government. Field programs included wildlife habitat assessment, air quality and climate monitoring and regional studies review. The baseline information was used to identify parameters for the EIA together with materials prepared by the proponent with respect to mine and plant design.

The proponent also held a series of meetings with public and private sector representatives to identify socio-economic issues prior to submitting its EIA (3, Appendix 3). Participants included governmental service providers, Chambers of Commerce, outdoor recreation organizations and individuals that the proponent described as “key community members”. The proponent identified the following issues: infrastructure and services (including education, health, fire and police protection, community recreation, housing, utilities, commercial services and transportation); social features (community cohesion and social problems) and land and resource use (including land use policy and recreational use).

The environmental impact assessment was carried out on the following environmental components:

- Climatology and air quality
- Groundwater
- Hydrology
- Fisheries and aquatic ecology
- Geology and surficial geology
- Soils
- Vegetation
- Wildlife
- Forestry

3.2 VEC and Indicator Selection

Wildlife VECs identified were as follows:

- Elk
- Deer
- Horses
- Snowshoe hare
- Red squirrel
- Beaver
- Muskrat
- Coyote
- Wolf
- Black bear
- Grizzly bear
- Marten and fisher
- Ermine
- Mink
- Wolverine
- Lynx

In addition, the proponent studied small mammals, amphibians and reptiles. Birds were divided into water birds, upland game birds, raptors and non-terrestrial game birds.

3.3 Spatial Bounding

The proponent included a brief discussion of regional development in the area, including historical development of the coal industry and other types of industry (forestry in particular) (2, page 11). The scope of the EIA was intended to address impacts associated with the project, including both regional and site specific considerations (2, page 13).

The region encompassed the Hinton-Edson and Coal Branch area of west central Alberta. Specific regions were identified for some environmental impact parameters and general regional characteristics for others (e.g., soils, geology, vegetation, and forestry).

Regional aspects of air quality and climatology were assessed for a large area (up to 40 km from the proposed project) bounded by the availability of stations providing data. For hydrology studies, the McLeod River watershed was delineated; the entire project lay within this watershed. Baseline water quality data was studied or collected from several streams in the watershed. For socio-economic analysis, the proponent identified an area of influence directly and indirectly affected by the proposed project and other resource developments approved or proposed for the region.

3.4 Temporal Bounding

The proponent included biophysical impacts spanning construction, operations and reclamation phases of the proposed project, a period of approximately 30 years. As to socio-economic impacts, population and labour force projections were extended to 1991, although analysis was largely confined to the 1987 forecast.

3.5 Included Projects

The proponent discussed historical developments in the area, as well as other regional developments. In characterizing the baseline, the proponent, in effect, was identifying the impacts of all previous development in the area. However, the proponent did not address proposed or future regional developments in the context of its biophysical impacts analysis.

The proponent explicitly stated, "It is a generally accepted principle that a socio-economic impact assessment should develop a base case of likely future events in the study region against which the incremental effects of the project are compared in a consistent manner" (3, page I-2) and that the "information is required to construct scenarios of future development without the project and therefore to enable the impacts of the proposed McLeod River Project to be assessed in the context of development already underway or proposed by the mid 1980s" (3, page III-5). Potential developments in mining, forestry, oil and gas and tourism were described. Labour force increases for forestry and oil and gas developments were predicted to total 120 at most. No population increases were forecast for tourism.

Four approved and two proposed mining operations other than the proposed project were identified, with a 1990 estimated "incremental operations workforce" of 1,980 (3, Table 3-7). The proposed project was projected to add a further 600 workers during full operations. All proposed mining operations had applied for approval as at the date of the proponent's EIA. A proposed transportation development improving access to mining projects within the study area was also included. The proponent then developed four scenarios based on population projections for Hinton and Edson with and without the proposed project and with and without the proposed road (3, pages III-20 and III-21).

3.6 Assessment Methods

For each parameter, the proponent first described existing conditions (the baseline), then the impact of the project and mitigating measures. Some of the baseline information was derived from previous studies in the area, and the proponent prior to submitting the EIA carried out some field studies. Modelling was conducted for some parameters, including air and water quality.

3.7 Impact Characterization

Impacts were assessed on the basis of magnitude, duration and value (positive or negative), qualitatively or quantitatively. The EIA contained a series of tables, which identified environmental impacts and mitigating measures, summarized as follows:

Parameter	Method of Assessing Impact
Climatology and air quality	Predictions based on baseline data and expected impacts
Groundwater	Predictions based on baseline data and expected impacts
Hydrology	Predictions based on baseline data and expected impacts Comparison to water quality guidelines
Fisheries and aquatic ecology	Predictions based on baseline data and expected impacts
Geology and surficial geology	Predictions based on baseline data and expected impacts
Soils	Predictions based on baseline data and expected impacts
Vegetation	Predictions based on baseline data and expected impacts Vegetation mapping
Wildlife	Estimates of wildlife density
Forestry	Mapping of forestry leases and productivity Economic calculations of lost productivity due to mine development and operation

Estimates of wildlife density in the Athabasca River Basin (which includes the McLeod River study area) were provided for 1973. The proponent listed other activities in the area which had impacted wildlife (e.g. logging, hunting, mining, petroleum and natural gas development). Field investigations were carried out to inventory wildlife and to describe their distribution with particular attention given to those having regional and management significance such as big game and fur bearers (2, page 203). Field investigations for wildlife included:

- Aerial surveys
- Pellet group counts
- Track counts
- Browse plant utilization

In addition, a small mammal inventory was undertaken using live traps. A literature review supplemented the findings of the field studies. Similar studies were carried out for bird populations and habitat classification. Aquatic resources were assessed in field studies as an indicator of water quality.

3.8 Significance of Cumulative Effects

The proponent defined significance of impacts as follows (2, page 31):

> An assessment by the applicant of the potential effects of the impact on the existing project area environment and/or resource users of the area: major, minor and intermediate.

In general, evaluating the magnitude, duration, extent and value of the impact assessed significance. Mitigation measures were outlined where impacts were moderate to high and negative. Extent of impact referred to whether the impact was local (site-specific in areas immediately adjacent to the permit area) or regional (outside the permit area). Workforce hunting pressure, workforce angling pressure, and sewage treatment plant operation were found to have regional impacts (ranging from minor to major). All other impacts were found to be local, and of varying significance.

The proponent was asked to provide a description of how planned monitoring programs would be designed to differentiate project-related effects from the effects of other activities occurring in the region (incremental versus cumulative effects). In its response, Mercoal commented that the baseline data they had collected could be used as a without-project reference which included impacts from other projects in the area. Monitoring after the project commenced would assess both cumulative impacts from all projects and allow the proponent to identify incremental impacts from its own projects.

As to socio-economic impacts, the proponent evaluated significance by comparing population increases caused by the proposed project to population increases caused by other approved and proposed regional developments. Impacts on Edson were declared to be “minimal relative to increases from all other resource projects”, representing “less than 17%” of the total (3, page V-39). Impacts on Hinton were examined in more detail but generally discussed in terms of municipal planning and ways in which the proponent could co-operate by providing pertinent data in a timely fashion. Impacts on land and resources (trapping, outdoor recreation, subsistence hunting, agriculture and water resources) caused by increased human populations were addressed but significance was either not evaluated due to lack of data or declared to be minimal due to geographical location (3, pages V-72 and V-74).

3.9 Future Management Options

The proponent planned extensive monitoring programs to monitor the impacts of the mine on the environment and the success of reclamation/mitigation measures. No recommendations for management of other activities were suggested.

4.0 Contribution to Practice and Implementation of CEA

The proponent conducted extensive studies to characterize the baseline of the area, in some cases examining regional data. A thorough characterization of the baseline is a crucial first step in assessing cumulative impacts.

References:

1. Mercoal Minerals Ltd. Volume 1: Application and Executive Summary. April 1982.

2. Mercoal Minerals Ltd. Volume 2: Environmental Impact Assessment. March 1982.

3. Mcleod River Coal Ltd. Volume III: Socio-Economic Impact Assessment. 1982.

4. Mercoal Minerals Ltd. Deficiency Responses: Environmental and Social Aspects. Undated.

APPENDIX A11

MOBIL OIL CANADA and SHELL CANADA LIMITED SABLE ISLAND OFFSHORE ENERGY PROJECT

Description of Project

Location:	Sable Island, Nova Scotia
Type:	Production, Transmission and Processing of Natural Gas.

Process

Regulators:	Canadian Environmental Assessment Agency, N.S. Department of Environment, National Energy Board, Canada-N.S. Offshore Petroleum Board, N.S. Energy and Mineral Resources Conservation Board.
Guiding Legislation:	Federal: Canadian Environmental Assessment Act, National Energy Board Act, Canada - Nova Scotia Offshore Petroleum Resources Accord Act, Canada - Nova Scotia Offshore Petroleum Resources Accord Implementation (Nova Scotia) Act; Provincial: Environment Act, Energy and Mineral Resources Conservation Act, Pipeline Act.
Public Issues:	Long-range transport of air pollutants, additional vessel traffic, changes to marine habitats, declining fish stocks, other planned offshore developments, resource conflicts, SO_2 emissions, noise and marine mammals, waste disposal, bioaccumulation of heavy metals, global warming.
Regulatory Direction:	Decision not reviewed.
Dates:	1996: EIA submitted; 1997: Decision to approve.

Approach

Issues:	Weather and climate effects, oceanography, sea ice, coastal ecosystems, and terrestrial environment.
Assessment Methods:	Issues were subjected to pathways analysis to identify interactions between the project activities and the environment. Other methods included expert opinions, models and extrapolation from datasets and trends, workshops and public consultations.

Contribution to Practice and Implementation of CEA

The proponent considered space-time crowding and lag effects.

MOBIL OIL CANADA AND SHELL CANADA LIMITED:

SABLE ISLAND OFFSHORE ENERGY PROJECT

1.0 Description of Project

Project: Natural gas production, transmission and processing facilities, including offshore wells, production platforms, inter-field pipelines, on-shore processing facilities, project management, decommissioning and abandonment.

Proponent: Mobil Oil Canada, Shell Canada Limited, Imperial Oil Resources and Nova Scotia Resources Limited.

Dates: 1996: EIA submitted; 1997: Decision.

2.0 Process

2.1 Regulators

- Canada-Nova Scotia Offshore Petroleum Board
- Canadian Environmental Assessment Agency (CEAA)
- National Energy Board (NEB)
- Nova Scotia Department of the Environment (NSDOE)
- Nova Scotia Energy and Mineral Resources Conservation Board

2.2 Guiding Legislation

<u>Federal</u>

- Canadian Environmental Assessment Act
- Canada-Nova Scotia Offshore Petroleum Resources Accord Act
- National Energy Board Act

Provincial

- Canada-Nova Scotia Offshore Petroleum Resources Accord Implementation (Nova Scotia) Act
- Energy and Mineral Resources Conservation Act
- Environment Act
- Pipeline Act

2.3 Intervenors and Public Issues

Intervenors included the Provinces of New Brunswick, Quebec and Nova Scotia, individuals, power companies, labour organizations, conservation organizations, and several federal government departments (DFO, Environment Canada and the Coast Guard). Issues ranged from socio-economic and occupational health and safety concerns to environmental concerns.

2.4 Regulatory Direction

Not reviewed.

3.0 Approach to CEA

3.1 Issue Identification

The proponent described its approach as issue-driven and began by identifying elements in the environment likely to be affected and the value attributed to these elements. Issues were identified through the following:

- Review of previous impact statements, subsequent panel reports and recent data and information
- An extensive public and stakeholder consultation program
- Technical, scientific and engineering analyses by scientists and other experts.

Baseline information for the assessment was drawn from earlier work (1983 Environmental Assessment for the Venture Development Project) and supplemented by extensive studies conducted since 1983.

Issues raised by the intervenors included:

- SO_2 emissions
- Waste disposal (particularly drilling wastes)
- Effects of effluent on groundwater quality

- Noise and marine mammals, particularly in the seismic exploration phase
- Effects on both commercial fisheries and traditional fisheries
- Bio-accumulation of heavy metals
- Global warming

Issues specific to cumulative effects assessment which elicited widespread public concern were also identified:

- Long-range transport of air pollutants and its addition to existing sources or other future industrial developments in the area of concern
- Additional vessel traffic
- Increased sediment, chemical and thermal loading of marine habitats over the life span of the project (i.e., added to past and future drilling activities of other projects)
- Other existing and planned offshore development and exploration drilling activities by the proponents and others
- Declining fish stocks due to resource exploitation
- Resource conflicts (e.g., offshore mining aggregates, placer gold mining claims, etc.), and
- Other projects and regional planning.

3.2 VEC and Indicator Selection

An issues scoping exercise identified VECs which included elements of the environment that could be affected by the proposed project and are protected by regulation or legislation. VECs were characterized, including scope, spatial and temporal boundaries and description of linkages with the project and other components of the environment. The proponent stated it will continue to identify biophysical issues relevant to identified VECs through the life of the project.

3.3 Spatial Bounding

The proponent delineated the same study area as that defined in the 1983 EIA and included new aspects of the currently proposed project (fields south of Sable Island; Thibaud, North Triumph, Alma and Glenelg). The offshore extent of the study area boundary covered the Scotian Shelf and slope, including the entire Sable Island Bank, Banquereau, Emerald Bank, and extended northward to southern Cape Breton Island. This large area was said to encompass the effects of any significant spill or effluent discharges and also any VECs that may be affected as a result of the project.

The terrestrial study area included areas impacted by terrestrial aspects of the project. Particular attention was paid to features falling within a corridor enclosing the potential pipeline routing. Ecological spatial boundaries varied somewhat according to the VEC but were based on the possible influence of the proposed project, including accidental spills (1, volume 3, page 2-10). The same spatial boundaries were used for the main EIA and the cumulative effects assessment (1, volume 3, page 2-12).

The study recognized four types of temporal and spatial boundaries; project, administrative, ecological and technical boundaries. Project boundaries refer to the time and space scales occupied by the project (footprint). Administrative boundaries were defined as time and space limitations imposed on the assessment for political, social or economic reasons. Administrative boundaries (regional or provincial scale) were used for the socio-economic impact statement.

3.4 Temporal Bounding

- Mid 1997 (project start-up) to 2022 (abandonment phase): used for the project boundary
- Ecological time boundaries were established on the basis of temporal characteristics of the natural system and its interactions with project activities (e.g. seasonality, population and ecological sensitivity).

3.5 Included Projects

The proponent did not indicate specifically what other projects were included in the assessment. The area has been subject to intense development for decades and hundreds of small developments are active.

3.6 Assessment Methods

As a first step, baseline information from 1983 was reviewed and evaluated according to three criteria:

1. Was the original 1983 information adequate?
2. Has a significant change occurred since 1983? (more likely to be the case for socioeconomic data than for biophysical data)
3. Is additional information needed to investigate the issues identified through the consultation program?

The issues identified above were subjected to pathway analysis which examined potential interactions between the project activities and the receiving environment. If pathways or linkages could not be determined, the issue was deemed not to be affected by the project. Impact statements were prepared for each of the issues, as follows (1, volume 1, page 29):

Issue	Effect
Physical Marine Environment Weather, climate, air quality, marine chemistry, oceanography, sea ice and icebergs and surficial geology	 Unpredictable weather Physical environment affects marine life and design features of the project
Biological Marine Environment Coastal ecosystems	 Fisheries, shellfish, food chain Salt marshes; migratory and water fowl Aquatic mammals and fur bearers
Terrestrial Environment	 Wetlands; migratory and water fowl Mammals; endangered or threatened species (e.g. eastern cougar, southern flying squirrel), birds

Additional assessment methods included interviews with resource persons and knowledgeable individuals; models and extrapolation from datasets and trends; compilation of relevant statistical datasets; disciplinary and interdisciplinary workshops and public consultations (1, volume 3, page 2-10). Dispersion models for oil slicks and gas condensate behaviour and fate in the event of blowouts and pipeline ruptures were used to assess impacts.

A very simplified model of the marine ecosystem was developed to assess impacts on the marine environment. Water depth was divided into three zones: (1) water surface, the top 10 metres; (2) the bottom layer, comprising the bottom 10 metres and (3) the water column, in between (1) and (2).

The cumulative effects assessment also considered:

- Multi-disciplinary effects
- Space/time crowding and lags
- Indirect, threshold and incremental effects
- Future projects
- Experience from elsewhere

3.7 Impact Characterization

Pathways analysis was used to predict interactions between project activities and the receiving environment and to identify any plausible linkages between an identified concern and an aspect of the proposed project. Impacts were categorized in terms of the following:

- Whether the effect was adverse or positive
- Their significance (1, section 3.3.6)
- Likelihood

In addition to examining project impacts in isolation, the proponent also examined cumulative impacts of the project taken in conjunction with existing activities in the area (but did not define the other activities specifically), and, if there was sufficient information, with proposed future activities. Residual impacts were defined as those remaining after all mitigation measures had been considered and cumulative effects had been assessed.

The proponent does not specifically mention uncertainty, although it may be captured in likelihood.

3.8 Significance of Cumulative Effects

The significance of environmental impacts was evaluated according to a common scale developed using criteria provided by the Canadian Environmental Assessment Agency (1, volume 1, page 28). Major and moderate impacts were categorized as significant, requiring mitigation response, and minor and negligible impacts were categorized as insignificant.

	Biophysical Impact	Socio-Economic Impact
Significant		
Major	Seriously affects a whole population or species over several generations; may also affect a resource user over a long period of time	Causes permanent change in community life, and would not necessarily respond well to mitigation
Moderate	Affects a portion of the population or species, but does not endanger the integrity of the population as a whole	Causes considerable local disturbance, but with mitigation can be absorbed by the community

	Biophysical Impact	Socio-Economic Impact
Insignificant		
Minor	Affects a specific group of individuals within a population over a limited area and a short time period	Some local disturbance or inconvenience but can be absorbed by the community without prolonged mitigation
Negligible	Impact no greater than that of small random changes caused by natural environmental fluctuations	May cause some very minor and localized change of short duration, likely to go unnoticed by most people

The next step was to identify mitigation and enhancement measures for significant impacts. Mitigation measures were defined as steps taken to reduce adverse impacts, sometimes by altering the project. After the effect of mitigation measures were taken into account, the remaining impacts, or residual impacts were identified.

Residual impacts were evaluated for the need for effects monitoring and further studies. The information was then incorporated into the proponent's Environmental Protection Plan, Safety Plan and Contingency Plans.

Cumulative effects were considered in the context of a multi-disciplinary effects assessment. For example, the interactions between water contamination, fisheries and effects on the livelihood of people in the area. Fisheries resources can be affected by water quality, marine resources, sediment or navigation restrictions.

Space/time crowding and lag effects were also examined. The proponent concluded there was limited potential for these types of effects with the proposed project because it will be spread over a long period of time, increasing the potential for recovery of impacted elements of the environment.

The proponent commented that the potential for indirect or secondary effects is more likely when direct effects are considered significant. In general, the potential for direct effects was considered to be low, and secondary effects unlikely. No basis for threshold impacts was identified and it was concluded that the project would result in little change from the baseline.

Some cumulative effects on fisheries were predicted in certain areas. Impacts on fisheries were estimated to involve the following:

- Safety zones and exclusion areas slightly reducing fishing areas
- Drilling discharges resulting in a minor loss of benthic productivity in exclusion zones
- Production water discharges resulting in elevated production in the immediate vicinity of the platform
- Blasting in inshore areas resulting in localized and minor reduction in catch
- Possible tainting in scallops

These impacts were related to the proposed project only. The proponent went on to comment that current activity in the area (the Scotian Shelf) had not had any observable impact on the fishery, and the impacts of the proposed project would be negligible compared with fishing mortality.

According to the proponent, prior oil and gas activity on the Eastern Scotian Shelf had had no observable impact on marine mammals and seabirds; it therefore argued that its proposed project is unlikely to have an impact.

3.9 Future Management Options

Only developments within a reasonable distance from the proposed project were considered in the cumulative effects assessment (1, volume 3, page 6-30). A reasonable distance was not defined.

4.0 Contribution to Practice and Implementation of CEA

The proponent considered space/time crowding and lag effects as part of the CEA. However, they were not evaluated in depth.

References:

1. Mobil Oil Canada and Shell Canada Limited. Volume 3: Environmental Impact Assessment. Sable Offshore Energy Project. 1996.

APPENDIX A12

PARKS CANADA
TRANS-CANADA HIGHWAY PHASE IIIA

Description of Project

Location:	Banff National Park, Alberta
Type:	Highway Expansion (twinning)

Process

Regulators:	Parks Canada, Federal Environmental Assessment Review Office.
Guiding Legislation:	Environmental Assessment and Review Process Guidelines Order.
Public Issues:	There was no public hearing.
Regulatory Direction:	Application of mitigation measures as demonstrated in previous twinning projects along same highway.
Dates:	1994: EIA submitted; 1995: Decision.

Approach

Issues:	Loss/alteration of wildlife habitat, wildlife disturbance due to alienation, collision mortality of wildlife, and disruption of wildlife movements due to habitat fragmentation.
Assessment Methods:	Spatial analysis using a GIS to determine loss or reduction of habitat value due to various types of disturbances to wildlife.

Contribution to Practice and Implementation of CEA

Assessment and mitigation of effects with a transportation corridor on far-ranging wildlife.

PARKS CANADA:

TRANS-CANADA HIGHWAY PHASE IIIA

1.0 Description of Project

Project: Twinning 18 km of and adding interchanges on the Trans Canada Highway between Banff and Lake Louise in Banff National Park, Alberta. The highway followed the Bow River along its entire length along a narrow mountain valley.

Proponent: Parks Canada

Dates: 1994: EIA submitted; 1995: Decision.

2.0 Process

2.1 Regulators

- Parks Canada (Minister of Canadian Heritage)

2.2 Guiding Legislation

Federal

- Environmental Assessment and Review Process Guidelines Order

2.3 Intervenors and Public Issues

Although there were no public hearings, Parks Canada did hold a series of consultation sessions with various stakeholder groups, including local and national environmental organizations, local First Nations (with a claim to a portion of the highway route), and local business interests. The public questioned the need for further twinning and identified movement barriers affecting bears and ungulates, continued loss of montane ecosystem and effects on fish in the Bow River as the major environmental issues.

2.4 Regulatory Direction

Public hearings had been held for two earlier phases in the highway twinning project; they and the 1994 Initial Assessment served to update the first assessment (1985), which had included cumulative effects issues. A hearing was not held as it was assumed that, based on earlier assessments and hearings, no new issues of public concern would occur and that mitigation measures were well developed.

3.0 Approach

3.1 Issues Identification

The 1994 assessment examined local effects on nine environmental components: streams, air quality, vegetation, fish, wildlife, land use and recreation, land use and history, visual resources and socio-economics and tourism. The specific environmental components of most concern were wetlands, the river channel, fish bearing streams, wildlife (particularly large carnivores and ungulates with regional movements), vegetation and fish. Residual effects on wildlife were summarized in an EIA (which preceded the CEA) for nine species and five wildlife categories. Based on these results, vegetation, fish and wildlife were identified as most likely to be cumulatively affected. Of most concern was loss/alteration of wildlife habitat, wildlife disturbance due to alienation, collision mortality of wildlife, and disruption of wildlife movements due to habitat fragmentation.

3.2 Assessment Methods

The cumulative effects assessment consisted of three parts:

1) Screening other projects and environmental effects (based on the results of the local effects assessment which preceded the cumulative effects assessment);

2) Quantitative analysis of effects on six wildlife species and vegetation and a qualitative analysis of effects on other wildlife species and fish in the Middle Bow Valley; and

3) Quantitative analysis of overall habitat loss due to human disturbances within the Central Rockies Ecosystem.

3.2 VEC and Indicator Selection

Elk, moose, wolf, coyote, grizzly bear and black bear were used as both VECs and indicators. They were selected based on the availability of data (i.e., life history, movements, and population dynamics) and their scientific and public profile.

3.3 Spatial Bounding

The assessment identified two study areas:

- Middle Bow Valley within the immediate vicinity of the highway right-of-way (1,150 $km^{2)}$, and
- Central Rockies Ecosystem (43,000 km^2).

Most of the analysis focussed on the Middle Bow Valley, the boundaries of which were based on constraining topography (i.e., mountain valleys) and their implications for watersheds and physical barriers to wildlife movements. Results of the Middle Bow Valley assessment were extrapolated to the Central Rockies Ecosystem the boundaries of which were based partly on administrative borders.

3.4 Temporal Bounding

Temporal bounds were not defined as the affected environment was assumed to exist indefinitely in a national park.

3.5 Included Projects

Twenty-eight projects were screened to determine "which projects are likely to make a measurable contribution" to cumulative effects in the Middle Bow Valley. Linear projects were separated from areal projects due to the different analytical approaches used for each. Other past, existing and proposed projects and activities considered for inclusion included a railway, other highways, utility corridors (e.g., transmission lines), communities, recreational areas, abandoned industrial areas, prescribed burning, resource harvesting (prior park establishment), wildlife control measures, and front- and back-country recreational use.

Sixteen projects were included in the assessment, having been considered as possible contributors to cumulative effects.

3.6 Assessment Methods

A screening table rated the likelihood of effects on ten environmental components (i.e., terrain, hydrology, air quality, vegetation, fish, wildlife, recreation, history and archaeology, visual, socio-economic) and various projects, and qualitatively ranked on a four point scale (negligible, low, moderate and high). Quantitative analysis was performed on six wildlife indicators: elk, moose, wolf, coyote, grizzly bear and black bear. The assessment used Ecological Land Classification and wildlife data to analyse effects.

For each species, the cumulative effects contributions of sixteen projects were ranked in a matrix against habitat loss/alteration, disturbance due to alienation, collision mortality, and disruption of movements due to habitat fragmentation. The

relative contribution of each project to overall cumulative effects in the Middle Bow Valley ecosystem was also ranked. The actual rankings were qualitatively determined, but based on the results of the GIS analysis.

3.7 Impact Characterization

The GIS calculated a series of indices that were based on the degree by which habitat suitability was reduced or lost due to various disturbances. A map of the sixteen projects was overlaid on a habitat map for each species. The area of spatial overlap was multiplied by the habitat suitability rating for that ecosite and a modifier specific to the type of disturbance and species being modelled. Modifiers were estimated, based on professional judgement, in recognition of the animals' known behavior, and in some cases on empirical data. Modifiers were used to represent alienation effects (i.e., "0" represented no disturbance, "5" represented a highly disturbed area), a barrier factor for blockage of movement effects, and a collision mortality factor for death due to collisions with vehicles. A specific distance around disturbances ("zone of disturbance") was also defined for areas of human use to define a spatial buffer in which alienation effects were expected to occur.

Finally, the total of each index for each species and type of effect (loss, alienation, fragmentation and mortality) was calculated and the incremental changes compared between three scenarios:

- Existing,
- Existing with proposed project, and
- All possible future projects.

Areas of human development in the Central Rockies Ecosystem were mapped at three levels:

- No and low development,
- Moderate, and
- High.

The density and distribution of three wildlife indicators (elk, moose and bear) were also mapped. Spatial overlap of these maps indicated how severely the cumulative effect of these developments may have already impaired habitat supporting these species. Areas of high habitat potential that were disturbed by areas of high or moderate development were considered of concern. For example, 30% of the Central Rockies Ecosystem had high or very high habitat capability for large carnivores, yet 87% of that area occurred in areas of moderate or high disturbance.

3.8 Significance of Cumulative Effects

The final results were discussed and summarized as qualitative rankings. For example, the results for grizzly bear indicated that:

- Overall cumulative effect from all activities was “major” (i.e., long term adverse effects on population in study area),
- Main contributors to the overall cumulative effect on bear were the existing Trans Canada Highway and the Lake Louise townsite,
- Incremental effects of the proposed project as a contribution to overall cumulative effects on grizzly bear was “moderate”, and
- Two other projects (controlled burns and existing powerlines) contributed to an equal level of incremental effect as the proposed highway twinning project.

The following summarizes the conclusions regarding the contribution of the project to cumulative effects in the region:

- ***Wildlife***: project contribution is moderate for large carnivores, beneficial for ungulates and minor for most other species

- ***Vegetation***: project contribution is low due to small area of ecosites affected and minimal effects on fragmentation due to routing along an existing alignment

- ***Fish***: project contribution is minimal due to significant existing disturbances on fish populations in river drainage

3.9 Future Management Options

Most mitigation was directed to address wildlife effects, with some mitigation to protect fish and rare vegetation. Parks Canada decided to monitor wildlife crossings for several years to determine which location would best facilitate regional movements; build two overpasses (instead of underpasses) based on existing knowledge of crossing locations and erect fencing along the highway to reduce collisions and guide wildlife to the overpasses; create carnivore conservation areas; avoid construction during certain times of the year critical to wildlife and deploy an Environmental Coordinator to monitor mitigation measures during construction and, lastly, to continue prescribed burns so that successional change would return to original natural conditions.

4.0 Contribution to Practice and Implementation of CEA

Parks Canada benefited from having relatively well-defined land use goals (e.g., from the *Park Management Plan* and other guidelines), data from extensive ecological research, and ready access to descriptions of other projects and activities in a large regional study area. The mitigation in response to cumulative effects included innovative on-site design modifications (i.e., overpasses). Such practices may be necessary in other cases to address effects on large-scale movements of wildlife.

References:

1. Parks Canada. Initial Assessment of Proposed Improvements to the Trans Canada Highway in Banff National Park, Phase IIIA, Sunshine Interchange to Castle Mountain Interchange. Prepared by Thurber Environmental Consultants for Canadian Heritage, Parks Canada, Banff National Park, Alberta. 1994.

APPENDIX A13

SHELL CANADA LIMITED
CAROLINE EXPANSION

Description of Project

Location:	Between Sundre and Caroline, Alberta
Type:	Natural Gas Processing Plant

Process

Regulators:	Alberta Energy and Resources Conservation Board, Alberta Environmental Protection.
Guiding Legislation:	Energy Resources Conservation Act, Oil and Gas Conservation Act, Alberta Land Surface Conservation and Reclamation Act.
Public Issues:	Sulphur emissions and deposition, sour gas health risk, water contamination, loss of wildlife habitat.
Regulatory Direction:	Maximum sulphur recovery level imposed, design and implementation of an environmental monitoring program, required no net loss of fish and wildlife habitat, baseline data collection for wildlife.
Current Assessment Status:	Decision not reviewed.
Dates:	1989: EIA submitted; 1990: Decision to approve.

Approach

Issues:	Lack of deposition thresholds, lack of wildlife data, uncertainty of air quality modelling.
Assessment Methods:	Air quality models, wildlife habitat analysis.

Contribution to Practice and Implementation of CEA

Examination of impacts and issues beyond those strictly required for a single-project application due to the mandate of the reviewing agency to consider the implications of future resource extraction from the same and nearby reservoirs.

SHELL CANADA LIMITED:

CAROLINE EXPANSION

1.0 Description of Project

Project: Sour gas processing plant, pipeline (for liquid sulphur), train loading terminal, and field gas gathering system (15 wells and 3 compressor stations) in the Caroline Swan Hills Reservoir. The reservoir extends approximately 30 km (with a maximum width of 5 km) between the towns of Caroline and Sundre, Alberta. The reservoir already had a number of exploratory wells.

Proponent: Shell Canada Limited

Dates: 1989: EIA submitted; 1990: Decision.

2.0 Process

2.1 Regulators

- Energy Resources Conservation Board (EUB)
- Alberta Environmental Protection

2.2 Guiding Legislation

- Energy Resources Conservation Act
- Land Surface Conservation and Reclamation Act
- Oil and Gas Conservation Act

2.3 Intervenors and Public Issues

Intervenors during the hearings included other energy operators, recreational organizations, local residents and landowner organizations, representatives of local administrations and local environmental groups. The principle issues of concern included sulphur emissions from stacks and deposition onto vegetation and water bodies, sour gas health risks to humans, water contamination due to spills and leaks, and loss of wildlife habitat due to land clearing and other impacts.

A Caroline Area Gas Development Group (CAGDG) was formed to coordinate development of the gas field amongst 16 energy operators. A Caroline Advisory Board was also formed, consisting of local representatives, to meet with CAGDG during public consultations. CAGDG prepared a Selected Development Option for regulatory submission, which consisted of an expansion of two existing plants and the construction of a new plant. After a major industry participant (Husky) withdrew from the Option, Shell led a regulatory submission based on developing one new plant to process gas from the Caroline and nearby Bearberry fields. In anticipation of commercial development at Bearberry, Shell predicted that the new plant would result in less environmental impact as a result of coordinated development for the two emerging fields. Although Shell made its application on behalf of all the CAGDG operators except Husky, this project review discusses only the Shell proposal.

2.4 Regulatory Direction

The Board rejected Husky's proposal and approved Shell's application to be principle processor of natural gas for the Caroline/Bearberry reservoirs. Aside from standard design requirements for mitigation, the Board included a number of conditions with implications for cumulative effects, including a minimum sulphur recovery level at stacks, design and implementation of an environmental monitoring program in consultation with local residents and municipal administrations, a no-net-loss policy for fish and wildlife habitat, and further baseline data collection for wildlife to address some information gaps.

3.0 Approach to CEA

3.1 Issue identification

Air emissions (i.e., H_2S, SO_2, CO_2, NO_x), constituted the major regional concern, particularly sour gas emissions. Effects related to emissions included acidification, ground-level ozone, greenhouse gases, deposition effects on water and vegetation, and effects on human health.

3.2 VECs and Indicator Selection

H_2S, SO_2, CO_2, NO_x were chosen as indicators for air quality and moose habitat quality was chosen as the indicator for wildlife.

3.3 Spatial Bounding

A specific study area was not defined; however, the assessment of most environmental components consistently used a base map, referred to as the "Project Area", covering what could be considered a regional area and extending over approximately 48 km^2. The footprint associated with the proposed project's gathering system and plant occupied only a small portion of the study area.

3.4 Temporal Bounding

No temporal bounds were defined. The anticipated project life was not stated.

3.5 Included Projects

Existing projects in the region contributing to air emissions were considered; however, future sources were not included, in part because of the large intervening distances and therefore a low likelihood of significant interaction.

The EIA identified and the Board considered other proposed projects, most of which comprised pipelines and transmission lines being built in support of the Shell project. Associated applications were considered for approval at the hearing, and included three pipelines. The Board also considered possible effects of these facilities on the relative merits of the two competing applications (i.e., Shell vs. Husky). In addition, the EIA examined a future development scenario which included processing gas from the Bearberry reserves, approximately 15 km from Shell's proposed plant site.

Future projects that were not being considered for approval during the hearing were excluded from the Board's review of Shell's application. Such future projects (one pipeline and one transmission line) were thought to be "induced actions" which would probably occur if the project under review was approved.

3.6 Assessment Methods

The proponent examined several environmental components including land use, climate and air quality, geology and geotechnical conditions, groundwater, surface water, soils and agriculture, vegetation and forestry, wildlife and fisheries. Quantitative analysis was performed with air quality models and wildlife habitat analyses.

The term "cumulative effects" was never explicitly used in the EIA. However, the Board recognized the need to consider the many existing sources of sulphur and the incremental effect of the proposed project. In all, contributions from seven existing gas processing plants were considered for air quality.

3.7 Impact Characterization

Several approaches were used in assessing environmental components and their indicators. The assessment did not explicitly assess “cumulative effects”; however, as baseline data collection and project effects were generally considered throughout the “Project Area”, the contribution of other sources is implied.

The following table identifies aspects of the assessment for each environmental component that are most relevant to the discussion of cumulative effects.

Environmental Component	Impact Characterization
SO_2 emissions and deposition	Models were used to predict worst-case SO_2 concentrations at various distances from the plants. Existing sources were included.
CO_2	Local combustion emissions calculated, as well as emissions from electricity generation from the provincial utility (i.e., Alberta’s coal-fired generating stations). Also, emissions due to product transport were estimated (i.e., pipelines, railway).
NO_x	Emissions were calculated for various project related combustion sources.
Surface water	Water withdrawals were calculated from various project-related sources. It was concluded that water quality would not be compromised by sulphate deposition.
Groundwater	Risk of contamination was assessed based on leaks, spills and continual air emissions in the Project Area.
Wildlife	Moose habitat lost due to clearing (e.g., for plants, pipelines) was calculated using the Habitat Evaluation procedure. Key wildlife areas were identified throughout the Project Area (i.e., areas important to a number of animals for some part of a year) and their combined area compared to the Project Area. Effects were discussed qualitatively (except for moose habitat), including habitat loss and alteration, disturbance, obstruction to movement, increased hunting pressure, changes in air quality vehicle collisions and refuse disposal.

Environmental Component	Impact Characterization
Fish	The assessment focussed principally on possible effects at pipeline stream crossings, implications of increased human access, and upset events (e.g., well leak, pipeline rupture).
Vegetation	Vegetation communities were identified using an Ecological Land Classification, which allowed determination of the direct loss of each community as a result of land clearing. It was recognized during the hearing that there were already significant SO_2 emissions in the region from existing sources, and that the proposed project would add to existing emissions. An intervenor provided evidence that indicated existing adverse effects on vegetation and the prediction that this condition would worsen over time based on future regional development.
Soil	Analysis of the susceptibility of soil to acidification was assisted by using a number of monitoring stations throughout the Project Area, with the majority clustered around the proposed Caroline plant site. These analyses established baseline conditions to which the incremental effects of new sources could be compared.
Land Use	The effects of lost land capability to support various resource uses (e.g., agriculture, forestry, and recreation) were examined.
Bearberry reservoir	A brief assessment was made of effects on the Bearberry reservoir for the same environmental components examined in the Caroline assessment. The assessment was conceptual, as specific project design information was not yet available. The assessment focussed on sulphate deposition due to the combined processing of the two reservoirs.

3.8 Significance of Cumulative Effects

Significance was rated for each project facility component that could affect the various environmental components. In summary, the proponent stated there would only be minor or moderate (reversible in ten years) effects on the environment. Most effects rated as moderate related land clearing; in addition, the Board considered

the degree to which land subject to further clearing activities was already under some form of disturbance.

Various management options were recommended; the following identifies those with cumulative effects implications:

- Air quality compliance with Alberta Environment Clean Air Standards
- Sulphur recovery before stack
- Plant and process redesign to reduce emissions
- Avoidance of critical wildlife habitat, reclamation of disturbed areas to provide browse for some species, and implementation of a "no-net-loss" habitat policy
- Access control (limited by legal status of land), and
- Liming of soil and water to address acidification

3.9 Future Management Options

Future management options or scenarios were not considered.

4.0 Contribution to Practice and Implementation of CEA

Despite the fact that no effects were referred to as "cumulative" in the EIA or Board decision, it became apparent that the combination of assessment effort and regulatory review nonetheless resulted in the consideration of various cumulative effects issues.

The Board stressed the importance of considering regional implications notwithstanding that the proponent principally viewed effects as a local issue. For example, the Board recognized that development of the large Caroline gas field could result in significant adverse effect on wildlife. The Board recommended an audit of the accuracy of the assessment's predictions, presumably because the proponent did not develop monitoring plans. Monitoring programs are now planned routinely as a part of project operations.

References:

1. Shell Canada Limited. Caroline Gas Environmental Impact Assessment. September 1989.

APPENDIX A14

SHELL CANADA LIMITED
ETHYLENE GLYCOL PLANT, SCOTFORD, ALBERTA

Description of Project

Location:	Scotford, Alberta
Type:	Ethylene Glycol Plant

Process

Regulators:	Alberta Energy and Utilities Board, Alberta Environmental Protection, Department of Fisheries and Oceans, Canadian Coast Guard.
Guiding Legislation:	Provincial: Alberta Environmental Protection and Enhancement Act, Oil and Gas Conservation Act. Federal: Navigable Waters Protection Act, Fisheries Act.
Public Issues:	Cumulative effects relating to air quality, noise and lighting, regional emergency services, regional economic benefits and impacts if project did not proceed.
Regulatory Direction:	Decision not reviewed.
Dates:	1997: EIA submitted; 1998: Decision to approve.

Approach

Issues:	Issues identified through consultation and expert opinions included groundwater depletion and contamination, noise and lighting, flaring, regional soil productivity, effects on vegetation, effluent discharge into North Saskatchewan River, wildlife habitat and effects on the regional social environment.
Assessment Methods:	Numerical modelling for impacts with federal or provincial guidelines (e.g., water and air quality). Qualitative assessments of other parameters.

Contribution to Practice and Implementation of CEA

The proponent has been fairly successful in interacting with the surrounding community and addressing their concerns, some of which relate to cumulative effects.

SHELL CANADA LIMITED:

ETHYLENE GLYCOL PLANT, SCOTFORD, ALBERTA

1.0 Description of Project

Project: Expansion of the existing Scotford Chemical Plant facilities located 11 km northeast of the City of Fort Saskatchewan, Alberta. The original site was selected in 1984 due to its location and proximity to intersecting pipelines, roadways and rail lines. The plant is currently licensed to produce 485,000 tonnes of styrene monomer. The proposed Ethylene Glycol unit will produce 443,000 tonnes/year and will require the installation of additional processing equipment, storage and shipping facilities. It may also involve the development of an air-separation plant and co-generation power facility (1, page xxiv-xxvii).

Proponent: Shell Chemicals of Canada Ltd. ("Shell").

Dates: 1997: EIA submitted.

2.0 Process

2.1 Regulators

- Energy and Utilities Board
- Environmental Protection
- Department of Fisheries & Oceans
- Canadian Coast Guard

2.2 Guiding Legislation

Federal
- Navigable Waters Protection Act
- Fisheries Act

Provincial
- Alberta Environmental Protection and Enhancement Act
- Oil and Gas Conservation Act

2.3 Intervenors and Public Issues

Shell had worked within the community over the past 12 years to facilitate communication and build public awareness, dialogue and understanding. The public consultation program for the proposed project built upon existing relationships through a series of open houses, presentations, meetings and press releases. Key issues that were identified by the public and related to cumulative effects included air quality, noise and lighting issues, fog formation, regional emergency services requirements, regional economic benefits, and what the community impacts would be if the project did not proceed.

2.4 Regulatory Direction

The decision is pending as of February 1998.

3.0 Approach to CEA

3.1 Issues Identification

Issues pertinent to CEA included noise, hydrogeology, surficial geology, land use, soils, vegetation, fish resources, wildlife and socio-economics. Expanded regional approaches were taken for air quality and surface water quality and quantity, although the proponent did not characterize these topics as CEA issues. CEA issues which were identified included:

- Ground water depletion and contamination
- Daytime and nighttime industrial noise
- Plant lighting during construction
- Flaring operations
- Regional soil productivity
- Reduction in area of natural vegetation
- Effluent discharge into the North Saskatchewan River
- Preservation of wildlife movement corridors & treed areas
- Short and long-term impact on regional social environment

3.2 VEC and Indicator Selection

The proponent did not choose VECs, although it identified key ecologically significant, sensitive, rare and endangered resources. These resources were highlighted through a combination of public input and professional knowledge applied by the project's consultants. It was noted that the plant site was located in an existing and highly developed industrial area which did not exhibit a high degree of biological diversity. As a result, local and cumulative impacts of the proposed project on ecological resources were generally considered to be low.

3.3 Spatial Bounding

Separate study areas were delineated for each type of potential impact, as follows:

Potential Impact	Study Area Boundary
Air Quality	10 km and 5 km radius from main plant (1, page 4-1)
Hydrogeology	Primary Study Area – plant site Regional Study Area – 5 km radius bounded by the North Saskatchewan River (NSR)
Surface Water	Low Level Bridge in Edmonton to Alberta/ Saskatchewan border along the NSR
Surficial Geology	3.2 km radius from plant site
Vegetation	3.2 km radius from plant site
Fisheries	2 km section near Shell intake and outfall locations
Wildlife	4 km radius of plant site
Human Health	5 km radius of plant site
Socio-Economic	Study Area – Cities of Fort Saskatchewan, Edmonton and the County of Strathcona Local Area – 4.8 km radius from plant site

3.4 Temporal Bounding

Although temporal boundaries were not defined for the purpose of CEA, a project master schedule was produced which described the evolution of the ethylene glycol (EG) plant from design through to plant decommissioning. The following periods were identified:

- 1998, 2nd quarter: site preparation
- 2000, 2nd quarter: plant start-up (1, page 2-14)
- 2020: approximate operational life expectancy (1, page16-28).

3.5 Included Projects

The following projects were included in the CEA.

- Shell Oil Scotford Refinery
- Shell Chemicals Scotford Chemical Plant
- Nova Gas Clearing House
- Dupont
- Agrium Fertilizers
- Dow Chemicals
- Alberta BioClean

3.6 Assessment Methods

The proponent presented CEA under separate sections pertinent to each project component with the exception of air quality, which dealt with some regional aspects, and surface water quality and quantity. A quantitative (numerical) approach was taken in assessing an impact's level, magnitude, duration, etc., where appropriate and based on comparisons to baseline monitoring levels, or provincial or federal guidelines. Where no Alberta provincial guidelines existed, Ontario guidelines were used. CEA parameters included magnitude, direction, duration, frequency, spatial scope and degree of reversibility. (1, Table 1.1) Otherwise, the cumulative impacts were discussed qualitatively.

3.7 Impact Characterization

A summary of the CEA methods applied by each project discipline is provided below.

Impact	Method Used
Noise	Noise measurements of ambient levels were combined with predicted EG plant levels to determine the predicted absolute levels using the "soundPLAN" noise modelling software application. Predicted sound levels were also made under the effects of various wind gradients to determine potential sound propagation effects on nearby communities (1, page 5-13).
Hydrogeology	Quantitative modelling of down-draw cones simulated cumulative residual effects of site dewatering during construction.
Surficial Geology	No cumulative effects anticipated
Air Quality	Application of the "ISC3" plume dispersion model to determine the concentration of a number of

Impact	Method Used
	compounds under normal operating and 'upset' conditions. Plumes combining emissions from the chemical plant and the neighbouring refinery were similarly modelled.
Land Use	Assessment of land use involved qualitative discussion of the effects of lighting, flaring and interruptions of residential activity due to construction.
Vegetation	Air-photo interpretation methods were used to develop vegetation maps which were qualitatively compared to the development footprint, and area of effect of the proposed project.
Socio-Economic	Labour market supply was quantitatively analysed, taking into account construction and operations workforce requirements of several other regionally significant developments announced at the same time-frame. The socio-economic component cited a lack of available data to provide a more detailed numerical assessment of cumulative issues.
Human Health	The human health EIA involved a sophisticated application of ecological risk assessment methods using paired deterministic and stochastic models that represented operational and worst-case exposure scenarios to adults and children. These methods were applied only to the effects of the Scotford Chemical Plant within a 5 km radius. Additional contributions by other regional facilities do not appear to have been considered.

3.8 Significance of Cumulative Effects

The significance, likelihood, duration and magnitude of cumulative effects were discussed in the context of each discipline. Mitigation measures were also identified. No confidence indicators were used as a measure of potential uncertainty. Significance was not specifically defined.

In general, the proponent rated all negative environmental cumulative effects as low or negligible in the long-term, and rated socio-economic consequences of the development as positive in the long-term.

3.9 Future Management Options

The proponent is a member of the Canadian Chemical Producers Association and therefore subscribes to the Responsible Care program which supports active community involvement and ongoing public consultation.

The proponent did not mention whether Shell has or will partner with its industrial neighbours to develop a program of environmental effects monitoring.

4.0 Contribution to Practice and Implementation of CEA

The proponent appears to have been quite successful over the past 12 years in aligning itself with the local regional community. Although an ongoing public consultation process is not a direct component of CEA, it is an effective strategy in helping determine the scope of cumulative issues, communicating scientifically-determined issues and designing appropriate mitigation activities.

References:

1. Shell Chemicals Canada Ltd. Environmental Impact Assessment Ethylene Glycol Project at Scotford Chemical Plant Main Report. May 1997.

APPENDIX A15

SHELL CANADA LIMITED
MUSKEG RIVER OILSANDS MINE

Description of Project

Location:	Fort McMurray, Alberta
Type:	Oilsands Mine

Process

Regulators:	Alberta Energy and Utilities Board, Alberta Environmental Protection.
Guiding Legislation:	Energy Resources Conservation Act, Alberta Environmental Protection Act, Oil Sands Conservation Act.
Public Issues:	Extensive public consultation revealed a large number of issues which were incorporated into the EIA and are presented below.
Regulatory Direction:	Decision pending.
Dates:	1997: EIA submitted.

Approach

Issues:	Air quality, groundwater effects, surface water hydrology, surface water quality, aquatic resources, ELC, terrain and soils, terrestrial vegetation, wetlands, human health, resources use, traditional land use.
Assessment Methods:	Air emissions were predicted based on projected activities and concentrations were modelled. Estimates were used for surface water hydrology, and hydrogeology effects were calculated. Water quality and temperature models were used to predict impacts on water quality. Modelling was also used for impacts on wildlife.

Contribution to Practice and Implementation of CEA

The inclusion of a regional development review which examines the potential impacts of proposed projects in an area as a tool to assist in regional planning.

SHELL CANADA LIMITED:

MUSKEG RIVER OILSANDS MINE

1.0 Description of Project

Project: Oilsands mine near Fort McMurray in northeastern Alberta. The proposed mine is contiguous to existing and previously proposed oilsands projects operated by Suncor Inc. and Syncrude Canada Inc.

Proponent: Shell Canada Limited (Shell)

Dates: 1997: EIA submitted.

2.0 Process

2.1 Regulators

- Energy and Utilities Board
- Alberta Environmental Protection.

2.2 Guiding Legislation

- Alberta Environmental Protection and Enhancement Act
- Energy Resources Conservation Act
- Oil Sands Conservation Act

2.3 Intervenors and Public Issues

Shell carried out an extensive public consultation process early in the development of the application (1, Section 12.1). Key areas of concern were identified in the initial consultations to ensure they were addressed from the outset. Stakeholders identified included adjacent leaseholders, environmental groups, educational institutions, federal government, First Nations and Metis communities, the provincial government and trappers. Consultations involved working groups, open houses, environmental review workshops and information sharing. Issues with a high degree of concern were addressed through working groups or committees. The application states (1, pages 12-35):

Issues are then resolved by modifying policies, socio-economic and environmental impact mitigation steps, where appropriate, and other relevant project components.

The application contains an extensive table outlining key issues, responses and stakeholders.

2.4 Regulatory Direction

Decision was pending as of February 1998.

3.0 Approach to CEA

3.1 Issue Identification

Key questions or issues were identified for the CEA in several areas. The questions were derived from consultations with government agencies, local communities and other stakeholders. The issues identified for the CEA were the same as those used for the Regional Development Review and are summarized below:

Area of Concern	Issues
Air Quality	Exceedances in guidelines and effects on human health Acid forming compounds, ozone concentrations
Hydrogeology-groundwater	Drawdown of basal aquifers and effects on lakes
Surface Water Hydrology	River flows, sedimentation, channelization changes on Muskeg and Athabasca rivers Open water areas
Surface Water Quality	Exceedances of guidelines, dissolved oxygen, toxicity, temperature, PAHs and acidifying emissions
Aquatic Resources	Fisheries health
ELC	Alteration in diversity or loss of ELC units
Terrain and Soils	Quantity and distribution of soil and terrain units, altered soil capability and sensitivity
Terrestrial Vegetation	Alteration in vegetation communities or diversity Air emissions and vegetation health

Area of Concern	Issues
Wetlands	Loss or alteration of wetlands
Human Health	Changes in water or air quality affecting human health Changes in plants, game, concentrations of residual chemicals, noise
Resources Use	Changes in forestry, mineral extraction, trapping, etc.
Traditional Land Use	Changes in traditional land use

3.2 VEC and Indicator Selection

Shell identified Key Indicator Resources (KIRs) to focus the environmental assessments for terrestrial, wildlife and aquatic components of the EIA (1, pages E1-14). Shell made an effort to use the same KIRs as Syncrude and Suncor to allow comparison to the impacts of other projects. KIRs were selected based on:

- Ecological importance
- Vulnerability
- Resource use value
- Monitoring value
- Political importance

Additional KIRs were identified through consultation. The application contains a table outlining criteria for selecting KIRs and a description of how they were ranked in terms of response to environmental impacts (pages E1-15). For example, terrestrial vegetation and wetland KIRs were selected on the basis of:

- Abundance
- Status classification
- Diversity
- Sensitivity to physical disturbance
- Economic importance (consumptive use)
- Recreational importance

3.3 Spatial Bounding

The proponent delineated local and regional study areas. The local study area (LSA) corresponded to the actual mine footprint. The regional study area (RSA) corresponded to the one used in the Suncor Steepbank and Syncrude Aurora applications (1, volume 4, page F1-4) but was slightly altered to include a longer, downstream portion of the Athabasca River to the confluence with the Embarras River. Airshed, watershed and landscape areas were delineated and a line drawn around all three to identify the RSA.

In addition, the RSA for human health cumulative effects was extended to encompass the communities of Fort McMurray, Fort McKay and Fort Chipewyan.

3.4 Temporal Bounding

The CEA analysis was conducted over a range of temporal scales, depending on the impacts being assessed, as follows:

For example, impacts were estimated at:

- 2007, 2020, 2030 (reclamation and end-pit discharge) and far future equilibrium conditions (after closure of the mine) - surface water hydrology
- 1998-2002 (construction phase) - wildlife habitat modelling

The temporal scale chosen for hydrology was justified on the grounds of uncertainty associated with future reclamation plans and was considered to be conservative since it did not account for reclamation's positive impacts.

3.5 Included Projects

All pre-existing projects within the RSA are included, as are approved projects (Syncrude Aurora North and South, Suncor Steepbank Mine and Fixed Plant Expansion and Forestry) (1, Table F1-1). The Regional Development Review also includes disclosed projects: Suncor Project Millennium Upgrader and Mine, Shell Lease 13 East Mine, Mobil Kearl Mine and Upgrader, SOLV-EX JACOS Hangingstone *in situ*, Gulf-Surmont *in situ* and major pipelines, utility corridors and roadways. Some components of the CEA included only projects deemed to affect that component. For example, only the SOLV-EX, Muskeg River Mine project and the Syncrude Aurora North and South projects were considered for effects on hydrology.

3.6 Assessment Methods

The proponent was directed in its terms of reference to address cumulative effects and to identify approaches and methods used to identify and assess cumulative impacts. Shell made the following premises in assessing cumulative effects:

- There must be an environmental effect related to the proposed project
- The environmental effect must be demonstrated to operate cumulatively with the environmental effect from other developments or activities
- Other developments or activities either have been or will be carried out and are not hypothetical

The CEA followed the same approach as that used for the main EIA, but extended the analysis of impacts to cover projects which are approved, although not yet operational, near or within the RSA. The filing also contained a regional development review in response to the EUB's and the community's desire for a better understanding of the issues; the supplementary information is, in effect, an extension of the CEA to include speculative future developments.

Air emissions were predicted based on projected activities and concentrations were modelled.

Potential linkages between project activities and environmental change were evaluated for each KIR and environmental component (1, page E1-18).

3.7 Impact Characterization

Projected air emissions were modelled to determine expected concentrations. Future emissions of SO_2 in the RSA were expected to remain close to the baseline (current) conditions and therefore ascribed no cumulative effect (1, volume 4, page F2-1). THC emissions are expected to increase by 15% and NO_x emissions by about 40%. The estimates for NO_x emissions were presumed to have a greater level of confidence because they are directly related to fuel consumption whereas estimates for VOCs were extrapolated from other fugitive emission estimates. In general, levels of NO_x, ozone and VOCs were predicted to be lower than those found in many urban areas. Uncertainty as to the results of modelling and emissions projections was acknowledged and the proponent commented that more refined emissions data to be collected in the future will help produce predictions with a higher confidence level.

The level of certainty for predictions of impact for each of the VECs is discussed separately under each section. The certainty associated with predictions of fish abundance, for example, is estimated to be limited by uncertainty related to extrapolations from habitat to populations of fish in the field.

For hydrogeology, the cumulative draw down of the aquifer, and effects on depressurization at Kearl Lake by projects in the area, was calculated. Surface water hydrology impacts were estimated based on a series of time snapshots over the life of the mine and continuing into the far future (after 2030) based on mine activities taking place at the time, as well the activities of other developments.

Water quality and temperature models were used to predict impacts on water quality, which were then used to predict impacts on aquatic resources, wildlife and human health. Worst-case snapshots over the life of the project were modelled for the Muskeg and Athabasca rivers.

Vegetation was mapped using a geographical information system. Baseline information, the proposed project and other approved development plans were then superimposed on the RSA. Further, planned reclamation activities were also superimposed.

Impacts on wildlife were modelled using Habitat Suitability models and wildlife risk assessment. Three Key Indicator Resources (KIR) were modelled for effects of habitat loss: moose, beaver and western tanagers. The impacts of alterations to water, aquatic prey and plant quality on other KIRs was evaluated.

3.9 Significance of Cumulative Effects

Parameters and stages of mine development classified the degree of concern associated with cumulative effects. The table below presents the classification of mine operation impacts on the surface water hydrology (1, page F4-14):

Parameter	Construction and Operation	After Closure
Direction	Negative	Negative
Magnitude	Low to high	Low
Geographic Extent	Local	Local
Duration	Medium term	Long term
Reversibility	Reversible	Irreversible
Frequency	Continuous	Continuous
Degree of Impact	Moderate	Low

Air emissions impacts were rated as negligible to moderate in terms of degree of concern. NO_2 and PM_{10} were assigned a low to moderate degree of concern (1, page F2-3). Emissions were characterized in terms of decreasing certainty of predictions. The models were expected to provide realistic concentration estimates based on provided emissions values (1, page F2-8). Impacts were characterized in terms of the environmental component they affected (water, soil, vegetation, etc). For example, the effects of operational activities on potentially acidifying emissions were estimated to have a moderate to high level of concern.

The proponent concluded that combined developments in the area would negatively affect the aquifer levels and levels in Kearl Lake, the impact was designated as low to moderate based on the limited geographic extent of impact (Kearl Lake only) and the likely complete recovery of groundwater levels in the aquifer (estimated to take up to 30 years after mine closure) (1, page F3-3).

Cumulative effects on surface water hydrology in the Muskeg River were estimated to be relatively high during the development of the Muskeg River and Aurora mines due to muskeg dewatering and varied for other time frames. Impacts on Athabasca River flows were estimated to be negligible.

Linkages between cumulative changes to water and air quality and human health were evaluated using human health risk assessment methods for specific chemicals (1, pages 12-3).

3.9 Future Management Options

The regional development review (RDR) section of the EIA extends cumulative effects assessment to encompass possible projects in the regional study area. The RDR is presented as a tool to assist the EUB, AEP and regional communities in understanding regional issues and planning regional development (1, page G1-1).

4.0 Contribution to Practice and Implementation of CEA

The proponent included a regional development review which examines potential impacts of proposed projects in an area as a tool to assist in regional planning. The CEA explicitly addressed the issue of scientific uncertainty for each environmental parameter assessed.

In assessing the cumulative impact of other projects in the area, the proponent focussed only on projects which would impact the same resource or environmental parameter as its proposed project.

References:

1. Shell Canada Limited. Muskeg River Mine Project. Volume 3: Environmental Impact Assessment. December 1997.

APPENDIX A16

SUNCOR INC. OIL SANDS GROUP STEEPBANK MINE

Description of Project

Location:	Fort McMurray, Alberta
Type:	Oilsands Mine

Process

Regulators:	Alberta Energy and Utilities Board, Alberta Environmental Protection.
Guiding Legislation:	Federal: Radiocommunications Act, Navigable Waters Protection Act; Provincial: Environmental Protection and Enhancement Act, Oil Sands Conservation Act, Water Resources Act, Hydro and Electric Energy Act, Pipeline Act, Quarries Regulation Act, Surface Rights Act, Municipal Government Act, Public Lands Act, Historical Resources Act.
Public Issues:	Traditional land use, long-term impact on demographics, employment housing and infrastructure, human health, biodiversity, species migration and migration routes, effects of long-range air emissions and pollutants on human health and on aquatic and terrestrial resources, commercial and recreational fisheries and loss of aquatic habitat.
Regulatory Direction:	The project was approved by the EUB without a hearing, although a number of deficiencies in the EIA had to be addressed.
Dates:	1996: EIA submitted; 1996: Decision to approve.

Approach

Issues:	Eight major components: socio-economics, human health, terrestrial, wildlife, surface and groundwater resources, aquatic resources, air quality and historical resources.
Assessment Methods:	GIS and remote sensing were used extensively for quantitative analysis of impact modelling. Cumulative effects on human health and the engineering performance assessment were done according to risk models of a worst-case scenario. Projections were used to estimate socio-economic effects. Models were used for habitat suitability issues and for water assessment. Lab tests were used in conjunction with field data and modelling to assess fish health.

Contribution to Practice and Implementation of CEA

The use of GIS and remote sensing helped to unify data resources and to provide important baseline data. Also valuable were the application of ecologically based risk assessment modelling for human health and the use of impact hypothesis statements which were based on scientific as well as public and stakeholder input. Finally, the assessment parameters were unique to each

SUNCOR INC. OIL SANDS GROUP:

STEEPBANK MINE

1.0 Description of Project

Project: Steepbank Mine located on the river escarpment and upland area to the east of the Athabasca River some 35 km north of Fort McMurray, Alberta. Other associated developments covered under the Steepbank EIA include the expansion in production capacity (from 87 to 107 Kbpcd thousand barrels per calendar day) of the fixed plant located in Lease 86/17 on the adjacent west bank of the Athabasca River, as well as the construction of a connecting bridge intended to provide transportation access, power, hydrotransport and fuel via internal pipelines (1, section C4.0).

Proponent: Suncor Inc. Oil Sands Group (Suncor)

Dates: 1996: EIA submitted; 1996: Decision.

2.0 Process

2.1 Regulators

- Alberta Environmental Protection (AEP)
- Alberta Energy and Utilities Board (EUB)

2.2 Guiding Legislation

Federal
- Radiocommunications Act
- Navigable Waters Protection Act

Provincial
- Alberta Environmental Protection and Enhancement Act (AEPEA)
- Oil Sands Conservation Act (OSCA)
- Water Resources Act
- Hydro-Electric Energy Act
- Pipeline Act
- Quarries Regulation Act

- Surface Rights Act
- Municipal Government Act
- Public Lands Act
- Historical Resources Act

2.3 Intervenors and Public Issues

The proponent conducted public consultation with local and regional stakeholders from the project pre-feasibility stage through to when it filed its application (a period beginning late in 1994 and extending through mid-April, 1996). Stakeholders included aboriginal groups, residents and leaders of the municipality of Wood Buffalo, the Fort McKay First Nation and Metis Local 122, Fort Chipewyan, regulatory agencies and the Oil Sands Environmental Coalition (OSEC). OSEC included the Pembina Institute for Appropriate Development, the Fort McMurray Environmental Association, the Toxic Watch Society and the Environmental Resources Centre (1, section A3.3.1).

Issues which were identified as being pertinent to cumulative effects included:

- Traditional land use
- Long-term impact on demographics
- Employee housing and infrastructure
- Human health
- Biodiversity
- Species migration and migration routes
- Effects of long-range air emission and pollutants on human health and on aquatic and terrestrial resources
- Commercial and recreational fisheries
- Loss of aquatic habitat. (1, Tables E1.1-1 and E2.0-1)

2.4 Regulatory Direction

After a number of deficiencies in the submitted EIA document were addressed to the satisfaction of the regulators, the project was approved without a hearing.

3.0 Approach to CEA

3.1 Issues Identification

The issues were identified by two key sources; 1) professional knowledge and experience; and, 2) public and stakeholder consultation. A comprehensive Issues Database was compiled and maintained through the course of public consultation (1, Table E1.0-1). The issues identified by the public and stakeholders were integrated

with the professional knowledge of the project study team, and were represented by Impact Hypothesis Statements (1, Table E2.0-1). These hypotheses were assessed according to a list of pre-determined parameters (1, Table E2.0-2) for direction, severity, duration, geographic extent and degree of concern.

3.2 VEC and Indicators Selection

The proponent did not describe its VEC definition and selection process in any detail in its EIA but subsequently provided an expanded description of its VEC selection methodology. VECs were identified as a focus for terrestrial, wildlife and aquatic environmental components, and were chosen as priority points for investigation. (1, sections E5.3.1, E2.0 & Table E2.0-3).

3.3 Spatial Bounding

Regional Study Area (RSA) boundaries were developed in consultation with the public and Syncrude Canada Ltd. (Syncrude) on the basis of the following criteria:

- Maximum real extent where resources could be impacted by SO_2 concentrations
- The drainage basins of key rivers including the Steepbank, Muskeg, Mackay and portions of the Athabasca and Clearwater Rivers, and
- Landscape units according to climatic, landform, soil, vegetation and wildlife habitat characteristics (1, section E2.0, page 18)

The same RSA was used to address regional terrestrial, wildlife and air quality impacts. The general Local Study Area (LSA) was defined to encompass boundaries containing the proposed Lease 86/17 and the proposed project; several smaller LSAs particular to various discipline requirements were also defined. The general LSA corresponded to terrestrial and wildlife components, whereas hydrology and hydrogeology, forestry (Alberta Vegetation Inventory, AVI) and historical resources each had their own LSAs.

3.4 Temporal Bounding

The baseline year for assessing the proposed project was 1995 although, in specific circumstances, conditions prior to that date were considered. The project description was broken into phases according to the following timeline:

- 1995: baseline
- 1997-2000: construction phase
- 2000-2020: operation and mine advance phase
- 2020+ : mine closure and reclamation phase

In terms of the EIA and CEA, the timeline was further refined to include assessment end-points as follows:

- 1995: baseline
- 2001
- 2010
- 2020
- long-term scenario

Maps describing the incremental project advance for both the general LSA and the RSA were also produced for each of these timeframes.

3.5 Included Projects

Five existing and proposed developments were identified as having potential significance for cumulative effects, as follows:

- Syncrude Mildred Lake
- Syncrude Aurora Mine
- Solv-Ex
- Alberta Pacific Forest Industries (AlPac)
- Northlands Forest Products Ltd.

Only the physical extents for Mildred Lake, Aurora, and Solv-Ex could be mapped and integrated with cumulative impact models using GIS. AlPac and Northlands could provide only projected allowable timber harvest volumes in their forest management districts. The location and timing of their logging activities will be primarily related to salvage logging preceding new oilsands mine development. (1, Table E5.0-3)

3.6 Assessment Methods

Eight major components were examined, as follows: socio-economics, human health, terrestrial, wildlife, surface and groundwater resources, aquatic resources, air quality and historical resources. The detailed local, regional and cumulative impacts associated with each component are discussed in separate Impact Analysis reports (1, Figure E2.0-2). The EIA document provided summaries of these results.

The proponent stated it intended its EIA to be issue driven, transparent, quantitative and provided in a regional/cumulative context. The CEA component was not separated from the EIA, but was integrated into the overall EIA process and documentation. The Impact Hypotheses were the primary focus for each component analysis pathway.

Impacts were evaluated in two ways. First, the individual and combined effects associated with the direct project development were assessed relative to baseline conditions within a particular discipline's LSA (1, Figure E2.0-4). Secondly, effects of the proposed project were evaluated in combination with the known or anticipated

impacts of other developments within the RSA (1, Figure E2.0-3) and again assessed in relation to baseline conditions where appropriate. (1, section 2.0)

GIS and remote sensing techniques using satellite information played a key role, and were used extensively throughout the assessment process as a basis for map data storage, manipulation, display and quantitative analysis or impact modelling. (1, section 5.1)

Cumulative effects associated with human health and the engineering performance assessment were assessed according to risk models of worst-case scenarios.

3.7 Impact Characterization

Cumulative impact assessment involved both quantitative and qualitative approaches, depending on the requirements of the specific project disciplines. Where possible, deterministic or stochastic models were used to determine the direction (+ or -), severity, duration and geographic extent of effects. Geomatics technology (GIS, remote sensing and CAD) were used extensively to determine spatial extents and make other quantitative measurements such as diversity and variation. A summary of the assessment approach used for each environmental component is provided below:

Component	Approach
Socio-Economics	Impacts assessed included numerical projections of anticipated capital flows into the region and the corresponding effects on the economies of the region, Alberta and Canada. Additional impacts considered were the numerical projections of the human resource requirements over the life-cycle of each oilsands project (1, Figure E3.0-1) and projected housing and infrastructure requirements related to increased population (1, section E3.0).
Human Health	With regards to human health, one of the approaches applied an ecological risk assessment process using deterministic and stochastic modelling. The modelling compared a likely human exposure to a conservative worst-case exposure scenario, which included all ways that a person was likely to use resources in the region (eating, drinking, swimming, hunting, trapping, etc.). Another approach applied human health modelling which involved linking air emissions, surface and groundwater models and habitat models together (1, section E4.0).

Component	Approach
Terrestrial Resources	GIS and remote sensing were used to classify, map and analyse the extents of terrestrial resources based on an Ecological Land Classification (ELC) approach. This approach integrated landform, soil and vegetation into map units which were used as a basis for assessing potential cumulative effects. Incremental reclamation was also factored into the development scenarios of Suncor and Syncrude to show habitat replacement and mitigation over time (1, section E5.0). Areal estimates of forest harvesting activities were provided by AlPac and Northlands, which were also factored into the cumulative terrestrial impacts analysis process. The extent and area of potential emissions effects on vegetation were mapped using GIS; however, no clearly quantified causal relationship between vegetation patterns and SO_2 emissions was determined.
Wildlife	GIS-based wildlife habitat suitability models (HEP models) were used to evaluate changes in habitat suitability (quality and quantity) for each VEC species on both a local and regional level. Quantitative comparisons were made between baseline conditions, maximum mine extent and long-term mine closure. (1, section E6.0).
Surface and Groundwater	The flow rates of major surface watercourses (Steepbank and Athabasca) were modelled including potential effects of the proposed project and Lease 87/17, and compared to baseline conditions. Contamination of surface water resources was modelled factoring in only water derived from reclamation and tailings management (the operational discharge of mine waters will not be practiced). Groundwater resources including the Basal Aquifer were modelled regionally using a finite element modelling approach and factoring in both the Suncor and Syncrude pit design.
Aquatics	An assessment was performed to determine potential regional levels of fish tainting, fish health and habitat quality and quantity in the Steepbank and Athabasca rivers. Fish health included biochemical, physiological,

Component	Approach
	whole-organism, population and community levels of assessment. Laboratory experiments were used in conjunction with field data and computer modelling studies to examine the effects of operational and reclamation waters on fish health.
Air Quality	Air quality assessment focussed on selected emissions from the proposed project and their effects on the regional air-shed relative with respect to ambient air quality and a particular receptor (i.e., human, plants, soil, and aquatic resource). Other emissions sources were added to this analysis, including Syncrude, Solv-Ex, Ruth Lake, and traffic/residential sources. A number of emissions were determined to have measurable effects on cumulative air quality, including SO_2, The maximum hourly average emission concentrations for NO_x, CO_2, TRS, H_2S, particulates, VOC and THC were modelled, although the methods were not specified in the EIA (1, section E9.0).
Historical Resources	No cumulative or regional assessment was completed.

3.8 Significance of Cumulative Effects

The proponent discussed significance (degree of concern) of cumulative effects in the context of its impact hypotheses (which related to the original public issues) and of any corresponding mitigation or monitoring activities but did not specifically define significance. The duration and extent of each impact was also discussed. The results were presented in tabular form (1, Table E11.0-1).

3.9 Future Management Options

The proponent will be participating with Syncrude in the Regional Air Quality Coordination Committee (RAQCC), and with the Canadian Forest Service to develop an environmental effects monitoring program. Recently, the proponent, Shell and Syncrude have teamed with provincial agencies to create the Regional Aquatics Management Program (RAMP) committee.

4.0 Contribution to Practice and Implementation of CEA

The CEA used GIS and remote sensing as a core integrating technology behind the terrestrial assessment. These technologies also served to unify the data resources used by other project disciplines such as aquatics, surface and groundwater. The techniques allowed the proponent to develop a regional spatial database of environmental parameters (digital elevation models, vegetation, soils, hydrology, etc.), which have provided important baseline data for ongoing and future monitoring in the region by a number of other proponents, including Syncrude and Shell Lease 13.

Additionally, ecologically-based risk assessment modelling for human health and the engineering performance assessment allowed the proponent to determine likely and worst-case impact scenarios.

The EIA and CEA components were driven by impact hypothesis statements which were based on scientific as well as public and stakeholder input. The focus of the assessments was then directed at proving these hypotheses using quantitative methods where possible.

The assessment parameters were unique to each discipline, which allowed for a more sensitive treatment of each impact.

References:

1. Suncor Inc. Oil Sands Group. Steepbank Mine Project Application. April 1996.

APPENDIX A17

SYNCRUDE CANADA INC.
AURORA OILSANDS MINE

Description of Project

Location:	Fort McMurray, Alberta
Type:	Oilsands Mine

Process

Regulators:	Alberta Energy and Utilities Board, Alberta Environmental Protection.
Guiding Legislation:	Environmental Protection and Enhancement Act, Energy Resources Conservation Act, Oil Sands Conservation Act.
Public Issues:	Lack of emergency response plans, water quality, air quality, surface water levels, loss of bird habitat, effects on wildlife, fish habitat, fish tainting, effects on migratory birds, resource use and environmental space, consistency with Integrated Regional Plan.
Regulatory Direction:	Decision not reviewed.
Dates:	1997: EIA submitted; 1997: Decision to approve.

Approach

Issues:	Surface hydrology, terrain, vegetation, wildlife, fisheries, human health, air quality, soils, surface water quantity and quality.
Assessment Methods:	Based on scientific methods and traditional ecological knowledge. Quantitative modelling was used for NO_x and SO_2 emissions. Continuous ambient monitoring and dispersion modelling was used with respect to ground-level ozone. Estimates were used to assess surface water quantity, while tests and modelling were used for quality. Lab tests were done to assess fish tainting risks. Assessment of health risks was based on certain assumptions along with estimated emission.

Contribution to Practice and Implementation of CEA

Suncor and Syncrude co-operated in establishing a regional study area for analysing cumulative effects.

SYNCRUDE CANADA INC.:

AURORA OILSANDS MINE

1.0 Description of Project

Project: Oilsands mine of approximately 15,000 ha near Fort McMurray, Alberta.

Proponent: Syncrude Canada Inc. (Syncrude)

Dates: 1996: EIA submitted; 1997: Decision.

2.0 Process

2.1 Regulators

- Alberta Environmental Protection
- Energy and Utilities Board

2.2 Guiding Legislation

- Alberta Environmental Protection and Enhancement Act
- Energy Resources Conservation Act
- Oil Sands Conservation Act

2.3 Intervenors and Public Issues

The Pembina Institute intervened to raise concerns about the lack of emergency response plans for spills or pipeline breaches across the river, or contingency plans in the event consolidated tailings (CT) emissions proved to be too toxic. In terms of cumulative effects, Pembina expressed concern about the cumulative effects of all activities in the area on the quality and flows of the Athabasca river, on habitat loss (patterned fens in particular) for bird species and long term post reclamation effects on wildlife, water quality, etc. Air quality concerns included incomplete predictions of cumulative ozone concentrations, CO_2, GHG emissions and particulates monitoring.

The proponent supplemented information on this point in a later filing.

The Department of Fisheries and Oceans (DFO) intervened with concerns about contingency plans in the event CT emissions proved too toxic, and post reclamation monitoring activities and time frames, particularly with respect to the suitability of end-pit lakes for fish habitat. In addition, concerns about impacts on two lakes in the area (McLelland and Kearl) were raised with regards to reducing flows into the lakes. The concerns raised by DFO were primarily related to the impact of the proposed project itself. However, it raised its concerns in the context of cumulative effects, given that nearby mines also plan to use CT technology and end-pit lakes which will discharge water into the Athabasca River.

Shell Canada and Northland Forest Products intervened and raised concerns primarily about resource use, rather than cumulative impacts. However, Shell also introduced the concept of environmental space in referring to cumulative effects caused by the proposed project taken together with projected activities on adjacent Lease 13.

Environment Canada, although not an official intervenor, raised concerns about contingency plans in the event CT water proves to be too toxic, effects of emissions on fish tainting (which is already a problem in the area), effects of CT on migratory birds, impacts of pipeline failures across the Athabasca River, cumulative effects of mine activities on the water quality and flows in the Athabasca river, consistency with regional plans such as the IRP, cumulative effects on patterned fens and bird habitat. For air data presented, Environment Canada also commented that the proponent provided incomplete predictions for cumulative ozone concentrations, CO_2, GHG emissions and particulates monitoring

2.4 Regulatory Direction

The project was approved without a public hearing.

3.0 Approach to CEA

3.1 Issues Identification

The issues identified for the EIA, and subsequently the CEA, were derived from a knowledge of the project and study area and public consultations. Assessments were based on scientific methods and traditional ecological knowledge (1, page 5-1). Impact hypothesis A-1 (1, section 5) refers to the effects of the project on regional ambient air quality but the remainder of the hypotheses relate to the local study area and local impacts only (1, pages 5-1 to 5-26). Significant natural features were summarized as follows:

Significant Natural Features	Effects
Air	NO_x, SO_2 (and acidification), CO_2, THC, TRS, O_3
Surface water quantity	
Surface water quality	
Groundwater	CEA not done
Soils	Disturbance, acidifying emissions
Vegetation	Disturbance, acidifying emissions
Wildlife	Habitat loss/disturbance Wildlife Key Indicator Species (1, page 5-452)
Fisheries	Tainting, habitat
Resource use	
Human health	Noise, air, reclamation

[1] Significant natural features (SNF) within both the LSA and the RSA were identified and the CEA performed for surface hydrology, terrain, vegetation, wildlife and fisheries within the SNFs. The Athabasca-Tar-Sands reach of the Athabasca River was rated as nationally significant, with other areas as regionally or provincially significant.

3.2 VEC and Indicators Selection

Key Indicator Resource (KIR) selection for the EIA was based on ecological importance and vulnerability, resource use value, monitoring value and political importance and was intended to be representative of the LSA. For example, vegetation was chosen based on abundance in the LSA, status classification (national, provincial, or regional classifications of rare species), diversity, sensitivity to physical disturbance, economic importance (consumptive use) and recreational importance (1, page 5-1). Criteria for fish were similar and also included spawning in the study area and habitat niche/ sediment exposure. The same KIRs were used for the CEA on a regional basis.

3.3 Spatial Bounding

The regional study area was chosen jointly by Suncor and Syncrude in order to pool their resources in conducting a CEA. The proponents used an ecosystem-based approach to select the boundary and to allow for assessment of the effects of regional developments on air quality, surface water, vegetation, soil, wildlife resources and resource use.

An airshed boundary was established by air quality modelling of concentrations and depositions to account for the potential direct and indirect impacts of air emissions on soil, water and vegetation (1, page 1-86). The boundary was then set at a specific effective acidity contour related to soil types.

A watershed boundary was established based on topographic contours and vegetation conditions and includes watersheds or watercourses in the vicinity of existing oilsands operations and those potentially impacted by proposed developments.

A landscape boundary was established based on ecodistricts identified by Strong (1992). Overlaying the boundaries for the airshed, watershed and landscape and connecting the outermost boundaries arrived at the final boundary for the regional study area (RSA). The RSA included the municipalities of Fort McMurray and Fort McKay.

3.4 Temporal Bounding

The CEA was based on the life of the mine and reclamation activities, a period extending to 2045.

3.5 Included Projects

Although the identified RSA included the municipalities of Fort McMurray and Fort McKay, it was not clear they were represented in the CEA. Regional sources of NO_x emissions were identified as follows: Syncrude Aurora, Syncrude Mildred Lake, Suncor Steepbank, Solv-Ex, AOSTRA, Northlands Forest Products, other industrial sources and other sources (which may include the municipalities). Regional sources of SO_2 were identified as follows: Syncrude Aurora and Mildred Lake, Suncor and Solv-Ex. Regional sources of CO_2 assessed covered Syncrude Aurora and Mildred Lake, Suncor, other industries, transportation and residential sources.

Suncor and Syncrude's activities in the RSA were identified as the only potential contributors to THC/TRS emissions. Ozone is monitored at Fort McMurray and therefore presumably includes all possible ozone emitting activities in the RSA (and possibly beyond).

3.6 Assessment Methods

Cumulative effects assessment was presented in a separate section of the biophysical impacts assessment. The proponent commented that, in conducting the CEA, it examined multiple impacts (additive), magnification of impacts (interactive) and synergistic impacts (interactive) and for each issue, reviewed existing impacts, incremental impacts and cumulative impacts (combination of existing and incremental).

In the EIA, impacts were assessed as indicated in Table 2 (1, page 5-15).

Terms used to define "Degree of Concern" of impact ratings for non-air quality issues are summarized below (1, page 5-15):

Magnitude of Impact on Resource	Direction of Impact	Duration of Impact	Frequency of Impact	Scope of Impact	Degree of Reversibility of Impact
Low (<1%)	Positive	Short term (< 1 year)	Once	Local	Reversible
Moderate (1 to 10%)	Negative	Moderate term (1-10 years)	Intermittent	Regional	Irreversible
High (>10%)	Neutral	Long term (>10 years)	Continuous	Provincial	

Degree of concern related to residual impacts of the activity, which is relevant to CEA, and identified the importance of those impacts using the above set of terms. Residual impacts were classified as Types A (high magnitude, greater than 10% of resource affected and greater than 1 year duration, affecting LSA or RSA) through C, or undetermined.

3.7 Impact Characterization

The proponent concluded that, although some of the SNFs in the RSA would be affected by the proposed project, all effects will be minor to insignificant or reversible through mitigation (1, pages 5-409 to 5-411).

Cumulative effects assessment was carried out for air quality including regional NO_x emissions, long term acidification due to SO_2 emissions, regional CO_2 emissions, generation of odours from THC and TRS emissions, and production of ozone from NO_x and THC emissions.

The CEA used ISC3BE dispersion modelling to predict regional NO_x emissions from existing point sources in the region (1, page 5-412). A major source of NO_x emissions not included in the modelling at this point were the emissions from mobile sources such as the mine fleet. The modelling predicted that NO_x concentrations would not exceed AEP guidelines and therefore had no impact.

Regional SO_2 emissions were predicted based on the assumption that upgrades to Suncor's facilities would result in significant decreases in emissions. In 2001, SO_2 emissions (with the proposed project in operation) were assumed to be approximately the same as they were in 1995. Modelling predicted that the overall maximum predicted hourly average concentrations associated with the proposed project would not have significant impacts on maximum predicted SO_2 concentrations and therefore no cumulative impact (1, page 5-416).

Although the proponent predicted increases in regional CO_2 emissions due to the operation of the proposed project, it assumed that these increases would be offset by reduced activities at the Mildred Lake Mine and by introducing more energy efficient technologies. Sources of THC/TRS emissions were identified, but emissions were assumed to be dispersed over such a large area that they would not contribute significantly to odours. Ozone is currently monitored on a continuous basis in Fort McMurray. The proponent concluded that ozone criteria were currently routinely exceeded in the area and were not necessarily associated with anthropogenic emissions (1, page 5-420). Predictions for ozone concentration were based on ambient monitoring results and dispersion modelling. The proponent concluded that emissions attributable to the proposed project would have a minimal effect on the maximum predicted ozone concentration (< 5%) and therefore would have no impact.

Existing water allocations in the Athabasca River basin were presented in the CEA. The proposed project was predicted to use significant amounts of water only in the development and reclamation phases, especially for end-pit lake formation (2035-3037 and 2040-2045). Withdrawals were predicted to reduce flows in the Athabasca River by between 0.74 and 1.3%. Cumulative effects of mine water discharges from the Aurora Mine and existing and proposed oilsands plants to the 'far future' were estimated. The net effects on surface water flows resulting from water withdrawals, mine water releases and catchment runoffs were concluded to be negligible in terms of water quantity.

Losses in wetland area were predicted with the development and operation of the mine, but it was assumed that losses would be 'eliminated' following reclamation (1, page 5-429). Reclamation was predicted to result in an increase in the area of lakes and streams in the area. The fraction of wetland loss relative to total wetland area in the RSA was predicted to be negligible.

Surface water quality was assessed for the Athabasca River and the Muskeg River watersheds for operational and post-operational releases, for existing Syncrude, existing and proposed Suncor and proposed Solv-Ex operations. The proponent concluded that existing and proposed sources of operational releases would have no significant impact on water quality. Operational waters released from the proposed project were expected to result largely from muskeg drainage and would not affect water quality.

Reclamation waters (CT water) were to be released into the Athabasca and Muskeg drainage. The proponent employed mathematical modelling to predict water quality changes associated with these releases. Some changes in water quality in a nearby lake and the Muskeg River were predicted, but were expected to have no significant impact. Increases in the concentration of CT water in the Athabasca River was also predicted with modelling, but these changes were not expected to adversely affect human health or aquatic biota (1, page 5-441). The criteria used to conclude there would be no impact on human health or aquatic biota were not presented in this section.

Effective acidity (as a result of SO_2 emissions) was modelled and emission levels from Aurora were found to be “too low to add incrementally to the potential acidification of water bodies in the region based on the critical loading value for sensitive lakes.

A CEA for the proposed project for soil disturbance, and the effects of acidifying emissions was carried out. Permanent disturbance of soils in the area (after reclamation) was calculated as 21 ha, or <0.1 % of the RSA and assumed to be insignificant.

The proponent did not predict maximum Effective Acidity (EA) from the proposed project since it expected SO_2 emissions to be very small. Therefore, it concluded that incremental impact of the project on soil acidification would be insignificant, as would cumulative effects. NO_x emissions were predicted to have vegetation *growth-promoting* effects in the area.

A CEA for the proposed project on soil disturbance, and the effects of acidifying emissions, was carried out. Permanent disturbances of vegetation in the area due to other projects or developments were identified. In general, vegetation disturbances were assumed to be reversed after reclamation of the Aurora mine. Reclamation would result in changes in vegetation patterns, but the proponent argued that the changes were minor in the context of the RSA.

The CEA also covered the effects of acidifying emissions on vegetation and the proponent concluded that SO_2 emissions from proposed project would be insignificant. Increases in NO_x emissions (and effects on vegetation) were assumed to be local in nature and therefore not cumulative with other projects.

The CEA for wildlife focussed on habitat loss. The proponent concluded that the incremental impact of the proposed project on habitat loss for the Key Indicator Species represented a small component of total habitat loss in the area, and affected only a small portion of the habitat available in the RSA.

CEA was performed for fish tainting, fish health and habitat in the Muskeg and Athabasca watersheds. Effects on fish tainting and health (as well as for other aquatic organisms) were examined through laboratory tests with CT water to determine No and Lowest Observable Effects Concentrations. Releases to the watersheds were not predicted to exceed guidelines for toxicity suggested by AEP and therefore deemed to be unlikely to cause adverse effects on fish health. Tainting refers to a disagreeable taste or smell, as a result of emissions of refinery wastewater, which does not affect fish or human health. The proposed project was not expected to add incrementally to fish tainting since it does not produce refinery wastewater.

Fish habitat was expected to increase in the area due to the formation of the end-pit lakes during the reclamation phase.

Changes to the merchantable forest cut as a result of the proposed project were predicted to be negligible. Sport fishing was assumed to be positively impacted as a result of the creation of more fisheries habitat after reclamation. However, a decrease in hunting and trapping was predicted over the moderate to long term. The cumulative effects of visual impacts was expected to be low due to the terrain and local forests.

Cumulative impacts on human health were estimated for noise and air emissions, and exposure to chemicals in the reclaimed landscape. The relatively isolated nature of the development indicated that noise would not contribute incrementally to noise levels in the area. Since changes in air emissions were expected to be slight, no effects on human health were predicted.

Possible health impacts associated with the post-reclamation landscape were assessed by both Syncrude and Suncor using a series of conservative assumptions (e.g. year round residency, cumulative exposure to chemicals from various pathways). Potential exposure resulted from inhaling air emissions from CT deposits and ingesting plants grown on CT deposits. However, a lack of data prevented further analysis of impacts.

3.8 Significance of Cumulative Effects

For the majority of issues examined, the proponent concluded with findings of ‘no significance’ based on either established guidelines or simply based on the proportion of effect attributable to the project. For example, incremental habitat loss in the RSA attributable to the Aurora mine was assumed to be negligible based on the proportion of the RSA it represents.

The creation of end-pit lakes was predicted to impact fisheries and wetland areas positively, but no significance was attached to the prediction.

3.9 Future Management Options

Suncor and Syncrude are participating in an initiative with the Regional Air Quality Co-ordinating Committee and the Canadian Forest Service to design and implement an environmental effects monitoring program to monitor the effects of oil sands emissions, particularly acidifying emissions, on biophysical receptors for the northeastern portion of the province (1, page 5-441).

No other future management options for the area were suggested.

4.0 Contribution to Practice and Implementation of CEA

Suncor and Syncrude co-operated in establishing a regional study area and sharing data collection and monitoring activities.

References:

1. Syncrude Environmental Impact Assessment for the Syncrude Aurora Mine. June 1996.

APPENDIX A18

THREE SISTERS GOLF RESORTS INC.: THREE SISTERS RESIDENTIAL and FOUR SEASONS DESTINATION RESORT

Description of Project

Location:	Canmore, Alberta
Type:	Tourist Resort, Residential Sub-Division, and Commercial Development, Recreational Development

Process

Regulators:	Natural Resources Conservation Board, Alberta Environment.
Guiding Legislation:	Natural Resources Conservation Board Act, Alberta Environmental Protection and Enhancement Act.
Public Issues:	Continuing loss of montane ecosystem, continued population growth and increased demands on municipal infrastructure, loss and displacement of wildlife, loss of wildlife habitat, changes to public recreational use.
Regulatory Direction:	Development of regional planning bodies to direct future growth in the valley, rejection of a major component of the project (Wind Valley resort) due to concerns of regional-level effects on some wildlife species.
Dates:	1991: EIA submitted; 1992: Hearing and Decision to approve.

Approach

Issues:	Determining which future projects should be considered, use of multiple assessment study areas, inclusion of larger regional areas as warranted by nature of valued ecosystem component being assessed.
Assessment Methods:	Air quality modelling, habitat suitability analysis for wildlife; otherwise, standard assessment approaches for local effects.

Contribution to Practice and Implementation of CEA

Recognition of regional concerns arising from local effects, and the need for regional coordination of development within a topographically constrained area.

THREE SISTERS GOLF RESORTS INC.:

THREE SISTERS RESIDENTIAL AND FOUR SEASONS DESTINATION RESORT

1.0 Description of Project

Project: Resort hotel, golf courses, homes and some commercial development on 1036 ha located west of the Town of Canmore on the lower slopes of the Bow River valley. Total anticipated resident and visitor population was approximately 20,000.

Proponent: Three Sisters Golf Resorts Inc. (Three Sisters)

Dates: 1991: EIA submitted; 1992: Decision.

2.0 Process

2.1 Regulators

- Natural Resources Conservation Board (NRCB)

2.2 Guiding Legislation

Provincial

- Natural Resources Conservation Board Act

2.3 Intervenors and Public Issues

Intervenors during the NRCB hearings included national and local environmental organizations, local residents, local government agencies and social services, First Nations, hunting and fishing organizations, federal, provincial, municipal and town governments, and industry and tourism organizations.

2.4 Regulatory Direction

The NRCB rejected a component of the proposed project which would most likely have caused significant adverse effects on far-ranging wildlife species, and also recommended that an advisory body be established to direct monitoring and land use planning efforts in the valley (1).

3.0 Approach to CEA

3.1 Issue Identification

Local residents were particularly concerned about continued incursions of residential and industrial development into wildlife habitat, the effect that major transportation corridors such as highways and railways were having on wildlife mortality, and changes to recreational use (consumptive and non-consumptive) (2).

3.2 VEC and Indicator Selection

The following indicators were used to assess environmental components involving potential cumulative effects:

Environmental Component	Indicator
Air	CO, NO_2, Total Suspended Particulates, Benzo(a)Pyrene
Fish	Mountain whitefish, Trout (various species)
Vegetation	Dominant vegetation communities (e.g., closed spruce, closed pine, open spruce, and open pine)
Wildlife	Wood Frog, Wandering Garter Snake, Osprey, Red-tailed hawk, Golden Eagle, Ruffed Grouse, Mallard, Songbirds, Red-backed Vole, Meadow Vole, Red Squirrel, Snowshoe Hare, Ermine, Beaver, Marten, Coyote, Lynx, Cougar, Black Bear, Grizzly Bear, Bighorn Sheep, Elk, Wolverine

Environmental Component	Indicator
Visual Assessment	Visual sensitivity ranking for Bow Valley, indicating degree by which an area's visual disturbance is determined based on the type of landscape and project feature

3.3 Spatial Bounding

Separate study areas were delineated for each type of potential impact. Some boundaries remained within or immediately adjacent to the immediate project area. For example, the study area for fish included the section of the Bow River paralleling the project whereas the biophysical study area for vegetation and wildlife extended beyond the project area by a few kilometres to include a larger and representative area within the Bow River Valley. This area supported a more meaningful assessment of direct and indirect effects on local wildlife populations. However, the analysis acknowledged regional linkages by way of wildlife corridors to distant areas for some far-ranging wildlife species, a proposition especially true for the Wind Valley which partially overlapped the southern portion of the proposed project.

The visual and socio-economic study area extended even further to take into account human use and occupation throughout the valley.

3.4 Temporal Bounding

Although no specific temporal bounds were stated, the proponent generally considered current conditions to represent the baseline, except when discussing historical trends on some wildlife species. The build-out period of 20 years for the proposed project was also considered.

3.5 Included Projects

Only future projects that had received regulatory approvals were included in assessing cumulative effects. The assessment considered two specific future projects (only two other major nearby developments were known to be proceeding) and the general growth of the Town of Canmore. The Board identified a "base case" in which specific existing and approved projects were considered in examining cumulative effects. These projects included existing communities in and near Canmore, residential subdivisions, golf courses, and existing major infrastructure (e.g., highways, and railways).

3.6 Assessment Methods

The proponent considered all typical environmental components of an EIA, including geology, vegetation and wildlife, surface water hydrology, water quality, fisheries and aquatic resources, air quality, visual resources, historical resources. The EIA included a section on socio-economic effects, which included cumulative effects.

The proponent explicitly addressed cumulative effects in its conclusions (1, section 3.3.6) and when discussing the implications of continued growth in Canmore. Cumulative effects were implicitly addressed within the context of local effects, with contribution from other impacts considered as appropriate. This approach focussed the assessment on vegetation and wildlife, especially the latter. Due to the regional nature of wildlife movements, cumulative effects were reflected in the type of spatial analysis performed.

3.7 Impact Characterization

The proponent considered air quality effects on a regional basis due to the many contributing sources in the valley. Emissions were considered from natural gas consumption, wood combustion and vehicle traffic.

Incremental effects on water quality were not considered to be important on a regional basis in consideration of contributions from other existing sources. Local mitigation was deemed adequate to address water quality concerns.

Vegetation effects were rated as local (Biophysical Study Area) or regional (Bow Corridor and adjacent natural areas). Effects included local clearing, burns and use of vegetation control measures.

For wildlife, various types of effects were examined as appropriate for the species: loss of habitat, sensory disturbance, obstructions to movement, direct mortality, and interactions with humans. The assessment was based on qualitative discussion using best available information and data obtained from a quantitative Habitat Suitability Analysis (indicating the number of habitat units directly and indirectly lost for each habitat type).

Wildlife movement linkages beyond the Biophysical Study Area were identified and their importance to regional populations discussed. Particular attention was given to effects on grizzly bears due to their large home ranges, and on elk due to the continuing loss of habitat and requirement for movement corridors. Much of the assessment focussed on the potential for development in the Wind Valley to significantly reduce the movement of elk and grizzly bears regionally. This issue was also raised as a concern in public hearings.

3.8 Significance of Cumulative Effects

Significance was implied through the ranking of residual impacts (e.g., negligible, regionally minor, important) for a variety of environmental and socio-economic components. Cumulative impacts were defined as those impacts to which the project contributed but was not solely responsible. Impacts were categorized as follows:

- Class 1: Important impacts that cannot be avoided or mitigated
- Class 2: Important adverse impacts that can be avoided or mitigated
- Class 3: Minor adverse impacts that are considered important in a regional or local sense
- Class 4: Positive impacts
- Class 5: Cumulative impacts

Most of the Class 5 effects were identified as “Negligible” or “Regionally Minor”. However, impacts on air quality, transportation, vegetation, demographics and fisheries were identified as “Important”.

3.9 Future Management Options

The Board recommended that the project design be changed to preserve or enhance certain landscape features, and that construction and operational schedules and procedures be changed. The provincial government later facilitated an exchange of property holdings in order to protect Wind Valley. Additional measures with more regional implications were also recommended by the Board, including:

- Controls on wood burning stove emissions
- Reduction of surface runoff from site
- Adequate wastewater treatment
- Vegetated buffer strips to protect riparian and terrestrial habitat
- Wildlife movement corridors
- Modification of project design to avoid ecologically sensitive areas, and
- Formation of a Bow Valley Planning and Advisory Committee to gather data and monitor effects in the valley

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4.0 Contribution to Practice and Implementation of CEA

Results from a relatively localized EIA were, during the project review, expanded to consider regional effects. Although the proponent did consider some regional implications, the Board reinforced the importance of and critically examined the issues. The Board concluded that cumulative effects could not be adequately

addressed on a project-by-project basis, and that a new and regional decision-making body would be required to coordinate future developments and information gathering to assist in subsequent decision-making.

References:

1. DeSorcy, G.J., G.A. Yarranton, C.H. Weir and C. Dahl Rees. Application to Construct a Recreational and Tourism Project in the Town of Canmore, Alberta: Decision Report: Application #9103 - Three Sisters Golf resorts Inc. Natural Resources Conservation Board, Edmonton, Alberta. 1992.

2. Three Sisters Golf Resorts Inc. (TSR). Volume II: Environmental Impact Assessment Report. Prepared by UMA Engineering Ltd. for Three Sisters Golf Resorts Inc., Calgary, Alberta. 1991.

APPENDIX A19

UNION CARBIDE CANADA INC.
PRENTISS EXPANSION PROJECT

Description of Project

Location:	Joffre, Alberta
Type:	Expansion of an Existing Petrochemical Facility and Construction of a Low Pressure Polyethylene Plant

Process

Regulators:	Alberta Energy and Utilities Board, Alberta Environmental Protection.
Guiding Legislation:	Environmental Protection and Enhancement Act, Oil and Gas Conservation Act, Energy Resources Conservation Act.
Public Issues:	Employment, economic benefits, quality of life, traffic, noise, air quality, surface water quality, fish and fish habitat, wildlife, soils and groundwater, effects on crops, biophysical resources, night lighting, visual impacts, health, cultural resources.
Regulatory Direction:	Decision pending.
Dates:	1997: EIA submitted.

Approach

Issues:	Traffic, noise, air quality, surface water and aquatic environments, groundwater, crops and biophysical resources, lighting, visual, community health and livestock.
Assessment Methods:	Noise levels were measured, and a sound model was created to simulate baseline conditions. Plume dispersion modelling was used to predict emissions concentrations. Habitat modelling and air quality modelling were also used.

Contribution to Practice and Implementation of CEA

Study area boundaries were clearly defined and rationalized for different environmental parameters.

UNION CARBIDE CANADA INC.:

PRENTISS EXPANSION PROJECT

1.0 Description of Project

Project: Expansion of an existing petrochemical facility and construction of a low pressure polyethylene plant to use ethylene from a joint venture with Nova at Joffre, Alberta.

Proponent: Union Carbide Canada Inc. (UCCI)

Dates: 1997: EIA submitted.

2.0 Process

2.1 Regulators

- Alberta Environmental Protection
- Energy and Utilities Board

2.2 Guiding Legislation

Provincial

- Environmental Protection and Enhancement Act
- The Oil and Gas Conservation Act

2.3 Intervenors and Public Issues

The proponent contacted neighbours and directly affected stakeholders and conducted consultations with other interested groups. Issues identified included:

- Land rezoning
- Rail access
- Emergency response plans
- Business and employment opportunities
- Industrial co-operation

- Construction camp and traffic volumes
- Air quality
- Water quality
- Noise and lighting issues

These issues were addressed in the assessment which was characterized as issue-driven, and addressed issues identified by stakeholders, Union Carbide staff, the consulting team and regulators (Public Consultation and Communication Document, page 11).

2.4 Regulatory Direction

Decision was pending as of February 1998.

3.0 Approach to CEA

3.1 Issue Identification

Issues were identified by stakeholders, staff, the consulting team and regulators as follows (1, pages 57-59):

- Jobs, economic benefits, infrastructure, quality of life
- Traffic
- Noise
- Air quality; emissions, greenhouse gases, fog formation, odour
- Ecosystem health, fish habitat, water quality, fish abundance
- Soils and groundwater; potable water quality, migration off-site
- Effects of emissions on crop yields and health
- Biophysical resources
- Night lighting
- Visual impacts
- Wildlife, human and livestock health
- Cultural resources

3.2 VEC and Indicator Selection

The assessment was issue-driven rather than driven by the identification of specific VECs or indicators. For some issues, such as human and livestock health, parameters for analysis were based on the availability of data.

3.3 Spatial Bounding

The main study area for the EIA was centered on the proposed project. However, separate study regions were delineated for each type of potential impact, as summarized in the table below (1, page 60-63). The socio-economic assessment focussed on eight communities identified based on discussions with community representatives and the locations of the residences of employees.

Potential Impact	Study area boundary	Rationale (if given)
Traffic	5 km radius	Identified by study team
Noise	2 km radius	Defined as the region that could reasonably be expected to be impacted by noise as defined by EUB Noise Control Directive ID94-4.
Air quality	10 km radius	Maximum geographic extent in which significant air quality changes could occur
Surface water and aquatic environments	Dickson Dam to Drumheller	Regional study area included the Red Deer River upstream from the Dickson Dam, downstream to Drumheller and other significant developments in the area
Groundwater	3 km radius from fence line	
Crops and biophysical resources	10 km radius	Maximum geographic extent in which significant air quality changes could occur
Lighting	5 km from plant	
Visual	Viewshed	Sum of the viewpoints from which the tallest component of the project will be visible
Community health and livestock	Local residences and nearby communities	Based on study areas for which community health data was available

3.4 Temporal Bounding

The temporal period for assessment varied according to the impact being assessed. Impacts from construction, for example, were assessed during the construction phase only (27 months) whereas other impacts were assessed over a longer (but unspecified) term.

3.5 Included Projects

The study included existing projects plus the ethylene and polyethylene projects at Joffre. The impacts of other types of activities were also evaluated to some extent (e.g., the role agriculture plays in phosphorous loading on the Red Deer River).

3.6 Assessment Methods

The proponent identified potential impacts of other projects in the region, but left the actual evaluation of impacts to regulators, the community and other stakeholders (1, page iv). However, some issues of regional concern were identified, including phosphorous loading in the Red Deer River.

3.7 Impact Characterization

Impacts were characterized as follows:

Potential Impacts	Impact Characterization
Noise	Impact characterization was based largely on comparison to established guidelines or regulations. Construction noise was assessed and determined likely to be within limits that other jurisdictions have established for construction noise at nearby residences. The noisiest phase of construction was used as the worst case scenario. Impacts related to increased traffic on roads and the railyard were acknowledged but predicted to be slight. Background noise levels and distance of nearby residences to the plant site were measured in determining levels of impact of noise related to plant operation. In addition, other sources of noise in the study area were identified and a sound level model created to simulate baseline conditions. The model found that nighttime permissible sound levels may be exceeded at present and enabled the proponent to identify noise sources for targeting noise control measures.
Air Quality	The proponent planned to make changes in current operations at the site, which were predicted to result in

Potential Impacts	Impact Characterization
	marginal exceedances over AEP guidelines for ethylene concentrations in a small area of land owned by the proponent. Emissions from the new developments were modelled using plume dispersion modelling which indicated that air quality standards would be met with the exception of ground level concentrations of ethylene. Emissions of NO_2, NO_x, CO, suspended particulates, ethylene and n-hexane from three plants in the Prentiss region were calculated (1, page 107). Predicted concentrations were modelled using plume dispersion models. The modelled results were compared with observed data from the proponents air quality monitoring station to the north of the facility and were found to be identical up to the 95 percentile value. The impacts of ethylene on crops and vegetation in the area around the plant were assessed based on physical observations. No evidence that ethylene affects crop yields or other vegetation was found.
Water	The impacts of water withdrawal for the proposed project in combination with the expansion at Nova Chemicals (Joffre) were assessed. Habitat modelling indicated that small, but measurable effects on fish habitat availability would occur during the summer months.
Soil and Groundwater	Safety and environmental measures at the plant were expected to eliminate soil and groundwater impacts on-site. No cumulative effects of impacts on off-site terrestrial and aquatic systems were predicted.
Vegetation and Wildlife	The project will result in the loss of 124 ha of agricultural land and thus will have minimal impact on native vegetation, wetlands and habitat loss. Impacts on wildlife were assumed to be negligible as long as emissions to water and air complied with AEP guidelines. The proponent comments that little is known regarding the direct impact of industrial air emissions on wildlife (1, page 134).

Potential Impacts	Impact Characterization
Human Health	With regards to emissions with possible human health effects, n-hexane, NO_2, CO and particulate matter were identified. Air quality modelling and further review indicated that these chemicals do not pose a concern to local residents or others in the region.

3.8 Significance of Cumulative Effects

Thresholds or guidelines were used for assessing the impact of noise in the area. New noise control measures were predicted to reduce future noise below current levels and therefore have a positive impact. In general, ambient air quality guidelines were used to determine the significance of the emissions from the plant and surrounding plants.

Modelling predicted that ethylene concentrations would exceed AEP guidelines in small areas around the project. The proponent concluded these exceedances would not have a significant impact because the guidelines are preliminary, based on potential for ethylene to affect plant growth and no adverse effects on plant growth have been reported in the vicinity of the site.

Levels of phosphorous in the Red Deer River were identified as an issue of regional concern about emissions from the proponent's activities, agriculture, industry and municipalities. The proponent is in the process of investigating methods for reducing phosphorous loads, but amounts from the facility were anticipated to be small relative to that produced by the Red Deer sewage treatment plant and have little impact on organisms in the river.

Changes in fish habitat in the Red Deer River were expected to be positive for some species (e.g. walleye) and negative for others (e.g. brown trout), but generally insignificant (1, page 120).

3.9 Future Management Options

The proponent committed to ongoing monitoring activities (e.g. , air emissions and water quality) and mitigation options to address areas of concern highlighted throughout its EIA.

4.0 Contribution to Practice and Implementation of CEA

Study area boundaries were clearly defined and rationalized for different environmental parameters.

References:

1. Union Carbide Canada Inc. Proposed Prentiss Expansion Project. Environmental Impact Assessment. February 1997.

2. Union Carbide Canada Inc. Proposed Prentiss Expansion Project. Public Consultation Document. February 1997.