Local and Regional Ecological Effects Analysis:

Proposed Drilling Program of Vermilion Resources Ltd at 11-25-17-3 W5M (Well Licence Application No. 1247320)

Prepared for
Pekisko Land Owners Association

By
Cheryl Bradley

&

Michael Quinn & Danah Duke
(Mïistakis Institute for the Rockies)

DRAFT 17 September 2002
To perceive the world and our life in it as gifts originating in sanctity is to see our human economy as a continuing moral crisis. Our life of need and work forces us inescapably to use in time things belonging to eternity, and to assign finite values to things already recognized as infinitely valuable. This is a fearful predicament. It calls for prudence, humility, good work, propriety of scale. It calls for the complex responsibilities of caretaking and giving-back that we mean by “stewardship.” To all of this the idea of the immeasurable value of the resource is central. (p. 53)

What is the best way to use land? Agrarians know that this question necessarily has many answers, not just one. We are not asking what is the best way to farm everywhere in the world .... We are asking what is the best way to farm in each one of the world’s numberless places, as defined by topography, soil type, climate, ecology, history, culture, and local need. And we know that the standard cannot be determined only by market demand or productivity or profitability or technological capability, or by any other single measure, however important it may be. The agrarian standard, inescapably, is local adaptation, which requires bringing local nature, local people, local economy, and local culture into a practical and enduring harmony. (p. 55)

Wendell Berry (2002)
Acknowledgements

The authors wish to recognize the many people who assisted with the preparation of this report. Bryne Butts is responsible for the high quality maps and preparation of GIS data for ALCES. Ken Sanderson and Samantha Managh contributed to the assembly and management of GIS data. Brad Stelfox provided invaluable consultation on running ALCES for the project. Jenny Scott assisted with the vegetation survey and transects. Hilary Hahn and the membership of the Pekisko Land Owners Association provided valuable information and ideas.
Executive Summary

Vermilion Resources Ltd. is proposing to explore for and develop gas in an area of high environmental significance within the Foothills Parkland natural subregion in southwest Alberta. This report describes the ecological setting of the project area and documents current information on environmental significance, with a focus on the vegetation. The significance of native vegetation for ranching and wildlife also are discussed. Impacts of the proposed project on the area’s significant vegetation are identified and discussed under three topic areas: 1) loss of rare vegetation and challenges in restoration, 2) invasion of native prairie by non-native species following disturbance, and 3) fragmentation of native parkland. The project and potential future projects are then discussed from a more regional perspective towards a cumulative effects approach.

Local and regional project areas are defined. The local project area includes the well site and road described in Well Licence Application No. 1247320 and four sections identified by the proponent as possible locations for additional wells. The regional project area includes land within the boundary of the Foothills Parkland natural subregion south of the Highwood River. This regional area is ecologically defensible and socioeconomically relevant to the Pekisko Land Owners Association. The Pekisko Land Owners Association feels that the overall area of concern extends south of the Foothills Parkland Boundary to the Oldman River.

The project area has been recognized in several provincial and municipal government reports since the early 1980s as of high environmental and historical/cultural significance. It has been assessed as nationally significant and as having the greatest potential to meet provincial targets for protecting representative features of the Foothills Parkland natural subregion. The greater area is contiguous with the Bar U Ranch National Historic Site. The Provincial Government has also recognized the value of the area through a “protective notation” due to the significance of the native grasslands. Foothills rough fescue (Festuca campestris) grasslands and willow shrublands known to occur in the study area are considered of conservation concern by the Alberta Natural Heritage Information Centre (ANHIC) and hence included on the provincial plant community tracking list. A suite of significant wildlife species, including several species identified as “at risk” or “sensitive” (e.g. Grizzly Bear, Sharp-tailed Grouse, Long-toed Salamander) are known to utilize the area. These habitats are also important for sustainable ranching operations, which include use of rough fescue grasslands for winter grazing. A rare plant species survey has not been conducted, however, rare vascular plant species on the ANHIC tracking list have been found in or near the project area.

The recognition of the region as having the greatest potential to meet provincial targets for representation of Foothills Parkland features led to nomination for
legislated protection under the Alberta Special Places program. However, the program ended before any designation was given due consideration by the local committee. The Foothills Parkland Natural Subregion remains one the most under-represented subregions in the province with only 21.1% of the natural history theme targets having some level of protection.

Several recent documents prepared by provincial government agencies, including the Alberta Energy and Utilities Board, recommend avoidance of sensitive prairie landscapes and features as a priority in pre-development planning. Avoidance is particularly important in this situation, as currently there are no documented examples of successful restoration of rough fescue grassland following surface disturbances caused by oil and gas development except for small pipelines using “no strip” construction. Given the limitations of the terrain for development and the predominantly native character of the area, it is likely that well sites, roads and pipelines will be proposed predominately within native foothills rough fescue grasslands and will negatively impact willow communities in riparian areas.

A survey of non-native plant species invasion along an access road to a previous well site drilled in 1980 found nineteen non-native plant species. Forty percent of vegetation encountered along ten transects running 50 metres from the road had greater than 50% cover of non-native species. Although not precise, the mean extent of vegetation with more than 25% non-native species cover, which would be considered non-native communities for ecological classification purposes, was calculated as 35.8 metres over two decades. Alien species invasion of ungrazed rough fescue grasslands up to 100 metres from roads has been documented in Glacier National Park, Montana. Management recommendations by these researchers are to avoid road-building in bunch grass communities and to intensively monitor and manage alien flora where roads already exist.

A review of current information suggests that activities which lead to conversion of rough fescue grasslands to modified grassland communities in the project area would mean loss of opportunities for winter grazing, increased risk of succumbing to drought, and threats to opportunities currently being realized to conduct sustainable ranching operations with low inputs on native range.

Knowing what we know today about the area’s environmental significance and difficulties in restoration of native grassland, there may have been a different decision in 1980 about allowing a well to be drilled on the site in question.

A literature review and preliminary cumulative effects analysis was completed for the local and regional study area. The assumptions made to perform a landscape simulation modeling exercise were very conservative and based on values obtained from the proponent and other petroleum players in the region. The results of this preliminary cumulative effects analysis suggest that, even with very conservative disturbance estimates, published ecological thresholds for some sensitive wildlife species are exceeded and a significant loss of native
fescue grassland is incurred.

The information obtained and presented for this report highlights the national significance of the regional study area within which the current proposal for a wells site is located. Given the ecological and sociocultural values associated with this landscape, it would seem imprudent to proceed with any industrial activity in an ad hoc manner. The incrementalism that results from such an approach is the antithesis of good land-use planning and management. It seems more than reasonable to suggest that an integrated approach to planning and managing human activity in this landscape include a cumulative effects analysis. This position supports the view that once completed on a regional level, a cumulative effects analysis would provide the context within which site-specific assessments are performed. This approach is more conducive to landscape level planning exercises whereby proposed developments would be assessed in relation to an overall landscape plan. Such an approach would entail an elucidation of human values and interests (e.g. what do we want from the landscape? What do we want the area to look like?) along with an attempt to identify both the intensity and spatial distribution of human activities in a manner that does not exceed the ecological capacity of the region. In order to be effective, this must include the full suite of land-use activities and not just those of the petroleum industry.
# Contents

Acknowledgements ........................................................................................................... iii  
Executive Summary ............................................................................................................ iv  
Contents ............................................................................................................................. vii  
Maps ................................................................................................................................... ix  
Figures .............................................................................................................................. ix  
Tables ............................................................................................................................... xi  

1.0 Project Definition ........................................................................................................ 1  
1.1 Definition of Project Area ....................................................................................... 1  
1.2 Approach ..................................................................................................................... 4  

2.0 Ecological Setting ....................................................................................................... 6  
2.1 Climate, Landform and Soils ..................................................................................... 6  
2.2 Vegetation .................................................................................................................... 8  
2.2.1 Grasslands ............................................................................................................. 10  
2.2.2 Willow Shrublands ............................................................................................... 11  
2.3 Wildlife ........................................................................................................................ 11  

3.0 Environmental Significance ....................................................................................... 12  
3.1 Recognition as an Environmentally Significant Area .................................................. 12  
3.2 Rare Plant Communities and Species of Special Significance .................................... 19  
3.2.1 Rare Plant Communities and Species .................................................................. 20  
3.2.1.1 Rough Fescue Grassland Community ............................................................. 20  
3.2.1.2 Bebb’s Willow Shrubland Community ............................................................ 22  
3.2.2 Rare Plant Species ................................................................................................. 24  
3.3 Wildlife of Special Significance ................................................................................ 26  
3.4 The Significance of Rough Fescue Grasslands and Willow Shrublands for Ranching .......................................................................................................................... 31  
3.5 Significant First Nations Cultural Values ................................................................. 34  

4.0 Ecological Effects ........................................................................................................ 36  
4.1 Ecological Effects on Vegetation ............................................................................... 37  
4.1.1 Direct Loss of Rare Vegetation and Challenges In Restoration ................................ 37  
4.1.2 Invasion of Native Prairie by Non-Native Species from Disturbances ................. 42  
4.1.3 Survey of Non-Native Plant Species Invasion along the Access Road to 11-25-17-3 W5M ......................................................................................................................... 42  
4.2 Ecological Effects on Selected Wildlife Species (with an Emphasis on Linear Disturbance) ......................................................................................................................... 60  
4.3 Local and Regional Environmental Impacts: Towards a Cumulative Effects Approach ................................................................................................................................. 73  
4.4 A Landscape Simulation of Regional Effects ............................................................ 79  
4.4.1 Methods ................................................................................................................... 80  
4.4.2 Results ..................................................................................................................... 81  
4.4.2.1 Local Scale Results ............................................................................................ 81  
4.4.2.2 Regional Scale Results ..................................................................................... 84  
4.4.3 Discussion ................................................................................................................. 87  

5.0 Literature Cited ............................................................................................................ 89
Appendix 1: Description of Transects ................................................................. 101
Appendix 2  Assumption and values used in the ALCES model simulations ...... 104
  Model Assumptions for Regional Study Area ............................................. 104
    Low Trajectory .................................................................................. 104
    High Trajectory .............................................................................. 106
  Model Assumptions for the Local Study Area ........................................ 114
Appendix 3  Report Team ........................................................................... 116
  Cheryl Bradley .................................................................................... 116
  Michael Quinn .................................................................................... 116
  Danah Duke ........................................................................................ 117
Appendix 4  Progress and Priorities; a perspective on expansion of oil and gas
  interests in the Southern Foothills of Alberta ........................................... 118
Maps

Map 1a. Lands of Interest to the Pekisko Land Owners Association..................2

Map 1b Regional and local study areas..........................................................3

Map 2 Parkland Natural Region and Subregions Showing
Project Area Location in Foothills Parkland..............................................6

Map 3 Environmentally significant areas of the Calgary region
(from Lamoureaux et. Al 1993).................................................................16

Map 4 Extract from Alberta Natural Heritage Information Centre Map
– indicates that the region surrounding the proposed well site
is an Environmentally Significant Area of National Significance..............17

Map 5 Highest Priority lands for protection as identified for the
Alberta Special Places Program within the Foothills
Parkland Subregion. The region of the proposed well falls
within an area of National Significance for protection...............................18

Map 6 Nonnative plant species invasion survey – transect locations..............46

Figures

Fig. 3-1 Foothills Rough Fescue (Festuca campestris) grassland
near the 1980 well site (25-11-17-3W5M, 19 July 2002).............................21

Fig. 3-2 Bebb’s Willow (Salix bebbiana) / herb community along the
unreclaimed access road (Transect 5A, 19 July 2002)...............................23

Fig. 3-3 Image taken from the existing well pad looking west.
The willow shrub community provides continuous
hiding cover and landscape connectivity for wildlife (15 July 2002)..........27

Fig. 3-4 Site of archaeological significance approximately 1 km
south of the proposed drilling location (15 July 2002).............................34

Fig. 3-5 View from the vision quest site to the west.................................35

Fig. 4-1 1980 well site. Arrows indicate clearly discernable
vegetative boundaries more than 20 years after
disturbance (15 July 2002).......................................................................43
Fig. 4-2 Existing road cut showing cut (blue arrow) and fill with substantial exotic species encroachment and down hill side (red arrow) (15 July 2002)...43

Fig. 4-3 Existing road to proposed well site – note exotic vegetation encroachment on down slope side of the road (15 July 2002)...44

Fig. 4-4 Vegetation dominated by Crested Wheat Grass (Agropyron pectiniforme) and Russian Wild Rye (Elymus junceus) along portion of 1980 well site access road – Site 7, Winter Range, 19 July 2002............................51

Fig. 4-5 Crested Wheat Grass (Agropyron pectiniforme) has invaded up to 40 m from the existing access road – Transect 4B, Winter Range, 19 July 2002............................52

Fig. 4-6 Crested Wheat Grass (Agropyron pectiniforme) persists up to 9 m from existing access road – Transect 2A, Winter Range, 19 July 2002............................53

Fig. 4-7 Russian wild Rye (Elymus junceus) persists up to 5 m from existing access road – Transect 5A, Winter Range, 19 July 2002............................54

Fig. 4-8 Smooth Brome (Bromus inermis) and Kentucky Blue Grass (Poa pratensis) extend 17 m from existing access road. Crested Wheat Grass (Agropyron pectiniforme) persists along road – Transect 1A, Winter Range, 19 July 2002............................55

Fig. 4-9 Prickly Rose (Rosa acicularis) and Smooth Brome (Bromus inermis) on old well site – Site 12, Winter Range, 19 July 2002............................56

Fig. 4-10 Pipeline construction occurring southeast of the proposed wellsite in 2002 illustrates the temporary impediment to wildlife movement............................61

Fig. 4-11 Regional distribution of marketable gas reserves ($10^9$m$^3$)..........................73

Fig. 4-12 Alberta natural gas drilling activity and price..........................74

Fig. 4-13 Native grassland area (local)..........................81

Fig. 4-14 Net loss of native grassland (local)..........................82

Fig. 4-15 Area of linear disturbance (local)..........................82

Fig. 4-16 Length of linear disturbance (local)..........................83
Tables

Table 2-1 Range Types identified on Winter Range Grazing Lease...................9

Table 3-1 List of Vascular Plants on the ANHIC Tracking List
Potential Occurring in the Area of Interest.................................24

Table 3-2 Estimated Harvest of Selected Species in WMU 310.....................27

Table 4-1 Physical characteristics and plant species composition
of five 10m x 10m plots on the reclaimed 1980 well site
(11-25-17-03 W5; 8 Sep 2002)....................................................39

Table 4-2 List of Non-Native Species and Frequency of Occurrence
on Transects along the Unreclaimed Portion of 1980 Wellsite Access........47

Table 4-3 List of Non-Native Species and Frequency of Occurrence
on Transects along Reclaimed Portion of the 1980 Wellsite Access.........48

Table 4-4 Relative Occurrence of Non-Native Vegetation Classes.............50

Table 4-5 Extent of vegetation with >25% non-native species
cover from road centre..........................................................58

Table 4-6 Primary wildlife impacts potentially resulting
from environmental disruptions..............................................61

Table 4-7 Secondary impacts which may occur as
consequences of primary impacts.........................................62
1.0 Project Definition

1.1 Definition of Project Area

The location of the well site proposed in Well Licence Application No. 1247320 is LSD 11-25-17-3W5M. Four additional sections - 36-17-3W5M, 24-17-3W5M, 13-17-3W5M, 18-17-2W5M - have been identified by Vermilion Resources Ltd. as possible locations for additional wells (correspondence from Paul Smith, Vermilion, to Stanley Church, Beaumont Church, 17 July 2001). The Pekisko Landowners Association has stated the immediate focus of members’ concerns is the five sections that are targets for drilling by Vermilion Resources Ltd. as well as surrounding lands in which they have an interest (correspondence from Keith Luft, Beaumont Church, to Douglas Larder, EUB, 19 June, 2002). The Pekisko Landowners Association own or lease most of the following four townships - 16-2W5M, 16-3W5M, 17-2W5M, 17-3W5M (correspondence from Stanley Church, Beaumont Church, to Karen Mather, EUB, 13 December 2001). The Alberta Energy and Utilities Board has stated that it is interested in Vermilion’s future plans in the event that the present application is approved and a successful well is drilled (correspondence from Douglas Larder, EUB, to Brian O’Ferrall, McLennan Ross, and Keith Luft, Beaumont Church, 5 July 2002).

Lands of broad interest to members of the Pekisko Land Owners Association are roadless rangelands between the Highwood River and Oldman River (Map 1a). These rangelands are part of the Foothills Parkland Subregion of the Parkland Natural Region and the Montane Subregion of the Rocky Mountain Natural Region (Government of Alberta, 1995; Alberta Environmental Protection, 1995 and 1997b). In the south is the Whaleback and Porcupine Hills and in the west is the Livingstone Range of Alberta’s Eastern Slopes.

For the purposes of this report we have defined the project area at two different scales. The “local project area” consists of the section that is subject of Well Licence Application No. 1247320 and four sections identified by Vermilion Resources Ltd. as possible locations for additional wells. The “regional project area” is comprised of lands within the Foothills Parkland Subregion between the Highwood River on the north and Willow Creek on the south (Map 1b). The regional project area boundary is ecologically meaningful and reflects the primary lands owned or managed by members of the Pekisko Land Owners Association. The regional project area is a more appropriate context for assessing the ecological effects of oil and gas development on valued ecosystem components than the local project area and both are more appropriate than Vermilion’s preferred definition of the project area which would include only the proposed well site and access road.
1.2 Approach

This report was prepared by a team of individuals with several decades of collective experience in native vegetation survey, geographic information systems, cumulative effects modeling and environmental assessment and management (Appendix C). Information contained in this report is drawn from:

- observations and expertise of consulting team members,
- local knowledge of members of the Pekisko Land Owner’s Association,
- discussions with other scientists and resource managers knowledgeable about the area, and
- government reports and scientific literature.

Based on a preliminary review and evaluation of information, the lead consultant determined that the potential effects on valued ecosystem components of the proposed project require an examination well beyond the one well site and access road identified in Well Licence Application No. 1247320. It is logical to assume that Vermilion Resources Ltd. is not proceeding with an expectation of failure in finding gas. This assessment, therefore, does not restrict itself only to Vermilion’s preferred definition of the project – construction of the proposed wellsite in 11-25-17-03-W5M and access road and its reclamation. Based on their expertise and past experience, consultants authoring this report believe that, in this situation, to restrict ecological effects assessment this narrowly would be inconsistent with professional practice. For this reason a broader assessment (at local and regional levels) of the ecological effects of predicted petroleum industry activity was undertaken as was consideration of cumulative effects. The approach to ecological assessment documented in this report is consistent with the direction provided in ERCB Informational Letter IL93-9: Oil and Gas Developments Eastern Slopes (Southern Portion) and with EUB Informational Letter IL200-1: Principles for Minimizing Surface Disturbance in Native Prairie and Parkland Areas. Although the proposed wellsite is approximately 5 km east of the Eastern Slopes boundary the authors feel IL93-9 should be considered because: a) the regional study area includes areas within the boundary, and b) the “sensitive” and “at risk” species potentially effected by the proposed well have home ranges that extend into the Eastern Slopes area).

Three days were spent in the project area. The first visit occurred on July 15, 2002 and was guided by members of the Pekisko Land Owners Association to familiarize team members with the area and issues. The second and third visits occurred on July 19 and September 8 and included surveys of vegetation on and adjacent to a road and well site constructed in 1980. The primary purpose of the surveys was to identify non-native species present on the road and well site constructed in 1980, assess restoration to native condition following
reclamation, and determine the extent of invasion of non-native species into native vegetation.

More detailed description of methods used in specific aspects of the work can be found within the relevant sections of the report.
2.0 Ecological Setting

2.1 Climate, Landform and Soils

The project area is within the Parkland Natural Region, Foothills Parkland Subregion (Government of Alberta, 1995; Alberta Environmental Protection, 1997b). Natural subregions are areas with similar landscape patterns including climate, soils and vegetation. The project area is within a portion of the Foothills Parkland Subregion considered distinctive because of the extensive occurrence of willow groveland (Alberta Environmental Protection, 1997b). There currently is a proposal to alter natural subregion boundaries to place the project area within the Grassland Natural Region, Foothills Fescue Subregion because of the high ratio of fescue grassland to aspen woodland and the lack of eluviated soil horizons that develop under aspen forest (B. Adams, pers. comm.). Contrary to the assertion that “the area has recently been re-classified” (Iris Environmental Systems Inc. 2002), the proposal for change has yet to be considered by a multi-departmental committee that makes decisions on natural region boundaries.

Map 2. Parkland Natural Region and Subregions Showing Project Area Location in Foothills Parkland

The project area is within Agroclimate Zone 4H which indicates the climate is unsuitable for production of agronomic crops except forage (Alberta Soil Information Centre, 2001). Mean annual precipitation is about 600 mm. The mean May-September temperature is 12-13°C and the frost-free period averages 90 days (AEP 1997b). Chinooks are common in winter.

The physiography of the regional project area is folded and faulted bedrock overlain by glacial till on the ridge tops and outwash and glaciolacustrine deposits in valley bottoms. Bedrock outcrops are common, especially on ridge tops. The regional project area includes portions of the following land systems as defined by the Alberta Soil Information Centre (2001) - Sheppard Hills in the west, Pekisko Plain in the northeast, Chain Lakes Valley in the south-centre and Cross Creek Hills in the southeast. To define land systems, information is integrated on climate, morphology, surface form and soils. The Sheppard Hills Land System is characterized by undulating to ridged terrain of moderate to high relief. The Pekisko Plain is inclined and undulating terrain of high relief. The Chain Lakes Valley is undulating terrain of high relief. The Cross Creek Hills are characterized by ridged terrain of high relief.

The local project area is within the Sheppard Hills Land System and encompasses most of a north-south trending ridge between Bull Creek in the north and Pekisko Creek in the south. The ridge is dissected by several small drainages. Elevation ranges from about 1260 m (4200 ft) a.s.l. in valley bottoms to 1470 m (4900 ft) a.s.l. on the ridge top.

The project area is within the Black Soil Zone, Soil Correlation Area 8 (Alberta Soil Information Centre, 2001). Major soils of the project area are Dunvargan (DVG), Maycroft (MFT) and Hatfield (HFD) soil series characterized as well-drained orthic black chernozems of medium to fine texture (loamy) with a black Ah horizon at least 10 cm thick darkened due to the accumulation of organic matter. Chernozem soils develop under grasslands. Minor soils include gleysols associated with wetland sites that experience prolonged water saturation, regosols associated with rocky ridge tops and coarse coarse floodplain deposits, and brunisols developed under poplar and conifer forests. A consultant to Vermilion Resources Ltd. refers to “McNeil soils” as predominant in the Pekisko Uplands (Iris Environmental Systems Inc., 2002) however this soil type is not defined and does not occur in the project area (B. Adams, pers. comm.).
2.2 Vegetation

Vegetation of the Foothills Parkland Subregion is transitional between the grasslands of the Foothills Fescue Subregion and the forests of the Montane Subregion. Because of rapid topographic and climatic change, the transition occurs over about fifteen kilometres. The compression results in small geographic areas being very diverse.

Grasslands dominated by foothills rough fescue (*Festuca campestris*) and Parry's oat grass (*Danthonia parryi*) are the predominant native vegetation on uplands in the Foothills Parkland Subregion. With prolonged heavy grazing pressure, particularly in more mesic sites, rough fescue declines and Kentucky bluegrass (*Poa pratensis*) and timothy (*Phleum pratense*) increase. Shrublands dominated by willows (*Salix bebbiana* and *Salix petiolaris*) occur on subirrigated sites on lower slopes and valley bottoms. Aspen (*Populus tremuloides*) forests with dense, species-rich understory of shrubs and forbs occur on moister sites mostly on north- and east-facing slopes and in shallow depressions. Riparian communities, bordering streams and wetlands include balsam poplar (*Populus balsamifera*) forest, willow shrublands and herbaceous meadows and marshes.

In the late 1990s, range resource inventories were conducted on sixteen foothills grazing leases some of which are included in the study area. The Winter Range Grazing Lease, which includes the proposed well site in 11-25-17-3 W5M, and potential additional well sites in sections 24 and 13 and SW36 was surveyed during the second week of August, 1996 (High Range Ecological Consultants, 1997). The Winter Range grazing lease was found to be “dominated by native grasslands (71.9% of the lease area) with shrubland and aspen forest vegetation types occupying most of the remaining area, typically in moist drainages and on north-facing slopes”. The following, extracted from the report by High Range Ecological Consultants (1997), is a list of range types, named according to dominant species, and the area occupied (Table 2-1).
Table 2-1  Range Types identified on Winter Range Grazing Lease

<table>
<thead>
<tr>
<th>Type</th>
<th>Area (acres)</th>
<th>% of Area</th>
</tr>
</thead>
<tbody>
<tr>
<td>Grassland</td>
<td>2147.9</td>
<td>71.9</td>
</tr>
<tr>
<td>Festuca campestris-Danthonia parryi</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Poa pratensis-Bromus inermis-Phleum pratense (non-native)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Shrubland</td>
<td>511.5</td>
<td>17.0</td>
</tr>
<tr>
<td>Salix spp.**/Carex spp.-Calamagrostis inexpansa</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Salix spp.**/Urtica dioica-Mentha arvensis</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Aspen Forest</td>
<td>154.0</td>
<td>5.2</td>
</tr>
<tr>
<td>Populus tremuloides-P. balsamifera/Salix spp./Symphoricarpos albus</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Herbaceous Wetlands</td>
<td>129.4</td>
<td>4.3</td>
</tr>
<tr>
<td>Water</td>
<td>41.1</td>
<td>1.4</td>
</tr>
</tbody>
</table>

** dominated by Bebb’s willow (Salix bebbiana) and/or basket willow (Salix petiolaris) (Alan Robertson, pers. comm.)

Similarly, the J.A. and J.C. Hughes lease (GRL #32574), which includes a potential well site location in N36-17-3W5, was found to be “dominated by native grasslands (69.1 percent of the lease area) with shrublands (closed and open canopy stands) occupying most of the remaining area” (High Range Ecological Consultants, 1998).

Since grasslands and willow shrublands comprise ninety percent of the vegetation, a more detailed description of these follows.
2.2.1 Grasslands

Grassland ecologists currently are analyzing vegetation plot data from long-term range exclosure studies, range surveys and ecological land classification studies to define rough fescue grassland communities in Alberta (Barry Adams, pers. comm., Lorna Allen, pers. comm.). The task of defining rough fescue communities is complicated by recent taxonomic studies that conclude foothills rough fescue (*Festuca campestris*) is a distinct species from plains rough fescue (*Festuca hallii*) (Aiken & Darbyshire, 1990). Formerly the two taxa were treated as one species – *Festuca scabrella*. Historically, plains rough fescue grasslands were prevalent in the Central Parkland (53,413 sq. km) and Northern Fescue (15,385 sq. km) natural subregions (Allen, 1998). Foothills rough fescue was the dominant grassland in the Foothills Parkland (4402 sq. km) and the Foothills Fescue (14,888 sq. km) natural subregions, covering a total of 25,277 sq. km. In addition, scattered communities of foothills rough fescue occurred in the southern part of the Montane Natural Region and plains rough fescue communities were present in pockets north of the Central Parkland, in the Boreal Dry Mixedwood. Both species of fescue occur in the Cypress Hills. A paper prepared by the plant community ecologist with the Alberta Natural Heritage Information Centre, notes: “Although the potential area that could have rough fescue grasslands is substantial, each of these subregions has been highly impacted by cultivation and by developments such as roads, cities and towns” (Allen, 1998).

Preliminary analysis of vegetation plot data recognizes one or more communities dominated by foothills rough fescue (*Festuca campestris*), bluebunch fescue (*Festuca idahoensis*) and Parry oat grass (*Danthonia parryi*) with a large diversity of forbs and other grass species (Adams et al., 2002). Common forbs include silvery perennial lupine (*Lupinus sericeus*), golden bean (*Thermopsis rhombifolia*), northern bedstraw (*Galium boreale*), three-flowered avens (*Geum triflorum*), and wild vetch (*Vicia americana*). Other grasses include northern wheat grass (*A. dasystachyum*), awned wheat grass (*Agropyron subsecundum*), June grass (*Koeleria macrantha*), and western porcupine grass (*Stipa curtiseta*). These communities generally are on mesic sites with black chernozem soils.

Community descriptions note that given the good soil moisture conditions associated with foothills rough fescue communities, there is considerable potential for non-native Kentucky bluegrass (*Poa pratensis*) and timothy (*Phelum pretense*) to become abundant. With disturbance, including fragmentation and heavy summer grazing pressure, foothills rough fescue decreases and Kentucky bluegrass and timothy increase. Range evaluations over several decades indicate that once these grasslands shift to Kentucky bluegrass dominated communities they are unlikely to revert back to rough fescue dominated communities even if management practices improve.
2.2.2 Willow Shrublands

Willow communities in the southern Alberta recently have been classified as part of a project to classify riparian habitats in southern Alberta (Thompson and Hansen 2002). Six habitat types with dominant shrub canopy of Bebb’s willow (*Salix bebbiana*), basket willow (*Salix petiolaris*) or flat leaf willow (*Salix planifolia*) occur in the Foothills Parkland natural subregion. They occupy moist to wet areas on alluvial terraces and near springs, seeps, and subirrigated meadows. Sedges dominate understories on wet sites. The presence in the understory of a tall shrub layer containing red-osier dogwood (*Cornus stolonifera*) and a rich herbaceous layer of native species is indicative of moist sites which have received little grazing pressure. With prolonged moderate to heavy grazing pressure, shorter/drier shrub species increase as do non-native herbaceous species such as Kentucky bluegrass (*Poa pratensis*), timothy (*Phelum pratense*) and Canada thistle (*Cirsium arvense*).

2.3 Wildlife

Fauna in the region occurs largely in response the vegetation conditions and resultant habitat types described above. The area is an ecotone (transitional between the prairies and foothills) and, as mentioned above, the zone of transition is relatively narrow. The result is a mix of species that are characteristic of both prairies and foothills, as well as some that are likely obligate to the ecotone itself. Therefore, the overall species assemblage is relatively diverse. The rolling terrain and abundant riparian areas provide security cover and habitat value that provide both core habitat and landscape connectivity. The portion of the region containing Pekisko Creek, the Highwood Pekisko Upland and Meinsinger Lake Environmentally Significant Areas (Highwood Chaffen) have been described as having “one of the finest Moose ranges in Alberta”, “excellent Elk habitat”, “important spawning habitat for Bow River Rainbow Trout”, and significant Great Blue Heron breeding habitat on Meinsinger Lake (Lamoureux et al. 1983, Poston et al. 1990). This same area has the highest degree of ecological integrity of any remaining Foothills Parkland with the lowest wellsite (.27/km²) and road densities (0.79 km/km²) (Alberta Environmental Protection 1997b). These conditions provide security for “sensitive” and “at risk” species including Grizzly Bears (*Ursus arctos*), Wolves (*Canis lupus*), Badgers (*Taxidea taxus*), Cougars (*Puma concolor*), Ferruginous Hawk (*Buteo regalis*), Long-toed Salamanders (*Ambystoma macrodactylum*) and others.

It was beyond the scope of the current report to provide a comprehensive analysis of wildlife in the region, but a preliminary review based on the literature and limited observation is included below. In general, there is a paucity of site-specific information for most species with a particular lack of published data on invertebrates.
3.0 Environmental Significance

3.1 Recognition as an Environmentally Significant Area

The project area is part of a larger block of land that has been recognized since the early 1980s as of high environmental significance.

A 1983 study of environmentally significant areas in the Calgary Region for the Calgary Regional Planning Commission (Lamoureux et al. 1983) identifies the block as environmentally significant (Map 3) and defines the environmental significance as follows (p.58-59):

South of the Highwood River, between the Highwood River and Pekisko Creek, lies the most remote portion of the M.D. of Foothills. In this ranching area can be found the single largest block of natural terrain in the M.D. This area subdivides into two areas, a willow shrubland area (#4114) adjacent to the gorge section of the Highwood River and a very extensive area of foothills grassland (#4115).

The Pekisko Creek Valley (#4116) and adjacent uplands (#4117) together represent a willow shrubland type of environment that now has relatively limited representation in the Region. The area provides excellent habitat for big game animals such as Moose and Elk.

The report assesses the block as an “environmental priority area” based on “outstanding natural characteristics.” The outstanding natural characteristics are described as follows (p. 146-147):

An outstanding area of isolated shrubland south of the Highwood River (F-19) provides excellent moose habitat and has been selected as a priority area. To the south of this area lies a vast tract of natural grassland (F-20) without permanent roads. This is undoubtedly the closest thing to a native grassland that exists within the Calgary Region and may be one of the finest areas of its type in Alberta.

The Pekisko Creek Valley (F-21) and adjacent uplands (F-22) characterize the willow shrubland environment that is rapidly disappearing from the M.D. of Foothills. The area provides excellent habitat for Moose and Elk. Moreover the natural environment of the area has excellent visual qualities. Pekisko Creek itself is also an important spawning habitat for Bow River Rainbow Trout.

The Pekisko Creek area has figured prominently in the history of ranching in southern Alberta. The area is also of historical interests because the late
Prince of Wales (subsequently crowned Edward VIII) once owned a ranch there.

The area between the Forest Reserve boundary and the dotted line on Map 9 [Map 3 in this report] encompasses a significant portion of the classic ranching country of southern Alberta. Because of the continued importance of ranching in this area, the significance of the environmental resources protected by this form of land use and the irreplaceable heritage value of this part of the Region, it is recommended that this area be designated as a “Special Ranching Area” within which other incompatible forms of land use are strictly regulated to prevent erosion of the unique character of the area.

In 1991, the significance of this natural environment and its importance for ranching was nationally recognized with establishment of the Bar U National Historic Site. The Bar U National Historic Site is situated in 8-17-2 W5M, on the eastern edge of the project area. Established in 1882, the Bar U was one of the foremost ranching operations in Canada. Management vision for the Bar U National Historic Site is “to commemorate the evolution of the Canadian ranching industry and the contribution of the industry to the development of Canada...This national historic site uses a living history approach to present one of Canada’s most vital industries — the ranching industry” (Parks Canada, 1998). The ranching industry in western Canada relies on extensive areas of native range.

In the mid 1990s, the project area was included in environmentally significant areas defined by the East Slopes Environment and Energy Committee (Cliff Wallis, pers. comm.). The priority areas that were the focus of consideration by that committee were based on environmentally significant areas reports for municipalities as well as critical habitat maps developed by Alberta Fish and Wildlife. The committee was composed of representatives from the oil and gas industry as well as representatives from environmental organizations.

A 1997 report prepared for the Alberta government that compiled information on all environmentally significant areas in Alberta identified two environmentally significant areas relevant to the project area – the Highwood Pekisko Upland ESA and the Pekisko Creek ESA (Map 4) (Sweetgrass Consultants 1997). The report table ranks these ESAs as of provincial significance (Volume 1, p. 50). The Highwood-Pekisko Upland ESA is described as “one of the finest Foothills Parkland areas in Alberta” with “excellent moose habitat” and “no permanent roads”. Management suggestions are to “maintain the natural cover and habitats of the area”. The Pekisko Creek ESA is described as having “some of the most extensive foothills parkland willow in Alberta”, “one of the finest Moose ranges in Alberta”, and “excellent elk habitat” (Volume 2).

A 1997 government report on the Parkland Natural Region of Alberta prepared for the Special Places 2000 Provincial Coordinating Committee includes the project area in an environmentally significant area (ESA) named Highwood.
Chaffen. The Highwood Chaffen ESA includes Highwood-Pekisko Upland, Meinsinger Lake and Pekisko Creek and Highwood-Pekisko Additions (Map 5). The area is ranked as of national significance because it is the most extensive area of Foothills Parkland in Alberta and Canada (Alberta Environmental Protection 1997b). Features noted include (pp. 86-87):

- diverse foothills ridges and valleys on a variety of geological substrates
- variety of grassland, wetland and woodland habitats
- excellent Elk habitat
- numerous small wetlands
- important spawning habitat for Bow River Rainbow Trout in Pekisko Creek
- provincially significant Great Blue Heron breeding habitat at Meinsinger Lake
- area has figured prominently in the history of ranching in southern Alberta
- historical interest because the Prince-of-Wales (Edward VIII) once owned a ranch there.

Highwood Chaffen is assessed within the government report as the area with the greatest potential to meet provincial targets for protection of Level 1 Natural History Themes (NHTs) within the Foothills Parkland Subregion (Alberta Environmental Protection, 1997b).

Crown lands [or the Highwood Chaffen ESA] have excellent potential for contributing to the following NHTs that are currently underrepresented in protected areas: Glacial Lake Bed, Ground Moraine, Exposed Slope, Protected Slope, Floor/Stream, Ridge/Valley Wall, Springs, Wet Meadow, Deep Marsh and Shallow Marsh.

The report recommends that all crown lands [in the area] should be maintained in their natural state. The Pekisko area also is noted as having a special vegetation community feature - *Salix bebbiana* Foothills Parkland groves and special landform features – crag-and-tail, hogbacks, and cuestas (Alberta Environment, 1998).

Although the ESAs in the Pekisko area were nominated for consideration within the Special Places Program and consideration of the site for official protective designation was supported by the multistakeholder Provincial Coordinating Committee, the program ended prior to the nomination being referred to local committee (Archie Landals, pers.comm.). The goal of the Special Places Program was to complete a system of protected areas on provincial land that includes the environmental diversity of Alberta’s six natural regions. Provincial targets for protection of Level 1 Natural History Themes within the Foothills Parkland and Foothills Fescue natural subregions have not yet been achieved. Only 21.1% of the target for the Foothills Parkland Subregion has been achieved and only 22.8% of the target for the Foothills Fescue Subregion.
In June 2001, the Alberta Government’s Public Lands Division also officially recognized the environmental and heritage significance of the project area. The Division placed a protective notation on 27,655 hectares of public land southwest of Longview, including the lands, which are the subject of Well Licence Application No.1247320 (G. McAndrews, pers. comm.). The protective notation recognizes the importance of the region’s native rangelands. Protective notations alert industry that special measures will be required to avoid or reduce impacts. This particular protective notation states there will be no surface disposition and that grazing and industrial use requires an access management plan prior to entry, use of existing trails in an undeveloped state, entry only during dry or frozen ground conditions, and restriction of entry during times when the risk of wildfire is high. Given the high quality of the upland range in the area, Alberta Sustainable Resource Development’s Rangeland Management Branch will be establishing a long-term rangeland reference site on the Hughes grazing lease (B. Adams, pers. comm.). The Hughes grazing lease includes section 36-17-3 W5M, which has been identified by the proponent as a location for an additional well site.

The Municipal District of Foothills No. 31, in collaboration with Agriculture and Agri-Food Canada, produced a report aimed at identifying environmentally important areas to assist the M.D. with land use and planning issues (Agriculture and Agri-Food Canada 2002). The project followed attempts by the M.D. environment committee to consolidate and summarize past work on environmentally significant areas (Coughlan 1999). The results of the GIS-based analysis was the delineation of “conservation based management zones” that include:

- key physical ecosystem components and complexes that are vulnerable to the potential impacts of a broad range of land use, development and management activities, particularly the alteration, disruption or destruction of fish and wildlife habitat, permanent or temporary soil disturbance, the removal or modification of native vegetation cover, or the release of biological or chemical contaminants (p.10).

The final report identifies the region surrounding the proposed gas well as the largest block of roadless area (areas with roads >1000 m away) remaining in the M.D. In addition, the area of Pekisko Uplands have medium to high environmental sensitivity indices based on a combination of aquifer vulnerability, riparian sensitivity, rare species, landcover, roadless areas and protected areas designations. “The AAFC-PFRA recommends that the M.D. of Foothills No. 31 implement environmental planning and control measures, in accordance with the results of this environmental analysis, that will protect the integrity of sensitive environmental features and lands throughout the M.D.” (p. 34).
Map 3 Environmentally significant areas of the Calgary region (from Lamoureux et al. 1993).

Location of Regional Study Area
Map 4  Extract from Alberta Natural Heritage Information Centre Map –
indicates that the region surrounding the proposed well site is an
Environmentally Significant Area of National Significance (scale
altered to fit this page)
Map 5. Highest Priority lands for protection as identified for the Alberta Special Places Program within the Foothills Parkland Subregion. The region of the proposed well falls within an area of National Significance for protection (scale altered to fit this page).
In summary, the portion of the Foothills Parkland ecological subregion identified as the regional focus for this analysis has been recognized time and again as having national ecological significance. This area comprises the best opportunity to more adequately represent the subregion in a comprehensive system of protected areas.

### 3.2 Rare Plant Communities and Species of Special Significance

Lacking for the project area is a comprehensive survey of rare plants and plant communities. Alberta Energy and Utilities Board Informational Letter IL 2002-1: Principles for Minimizing Surface Disturbance in Native Prairie and Parkland Areas includes the following guiding principle (Alberta Energy Utilities Board, 2001):

> 6) Predevelopment site assessments of unique features (e.g. rare plants or plant communities, species of special concern, historical resources) improve potential to avoid or minimize disturbance of native prairie or parkland and should be conducted.

The informational letter refers to a set of guidelines entitled Petroleum Industry Activity in Native Prairie and Parkland Areas: Guidelines for Minimizing Surface Disturbance (Native Prairie Guidelines Working Group, 2002). This document refers to the Alberta Native Plant Council’s Guidelines for Rare Plant Survey (2000) as a methodology for conducting assessments and also to the database of the Alberta Natural Heritage Information Centre (ANHIC) for determination of rare plants and plant communities. ANHIC collects, evaluates and makes available information on the elements of native biodiversity of Alberta. ANHIC produces tracking and watch lists of plant species and communities that are considered of high priority because they are rare or special in some way”. These lists serve as a focus for data gathering to increase our knowledge and understanding of the elements of Alberta’s biodiversity. The authors recommend a comprehensive survey of rare plants and plant communities.

Definition of elements that occur or potentially occur in the project area and are on ANHIC lists of conservation concern follows.
3.2.1 Rare Plant Communities and Species

3.2.1.1 Rough Fescue Grassland Community

Included on the ANHIC plant community tracking list (Allen 2002) is:

Danthonia parryi-(Festuca idahoensis)-Festuca campestris

Parry oat grass – (Idaho fescue) – mountain rough fescue

CEAB000059

Rank: SU [Status is uncertain]

- generally found on subxeric to submesic, rapidly well drained sites with a southerly aspect in the Montane (Willoughby et al. 1997)
- either Danthonia parryi or Festuca idahoensis may be dominant and Festuca campestris is prominent
- dry pockets within this community may have extensive Juniperus communis and Arctostaphylos uva-ursi cover.

Figure 3-1 is a photo taken on July 19 of the rough fescue grassland community near the reclaimed wellsite developed in 1980. The wellsite and most of the access road are located within a polygon mapped under the Winter Range Grazing Lease inventory as grassland dominated by foothills rough fescue and Parry’s oat grass on orthic black chernozem soils (High Range Ecological Consultants, 1997). Allen (1998) states:

In 1986, a reconnaissance survey of crown lands in the Foothills Fescue and Foothills Parkland subregions found few sites with remnant fescue grasslands….ESA studies need to be reviewed for potential sites. These would need to be field checked to confirm the continued presence of mountain rough fescue, to define community boundaries and to assess community composition and condition.

Noteworthy is that field checking of potential sites for plain’s rough fescue (Festuca hallii) dominated communities in the Central Parkland and Northern Fescue Grassland has resulted in all communities being included on the ANHIC Community Tracking list and ranked as S1 (five or fewer occurrences or very few remaining hectares) or S2 (six to 20 occurrences or few remaining hectares).
Fig. 3-1  Foothills Rough Fescue (*Festuca campestris*) grassland near the 1980 well site (25-11-17-3W5M, 19 July 2002) © Cheryl Bradley
3.2.1.2 Bebb’s Willow Shrubland Community

Included on the ANHIC plant community tracking list (Allen 2002) is:

*Salix bebbiana/Rubus ideaus/Geranium richardsonii*
  Bebb’s willow/wild red raspberry/wild white geranium
  CEA000014

Rank: S2 [Six to 20 occurrences or few remaining hectares]
- groves dominated by Salix bebbiana found primarily in the Foothills
  Parkland (Wallis 1980)
- found on moderately to imperfectly drained sites
- significant tall herb component

Willow shrublands dominated by Bebb’s willow (*Salix bebbiana*) occur mainly in the northern portion of the Foothills Parkland Natural Subregion and are distinctive to this part of Alberta (Achuff, 1992). *Salix bebbiana* communities are known to occur in the project area (High Range Ecological Consultants 1997 and 1998; A. Robertson, pers. comm., C. Bradley, pers. obs.). Understories are mostly described as dominated by sedges (*Carex spp.*), northern reed grass (*Calamagrostis inexpansa*) and tufted hair grass (*Deschampsia cespitosa*) or stinging nettle (*Urtica dioica*) and mint (*Mentha arvensis*). High Range Ecological Consultants, however, also describes understories with wild red raspberry as the dominant shrub and Cheryl Bradley observed a willow shrubland community along one transect with a rich herb understory. The status of this community type in the project area requires further investigation. Figure 3-2 depicts the willow-forb community along the unreclaimed wellsite access road.
Fig. 3-2  Bebb's Willow (Salix bebbiana) / herb community along the unreclaimed access road  (Transect 5A, 19 July 2002).
© Cheryl Bradley
3.2.2 Rare Plant Species

During range surveys of grazing leases in the region in 1997 and 1998, plants on the ANHIC vascular plant tracking list encountered along transects were noted (High Range Ecological Consultants, 1997, 1998 and 1999). Species noted which are on the current tracking list (Vujnovic and Gould 2002) include:

*Juncus stygius var americanus*
Marsh Rush
PMJUN012N1
Rank: S2, G5T5
- found on the J.A. and J.C. Hughes Grazing Lease (High Range Ecological Consultants, 1997)

*Alopecurus occidentalis*
Alpine Foxtail
PMPOA07020
Rank: S2, G5
- found on the J. Cartwright Grazing Lease (High Range Ecological Consultants, 1999)

Over 60 vascular plant species on the ANHIC tracking list potentially occur in the project area (Table 3-1). Determination of their status in the project area will be adequately assessed only after a qualified botanist conducts a comprehensive rare plant survey.

### Table 3-1: List of Vascular Plants on the ANHIC Tracking List Potentially Occurring in the Area of Interest (compiled from Vujnovic and Gould, 2002; Kershaw et al., 2001)

**Dicots**

<table>
<thead>
<tr>
<th>Common Name</th>
<th>Scientific Name</th>
<th>Location</th>
</tr>
</thead>
<tbody>
<tr>
<td>Floating-leaved pondweed</td>
<td>Potamogeton natans</td>
<td>Shallow water</td>
</tr>
<tr>
<td>Blunt-leaved pondweed</td>
<td>Potamogeton obtusifolius</td>
<td>Shallow ponds</td>
</tr>
<tr>
<td>White-stemmed pondweed</td>
<td>Potamogeton praelongus</td>
<td>Blue camas</td>
</tr>
<tr>
<td>Blue camas</td>
<td>Camassia quamash</td>
<td>Pale blue-eyed grass</td>
</tr>
<tr>
<td>Pale blue-eyed grass</td>
<td>Sisyrinchium septentrionale</td>
<td>Slender bog orchid</td>
</tr>
<tr>
<td>Slender bog orchid</td>
<td>Plantanthera stricta</td>
<td>Silver-plant</td>
</tr>
<tr>
<td>Silver-plant</td>
<td>Eriogonum ovalifolium</td>
<td>Early buttercup</td>
</tr>
<tr>
<td>Early buttercup</td>
<td>Ranunculus glaberrimus</td>
<td>Northern bladderpod</td>
</tr>
<tr>
<td>Northern bladderpod</td>
<td>Lesquerella arctica</td>
<td>American wintercress</td>
</tr>
<tr>
<td>American wintercress</td>
<td>Barbarea orthoceras</td>
<td>Small-flowered rockstar</td>
</tr>
<tr>
<td>Small-flowered rockstar</td>
<td>Lithophragma parvillorum</td>
<td>Small northern grass-of-</td>
</tr>
<tr>
<td>Small northern grass-of-</td>
<td>Parnassia parvillora</td>
<td>pannassus</td>
</tr>
<tr>
<td>pannassus</td>
<td>Potentilla macounii</td>
<td>Macoun's cinquefoil</td>
</tr>
<tr>
<td>Macoun's cinquefoil</td>
<td>Gayophytum racemosum</td>
<td>Low willowherb</td>
</tr>
<tr>
<td>Low willowherb</td>
<td></td>
<td>Disturbed ground</td>
</tr>
<tr>
<td>Botany</td>
<td>Description</td>
<td>Habitat</td>
</tr>
<tr>
<td>--------</td>
<td>-------------</td>
<td>---------</td>
</tr>
<tr>
<td>Osmorhiza purpurea</td>
<td>Purple sweet cicely</td>
<td>Moist woods</td>
</tr>
<tr>
<td>Lomatogonium rotatum</td>
<td>Marsh felwort</td>
<td>Wet meadows</td>
</tr>
<tr>
<td>Linanthus septentrionalis</td>
<td>Northern linanthus</td>
<td>Dry hillsides</td>
</tr>
<tr>
<td>Phlox graciosilis</td>
<td>Slender phlox</td>
<td>Dry to moist open ground</td>
</tr>
<tr>
<td>Ellisia nystelea</td>
<td>Waterpod</td>
<td>Moist woods and streambanks</td>
</tr>
<tr>
<td>Hydrophyllum capitatum</td>
<td>Woolen-breeches</td>
<td>Moist slopes</td>
</tr>
<tr>
<td>Nemophila breviflora</td>
<td>Small baby-blue-eyes</td>
<td>Moist woods and open slopes</td>
</tr>
<tr>
<td>Phacelia linearis</td>
<td>Linear-leaved scorpionweed</td>
<td>Dry open slopes</td>
</tr>
<tr>
<td>Mertensia longiflora</td>
<td>Long-flowered bluebells</td>
<td>Open woods, meadows</td>
</tr>
<tr>
<td>Onosmodium molle</td>
<td>Western false gromwell</td>
<td>Shallow water</td>
</tr>
<tr>
<td>Veronica catenata</td>
<td>Water speedwell</td>
<td>Grasslands</td>
</tr>
<tr>
<td>Castilleja cusickii</td>
<td>Yellow paintbrush</td>
<td>Moist woods</td>
</tr>
<tr>
<td>Orobonache uniflora</td>
<td>One-flowered cancer-root</td>
<td>Grassy slopes</td>
</tr>
<tr>
<td>Plantago canescens</td>
<td>Western ribgrass</td>
<td>Dry, eroding slopes</td>
</tr>
<tr>
<td>Aster pauciflorus</td>
<td>Few-flowered aster</td>
<td>Open woods</td>
</tr>
<tr>
<td>Aster eatonii</td>
<td>Eaton’s aster</td>
<td>Grassy slopes and open woods</td>
</tr>
<tr>
<td>Erigeron radicatus</td>
<td>Dwarf fleabane</td>
<td>Moos woodlands</td>
</tr>
<tr>
<td>Erigeron flagellaris</td>
<td>Creeping fleabane</td>
<td>Rocky slopes</td>
</tr>
<tr>
<td>Antennaria luzuloides</td>
<td>Silvery everlasting</td>
<td>Disturbed areas</td>
</tr>
<tr>
<td>Crepis occidentalis</td>
<td>Small-flowered hawk’s-beard</td>
<td>Gravely slopes</td>
</tr>
<tr>
<td>Hieracium albertinum</td>
<td>Wooly hawkweed</td>
<td>Open woods</td>
</tr>
<tr>
<td>Microseris nutans</td>
<td>Nodding scorzonella</td>
<td></td>
</tr>
</tbody>
</table>

**Grass-like Plants**

<table>
<thead>
<tr>
<th>Botany</th>
<th>Description</th>
<th>Habitat</th>
</tr>
</thead>
<tbody>
<tr>
<td>Juncus parryi</td>
<td>Parry’s rush</td>
<td>Moist meadows and grasslands</td>
</tr>
<tr>
<td>Juncus confusus</td>
<td>Few-flowered rush</td>
<td>Springs and seepages</td>
</tr>
<tr>
<td>Juncus stygius</td>
<td>Marsh rush</td>
<td>Wet places</td>
</tr>
<tr>
<td>Eleocharis engelmannii</td>
<td>Engelmann’s spike-rush</td>
<td>Grassland and open woods</td>
</tr>
<tr>
<td>Carex petasata</td>
<td>Pasture sedge</td>
<td>Moist sites</td>
</tr>
<tr>
<td>Carex scoparia</td>
<td>Broom sedge</td>
<td>Dry, open coniferous woods</td>
</tr>
<tr>
<td>Carex platyepis</td>
<td>Broad-scaled sedge</td>
<td>Shady woods</td>
</tr>
<tr>
<td>Carex backii</td>
<td>Back’s sedge</td>
<td>Open wet ground</td>
</tr>
<tr>
<td>Carex apera</td>
<td>Open sedge</td>
<td>Marshes and shorelines</td>
</tr>
<tr>
<td>Carex vesicaria</td>
<td>Blister sedge</td>
<td>Prairie grassland</td>
</tr>
<tr>
<td>Schizachyrium scoparium</td>
<td>Little bluestem</td>
<td>Dry sand slopes</td>
</tr>
<tr>
<td>Muhlenbergia racemosa</td>
<td>Marsh muhly</td>
<td>Shores and open woodland</td>
</tr>
<tr>
<td>Alopecurus alpinus</td>
<td>Alpine foxtail</td>
<td>Meadows</td>
</tr>
<tr>
<td>Deschampsia elongata</td>
<td>Slender hair grass</td>
<td>Moist woods</td>
</tr>
<tr>
<td>Trisetum cernuum</td>
<td>Nodding trisetum</td>
<td>Open rocky ground</td>
</tr>
<tr>
<td>Danthonia unisipicata</td>
<td>One-spoke oat grass</td>
<td>Moist meadows</td>
</tr>
<tr>
<td>Spenopholis obtusata</td>
<td>Prairie wedge grass</td>
<td>Open woods</td>
</tr>
<tr>
<td>Poa nervosa</td>
<td>Wheeler’s bluegrass</td>
<td>Wet places</td>
</tr>
<tr>
<td>Poa stenanth</td>
<td>Narrow-leaved bluegrass</td>
<td>Moist woods and thickets</td>
</tr>
<tr>
<td>Torreyochloa pallida</td>
<td>Few-flowered salt-meadow grass</td>
<td>Moist streambanks</td>
</tr>
<tr>
<td>Festuca subulata</td>
<td>Bearded fescue</td>
<td>Open woods</td>
</tr>
<tr>
<td>Bromus latiglumis</td>
<td>Canada brome</td>
<td>Dry plains and open woods</td>
</tr>
<tr>
<td>Bromus vulgaris</td>
<td>Woodland brome</td>
<td>Open woods and thickets</td>
</tr>
<tr>
<td>Elymus elymoides</td>
<td>Squirreltail</td>
<td>Moist woods and meadows</td>
</tr>
<tr>
<td>Elymus virginicus</td>
<td>Virginia wild rye</td>
<td></td>
</tr>
<tr>
<td>Poa gracillima</td>
<td>Pacific bluegrass</td>
<td></td>
</tr>
</tbody>
</table>

**Ferns and Fern Allies**

<table>
<thead>
<tr>
<th>Botany</th>
<th>Description</th>
<th>Habitat</th>
</tr>
</thead>
<tbody>
<tr>
<td>Botrychium hesperium</td>
<td>Western grape fern</td>
<td>wooded areas</td>
</tr>
<tr>
<td>Botrychium simplex</td>
<td>Dwarf grape fern</td>
<td>Moist meadows</td>
</tr>
</tbody>
</table>
3.3 *Wildlife of Special Significance*

It was beyond the scope of this project to complete a full site analysis for terrestrial and aquatic wildlife. However, the following summary is a result of two site visits, a review of the literature and contact with knowledgeable professionals in the field. This is not meant to be a comprehensive review, but focuses on confirmed sightings and species of significance. In general, there is a deficiency of site and regionally specific wildlife inventory for the project area. This review does not include a discussion of aquatic or invertebrate species. The authors recommend that an invertebrate survey be completed for the area.

The Foothills Parkland subregion is transitional between the Foothills Fescue subregion and the Montane ecoregion. Hence, many grassland and mountain species come together to enrich this ecotone. For example, the upland forest and shrublands include such mountain birds as Dusky Flycatcher (*Empidonax oberholseri*), MacGillivray’s Warbler (*Oporinis tolmiei*), Lazuli Bunting (*Passerina amoena*) and White-crowned Sparrow (*Zonotrichia leucophrys*), while the more easterly and lowland portions provide habitat for species more characteristic of grasslands (AEP 1997b). Further south, Black-head Grosbeaks (*Pheucticus melanocephalus*) and Blue Grouse (*Dendragapus obscurus*) are found in the aspen forests. The transitional nature of the subregion results in highly diverse habitat structure comprised of open grasslands, shrublands, deciduous and mixed forests, as well as wetlands and associated riparian habitat. The rolling topography and connective corridors of shrublands and riparian areas provide excellent cover for wildlife movement from the proposed wellsite west to the montane ecoregion (Fig. 3-3). The structural diversity and qualities associated with being an ecotone results in the Foothills Parkland being rich in biological diversity and certainly not “depauperate” as suggested by Iris (2002, p. 11).

The area of the proposed wellsite is located within the Pekisko Wildlife Management Unit (310) with hunting seasons during specified times for: Mule Deer, White-tailed Deer, Elk, Moose, Black Bear, Cougar and upland gamebirds. Table 3-2 provides a summary of estimated harvest for selected species in 2000 and 2001 within WMU 310 to provide an indication of their regional presence and relative abundance.
Table 3-2. Estimated Harvest of Selected Species in WMU 310 (from ASRD 2002)

<table>
<thead>
<tr>
<th>Species</th>
<th>Estimated Harvest</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>2000</td>
</tr>
<tr>
<td>Mule Deer</td>
<td>152</td>
</tr>
<tr>
<td>White-tailed Deer</td>
<td>164</td>
</tr>
<tr>
<td>Elk</td>
<td>7</td>
</tr>
<tr>
<td>Moose</td>
<td>42</td>
</tr>
<tr>
<td>Black Bear</td>
<td>0</td>
</tr>
<tr>
<td>Cougar</td>
<td>2</td>
</tr>
<tr>
<td>Sharp-tailed Grouse</td>
<td>175</td>
</tr>
</tbody>
</table>

Fig. 3-3 Image taken from the existing well pad looking west. The willow shrub community provides continuous hiding cover and landscape connectivity for wildlife (15 July 2002). © Michael Quinn

The Foothills Parkland provides productive wetlands for a diversity of waterfowl. Trumpeter Swans (*Olor buccinator*) are recognized as “at risk” in Alberta and have been assigned the status of “threatened” under the Provincial Wildlife Act. Trumpeter Swans nest further south near Waterton, but may utilize wetlands within the Foothills Parkland and adjacent Montane zone. Unidentified species...
of swans (Tundra (Olor columbianus) or Trumpeter) utilize wetlands in the area and American White Pelicans (Pelecanus erythrorhynchos) are found on Chain Lakes (F. Gardner, pers. comm.). Along with Swainson's Hawk (Buteo swainsoni) and Red-tailed Hawk (Buteo jamaicensis) there is also a recent breeding record for Ferruginous Hawk (Buteo regalis) in the region (Semetchuk 1992; see also Schmutz 1999). Ferruginous Hawks are listed as “at risk” in Alberta and are identified as threatened under the Wildlife Act (Alberta Sustainable Resource Development (ASRD) 2000). Other raptors include the Prairie Falcon (Falco mexicanus) and American Kestrel (Falco sparverius).

Baird’s Sparrow (Ammmodramus bairdii) may occur in the area within continuous patches of fescue grassland. Baird’s Sparrow is listed as “sensitive” in Alberta (ASRD 2000) due to habitat loss and resultant population declines across its range.

Aerial wildlife surveys conducted in the spring of 2002 identified Sharp-tailed Grouse (Tympanuchus phasianellus) dancing grounds (leks) at SE-19-17-2 W5 (approx. 1.5 km from the proposed wellsite; Pat Young, pers. comm.). There were 16 males and 2 females sighted, with additional birds in background. Other leks are suspected along the north-south ridge west of Highway 22, but further verification is required. Sharp-tailed Grouse are currently listed as “sensitive” in Alberta (ASRD 2000). The interspersion of shrub and native grassland habitat in the area of the proposed wellsite is ideal for this species. Draft setback guidelines for areas of long-term vegetation disturbance (including roads, wellsites and pipelines) proposed for Sharp-tailed Grouse leks recommend at least 500 m of distance from the lek (ASRD 2001).

Avian species seen or heard on the 15 July 2002 site visit include: Swainson’s Hawk, Red-tailed Hawk, Killdeer (Charadrius vociferous), Northern Flicker (Colaptes auratus), Western Wood-Pewee (Contopus sordidulus), Alder Flycatcher (Empidonax alnorum), Least Flycatcher (Empidonax minimus), Eastern Kingbird (Tyrannus tyrannus), Tree Swallow (Tachycineta bicolor), Black-billed Magpie (Pica pica), American Crow (Corvus brachyrhynchos), Common Raven (Corvus corax), Rock Wren (Salpinctes obsoletus), House Wren (Troglodytes aedon), American Robin (Turdus migratorius), Cedar Waxwing (Bombycilla cedrorum), Warbling Vireo (Vireo gilvus), Yellow Warbler (Dendroica petechia), Clay-colored Sparrow (Spizella pallida), Vesper Sparrow (Pooecetes gramineus), Savannah Sparrow (Passerculus sandwichensis), Brewer’s Blackbird (Euphagus cyanocephalus), and American Goldfinch (Carduelis tristis). All of the observed species are listed as “secure” in Alberta (ASRD 2000).

Ungulates known to utilize both the local area and region include Mule Deer (Odocoileus hemionus), White-tailed Deer (O. virginiana), Elk (Cervus elaphus), and Moose (Alces alces). All of these species are classified as “secure” but are significance because of their socioeconomic value (ASRD 2000).

Large and meso-carnivores known to frequent the area of the proposed well site include cougar (Puma concolor), grizzly bear (Ursus arctos), wolf (Canis lupus),...
coyote (Canis latrans), American badger (Taxidea taxus). Fresh diggings by badgers were abundant during our site visit on 15 July 2002. Badgers are listed as "sensitive" in Alberta and opinions vary as to population trends (ASRD 2000). The Alberta Natural History Information Centre (ANHIC) includes badgers on the "watch list." Cougars have been tracked through the valley west of the proposed wellsite (Ross, pers. comm.) and a cougar was seen on the northeast corner of the Winter Range Lease during a site assessment in 1996 (High Range Ecological Consultants 1996a). Cougars are classified as “sensitive” in Alberta (ASRD 2000). There are regular sightings of wolves in the immediate vicinity of the site and several incidences of wolves preying on cattle were reported nearby in the winter of 2002 (Musiani, pers. comm., see also Southern Alberta Conservation Cooperative 2002).

Grizzly bears are reported relatively frequently in the area (Ross, pers. comm., Cartwright pers. comm., Jorgenson pers. comm.) and were recorded visiting the site during the previous drilling program (Iris Environmental Systems 2002). Alberta Alberta Fish and Wildlife (1990) includes the current study area within Bear Management Area 7 (BMA 7) and classifies it as secondary habitat supporting seasonal and low density populations of grizzly bears. There is some concern over BMA 7 and BMA 6 (west of BMA 7) as grizzlies have suffered a 31% population decline in the past decade (Kansas 2002). Grizzlies previously existed on the plains and have been reoccupying territories that extend well out into grassland systems along the eastern front of the Rocky Mountains (Associated Press 2002). Kansas (2002) indicates: “Grizzly bears are particularly prone to cumulative land use effects because of their inability to adapt to human disturbance.” Human caused mortality is the primary factor limiting grizzly bear populations (Knight, Blanchard & Eberhardt 1988, Knight & Eberhardt 1985).

Spatial analyses of grizzly bear mortality locations in the Central Rockies Ecosystem showed that most bears died within a few hundred metres of roads and trails (Benn 1998). Grizzly bears are currently identified as “may be at risk” in Alberta (ASRD 2000). However, the Alberta Endangered Species Coordinating Committee, after an examination by the Endangered Species Scientific Subcommittee using IUCN criteria, have recommended to the Minister of Sustainable Resource Development that the Grizzly Bear be listed as “threatened” under the Wildlife Act.

Herpetofauna in the immediate vicinity of the site also reflects the transitional nature of the subregion as both prairie and mountain species are likely to occur. A wood frog (Rana sylvatica) was seen on the access road during the 15 July 2002 site visit. High Range Ecological Consultants (1996a) reported unidentified salamanders in a pond within LSD 10 of Section 24 (either Ambystoma tigrinum or A. macrodactylum are possible). The Long-toed salamander is designated a “species of special concern” under the Wildlife Act. Other herpetiles probable in the area include the Western Toad (Bufo boreas; sensitive), Boreal Chorus Frog (Pseudacris triseriata), Northern Leopard Frog (Rana sylvatica; at risk), Columbia Spotted Frog (Rana luteiventris; sensitive), Wandering Garter Snake (Thamnophis elegans), Red-sided Garter Snake (Thamnophis sirtalis), and Plains Garter Snake (Thamnophis radix). All of the garter snakes are listed as “sensitive” (ASRD 2000).
Wildlife sightings for the Winter Range Grazing Lease and Hughes Grazing Lease collected by High Range Ecological Consultants (1997, 1998) are quoted below in their entirety to supplement the scant site-specific information available.

Winter Range Grazing Lease     GRL #780027
Both mule deer and white-tailed deer were abundant throughout the lease. A small herd of eight elk were observed several times using the drainages and steeper grasslands associated with the ridges in the east half of the lease. On another occasion two spike elk were observed in the same general area. One cougar was also observed in the northeast corner of the lease. In section 24 LSD 10 there are two small ponds lying between uplifted bedrock near the top of the ridge. The larger southern pond supports a population of salamanders. It was not determined if they were tiger or long-toed salamanders.

J.A. and J.C. Hughes Grazing Lease    GRL #32574
Both Mule Deer and White-tailed Deer were abundant throughout the lease and Elk scat and beds were observed in the Willows in Pasture #9S. One cougar was also observed on the lease. The creek flowing through Pasture #’s 9S and 10S had a population of minnows, generally in the deeper holes and a small slough in Pasture #3C had a population of tiger Salamanders, Wood Frogs and Striped Chorus Frogs. Sharp-tailed Grouse and Ruffed Grouse were observed along the edge of several Willow stands.
3.4 The Significance of Rough Fescue Grasslands and Willow Shrublands for Ranching

Foothills rough fescue grasslands and willow shrublands in the project area have supported grazing by ungulates since deglaciation over 10,000 years ago. Prior to European settlement bison, elk, and deer grazed the grasslands and browsed the shrublands. For millennia bison were drawn to the shelter of the foothills and abundant rough fescue forage growth made available by frequent Chinook winds. Early ranching, which became established in the 1880s, responded to the same grazing opportunities as the bison did. Over the past century many ranchers have learned to imitate the natural system by saving the best rough fescue grasslands for winter use, a practice that both sustains the grassland and reduces the reliance on hay.

Rough fescue grasslands and willow shrublands are underlain by highly productive soils that have been cultivated throughout much of their range in Alberta. Steep terrain and public ownership of the area has spared much of the grassland in the project area from cultivation. For many years portions of the project area were the primary winter range for the Bar U Ranch (K. Stiles pers. comm.).

Foothills rough fescue grasslands are one of the most productive range types on the Northern Great Plains (Willms et al., 1996). Forage yields over 8 years in moderate to lightly grazed foothills rough fescue grasslands near Stavely about 50 km east of the project area averaged over 2,000 kg/ha and rough fescue itself was determined to be the most productive forage species on the grassland (Willms et al., 1985). Grassland communities dominated by rough fescue, Idaho fescue and Parry oatgrass in the Montane Subregion of Alberta have forage production values averaging 1928 kg/ha (Willoughby et al. 1998).

Research and experience has shown that foothills rough fescue grasslands are very sensitive to stocking rate during the growing season, May to November. The results of a 35-year study on rough fescue grasslands near Stavely are that “a stocking rate of approximately 1.2 AUM/ha [during the growing season] should be used to maintain a productive vegetative resource as well as to sustain a habitat for wildlife in the rough fescue grasslands [of southwestern Alberta]” (Willms et al. 1986). [Note: An animal unit (AU) is defined as one mature (1,000 lb) cow with or without an unweaned calf at side, or equivalent, and is based upon the average daily forage consumption of 26 lb dry matter per day (Wroe et al. 1988).] Within the Montane natural subregion a stocking rate of 2 AUM/ha is recommended on foothills rough fescue grassland (Willoughby et al. 1997). A modest increase in stocking rate results in a rapid increase in the proportion of unproductive forbs and grasses and a reduction in the proportion of rough fescue (Willms et al. 1985). The net effect is a decline in range condition and a reduction in the recommended carrying capacity. Once range has
deteriorated, recovery of grassland to a stable range condition was found to require 20 to more than 32 years (Willms et al. 1985).

A range resource inventory for the Winter Range Grazing Lease assessed 70% of the range to be in good or excellent condition and the remaining 30% in fair or poor condition (High Range Ecological Consultants 1997). Sites in fair or poor condition are attributed to past grazing practices, which have led to invasion by Kentucky bluegrass. The recent shift back to dormant season (winter) grazing is expected to improve range condition on these sites. Rough fescue tolerates grazing while dormant. This may reflect the historical use of the fescue prairie that is believed to have been subjected to winter grazing by bison. The rough fescue grasslands have physical and nutritive properties that make them suitable for winter grazing thereby reducing the cost of winter feeding while preserving the integrity of the grasslands (Willms et al. 1998). Winter grazing by cattle has been found to be an economically sound management practice by ranchers in the project area and elsewhere (Willms et al. 1993). When compared with the Parry’s oatgrass-Kentucky bluegrass community and the Kentucky bluegrass-sedge community, the foothills rough fescue community has the greatest production, is the least dependent on precipitation during the growing season and is the least susceptible to weathering losses and, therefore, has the greatest forage value (Willms et al. 1996). The Kentucky bluegrass-sedge community has the lowest forage value. Maintaining a high proportion of rough fescue on winter range ensures the best grazing opportunities for cattle and elk.

According to Adams and Ehlert (1990) intact native grassland communities provide managerial values not supported by altered or degraded rangelands. Values include:

- **Higher Productivity** – Native rough fescue grasslands provide consistently higher production and forage value throughout the year and from year to year compared to rangelands dominated by soft grasses such as Kentucky bluegrass, timothy and brome.
- **Flexibility** – Native rough fescue grasslands provide ranchers the ability to graze in four seasons, not just spring and summer as with pastures dominated by soft grasses.
- **Efficiency** – Livestock do their own harvesting of feed all year round, hence there is less reliance on costly machinery and fossil fuels to put up and feed hay.
- **Stability** – Productivity from rough fescue grassland is less erratic than from ranges dominated by soft grasses which ‘crash’ in dry years.
- **Less Risk** – Ranchers with rough fescue grasslands are able to sustain a stable stocking rate and incur less financial risk.
- **Less Maintenance** – Weed control costs are less within late seral grassland communities, such as those dominated by rough fescue, compared to disturbed and early seral communities.

Introduction of non-native invasive plant species is one of the biggest threats to rough fescue grassland. Kentucky bluegrass, smooth brome and timothy readily establish on disturbed sites and invade non-disturbed areas as well. Range
managers, after years of observation and monitoring of range sites, have
determined that the conversion of a rough fescue dominated community to a
Kentucky bluegrass dominated community is irreversible within a meaningful time
span. This conversion occurs most readily on moist sites with thick black
chernozem soils that are heavily grazed or fragmented by developments (B.
Adams, pers. comm.). Activities which lead to conversion of rough fescue
grasslands to modified grassland communities in the project area would mean
loss of opportunities for winter grazing (Kentucky bluegrass loses its palatability
and nutrient content in winter), increased risk of succumbing to drought, and
threats to opportunities currently being realized to conduct sustainable ranching
operations with low inputs on native range (Cartwright 2002).

Willow shrublands in the project area are very important to livestock and wildlife
for forage, shelter during winter storms and often there is a water source
associated with these types (K. Stiles and S. Hughes pers. comm., High Range
3.5 **Significant First Nations Cultural Values**

This report does not include an archaeological survey or assessment of First Nations cultural features. However, during the first site visit, we found evidence consistent with other known “vision quest” or “dream bed” sites in southwestern Alberta (Fig. 3-1). The location of these features is approximately 1 km south of the proposed drilling location in section 24-17-03-W5. This section has been identified as a possible location for additional wells. Based on these findings we recommend that an archaeological assessment of the area be completed. A conversation with the Head of the Archaeological Survey of Alberta (Dr. David Link, pers. comm., 16 Aug 2002) confirms the significance of the finding. There are only about 14 recorded vision quest sites in the province (Kristine Fedynaik, Archaeology Assistant Curator, Provincial Museum of Alberta, pers. comm., 28 Aug 2002). The quarter section with these features has now been identified on the “list of concern” at Archaeological Survey, Heritage Resource Management Branch.

**Fig. 3-4** Site of archaeological significance approximately 1 km south of the proposed drilling location (15 July 2002). © M. Quinn
The site described above was found in association with other cairn type structures. All of these structures were relatively undisturbed. The setting of this site is consistent with others in southern Alberta and northern Montana. Concerns have been raised that increased access may put such sites in jeopardy.

Fortunately, many sites are still undisturbed because of their remoteness and inaccessibility. The lack of artifacts and lithic material did not encourage visits and excavations. Nevertheless, with increased easy access via many new roads built for timber, oil and gas extraction, too many of the areas with vision quest sites that at one time were very isolated, are losing their identify or have been eliminated entirely. The accessibility of many mountain ridges by helicopter has further led to pilfering of the stones of the rock features for propping up survey stakes and plastic beacons (Dormaar and Reeves 1993).
4.0 Ecological Effects

Previous sections of this report establish the environmental significance of foothills rough fescue grasslands, of foothills parkland willow communities and of that portion of the Foothills Parkland natural subregion that includes the local and regional project areas. A rare plant species survey of the project area has not been conducted so all significant vegetation components may not be defined. Environmental impacts of the proposed project on known significant vegetation components are grouped into three key areas that are interrelated:

1) Direct loss of rough fescue grasslands and willow communities and challenges in restoration,
2) Invasion of fescue grasslands by non-native species from linear disturbances,
3) Fragmentation of local and regional project areas.

This assessment assumes that Vermilion Resources Ltd. is not proceeding with an expectation of failure in finding gas. This assessment, therefore, does not restrict itself only to Vermilion’s preferred definition of the project - construction of the proposed well site in 11-25-17-03-W5M and access road and its reclamation. Based on their expertise and past experience, consultants authoring this report believe that to restrict environmental assessment this narrowly would be inconsistent with professional practice. Therefore, this section also includes an overview of potential effects of regional land use on selected wildlife species as well as a preliminary cumulative effects analysis.
4.1 Ecological Effects on Vegetation

4.1.1 Direct Loss of Rare Vegetation and Challenges In Restoration

The following surface disturbance from the project is predicted based on the information provided by the proponent including Answers to June 17 Information Request with a cover letter from Daron Naffin, McLennan Ross LLP, to Keith Luft, Beaumont Church LLP, dated 31 July 2002 and the Siting Information Report of Alberta Sustainable Resource Development dated 19 March 2001.

- At least five well sites as large as the previous one drilled in 11-25-17-3 (122 metres by 122 metres) or maybe less. Well sites will be spaced one per section. Dehydrators may be required.
- Berms made from on-site clay or other materials around wells to avoid fluid contamination.
- All-weather access roads to well sites with a width of 15 metres or maybe less.
- A central compressor located on a well site or at a remote location.
- Pipelines for tying in producing wells to the central compressor and for tying in the central compressor to the Nova line. No specifics regarding size or predicted disturbance of pipelines are provided.
- Powerlines. No specifics are provided.

In 1980 an exploratory gas well was drilled in the project area - LSD 11 of Sec 25-17-03-W5M - and a road was built to access the site. The first two kilometers of the former wellsite access route is a graded road, which prior to 1980 was an ungraded trail, continuing west. The road was not reclaimed and continues to be used by grazing leaseholders for ranch operations (Figs. 4-2 & 4-3). The last one kilometre of the access route running north and east to the old well site appears to have been partially reclaimed. The well site also has been reclaimed. The proponent proposes to redisturb the reclaimed well site and access road to reach its first target.

Given the high relief of terrain generally in the project area, reducing surface disturbance from that predicted will represent a major challenge. The slope of the well site in 11-25-17-3 is high (20-30%) requiring cut and fill of 15 m each. Erosion control ditches are required. Similar relief can be anticipated for other well sites located on drier mid to upper slopes and for roads crossing these slopes. Seepage areas supporting willow shrublands also are common on slopes. Valley bottoms are generally wet, either permanently or seasonally. These riparian and wetland sites will be unsuitable for well sites and roads. The Siting Information Report notes evidence of soil creep and mass wasting in large drainage draws. The access road to 11-25-17-3 crosses two large drainage
draws requiring culverts.

Given the limitations of the terrain for development and the predominantly native character of the area, it is likely that well sites and roads will be proposed predominantly within native foothills rough fescue grasslands. This is the situation for the well site and access road constructed in 1980 (High Range Ecological Consultants, 1997). Both seepage willow communities on slopes and riparian and wetland communities in valley bottoms will need to be crossed by roads to accomplish drilling objectives. The extent and effects of this fragmentation on vegetation in the project area are discussed in the Regional Effects portion of this report.

In Answers to the June 17 Information Request the proponent states "...it is anticipated that the site [11-25-17-3W5M], after implementation of current reclamation techniques and use of a better seed mix, will be closer to the original native condition than at present". The reclamation consultant to the proponent states (p.6) "If the site is disturbed again for drilling, a similar or higher quality of fescue plant community is possible" (Walker, 2002).

On July 19 and September 19, we surveyed the current vegetation on the reclaimed wellsite and access route, which are proposed for redisturbance. Field investigation on July 19 included walking the route taking photos and notes regarding the vegetation. A more detailed description of vegetation was conducted on September 19. For the reclaimed well site, five 10m x 10m plots were described. Four plots were located 30 m along a diagonal from each corner of the well site and the fifth plot was located in the centre of the well site. UTM coordinates of the centre of each plot were recorded using a Garmin GPS 12CX Personal Navigator. Within each plot, all species were identified and canopy cover was estimated visually to the nearest percent both for individual species and for the shrub and herbaceous layers. Cover also was estimated for ground litter, bare mineral soil, and rocks and stones. Physical environmental factors noted include: landform, topographic position, relief shape, slope angle and aspect, moisture regime, drainage, and soil. A photo was taken looking across each plot from the SE corner.

Plant species composition and physical characteristics of plots on the reclaimed well site are provided in Table 4-1. All plots had a shrub layer dominated by common wild rose (Rosa woodsii). Mean shrub cover was 34% and varied from 15% to 55%. All plots had an herbaceous layer which averaged 69% cover, varying from 60% to 75%. The herbaceous layer was overwhelmingly dominated by two non-native grasses - ownless brome (Bromus inermis) and Kentucky bluegrass (Poa pratensis). Average cover of these two species was 46% and 33% respectively. Herbs comprised less than 15% cover in all plots. Of the 34 herb species identified, most common were two non-native species, common dandelion (Taraxacum officinale) and Canada thistle (Cirsium arvense), and one native species, common yarrow (Achillea millefolium).
Table 4-1  Physical characteristics and plant species composition of five 10m x 10m plots on the reclaimed 1980 well site (11-25-17-03 W5; 8 Sep 2002)

<table>
<thead>
<tr>
<th>Plot #</th>
<th>01 (SE)</th>
<th>02 (NE)</th>
<th>03 Middle</th>
<th>04 (SW)</th>
<th>05 (NW)</th>
<th>Mean</th>
</tr>
</thead>
<tbody>
<tr>
<td>Slope &amp; Aspect</td>
<td>31% NW mesic well</td>
<td>23% NW mesic well</td>
<td>26% NW mesic well</td>
<td>25% NW mesic well</td>
<td>21% NW submesic well</td>
<td>25% NW</td>
</tr>
<tr>
<td>Moisture</td>
<td>mesic</td>
<td>mesic</td>
<td>mesic</td>
<td>mesic</td>
<td>submesic</td>
<td></td>
</tr>
<tr>
<td>Drainage</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Litter (%)</td>
<td>95</td>
<td>97</td>
<td>97</td>
<td>97</td>
<td>95</td>
<td>96</td>
</tr>
<tr>
<td>Mineral Soil (%)</td>
<td>4</td>
<td>3</td>
<td>2</td>
<td>2</td>
<td>3</td>
<td></td>
</tr>
<tr>
<td>Rock (%)</td>
<td>1</td>
<td>0</td>
<td>1</td>
<td>1</td>
<td>2</td>
<td>3</td>
</tr>
<tr>
<td>Shrub Layer (%)</td>
<td>25</td>
<td>35</td>
<td>15</td>
<td>40</td>
<td>55</td>
<td>34</td>
</tr>
<tr>
<td>Herbaceous Layer (%)</td>
<td>70</td>
<td>60</td>
<td>75</td>
<td>75</td>
<td>65</td>
<td>69</td>
</tr>
<tr>
<td>Bryoid Layer (%)</td>
<td>0</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>2</td>
<td>1</td>
</tr>
<tr>
<td>Shrubs (% cover)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Rosa woodsii</td>
<td>25</td>
<td>35</td>
<td>15</td>
<td>40</td>
<td>55</td>
<td>34</td>
</tr>
<tr>
<td>Symphoricarpus occidentalis</td>
<td>0.5</td>
<td>2</td>
<td>&lt;1</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Potentilla fruticosa</td>
<td>0.5</td>
<td>0.5</td>
<td>&lt;1</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Grasses (% cover)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Bromus inermis</td>
<td>√</td>
<td>50</td>
<td>40</td>
<td>60</td>
<td>50</td>
<td>46</td>
</tr>
<tr>
<td>Poa pratensis</td>
<td>√</td>
<td>30</td>
<td>25</td>
<td>30</td>
<td>40</td>
<td>33</td>
</tr>
<tr>
<td>Agropyron pectiniforme</td>
<td>√</td>
<td>0.5</td>
<td>5</td>
<td></td>
<td></td>
<td>1</td>
</tr>
<tr>
<td>Agropyron repens</td>
<td>√</td>
<td>5</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Agropyron smithii/dasy</td>
<td></td>
<td></td>
<td></td>
<td>0.5</td>
<td>&lt;1</td>
<td></td>
</tr>
<tr>
<td>Agropyron subsecundum</td>
<td>2</td>
<td></td>
<td></td>
<td>0.5</td>
<td>&lt;1</td>
<td></td>
</tr>
<tr>
<td>Danthonia parryii</td>
<td></td>
<td>1</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Phleum pratense</td>
<td>√</td>
<td>0.5</td>
<td>0.5</td>
<td>2</td>
<td>&lt;1</td>
<td></td>
</tr>
<tr>
<td>Stipa columbiana</td>
<td></td>
<td></td>
<td></td>
<td>0.5</td>
<td>&lt;1</td>
<td></td>
</tr>
<tr>
<td>Herbs (% cover)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Taraxacum officinale</td>
<td>√</td>
<td>0.5</td>
<td>5</td>
<td>5</td>
<td>10</td>
<td>2</td>
</tr>
<tr>
<td>Achillea millefolium</td>
<td></td>
<td>2</td>
<td>5</td>
<td>1</td>
<td>1</td>
<td>3</td>
</tr>
<tr>
<td>Cirsium arvense</td>
<td>√</td>
<td>0.5</td>
<td>5</td>
<td>0.5</td>
<td>0.5</td>
<td>1</td>
</tr>
<tr>
<td>Agoseris glauca</td>
<td></td>
<td></td>
<td></td>
<td>0.5</td>
<td>&lt;1</td>
<td></td>
</tr>
<tr>
<td>Artemisia campestris</td>
<td></td>
<td></td>
<td></td>
<td>0.5</td>
<td>&lt;1</td>
<td></td>
</tr>
<tr>
<td>Artemisia frigida</td>
<td>1</td>
<td>1</td>
<td>0.5</td>
<td>2</td>
<td>&lt;1</td>
<td></td>
</tr>
<tr>
<td>Artemisia ludoviciana</td>
<td>0.5</td>
<td>2</td>
<td>0.5</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Aster ericoides</td>
<td>0.5</td>
<td>0.5</td>
<td>0.5</td>
<td>1</td>
<td>&lt;1</td>
<td></td>
</tr>
<tr>
<td>Aster laevis</td>
<td>0.5</td>
<td>0.5</td>
<td>0.5</td>
<td>0.5</td>
<td>0.5</td>
<td></td>
</tr>
<tr>
<td>Campanula rotundifolia</td>
<td></td>
<td>0.5</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Chenopodium album</td>
<td>√</td>
<td>0.5</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Erigeron glabellus</td>
<td></td>
<td></td>
<td></td>
<td>1</td>
<td>&lt;1</td>
<td></td>
</tr>
<tr>
<td>Erigeron speciosus</td>
<td></td>
<td>0.5</td>
<td>0.5</td>
<td>0.5</td>
<td>&lt;1</td>
<td></td>
</tr>
<tr>
<td>Fragaria virginiana</td>
<td>0.5</td>
<td>0.5</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Galium boreale</td>
<td>1</td>
<td></td>
<td></td>
<td>0.5</td>
<td>&lt;1</td>
<td></td>
</tr>
<tr>
<td>Geranium viscossimum</td>
<td>0.5</td>
<td>3</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Geum triflorum</td>
<td>0.5</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Hedysarum alpinum</td>
<td></td>
<td>1</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Lathyrus ochroleucus</td>
<td></td>
<td>0.5</td>
<td></td>
<td>0.5</td>
<td>&lt;1</td>
<td></td>
</tr>
<tr>
<td>Lilium philadelphicum</td>
<td></td>
<td>0.5</td>
<td></td>
<td>0.5</td>
<td>&lt;1</td>
<td></td>
</tr>
<tr>
<td>Linaria vulgaris</td>
<td>√</td>
<td>0.5</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Lupinus sericeus</td>
<td></td>
<td>0.5</td>
<td></td>
<td>5</td>
<td>1</td>
<td></td>
</tr>
<tr>
<td>Monarda fistulosa</td>
<td></td>
<td>0.5</td>
<td></td>
<td>5</td>
<td>1</td>
<td></td>
</tr>
<tr>
<td>Oxytropis sericea</td>
<td></td>
<td>0.5</td>
<td>0.5</td>
<td>0.5</td>
<td>0.5</td>
<td>&lt;1</td>
</tr>
<tr>
<td>Polygonum convulvis</td>
<td>√</td>
<td>0.5</td>
<td></td>
<td>0.5</td>
<td>&lt;1</td>
<td></td>
</tr>
<tr>
<td>Potentilla arguta</td>
<td></td>
<td>0.5</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Potentilla gracilis</td>
<td></td>
<td></td>
<td></td>
<td>1</td>
<td>&lt;1</td>
<td></td>
</tr>
<tr>
<td>Potentilla pensylvanica</td>
<td></td>
<td>0.5</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Solidago canadensis</td>
<td></td>
<td>3</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Solidago missouriensis</td>
<td></td>
<td>1</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Thermopsis rhombifolia</td>
<td></td>
<td>0.5</td>
<td></td>
<td>0.5</td>
<td>&lt;1</td>
<td></td>
</tr>
<tr>
<td>Thlaspi arvense</td>
<td>√</td>
<td>0.5</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Tragopogon dubius</td>
<td>√</td>
<td>0.5</td>
<td>0.5</td>
<td>0.5</td>
<td>0.5</td>
<td>&lt;1</td>
</tr>
<tr>
<td>Vicia americana</td>
<td>0.5</td>
<td>0.5</td>
<td>0.5</td>
<td>0.5</td>
<td>0.5</td>
<td>&lt;1</td>
</tr>
<tr>
<td>non-native()/native</td>
<td>12/46</td>
<td></td>
<td></td>
<td>(26%)</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
The reclamation consultant for the proponent states “The plant community on
the well site can be best described as one that is mostly native and undergoing
rapid (for plant communities) successional change” (Walker, 2002; p.6). Based
on analysis of plot data, our conclusion is that although the majority of plant
species occurring on the well site are native (74%), the cover of the plant
community is overwhelmingly dominated by non-native plant species which are
persistent and are known to invade native rangeland in sites with better moisture
and soil (i.e. black chernozems) (Tannas, 1998). Drier patches of the well site
appear to support a greater cover and diversity of native species, but these
patches comprise a small proportion of the well site and it is not known if they
are expanding, contracting or simply holding their ground.

The reclamation consultant for the proponent states “Rough fescue plants were
located in a number of places on the abandoned well site indicating that the
species is beginning to re-establish into the plant community” (Walker, 2002; p.5).
We did not find foothills rough fescue (Festuca campestris) in plots or along our
traverses of the reclaimed well site although it is the dominant grass in the native
community at the edge of the well site. Fig. 4-1 shows that the edges of the well
site are still clearly visible after 20 years suggesting that revegetation by native
species is not occurring quickly. Rough fescue is a bunch grass and does not
spread by rhizomes (like Kentucky bluegrass, smooth brome, timothy) but rather
by tillers which are sent up a very short distance from the plant hence its
potential to spread vegetatively is low (Walter Willms, pers. comm.). In addition,
rough fescue has unreliable seed production (both in terms of volume and
viability). It is our view that determination of whether rough fescue specifically,
and a more native community generally, is re-establishing would require a more
thorough investigation over several years.

Our observations along the reclaimed access road are that as with the wellsite
much of the vegetation is dominated by non-native species that are persistent
and invasive. Common non-native species include awnless brome, Kentucky
bluegrass, crested wheat grass and Canada thistle.

We lack confidence in the proponent’s assertion that re-disturbing the site will
hasten restoration of the native community. In fact it may have the opposite
effect as current thinking is that rough fescue communities are climax
communities (like old growth forest) which can only establish after colonizing
successional communities have created suitable conditions, such as a thick litter
layer, increased moisture retention capability and microrhizal networks in the soil
(Walter Willms, pers. comm.). Furthermore, there is no guarantee that native
successional communities will establish. Awnless brome, Kentucky bluegrass and
timothy occur in draws and woodlands around the wellsite and along the access
road and can be expected to re-invade the new disturbance.

The remainder of this section deals with challenges associated with restoring
rough fescue grasslands which have been documented by others.

“One of the first things to keep in mind when considering land reclamation and
restoration is... that they’re separate and very different activities” (Naeth, 1997). “Reclamation is returning disturbed land to productive use and equivalent land capability....Restoration, on the other hand, involves returning the conditions and ecosystem that existed in an area before it was disturbed by humans.” Four recent publications – *Native Plant Revegetation Guidelines of Alberta* (Native Plant Working Group 2000), *Prairie Oil and Gas: A Lighter Footprint* (Sinton 2001), *Petroleum Industry Activity in Native Prairie and Parkland Areas: Guidelines for Minimizing Surface Disturbance* (Native Prairie Guidelines Working Group 2002) and *EUB IL2001-1: Principles for Minimizing Surface Disturbance in Native Prairie and Parkland Areas* (EUB 2002) - recommend avoidance of sensitive prairie landscapes and features including rare landforms, plants or plant communities as a priority in pre-development planning. Presumably the potential for restoration of these sensitive areas, as opposed to reclamation, would have a bearing on a decision about avoidance.

Currently there are no documented examples of successful restoration of rough fescue grassland following surface disturbances caused by oil and gas development (B. Adams, pers. comm.; H. Sinton, pers. comm.). Small pipelines using “no strip” construction (trench <30 cm) are the exception. A summary of the results of some investigations into reclamation and restoration of rough fescue prairie follows.

A restoration experiment in the grasslands of central Saskatchewan combined with a review of other research information about native prairie restoration led the researcher to conclude that because of the lack of success in establishing seed mixes on black soils, “conserving remaining rough fescue prairie rather than restoring it would have greater benefit” (Clark, 1998). Native plantings in the black soil zone (fescue prairie and parkland) were more seriously invaded by perennial weeds and experienced poorer seed production than native plantings in the mixed and tall-grass prairie region. Clark (1998) states “These problems generally become more severe as one moves west in the parklands from eastern Saskatchewan into Alberta”.

In the Rumsey Block of central Alberta, an area supporting grasslands dominated by plains rough fescue (*Festuca hallii*), vegetation inventories of six gas well sites abandoned five to thirteen years previously found fair to poor establishment of native species and invasion into native grasslands of non-native species used in reclamation (Integrated Environments Ltd., 1991). Revegetation by native species of two pipeline right-of-ways was more promising. Rough fescue in reclamation seed mixes had not become established. The author of the study also observed that cattle concentrated on the disturbed sites and that cattle management should be a key aspect of revegetation programs.

Efforts to restore native rough fescue prairie are being attempted by industry in Alberta and some are being monitored. Examples of projects where restoration has or is being attempted include exploratory well sites in the Rumsey Heritage Rangeland, the Express pipeline in southeast Alberta and EnCana’s gas field development south of the Cypress Hills in Alberta and Saskatchewan.
Documentation of the progress of these efforts is not available. A report describing 5-year monitoring results of the Express Pipeline reclamation program, required by the National Energy Board as a condition of project approval, is expected to be available in Fall, 2002 (J. Lancaster, pers. comm.).

### 4.1.2 Invasion of Native Prairie by Non-Native Species from Disturbances

An environmental impact of the proposed project is invasion of non-native species into native vegetation. Scientific literature documents rapid invasion by non-native species and displacement of native species in many grasslands of western North America and elsewhere (Mack 1989). Grasslands dominated by bunch grasses, such as rough fescue, are particularly susceptible. Soil disturbance, water enrichment and increased fertility provide a competitive advantage to invasive non-native species over many native grassland species (McIntyre and Lavorel, 1994). One of the most relevant scientific papers for this proposed project is a study in Glacier National Park, Montana (Tyser and Worley, 1992). The study found alien species invasion of ungrazed rough fescue grasslands up to 100 metres from both paved two-lane roads and unimproved dirt roads, with further invasion anticipated over time. Management recommendations by these researchers are to avoid road-building in bunch grass communities and to intensively monitor and manage alien flora where roads already exist.

### 4.1.3 Survey of Non-Native Plant Species Invasion along the Access Road to 11-25-17-3 W5M

Past disturbance provides the setting for investigation of non-native plant species invasion in the project area. On July 19, 2002 and September 8, we conducted surveys of non-native vascular plant species along the route used in 1980 to access a wellsite in 11-25-17-3 W5M. The first two kilometers of the route were unreclaimed and the last kilometer was partially reclaimed. The purpose of the survey was to determine non-native species occurring along the access route, their frequency of occurrence and the width of the vegetation corridor along the access route that has significant cover of non-native species. Methods and results of this survey follow.
Fig. 4-1  1980 well site. Arrows indicate clearly discernable vegetative boundaries more than 20 years after disturbance (15 July 2002). © M. Quinn

Fig. 4-2  Existing road cut showing cut (blue arrow) and fill with substantial exotic species encroachment and down hill side (red arrow) (15 July 2002). © M. Quinn
Fig. 4-3  Existing road to proposed well site – note exotic vegetation encroachment on down slope side of the road (15 July 2002).
© M. Quinn
On July 19, five sites were sampled at regular intervals along the first 1.5 km of the access road. The first site was ~50 m west of the gate on the east boundary of Section 25. Each additional site was 500 paces or ~350 metres beyond the previous one. Sites are indicated on Map 6. Landform, topographic position, elevation (estimated from 1:50,000 topo map 82J8), slope, aspect, moisture and drainage were described for each site using standard field methods and categories developed for ecological land classification in Alberta. At each site two 50 metre x 1 metre transects were run perpendicular to the road and in opposite directions. If a predominantly non-native vegetation type extended beyond the 50-metre point, transects were extended until predominantly native vegetation was encountered. The starting point of each transect was the centre of the road. Two photographs were taken of each transect. Vegetation types encountered along each transect were placed into four categories according to the percent of non-native species cover (<10% non-native, 10-25% non-native, 25-50% non-native, and 50-100% non-native). Dominant species with >10% cover were noted for each vegetation type. Taxonomy is according to Moss and Packer (1983). All non-native species encountered along transects were noted. Notes were made on land use and disturbance. Beyond the last transect, surveyors continued to walk the access route to the old well site and took photographs and notes regarding vegetation.

On September 19, the 1-km stretch of the access road closest to the wellsite was surveyed in more detail. Ten transects oriented perpendicular to the road and at intervals of 100 m were surveyed. For each transect the zone of vegetation with >25% non-native species cover was measured and non-native species along each transect were noted.
Nineteen non-native plant species were encountered at five sites (ten transects) along the unreclaimed road (Table 4-2). Twelve non-native plant species were encountered on ten transects along the reclaimed road (Table 4-3). Twenty non-native plant species in total were identified on transects.

Table 4-2  List of Non-Native Species and Frequency of Occurrence on Transects along the Unreclaimed Portion of 1980 Wellsite Access (transects spaced at 350 m intervals; 19 July 2002)

<table>
<thead>
<tr>
<th>Species</th>
<th>1 A</th>
<th>1 B</th>
<th>2 A</th>
<th>2 B</th>
<th>3 A</th>
<th>3 B</th>
<th>4 A</th>
<th>4 B</th>
<th>5 A</th>
<th>5 B</th>
<th>Freq. of Occur.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Agropyron pectiniforme</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td></td>
<td></td>
<td></td>
<td>100%</td>
</tr>
<tr>
<td>Crested Wheat Grass</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Cirsium arvense</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td></td>
<td></td>
<td></td>
<td>X</td>
<td></td>
<td></td>
<td></td>
<td>80%</td>
</tr>
<tr>
<td>Canada Thistle</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Phleum pretense</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td></td>
<td>X</td>
<td>X</td>
<td></td>
<td>80%</td>
</tr>
<tr>
<td>Timothy</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Poa pratensis</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>70%</td>
</tr>
<tr>
<td>Kentucky Bluegrass</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Bromus inermis</td>
<td>X</td>
<td>X</td>
<td></td>
<td>X</td>
<td></td>
<td></td>
<td>X</td>
<td></td>
<td></td>
<td></td>
<td>50%</td>
</tr>
<tr>
<td>Awnless Brome</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Elymus junceus</td>
<td>X</td>
<td>X</td>
<td></td>
<td>X</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>30%</td>
</tr>
<tr>
<td>Russian Wild Rye</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Cirsium vulgare</td>
<td>X</td>
<td></td>
<td>X</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>30%</td>
</tr>
<tr>
<td>Bull Thistle</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Tragopogon dubius</td>
<td>X</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>30%</td>
</tr>
<tr>
<td>Common Goat’s-beard</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Monolepis nuttalliana</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>X</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>20%</td>
</tr>
<tr>
<td>Spear-leaved Goosefoot</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Medicago sativa</td>
<td>X</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>20%</td>
</tr>
<tr>
<td>Alfalfa</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Artemesia dracunculus</td>
<td>X</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>10%</td>
</tr>
<tr>
<td>Dragonwort</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Axyris amaranthoides</td>
<td>X</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>10%</td>
</tr>
<tr>
<td>Russian Pigweed</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Chenopodium album</td>
<td>X</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>10%</td>
</tr>
<tr>
<td>Lamb’s-quarters</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Cirsium vulgare</td>
<td>X</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>10%</td>
</tr>
<tr>
<td>Bull Thistle</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Festuca pratensis</td>
<td>X</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>10%</td>
</tr>
<tr>
<td>Meadow Fescue</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Lappula squarrosa</td>
<td>X</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>10%</td>
</tr>
<tr>
<td>Bluebur</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Polygonum monspeliense</td>
<td>X</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>10%</td>
</tr>
<tr>
<td>Knotweed</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Sonchus uliginosus</td>
<td>X</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>10%</td>
</tr>
<tr>
<td>Perennial Sow Thistle</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Bradley, Quinn & Duke  DRAFT 17 September 2002  47
Table 4-3  List of Non-Native Species and Frequency of Occurrence on Transects along Reclaimed Portion of the 1980 Wellsite Access  
(transects spaced at 100 metre intervals; 8 September 2002)

<table>
<thead>
<tr>
<th>Species</th>
<th>1</th>
<th>2</th>
<th>3</th>
<th>4</th>
<th>5</th>
<th>6</th>
<th>7</th>
<th>8</th>
<th>9</th>
<th>10</th>
<th>Freq. of Occur.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Agropyron pectiniforme</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td>90%</td>
</tr>
<tr>
<td>Crested Wheat Grass</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Cirsium arvense</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td>90%</td>
</tr>
<tr>
<td>Canada Thistle</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Bromus inermis</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>X</td>
<td>70%</td>
</tr>
<tr>
<td>Awnless Brome</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Poa pratensis</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td>70%</td>
</tr>
<tr>
<td>Kentucky Bluegrass</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Chenopodium album</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>X</td>
<td>50%</td>
</tr>
<tr>
<td>Lamb’s-quarters</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Thlaspi arvense</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td>40%</td>
</tr>
<tr>
<td>Stinkweed</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Tragopogon dubius</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>X</td>
<td>40%</td>
</tr>
<tr>
<td>Common Goat’s-beard</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Phleum pratense</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td>30%</td>
</tr>
<tr>
<td>Timothy</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Elymus junceus</td>
<td>X</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>20%</td>
</tr>
<tr>
<td>Russian Wild Rye</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Erucastrum gallicum</td>
<td></td>
<td>X</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td>20%</td>
</tr>
<tr>
<td>Dog Mustard</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Lappula squarrosa</td>
<td>X</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>20%</td>
</tr>
<tr>
<td>Bluebur</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Taraxacum officinale</td>
<td>X</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>10%</td>
</tr>
<tr>
<td>Common Dandelion</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

A brief summary of the frequency of occurrence, cover and invasiveness of individual species follows. Notes also are provided on use by livestock and for reclamation of disturbed areas.

Crested wheat grass (Agropyron pectiniforme) occurred on all but one transect. Our observations suggest that this species was seeded in the 1980s along the entire route to stabilize bare ground exposed during road construction, as it is predominantly on areas that were disturbed in grading the road. Crested wheat grass was a species commonly used in reclamation at the time. Invasion by crested wheat grass into areas where it was not seeded has occurred. Crested wheat grass was a dominant species (>10% cover) in vegetation along eight transects extending to a distance of 7 to 26 metres from the unreclaimed road centre. Patches were observed as far as 40 metres from the road. Crested wheat grass also persists along most of the reclaimed route leading north and then east to the old wellsie and was observed as far as 30 metres from the road. Although used extensively in the past for reclamation because of its drought and cold tolerance, crested wheat grass no longer is favoured because of its ability to replace more desirable native grasses and possible detrimental effects on soil in that it adds little or no organic matter (Tannas, 1998). Crested wheat grass is grazed by livestock in early spring, but becomes unpalatable by mid-summer.

Canada thistle (Cirsium arvense) was encountered on 17 of 20 transects. The
transects along which it did not occur were the most xeric of the sites sampled. Where it was observed it was not considered dominant (i.e. >10% cover). Canada thistle is designated as a noxious weed in Alberta. It is common along roads and trails and in cultivated fields and can invade heavily grazed pastures on mesic sites. Canada thistle is very persistent and difficult to control. It is unpalatable to livestock (Tannas 1998).

Kentucky bluegrass (*Poa pratense*) occurred on 16 of 20 transects and usually was a dominant species where it did occur. It occurs in association with buckbrush and common wild rose as well as with smooth brome on more low-lying sites. Transects along which it was not found were the driest of those surveyed. Kentucky bluegrass is thought to have both native and introduced elements in Alberta. It is an aggressive invader and can completely replace more desirable native grasses, especially in foothills rough fescue grasslands that are fragmented or overgrazed. Kentucky bluegrass is not recommended as a reclamation species because of its invasive and persistent nature. Although nutritious and palatable in early spring, Kentucky bluegrass plants rapidly become unattractive to livestock. Kentucky bluegrass does not cure on the stem, unlike many native grass species in the foothills rough fescue grasslands, hence makes poor quality fall and winter pasture (Tannas 1998).

Awnless brome (*Bromus inermis ssp inermis*) was encountered on 12 of 20 transects. It tends to occur in patches and was found up to 25 metres of the unreclaimed road centre. Awnless brome also was observed to dominate low-lying meadows along the little used sections of the road running north and then east to the old well site. It together with common wild rose (*Rosa woodsii*) was the dominant vegetation on the old well site, suggesting it may have been seeded there during reclamation. Awnless brome can spread from disturbed sites by rhizomes and seeds into native vegetation where there is sufficient moisture. It is described as “an aggressive invader of prairie dominated by plains rough fescue” (Grilz and Romo 1995). Awnless brome tolerates high levels of utilization, making replacement by former dominants very difficult (Thompson and Hansen, 2002). Like timothy and Kentucky bluegrass, its protein content and digestibility for livestock drop rapidly by mid summer. Because of its invasive and persistent qualities, awnless brome is not recommended for reclamation. A native subspecies of the introduced awnless brome – northern awnless brome (*Bromus inermis ssp pumpellianus*) – which has hairy stems and heads, also was observed along some transects. The two subspecies are known to hybridize when growing in close association. The native northern awnless brome shows a similar ability to readily revegetate disturbances, but once established is much less invasive (Tannas 1998).

Timothy (*Phleum pretense*) was encountered on 11 of 20 transects. It occasionally dominated the plant community. Timothy usually is associated with mesic lower slopes and slight depressions where it grows together with Kentucky bluegrass and awnless brome. Timothy is a prolific seed producer that establishes readily on disturbances and encroaches into rangeland especially on mesic sites (Tannas 1998). It has been used extensively for erosion control and
soil stabilization in Alberta, but because of its invasive and persistent nature is no longer recommended for this purpose, especially when reclaiming sites in the foothills rough fescue grasslands. The protein content of timothy is high in early spring, but it drops rapidly making poor quality fall and winter pasture. Native species are considered to provide better quality forage for livestock in foothills rough fescue grasslands (Tannas 1998).

Russian wild rye (Elymus junceus) was encountered on 5 of 20 transects where it was a dominant species in vegetation within 10 m of the road centre. It was found up to 35 m from road centre along the reclaimed road. It occurs together with crested wheat grass and likely was seeded along the road in an attempt to stabilize soil disturbed during road construction. Russian wild rye is considered to be persistent, but not invasive (Tannas 1998). Russian wild rye is palatable for livestock from early spring to fall and it maintains some nutritional value through winter (Tannas 1998).

Fourteen additional non-native species were found all which occurred on less than half of transects and were not considered dominant species. Of these species, eight are annuals or biennials relying on annual seed production and exposed seed beds to persist. They include stinkweed (Thlaspi arvense), spear-leaved goose foot (Monolepis nuttalliana), Russian pigweed (Axyris amaranthoides), lamb’s quarters (Chenopodium album), bull thistle (Cirsium vulgare), bluebur (Lappula squarrosa), knotweed (Polygonum monspeliense) and dog mustard (Erucastrum gallicum). These species mostly were observed on or near the road, on microsites where bare soil was exposed due to recent disturbance such as rodents burrowing or cattle loafing. Perennial non-native species observed along the road and not considered abundant were common dandelion (Taraxacum officinale), common goat’s beard (Tragopogon dubius), alfalfa (Medicago sativa), dragonwort (Artemesia dracunculus), meadow fescue (Festuca pratensis) and perennial sow thistle (Sonchus uliginosus).

Table 4-4 provides information on the relative occurrence on transects along the unreclaimed road of four vegetation classes based on percent of non-native species cover - <10%, 10-25%, 25-50% and 50-100%. Figures 4-4 through 4-9 illustrate the extent of non-native species encroachment observed along transects.

<table>
<thead>
<tr>
<th>Vegetation Class (% Non-Native Species Cover)</th>
<th>Length of Transect Occupied by Cover Class (metres)</th>
<th>Total m/%</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>1A</td>
<td>1B</td>
</tr>
<tr>
<td>100-50%</td>
<td>22.5</td>
<td>33.0</td>
</tr>
<tr>
<td>50-25%</td>
<td>5.0</td>
<td>5.0</td>
</tr>
<tr>
<td>25-10%</td>
<td>10.0</td>
<td>0</td>
</tr>
<tr>
<td>&lt;10%</td>
<td>12.5</td>
<td>12.0</td>
</tr>
<tr>
<td></td>
<td>50.0</td>
<td>50.0</td>
</tr>
</tbody>
</table>
Fig. 4-4  Vegetation dominated by Crested Wheat Grass (*Agropyron pectiniforme*) and Russian Wild Rye (*Elymus junceus*) along portion of 1980 well site access road – Site 7, Winter Range, 19 July 2002.

© Cheryl Bradley
Crested Wheat Grass (*Agropyron pectiniforme*) has invaded up to 40 m from the existing access road – Transect 4B, Winter Range, 19 July 2002. © Cheryl Bradley
Fig. 4-6  Crested Wheat Grass (*Agropyron pectiniforme*) persists up to 9 m from existing access road – Transect 2A, Winter Range, 19 July 2002. © Cheryl Bradley
Fig. 4-7  Russian wild Rye (*Elymus junceus*) persists up to 5 m from existing access road – Transect 5A, Winter Range, 19 July 2002.
© Cheryl Bradley
Fig. 4-8  Smooth Brome (*Bromus inermis*) and Kentucky Blue Grass (*Poa pratensis*) extend 17 m from existing access road. Crested Wheat Grass (*Agropyron pectiniforme*) persists along road – Transect 1A, Winter Range, 19 July 2002. © Cheryl Bradley
Fig. 4-9  Prickly Rose (Rosa acicularis) and Smooth Brome (Bromus inermis) on old well site – Site 12, Winter Range, 19 July 2002.  © Cheryl Bradley
One-third (33%) of the vegetation within 50 metres of the unreclaimed road has less than 10% cover of non-native species cover. These native vegetation types are on drier sites or on mesic sites generally furthest from the road and dominated by various combinations of rough fescue (Festuca campestris), Idaho fescue (Festuca idahoensis), Parry’s oatgrass (Danthonia parryi), western wheatgrass (Agropyron smithii), awned wheatgrass (Agropyron trachycaulum), Columbia needle grass (Stipa columbiana), green needle grass (Stipa viridula), June grass (Koeleria macrantha), inland bluegrass (Poa interior) and thread-leaved sedge (Carex filifolia).

Thirteen percent of the vegetation within 50 metres of the road has 10-25% cover of non-native species cover. Grassland communities with this proportion of non-native species are classified as native by ecologists and as potential natural community by range managers (Achuff et. al 2002, Adams 2002). These communities would be expected to retain their native character provided there is no additional disturbance to threaten native bunchgrasses.

Seventeen percent of vegetation within 50 metres of the road has 25-50% cover of non-native species. Grassland communities with this proportion of non-native species cover are generally not considered native for the purposes of ecological land classification (Achuff et al., 2002). Protected areas managers would focus management activities to prevent further invasion of non-native species on these communities. Range managers would consider grassland communities with this proportion of non-native species cover as recoverable to potential natural community with appropriate management (Adams et al., 2002).

Thirty-seven percent of vegetation within 50 metres of the road has greater than 50% cover of non-native species. These vegetation types are dominated by various combinations of crested wheat grass (Agropyron pectiniforme), Russian wild rye (Elymus junceus), awnless brome (Bromus inermis), timothy (Phleum pratense) and Kentucky bluegrass (Poa pratensis). It is debatable whether these communities can be recovered to native condition. Depending on site conditions and opportunity for altering management practices, range managers may classify these as permanently ‘modified’ grassland communities which no longer can be expected to revert to potential natural community (Adams et al., 2002).

The mean extent of non-native vegetation (>25% non-native species cover) from the road centre based on transect data is 35.8 m (± 23.1 m). Although not precise, this data suggests that 70 metres is the average width of the corridor of non-native vegetation along the access road. Along the reclaimed portions of the access road, plant communities dominated by non-native plant species extend from 6 m to over 50 m from apparent road centre. The corridor is widest on lower slopes and in valley bottoms. Average corridor width of non-native vegetation (>25% non-native species cover) along ten transects is at least 50 m.
Table 4-5  Extent of vegetation with >25% non-native species cover from road centre

<table>
<thead>
<tr>
<th>Transect #</th>
<th>1A</th>
<th>1B</th>
<th>2A</th>
<th>2B</th>
<th>3A</th>
<th>3B</th>
<th>4A</th>
<th>4B</th>
<th>5A</th>
<th>5B</th>
</tr>
</thead>
<tbody>
<tr>
<td>Maximum Extent of vegetation with &gt;25% non-native cover (m)</td>
<td>37.5</td>
<td>67.0</td>
<td>9.0</td>
<td>13.0</td>
<td>60.0</td>
<td>64.0</td>
<td>55.0</td>
<td>36.0</td>
<td>11.0</td>
<td>6.0</td>
</tr>
</tbody>
</table>

Mean = 35.8
Std. Dev. = 23.1

In the absence of information on vegetation prior to road construction and on reclamation techniques, it is not possible to discern what proportion of non-native species invasion is attributable to road construction. An agrologist hired by the proponent states: “This road is rife with crested wheatgrass, quack grass, rye grass, and brome grass, all weeds or agronomic species not native to the area. They likely exist due to activity from cattle, horses, or trucks regularly on the roadway.” (letter from Robert Berrien, Berrien Associates Ltd., to Brian O’Ferrall, McLennan Ross, dated August 15, 2002). Our conclusion based on the observed distribution of non-native species is that crested wheat grass, Russian wild rye and probably awnless brome were planted on areas disturbed in grading and reclaiming the wellsite and the road in the early 1980’s and have since persisted and invaded native vegetation communities. Some aggressive non-native species such as Kentucky bluegrass, timothy and awnless brome may already have been present in the vicinity, however it is likely that surface disturbance from road construction contributed to their spread, especially into moister sites. Non-native annual species may have been introduced by road construction and reclamation activities, which also exposed bare ground for their establishment, or by subsequent vehicular use of the road. When summer grazing occurred in the area, cattle may also have been attracted to green vegetation on disturbed sites adjacent to the road, and contributed to persistent destabilization and non-native species invasion.

There is evidence that livestock can introduce non-native species to native environments, particularly plant species found in hay such as Kentucky bluegrass, timothy and clover. A vegetation and range resource inventory for the Winter Range grazing lease found sites with gentle or no slope and often near water (about 30% of the area) were “generally invaded by Kentucky Bluegrass and Timothy or had a high proportion of weedy species such as Canada Thistle” (High Range Ecological Consultants, 1997). Past (historic) grazing practices were blamed in part although it was pointed out that a recent shift to dormant season grazing was improving range condition in these sites. Researchers in Glacier National Park, Montana note “unexpectedly high levels of alien species richness” in areas used by concession horses currently or in the past (Tyser and Worley 1992). A management recommendation by these researchers is to quarantine livestock feeding on hay to allow seeds in manure to be expelled prior to use of
nature reserves.

There is, however, also ample evidence that soil disturbances contribute to invasion of native vegetation by non-native species whether livestock are present or not. Researchers of alien species invasion into ungrazed grasslands from roads in Glacier National Park, Montana note “…*Phleum pratense* [timothy] and *Poa pratensis* [Kentucky bluegrass] being particularly common in most of the study sites. In sites adjacent to primary and secondary roads, alien species richness declined out to the most distant transect [100 m], suggesting alien species are successfully invading grasslands from the roadside areas.” (Tyser and Worley 1992). Management recommendations by these researchers are to avoid road-building in bunch grass communities and to intensively monitor and manage alien flora where roads already exist. Additionally, minutes of a joint meeting among members of the Alberta Prairie Conservation Forum and the Saskatchewan Prairie Conservation Action Plan Committee in June 2002 state “The encroachment of invasive agronomic species and weeds onto native prairie remains a serious threat. Weeds and land disturbance are seen to be greater threats than poor range management.”
4.2 Ecological Effects on Selected Wildlife Species (with an Emphasis on Linear Disturbance)

In a review of wildlife impacts resulting from petroleum exploration and development along the Rocky Mountain Overthrust Belt, Bromley (1985) concludes that:

The presence of human-associated structures and facilities (buildings, roads, pipelines, transmission lines) will increase. Substantial human intrusion into wildlife habitat will result from (1) activities directly related to oil field operations and (2) secondary activities related to the resultant increases in access and population. Traffic will increase significantly. There will be a greater demand on wildlife and its habitat for recreational purposes. Sociological data indicate that energy-development-related workers have a higher demand for outdoor recreation, especially hunting and fishing, and use of recreational vehicles, and therefore a greater potential for increasing impacts on wildlife, than do resident populations in development areas (Streeter and others 1979). Effects from secondary activities may be greater in the long term than those from development itself. (p. 8)

The effect of any disturbance on wildlife is complex and multivariate. Tables 4-6 & 4-7 summarize some of the primary and secondary effects to be considered when wildlife habitat is altered. For relatively intact areas, it is the presence of roads and other linear features that may be the most significant; especially in the long term. Wisdom et al. (2000) identified more than 65 species of terrestrial vertebrates negatively affected by many factors associated with roads in the interior Columbia Basin, USA. A review by Gucinski et al. (2001) concludes: “no terrestrial vertebrate taxa seem immune to the myriad of road-associated factors that can degrade habitat or increase mortality.” (p. 34). This section of the report comprises a review of linear disturbance effects on selected wildlife species from the project area.
Fig. 4-10  Pipeline construction occurring southeast of the proposed wellsite in 2002 illustrates the temporary impediment to wildlife movement. © M. Quinn

Table 4-6  Primary wildlife impacts potentially resulting from environmental disruptions (adapted from Bromley 1985).

<table>
<thead>
<tr>
<th>Primary Impact</th>
<th>Environmental Disruption</th>
</tr>
</thead>
<tbody>
<tr>
<td>Interruption / alarm / flight</td>
<td>✔</td>
</tr>
<tr>
<td>Avoidance / displacement</td>
<td>✔</td>
</tr>
<tr>
<td>Perm. loss of habitat use</td>
<td>✔</td>
</tr>
<tr>
<td>Decr. Reproductive success</td>
<td>✔</td>
</tr>
<tr>
<td>Interference with movement</td>
<td>✔</td>
</tr>
<tr>
<td>Direct mortality</td>
<td>✔</td>
</tr>
<tr>
<td>Interference with courtship</td>
<td>✔</td>
</tr>
<tr>
<td>Alteration of behaviour</td>
<td>✔</td>
</tr>
<tr>
<td>Change in community</td>
<td>✔</td>
</tr>
</tbody>
</table>
Table 4-7  Secondary impacts which may occur as consequences of primary impacts (adapted from Bromley 1985).

<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Decr use of habitat</td>
<td>✓</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Shift in range</td>
<td>✓</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Change in distribution</td>
<td>✓</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Overuse of adjacent habitat</td>
<td>✓</td>
<td>✓</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Use of marginal hab.</td>
<td>✓</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Range abandonment</td>
<td>✓</td>
<td>✓</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Inefficient hab. use</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Mortality</td>
<td>✓</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Decr feeding efficiency</td>
<td>✓</td>
<td>✓</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Change in act. patterns</td>
<td>✓</td>
<td>✓</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Interference with movmt</td>
<td>✓</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Decr food availability</td>
<td>✓</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>✓</td>
</tr>
<tr>
<td>Inadequate nutrition</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>✓</td>
</tr>
<tr>
<td>Decr energy for migration</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>✓</td>
</tr>
<tr>
<td>Pop’n reduction</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>✓</td>
</tr>
<tr>
<td>Physiological effects</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>✓</td>
</tr>
<tr>
<td>Disrupt social structure</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>✓</td>
</tr>
<tr>
<td>Reduced repro success</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>✓</td>
</tr>
<tr>
<td>Nest/den desertion</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>✓</td>
</tr>
<tr>
<td>Decr breeding sites</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>✓</td>
</tr>
<tr>
<td>Delay/failure to den</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>✓</td>
</tr>
<tr>
<td>Den displacement</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>✓</td>
</tr>
<tr>
<td>Decr juv survival</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>✓</td>
</tr>
<tr>
<td>Incr use alternate nests</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>✓</td>
</tr>
<tr>
<td>Decr aquatic productivity</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>✓</td>
</tr>
<tr>
<td>Human injury/property damage</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>✓</td>
</tr>
<tr>
<td>Delay/failure to reach traditional range</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>✓</td>
</tr>
<tr>
<td>Ease of travel</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>✓</td>
</tr>
<tr>
<td>Incr. predation</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>✓</td>
</tr>
<tr>
<td>Interference with mating synchrony</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>✓</td>
</tr>
</tbody>
</table>
When considering the impacts of a well site, it is important to consider the impacts from all associated linear disturbances. Linear disturbances can be defined as features on the landscape (both linear and point features) that alter natural habitat. In relation to the area of interest, these disturbances include well sites, well site access roads, pipelines and seismic lines. Recognizing the importance of cumulative impacts of well sites, the total amount of land that is disturbed is less important than the recognition that individual well sites each contribute to a total amount of land or linear disturbance (Creasy 1998). These disturbances can have a considerable negative effect on wildlife populations.

The Pekisko Creek valley and associated Uplands have been identified as important habitat for ungulate species including moose and elk. This area also serves as an important regional movement corridor for large carnivores (grizzly bear, wolf and mountain lion) linking the Rocky Mountain Cordillera and the Northern United States. The following summary is taken primarily from Jalkotzy et al. (1998) with additional references as indicated (see also reviews by Bennett 1991 and Gucinski et al. 2001).

The effects of linear disturbance on wildlife can include individual disruption, habitat avoidance, habitat disruption, direct and indirect mortality, and population effects. The presence or absence of any particular effect is dependent on the species of wildlife and type of linear disturbance. The disturbance itself or activities associated with the disturbance often result in wildlife leaving the disturbed area or altering patterns of use, responses that carry with them costs in terms of energy expenditure and possibly lost opportunities. Linear disturbance and activities associated with them may lead to wildlife avoiding habitats close to the disturbance, resulting in habitat loss in the vicinity of the disturbance.

Fragmentation of the landscape may occur if avoidance of linear disturbances prevents wildlife from fully utilizing land on either side or surrounding a disturbance. Habitat fragmentation has many deleterious effects including insularization, reduced population viability, increased edge effects and loss of genetic variability (Wilcox and Murphy 1985, Hobbs 1993, Ims et al. 1993, McNally and Bennet 1996, Oehler and Litvaitis 1996, Burkey 1997). Over time, these processes may result in the loss of biological diversity and eventually, local extinctions (Wilcox and Murphy 1985, Swart and Lawes 1996). The effects of habitat fragmentation are particularly evident in areas that are heavily influenced by human activity, where habitat persists in patches within heterogenous landscapes.

In the short term, restricted movements, resulting from habitat fragmentation can have negative impacts on populations and ecosystem functions. In the long term, restricted movements can reduce gene flow and have negative impacts on metapopulations and species. To maintain biodiversity and ecosystem functions in both the long and short term it is necessary to maintain habitat connectivity so the individual animals can move across the landscape.
railways, trails and other linear developments often reduce or eliminate animal movements and habitat connectivity.

To maintain biodiversity and ecosystem function it is necessary to preclude linear disturbance in the few areas of today’s landscapes that are still relatively undisturbed. As the human population expands in southern Alberta and vehicle traffic along transportation corridors increases, adjacent land is being developed and human access to previously remote and inaccessible lands is increasing. This exemplifies the importance of preserving intact tracts of land.

Of all linear disturbances that humans create, roads probably have the greatest impact on wildlife populations. The most important effects are direct and indirect mortality and the loss of habitat effectiveness as a result of habitat avoidance in the vicinity of linear disturbances. Roads also impact wildlife by increasing human access to areas or by creating barriers to wildlife movement. Direct mortality is most often associated with high volume roads. Indirect mortality is typically associated with human access.

In the Pekisko Uplands region, roads primarily impact wildlife by providing increased human access to the area. The building of roads and provision of increased human access to wildlife habitats has been identified as having negative effects on many species. Wildlife populations that are subjected to hunting and trapping sustain increased mortalities as a result of better human access (e.g., grizzly bears, black bears, wolves, cougars, elk, deer and moose). Typically, hunted wildlife populations exhibit stronger disturbance reactions to roads than do wildlife in protected areas.

Other sources of indirect mortality include poaching and management actions (elk, deer, grizzly bears, cougars, wolves). Increased predation arising from carnivore use of corridors is an indirect cause of mortality for many prey species (e.g., wolves and caribou in winter).

The effects of trails, pipelines, and seismic lines on wildlife are similar in nature to those of roads. However, effects tend to be less significant for these smaller disturbances since their physical attributes are less disruptive (e.g., narrower rights-of-way, increased curvilinearity of trails) and human use rates are often lower.

Pipelines under construction may be significant filters to ungulate movement. Elk, moose, and deer have been documented to have difficulties crossing welded pipe strings when they were left above ground on blocks prior to burial. Visibility across the right-of-way and the number of pipes, berms, and ditches appeared to be the major factors affecting the willingness of all ungulates to cross these disturbances. Conversely, completed buried pipelines, seismic lines, and trails were not significant filters to wildlife movement.

Wildlife will frequently avoid habitats in the vicinity of roads and similar linear disturbances because of repeated disturbances along the corridor or as a result
of the death of less wary animals. Habitat avoidance may also occur in the vicinity of trails, cutlines, and seismic lines, although wildlife appears to avoid these smaller disturbances less than roads. The degree of avoidance is species-specific. Zones of influence used in cumulative effects models for grizzly bears range from 200 to 1,600 m for areas with hiding cover, and 800 to 3,200 m for open habitats. Black bear avoidance of open roads appears to be less than that of grizzlies. Habitat avoidance in the vicinity of linear developments has not been reported as frequently for wolves as for bears. However, the avoidance of open roads by wolves can be inferred from the absence of wolves in landscapes with road densities >0.6 km/km². Cougars may also avoid areas with higher road densities when establishing home ranges.

Population effects have been identified in wildlife populations that suffered losses directly attributable to linear disturbances. Historically, mountain goat and caribou population declines due to overhunting have been linked to access. In the Greater Yellowstone Ecosystem, grizzly bears probably suffered significant demographic consequences as a result of indirect mortality. In the Swan Mountains of Montana, grizzly bear mortality associated with road access and unnatural food sources, in conjunction with natural mortality, inhibited population growth. Population effects have been documented frequently among bird species in the vicinity of linear developments. Since demographic parameters of many wildlife populations are not known, whether mortalities related to roads are causing significant population effects are also not known.

Most regions are affected by development and linear disturbance to some degree and in many cases disturbance to wildlife occurs as a result of many different factors. The effects of human disturbance tend to accumulate within landscapes. Cumulative effects assessment (CEA) and geographic information systems (GIS) have been used as powerful tools in assessing the cumulative impacts of linear developments on wildlife. New CEA techniques and the use of GIS for analysis will provide better ways of assessing the effects of linear developments on wildlife.

Since the detrimental effects of linear disturbances may accrue in wildlife populations without generating obvious population responses (e.g., precipitous declines), regional planning in the future may require that different interests use regions or landscapes in a staggered fashion. By reducing the levels of human use in a landscape over a given period, the deleterious cumulative effects of several disturbance activities occurring at the same time can be avoided. This staggering of use should include public access. Public access for recreational purposes, particularly hunting, probably results in the most detrimental disturbance effects of development corridors.

**Grizzly Bear.** Mineral and gas exploration forms an important disturbance type for grizzly bears, primarily through associated road development (McLellan and Shackleton 1989, McLellan 1990). Grizzly bears may be vulnerable to individual disruption arising from construction, maintenance, and use of linear...
developments. Linear developments may result in habitat avoidance for grizzly bears. Grizzly bear studies have determined that zones of influence for grizzly bears for habitats that offer cover include: 0.8km for low-use motorized roads, 1.6km for low-use motorized point features and 0.5km for low use non-motorized roads. Of more significance for the study area in question are habitats that offer reduced cover, these zones of influence include the following: 3.2km for low use motorized roads, 3.2 km for low intensity motorized point features and 0.8 km for non-motorized low use roads.

Road use by humans may also disrupt bear behaviour and social structure, reduce the availability of adjacent foraging habitats and create barriers to movement (Archibald et al. 1987, McLellan and Shackleton 1988, McLellan 1990). These effects may extend up to 3km from primary roads and 1.5 km from secondary roads (Kasworm and Manley 1990, Mattson and Knight 1991).

Trails used by motorized off-highway vehicles are presumed to have the same effects on grizzly bears as roads. In northwest Montana, grizzlies avoided habitats within 274m of trails. Overall, trails displaced grizzly bears less than roads did in this study. In the Swan Mountains, Montana, grizzlies were found significantly further than expected from trails during spring, summer, and autumn. These authors concluded that grizzly bears using the hiking area have become negatively conditioned to human activity occurring within and outside the area, and that they minimized their interaction with recreationists by spatially avoiding high use areas.

Grizzly bear habitat may be disrupted by industrial developments, including roads and pipelines. There is, obviously, a direct and complete loss of habitat associated with the structure of a road or other linear development. Soil and vegetation disturbance during construction of roads may reduce habitat quality. Intensive vegetation management on hydroelectric rights-of-way may also reduce habitat quality. As with roads, trails involve physical alteration of bear habitat, although the relatively narrow width of most trails means that less habitat is directly affected than by roads.

Roads and other linear developments may serve as travel corridors for grizzlies. Use of roads as travel routes may lead bears into developed areas with increased risk of negative interactions with humans. Linear developments like roads generally lead to increased indirect mortality for grizzlies. Many authors have identified shooting mortality in grizzly bear populations that are related to roads or other industrial access. In an Alberta study, 75% of all bear mortalities occurred within 1 km of all weather roads.

Although direct mortality of grizzly bears from roads has been documented, the most important effects of roads on grizzly bears are: (1) loss of habitat effectiveness because of bears avoiding the disturbance associated with roads, and (2) shooting mortality facilitated by the development of new access routes for hunters and others with firearms.
Black Bear. In ways very similar to grizzly bears, black bears are subject to the same realm of effects from linear developments. Many of the effects and considerations described for the grizzly bear (see above) are directly applicable to black bears, and will not be repeated here. Construction of roads, pipelines, powerlines, and other linear developments normally generates some degree of habitat disruption, at least temporarily. Significantly, however, habitat may be enhanced (at least temporarily) for black bears. Researchers have documented the importance to black bears of seeded crops used to revegetate road and pipeline rights-of-way in Alberta. They speculated that this habitat manipulation contributed to range expansion by black bears in areas. It has also been reported that black bears have benefited from early-successional vegetation induced by roadside cutting and pipeline construction. The effects of habitat enhancement, however, may be offset by increased mortality if access control is not invoked.

Some researcher have felt that the secondary effects of industrial activities, including development of new roads, increased bear hunting, and human habituation, would have greater negative impacts on a black bear population in northeastern Alberta than would the primary effects of habitat alteration and loss.

Wolf. Roads, by increasing human access, have been shown to negatively affect wolf populations at local, landscape and regional scales. At local scales, this disturbance can be measured as the distance from roads: an avoidance zone of 500m to 5 km has been documented. Road density is a relevant index to human disturbance at regional and landscape levels (Mladenoff et al. 1995). Studies have shown a strong relationship between road density and absence of wolves. Wolves have been documented to avoid areas where the density of roads exceeded 0.58km/km2 (Thiel 1985, Mech et al. 1988, Fuller 1989). Road density has been documented to be much lower in pack territories (0.23km/km2 in 80% use area) than in random nonpack areas (0.74km/km2). High road densities may constitute a barrier to wolf dispersal (Jensen et al. 1986).

Wolf packs have large home ranges and cover vast amounts of area in their daily excursions for food and shelter. Dispersing wolves also travel large distances to find new territories and mates. These regional movements often require forays into areas that experience high levels of human disturbance with road densities approximating the threshold for wolves. This exemplifies the importance of maintaining intact landscapes that allow movement for wolves.

Linear developments could be considered habitat enhancement since they often serve as travel corridors for wolves, probably more so than for most other large carnivores. Oilfield access roads, which receive substantial industrial use and are open to public use all year have been documented to be avoided by wolves. Wolves have also been documented to be attracted to a gravel pipeline access roads, which was gated and closed to vehicles for most of the year. Gravel roads, which are available to the public but are unplowed during winter have also been documented to be used by wolves. Attraction to linear
disturbances that offer energy efficient travel routes may offer increases access
to prey populations, altering the predatory-prey dynamics of a region.

Indirect mortality as a result of linear corridors can be a serious problem. Roads
themselves do not prevent wolves from inhabiting an area. However, the threat
is from intentional or accidental killing by humans gaining access. Wolf packs in
hunted areas in Canada often use areas less fragmented by roads where access
is limited (Paquet et al. 1996). Local wolf populations may be adversely affected
by the increased access to hunting and trapping that increased roads afford.

**Cougar.** Habitat avoidance has been documented in some, but not all,
circumstances where cougars are confronted by human developments. The
most significant linear disturbance impact to cougars is indirect mortality. In most
western states and provinces, cougars are hunted with dogs, and most track
searches are conducted from motorized vehicles along linear developments like
roads and cutlines. In Alberta, the cougar harvest is directly linked to the degree
of motorized access that exists in an area. In hunted populations, large
mammals such as cougars may avoid roads to reduce exposure to hunters.
Fragmentation of habitat may have deleterious consequences for cougar
populations if the movement of individuals between habitat patches is
eliminated. The most serious threat to western mountain lion populations is
degradation of habitat resulting from residential developments, recreational
developments and road building for access to residential, recreational and
industrial activities (M. Jalkotzy pers. comm. cited in Carroll et al. 1998).

**Elk.** Habitat avoidance is the most serious effect linear developments may have
on elk. Human entry into an area occupied by elk for any purpose may reduce
the security of the habitat in that area for elk. The degree of habitat avoidance
is directly related to the types and amounts of human disturbance to which elk
are subjected.

Declines in use of habitat adjacent to forest roads have been documented in
studies of hunted elk in most of their range in North America. Avoidance
distances are quite variable and dependent on the amount of traffic on the
roads, the type of traffic, the topography of the area, and the ratio of closed
and open habitats. The loss in habitat effectiveness has been shown to be
greatest near primary (paved) roads, and least near primitive roads, greatest
where cover was poor and least where cover was greatest, and greater during
the hunting season than at any other time of the year.

Researchers radiotracked 70 elk in a hunted population in southwestern Alberta
to determine whether access features had an effect on elk distribution.
Preliminary results based on 4,409 radiolocations and visual sightings are outlined
below. Within the Pincher Creek study area elk appeared to avoid habitat within
300 m of primary (paved) roads in all seasons. Secondary roads (gravel) did not
appear to exert as strong an influence on habitat use, but elk avoided
secondary roads in autumn and winter. Elk appeared to avoid habitat within 100
m and 200 m of pipelines and transmission lines, respectively, in spring, autumn and winter, and avoided habitat within 300 m of these features in autumn. Elk did not appear to avoid seismic lines and cutlines. Seismic lines and cutlines tend to be narrower in width than pipelines and powerline corridors. In fact, the data showed a higher than expected number of elk within 100 m, 200 m, and 300 m of seismic lines and cutlines in all seasons but winter.

In the Castle-Carbondale study area there were more elk than expected in all seasons within undisturbed habitat (at least 500 m from any form of access). Fewer than expected elk occurred within 300 m of primary roads in all seasons except spring. Fewer than expected elk occurred within 250 m of secondary roads in all seasons except spring.

Secondary roads had less influence on habitat use than primary roads at distances of >250m. There was no significant difference between the observed and expected number of elk observations within 500 m of seismic lines and track trails. Elk were found closer to these access features in the spring than in summer, fall, and winter. Observations during summer, autumn, and winter within 250 m of these access features were lower than expected. Data from this study seemed to indicate that truck trails and seismic lines had less influence on elk habitat use than did primary and secondary roads. From a habitat use perspective, researchers found that during the autumn (hunting season), conifer stands were highly selected for, while grasslands were utilized much less than expected and cultivated areas were completely unused.

Similarly, in westcentral Alberta, hunted elk tended to avoid areas surrounding a pipeline corridor during winter construction activities; higher numbers of elk were seen farther from the pipeline right-of-way during construction periods as compared to periods with no construction activity on the right-of-way. Roads and associated disturbances have been presumed to be the primary agent driving elk distribution across seasons and landscapes (Rowland et al. 2000). Persistent road-mediated disturbance may lead to permanent shifts in habitat use by elk away from roads and thereby effect greater levels of herbivory in some sites (Rowland et al. 2000).

Habitat avoidance can also occur if some or all individuals in an elk population are unwilling to cross linear disturbances, that is, the corridors act as barriers or filters to movement. Winter construction of a 109 cm diameter pipeline was routed through elk winter range in west-central Alberta. Monitoring of the pipeline right-of-way during construction showed that only 52% of 23 groups of elk that encountered the pipeline lying on the right-of-way or elevated on blocks successfully crossed it. Earth and snow berms were associated with another pipeline construction project through elk winter range in west-central Alberta. Impacts of berms were reduced by the presence of breaks and openings. In this case, 2 and 3 pipes were laid. However, because of their small diameter (9, 11, 46, 6, 17 cm), unwelded and welded pipe strings individually did not present a barrier to ungulates. Overall, failure to cross berms was 9% of the total number of elk encounters. However, 2 or more welded pipe strings were a major filter to
movement across the right-of-way. The filter effect resulted from the presence of 2 or more pipe strings, their height and distance apart, and the presence of dirt berms and sometimes ditches. Elk failed to cross 33% (5 of 15) of the time when 2 welded and 1 strung pipe (47 cm) are encountered.

Ungulate avoidance of habitat in the vicinity of trails is variable. In southwestern Alberta, elk avoided habitat within 100 m of pipelines in spring, summer, and winter, and habitat within 300 m in fall. However, elk did not avoid seismic lines and cutlines in the same study.

Linear developments can have a positive effect on elk through habitat enhancement. In southwestern Alberta, researchers found that although fewer than expected elk occurred within 300 m of primary roads in summer, fall, and winter, this was not the case in spring, probably because roadsides tended to green up sooner in the spring than surrounding habitat. Similar effects were reported for pipeline rights-of-way in west-central Alberta. Construction of the pipeline right-of-way increased wildlife habitat diversity. Elk seemed to respond primarily to greater forage supplies along the pipeline.

Indirect mortality occurs as a result of linear developments because these corridors allow human access into areas for hunting and poaching. The probability of mortality increased with increasing road and hunter densities, and was lower in areas with highly broken or dissected terrain. Increased road access into an area open to hunting without adequate regulations can lead to excessive bull mortality, altering the social structure of the local elk population.

Deer. Mule deer and white-tailed deer are ecologically and behaviourally different. However, the effects of linear developments on white-tailed deer and mule deer will be dealt with together since broad aspects of the two species' behavioural responses to disturbance are similar.

Linear developments can result in the disruption of individuals in a deer population. Deer living alongside development corridors may choose to leave the area when disturbed by humans. Many factors affect the degree to which humans along these corridors will disrupt deer movements. Hunting tends to make deer more wary of humans and human disturbance of deer along roads is greater in hunted deer populations.

White-tailed deer and mule deer disturbed by human activity exhibit habitat avoidance in ways similar to elk. In westcentral Alberta, deer winter habitat utilization was not strongly related to browse availability, but appeared to be related to traditional wintering areas and to human disturbance. In Colorado, fecal pellet counts indicated that deer avoided areas near paved and dirt roads on winter range, particularly those areas within 200 m of roads. Avoidance was particularly evident in shrubland habitat types; pellet group densities 300-400 m from the road averaged 3.2 times greater than in areas within 100 m of the road.

Pipelines under construction can also act as barriers or filters to deer movements.
Size and clearance of the pipeline are important determinants in deer crossing success. The effects of temporary barriers like pipelines under construction did not appear to be severe.

Linear disturbances such as roads can disrupt habitat indirectly through the introduction of exotic plants, and pollutants like dust, salt, and automobile emissions.

Indirect mortality occurs as a result of linear developments because these development corridors allow human access into areas for hunting. Linear developments, more than any other factor, affect the distribution of hunters and therefore, the distribution of the hunter kill.

**Moose.** Individual disruption of moose may occur along linear disturbances. Intuitively, this effect is likely most prevalent in hunted populations, but it may also occur within protected areas. Moose avoid habitat in the vicinity of roads because of human activity associated with them. Linear developments like roads provide access for humans using motorized and non-motorized means. Again, this is most evident in hunted populations. A hunted moose population near Rochester, Alberta was distributed significantly further from roads between November through January than would be expected by chance over a 13-year period. In a study of moose distribution in an area of oil and gas development in northwestern Alberta, use of habitat near roads was significantly reduced compared to control areas away from a road. Moose use of browse along transects within 200 m of roads was 55% less than on transects 200 to 400 m from roads. In this case, particularly heavy hunting pressure along the roads probably caused the observed effect.

Human activity associated with pipelines, cutlines, and seismic lines has the potential to displace moose. Linear developments such as pipelines may act as barriers or filters to movement of moose. Several studies have examined the effects of pipelines on moose populations. Buried pipelines were not a barrier if large berms were not associated with them. Elevated pipelines constituted a barrier to movement if the ground clearance under the pipe was too low for moose to travel underneath, and too high to jump over. Several studies in Alberta and elsewhere have shown that berms of snow and/or earth, and slash piles associated with pipelines, roads, and railways could have a significant effect on moose movements. Sight lines at berms, height of berms, and berm composition seemed to be important attributes that affected moose movements over them.

Linear corridors may create or remove habitat for moose depending on the habitat types they are traversing. Any linear development through a closed forest will open up the canopy, creating edges that encourage the growth of shrubs, preferred browse species for moose. Conversely, corridors that traverse riparian areas, habitat that is already good for foraging moose, remove habitat, reducing the carrying capacity of the landscape for moose. The degree of impact is proportional to the width and length of the disturbance corridor.
Freeways and paved primary highways remove more habitat than narrow country roads and truck trails. A 20 m wide corridor in riparian habitat removes 1 km² of moose habitat for every 500 m of linear distance. As is the case with other ungulates, this impact is probably minor in comparison with avoidance and mortality impacts associated with disturbance corridors.

Indirect mortality as a result of linear developments in moose habitat has also been documented. Moose attracted to or crossing a disturbance corridor may suffer greater mortality than elsewhere within their home ranges. Mortality often occurs as a result of hunting. Overharvests of moose have been documented in areas with greater access. Researchers have documented increased moose harvests in an area of intensive oil and gas development with associated increases in access. Most hunting activity occurred within 1.6 km of roads and most successful hunters were using all-terrain vehicles.

To summarize, in relatively remote areas, with an absence of high volume roads, the predominant effect of linear disturbance on wildlife is increased access to humans. Increasing access to humans contributes to indirect mortality through increased hunting, trapping and poaching. It also contributes to increased disturbance by increasing access to humans to recreate on the landscape. As linear disturbances continue to fragment intact ecosystems and habitats it is important to manage the remaining intact, undisturbed tracts of land to minimize further disturbance. Lands that provide buffers between protected areas (mountain parks) and urbanized landscapes play a vital role in providing movement and habitat opportunities for wildlife. A natural area, with minimal impact from linear disturbances, of seemingly marginal significance can be enormously valuable if its position and ecological role in the landscape contribute to the persistence of populations on a regional scale. Such is the case for the Pekisko Uplands, constituting one of the last remaining intact fescue grasslands/parkland in western Canada.
4.3 Local and Regional Environmental Impacts: Towards a Cumulative Effects Approach

The small, predictable, and individually modest impact of individual well sites belies their potentially significant cumulative effect (Creasey 1998, p. 6).

The natural gas industry in Alberta is predicted to maintain or increase current production levels over the next decade (Figs. 4-11 and 4-12; note the projected development along the eastern slopes – zone 2). This activity is coupled with increasing land use pressures from forestry, agriculture, rural residential subdivision, recreation and a host of other activities. Each individual activity may appear to have minor or negligible deleterious effects, but, combined in space and time, they act additively and synergistically in a significant and negative manner. Before proceeding further, it is necessary to examine the notion of “cumulative effects.”

Fig. 4-11  Regional distribution of marketable gas reserves (10⁹m³) (from AEUB 2002c)
A cumulative effects approach to understanding the impacts of human land-use decisions is not entirely new. However, it is only recently (within the past two decades) that a theory and practice of cumulative effects analysis (CEA) has emerged.

This interest in the assessment of cumulative effects (CEA) reflects a paradigm shift from a more narrow environmental approach, examining linear cause and effect relationships, to an holistic, ecosystem perspective, which explores indirect and multiple causality. Explicit in the study of cumulative effects is a recognition that the existing state of the environment is not simply the product of individual impacts occurring independently of each other, but is, rather, the result of many interacting factors and that the environment provides services of “value” to humans (Griffiths and McCoy 2002).

The Canadian Environmental Assessment Agency (Hegmann et al. 1999) captures the nature of cumulative effects assessment in its Practitioners Guide:

Concerns are often raised about the long-term changes that may occur not only as a result of a single action but the combined effects of each successive action on the environment. Cumulative effects assessment (CEA) is done to ensure the incremental effects resulting from the combined influences of various actions are assessed. These incremental effects may be significant even though the effects of each action, when...
independently assessed, are considered insignificant.

Similarly, Cumulative Effects is defined by the US Council on Environmental Quality (CEQ) as,

... the impact on the environment which results from incremental impact of the action when added to their past, present and reasonably foreseeable future actions regardless of what agency (federal or non-federal) or person undertakes such other actions (1994).

CEA is a process that involves assessing multiple causes and effects, over large regional boundaries and long time frames.

CEA has most often been applied with respect to a particular project under review. Typically, as required under legislation, the responsibility of undertaking a CEA has been the proponent of the project. This position supports the polluter pay principle whereby the organization proposing to introduce an environmental hazard must demonstrate that the development will not cause irreparable damage. In these cases it is the responsibility of the proponent to gather environmental information and assess the past, present and future landscape impacts. Other projects in the region may also be subject to individual review, resulting in efficiencies of duplication. There is also concern the project specific approach to CEA may be inadequate to capture the full extent of the regional impacts.

An emerging view recognizes that CEA should also be used more as a regional planning tool whereby government, industry and community members work together to assess the impacts of specific projects and regional impacts of a development on the landscape. This position supports the view that once completed on a regional level, a CEA would provide the context within which site-specific assessments are performed. This approach is more conducive to landscape level planning exercises whereby proposed developments would be assessed in relation to an overall landscape plan. The CEQ suggests that the “goal of cumulative effects analysis... is to inject environmental considerations into the planning process as early as is needed to improve decisions” (CEQ, 1997). Such an approach would engage regional stakeholders in collaborative visioning, acceptable threshold establishment, shared data management and modeling exercises.

Overall, CEA practice has focused more on project assessment than regional management of cumulative effects. Less attention has been given to creating a management system across projects and among stakeholders for establishing a shared regional database, determining regional environmental capacity and acceptable thresholds for cumulative effects, co-coordinating stakeholder participation in CEAs of multiple projects, and enabling a more efficient regulatory review and approval process for overlapping CEAs. Effective consideration of
cumulative effects requires both project-based assessment and management of cumulative effects at the regional scale (Spaling 2000).

The projected growth of all land-use activities in the regional project area suggests that such a cumulative effects initiative be undertaken.

The AEUB has recognized the significance of cumulative effects for some time. For example, in the Waterton Gas Field area (Whitney Creek) the Board (at that time the Energy Resource Conservation Board) stated in a well application decision:

the Board (ERCB) recognizes that nickel and dime encroachments into wildland areas do have the potential of ultimately depriving wildlife of access to critical habitat. It is in this regard that the Board is convinced that, even where will developments are allowed to proceed, continuing comprehensive studies to assess ecosystem effects and the need for alternative environmental enhancement programs should be conducted (ERCB 1988).

However, the traditional decision making processes and mandates of regulatory agencies preclude the comprehensive consideration of cumulative effects. That is, “the problem with cumulative effects generally, and in particular the wellsite cumulative effects … is a problem related to the scope of routine decision making policy rather than a problem of environmental scientific methodology” (Creasey 1998, p. 14). Odum (1982), following Kahn (1966), referred to this phenomenon as environmental degradation through the “tyranny of small decisions.” Creasey (1998) suggests that cumulative effects analysis is antithetical to the usual regulatory approach since “[r]egulators are compelled to address only what is before them at the present time, as that reflects their role in the complete approval process, and allows them to make an expedient decision in order that they can address the next proposal” (p. 32).

Perhaps the best recent example of this comes from another natural gas application in southwestern Alberta. In this case, Shell Canada indicated it was probable that regional thresholds had been exceeded for key species within the area it wished to drill.

In conjunction with Canadian 88, Shell submitted an environmental assessment as part of its application, in accordance with the requirements outlined in IL 93-9. As a result of the findings of this assessment, Shell submitted that it believed that there were significant regional, cumulative environmental effects attributable to energy, agricultural, recreational, and residential development. Furthermore, Shell believed that while such thresholds were not as yet established, it was possible that the biological thresholds for some species in the region were either being approached or may have been exceeded (AEUB 2000, p. 8).
The response of the Board was to recognize the situation, but defer the matter to other authorities within the Province of Alberta:

In order to ensure that future energy development in the region continues to be environmentally acceptable, the Board strongly believes that additional evidence such as would be found in an updated integrated resource management strategy must be developed to confirm that the region’s environmental values are being adequately protected. Alternatively, work needs to be initiated in a timely fashion to create strategies to address the future cumulative effects of human activities, including energy development, in the Castle Crown region. The Board intends to raise this issue with the appropriate land management agencies to consider such an initiative for this region of the province. The Board expects that the energy industry would also be interested in participating in such an initiative in order to establish some certainty for future development. (AEUB 2000, p. 10).

The application was approved and activity continues in the area without the benefit of the cumulative effects analysis recommended.

One might assume that cumulative effects have been considered under integrated resource management planning exercises for Crown land in Alberta. However, the resultant zoning from such exercises go only as far as identifying acceptable uses and provide no guidance on critical issues such as intensity, timing and duration of activities. There is clearly a need to couple cumulative effects analysis with land-use planning and not simply with individual project assessment (Kennett 1998, 2002).

The concept of thresholds and carrying capacity are central to applying cumulative effects analysis as a land-use planning and management tool. The ecological notion of carrying capacity for human populations is a topic of much debate in the literature (see for example Cohen 1995). However, if we define carrying capacity in terms of system capacity rather than as a population value, it becomes a useful construct for CEA. In this sense, carrying capacity for human populations is a function of population x per capita impact (Catton 1980). Barbier, Burgess and Folke (1994) describe carrying capacity in terms of the maximum level of stress that the ecosystem can maintain. Thresholds refer to boundaries or limits beyond which unacceptable circumstances are incurred. Theoretically, if one could calculate a carrying capacity for a defined region, then thresholds could be determined and the number and type of land-uses could be decided upon based on their individual contributions to resource use and waste discharge within the system. However, the complexity of ecological systems has precluded such a simple solution. Instead, it has been suggested that a “Limits of Acceptable Change" (LAC) approach be utilized (Macleod Institute 2002). Such an approach shifts the focus away from examining outputs and, instead, focuses on desired future conditions. LAC is predicated on good science, but explicitly incorporates societal values.
[LAC] factors environmental, social and economic considerations into the framework for managing human activities in a way that maintains respect for ecological well-being. Goals and objectives emphasize the positive, by describing environmental and social conditions that reflect desired outcomes as seen from a multi-stakeholder perspective. LAC is also action-oriented. It explicitly drives toward a management program that includes an implementation schedule and monitoring agenda, yet it avoids mechanistic or formula-driven management interventions (Macleod Institute 2002. p. vi).

The theory and practice of CEA, and good land-use planning and management, suggests that it would be imprudent, inefficient and impractical to proceed with significant land-altering activities without first engaging in a broader planning exercise to determine desired future conditions.

The following section represents an initial analysis of cumulative effects, although it only considers the activities of the petroleum industry (specifically natural gas exploration and development). A full cumulative effects assessment for regional planning purposes would need to consider all land uses.
4.4 A Landscape Simulation of Regional Effects

The Miistakis Institute for the Rockies conducted a local-scale and regional-scale analysis of the impacts of energy sector activities on the native grassland communities located in the Pekisko Creek Valley and associated Uplands (see Map 1a). Miistakis used the ALCES simulator model to predict the impacts of point and linear disturbances on various metrics of native grasslands.

ALCES is a powerful, fast and user-friendly landscape simulator that enables resource managers, industry, society and the scientific community to explore and quantify landscapes subjected to single or multiple human land-use practices and to various natural disturbance regimes such as fire and flooding. ALCES assists resource managers in identifying environmental and industrial problems and in discovering mitigation strategies for issues related to flows of natural resources. ALCES can be utilized for relatively small landscapes or for large regional landscapes of millions of hectares.

ALCES enables resource managers and research scientists to explore and quantify such landscape management issues as:

- Landscape composition and dynamic transformations
- Forest harvest levels and timber damage assessments
- Mixedwood management scenarios
- Changes to forest age class structure caused by fire, logging and other human landuses
- Competing relationships between land uses for space and resources (nutrients, water, wildlife populations)
- Linear disturbances (roads, seismic, pipelines) including length, area, buffer and effects on landscape fragmentation
- Forest patch size frequency distributions
- Wildlife habitat responses to dynamic landscape patterns
- Wildlife population dynamics in response to changing habitat and defined mortality and harvest schedules
- Carbon pool dynamics relating to extraction of hydrocarbons and to forestry practices
- Aboriginal features (traditional hunting areas, traplines, burial sites, traditional trails, etc.)
- Stream features (culverts, bridges) and consequences to sediment and fish migration
- Relationships dealing with surface and subsurface water flow
- Relationships dealing with agriculture (irrigation water withdrawal, fertilizers, livestock stocking rates, area in cereal, forage and irrigation crops, improved and native pasture etc.)
- Size of various hydrocarbons reserves, their depletion rates, and levels of emissions.
ALCES is a spatially stratified model that allows the user to track the area and length of each landuse footprint (i.e. cutblocks, seismic lines, roads, wellsites, settlements) within each landscape type (i.e. hardwood forest, shrubland, grassland). ALCES is not a spatially explicit model, and therefore cannot provide descriptions of the spatial arrangement of landscape elements. For example, while ALCES can track the area and length of seismic lines on each landscape type at any given time, it does not know how far they are from each other.

ALCES first calculates the initial landbase for a landscape and then projects this landbase into the future based on various landuse inputs (in the case of our analysis it included information such as projected future trajectories of well sites, well site access road length, pipeline length etc.). ALCES categorizes the landbase into vegetated (natural and anthropogenic) and unvegetated (natural and anthropogenic). The composition of the future landbase is displayed at each step of the simulation exercise, allowing the user to identify critical targets and thresholds. For current reviews of the ALCES model, see Van Lakke, P. E. (2002) and Hudson (2002).

4.4.1 Methods

Miistakis conducted a local-scale and regional-scale analysis of energy sector impacts on native grassland communities. The local project area was defined by the Vermilion Resources proposed well site application number 1247320 (11-25-17-3 W5M) and four additional quarter sections that have been identified by Vermillion as potential targets for future drilling (36-17-3 W5M, 24-17-3 W5M, 13-17-3 W5M, 18-17-2 W5M). The regional project area was defined by the boundaries of Highwood River to the north, South Willow creek to the south and the Foothills Parkland Natural Sub-region to the east and west. These boundaries define the socio-ecological community of the Pekisko Uplands.

For both the local and regional scale, landscape compositions were summarized using recent (>1988) spatial inventories housed within a Geographic Information System (GIS). Energy sector information was acquired from historical trends (ACCU map), air photo analysis, and personal communication with resource industry representatives (see model assumptions).

While ALCES is designed to simultaneously examine multiple land-uses, we used this model to explore the relationships between the energy sector and native grassland habitat only. For these reasons, it is important to point out that all results reflect very conservative responses, as 1) there are likely to be more petroleum-related activities than we assumed, and 2) additional land-uses (e.g. forestry, agriculture, recreation, etc.) would contribute to cumulative impacts, not addressed in this study.

Model input and assumptions are outlined in detail in Appendix 2. We
conducted two regional scale analyses; one using low trajectories for future projected well sites and one using a high trajectory. We used two trajectories to demonstrate the effects, based on incremental changes, of the projected development of hydrocarbons on the landbase.

4.4.2 Results

Results are summarized in the following figures:

- Future land area of native grasslands
- Total grassland habitat loss
- Area of linear disturbance (km/km2)
- Length of linear disturbance (km)
- Comparative human land-use footprints

Results are presented for both the local project area and the regional project area (including low and high use trajectories)

4.4.2.1 Local Scale Results

Future Landbase of Native Grasslands. Temporal change in the gross area of native grassland. Initial increase is due to the reclamation of existing seismic lines; subsequent decline is due to landbase loss to roads, wellsites, pipelines etc. These values do not incorporate losses due to buffers along linear features.
Net loss of native grassland habitat to buffers applied to roads, wellsites and pipelines (no buffer applied to seismic lines).

Temporal trends in density (km/km2) of anthropogenic linear features. The increase in observed density is attributed primarily to the construction of roads, pipelines, wellsites and seismic lines. The reduction in density between Year 5 and Year 10 is due to the rapid reclamation of seismic lines.
Temporal changes in the amount of length (km) associated with human landuse practices. The increase in observed density is attributed primarily to the construction of wellsites, roads, pipelines and seismic lines. The reduction in density between Year 5 and Year 10 is due to the rapid reclamation of seismic lines.
Temporal trends in the area (ha) of different human landuse footprints. Roads represent the single largest contribution to anthropogenic area, reflecting their considerable width and lifespan.

4.4.2.2 Regional Scale Results

![Native Grassland Area Graph](image)

**Fig. 4-18** Native grassland area (regional low & high)

1. Regional Low (blue)
2. Regional High (red)

Future Landbase of Native Grasslands Temporal change in the gross area of native grassland. Initial increase is due to the reclamation of existing seismic lines; subsequent decline is due to landbase loss to roads, wellsites, pipelines etc. These values do not incorporate losses due to buffers along linear features.
Fig. 4-19 Net loss of native grassland (regional low & high)

Net loss of native grassland habitat to buffers applied to roads, wellsites and pipelines.

Fig. 4-20 Area of linear disturbance (regional low & high)

Temporal trends in density (km/km2) of anthropogenic linear features. The increase in observed density is attributed primarily to the construction of roads, pipelines, wellsites and seismic lines.
Temporal changes in the amount of length (km) associated with human landuse practices. The increase in observed density is attributed primarily to the construction of wellsites, roads, pipelines and seismic lines.

Regional-Low - Temporal trends in the area (ha) of different human landuse footprints. Roads represent the single largest contribution to anthropogenic area, reflecting their considerable width and lifespan.
Regional – high. Temporal trends in the area (ha) of different human landuse footprints. Roads represent the single largest contribution to anthropogenic area, reflecting their considerable width and lifespan.

### 4.4.3 Discussion

The future landbase of native grasslands decreases for both the local and regional project areas due to the human footprint of well site access roads, well pads and pipelines. This future landbase does not account for losses due to buffers associated with linear features. The local project area, over ten years, experiences a net loss of grasslands between 20 ha and 50 ha. For the regional project area, net loss of grasslands ranges between 600 and 2500 ha for the low trajectory, and 600 to over 4000 ha for the high trajectory. Net loss of grassland habitat incorporates losses due to buffers along linear features. This has significant implications for the Pekisko Creek Valley and associated uplands. This region has been described as an environmental priority area based on outstanding natural characteristics including “the closest thing to a native grassland that exists within the Calgary region and may be one of the finest areas of its type in Alberta” (Lamoureux et al. 1983).

Anthropogenic length (km/km²) for the local project area peaks at 2.5km/km² at 5 years and then declines to just over 1km/km² at 10 years. Anthropogenic length for the regional project area increases from <0.50km/km² to >1km/km² for the low trajectory and increases from < 0.5km/km² to >1.75km/km² for the high trajectory, over 50 years. Both the local and regional scale results for anthropogenic length have significant implications for local and regional wildlife.
populations. It has been documented that wolves are generally not present where the density of roads exceeds 0.58 km/km² (Carroll et al. 2000) and mean road density has been documented to be much lower in pack territories (0.23 km/km² in 80% use areas) than in random nonpack areas (0.74 km/km²). Road density has also been documented to be the strongest predictor of wolf habitat favorability out of five habitat characteristics and six indices of landscape connectivity (Mladenoff et al. 1995). It has been reported that a road density of 0.8 km/km² reduces habitat effectiveness for grizzly bears to 50% and a density of 1.6 km/km² reduces habitat effectiveness to 25% (USDA Forest Service 1990). The reported threshold density for functioning landscapes with large carnivores is approximately 0.6 km/km² and is based on field studies of wolves, cougars and bears (Thiel 1985, Jensen et al. 1986, Mech et al. 1988, Van Dyke et al. 1986, Clevenger et al. 1997). This would indicate that any increase in the anthropogenic length (km/km²) to the existing regional landscape (<0.5 km/km²) may be detrimental to local and regional carnivore populations.

Temporal trends in the area of different human landuse footprints indicates that the largest single contribution to anthropogenic area is roads for both the local project area and the regional project area, followed by wellsite pads, pipelines and seismic lines. This emphasizes the impact that roads have on the landbase and demonstrates that of all the energy sector footprints, well site access roads are the single biggest contributor to anthropogenic area.

The results of this analysis outline the importance of addressing the environmental impacts of well site development at a regional scale. While the results of the local scale analysis indicate significant impacts to native grassland habitat (decreased future landbase of native grasslands, habitat loss and increased anthropogenic effects), impacts are a magnitude smaller than those seen for the regional scale analysis. Considering the regional study area is composed of approximately 30000 ha of grassland in today’s landscape, a loss of > 4000 ha over 50 years represents a 13% loss of grassland, considering the high trajectory and a 8% loss grassland for the low trajectory.

It is important to emphasize that the results from this analysis outline the impacts of conservative estimates for energy sector activities on native grassland habitat only. They do not consider the cumulative impacts on grasslands of additional land-uses including recreation, agriculture, settlements and hunting. For this reason, the impacts outlined above are conservative, minimum estimates of the projected impacts for grassland communities. A natural area, with minimal impact from various land-uses, of seemingly marginal significance, can be enormously valuable if its position and ecological role in the landscape contribute to the persistence of populations on a regional scale. Such is the case for the Pekisko Uplands, constituting one of the last remaining intact foothills parkland fescue grasslands in western Canada.
5.0 Literature Cited


http://www.energy.gov.ab.ca/com/Gas/Introduction/Natural+Gas.htm
(accessed 21 August 2002).

Alberta Energy and Utilities Board. 2002a. About the EUB. 


Alberta Sustainable Resource Development. 2001. Recommended land use guidelines for protection of selected wildlife species and habitat within grassland and parkland natural regions of Alberta. ASRD. Fish and Wildlife Division, Edmonton, July 26, 2001 DRAFT.


Griffiths, A. and E. McCoy (Macleod Institute). Cumulative effects assessment generic framework. Prepared for Canadian Arctic Resources Committee, Calgary, AB.


appendices and maps.


Conservation Association, Wildlife Status Report No. 37, Edmonton, AB.


McIntyre S and S. Lavorel. 1994. Predicting richness of native, rare, and exotic


Tannas, Kathy. 1998. Common Plants of the Western Rangelands (Volume I and


USDA Forest Service. 1990. CEM – A Model for assessing effects on grizzly bears. USDA Forest Service, Missoula, Montana, USA.


Personal Communications

Barry Adams, Public Lands, Alberta Sustainable Resource Development, Lethbridge AB

Lorna Allan, Alberta Natural Heritage Information Centre, Alberta Community Development, Edmonton AB

Kristine Fedynaik, Archaeology Assistant Curator, Provincial Museum of Alberta, Edmonton

Stephen Hughes, Leaseholder, Hughes Grazing Lease, Longview AB

Jane Lancaster, Kestrel Research Inc., Cochrane AB

Archie Landals, Parks and Protected Areas, Alberta Community Development, Edmonton AB

Greg McAndrews, Public Lands, Sustainable Resource Development, Calgary AB

Marco Musiana, Southern Alberta Conservation Cooperative, Calgary

Allan Robertson, High Range Ecological Consultants, Edmonton AB

Ian Ross, Arc Wildlife Limited Services, Calgary

Heather Sinton, Alberta Environment, Edmonton AB

Ken Stiles, Leaseholder, Winter Range Grazing Lease, Longview AB

Cliff Wallis, Alberta Wilderness Association, Calgary AB

Walter Willms, Range Scientist, Agriculture and Agri-food Canada, Lethbridge Research Station.

Pat Young, Alberta Sustainable Resource Development, Fish and Wildlife, Calgary, AB
### Appendix 1: Description of Transects

**Site #1** (~50 m from gate)  
**UTM Coordinates (NAD 83):** 11U E693247 N5592811

**Site Description:** ridged moraine; lower slope; 1340 m (4400 ft) a.s.l.; 5% (9°) slope with SE aspect; mesic; well-drained.

**Notes:** minor cut and fill to construct road; soil surface fine loam; burrows at 17-27 m on Transect 1A; the native Bromus inermis ssp. pumpellianus present in patches.

<table>
<thead>
<tr>
<th>Transect 1A (Dir: S, 180°, level)</th>
<th>Distance</th>
<th>0-6m</th>
<th>6-17m</th>
<th>17-27m</th>
<th>27-32m</th>
<th>32-37.5m</th>
<th>37.5-50m</th>
</tr>
</thead>
<tbody>
<tr>
<td>Non-Native Veg. Cover</td>
<td>100-50%</td>
<td>100-50%</td>
<td>25-10%</td>
<td>50-25%</td>
<td>100-50%</td>
<td>&lt;10%</td>
<td></td>
</tr>
<tr>
<td>Dom. Spp. (&gt;10% cover)</td>
<td>Brom ine*</td>
<td>Symp occ Poa pra*</td>
<td>Rosa aci Symp occ Stip col Arte fri</td>
<td>Rosa aci Poa pra* Stip col Arte fri</td>
<td>Brom ine*</td>
<td>Agro tra Koel mac Stip col Arte fri</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Transect 1B (Dir: N, 0°, upslope)</th>
<th>Distance</th>
<th>0-26m</th>
<th>26-38m</th>
<th>38-43m</th>
<th>43-67 m</th>
</tr>
</thead>
<tbody>
<tr>
<td>Non-Native Veg. Cover</td>
<td>100-50%</td>
<td>&lt;10%</td>
<td>50-25%</td>
<td>100-50%</td>
<td></td>
</tr>
<tr>
<td>Dom. Spp. (&gt;10% cover)</td>
<td>Rosa aci Agro pec* Brom ine* Phle pra* Agro smi Agro tra Gera vis Poa pra* Arte lud Aste eri bare ground</td>
<td>Symp occ Poa pra*</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**Site #2** (~ 400 m from gate)  
**UTM coordinates (NAD83):** 11U E692961 N5592942

**Site Description:** ridged moraine; upper slope; ~1370 m (4500 ft.) a.s.l.; 10% (18°) slope with W aspect; sub-mesic; very well drained.

**Notes:** major cut and fill to construct road; soil surface stony.

<table>
<thead>
<tr>
<th>Transect 2A (Dir: W, 270°, downslope)</th>
<th>Distance</th>
<th>0-9m</th>
<th>9-50m</th>
</tr>
</thead>
<tbody>
<tr>
<td>Non-Native Veg. Cover</td>
<td>100-50%</td>
<td>&lt;10%</td>
<td></td>
</tr>
<tr>
<td>Dom. Spp. (&gt;10% cover)</td>
<td>Agro pec* Agro smi Dant par Fest cam Stip col</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Transect 2B (Dir: E, 90°, upslope)</th>
<th>Distance</th>
<th>0-7m</th>
<th>7-13m</th>
<th>13-50m</th>
</tr>
</thead>
<tbody>
<tr>
<td>Non-Native Veg. Cover</td>
<td>100-50%</td>
<td>50-25%</td>
<td>&lt;10%</td>
<td></td>
</tr>
<tr>
<td>Dom. Spp. (&gt;10% cover)</td>
<td>Agro pec* Ther rom Agro pec Agro smi Stip col Care fil Poa int Fest cam bare ground</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
Site #3 (~750 m from gate) UTM coordinates (NAD83): E692813 N5593218

Site Description: ridged moraine; level & depression; 1350 m (4450 ft) a.s.l.; 1% (2°) slope with W aspect; mesic and subhygric; moderately well drained
Notes: moderate cut and fill to construct road; loafing area for cattle along Transect A; Transect B runs along the edge of sedge-dominated wetland (Care ath); soil surface fine loam; burrows along both transects

<table>
<thead>
<tr>
<th>Transect 3A (Dir: S, 195°, level)</th>
<th>Distance</th>
<th>0-8m</th>
<th>8-60m</th>
</tr>
</thead>
<tbody>
<tr>
<td>Non-Native Veg. Cover</td>
<td>100-50%</td>
<td>50-25%</td>
<td></td>
</tr>
<tr>
<td>Dom. Spp. (&gt;10% cover)</td>
<td>Agro pec*</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Symp occ</td>
<td>Agro smi</td>
<td>Poa pra*</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Transect 3B (Dir: N, 15°, downslope)</th>
<th>Distance</th>
<th>0-7m</th>
<th>7-12m</th>
<th>12-16m</th>
<th>16-64m</th>
</tr>
</thead>
<tbody>
<tr>
<td>Non-Native Veg. Cover</td>
<td>100-50%</td>
<td>25-10%</td>
<td>100-50%</td>
<td>100-50%</td>
<td></td>
</tr>
<tr>
<td>Dom. Spp. (&gt;10% cover)</td>
<td>Agro pec*</td>
<td></td>
<td>Agro smi</td>
<td>Symp occ</td>
<td>Brom ine*</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Junc bal</td>
</tr>
</tbody>
</table>

Site #4 (~1200 m from gate) UTM coordinates (NAD 83): E0692486 N5593329

Site Description: ridged moraine; middle slope; 1400 m (4600 ft) a.s.l.; 14% (25°) slope with SE aspect; mesic; well to moderately well drained
Notes: major cut and fill to construct road; both transects cross swales; soil surface rocky

<table>
<thead>
<tr>
<th>Transect 4A (Dir: SW, 210°, downslope)</th>
<th>Distance</th>
<th>0-10.5m</th>
<th>10.5-25m</th>
<th>25-55m</th>
<th>55-78m</th>
</tr>
</thead>
<tbody>
<tr>
<td>Non-Native Veg. Cover</td>
<td>100-50%</td>
<td>&lt;10%</td>
<td>100-50%</td>
<td>&lt;10%</td>
<td></td>
</tr>
<tr>
<td>Dom. Spp. (&gt;10% cover)</td>
<td>Agro pec*</td>
<td>Elym jun*</td>
<td>Agro smi</td>
<td>Brom ine*</td>
<td>Fest cam</td>
</tr>
<tr>
<td></td>
<td>bare ground</td>
<td>Fest ida</td>
<td>Stip vir</td>
<td>Poa pra*</td>
<td>Phle pra*</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Transect 4B (Dir: NE, 30°, upslope)</th>
<th>Distance</th>
<th>0-5m</th>
<th>5-14.5m</th>
<th>14.5-36m</th>
<th>36-47m</th>
<th>47-50m</th>
</tr>
</thead>
<tbody>
<tr>
<td>Non-Native Veg. Cover</td>
<td>100-50%</td>
<td>100-50%</td>
<td>50-25%</td>
<td>25-10%</td>
<td>&lt;10%</td>
<td></td>
</tr>
<tr>
<td>Dom. Spp. (&gt;10% cover)</td>
<td>Agro pec*</td>
<td>Elym jun*</td>
<td>Rosa aci</td>
<td>Agro smi</td>
<td>Agro smi</td>
<td>Agro smi</td>
</tr>
<tr>
<td></td>
<td>Poa pra*</td>
<td>Phae pra*</td>
<td>Poa pra*</td>
<td>Brom ine*</td>
<td>Poa pra*</td>
<td>Fest ida</td>
</tr>
<tr>
<td></td>
<td>Stip col</td>
<td>Phae pra*</td>
<td>Stip col</td>
<td>Poa pra*</td>
<td>Phae pra*</td>
<td>Stip col</td>
</tr>
</tbody>
</table>

Bradley, Quinn & Duke             DRAFT 17 September 2002
**Site #5** (~1550 m from gate)  UTM coordinates (NAD83): 11U E692144 N559336

Site Description: ridged moraine; middle slope; 1410 m (4650 ft) a.s.l.; 17% (30°) slope with SW aspect; subxeric-mesic; well to moderately well drained

Notes: major cut and fill to construct road; Transect A extends to shallow valley bottom; soil surface fine loam along Transect A and more stony along Transect B

### Transect 5A (S, 190°, downslope)

<table>
<thead>
<tr>
<th>Distance</th>
<th>0-5m</th>
<th>5-11m</th>
<th>11-40m</th>
<th>40-50m</th>
</tr>
</thead>
<tbody>
<tr>
<td>Non-Native Veg. Cover</td>
<td>100-50%</td>
<td>50-25%</td>
<td>25-10%</td>
<td>25-10%</td>
</tr>
<tr>
<td>Dom. Spp. (&gt;10% cover)</td>
<td>Agro pec* Elym jun* bare ground</td>
<td>Rosa aci Symp occ Agro rep*</td>
<td>Popu bal Salic bal Corn can Cala can Poa pra* Equi arv</td>
<td>Salic bal Poa pra* Epil ang Hera lan</td>
</tr>
</tbody>
</table>

### Transect 5B (N, 10°, upslope)

<table>
<thead>
<tr>
<th>Distance</th>
<th>0-6m</th>
<th>6-50m</th>
</tr>
</thead>
<tbody>
<tr>
<td>Non-Native Veg. Cover</td>
<td>100-50%</td>
<td>&lt;10%</td>
</tr>
<tr>
<td>Dom. Spp. (&gt;10% cover)</td>
<td>Phle pra*</td>
<td>Juni hor Dant par Fest cam Fest ida</td>
</tr>
</tbody>
</table>

Notes:
* Indicates a non-native species.
** The road is about 4 metres wide hence the first 2 metres of each transect are predominantly bare of vegetation.
*** The north-south section of the old road is vegetated with Agro pec-Elym jun in the south portion and with Agro pec-Poa pra-Thla arv in the norther n portion. Lowland sites adjacent to the old road are dominated by Bro mine and Poa pra. The old wel site is vegetated with Rosa aci-Bro ine. Grassland dominated by Fest cam occur at the edges of the old well site.

Plants Collected and Verified:
Site 1 - Bromus inermis ssp. pumpellianus, Koeleria macrantha
Site 2 - Lappula squarrosa, Monolepis nuttalliana, Poa interior, Polygonum monspeliense, Stipa columbiana
Site 3 - Axyris amaranthoides
Site 4 - Bromus inermis ssp. pumpellianus, Elymus junceus, Potentilla gracilis, Stipa viridula
Site 5 - Agropyron repens, Bromus ciliatus, Festuca pratensis, Glyceria striata, Salix bebbiana, Sonchus uliginosus

Wildlife observed: Moose (cow and calf), Marsh Hawk, Swainson’s Hawk, Redtail Hawk, American Kestrel, Magpie, Goldfinch
Appendix 2  Assumption and values used in the ALCES model simulations

Model Assumptions for Regional Study Area

Low Trajectory

Fig. A2-1  Annual number of new wells drilled (low trajectory regional)

Projected number of new wellsites drilled annually in the regional project area. This number was calculated using historical wellsite information (see Figure A2-2). Assuming a continued cumulative increase in the number of well sites, a conservative number of 45 was used as the projected number of new wells to be drilled in the areas defined in Figure A2-2. Our regional study area was 25% of this larger region, therefore we calculated 25% of 45 well sites, resulting in 11 new well sites for our regional project area. Recognizing the location of well sites is determined by specific hydrocarbon metrics, we understand that arbitrarily assigning a calculated ratio of new well sites is inaccurate. However, failing additional information from the energy sector we believe our conservative number accurately represents the projected trend of well sites. This pattern suggests growth in wellsite activity during the next 2 decades, followed by a rapid decline in drilling activity during the following 3 decades.
Fig. A2-2  Total and Cumulative Number of Well Sites - SW Alberta (420660 ha)
High Trajectory

Fig. A2-3  Annual number of new wells drilled (high trajectory regional)

Projected number of new well sites drilled annually in the regional study area. Increase in number of well sites from the low trajectory includes projected number of wells to be drilled by Talisman Energy in the Callum Creek area (Talisman Energy 2001). Note – this was the only value changed for the to run the high trajectory so the overall results are very conservative.

Fig. A2-4  Buffers for linear features (regional)

Buffer width (in meters) applied to linear features. Buffers apply to that region adjacent to linear features where native grassland species are affected by exotic species. Based on data collected by Cheryl Bradley, 2002 (see section XX of report).
Number of kilometers of seismic line per well site was calculated using averages calculated from Alberta boreal forests. In boreal forests, average seismic line length is 5km (B. Stelfox pers comm.). In the Pekisko Uplands region, 30% of the landbase is forested, therefore we used a calculation of 30% of 5km to determine 1.5km/wellsite, recognizing that in a predominantly grassland community, forested regions primarily sustain disturbance from seismic lines.

Seismic line width was determined as 2m. Seismic lines were not included as buffered features to determine impact on native grasslands. Seismic lines were only included in their impact on the forested portion of the landscape (see above).
Pipeline disturbance lifespan was estimated to be 50 years.

Prevalence of native grassland species at different distances from the edge of the buffered linear feature. Relationship indicates that % prevalence of native species is ~25% adjacent to the linear feature and increases to ~ 72% at the distant edge of the 50 meter buffer. Data provided by C. Bradley 2002 (see section XX of report).
Projected area of wellsite pads (ha). A value of 1.4 ha was chosen, consistent with data provided to Miistik Institute by Vermillion Resources.

Projected lifespan of wellsite pads. The value of 50 years represents the combined active well lifespan and the time required to fully return abandoned wellpads back to native grasslands.
Projected relationship between seismic line lifespan and seismic line width. For this simulation exercise, a seismic line width of 2 meters was used, creating an average seismic line lifespan of 6.5 years.

Projected Pipeline length (km) for each drilled well. A conservative value of 300m was chosen, assuming that the regional landscape already possesses a portion of the desired pipeline infrastructure, and hence tie-in lengths are lower.
Average wellsite access road length of 2km was used. This length was based on existing access roads in the study area. Previous research has shown average well site access road length to be >7.0 km (Creasy 1998) for areas in south-western Alberta, therefore 2km is a conservative number.

A well lifespan of 50 years was used, representing the amount of time the well site remains on the landscape.
A standard number of 1 well/pad was used.

Wellsite road width was determined from previous well site access road width calculations (aerial photo interpretation).
Fig. A2-17  Wellsite access road lifespan

Fig. A2-18  Pipeline width (regional)

Wellsite access road life.

Pipeline width.  A larger pipeline width was used for the regional project area than the local project area as it was assumed that pipelines, additional to feeder lines from individual well sites would be required.
Model Assumptions for the Local Study Area

Assumptions used in the local scale analysis (including quarter sections 11-25-17-3 W5M, 36-17-3 W5M, 24-17-3 W5M, 13-17-3 W5M, 18-17-2 W5M) are the same as the regional scale analysis unless otherwise indicated (see Figures below).

**Fig. A2-19  Annual number of new wells drilled (local)**

Projected number of new well sites drilled annually in the local study area. Data provided by Vermillion Resources.

**Fig. A2-20  Pipeline lifespan (local)**

Pipeline Lifespan. Smaller pipelines associated with individual well sites are assumed to have a lifespan of 5 years, indicative of the time required for native vegetation to return to the disturbed site.
Pipeline Width. A smaller pipeline width for the local scale analysis was used as small width pipelines are required for each individual well site.

Buffer width (in metres) applied to linear features. Buffers apply to that region adjacent to linear features where native grassland species are affected by exotic species. Based on data collected by Cheryl Bradley (2002).
Appendix 3  Report Team

Cheryl Bradley

Cheryl Bradley is an environmental and public participation consultant based in southern Alberta. Cheryl’s professional experience in the environmental and public consultation fields spans over twenty-five years. Her most recent projects have involved working with an international team to classify and map vegetation in the International Peace Park (Waterton Lakes National Park and Glacier National Park), a rare plant survey in Cypress Hills Provincial Park and surveys of rare plants for proposed pipeline developments in Alberta and Saskatchewan. Prior to this she has coordinated a process to identify and evaluate special natural features in Alberta, assessed instream flow needs for riparian forests along the middle Bow River, worked with a team to complete public participation and environmental assessment for parks redevelopment in Lethbridge, wrote a discussion document on prairie ecosystem management based on multi-interest consultation, and facilitated workshops for a variety of clients.

Michael Quinn

Michael Quinn has held the position of assistant professor in the Faculty of Environmental Design at the University of Calgary since 1997. In 2001, he accepted the additional responsibilities of Director of the Miistakis Institute for the Rockies – a research support organization specializing in spatial data and analysis. He holds a B.Sc. in Forest Science from the University of Alberta, an M.Sc. in Forest Wildlife from the University of Alberta and a Ph.D. in Environmental Studies from York University. Mike’s teaching and research interests are in the areas of ecosystem management, protected areas management, community-based natural resource management and urban ecology. Current research projects include landscape scale cumulative effects assessment in the Central Rockies, green infrastructure demonstration research in the City of Calgary, and integrated landscape planning in southern Alberta. He co-manages the Transboundary Environmental Policy, Planning and Management initiative between the University of Calgary and University of Montana. Before returning to his hometown of Calgary, Mike held faculty positions at University of New Brunswick, Ryerson Polytechnical University, Lakehead University and Boston University (School for Field Studies). Recent professional reports include an analysis and classification of avalanche habitat for grizzly bears in the Purcell Mountains and wildlife issues related to expansion of Highway 1A west of Calgary.
**Danah Duke**

Danah is the Executive Coordinator of the Miistakis Institute for the Rockies. Danah completed her B.Sc. at McMaster University (1994) and her M.Sc. at the University of Alberta (2001). Danah has been working in the Rocky Mountains of Alberta and British Columbia for the past 8 years focusing on large mammal ecology. She has a particularly strong background in the science and management of wildlife corridors in the Rocky Mountains. The projects she has worked on include habitat use and movement patterns of wolves and cougars, habitat use of big horn sheep, bull trout distribution, black bear and grizzly bear distribution and habitat use, aspen regeneration, post-fire vegetation regeneration. As Executive Coordinator of Miistakis, Danah oversees multiple landscape ecology projects that focus on integrating spatial (GIS) and biological information to conduct transboundary ecological analyses in collaboration with both government and non-government organizations.
Appendix 4  Progress and Priorities; a perspective on expansion of oil and gas interests in the Southern Foothills of Alberta

Gordon Cartwright

In the coming months the Energy and Utilities Board will have to make a significant choice for Albertan’s. This is a choice between new interests in the oil industry, and the future of one of the landscapes in Alberta, where the footprint of nature is more evident than the footprint of man. The preservation, of this landscape has not happened by design. It is the ruggedness of the area, the severe climatic extremes, and short frost free periods that spared the grassland from cultivation. The same factors, and lack of infrastructure, left the area as a pipe dream for country residential development. The obstacles of expense: difficulty in development and movement of product, has kept the oil patch from developing a relatively small area that runs west of Longview to the Southern Whaleback. Now as technology increases, and hydrocarbon appetites increase, the petroleum industry looks to the last undeveloped area of the province.

The community of ranchers that exist in this area have persevered the physical and monetary challenges of life here, by placing a high value on the aesthetics and inherent resilience of a landscape that is managed with future generations in mind. Healthy ranches value good water and watersheds, wildlife, and productive grasslands that sink atmospheric carbon and build soil, while providing high quality food and wildlife habitat, with minimal use of fossil fuels or fertilizers. This is an area where the biological capital remains largely in tact, because the future here relies on maintaining a healthy biodiversity. This is one of the few grassland regions of Alberta, where complex natural communities exist and function, underwritten with millennia of genetic selection for survival through extremes of climate, grazing, disease and fire.

If we look to the vast area of northern Alberta, most of this geographic area is scarred by harvesting wood fiber and petroleum, and the infrastructure that moves and processes product for consumption. More boreal forest has been cleared for oil industry access than for lumber harvesting. A dutiful bureaucrat will say the figure is misleading, because most clearing is restricted to lower yield forest. Implicit in the message is the policy preference for high yield species to the boreal forest community.

For decades I have heard the term ‘improved’ lands applied to native grasslands that have been cultivated to plant high yield species. Billions of dollars have been spent on this continent to encourage the cultivation of lands, including millions of acres where gambling with natural extremes requires crop
insurance and financial support. Now governments are faced with spending billions in North America to put areas under permanent cover,—simple polycultures that are poor replacements for the original complex communities of biota. Areas of original tall grass, short grass prairie, and foothills fescue grasslands, are far more capable of sustaining production over climatic extremes than in cultivated or degraded communities. Good condition native range provides more consistent production through climatic swings, and more effective water capture, where growing conditions for cultivars are marginal.

The great terrestrial carbon sinks are on grasslands, and the great cyclers of carbon, water, and energy are the great rain forests. Over millennia, grasslands built the organic base and fertility that the major bread baskets of the world enjoyed. In the past one hundred twenty years, 60 percent of the organic matter on cultivated lands has disappeared, destroying hundred millions of acre feet of carbon rich humus and biota. On the last remaining intact grasslands, introduction of foreign species remains a threat to the integrity of native plant communities and biodiversity.

The first well site the EUB must rule on, is a good example of what ecologists call anthropogenic edge; creation by man of foreign biological communities within the natural communities. Vermilion resources wishes to drill on an old site. Twenty-two years after site was abandoned, the access, and the site itself remain clearly delineated by the change to plant cover, and species composition. The old site itself is dominated by smooth brome which is developing a simplified community that will never restore itself to the indigenous community. Indeed over time, brome in wet years, will likely invade adjoining areas, especially along the cooler and more sheltered slopes.

A ranching operation winter grazes the land where this old site resides. This means a herd of brood cows harvest thousands of gigajoules of solar energy stored in native plants, without burning fossil fuels. In other modified landscapes, cattle require supplemental feed that is cultured, harvested, and distributed using fossil fuels. Typically, most food on our plate represents as much as ten calories of fossil fuel for every food calorie consumed. The stewardship of native grasslands to provide year round sustenance to ruminants, without fuel and fertilizer, represents one of the most sustainable, and cost efficient means of providing food. Winter grazing also provides energy flow in the ecosystem through winter, and reduced senescence of key bunch grasses.

The introduction of new species, disrupts the integrity of the checks and balances that have evolved within plant communities, and as is illustrated on the existing site, totally changes the productive quality on the land. Anthropogenic edge, invariably creates disruptions in grazing patterns of domestic, and wild ungulates, that reinforce divisions between native and modified communities, and create potential for further changes to the entire ecoregion, that affect succession, mineral and water cycling, and energy flows. Disturbance by wildfire, may even further amplify the contrasts by its affect on soil exposure and plant succession. Even soil morphology developed by these native grasslands is
uniquely adapted to wildfire.

In the past twenty years, with increased mobility of people and disturbances on lands, foreign plants and noxious weeds have invaded millions of acres. Even if there were clean native seed sources to reclaim disturbed sites, increased traffic, and interim bare ground, make contamination of the region almost certain, where new development occurs.

In business we use a double entry accounting system where every credit transaction is offset by a debit transaction that balances the distribution between assets, and liabilities and equity created by economic endeavor. But we have not employed the same measures to the environment we exploit.

In Alberta most hydrocarbon deposits are a public asset. When a company is awarded the right to exploit the asset, it sells off the asset to create income that is spent or reinvested. The liquidation of petroleum reserves also creates liabilities: carbon dioxide load, pollutants, disturbance of native plant communities, human activity, aesthetic, other economic interests and non renewable consumption of water resources and biological capital. Currently it is said, that the Alberta oil industry, pumps unrecoverable water underground equivalent to five times the annual consumption of water in the City of Red Deer. To date, most Albertans have been willing to ignore the costs, in order to encourage as much economic activity as possible. While we are very successful in exploiting irreplaceable, or non-renewable assets, the question must arise, how effectively is the economic activity dealing with liabilities, and the building of long term benefits to Albertans?

Surely, one of Alberta’s responsibilities is to direct this economic activity to preserving quality of life for future generations, by planning for aesthetics, sustainable enterprise, health and wellness.

I once asked James Strock a former environment minister for California what the greatest revelation of his job was. Without hesitation and in few words, - the complete lack of vision and planning for the future.

Rejection of the Kyoto accord, centers around loss of economic activity, without accounting for the liabilities and costs that will certainly impact our future communities and economy by ignoring legitimate issues.

As a young man growing up on a ranch, I was taught a responsibility to use land with future generations in mind. Holding private and public lands, I have seen a mandate within our capabilities to preserve the biological capital of land, of biotic communities, and watershed that not only sustain grazing ungulates, but preserve enduring values and the perpetuation of natural systems on which we depend. In preserving the biological capital we produce sustainable incomes.

The Energy and Utilities Board will soon begin ruling on a well, which potentially begins a huge transformation to the human and biotic communities west and
south of Longview. The EUB it seems, is the only sounding board to question priorities for society with respect to oil and gas development, and its mandate in practice has been to facilitate the extraction of subterranean resources.

While hydrocarbon is in the ground, it still is a public asset. Will the EUB determine the transformation of this area, one approval at a time, depleting petroleum reserve capital, while destroying biological capital, and jeopardizing sustainable ecologic and economic systems and communities?

Many in our community would be happy to see a moratorium on drilling activity. Companies holding rights should in turn receive consideration in tax credits or other arrangements where their rights may be set aside or deferred. At least we should weigh what the enduring public interests are for the future. People in part are attracted to Alberta by economic opportunity, but our government markets this province heavily on the few remaining open landscapes. We don’t promote this province to the world with pictures of oil, coal, forestry, or industrial agriculture footprints. I believe Albertans still value open space and nature, though governmental policy sometimes runs roughshod over these values.

The economic accounting in this province seems to be centered on cash flow and profit taking, while ignoring the total economic balance sheet. Values centered on quality of life seem to be confused with the tempo and quantity of economic activity. Careful and honest economic accounting, and enduring human values and aspiration must be weighed into our paradigms of success, if we are to have quality of life in local and global communities.

It is ironic, that much interest in hydrocarbon exploration centers on our export market to the U.S., while a state like Montana has placed a moratorium on areas of similar aesthetic and environmental significance.

The foothills ranching community that has evolved over the last one hundred years depends on a functioning landscape, and livestock that has been habituated, bred and adapted to land and climate.

Changes around us occur incrementally, and in the rush of our day obligations, we lose sight of how quickly and irrevocably changes accumulate in the environment on which we depend. The subjugation of the southern foothills ecoregion may occur one well, one road, one pipeline, and one industrial service at a time. Each development creates anthropologic edge, and an opportunity by ongoing activity for corruption of the natural ecosystem. In the next ten years, the sustainable nature of the economy and ecology of this landscape can be completely jeopardized, one gas well at a time.

The foothills from Longview to the southern Whaleback, are amongst the least disturbed lands of Alberta, and the settled regions of the world. They encompass a high proportion of fescue grassland community, and a small proportion of petroleum reserves. This region left intact provides a quality sustainable source of range based food, and habitat. The southern foothills are a critical area for
watershed, and aquifer recharge. These are one of the few remaining landscapes where a Ferruginous Hawk might feel at home, and where natural communities and ecologic process abide food production. How we treat this region, will reflect our values, and our true inclinations for stewardship of irreplaceable resources.

One thing remains certain, no mitigation will ever undo the ecologic and economic damage if the integrity of the existing complex is lost, and that would not weigh well on our provincial balance sheet, or mankind.

Respectfully: Gordon Cartwright March 2002, Revision July 30, 2002