PRAIRIE CONSERVATION FORUM

Minimizing the Effects of Oil and Gas Activity on Native Prairie in Alberta

Occasional Paper Number 4

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Prairie Conservation Forum.
Occasional Paper No. 2.

Dormaar J.F. and R.L. Barsh. December 2000.
The Prairie Landscape: Perceptions of Reality.
Prairie Conservation Forum.
Occasional Paper No. 3.

Prairie Conservation Forum

Minimizng the Effects of Oil and Gas Activity on Native Prairie in Alberta

Heather Sinton and
Christine Pitchford

October, 2002

Occasional Paper

Number 4

PRAIRIE CONSERVATION FORUM

Foreword

In its desire to raise public awareness, disseminate educational materials, promote discussion, and challenge our thinking, the Prairie Conservation Forum (PCF) has launched an Occasional Papers series and a Prairie Notes series.

The PCF's **Occasional Papers** series is intended to make a substantive contribution to our perception, understanding, and use of the prairie environment - our home. This series offers an alternative to scholarly journals for those authors who would like to get their message into the hands of a wider audience, including: landholders, industry representatives, environmental advocates, farmers, ranchers, government and non-government resource management professionals, and members of the broader public. Topics covered in this series will contribute to the wise use and conservation of biological diversity in the northern prairies.

We encourage the submission of papers that take a holistic perspective on issues affecting prairie conservation, that synthesize existing knowledge, that offer practical and applied advice on best management practices, that question existing points of view or which open doors to new ways of seeking harmony and promoting the sustainability of our prairie environment.

The PCF's **Prairie Notes** series is intended to provide an open forum for non-technical perspectives on prairie conservation issues. Authors are free to present their insights and 'world view' on any prairie conservation issue. A source of material for future Prairie Notes will be 'Straight Talk', a standing agenda item at Prairie Conservation Forum meetings where topical prairie issues are candidly discussed and are usually introduced by an invited speaker.

Interested individuals are encouraged to submit draft essays, articles, and papers to the PCF Steering Committee for review as a future Occasional Paper or Prairie Note. Prospective authors may wish to contact the PCF Secretary to discuss potential ideas and proposals before commencing with a writing project. Manuscripts should be submitted in electronic form to the PCF Secretary: Ian.Dyson@gov.ab.ca. Accepted articles will be posted on the PCF's web site and Occasional Papers may be published.

Disclaimer

The ideas and viewpints that are contained in this paper are those of the author(s) and do not necessarily represent the opinions or position of the Prairie Conservation Forum.

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This Occasional Paper is based on the material synthesized by Heather and the Native Prairie Guidelines Working Group for an educational document, *Prairie Oil and Gas: A Lighter Footprint* (Sinton, 2001). This Prairie Conservation Forum Occasional Paper is intended for oil/gas industry project planners and co-ordinators, and landowners who own or manage areas of native prairie. It will also be of interest to concerned members of the public who want to conserve native prairie ecosystems. The paper explores the impacts of various activities and presents options for conducting oil and gas operations in a manner that causes minimal disturbance to native prairie and parkland environments. Although references to regulatory requirements are exclusive to Alberta, the mitigation strategies presented are applicable anywhere on the prairies. Further information on the same topic can be found in:

- *Petroleum Industry Activity in Native Prairie and Parkland Areas: Guidelines for Minimizing Surface Disturbance.* (Native Prairie Guidelines Working Group, 2002). http://www.eub.gov.ab.ca/BBS/documents/reports/NativePrairie Guidelines.pdf
- *Prairie Oil and Gas: A Lighter Footprint.* Sinton, H.M. 2001. Alberta Environment. ISBN 0-7785-1711-X. 67 pp. http://www3.gov.ab.ca/env/protenf/publications/PrairieOilAndGas-Section1.pdf and http://www3.gov.ab.ca/env/protenf/publications/PrairieOilAndGas-Section2.pdf
- *Principles for Minimizing Surface Disturbance in Native Prairie and Parkland Areas.* Alberta Energy and Utilities Board Informational Letter 2002-1. http://www.eub.gov.ab.ca/bbs/requirements/ils/ils/il 2002-01.htm

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1.0 Introduction

Native prairie is an area of unbroken grassland or parkland dominated by native plant and wildlife species. The prairie landscape is part of our cultural heritage and is a significant aspect of our Canadian identity. Prairie plants have provided food for indigenous peoples and were used for medicinal and spiritual purposes. Early European settlers used native plants for food and as raw materials to produce various goods.

Deep rooted, fibrous native grasses and wildflowers have contributed to the formation of rich topsoil that is valued today for agricultural production. Native plants also store carbon and help to clean the air. In fact, prairie can actually store more carbon than a forest because of the extensive root systems of native plants.

Native grasslands and parkland have international significance as waterfowl breeding areas; they provide nesting and resting habitat for migratory songbirds and waterfowl. The prairies also provide habitat for rare, endangered, and threatened species including the burrowing owl *(Athene cunicularia)* and loggerhead shrike *(Lanius ludovicianus)*.

Native prairie is one of our most important natural resources - it is also one of our most threatened resources. The endless grasslands that were home to roaming herds of bison have been ploughed, drilled, and developed - leaving precious little of what was once a dramatic landscape *(Morgan, 1999)*.

Because we do not fully understand complex natural systems and the roles of individual species, it is wise to protect as much native prairie and parkland as possible. These landscapes have survived waves of drought, insect infestations, fires, floods and other natural processes that have occurred over thousands of years. Native species have developed adaptations for these extreme conditions.

With expanding human populations and industrial growth, increasing pressure is being placed on remaining native prairie areas. With an appreciation for the importance and value of prairie, industry, governments, and landowners must work together to plan the wise extraction of oil and gas reserves that lie below native prairie.

2.0 What are the effects of oil and gas development?

The undisturbed prairie landscape is a resilient, balanced system, well adapted to the regional climate. However, disturbance to this system is not easy to repair and many decades or even centuries may be required to re-establish or replace lost vegetation and soil. Some heritage resources that are disturbed, like teepee rings, are lost forever. The breeding sites and habitat of wildlife species may also be threatened or irretrievably lost.

2.1 Fragmentation of the Landscape

Although cultivation has contributed most to the fragmentation of prairie landscapes, the development of wellsites, pipelines and access roads have cut remaining prairie areas into increasingly smaller pieces. The Grassland Natural Region in Alberta, for example, contains over 75,000 wellsites, 45,000 km of access roads, and 3000 km of pipelines.

2.2 Risks to Wildlife

Disturbance to wildlife takes a number of forms. During construction and reclamation, physical disruption and noise may affect the life cycle of animals, especially during sensitive breeding periods. Fragmentation of the landscape with roads and pipelines may cause restriction of movement and mortality. Vegetation and soil disturbance can affect food sources for larger animals and may disrupt the life cycles of micro-fauna.

2.3 Risks to Soils

Topsoil takes a very long time to develop in the dry prairie environment. Sometimes there may only be a few centimeters of this valuable source of organic material and nutrients that are essential for plant growth. Disturbance poses several potential risks to soils. Wind erosion is the biggest risk to unprotected soils in flat prairie environments. In hilly areas, water erosion can wash away valuable topsoil very quickly.

Oil and gas activities can have significant long-term, adverse impacts on prairie soil if soil-handling procedures are not planned and implemented appropriately. Frozen, very wet or very dry soil conditions are usually not favourable for separating topsoil from subsoil. Physical and chemical properties of soil horizons, especially topsoil, can be degraded when subsoil is mixed with topsoil. A degraded soil may be less hospitable for plant growth and more susceptible to wind and water erosion. In addition, heavy traffic over soils can result in compaction that makes it difficult for plant roots to grow.

Potential for contamination from various equipment and facilities, including trucks, tanks and rigs, is always a risk during oil and gas operations. Oil, gas, diesel or salt spills may occur and contaminate soil and groundwater.

2.4 Risks to Native Vegetation

Some native plants take a very long time to recover from disturbance. For example, little club moss *(Selaginella densa)*, the cushion-like prairie plant that protects the soil surface from erosion, often does not reappear for forty to fifty years after a disturbance. Recovering vegetation may be damaged by grazing animals if reclamation sites are not adequately protected.

Invasive plants or weeds can be introduced during industrial activities through the application of contaminated topsoil, straw or amendments, and seed, or through the use of equipment and construction materials that are not clean. Weeds such as downy brome *(Bromus tectorum)* and some introduced forage crops such as smooth brome *(Bromus inermis)* and crested wheatgrass *(Agropyron cristatum)* can invade native prairie, adjacent to industrial sites. Invasive species compete with native species for light, nutrients and water and are a serious threat to the success of revegetated native plant communities.

2.5 Risks to Water Supplies

It is estimated that approximately one million hectares of prairie-parkland wetlands have been drained and converted to agriculture use. Wetland drainage and cultivation results in a loss of surface water storage and in a loss of wildlife habitat, grazing potential and recreational opportunities.

Drilling for oil and gas uses considerable volumes of water (approximately 440,000 liters are required for an average oil well; 85,500 liters are required for a shallow gas well) (McNeil, 2001). During times of drought, this additional demand on scarce water supplies can conflict with other land use needs.

Care must be taken to avoid contamination of water supplies by hydrocarbons, salts and sediment. Proper erosion control methods during construction and reclamation can prevent valuable soil resources blowing away or washing into watercourses. The presence of silt can result in the deterioration of fish habitat. Eventually sediments will settle out of the water and can cause problems downstream by filling waterbodies, which may necessitate costly removal.

3.0 What is the objective of reclamation in Alberta?

The objective of reclamation in Alberta is to return disturbed land to "equivalent land capability". The *Alberta Environmental Protection and Enhancement Act* (1993) defines equivalent land capability: "the ability of the land to support various land uses after reclamation is similar to the ability that existed prior to any activity being conducted on the land, but the ability to support individual land uses will not necessarily be equal after reclamation". Public land managers in Alberta have established the following goal for reclaiming prairie and parkland landscapes: "to promote the re-establishment of sound ecological function and the eventual restoration of the original range of variability in biological structure and diversity."

Achieving equivalent land capability is not a simple task, particularly on sensitive areas. The following need to be taken into consideration when undertaking reclamation work: climate, rough topography or unstable slopes, erosion-prone or saline soils, water bodies and wetlands, the presence of rare or threatened plants, plant communities or animals, important wildlife areas (e.g., breeding grounds, nesting areas and winter ranges), palaeontological and archaeological resources, the presence of unique features, and whether a site has been identified as having regional, provincial or national importance.

4.0 How should development be properly planned?

An effective oil and gas development program incorporates all of the following:

- Locating the development to avoid sensitive areas;
- Planning to minimize disturbance; and
- Using best management practices throughout construction, operations and reclamation.

4.1 Avoidance

Avoiding very sensitive areas is the most successful technique for mitigating the impacts of oil and gas activities. Methods of avoidance include:

- Relocating the project footprint;
- Utilizing existing disturbances (e.g., existing access);

- Reducing the size of the area by narrowing or changing the shape of the disturbance;
- Reducing the length of time the disturbance lasts or undertaking construction at a different time;
- Using alternative techniques to avoid direct surface disturbance; and
- Working from outside the project area (e.g., using directional drilling to avoid disturbing the sensitive area).

4.2 Communication

In planning operations for conservation and minimal disturbance, it is essential that all possible sources of information be utilized. There are often numerous land uses in a particular area and sometimes reclamation prescriptions only address one or a few of the many possible land uses. Conflicts can arise among various users or uses (e.g., the best time for establishing a native plant community may conflict with breeding birds) so early consultation (before formal applications for licencing are submitted) with landowners, land managers and government agencies is important.

Landowners have the right to specify how operations are conducted on their land within certain limits. On public land, operators need to talk to land managers to determine if there are any specific features or management concerns that should be addressed in a reclamation plan. A significant proportion of public land, for example, is under grazing disposition. It can be very helpful to consult with the grazing disposition holder or the land manager to determine grazing patterns and how they can be managed to assure reclamation success.

The Land Status Automated System (LSAS) can be consulted to get information about surface restrictions on public lands (i.e., protective and consultative notations). LSAS information may be obtained (for a fee) by contacting: Calgary Information Centre, Alberta Energy, 3rd Floor, Monenco Place, 801 - 6th Ave, SW, Calgary, AB. T2P 3W2 (Telephone 403-297-6324; Fax: 403 297-2576). Direction on land and resource use in Alberta is found in a variety of planning documents that cover much of the public land base in the province. These plans may provide guidance about permitted end land uses in an area, which in turn can affect the chosen reclamation strategy. A good place to start is at the Alberta Environment Information Centre (780) 422-2079.

The Alberta Energy and Utilities Board Informational Letter (EUB IL) 89-4 and EUB Guide 56 outline public involvement guidelines for companies when developing energy resources. Some companies set up telephone inquiry lines, provide information packages, fact sheets, and landowner notification materials, and hold open houses and consultation sessions. For large projects, environmental advisory committees should be set up and should include special interest groups and regulators. It is very important to discuss with the landowner/occupant ways to minimize disturbance. Equally important is ensuring those concerns are communicated to people involved in all stages of construction and operations.

Despite the best efforts to communicate and coordinate activities, it is important to have contingency plans in place in case sudden, unplanned constraints or challenges occur. The plan must be in place well ahead of time to enable project personnel to respond to last minute changes. Given the limitations of weather, availability of equipment and experienced labour, in some cases a well-planned large disturbance may be preferred over a poorly implemented minimal disturbance project.

4.3 Resource Inventories

As part of the planning process, pre-disturbance site assessments and resource inventories should be undertaken. The level of pre-disturbance assessments can vary, depending on the size and type of the project. They range from full Environmental Impact Assessments to quick surveys depending on the specific regulations that apply for the type of disturbance that is anticipated. On public land, a Site Information Report (SIR) is now required for oil and gas activities. This gives an overview of potential concerns.

Every effort should be made to compile as much information as possible about the history of the site. Information about construction and operations can provide valuable insights into possible problem areas. For example, with respect to well-sites, it is imperative to have a construction diagram that indicates where 'hotspots' like the well centre, the sump (for disposal of drilling waste) and the flare pit are located. These hotspots are more likely to experience hydrocarbon contamination than other areas of the site.

Other information that can be useful includes: history of sterilant use, herbicide/pesticide and fertilizer use on the area, what kind of vegetation has been growing there and for how long, types of weeds that have been on the site, location of topsoil storage piles, and whether soil amendments such as manure or straw were used. These types of records are hard to locate for older sites (pre-1980s). If the site is on public land, there may be information on lease files that can be accessed by contacting the local Public Lands or Special Areas Board office.

4.3.1 Wildlife

Use of a specific area by wildlife should be considered prior to disturbing a site. It is important to consult with local wildlife specialists including those knowledgeable about and/or responsible for various animal groups (e.g., fish, ungulates, predators, insects, etc.). Particular emphasis should be placed on rare or endangered species and those with very narrow environmental tolerances. The assessment period varies among animal species (e.g., fisheries require a longer assessment period than do ungulates).

The placement of timing restrictions during construction, operation and reclamation can minimize effects on wildlife. Construction during spring (April to June) is extremely disruptive to nesting songbirds. Raptor nesting can be disrupted unless construction is delayed until after mid July. Sensitive features (e.g., denning or nesting sites) can be avoided through observation of setback distances for particular species (Scobie and Faminow, 2000, Alberta Sustainable Resource Development, 2001).

4.3.2 Soils

Site assessments must include an inventory of soil resources. A soil inventory, whether pre- or post-disturbance, is essential for conservation and reclamation planning. The primary purpose of soil inventories and assessments is to identify, describe and map site diversity and associated features. The quality of conservation and reclamation plans is directly dependent on the level, detail and quality of the soil inventory.

A qualified soil specialist should conduct the inventory. The specialist must be able to provide the type of information that is useful for conservation and reclamation planning. The specialist must use an appropriate inspection density, conduct the inventory at the proper time (i.e., avoid frozen or snow covered ground and dark or wet conditions), use appropriate inspection techniques and equipment, and obtain correct soil information using appropriate techniques and systems (Alberta Environment, 1988; Pettapiece, 1996) for pre-disturbance sites and post-disturbance sites (Alberta Environmental Protection, 1995).

As part of the inventory, the specialist must be able to identify landscape features that may affect conservation and reclamation planning. Air photos, soil surveys, and historical site management information should be used for both pre- and post-disturbance areas. Pre-disturbance descriptions should include the following: land use, land management, landform, surficial deposits, topography, soil type and texture, stoniness, site drainage and drainage-ways, groundwater discharge areas, erosion, vegetation characteristics and surface salinity (Arnold Janz, personal communication). For post-disturbance assessments, landscape features should be described according to regulatory requirements.

4.3.3 Vegetation

A vegetation survey should be completed by a qualified vegetation specialist before disturbance occurs and should include an inventory of: native vegetation, existing weeds and invasive species, and rare plants/plant communities. These inventories should be extensive and include not only the construction site but also adjacent and surrounding sites.

- **Native Vegetation:** The goal of this assessment is to identify, describe and map the native plant communities that are present on-and off-site. It is important to record dominant plant species in order to determine what should be replanted on the disturbed area. The assessment should be conducted during the growing season, and if possible, during the flowering period. Adjacent native plant communities, if present, can provide a source of native propagules such as seeds or cuttings. These can sometimes be salvaged prior to disturbance. Range health/condition also affects the success of reclamation and should be recorded.

- **Weeds and Invasive Species:** Existing weeds and invasive plants are often a primary source of problems following site disturbance. It is important to remember that weed seeds can be found in most prairie soils -scattered there by wind from adjacent croplands. Often weeds won't appear on a site until the ground is disturbed and the conditions are right for germination. A weed survey should be conducted prior to any disturbance and the legal location, species, degree of infestation and growth stage recorded. It is a good idea for the company and land manager/landowner to co-sign the survey.

  The presence of perennial weeds (e.g., Canada thistle - *Cirsium arvense,* toadflax - *Linaria vulgaris,* purple loosestrife - *Lythrum salicornia*) or invasive species (e.g., smooth brome - *Bromus inermis*, crested wheatgrass - *Agropyron cristatum*; timothy - *Phleum pratense*) on or adjacent to a site can discourage or inhibit the establishment of native plants. Annual weeds (e.g., kochia - *Kochia scoparia*, flixweed - *Descurainia sophia*, stinkweed - *Thlaspi arvense*) in large quantities can also hinder the establishment of native plant communities. Control measures must be considered in the planning stage. Large populations of weeds and invasive species on a site may require years of control.

- **Rare Plants and Plant Communities:** A rare plant species is any native species that, because of its biological characteristics or its occurrence at the edge of its range or for some other reason, exists in low numbers or is confined to restricted areas. Rare plant species or rare plant communities in Alberta include those listed on the current Alberta

Natural Heritage Information Centre (http://www.cd.gov.ab.ca /preserving/parks/anhic/index.asp) tracking list (Allen 2002) and may include those listed by the Committee on the Status of Endangered Wildlife in Canada (COSEWIC) (www.cosewic.gc.ca). Conservation Data Centres (CDCs) in other provinces have developed tracking lists for rare species within their borders. Lists of rare species may change as new information becomes available or as the status of populations changes.

Rare plant surveys are undertaken to determine the presence and location of all rare plant species and botanically significant plant assemblages on a survey site. A rare plant survey can confirm the presence of rare species on a site, but it cannot rule out the existence of rare species on a site. Surveys should be undertaken three times during the growing season (early, mid and late) to catch the majority of species when they are flowering. Transects should be used for surveying. The Alberta Native Plant Council (ANPC) has published *Guidelines for Rare Plant Surveys* (Lancaster 2000), which are available on their website (www.anpc.ab.ca). Obtaining information about rare plants (when possible) assists in understanding the impact of a proposed project and in determining the best course of mitigation. The book, *Rare Vascular Plants of Alberta,* (Johnson and Lefebvre, 2000) is a good place to start.

Once a rare plant or rare plant community has been identified within a project area, four types of mitigation action can be considered: avoidance, impact minimization, plant or propagule salvage, or propagation. The primary consideration is whether disturbance can be avoided. In the case of pipelines, for example, it is often possible to re-route around or drill under the rare plant population. It is also important to have back-up mitigation measures in place in case changes in operating conditions make the planned mitigation unworkable. For instance, collecting seeds from plants that are to be avoided is good insurance. If successful, seed can be replaced during the post-construction stage.

4.3.4 Historical Resources

Historical resources in Alberta are defined within the *Historical Resources Act* as "any work of nature or of man that is primarily of value for its palaeontological, archaeological, prehistoric, historic, cultural, natural, scientific or aesthetic interest." Planners in Alberta need to review the *Listing of Significant Historical Sites and Areas* (Alberta Community Development, 2001) to determine if any designated historic sites (i.e., Provincial Historic Resources, Registered Historic Resources) or other significant historical resources are situated within the proposed development area. Alberta Community Development reviews development plans within buffer zones around designated historic sites.

5.0 How can we minimize the impacts of different types of oil and gas activity?

Minimal disturbance is "reducing the area of disturbance from the survey perimeter (maximum) to that deemed necessary to safely conduct the activity as well as ensuring the maintenance of equivalent soil capability" (Powter, 2002). There should be a holistic approach to minimal disturbance during all stages of the project (from site selection to reclamation). **Minimal disturbance is not something that occurs only during construction.** "Full life cycle planning" or "cradle to grave planning" ensures that minimal disturbance achieved during the construction stage is not compromised by, for example, maximum impact during abandonment operations. The following is a brief discussion of currently used minimum disturbance techniques for various oil and gas activities on native prairie landscapes.

5.1 Geophysical (seismic) Activity

There is generally little impact from geophysical activity on prairie. Where brush is found in coulees or valleys, hand-cut lines (or lightweight, portable equipment) can be used. Low-impact seismic (LIS) activity is a combination of hand and dozer cut lines. Narrow lines are typically 0.5 m wide. When using graders in areas where brush occurs (e.g., in coulees) the path should meander and follow the path of least resistance. LIS avoidance cutting is a line that meanders on and off the surveyed straight line, in order to minimize disturbance or avoid specific areas. Existing roads, trails and stream crossings should be used if possible. Seismic activity should be conducted in the winter to avoid damage to soft ground.

5.2 Wellsites

The least environmentally sensitive areas that meet technical requirements should be selected for drilling. Oil rigs are larger and usually require a pad; they are on-site for a much longer period than gas rigs and they require more frequent maintenance. There is also a greater risk of contamination occurring at oil wellsites. Topsoil and subsoil are usually salvaged and stored separately along the edge of the site. For shallow gas drilling, small conventional rigs are driven on prairie trails to the site.

Sometimes oversized tires are used to reduce the impacts of heavy loads. However, these are not recommended for sandy soils. Tanks are used, so there is no need to dig a sump for containing drilling fluids. The rig is parked on the prairie and little, if any, soil salvage is required. The rig drills through the prairie sod and leaves only a few meters of disturbed ground. Any salvaged soil is replaced and the site is left to recover naturally. Rigs are generally on-site for a couple days and there is limited maintenance and vehicle traffic to the drill site.

Timing is important. Ground conditions for minimal disturbance are ideal during late fall and winter. The site must be dry and firm, or frozen. Spring and summer operations during wet weather may impact surface soils. Frozen, very wet or very dry soil conditions are often not favourable for separating topsoil from subsoil. Some companies have agreed not to do summer drilling if the site cannot be placed near a road. Caution should be exercised under extremely dry conditions, as vehicle traffic can pulverize and erode very dry soil.

There are numerous techniques and factors to consider in planning minimal disturbance wellsites on native prairie:

- **Directional and Horizontal Drilling:** Directional drilling, or drilling at an angle to reach an underground formation, can be done under some circumstances thereby confining surface disturbance to a less sensitive location. The drilling equipment can handle up to a 10 to 20 per cent slope. Horizontal drilling (drilling straight down and then horizontally for up to 1.8 km) is useful in re-drilling old areas. Horizontal drilling requires larger rigs than conventional drilling.

- **Pad Drilling:** Pad drilling is the drilling of multiple directional or horizontal wells from one surface location. Having many wellheads on one site decreases the area disturbed by reducing the number of pipelines and access roads needed. It does, however, lead to a large area of the pad being disturbed (usually about 80%). Pad drilling requires foresight and knowledge of what other wells may be drilled in the area. The initial (exploratory) well should be drilled in a centralized location so that it can be integrated later into the larger multi-well pad. In the short term, the initial well may not be in an ideal location, but that location may be best for long-term pad development. Pad drilling requires long-term, big picture thinking.

- **Soil Salvage Options:** Shallow gas facilities require soil salvage if process facilities such as water separation are installed or if the topography is rough. For conventional exploratory and development wells, the stripped area of the lease is enlarged to meet spacing requirements and (if necessary) to accommodate storage tanks. If a well goes into production, surface soil and subsoil must be salvaged prior to commencement of fluid production regardless of the duration of production. Production facilities must not be placed directly on topsoil under any circumstances.

- **Drilling Fluids:** According to the Alberta Energy and Utilities Guide 50, companies are required to use environmentally safe drilling fluids. Drilling and completion operations must have a preventative maintenance schedule to limit and minimize the risk of hydraulic leaks. If a leak does occur, a drip tray must be installed to minimize contamination and facilitate cleanup. Undisturbed prairie should not be disturbed to accommodate drilling fluid disposal. Land spraying while drilling (LWD) is a means of disposing of water-based drilling fluids using vacuum trucks equipped with sprayers. The fluids are sprayed on cultivated land and left on the surface, thereby eliminating the need for digging a sump. LWD on prairie is no longer allowed by most land management agencies. Where hauling LWD to cultivated land is not an option, remote sumps may be used. Oversized tires may be used to minimize disturbance and compaction.

- **Access Roads:** The type of access that is needed is dependent on the following: type of well, type and size of drilling rig, duration of drilling, probability of success, and type of pad (single or multi-well). If a road is to be built, low-grade access is preferable to high-grade access. Access roads should not be stripped during wet spring or summer conditions or during winter chinook periods when surface soils are moist. A contingency plan should be in place when the access is not stripped. When ruts reach a depth of 7.5 to 10 cm, gravel can be used to fill ruts. Prairie vegetation will establish itself over the filled area in a few years. If several companies want to use the same road, it is best to locate the access road on a road allowance that all companies can have access to. Limiting the number of roads built and having common use agreements is a good way of minimizing impacts to the prairie landscape and to plant and animal species.

- **Special Equipment/Techniques:** A textile pad or a straw mat, laid on the prairie and covered with clay, can be used as a pad for wellsites in very sensitive areas (e.g., sand hills) to reduce the impacts caused by equipment tires and tracks. At the end of operations, the clay is lifted, the straw or textile removed, and the prairie swept with a street sweeper. There is very little evidence of any activity and perennial prairie vegetation grows back quickly from undisturbed roots. Companies may offer to dig a dugout for landowners (as long as it is in a viable location) and then use the clay for a clay cap on top of sandy subsoils. Construction on frozen soil can be advantageous since it minimizes compaction, however, separating frozen topsoil from subsoil can be difficult. Special frozen soil cutters have been developed to improve both separation and soil handling. When snow removal equipment is used, the blades should be raised to prevent scalping of prairie sod. Another option is to salvage topsoil in the late fall, ensuring that stockpiles are stabilized before freeze-up.

5.3 Pipelines

Quality control is probably the most important factor in achieving minimal disturbance during pipeline construction. Properly trained environmental inspectors with the necessary authority should be present during all phases of construction and reclamation. Matching the size of equipment to the size of the pipeline construction job is one of the most effective ways to ensure minimal disturbance of prairie environments during pipeline construction. The least invasive procedure should always be given first consideration for use. Generic prescriptions should be avoided because a construction or reclamation technique that is appropriate under one set of conditions may be entirely inappropriate in another situation.

The application of minimal disturbance techniques should be on a site-specific basis. Choice of appropriate techniques for a particular job should be based on an evaluation of soil (texture, depth, rocks, moisture and chemical characteristics), vegetation (type, sod thickness, range condition), weather and season, protection of other resources (wildlife, cultural), available machinery, safety, project size and length, and landowner/land manager preferences.

Companies are encouraged to incorporate new pipeline development with existing pipeline corridors and access roads to minimize fragmentation of the prairie landscape. When existing facilities are already seeded to invasive plants like crested wheatgrass, control programs should be initiated for several growing seasons and the whole area seeded to native species. Where this is not feasible, new pipelines should be placed at a distance so that invasive plants from the existing pipeline corridor do not spread to the new line. Sharing pipeline rights-of-way with other companies is also encouraged, providing separation requirements (specified distances between existing and new facilities) are followed for safety reasons.

Several ploughing, stripping and construction options exist for minimal disturbance pipeline construction:

- **Narrowing the Right-of-Way:** Minimizing disturbance to prairie vegetation by narrowing rights-of-way is desirable for pipeline construction, but should be conducted in conjunction with topsoil salvage, wherever possible. More grading has to be done in hilly areas to ensure safety and to overcome limitations in the ability to bend large diameter pipe. Companies should prepare "strip and grade" plans in the field with construction and environmental personnel in attendance.

The soil stripping progression (from least to most disturbance) starts with stripping of the trench only, followed by: blade width, double blade width, trench and spoil, trench and work side, and full width stripping. A step blade has been developed to facilitate trench-line stripping. A step blade has a fixed or adjustable depth and narrow width (generally less than two meters). It is attached in the centre of the blade of a grader. Step blades can be mounted on a conventional dozer for stripping the trench-line under frozen ground conditions only. The center (step) blade removes a predetermined topsoil depth and rolls the topsoil to the side of the future trench.

- **"No Strip":** Some small diameter pipelines have been constructed on the prairies without salvaging topsoil (referred to as "no strip"). Topsoil and subsoil are excavated in one lift, with the replaced material being a mixture of the two. This procedure constitutes a "trade-off"; salvaging the topsoil is sacrificed to reduce the amount of prairie vegetation that is disturbed. A better solution would be to salvage prairie vegetation and topsoil if at all possible. Future innovation may produce equipment that can accomplish both. In the meantime, if the "no strip" procedure is done properly under the right conditions, there may be significantly less disturbance to prairie vegetation. This technique should not be used when underlying soils or spoil have physical or chemical properties that could negatively affect the growth of vegetation (e.g., subsoils with a higher salt content than surface topsoils).

- **Ploughing-in:** Ploughing-in is a feasible alternative to stripping soils when low pressure, small diameter, sweet gas pipelines do not exceed 15 cm in diameter. There is no open excavation; a plough simply creates a narrow trench up to two meters deep that plastic or welded steel pipe is immediately fed into. Disturbance is minimal; only cracks in the sod layer appear (assuming the work is done under appropriate soil moisture conditions). In a prairie environment, large rocks, frozen, wet or heavy clay soils, extremely dry soils and complex topography may cause limitations to ploughing-in a small line.

- **Roaches:** Roaches are elevated ridges over the pipeline trench. When soil is excavated from the trench, it tends to bulk up. Larger pipes also take up space underground, displacing soil material. The bigger the pipe, the larger the displacement. The extra soil material is often left as a roach on the trench surface. In moist environments, materials in the trench will subside and the roach profile will be reduced. It is generally thought that trench subsidence (i.e., settling below the adjacent ground level) is less desirable than having a roach. However, leaving high roaches in dry prairie environments causes water to run off the top, leaving very dry soil in which plants cannot grow. Every effort should be made to maintain contours over the trench. Lower roaches can be achieved by feathering soil/spoil materials in a thin layer (less than three centimeters) over adjacent prairie sod and let the plants grow through. Following the feathering with a light harrowing facilitates the growth of vegetation through the soil/spoil.

- **Traffic Management:** Pipeline construction involves multiple passes by heavy equipment. This can lead to pulverization and compaction of soils. Dust can be controlled by spraying water (if available) on the right-of-way. Ways in which pipeline contractors can reduce the impacts of traffic on the right-of-way include: implementing one way traffic (this concentrates impact on the driving lane), using multiple passenger vehicles to transport workers to and from the site, designating access and turn-around points, and setting speed limits.

- **Watercourse Crossings:** Considerations for the design of a pipeline watercourse crossing include: geotechnical/hydrological conditions, soil, vegetation, fisheries and wildlife, land use and downstream water users. Other factors in selecting a watercourse crossing technique include: pipeline diameter, watercourse dimensions, environmental sensitivity, navigation, equipment availability, contractor expertise, engineering constraints and season.

Fisheries and wildlife construction timing windows have to be determined to select an appropriate crossing schedule that corresponds to the lowest period of environmental and watercourse sensitivity. Construction activities need to be designed to minimize equipment activity within the area of the watercourse crossing, ensure noxious weeds are not transferred from construction equipment to the crossing habitat, and provide sufficient work space on approach slopes and watercourse crossings to ensure surface and spoil material does not impact fisheries resources and habitat.

Conventional water crossing methods that require trench excavation can release significant amounts of sediment into the watercourse during in-stream construction, post-construction runoff and erosion of disturbed bank slopes. Horizontal directional drilling (HDD) is a useful technique for pipeline installation at sensitive watercourses (two main concerns are fisheries and/or slope stability). HDD is good because it places the pipe deep so there is little maintenance, it maintains good vegetation cover and it does not create erosion concerns. It has good aesthetics and aids in habitat protection. The open cut method may be necessary in situations where the subsurface conditions do not allow for HDD (e.g., very rocky, unstable slopes).

- **Special Equipment and Procedures:** Industry has been innovative in the design and development of equipment and procedures to meet specific needs. The prairie protector blade is a multi-layered epoxy resin blade that can be attached to a grader blade or a backhoe bucket and used to retrieve topsoil and spoil stored on top of undisturbed sod. The prairie protector minimizes disturbance to native vegetation by preventing sod scalping.

Street-sweepers have sometimes been used to collect the upper two to five cm of the soil seed bank prior to stripping the rest of the soil or trenching. This material is gathered by a bobcat and stored for re-spreading during reclamation. Street sweepers have also been used to gather the small amount of soil remaining after the grader and backhoes have replaced most of the spoil and topsoil into the trench. Bristles should be modified or replaced with floppy bristles with a soft texture so they do not rip the prairie sod and clog with vegetation.

Equipment has been developed to strip soil on slopes so that extensive topsoil handling is not required. For example, rubber-tired backhoes with cab levelers have been designed to work on steep slopes. Specialized equipment (e.g., Ossie Padders or Dyna Padders) can be used for backfilling rocky subsoil. These machines separate rocks from the subsoil before placing the subsoil in the trench. Frozen topsoil cutters have been developed to assist in winter topsoil salvage; they are more accurate than a standard ripper behind a bulldozer.

Sod salvage has been conducted on several projects on an experimental basis. Trials to date have been successful though expensive and labour intensive. Machinery developed for other projects (Western Rangeland Consultants, 2000) may have applications for oil and gas operations in the future.

6.0 How can conservation and reclamation assure the protection of prairie resources?

Equivalent capability is re-established by ensuring that care is taken to properly conserve resources and reclaim disturbed areas. Reclamation "sets the stage" for the eventual complete recovery of the disturbed area to a state similar to pre-disturbance or offsite conditions. This is most successful and cost effective if it is done correctly the first time. Another key ingredient in the reclamation process is time. It may take many years for vegetation to look similar to adjacent undisturbed areas.

Every effort should be made to re-establish a functioning ecosystem as quickly as possible. Re-contouring should be done to blend the disturbed area into the surrounding landscape and to re-establish drainage patterns and micro-topography. Soils must be properly conserved and replaced. Vegetation that is compatible with the surrounding landscape and with wildlife needs must be established on-site.

Monitoring is vitally important to determine whether equivalent capability has been achieved. Monitoring also validates the effectiveness of various techniques and practices. Problems can be identified at an earlier stage making corrective action easier and more effective. Adaptive management for future projects is also dependent on monitoring results.

6.1 Landscape

It is important that reclaimed sites be blended into the larger landscape. This can be accomplished by minimizing the disturbance and by using appropriate reclamation practices. Contours should be matched to surrounding topography and revegetation species should be matched with species that are found on adjacent lands. This provides landscape continuity for land use (e.g., grazing, wildlife) and improves aesthetics.

Fragmentation of the prairie can be minimized at the planning stage. As already stated, avoidance is the best strategy. When planning for the reduction of fragmentation, it is important to consider the current status of fragmentation in the area. Most fragmentation is a result of cultivation, urbanization, or roads. However, it can also exist because of overgrazing or the presence of persistent or invasive non-native species that have been planted on existing wellsites and pipelines. Where a new disturbance exists next to an existing disturbance that contains inappropriate species, reasonable measures should be taken to control invasive plants and to reseed the whole area with native species. This provides more continuity of land use and aesthetics in the landscape.

Efforts need to be made to conserve larger blocks of prairie but also to maintain smaller fragments and the connections between fragmented parcels. This is necessary for the survival and propagation of many plants and animals. The availability of water and wetlands also needs to be considered in reclamation planning. There are sometimes opportunities to enhance these during reclamation.

6.2 Soil

Topsoil is one of the most important resources in a functioning prairie ecosystem. Considering the length of time required for its natural development, it should be considered a non-renewable resource. Topsoil must be conserved and spread on reclamation and revegetation sites. Exceptions may occur where weed populations in the topsoil jeopardize the success of the revegetation project.

Topsoil is considered important because it is a seed source, a nutrient source and the site of major biological activity. Organic matter in soil offers many benefits. It holds soil particles together, reducing the risk of erosion and improves the ability of the soil to accept and transmit air, water and nutrients. It also retains carbon from the atmosphere. Topsoil storage time should be kept to a minimum to improve the chances that seeds, rhizomes and microbes in the soil survive. Topsoil storage piles should have a low profile and must be revegetated or protected as soon as possible to prevent erosion and to sustain biological activity (Thurber et al, 1990).

Measures must be taken to reduce the risk of soil erosion during the construction and reclamation stages. In areas prone to wind erosion, soils stored, even for short periods of time, should be protected. Various methods are available including tackifiers, straw, wind fences, etc. Tackifiers are non-toxic mixes of wood fiber and biodegradable glues that are combined with water and sprayed on the soil. They can prevent erosion for a few days through several weeks, depending on the product.

Other methods of controlling wind erosion include the planting of annual crops (at less than half the normal rate) and the use of straw crimping. The former is preferred due to the lower risk of weed contamination. Straw crimping is very valuable under drought conditions, however, when little grows. It involves spreading and pressing long stems of fresh wheat, barley or flax straw into the soil with a disc. Crimping is most effective when it is done in two directions, at right angles.

It is extremely important to use weed-free straw. Source fields must be inspected for weeds. The use of straw for crimping must be approved by the public land manager when applied to public land in Alberta. Purchasers can request that straw vendors roll out bales for inspection. Straw can also be sampled to determine weed content. Several samples should be pooled from several bales and sent to a qualified seed analysis laboratory for weed seed analysis. Operators must monitor disturbed areas for weed establishment following reclamation.

Square straw bales are only useful for wind erosion control when they are placed in a grid pattern. The use of brush mulch where it is available can also be considered. Spraying water on the soil surface to create a crust (in high clay soils) works well where surface traffic (e.g., cattle, vehicles) is minimal. Surface modification using a gouger or imprinter is another way of reducing erosion and providing a diversity of sites for seedlings to become established.

Water erosion risk can be reduced with the use of channel liners and diversion berms (water bars). Straw bales are not a good choice for controlling water erosion. Water tends to undercut or go around the bales. It is important to choose the right product for the job and install it correctly. Some erosion control products are made for lining channels (i.e., products that are thick and stiff), while others are made for protecting soil on slopes (i.e., products like coir or jute matting that are thinner and more flexible).

Soil compaction resulting from heavy equipment should be relieved prior to topsoil replacement and revegetation. Decompaction should be done by ripping the subsoil under dry conditions to the depth of compaction or 30 centimetres. Discing, harrowing and ploughing with agricultural equipment can be done on level, rock-free soils where compaction is at a depth of less than 20 centimetres. Paratillers are often used to alleviate compaction on wellsites and pipelines with minimal disturbance to vegetation. Paratilling lifts the soil, without overturning vegetation. Care should be taken to ensure good soil-seed contact following the alleviation of compaction. This can be accomplished by lightly rolling the area following seeding.

6.3 Vegetation

The goal for revegetation on prairie reclamation sites is the re-establishment of sound ecological function and the eventual restoration of the original range of variability in biological structure and diversity. The revegetation plan must conform to the end land use goals and management objectives. Some specific factors that need to be evaluated during revegetation planning include: grazing intensity, wildlife needs, weed problems and erosion potential.

When planning for revegetation, it is important to conduct a pre-disturbance site assessment and gather all available information about the plant communities on and around the area to be disturbed. When selecting species for revegetation, consider the scale of disturbance, degree of disturbance and risk of erosion. In some cases, a phased approach for reaching goals may require the use of short-lived native species to provide interim stabilization while being compatible with the long-term goal of native plant community establishment. To ensure the greatest chance of seeding success, information on site characteristics (past and present) should be obtained to identify whether special species adaptations are required.

Native species that grow in, and which are adapted to, the local area are the best choice for revegetating prairie disturbances. Native plants are species that occur within their historic range or whose presence outside that range is limited to the dispersal potential of the plant and is not known to be related to human activities. Common reasons for using native plants include: maintenance of biodiversity and aesthetics, sustaining multiple uses, and providing erosion control. Native plant material collected on site can sometimes be propagated offsite in nurseries to develop adequate supplies for longer-term projects.

Useful references for seed mix design are the *Guide for Using Native Plants on Disturbed Lands* (Gerling et al., 1996) and *Establishing Native Plant Communities* (Smreciu et al, 2002). Other useful references include: Dr. David Walker's *Seed Mix Calculator* (david.walker@shaw.ca), the Alberta

Native Plant Council (www.anpc.ab.ca) and the Native Plant Society of Saskatchewan (www.npss.sk.ca).

For some sites, natural recovery (no seeding) is an option. Generally, natural recovery is more suitable for small disturbances surrounded by native prairie where there is a low potential for erosion, effective salvage of the topsoil seed bank, good grazing management, and invasive weeds or agronomic species are distant (Alberta Environment, 2002).

Care should be taken during revegetation to prevent the introduction of weeds or invasive plants onto sites. All equipment should avoid existing weed infestations. All vehicles, including quads, should be cleaned to remove weed seeds prior to entering native prairie areas. Seed mixes should be screened for weeds and invasive species like crested wheatgrass, smooth brome and timothy. It is recommended that a seed analysis certificate be obtained for each seed lot (prior to mixing). Public Lands has a 'zero tolerance' policy for the presence of invasive and/or persistent non-native species in seed mixes (Alberta Agriculture, Food and Rural Development, 2000). Annual weeds such as flixweed are usually not a problem - except for downy brome; information on downy brome prevention and control is available in the publication, *Control Options for Downy Brome on Prairie Reclamation Sites* (Gerling, 2000). Perennial native plants eventually out-compete the annuals even if annuals set seed. Annual weeds may slow the establishment of seeded species due to shading. In these cases, annuals should be mowed prior to seed set and mulched or removed. Perennial noxious and restricted weeds designated by the *Alberta Weed Control Act* or by individual municipalities must be controlled.

Decisions affecting revegetation should be integrated with existing grazing management plans. This means selecting plant species for revegetation that can be grazed at the same time as the surrounding range. Cattle are attracted to new growth on reclaimed areas because it is more palatable and often more productive than adjacent native range areas. This can lead to trampling and overgrazing. It takes a full growing season, and often several in drought conditions, for newly planted vegetation to develop sufficiently to withstand grazing. If possible, the reclaimed area should be protected from grazing by fencing during the establishment period. Electric fencing may be a viable option for sensitive areas on pipelines. If fencing is not possible, changing the grazing rotation to keep cattle out of the reclaimed area during plant establishment may be necessary. It is also important to keep salt blocks away from newly revegetated areas.

Reclamation practices should consider the overall retention of habitat for a wide range of animal species. Wildlife habitat is a combination of landforms, plant communities, and water bodies that provide basic life requirements (i.e., food, water, cover) for wildlife species on a seasonal or year-round basis. Reclamation for wildlife should aim to provide these elements and allow for natural processes to adjust habitat structure over time. Seasonal habitat requirements for key species, size of the reclamation area, site constraints, selection of palatable and/or unpalatable species, and the arrangement of plants and plant communities must also be considered.

7.0 How do other prairie issues relate to oil and gas development?

7.1 How Pristine is the Native Prairie?

When reclaiming native prairie, a valid question is raised as to the degree to which care, time, and money should be applied to reclaim areas that were not "pristine" in character prior to disturbance (i.e., a non-native vegetation component existed before disturbance). There are many abandoned cultivated areas, for example, that contain a mixture of native and non-native species. Alberta Environment has completed an inventory of native prairie in the Grassland and Parkland Natural Regions of Alberta. Quarter sections that have more than 75% native vegetation are mapped as "native". This information is available on the Prairie Conservation Forum website: http://www.albertapcf.ab.ca/.

Land managers and landowners are generally most concerned about relatively "pristine" native prairie. These areas should be avoided if at all possible. If avoidance is impossible, the greatest amount of planning and effort should be used to minimize both the extent and duration of oil and gas activity in such areas. It is also equally important to take special care in avoiding small fragments of native prairie scattered throughout an otherwise cultivated landscape. These fragmented parcels can be vitally important as corridors or havens for threatened prairie wildlife and native plant species.

As a general rule, native species should be planted on those sites that were dominated by native species in their pre-disturbance state. If the surrounding vegetated area consists of more than 50% non-native species, it makes more sense to match the re-vegetated area with offsite conditions (particularly to keep the season of grazing the same). It is likely that the dominant species will re-establish themselves from the existing seed bank anyway.

7.2 Cultivation of Remnant Prairie

The oil and gas industry is trying to reduce the footprint of its activity on native prairie. As a result, well sites are generally smaller, pipeline rights-of-way are narrower, and more effort is being made to phase, time and integrate activities to reduce overall impacts. Efforts are being made to conserve soils, native species are being planted on disturbed areas, and specialized equipment is being developed and used. With industry expending a considerable amount of time, effort and money on minimal disturbance, it is unfortunate when landowners decide to cultivate remnant native prairie.

There are few controls on the use of private land in Alberta, and perhaps many people might argue that there shouldn't be any land use controls on deeded land. However, there are some places in the world where natural ecosystems on private land are protected. In Australia, at least four states have introduced Native Vegetation Conservation Acts that require landowners to make application prior to clearing or otherwise affecting native vegetation. Prior to the introduction of this legislation, Australia had the highest level of vegetation clearing of any country in the western world, and the eighth highest rate of any country in the world (New South Wales Department of Land and Water Conservation, 1998). Applications are evaluated and either approved (with conditions) or denied, on the basis of biological diversity, heritage issues, potential land and water degradation, economic and social costs and benefits, and the presence of threatened species. Perhaps it is time to look at similar protection for Canada's prairies.

7.3 Grazing Management

Many rangelands in Alberta continue to be overgrazed, despite the outstanding efforts of many range management professionals and land managers who have dedicated their careers to improving practices through education and example. Reclamation on overgrazed rangelands is very difficult. Soils are less productive because they have less organic matter and seedbanks of native species are depleted because the plants on overgrazed areas rarely get a chance to go to seed. Revegetated sites are, at the best of times, an attractant for livestock and wildlife because of the succulent young plants. When this is compounded by overuse, reclamation is often a failure or takes many more years to accomplish. It is difficult to impose strict standards on industry when landowners or land managers are not using the same land base in a sustainable manner.

Fencing of reclamation sites, though not always a perfect answer, is necessary in many cases to let the newly planted vegetation become well established. On pipelines, electric fencing may be a viable alternative to more permanent structures. Ranchers and industry need to work together to plan grazing management around oil and gas activity. Sometimes deferring grazing or changing the cattle rotation during the vegetation establishment years is sufficient to ensure success.

7.4 Water Conservation

As mentioned earlier, approximately 87,500 liters (87.5 cubic meters) of water are required for drilling a shallow gas well while an average oil well requires 440,000 liters (440 cubic meters). While this water is not lost to the environment forever, it becomes unavailable in the short term. In areas where surface water supplies are very scarce, deeper water wells are drilled.

Conventional pumping only retrieves about 25 per cent of oil from reservoirs. Waterflooding is a process where water is pushed at high pressure down into older oilfields to bring up 5-10 per cent more oil. There is increasing concern about the amount of potable water being used by the oil industry for this purpose, especially in arid areas. Industry should use re-circulated water (formation brines) for waterflooding. There are other options that should be explored that may even be more efficient. One of the most promising is the use of carbon dioxide. This is, of course, more expensive than the free water that companies are currently using.

There are some things that should be done to conserve water, especially in times of drought. Care should be taken to maintain equipment so that it doesn't leak (Mckinnon, 2001). Drilling fluids get laden with solids and are very hard to reuse. Mobile treatment facilities are available but they are mostly designed to clean up salts and are cost prohibitive for removing solids. About half of all 'completion' fluids can be reused (Skarstol, 2001). This is an area that requires more innovation to meet water conservation objectives.

7.5 Deregulation

Alberta has developed a national reputation for its upstream oil and gas environmental regulatory structure. British Columbia and Saskatchewan have adopted the principles (and in the case of BC, the content) of our reclamation criteria. Site abandonment and reclamation work is steadily increasing. This has placed untenable workloads on regulators in the province. As a result, the trend in Alberta is towards education and deregulation (i.e., provide industry with codes and criteria and remove restrictions or regulations). It is thought that industry should take more responsibility for regulating itself. While this in itself is not a bad idea, there have to checks and balances in such a system to prevent abuse.

First of all, clear expectations have to be established. The reclamation criteria for wellsites that have been in use since 1995 need to be reviewed and adjusted on the basis of scientific studies and experience. New, objective evaluation tools also need to be developed. Industry needs to be educated about best management practices for various types of activities.

Areas for future research and innovation need to be identified. Some of these initiatives are already underway, however, it is important that industry take a lead role in educating their staff and their contractors. Industry needs to ensure that there is good consistent environmental inspection by properly trained and experienced personnel. There need to be clear penalties for infractions and a strong enforcement system. This requires auditing to ensure continued compliance. It is hoped that an effective system can be put in place that provides adequate protection for all lands, particularly sensitive landscapes like prairie.

7.6 Problem Agronomic Plants

Alberta Environment issued an Information Letter on this topic (AENV 2001) that outlines the expectations for the use of native species on reclamation sites in prairie and parkland areas. Elimination of problem introduced species (e.g., crested wheatgrass) is required on any prairie or parkland reclamation site constructed after January 1, 1993. Most sites constructed before 1993 were seeded to introduced forages. When re-disturbance takes place at the final clean-up stage (post-January 1993), companies must reseed to native species. A re-occurring problem is the considerable amount of non-native seed that is present in the soil and how to control emerging problem species. The University of Alberta currently has a graduate student researching this problem (Darcy Henderson, personal communication).

Another problem is how to address sites that are effectively "sterilized" or unfit for grazing in native prairie areas because problem agronomic plants mature much earlier than native plants in the surrounding rangeland. This problem is likely too large to address effectively. Some jurisdictions have developed risk assessment tools to aid in decision-making about what invasive plant populations they can control. Development of similar tools in Alberta would help land managers to allocate funding and energy to the most effective control strategies.

8.0 Conclusion

Landowners, land managers, industry representatives and conservationists can make informed decisions on issues regarding native prairie when they have an appreciation for its value and an understanding of how to reduce the impact of industrial activities such as oil and gas development. Technology and industrial practices are constantly changing and improving, so it is important to stay informed. Careful planning and good environmental inspection, the use of best management practices, monitoring, and the communication of results by all involved parties are key to reducing the footprint of these activities.

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