the PEMBINA institute

Well Site Operation

Environment & Energy in the North

A PRIMER

About the Pembina Institute

The **Pembina Institute** is an independent non-profit research, education and advocacy organization. It promotes environmental, social and economic sustainability through the development of practical solutions for businesses, governments, individuals and communities. The Pembina Institute provides policy research leadership on climate change, energy policy, green economics, renewable energy, and environmental governance, as well as extensive formal and public education programs. More information about the **Pembina Institute** is available at **www.pembina.org** or by contacting

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Contents

About the Primers

The Pembina Institute's Energy Watch program has developed a series of eight primers to help northern communities understand the potential environmental and, where applicable, human health impacts of oil and gas development. The primers also aim to help these communities effectively take part in managing these risks, ensuring that governments and oil and gas developers are using the best environmental practices available.

Each of the first six primers focuses on a different phase of oil and gas development.

There are four parts to each of these primers:

1. A basic description of the activities of that phase
2. The potential environmental and human health risks of that phase
3. The best practices available to reduce those risks
4. Opportunities for citizens to get involved in deciding how developers carry out the activity.

The following are the six phases of oil and gas development addressed by the primers:

Seismic Exploration—industry activities to create a picture or map of the geology below the Earth's surface to find oil and gas reserves.

Land Disposition—the actions companies need to take to get the rights to explore for and produce oil and gas reserves.

Exploration and Production Drilling — the activities companies perform to first locate oil and gas, then to find out the size and usability of an oil and gas reservoir, and finally to reach the oil and gas using intensive production drilling.

Well Site Operation—industry practices to remove oil and gas from underground reservoirs and transport them to the surface.

Oil and Gas Processing—actions companies take to process oil and gas to prepare it for sale.

Pipeline Construction and Operation—industry activity to set up pipelines that carry oil and gas from the place it comes out of the ground to the places where consumers will use it.

The last two primers focus specifically on citizens' rights around oil and gas development projects:

Citizens' Rights and Oil and Gas Development: Northwest Territories explains the rights that citizens have related to oil and gas development in the Northwest Territories.

Citizens' Rights and Oil and Gas Development: Yukon Territory explains the rights that citizens have related to oil and gas development in the Yukon Territory.

To produce these primers, the authors reviewed the limited oil and gas development already under way in Canada's North. They also researched the current issues and practices in Alberta, northeast British Columbia, and the Alaskan North Slope, where intensive oil and gas development is already occurring.

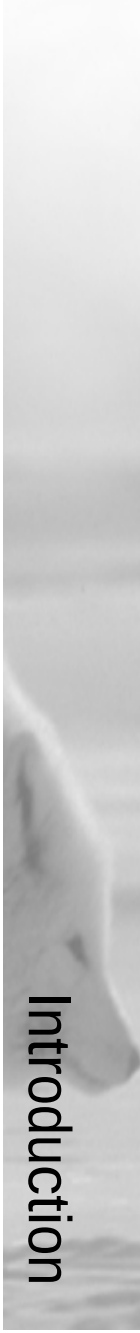
Introduction

Just as they were about twenty years ago, companies are once again actively exploring for oil and gas reserves in the frontier regions of the Northwest Territories and the Yukon Territory. If developers decide to develop these resources, they will have to build a large capacity (or large diameter) pipeline to export the oil and gas from the far North to other regions. Once developers make a final decision to build one or more pipelines, and once regulators approve the plans, oil and gas exploration and production activity in the North will quickly increase.

Developing the oil and gas resources of the North would offer the people living there many opportunities for economic development. But it is important that companies developing oil and gas reserves, and governments and other regulators overseeing the work, make sure they do not damage the cold, slow-growing and sensitive northern ecosystems. While there will be unavoidable environmental impacts because of oil and gas exploration, developers and regulators can reduce impacts with careful planning and by using the best available technologies and practices.

Since it is the people of the North who will experience the most direct impacts, it is important that they play a strong role in setting the terms and conditions of such development. When deciding on the actions they will take, industry and various levels of government need to be respectful of and consider the needs and wishes of Northern communities.

During the past few decades, the oil and gas industry has become more aware of the environmental impacts associated with its work. Technologies and practices have become much less environmentally damaging than they were in the past. And most, though not all, companies have responded to social and environmental concerns. Despite these improvements, there are still negative environmental impacts associated with oil and gas development and production. This is especially true in areas where the activity is intensive.



When the public shares their questions, concerns and expectations about this work — directly to companies, through the media, and through regulators that inspect the work and enforce regulations — this helps to uphold and improve industry performance. When the public is able to take part in effectively influencing decisions around oil and gas exploration, this pushes companies to higher levels of performance. When the public gives their input they tend to examine all companies equally; their participation ensures that all developers follow the best practices possible.

When companies involve local people and their concerns for the long-term health of their communities and environment they can build positive relationships, increase certainty and decrease conflicts around the project, and lower their investment risk.

This primer, ***Well Site Operation***, focuses on industry activities to remove oil and gas from underground reservoirs and transport it to the surface and the role of governments in setting and enforcing the rules to which industry must abide.

There are four sections in this primer:

- Part 1 provides a general description of well site operations
- Part 2 outlines the potential environmental impacts associated with well site operations
- Part 3 describes technologies and best practices that companies can use to reduce environmental risks
- Part 4 offers information on citizen rights and opportunities to influence government decisions to approve well sites.

What is Well Site Operation?

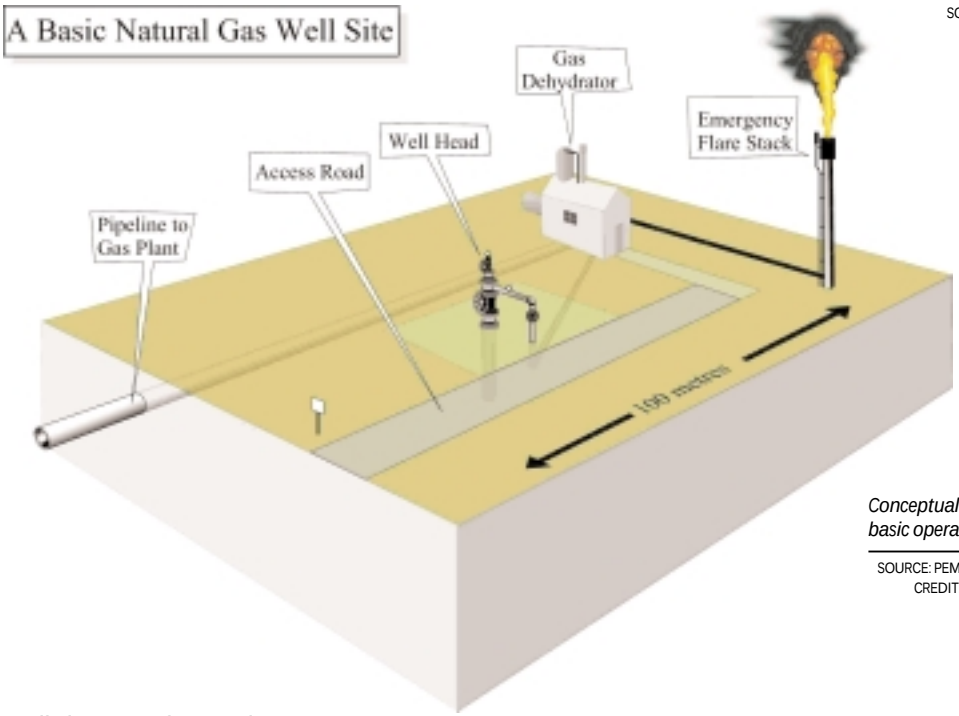
"Well site operation" includes the oil or gas production phase that starts when workers have drilled a production well and ends when they deactivate the well and reclaim the well site.

All wells sites have two basic features:

- ***wellhead*** — contains valves to control the flow of oil or gas from the reserve.
- ***well pad*** — normally made of gravel and large enough to hold all the equipment needed on the well site, as well equipment to service the well.

Wellhead

SOURCE: PEMBINA INSTITUTE



Conceptual drawing of basic operating well site

SOURCE: PEMBINA INSTITUTE
CREDIT: DAVE MUSSELL

Well sites can also include the following equipment:

Equipment	Description	Applicability	
		Oil	Gas
Pumpjack  SOURCE: PEMBINA INSTITUTE	When there is not enough pressure in the formation to automatically force the oil to the surface, workers will use a mechanical pump to bring the oil up. A pump jack works like an old-fashioned water pump. It is powered by a motor that uses electricity, diesel or propane. Companies choose the size of the pump and the pumping rate to correspond with the desired production rate of the well.	✔	
Separator  SOURCE: PEMBINA INSTITUTE	This is a vessel used to separate water and liquid hydrocarbons from gas in the case of a gas well site — or a vessel used to separate entrained gas from produced oil in the case of an oil well site.	✔	✔
Tanks	Companies use tanks to store produced water and/or oil.	✔	✔
Glycol dehydrator  SOURCE: PEMBINA INSTITUTE	When natural gas comes out of the formation, it may contain small quantities of water. Once in the pipelines, this water could cause the gas to freeze, and could also corrode the lines. To avoid this, workers may use a glycol dehydrator to remove the water from the gas before it enters the gas gathering system.		✔

Equipment	Description	Applicability	
		Oil	Gas
Line heater	Crews may use a line heater to heat the oil or gas while it is in the pipeline. This prevents it from freezing while it is transmitted (transported by pipeline) to the processing facility.	✔	✔
Flare stack or incinerator  SOURCE: PEMBINA INSTITUTE	Companies use either flaring or incineration to burn waste gases that have not been captured and fed into a pipeline.	✔	✔
Disposal wells	Disposal wells are drilled into deep underground geologic formations and are used to dispose of liquid and gaseous wastes. The formations must be "confined" — that is, there is no chance of these wastes moving into other geologic formations or into potential potable water aquifers. Companies often use drained oil and gas wells as disposal wells.	✔	✔
Compressors  SOURCE: PEMBINA INSTITUTE	Workers use gas- or electric-powered compressors to increase gas pressure so it will flow through pipelines.		✔

Equipment	Description	Applicability	
		Oil	Gas
Pumps	Crews use gas- or electric-powered pumps to apply pressure to oil or water so it will flow through pipelines.	✔	
Electricity generators or power lines	If workers need electrical power at a well site, they may use a portable generator to generate the power on site or they may connect the well site to a local power grid.	✔	✔
Meters	Crews use meters to measure the flow of oil and gas into the pipeline as it leaves the well site and travels to a processing facility.	✔	✔
Surface water containment ponds	Companies normally design well sites so that all of the rain water that lands on the well pad flows to one part of the site. They do this by making a depression or dug out area on the site large enough to contain all of the precipitation that may collect. The area where the water collects is called a surface water containment pond.	✔	✔
Microturbines	At the well site, companies can use microtubines (small electric generating units) that burn solution gas (gas that crews have removed from a well that mainly contains oil) to produce electricity.	✔	

Well sites often connect to all-season roads, or to winter access roads and a dedicated helicopter landing area. Almost all well sites have a connection with a gathering pipeline that transports the oil or gas to a processing facility and then to a large-volume transmission pipeline. The exact design of the well site depends on the oil and/or gas formation that crews have drilled into, and the hydrocarbon material they are removing. Crews will need different types of equipment depending on what they are drawing up the well. Here are some typical combinations:

Gas plus	Equipment needed
small quantities of water	dehydrator or line heater, flare stack
large quantities of water	separator, tank for water, dehydrator or line heater, flare stack
small quantities of oil	separator, tanks for oil and water, dehydrator, flare stack
large quantities of oil	flare stack, second pipeline for oil

Oil plus	Equipment needed
small quantities of water	none
large quantities of water	separator, tank for water
small quantities of gas	flare stack
large quantities of gas	flare stack, second pipeline for gas

Hydrocarbons are organic compounds that contain carbon and hydrogen molecules. Crude oil is a complex mixture of hydrocarbon compounds. Crude oil may contain small hydrocarbon compounds, such as propane and butane that are gases at atmospheric pressures (gas liquids); medium hydrocarbon compounds, such as gasoline-like liquids (condensate) and thick black oil (light crude); and large hydrocarbon compounds, such as heavy oil.

Raw natural gas is a fossil fuel that is in the gaseous state. Natural gas is a mixture of light hydrocarbons: methane (CH_4), gas liquids, and condensate.

Crude oil and raw natural gas may also contain impurities such as hydrogen sulphide (H_2S) and carbon dioxide (CO_2).

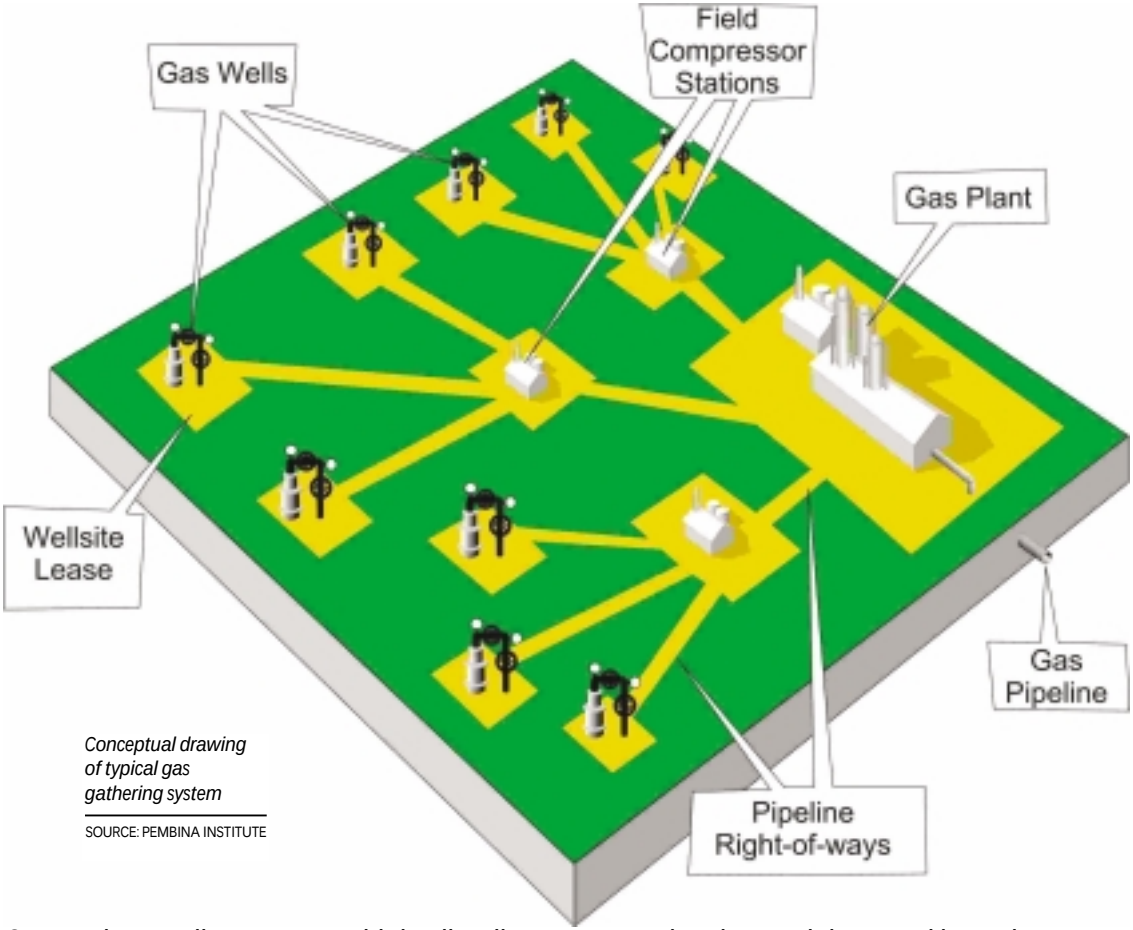
Although some wells produce only oil or gas, many wells produce both. Gas produced from a well containing mainly oil is called "solution gas" or "produced gas." Oil produced from a well containing mainly gas is called "produced oil." Water that comes to the surface when crews remove the oil or gas is called "produced water." There is almost always some water produced with oil or gas removal. The amount produced depends on the nature of the oil or gas formation and the quantity of oil or gas produced. It also determines the well site equipment needed to deal with it.

Sign warning of sour gas operations in the area

SOURCE: NIKI WILSON

Oil and gas wells that contain hydrogen sulphide gas are called "sour." Those without hydrogen sulphide, or with low concentrations of hydrogen sulphide, are called "sweet." The hydrogen sulphide content of wells can range from less than 1 percent to 30 percent or more. Whether hydrogen sulphide is present depends on the underground rock formation where the well has been drilled. There may be both sweet and sour wells in the same geographic area, because there may be different types of formations underground — some containing oil, some containing gas, some containing both. Produced oil, gas or water is therefore also considered sour or sweet, depending on the hydrogen sulphide content of the well from which they were removed. Some formations may contain hydrogen sulphide and others may not.

If crews drill into an oil or gas reserve on a curve, instead of straight down, they may be able to put multiple wells and wellheads at a single well site. The wells remove the oil or gas from the reserve and bring it to the surface for gathering in a pipeline and transporting to another site for processing. Companies can also use a single well bore (the hole made in the rock by the drill bit) to bring oil or gas to the surface from different underground formations. Workers would use separate production tubing (the pipe inside the well through which the oil or gas flows from the underground formation to the Earth's surface) to transport the oil or gas from the different formations.



Conceptual drawing of typical gas gathering system

SOURCE: PEMBINA INSTITUTE

Companies usually connect multiple oil wells to an oil battery with an oil gathering system pipeline. Here the oil undergoes basic separation and processing before it travels to a storage facility or large transmission pipeline for distribution and use. Developers connect multiple gas wells to gas plants with a gas gathering system pipeline. Workers process the gas at the plant and then send it to a large transmission pipeline for distribution and use.[1]

Workers can send oil and gas from wells that produce a mixture of the hydrocarbons to a processing facility through a "multi-phase" gathering system pipeline. Alternatively, crews can separate the oil and gas at the well site before pipelining.

1 These types of facilities are described in more detail in two of the other primers in this series: Oil and Gas Processing: A Primer and Pipelines: A Primer.

If quantities of oil or gas are too small to warrant a gathering system pipeline, crews can use other measures to deal with the product. In areas where there are roads, companies may choose to store small quantities of oil on site in tanks and then transport it by truck to processing facilities. Crews can combine ("cluster") solution gas from one well with gas from other nearby wells until they have enough gas gathered together to justify the cost of a pipeline or use it to fuel an electric generator at the well site. Or they may re-inject the gas, or dispose of it by incineration or flaring.

Companies must properly dispose of any produced water created during oil and gas extraction. According to law, they cannot normally dispose of produced water at the surface because such water can contain high levels of salts and trace levels of hydrocarbons and other pollutants. When crews remove produced water at the well, they can re-inject the water directly into the oil or gas formation (which can also sometimes maintain or improve recovery of the oil or gas resource). Alternatively, they can dispose of it in a deep disposal well,[2] either re-injecting it directly at the well site or trucking it to a disposal well off-site. Governments may allow some companies operating offshore oil and gas wells to release produced water into the ocean.

When the production rate of a well slows down, companies can try to increase the production rate of the well by bringing in a service rig. Alternatively, they can stop producing oil or gas from the well. Often producing wells will be "suspended" (put on hold temporarily) if the price of oil or gas is not enough to cover the costs of operating the well. Suspended wells may still have producible reserves, but developers will only reactivate them when market conditions improve. Sometimes a company will leave a well suspended for years or even decades before it decides to try to increase the production rate of the well. Or, the company may abandon the well altogether if they have removed all economically recoverable resources.

When a company decides to abandon a well, crews plug it by injecting cement into the well bore at the production zone (deep below the surface). They then cap and fill the surface portion of the well with cement. After workers have abandoned the well, they remove all surface facilities and structures. Next, they "remediate" (clean up and treat) any contamination of the lease site. Then crews "reclaim" the site by resurfacing it, returning top soil to the area, and shaping it so it fits into the landscape. Finally, they "revegetate" the area by putting in plant material that is native to the surroundings, or by scattering a standard seed mix that is designed to grow quickly to prevent erosion.

2 Depleted oil and gas wells are often used as disposal wells. Disposal wells are used to inject liquid wastes into permeable geologic formations that have no potential to allow migration of contaminants into potential potable water aquifers.

Environmental Impacts

Canada's north is a diverse landscape. It contains seven distinct ecological areas:

Arctic Cordillera Ecozone	mountains, rock, ice and glaciers, few plants and animals
Northern Arctic Ecozone	barren plains, permafrost, some rock, seabirds and muskox
Southern Arctic Ecozone	shrubs, meadows, lakes, large mammals
Taiga Cordillera Ecozone	mountains, arctic shrubs and flowers, wetlands, valleys, waterfalls, canyons, rivers, wide range of mammals
Taiga Plains Ecozone	low-lying plains, large rivers, rich diversity of plants, birds and mammals
Taiga Shield Ecozone	coniferous forest, bedrock, lakes, wetlands, meeting of the boreal and arctic zones
Boreal Cordillera Ecozone	mountains and valleys separated by wide lowlands

Since each area is unique, any oil and gas development will impact each area differently. The nature and extent of environmental impacts will depend on the regional ecosystem type, local terrain characteristics, the presence or absence of tree cover and permafrost, and the soil.

This section identifies potential land disturbances that may result from well site operation. Some impacts are common to all areas; others are particular to an area that may be sensitive in some way.

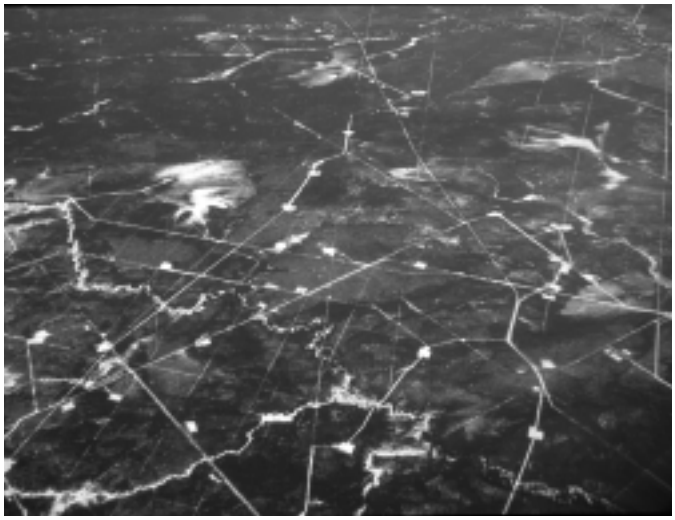
Disturbance of the Land Surface

Developing access roads, well pads, and associated facilities to support operating well sites and extracting resources disturbs the surface of the land. This disturbance starts at the stage of exploration and production drilling (see *Exploration and Production Drilling: A Primer*) and lasts until companies have fully reclaimed and restored roads, utility corridors, and well pads.

When developers create roads, camps, equipment storage areas, and other clearings this leaves breaks or separations in ecosystems. Fragmenting the landscape disrupts habitat and affects the way wildlife travels. Well site operation can also impact the land if vehicles compact the soil or damage the vegetative mat.

The time it takes for crews to reclaim well pads and roads can vary significantly. It depends on the time of year the operation takes place, the surface preparation and equipment transport methods they use, and the sensitivity of the soil and vegetation. Production wells, pads and roads may remain open and active for years or decades before companies finally abandon the wells and reclaim the surface. Of the habitat on the Alaska North Slope affected by gravel fill, only one percent has been restored.[3]

Over time, as companies build more and more pipeline and processing infrastructure in an area, production costs become cheaper. This means that previously uneconomic reserves of oil and gas can become economic to produce. This can result in multiple waves of oil and gas exploration and production activity in a given area and lead to cumulative impacts.



Well pads and roads near Grande Prairie Alberta.

SOURCE: WAYNE SAWCHUK

Camp Farewell staging area, NWT

SOURCE: ENVIRONMENT CANADA

3 National Research Council of the National Academies, Cumulative Environmental Effects of Oil and Gas Activities on Alaska's North Slope. March 2003.

Permafrost

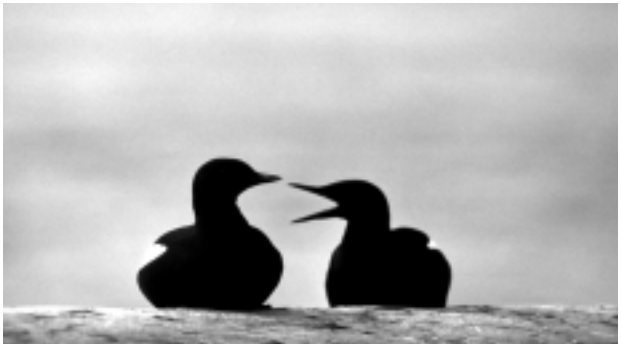
In arctic environments, the extent of surface disturbance depends on the type of soil and whether the soil is permafrost (a permanently frozen layer of soil underlying the "active layer" on top that melts and re-freezes each year). Permafrost soils are easily damaged. They are very sensitive to changes in temperature. Human activities, including the operation of large equipment, can result in dramatic reshaping of the land through rutting of roads, "melt-outs" and subsidence (settling of the land). Disturbing, compressing or removing any surface material and vegetation can result in increased soil temperatures in summer months. This can seriously damage the permafrost.

Wildlife

Areas where there are a lot of cutlines and access roads are known to impact wildlife and wildlife movement. For example, although woodland caribou often cross cutlines to access adjoining habitat, they will generally avoid being within 250 metres of these lines.[4] Wolves will use cutlines to quickly access an area, thus increasing predation on certain animals. Cleared areas have created more habitat for moose. The presence of larger moose populations may decrease habitat available to other animals, attract predators to the area and thereby upset the ecological balance.[5] Seismic activity may generally affect the size of wildlife populations, the location of herds, and their traditional migratory paths.

North Yukon: new tracks have been created to avoid further damage to old tracks

SOURCE: NIKI WILSON



Noise from wellsite equipment can disturb wildlife

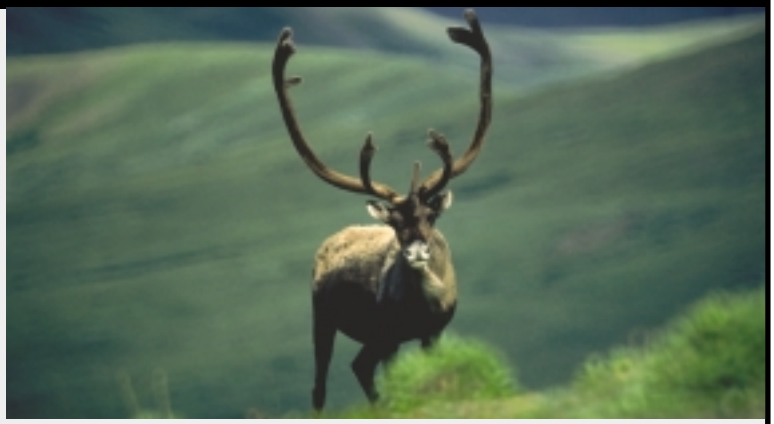
SOURCE: KEN MADSEN

4 Dyer, Simon. 1999. Movement and distribution of woodland caribou in response to industrial development in northeastern Alberta. Master of Science Thesis. Edmonton: University of Alberta. Also available online at http://www.deer.rr.ualberta.ca/caribou/SD_MSc.pdf .

5 Wyne, Bob. 2002. Boreal Caribou Research Program: Alberta's boreal caribou and oil and gas development. Paper presented at CPAWS Oil and Gas Workshop, May 26, in Edmonton, Alberta.

ARCTIC CARIBOU

Arctic caribou can be affected by the presence of oil and gas well pads, roads, processing facilities, and pipeline and utility corridors:[6]



Caribou

SOURCE: CPAWS YUKON CHAPTER

Increased Predation

Oil-field development may increase the impact of predators on caribou by forcing them to move into areas that have more predators, by increasing access of predators into areas where the caribou live, and by making caribou more vulnerable to predators by forcing them into open areas more often where they have less protection.

Changes in Distribution

Studies in Alaska have found that, when they give birth to their calves, caribou will move away from areas where companies are developing. Caribou that have just given birth are sensitive to disturbance and avoid roads and gravel pads with human activity for up to two to three weeks. Conversely, caribou will sometimes stand or lie on gravel pads and roads during times when there are a lot of insects. The lack of vegetation and the cooler air on gravel surfaces means there are fewer insects to trouble the caribou.

Energy Stress

When vehicles and roads disturb an area, caribou react by becoming more active. This means that they spend more time and energy walking and running than do undisturbed caribou. However, caribou that are also being harassed by insects tend to be less sensitive to oil-field disturbances.

Productivity

The amount of weight that Arctic caribou gain depends on the vegetation they eat during the summer. Caribou that do not gain enough weight during the summer are less likely to become pregnant. The size of caribou herds could become smaller if oil and gas activity were to reduce the quality of and access to the vegetation they eat.

6 Truett, J. and S. Johnson. 2000. The Natural History of an Arctic Oil Field: Development and Biota.

Noise from well site equipment, such as pump-jacks, motors, compressors and engines, can also disturb wildlife. When workers transport personnel, equipment and produced liquids to and from well sites they can disrupt wilderness areas. Permanent well pads, roads and pipeline corridors provide extensive and long-term access to hunters, fishers, and industrial and recreation users, which can have a severe impact on wilderness areas and wildlife populations.

Vegetation

Besides wildlife, land disturbance caused by well site operation also affects trees and other plants. When crews damage or remove vegetation in arctic regions it takes a long time to grow back. This is because the growing season is short and many areas have permafrost soils and slow- growing plant species. Compared with more southern parts of Canada, northern Canadian vegetation takes more time to recover from surface disturbances like roads and well pads.

Since oil and gas are non-renewable resources, companies will eventually exhaust supplies. Any surface impacts associated with resource extraction should, in theory, be temporary. However, surface impacts associated with oil and gas development often last far longer than initially expected. This is because oil and gas production typically becomes cheaper as developers build production and transmission infrastructure and as there are advances in technology. This means that previously uneconomic reserves of oil and gas can become economic to produce. In other words, previously drilled wells can be in production longer and companies may drill new wells in areas initially thought to be fully exploited.

Damage to Soil and Water

Well site operation can cause damage to both soil and water quality, as outlined in detail below.

Spills and Leaks

Well operations can contaminate soil and water through spills, leaks and blowouts of hydrocarbon and produced water. Drips and small leaks can occur at the wellhead, at pipe connections, and at vehicle loading areas. Contamination can result when workers clean equipment and vehicles on site. Workers can also accidentally release well fluids on site during well servicing operations.

Service rig.

SOURCE: PEMBINA INSTITUTE

SOME TERMS DEFINED

Well bore: *The hole that workers make in the underground rock formation using a drill bit.*

Down-hole: *A term to describe the tools, equipment and instruments that workers use in the well bore.*

Production tubing: *Tubing made of steel that carries hydrocarbons from the underground formation to the surface.*

Well casing: *Steel lining that supports the sides of the well bore and holds the production tubing in place.*

Cement plugs: *A barrier between the production formation and the well bore so that the only route that production fluids can take to the surface is up the production tubing.*

Down-hole equipment includes steel production tubing, the well casing, and cement plugs (see box for definition of terms). Holes or cracks in any of this equipment can result in leaks of fluid. The leaks occur when fluids move from the production zone (the area where the oil or gas is being brought from underground to the surface) through the cracks in the damaged equipment, into other underground rock formations, or travel up the well inside the casing and then through surface casing vents, which are there to prevent a build-up of gases in the casing. If the fluids leak out of the casing they may travel up the outside of the casing into groundwater-bearing zones closer to the land surface or travel all the way to the surface of the land.

Improperly abandoned wells and improperly reclaimed sites can result in contamination of soil, surface water and groundwater.

Produced Water

The federal government currently allows companies operating offshore wells to dump produced water into the ocean. The Department of Fisheries and Oceans is conducting research to address concerns that produced water discharges to the ocean environment in Canada are causing contamination and negative effects on fish and fish habitat.[7]

Water Use

When companies use surface water and groundwater to increase oil recovery, this is a drain on freshwater resources. This is especially a growing concern in drought-prone areas of Alberta and among farmers who rely on groundwater for drinking water, as well as in areas where there are competing uses for fresh water. According to the Alaska Oil and Gas Conservation Commission Annual Report for 2000, water injection for improved oil recovery operations in Alaska totalled more than 6 billion cubic metres (m3) in the year 2000. In 2002, the province of Alberta allocated 380 million m^3 of surface water and 58 million m^3 of groundwater for use by the petroleum industry for oil extraction and processing.[8]

7 Cranford, P.J. (Editor), 2001. Scientific Considerations and Research Results Relevant to the Review of the Offshore Waste Treatment Guidelines. Scientific Advice from DFO Atlantic Zone to DFO Management, Fisheries and Oceans Canada.8 Griffiths, M., and Woynillowicz D., Oil and Troubled Waters. Pembina Institute, April 2003.

8 Griffiths, M., and Woynillowicz D., Oil and Troubled Waters. Pembina Institute, April 2003.

Water Crossings

Roads and cutlines that cross or come too close to the edges of water bodies can damage vegetation and soil on the banks of watercourses. If not properly designed and maintained, both permanent and temporary stream crossings can become barriers to fish, preventing them from travelling up- or downstream.

Snow or ice crossings that are not properly removed before spring could also become impassable barriers to fish movement. In addition, these crossings can cause bank and bed erosion if the spring waters are forced to flow around the blocked watercourse.[9]

To cross streams and creeks, companies often install concrete or steel drainage pipes, called "culverts," instead of bridges. Culverts can pose barriers to fish, preventing them from travelling upstream. On the downstream side, water flowing through the culvert may erode the streambed, causing depressions and making a small waterfall too large for fish to jump over. If the culvert is too narrow, the force of the water flowing through the culvert can be too strong for fish to move through while trying to travel upstream.

Damage to Air Quality

Air emissions from well site operations vary according to the hydrocarbon a company is producing and the treatment that occurs on the well site.

One of the largest sources of air emissions from well sites is the flaring at oil wells of solution gas that is not economic to send by pipeline to a gas processing facility. Flaring releases typical products of combustion, as well as products of incomplete combustion, that are of concern to human and animal health. Products of combustion include carbon dioxide, nitrogen oxides, and sulphur dioxide (if the gas is sour). Products of incomplete combustion can

Undisturbed riverbank

SOURCE: CPAWS YUKON CHAPTER

9 Department of Fisheries and Oceans. 2002. Protocol for temporary winter access water crossings for oil and gas activities in the Northwest Territories.

SOUR GAS

Gas is considered "sour" if it contains hydrogen sulphide (H_2S).[10] H_2S is acutely toxic to humans at low levels. Humans exposed to levels of 1,000 parts per million (ppm) of H_2S can instantly die. At sour well site operations, where the operator is handling potentially dangerous H_2S gas, there are additional air quality risks and potential impacts that must be managed.

OIL & GAS

Oil and gas development in Alaska started in 1960 with one producing oil field. By 2001 oil development consisted of 19 producing fields, 20 pads with processing facilities, 115 pads with support facilities, 91 exploration sites, 13 off-shore exploration islands, 4 offshore production islands, 16 airstrips, 1,395 culverts, 960 km of roads and permanent trails, 725 km of pipeline corridors, 353 km of transmission lines, and gravel mines affecting 2,600 ha.[11]

include many harmful substances, such as benzene and other BTEX aromatics,[12] polycyclic aromatic hydrocarbon compounds (PAHs), methane, and hydrogen sulphide (if the gas is sour).

Flares had traditionally been thought to combust "waste" methane at greater than 98 percent efficiency. However, a 1996 Alberta Research Council study showed that flaring efficiency might be as low as 64 to 85 percent. This means that between 15 and 36 percent of the gas is not broken down at all, is only partially broken down, or is changed into other compounds and is emitting harmful substances. Studies carried out in a specially designed laboratory at the University of Alberta have found that wind and the speed at which the gas exits the flare stack are two key factors that effect the flare combustion efficiency. Efficiencies ranging from 99% to 82% have been measured at the in the lab.[13]

The Alberta Research Council study also showed that emissions released from flares contained over 250 different compounds. These compounds included hydrogen sulphide, benzene (a known cause of cancer), polycyclic aromatic hydrocarbons, and a host of other toxic products associated with incomplete combustion of solution gas.[14]

Flaring is also a significant source of greenhouse gases. Of the 1,534 million m^3 of solution gas that the petroleum industry flared and vented in 2000, approximately 639 million m^3 consisted of vented unburned

10 H2S is not found in all oil and gas formations. For example the gas reserves that have been found in the Mackenzie Delta in NWT is "sweet" (i.e., it does not contain H2S).

11 Upstream Petroleum Industry Flaring and Venting Report: Industry Report for Year Ending December 31, 2001. July 2002. National Research Council of the National Academies, Cumulative Environmental Effects of Oil and Gas Activities on Alaska's North Slope. March 2003.

12 BTEX aromatics consist of benzene, toluene, ethylbenzene, and xylene.

13 M.R. Johnson, O. Zastavniuk, D.J. Wilson and L. W. Kostiuk, Efficiency Measurements of Flares in a Cross Flow, Combustion and Environment Group, Department of Mechanical Engineering, University of Alberta, 1999.

14 M. Strosher, Investigations of Flare Gas Emissions in Alberta; Report to Environment Canada, Alberta Energy and Utilities Board, and Canadian Association of Petroleum Producers, (Environmental Technologies, Alberta Research Council, November 1996). 14 EUB Statistical Series 2002-60B,

hydrocarbons.[15] Methane is the primary compound released during venting, and is over 20 times more potent than carbon dioxide as a greenhouse gas.

Oil and gas wells are a significant source of fugitive emissions of volatile organic compounds (VOCs),[16] hazardous air pollutants (HAPs),[17] and greenhouse gases. The Alberta Energy and Utilities Board estimated that, in 1999, various sources in Alberta's upstream oil and gas industry vented 491 million m3 of gas direct to the atmosphere.[18]

Cumulative Impacts

A single oil and gas project, including for example a well, a pipeline and a road, may by itself have only a small impact on the environment. However, in combination with other projects that occur over time, the impacts can become bigger and bigger. Since many wells, roads and pipelines will be needed over time to exploit the large oil or gas reserves in the North, such cumulative impacts will likely be significant.

GAS FLARES

In 1996, there were 5,246 solution gas flares in Alberta. These flares burned 1.8 billion m^3 of gas, eight percent of the total volume of natural gas produced during that year. Residents living near such flares have long expressed concerns about problems with their health and the health of livestock, and about environmental impacts associated with flaring. The Clean Air Strategic Alliance (CASA)[19] set up a multi-stakeholder group in 1997 to develop recommendations that would address potential and observed impacts associated with routine solution gas flaring. In 1998 CASA set a target to reduce solution gas flaring by 15 percent by the end of 2000 and 25 percent by the end of 2001. Companies had reduced solution gas flaring by 30% by 2000 and by 62% by 2002, far exceeding CASA's original targets[20] and expect to achieve further reductions in subsequent years.

Flare

SOURCE: PEMBINA INSTITUTE

15 EUB Statistical Series 2002-60B, Upstream Petroleum Industry Flaring and Venting Report: Industry Report for Year Ending December 31, 2001. July 2002.
16 Volatile organic compounds are made up of hydrocarbon compounds larger than three carbon molecules in size and that "volatilize" (evaporate into the air).
17 Hazardous air pollutants include toxic hydrocarbon compounds such as benzene, fine particulate matter, heavy metals, and persistent organic pollutants such as dioxins.
18 EUB Statistical Series 2000-60B: "Upstream Petroleum Industry Flaring Report," 1999.20 National Research Council of the National Academies, Cumulative Environmental Effects of Oil and Gas Activities on Alaska's North Slope. March 2003.
19 The Clean Air Strategic Alliance (CASA) is a non-profit association of diverse stakeholders from government, industry, and non-government organizations (such as health and environment groups). Senior representatives from each of the three sectors are committed to developing and applying a comprehensive air quality management system for the people of Alberta through consensus.
20 EUB Statistical Series 2003-60B: "Upstream Petroleum Industry Flaring and Venting Report," 2002.

THERE IS STILL A LOT WE DON'T KNOW

There may be more environmental impacts associated with oil and gas development than are described in this primer. There are many things we still do not know about the impact of the oil and gas industry on the environment in Arctic Canada.

The Committee on Cumulative Environmental Effects of Alaskan North Slope Oil and Gas Activities has identified several major knowledge gaps in Alaska:[21]

Need for Comprehensive Planning
The government has typically decided who is given a permit to develop on a case-by-case, individual application basis. There is not a comprehensive plan to identify the scope, intensity, direction, or consequences of all industrial activities over time.

Ecosystem-level Research
Most ecological research in the Prudhoe Bay region of Alaska has focused on local studies of the behaviour and population of animal species. Long-term studies are needed to determine the impact of industrial activity on the productivity of tundra ecosystems.

Human Health Effects
There is not much information available on the effect of oil and gas activities on human health. More research is needed in this area.

Zones of Influence
The effects of industrial activities go beyond the industrial sites themselves and even the immediate area. Animals can be affected by gravel roads and well pads to a distance of several kilometres. Industrial structures on the tundra can be seen as far as 100 km away. More research is needed to learn about the impacts of activities and structures, and the distances over which the effects occur.

Air Contamination and its Effects
More research is needed to find out how much local emissions oil and gas facilities produce, and to determine ways that local and regional air masses and their contaminants interact.

Seismic Exploration and Other Off-Road Traffic
Studies are needed to determine the amount of snow cover and the depth of frost penetration into the soil that is required to adequately protect the tundra from the effects of seismic exploration vehicles. We need more information on the effects of trails from off-road vehicles, and how long these impacts last.

Bowhead Whales
Studies are needed to find out whether there is a relationship between noise generated by offshore oil and gas activity and the behaviour of bowhead whales.

Water Withdrawals
In Alaska, developers that wish to extract water from fish bearing lakes in the winter time are required to estimate the minimum water volume of the lake and then take no more than 15% of that volume. This level was arbitrarily set. Researchers need to find out whether this level of water withdrawal actually protects fish and invertebrates.

21 National Research Council of the National Academies, Cumulative Environmental Effects of Oil and Gas Activities on Alaska's North Slope. March 2003.

Using the Best Practices Available

Operation of oil and gas wells involves activities that will result in some environmental damage. Regulators and developers can minimize disruption of the environment by using "best practices and technologies" — the most environmentally effective standards, practices and technologies that have been proven to minimize environmental damage.

Overall, best practices aim to ensure the sustainability of human communities in areas where oil and gas development is occurring. When companies use best practices they take a "triple bottom line" approach, considering the economic, environmental, and social impacts on the community of any action they take. In each of these areas, regulators and developers design best practices to minimize damage to the community's well-being and to increase its viability. This document focuses primarily on environmental best practices.

In oil and gas development there are three types of best practices:

- those that apply to the principles of how a company plans and carries out the work
- those that refer to the practices and standards a company uses in the field
- those that have to do with the equipment a company uses.

With well site operation, most of the best practices refer to equipment and technology choices that industry can make before production at the well site begins. Compared with the past, companies plan more carefully, use smaller well pads and fewer roads, and use equipment and technology that produce less waste and fewer air emissions. These practices serve to reduce impacts of well site operation.

At this stage of oil and gas development regulators can use also best practices to minimize waste and air pollution as well prevent long-term liabilities associated with development. This includes considering immediate and future cumulative impacts of any proposed development.

Best practices that minimize the risk of environmental impacts from well site operation specifically aim to

- minimize soil compaction and erosion
- avoid soil and water quality impacts
- minimize direct and indirect wildlife disturbance and mortality
- ensure timely and proper abandonment and reclamation of wells and facilities
- ensure the availability and proper use of suitable waste treatment and disposal facilities
- avoid or minimize flaring and venting of gases
- recycle or treat wastes rather than dispose of them

- ensure worker and public safety in the event of an accident or upset.

The particular suite of practices and measures adopted for operating a specific well site should reflect local circumstances. Not all the best practices or measures listed below are suitable in all cases.

Planning

Integrated Land Use Planning

Governments should carry out as much land use planning as possible before the oil and gas development activity occurs. Governments should identify and map the areas that are most important from an ecological and cultural perspective, as well as the important habitat areas and wildlife corridors that are needed to connect protected areas together in a way that preserves the overall ecological integrity of the region.

By designating regions as protected, regulators preserve wildlife habitat, sacred sites, areas of traditional use for travel, hunting and gathering, burial grounds, and other sites of deep cultural significance. More work is needed to establish a network of protected areas that is representative of Canada's natural regions. In 1992, federal, territorial and provincial governments in Canada committed to a plan to establish a national network of terrestrial protected areas by 2000. The goal was not achieved. By 2000 only one-third of Canada's 486 terrestrial natural regions were adequately or moderately represented.[22]

Protected Areas

One way regulators can ensure they protect a region from some of the impacts of oil and gas development is to designate a network of parcels of land as "protected areas." These are areas that are of ecological, historical or cultural importance. Ideally, protected areas should be allowed to continue to function naturally and without any disruption. They should be large enough to preserve existing natural relationships and to allow these relationships to cycle and change according to natural forces, and without the impacts of industrial development.

Protected areas can serve as important regions where regulators and developers can conduct scientific research. They can compare the health of ecosystems in areas where oil and gas development has taken place with the health of ecosystems in protected areas where regulators have not allowed any development to occur. By using protected areas as benchmarks, government and industry can also evaluate the performance of measures that are used to mitigate impacts in areas where oil and gas development is allowed.

Special Management Areas

Besides establishing protected areas, another way governments can protect regions from the impacts of oil and gas development is to set aside lands as "special management areas" — areas where, temporarily, they will not allow any

22 World Wildlife Federation pamphlet, A Conservation Vision for the Mackenzie Valley natural gas pipeline: Balancing Nature and Industrial Development, July 2002.

THE MUSKWA-KECHIKA MANAGEMENT AREA

Muskwa-Kechika Management Area

SOURCE: GOVERNMENT OF BRITISH COLUMBIA *(http://srmwwwlgov.bc.ca/rmd/rmp/mk/maps/general/mk-over.htm) Feb 2004*

The Muskwa-Kechika Management Area was established in 1997. In 2001 it was enlarged to encompass a total area of 6.4 million hectares. Over one million hectares of the total area are parks and are therefore excluded from industrial development. Resource development including oil and gas is allowed in the rest of the management area in a manner that ensures protection of important wildlife and environmental values in the area.[23]

23 World Wildlife Federation pamphlet, A Conservation Vision for the Mackenzie Valley natural gas pipeline: Balancing Nature and Industrial Development, July 2002.

development to occur or where they will only allow certain types of development activity. The Muskwa-Kechika area of North Eastern British Columbia is an example of a special management area.

Many migratory bird species spend part of their life cycle in Canada's North.

SOURCE: KEN MADSEN.

Special management areas must be large enough to preserve ecological integrity and to support biodiversity. They can also act as laboratories for scientific inquiry. Similar to protected areas, special management areas can include areas that serve as "ecological benchmarks" against which industry can measure the success of its reclamation efforts in the parts of the region open to development.

To preserve a healthy ecosystem, special management areas cannot exist by themselves. They must connect with other surrounding areas that are also excluded from development, including undisturbed corridors that allow for wildlife to move and wander, and wetland areas for migratory birds.

Special management areas may have restrictions on the total amount of industrial activity that occurs at one time. Once developers have finished their oil and gas work in an area, they may do work to reclaim those areas, restoring as much as possible the original ecological integrity and biodiversity. When regulators deem the reclamation work to be successful, developers can then begin to develop areas originally set aside as reserves. This approach ensures that a certain percentage of the land at any given time is non-developed and functioning as a natural ecosystem.

LAND USE PLANNING IN THE GWICH'IN COMMUNITY

In the Northwest Territories, residents of the Gwich'in First Nation Settlement Area developed a land use planning strategy. Out of this, the Gwich'in Land Use Planning Board issued a land use plan in 1999 entitled Nanh' Geenjit Gwitr'it T'Igwaa'in (Working for the Land). Under this plan, the government divided the entire Gwich'in Settlement Area into three zones: protected areas, special management areas, and general use areas.

Protected Areas

Of the whole settlement region, the Gwich'in have set aside about 10% of the land as protected areas. In Gwich'in Settlement Areas, the traditional knowledge and experience on the land of residents and communities were a key factor in the land use planning process. The Land Use Planning Board has identified four types of Gwich'in Protected Areas in the land use plan:

- *core areas communities would like to see protected based on a variety of values ranging from current and historical use, heritage resources, wildlife, fish, forests, vegetation and water resources;*
- *core areas the scientific community would like to see protected based on critical wildlife habitat and populations, outstanding heritage sites, unique land features and ecological processes;*

SOURCE: NORTH YUKON RENEWABLE RESOURCE COUNCIL

SOURCE: NORTH YUKON RENEWABLE RESOURCE COUNCIL

- *five out of the six ecoregions of the Gwich'in Settlement Area; and*
- *areas that do not unreasonably limit the ability of resource development to occur in the Gwich'in Settlement Area.*

LAND USE PLANNING IN THE GWICH'IN COMMUNITY

As well as these four types of areas, there are also another 13 smaller Gwich'in Heritage Areas. These are areas of outstanding historical or cultural significance in the Gwich'in Settlement Area. These areas have the same status as Gwich'in Conservation Areas. The Gwich'in identified these areas through community consultation and with the help of the Gwich'in Social and Cultural Institute.

Special Management Areas
Of the whole settlement region, the Gwich'in have set aside about 33% of the land as special management areas. These are areas of special value to residents and communities of the Gwich'in Settlement Area where multiple uses may take place, provided potential developers meet the land use planning conditions of the particular Gwich'in Special Management Area.

General Use Area
Of the whole settlement region, the Gwich'in have set aside about 57% of the land as general use areas. These are areas that communities and other groups decided did not contain any specific resources needing special protection beyond what is available through the normal regulatory system.

Within the Gwich'in Settlement Area, all groups, including the Gwich'in, federal government, territorial government, co-management boards and business groups, must conform to the regulations Land Use Plan once it is approved. Regulators, like the Gwich'in Land and Water Board, cannot issue a licence, permit or authorization until developers show that their proposed activities conform to the Land Use Plan.

Orphan Well/Facility Programs

Wells and facilities that companies suspend but do not properly abandon represent a source of continuing environmental and financial liability. Experience in Alberta has shown that, without regulated time limits for abandonment and reclamation, many wells have been "suspended" indefinitely or become ownerless. The Alberta Energy and Utilities Board (EUB) estimated there were over 35,000 inactive wells in Alberta in 1997, of which about 10,000 had been inactive for ten or more consecutive years.[24] The EUB could not find the owners of many of these wells. The government classifies these wells as "orphan wells."

The EUB introduced its Long-Term Inactive Well Program in 1997. The focus of the program was on proper abandonment of the "down-hole" portion of wells (that is, the part of the well below the surface). The five-year program gave time frames for owners to properly abandon wells that had been inactive for more than ten years. In 2000, the EUB expanded the program to include a schedule for companies to reclaim

24 Interim Directive ID 97-08, "Long Term Inactive Well Program Requirements" (Alberta Energy and Utilities Board Corporate Compliance Group, 1997).

SOURCE: CANADIAN PARKS AND WILDERNESS SOCIETY – YUKON CHAPTER

the well site surfaces of previously orphaned wells. More recently, the EUB proposed changes to the Oil and Gas Conservation Act to add inactive upstream oil and gas facilities and pipelines to the program.[25] An annual fee charged to companies for each active well or facility funds the program. The amount of the fee is the cost of the previous year's orphan abandonment and reclamation projects divided by the number of inactive wells and facilities.

LAND USE PLANNING IN THE DEH CHO COMMUNITY

In April 2003 the Deh Cho First Nations and the Government of Canada announced that, for a five-year period as part of a longer-term land use planning process, it had formally withdrawn from development land totalling 10.1 million hectares[26] of northern boreal forest and wetland habitat in the Mackenzie Valley.[27] The temporary set aside of land in advance of proposed construction of a major natural gas pipeline along the Mackenzie Valley will allow the community to complete a Deh Cho land use plan. The plan will define how land will be managed in the Deh Cho territory.[28]

No development at all will be allowed on some of the lands withdrawn. In other cases only sub-surface development, such as oil and gas extraction, is excluded.

The land withdrawals process included consultations with Deh Cho community members, as well as third parties who have interests in the region like mining companies, oil and gas companies, and environmental groups. The decision to withdraw portions of the Deh Cho lands took account of the following criteria:

- *Lands harvested for food and medicinal purposes*
- *Culturally and spiritually significant lands*
- *Lands that are ecologically sensitive*
- *Watershed protection.*

25 The Liability Management Project – Presentation, AEUB, November 2000. For more information about the EUB Orphan Program contact Hal Knox, Corporate Compliance Group, AEUB (403) 297-3563.
26 The Deh Cho region of the Northwest Territories encompasses 20.8 million hectares.
27 Gift to the Earth #84, World Wildlife Fund, 17 April, 2003.
28 Backgrounder. Deh Cho Process – Interim Land Withdrawals, www.ainc-inac.gc.ca/nr/prs/j-a2003/02287bbk_e.html, April 17, 2003.

The EUB has also taken steps related to well licensing to reduce the number of future orphan wells, well sites, facilities and pipelines. These include

- retroactively licensing currently unlicensed facilities to ensure ownership is properly assigned;
- imposing qualification requirements to licence (gathering information about corporate structure, people in control, insurance, etc.);
- regulating licence transfers to prevent dumping of liabilities; and
- requiring licence to keep a minimum ratio of active to inactive wells and facilities.[29]

When an oil and gas field ages, and developers have removed most of the resources, companies that specialize in optimizing existing oil and gas wells buy wells from the original owners. These specializing companies continue to operate the wells for a period of time. An oil and gas well can change owners many times before it finally becomes uneconomical. At this point the new owner may not have the financial means to properly abandon and reclaim the well. Therefore, governments should set up a system whereby operators of economical wells pay into a fund. They can then use this fund to properly abandon and reclaim wells and well sites that might otherwise be "orphaned" at the end of their economic life.

Contamination Sampling before Reclamation

To decide when they can transfer responsibility for the site back to the surface rights holder, regulators use well site reclamation and remediation criteria. Regulators should consider including a requirement that companies carry out sampling for surface and subsurface contamination on a site before they apply for a reclamation certificate.

Minimizing Ongoing Access to Wells

Traditionally, a field operator visits oil and gas wells once a day. Operators should minimize their visits whenever possible to reduce the chances of disturbing wildlife. SCADA systems (Supervisory Control and Data Acquisition technology) allow operators located at central facilities such as gas plants to remotely control wells and pipelines that are tied into the facility by computer.

In some areas, workers can access well sites by helicopter, small all-terrain vehicles, low ground pressure vehicles on compacted snow roads, or snowmobiles. This allows them to avoid the cost and impacts of building, using and maintaining an all-weather road.

Selection, Handling and Storage of Materials

Preventing Tank Sludge

When crews remove oil from a well and store it in tanks, solids that are heavier than the oil

29 Expanded Orphan Program Legislation Overview (presentation slides), Hal Knox, Corporate Compliance Group, AEUB, (403) 297-3563.

settle at the bottom of the tank forming a layer of sludge. "Tank sludge" (or "tank bottoms") is a type of toxic waste. Companies can minimize oily sludge formation in well-site storage vessels by using recirculating pumps or mixers inside tanks to keep heavier parts suspended throughout the oil, rather than allowing them to collect on the bottom. Cone-shaped tanks also help prevent solids from building up. Workers can also minimize oily sludge by preventing contact with an oxidizing environment (that is, exposure to air). They can do this by using a "gas blanket" (replacing air in the tank headspace with a non-oxidizing gas) or by using a "floating top" (a top that moves up and down depending on the volume of product in the tanks, so there is no tank headspace filled with air).

Down-hole Separation of Oil or Gas and Water[30]

Treating and disposing produced water is expensive for companies and a potential risk to the environment. Produced water contains high levels of salt compounds and trace levels of hydrocarbon and metals, and can be highly corrosive. The volumes of produced water from a given well often increase as the reserve is emptied. Because of environmental impacts and the availability of alternative disposal options (such as re-injection to keep formation pressure and deep well disposal), companies throughout Canada are no longer allowed to release produced water at the surface in on-shore operations.

Produced water can make its way into the environment through leaks and spills. Developers can use "down-hole separation" to prevent these impacts by reducing the volume of produced water they must handle and dispose at the surface. With down-hole separation workers use gravity or mechanical separation techniques inside the well bore to separate the water from the resource they are removing. They then inject the water into another geological formation, typically deeper than the production zone. Workers will still need to manage some produced water at the surface, but these techniques will greatly reduce the volumes and therefore the cost and environmental risk.

Down-hole separation also eliminates the need for water filtering, water pumping, ocean dumping (in the case of off-shore oil and gas), water transportation and deep-well disposal.

Different down-hole separation technologies are available for different types of wells and the oil or gas products to be handled. In formations where oil and water are separate, crews can make two holes in the well. They remove oil from one hole and bring it to the surface; from the other hole they remove water and then inject it into a lower disposal zone using gravity. Alternatively, workers can use a hydrocyclone

30 US EPA Sector Notebook Project, "Oil and Gas Extraction," October 1999; U.S. Department of Energy, "Environmental Benefits of Advanced Oil and Gas Technology," http://www.fe.doe.gov/oil_gas/environ_rpt/index.html, March 2000; John A. Veil, Bruce G. Langhus, and Stan Belieu, "Feasibility Evaluation of Downhole Oil/Water Separator (DOWS) Technology," prepared for the U.S. Department of Energy, National Petroleum Technology Office, January 1999.

down-hole to separate free water from oil- or gas-containing fluid by applying centrifugal force. The water is then injected into the disposal zone. For gas wells, simple gravity can be used to separate gas and water in the well bore.

Deep Well Disposal

Companies should try to dispose of oilfield wastes they cannot prevent or recycle by using deep well disposal into an underground formation that is geologically confined. This is preferred to landfilling, or land treatment (spreading the waste on the land surface and encouraging microorganisms to break it down).

Wells used for deep well disposal must be properly designed to handle the expected waste streams. Governments should adopt a disposal well classification system that covers the design requirements for each class of disposal well.[31]

Companies operating in Alaska's North Slope region must now use deep wells to dispose of all non-recyclable oilfield wastes that they produce in the region. A "grind and inject" facility crushes the waste material, turns it into fluid, and then injects it into deep disposal wells.

Storage Vessel Spill Prevention[32]

Because of the risk of soil or groundwater contamination, companies should not use below-ground storage tanks.

Developers should ensure that they build tanks on an impermeable or lined surface.

Companies should use tanks that have extra containment features, such as double walls, or they should surround the tanks with a diked area that has the capacity to contain at least 110 percent of the tank storage volume.

Workers should be careful not to overfill or put too much pressure in tanks. They can do this by using high-level alarms that warn workers when tanks are close to being filled, automatic shut-off devices that stop the filling of tanks when high levels are reached, and simple periodic visual checks to make sure that the products in tanks are at safe levels.

At well sites workers should use oil drip pans on major equipment such as generators, trucks and other vehicles to avoid impacts associated with ongoing small leaks and spills. Workers can also limit soil impacts by refuelling and servicing equipment in dedicated areas that are equipped with spill capture and containment devices.

Companies should develop fuel spill contingency plans for fuel storage and refuelling sites. To minimize environmental impacts and personal safety hazards, all workers should be aware of what to do in the event of a spill.

"Zero Drip" While Operating and Servicing

Companies that have a zero-drip policy try to avoid surface contamination by preventing spills from happening, and to contain and quickly clean up any spills that do occur. Zero-drip measures are especially applicable under

31 Alberta has adopted a comprehensive classification of disposal wells. EUB Guide 51, "Injection and Disposal Wells."
32 "Alberta Environment Guidelines for New Above Ground Storage Tanks" – Draft, March 2000.

equipment that contains fuel oil or requires regular refuelling, such as diesel generators, and in locations prone to leaks or spills.[33]

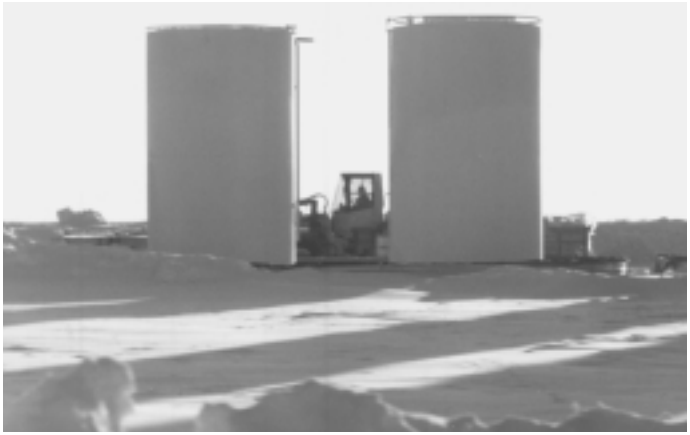
Eliminating or Minimizing Air Emissions

Flaring and Venting

Companies should avoid routine venting and flaring of solution gas (gas associated with oil production). Such practices waste a valuable resource and release significant volumes of greenhouse gases and potentially hazardous air pollutants.

In Alberta the EUB requires that companies conserve, and not flare or vent, any gas that they can economically recover. The EUB's Guide 60: Upstream Petroleum Industry Flaring Requirements sets out Alberta requirements and expectations for all upstream petroleum industry flaring.[34] The Clean Air Strategic Alliance (CASA) developed many of the requirements for flaring and venting management.[35]

At the end of 2002, industry had reduced solution gas flaring by 62% compared with 1996 levels. Part of the reason for this success was that the



Tanks located within concrete dike.

SOURCE: PEMBINA INSTITUTE

Drip tray to prevent soil and water contamination

SOURCE: PEMBINA INSTITUTE

33 See the third primer in this series, Exploration and Production Drilling: A Primer, for more information about drip trays and well-servicing leak containment devices.

34 Alberta Energy and Utilities Board, Guide 60: Upstream Petroleum Industry Flaring Requirements, 2002.

35 The Clean Air Strategic Alliance (CASA) is a non-profit association of diverse stakeholders from government, industry, and non-government organizations (such as health and environment groups). Senior representatives from each of the three sectors are committed to developing and applying a comprehensive air quality management system for the people of Alberta through consensus. www.casahome.org (January 2004)

government required companies to conduct a flaring management decision-tree analysis for all flares. This decision-making process included criteria that companies could use to decide whether it was economically viable to conserve gas instead of flaring it. If it was found to be economic, companies were then required to conserve the gas.

CASA's Flaring/Venting Project Team reconvened in 2003 to discuss setting up specific reduction targets for venting as well as for increasing reduction targets for remaining sources of flaring. This team is expected to report on its progress in 2004.

These initiatives will reduce human exposure to hazardous air pollutants emitted by flares, as well as significantly decrease greenhouse gas emissions from these sources. In 1996, solution gas flaring in Alberta resulted in 5 megatonnes (Mt) of CO_2-equivalent emissions.[36] The government expects that targeted reductions in solution gas flaring will decrease these emissions by 1.25 Mt of CO_2-equivalent by 2001 and by 3 to 3.5 Mt of CO_2-equivalent by 2007.[37]

Alternatives to Flaring of Solution Gas

There are three basic alternatives to solution gas flaring:

1. Eliminate — through increased conservation and re-injection
2. Reduce — through heat or power generation
3. Mitigate — through incineration, improved flare design, or improved flare operation

Solution Gas Flaring

SOURCE: ALBERTA ENERGY AND UTILITIES BOARD

These alternatives are listed below, beginning with the "most desirable" and moving down the list to the "least desirable."

Increased Conservation: This involves companies collecting, processing and selling gas that they are currently allowed to flare. Companies can make enough money from clustering to justify the cost of building a pipeline. They can use the pipeline to connect the gas to a processing facility, where they can then compress, process and sell it, or use it to produce electricity or heat that is needed for an industrial purpose.

36 One megatonne (Mt) = one million tonnes.

37 Oil and Natural Gas Industry Foundation Paper, Background Information On The Ability of the Industry to Contribute to Greenhouse Gas Emission Reductions, Prepared For The National Climate Change Secretariat, September 1998.

Re-injection: This involves crews disposing of solution gas in a depleted oil- or gas-bearing zone, or using solution gas to improve recovery in an active oil- or gas-bearing zone. If companies cannot sell the gas (either because there is no access to a market or the gas is not high enough quality to sell), then re-injection would be the best method to use to deal it.

Heat or Power Generation: Sometimes developers can use the gas at the well site to produce heat needed to process the oil, power pumps, or even generate electricity. The most significant direct benefit of on-site heat or power generation is that it nearly eliminates the hazardous air pollutants emitted by flares.

Incineration: Incineration involves more complete combustion than flaring and thus avoids the release of hazardous air pollutants.

Improved Flare Operation: Companies can try to improve flare combustion efficiencies by improving the separation of liquids carried in solution gas before they direct the gas to a flare.

Alternatives to Venting of Solution Gas

In Alberta, CASA's Flaring/Venting Project Team is developing a provincial management framework for reducing solution gas venting. Preliminary work by this team resulted in a recommendation that industry and government set up a hierarchical decision-tree process similar to that used for flaring. Companies would conserve gas from venting wells that met the agreed-upon economic criteria.[38]

New Paradigm Engineering Ltd. completed a study that identifies technology options, and their associated costs, to reduce gas venting in the heavy oil sector.[39] The following are some of the options they studied:

- using the vent gas in the production process to heat the holding tank and/or run the well, thus eliminating the need to buy more gas
- improving the quality of the vented gas to allow companies to export the gas from the site
- using the gas in power generation.

Solution Gas Flaring Prevention during Plant Turnarounds

The Red Deer, Alberta regional office of the EUB introduced a policy in 1997 that prevented the flaring of solution gas during plant "turnaround."[40] Turnarounds are scheduled facility shut-downs for major upgrading or plant-wide maintenance. Before this policy was introduced, when gas plants that normally processed the solution gas were not in operation, companies would simply flare the gas. This was because, during shut-downs, some companies continued to produce oil from wells that contained solution gas and the solution gas had to be destroyed. Companies met the requirement for zero flaring by a combination of the following:

38 Gas Flaring and Venting in Alberta: Report and Recommendations for the Upstream Petroleum Industry by the Flaring/Venting Project Team, Clean Air Strategic Alliance, June 2002.
39 Conventional Heavy Oil Vent Mitigation, New Paradigm Engineering Ltd., Bruce Peachy
40 Letter to Industry Operators in the Red Deer EUB Region, Red Deer Regional AEUB Office, 1996. Contacts: Bill Starling or Andy Milne (403) 340-5454.

SWEET WELLS, SOUR WELLS & FUGITIVE EMISSIONS

Sweet oil and gas wells are wells without hydrogen sulphide or that have low concentrations of hydrogen sulphide. Sour oil and gas wells contain hydrogen sulphide. Oil, gas or water is therefore also considered sour or sweet, depending on the hydrogen sulphide content of the well from which they were removed.

The presence of hydrogen sulphide depends on the characteristics of the geologic formation that the well is drilled into. It is possible to have sweet and sour wells in the same geographic area because the wells can be drilled into different geologic formations that have different characteristics. The hydrogen sulphide content of wells can range from less than 1 percent to 30 percent or more.

Well sites may have numerous valves and pipe connections that can develop tiny leaks. These leaks can release methane and volatile organic compounds (VOCs) [41] to the air. These types of emissions are referred to as "fugitive emissions." Another source of fugitive emissions at these facilities is vapours from liquid hydrocarbon storage tanks.

- re-injecting the gas
- sending the gas to a plant that was not shut down
- minimizing plant turnaround time
- temporarily ceasing to produce, or "shutting-in" of the production from wells.

Improved Fugitive Emission Controls on Sweet Wells

Sweet wells have higher rates of fugitive emissions of methane and carbon dioxide than do sour wells.[42] Measures that reduce fugitive emissions from sour wells and associated facilities for health and safety reasons could be applied to sweet wells to reduce this source of greenhouse gases. These measures include:

- preventing "blowdowns" (direct venting from tanks to the atmosphere) when wells, pipelines, or processing facilities need to be purged of gas; to do this workers can use a portable pulldown or pumpdown compressor, which draws as much gas out of the vessel, well or pipeline as possible before they open it to the air
- ensuring tighter connections at wells, pipelines, and processing facilities
- using more rigorous leak detection and repair programs
- substituting pneumatic devices (devices that convert gas pressure from natural gas wells to a force that can be used to open and

41 Volatile organic compounds are comprised of hydrocarbon compounds larger than three carbon molecules in size and that "volatilize " (evaporate into the air).
42 Oil and Natural Gas Industry Foundation Paper, prepared for the National Climate Change Secretariat, September 1998.

close valves or drive pumps) with instrument air- or electric-powered valves and pumps

- injecting carbon dioxide extracted from sweet gas into deep disposal wells or active formations rather than venting it to the atmosphere.

For a leak detection program to be effective, workers must regularly inspect equipment. They can use handheld devices to detect gas in the air. One of the simplest methods to pinpoint a leak is to apply a soap and water solution to fittings and valves where the leaks generally occur and watch for bubbles. Workers can also use new handheld devices, such as high flow samplers, to quantify sweet gas fugitive emissions. When companies quantify fugitive emissions, this provides them with important information they can then use to design the most effective leak repair program for their company. It also enables them to provide accurate estimates of their greenhouse gas emissions to the government.[43]

Surface Casing Vent Flow Prevention

Gas from a well is supposed to flow from underground, through the inside of the production casing, and up to the surface. If there are leaks in the production casing, or an improper cement seal of the production zone, gas may be released from the well to the atmosphere. Workers must regularly check vents in the surface casing to ensure that leaks have not developed.

Workers usually leave surface casing vents on sweet wells open to the atmosphere so that pressure does not build up inside and break through the casing. If the gas does break through the surface casing, it could enter another sub-surface rock formation, make its way into groundwater and possibly cause subsurface contamination, or rise along the outside of the surface casing to the surface and escape into the air.[44] If workers detect a leak from surface casing vents they may need to re-cement the production casing. Crews can also collect vent gas and recover or direct it to an incinerator or flare rather than allowing it to vent into the air directly.

Glycol Dehydration Vapour Mitigation

To avoid corrosion and prevent "hydrate" (a solid compound containing water molecules) from forming inside pipelines, crews normally direct gas through a glycol dehydrator unit to remove water at well sites before it enters a gas gathering system. Called glycol dehydration, this technique works by percolating the gas through a substance called ethylene glycol and then boiling the glycol to evaporate the small quantities of water present in the gas.

As well as removing water from natural gas, glycol will also remove some benzene, toluene, ethyl benzene, and xylene (collectively referred to as BTEX) molecules, and H2S, if present. Water and any absorbed BTEX are evaporated out of the glycol using a process called heat regeneration, allowing the glycol to be reused.

43 US DOE Environmental Benefits of Advanced Oil and Gas Exploration and Production Technology, "Production Tech Facts," http://www.fe.doe.gov/oil_gas/environ_rpt/index.html. (July 2003)
44 EUB Oil and Gas Conservation Regulations, Section 6.100

ALTERNATIVES TO GYLCOL DEHYDRATORS

Other alternatives, which can be an improvement over glycol, include the following:

Molecular Sieve Dehydrators — For many years, companies have successfully used molecular sieve dehydrators in large liquid recovery plants where they needed extreme freeze protection. Molecular sieve dehydration involves "adsorbing" water by capturing it and making it accumulate on the surface of a crystalline solid. It is typically a closed system that removes water by heating the crystals to above the boiling point of water, releasing the water and regenerating the crystals so they can be reused. This process almost eliminates vapour and BTEX emissions. Because of its closed-system process, molecular sieve is suitable for dehydration of sour gas where the release of H_2S could be lethal.

Line Heaters/ Insulated Gathering Systems — For many years, companies have used line heaters and insulated gas gathering systems to raise the gas temperature above the freezing point as it enters and travels through the pipeline. Crews heat gas from multiple wells and then transport it by the pipeline to a central processing plant where one larger dehydrator (either glycol or molecular sieve) removes any water. The advantage of this system is that it requires fewer individual well-site dehydrators and results in better overall efficiency, with lower emissions because of economies of scale.

A standard dehydrator typically vents the water and hazardous BTEX molecules direct into the atmosphere. The glycol circulating pump and instrumentation, which are gas driven, also create emissions. There are some alternatives that companies can use to reduce or eliminate the emissions from glycol dehydrators.

In 1996, around 3,500 glycol dehydrators were in use in Canada.[45] In 1995, glycol dehydrators emitted 9,000 tonnes of benzene into the atmosphere. Benzene is a known carcinogen (able to cause cancer) that can cause harmful effects at any level of exposure. When the government listed benzene as a toxic substance under the Canadian Environmental Protection Act, industry voluntarily agreed to a series of emission reduction targets. Efforts by industry to reduce benzene emissions from glycol dehydrators so far have been successful in achieving roughly 75% reduction compared with the 1995 baseline. Industry has committed to a target of 90% reduction by 2005.

On all modern dehydration units, operators can reduce emissions simply by operating the dehydration unit in the most efficient way. For example, they can reduce the glycol circulation rate to the minimum level needed to ensure enough freeze protection, or to optimize the operating temperature of the unit. If crews use a separator before the dehydration unit to remove some of the water in gas, this will also reduce glycol circulation and therefore the volume of emissions.

45 "Best Management Practices for the Control of Benzene Emissions from Glycol Dehydrators," by the Working Group on Benzene Emissions from Glycol Dehydrators, November 1997.

Neither of the above approaches can eliminate emissions from glycol dehydrators. To have near-zero emissions from glycol dehydrators, workers would have to collect, and then flare or incinerate, all vapours from the glycol dehydrator vent. Crews would also need more equipment to condense as much water as possible before flaring or incineration. Finally, workers may need to add some fuel gas so that the vapours from the glycol dehydrator vent burn properly.

Glycol dehydrators are also used in gas processing plants, and the above comments apply to these as well.

Dehydrator at well site

SOURCE: PEMBINA INSTITUTE

Emission-controlled Pneumatic Devices

In well site locations without electrical power, workers can use pneumatic devices, which can run on natural gas from oil and gas formations, to drive pumps as well as power instrumentation and control equipment. High-bleed pneumatic devices can be major sources of methane emissions. Alternative technology is available that, while still using natural gas to drive pumps and instruments, does not vent to the atmosphere. An example of this is the Handfield Glycol Pump.[46] The gas used in this natural gas dehydrator pump is captured and used to partially fuel the glycol dehydrator.

Another system uses a small compressor to draw vented vapours back into the gas gathering system.

Many instrumentation suppliers now offer low-bleed or no-bleed pneumatic devices.[47] Although low-bleed devices cost more, most operators that install them (either initially or as a retrofit) end up making their money back on the investment.[48]

As a last resort, crews could collect vapours from high-bleed pneumatic devices and burn them in a flare or incinerator system.

46 Handfield Pump – Handfield Pumps Corporation;, www.pumps.ab.ca (July 2003).
47 By definition, an instrument that emits more than six cubic feet per hour is considered to be a "high-bleed" device. It is common for older instruments to bleed 50 to 100 times this amount.
48 U.S. DOE Environmental Benefits of Advanced Oil and Gas Exploration and Production Technology, "Production Tech Facts," http://www.fe.doe.gov/oil_gas/environ_rpt/index.html.

Industry Best Practice Commitment to Reduce Greenhouse Gases

The Kyoto Protocol, ratified by Canada in December 2002, requires a reduction in Canada's greenhouse gas emissions to six percent below the 1990 level during 2008–2012. In 2001, industrial facilities, including electricity generation, accounted for 53 percent of Canada's greenhouse gas emissions.[49]

To comply with the Kyoto Protocol, Canada needs to reduce its annual greenhouse gas emissions of 240 Mt of CO2-equivalent (Mt CO2e) below the latest official federal government projection of what emissions would be in 2010 under a "business-as-usual" scenario in which no deliberate action was taken to reduce emissions. The Climate Change Plan for Canada allocates 180 Mt of this 240 Mt so-called "Kyoto gap" to specific types of emissions sources. Of the 180 Mt, the Climate Change Plan allocates 99 Mt to industry.

Oil and gas companies and jurisdictions within Canada should develop and carry out greenhouse gas management plans to minimize the cost of complying with Kyoto and with subsequent emission reduction requirements. Such plans should include ways to reduce emissions through internal energy efficiency, investments in offsets and "green power," and a commitment to limiting absolute volumes of emissions. One company, BP, has set a goal to maintain its greenhouse gas emissions at 10 percent below its 1990 baseline level until the year 2012.[50]

PNEUMATIC DEVICES

Pneumatic devices are devices that are moved or worked by pressure or flow of a gas. They can use the pressure from natural gas wells to provide the force needed to operate control equipment on gas distribution systems, such as the opening and closing of valves. Some of this "power" gas is emitted to the atmosphere when these devices are operated. In some cases, natural gas must be continuously vented to the atmosphere for the equipment to operate properly. Over time, the vented gas adds up to a significant amount of greenhouse gas emissions.

Maintenance and Follow Up

Well Integrity Testing

Workers should periodically test new and existing wells (including suspended wells) to ensure that well activity and corrosion have not damaged the well casing. Integrity testing may include pressure or corrosion tests or both. Crews can perform corrosion tests using a magnetic flux device, which can detect internal and external pitting of the well walls, or by using an ultrasonic imager, which detects corrosion by measuring the thickness of the casing. If well integrity testing reveals a casing failure or the potential for a casing failure, crews should repair the well to prevent surface or subsurface release of gas or liquids.

49 Environment Canada, Greenhouse Gas Emission Summary, http://www.ec.gc.ca/pdb/ghg/canada_2001_e.cfm (July 2003)
50 BP - www.bp.com/environ_social/environment/clim_change/position.asp (July 2003)

Proper Power Sizing and Periodic Power-Use Surveys

It is common for workers to install equipment such as pump-jacks, circulating motors, cooling fans, and other well-site equipment that is larger or more powerful than is actually needed to ensure uninterrupted operation of oil and gas facilities. This is partly because, as workers deplete the wells, the power that is needed changes (for example, workers can turn down glycol circulating motors in gas dehydration units, but likely need to turn up oil pump-jacks). The tendency of crews to err on the side of over-powering can unnecessarily use energy and create air emissions. From time to time, operators should conduct power-use surveys to gather the information they need to properly match and tune facility power needs over time.

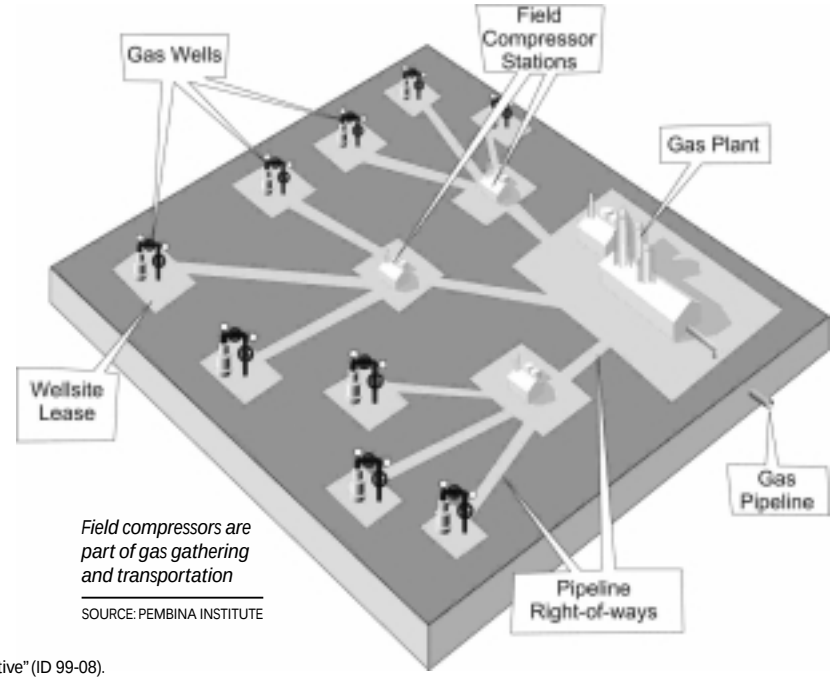
Noise Mitigation

There are many ways to reduce noise from well-site equipment, such as attaching mufflers, erecting acoustic buildings or adding insulation around equipment. A field compressor is the noisiest equipment associated with well site operation. Field compressors are usually a part of the gas gathering system, and are often located at a well site.

Companies can fit field compressors with mufflers to silence the engine exhaust. Industry can design the fans on compressor after-coolers for slow-speed operation to reduce fan noise.

Pump-jack motors and engines can also be a source of noise. They can be silenced with a properly designed acoustic enclosure.

Some jurisdictions have developed noise guidelines for the upstream oil and gas industry.[51] Alberta's guidelines, for example, set out allowable noise levels for affected residents near oil and gas industry development. The government could apply comparable guidelines to control noise impacts on recreation use and wildlife.



Field compressors are part of gas gathering and transportation

SOURCE: PEMBINA INSTITUTE

51 "Alberta Energy and Utilities Board Noise Control Directive" (ID 99-08).

Area of Concern	Best Practice
Comprehensive land use planning after subsurface rights are granted to industry	• Exclude oil and gas activity in areas that are of special ecological, historical or cultural importance. • Create special management area rules to govern oil and gas activity in ecologically important areas.
Orphaned wells	• Regulate time limits for abandonment of suspended or inactive wells, pipelines and field facilities. • Retroactively license all unlicensed facilities. • Regulate licence transfers on sale of properties; ensure operators do not have a high ratio of inactive to active wells.• • Set up funds to properly abandon inactive wells and facilities and reclaim sites at the end of their useful life.
Well site abandonment without enough contamination testing	• Conduct surface and subsurface sampling for contaminants before abandonment.
Generation of oil waste sludge	• Design facilities to minimize build-up of oily sludge. Use cone-shaped tanks, circulating pumps, and gas blankets.
Production of produced water	• Use down-hole separation techniques such as dual perforations and cyclones where possible.
Integrity of deep disposal wells	• Use a properly designed and classified deep well disposal system to handle produced water, drilling fluid wastes, and other liquid wastes.
Periodic storage vessel spills and leaks	• Use only above-ground storage vessels. • Locate tanks away from flood plains. • detection, secondary containment, and overfill and overpressure protection.

Area of Concern	Best Practice
Leaks/spills during well operation and servicing	• Impose a zero-drip policy that strives to eliminate surface contamination by using spill prevention measures and containment and rapid cleanup of all spill material.
Routine solution gas flaring and venting	• Eliminate or reduce flaring and venting by using the following alternatives: - increased conservation - re-injection - electricity generation - incineration - improved flare design and operation.
Flaring associated with well servicing	• Minimize flaring associated with servicing by using a separating system that allows a well to flow direct to the gathering system.
Solution gas flaring during plant turnarounds	• Prevent or reduce solution gas flaring during solution gas plant turnaround through a combination of - re-injecting the gas - sending the gas to a plant that was not shut down - minimizing plant turnaround time - scheduling maintenance of parallel oil production infrastructure to coincide with gas plant turnaround - temporarily shutting-in of well production.
Fugitive emissions from sweet wells	• Use the following measures to reduce fugitive emissions: - prevent direct venting and blowdowns to the atmosphere from drill stems, wells, pipelines (use pulldown compression), processing facilities and tanks - ensure tighter connections at wells, pipelines, and processing facilities - use more rigorous leak detection and repair programs - substitute pneumatic devices with instrument air or electric-powered valves and pumps - inject carbon dioxide extracted from sweet gas into deep disposal wells or producing formations rather than venting to atmosphere.

Area of Concern	Best Practice
Surface casing vent flow	• Prevent casing vent flows by regular checking to ensure that leaks have not developed that could potentially emit hazardous pollutants to the atmosphere or contaminate surrounding groundwater aquifers.
Integrity of wells	• Periodically conduct integrity testing on all new and existing wells (including suspended wells) to ensure that well activity and corrosion have not damaged the casing. Integrity testing includes pressure and corrosion tests.
Over-powering of well site equipment.	• Conduct periodic power-use surveys to properly match and tune facility power needs over time.
Emissions from pneumatic devices	• Use "low-bleed" or "no-bleed" pneumatic devices.
Noise	• Use noise abatement measures for well-site equipment such as mufflers, acoustic buildings, and acoustic insulation/lagging.0
Glycol dehydration emissions	• On existing dehydration units, reduce emissions by optimizing the operation of the dehydration unit. Also reduce the glycol circulation rate to the minimum needed to ensure enough freeze protection, and remove free water using a separator before the dehydration unit. Use other alternatives, which can be an improvement over glycol, such as line heaters/insulated gathering systems and molecular sieve/solid desiccant.
Ongoing activity/road access to wells	• Use SCADA to reduce the need to visit well sites daily, thus reducing traffic and the need for all-season roads.

Citizens' Rights

If you are concerned about a well site operation project and think that you may want to take part in the regulatory approval process, this section gives you information and advice on how to go about it.

It explains how you can get information and summarizes the key issues associated with a well site operation project. It also gives advice on how to have a say in the government's decision-making process when approving such a project. It is important to note that, in many cases, the best opportunity for the public to participate in the regulatory review of a well occurs before the well goes into production, at the well drilling stage (see the third primer in this series, Exploration and Production Drilling).

To conduct oil and gas exploration, companies have to get a permit or licence from the government that will allow them to do the work. The way companies get these rights and permits and licences varies between the NWT and the Yukon, and from region to region within each territory. The rules about public consultation and public intervention opportunities can also vary. You can find more details about the laws and procedures for each region of the Yukon and NWT in Citizens' Rights and Oil and Gas Development: Northwest Territories and Citizens' Rights and Oil and Gas Development Yukon Territory respectively.

If you have concerns about a well site that is in production and has been granted permits and licences to operate, you should direct your questions, comments or concerns to the company and/or appropriate regulatory agency directly — in person, by phone or in writing. Most companies will be interested in addressing public concerns even if the project has already received government approvals.

Here are some steps to follow if you wish to review and comment on a well site operation that requires a government approval or licence, or if you are concerned about a well site operation that already has the necessary government approvals:

Find out about Proposed Projects

The first thing you need to do is make sure you know what proposals there are for companies to carry out well site operation projects.

Companies send copies of well site operation proposals and licence applications to government agencies, Aboriginal Nations or Groups, and interested parties. Companies may also arrange for copies to be available for public viewing at libraries and government offices.

You can register yourself as an "interested party" by contacting the primary government agency responsible for oil and gas development in your region. You will receive notice of

new well site operation proposals and information about timelines for public comment on the regulatory approvals process.

Another way to get information about a proposed well site operation project is to contact the company directly and ask for a copy of detailed proposals or licence applications, as well as information about future development plans.

A company planning to conduct well site operation (the proponent) must give public notice of their plans before they receive regulatory approval. Notice requirements vary from region to region. Sometimes companies will post notices in local newspapers or other media to announce proposed projects; other times you may have to be more active to ensure you are aware of new proposals.

Learn about Public Consultation Rules

Next, you need to find out the rules for public consultation in your area.

Contact the primary government agency responsible for oil and gas development in your region and get answers to the following questions:

- What does the company have to do to give notice of their proposed project? Who do they have to consult? What form does the consultation have to take (meetings, open houses, etc.)?
- What does the company have to do with the public comments they receive?
- What is the deadline for public comments?
- To what government agency approving bodies does the company have to send public comments?
- What do government agencies do with public comments and concerns they receive?
- What happens if the public objects to or wants conditions attached to the approval, licence or permit?
- What is the process for deciding whether and how the project will proceed?
- Is it possible to call for a public hearing, if needed?
- How can the public find out whether the government has granted a drilling approval, licence or permit?
- How can the public get a copy of a drilling approvals, licences or permits?
- Can the public appeal an approval, licence or permit? If so, how?

Review the Well Site Operation Application

Once you've received a copy of a company's proposal for well site operation, and have learned about the rules for public consultation, you'll next want to review the project application.

When you review the application you may find that you are satisfied with the information presented or you may have questions or concerns about the project.

If you have questions or concerns, make of list of these and call a meeting with the company and/or proper government agency to discuss them (see box on page 51: *How to negotiate with companies*).

If you can't resolve your concerns about the project directly with the company or government agency you may wish to call for a public hearing (see section on page 50: *Participate in Decision Making*) if such a legal avenue is available.

Key questions to ask when reviewing a well site operation application:

- ❑ What type of well is the developer proposing? What well components will they have on site?
- ❑ Will there be all-season access to the well site? How often will vehicles travel there?
- ❑ When do developers plan to abandon and reclaim the well site?
- ❑ How the does the developer plan to reclaim any access roads to well sites?
- ❑ How will crews manage and dispose of surface water?
- ❑ How will crews manage and dispose of waste?
- ❑ What are the company's spill detection, response and cleanup capacity and measures?
- ❑ How large is the well pad?
- ❑ What permafrost protection measures will crews use?
- ❑ What sources of freshwater will they use? How much water will they need?
- ❑ How will crews manage and dispose of produced water?
- ❑ Is there any chance the workers will encounter hydrogen sulphide?
- ❑ Does the developer have an Emergency Response Plan? How big is the evacuation zone?
- ❑ Will crews use alternatives to flares and flare reduction measures?
- ❑ What type of fugitive emission detection / control system does the developer have in place?
- ❑ Are there emission controls on pneumatic devices?
- ❑ Are there emission controls on dehydration units?
- ❑ What tank waste prevention measures will crews use?
- ❑ What well casing protection measures does the company have in place?
- ❑ How will the developer monitor ground-water quality?
- ❑ What noise mitigation measures are being utilized?
- ❑ Has the company clearly outlined measures to avoid disturbing wildlife? Does the company have policies to ensure workers know how to minimize impacts on wildlife?

- ❑ Has the developer assessed socio-economic benefits (e.g., employment of local residents) and impacts associated with the proposed project?
- ❑ How will the company manage any newly created recreational access to the area?

Participate in Decision Making

If you meet with the company and government agencies directly and find you can't resolve your concerns about the project, you may wish to call for a public hearing.

Public hearings are meetings held to get comments from the general public, businesses, special interest groups, and local officials about proposed regulations, permits, or other changes that could affect the public.

You'll need to find out the rules for holding public hearings in your region, whether such a legal avenue is available for commenting on drilling projects and what the terms are.

You can find more details about public participation in regulatory decision making in *Citizens' Rights and Oil and Gas Development: Northwest Territories* and *Citizens' Rights and Oil and Gas Development: Yukon Territory*. These guides include government agency contacts that you can call to get more information about how governments conduct hearings and the specific rules for members of the public to call for and participate in hearings.

You'll want to find out

- When are the deadlines for letters calling for hearings and for written and oral submissions?
- Who has intervener status — that is, the legal right to call for a hearing?
- Is there funding available for interveners to hire experts, including lawyers?
- What are the hearing procedures?
- Are there any appeal mechanisms?

HOW TO NEGOTIATE WITH COMPANIES

Most companies have experience dealing directly with members of the public who have questions and concerns about oil and gas projects. They usually welcome opportunities to meet with interested parties, to provide information and to try to resolve issues outside of formal regulatory decision-making forums.

When involved in discussions with a company, make sure you

- ❑ *Get everything in writing. If you have an oral agreement or telephone conversation with a company representative, ask him or her to confirm it in writing and to send copies to the proper government agencies.*
- ❑ *Ask the company to explain anything you do not understand. If some of the written information the company has provided is ambiguous, ask for clarification in writing.*
- ❑ *Tell the company any concerns you have about the project. Suggest ways they could change the project to address your concerns. Be persistent if the company does not adequately resolve your concerns right away.*
- ❑ *Don't make a deal with the company wherein they only agree to deal with your issues of concern if you agree to not take part in a hearing. Sometimes it is not possible for you and the company to resolve all of the issues. But, if a public hearing is held, it will be shorter and more focused if you have resolved as many of the issues as possible. A shorter, more focused hearing is to the benefit of all parties involved.*
- ❑ *Recognize that some "give and take" may be necessary. For successful negotiation, both parties must be able to reach their final objectives and be willing to agree with the other.*
- ❑ *Negotiations can take a long time. Often members need a lot of time to both review and write documents. Therefore, it is important to research opportunities for intervener funding. It may be reasonable to ask the company for funding to make sure that members of the public can be more effectively engaged in the consultation.*

WORKING WITH THE MEDIA

Using the media to raise public awareness about an issue is not always appropriate. Under some circumstances, however, it can be an important tool:

- ❑ *It can make other members of the public aware of the proposed project and your concerns. This can help build support for your activities and increase your chances of success in negotiating with the company.*
- ❑ *It can encourage a company to negotiate. Many companies worry about their public image and would like to avoid negative publicity. Real or potential media attention on an issue may be an incentive for a company to try to resolve issues.*
- ❑ *It may ensure the government agencies are aware of and involved in your issue.*

Media include:

- ❑ *local, regional and national newspapers*
- ❑ *local and regional radio stations*
- ❑ *community and regional television stations*

If you have a message to get out, sending out a news release can be helpful. It does not have to be long, but you need to consider the following:

- ❑ *Decide on your main message and state this clearly in the first sentence.*
- ❑ *Include a brief outline of your key concerns and the outcome you want.*
- ❑ *Include one or more contact names and numbers.*
- ❑ *Put a short title at the top of the release — something eye-catching. Put the date at the top as well.*
- ❑ *Keep the release short — less than a page. You may want to include quotes and position statements.*
- ❑ *Consider including a separate "backgrounder piece." A backgrounder gives only factual information on the subject, rather than opinions.*
- ❑ *Make sure you are aware of the deadline for making submissions to the media.*
- ❑ *When your news release is ready, you should fax or deliver it to your local and regional newspapers, radio and television stations. Follow up with phone calls to select media contacts.*
- ❑ *Send a copy of your news release to both the company and the proper government agency. This will allow them to be better prepared to respond to the media if they know in advance what you are saying.*

For More Information

For information on government agencies, industry associations, and further reading on this issue, please consult the companion publication entitled: **Resources and Contacts**.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