10 ENVIRONMENTAL ASPECTS AND REGULATIONS

10.1 Introduction and Information Sources

This section focuses on environmental regulations approaches developed in Alberta for CHOPS wastes. In Alberta, the mandate for environmental issues in the petroleum industry resides with the EUB. It is also responsible for royalty management, conservation, and industry regulation for the Government of Alberta.[59] Oilfield wastes are exempt from the approval procedure of the Alberta Environmental Protection and Enhancement Act (EPEA).

Various environmental aspects of CHOPS waste treatment, such as definitions of wastes for the petroleum industry, groundwater monitoring requirements, and so on, are defined in EUB Guide 58 Document.[60] In addition, other related guides (especially Guides 50 and 55) are considered relevant to environmental practices in heavy oil.

In Saskatchewan, the environmental mandate also resides with the petroleum industry regulatory authority, the **S**askatchewan Department of **E**nergy and **M**ines (SEM)[61]. SEM regulatory documents are similar to those of the EUB, as the SEM generally follows the lead of the EUB. The EUB has also been a model for other conservation authorities around the world for management of government-owned resources.

Although the oil and gas regulatory agencies in Alberta and Saskatchewan have environmental authority over upstream waste management practices, there is a deliberate effort on the part of the EUB and the SEM to establish practices that also correspond to guidelines established by provincial environmental agencies so that there are no glaring conflicts among government ministries.

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[59] Is this wise?Giving the agency responsible for production and royalties the mandate to also enforce environmental regulations leads to a difficult internal conflict-of-interest. The result is usually a clashing of goals. Most commonly it is the enforcement of environmental regulations that suffers in both Alberta and Saskatchewan. Furthermore, there is a clear difference in the enforcement of environmental regulations for waste disposal companies compared to oil companies . The latter are often treated leniently, not having to provide full audits and detailed manifests, etc., whereas the former experience more rigorous enforcement.

[60] Access to the EUB Guide 58 is considered a necessary part of understanding this report. A full copy of this document can be downloaded in PDF format from the website http://www.eub.gov.ab.ca.

[61] Relevant SEM documents can be accessed from the website http://www.gov.sk.ca/enermine/energy/engstart.htm.

In all aspects of waste handling and disposal, the EUB and the SEM seek to develop policies that include input from all stakeholders: local farmers and villagers, oil company shareholders and employees, the citizens of the province, environmental protection groups, and so on. In Alberta, this is accomplished through a series of standing EUB committees that include EUB personnel, various stakeholders, scientists, and representatives of government ministries. These committees modify regulations as required by technological advances, social awareness, and environmental needs. The new regulations are published in draft form and comments solicited for many months or even years before a final draft is published. The process appears\ relatively egalitarian and in general, the results appear to be of excellent quality and adequately reflect the various and inevitably conflicting needs and concerns of all the stakeholders. Nevertheless, in the final analysis, the most important role of the EUB is to manage the industry to collect government royalties and land fees. Another jurisdiction that is of interest is California, where there historically has been conflict between the California Department of Oil and Gas (development oriented), and the Federal Environmental Protection Agency (EPA, environment protection oriented).[62] Their websites contain information about sand management.[63]

It is perhaps worth repeating that reference to the regulatory documents of pertinent jurisdictions is considered necessary to amplify and clarify issues in waste treatment and disposal in CHOPS technology.

10.1.1 Definition of Wastes

Oilfield wastes are divided into **N**on-hazardous **O**ilfield **W**astes (NOW) and **D**angerous **O**ilfield **W**astes (DOW). Specific levels of toxic materials (such as cadmium, mercaptans, etc.) are used to classify waste materials. The major approach used in most jurisdictions is to carefully define what is DOW; then, by default, other materials are classified as NOW (the term "non-hazardous" is preferred to avoid issues of quantitative toxicity definition).

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[62] In California, the issue of an internal conflict of interest does not exist. However, the aggressive enforcement of environmental regulations in California by the EPA has led to conflict with the DOG (Department of Oil and Gas), leading to shutting down the Santa Barbara Channel offshore exploration and production, for example, as well as other conflicts.

[63] The regulations are at ftp://ftp.consrv.ca.gov/pub/oil/regulations/PRC04.PDF. This can be accessed as well through the site http://www.consrv.ca.gov/dog/index.htm, which contains ancillary information.

It is the responsibility of the waste generator to properly classify materials through approved procedures, listed in detail in Appendix 3 of EUB Guide 58. If there is any doubt on the classification of materials, the waste generator is required to treat them as DOW, rather than NOW.

A typical reporting form used commercially to characterize wastes is included in the appendices. These and similar forms are widely used by third parties accepting wastes from oil companies for treatment and disposal. These forms are filled out by oil companies or by service companies with the approval of the oil companies, and are intended to provide legal protection, environmental control, and materials audit information. There are fewer reporting requirements if the waste remains entirely within the domain of the oil company; every time a waste material changes hands, it must be carefully documented so that it can be traced at a future date. Despite attempts to regulate and monitor waste management activities, the low number of government employees dedicated to this task, and the “self-regulating” approach permitted have led to environmental infractions that are known to employees and residents. Usually, these are not reported because the local economy is linked to the oil company. However, such situations may become serious problems in the future, and more rigorous approaches to waste management regulation enforcement should be considered.

The following table contains the definitions of DOW according to the AEUB, presented virtually verbatim from government documents.

Table 10.1 Properties of Dangerous Oilfield Wastes (DOW)

Flammability	Waste has a flashpoint less than 61°C Waste ignites and propagates combustion in a test sample
Spontaneous Combustion Potential	Waste generates heat at a rate greater than it loses heat and reaches the auto-ignition temperature
Water Incompatibility	Waste generates flammable or explosive gases in contact with water
Oxidizing Potential	Waste contributes oxygen for combustion at a rate that is equal to or greater than that provided by ammonium persulphate, potassium perchlorate, or potassium bromate
Toxicity	Waste has an oral toxicity LD50 not greater than 5000 mg/kg

	Waste has a dermal toxicity LD50 not greater than 1000 mg/kg Waste has an inhalation toxicity LC50 not greater than 10000 mg/m^3 at normal atmospheric pressure
Corrosivity	Waste has a pH value less than 2.0 or greater than 12.5
PCB content	Waste contains polychlorinated biphenyls at a concentration equal to or greater than 50 mg/kg.
Leachate Toxicity	Waste is a liquid or a solid that passes a 9.5 mesh opening, or a friable solid that can be reduced by grinding in a mortar and pestle to a particle size that passes a 9.5 mesh opening, or a mixture of these. it contains at a concentration of 100 mg/L or higher any substance listed in Table 1 of the Schedule to the *Alberta Users Guide for Waste Managers***, published by AEP [Alberta Environmental Protection] The leachate contains any substance listed in Table 2 of the Schedule to the *Alberta Users Guide for Waste Managers*, in excess of the concentrations listed in Table 2, or It contains any of the following substances in a concentration greater than 0.001 mg/L: [**list omitted for brevity, but includes polychlorinated HCs, mercaptans, dioxins, etc.**][64]

Table 10.2 Dangerous Oilfield Wastes (references are to original guidelines)

Dangerous Oilfield Wastes	The following are dangerous oilfield wastes (DOW): Waste types listed in Table 3 of the Schedule to the *Alberta Users Guide for Waste Managers* Commercial products or off-specification products listed in Part A of Table 4 of the schedule to the *Alberta Users Guide for Waste Managers* Commercial products or off-specification products listed in Part B of Table 4 of the schedule to the *Alberta Users Guide for Waste Managers* Waste with any of the properties as per Table 4.1a, Properties of Dangerous Oilfield Wastes [**given above as Table 10.1**], or Containers as identified in Section 5.3 of the Guidelines, Dangerous Oilfield Waste Containers

[64] This information is not provided in this report for brevity. It can be obtained from the EUB or the Alberta Department of the Environment (www.gov.ab.ca then follow links).

Although not dangerous, NOW are not necessarily pleasant materials. The NOW classification is linked to the concept that although the material may be noxious, smelly, difficult to handle, and so on, it presents no known health hazards if handled by normal means such as LHD units or tanker trucks taking ordinary precautions. NOW wastes, when solidified, can be disposed of directly in a suitably engineered landfill (Class II) without additional treatment, or disposed of in other ways that do not require dilution or treatment of the noxious substances.[65] Nevertheless, such substances do interact with the groundwater, the atmosphere, and can generate odors or tastes that are considered offensive. In Alberta and Saskatchewan, the following wastes are generally classified as NOW:

- Drilling wastes. It is important to note that oil-based mud wastes are treated differently than water-based mud wastes. Saskatchewan, for example, has prohibited oil-based mud drilling because of the difficult wastes it generates.
- **O**ily **B**yproduct**S** (OBS), such as heavy ends from refining, oils that have degraded or been contaminated by non-hazardous materials, or viscous treater residues.
- Emulsions formed during CHOPS processes (also classified as OBS).
- Oily sand from CHOPS wells (classified as a solid).
- Soil and gravel contaminated by conventional hydrocarbon spills, but not soil and gravel contaminated by man-made NAPLs such as chlorinated compounds or other hazardous substances.
- “Slops”, or “oil slops” (general terms for aqueous-based fluids from site or tank clean-up; the term oil slops is used by some to include stable emulsions).
- Sludges, tank bottom sediments, and other mixtures of oil, water and solids from tank clean out activities.
- Salt cavern oil returns and water returns, such as the brine generated during the solutioning phase, or displaced brine produced in the operating phase.

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[65] In general, a solid (or very thick sludge) NOW waste can be disposed of in a Class II landfill. A liquid oil or water-based material cannot, but sand containing a substantial amount of residual oil and water can be, providing it is not a liquid slurry. Emulsions and slops cannot be placed directly in a Class II landfill. Any solid waste suitable for Class II landfills can also be disposed through spreading, slurry fracture injection, or salt cavern placement.

- Produced water or surface water contaminated by formation water chlorides or other ions (there are special guidelines for the disposal of sour water containing large quantities of H_2S).

The solid wastes in the preceding list can be disposed of with any of the technologies described in later parts of the report, including direct placement in a Class II landfill, washing, road spreading and land spreading (within limitations and depending on chloride contents, etc.), slurry injection and salt cavern disposal. Liquid wastes can be disposed of by slurry injection and salt cavern disposal, or the phases (oil and water) can be separated, treated, and the clean water disposed of in a licensed water disposal well (see EUB guidelines for more data on water disposal wells).

10.1.2 Classification of Sand Wastes

Heavy metals content, chlorides content, liquid phase contaminants, and other factors affect the classification of sand waste. It is the responsibility of the waste generator to determine the nature of the wastes through chemical analysis and register the proper classification. Several companies in Alberta and Saskatchewan provide waste analysis services; analyses are carried out for major elements and ions, for HC content by Dean-Stark methods, and so on (Appendix 3, EUB Guide 58, gives acceptable procedures).

Produced sand withdrawn from stocktanks and allowed to drain gravitationally (without evaporative drying) in concrete sumps or stockpiles will approach a "steady-state" condition of wetness sustained by the sand capillarity. Thus, fine-grained sand will have more water by weight (approaching 15%) than coarse-grained sand (as low as 5%). This affects the chloride content of the waste and directly affects its classification and disposal. Specifically, if the chloride content of a bulk solid waste is in excess of 3000 ppm, it is not allowed to be placed in a Class II landfill. Also, high chlorides content will render wastes unsuitable for asphalt or for road base construction.

The retained water in the sand will also be affected by the quantity of oil: more oil in the sand usually means more water is retained because of pore throat capillary blockage. This will lead to higher chlorides content. Coarse-grained sand also usually contains less oil, partly because of lower surface area, and partly because coarse-grained sand sediments more rapidly and effectively in stocktanks. Composition by weight percent for produced sand is 80-95% sand, 5-15% water and 2-8% oil (HCs).

A full environmental classification of sand waste would require the following information:

- Bulk sand, water and HC contents
- Nature of solids, including grain size distribution, clay content, percentage of individual minerals (Quartz, Feldspar, Mica…), and heavy metal content (Fe, Ni, V, Ti, Cd…)
- Wetness condition of the sand (% oil-wet and % water-wet)
- Nature of the HC phase, including viscosity, density, and composition
- Dissolved species content in the aqueous phase, including chlorides (Cl^-) and major cations (Na^+, Ca^{++}…)
- Physico-chemical parameters that may be important for the particular treatment process, such as permeability of the waste sand at various porosities and phase interfacial tensions

Clearly, information this detailed is never collected, and would be relevant only for a careful optimization process associated with a multi-stage washing treatment to generate clean sand for industrial use.

Generally, sand is roughly divided into “clean sand”, visually estimated to contain only a few percent oil, and “oily sand”, visually estimated to have a substantial quantity of oil, perhaps > 5%. Most companies have stopped any attempts to classify sand because sand washing and other methods of oil extraction have been abandoned. Because the EUB and the SEM accept a classification of oily sand of all types as NOW, there is little incentive for any classification if the treatment or disposal process is not sensitive to the classification variables. The only issue that is relevant to sand disposal is whether it contains more that 3000 ppm chlorides.

10.1.3 Volumes of Produced Sand, Limits to Sand Production

It is estimated that in Alberta and Saskatchewan in 1997, the peak year for CHOPS production for which adequate data are available, the produced sand amounted to approximately 330,000

m^3.[66] Sand production dropped in 1998 and again in 1999 because the low oil price dampened new drilling programs (Figure 1.4), but has risen again in 2000 and 2001 because newly-drilled CHOPS wells produce both proportionately and absolutely more sand than old CHOPS wells. It is expected that heavy oil production by CHOPS will rise for some time, and thus sand production will soon exceed 1997 levels (if it has not happened already). More than 400,000 m^3 of sand produced is expected for the year 2001, but in the absence of government-mandated audits, this estimate is somewhat unreliable.

It is believed that gradual expansions in existing refineries will cause the number of upgrading facilities to rise slowly. Imperial Oil Resources, Gulf Canada and BP refineries in the Edmonton area, the Co-op refinery in Regina, the Shell refinery in Scotsford Alberta, the Husky Lloydminster Regional Upgrader, and several small local refineries are all slowly increasing their capacity to refine heavy oil because of the continued decline in conventional oil production. No new large upgraders similar to the Husky Lloydminster facility have been announced, but announcements of smaller-scale upgraders are expected.

10.2 Other Hydrocarbon Fluid Wastes From CHOPS

10.2.1 Stable Emulsion

Stable emulsion is empirically defined as a homogeneous colloidal mixture of water, HC and fine-grained minerals that does not segregate gravitationally over long residence times in a tank. It is formed during CHOPS production, and also partly as a consequence of stocktank cleaning. The composition of the emulsion varies greatly, depending on factors such as oil viscosity (linked to asphaltene content in the crude oil), the fraction of clay minerals and fine-grained silicate minerals in the produced solids (a function of the geology of the reservoir) and the temperature at which the emulsion was formed (low temperature shearing is more effective at generating an emulsion) . CHOPS activities in coarse-grained sands with few clay minerals will generate less emulsion than CHOPS from unconsolidated sandstones with a high clay content.

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[66] Exact quantities are impossible to cite because the reporting of sand audit data by oil companies has not yet been mandated.

Emulsion composition overall is ~65% water (range of 50-85%), ~30% HC (range of 10-50%), and ~5% mineral matter (range of 1-10%). Density can vary from less than 0.98 if the emulsion has a high oil content (in higher API gravity oil with perhaps a bit of gas remaining) to as high as 1.08 if it has a high solids content. Heavy oil contains 8-15% asphaltenes, but the HC phase in the emulsion is asphaltenes-enriched (specific numbers could not be found). The emulsion is classified as NOW. As with all other liquid NOW wastes, the options are salt cavern placement, slurry injection, or phase separation with separate or co-disposal of the solids and water phases.

10.2.2 Slops, Site Clean-Up Wastes, Treater Residues

These wastes are all classified as NOW. Slops are generally considered to be non-emulsified mixtures of aqueous and HC liquids; the term "slops" often includes many of the wastes that might also be classified as emulsions or even aqueous tank bottoms.

Spills of oil or wastes into the ground must be cleaned up quickly to avoid groundwater contamination. Because clean-up is carried out using water, more slops are generated. The clean-up wastes may be "dry" or "wet" (slops); the latter contain excess water that will drain if the solids are stacked and left to sit. Because of the generally low oil content of slops, there is little incentive to try to recover the oil directly. For example, placement in a large tank (a "slops tank") concentrates the solids (on the bottom) and the oil (floating on the top of the water); both are then withdrawn and handled by other means. Similarly, slops placement in salt caverns allows slow gravitational separation, and high oil content "cavern returns" are sent to treaters at batteries.

Treater residues are generally viscous mixtures of solids and tarry oils that accumulate slowly during battery treatment of heavy oil. Unless particular chemicals have been added to aid treatment or to break emulsions, treater residues are classified by the EUB as NOW. Treater residues can be separated physically by high-speed centrifuge. Other options include a number of technologies available for chemically, electrostatically, and physically enhanced phase separation, resulting in materials that can be disposed of in landfills or disposal wells, or sent to batteries for inclusion in the oil treatment stream. (Most methods are singularly ineffective in these emulsions.)

10.3 Large Storage Tank Sludges and Solids

10.3.1 Storage Tanks as Separators

Tank facilities are used for storage of liquids of various types, including hot oil at batteries, slops for slow separation, water for solids settling, and so on. They are used as treater tanks for clarification of produced water before it is disposed of in a water disposal well (Class II disposal well).

For environmental reasons, permanent tanks for slops and produced water must be placed on a site where organic soil has been removed, and a berm must be constructed to "trap" tank material if a breach occurs. If the tank contains mainly oil, as in battery tanks, more rigorous site preparation and maintenance are required than if the tank is for produced water storage only.[67]

Sludge or solids from water treatment slop tanks ("tank bottoms") must go to a EUB or AEP approved facility for treatment or disposal. Once partially dewatered, bottom contents are often environmentally acceptable for direct placement in a Class II landfill; otherwise, they can be injected or placed in a salt cavern. The oil phase, referred to as "skim oil" and not considered to be an emulsified phase, contains water and a small amount of fine-grained oil-wet solids. It is usually skimmed and sent directly to a battery for conventional treatment. In exceptional circumstances, depending on water and solids contents, the skim oil may be sent for special centrifugal or chemical treatment.

10.3.2 Cleaning or Decommissioning of Facilities Containing Sludges

After storage tanks have been used for some time, they contain thick layers of sludge, mainly an agglomeration of mineral matter, precipitated asphaltenes, water, and residual oil. This sludge, once dewatered so that it is largely a solid, can be disposed of directly in Class II landfills, in injection wells or salt caverns, or sent to an EUB or AEP approved NOW facility for further treatment, generally by high-speed centrifuge or flash treaters.

The EUB specifies that reasonable efforts must be taken to remove all NOW wastes from tanks and other facilities containing sludges before they are disassembled, but does not specify what technology is preferable. Thus, stinging and vacuum trucks are most commonly used, generating large amounts of liquid sludge and slops (all NOW) that in principle cannot be sent directly to a landfill even if the chloride content is below 3000 ppm. If the sludge content is larger than 3000 ppm, it will be sent for slurry injection or salt cavern placement, or to a waste treatment facility to be centrifuged.

10.4 Environmental Interactions

10.4.1 Landfills and Subsurface Groundwater Protection

The issue of groundwater protection remains the most important environmental aspect of NOW disposal, and a major part of this issue is concerned with landfill design and maintenance. In order to minimize conflict, the EUB in Alberta has mandated that all such facilities must be consistent with EAEP (Environment Alberta) rules and the AEP Code of Practice. This code specifies amounts of various materials that can be present in materials to be landfilled, and the most difficult constraint is the chloride content limit of 3000 ppm. Furthermore, the disposal of any liquids in approved landfill facilities is prohibited.

Approved Class 1a and 1b landfills are designated to receive DOW (and NOW) as well as solids containing more than 3000 ppm Cl^-; Class II landfills may receive NOW, and Class III may receive only other wastes (e.g. waste timber, metals, asphalts, etc.). Class I must have two liners, one of which is an impermeable membrane, the other, for example, a rolled clay membrane meeting certain permeation standards. Class II landfills require one liner only. Both types require run-off control and management.

Because NOW are non-toxic, and because the soluble phases that enter into the groundwater present no known direct health hazards, the groundwater protection issues are mainly associated with:

- Keeping the dissolved solids content of the groundwater for various species (heavy metals, chloride content, etc below the mandated limits set by provincial environmental protection authorities.

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[67] Produced water generally has 50-70,000 ppm NaCl, and will contain very small amounts of oil, along with a number of natural organic trace chemicals in solution.

- Keeping potable groundwater quality high in terms of factors such as odor and taste.

The international (UNESCO) standards for chlorides in groundwater are 250 ppm, and it is thought that limiting the chlorides content in landfilled NOW to 3000 ppm will, in all expected circumstances, lead to values no larger than this because of dilution and retardation of leaching into the groundwater.

The aromatic components of heavy oil are only slightly soluble in groundwater, but give it a distinct taste and odor. Even though the population is sparse in the Heavy Oil Belt, there is concern that road spreading, land spreading, and landfill placement of NOW from heavy oil operations will impair the future quality of shallow potable water through slow leaching of HCs into regional aquifers. The average precipitation in the area is about 500 mm/year (350 mm in the south, 550-600 mm in the north).

It is widely known that heavy oil is high in certain heavy metals (nickel, vanadium, titanium). It is not known if leaching of wastes on roads, fields or in landfills can lead to a concentration of heavy metals in the groundwater that could be a long-term problem.

The environmental issues related to groundwater are not significant in lightly populated areas, but there is a concern because groundwater contamination is difficult and expensive to remedy. According to environmental regulations, groundwater monitoring programs for NOW landfills must be established and maintained to demonstrate that leachates are not exceeding mandated limits.

10.4.2 Surface Stockpile Issues

Differentiation is made between "storage sites" and "transfer sites". A storage site is operated by one oil company only, but it can accept wastes from a number of producing sites and fields, provided they are owned by the same company. A transfer site is operated by a third party company and accepts wastes from a number of oil companies or from other waste treatment companies before further treatment, disposal, or transshipment. More rigorous rules and enforcement apply to transfer sites, such as additional groundwater monitoring requirements and more careful auditing of materials.

Surface stockpiles are of two types: the "ecology" pit, and the concrete pit. In both of these types of retention structures, rainfall "washes" the sand wastes, the chances of leaking are extremely high, and environmental concerns exist over seepage of chloride-rich water with an oily taste into the subsurface. One benefit of rainfall washing the sand in a stockpile is that the chlorides content is so reduced, allowing eventual placement in landfills.

The ecology pit, a shallow depression lined with a plastic membrane surrounded with a low berm, in theory is isolated from the groundwater by virtue of the impermeable membrane. In practice, it is widely known in the environmental industry that such membranes are rarely watertight; one puncture hole or one seam not completely heat welded will leak large amounts of contaminated water in a short time.

Concrete pits suffer from similar problems of leakage, even if built with high-quality construction practices. Because of normal concrete shrinkage and cracking during set and cure, it is impossible to build a concrete structure that is watertight. External membranes or internal membranes placed between the concrete and the produced sand and slops are easy to breach during construction and operation. The concrete dump pits used in sand cleaning plants are known to leak, and the now-defunct Bromley-Marr sand washing facility in Bonnyville, Alberta was closed at least twice because of leakage from the receiving pits.

Much of the produced sand in Canada is 60-150 μm, a size range easily carried away by the wind. High winds can mobilize dry sand in surface stockpiles, although because of the presence of residual oil (finer-grained sand tends to have more oil as well), serious problems associated with blowing sand are not common. Despite the fact that dust clouds can occasionally be seen downwind of stockpiles on windy days, wind-borne transport is not considered an environmental problem with produced sand stockpiles.

It is likely that all ecology pits and concrete stockpile pits leak to some degree, and this may generate liability problems in the future. One simple method of reducing the risk is to keep the size of the sand stockpile as small as possible to prevent overflow, high gradients, or other conditions that can lead to groundwater contamination.

10.4.3 Surface Spills of Oilfield Wastes

All oil companies are required to contain spills and clean them up quickly. In the letter of the regulations, all NOW spills (including oil spills) over a certain size should be reported. All wastes generated from NOW spills are also classified as NOW.

10.4.4 Environmental Liability, Companies and Contractors

The principle of waste generation and liability in the oil industry appears to be simple: the waste generator never loses the liability associated with possible future environmental problems. This liability cannot be "sold" to another company. Furthermore, any other company that handles the wastes during the waste management process acquires liability as well.

To date, apparently there have not been any major environmental-damage lawsuits associated with CHOPS wastes (no actions that have become public knowledge). Every year the EUB in Alberta pursues several cases of environmental contamination, levies a fine, and requires clean-up by the company. Generally, if a case is clearly identified and pursued by a third party (e.g. a farmer or a municipality), a committee is struck by the EUB, the case is studied and a decision rendered. To this point, it has been extremely rare in Canada for any case of environmental contamination in the oil industry to go beyond the regulatory bodies and be treated by the courts of law; therefore, the issue of long-term environmental liability remains undefined in a practical sense.

Liability that leads to a requirement to rectify the problem remains in force even if the companies can demonstrate "best-possible-practice" during the events that led to contamination. Additional penalties may be levied if negligence or failure to use "best possible practice" can be demonstrated.

There have been no precedent-setting legal cases in Alberta that have clarified the ownership of wastes and the liability associated with them if they have passed through two or more companies. For example, if an oil company manages a waste stockpile, any environmental liability related to that stockpile belongs to that company, likely in perpetuity, and the liability is passed on to any company that purchases the first company. Thus, if the oil-producing property and the stockpile are sold to another oil company, it is likely that the first company still can be found liable for environmental damage from that stockpile, particularly if it can also be shown that inadequate care was taken during design, building and operation of the stockpile. Clearly, if the waste stockpile leaks leachate into the groundwater, it would be extremely difficult for the first company to demonstrate lack of culpability. Even if no negligence can be demonstrated, the original company may have to share part of the clean-up costs. Thus, liability can be assumed to be shared by all companies that have been involved in production, storage, treatment, transport, etc of wastes.

Service companies that accept waste for cleaning and disposal clearly accept legal responsibility as well. However, even though the oil company has paid them to treat and dispose of the waste, the commonly-accepted interpretation is that, no matter what contract exists, the oil company that generated the waste retains liability. For example, if one of the two active sand washing plants in Alberta is shown to have caused groundwater contamination and the local municipality decides to seek legal recourse, the lawsuit is likely to name all oil companies who delivered waste as well as the washing plant company itself.

However, there are occasions where the operating company (or the waste treatment company) has disappeared as a corporate entity and its assets were abandoned rather than being acquired by another company, and therefore the oil properties reverted to the Crown, or the assets were liquidated. An example is the "Orphan Well Program" of the EUB, designed to cope with abandoned wells for which no existing owner can be identified.[68]

The retention of environmental liability by the original waste generator has been accepted in the United States as a necessary aspect of environmental protection. This liability retention avoids the establishment of companies whose purpose is solely to "buy" liability, and then declare bankruptcy, leaving "orphan" wastes, for which no legal and financial responsibility can be allocated. Nevertheless, even though the current state of liability ownership seems clear, further legal clarification of these issues in Canada remains to be decided by the courts, as cases come forward.

*10.5 History of Regulatory Authority Development**

10.5.1 History of Environmental Guideline Development

Hydrocarbon resources and their regulation in Canada are generally the responsibility of the provincial governments. However, many exceptions exist, and there are many cases where the responsibility is shared or unclear. To understand this, it is necessary to divide hydrocarbon resources into three categories: land-based, arctic, and off-shore. Each must be considered separately.

In general, land-based or on-shore hydrocarbons are owned and regulated by the government ("Crown") of the province in which they are found.

For ordinary land-based oil and gas activity in Saskatchewan, Alberta, and British Columbia, environmental guidelines have been adopted "wholesale" from the most senior regulatory body, the Alberta EUB. Even though there is a federal Department of the Environment, it has no direct jurisdiction over environmental policy in any province on matters pertaining to the oil and gas industry, except in cases where products or waste materials cross provincial boundaries.

Land-based oil and gas activity in the Canadian north (north of 60° latitude) is under the jurisdiction of the Canadian Federal Government.

For offshore activity, even though the Maritime Provinces claim jurisdiction over near-shore fisheries and minerals, the Canadian Federal Government has been allocated jurisdictional authority to develop and enforce environmental policy in the oceans.

For provincial land-based oil and gas activity, the resource management regulatory aspects of the industry developed far earlier than the environmental aspects. Because over 90% of subsurface mineral rights are held by the Crown (i.e. the provincial governments) in Western Canada, the protection of the resources by the provincial governments was the dominant factor leading to the establishment of the first regulatory body in the early 1950's in Alberta. Specifically, setting a royalty structure for the industry and collecting royalties through careful monitoring of production were the primary responsibilities of the EUB. The board also developed the policy of selling mineral rights through a closed-letter bidding approach, and developed many novel methods of insuring that companies would avoid wasteful production practices. Many other regulatory responsibilities were gradually placed in their hands; for example, production allocation rates in fields with many operators; enforced unitization in fields with many operators where production agreements could not be reached; company rights to rent or buy private land or use public land for access to resources or for E&P activity such as seismic surveys; water

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[68] Incidentally, leakage in many wells occurs despite proper plugging and decomissioning in full compliance with regulatory body regulations. These long-term gas seeps develop because of leakage behind casing, and are linked to

disposal well regulations; and allocating reasonable and equal access to facilities such as inter- and intraprovincial pipelines. The EUB has become a world model for other countries. However, only in the period since approximately 1970 has there been a strong focus on environmental issues, driven by a general awareness increase in society.

Given this history, the EUB has tended to be somewhat reactive in terms of environmental policy, generating and enforcing policy only after concerns have developed. The conflict-of-interest between financial goals and conservation or environmental protection remains an issue: it is difficult for a single agency to be a promoter of increased activity, a collector of revenues from increased production, and also a strict enforcer of environmental regulations. Incidentally, the Federal Government has wrestled with similar issues, and has not found entirely satisfactory solutions.

10.5.2 EUB (Alberta Energy Utilities Board)

The approach of the EUB to Materials Classification and to several environmental issues has been discussed in previous sections. Here, the method of regulatory enforcement is discussed in greater detail, as it has had a substantial effect on oil industry procedures.

In the 1990's, government downsizing had a huge impact on the EUB. Personnel numbers, particularly field personnel, have declined despite increases in the number of wells in production and in the oil production rate in Alberta (proportionately more and more from heavy oil). Furthermore, the EUB focuses on many issues other than environmental compliance (new drilling licenses and drilling progress, production proration, etc.).

These developments have generated the concept of "self-regulation" (refer to EUB guidelines for a discussion of this concept). Companies are expected to report production rates from wells, register all information required by the EUB, and to follow environmental guidelines listed in documents such as Guide 58. The EUB carries out spot checks and occasional audits to make sure that self-regulation is occurring properly.

Self-regulation works extremely well for production data and for formal reporting of necessary information from E&P activity. For example, when Crown land is involved, geophysical logs,

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issues of cement shrinkage and poor quality cement placement.

drilling records, and many other types of data have to be given to the EUB. For environmental issues, industry and business generally consider this approach to be successful, but local citizens and environmental activists often disagree.

An example of a common alleged violation is the disposal of small amounts of DOW in injection wells specifically licensed for NOW only. Another allegation voiced in the Lloydminister area is that DOW have been diluted with NOW to allow treatment in the less stringently regulated NOW category. These purported violations are generally attributed to oil companies rather than to waste service companies. In fact, if true, these violations are likely due to local operators. It is not likely that a large oil company would permit actions that could result in lawsuits or interruption of production by the regulatory body.

There is a general consensus in Alberta (except within oil companies) that the environmental aspects of the oil and gas industry require better management and enforcement by the EUB, or alternatively that the authority should reside with Alberta Environment, a separate provincial department. Any failure of the EUB to effectively police environmental aspects of oil production could ultimately place a large liability burden on oil companies, rendering them susceptible to future lawsuits.

10.5.3 SEM (Saskatchewan Energy and Mines Ministry)

The oil and gas industry in Saskatchewan is about 10% the size of the industry in Alberta and therefore Saskatchewan's regulatory body, the SEM, like other provincial regulatory bodies such as Ontario's, has essentially followed the lead of the Alberta body. This is usually directly stated in their documentation, indicating which EUB documents formed the source for SEM regulations. AEUB developments continue to be monitored by the other provincial agencies, with various policies and guidelines adopted after suitable modifications to reflect local requirements.

A pertinent example is provided by the regulations concerning injection wells for sand disposal. In the 1960's, the EUB adopted a rule that injection could not take place above fracture pressure in any injection well. This occurred in approximately the same time period that similar regulations were adopted by many American regulatory agencies. The goal was to avoid injection fluids breaking through to other formations or migrating through fracturing to the surface. Soon after the EUB formulated their policy for injection wells (including a classification system and a number of other rules), the SEM and other provincial agencies adopted it.

However, the rule made waste injection by fracturing impossible, as solids injection must take place at bottom-hole pressures that exceed fracture pressure. When waste injection was first proposed in Saskatchewan (before use in Alberta incidentally), the SEM gave a permit without a detailed study. A few years later, when slurry fracture waste disposal was introduced to Alberta, a lengthy consultation process with the EUB was necessary, and a variance[69] was issued only after detailed geological studies and technical discussions with experts in fracturing and injection over a period of 18 months.

The EUB guidelines for injection into wells are currently in the process of a major revision, and waste injection will apparently be permitted with the submission of a suitable site analysis, well study, waste management approach, and surveillance program. Undoubtedly, these new regulations will be adopted by the SEM and other agencies, such as the federal government for offshore E&P activity. This constitutes an example of how regulations can evolve, and diffuse across other regulatory agencies in different geographical regions,

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[69] A variance is a formal permission in a specific case to carry out activities that contravene regulatory guidelines. It does not constitute a legal precedent, and each new application requires a new variance.