Frequently Asked Questions on the Remediation and Reclamation of Soil and Groundwater

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Preface

In June 2001, Alberta Environment hosted two workshops in Red Deer, Alberta, to introduce the draft *Alberta Soil and Water Quality Guidelines for Hydrocarbons at Upstream Oil and Gas Facilities*, *Phase 1 Environmental Site Assessment Guideline for Upstream Oil and Gas Sites*, and the *Salt Contamination Assessment and Remediation Guidelines*. Workshop participants provided written questions to the presenters to answer verbally during the sessions. For the benefit of the workshop attendees and others who are interested in the workshop material, these questions and answers have been drafted into the document *Frequently Asked Questions on the Remediation and Reclamation of Soil and Groundwater*. Other frequently asked questions on remediation of soil and groundwater have been included to provide readers with broader scope of information.

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1. General Information on Regulations and Administration

Does the term "operator" mean the petroleum company? The drilling company? The operator who runs the site?
The operator, under the Environmental Protection and Enhancement Act, is the licensee of record in the Alberta Energy and Utilities Board's database. Generally it is a petroleum company. The people working for or contracted by the licensee are not generally considered to be an operator.

Who is considered the "current licensee" when a well is already abandoned?
Alberta Environment looks at the records of the Alberta Energy and Utilities Board to determine whom the licensee is. The licensee of record may be the first operator if the property never changed hands, or the last operator if the property changed hands and the license was transferred. The number of transfers in between is not relevant, only who is listed as the licensee. Many operators have been surprised that they are still listed as the licensee of, and are therefore responsible for, a well that they sold to another operator.

Where the well licensee and the surface lease holder are different why do you look to the licensee as the operator?
Alberta Environment does not have access to the private arrangements between the landowner and the company and therefore does not know who the lease holder is. Alberta Environment does have access to the record of who the licensee is, and both industry and the Alberta Energy and Utilities Board support the concept of holding the licensee as being responsible for reclamation and remediation.
On public land, where the government is the landowner and therefore has records of who the lease holder is, we may look to the lease holder in the first instance as being responsible for reclamation and remediation.

If the current license holder is not found, what do you do prior to bringing the well forward to the Orphan Program? Do you look for other interested owners?
If the current licensee is an insolvent company is there a provision in the Act to go after companies that have previously leased the site?
The definition of an operator (s. 119(b) of the Environmental Protection and Enhancement Act) is quite broad and allows for a number of parties to be named as operators of a site. These include, among others, the lease holder and working interest participants, and anyone who previously held a license, lease or working interest participant share. Alberta Environment will review all the potential people that could be named as operators and let them know they have obligations under the Act to remediate and reclaim the site. If necessary Alberta Environment may issue an Environmental Protection Order to the parties to have them do the remediation and reclamation work.
It is important to note that standard industry practice is to have working interest participants pay their proportional share for abandonment, remediation and reclamation actions. However, the Environmental Protection and Enhancement Act provides for joint and several liability – that is each party named in an Order is responsible for 100% of the costs associated with the work, not their proportional share. As a result, it is in the best

interests of the companies to work out an arrangement to do the work instead of having an Order issued.

Are there any guidelines for old (some more than 50 years) pipelines (active or abandoned) that are aboveground? Is there a deadline to bury or remove them?
Concerns about specific pipelines should be addressed to the local Alberta Energy and Utilities Board office. General questions about pipelines may be addressed to Tom Pesta, Alberta Energy and Utilities Board, Calgary at (403) 297-8148.
There are no requirements to bury these lines.

When a pipeline is abandoned will the company remove the line at the landowner's request? Is there legislation to force this? If not, can it be added to the new guidelines?
Landowners may request the company to remove abandoned pipelines. If that does not work, they may ask the Alberta Energy and Utilities Board to examine the situation. The *Pipeline Act*, administered by the Alberta Energy and Utilities Board, does not require the removal of abandoned pipelines and there are currently no proposed changes to the legislation.

What is the length of time for a wellsite lease or pipeline easement? Is not reassessment of the reclamation and/or remediation guidelines affecting original leases or easements?
Leases or easements are private agreements between the landowner and the company. Both parties need to understand and abide by the legal agreement found in those documents. The government is not a party to the private landowner's lease.
The government does set general provincial requirements (known as criteria or guidelines) that industry is required to meet under the Environmental Protection and Enhancement Act. Unless the lease specifically incorporates the government's expectations there is no relationship between the government's expectations and the legal agreement signed by the two parties. To be more specific, acceptance of the condition of a site by the government does not automatically mean the company has met the requirements of the private lease or easement agreement reached with the landowner.

Where can I find information on which municipalities/landowners are restricting topsoil movement?
You would have to contact each municipality and landowner directly.

Where can I get more hard copy information? I do not have a computer.
All the information available on our website is available in hard copy through Alberta Environment's Information Centre. You can contact them by phone at (780) 944-0313 or by mail at Alberta Environment, Information Centre, Main Floor, Great West Life Bldg., 9920 – 108 Street, Edmonton, Alberta T5K 2M4.

What are the website addresses mentioned?
Alberta Environment publications are available at
http://www.gov.ab.ca/env/info/infocentre/

You can also consult the following site for land reclamation and soil and groundwater information:
http://www.gov.ab.ca/env/land.html

Does a landowner have to pay for the environmental assessments required by banks when the land is being used for collateral or is up for sale?
The bank's environmental questionnaire deals with more than just industry activities on the land - it also addresses landowner activities such as fuel and pesticide storage. Landowners may wish to contact companies to see if site assessments have already been done that the landowner could use to satisfy the bank's needs.

If there is a wellsite that had temporary production tanks on it for six years and the company declares it has no records, who pays for the soil testing?
Soil sampling and analysis is the responsibility of the operator; the landowner should not entertain taking on this responsibility for liability reasons. A Phase 1 Environmental Site Assessment is required at each site to evaluate the likelihood of contamination.

Is a landowner considered to be a "person responsible" for contamination caused by their agricultural activities (e.g., fuel storage areas, herbicide spills, etc.)?
Yes.

Section 227 of the Environmental Protection and Enhancement Act says it is an offence to provide false or misleading information. What does Alberta Environment do when the company has signed the declaration that there are no chemical problems on the site and yet contamination is found?
Where the Inspector has reason to believe that the company was intentionally providing false or misleading information the case will be referred to the enforcement group. We recognize that there are cases where the application is wrong but the intent was not to provide false or misleading information. It is also important to note that the Act provides for a due diligence defense – that is, the company did everything that could be reasonably expected and still something went wrong.

Oil and gas companies transfer or sell sites frequently. Smaller producers may not understand the liabilities/costs associated with soils/groundwater contamination. What is the government doing to ensure these liabilities are addressed?
The Alberta Energy and Utilities Board has implemented a number of policies and procedures to screen transactions and ensure that both the purchaser and seller have enough producing sites left after the transaction to fund their liabilities. If either party is left without adequate producing sites they must place a deposit with the Alberta Energy and Utilities Board to cover estimated abandonment and reclamation costs. Please refer to their website at www.gov.ab.ca/eub for the latest information on this subject.
The Orphan Fund has been in place for a number of years to take care of abandonment and reclamation responsibilities of orphan companies. This fund is 100% funded by industry and is a showcase of environmental stewardship.

What legislation governs access to farmland for oil and gas development in Alberta? May a landowner deny access?
The Alberta Surveys Act and Surface Rights Act are the main pieces of legislation affecting right of entry. In Alberta, energy companies must seek the consent of a landowner and occupant before entering. Where a company and landowner cannot agree to satisfactory compensation for entry onto the land the Surface Rights Board will determine compensation rates. This right of entry does not entitle a company to damage or pollute the land. Energy companies must abide by the terms of the lease agreement with the landowner and the regulatory requirements of the government.

What would be advised re: environment information, before pipeline construction or before construction of a wellsite?
Many companies are now conducting pre-construction site assessments to determine what soils, vegetation, drainage patterns, landscape features and land management practices are in place prior to disturbance. Alberta Environment does not currently require a pre-construction site assessment to be conducted, but it is recommended. An Information Letter, Pre-Construction Assessment Report for Wellsites, C&R/IL/00-8, is available at www.gov.ab.ca/env/info/infocentre/index.cfm.

Who is responsible for reclamation of oil and gas sites in the Green Area?
Sustainable Resource Development, formerly Lands and Forest Service of Alberta Environment, is responsible for managing public land in Alberta. Enforcement of the Environmental Protection and Enhancement Act is the responsibility of Alberta Environment.

Define the difference between a "guideline" and a "regulation" as it applies to oil industry activities and compliance issues
A regulation has legal underpinning, i.e., the requirements of a regulation must be adhered to or enforcement action can be taken by Alberta Environment on environmental matters. Guidelines are scientifically defensible documents that provide guidance on a particular environmental issue, e.g., Guideline for Remediation of Petroleum Storage Tank Sites.

What action can be taken if consulting firms present false reports?
It is an offence to knowingly provide false or misleading information under s. 227. It is in the interest of the consultant to undertake credible work that is scientifically defensible. There are groups like the Association of Professional Engineers, Geologists and Geophysicists that require members to conduct work according to a strict code of ethics. Oil and gas companies are unlikely to rehire consultants who provide false reports.

2. RECLAMATION CRITERIA/PROCESS

Are there any guidelines that abandoned wells must be reclaimed within a certain time frame after abandonment?
Alberta Environment has not put into place a regulatory requirement for sites to be reclaimed within certain timeframes but we are investigating the merits of such a requirement. There are a number of "drivers" such as lease payments, orphan fund levy, and the soon to be introduced licensee liability rating system of the Alberta Energy and Utilities Board that serve to encourage operators to reclaim sites.

How soon does an historical flare pit that has been unearthed have to be remediated?
There are no timelines for remediation. However, unmanaged contamination that is causing or may cause adverse effect is subject to enforcement action. Therefore, by remediating sooner, the less chance for the extent of the problem to increase and the need or likelihood of an enforcement action. If there are concerns about the progress of remediation efforts the inspector in the local office should be contacted. In addition, the Alberta Energy and Utilities Board has issued information letters regarding the retirement of flarepits (e.g., IL96-04).

Section 137 of the Environmental Protection and Enhancement Act says an operator must conserve and reclaim. To what standard – 60%, 70% and 80% ?
The standard for reclamation is the Reclamation Criteria for Wellsites and Associated Facilities – 1995 Update. These Criteria recognize the different regulatory requirements for topsoil salvage over the years and the practical difficulties in replacing salvaged topsoil by placing minimum acceptable topsoil depths of 60%, 70% and 80% based on the date of site construction. These topsoil depths are the minimum. Most companies achieve more than the minimum.

Why is the term "restore" still used by Alberta Environment? Does s. 112 of the Environmental Protection and Enhancement Act say "restore the environment"? Can the environment ever be "restored"? Is "equivalent capability" the goal?
Equivalent capability is the goal for reclamation under Part 6 of the Act. The terminology used under Part 5 of the Act is "restore to the satisfaction of the Director". In practice, if the Director were to request guidance on the expected outcome of a project we would refer him to the Reclamation Criteria for Wellsites and Associated Facilities – 1995 Update as the target. However, the Director has the final say.

Do all records of reclaimed sites follow when ownership of companies changes hands?
Sites that have been abandoned may be sold to another party but the Alberta Energy and Utilities Board license cannot be transferred. Therefore, the original party retains liability for the site (since they remain the licensee). When a company is absorbed into another company all the licenses will be transferred to the new company who will assume the liability.

When an active site is sold to a new company the records should follow but this often does not happen. This potentially places the purchaser at a disadvantage as they will not know the extent of the potential liability at the site. Companies are encouraged to obtain as much information as possible as part of their due diligence in buying property.

Can inert waste (concrete, pipe, wood) be buried on a lease without causing the lease to fail at the time of reclamation certification?
Yes, providing certain requirements are met:

- The landowner must agree to the materials being buried
- The materials must be at least 1.2 m below the soil surface
- Concrete must be broken up into small pieces

Materials that are considered to be oilfield waste must be disposed of according to the requirements of the Alberta Energy and Utilities Board's Guide 58.

Part of a battery site was certified in the 70s. I still plow up pieces of pipe and other debris. The site soils are also not comparable to the adjacent soils. Can this situation be re-evaluated?
For sites certified before September 1, 1993 the government has liability for reclamation problems. For sites certified after September 1, 1993 the company has liability for a period of five years and then the government has liability. You should contact the reclamation inspector in the local office to have him or her assess the site.

When building a lease, clay was hauled in to stabilize the road over a small muskeg. When reclaiming the site can clay be left, spread out and topsoil added or must the clay be removed and the area returned to muskeg?
The peat section of the reclamation criteria provides for both options. The landowner should be consulted to determine if he wishes to use the land for agriculture (usually grazing), or wishes to have the road remain as is for access (a release is required), or wishes to have the site returned as wetland (for waterfowl/wildlife habitat). Generally topsoil would not be hauled in to cover the clay. Rather the adjacent muskeg soils would be spread out over the road.

Is trespassing off the access road to a wellsite part of specified land and subject to a reclamation certificate?
All lands physically disturbed by the activity can be considered specified land and therefore require a reclamation certificate.

What is the process in the case of a site that is properly reclaimed but the vegetation species or growth rates appear to be the result of actions taken by the landowner or another party?
Information Letter C&R/IL/97-4 Third Party Damage describes the procedure. Basically the company should contact the inspector and ask that the inspector determine if the damage is caused by the company or not. If not, and all other criteria are met, the site could be certified.

How do you cancel a lease once the reclamation certificate is issued?
The Environmental Protection and Enhancement Act says that a lease or easement is not legally cancelled until a reclamation certificate is issued. Once the certificate is issued one of the requirements to cancel the lease has been met. Both parties to the lease must agree that all other requirements contained in the specific lease or easement have been met before the parties agree the lease can be cancelled.

Why are flow lines not part of the certificate requirements? Is there any intent to include these in the future?
Flow lines are pipelines under the Environmental Protection and Enhancement Act and have required a reclamation certificate since 1963.

Who is legally required to sign the reclamation certificate? Is the landowner's endorsement necessary?
The Alberta Environment or Alberta Sustainable Resource Development Inspector is the only person who signs the reclamation certificate. The Inspector will take into account the views of the landowner and the company in making the decision to sign the certificate.
Landowners or companies who disagree with the Inspector's decision may make an appeal of the decision to the Environmental Appeal Board.

When industry applies for a reclamation certificate in the Green Area or on White Area public land does an Alberta Environment inspector do a check to verify whether or not there is contamination, or is that only 10% of the total that is audited?
There are no audits for private land sites. Every site has an inquiry with a reclamation inspector present. Wellsites on White Area public lands have inquiries like private land, except that the reclamation inspector is from Alberta Sustainable Resource Development. Wellsites in the Green Area do not have an inquiry - instead they are issued a certificate once the application is deemed complete and then an inspector from Alberta Sustainable Resource Development inspects (audits) a portion of the sites to determine if the reclamation criteria have been met. If they have not, the reclamation certificate may be cancelled.

You indicated that approximately 45,000 reclamation certificates have been issued. Another speaker said there were approximately 250,000 wells in the province. How many wells are active and how many are abandoned but not yet certified?
There are approximately 21,000 wells that were abandoned prior to July 1, 1963 when reclamation certification was first required – these sites do not require certification. There are approximately 30,000 suspended wells – these are neither producing nor abandoned, they are awaiting the right conditions to produce. Finally there are approximately 25,000 abandoned but not yet certified wells. This means there are approximately 129,000 active wells.

3. REMEDIATION

Does the operator have to provide soil sample data to prove remedial work meets criteria if the inspector requests it?
Yes. The inspectors will generally ask for data if they suspect contamination is present. They may also request confirmatory data once the operator re-applies on a site that first failed for contamination.

Regardless of the criteria's scientific basis, sometimes there is the technical capability to reach lower levels. Can a landowner demand that the soil on their land is cleaned up to more stringent levels? Or to background levels if it is technologically feasible?
A landowner and operator are entitled to pursue any contractual arrangements that suit them within the law. Such an agreement could include more stringent cleanup measures. However, Alberta Environment requires only that the criteria be met to avoid any potential compliance or enforcement action.

Is mixing polluted soil with clean soil an acceptable form of remediation?
That is not the intent of the *Alberta Soil and Water Quality Guidelines for Hydrocarbons at Upstream Oil and Gas Facilities,* Volumes 1 - 3. Removal or treatment of contaminants is the preferred remediation technique. The Alberta Energy and Utilities Board does not endorse diluting oilfield waste with a solid or liquid to meet regulatory standards.

Is it scientifically defensible to replace contaminated soil from a pipeline break after the line is repaired and then treat it as an in-situ remediation?
If the soil has been excavated it is subject to the requirements in the Alberta Energy and Utilities Board's *Guide 58: Oilfield Waste Management Requirements for the Upstream Petroleum Industry*. Therefore, any management options should be discussed with the Alberta Energy and Utilities Board.

What are hydrophobic soils?
Hydrophobic soils are soils that repel water. The cause of hydrophobicity is not well understood. Studies on the cause of hydrophobicity and remedial methods have been conducted at the University of Alberta.

When historical contamination is found at a site during assessment, remediation or reclamation and no previous report of a release has been filed with the Alberta Energy and Utilities Board or Alberta Environment is it reportable at the time of discovery?
If someone (e.g., landowner or developer) excavates a site and discovers contamination who keeps track of the material?
Yes, discovery of contamination must be reported, as per the IL 98-01, *A Memorandum of Understanding Between Alberta Environmental Protection and the Alberta Energy and Utilities Board Regarding Coordination of Release Notification Requirements and Subsequent Regulatory Response*, published by the Alberta Energy and Utilities Board.

Once Alberta Environment is notified, they will determine who is responsible for remediation and will require the responsible person to undertake remediation. If the material is excavated it becomes oilfield waste and is subject to the Alberta Energy and Utilities Board's Guide 58 requirements.

Do companies have to report remediation efforts to Alberta Environment?
Alberta Environment receives information from the Alberta Energy and Utilities Board on all reported upstream oil and gas releases. Alberta Environment will determine the extent of its involvement based on the nature and extent of the release and the operator's past history. Some releases will require ongoing reporting of remediation progress to Alberta Environment. Others will not, but operators should retain records of the work done to remediate the site.

What criterion is applied to buried drilling fluids onsite?
The Alberta Energy and Utilities Board requires drilling waste products to be managed in accordance with the *Guide 50: Drilling Waste Management* guidance document. Alberta Environment is working with the Alberta Energy and Utilities Board to revise the Guide 50 document to include the Canada-Wide Standards for Petroleum Hydrocarbons in Soil (PHC CWS) values for remediation of drilling wastes. However, if contamination is suspected, Alberta Environment's remediation criteria must be met; following the Alberta Energy and Utilities Board's Guide 50 (or Guide 58 for other oilfield wastes) is not a defense if contamination results from waste treatment or disposal practices.

Who regulates contamination on-site (e.g., a sump)?
The Alberta Energy and Utilities Board's Informational Letter 98-02*: Suspension, Abandonment, Decontamination, and Surface Land Reclamation of Upstream Oil and Gas Facilities* identifies who is responsible based on whether or not the material is excavated. Once excavated, the material becomes oilfield waste and is subject to *Guide 58: Oilfield Waste Management Requirements for the Upstream Petroleum Industry* that is administered by the Alberta Energy and Utilities Board. If the material is remediated *in-situ* Alberta Environment is the regulatory body. Remediated soil at the site must meet Alberta Environment's criteria.

Batteries have owners/operators not licensees. Does the Alberta Energy and Utilities Board document these owners/operators and are the owners/operators responsible for remediation?
The Alberta Energy and Utilities Board is in the process of licensing all non-abandoned batteries and other facilities so there will be a record of who is responsible. For abandoned batteries that require remediation or reclamation Alberta Environment will review the records of the Alberta Energy and Utilities Board and Alberta Energy to determine who is responsible. Alberta Environment may also ask the landowner if lease payments were made for the site. The owners/operators are the most likely people to be considered responsible.

Is the Alberta Energy and Utility Board's database accessible to industry and landowners?

The Alberta Energy and Utilities Board database is accessible by the public through Information Services, Alberta Energy and Utilities Board, Calgary at 403-297-7040 or by fax at 403-297-8190. You should ask for a Drill Hole Page for the legal land location. The cost is $6 per well.

Are the inspectors qualified to identify contamination and decide that the sites fails based on contamination?
Inspectors are trained in a number of areas, including recognizing signs of contamination. If they are in doubt about a particular site they can call for assistance from the regional Contaminated Sites Specialist in their office.

Does an oil company have to hire a consulting firm to carry out the assessments or can they do it themselves?
Most companies hire consultants, however they are allowed to do the assessments themselves. The primary goal is to ensure that the representative samples are taken, the correct analyses are carried out and the data are interpreted correctly. A properly trained professional in either a consulting firm or the company can do this.

Who is to pay for Tier 1, 2 and 3 testing on landowner's land?
Industry is responsible for contaminant identification and remediation costs related to these activities. Landowners with specific, reasonable concerns about potential or actual contamination should contact the company and ask them to assess the concern. If this fails the landowner should contact the local office of Alberta Environment.

What happens when land use changes over the years – i.e., you build a house on a remediated site and drill a well years later?
How can you determine what use land will be put to in 30 or 100 years?
In the case of upstream oil and gas sites, the present and next use is usually agricultural or natural area. Sites remediated to agricultural criteria are not expected to pose a re-development risk because these are the most stringent criteria.
Many municipalities and municipal districts now require an environmental site assessment prior to issuance of a development permit. The local zoning authority should be consulted for specific requirements.

Does site failure mean the oil production operations are suspended until the contamination is cleaned up?
If the site fails at an inquiry the site is already abandoned so there is no production to suspend.

Do lending institutions have access to the remedial, etc. information brought to light through implementation of these guidelines?
Lending institutions, like anyone else, can obtain the information from the landowner or the companies, or from the government through the Freedom of Information and Protection of Privacy Act. Depending on the situation, a lending institution may request information on the environmental condition of a property.

4. HYDROCARBON GUIDELINES

The following sections pertain to the draft *Alberta Soil and Water Quality Guidelines for Hydrocarbons at Upstream Oil and Gas Facilities, Volume 3: User Guide*.

Hydrocarbon Guidelines: General Information

When is the PHC CWS to be implemented?
For remedial work initiated after July 1, 2001, the PHC CWS must be used.

Are the draft Alberta Hydrocarbon Guidelines in effect now? If not, when will they come into force?
They are in effect now. Experience gained in application to sites over the next year will be used to finalize the guidelines.

As of now, do we consider Alberta Tier I (1994) criteria for BTEX, mineral oil and grease and PAHs retracted?
Yes.

Now that CCME PHC guidelines have been adopted for use, do we continue to use Alberta Tier I Criteria for metals, salinity and other parameters, or can we begin using CCME agricultural guidelines for upstream oil and gas sites?
Applicable guidelines for PHC, BTEX and PAH are presented in the draft *Alberta Soil and Water Quality Guidelines for Hydrocarbons at Upstream Oil and Gas Facilities*. Guidelines for other substances in soil should be drawn from the *Salt Contamination Assessment & Remediation Guidelines* (2001), *CCME Environmental Quality Guidelines* (1999). If a substance is not present in this volume, the *CCME Interim Canadian Environmental Quality Criteria for Contaminated Sites* (1991) should be consulted for commercial/industrial sites and the *Alberta Tier I Criteria* (1994) should be used for agricultural/residential sites.

On sites where remediation has begun according to Alberta Tier I Criteria, will there be "grandfathering" of sites whereby a reclamation certificate will be granted to a site that meets Tier I as the new CCME PHC is being implemented? Or will sites have to meet CCME PHC CWS? What grandfathering allowances for recently initiated projects?
Will the new guidelines be implemented on a go-forward basis, or will they be applied to on-going projects and yet-to-be assessed sites? Will the age of the sites be taken into account or all sites must meet the same criteria?
The guidelines are applicable to all sites undergoing assessment and remediation. This includes on-going projects and yet-to-be assessed sites. The age of the facility or site does not influence the assessment and management goals. In the absence of adverse effect, we are not requiring companies to return to remediated sites.
The best way to ensure that there can be no conflict in the assessments for gross hydrocarbons is to conduct a supplementary analysis under PHC CWS methodology and document results.

Are PHC CWS legally enforceable or only guidelines?
Canada-Wide Standards are agreements among Ministers of Environment and between those Ministers and their publics. The PHC CWS does not specify a pace at which PHC releases must be addressed, rather it specifies that jurisdictions must implement the standard, and where such contamination becomes a priority, it must be addressed using the jurisdiction's implementation of the standard.
In Alberta, releases of PHC at upstream oil and gas sites must be addressed using the draft *Alberta Soil and Water Quality Guidelines for Hydrocarbons at Upstream Oil and Gas Facilities*. Releases not managed within the scope of the PHC CWS will be subject to enforcement action.

Why was the non-specific term "guideline" used vs. the term "standard"?
The Canada-Wide Standard for Petroleum Hydrocarbons in Soil was designed as a standard for which jurisdictions would be held accountable in their implementation. CCME's *Environmental Quality Guidelines*, by contrast, are recommendations for jurisdictions to implement as appropriate in their circumstances. In Alberta's case, the PHC CWS was taken as a sound basis for the implementation of related guidelines for BTEX and PAH. Application of the draft *Alberta Soil and Water Quality Guidelines for Hydrocarbons at Upstream Oil and Gas Facilities* will be the same irrespective of substance.

Is there a downstream guideline coming out? Why would a downstream guideline be different if it is based on human and environmental risk-based criteria? Are these criteria going to apply to downstream as well? If so, when?
Downstream guidelines *Risk Management Guidelines for Petroleum Storage Tank Sites* were released in October 2001. They have the same risk basis as the upstream guidelines.

***Alberta Soil Quality Guidelines*, *Alberta Soil and Water Quality Guidelines for PHC* – are these two separate guidelines?**
The *Alberta Soil Quality Guidelines* is a project for this year at Alberta Environment. The aim of the project is to integrate all current and applicable soil quality guidelines into a single document. The present draft *Alberta Soil and Water Quality Guidelines for Hydrocarbons at Upstream Oil and Gas Facilities* will be integrated into this effort. Water quality guidelines will be restricted to substances that are mobile from soil to groundwater, with emphasis on the groundwater-protective soil guidelines.

For reporting, how do we reference the new Alberta PHC guideline? Any forms planned for tabulating data for presentation in reports to Alberta Environment?
The guidelines can be referred to as the draft *Alberta Soil and Water Quality Guidelines for Hydrocarbons at Upstream Oil and Gas Facilities*.
CCME is planning the development of a web-available spreadsheet to assist with calculations at the Tier 2 level. Alberta Environment is not planning on review of all reports generated in respect of these guidelines, however, operators must document environmental site assessment information and any remediation stemming from these assessments.

Will there be a "Scientific Rationale" document similar to the Canada-Wide Standard published by Alberta Environment that supports the Upstream Oil and Gas Guidelines for BTEX, B(a)P etc. that includes Alberta Environment's eco-study for BTEX chemicals?
Will Volumes 1 and 2 be available?
Yes. The present guidelines were developed as three volumes. Volume 1 is the protocol used in developing the guidelines. Volume 2 is a detailed account of how the protocol was implemented in doing the actual calculations supporting the guidelines. Volume 3 is the User Guidance, which was distributed in draft form at the June 2001 workshops in Red Deer. These volumes were released on November 14, 2001 and were sent to all workshop participants and they are posted at the Alberta Environment website under Publications, sub-heading "soil".

Do the guidelines have any application for operating oil and gas sites with Alberta Environment approvals, particularly related to required soil monitoring and soil management?
The PHC CWS is a remedial standard applicable to all sites. Facilities with soil monitoring clauses in their approval will be subject to the PHC CWS.

Is the Minister of the Environment the only one that attends Canadian Council of Ministers of the Environment (CCME) meetings? If so, what is his expertise in the field?
The Minister of the Environment is the official Alberta member of the Council of Ministers. The Council is supported by a Deputy Ministers Committee and the Assistant Deputy Minister-level Environmental Planning and Protection Committee. These senior bodies define the priorities for CCME. Specific tasks, such as standards and guidelines development, are assigned to working level committees with technical and policy experts from the participating jurisdictions. In the case of the Canada-Wide Standard for Petroleum Hydrocarbons in Soil (PHC CWS), a Development Committee was co-chaired by Environment Canada and Alberta Environment.

How can Canada-Wide Standards be even close to reality in the varying conditions across Canada?
Canada-Wide Standards are calculated, based on a conservative generic set of parameters, to be protective of human and ecological health at the majority of sites across Canada. Tier 2 and Tier 3 exist so that the varying conditions across Canada can be taken into account, if desired.

***Alberta Soil and Water Quality Guidelines for Hydrocarbons at Upstream Oil and Gas Facilities* were prepared with the assistance of a consultant. How was this consultant selected?**
The consultant was selected on the basis of qualifications, experience with upstream oil and gas environmental management, and the quality of its proposal.

Who peer-reviewed the work and/or calculations in the *Alberta Soil and Water Quality Guidelines for Upstream Oil and Gas Facilities*?
It seems the consultant is the only entity mentioned in determining the guidelines. If so, why was the process not a collaborative effort among experts in different organizations? Who is checking the science of the consultant?
Much of the information in the draft *Alberta Soil and Water Quality Guidelines for Hydrocarbons at Upstream Oil and Gas Facilities* is adopted directly from the PHC CWS. The PHC CWS was reviewed by experts in Canadian environment ministries, sister agencies (e.g., Health), academics (University of Alberta, University of Waterloo, Royal Roads University), industry and consultants. As well, during development, technical advisory groups were used to ensure that current science was being appropriately applied. The technical advisory groups included government, academic and industry scientists from both Canada and the USA.
Specific work undertaken by the consultant to extend the PHC CWS to other compounds has been reviewed by experts at Alberta Environment, academia, and the environmental consulting industry. Finally, the guidelines are being released in draft form subject to a one-year post-publication review. The guidelines are subject to further review in that period and any tune-ups as related to experience in application.

In the workshop there was no reference to Agriculture Canada and their in-depth involvement of all surface soils. Can you provide some insight?
During the development of national soil quality guidelines and standards the federal government has been represented by Environment Canada and Health Canada. Agriculture Canada reviewed CCME's guideline development protocol and attended rollout sessions for the Canada-Wide Standard for Petroleum Hydrocarbons in Soil.

How will Alberta Soil Quality Guidelines accommodate required criteria for land application practices (i.e., activities that may involve purposeful addition of residual contaminants)?
The present draft *Alberta Soil and Water Quality Guidelines for Hydrocarbons at Upstream Oil and Gas Facilities* were developed primarily to assist in the assessment and management of existing contamination. Areas that have been used for biological treatment of hydrocarbons will, upon completion of treatment activities, be expected to comply with the guidelines. During treatment in designated areas the guidelines do not apply. Alberta Environment will work with stakeholders to define the appropriate use of the guidelines in biological treatment scenarios.

Regarding a cooperative approach from all stakeholders, how does a landowner get involved in the process (e.g., Tier 2)? Who was involved in Tier 1?
Many stakeholders were involved in the development of the Tier 1 guidelines. Stakeholders included members of the insurance industry, environmental industry, government, academia, Farmer's Advocate, oil and gas industry, environmental non-governmental organizations etc. A complete list of stakeholders consulted during the development of the PHC CWS is available from CCME. At Tier 2, site information is used to modify the relevant guideline value.

Who was involved during the consultation process to develop hydrocarbon in soil guidelines?
Three processes contributed to the creation of the current guidelines. (a) Development of the Canada-Wide Standard for Petroleum Hydrocarbons in Soil involved extensive stakeholder consultation through workshops, advisory groups, website postings and peer reviews. Stakeholders included environmental non-governmental organizations, Insurance Bureau of Canada, laboratories, consultants, academics, Farmer's Advocate, governments and the oil and gas industry. (b) The *Reclamation and Remediation Framework* developed in 1999/2000 involved consultation with governments, consultants, producer organizations, oil and gas industry, Farmer's Advocate, Canadian Banking Association and others. (c) The draft *Alberta Soil and Water Quality Guidelines for Hydrocarbons at Upstream Oil and Gas Facilities* relied on consultations under processes (a) and (b) to provide overall direction. Products were reviewed internally and any areas that were felt in need of additional consultative input were highlighted (i.e., conditional closure states Tiers 2B, 2C and 3B). These areas were the subject of consultation at the workshops in Red Deer in June of 2001.

Why was the Farmer's Advocate involved in the consultation process?
We find the Farmer's Advocate useful in alerting us to rural concerns. Alberta Environment does not rely solely on the Farmer's Advocate as a barometer of public position on environmental issues. Environmental non-government organizations and others are also consulted regularly, and landowners provide constant feedback through the reclamation inquiry process. In addition, the workshops in Red Deer were important consultations that allowed Alberta Environment to gauge the views of various publics and refine remediation goals and processes as a result.

How does World Health Organization become part of Canada's internal laws on extent of contamination and policies, etc.?
We use Health Canada toxicological reference values when available, otherwise we draw on high quality toxicological data from regulatory agencies around the world, including the U. S. Environmental Protection Agency and the World Health Organisation.

It appears that using the remediation guidelines can be challenging (intellectually and requiring experience) and requires knowledge in various sciences. How will Alberta Environment ensure that this exercise will be completed by appropriately trained people and completed correctly? Will Alberta Environment have the appropriately trained staff to evaluate the results in a timely way?
Alberta Environment is taking steps to ensure that its personnel are appropriately trained and will provide assurance through an audit function. At present, the audit is confined to Phase 1 assessments and activities of the Reclamation Officer at the wellsite inquiry. The issue of the degree of training of field consultants and environmental coordinators is one of ongoing education and professional diligence. Operators should ask questions – are people they are considering qualified?

Hydrocarbon Guidelines: Guideline Protocols

What is the definition of consensus-based decision-making process? Is it scientifically based? My understanding is that CCME is more scientific-based – not like Alberta Tier I. How can you have consensus-based decision making process for important scientific issues?
Consensus-based decision-making is defined as a process in which stakeholders define common goals and develop means of achieving those goals that all stakeholders can live with. CCME established a science-based approach to soil guideline development in 1996 and has continued to improve that approach through the multistakeholder deliberations of the Canada-Wide Standard for Petroleum Hydrocarbons in Soil. Consensus is confined to deliberation around various ways of implementing the relevant science in a way that is protective of human and environmental health.

Is it appropriate to incorporate biodegradation into Tier 1 guidelines if Alberta Environment has not concluded that natural attenuation is applicable to all sites?
Biodegradation is implemented in the guideline derivations only in the case of aquatic life protection and livestock watering pathways in coarse textured situations. Even here, biodegradation is restricted to the groundwater only and at a conservative, first-order rate consistent with anaerobic processes. Biodegradation is not applied to soil exposure pathways or with respect to potable groundwater protection, nor in the case of fine-textured materials. In the latter case, the guidelines focus on determination of groundwater concentrations near the water body or well.

What "other jurisdictions" have MNA guidelines?
Monitored Natural Attenuation (MNA) is being used in the US and in some European countries. Guidelines that detail the MNA process are available from the US Environmental Protection Agency and the American Society for Testing and Materials. Alberta will review guidelines from other jurisdictions in preparing an MNA guideline for Alberta.

Where are the approximate zones of aerobic and anaerobic activity – what depths? Do varying soil types (e.g., textures) promote certain microorganisms or inhibit?
Aerobic and anaerobic zones are established in relation to the amounts or concentrations of decomposable substrates (e.g., plant residues, many PHC) and the availability of electron acceptors (e.g., oxygen, nitrate). Where organic substrate is abundant, demand for oxygen is high. This can lead to localized depletion of oxygen and the onset of anaerobic processes, which are generally slow in comparison to aerobic processes. Large zones of anaerobic activity may be established in a region of PHC contamination (e.g., metres in depth, 10s to 100s of metres in length). However, small scale zones of anerobiosis may also occur in uncontaminated soils under wet conditions. For example, large soil aggregates may develop anaerobic centres following a rainfall. So it is not possible to generalize on the depth or lateral extent of anaerobiosis without information on a soil's moisture status and residue addition history. In the case of PHC contaminated groundwater, it is very common that most of the plume will become anaerobic as relatively small amounts of PHC can, upon biodegradation, exhaust supplies of oxygen at

depth. Fine textured materials tend to become anaerobic more easily and, once in this condition, remain anaerobic for longer periods of time. This is because the transport of oxygen from the soil surface to buried contamination is much slower in fine textures than in coarse textures. Under sustained contamination loads, this could be expected to promote the growth of anaerobic microorganisms (e.g., sulfate reducers) over aerobic organisms. These considerations led the CCME PHC CWS Development Committee to implement only a very slow anaerobic biodegradation rate for PHC fractions F1 and F2.

What document can we review to evaluate the rigour of a site-specific risk assessment for the ecological soil contact pathway?
Complete documentation for the draft *Alberta Soil and Water Quality Guidelines for Upstream Oil and Gas Facilities* has now been posted on the Alberta Environment website. Detailed documentation of how Tier 1 guidelines were developed can be found in the PHC CWS Scientific Rationale document posted at the CCME website. Tier 2 and 3 approaches must deliver equivalent or better protection. Bioassay for ecological contact is an acceptable Tier 3 procedure, but it must cover the suite of organisms considered in developing the criteria.

Has Alberta Environment taken into consideration gross parameters such as odour and visual staining when determining remediation criteria?
Such factors were considered in the development of the Canada-Wide Standard for Petroleum Hydrocarbons in Soil and incorporated into the "Eco-Contact" pathway for subsoil. Additional research is needed on formal methods for incorporation of such factors.

Are there any protocols for establishing cancer end-points for animals?
No protocols are available in Canada or elsewhere, as far as we are aware, for developing guidelines for livestock based on a cancer endpoint.

Is synergistic relationship of chemicals such as BTEX, F1, and F2 considered when a risk-based analysis is conducted?
No, as insufficient information is available to quantify such effects. The issue is addressed through appropriate application of conservatism in the guideline derivation process as per standard CCME and US EPA procedures.

Are the soil guidelines/criteria set at the point (level) of impact? If not, what is the safety factor (2x – 10x? or 0)?
Guidelines are set at a level low enough to be confident that adverse impacts will not occur in situations compatible with application of Tier 1 Guidelines. Safety factors are included in this process as related to the quality and type of the toxicological data. Full details are available in Volume 2.

Do the new guidelines account for carbon chains related to organic matter? Do the accepted methods of analysis account for this?
Yes. Some native organic matter is inevitably extracted from soils by solvents used for extracting PHC. This organic matter is generally more polar in chemical nature and

small amounts can be removed by the silica gel cleanup procedure specified in the PHC CWS analytical method. Soils containing very high amounts of organic matter (e.g., organic soils from fens or bogs, soils amended with large amounts of organic matter such as manure or compost) may release too much organic matter to the solvent system to be efficiently removed by the silica gel procedure. In such cases, a background control and difference chromatography as described in Section 15 of the PHC CWS analytical method is an appropriate alternative.

Why are there no freshwater aquatic criteria for F3 and F4?
F3 and F4 are not sufficiently soluble to be transported from soil to groundwater and subsequently to a surface water body.

The CCME 1996 Protocol recommends using an adult receptor for derivation of Soil Quality Guidelines for known carcinogens (regardless of land-use). Was this the case for these guidelines or was a toddler used?
Adult were used for carcinogens, toddlers were used for non-carcinogens.

Why consider deer as an ecological receptor in a natural land use when the driver for criteria selection will be ecological soil contact?
Following CCME protocol, guidelines were developed for each potential exposure pathway. The applicable pathway with the lowest guideline will be limiting.

You use 300 m in this presentation but 500 m was presented in the PHC CWS workshop. Why the difference?
These distances refer to the setback from a PHC-contaminated site necessary to eliminate consideration of the Aquatic Life Protection pathway – i.e., the transport of PHC from a soil source through groundwater to an adjacent surface water body. The PHC CWS contains many default values that are specified to ensure that it would be effective in application in all Canadian jurisdictions, including those with the most sensitive hydrogeology. The 500 m setback was chosen to cover sensitive hydrogeological conditions – those that would provide minimal attenuation of dissolved contaminants. Alberta's stratigraphy and hydrogeology is more favourable to contaminant attenuation than some others in Canada. Recent information indicates that contaminant plumes from hydrocarbon release to groundwater systems – excluding fractured bedrock – rarely exceed 250 m in length. Hence, a 300 m setback is considered adequate to identify sites where potential for PHC transport to an adjacent water body is negligible. The objective under the 300 m and 500 m setbacks is identical – no adverse effects to aquatic life.

Hydrocarbon Guidelines: Guideline Selection Process

Please tell us a bit more about how to include or exclude a pathway with reference to some guideline values?
See the draft *Alberta Soil and Water Quality Guidelines for Hydrocarbons at Upstream Oil and Gas Facilities, Volume 3*: *User Guide,* Section 2.6, for a full explanation.

Why does the Green Area not consider cattle as a pathway?
There are no guidelines developed directly for the Green Area. While much of the Green Area will fall under natural area land use, if cattle are grazed on the land, water and soil ingestion of cattle must be considered.

In the User Guide, soil is divided into fine and coarse textures. Where or how does high organic soil (e.g., peat) fall into these guidelines?
The guidelines do not explicitly address the soil component of peatlands. The Canada-Wide Standard for Petroleum Hydrocarbons in Soil does provide guidance on how to make measurements of PHC contamination in high organic soils. However, information on the effects of PHC on wetland biota that would be adequate for guideline development is lacking. Alberta Environment and CCME are currently considering options for evaluation of PHC contamination in wetlands. In the meantime, groundwater quality in peatlands can be evaluated using the draft *Alberta Soil and Water Quality Guidelines for Hydrocarbons at Upstream Oil and Gas Facilities*. Contamination of the soil materials themselves must be evaluated on a site-specific basis.

How do the guidelines take into account fractured bedrock?
Does one use coarse grain criteria in known, fractured subsoil?
When you have contaminated groundwater in a fractured rock, do you use fine or coarse grained soil type for groundwater criteria?
Did the groundwater modelling of chemicals in fine-grained soil consider fractured flow? (i.e., in weathered till).
Movement of water and contaminants in fractured bedrock is known to NOT conform to the models used in the development of the draft *Alberta Soil and Water Quality Guidelines for Hydrocarbons at Upstream Oil and Gas Facilities*. Contamination in fractured bedrock should be assessed using a site-specific (Tier 3) approach. In a Tier 3 evaluation, Tier 1 guidelines applicable to *in-situ* receptors/exposures (e.g., eco-contact, soil ingestion, dermal contact etc.) may still be appropriate, however, guidelines related to transport in groundwater (protection of potable groundwater, aquatic life) must be assessed site-specifically.

Why can subsoil criteria be used only within the setback around the wellhead?
When the well is abandoned, do remediation criteria revert to those for surface soil? If not, why not?
Use of subsoil criteria results in on-going risk management considerations – subsoil must remain subsoil. This risk management consideration can be met through observance of a developmental control within the 15 m setback. This setback must be observed indefinitely.

How can flare pits, battery sites NOT be assessed with subsoil guidelines as well as surface guidelines? (The setback of 15 m does not seem adequate to address all types of sites)
Use of subsoil guidelines depends on a mechanism to ensure that subsoil is not disturbed or exhumed. The developmental setback from an abandoned well provides such a

mechanism. Stratified remediation of sites not within a developmental setback presently require that the operator have care and control of the affected property.

Can you only use subsoil guidelines at a site within 15 m of a wellhead and at no other sites such as gas plants, battery sites etc. that do not have wellheads?
Subsoil guidelines can be applied within 15 m of an abandoned wellhead without limitation. Within this radius there are restrictions on re-development to ensure that the wellhead remains accessible, should it require servicing. Application of subsoil guidelines elsewhere constitutes a Type B closure that requires passive, on-site management to ensure that subsoil is not brought to the surface. This form of stratified management is available to proponents that have care and control (i.e., ownership) of the property. Most upstream facilities are located on leased land – on such land, the buy-in of the landowner would be required to apply subsoil guidelines. At present, this option is not enabled, pending consultation with stakeholders.

Is the reason subsoil guidelines only apply within the setback from the wellhead due to cumulative releases from the wellhead over time as opposed to a one-time release?
No. The application of subsoil guidelines near the wellhead is possible because administrative guidelines ensure on-going risk management considerations posed by stratified remediation.

If drill logs show hydrocarbon contaminated soil is contained within a fine textured till with lenses of coarse-textured material which guidelines should be used?
Selection of appropriate guidelines is based on the soil type that controls contaminant movement at the site. Contamination will move more quickly through coarse textured materials. An assessor must use judgement in making this determination. Is it a single lens or multiple lenses? Are the lenses thick or thin? Truncated or continuous? Is contamination present in the lenses at levels exceeding the guidelines for coarse textured soils? Is there a domestic use aquifer beneath the site or nearby surface water bodies? These are some of the typical factors an assessor must consider in making the decision. In cases where it is not clear which soil type should be applied at a site, the more conservative guidelines for coarse soil should be used.

Why is F3 more restrictive than F2? Please confirm that Tier 3 is currently usable.
Guidelines for F3 are not generally more restrictive than those for F2, however, the eco-contact guidelines are more restrictive. This is because the eco-contact guidelines are based on direct toxicity testing with representative organisms and, in these tests, F3 was slightly more toxic.
Tier 3 is currently usable. Tier 3A is eligible for a reclamation certificate.

If Tier 3 site-specific guidelines are evaluated for a site and are found to be lower (i.e., more stringent) than the more generic Tier 1 standards, is there an obligation to report and use the more conservative values?
Yes. By definition, more and better information is available as one ascends the tiers. Because guidelines are designed to be conservative, it is commonly found that

assessments at higher tiers lead to less stringent remediation targets and, therefore, lower costs. However, situations do occur where guidelines may not be effective because the site is more sensitive than was the base case used for guideline development. The case of contamination in fractured bedrock is a case in point – guidelines assume that contaminants in groundwater move through a porous medium – but contaminants in fractured bedrock can move further and more quickly through fractures. When an assessor identifies a situation such as this, (s)he is responsible for reporting the findings to the operator.

Could you elaborate on how the 10-metre distance was selected for the limit to which contamination will migrate in a fine soil. In a fractured clay, contamination will likely travel >10 metres from the source. Do you expect the average consultant to use coarse-grained criteria when fractured, fine-grained soil is present?
The 10 m distance to evaluate groundwater transport was adopted from the Canada-Wide Standard which was based on extensive literature review of contaminant movement. In all cases, the flow was assumed to be through a porous medium (intergranular). Tier 1 guidelines do not apply to materials where fracture flow is dominant.

Hydrocarbon Guidelines: Land Use

What land use are the national parks?
Alberta Environment does not have jurisdiction in national parks. Parks Canada did attend the CCME PHC CWS rollout workshop in Calgary on May 10-11/01. Parks Canada should be contacted for an answer to this question.

With the increased tendency of industry to move into the rural and farming areas why isn't livestock and wildlife just as important in industrial areas as in farming, residential and other areas?
Guidelines are developed to protect receptors of concern under particular land uses. When guidelines are applied as remediation criteria, they must be protective of the next land use. If the next use, supported by zoning, remains industrial then wildlife and livestock are omitted from the assessment. If next use is agricultural, wildlife and livestock must be protected. The approach to identification of receptors of concern in relation to land use is adopted unaltered from the national approach developed by CCME. The CCME approach received scientific peer and stakeholder review.

In southeastern Alberta you often find hydrocarbon contaminated soils associated with sodic clay/clay loam till over sodic shale or mudstone. The land use is grazing "natural" – or is it agricultural if ownership is "Special Areas"?
The default assumption is that the land would be agricultural. Where an assessor judges agricultural capability to be restricted solely to grazing, the assessment must be labelled as such, and the site may be remediated to natural area guidelines, including ingestion pathways for cattle. Water and soil ingestion by cattle must be considered.

Is a reclaimed wellsite or facility considered to be an agriculture or forest land use or the industrial classification?
Sites must be reclaimed to equivalent land capability. Normally, this is the same as the surrounding land use, however, a local zoning authority can make land use decisions that change the management endpoint. For example, a zoning authority may decide – subject to necessary vendor-purchaser agreement -- that an area surrounding a larger oil and gas facility is now needed for industrial purposes. In this case, remediation focuses on the next intended use – which is industrial.

"Natural area" – does it include urban parks?
No, an urban park is included in the residential/parkland land use.

What if present inapplicable use becomes a factor at a later date? There may be an inability to sub divide. In such cases, who is liable for financial loss, the landowner, energy company or Government of Alberta?
Agricultural land use guidelines are more sensitive than residential guidelines. Pathways are only excluded in situations where the reason for the exclusion is unlikely to change in future (e.g., the location of a creek).
EPEA regulations and the existing guidelines are designed to prevent this outcome. The operator retains liability indefinitely. Where the operator no longer exists, the industry-funded Orphan Program addresses residual reclamation and remediation issues.

Hydrocarbon Guidelines: Offset From an Abandoned Wellhead

Many workshop participants had questions concerning the setback around an abandoned wellhead and use of subsoil criteria. All questions have not been reproduced here, rather a general description of stratified remediation and administrative controls is presented. The following questions refer to the offset around an upstream oilfield wellhead which has been changed to 15 m following feedback from workshop participants. The Alberta Energy and Utilities Board (AEUB) has guidelines recommending a restriction on development immediately around a present or former wellhead. Accordingly, the use of subsoil guidelines for assessment and remediation of subsoils is permitted within a 15 m radius of a wellhead. Outside this area, surface soil guidelines are used for assessment and remediation of both surface soil and subsoil. The rationale for this is that subsoil guidelines are only protective if subsoil remains subsoil, and this cannot be ensured without some restriction on land use.

Flare pits are normally found >15 m from the well centre. Does that mean you only use surface soil guidelines (i.e., test just to 1.5 m) or apply the surface soil guidelines to the subsurface soil (>1.5 m)? What if the plume/contamination goes beyond 15 m?
Outside the 15 m offset, surface soil guidelines are used to assess both surface soil and subsoil. Soil sampling for contamination should extend at least 0.5 m deeper than visible contamination to ensure the contamination has not extended further down.
Subsoil guidelines would not apply to contamination outside 15 m.

If subsoil criteria can only be used within a certain setback of the wellhead does that mean that surface criteria must be used at all depths for pipelines? What about sites with no wellhead – i.e., major wellsites/batteries?
The restriction on use of subsoil criteria applies only to lands not owned by the operator. If the operator has care and control and wishes to carry out a stratified remediation, he is entitled to do so. However, the stratified condition must be noted such that future purchasers understand the obligation to maintain subsoil as subsoil. Because this is an environmental restriction – albeit a minor one – it is not appropriate to impose same on a landowner without their agreement. Stratified remediation is allowed within the wellhead setback because this portion of the lease is restricted in any case.

Regarding the wellhead and surface versus subsurface criteria; would re-evaluation of a pit, remediated to subsurface criteria, be required after abandonment?
Not if the pit is within 15 m of the wellhead.

Hydrocarbon Guidelines: Toxicity

Explain the new toxicity based guidelines as opposed to zero tolerance toxicity for humans and animals?
Guidelines are based on scientific analysis of toxicity of and potential exposure to contaminants. They are designed to ensure no toxic effect from long term exposure to contaminated soils or groundwater.

What is the safe amount of toxins inhaled, ingested or exposure of petroleum chemicals residue or materials used to find, produce and transport petroleum in this initial exploration and production? For humans and for animals?
Safe levels of exposure are based on a tolerable daily intake (TDI) recommended by Health Canada. The TDI is normally derived by dividing a no effect level determined on laboratory animals by a safety factor between 100 and 1000. The magnitude of the safety factor is set in consideration of the amount of information available regarding the substance. When CCME or Alberta Environment develops guidelines, it uses a conservative estimate of exposure (i.e., a high exposure) to the medium (soil, soil gases) to ensure that a person's TDI is not exceeded. The same approach is taken regarding protection of animal life, however, the safety factors may be less, particularly if test data are available for an animal that is similar to those being protected.

Are the risk-based criteria for BTEX based on chronic, long-term effects, or LD_{50} numbers? How do these criteria relate to the CWS for benzene (i.e., no threshold toxicant)?
Different toxicological data sets are used for different receptors – one for humans, one for plants, one for soil invertebrates and one for freshwater aquatic life including fish and freshwater invertebrates. Refer to Volume 2 for details. For humans, the BTEX guidelines are based either on long-term (chronic or sub-chronic) studies, on epidemiological studies, or in the case of the protection of potable groundwater pathway

for toluene, ethylbenzene, and xylenes on the smell and taste threshold for these compounds.

Why should we have different guidelines for humans vs. cattle, wildlife, etc.? For water, can animals pass contaminants where we cannot? Don't we use them for food?

Guidelines were developed based on standard Health Canada and Canadian Council of Ministers of the Environment (CCME) protocols. Cattle and wildlife guidelines differ from human values for two reasons: (1) the different amounts they drink relative to their body weights and (2) the different safety factors that are required to extrapolate from laboratory studies. Hydrocarbons do not normally bioaccumulate in plant or animal tissue, and hence possible hydrocarbon exposure through eating livestock or wildlife was not considered in this project. Long term (chronic or sub-chronic) studies were used as the toxicological bases for human, livestock and wildlife guidelines.

In all the development of these remediation guidelines has there ever been any scientific and medical investigation of the increase in asthma, cancer, and other preventable diseases to humans and animals which are on the increase and how much is safe toxin levels for them?

The guidelines are based upon safe levels of exposure derived from one of two primary health disciplines: toxicology, which determines effects in relation to known and controlled exposures in test animals; and epidemiology, which includes study of the occurrence and distribution of human disease in relation to environmental factors. Most human health-protective guidelines are based on toxicological information. Epidemiological information can be useful, but is incomplete or lacking for many toxic substances because health effects at environmental exposure levels usually cannot be observed and there are many other factors determining the health of a population that can interfere with this type of approach. Where epidemiological information does exist for a substance, it is considered in the guideline derivation. For example, epidemiological information exists for benzene based on observations in occupational health. Alberta Health and Health Canada conduct and publish epidemiological studies as part of their mandates to protect the health of Canadians. More information on these activities can be obtained at their websites (<http://www.health.gov.ab.ca/>) and (<http://www.hc-sc.gc.ca>), respectively.

Draft *Alberta Soil and Water Quality Guidelines for Hydrocarbons at Upstream Oil and Gas Facilities* are based on the CCME approach to guideline derivation. For most substances, the guideline is based upon a safe level of exposure known as the Tolerable Daily Intake (TDI) that is derived from toxicological studies. The TDI represents a no adverse effect level plus added safety factors to address sensitive individuals and for any other uncertainties that exist in the toxicology study. For substances like benzene where epidemiological data are known, the guideline is established at a level at which there will be no apparent increase in health risk. Overall, the guidelines are designed to ensure cleanup to levels that will not cause disease in any individual or population.

When conducting toxicological studies to determine guidelines, was long-term exposure to low levels of contaminants considered as well as short-term exposure to higher levels?
Long term (chronic or sub-chronic) studies were used as the toxicological bases for human, livestock and wildlife guidelines.

Why is livestock watering not aesthetic based for cattle since it is a known fact that if the water is of poorer potability weight gains and cattle health is affected?
In our literature search we did not find evidence that PHC contamination results in feeding/watering aversion by cattle. We based the guidelines on toxicology and exposure.

Hydrocarbon Guidelines: PAHs

What exactly do we subtract out of fraction 3? Guidance provided in Section 2.7 and later passages appear contradictory. Do we or do we not subtract the 8 carcinogenic PAHs from fraction 3?
What exactly do we (an analytical laboratory) need to report? F3, F3-PAH (CCME) or F3-carcinogenic PAH?
The November 14/01 release of the draft *Alberta Soil and Water Quality Guidelines for Hydrocarbons at Upstream Oil and Gas Facilities* consistently recommend that, where carcinogenic PAH are present, these observations NOT be subtracted from the F3 total. The analytical laboratory should report F3 and, separately, any carcinogenic PAH present in the sample. Whether a carcinogenic PAH analysis is required is discussed in Section 2.7.1 of Volume 3.

Do we still need to test for the rest of the PAHs on the CCME list – not just the 8 carcinogenic members?
Not when non-carcinogenic PAH are present as a component of a PHC source or product. The draft *Alberta Soil and Water Quality Guidelines for Hydrocarbons at Upstream Oil and Gas Facilities* address carcinogenic PAHs directly and non-carcinogenic PAH as normal components of PHC. PAH were present in the crude oil used for development of eco-contact guidelines and human health derivations assumed a 20% content of aromatics within each fraction. CCME guidelines for PAH would apply only in cases where non-carcinogenic PAH are present as the sole contaminants or at concentrations exceeding 20% of the relevant guideline within the relevant fraction – F2 for 2- and 3-ring PAH or F3 for PAH containing more than 3 rings.

Why are the PAHs in the Alberta guideline different from the CCME guideline? -- i.e., Alberta includes chrysene and benzo(a)fluoranthene and CCME does not. CCME includes pyrene and Alberta does not. Which ones do we sample for? Labs also report others, what about them?
Do the CCME PAH guidelines also apply?
Are there any standards for non-carcinogenic PAHs?

The PAHs included in the Alberta guidelines are known carcinogens. These substances require special management. Other non-carcinogenic PAHs such as pyrene are considered in the PHC guidelines under fractions 2 and 3. When PAH are not components of a PHC release, the CCME 1999 *Canadian Environmental Quality Guidelines* should be used. The approach to protection of human health assumed that 20% by mass of these fractions was aromatic and PAH surrogates were chosen to represent this. So, from a human health protection standpoint, additional non-carcinogenic PAH management would be required only if PAH were present at over 20% of the PHC guideline value. Again, for PHC, ecological health protection is based on direct bioassay of soils contaminated by crude oil containing PAH. Thus, PHC guidelines are also protective of ecological health when PAH are present at levels characteristic of petroleum sources and products. Individual non-carcinogenic PAH must be measured and reported in situations where they are present not as components of a PHC mixture, or when they exceed 20% of the mass of a guideline value.

Do the PST draft 1994 guidelines still apply at UST and AST sites? If one soil sample from a total of 15 slightly exceeds the standard, is further remediation required?
The 1994 PST guidelines have undergone revision to harmonize the scientific and risk management basis with the *Canada-Wide Standard for Petroleum Hydrocarbons in Soil* – as was done in the Upstream Guidelines.
Our objective is to ensure that the entire site meets the standard. However, sampling and analytical error should be taken into account in the assessment. We would consider a recommendation from the consultant in situations such as this.

Do the groundwater models take into account dilution at the discharge point?
No. However, where applicable, this phenomenon can be taken into account at Tier 3.

Could you explain exactly how the values for relative carcinogenic potency were calculated/estimated?
The values are adopted from the British Columbia Ministry of Environment, Lands and Parks (BCMELP), and the United States Environmental Protection Agency (US EPA). References are provided in the User Guide.

Relative Carcinogenic Potency for PAHs – the same value for all media and/or receptors?
Yes (to all media). The cancer endpoint is only considered for humans, and not for ecological receptors.

The case studies present analyses for PAHs. Federally, benzo(a)pyrene will be regulated as hazardous waste at 1 part per billion (0.001 mg/L in TCLP leachate). How will this affect remediation? Do PAHs have to be looked at for crude oil spill? Diesel? Asphalt?
Hazardous waste considerations apply when earthy materials are exhumed and transported for treatment or disposal. PAH analyses should be conducted wherever the nature of contamination suggests their likely presence. Crude oils, diesels and

hydrocarbons in flare pits are examples of sources known to include PAHs. Analysis of asphalt components is relevant only when such are contaminants in soil. More advice on when and how to measure PAHs is found in the User Guide.

Doesn't expressing the 8 PAHs as equivalent benzo(a)pyrene assume they act the same in soil?
It assumes they have the same toxicological endpoint. B(a)P guidelines are only derived for direct human contact pathways (soil ingestion and soil dermal contact) and so no assumption is required concerning the differing ways these PAHs might be transported in soil.

Are the B(a)P concentrations specified in the Guidelines (Tables 3-7) just for B(a)P or for all PAHs expressed as B(a)P?
For all eight carcinogenic PAHs (listed in Table 2 of the User Guide) expressed as B(a)P.

Should we consider the relationship between PAHs and phenols? Does a positive PAH test prompt testing for phenols? What criteria should be used?
Phenols, if present, should be assessed using the CCME 1999 Environmental Quality Guidelines.

Hydrocarbon Guidelines: Vapour Inhalation Pathway

How far from the source should one consider the vapour inhalation pathway?
With the exception of the natural area land use, we consider that the pathway must be assessed everywhere except within 15 m of an abandoned wellhead. This is because we cannot assume any particular lateral placement of future buildings. Tier 2 and 3 procedures to accommodate the geometry between contamination and existing buildings are available for proponents having care and control of the affected property.

Can the human inhalation pathway be excluded if the site is not suitable for (residential) development?
Yes. However, within the White Area it is difficult to show non-habitability. The pathway is "off" by default in Natural Areas.

It appears that vapour migration/release to the atmosphere of the volatile compounds has not been included as a potential exposure/source/pathway. Can you please speak to the rationale for this apparent exclusion, notwithstanding the Indoor Air Quality criteria?
In the example of agricultural land use, on a fine textured soil, the inhalation benzene level is 1.9 ppm. Could you explain the inhalation exposure for agricultural land, as the exposure time is limited to driving or walking over a site? Exposure may be one minute per year. Is this a correct interpretation?
Vapour releases from contaminated soil to outdoor air have been shown to be much smaller than releases to indoor air, due to the large amount of dilution that can occur in outdoor air. Accordingly, the indoor vapour inhalation pathway is also protective of

outdoor vapour inhalation. See the discussion in Volume 1. In regards to a short exposure time for driving or walking over agricultural land, the values are protective for indoor air to allow a farm family to position their residence anywhere on the farm, except within 15 m of the wellbore.

Hydrocarbon Guidelines: Water Quality and Groundwater Pathways

Do the groundwater quality guidelines replace Canadian Drinking Water Guidelines in all cases when evaluating hydrocarbons at an upstream petroleum site? For example, when conducting annual groundwater monitoring as required by licensing of a facility?

The groundwater quality guidelines for domestic use aquifers in the draft *Alberta Soil and Water Quality Guidelines for Hydrocarbons at Upstream Oil and Gas Facilities* are based on the Canadian Drinking Water Guidelines (CDWG). The CDWGs are the protection target for domestic use aquifers (DUAs) – these are the values listed for BTEX and B(a)P in the top line of Table 7 in Volume 3. The groundwater quality guidelines listed for F1 and F2 were derived by the CDWG method as part of the Canada-Wide Standard for Petroleum Hydrocarbons in Soil.

Groundwater quality objectives under an EPEA approval may differ from those presented in the draft *Alberta Soil and Water Quality Guidelines for Upstream Oil and Gas Facilities*, which were developed to support remedial activities. Monitoring under an approval is usually oriented toward pollution prevention, and trend analysis is normally used for assessment. The draft *Alberta Soil and Water Quality Guidelines for Upstream Oil and Gas Facilities* may be appropriate in a remedial situation.

Would I be correct in assuming that a site subject to reverse-flow aquifers (flooding and draining) from the subsurface pose a more difficult situation in contaminant stability?

Groundwater-protective values in the draft *Alberta Soil and Water Quality Guidelines for Hydrocarbons at Upstream Oil and Gas Facilities* are based on relatively simple models that assume the presence of an unconfined aquifer exhibiting Darcian flow in a known direction. If a site does not conform well to these assumptions, predictions of what contaminant concentrations in soil would be protective of groundwater may fail. The professional is responsible for identifying such conditions and taking appropriate steps in response. An appropriate response will vary with the nature of the deviation from the guideline assumptions.

Why are wildlife watering groundwater criteria approximately two times that for livestock?

Wildlife watering guidelines are based on deer; livestock watering guidelines are based on cattle. Cattle drink about twice as much as deer on a bodyweight basis and therefore, have twice the potential exposure.

What are some general rules of thumb to exclude hydraulic contact, e.g., metres of fine material between a source of contamination and a domestic use aquifer?

The User Guide provides a general rule of thumb: at least 5 m of saturated fine-grained material with a bulk hydraulic conductivity of less than 10^{-7} m/s is generally sufficient to ensure hydraulic isolation. Exceptions would have to be justified by the assessor.

I am concerned that various abandoned oil and gas wells may provide a path for contamination to move to the groundwater. Are there regulations in place for well abandonment to prevent this?
The Energy and Utilities Board has regulations for proper abandonment of wells to minimize the transfer of contamination.

Why do the authors of the draft *Alberta Soil and Water Quality Guidelines for Hydrocarbons at Upstream Oil and Gas Facilities* assume groundwater plumes are less than 300 m?
As stated in the scientific rationale presentation, hydrocarbons can travel a few hundred metres from a source. The value of 300 m is used as a reasonable upper limit of hydrocarbon transport in groundwater, based on a compilation of 647 petroleum hydrocarbon plumes in the U.S. in which it was determined that 98.1% of the plumes were less than 900 feet (274 m) long. A recent study of plumes in Alberta was consistent with the U.S. study. Where hydrocarbon plumes exceed 300 m, movement through fractured bedrock is usually implicated. This situation is NOT covered by Tier 1 guidelines. A full discussion of this issue, including references, is provided in Volume 1.

Are the groundwater criteria for BTEX all risk-based (for human drinking water), or are some still based on aesthetic objectives?
The guideline for the protection of potable groundwater for benzene is health-based; the guidelines for toluene, ethylbenzene, and xylenes are based on aesthetic objectives. Guidelines for other receptors are health-based.

Can a water well search be conducted to exclude the requirement to use Human Drinking Water Criteria?
No. The requirement to use drinking water protection guidelines is based on current and potential use.

For groundwater guidelines, you use them if groundwater is close to surface, hydraulically connected or under coarse surface and subsoil?
Groundwater guidelines were developed for four water uses. A detailed explanation of when the guideline for each water use is applicable is provided in Section 4.2 of the User Guide.

Why is vapour inhalation not considered for groundwater guidelines?
Soil remediated to vapour inhalation guidelines has pore water that is protective of the vapour inhalation pathway. When this porewater mixes with groundwater, hydrocarbon concentrations in the groundwater will be lower than in the pore water. Accordingly, groundwater sourced from soils remediated to inhalation pathway guidelines will not cause adverse effects, and accordingly no groundwater guidelines are required for the

vapour inhalation pathway. This explanation assumes all sources have been identified and managed to the relevant guideline level.

Why does the livestock watering criteria remain unchanged unlike freshwater aquatic life and wildlife watering?
The human drinking water and livestock watering groundwater guidelines are based on the assumption that a water well or dugout could potentially be constructed at any location in future. Accordingly, distance to a surface water body and soil type do not affect these guidelines.

Is there a guideline for fish and aquatic life and what guidelines are used?
Yes. See User Guide Table 7.

Could you please provide a "complete" reference source for the USEPA plume migration that you referenced in your presentation on Freshwater Aquatic Life Pathway exclusion.
Wiedemeier, T.H., H.S. Rifai, C.J. Newell, and J.T. Wilson, 1999. Natural Attenuation of Fuels and Chlorinated Solvents in the Subsurface. John Wiley and Sons, New York. For further discussion, see Section 2.7.3 of Volume 1.

Under the draft *Alberta Soil and Water Quality Guidelines for Hydrocarbons at Upstream Oil and Gas Facilities*, are wetlands and ephemeral streams included as surface water bodies?
A surface water body is defined as a water body that supports freshwater aquatic life (fish, plants, and/or invertebrates). The term creek includes sloughs and other standing water and peatlands. Pore water in wetlands should meet aquatic life criteria. If it does not, the wetland may be part of a planned remediation strategy. Such strategies must be approved by Alberta Environment.

No surface water body within 300 m – is this grassed or bare soil? Should be clarified since both have very different characteristics.
The 300 m distance to the surface water body is based on empirical studies of groundwater plume length, and is a function of the properties of the groundwater-bearing zone. It does not relate to overland flow and therefore applies equally to grassed or bare soil.

Which water use category is used for irrigation water?
The irrigation pathway is not expected to be significant, based on the volatility and rapid biodegradation of the lighter hydrocarbons in aerated surface water. Heavier hydrocarbons are strongly bound to soil, and are not expected to reach surface water bodies from contaminated soil.

When calculating Tier I values, you assume a distance of 10 m to a creek. Is that distance used for the Tier I Guidelines >10 m from water body?
The default Tier 1 condition is 10 m separation. This distance can be varied up to 300 m at Tier 2.

Hydrocarbon Guidelines: Apparent Inconsistencies

Many factors go into the calculation of each guideline. Occasionally this leads to pairs of numbers that may seem counterintuitive. The following questions relate to such issues.

In Table 3 for agricultural use, the human soil ingestion for benzene is 1,200 mg/kg. This appears to be high. For example, the soil ingestion for livestock is only 33 mg/kg. Please comment on why the large difference.
The main difference here is the amount of soil that is consumed daily on a body weight basis. Humans typically consume very minor amounts of soil via incidental ingestion. Cattle, being grazers, consume a much greater amount of soil.

Why, if 0.005 mg/kg or mg/L for benzene is considered the maximum allowable limit for human consumption, is a level of 1.8 mg/L allowed for wildlife consumption?
The human drinking water guideline for benzene is based on reducing the incremental cancer risk to any given individual to a level that is "essentially negligible". The wildlife watering guideline is set at a level to maintain a healthy population of deer.

Tables 2 and 4 indicate toluene criteria lower than benzene, whereas in Tables 1 and 3 toluene criteria are higher than benzene. Is this correct?
The chemical with the lowest guideline can be different for differing pathways. One of the contributing reasons for this is that the toxicological response of different chemicals varies depending on the type of receptor considered. For example, of the BTEX compounds, human guidelines are lowest for benzene, based on its carcinogenic properties. However, freshwater aquatic life are most sensitive to toluene.

The most conservative number for benzene in agricultural use for cultivated land (excluding protection of potable water) is 1.9 mg/kg. This is an increase of 40 times from existing Tier I criteria. How is that justified? What is the decision-making process behind your new guidelines?
The scientific basis for the former Alberta Tier 1 Criteria for benzene is documented in the original PST guidelines. Since publication of these guidelines in 1989, advances in the description of the vapour intrusion pathway have occurred and were captured in the PHC CWS. Alberta has also adopted an incremental cancer risk of one in one million since 1994. If the benzene guidelines for the protection of potable groundwater are included, the numbers are 0.073 mg/kg and 0.13 mg/kg for Fine and Coarse soil, respectively, and are the same order of magnitude as the Alberta Tier 1 benzene Criteria of 0.05 mg/kg.

Hydrocarbon Guidelines: Analytical Issues

What problems arise when trying to transform historic analytical results (e.g., TPH, TEH) to CCME groupings (F1, F2 etc.)? Is this possible? Are results more or less

conservative based on analytical methods? What does Alberta Environment want to see happen?

Studies undertaken during the development of the CCME PHC CWS showed that much of the lack of precision in measurement of soil PHCs between laboratories was attributable to "systematic error" related to lack of standardization in analytical determination. Therefore, standardization of analytical methods is a key element in the PHC CWS. The principal operations requiring standardization are the extraction method, cleanup of polar interferences, and gas chromatographic system and operating parameters. In order to derive PHC CWS-compatible information from earlier determinations, the following conditions must be met:

- Purge and trap extraction for F1 or volatile equivalent;
- Soxhlet extraction of F2 to F4 using hexane/acetone or more aggressive solvent such as dichloromethane;
- Determination of all components by gas chromatography using flame ionization detection;
- Removal of polar interferences by silica gel OR determination of PHC in both an appropriate control and contaminated samples with difference chromatography;
- The analytical chromatograms must be available such that integration of peaks in the CCME fractions can occur.

Details can be found in the CCME PHC CWS analytical method posted at the CCME website – www.ccme.ca. It is possible to compare older data to those that would be generated under the PHC CWS should the above conditions be met.

There is no general rule that can be used to relate results obtained under different hydrocarbon analytical schemes to those that might be obtained under the PHC CWS. The best way to ensure compliance is to take additional samples and analyze them under the PHC CWS. This is the recommended approach for on-going projects.

The CCME considers an F4G for analysis. Will the Alberta guidelines be including this as well?

The draft *Alberta Soil and Water Quality Guidelines for Hydrocarbons at Upstream Oil and Gas Facilities* do include criteria for F4. F4 may be addressed through extended range FID chromatography or through the gravimetric procedure described in the CCME PHC CWS analytical method.

Groundwater Guidelines – What method of extraction (i.e., hexane:acetone) is to be used for F2? Will a prescribed analytical method for water be stipulated as is now the case for CCME PHC soils?

Currently no standard methods exist for extractable hydrocarbons in water. While the need for an analytical method for F1 and F2 in water is acknowledged, it was out of the scope of the current work. Until such a method becomes available, it is recommended that F2 in water be evaluated using one of the currently acceptable methods for extractable hydrocarbons in water, but integrating only between the centres of the C_{10} and C_{16} peaks.

Do you subtract the BTEX data from F1 and F2 in order to calculate?

F1 is defined as the total concentration of C_6 to C_{10} hydrocarbons minus the concentrations of BTEX compounds. Full details of the analytical method can be found on the CCME website.

Using Canadian Society of Soil Science terminology, what is the difference between fine grained and coarse grained soil?
Textural determinations for the draft *Alberta Soil and Water Quality Guidelines for Hydrocarbons at Upstream Oil and Gas Facilities* are based solely on the percentage sand present. This means that fine and coarse soils can be determined by using the bottom axis of the CSSS textural triangle. With few exceptions, a coarse-textured soil will have "sand" in its textural designation – loamy sand, sandy loam, sand etc. will all be "coarse". Soils, with the exception of a coarse textured loam, lacking the word "sand" in their CSSS texture designations will be fine for the purposes of these guidelines.

Why set 75 μm for particle size cutoff?
Systems for classifying soils based on distribution of particle size are available from the Canadian Society of Soil Science, Soil Science Society of America, and American Society for Testing and Materials (ASTM). The last named differs from the first two primarily in the size cutoff between silt and sand. ASTM uses 75 μm, whereas the other two use 50 μm. CCME considered both systems and concluded that the ASTM classification may be preferred on the basis of familiarity to practitioners, and availability of standard methods for mechanical analysis. Alberta Environment believes that selection of the cutoff at 50 or 75 μm would have a relatively minor influence on exposure and risk when compared to other factors that are known only to within an order of magnitude.

Will there be a requirement to demonstrate soil texture and thus a specified method required?
Yes. At the moment, the ASTM method for determination of soil texture is acceptable. Additional work will be undertaken to develop a method based on Canadian Society of Soil Science procedures and conventions.

What kind of test is considered appropriate for determining hydraulic conductivity of saturated fine grained material? Ex Situ – falling head test, Shelby tube. *In situ* – slug and bail tests, pump tests.
Hydraulic conductivity information for fine-grained material can be obtained from permeameter tests in a lab or in the field through the use of single well response tests.

Hydrocarbon Guidelines: Tier 2

The User Guidance states that, for Tier 2, all soil parameters must be measured on the same sample. However, organic carbon is important in the zone of partitioning, while other parameters are more relevant in the soils the hydrocarbons are transported through or near the building. Do they really all need to be measured on the same sample?

At Tier 2, do you always need to measure site-specific values for all parameters listed in the user guidance? Some (i.e., vapour permeability) are difficult to measure properly.
The model assumes that soil organic carbon is uniform between the source and the building. While soil organic carbon does rise considerably in the top 50 cm of most undisturbed mineral soils, such material is not normally in the path of approaching PHC. In cases where the soil organic carbon is distinctly different in the strata positioned between the source and the building, Tier 3 calculations can be carried out using a general form of the Johnson and Ettinger model. The latest version of the User Guide has been re-phrased to take the above two comments into account.

If Tier 2 guidelines may be modified by precipitation, what other factors may be used to modify the Tier 1 to create a more site-specific Tier 2? Also, if infiltration rate was carefully studied for Tier 1, should not the same degree of effort be made to determine Tier 2?
The extent of modification possible for the guidelines is laid out in the User Guidance for the CCME PHC CWS, available at the CCME website – www.ccme.ca. Allowable adjustments focus on factors that are influential to transport and exposure but are also relatively stable and verifiable. Examples include soil organic C content, hydraulic conductivity and gradient. Alberta plans Tier 2 guidance development in fiscal year 2002-03.
In response to the second question, you are correct. Replacing good information with poorer information is clearly not in the spirit of the tiered approach and would be unacceptable to Alberta Environment. Note that it is actually the groundwater recharge rate that is influential in the soil guidelines related to groundwater protection and, infiltration rate is only one input needed.

Where are the equations and assumptions we can use to modify for Tier 2A criteria? What is the calculation to go from Tier 1 to Tier 2A (i.e., how did you get from 0.36 to 0.61 mg/kg for ethylbenzene?)
The equations, calculations, and assumptions requested in these last two questions are provided in Volume 2.

Hydrocarbon Guidelines: Conditional Closure and Risk Management

With reference to the User Guide, Page 3, Section 2.1.3 Type C (Conditional) Closure – explain "certain guidelines may be relaxed". Also, please explain landowner's participation in risk management when the energy company is responsible for the contamination.
Type C Closure is not presently available for use at Tier 2. It is based on use of natural attenuation in subsoil and groundwater and leads to a situation where groundwater cannot be used for certain purposes during the attenuation period. If this option comes available in future, it will be contingent upon operator and landowner reaching agreement on appropriate roles, responsibilities and financial arrangements.

Who retains liability for conditional closure?
Conditional closure is not presently implemented. However, as proposed, liability would remain with the operator so long as the landowner adhered to the agreed-upon remediation plan.

Is financial security provided to Alberta Environment to cover the risk or area of uncertainty? What incentive exists to remediate to Tier 1?
No financial security is provided to Alberta Environment to cover the risk or area of uncertainty. The draft *Alberta Soil and Water Quality Guidelines for Hydrocarbons at Upstream Oil and Gas Facilities* are themselves risk-based. By this, we mean that guidelines are based on a systematic consideration of the values to be protected and how these could be affected by exposure to contamination. Under a Tier 3A assessment, the protection of values (receptors, media) is achieved by remediating soil and groundwater to protection levels matching those of Tier 1. Under such conditions, a reclamation certificate can be issued. At Tier 3C, the other level currently available, risks are controlled through exposure management – typically involving engineered or administrative controls or a combination of the two. Maintenance of the risk management system represents an on-going responsibility of the operator and no reclamation certificate is issued and therefore the surface lease cannot be cancelled. There is thus strong incentive to pursue remediation to management level A – whether at Tier 1, 2 or 3.

Explain the risk management policy and how it will affect both companies and landowners.
Alberta Environment's draft *Guideline for the Management of Risks at Contaminated Sites in Alberta* (Alberta Environment 2000) describes two broad methods of ensuring that contamination in the geo-environment does not result in undue exposure to humans and ecological receptors. The guideline-based approach entails remediation of affected media (soil, groundwater) to generic standards. This approach requires no additional monitoring or management. Alternatively, if remediation is not feasible and/or appropriate, a person having care and control of the property may elect to manage risks by preventing exposure to receptors of concern (people, livestock, other living things). In either case, the operator is responsible for managing the contamination. During the period that contamination is being managed the operator must ensure that a landowner does not undertake inappropriate uses of the affected land and/or groundwater that is undergoing remediation.

5. PHASE 1 ENVIRONMENTAL SITE ASSESSMENT

During a reclamation inquiry can the Inspector request a Phase 1 assessment even if there is no evidence of adverse effect?
Will reclamation Inspectors request a Phase 1 Environmental Site Assessment if they suspect subsurface contamination?
In general, the Inspector will only be requesting the Phase 1 assessment where an adverse effect is seen that cannot be explained by soil physical properties (i.e., there is some other cause for the poor site performance). There may be cases where contamination is suspected but there is no adverse effect – in those cases the Inspector may request to see the Phase 1 assessment.
If a Reclamation Inspector suspects surface or subsurface contamination at a site, he/she can request to see the Phase 1 environmental site assessment. Failure to provide the assessment can lead to a refusal to issue the certificate.

In regards to the Phase 1 Environmental Site Assessment audits, do you plan to audit 10% of the Wellsite Reclamation Certificate Applications submitted by each company or 10% of all the applications submitted?
Approximately 10% of all Wellsite Reclamation Certificate Applications received in the Edmonton head office will be randomly audited for Phase 1 Environmental Site Assessment compliance. Generally, companies who submit more applications will likely be randomly chosen more frequently for an audit than companies that submit fewer applications. We will also try to audit as many companies (and their consultants) as possible.
The audit of the Phase 1 Environmental Site Assessment does not impact the process of conducting inquiries to determine if a reclamation certificate should be issued by Alberta Environment's Reclamation Inspectors. Reclamation Inspectors will still conduct an inquiry for every application received before issuing or refusing to issue a reclamation certificate.

Why is there no sampling during a Phase 1 Environmental Site Assessment?
The North American standard process is to use a Phase 1 Environmental Site Assessment as a non-invasive review of a site by doing a desktop review, interviews and a site visit. If the Phase 1 Environmental Site Assessment indicates there is a likelihood of contamination, a soil and groundwater sampling plan can be formulated and executed, which is known as a Phase 2 Environmental Site Assessment.

Are there any specific qualifications or certification requirements for individuals or companies to do Phase 1 Environmental Site Assessments?
No specific qualifications or certification requirements are legally required. As with many other occupations, it is advisable to get referrals or references about a company or individual from someone who can personally attest to the quality of their work.

Is a reclamation certificate from the 1970s enough to rate a site as "clean" for Phase 1 Environmental Site Assessment purposes? (Along with interviews, air photos, etc.)

A Phase 1 Environmental Site Assessment is not required for sites that already have a reclamation certificate. In any case a certificate does not relate to contamination and is not good evidence of contaminant remediation for a Phase 1 assessment.
Companies wishing to re-use a previously drilled site should conduct and document an assessment prior to re-use. If contamination is found they should notify Alberta Environment so that the previous licensee can be required to clean it up. If Alberta Environment is not notified, the contamination will be the responsibility of the new licensee.

What is the role of a Phase 1 Environmental Site Assessment in relation to the detailed site assessment for the *Wellsite Reclamation Certificate Application* form? The Phase 1 Environmental Site Assessment seems to be only a different way of presenting the same information on the detailed site assessment.
The reclamation process, including the detailed site assessment, does not specifically address contamination, as remediation is presumed to be completed prior to reclamation. The Phase 1 Environmental Site Assessment is a separate process, which is designed to investigate the likelihood of contamination at a site. The Phase 1 Environmental Site Assessment should be conducted at the abandonment stage not after reclamation has occurred. Some of the questions on the application for certification pertaining to site history do overlap the information required in the Phase 1 Environmental Site Assessment. Specifically, application questions pertaining to the sump location, remote sump location, drilling mud and drilling waste disposal are likely to overlap with the Phase 1 Environmental Site Assessment information. However, the information collected for the reclamation certificate application will not provide a comprehensive history of the site and therefore, the likelihood of contamination.

Does a dry and abandoned wellsite (i.e., drilled but never produced) require a Phase 1 Environmental Site Assessment?
Is an air photo review necessary for dry and abandoned wellsites from 1996 to 2001?
Yes, dry and abandoned wellsites do require a Phase 1 Environmental Site Assessment as produced water containing salt may have been released or spilled or other products may have been released during the drilling process. If a site was cleared but never drilled it would not require a Phase 1 Environmental Site Assessment.
A Phase 1 Environmental Site Assessment is required for dry and abandoned sites that never produced, regardless of when they were drilled or abandoned. Try to obtain an aerial photograph of the site while it is being drilled, if one exists. Depending on the timing of the aerial photo and drilling phase, aerial photographs may not be available to show the drilling stage. If there is not a photograph, provide the list obtained from Air Photo Services. Aerial photographs are an important component of a Phase 1 environmental site assessment as spills may be evident with a resolution of 1:5000 or 1:7500.

When the Phase 1 Environmental Site Assessment has been done and the operator no longer exists, who becomes responsible to carry on the reclamation process?

The current Alberta Energy and Utilities Board licensee is the operator responsible for remediating and reclaiming a site. If the operator has gone bankrupt, an Orphan Fund has been established by the oil and gas industry to fund the remediation and reclamation of sites when the operator is no longer a viable entity. If another licensee has taken over the site the new licensee is responsible.

Most reputable companies have been undertaking desktop Phase 1 Environmental Site Assessment reviews of some sort for many years. Will Alberta Environment accept these reviews as equivalent to the new Phase 1 Environmental Site Assessment or will they all have to be re-done?
The standard reporting form for the Phase 1 Environmental Site Assessments is located in Appendix 3 of the *Phase 1 Environmental Site Assessment Guideline for Upstream Oil and Gas Sites* (Alberta Environment 2001). Minor changes to the form are permitted but all the required information must be presented in the same order.

Will operators be required to provide a copy of the Phase 1 Environmental Site Assessment to the landowner? Will the Phase 1 Environmental Site Assessment be available to other interested parties, for example, potential buyers of the property?
The landowner can ask the operator for a copy of the Phase 1 Environmental Site Assessment. Audited Phase 1 Environmental Site Assessments can be obtained through the Freedom of Information and Privacy office by interested parties, but only 10% of all *Wellsite Reclamation Certificate Applications* will be audited for the Phase 1 Environmental Site Assessment documents. Phase 1 Environmental Site Assessments that are not audited are the property of the operator and the document would be released at their discretion.

When does conducting a Phase 1 Environmental Site Assessment (ESA) for upstream oil and gas sites become mandatory?
If a site is actively undergoing remediation and reclamation but the soil assessment for final reclamation has not been completed is a Phase 1 Environmental Site Assessment still required?
A Phase 1 is required if a "soil" assessment was conducted after July 1, 2001. Please clarify as the IL states the requirement is for an "assessment" not just a soil assessment.
If soils for the detailed site assessment were assessed prior to July 1, 2001, then a Phase 1 Environmental Site Assessment is **not** required. For sites with the final detailed soils assessment conducted **after** July 1, 2001, a Phase 1 Environmental Site Assessment is required. For example, if the soils were assessed in May 2001, but the vegetation assessment will be done next year, a Phase 1 Environmental Site Assessment will not be required for that site as the final detailed soil assessment was completed before July 1, 2001.

Is a Phase 1 Environmental Site Assessment required for any soil assessment (i.e. spill assessment, soil monitoring, active facility, flare pit assessment, etc.) or just for decommissioning and reclamation?

The Phase 1 Environmental Site Assessment is required for **abandoned** sites on private and public land, prior to undertaking reclamation activities. It applies to all upstream oil and gas sites, such as compressors, flare pits, remote sumps, dry and abandoned wellsites, oil production sites, batteries, pipelines, satellites and wellsites. It does not apply to active sites where a spill or release has occurred.

When do sites on public land that do not require a soils assessment have to start conducting Phase 1 Environmental Site Assessments?
Operators of sites on Forested Land in the Green Area or Peatland are required to evenly replace soils and should be checking that this has been done as part of their reclamation certificate assessment. This check should be done as part of the overall reclamation certification assessment. Therefore, these sites will not require a Phase 1 Environmental Site Assessment where the final reclamation certification site assessment has been done prior to July 1, 2001. If the final reclamation site assessment was done after July 1, 2001, a Phase 1 Environmental Site Assessment will be required.

What happens if company file information is not available due to changes in ownership?
Alberta Environment recognizes that in some cases company files will not be available. However, due diligence should be exercised in finding the appropriate files and checking with the Energy and Utilities Board for drilling records and spill releases. Generally speaking, a lack of information at the Phase 1 step should lead the diligent operator to suspect there is a potential for contamination on the site and thus to a Phase 2 environmental site assessment.
Other information obtained through aerial photograph reviews, site visits and interviews with landowners, occupants and/or current and past facility operators is also valuable and essential for completing the Phase 1 Environmental Site Assessment.

What is in place to stop fraudulent reports?
It is an offence under s. 227 (a) or (b) of the Environmental Protection and Enhancement Act to provide false or misleading information.

What prevents an oil and gas company from waiting until they get audited to perform a Phase 1 Environmental Site Assessment?
The operator runs the risk of the application or the certificate being refused. An inspector may request to see the Phase 1 Environmental Site Assessment report at the inquiry.

If a reclamation inspector refuses to issue a reclamation certificate on the basis of no or inadequate Phase 1 Environmental Site Assessment information, will the operator have an opportunity to appeal the refusal to the Environmental Appeal Board?
Yes. The operator has a right to appeal the refusal to issue a reclamation certificate.

If a Phase 1 Environmental Site Assessment identifies a potential contaminant source will action be outlined by Alberta Environment?

Under the Environmental Protection and Enhancement Act, there is a duty to remediate contaminated soils and groundwater. Alberta Environment identifies the current Alberta Energy and Utilities Board licensee as the person responsible for the remediation and associated liabilities. If the licensee has not remediated contamination that is causing an adverse effect, the reclamation certificate will not be issued and an Environmental Protection Order can be issued.

Why is a multi-phase environmental review not required by law before any construction starts as baseline information?

A pre-construction assessment is strongly recommended to provide baseline information and there is a question on the Wellsite Reclamation Certificate Application pertaining to that assessment. Alberta Environment has issued an Information Letter, Pre-construction Assessment Report for Wellsites, C&R/IL/00-8, that outlines some of the areas to consider. The pre-construction assessment is most useful for designing site location and construction practices. It is less useful for remediation and reclamation purposes, especially if the site will be in production for many years. Alberta Environment prefers to use adjacent controls as the performance measure at remediation and reclamation time. After abandonment, completion of a Phase 1 Environmental Site Assessment is mandatory and should be conducted prior to starting reclamation of the site.

Why do pipelines require a Phase 1 Environmental Site Assessment if no reclamation certificate is required?

Pipelines have required reclamation certificates since 1963. Section 144 of the Environmental Protection and Enhancement Act applies to pipelines, so an easement cannot be legally terminated without a reclamation certificate. Pipeline criteria for reclamation are available and companies can apply for a reclamation certificate for segments of pipelines that have been successfully reclaimed. In any case, Phase 1 assessments are for contamination not reclamation.

Will companies be expected to have a Phase 1 Environmental Site Assessment completed for every pipeline leak that occurs?

Companies are responsible for remediating all contamination resulting from the operation of their sites. A Phase 1 Environmental Site Assessment is to be completed after pipeline abandonment, prior to reclamation. Leaks and spills are required to be remediated as soon as possible after the contamination is discovered, but a Phase 1 Environmental Site Assessment will not have to be completed until the pipeline is abandoned.

6. PHASE 2 ENVIRONMENTAL SITE ASSESSMENT

If a Phase 2 Environmental Site Assessment has been conducted, can a landowner request the soil analytical data?
Yes, a landowner can request to see the data from the operator.

Does Alberta Environment have any plans to introduce a Phase 2 Environmental Site Assessment Guidelines document?
At this time, Alberta Environment has no plans to introduce a Phase 2 guidance document. However, a guidance document for conducting Phase 2 environmental site assessments is available through the Standards Council of Canada at www.scc.ca and go to "Search" and enter "Phase 2 Environmental Site Assessment" to obtain information on the document entitled *Phase II Environmental Site Assessment*, Z769-00 (Canadian Standards Association, 2001). Another document that provides information on conducting Phase 2 ESAs is the *Guidance Document on the Management of Contaminated Sites in Canada* (CCME 1997).

What triggers a Phase 2 Environmental Site Assessment?
A Phase 2 Environmental Site Assessment should be conducted if the Phase 1 Environmental Site Assessment indicates that there is a likelihood of contamination at the site or if there is insufficient information to conclude the likelihood of contamination at a site. Alberta Environment does not require a Phase 2 Environmental Site Assessment to be conducted nor do the results of the remediation activities that flow from a Phase 2 investigation have to be reported to Alberta Environment. If the Phase 1 Environmental Site Assessment indicates a spill has been excavated or cleaned-up, confirmatory sampling data, if not available through the company files, should be obtained to ensure criteria has been achieved.

If a company has inadequate records does this mean a Phase 2 Environmental Site Assessment will be required? Would it be necessary to do a soil, subsoil and groundwater investigation?
A lack of information at the Phase 1 step should lead the diligent operator to suspect there is a potential for contamination on the site.

Do we expect that most or a few sites will proceed to a Phase 2 Environmental Site Assessment?
At older producing sites and batteries, contamination is more likely to be present due to less stringent operating practices. However, industry practices and record keeping have improved considerably over the past decade, so the likelihood of contamination and/or poor documentation at newer sites has decreased, reducing the need for Phase 2 Environmental Site Assessments.

7. SALT CONTAMINATION

What is the Alberta Salt guideline?
The document, *Salt Contamination Assessment and Remediation Guidelines,* contains general guidance for assessing and remediating salt-contaminated sites. It also contains specific numerical guidelines from which remediation objectives can be developed.

Why is there no specific value for chlorides in soil? Plants must have an upper tolerance for chlorides.
Alberta Environment's *Salt Contamination Assessment and Remediation Guidelines* specify levels of electrical conductivity (EC) in soil that do not inhibit the growth of most plants. The studies used to determine the safe EC levels were undertaken mainly with chloride salts. So, while there is no explicit chloride guideline, it is believed that the EC levels specified will not induce chloride toxicity in most plants. Nevertheless, chloride migration to groundwater, surface water bodies and wetlands is an issue, and Alberta Environment is encouraging further research in this area.

When will a salt water spill receive a reclamation certificate?
Reclamation certificates are not for remediation work. The wellsite or battery or pipeline that created the spill can be certified when the site has been successfully remediated and reclaimed. Any off-site damaged areas will not receive a reclamation certificate but must be remediated to meet Alberta Environment's criteria and the surface reclaimed.

Benefits from addition of calcium amendments to soils far outweigh the increase in salinity (EC). Is Alberta Environment willing to accept a temporary increase in salinity (possibly higher than Tier I levels) as an acceptable change if long-term benefits are realized on the site (e.g., improved production and tilth)?
The *Salt Contamination Assessment and Remediation Guidelines* indicates use of gypsum is effective when conditions are appropriate. If the impacts are truly short-term then the company should wait for them to abate before applying for certification. If the impacts are not short-term then the goal of equivalent capability has not been met and the site will not be certified.

What analytical method is electrical conductivity (EC) based on?
Electrical conductivity is measured in a saturated paste extract. A saturated paste is prepared by adding water to a soil sample until saturation is reached. After an equilibration period the water is removed from the sample and its electrical conductivity is measured with a conductivity meter. A more complete description of the method is provided in Sections 18.2.2 and 18.3.1 of:
Carter, M. (ed.) 1993. Soil Sampling and Methods of Analysis. Canadian Society of Soil Science. Lewis Publishers, Boca Raton.

How does one determine EC on gravels?
If the material has a significant portion of fines, it is likely best to remove the large fragments and then prepare a saturated paste extract with the fine material. For gravel without a significant fine fraction, a reasonable approach may be to add water until the

pores are water-filled, equilibrate, then drain the water and measure EC. A larger sample will likely be needed than is typically used for soil; therefore, the analysis should be discussed with the lab before proceeding with sampling.

What does subsurface include?
In the context of the *Salt Contamination Assessment and Remediation Guidelines*, subsurface means the zone between the bottom of the A horizon and the water table.

Does the 'C' horizon include soil beneath the root uptake zone?
It depends on the rooting depth of the crop or species. Some portion of the roots of most plant species will penetrate into the C horizon. This may be a small portion for shallow rooted crops and much greater for deeper-rooted crops. In dry years, water and nutrients stored in the C horizon can be important for plant survival.

Is there a "rule of thumb" for when treatment of salt-contaminated soils is possible (i.e., ppm chloride or sodium) or when excavation and disposal is the only option? (i.e., when are landfarms not a viable option for treatment of salt contaminated soils?)
In theory, there is no limit on the concentration of chloride or sodium that is suitable for treatment rather than disposal. In practice, other factors such as soil texture, the age of the spill, and sodium adsorption ratio (SAR) can impose barriers to successful treatment. In order to remove salts, water must be able to enter and move through the soil. Fine textured soils can impede water movement, particularly when SAR is high and EC is low. Under these conditions, treating the soil can be slow and difficult.
Landfarming is typically used to treat hydrocarbon-contaminated soil. It may be possible to wash salt-contaminated soil in a similar process but only if the site is constructed so that water can be applied and the leachate collected for disposal. Because salts are mobile, the contaminated soil must be placed on a liner or clay base to prevent leaching of salts into the underlying soil. The site must also be bermed to prevent saline run-off from leaving the treatment area.
Factors to consider in the selection of a remedial option are discussed in the *Salt Contamination Assessment and Remediation Guidelines* in detail.

Field tools for determining EC in water measure in µS/cm yet the guidelines are in dS/m. This may cause confusion as did 0.1% or 1000 ppm total hydrocarbon concentration.
Different units are often used for different environmental media. It is important to be aware of the units used for any analysis and to be careful in making conversions. Standard units for expressing EC in soil extracts are dS/m. Multiply water measurements in µS/cm by 1000 to convert them into dS/m.

How different would the evaluation process be if salts were suspected and identified in the flare pit, or produced water was a part of the pipeline break in addition to hydrocarbons?
The general approach to evaluating a substance release is similar regardless of whether salts or hydrocarbons are suspected. The types of field and lab analyses will change,

depending on the contaminants. When salts are present, electromagnetic conductance (EM) surveys are an additional valuable assessment tool. Salts, particularly chlorides, can be more mobile than hydrocarbons, so the assessor needs to be aware that different volumes of soil or groundwater may be affected by hydrocarbons than by salts.

The Alberta Energy and Utilities Board uses a general limit of 500 ppm of chloride as a cleanup criterion. Does Alberta Environment support this general limit?
Under the Memorandum of Understanding Between Alberta Environmental Protection and Alberta Energy and Utilities Board on *Suspension, Abandonment, Decontamination, and Surface Land Reclamation of Upstream Oil and Gas Facilities* (Alberta Energy and Utilities Board Informational Letter 98-2), Alberta Environment has the responsibility and authority to develop remediation guidelines. The Alberta Energy and Utilities Board has the responsibility for regulating facility operations and oilfield waste disposal. Storage Requirements for the Upstream Petroleum Industry (Guide 55) and Oilfield Waste Management Requirements for the Upstream Petroleum Industry (Guide 58) outline Alberta Energy and Utilities Board requirements for oilfield facilities, including a chloride release limit for surface water collection ponds of 500 mg/L. This is not a cleanup criterion and should not be used as such. Alberta Environment requires that salt-contaminated soil and water be remediated to the guidelines specified in the *Salt Contamination Assessment and Remediation Guidelines*.

For a calcium replacement to soil, should the type of calcium amendment be considered (i.e., gypsum, calcium carbonate, etc)? Should the type of calcium amendment should be considered when natural sulphates are present?
Different calcium amendments have different properties that should be considered when choosing the appropriate one. The most important property is solubility because the calcium ions must be dissolved in soil pore water to effectively displace sodium from the soil. Gypsum ($CaSO_4$), a relatively soluble form of calcium, is the most commonly used calcium amendment. Other compounds, such as calcium nitrate, are more soluble and will reach a greater depth in a shorter period of time than will gypsum. This is useful for salts that are deep in the soil profile but care must be taken to protect groundwater, particularly from the nitrate ion that accompanies the calcium. Calcium carbonate is too insoluble to be useful unless added to acid soils.
In most Alberta soils, natural sulphates are accompanied by either calcium or sodium. The presence of sulphates and associated cations does not affect remediation of salt-contaminated soil, but it may affect the background EC and SAR levels on which the remediation objectives are based. Elevated levels of natural sulphates may result in naturally elevated EC readings and, if accompanied by sodium, background SAR levels will be high.

For the purpose of reclamation-remediation, are the levels given in the generic guidelines for industrial purposes the level that an industrial site needs to be reclaimed to, or is this an operating level of contamination?
The guidelines do not promote "pollution to" the acceptable limit – pollution prevention is expected. The guidelines focus on the acceptable level to which a polluted site must be cleaned up to.

The industrial guidelines can only be used at sites that are operating as industrial or commercial facilities, and are zoned as such by municipal authorities. Sites that are being reclaimed and will no longer be under industrial use, must meet the guidelines outlined in Table 2.2 of the *Salt Contamination Assessment and Remediation Guidelines* or a risk-based equivalent (Section 2.4.2 of the Guidelines).

This guideline process is filled with may do this or that, instead of shall. Please explain.

Persons or companies responsible for remediating a salt-contaminated site must meet the generic guidelines or obtain approval for a risk-based alternative. May is used when describing assessment and remediation options. Because every site is different, the Guidelines outline a range of possible techniques for assessing and remediating sites. It is up to the responsible party to choose the best method for each particular site.

What is the chemistry behind the replacement of Na^+ with Ca^{2+}?

The clay minerals and organic matter found in soil possess a negative charge that attracts positively charged ions (cations) such as sodium and calcium. These cations are loosely held on the surface of the soil particles because of this electrical attraction. Most soils contain a mix of cations, dominated by calcium. When a soil is contaminated by produced brines or road salt, the large quantity of sodium added to the soil forces calcium (and other cations) off the soil particles. In order to reverse this process, calcium ions must be added to the soil so that they can, in turn, force the excess sodium off of the negatively charged clay and organic matter.

Large amounts of salt are used in road maintenance activities. I have seen damage to land as a result. What is being done about this?

Unlike many sources of salt contamination that result from spills and leaks, road salt is intentionally released into the environment to improve highway safety under icy conditions. Nevertheless, improper storage and excessive application of road salt can result in unnecessary contamination. The *Salt Contamination Assessment and Remediation Guidelines* apply to sites contaminated by any source of salt, including road salt. Adverse effects caused by road salt can be reported to Alberta Environment at 1-800-222-6514.

Recently, the federal government declared road salt as "toxic" as defined in Section 64 of the Canadian Environmental Protection Act (CEPA) 1999. Alberta is working with the federal government to ensure road salt management improves under this designation.

I understand that the background concentration of chlorides set the standard. If these levels are less than 500 ppm, does a spill need to be cleaned up to that level?

Background chloride levels do not set the standard. Rather, the remediation objectives are based on background electrical conductivity (EC) and sodium adsorption ratio (SAR) levels. EC and SAR levels measured at control locations that are unaffected by the salt contamination determine which category the site falls within (See Table 2.2 of the Guidelines). Site remediation must return EC and SAR levels in the contaminated area to within the range specified for that category (e.g., EC of 2 to 4 dS/m or SAR of 4 to 8).

APPENDIX A

List of Acronyms

AENV	Alberta Environment
AEUB	Alberta Energy and Utilities Board
ASTM	American Society for Testing and Materials
B(a)P	Benzo[a]pyrene
BTEX	Benzene, Toluene, Ethylbenzene, Xylene
CCME	Canadian Council of Ministers of the Environment
CEPA	Canadian Environmental Protection Act
CDWG	Canadian Drinking Water Guidelines
DUA	Domestic Use Acquifer
dS/m	deciSiemens per metre
EPEA	Environmental Protection and Enhancement Act
EC	Electrical Conductivity
ESA	Environmental Site Assessment
Na	Sodium
PAH	Polycyclic aromatic hydrocarbons
PHC CWS	Canada-Wide Standards for Petroleum Hydrocarbons in Soil
ppm	parts per million
TCLP	Toxicity Characteristic Leaching Procedure
µS/m	microSiemens per metre