Contaminated Sites Policy Framework

October 31, 2014

ISBN: 978-1-4601-0596-2 (Printed Edition)
ISBN: 978-1-4601-0597-9 (On-line Edition)

Citation: Alberta Environment and Sustainable Resource Development (ESRD). 2014. *Contaminated Sites Policy Framework*. Land and Forestry Policy Branch, Policy Division. 25pp.

Any comments, questions or suggestions regarding the content of this document may be directed to:

Land and Forestry Policy Branch
Policy Division
Alberta Environment and Sustainable Resource Development
10th Floor, Oxbridge Place
9820 – 106 Street NW
Edmonton, Alberta T5K 2J6
Fax: (780) 422-4192
Email: Land.Management@gov.ab.ca

Additional copies of this document may be obtained by contacting:

Information Centre
Alberta Environment and Sustainable Resource Development
Main Floor, Great West Life Building
9920 - 108 Street NW
Edmonton, Alberta T5K 2M4
Phone: (780) 310-3773
Fax: (780) 427-4407
Email: ESRD.Info-centre@gov.ab.ca
Website: esrd.alberta.ca/

Disclaimer

This *Contaminated Sites Policy Framework* document presents the Government of Alberta's policy framework for the management of contaminated sites. It is a living document that has been developed by the Department of Environment and Sustainable Resource Development (ESRD) (the Department), and will be updated periodically.

This document provides the framework for the *Alberta Tier 1 Soil and Groundwater Remediation Guidelines* (Alberta Tier 1 guidelines; ESRD 2014a, as amended), *Alberta Tier 2 Soil and Groundwater Remediation Guidelines* (Alberta Tier 2 guidelines; ESRD 2014b, as amended). This document supersedes the *Draft Policy for Management of Risks at Contaminated Sites in Alberta* (AENV, 1999).

This *Contaminated Sites Policy Framework* also forms the basis for the *Alberta Exposure Control Guidelines* (ESRD, draft 2014), and the *Environmental Site Assessment Standard* (ESRD, draft 2013). These two documents are currently not available in final form since they are under review based on public comments. The drafts that were released for public review may be requested from ESRD but are not to be cited as ESRD policy until released in final form. Inquiries regarding development of these documents should be addressed to the Department of Environment and Sustainable Resource Development. Land Policy Section.

For oil, gas and coal activities, the Alberta Energy Regulator (AER) as a Provincial regulator will use the *Contaminated Sites Policy Framework* to ensure the Department's objectives are met. The AER operationalizes the Department's policies, including policies for contaminated site assessment, risk management and remediation. The AER provides feedback on, and input into, the Department's policies from an operational perspective.

TABLE OF CONTENTS

LIST OF FIGURES

1. INTRODUCTION

1.1 Purpose

This document presents the Government of Alberta's policy framework for the management of contaminated sites. It applies when developing and assessing options for management of contaminated lands in Alberta. The framework informs on Director Requirements under Part 5, Substance Release in the *Environmental Protection and Enhancement Act* (EPEA), (referred to here as "the Act;" Government of Alberta, 2010) as it relates to Sections 111, Manner of Reporting, and 112, Duty to take Remedial Measures. This document is not intended to provide information regarding other regulatory requirements outside of Part 5 of the Act or enforcement actions for non-compliance.

1.2 Relationship to Other Guideline Documents

This document provides the framework for the *Alberta Tier 1 Soil and Groundwater Remediation Guidelines* (Alberta Tier 1 guidelines; ESRD 2014a, as amended), *Alberta Tier 2 Soil and Groundwater Remediation Guidelines* (Alberta Tier 2 guidelines; ESRD 2014b, as amended), the Alberta Exposure Control Guidelines (ESRD, draft 2014), and the Environmental Site Assessment Standard (ESRD, draft 2013) (see Figure 1). This document supersedes the *Draft Policy for Management of Risks at Contaminated Sites in Alberta* (AENV, 1999).

1.3 Legislation

Two key acts, the *Environmental Protection and Enhancement Act (EPEA)* (Government of Alberta, 2010), and the *Water Act* (Government of Alberta, 2000) form the legislative basis of Alberta Environment and Sustainable Resource Development (ESRD), also referred to as "the Department" policy on the management of contaminated soil and groundwater.

1.3.1 Environmental Protection and Enhancement Act

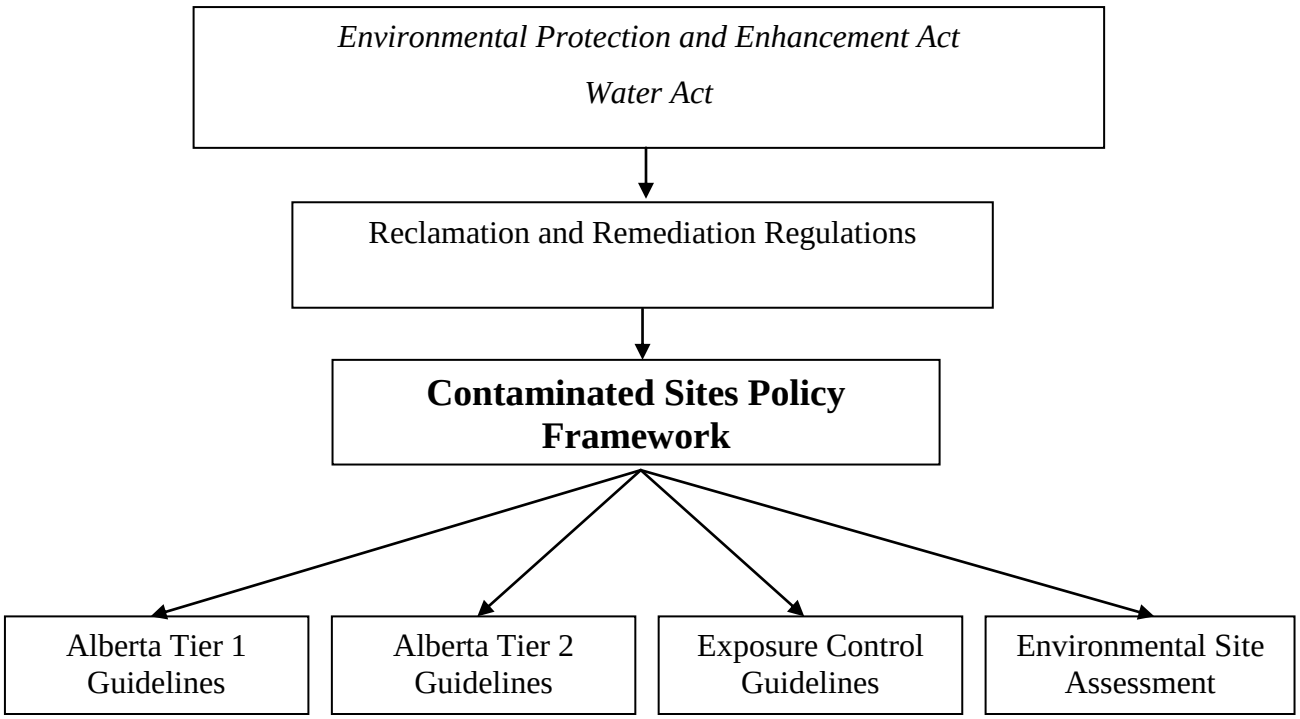
The EPEA lays out the regulatory requirements related to substance releases, remediation, and reclamation in Alberta. The purpose of the Act is 'to support and promote the protection, enhancement and wise use of the environment.' The EPEA allows the Minister to establish guidelines and objectives.

1.3.1.1 Substance Release Provisions

The Act prohibits the release of substances in an amount that causes or may cause a significant adverse effect. "Release," "substance," and "adverse effect" are defined in the Act. The release of a substance to the environment can occur rapidly (as in the rupture of a vessel containing the substance) or over a longer period of time (as with a gradual leak from an underground pipeline that goes undetected). When a substance is released and causes an adverse effect or, for releases after September 1, 1993, has the potential to cause an adverse effect, the release must be reported. Remedial measures must be implemented whenever a release causes, or has the potential to cause, an adverse effect. Additional guidance on release reporting can be found in *A Guide to Release Reporting* (AENV, 2005) and *Informational Letter 98-1* (AER, 1998).

1.3.1.2 Conservation and Reclamation

The Act includes requirements for the conservation and reclamation of specified land. Specified land is defined in the Act and in the *Conservation and Reclamation Regulation* (C&R Regulation). The Act and the C&R Regulation require reclamation of specified land to an equivalent land capability. Equivalent land capability is defined in the



Reclamation and Remediation Regulations: include existing or future Regulations under the EPEA that pertain to reclamation or remediation in Alberta. Examples include: *Conservation and Reclamation* (AR 115/1993), *Release Reporting* (AR 117/93), *Remediation Certificate* (AR 154/2009).

Contaminated Sites Policy Framework: provides policy guidance for the management of contaminated sites in Alberta. It provides overall policy links to site assessment guidance (Environmental Site Assessment Standard) and the options for management of contaminated sites (Alberta Tier 1, Alberta Tier 2, and Exposure Control Guides). It applies when developing and assessing options for management of contaminated lands in Alberta.

Alberta Tier 1 Guidelines: Alberta Tier 1 Soil and Groundwater Remediation Guidelines are generic remediation guidelines; that is, they are developed to protect sites at the more sensitive end of the range and can, therefore, be used at most sites without modification.

Alberta Tier 2 Guidelines: Alberta Tier 2 Soil and Groundwater Remediation Guidelines apply the same protection objectives as Tier 1 but allow for modification of the Tier 1 guideline value based on site-specific conditions.

Exposure Control Guidelines (Draft): Exposure Control involves risk management through exposure barriers or administrative controls based on site-specific risk assessment. This document clarifies the Government of Alberta's expectations for exposure control plans if this is to be considered as an option for management of risks at a contaminated site.

Environmental Site Assessment Standard (Draft): outlines minimum requirements for conducting environmental site assessments (ESAs) in Alberta. It is intended to assist in planning, implementation, and interpretation of the results of Phase 1 and 2 ESAs, remediation, and confirmatory investigations when they are required by the appropriate regulator.

Figure 1: Risk Management for Contaminated Sites: Relationship between Policy Documents

C&R Regulation. With respect to soil and groundwater contamination on specified land, the Alberta Tier 1 guidelines (ESRD, 2014a, as amended) establish generic remediation guidelines for achieving equivalent land capability. The process for developing site-specific remediation guidelines for achieving equivalent land capability is described in the Alberta Tier 2 guidelines (ESRD, 2014b, as amended).

1.3.1.3 Remediation Certificates

Under the Act, the *Remediation Certificate Regulation* (Government of Alberta, 2009) authorizes the Director or Environmental Protection Officer to issue a remediation certificate when contaminated land has been remediated. While encouraging remediation of contaminated land, the remediation certificate also protects the responsible party from future Environmental Protection Orders related to the remediated zone and provides assurance to stakeholders that the remediation has been completed satisfactorily. The remediation certificate is a voluntary process of regulatory liability closure and applies to a remediated area, but does not apply to the entire site in question.

1.3.2 Water Act

Water is a public resource and is owned and regulated by the Government of Alberta. The *Water Act* provides the regulatory requirements related to the management of water supplies and water quality. The purpose of the *Water Act* is "to support and promote the conservation and management of water, including the wise allocation and use of water". The *Water Act* allows the Minister to establish guidelines for water management.

1.4 Desired Outcomes

Alberta's framework for the management of contaminated sites is designed to achieve three policy outcomes:

- Pollution prevention: Avoid impairment of, or damage to, the environment, human health or safety, or property.
- Health protection: Take action on contaminated sites that is commensurate with risk to human health and the environment.
- Productive use: Encourage remediation and return of contaminated sites to productive use.

Pollution prevention is a critical factor in maintaining a healthy environment. The Department's policy strongly emphasizes the importance of proactive efforts that keep soil and groundwater clean and free of contaminants rather than relying on remediation after contamination has occurred. Remediation programs are often costly and, in the case of large and complex contaminant releases, may not be capable of fully restoring the quality of contaminated land or water, leading to a loss of land or water use options. Soil and groundwater contamination may be prevented or minimized by exercising care and control through the following:

- proper siting for facilities and chemical storage areas;
- secondary containment of contaminants of potential concern (CoPC);
- regular inspections and maintenance of facilities, tanks and pipelines;
- soil and groundwater monitoring programs;
- early source identification and removal or management; and

- proper waste disposal and management.

One of the purposes of the Act is "to support and promote the protection, enhancement and wise use of the environment." Proactive prohibition on release of substances is a critical step for contamination prevention. Part 5 of the Act prohibits "the release of substances in an amount that causes or may cause a significant adverse effect."

If contamination has occurred, three key elements of Alberta's framework for management of contaminated sites are employed: source control, contamination delineation, and contaminant management, including remediation.

Under productive use, the goal is to preserve as wide a range of options for use of the land when a substance release has occurred. There are many competing needs for land. Contamination can restrict land use or even prevent any form of productive land use. The goal of contaminant management is to return land to unrestricted use wherever feasible. Where this is not feasible, highest and best use of the land needs to be considered in how the land is to be managed.

1.5 Alberta's Contaminated Sites Policy Framework

Where a substance release has occurred, the Department's policies promote the return of contaminated sites to productive use and to ensure that risks to human health and the environment are minimized. For upstream oil and gas and coal activities, the Alberta Energy Regulator (AER), as the Provincial regulator will use these policies to ensure the same objectives are met for these activities. Figure 2 provides an overview of the requirements for reporting, site assessment and remediation in Alberta.

A detailed overview of reporting requirements is beyond the scope of this document but has been included in Figure 2 for completeness. Sections 110 and 111 of EPEA provide the basis for Alberta's *Release Reporting Regulation*, which stipulates what must be reported, when, how and to whom. *A Guide to Release Reporting* (AENV, 2005) provides further information about Alberta's regulatory release reporting and 7-day reporting requirements. Alberta's *Environmental Site Assessment Standard* (ESRD, draft 2013) provides additional information regarding requirements for Phase 1 and Phase 2 Site Assessments.

Requirement related to reclamation of specified land under Part 6 of the EPEA is also beyond the scope of this document and has not been included in this overview. The requirement for a Phase 2 site assessment or remediation could be part of a reclamation certificate application for specified land. This has not been included in figure 2.

Under this framework, strategies for the management of risks at contaminated sites in Alberta include: Alberta Tier 1 Guidelines, Alberta Tier 2 Guidelines, and Exposure Control. Within a given land use, sites will fall into a range of sensitivities because of differences in receptors and site conditions.

Remediation may meet generic objectives, as outlined in Alberta Tier 1 Guidelines. These Guidelines were developed to protect more sensitive receptors expected to be present within a given land use; therefore, can be used at most sites without modification. The Tier 1 approach is based on the assumption that all generic exposure pathways and receptors relevant to a particular land use are present and may not be screened out.

Alternatively, the proponent may employ modified risk-based remediation objectives as outlined in Alberta Tier 2 Guidelines (ESRD, 2014b, as amended). There are two options available under the Tier 2 approach: (a) modification of the generic Tier 1 Guidelines within limits defined in the

Guidelines or (b) development of site-specific remediation objectives. Under Tier 2, it may be possible to screen out certain exposure pathways and/or modify the Tier 1 Guidelines on the basis of site conditions. The Alberta Tier 2 Guidelines describe how the Tier 2 approach might be used to develop remediation objectives for a site. Development of site-specific remediation objectives requires more detailed planning and a more detailed site-specific ecological and human health risk assessment. For this option, more interaction with the appropriate regulator for the industry sector is expected, and only general principles are provided in the Alberta Tier 2 Guidelines.

The *Alberta Exposure Control Guidelines* (ESRD, draft 2014) outline exposure control requirements involving the use of physical and/or chemical exposure barriers, administrative controls, or other forms of exposure management. It also outlines requirements for source control, mitigation of off-site contamination, regulatory and stakeholder input and agreement, and lists other fundamental requirements independent of risk. Exposure Control involves risk management through exposure barriers or administrative controls. Under this policy, risk management will, by its nature, lead to conditions or restrictions which would preclude regulatory closure.

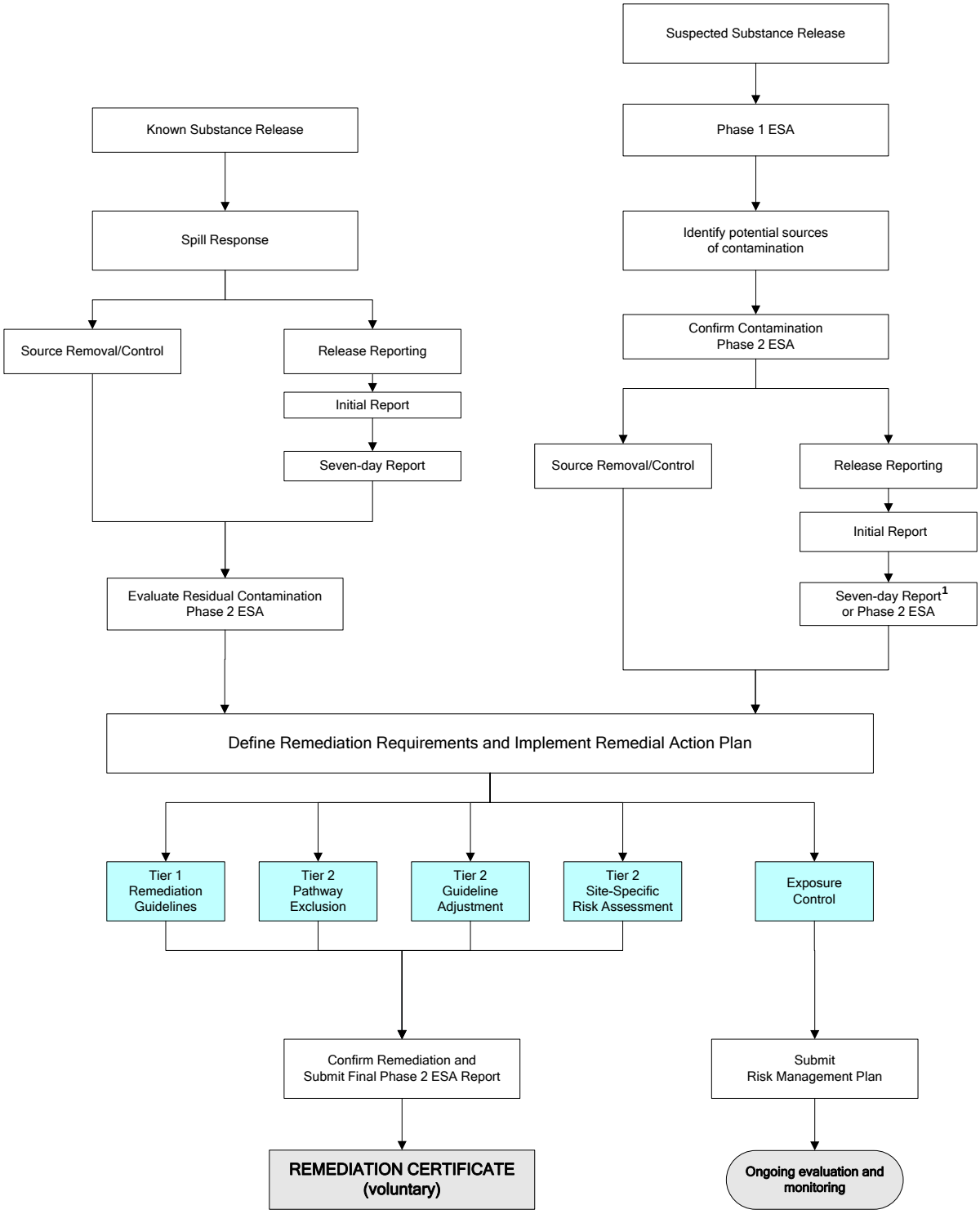


Figure 2: Framework for Contaminated Sites Management in Alberta

[1]This step will depend on the complexity of the situation. In some instances such as abandoned well sites or pipelines where contamination is discovered as part of the reclamation application, there is no need to submit a 7-day report. In other instances, such as small spills that are addressed quickly after the release, sites may move directly from the 7-day report to remediation. For other, more complex sites, this step may result in several iterations of the Phase 2 site assessment prior to remediation.

2. STAKEHOLDER ROLES AND RESPONSIBILITIES

2.1 Role of Proponent

For the purpose of this document the term proponent is used broadly to encompass any person that is initiating an Environmental Site Assessment (ESA) that must be reported to the appropriate regulator for that industry sector. This may include any of the person responsible, owner, operator as defined in the *EPEA* or any other person who initiates an ESA that must be reported to the appropriate regulator for the industry sector.

Reports pertaining to oil, gas, and coal should be directed to the Alberta Energy Regulator (AER), and reports for other sectors directed to ESRD.

As directed in the Act (sections 110, 111 to 112), the person responsible is required to report the substance release to the Director, other local authorities, or relevant persons, as defined in these sections of the EPEA, and take timely remedial measures. When the first discovery of a substance release is during a Phase 2 ESA, the duty to report and take remedial measures would apply at the time of discovery (see Figure 2). When an ESA must be submitted to the appropriate regulator as part of a substance release report, the proponent must fulfill all responsibilities as specified in the Phase 1 ESA standard published by the Canadian Standards Association (CSA, 2012), the Phase 2 ESA standard (CSA, 2013) and the Department's *Environmental Site Assessment Standard* (draft 2013).

In addition, the proponent must:

- ensure that all acts, regulations, procedures, and other regulatory guidance in Alberta are followed during the work;
- ensure that all appropriate documents are submitted to the regulator(s), all affected third parties, and that the information is accurate, consistent, and complete; and
- ensure that the site's environmental conditions are suitable for its intended use and it meets all legal conditions and requirements.

2.2 Role of Environmental Professionals

The professional provides guidance to the proponent to ensure that all relevant regulatory requirements in provincial and municipal governments for ESAs, remediation, risk management and reclamation are adhered to. The environmental professional must be a member in good standing with one of: *Alberta Institute of Agrologists* (AIA), *Alberta Society of Professional Biologists* (ASPB), *Association of Professional Engineers and Geoscientists of Alberta* (APEGA), *Association of the Chemical Profession of Alberta* (ACPA), *College of Alberta Professional Foresters* (CAPF), *College of Alberta Professional Forest Technologists* (CAPFT), or the *Association of Science and Engineering Professional Technologists of Alberta* (ASET). The professional must have a minimum of 5 years of relevant experience based on the *Competencies for Reclamation and Remediation Advisory Committee's Recommendations Report* (2006) and carry adequate insurance throughout the duration of the assessment, including, but not limited to, general liability and errors and omission insurance.

2.3 Role of the Department

The role of the Department is to ensure Alberta's environmental outcomes are established that are protective of human health and the environment. The Department develops new and improves

existing provincial standards, guidelines, and other regulatory tools to provide assurance of the environmental outcomes related to management of contaminated sites. The Department works closely with the Alberta Energy Regulator to ensure that these policies will meet the intended outcomes for all industry sectors.

The Department also promotes assessment, proper management of risks and productive use of contaminated sites. This may be achieved through programs such as remediation certification, reclamation certification, professional sign-off for site assessment reports and brownfield strategies.

The Department and the AER provide access to environmental information that is under their jurisdictions regarding contaminated or potentially contaminated sites.

The Department engages with professional members, agencies, other government departments, industry and the general public for implementation of policies and regulations related to remediation and management of contaminated or potentially contaminated sites.

2.4 Role of the Alberta Energy Regulator

In 2013, the Alberta Energy Regulator began taking on regulatory functions related to energy development that were previously held by the Department, including the EPEA and the Water Act. This transition was completed in March 2014, and the AER is now the single regulator of energy development in Alberta—from application and exploration to construction and development, to abandonment, reclamation, and remediation. The AER operationalizes the Department's policies, including policies for contaminated site assessment, risk management and remediation.

The AER's role in contaminated site management includes several components. The AER investigates spills and reviews spill reports and remediation plans required for spill response to ensure compliance with the legislation, AER's Directives and Department's policies. Soil monitoring and soil management plans and reports required under an EPEA approval are reviewed for compliance with the activity's approval. Upstream oil and gas contaminated site reports are assessed using the AER's Directives and Department's policies.

The AER also reviews remediation certificate applications for upstream oil and gas facilities and reclamation certificate applications for energy activities and issues a certificate if the area meets the Department's policies.

The AER's compliance assurance program and supporting processes use education, prevention, and enforcement activities to facilitate efficient and effective compliance with legislation, AER's Directives, and the Department's policies. Its ultimate goal is to ensure compliance with written requirements, monitored and enforced by the AER.

The AER provides feedback on, and input into, the Department's policies from an operational perspective.

3. PRINCIPLES OF CONTAMINANT MANAGEMENT

The EPEA requires remedial measures to be implemented whenever a release causes, or has the potential to cause, an adverse effect. The implementation of remedial measures involves key elements of Alberta's framework for the management of contaminated sites: source control, ESAs, risk assessment, and contaminant management, including remediation.

3.1 Source Control

A source of contamination is anything that adds contaminant mass to the environment. Source control is a necessary action in support of pollution prevention, a key outcome of Alberta's policy on contaminated site management (ESRD, 2014a, as amended). Failure to control sources allows contaminants to spread, increasing risk and remediation costs, and potentially limiting future land use if remediation to Alberta Tier 1 or Tier 2 Guidelines is not possible. If there is evidence of soil or groundwater contamination, the source, if it is still present, must be identified and removed or controlled. Source control is not considered complete unless it can be demonstrated that contaminant migration has either stabilized or decreased in all environmental media and that the degree of contamination at any point is unlikely to worsen over time.

To ensure consistency with pollution prevention, the Tier 1 Soil and Groundwater Guidelines are not "pollute-up-to" levels (AENV, 2007a, as amended). The Department requires responsible environmental practices and does not accept the action of polluting up to a limit. If an ESA detects cumulative release of substances to the environment, mitigative measures must be taken, including, at a minimum, source control, even when a contaminant concentration is below an applicable soil or groundwater quality standard. Sources must not be left uncontrolled until cumulative releases result in an exceedance of a remediation guideline value in the Tier 1 or Tier 2 Guidelines.

Contaminants can be introduced from a variety of sources. Leaking pipelines and storage tanks are common sources of contamination. Contaminated soil and groundwater may be a source of contamination to other areas of a site, if the contaminants are mobile. Soil or groundwater with naturally elevated substance concentrations may become a source of contamination, if they are redistributed and cause the receiving soil or water to exceed Alberta Tier 1 or Tier 2 Guidelines.

There is differentiation between sources that are remediated to an acceptable land use endpoint and those that are managed by exposure barriers and administrative controls. Where complete source removal is not feasible, the source must be removed to the greatest extent possible and treatment, control, and/or management measures must be implemented to address the residual source. Where this option is employed, the source is considered to be managed through exposure control (ESRD, 2012) and the site will not be eligible for a remediation certificate.

Control or management measures must prevent the contaminant from spreading to adjacent areas, causing the soil or groundwater there to exceed Alberta Tier 1 or Tier 2 Guidelines. If source control measures are required, they must operate until the contaminant concentration meets Alberta Tier 1 or 2 Guidelines. Source control must be supported by a monitoring program that demonstrates its efficacy.

3.2 Environmental Site Assessment

An ESA is implemented to determine whether soil or groundwater contains contaminants in excess of Alberta Tier 1 or Tier 2 Guidelines. The ESA process may be conducted in phases, but the overall process must be thorough enough to characterize site conditions and to identify and

delineate all areas of residual contamination on the site prior to being considered complete. Additional ESA information can be found in the Department's *Environmental Site Assessment Standard* (draft 2013).

Environmental site assessments must be extensive enough to review the site information, summarize the site conditions, and prepare a conceptual site model. The ESA report must summarize the relevant site information from a risk perspective, identify issues that may pose unacceptable risks, and facilitate the evaluation of the exposure scenarios. This would include an evaluation of all CoPCs, areas of potential concern, human and ecological receptors, and exposure routes including preferential pathways.

As part of the ESA, complete delineation must be accomplished prior to undertaking risk assessment, including risk assessments that compare against the Alberta Tier 1 Guidelines. Adequate delineation provides information needed to support appropriate decisions about contaminant remediation and management. Delineation programs must be extensive enough in both horizontal and vertical directions to enable the proper assessment of all applicable exposure pathways and receptors. Where this includes risk to the groundwater pathway, delineation will include characterization of the significant surficial and bedrock geology unit contributing to lateral or vertical groundwater flow to a depth consistent with the scale of the hydrogeological assessment required. Delineation is considered complete when measured concentrations are consistently less than Alberta Tier 1 or Alberta Tier 2 Guidelines developed using the pathway exclusion approach.

In some instances, aspects of remediation, source control or exposure control may be undertaken concurrently with delineation. For instance, this might occur when there is an immediate risk to human health, or the environment and remediation and exposure control must be initiated concurrently with delineation, or for simple excavations where compliance with Alberta Tier 1 Guidelines is shown by a sufficient number of post-excavation confirmatory samples from the excavation base and side walls. This work, however, cannot be assumed to complete requirements for delineation and risk assessment until contaminant delineation has been completed. For instance, where post-excavation samples fail to comply with Alberta Tier 1 Guidelines after excavation is complete, full delineation of the remaining contamination must be undertaken and used to develop further remediation actions or exposure control programs.

Where contaminant concentrations in soil or groundwater exceed the risk-based endpoints at the property boundary, delineation will only be considered complete if it is adequate to assess concentrations to the edge of the contaminated area past the property boundary.

3.3 Risk Assessment

Risk assessment evaluates information on the potential toxic effects of contaminating substances on biological systems (receptors) in contact with contaminated soil, air, water and food through various exposure routes (pathways). Risk assessment must answer the following key questions:

- What contaminating substances present on the site may be a cause for concern?
- How can humans or other receptors in the environment (for example, plants and animals) become exposed to those substances and what is the likelihood that exposure will occur?
- If exposure occurs, what is the likelihood that the substances will produce harmful effects?

Alberta Tier 1 and Tier 2 Guidelines form the basis of risk assessment policy for substance releases and contaminated sites management under Part 5 of the EPEA in Alberta. Where a substance has been released that causes an exceedance of the Alberta Tier 1 Guidelines in soil or groundwater, it has the potential for adverse effect, unless otherwise demonstrated through the Alberta Tier 2 process in a manner acceptable to the Director that there is no potential for adverse effect. This does not preclude other requirements or approval conditions that may be in place or requirements for source control as outlined in this framework, regardless of the concentration relative to the Alberta Tier 1 Guidelines.

When a particular substance is not listed in Alberta Tier 1 Guidelines, the proponent will need to develop a site-specific remediation objective using the same procedures outlined in Alberta Tier 1 and Tier 2 Guidelines. The first step in this process will be establishing acceptable exposure endpoints for receptors. Alberta Tier 1 and Tier 2 Guidelines are considered the primary source of information in Alberta. When the information is unavailable from these guidelines, reference concentrations may be adopted from the following sources, in order of preference:

- Health Canada or Environment Canada;
- CCME Canadian Environmental Quality Guidelines and supporting documents;
- The United States Environmental Protection Agency (IRIS database); and,
- The United States Oak Ridge National Laboratory toxicological database.

When information is not available from these sources, other jurisdictions can be considered. When reference concentrations or acceptable endpoints are adopted from jurisdictions other than those listed here, they must be reviewed and accepted by the Department before use.

3.4 Contaminant Management

3.4.1 Requirement to Remediate

When the volume of soil or groundwater containing contaminant concentrations that exceed Alberta Tier 1 or Tier 2 Guidelines is delineated, a plan must be developed to remediate or otherwise manage the contaminants in a manner that is consistent with the framework outlined here. Using dilution to reduce contaminant concentrations is not an acceptable form of management, unless authorized by the appropriate regulator for the industry sector.

3.4.2 Remediation vs. Exposure Control

The Department distinguishes between sites that are remediated to an acceptable land use endpoint and those that are managed by technical controls, such as exposure barriers and/or administrative controls. Sites managed through technical or administrative controls are not eligible for regulatory closure due to the on-going need to manage site risk.

Risk management through use of technical or administrative controls requires regulatory and stakeholder consultation followed by effective and accountable action by those responsible for maintaining the management program in the future. Requirements for acceptable risk management plans are described further in Alberta's Exposure Control Guide.

Exposure control may also be used as an interim measure while a site is being remediated with the goal of meeting an acceptable endpoint, such as Alberta Tier 1 or Tier 2 Guidelines. Once the area meets the applicable guidelines, it is no longer considered under exposure control and will be eligible for a remediation certificate.

Exposure control will not be considered by the Department for new construction on a contaminated site with residential-only or agricultural-only land use, unless authorized by the director. The Department recognizes the need to consider exposure control for existing residential infrastructure that has been impacted by a contaminated site.

3.4.3 Contravention of the Environmental Protection and Enhancement Act

Contaminant management cannot contravene any provisions in the Act. When adverse effects are evident, contaminants must be managed to alleviate adverse effects, regardless of whether a site meets Alberta Tier 1 or Tier 2 Guidelines. Disposal of wastes or contaminated materials from remediated sites will need to be done in a manner consistent with the Act and regulations. The Department's representatives are available to participate in the risk management process to ensure that all Department regulatory requirements are met.

3.5 Considerations other than Risk

3.5.1 Off-site Contamination and Impairment of Property

If contamination has migrated or may migrate off the proponent's property, the proponent is required under the Act to notify any affected party and take action to prevent adverse effect. In treating off-site impacts, the proponent must achieve an acceptable solution that involves input from all parties. If the proponent(s) does not have care and control of an affected property, an exposure control decision must involve input from the affected stakeholders to ensure that the plan is viable and restrictions on the land are acceptable to the impacted party. An affected third party could include owners, lessees, and tenants of a neighbouring parcel, roadway, easement, or utility corridor that is likely or actually contaminated by the migration of a substance. This could include municipalities and/or the provincial government.

In cases when the affected party will not participate in the process, the proponent must apply remediation objectives for the appropriate land use based on options outlined in Alberta Tier 1 or Tier 2 Guidelines to address adverse effect issues on the affected off-site property. More information on this issue can be found in the Alberta *Exposure Control Guidelines* (ESRD, draft 2014).

3.5.2 Safety, Odours and Nuisance

Offensive odours, safety issues, and nuisance conditions are regulated under the EPEA and other provincial legislations but are not strictly related to human health or ecological effects. These issues require resolution independent of the level of human and ecological health risk on a contaminated site.

4. ALBERTA'S RISK MANAGEMENT FRAMEWORK

This section provides an introduction to the guiding principles that underlie the Department's policy for risk management on contaminated sites.

In Alberta, three risk management options are provided for contaminated sites:

- Tier 1 - generic remediation guidelines.
- Tier 2 - site-specific remediation guidelines based on the modification of Alberta Tier 1 Guidelines.
- Exposure Control - risk management through exposure barriers or administrative controls (may be based on site-specific risk assessment).

Regardless of the option chosen, the target level of human health and ecological protection afforded by Tier 1, Tier 2, or Exposure Control is the same.

Regulatory closure is available for sites which are managed to achieve Alberta Tier 1 and Alberta Tier 2 remediation guidelines where no conditions are imposed on future use of the site, within a given land use. Figure 3 outlines the implementation of Alberta Tier 1 and Tier 2 Guidelines.

The objective of Alberta Tier 1, Tier 2 and Exposure Control Guidelines is to deliver the same degree of human health and ecological protection, regardless of which option is used. Human health and ecological protection objectives must be maintained at all management levels (Alberta Tier 1, Tier 2, and Exposure Control). Changes to the Alberta Tier 1 or Tier 2 Guidelines that require ongoing administrative or barrier site risk management controls are considered to be Exposure Control.

The same protocols are used to develop both Alberta Tier 1 and Tier 2 Guidelines. The two options differ in the amount of site-specific information used to develop the guidelines.

The generic Alberta Tier 1 Guidelines are simple tabular values that require minimal site information for their use. Conservative assumptions about soil and groundwater characteristics have been used to develop the Alberta Tier 1 Guidelines. This will make these guidelines protective for the majority of sites in Alberta. However, some site information is needed to ensure that site conditions are adequately represented by the assumptions used to develop the Alberta Tier 1 Guidelines. Where assumptions used in developing Tier 1 Guidelines are not conservative enough, assumptions will need to be modified and the guidelines re-assessed under the Tier 2 approach.

Applying Alberta Tier 2 Guidelines requires more information about the site than for Alberta Tier 1 Guidelines. This additional information allows the assessor to develop guidelines that are tailored to the particular characteristics of the site. When a site has characteristics that make it more sensitive than the Tier 1 assumptions, the resulting Alberta Tier 2 Guidelines may be more restrictive than Tier 1 values. Sites that are less sensitive may have Alberta Tier 2 Guidelines that are less restrictive than Tier 1 values, while delivering the same level of human and ecological health protection because they are tailored to that specific site.

4.1 Alberta Tier 1 – Generic Remediation Guidelines

Generic guidelines are based on identification of the receptors to be protected under various land uses, the applicable exposure pathways, and a corresponding set of parameters that allow

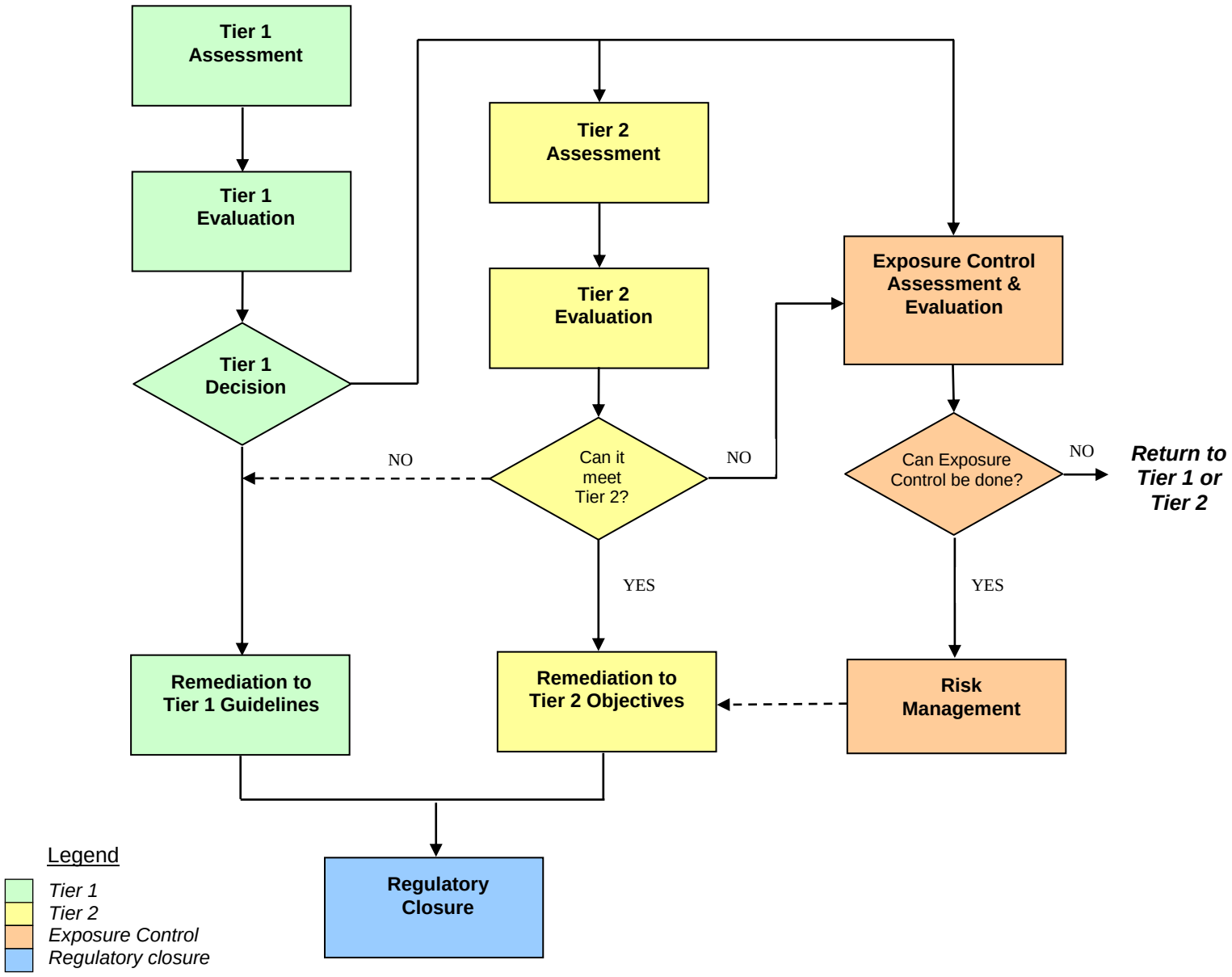


Figure 3: Implementation of Tier 1, Tier 2 and Exposure Control Guidelines

reasonably conservative predictions of risk at sites throughout Alberta. Whenever possible, the derivation of risk-based Alberta Tier 1 Guidelines uses models that incorporate toxicity information, receptor characteristics, and fate and transport mechanisms. Some compounds have been evaluated for only a limited number of exposure pathways; if ESAs identify the presence of other influential exposure pathways related to these substances, Alberta Tier 2 Guidelines may need to be developed for these pathways.

Alberta Tier 1 Guidelines are expected to be applicable to the majority of contaminated sites in Alberta, although site managers may choose a Tier 2 approach to incorporate more site information in the development of remediation guidelines. Even at sites that eventually apply a Tier 2 or Exposure Control approach, Alberta Tier 1 Guidelines are used for an initial screening as the first step in a phased ESA.

There may be some situations when site conditions result in a more sensitive scenario than is captured by the conservative generic scenarios (e.g., a site underlain by very coarse sand and gravel with a high hydraulic conductivity). Information on situations where Alberta Tier 1 Guidelines is not applicable is provided in the *Alberta Tier 1 Soil and Groundwater Remediation Guidelines* (ESRD, 2014a, as amended). In such cases, a Tier 2 or Exposure Control approach will be required. Where the Tier 2 approach is required, it can be restricted to the specific pathway/receptor relationships that are in question (ESRD, 2014b, as amended).

4.2 Alberta Tier 2 – Modified Remediation Guidelines

There may be circumstances when site-specific conditions modify potential human and ecological exposure, relative to the generic conditions used to derive Alberta Tier 1 Guidelines, such that the generic guidelines are unnecessarily conservative. Alternatively, site-specific conditions may increase risks to a level that renders a Tier 1 approach unacceptable. Accordingly, guidance is provided on methods under which Alberta Tier 1 Guidelines can be adjusted to a particular site, including a discussion of parameters for which generic values could be replaced by site-specific values. Some site conditions may not fit the assumptions of the Tier 1 or Tier 2 models, and will require a mandatory site-specific risk assessment.

Options that can be applied at Tier 2 level are:

1. Modifying the Alberta Tier 1 Guidelines based on exclusion of exposure pathways and receptors that may not be operable at the site.
2. Adjusting the Alberta Tier 1 Guidelines using site-specific values for certain parameters determined as part of a more detailed ESA. The same models and approaches are used as for the development of the Alberta Tier 1 Guidelines and a limited range of parameter adjustments to these models is allowed based on site-specific conditions.
3. Site-specific risk assessment (SSRA).

More information on these options is provided in *Alberta Tier 2 Soil and Groundwater Remediation Guidelines* (ESRD, 2014b, as amended).

4.3 Exposure Control – Risk Management

Risk management relies on ongoing exposure control to mitigate risks to human health and the environment. This option is used for sites that require restrictions to the typical activities considered under a given land use or require ongoing management. This can be accomplished by providing exposure barriers such as physical or chemical barriers to exposure and/or by

implementing administrative controls on a property. These options normally require long-term care and control by one or more responsible parties.

While this option is available for management of risks at contaminated sites, it renders the site ineligible for regulatory closure that is available under Tier 1 and Tier 2 approaches.

The use of the Exposure Control Guidelines is described in the *Alberta Exposure Control Guidelines* (ESRD, draft 2014).

4.4 Using Tier 1 or Tier 2 Soil and Groundwater Remediation Objectives

4.4.1 Source Control and Pollution Prevention

The goal of the Alberta Tier 1 or Tier 2 Guidelines is to provide either generic or site-specific numerical targets for remediation of contaminated soil and groundwater. As previously discussed, these soil and groundwater remediation guidelines are not "pollute-up-to" levels (ESRD, 2014a, as amended). Sources must not be left uncontrolled until cumulative releases result in an exceedance of Alberta Tier 1 or Tier 2 Guidelines. Source control is a crucial component of proactive pollution prevention.

4.4.2 Background Soil and Groundwater Quality

4.4.2.1 Definition of Background

For the purpose of applying Alberta Tier 1 or Alberta Tier 2 Soil and Groundwater Remediation Guidelines, the background concentration of a substance in soil or groundwater is defined as:

1. The natural concentration of that substance in the absence of any input from anthropogenic activities or sources; or
2. The background concentration in the surrounding area as a result of generalized non-point anthropogenic sources.

In some situations, the background concentration of a substance can be a significant proportion of, or even exceed, the Alberta Tier 1 Guidelines (ESRD, 2014a, as amended). In cases when the background concentration is demonstrated to be greater than Alberta Tier 1 Guidelines, the remediation level shall be set to background or to guidelines developed using Tier 2 procedures.

The definition for background cannot be used to eliminate point source emissions, anthropogenic activities that cause redistribution of soil or water sources with elevated substance concentrations, or non-point anthropogenic sources that result from activities at the site in question. For example, surface soils in urban areas that have variable levels of polycyclic aromatic hydrocarbons (PAHs) as a result of generalized automobile emissions can be considered as background based on the definition; however, additional PAH contamination may result from industrial activities at the site in question and the latter cannot be considered part of the urban background.

Similarly, some sites may have elevated electrical conductivities in the surface soil or groundwater due to natural conditions at the site. While this would be considered natural background, if material with elevated conductivity is brought to the surface from deeper sediments or groundwater due to anthropogenic activities, this should be assessed as a CoPC.

4.4.2.2 Selecting Background Sample Locations

For soil, background concentrations of CoPCs will vary with parent material, depth, hydrologic regime and biological activity. These factors lead to spatial variations in background

concentrations that may or may not be predictable. For groundwater, background conditions will be specific to the groundwater zone being considered and can vary both spatially and temporally. These factors will need to be accounted for in assessing background conditions. Sites chosen for background determination need to closely match the site in question with respect to:

- geographical characteristics (e.g., location, topography, geological deposits, size/area, etc.),
- physical characteristics, chemical characteristics, hydrology, and
- sampling depths and time.

In some cases, it will be necessary to sample outside the site in question due to the difficulty in obtaining a pristine sample. Within urban areas, preference must be given to undeveloped land that has not received imported fill, naturally wooded areas, parks or large residential lots where there is limited influence from human activity. Background sampling locations for groundwater must be located upgradient of the contaminated area in question. Background sites must not be located next to or within the general vicinity of contaminant point sources, and the history of the reference site and adjacent land, including current and previous activities, must be considered and documented.

4.4.3 Land Use

Potential adverse effect provisions seek to preserve, recover and protect options for future land use and function. Consequently, Alberta's regulatory framework requires that risk management decisions on contaminated sites consider not only current, but future land and water use.

The most sensitive land use applies to the entire property, irrespective of the location of the contamination, because changes in current development, conditions, or activities may occur at some point in the future within the range of allowable uses. The land use selected must provide for unencumbered development options within that land use so that future excavations, buildings, groundwater wells or other typical development and activities for a particular land use are not restricted. Alberta Tier 1 and Alberta Tier 2 Guidelines allow for some modification of this rule for sites that are adjacent to a more sensitive land use (see these guidelines for further detail).

Alberta Tier 1 guidelines are calculated for five types of land use: natural areas, agricultural, residential/parkland, commercial, and industrial. For further guidance on the definition of the individual land uses, see the Alberta Tier 1 Guidelines (ESRD, 2014a, as amended).

The proponent opting to use the Alberta Tier 1 or Tier 2 approach to determine acceptable remediation objectives on a contaminated property must ensure that the definition of land use is consistent with the land use allowed under the relevant zoning for the selected option. In addition to the current zoning, the proponent must consider changes to more sensitive zoning that are in progress or are reasonably foreseeable. Land uses defined in the Alberta Tier 1 Guidelines may not correspond exactly to the range of municipal zoning options, but by evaluating the types of receptors and exposure conditions used in calculating the guidelines for each land use scenario, it is possible to identify which land use scenario is protective for a particular municipal zoning requirement. Assessors must determine the full range of uses allowed under the applicable zoning bylaw when determining the appropriate land use for Tier 1 application. Where a municipal zoning decision incorporates more than one land use scenario, the most conservative land use must be applied (refer to Alberta Tier 1 Guidelines for more details).

4.4.4 Relationship between Soil, Air and Water Quality

Environmental media are interconnected. Contaminants in soil may leach into pore water or groundwater. Contaminants in groundwater can act as sources for soil contamination. Volatile compounds in soil or groundwater may volatilize and can migrate through the soil into the interior space of buildings. Soluble contaminants in groundwater can be transported laterally with the groundwater flow, and potentially enter a surface water body (creek, slough, lake, etc.) at the point of groundwater discharge.

Alberta Tier 1 Guidelines are developed to protect indoor air quality, plants and soil invertebrates, human direct contact, and water quality for a range of uses. Guidelines to protect a particular water use are calculated based on the corresponding water quality guideline (drinking water, aquatic life, irrigation, or livestock or wildlife watering).

Under the Alberta Tier 2 approach, it is possible to use site-specific information to evaluate risk to groundwater receptors. As a minimum, this approach will involve more detailed site-specific assessment information to support the Tier 2 decision. Generally, under the Tier 2 approach, site-specific information is used to more closely assess the risk of the substance interacting with the receptor of concern. Reference values representing safe levels of exposure (such as drinking water, aquatic life guidelines, toxicity reference values, etc.) are not open to modification under the Tier 2 approach.

4.4.5 Relationship to the Beneficial Use of Waste Policy

The *Beneficial Use of Waste* (ESRD, 2012) policy states that excavated contaminated soils going for disposal are to be dealt with as wastes. This includes any contaminated soil that is excavated and disposed of in another location, including contaminated soils that will be disposed of in allowable manners, such as land treatment cells where soil is left in place after treatment, materials used as soil amendments or materials used in construction or manufacture of other products.

Under this policy, materials intended to be used as products for beneficial purposes must be designed to meet a specific use and are characterized by well-defined physical, chemical, or biological characteristics that meet specific quality criteria (ESRD, 2012). Alberta's approach to the management of wastes, industrial byproducts, composts, and other materials is based on the potential to improve soil quality. Wastes that provide no benefits to soil quality must not be applied to land in a manner that causes soil contamination. Industrial byproducts, composts, and other materials that provide a potential benefit to soil quality may be applied to land according to good agronomic or forestry practices and in accordance with any other regulatory requirements.

Even when benefits can be shown, any potential contaminants in the byproduct must be managed to prevent their buildup in soil (ESRD, 2012). Alberta Tier 1 Guidelines are used to evaluate contaminant concentrations in soil. They must not be used to evaluate concentrations in the byproduct or organic material itself, unless the material is to be placed directly on land without being mixed with soil.

Alberta Tier 1 pesticide guidelines have been developed for a limited number of exposure pathways for which sufficient information is available. These values are intended for use in the remediation of pesticide-contaminated sites and not for restricting pesticide use in accordance with registered application rates.

Disposal and treatment of wastes generated by the upstream oil and gas industry is regulated by the Alberta Energy Regulator. *Directive 50, Drilling Waste Management* (AER, 2012, as amended) describes the requirements for the treatment and disposal of drilling waste and supports

waste disposal to land when there are agronomic benefits. It promotes the development of technology to improve waste recycling and reuse options and to reduce the volume of wastes sent for disposal (including land disposal). *Directive 58, Oilfield Waste Management Requirements for the Upstream Petroleum Industry* (AER, 2006, as amended) identifies oilfield waste management responsibilities for licensees and approval holders and encourages waste volume minimization by reuse, recycling, reduction, and recovery. *Assessing Drilling Waste Disposal Areas: Compliance Options for Reclamation Certification* (AENV, 2009b) can be used to assess and remediate drilling waste disposal areas for reclamation certification.

4.4.6 Protection of Domestic Use Aquifers

Groundwater for domestic use is a significant current and future resource distributed over large geographic ranges in Alberta. Consequently, there is a need to protect the quality of domestic use aquifers (DUAs).

For specific guidance regarding implementation, determination of the sustained yield or exclusions allowed within this definition, see Alberta Tier 2 Guidelines, Appendix E.

4.5 Conditions and Restrictions Associated with Alberta Tier 2

4.5.1 General Conditions and Restrictions

Certain types of site-specific data or assumptions dictate the need for ongoing site management to ensure that the assumptions used to assess human and ecological risks or to develop site-specific objectives remain valid. Ongoing management of a site, or of the contaminants present, will generally invoke a land use restriction or condition that will preclude regulatory closure; therefore, site-specific adjustments or assumptions that would trigger ongoing management requirements can only be implemented under the exposure control option.

To avoid the need for ongoing management and associated conditions and land use restrictions, Tier 2 adjustments are usually limited to parameters that are measurable and stable, such as soil properties, geological conditions, hydrogeology and distance to natural surface water bodies. Tier 2 assessments that involve full site-specific risk assessment using models and assumptions that may differ from those used in the calculation of the Tier 1 guidelines may be accepted, provided they do not require any form of ongoing risk management. Parameters that are unique to current site use, an existing development, or the location of a receptor, such as the characteristics of a site building or the distance to a water well, may change in the future, thereby invalidating the site-specific assumptions. An adjustment of such parameters is not allowed at Tier 2 level. In some cases, exposure pathways may be inoperative under a particular site use (e.g., direct human or ecological contact with contaminated soil at a commercial site that is paved or capped) or the frequency of exposure may differ from the generic assumptions. Preservation of these conditions would require ongoing management; therefore, these adjustments cannot be made at Tier 2 level. Further guidance on parameters and assumptions eligible for adjustment at Tier 2 level is provided in Alberta Tier 2 guidelines.

4.5.2 Conditions and Restrictions Associated With Site-Specific Risk Assessments

Tier 2 assessments that involve site-specific risk assessment using models and assumptions that may differ from those used in the calculation of the Alberta Tier 1 guidelines may be accepted provided they do not require any form of ongoing risk management. Site-specific risk assessments require additional considerations and monitoring that must be reviewed by the Department prior to acceptance.

For site-specific risk assessments, the proponent must consider all aspects of the CCME (2006) protocol. Exposure pathways and receptors and the choice of ecologically relevant receptors for the development of generic guidelines will need to be reconsidered to ensure that the most sensitive and relevant receptors have been captured and appropriately assessed for the site-specific assessment. Section 5 of this framework provides more information regarding the principles of the CCME *Protocol for the Derivation of Environmental and Human Health Soil Quality Guidelines (2006)*.

For site-specific risk assessments, monitoring or additional assessment is required to verify model assumptions and demonstrate the validity of the conclusions. Complex risk assessments that do not require restrictions to the typical activities considered under a given land use and do not require ongoing risk management may be acceptable for regulatory closure under the Tier 2 process.

5. DERIVATION OF RISK-BASED REMEDIATION GUIDELINES IN ALBERTA

5.1 Overview

The Department follows the principles outlined in *A Protocol for the Derivation of Environmental and Human Health Soil Quality Guidelines* (CCME, 2006).

5.2 Human Health Protection

5.2.1 Human receptors and exposure pathways

In keeping with CCME (2006), guidelines need to be based on a critical human receptor that represents the most sensitive receptor to the substance and the most critical health effect within the land use scenario. In addition, the entire range of activities associated with the land use must be free of appreciable health risks.

The most sensitive receptor is a function of the receptor characteristics, the degree of potential exposure, the exposure pathway(s) and the CoPC. In some instances, it may be necessary to identify the presence of uniquely sensitive receptors that may not be protected by the generic guidelines. Further guidance is available in CCME (2006).

At Alberta Tier 1 and Tier 2 levels, the general public is assumed to be present on agricultural, residential/parkland, and commercial land. The general public is considered to incorporate all age classes and the most sensitive pathway/receptor combination must be used in establishing the appropriate risk-based guideline. At industrial sites, only adults are assumed to be present, which precludes the use of the child exposure model parameters. Human exposure is assumed to be inconsequential in natural areas, except where underlying groundwater is considered to be a potential source of drinking water. When these definitions differ from the potential uses of a site, the risk assessment must be modified to consider the most sensitive case.

5.2.2 Human health protection endpoints

The human health protection endpoint is the same at all tiers of contaminated site management, and is expressed in terms of an allowable exposure level at which the likelihood of a receptor experiencing adverse health effects is essentially negligible. The level of human exposure to a threshold chemical[1] or non-carcinogen must not exceed the tolerable daily intake[2] specified by Health Canada or other appropriate regulatory agency, considering also background exposure to the chemical. Acceptable levels of exposure for contaminants that have been evaluated at Tier 1 are listed in Alberta Tier 1 Guidelines.

Normally, a hazard index[3] of 0.2 for threshold contaminants and an incremental lifetime cancer risk[4] of 1 in 100,000 for carcinogens are required as environmental protection goals for the purpose of developing remediation objectives in Alberta. In the Alberta Tier 1 Guidelines, allocation factors have been established based on the CCME protocol (2006) for the purpose of maintaining an appropriate hazard index. In some instances, these values will modify the base

[1]**Threshold chemical:** A contaminant for which there is a dose/concentration below which no adverse effect is expected to occur.

[2]**Tolerable daily intake:** The level/rate of chemical exposure to which a person may be exposed with no expected adverse effects. A tolerable daily intake can only be determined for contaminants with threshold effects (i.e., non-carcinogens).

[3]**Hazard Index:** The sum of more than one hazard quotient for multiple substances and/or multiple exposure pathways. The hazard index is calculated separately for chronic, sub-chronic, and shorter-duration exposures.

[4]**Incremental risk:** Risk due to exposure to a chemical in excess of the "background" risk.

hazard index of 0.2. Where this is not explicitly stated, an allocation factor value of 0.2 is assumed for the CoPCs.

5.3 Ecological Protection

5.3.1 Ecological receptors and exposure pathways

Risk-based remediation guidelines are required to fulfill two main goals from the ecological standpoint:

- protection of ecological receptors expected to be present at a site based on the setting and land use; and
- preservation of the ecological function of a site and the ecosystem components.

Alberta's guidelines for the protection of ecological receptors have been calculated in a manner consistent with *A Protocol for the Derivation of Environmental and Human Health Soil Quality Guidelines* (CCME, 2006).

A first step in developing risk-based remediation guidelines for ecological protection is to determine which ecological components are potentially at risk from a substance release. Ecological receptors at a contaminated site, within the range of generic land uses considered in the development of the Alberta guidelines, span a range of trophic levels including soil-dependent organisms (plants, soil invertebrates, and crops), soil functions (e.g., nutrient and energy cycling, related microbial activities), and higher-order consumers (terrestrial and avian wildlife, and livestock). In addition, there is the potential for groundwater underlying a site to discharge to a surface water body; therefore, aquatic receptors including invertebrates, fish and waterfowl are considered. Receptors assigned to each land use for the purpose of guideline derivation must include possible effects of contaminated soil or food to the most sensitive species.

5.3.2 Ecological protection endpoints

Ecological protection endpoints must be chosen to ensure that the ecological function will sustain activity within a given land use function (CCME, 2006). Ecological protection endpoints are the same at all levels of management, subject in some cases to a reduced requirement for ecological function based on land use.

Protection of ecological receptors is based on ensuring that exposure does not exceed appropriate toxicological benchmarks. At higher trophic levels, these benchmarks are based on designated chronic effects levels derived for specific species at the population level. For plants and soil invertebrates, the benchmarks are determined and applied on an ecosystem basis through the use of species sensitivity distributions. A lower level of ecological function is allowed at commercial and industrial sites. This is addressed by means of a less stringent protection level for plants and soil invertebrates when calculating the Alberta Tier 1 Guidelines.

5.4 Considerations other than toxicity

For complex risk assessments or where major changes to generic endpoints, models or pathway/receptor relationships are proposed, factors other than toxicity must be considered in the risk assessment.

Contaminants may have adverse effects in addition to producing toxic responses in human and ecological receptors. These may include aesthetic concerns (e.g., offensive odours), explosive hazards or damage to utilities and infrastructure. If there is evidence that a contaminant may

cause significant effects beyond toxicity to human and ecological receptors, then this evidence must be evaluated.

Certain contaminants may potentially degrade into more toxic or more mobile contaminants (e.g., degradation of trichloroethylene to vinyl chloride). Since degradation rates are affected by site-specific factors, potential for these types of effects and degradation products must be considered when developing Tier 2 remediation objectives.

6. REFERENCES

Alberta Environment and Sustainable Resource Development references are available at: http://esrd.alberta.ca/

AENV (Alberta Environment), 1999. Draft Policy for Management of Risks at Contaminated Sites in Alberta. Environmental Sciences Division. Edmonton, Alberta.

AENV (Alberta Environment), 2000. Industrial Release Limits Policy. Environmental Sciences Division. Edmonton, Alberta. AENV Publ. No. T/569.

AENV (Alberta Environment), 2005. A Guide to Release Reporting. Alberta Environmental Protection and Enhancement Act. Edmonton, Alberta. AENV Publ. No. I/792.

AENV (Alberta Environment), 2006. Competencies for Remediation and Reclamation Advisory Committee Recommendations Report. Edmonton, Alberta. AENV Publ. No. 978-0-7785-5470-7.

AENV (Alberta Environment), 2008. Code of Practice for Land Treatment of Soil Containing Hydrocarbons. Alberta Queen's Printer. Edmonton, Alberta.

AENV (Alberta Environment), 2009b. Assessing Drilling Waste Disposal Areas: Compliance Options for Reclamation Certification. Air, Land and Waste Policy Branch, Policy Division. Edmonton, Alberta. AENV Publ. No. T/779.

AER (Alberta Energy Regulator), 1998. 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. Information Letter 98-1. Dated 6 February, 1998. Calgary, Alberta.

AER (Alberta Energy Regulator), 2006. Oilfield Waste Management Requirements for the Upstream Petroleum Industry. Directive 58. Alberta Energy Regulator. Calgary, Alberta.

AER (Alberta Energy Regulator), 2012. Drilling Waste Management. Directive 50. Alberta Energy Resources Conservation Board. Calgary, Alberta.

CAN/CSA – Z768-01. 2012. Phase I Environmental Site Assessment (R2012). Canadian Standards Association. Toronto, Ontario.

CAN/CSA – Z769-00. 2013. Phase II Environmental Site Assessment (R2013). Canadian Standards Association. Toronto, Ontario.

CCME (Canadian Council of Ministers of the Environment), 2006. A Protocol for the Derivation of Environmental and Human Health Soil Quality Guidelines. Canadian Council of Ministers of the Environment. Winnipeg, Manitoba. PN 1332.

ESRD (Alberta Environment and Sustainable Resource Development), May 2012. Beneficial Use of Waste Acceptable Industry Practices.

ESRD (Alberta Environment and Sustainable Resource Development), draft 2013. Environmental Site Assessment Standard. Air, Land and Waste Policy Branch, Policy Division. Edmonton, Alberta. AENV Publ. No. 978-1-4601-0795-9.

ESRD (Alberta Environment and Sustainable Resource Development), draft 2014. Alberta Exposure Control Guidelines (in development). Land and Forestry Policy Branch, Policy Division. . Edmonton, Alberta. AENV Publ. No. 978-1-4601-1489-6.

ESRD (Alberta Environment and Sustainable Resource Development), 2014a, as amended. Alberta Tier 1 Soil and Groundwater Remediation Guidelines. Land and Forestry Policy Branch, Policy Division. Edmonton, Alberta. AENV Publ. No. 978-0-7785-9015-6.

ESRD (Alberta Environment), 2014b, as amended. Alberta Tier 2 Soil and Groundwater Remediation Guidelines. Land and Forestry, Policy Division. Edmonton, Alberta. AENV Publ. No. 978-0-7785-9948-7.

Government of Alberta, 1993. Conservation and Reclamation Regulation, with amendments up to and including Alberta Regulation 31/2012. Chapter 113/1993. Alberta Queen's Printer. Edmonton, Alberta. Available online at http://www.qp.alberta.ca

Government of Alberta, 2000. Water Act. Revised Statutes of Alberta 2000. Alberta Queen's Printer. Edmonton, Alberta. Available online at http://www.qp.alberta.ca

Government of Alberta, 2010. Environmental Protection and Enhancement Act. Alberta Queen's Printer. Edmonton, Alberta. Available online at: http://www.qp.alberta.ca

Government of Alberta, 2009. Remediation Certificate Regulation. Alberta Regulation 154/2009. Alberta Queen's Printer. Edmonton, Alberta. Available online at: http://www.qp.alberta.ca