



**Ecological Recovery Monitoring Program (ERMP) for  
Certified Reclaimed Sites in Alberta:  
Proposed Implementation Plan**

By

InnoTech Alberta

ERMP Project Advisory Group

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## **Ecological Recovery Monitoring Program Development Project**

The Alberta Biodiversity Monitoring Institute contracted InnoTech Alberta in 2017 to develop the direction, framework and implementation plan for the Ecological Recovery Monitoring Program. The Project has been divided into a series of Tasks:

Task 1: Describe the Goals and Objectives for a Long-Term Monitoring Program in Alberta

Task 2: Develop a Science-Based, Practical Protocol for the Long-Term Monitoring Program

Task 3: Develop an Information Distribution Plan

Task 4: Develop an Implementation Plan for the Long-Term Monitoring Program

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Documents produced for each Task were developed as drafts by InnoTech Alberta and then discussed with the PAG in a workshop format to develop a consensus position on the key

Program components. The final draft document of each Task informed development of the next Task document.

*Report*

This report describes the results of Tasks 1, 3 and 4.

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## 1 BACKGROUND

Alberta has a large industrial footprint, consisting of >400,000 oil and gas wells, >500,000 km of pipelines, hundreds of thousands kilometres of roadways, prairie and mountain coal mines, oil sands mines, oil production sites (in-situ oil sands sites), pits, quarries, plant sites and transmission lines. These disturbed sites, termed *specified land* in the *Conservation and Reclamation Regulation* (CRR; Government of Alberta, 1993), must be reclaimed and certified (*Environmental Protection and Enhancement Act*; EPEA; Government of Alberta, 2000) as having an equivalent land capability.

Reclamation certification is based on meeting one or more of the following:

- Certification criteria developed by Alberta Environment and Parks (or its predecessors) for a specific type of specified land (currently there are criteria for wellsites and batteries, pipelines (Draft), and railways);
- Requirements identified in specific approvals for individual sites (e.g., oil sands or coal mines, oil production sites and associated plants);
- Requirements identified in a Code of Practice (e.g., pits greater than or equal to 5 ha in size on private land, exploration operations); or
- General conservation and reclamation requirements developed by Alberta Environment and Parks (or its predecessors).

In addition, where a reclamation inquiry is held, the certification decision is based on experience and professional judgment of the reclamation inspector.

Ecological recovery is achieved when the biological, physical and chemical properties of a reclaimed site return to similar structure and function (in terms of vegetation, soil and biota) as found in a representative undisturbed reference area or in the pre-disturbance site conditions.

However, achieving requirements for certification noted above may or may not fully facilitate return of ecological structure and function at a site. Further complicating matters is the practice of certifying forested land, native prairie, or peatland/wetland sites that take decades to reach ecological maturity based on expectations or predictions of future performance (often referred to as being on an accepted recovery trajectory). As a result, immediately following reclamation certification, and for some unknown period of time afterwards, most sites will not have fully recovered their ecological structure and function. Previous studies (e.g., Avrimed et al., 2014; Desserud et al., 2010) and site inspections have identified cases where soil and vegetation chemical and physical parameters (e.g., pH, organic carbon, bulk density, plant species composition, aboveground biomass) and presence of invasive and/or undesirable plant species indicate a lack of full ecological recovery on reclaimed certified sites.

To date, there are no comprehensive programs in Alberta to monitor, evaluate and report on the recovery state and trajectory towards ecological recovery for reclaimed specified lands, and limited research into the physical, chemical and biological factors that affect recovery. Without a long-term program, there can be no assurance that ecological recovery has occurred.

## **1.1 Pilot Program**

Alberta Environment and Parks (AEP) (formerly Alberta Environment and Sustainable Resource Development and the Alberta Environmental Monitoring, Evaluation and Reporting Agency [AEMERA]), the Alberta Biodiversity Monitoring Institute (ABMI), and InnoTech Alberta (formerly Alberta Innovates – Technology Futures [AITF]) teamed up in 2012 to determine the need for, and if required the design of, an integrated, scientifically robust and financially sustainable program for the long-term assessment of ecological recovery of certified reclaimed specified lands (the Pilot). Prior to starting the Pilot, EBA, A Tetra Tech Company (2012a) conducted a literature search on benchmark protocols for monitoring reclaimed lands that have been developed worldwide as a basis for designing a monitoring protocol for Alberta.

Initial phases involved development and testing of monitoring protocols at 75 reclaimed and certified wellsites in native grasslands, forested lands and cultivated lands (2012-2015). To reduce the effects of site variability on the evaluation of protocol effectiveness, the Pilot focused on level sites with medium soil texture and no chemistry issues.

Substantial data were acquired including soil physical, chemical and biological measurements, vegetation species diversity and cover, crop yield (cultivated lands only), and data from various unconventional sensors (e.g., Unmanned Aerial Vehicle (UAVs) and soil proximal sensors). Results of the three-year pilot program identified enduring ecological impacts at reclaimed certified wellsites. The Pilot findings justify the development of an operational ecological recovery monitoring program (ERMP) to determine the magnitude, direction and duration of the impacts. The ERMP results can be used to assess the degree to which sites recover, the speed at which recovery occurs, identify the consequences of the impacts, and identify potential adaptive management responses (e.g., changes in industry construction, operation and reclamation practices, or adjustments to certification criteria and/or certification assessment methodology).

## **1.2 Regulatory Framework**

The regulatory framework for reclamation, certification and monitoring is set out in the *Environmental Protection and Enhancement Act* (EPEA; Government of Alberta, 2000) and *Conservation and Reclamation Regulation* (CRR; Government of Alberta, 1993). The *Responsible Energy Development Act* (Government of Alberta, 2012) adopted this framework for energy industry forms of specified land (including wellsites).

### **1.2.1 *Environmental Protection and Enhancement Act***

Section 137 of EPEA requires an operator of specified land to conserve, reclaim and obtain a reclamation certificate. Section 112 requires a person responsible for a substance [contaminant] released to the environment to repair, remedy and confine the effects of the substance and remediate, manage, remove or otherwise dispose of the substance [remediation].

EPEA was amended in 2016 to accommodate the transfer of the Alberta Environmental Monitoring, Evaluation and Reporting Agency into Alberta Environment and Parks. Section

15.1(2) describes the key roles of the Chief Scientist appointed to develop and implement a monitoring program (relevant sections abstracted below):

- (a) to plan, co-ordinate and conduct environmental monitoring;
- (b) to collect, store, manage, analyze, evaluate and assess environmental monitoring data and to ensure the information is scientifically credible, including through prior peer review where the Chief Scientist considers it appropriate;
- (c) to make environmental monitoring data and related scientific evaluations and assessments available to the public and to the Science Advisory Panel established under section 15.2(1);
- (d) to report to the public on the condition of the environment in Alberta on the basis of the scientific evaluations and assessments of the data collected;

Should the Ecological Recovery Monitoring Program be implemented it would be subject to Section 15, including possible review by the Science Advisory Panel and be managed by the Environmental Monitoring and Science Division (EMSD) of Alberta Environment and Parks.

### **1.2.2 Conservation and Reclamation Regulation (CRR)**

Section 1(t) of the CRR lists the types of industrial development – called specified land – that are subject to reclamation requirements<sup>1</sup>. Section 1(h.1) lists the types of additional disturbances, such as access roads and disposal sites (e.g., sumps), that also form part of each type of specified land (thus the *associated facilities* part of the Wellsite Criteria document titles).

Section 2 of the CRR states that the objective of conservation and reclamation of specified land is to return the specified land to an equivalent land capability. Equivalent land capability is defined in section 1(e) as the ability of the land to support various land uses after conservation and reclamation is similar to the ability that existed prior to an activity being conducted on the land, but that the individual land uses will not necessarily be identical. In the case of wellsites the majority of sites will be reclaimed to original or adjacent land use. However the definition does allow for alternative uses. This is important as land use will determine which areas can be used as Reference Areas (controls).

Section 3 of the CRR allows the Director to establish standards, criteria and guidelines for conservation and reclamation and requires operators to conserve and reclaim in accordance with the applicable standards, criteria and guidelines. The Wellsite Criteria are issued pursuant to this section.

Section 6(2) exempts wellsites, pipelines and batteries from the reclamation inquiry process and allows inspector to issue the certificate in the Director's opinion, the application is complete and accurate (this is commonly known as the audit process).

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<sup>1</sup> Note that *wellsite* is a plain language term – the term used in section 1(t)(i) is *well*.

### **1.2.3 Certification Criteria**

Prior to 1993 there were no formal criteria for certifying wellsites – the inspector would use professional judgment and experience, along with basic principles and expectations for landscape, soil and vegetation performance to assess success at the formal inquiry at the site. Certification criteria for wellsites were first issued in 1993, updated in 1994 and finally published as the formal criteria for certification in 1995 (the 1995 Criteria). The Criteria for forested lands were updated in 2007 and Criteria for all lands were completely rewritten in 2010. Minor updates were made in 2013 and Criteria for Peatlands were issued in 2015.

Reclamation certification criteria for railways were released in 1996 and draft pipeline criteria were released in 2001. In 2014 Alberta Environment and Parks published the draft criteria and indicators framework for oil sands mines proposed by the Cumulative Environmental Management Association. No other specified land types have published certification criteria.

### **1.2.4 Public Lands Administration Regulation**

Under the *Public Lands Administration Regulation* (Government of Alberta, 2011) the definition of equivalent land capability on public land is different than the EPEA definition; in addition, the Director has the authority to waive the goal of equivalent land capability – this may affect the selection of ERMP reference areas on public land. More specifically, the following section of the regulation are relevant to the ERMP.

1(1)(l) “equivalent land capability”, except in section 127, means, in respect of land that is the subject of a disposition, a condition in which the ecosystem processes on the land are capable of producing goods and services of a quality and in a quantity that is at least equivalent to that which existed before the disposition was issued to the holder;

21(1) The holder of a formal disposition

(f) must, on the expiry, cancellation, surrender or abandonment of the formal disposition, reclaim the subject land to an equivalent land capability,

(2) The holder of an authorization

(e) must, on the expiry or cancellation of the authorization, restore the subject land to an equivalent land capability,

23(1) The director may, on application by the holder of a disposition or on the director’s own initiative, issue an approval to a person for the restoration and reclamation of the subject land.

(2) An approval issued under this section may

(a) require or permit the holder to restore the land to

(i) an equivalent land capability, or

(ii) a condition that complies with the Act, this Regulation and any applicable ALSA regional plan,

(b) waive the requirements of section 21(1)(f) or (2)(e),

(c) waive any requirements of the disposition relating to reclamation of the subject land, or

(d) require or permit the holder to do anything that the director reasonably believes is necessary for the proper reclamation of the lands.

(3) A person to whom an approval is issued under this section is bound by the terms and conditions of the disposition in respect of which the approval is issued, whether or not that person is the holder of the disposition.

(4) If the holder contravenes section 21(1)(f) or (2)(e) or causes or allows a contravention of an approval issued under this section, the director may issue an order directing the reclamation of the land.

(5) This section applies in addition to any applicable requirements respecting conservation and reclamation under the *Environmental Protection and Enhancement Act* and in addition to the requirements of any applicable ALSA regional plan.

127(1) For the purposes of subsection (2)(b), “equivalent land capability” means a condition in which the ecosystem processes on the land within the right of way are capable of producing goods and services of a quality and in a quantity that is at least equivalent to that which existed before

(a) a disposition identified by the director was issued in respect of the land, or

(b) the pipeline was laid down, constructed or installed within the right of way,

whichever the director directs.

(2) Except where a pipeline is lawfully constructed above the surface of the right of way, an operator that lays down, constructs or installs a pipeline within the limits of a right of way must

(a) bury the pipeline, and

(b) restore and reclaim, to the director’s satisfaction, the right of way to an equivalent land capability

within one year after the date of execution of the agreement, in the case of the first pipeline constructed in the right of way, and within one year after the date of an approval under section 125(1), in the case of an additional pipeline in the right of way.

## 2 PROGRAM GOALS, OBJECTIVES AND SCOPE

The Ecological Recovery Monitoring Program is enabled through section 15 of EPEA (Government of Alberta, 1993). The goals of the ERMP are to:

1. Monitor, evaluate, and report to Albertans regarding the science of potential long term impacts of human disturbance on landscape, soil and vegetation; and,
2. Better inform Albertans on the rate, magnitude, direction, and extent of ecological recovery at reclaimed and certified industrial sites in Alberta and to support government evaluation of current reclamation policies and practices.

### 2.1 Program Objectives

The objectives<sup>2</sup> of the ERMP are to:

1. Provide landowners, the public and Aboriginal communities better understanding of the effectiveness and limitations of land conservation and reclamation practices;
2. Provide regulators with data to support: refinements to land conservation and reclamation requirements; land reclamation certification criteria; and, appropriate liability timeframes for different types of specified lands;
3. Provide data to support analysis of the impacts of changes over time in regulatory requirements and industrial practices on environmental outcomes;
4. Provide data to support development of reclamation trajectories that will better predict future performance and therefore permit certification of sites prior to full ecological recovery;
5. Provide data to evaluate which monitored parameters are key determinants of ecological recovery for types of specified land in each natural region (and therefore provide insights to improve conservation, reclamation and site assessment practices); and,
6. Improve understanding of linkages between monitoring parameters, ecological recovery, natural variability and regulatory requirements.

### 2.2 Program Components

The Ecological Recovery Monitoring Program consists of four core components (Figure 1), each supporting and interacting with the other in an adaptive management framework:

1. **Monitoring** – an annual field-based program to gather data on the ecological recovery status of reclaimed certified sites in Alberta. Methods to be used and the parameters to be evaluated are identified in Protocols developed for each disturbance

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<sup>2</sup> Objectives 1 to 4 support the program goals described above. Objectives 5 and 6 support ongoing improvements of the ERMP.

type (e.g., wellsites, pits, mines) and each relevant site type (e.g., grassland, cultivated, forested).

2. **Evaluation** – analysis of monitoring data from individual sites and specified land types, and, where applicable, synthesis of parameters into integrated measures of ecological recovery.
3. **Reporting** – public dissemination of monitoring results in the form of summary reports (by year and/or by type of specified land) that provide information on the state and condition of reclaimed specified land. Results can also be provided as raw data or in various summary data formats.
4. **Research and Development (R&D)** – ongoing development and refinement of the monitoring program protocols and evaluation methodology<sup>3</sup>.



Figure 1. Components of the Ecological Recovery Monitoring Program.

### 2.3 Program Stages

The ERMP should be implemented in stages to allow for incorporation of learnings and additional research to support design of protocols for new types of specified land, and to focus on areas where there is public interest and/or concern and little existing work (Figure 2)<sup>4</sup>. Each stage includes the Monitoring, Evaluation and Reporting (ME&R) components discussed in section 2.2, and R&D for the next disturbance type to be monitored. Each stage adds to the previous stage which means the Program cost is increased significantly with each new stage. Duration of each stage can be adjusted based on the number of sites assessed (to allow for an

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<sup>3</sup> Additional research using ERMP data may be carried out by external organizations. The Program managers will need to maintain awareness of the findings so they can be incorporated into the Program as necessary.

<sup>4</sup> The proposed progression of specified land types is based on a variety of factors, including: industrial sector, disturbance size and shape, number of certified sites, and level of public awareness/concern about the specified land type. The progression can be changed to address other priorities.

informed decision at the Program Evaluation stage) and available funding<sup>5</sup>. Note that oil sands mines are not identified here as there is considerable historical work completed and will likely be a key focus area of other monitoring programs (i.e., Canada’s Oil Sands Innovation Alliance monitoring initiatives).

The scope of monitoring work at each stage will consider the factors listed in Appendix 1, Table 1 as well as the program constraints in section 2.4. Each monitoring protocol includes criteria and a process for selecting monitoring sites.

**Stage 1 Wellsites ME&R:** The Program should continue to focus on wellsites to build on the previous work of the Pilot. Stage 1 should target wellsites across a broad range of construction ages (to assess impacts of soil conservation requirements) and certification dates (to assess effectiveness of certification criteria). Sites should be distributed over a range of natural regions, soil types and moisture regimes, and site types.

**Stage 1 Pits R&D:** Work to develop appropriate sampling and data analysis protocols for pits to be added to the Program in Stage 2 will start during Stage 1.

**Stage 1 ERMP Evaluation:** At the end of Stage 1 there should be an assessment of the effectiveness and value of ERMP and a decision to: (1) terminate the program; (2) continue with wellsites only; or, (3) expand the program to other types of specified land.

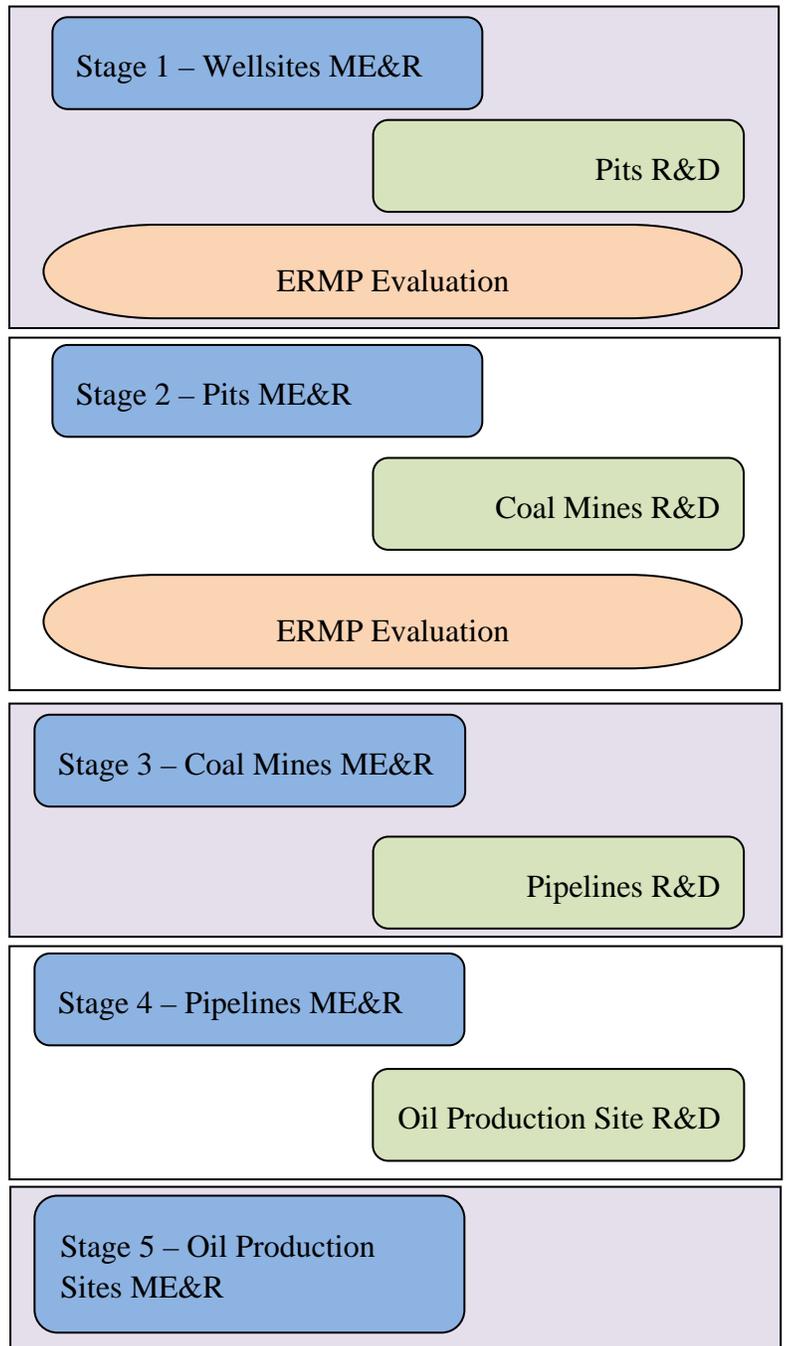


Figure 2. Stages of ERMP development

<sup>5</sup> Five years is suggested initially as a reasonable time for each stage.

**Stage 2 Pits ME&R:** In Stage 2 the ERMP should be extended to larger pits on public land (i.e., greater than or equal to 5 ha to match the current private land classification) and Class 1 pits (those with an EPEA approval and/or subject to the *Code of Practice for Pits*) on private land. It is recommended that emphasis be placed on pits certified after 1983 to focus on sites subject to the equivalent land capability policy (there are currently no formal certification criteria for pits).

**Stage 2 Coal Mines R&D:** Sampling protocols for prairie coal mines added in Stage 3 can be informed by the development work required for pits (Stage 1 R&D) but additional work may be required to refine the protocols for the larger disturbances. Most of the mountain coal mines added in Stage 3 are reclaimed to forestry and wildlife habitat so there will be a need to expand protocols generated in Stage 1 for wellsites on forested lands to larger disturbance areas.

**Stage 2 ERMP Evaluation:** At the end of Stage 2 there should be another assessment of the effectiveness and value of ERMP and a decision to: (1) terminate the program; (2) continue with wellsites only; (3) continue with wellsites and pits only; or (4) expand the program to other types of specified land.

**Stage 3 Coal Mines ME&R:** In Stage 3 the ERMP should be expanded to include coal strip mines in the prairies and open pit mountain coal mines.

**Stage 3 Pipelines R&D:** Sampling protocols for pipelines added in Stage 4 can be informed by the previous work on wellsites but adjusted to account for the linear nature of pipelines and multiple landowners. Conduct an evaluation of the need for, and value of, revisiting wellsites initially assessed in the Pilot and Stage 1 – the evaluation will include determining the appropriate parameters to be reassessed.

**Stage 4 Pipelines ME&R:** In Stage 4 the ERMP should be extended to include Class 1 pipelines (i.e., those that had an EPEA approval for construction).

**Stage 4 Oil Production Site R&D:** Sampling protocols for oil production sites added in Stage 5 can be informed by the previous work on forested wellsites and pits. Additional development work will be required if wetland portions of oil production sites are to be evaluated.

**Stage 5 Oil Production Sites ME&R:** By the time Stage 5 is initiated there should be oil production sites that have been reclaimed and certified although the time since certification will be short.

## 2.4 Program Constraints

The following constraints limit the Ecological Recovery Monitoring Program scope:

- ERMP only focuses on certified specified land sites; active sites (i.e., those that have not yet been certified) cannot be assessed under the Program even if they have been fully reclaimed (as is the case for pipelines and transmission lines which are reclaimed immediately after construction, and many pits). This will severely limit

the number of monitoring sites of specified land types other than wellsites as there are a limited number of those site certified.

- ERMP focuses on sites certified after specified times that reflect recent conservation and reclamation requirements (e.g., after 1995 for wellsites when certification criteria were published, or after 1983 for pits when soil salvage was required); therefore data on recovery of older sites will not be available.
- ERMP is not designed with the intent of making a certification decision, nor does it follow the existing reclamation certification criteria or sampling and analysis protocols; this means that care must be taken in framing the results of an ERMP assessment in the context of a certification decision.
- ERMP focuses on recovery of sites reclaimed to background or adjacent ecological conditions and uses. Sites reclaimed to alternative uses such as residential, commercial or industrial developments, intensive recreation, or pit lakes are not evaluated.
- ERMP only addresses reclamation of specified lands as defined in the *Conservation and Reclamation Regulation* (Government of Alberta, 1993). Expansion of the program mandate would allow methodologies developed for ERMP to be used to assess recovery of reclaimed or restored non-specified land sites (e.g., seismic lines) but the terminology would need to change.
- ERMP assesses reclamation effectiveness. Except to the extent that ecological recovery, and more specifically vegetation performance, is affected by the presence of contaminants, the Program does not directly evaluate presence or impacts of contamination or remediation requirements or practices.

### **3 PROGRAM GOVERNANCE**

The Chief Scientist and the Science Advisory Panel, established pursuant to sections 15.1(1) and 15.2(1) of EPEA (Government of Alberta, 1993), respectively, are charged with ensuring the department's environmental monitoring programs such as the ERMP are independent, transparent and scientifically credible.

The proposed governance structure for the program is depicted in Figure 3<sup>6</sup>. Details of the functions of the ERMP Program Lead, ERMP Steering Committee (ERMP-SC) and ERMP Technical Committee (ERMP-TC) are described below.

By participating in the ERMP-SC and ERMP-TC stakeholders will have the ability to influence the Program priorities; at the same time the Program will benefit from continued buy-in and support for the monitoring work. Members will be selected by their respective organizations and should be prepared to devote at least two years to the position to ensure continuity.

Alberta Environment and Parks, Environmental Monitoring and Science Division (EMSD) will administer the Program and house the ERMP data and reports. Administrative functions include:

- Assigning EMSD Program Lead to manage the Program;
- Establishing ERMP Steering Committee (ERMP-SC);
- Establishing the ERMP Technical Committee (ERMP-TC);
- Establishing the ERMP database (see section 5 below for details);
- Establishing the ERMP website (see section 5 below for details) and populate with Program description and existing reports;
- Ensuring availability of monitoring personnel for each field season; and,
- Contracting R&D work as required.

#### **3.1 ERMP Program Lead**

An EMSD staff member will be assigned (hired) as Program Lead to manage the Program. Functions include:

- Chairing the ERMP-SC and ERMP-TC;
- Managing all contracts for monitoring and R&D work;
- Managing the evaluation and reporting functions, including:
  - Developing a report format and template for authors;
  - Approving and releasing ERMP reports;

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<sup>6</sup> Ryerson (2013) and EBA, a Tetra Tech Company (2012b) reviewed various governance frameworks in place for other monitoring programs. The ultimate governance model for the Program will be determined by the organization in charge of Program delivery.

- Website development and maintenance; and,
- Securing annual Program funding.

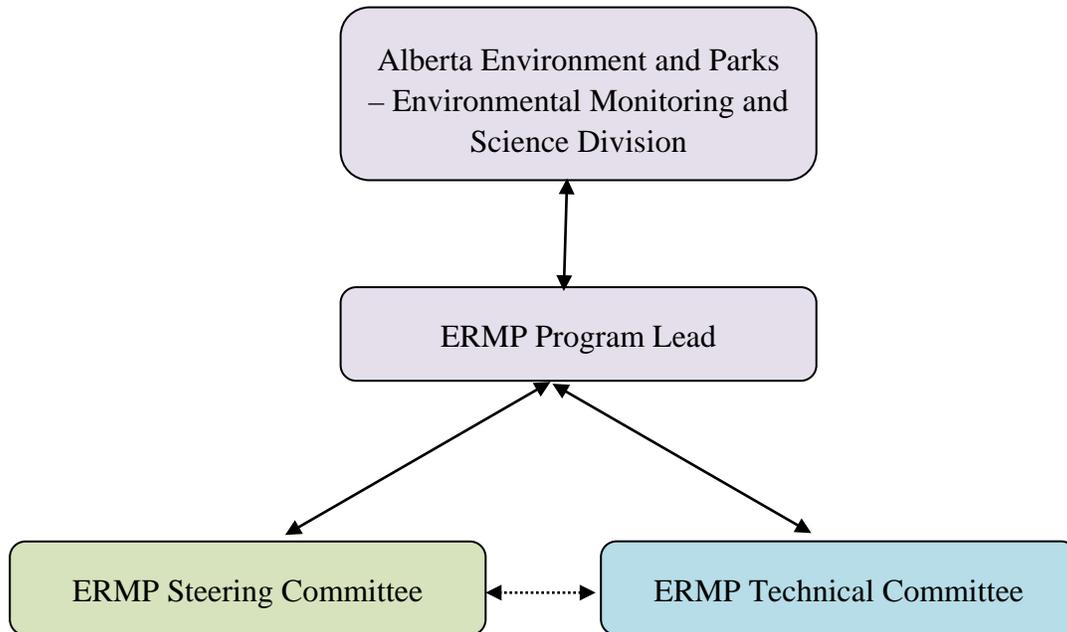


Figure 3. Proposed governance structure for the Ecological Recovery Monitoring Program.

### 3.2 ERMP Steering Committee

The ERMP Steering Committee (ERMP-SC) provides advice to the Program Lead on the annual monitoring and funding priorities for the Program, makes recommendation on changes to the Program, and serves to link EMSD to its key ERMP partners. ERMP-SC members include senior-level decision makers from:

- Environmental Monitoring and Science Division (the ERMP Program Lead as committee chair).
- The chair(s) of the ERMP Technical Committee(s).
- A representative from Alberta Agriculture and Forestry.
- A representative from the Alberta Energy Regulator.
- A representative from the Canadian Association of Petroleum Producers<sup>7</sup>.

<sup>7</sup> In later years, representatives from associations representing the types of specified land that are added to the Program scope will become members.

The ERMP-SC would meet once per year in December to review Program accomplishments and address issues that arose during the field season and to make recommendations on the next FY program and budget. ERMP-SC members are expected to be ambassadors for the Program within their organization. They are also expected to solicit input from their members on priorities and Program changes, and to coordinate program input with their respective ERMP-TC members.

### **3.3 ERMP Technical Committee**

The ERMP Technical Committee (ERMP-TC) provides technical advice to the ERMP Program Lead about Program priorities, monitoring site selection, methodology (including new and specialized technologies and techniques), evaluation and reporting functions. As the Program evolves to include other types of specified land beyond wellsites it may be more appropriate to have separate Technical Committees for each type of specified land.

ERMP-TC members include senior technical specialists from:

- Environmental Monitoring and Science Division (the ERMP Program Lead as committee chair).
- A public lands representative from Alberta Environment and Parks.
- A representative from Alberta Agriculture and Forestry.
- A representative from the Alberta Energy Regulator.
- A representative from Alberta Innovates (on behalf of the provincial innovation system).
- A representative from the Alberta Biodiversity Monitoring Institute.
- Two representatives from the upstream oil and gas industry<sup>8</sup>.

By having representatives from a variety of organizations with a range of technical expertise the ERMP-TC will promote collaborative and innovative thinking to maintain a high-quality monitoring program.

The ERMP-TC would meet at least twice per year – in October to review Program accomplishments and address issues that arose during the field season, and in February to determine the work for the coming field season. A key role for the committee is to increase credibility in measured parameters and data interpretation. ERMP-TC members are also expected to:

- Recommend R&D needs;
- Solicit input from their colleagues on sites to be monitored and the implications of monitoring results;

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<sup>8</sup> In later years, representatives from associations representing the types of specified land that are added to the Program scope will become members of this Committee or a separate Committee for their type of specified land.

- Provide Program updates to their colleagues; and,
- Coordinate Program input with their respective ERMP-SC members.

## **4 FUNDING AND PROGRAM DELIVERY**

Adequate and predictable financial support is crucial to ensure the success and sustainability of a monitoring program. Similarly, continuity of field monitoring staff will ensure consistent application of the monitoring protocols and significantly reduce training time.

To the extent possible the ERMP should look to partner with existing provincial monitoring programs<sup>9</sup>. Partnering with these programs could allow ERMP to save costs by sharing:

- Staff trained to do monitoring (skill set and know-how) and deployed around the province;
- Monitoring equipment (materials); and,
- Evaluation and reporting tools and systems.

At the least ERMP should learn from and build on the experience of these organizations.

Ryerson (2013) and EBA, a Tetra Tech Company (2012b) reviewed various funding and delivery frameworks in place for other monitoring programs.

### **4.1 Potential Funders**

Predictable and consistent funding is required to ensure proper functioning of the Program, especially given the need to have a full complement of trained staff ready to get into the field early in each Fiscal Year (FY).

#### **4.1.1 Core Funding**

Core funding includes the costs of annual monitoring campaigns as well as production and dissemination of the monitoring data and reports, and development and maintenance of the ERMP website and ERMP database. Alberta Environment and Parks, EMSD is the logical source of core funding for the Program given its mandate and the statutory obligations in EPEA section 15.1 (as described above in section 1.2.1).

Opportunities to partner with other government agencies (e.g., Alberta Agriculture and Forestry and Alberta Innovates), arms-length agencies (e.g., Alberta Energy Regulator) and industry organizations with similar interests should be explored but these organizations should not be counted on to provide the required long-term annual funding necessary to support the Program.

#### **4.1.2 Targeted Funding**

Research funding provided by EMSD can be leveraged by partnering with organizations that have access to co-funding mechanism (e.g., NSERC) or by applying for research grants/contracts through the Alberta innovation system (e.g., Alberta Innovates or InnoTech Alberta) or industry organization (e.g., PTAC) or individual companies.

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<sup>9</sup> This includes monitoring programs within Alberta Environment and Parks.

The Alberta Energy Regulator annually contracts site assessment work on certified wellsites as part of its audit program. EMSD could initiate discussions with the AER's Chief Scientist to see if there are opportunities to coordinate site work and/or develop site assessment protocols that could be used for both programs.

#### **4.2 Annual Monitoring Program Delivery**

EMSD and ABMI have developed a strong relationship through ABMI's delivery of the provincial biodiversity monitoring program. In addition, the Pilot used existing protocols developed and tested by the Alberta Biodiversity Monitoring Institute (ABMI) to develop the ERMP-specific protocols and ABMI staff participated in the Pilot design, monitoring, data analysis and reporting.

In the interests of building on the knowledge and experience gained by ABMI in the Pilot, and their extensive experience in other monitoring programs, it is suggested that the ABMI be approached to conduct annual monitoring for the ERMP. Should ABMI decline, the Program Lead would need to look externally for suitable monitoring personnel. If this were to occur, every effort should be made to contract personnel for an extended period of time (e.g., a five-year contract, annually renewable upon satisfactory performance) to ensure continuity and reduce training time.

#### **4.3 Collaborators**

To avoid duplication and build on the skills and resources of other organizations the Program Lead should reach out to potential collaborators in monitoring and evaluation, R&D, and communications organizations.

##### **4.3.1 *Monitoring and Evaluation***

A key role for the ERMP Program Lead is to ensure that the Program builds on the existing monitoring programs described above. To that end, the Program Lead will liaise directly with other EMSD monitoring program leads and with the Alberta Biodiversity Monitoring Institute to ensure that monitoring and evaluation methodologies are coordinated to the extent possible.

The Program lead will also need to maintain awareness of other monitoring and evaluation initiatives, and related R&D work, in government and industry. Such initiatives include work done by:

- Canada's Oil Sands Innovation Alliance
- Petroleum Technology Alliance of Canada
- Federal government (e.g., Canadian Forest Service)
- Academia

#### **4.3.2 *Research and Development***

Research and development work will be required to support development of protocols and data analysis methods for new types of specified land and new site types that are added to the program. Development and testing of specialized monitoring techniques should continue (see ERMP Project Advisory Group, 2017 for details on recent work). In addition, R&D will be required to develop more complex data analytics to examine the data and develop new data display tools.

The provincial research organizations that provided R&D support to develop the ERMP protocols – InnoTech Alberta, Alberta Biodiversity Monitoring Institute, and the University of Alberta – should be involved in future R&D work to capitalize on their familiarity and knowledge of the Program goals and objectives. The Canadian Forest Service and Northern Alberta Institute of Technology have additional skills and capabilities that could support ERMP development, especially for forested lands and peatlands/wetlands. If specific skills are required but not available in these R&D organizations they may be found in academia or consulting firms.

## 5 INFORMATION MANAGEMENT

This section describes a plan for the reporting function under the ERMP based on the Program goals and objectives listed above and the requirements in section 15.1(2) of the *Environmental Protection and Enhancement Act* (Government of Alberta 2000):

- (b) to collect, store, manage, analyze, evaluate and assess environmental monitoring data and to ensure the information is scientifically credible, including through prior peer review where the Chief Scientist considers it appropriate;
- (c) to make environmental monitoring data and related scientific evaluations and assessments available to the public and to the Science Advisory Panel established under section 15.2(1);
- (d) to report to the public on the condition of the environment in Alberta on the basis of the scientific evaluations and assessments of the data collected.

Information developed under the ERMP must be publicly accessible and available as soon as practicable. The information management plan consists of the following core components (described below): Data, Reports, and Programs Statistics. Additional information distribution channels are identified to increase awareness of the Program.

### 5.1 Assumptions

The information management plan is based on the following assumptions<sup>10</sup>:

- The ERMP is administered by Alberta Environment and Parks (AEP), EMSD;
- All data and reports produced under ERMP have been reviewed and approved for release prior to the activities described in this report;
- All data arising from the annual monitoring work have been rigorously reviewed according to EMSD quality assurance/quality control specifications<sup>11</sup>;
- Information management and information technology specialists have developed the appropriate hardware and software systems to implement the plan;
- EMSD will house the ERMP database;
- EMSD will upload the ERMP reports to an appropriate location on the AEP website (e.g., <http://environmentalmonitoring.alberta.ca/activity/land/>) (referred to in this report as the *ERMP website*); and,
- EMSD has developed a standard report format for ERMP reports.

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<sup>10</sup> Note: these are go-forward assumptions – for example, the Pilot data and reports are currently housed within the Alberta Biodiversity Monitoring Institute (ABMI); this may or may not be the case upon full implementation of the ERMP.

<sup>11</sup> Either currently in place or to be developed.

## 5.2 Data

Data for a variety of parameters are collected at each ERMP monitoring site. These data should be made accessible in their raw form and, where applicable, in summarized or aggregated form. To the extent possible, EMSD's existing data sharing platform, the Alberta Environmental Monitoring, Evaluation & Reporting Information Service (AEMERIS), should be used to house ERMP database.

Users should be able to request:

- Data for individual sites (perhaps through a map-based interface – see section 5.4.2);
- Data for all sites in a type of specified land;
- Data for all sites in a site type;
- Data for a specific geographic region (perhaps through a map-based interface – see section 5.4.2); and,
- Data for one or more parameters of interest (in all or part of the data set) <sup>12</sup>.

## 5.3 Reports

ERMP reports include program design reports, monitoring reports, and research and development reports. Reports may be prepared by EMSD staff or may be prepared by contractors<sup>13</sup> on behalf of EMSD. All reports should be in a format that allows for copying of text, figures and data for scholarly work (e.g., unprotected pdf files, Word files or Excel files).

### 5.3.1 Program Documentation

All of the design documents for both the Pilot Program and the ERMP should be made accessible (the former are currently housed within the ABMI site). Updates to the ERMP design documents should be uploaded but older versions<sup>14</sup> should be retained in an accessible archive to show the evolution of the Program.

Protocols for new types of specified land (e.g., pits, coal mines, pipelines) and site types (e.g., wetlands, mountains) should also be uploaded here.

### 5.3.2 Monitoring Reports

Technical reports describing the results of the past year's monitoring work should be made available as soon as practicable<sup>15</sup>.

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<sup>12</sup> See for example the ABMI data selection system – [http://www.abmi.ca/home/data-analytics/da-top/da-product-overview/Species-Habitat-Data\\_new.html?scroll=true](http://www.abmi.ca/home/data-analytics/da-top/da-product-overview/Species-Habitat-Data_new.html?scroll=true).

<sup>13</sup> *Contractors* includes consultants, government research organizations and academic institutions.

<sup>14</sup> The archives should contain major rewrites to documents, not errata corrections.

<sup>15</sup> See for example, McIntosh, A., 2014. Ecological Recovery Monitoring of Certified Reclaimed Wellsites in Alberta: Long-term monitoring framework to track ecological recovery - results from the Dry Mixedgrass. [http://ftp.public.abmi.ca/home/publications/documents/24\\_McIntosh\\_2014-09-30\\_ERMGrasslandsFramework\\_ABMI.pdf](http://ftp.public.abmi.ca/home/publications/documents/24_McIntosh_2014-09-30_ERMGrasslandsFramework_ABMI.pdf)

Periodic technical reports summarizing monitoring results for a type of specified land or a site type should also be produced. At a minimum, such reports should be prepared when the Program expands to cover the next specified land type (referred to as Program Stages in section 2.3 above).

### **5.3.3 *Research and Development Reports***

Reports on research work to prepare new protocols or revise existing protocols should be released, as supporting documentation for the protocols published pursuant to section 5.3.1. Reports on the additional R&D work identified in section 6 should also be made available.

### **5.3.4 *Scientific Papers***

Efforts should be made to publish ERMP work in appropriate peer-reviewed scientific journals.

### **5.3.5 *Fact Sheets***

Fact Sheets or Infographics may be prepared periodically to summarize Program achievements or to capture significant events (e.g., rare species encounters).

## **5.4 *Program Statistics***

Producing the statistics and maps described below will require a relational database (e.g., Access) containing all of the sites monitored by the program.

### **5.4.1 *Text-Based Statistics***

The following ERMP statistics will be updated at least annually:

- Number of sites monitored each year;
- Number of sites planned for monitoring next year;
- Number of sites monitored since Program inception;
- Number of sites monitored of each specified land type (e.g., wellsite, pit, coal mine);
- Number of sites monitored of each site type (e.g., cultivated, forested, grassland); and,
- Number of sites monitored on public land and on private land.

### **5.4.2 *Map-Based Statistics***

A map of Alberta showing all monitored sites will be updated at least annually. The map will use symbols or colours to show different types of specified land and monitoring years. Ideally the map would be interactive such that each site would be linked to its associated data.

## 5.5 Additional Information Distribution Channels

Efforts should be made to increase awareness of the ERMP methods and results through channels other than the ERMP website, data and reports, including:

- Using existing EMSD channels such as their blog (<http://environmentalmonitoring.alberta.ca/activity/blog/>)
- Videos showing ERMP field work (e.g., ABMI – Measuring Ecological Recovery on Alberta’s Reclaimed Wellsites <https://vimeo.com/140343926>);
- Conference presentations;
- Public presentations (general public plus knowledge users);
- Articles in professional magazines and newsletters; and,
- Sharing of resources and links with relevant organizations (e.g., Alberta Biodiversity Monitoring Institute, Alberta Land-use Knowledge Network, Alberta Centre for Reclamation and Restoration Ecology, Environmental Services Association of Alberta, Canadian Land Reclamation Association, Aboriginal Environmental Services Network).

## 6 RESEARCH AND DEVELOPMENT

As noted in section 2.2, the Research and Development (R&D) function includes ongoing development and refinement<sup>16</sup> of the monitoring program protocols and evaluation methodology. For example, section 2.3 identifies the need to develop monitoring protocols for the new types of specified lands to be added to the Program (i.e., pits, coal mines, pipelines, oil production sites). Appendix 2, Table 2 also proposes optional R&D work to develop monitoring protocols for new site types (e.g., wetlands, riparian grasslands, mountains).

### 6.1 Research

Preliminary research needs<sup>17</sup> identified during the Pilot program include:

- Develop statistical sampling designs (e.g., number of plots, number of samples, number of sites).
- Develop methods for statistical analysis of monitoring data (within and between sites).
- Explore alternative plot layout methods and designs (e.g., circles easier for one person to layout instead of squares for sub-plots).
- Determine the appropriate sampling scheme for applying the Canadian Forest Service's forest floor recovery index (Hoffman et al. 2017) to the ERMP forested land protocol.
- Continue to develop and field test methods to integrate monitoring parameters into a single ecological recovery index (there are two integration projects currently underway as part of the Pilot program – *Ecological recovery index for cultivated areas* (Huggard, 2016) and *Soil capability assessment* (Whitson, in prep.)).
- Continue to identify and test new monitoring technologies that can: reduce sampling subjectivity; provide better spatial representation of site characteristics; and, increase sampling efficiency.
- Determine if a null hypothesis approach to monitoring is an appropriate way to design the ERMP and subsequent analysis and reporting.
- Determine the benefits and drawbacks of deeper bulk density sampling.
- Determine the benefits and drawbacks (accuracy, cost, time, effort required) of using a Nuclear Density gauge rather than bulk density.
- Determine if and when to incorporate the specialized monitoring protocols in the basic monitoring protocols (ERMP Project Advisory Group, 2017).

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<sup>16</sup> *Development and refinement* include ongoing continuous improvement work required to maintain Program relevance.

<sup>17</sup> In the this context, *research* involves creation of new knowledge through experimentation and/or demonstration trials.

## 6.2 Development

Preliminary development needs<sup>18</sup> identified during the Pilot program include:

- Establish reclaimed site dimensions according to surveyed site boundaries on the reclamation certificate as opposed to setting standard site dimensions.
- Evaluate the benefits and drawbacks of obtaining soil profile descriptions at every site (for publication purposes some profile photos and descriptions may be useful and perhaps required).
- Develop protocols for characterizing topsoil and/or surface soil depth.
- Develop reference selection methods when the site is not uniform (e.g., how many reference areas for each part of the site).
- Evaluate tools and techniques to provide improved visualization of monitoring results and site recovery.
- Provide clear guidance on purpose and procedures for wellsite centre vs. well bore location and sampling.
- Develop and maintain a list of all certified sites, divided by type of specified land.
- Develop a process in collaboration with AEP and the Alberta Energy Regulator to ensure access to all site information – survey plans, reclamation certificate applications, Detailed Site Assessments, etc. Currently this is especially difficult to obtain for public lands.
- Explore opportunities to expand the ERMP to include reclaimed but not yet certified lands (especially relevant for pipelines which are reclaimed soon after construction and in many cases are not disturbed afterwards). Many types of specified lands have few if any reclamation certificates severely limiting the monitoring that could be done under the current Program restrictions.
- Explore opportunities to expand the ERMP to include non-specified lands (or create a new program for those lands). For example, seismic lines have a significant footprint in forested areas and have been shown to affect caribou habitat. Efforts are underway to restore these disturbed areas.

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<sup>18</sup> In the this context, *development* involves establishing operating practices and procedures without the need for experimentation or demonstrations trials.

## 7 GLOSSARY OF TERMS AND ACRONYMS

### 7.1 Terms

#### **Accessible**

ERMP information and data should be retrievable from a public website without permission or log-in requirements. The website, and all links to reports and data, should be permanent so that name changes in department or division do not require new URL's. Documents and data should be unprotected to allow for easy copying.

#### **Active Site**

A site that has not yet been certified. Some Active Sites may have been abandoned and reclaimed but have not yet applied for or received a reclamation certificate. To the extent possible the ERMP will only assess Certified Sites but there will be disturbance types (e.g., pits and pipelines) where few certificates have been issued but sites have been reclaimed – these may need to be included in the Program to provide adequate sample size.

#### **Certified Site**

An area of land that was previously disturbed by a specified land activity that has received a reclamation certificate from Alberta Environment and Parks or the Alberta Energy Regulator pursuant to requirements and procedures in the *Environmental Protection and Enhancement Act* and the *Conservation and Reclamation Regulation*. A certificate may be issued for an entire activity or part of an activity (common for large disturbances such as mines).

Care must be taken in the program design to ensure clarity in use of the term *certified site*, especially if the program is expanded to include activities that receive reclamation certificates in stages.

#### **Ecological Recovery**

The process and/or end state of the return of biological, physical and chemical properties of a reclaimed site to similar structure and function (in terms of vegetation, soil and biota) as found in a representative undisturbed reference area or pre-disturbance site.

#### **ERMP Database**

The digital system housing ERMP data – ideally part of EMSD's existing Alberta Environmental Monitoring, Evaluation & Reporting Information Service system or a standalone data infrastructure.

#### **ERMP Website**

The website within the Alberta Environment and Parks web architecture that houses ERMP data and reports.

## **Evaluation**

Analysis of monitoring data from individual sites and between sites within the same type of specified land, and, where applicable, synthesis of parameters into integrated measures of ecological recovery.

## **Governance**

Control or authority, actions, manner or system of governing which involves performance measures, management, policies and processes associated with the monitoring system and funding is the provision of financial resources to support the entire monitoring program in the long-term.

## **Monitoring**

An annual field-based program to gather data on the ecological recovery status of reclaimed certified sites in Alberta. Methods to be used and the parameters to be evaluated are identified in Protocols developed for each disturbance type (e.g., wellsites, pits, mines) and each relevant site type (e.g., grassland, cultivated, forested).

## **Monitoring Site**

An area of land subject to the Ecological Recovery Monitoring Program that includes:

1. Land that has been disturbed while conducting a specified land activity as defined in s. 1(t) of the *Conservation and Reclamation Regulation* (Government of Alberta 1993); and, has been certified by a government agency as being reclaimed pursuant to the requirements of the *Environmental Protection and Enhancement Act* (Government of Alberta 2000) and the *Conservation and Reclamation Regulation* (Government of Alberta 1993); and,
2. The associated reference areas.

## **Natural Region**

The largest mapped ecological units in Alberta's classification system. They are defined geographically on the basis of landscape patterns, notably vegetation, soils and physiographic features. Examples include Rocky Mountains, Grasslands and Boreal Forest.

## **Parameter**

A specific characteristic such as plant height or bulk density that is evaluated as part of the Program.

## **Pilot Program**

A four-year research program (2012-2015) to determine the need for, and if required the design of, an integrated, scientifically robust and financially sustainable program for the long-term assessment of ecological recovery of certified reclaimed specified lands. Partners in the Program included Alberta Environment and Parks (formerly the Alberta Environmental Monitoring,

Evaluation and Reporting Agency), the Alberta Biodiversity Monitoring Institute, and InnoTech Alberta (formerly Alberta Innovates – Technology Futures).

### **Program**

The Ecological Recovery Monitoring Program.

### **Reclamation Certification Criteria**

A document issued by Alberta Environment and Parks that defines the expected outcomes (usually in terms of landscape, soil and vegetation) for reclamation and which often specifies the methods for assessing the site (e.g., parameters, field assessment, laboratory analysis). In the case of Wellsite Criteria, there are separate documents and requirements for different types of land (e.g., forested, cultivated, grasslands, peatlands).

### **Recovery Trajectory**

The actual and expected (projected) rate and extent of change in monitored parameters (or a metric that combines parameters into a site recovery index value) at a site over time.

### **Reference Area** (often called a control)

Location off of the certified site where data are collected for comparison to the certified site data. Each reference area represents the ecological target for the entire certified site, or for a specific portion of the certified site where there is more than one ecological target represented. Note that reference areas for some site types can represent very long-term reference conditions (e.g., a 100-year-old forest).

### **Reporting**

Public dissemination of monitoring results in the form of summary reports (by year and/or by disturbance type). Results can also be provided as raw data or in various summary data formats.

### **Research and Development (R&D)**

Ongoing development and refinement of the monitoring program protocols and evaluation methodology.

### **Site Type**

Classification term for a monitoring site based on its use (e.g., cultivated) or ecology (e.g., grassland or forested).

### **Specified Land**

Activities listed in s. 1(t) of the *Conservation and Reclamation Regulation* (Government of Alberta, 1993) that are subject to requirements for conservation and reclamation, and that must obtain a reclamation certificate after abandonment.

## Wellsite

The term is generally used to describe the square or rectangular well pad. However, a wellsite reclamation certificate covers the well pad, the access road and any on-site or off-site associated disturbances such as a drilling sump or borrow site.

Care must be taken in the program design to ensure clarity in use of this term as sampling design for a well pad (and associated controls) would be quite different than for an access road.

## 7.2 Acronyms

ABMI	Alberta Biodiversity Monitoring Institute
AEMERA	Alberta Environmental Monitoring, Reporting and Evaluation Agency
AEMERIS	Alberta Environmental Monitoring, Evaluation & Reporting Information Service
AEP	Alberta Environment and Parks
AITF	Alberta Innovates – Technology Futures
EMSD	Environmental Monitoring and Science Division
EPEA	<i>Environmental Protection and Enhancement Act</i>
ERMP	Ecological Recovery Monitoring Program
ERMP-SC	ERMP Steering Committee
ERMP-TC	ERMP Technical Committee
FY	Fiscal Year (April to March)
ME&R	Monitoring, Evaluation and Reporting
NSERC	Natural Sciences and Engineering Research Council
PAG	Project Advisory Group
PTAC	Petroleum Technology Alliance of Canada
R&D	Research and Development
UAV	Unmanned Aerial Vehicle

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## **APPENDIX 1: Program Design Factors**

Factors to be considered in developing and designing a monitoring program to assess ecological recovery at reclaimed certified sites are identified in Table 1. These factors will have a direct impact on the sampling methods and data analysis, and will provide context for reporting of results.

Table 1. Summary of key factors to consider in program design.

Factor Affecting Program Design	Issues to be Considered	Program Design Options
Reclamation expectations have changed over time.	Initially certification was based on debris removal and contouring the land to reduce erosion; later on salvage and replacement of soil was required and vegetation performance (productivity) expectations were established; the objective of equivalent land capability was introduced in 1983; and only recently has there been emphasis on looking at ecological function of sites (Powter et al., 2012).	Give priority to sites constructed post-1983 (equivalent capability outcome established).  Classify and group sites by reclamation construction practices (i.e., minimal disturbance sites, topsoil salvage sites, etc.) for comparison.
Certification requirements have changed over time for many types of specified lands.	For example, wellsite criteria were first introduced in 1993, then revised in 1994, 1995, 2007 (forested land), 2010, and 2013. Prior to 1993 there were no specific criteria for determining success – however it is important to recognize that there are many sites certified prior to 1993.	Give priority to sites reclaimed under the current reclamation criteria; then sites with some form of criteria.  Consider certification criteria requirements in monitoring protocol designs.
Reclamation is controlled by the availability and quality of salvaged surface soils and subsoils.	Many sites disturbed from the 1960s to the early 1980s had little or no soil salvage. Furthermore, many large-scale disturbances such as mines, quarries and large pits must store salvaged soil for many years before land reclamation – thus quality of salvaged soil (especially biological activity) is likely reduced relative to natural soils. Therefore, time since original construction may be a better predictor of expected reclamation success than time since certification.	Give priority to sites constructed post-1983 (equivalent capability outcome established).  Classify and group sites by soil salvage requirements in place at time of construction for comparison.
Multiple research and monitoring programs have proposed and/or carried out monitoring of reclamation parameters.	Examples include the Alberta Biodiversity Monitoring Institute (ABMI), the Alberta Environmental Monitoring, Evaluation and Reporting Agency (AEMERA), Joint Oil Sands Monitoring (JOSM), National Forest Inventory (NFI), Environmental Effects Monitoring (EEM), Integrated Monitoring Evaluation and Reporting Framework (IMERF), Regional Aquatics Monitoring Program (RAMP), Wood Buffalo Environmental Association (WBEA), Cumulative Environmental Management Association (CEMA).	Design the ERMP to integrate into, collaborate and coordinate with, and/or build on existing government practices and programs to the extent possible to minimize cross-program complexity and reduce costs (the original ERMP protocols were designed to be complementary to types of data and methods in ABMI protocols).  Align ERMP with regional monitoring to better understand variations (or the range of natural variation) in the natural system.

<b>Factor Affecting Program Design</b>	<b>Issues to be Considered</b>	<b>Program Design Options</b>
Pilot program only evaluated wellsite reclamation.	Expanding the monitoring program to other forms of specified land is likely to require additional research, to determine appropriate sampling protocols for larger disturbed areas (e.g., pits and mines) or linear footprints (e.g., pipelines).	Conduct research to develop applicable monitoring protocols, indicators and parameters for other types of specified land (e.g., pits, coal mines, pipeline rights-of-ways) building on the design for wellsites.  Begin the ERMP focusing on wellsites only.
Few reclamation certificates have been issued to activities other than wellsites so there will be few sites available for monitoring.	Numerous sites must be monitored to allow for statistically valid conclusions about the status of ecological recovery of disturbance types.	Focus on certified sites but consider adding reclaimed, uncertified sites (Active Sites) for other types of specified land to the ERMP to provide adequate site numbers.
Intended land use determines reclamation practices and the appropriate monitoring protocols	The Pilot program focused on native grassland, forested and cultivated sites. In addition, the Pilot did not evaluate sites in some important natural regions such as the Rocky Mountains and Parkland. Expansion of the ERMP to other site types (e.g., peatland/wetland, wildlife habitat) and natural regions would require additional research.	Tailor monitoring parameters and protocols to natural region, site type and type of specified land.  Develop monitoring protocols and parameters for different site types and natural regions.
Site selection criteria should be as transparent as possible.	Selection criteria (e.g., natural region, site type, age, type of specified land, landowner permission, etc.) are not likely to lead to random site selection; this must be accommodated in any attempts to undertake statistical analysis of results.	Develop site selection criteria protocols and related analytical and reporting tools.
Site size will determine sampling design protocols.	Small areal disturbances permit aggregation of subsample data into a single site value that can be compared to an aggregated control value to determine ecological recovery status of the site. Larger disturbed areas and linear disturbances will not lend themselves to data aggregation at the activity scale (e.g., a mine, pit or a pipeline) as easily.	Design the monitoring protocols and reporting to accommodate disturbance scales.  Consider additional parameters to reflect the likelihood of changes to surface water (flow, ponding, etc), soil moisture and groundwater arising from larger and deeper excavations.

<b>Factor Affecting Program Design</b>	<b>Issues to be Considered</b>	<b>Program Design Options</b>
Numbers of sites sampled and their relative locations will affect costs.	The ERMP should be designed to minimize manpower and travel costs to the extent possible.	<p>Determine an appropriate annual sample size based on the available budget.</p> <p>Select sites in close proximity to each other to allow for multiple sites to be assessed in one trip.</p> <p>Train site assessment personnel to ensure efficient use of time on-site.</p> <p>Provide appropriate site assessment tools to field personnel (e.g., where appropriate use proximal sensors as much as possible).</p>
Repeat sampling will affect costs and complexity.	Repeat monitoring of selected sites is desirable as it will provide a better understanding of recovery trajectories over time. Repeat frequency would depend on the expected rate of change of the parameters being monitored – not all parameters need be sampled at the same frequency.	The program should initially focus on gathering results from many sites in a variety of disturbance types and age classes to develop an extensive data base. Therefore, sites should only be assessed once in Stages 1 and 2 (see section 2.3). Data gathered in the first two Stages can be used to identify a few candidate sites for reassessment (likely both best and worst performers). If the reassessment determines that there is value in subsequent assessments the ERMP scope can be modified to allow for reassessment of selected sites.
Sampling protocols will affect Program costs.	The ERMP should be designed to minimize sampling and analytical costs to the extent possible.	<p>Evaluate parameters and monitoring protocols developed for the Pilot program prior to selection of final protocols.</p> <p>Select the minimum number of environmental parameters to assess based on those which: provide information on meaningful change; support cumulative effects evaluation; provide information on adaptive management; and provide insight into reclamation trajectory models.</p>

## **APPENDIX 2: ERMP 10-Year Program Schedule**

Figure 4 and Table 2 below provide a high-level overview of the key activities occurring in each of the first 10 years of the ERMP. Table rows represent the four core ERMP functions: Monitoring; Evaluation, Reporting; and, R&D. A separate row provides details for administrative functions.

Full-scale implementation of ERMP begins in FY 2018/19. In FY 2017/18 the following activities must be completed to ensure proper functioning of ERMP in FY 2018/19:

- Assign EMSD Program Lead to manage the Program;
- Establish ERMP Steering Committee (ERMP-SC) and hold at least one meeting to prepare for 2018/19 implementation;
- Establish the ERMP Technical Committee (ERMP-TC) and hold at least one meeting to prepare for 2018/19 implementation;
- ERMP-TC selects sites for 2018/19 field season (see the individual monitoring protocol reports for selection methodology);
- Establish the ERMP database; and,
- Establish the ERMP website and populate with Program description and reports.

In addition, if 2017/18 funds are available, additional wellsites can be monitored and added to the ERMP database.

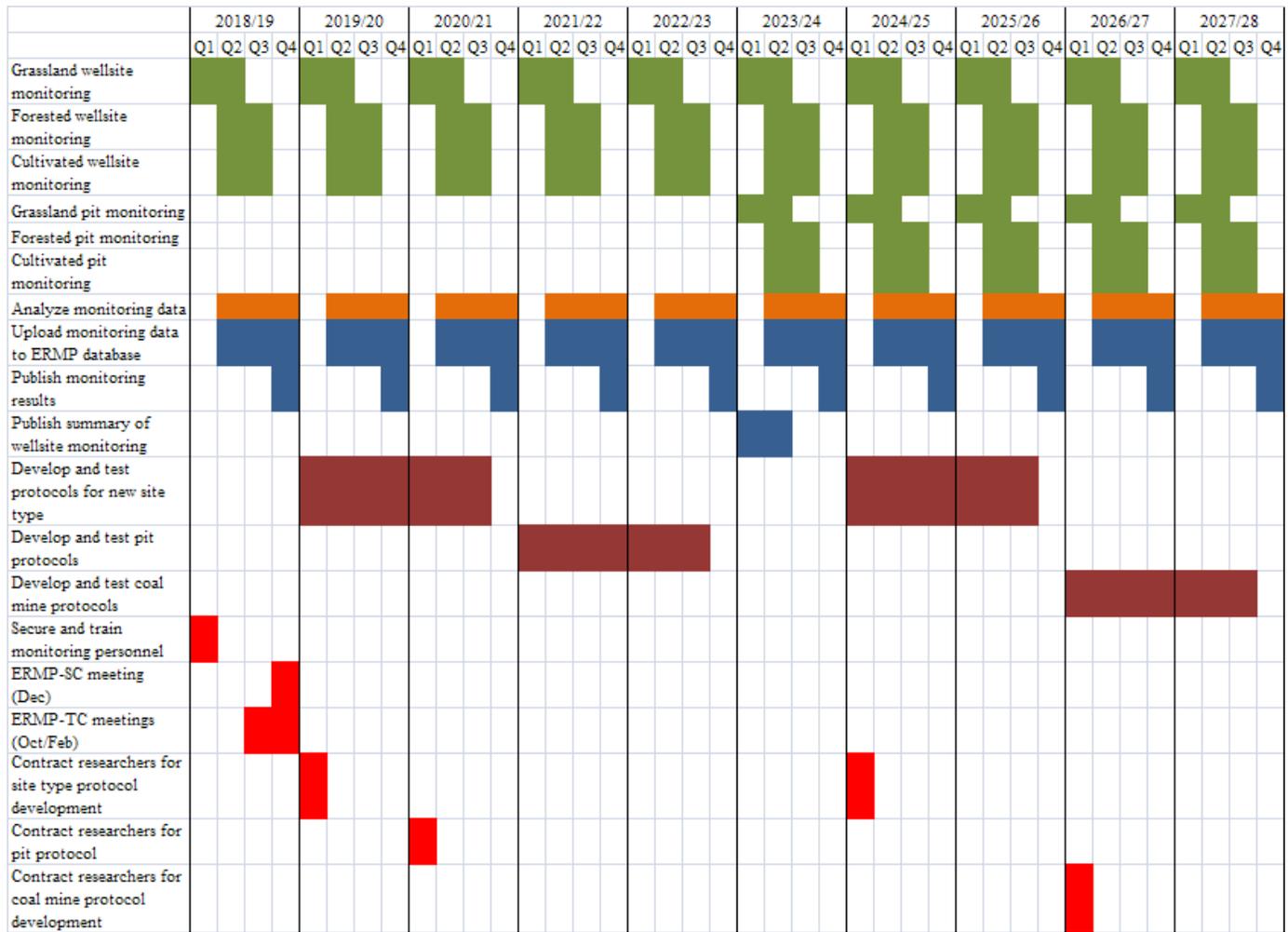


Figure 4. Proposed ERMP implementation schedule.

Table 2. 10-year schedule for the Ecological Recovery Monitoring Program.

	2018/19	2019/20	2020/21	2021/22	2022/23	2023/24	2024/25	2025/26	2026/27	2027/28
Monitoring	Wellsites Q1/2 – grasslands Q2/3 – forested Q2/3 – cultivated	Wellsites and pits Q1/2 – grasslands Q2/3 – forested Q2/3 – cultivated	Wellsites and pits Q1/2 – grasslands Q2/3 – forested Q2/3 – cultivated	Wellsites and pits Q1/2 – grasslands Q2/3 – forested Q2/3 – cultivated	Wellsites and pits Q1/2 – grasslands Q2/3 – forested Q2/3 – cultivated	Wellsites and pits Q1/2 – grasslands Q2/3 – forested Q2/3 – cultivated				
Evaluation	Q2-4 – analyze monitoring data and prepare appropriate stats and graphics									

Reporting <sup>1</sup>	Q2-4 – upload monitoring data to ERMP database  Q4 – publish monitoring results	Q2-4 – upload monitoring data to ERMP database  Q4 – publish monitoring results	Q2-4 – upload monitoring data to ERMP database  Q4 – publish monitoring results	Q2-4 – upload monitoring data to ERMP database  Q4 – publish monitoring results	Q2-4 – upload monitoring data to ERMP database  Q4 – publish monitoring results	Q2-4 – upload monitoring data to ERMP database  Q4 – publish monitoring results  Q1/2 – publish summary of wellsite monitoring results to date <sup>8</sup>	Q2-4 – upload monitoring data to ERMP database  Q4 – publish monitoring results	Q2-4 – upload monitoring data to ERMP database  Q4 – publish monitoring results	Q2-4 – upload monitoring data to ERMP database  Q4 – publish monitoring results	Q2-4 – upload monitoring data to ERMP database  Q4 – publish monitoring results
R&D <sup>2</sup>		Q1-4 – Develop protocols for new site type <sup>9</sup>	Q1-3 – Finalize protocols for new site type	Q1-4 – Develop protocols for pits	Q1-3 – Finalize protocols for pits		Q1-4 – Develop protocols for new site type <sup>9</sup>	Q1-3 – Finalize protocols for new site type	Q1-4 – Develop protocols for coal mines	Q1-3 – Finalize protocols for coal mines

Admin <sup>3</sup>	Q1 – Secure monitoring personnel <sup>10</sup> Q1 – Train monitoring personnel <sup>10</sup> Q4 – ERMP-SC meeting (Dec) Q3/4 – ERMP-TC meetings (Oct/Feb)	Q1 – Secure monitoring personnel <sup>10</sup> Q1 – Train monitoring personnel <sup>10</sup> Q4 – ERMP-SC meeting (Dec) Q3/4 – ERMP-TC meetings (Oct/Feb) Q1 – Contract researchers for site type protocol development <sup>9</sup>	Q1 – Secure monitoring personnel <sup>10</sup> Q1 – Train monitoring personnel <sup>10</sup> Q4 – ERMP-SC meeting (Dec) Q3/4 – ERMP-TC meetings (Oct/Feb)	Q1 – Secure monitoring personnel <sup>10</sup> Q1 – Train monitoring personnel <sup>10</sup> Q4 – ERMP-SC meeting (Dec) Q3/4 – ERMP-TC meetings (Oct/Feb) Q1 – Contract researchers for pits protocol development	Q1 – Secure monitoring personnel <sup>10</sup> Q1 – Train monitoring personnel <sup>10</sup> Q4 – ERMP-SC meeting (Dec) Q3/4 – ERMP-TC meetings (Oct/Feb)	Q1 – Secure monitoring personnel <sup>10, 11</sup> Q1 – Train monitoring personnel <sup>10</sup> Q4 – ERMP-SC meeting (Dec) Q3/4 – ERMP-TC meetings (Oct/Feb) Q1 – Contract researchers for site type protocol development <sup>9</sup>	Q1 – Secure monitoring personnel <sup>10</sup> Q1 – Train monitoring personnel <sup>10</sup> Q4 – ERMP-SC meeting (Dec) Q3/4 – ERMP-TC meetings (Oct/Feb) Q1 – Contract researchers for site type protocol development <sup>9</sup>	Q1 – Secure monitoring personnel <sup>10</sup> Q1 – Train monitoring personnel <sup>10</sup> Q4 – ERMP-SC meeting (Dec) Q3/4 – ERMP-TC meetings (Oct/Feb) Q1 – Contract researchers for coal mine protocol development.	Q1 – Secure monitoring personnel <sup>10</sup> Q1 – Train monitoring personnel <sup>10</sup> Q4 – ERMP-SC meeting (Dec) Q3/4 – ERMP-TC meetings (Oct/Feb) Q1 – Contract researchers for coal mine protocol development.	Q1 – Secure monitoring personnel <sup>10</sup> Q1 – Train monitoring personnel <sup>10</sup> Q4 – ERMP-SC meeting (Dec) Q3/4 – ERMP-TC meetings (Oct/Feb)
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<sup>1</sup> Reporting includes communication functions related to the ERMP website and data/report dissemination

<sup>2</sup> Research and Development

<sup>3</sup> Administration

<sup>4</sup> Q1 – April to June

<sup>5</sup> Q2 – July to September

<sup>6</sup> Q3 – October to December

<sup>7</sup> Q4 – January to March

<sup>8</sup> Optional 5-year summary report; update every five years (or each time a new type of specified land is added to the program).

<sup>9</sup> Optional R&D to develop protocols for new site types such as mountain/foothill or wetland/riparian areas.

<sup>10</sup> Ideally this is done April 1 (or in Q4 of the previous year) to allow for an early start to field work. Staffing and training time can be reduced significantly if the same people return each year.

<sup>11</sup> Additional staff will be required once pits are added in 2023/24.