2022-2023 OSM WORK PLAN APPLICATION

This form will be used to assess the merits of the proposed work plan and its fit with the Oil Sands Monitoring (OSM) Program mandate and strategic priorities. Applicants must complete the form in its entirety. Applicants that fail to use this form and complete all sections in the timeframe will not be considered.

OSM Work Plan Submission Deadline: The deadline for submission of proposed work plans is ***October 5, 2021 at 4:30 PM Mountain Standard time.***	***October 5, 2021*** *4:30 PM MST*
Decision Notification	*Mid to Late January 2022*

The OSM Program is governed by the Freedom of Information and Protection of Privacy Act (FOIP) and may be required to disclose information received under this Application, or other information delivered to the OSM Program in relation to a Project, when an access request is made by anyone in the public. Applicants are encouraged to familiarize themselves with FOIP. All work plans are public documents.

WORK PLAN COMPLETION

*Please **Enable Macros** on the form when prompted.*

The applicant is required to provide information in sufficient detail to allow the evaluation team to assess the work plan. Please follow the requirements/instructions carefully while at the same time being concise in substantiating the project's merits. *The OSM Program is not responsible for the costs incurred by the applicant in the preparation and submission of any proposed work plan.*

When working on this form, please maintain Macros compatibility by always saving your draft and your final submission as a **Microsoft Word Macro-Enabled Document**, failure to do so will result in loss of form functionality**.** This form was created using Microsoft word 2016 on a PC and may not have functionality on other versions of Microsoft on PC or MACS.

All work plans under the OSM Program require either a government lead or a government coordinator. This will ensure that the financial tables (for Alberta Environment and Parks & Environment and Climate Change Canada) are completed accurately for work plan consideration. ***However,*** if an ***Indigenous community, environmental nongovernmental organization*** *or any other* ***external partner*** *is completing a work plan proposal, they would* ***only*** *complete the* ***grant or contract budget component*** *of the* ***Human Resources & Financials Section*** *for their project. The government coordinator within Alberta Environment & Parks would be responsible for completing the remaining components of the Human Resources and Financial Section of this Work Plan Application, as they are responsible for contract and grant facilitation of successful submissions. All other sections outside of* ***Human Resources & Financials Section*** *of this work plan proposal are to be completed in full by all applicants.*

The OSM Program recognizes that majority of work planning submissions are a result of joint effort and monitoring expertise. Should the applicant wish to submit supplemental materials in addition to their application additional resources are available in the Work Planning Form and Distribution Package, accessible here: **Work Planning Form and Distribution Package**

Should you have any ***questions*** *about completing this work planning form or uploading your final submission documents, please send all inquiries by email to:* **OSM.Info@gov.ab.ca**.

WORK PLAN SUBMISSION

*Upon completion of this application, please submit the appropriately named work plan (**Microsoft Word Macro-Enabled Document**) and all supporting documents to the link provided below. Failure to follow the naming convention provided may result in oversight of your application.*

*Please upload (by drag and dropping) the **WORK PLAN SUBMISSION & ALL SUPPORTING DOCUMENTS** here:*

WORK PLAN SUBMISSION LINK (CTRL+CLICK HERE)

Please use the following file naming convention when submitting your WORK PLAN:

202223_wkpln_WorkPlanTitle_ ProjectLeadLastNameFirstName

Example:

202223_wkpln_OilSandsResiduesinFishTissue_SmithJoe

If applicable, **please use the following file naming convention when submitting your supplementary or supporting files.** Please number them according to the guidance and examples provided:

202223_sup##_WorkPlanTitle_ ProjectLeadLastNameFirstName

Examples:

202223_sup01_OilSandsResiduesinFishTissue_SmithJoe

202223_sup02_OilSandsResiduesinFishTissue_SmithJoe

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202223_sup10_OilSandsResiduesinFishTissue_SmithJoe

Do not resave your work plan or documents under any other naming conventions. *If you need to make revisions and resubmit before the work planning deadline of October 5, 2021, **DO NOT** rename your submission. When resubmitting, simply resubmit with the exact naming convention so that it replaces the original submission. **DO NOT** add any additional components such as versioning or dates to the file naming convention. Please direct any questions regarding the submission or naming of submissions to **OSM.Info@gov.ab.ca**.*

WORK PLAN APPLICATION

PROJECT INFORMATION	
Project Title:	Integrated Terrestrial Biological Monitoring
Lead Applicant, Organization, or Community:	David Roberts, AEP
Work Plan Identifier Number: *If this is an on-going project please fill the identifier number for 20/21 fiscal by adjusting the last four digits:* ***Example:*** *D-1-2020 would become D-1-**2022***	B-LTM-TB-1-2223
Project Region(s):	Oil Sands Region
Project Start Year: *First year funding under the OSM program was received for this project (if applicable)*	2019
Project End Year: *Last year funding under the OSM program is requested* ***Example: 2022***	2023
Total 2022/23 Project Budget: *For the 2022/23 fiscal year*	$11,042,915.70
Requested OSM Program Funding: *For the 2022/23 fiscal year*	$10,610,415.70
Project Type:	Longterm Monitoring
Project Theme:	Terrestrial Biological Monitoring
Anticipated Total Duration of Projects (Core and Focused Study (3 years))	Year 5
Current Year	**Focused Study:** Choose an item.
	Core Monitoring: Year 3

CONTACT INFORMATION	
Lead Applicant/ Principal Investigator: Every work plan application requires one lead applicant. This lead is accountable for the entire work plan and all deliverables.	David Roberts
Job Title:	Cumulative Effects Analytical Scientist
Organization:	Alberta Environment and Parks
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Phone:	403-333-6318
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PROJECT SUMMARY

Should your application be successful, The OSM Program reserves the right to publish this work plan application. Please check the box below to acknowledge you have read and understand:

☒ *I acknowledge and understand*

In the space below please provide a summary (300 words max) of the proposed project that includes a brief overview of the project drivers and objectives, the proposed approach/methodology, project deliverables, and how the project will deliver to the OSM Program objectives. The summary should be written in plain language.

Terrestrial biological resources are highly valued in the Oil Sands Region (OSR). Wildlife and biodiversity are important to people living and working in the OSR because of the cultural and spiritual, harvesting and subsistence, recreational, and clean water (ecosystem services) values they support. In addition, there are strong regional regulatory drivers encompassing species-at-risk and cumulative effects assessment. From both a western science and Indigenous perspective, it is important to understand how oil sands development in the region is impacting terrestrial biological resources. This includes understanding impacts both immediately adjacent to development as well as ambient impacts that extend more broadly, including into traditional use areas.

Focusing on indicators sensitive to oil sands development, this Integrated Terrestrial Biological Monitoring (TBM) workplan addresses the Oil Sands Monitoring Program (OSM) core outcomes:

1. Has there been change in wildlife and species?
2. Are changes linked to oil sands development?
3. What is the contribution of oil sands development in the context of cumulative effects?

Proposed work in 2022-23 is built using the Before-After Dose-Response (BADR) adaptive monitoring framework which was developed in collaboration with the TBM Technical Advisory Committee (Bayne et al. 2020) and supported by the OSM Oversight Committee as part of the 2021/22 workplan approvals. The 2022-23 TBM workplan has four major components:

1. Cross-Cutting Components
    a. Adaptive Monitoring Framework (BADR)
    b. Human Footprint Stressor Monitoring
    c. Habitat Monitoring (Forest Regeneration)
2. Terrestrial Wildlife and Species Monitoring
    a. Mammal Monitoring
    b. Landbird Monitoring
    c. Vascular Plant Monitoring
    d. Moss and Lichen Monitoring
3. Wildlife Health (Integrated monitoring of selected indicator species)
    a. Mammal Health Monitoring
    b. Colonial Waterbird Monitoring
    c. Amphibian Health Monitoring
4. Soil Health Monitoring

This terrestrial monitoring plan prioritizes specific indicators that are sensitive to oil sands development, are at-risk, or are important to Indigenous communities. Ongoing active engagement with the TBM Technical Advisory Committee and Indigenous Communities across the region will ensure that TBM indicators are adaptive to emerging priorities and concerns over time.

Major updates to the 2022/23 TBM workplan (compared to previous submissions):

1. We have directly integrated Human Footprint Stressor Monitoring into the Cross-Cutting section of this workplan because this product is critical to the ongoing implementation of the Adaptive Monitoring Framework (i.e. BADR). The deliverables from the Human Footprint Stressor Monitoring component support the detection of change, investigation of cause, and assessment of cumulative effects. The integration of this deliverable into the TBM workplan has resulted in a TBM budget increase relative to 2021/22 but against a decrease in workplan submissions to other TACs within OSM.

2. We have added a Habitat Monitoring program into the Cross-Cutting section of this workplan at the direct request of the TBM Technical Advisory Committee. In 2022/23, the Habitat Monitoring program will measure indicators related to habitat recovery on seismic lines, well pads, and other footprint associated with oil sands exploration and production. This information is critical for measuring the effectiveness of regulation of these two activities, which operate under differing regulatory frameworks and has been identified as a high priority indicator by the TAC due to the growing evidence that alternative successional pathways are resulting in shifts in wildlife communities. The addition of this deliverable has resulted in a budget increase relative to 2021/22. We recommend, with the endorsement of the TBM TAC, that this program leverage existing LiDAR data sets from OSM energy companies where access is permitted. We further recommend that the program be staggered over 3 years with a focus on the Athabasca Oil Sands Region in 2022/23. This work will operationalize approaches being developed by the BERA group by using a number of different sensing techniques combined with ground-truthing and will coordinate with the Boreal Ecosystem Recovery and Assessment (BERA; http://beraproject.org/) and Algar efforts to maximize efficiency.

3. We have reorganized the previous TBM vegetation monitoring program into two sub-workplans: (1) Vascular Plant Focused Study and (2) Lichen and Moss Monitoring. The Vascular Plant Focused Study prioritizes a set of indicator species that are sensitive to oil sands activities and/or of value to Indigenous Communities. The Lichen and Moss Monitoring Program now prioritizes a set of key indicators in a narrow set of functional groups that represent critical ecological functions.

4. Based on direction from SIKIC Industry Caucus following the review of a recent soil health technical report, we have added a Soil Health Monitoring component that uses a highly targeted confirmation monitoring program.

5. Based on analyses completed in 2021/22, Amphibian Monitoring in 2022/23 will focus on areas where environmental changes have been observed or at locations where there is potential for change, to assess whether change in amphibians and/or their habitats continues to be observed. This monitoring will be used to assess change across a larger spatial scale, enabling integration within the adaptive BADR EEM framework, as well as addressing the OSM core outcomes in an adaptive fashion.

6. The focus of colonial waterbird monitoring will shift to an Investigation of Cause to address priority questions on the downstream transport of mercury and the sources contributing to mercury burdens in wildlife or aquatic receiving environments.

7. In response to Indigenous community-based monitoring (CBM) priority questions and knowledge gaps, the mammal health program of this TBM sub-workplan has been extensively reworked to formally establish an OSR-wide muskrat surveillance program. As such, the mammal health program is re-focusing to establish muskrats as the primary sentinel species monitored with river otters being used when environmental trigger limits are exceeded, and biological effect assessments need confirmation in higher trophic biota. The new muskrat surveillance program aligns and is more closely coordinated with other ICBM activities, needs and concerns. The new program has also been discussed at length with the Athabasca University (AU) Facilitation Centre (Tracy Hillis) and all program partners; all are enthusiastic on the level of integration. The Indigenous Knowledge-driven approach to the muskrat surveillance program allows the tracking of impacts from oil sands development, for the integration of comprehensive and inclusive monitoring practices, and ensures relevance to stakeholders, Indigenous communities and policy and regulatory bodies. However, because its scope grew to include other communities, sampling regions and partners, budget figures related to training, enhancing capacity, sample collections and chemical analyses needed to increase to remain realistic and feasible.

1.0 Merits of the Work Plan

All work plans under the OSM Program must serve the mandate of the program by determining (1) if changes in indicators are occurring in the oil sands region and (2) if the changes are caused by oil sands development activities and (3) the contribution in the context of cumulative effects. In the space below please provide information on the following:

- *Describe the key drivers for the project identifying linkages to the EEM framework particularly as it relates to surveillance, confirmation and limits of change (as per OC approved Key Questions).*
- *Explain the knowledge gap as it relates to the EEM framework that is being addressed along with the context and scope of the problem as well as the Source – pathway – Receptor Conceptual Models .*
- *Describe how the project meets the mandate of the OSM Program*
- *Discuss results of previous monitoring/studies/development and* what has been achieved to date.

KEY DRIVERS and LINKAGES TO THE EEM FRAMEWORK:

The Key Drivers for The TBM workplan are generated from the OSM core outcomes:
1. Has there been change in wildlife and species?
2. Are changes linked to oil sands development?, and
3. What is the contribution of oil sands development in the context of cumulative effects?

The current priority stressors (see Bayne et al. 2020) are:
1. Landscape Disturbance
2. Physical Infrastructure
3. Contaminants
4. Climate Change

Each of these stressors has multiple sub-classifications (e.g., legacy seismic lines are a specific type of disturbance under Landscape Disturbance; see Bayne et al. 2020).

Following the Environmental Effects Monitoring (EEM) framework, the overall goal of the TBM workplan is to implement a tiered adaptive monitoring system that prioritizes activity toward the known and high-priority oil sands stressors. The foundation for our 2022-23 workplan is the Before-After-Dose-Response (BADR) monitoring framework (see BADR technical report; Bayne et al. 2020). The BADR framework provides a monitoring design that measures changes in selected indicator groups and attributes those changes to specific oil sands activities using two monitoring approaches:

1. Before-After: Monitoring at different phases of oil sands development (currently developed, not yet developed, and reference)
2. Dose-Response: Monitoring along a gradient of current oil sands disturbance (high to low)

The combination of these two approaches forms the BADR design. Fundamentally, this allows us to identify biological change and progressively evolve our monitoring under an EEM framework to identify causes and potential solutions. The flexibility of this BADR EEM framework also allows us to adapt the monitoring design and prioritize effort over time when we observe change in oil sands stressors, pathways, and biological responses, and in response to changing oil sands development.

The overview of this framework is as follows:

Surveillance Monitoring:
- Under the BADR EEM framework, the 'baseline' is 'reference' sites chosen to represent pre-industrial disturbance conditions.
- The BADR EEM framework further develops a baseline specific to oil sands footprint by monitoring along a gradient of current and future oil sands stressors (including in undisturbed reference sites).

Source-Pathway-Receptor Models and Effects Monitoring:

- The BADR EEM framework targets monitoring along a spectrum of disturbance, for a variety of landcover types, for ecologically relevant landscape spatial units (sub-watersheds) across the oil sands region.
- Stressor, pathway, and response indicators have been selected for the priority linkages within the OSM conceptual model. The response indicator groups are listed later in this document.
- Before-After is captured in two ways: repeated sampling of sites (measuring change over time); and space for time inference (measuring change in disturbed areas relative to controls).

Confirmation:
- The purpose of confirmation monitoring within the BADR EEM framework is to confirm changes detected via surveillance monitoring (i.e., a trigger has been reached). Within TBM, confirmation occurs using a number of approaches.
- Sources/Stressor: Human footprint information is assessed annually for its accuracy and ground validation surveys are conducted.
- Effects: Effect sizes are used to estimate the magnitude of indicator change with unit stressor change. Confidence intervals are used to estimate the level of certainty associated with these changes. Precision/power analyses determine the number of replicates required to ensure assessments of change meet a desired threshold of confidence and inform future design changes for adaptive monitoring.
- The BADR EEM framework is designed not only to identify whether there is a change from reference conditions, but the degree of change.
- The hierarchical BADR EEM framework will contribute scientific information to help judge the efficacy of existing regulations and compliance with approvals as they apply to "beyond the fence line" responses to oil sands stressors at local, sub-regional and regional scales.

Limits of Change:
- Limits of Change are predefined thresholds that trigger either a change in monitoring activity, and/or a management action.
- Limits of Change are not fully established within terrestrial ecology or within the TBM program.
- We are working with surveillance monitoring data to establish Limits of Change under the BADR EEM framework. We are also examining how existing and proposed policies and scientific guidance can inform these Limits of Change:
    - Indigenous indicators and ways of life such as ability to exercise s. 35 rights
    - Species at Risk listing criteria;
    - Biodiversity Management Framework indicators and triggers established through the Land Use Framework;
    - CEMA's RWG report entitled "Synthesis: Applying the Reference Condition Approach for Monitoring Reclamation Areas in the Athabasca Oil Sands Region" (Ciborowski et al.).
    - EPEA approval conditions for monitoring by category of monitoring.
    - Toxicity thresholds such as embryonic mortality in birds threshold for Hg levels in bird eggs, and total Hg in fur threshold (effect on cortisol levels in the animals)
    - CCME guidelines
    - Quantile regression approaches
- Cataloguing, scoping, and evaluating potential options to define terrestrial Limits of Change is ongoing within the TBM program. Note: the Limits of Change definition process requires us to use an engagement process to consider Indigenous communities' perspectives, scientific understanding, and management goals.

KNOWLEDGE GAPS WITHIN THE SOURCE-PATHWAY-RECEPTOR MODEL:

The TBM monitoring network is directly included in the conceptual model and is linked to wildlife and biodiversity responses, species-at-risk, wildlife health and human health. In 2022-23, data collected by the long-term TBM monitoring program will be used to address the following knowledge gaps within the source-pathway-receptor model:
- How have terrestrial ecosystems changed from baseline (species distributions, communities, populations, health)? (endpoints relating to stressors: land disturbance, noise and contaminants).
- How has landscape-level disturbance affected Indigenous endpoints of concern, such as populations of key species (high value species such as berries, pitcher plant, muskrat, beaver, fisher, moose, caribou, rat root, wood bison) in preferred locations and at relevant scale? How have these changes affected

the accessibility and health of resources? How has this affected opportunities for Indigenous communities to exercise constitutionally protected rights?.
- What are pathways of effect for terrestrial ecosystems?
- Are wildlife mitigation measures working effectively at the regional scale?
- What is the population status of species of concern compared to limits of change, including government standards and Indigenous indicators?
- What are the long-term trends of key indicators related to ecosystem and environmental effects using the adaptive monitoring approach?
- What are the patterns of change of key indicators in communities and at key receptor locations and what is responsible for these patterns?
- What are the effects of energy resources and commercial developments on wildlife health and biodiversity?
- What changes to key indicators are occurring in the oil sands region? Are they due to oil sands development?
- What are the background changes in wildlife and biodiversity?

The TBM TAC will continue to examine the monitoring priorities in the context of the BADR EEM framework.

FULFILLMENT OF THE OSM PROGRAM MANDATE:

The purpose of the Terrestrial Biological Monitoring (TBM) program is to directly address the overarching OSM priorities while leveraging the value of monitoring data acquired to date.

The oil sands facilities and stressors associated with surface mining and in-situ extraction activities are unique, as are the potential environmental impacts. Both are the focus of the BADR EEM framework which operates under the framework provided by the OSM conceptual model (environmental stressors, pathways, and resulting responses).

The OSM conceptual model also identifies Valued Components which represent aspects of the environment that local communities and greater society value and which have potential to be affected by oil sands activity. Within TBM, the priority Valued Components are Biodiversity, Healthy Ecosystems, and Traditional Resources and Cultural Practices (Bayne et. al., 2020). An additional conceptual model specific to TBM has also been developed and provides greater resolution for model components that are relevant to terrestrial ecosystems (Appendix I, Bayne et. al., 2020).

RESULTS OF PREVIOUS MONITORING STUDIES

Oil sands activities are impacting terrestrial biological indicators related to both species and landscape. See 3.4.5.2 below and appended sub-workplans for details on individual indicator groups.

2.0 Objectives of the Work Plan

List in point form the Objectives of the 2022/23 work plan below

1. To monitor impacts from oil sands activities on terrestrial biological indicators using the BADR EEM approach
2. Report on the key questions identified above to support regulators, government, communities, and the public in assessing risks to terrestrial ecosystems from oil sands activities
3. Implement an adaptive monitoring program for terrestrial biodiversity in the oil sands region, founded on the concepts of the BADR design and the EEM framework);
4. For priority indicators, establish scientifically robust approaches to the development of (a) baseline/reference conditions and (b) monitoring triggers, including a process of indicator selection based on sensitivity to different oil sands activities, , and engagement of key stakeholders on recommended approaches and outcomes;
5. Enhance efforts on the development of Indigenous-led indicators and community-based or participatory monitoring; working collaboratively with the OSM Indigenous Community-Based Monitoring Advisory Committee (ICBMAC) and the AU Facilitation Centre;

6. Implement data collection under the BADR EEM design to support timely development of the adaptive monitoring framework; data collection is needed in order to: a. Continue monitoring to address the information gaps related to stressor-response pathways and attribution of change identified above; b. Provide information on biodiversity outcomes at the temporal and spatial scales that meet OSM needs; c. Provide data for sensitivity analyses for adaptive monitoring planning and indicator selection; 7. Integrate footprint and habitat monitoring directly into TBM activities and expand the program to include qualitative assessments of oil sands footprint, targeted footprint attribution and recovery information.

3.0 Scope

Evaluation of Scope Criteria (Information Box Only- No action required)
Your workplan will be evaluated against the criteria below. A successful workplan would:

- be in scope of the OSM Program (e.g., regional boundaries, specific to oil sands development, within boundaries of the Oil Sands Environmental Monitoring Program Regulation)
- integrate western science with Indigenous Community-Based Monitoring
- addresses the EEM framework particularly as it relates to surveillance, confirmation and limits of change as per approved Key Questions.

have an experimental design that addresses the Pressure/Stressor, Pathway/Exposure, Response continuum

- produce data/knowledge aligned with OSM Program requirements and is working with Service Alberta
- uses Standard Operating Procedures/ Best Management Practices/ Standard Methods including for Indigenous Community-Based Monitoring

3.1 Sub Theme

Please select from the dropdown menu below the theme(s) your monitoring work plan relates to:

Terrestrial Biology

3.2 Core Monitoring or Focused study

Please select from the dropdown menu below if the monitoring in the work plan is "core monitoring" and/or a "focused study". Core monitoring are long term monitoring programs that have been in operation for at least 3 years, have been previously designated by the OSM program as core, and will continue to operate into the future. Focused studies are short term projects 1-2 years that address a specific emerging issue. For the purposes of 2022/23 work planning all Community Based Monitoring Projects are Focused Studies.

Core Monitoring

3.3 Sub Theme Key Questions

Please select from the dropdown menus below the sub-theme(s) your monitoring work plan relates to and address the Key Questions:

3.3.1 Surface Water Theme

3.3.1.1. Sub Themes:

Choose an item.

3.4.1.2 Surface Water Key Questions

Explain how your surface water monitoring program addresses the key questions below.

1. Are changes occurring in water quality, biological health (e.g., benthos, fish) and/or water quantity/flows, to what degree are changes attributable to oil sands activities, and what is the contribution in the context of cumulative effects?

Click or tap here to enter text.

2. Are changes in water quality and/or water quantity and/or biological health informing Indigenous key questions and concerns?

Click or tap here to enter text.

3. Are data produced following OSM Program requirements and provided into the OSM Program data management system?

Click or tap here to enter text.

4. Do methodologies use relevant Standard Operating Procedures/ Best Management Practices/ Standard Methods?

Click or tap here to enter text.

5. How does the monitoring identify integration amongst projects, themes or with communities?

Click or tap here to enter text.

6. 7.6. Where does the monitoring fit on the conceptual model within the EEM framework for the theme area and relative to the conceptual model for the OSM Program theme area? How will this work advance understanding transition towards of the conceptual model EEM framework?

Click or tap here to enter text.

7. Is the work plan contributing to Programmatic State of Environment Reporting?

Click or tap here to enter text.

3.3.2 Groundwater Theme

3.3.2.1 Sub Themes:

Choose an item.

3.3.2.2 Groundwater Key Questions

Explain how your groundwater monitoring program addresses the key questions below.

1.Are changes occurring in groundwater quality and/or quantity, to what degree are changes attributable to oil sands activities, are changes affecting other ecosystems, and what is the contribution in the context of cumulative effects?

Click or tap here to enter text.

2. 2. Are changes in groundwater quality and/or quantity informing Indigenous key questions and concerns Indigenous concerns and health?

Click or tap here to enter text.

3. Are data produced following OSM Program requirements and provided into the OSM Program data management system?

Click or tap here to enter text.

4. Do methodologies use relevant Standard Operating Procedures/ Best Management Practices/ Standard Methods?

Click or tap here to enter text.

5. How does the monitoring identify integration amongst projects, themes or with communities?

Click or tap here to enter text.

6. Where does the monitoring fit within the EEM framework and relative to the theme area? How will this work advance transition towards the EEM framework?

Click or tap here to enter text.

7. Where does the monitoring fit on the conceptual model for the theme area and relative to the conceptual model for the OSM Program? How will this work advance understanding of the conceptual model?

Click or tap here to enter text.

8. Is the work plan contributing to Programmatic State of Environment Reporting?

Click or tap here to enter text.

3.3.3 Wetlands Theme

3.3.3.1 Sub Themes:

Choose an item.

3.3.3.2 Wetland - Key Questions

Explain how your wetland monitoring program addresses the key questions below.

1. Are changes occurring in wetlands due to contaminants and hydrological processes, to what degree are changes attributable to oil sands activities, and what is the contribution in the context of cumulative effects?

Click or tap here to enter text.

2. Are changes in wetlands informing Indigenous key questions and concerns?

Click or tap here to enter text.

3. Are data produced following OSM Program requirements and provided into the OSM Program data management system?

Click or tap here to enter text.

4. Do methodologies use relevant Standard Operating Procedures/ Best Management Practices/ Standard Methods?

Click or tap here to enter text.

5. How does the monitoring identify integration amongst projects, themes or with communities?

Click or tap here to enter text.

6. Where does the monitoring fit within the EEM framework and relative to the theme area? How will this work advance transition towards the EEM framework?

Click or tap here to enter text.

7. Where does the monitoring fit on the conceptual model for the theme area and relative to the conceptual model for the OSM Program? How will this work advance understanding of the conceptual model?

Click or tap here to enter text.

8. Is the work plan contributing to Programmatic State of Environment Reporting?

Click or tap here to enter text.

3.3.4 Air Theme

3.3.4.1 Sub Themes:

Choose an item.

3.3.4.2 Air & Deposition - Key Questions

Explain how your air & deposition monitoring program addresses the key questions below.

1. Are changes are occurring in air quality, to what degree are changes attributable to oil sands emissions, and what is the contribution in the context of cumulative effects?

Click or tap here to enter text.

2. Are changes informing Indigenous key questions and concerns?

Click or tap here to enter text.

3. Are data produced following OSM Program requirements and provided into the OSM Program data management system?

Click or tap here to enter text.

4. Do methodologies use relevant Standard Operating Procedures/ Best Management Practices/ Standard Methods?

Click or tap here to enter text.

5. How does the monitoring identify integration amongst projects, themes or with communities?

Click or tap here to enter text.

6. Where does the monitoring fit within the EEM framework and relative to the theme area? How will this work advance transition towards the EEM framework?

Click or tap here to enter text.

7. Where does the monitoring fit on the conceptual model for the theme area and relative to the conceptual model for the OSM Program? How will this work advance understanding of the conceptual model?

Click or tap here to enter text.

8. Is the work plan contributing to Programmatic State of Environment Reporting? (Answer Box)

Click or tap here to enter text.

3.3.5 Terrestrial Biology Theme

3.3.5.1 Sub Themes:

Cross-Cutting

3.3.5.2 Terrestrial Biology - Key Questions

Explain how your terrestrial biological monitoring program addresses the key questions below.

1. Are changes occurring in terrestrial ecosystems due to contaminants and landscape alteration, to what degree are changes attributable to oil sands activities, and what is the contribution in the context of cumulative effects?

The BADR EEM design has been specifically designed to identify environmental change attributable to oil sands activity against a reference or baseline condition. This design achieves this by examining environmental response along stressor gradients at various spatial scales. More detailed information on how the BADR EEM design measures change is provided in Section 6.0. While TBM has provided substantial insight into the effects of oil sands development to date, the implementation of the BADR EEM design will allow for clearer linkages between both the effects of specific development components and broader cumulative impacts on the priority indicators.

Peer-reviewed literature has linked changes in biological ecosystems in the oil sands region to human activities, some related to oil sands development (summarized in Roberts et al. 2021). This evidence spans multiple taxonomic, spatial, and temporal scales, and reflects the complexities and interdependencies of this multi-stressor landscape. Terrestrial biota in the oil sands region are simultaneously subject to habitat alteration, human activity and infrastructure, chemical contaminants from both natural and anthropogenic sources, natural disturbance regimes, and climate change.

CONTAMINANTS

Studies have assessed changes in contaminant burdens and health metrics across many taxa in the OSR. Monitoring of the changes in contaminant burdens and health metrics across spatial and temporal gradients, along with investigation of pathways and sources represent a large and ongoing effort in the oil sands region. Briefly:

Birds. Research has shown higher mercury concentrations in the eggs of colonial waterbirds in downstream receiving environments of the Athabasca River (Dolgova et al. 2018; Hebert et al. 2011, 2013), and the critical role of riverine transport processes in regulating mercury availability to waterbirds (Hebert, 2019). In the Athabasca Oil Sands Region, research has shown that tree swallow nestlings will divert resources and energy to contend with contaminant exposure (Luis Cruz-Martinez et al. 2015), and PAC exposure and accumulation can influence tree swallows' reproduction, development, and thyroid function (Fernie et al. 2018; Godwin, Barclay, & Smits 2018; Fernie et al. 2019).

Mammals. Contaminant burdens in tissues and health responses have been measured in semi-aquatic mammals. PACs and heavy metals appear to be more elevated in wildlife collected on trap lines near oil sands industrial operations and in downstream environments (PAD), and changes in river otter baculum bone health have been observed in these regions (Thomas et al. 2020).

Amphibians. Oil extraction stressors are known to decrease amphibian populations and declines in oil sands amphibian populations have been observed (Hossack et al. 2018; Alberta Wild Species General Status, 2015). Further, wood frog tadpoles have elevated levels of contaminants in the oil sands region (Mundy et al. 2019). Preliminary modeling using legacy datasets from the OSR indicates that industrial development, such as oil sands development, are correlated with lower Canadian toad abundance (https://abmi.ca/home/data-analytics/biobrowser-home/species-profile?tsn=773521).

Plants. Berries collected near upgraders and open pit mines were shown to have a greater abundance of dust-supplied trace elements, including lead, aluminium, and uranium, on their outer surfaces, relative to berries collected outside of the oil sands region (Stachiw et al., 2019).

Mosses and Lichens. Lichens and mosses have been used extensively as biomonitors to assess patterns of oil sands related contaminants (e.g., review by Davidson et al. 2020). In addition to being excellent proven biomonitors and pathway indicators (e.g, Landis et al. 2019, Wieder et al. 2021), epiphytic lichen communities have been shown to shift within 5 km of OS and sour gas facilities in Alberta (Wiley 1978, Case 1985, Berryman et al. 2004). Berryman et al. (2004) observed that "shrubby lichens that are sensitive to air pollution were less abundant at sites closer to the mining operations. These shrubby lichens were often dwarfed and showed signs of stress when found growing in stands near mining operations".

Soil Health. Oil sands activities have shown to elevate contaminants in soils, including trace metals and parent & alkylated PAHs, and in some cases exceeding the set environmental guidelines for soil health (Boutin and Carpenter 2017). These elevated concentrations have been correlated to differences in soil chemistry (e.g. pH, soil Cation Exchange Capacity) and to the seedbank and above-ground vegetation (Boutin and Carpenter 2017). Currently, little is known about how the below-ground soil community is affected by oil sands related contaminants outside of reclamation or tailing ponds. However, the mite community is expected to be responsive to contaminants, as it generally responds quickly to changes in the soil habitat, even responding before changes can be detected in physical or chemical properties (Garay & Nataf 1982).

LANDSCAPE DISTURBANCE

Many taxa respond to landscape disturbance and habitat alteration, and differences in observed change may depend on the type and character of disturbances (e.g. linear vs. polygonal, small vs. large, vegetated vs. non-vegetated), the habitat preferences of the individual species, or the spatial scale of measurement (Venier et al. 2014; Fisher and Burton 2018; Toews et al. 2018). Briefly:

Landbirds. Statistical analyses and modelling of a number of bird species have identified cumulative effects and many analyses attribute these to specific oil sands (OS) activities, including clear evidence of response to land disturbance (Foster et al. 2017, Wilson et al. 2018), including from wells (Bayne et al. 2016), seismic lines (Bayne et al. 2005, Machtans 2006, Lankau et al. 2013) and other linear features (Ball et al. 2009, Bayne et al. 2016). In general, habitat specialists are more likely to be negatively impacted by anthropogenic disturbances, while habitat generalists are more likely to benefit (Mahon et al. 2019). Footprint mapping coupled with scenario modelling approaches have been used to assess bird population responses to habitat change caused by oil sands and other anthropogenic development (e.g., Mahon et al. 2014).

Mammals. Extensive field monitoring and multi-taxa analyses have linked oil sands industrial activities to changes in the health, behaviour, distribution, populations, and communities of many mammal species, though many specific species responses to specific stressors can vary in direction and magnitude (Fisher & Burton 2018, Toews et al. 2018).

Amphibians. Amphibians are vulnerable to direct and indirect effects of habitat loss and degradation (Alford and Richards, 1999) including sensory disturbance from increased noise levels (Simmons and Narins, 2018). Because they have both aquatic and terrestrial life stages, they can provide early warnings of changes in both types of environments. There is evidence for negative impacts of oil sands activities on amphibian species.

Vascular Plants. Local scale plant species richness is observed to be higher in sites closer to OS development (Boutin and Carpenter 2017; Mao et al. 2018) or near urban and industrial sites (Zhang et al. 2014), or at larger scales, within OS lease boundaries (Mao et al. 2018), likely due to increases in non-native species abundances. Edge effects from disturbance can alter abiotic habitats, even decades post-construction, leading to changes in vegetation condition and community composition (Dabros et al. 2017, Finnegan et al. 2019, Echiverri 2021).

Mosses and Lichens. OS-related habitat loss has a large, mostly negative, impact on this group, with species richness declining with increasing habitat removal/alteration (ABMI 2020), on well pads (Caners and Lieffers 2014, MacIntosh and Haughland, unpub.), and cover and composition affected by linear features such as seismic lines (Dabros et al. 2017, 2021) and roads (Saraswati et al. 2020, Strack et al.

2017).

Soil Health. Analysis of soil indicators (oribatid mites) has shown soil health to be negatively impacted by OS-related landscape disturbance, particularly related to mining and well sites with abundance, species richness, and species diversity impacted. Species richness and diversity also shows a downward trend with soft-linear disturbances (seismic, pipeline/transmission lines) (Lumley et al. 2021).

CUMULATIVE EFFECTS

Assessments of the contribution of oil sands activity in the context of cumulative effects have been partially addressed with existing datasets, more thoroughly for some taxonomic indicator groups than others. Species habitat models that describe relative abundance in response to oil sands disturbance and other stressors have been established with varying degrees of detail for species within all indicator groups. Refinements to achieve more detail are included in the sub-workplans for birds, amphibians, vegetation, and mammal models (details in the sub-workplan attachments).

The BADR EEM design was developed to measure impacts of specific oil sands stressors; it is stratified across key oil sands disturbance types/features in specific habitat types. Currently, joint environmental monitoring (JEM) sites avoid impacts from other industries and control for natural disturbance to the extent possible, to facilitate the separation of oil sands effects via robust statistical approaches.

In the longer term, the BADR EEM design can incorporate multi-stressor sites that include a range of anthropogenic or natural disturbance (e.g. different stand ages result from forest harvest or wildfire) to address specific cumulative effects questions. Future decisions of whether, when, and where to add these sites will be guided by evidence that cumulative effects are key contributors to changes in priority indicators, the magnitude of these changes, and the analytical need for ongoing surveillance or additional data resources to describe source-pathway-receptor relationships.

Geospatial data and analyses that are suitably fit for purpose are critical tools for cumulative effects assessment, including establishing and measuring against baselines, and understanding pathways of effects. Stressor monitoring to date has captured the amount and distribution of oil sands footprint. However, to understand and manage cumulative effects, trends in land surface trajectories with a targeted evaluation of drivers of change are needed at multiple temporal and spatial scales. The human footprint data development proposed here directly supports the assessment of cumulative effects that are already present, enables assessment of the incremental cumulative effects, and improves cumulative effects assessment over time.

* Full citations are listed in the sub-workplan appendix.

2. Are changes in terrestrial ecosystems informing Indigenous key questions and concerns?

Terrestrial biological monitoring occurs across the OSR, and thus overlaps with the traditional territories of multiple Indigenous communities. The data and knowledge generated can provide information on the landscapes and species that Indigenous communities rely on to support their rights to hunt, trap, fish, and gather, and maintain a traditional way of life. Exercising these rights requires: 1) healthy populations of all valued species, including birds, mammals, and vegetation; 2) sufficient quality habitat to support these species into the future; and 3) sufficient land that is safely and freely accessible for Indigenous community members. Footprint and biodiversity monitoring contained in this workplan provides robust data that can inform these three aspects of exercising Treaty rights, and can be enhanced or customized to address local priorities in partnership with communities.

Population monitoring under the BADR EEM design will efficiently and simultaneously collect multi-species data that can be evaluated by Indigenous communities for priority species, such as berries, medicines, furbearers, birds, and their habitats. This information can be summarized and presented using customized approaches and at scales in line with community interests. The monitoring of human footprint enables the assessment of cumulative effects in contexts meaningful to Indigenous communities. Specifically, it can serve as a foundation for assessing the cumulative loss of land and access issues that community members face.

Multiple Indigenous communities are also actively involved in tissue collection to monitor contaminant burdens in the biotic environment, including from harvested mammals. This work directly addresses community concerns over the safety of traditional foods for human consumption.

Engagement, capacity building, and field monitoring partnerships with multiple local Indigenous communities, specifically to identify and pilot opportunities to increase community involvement in data collection, will now occur under a separate 2022-23 workplan submitted to the Terrestrial TAC (workplan number forthcoming). This workplan is scoped and delivered, in consultation with the AU Facilitation Centre, by TBM PIs who are also involved in core terrestrial monitoring activities. Areas of focus with interested communities include capacity building via training on the use of wildlife cameras and autonomous recording units (ARUs), on the collection of animals and tissue samples for wildlife health and contaminants analyses, and on the implementation of vegetation protocols. Consistency of project participants in both the terrestrial core monitoring and ICBM workplans ensures that integration of new ICBM projects based on Western science methods is aligned to the greatest extent possible.

3. Are data produced following OSM Program requirements and provided into the OSM Program data management system?

YES. The TBM Theme is committed to alignment with OSM data requirements as these requirements are developed and distributed. Further, TBM PIs have been and will continue to be active with respect to identifying and utilising cross-party data repositories, with some already well established (e.g., WildTrax). TBM PIs continue to be active collaborators with Service Alberta in the development of the OSM Data Catalogue, providing data asset inventories and feedback on catalogue structures and organisation. The internal SOP for OSM geospatial data management will be used. Additionally, existing standards developed by ECCC and/or Government of Alberta will be considered.

4. Do methodologies use relevant Standard Operating Procedures/ Best Management Practices/ Standard Methods?

YES. Standard Operating Procedures and protocol documents are available for data collection, management, and analysis. Many of these have been developed and established by the various project PIs themselves; some have been carried over or adopted from well-established international monitoring programs. The specific field and geospatial monitoring methodologies used represent the most up-to-date monitoring methods available for biological data collections. The proposed work combines state-of-the-art field methodologies (e.g., remote camera arrays, autonomous recording units) and other long-proven approaches (e.g., mark-recapture surveys, vegetation quadrats) within a newly developed adaptive monitoring design to establish a standard methodology for terrestrial environmental monitoring in the oil sands region. Many of these survey methodologies are used in complementary monitoring programs, including site-specific monitoring conducted by industry, allowing for future interoperability and pooling of data.

5. How does the monitoring identify integration amongst projects, themes or with communities?

This workplan integrates all of TBM's activities into a single, cohesive program that follows the BADR EEM framework. Integration is a foundational principle of TBM work, and is occurring in the following ways:

Within the TBM team:

- Data collection is aligned under a unified monitoring design (BADR) grounded in the OSM conceptual model, and aligned within the EEM paradigm;
- Data collection protocols are integrated and co-delivered, where feasible and sensible, to maximise efficiency across the TBM team;
- Data collection is co-located at Joint Environmental Monitoring sites when feasible;
- Analytical efforts are collaborative or divided based on strengths of team members within the sub-workplan groups; and
- Housing data in shared repositories and managing data in common data platforms (e.g. WildTrax), including the integration of geospatial data pipelines, analysis, and co-deliverables both within TBM and

across the various OSM theme areas.

With other Themes:

- Collaborative deliverables with the Wetland Theme on analysis and monitoring design and ongoing discussions about protocol integration;
- Collaboration with the Air & Deposition Monitoring Theme on the use of lichens and other passive sampling techniques for contaminants monitoring; and
- Continued effort on scoping joint areas of work with the Surface Water and Groundwater Themes, including an integrated project to monitor Groundwater Dependent Ecosystems (scoped and proposed in the groundwater workplan GW-LTM-3-2223).
- Continued development of geospatial data products that are both critical to terrestrial monitoring and analyses, but also support monitoring across other theme areas.

With communities and other partners:

- Involvement of local communities in contaminant monitoring of Traditional Resources and with the reporting and outreach activities with the data;
- Engagement camps on indicator development, conceptual models, reporting outcomes, outreach activities, and the development or adaptation of other elements of the monitoring program to enable direct input from Indigenous communities;
- Identifying and building opportunities for Indigenous involvement in data collection; and
- Scoping opportunities to integrate on-site industry data, where available, into regional datasets.
- Generation of publicly available geospatial data and analytical products for use by OSM ICBM projects or other non-OSM community based monitoring efforts.

6. Where does the monitoring fit within the EEM framework and relative to the theme area? How will this work advance transition towards the EEM framework?

There is evidence of change as a result of cumulative effects in a range of terrestrial taxa at multiple scales. The BADR EEM design was specifically developed to more fully examine the magnitude of these and other observed changes in indicators in response to a gradient of oil sands disturbance. In an adaptive process, BADR EEM allows for stronger attribution of change and finer resolution in understanding of linkages between change and specific oil sands activities.

The BADR EEM design is adaptive, in that sampling can be adjusted in the future at either the landscape or the local scale to target data collection based on monitoring outcomes. This allows us to adapt monitoring to where it is most needed to capture information required to assess ongoing surveillance, develop focused studies, and/or implement investigation of cause. By aligning monitoring of various stressor-pathway-response linkages in time and space, questions related to identification of cause and cumulative effects can be better addressed in a more efficient and economical manner.

A major phase of work in 2022-23 will be to continue building the adaptive nature of the BADR EEM design. This will focus largely on the identification of baselines and monitoring triggers for priority indicators, which will include:
- Initiating a process of indicator selection based on sensitivity to different oil sands activities, where sufficient data are available.
- Using a review completed in 2021/22 of existing options to develop a TBM framework for identifying baselines and monitoring triggers for priority indicators.
- Testing the implementation of the framework through application to priority indicators with sufficient data to identify challenges and improvements.
- Engaging key stakeholders as part of these processes to ensure awareness and solicit input and feedback.

7. Where does the monitoring fit on the conceptual model for the theme area and relative to the conceptual model for the OSM Program? How will this work advance understanding of the conceptual model?

Terrestrial biological indicators are captured in several components of the conceptual model. Physical disturbance stressors, and valued components related to biodiversity and healthy ecosystems are explicitly listed. The conceptual model is fundamental to integration because it provides a consistent framework for all monitoring within and among OSM Themes. This TBM workplan uses the conceptual model to:

- Prioritize key linkages with oil sands-related stressors which have the potential to affect indicators at local, sub-regional and/or regional scales over various time scales;
- Ensure that monitoring addresses complete linkages across the model from stressors through pathways to responses which, in turn, affect the indicators;
- Assist in identifying linkages which may contribute to cumulative effects of multiple stressors or cumulative effects of individual stressors distributed across various spatial scales;
- Provide clarity regarding the required points of integration with other OSM Themes (e.g, connecting work on atmospheric deposition with TBM work on responses in vegetation and wildlife); and
- Explicitly illustrate the linkages to the three Indigenous Valued Components.

The TBM Theme has prioritized the stressor-pathway-response linkages as identified in the conceptual model (see Appendix 2) through a qualitative examination of risk completed collaboratively by the TAC and principal investigators. The proposed BADR EEM monitoring design is engineered to assess multiple indicators of stressors, pathways and responses at multiple scales and across multiple combinations of stressor intensity. The indicators focus on the stressor-response pathways from landscape disturbance on biodiversity through direct and indirect effects. Contaminant exposure pathways are also addressed for birds, mammals, and amphibians; and the rare habitats program under the landbird subworkplan addresses pathways from the surface water diversion stressor. Over the long-term, BADR EEM provides a design that will be able to detect changes due to climate change by ensuring sampling takes place in reference areas along latitudinal and longitudinal gradients.

See Appendix 2 – Conceptual Model and Indicators (202223_supp02_IntegratedTerrestrialBiologicalMonitoring_RobertsDavid.docx)

8. Is the work plan contributing to Programmatic State of Environment Reporting?

YES. Data and information to be generated from the proposed workplan can be incorporated into OSM State of Environment (SoE) Reporting. For the first iteration (2020/21) of the SoE report, TBM PIs provided content on the various indicators that have historically been monitored and reported against. Given the adoption of an adaptive monitoring framework for the OSM program, SoE reporting will necessarily adjust as workplan priorities evolve. A description of the fundamentals of the BADR EEM design, as presented in Bayne et al. 2020, and how it addresses OSM priorities, associated knowledge gaps, as well as the investigation of cause of changes in the terrestrial biological environment, could also be a valuable addition to the SoE report going forward.

3.3.6 Cross-Cutting Across Theme Areas

3.3.6.1 Sub Themes:

Choose an item.

If "Other" was selected from the drop down list above please describe below:

Click or tap here to enter text.

3.3.6.2 Cross-Cutting - Key Questions

Explain how your cross-cutting monitoring program addresses the key questions below.

1. Is data produced following OSM Program requirements and provided into the OSM Program data management system?

Click or tap here to enter text.

2. Do methodologies use relevant Standard Operating Procedures/ Best Management Practices/ Standard Methods?

Click or tap here to enter text.

3. How does the monitoring identify integration amongst projects, themes or with communities?

Click or tap here to enter text.

4. Where does the monitoring fit within the EEM framework and relative to the theme area? How will this work advance transition towards the EEM framework?

Click or tap here to enter text.

5. Where does the monitoring fit on the conceptual model for the theme area and relative to the conceptual model for the OSM Program? How will this work advance understanding of the conceptual model?

Click or tap here to enter text.

6. Is the work plan contributing to Programmatic State of Environment Reporting?

Click or tap here to enter text.

4.0 Mitigation

Evaluation of Mitigation Criteria (Information Box Only- No action required)
Your workplan will be evaluated against the criteria below. A successful workplan would potentially inform:

- efficacy of an existing regulation or policy
- an EPEA approval condition
- a regional framework (i.e., LARP)
- an emerging issue

Explain how your monitoring program informs management, policy and regulatory compliance. As relevant give consideration for the EEM framework and the approved Key Questions.

The major recurring terrestrial approval conditions that appear in most of the mining EPEA deemed compliance documents, and that fall within the scope of OSM, include:

1. Long-term monitoring of cumulative effects on biodiversity and wildlife;
2. Long-term monitoring of species at risk; and
3. Analysis & collection of regional data to validate Habitat Suitability Index (HSI) models.

1 - LONG-TERM MONITORING OF CUMULATIVE EFFECTS ON BIODIVERSITY AND WILDLIFE

Regional monitoring of biodiversity is a required activity for oil sands operators under EPEA approval conditions. The exact wording of this requirement varies across operators but generally refers to the requirement to monitor the long-term cumulative effects on biodiversity and wildlife. In some cases, these conditions make reference to specific programs or organizations such as ABMI and the former Ecological Monitoring Committee for the Lower Athabasca (EMCLA). The TBM component of OSM is the activity which facilitates compliance with these clauses. In other cases, the approval-holder is to select appropriate monitoring methods and actions and demonstrate that these are adequate, and in these instances, data produced in TBM programs (e.g., MAPS, regional yellow rail monitoring) may fulfil the requirements. The BADR EEM design will contribute scientific information with which to judge the efficacy of existing regulations and compliance with approvals as they apply to "beyond the fence line" responses to oil sands stressors at local, sub-regional and regional scales.

2 - LONG-TERM MONITORING OF SPECIES AT RISK

In addition, TBM monitoring either directly fulfils or provides relevant information to other, more specific clauses. These include long term species at risk monitoring programs, in particular for at-risk bird species such as whooping crane, yellow rail, Canada warbler and others. The bird monitoring component of this workplan provides data for several provincially listed species, including demographics for species monitored within the MAPS program.

3 - REGIONAL DATA TO VALIDATE HABITAT SUITABILITY INDEX (HSI) MODELS

Data collected under the TBM workplan to date have been used to generate multiple species-habitat models which are available at the regional scale. These models have applications for HSI clause requirements. They could be used to build maps for specific areas of concern, and for comparison with site-specific models to determine the appropriateness of a regional approach to model construction. We have models for hundreds of species regionally and provincially. In some cases, these models have been validated by using them to more efficiently find new locations where the species are present vs. absent (i.e. yellow rail, Canadian toad). Most importantly, these models are built from existing data and can be used to adaptively change our sampling design to identify the habitat conditions for which we need additional information versus those habitats and species we understand well.

OTHER LINKS TO MANAGEMENT AND REGULATORY COMPLIANCE

In addition to these three areas related to regulatory compliance, TBM outcomes will provide an understanding of the effects of oil sands land disturbance, by type, on a range of indicators. These results will have implications for company management programs and regulatory agency policy decisions such as industry environmental management procedures, regulatory limits on disturbance, disturbance-buffer selection, and restoration management requirements.

The protocols used by TBM are also used by other research and monitoring groups funded by forestry companies. This expands the ability to develop and validate HSI models at a regional scale, bringing in data from parallel programs to expand the scope of questions and analyses that can be conducted in support of indicator responses to regional stresses, at a cumulative effects scale. For example, landbird use of well pads can be compared to use of harvest blocks to provide an alternative reference comparison related to time since disturbance, using data collected in collaboration with numerous forestry companies in Alberta.

The BADR EEM design incorporates spatial stratification based on land use, allowing the monitoring to contribute directly relevant information to regional frameworks such as LARP regarding observed changes in response to oil sands stressors and cumulative effects.

Industry makes a significant investment each year in "within the fence line" wildlife monitoring and mitigation planning, often using the same or similar data collection techniques to TBM, such as MAPS, wildlife cameras, and acoustic surveys. Operators often also hold information on detailed land use and management decisions that occur within site boundaries. These data have the potential to contribute to regional monitoring efforts and help better inform the pathways of biodiversity change. TBM is interested in exploring integration with this and other available industry-operated programs and datasets.

5.0 Indigenous Issues

Evaluation of Indigenous Issues Criteria (Information Box Only- No action required)
Your workplan will be evaluated against the criteria below. A successful workplan would potentially:

- Investigate Indigenous communities key questions and concerns
- Includes culturally relevant receptor(s) and indicator(s)
- Include or be driven by Indigenous communities (participatory or collaborative)
- Develop capacity in Indigenous communities
- Include a Council Resolution or Letter of Support from one or more Indigenous communities
- Describe how ethics protocols and best practices regarding involvement of Indigenous peoples will be adhered to
- Provide information on how Indigenous Knowledge will be collected, interpreted, validated, and used in a way that meets community Indigenous Knowledge protocols

Explain how your monitoring activities are inclusive and respond to Indigenous key questions and concerns and inform the ability to understand impacts on concerns and inform Section 35 Rights

This workplan addresses, to a limited extent, whether changes in terrestrial ecosystems inform Indigenous concerns and Section 35 rights. Monitoring of contaminants in traditional foods informs the safety of foods for human consumption and relies on Indigenous involvement for delivery. Section 35 rights also require sustainable populations of plants and animals in critical local areas of harvest, as well as physical access for communities to traditional use areas. Data collected under this workplan can inform these issues by providing information on status and change of harvested species in spatially-explicit formats.

Integrated ICBM workplans within the core monitoring workplan were not offered as an option during this 2022-23 workplanning cycle. Indigenous communities interested in TBM work have submitted Expressions of Interest to the ICBMAC, and will be developing stand-alone workplans. Ongoing engagement with Indigenous communities is required on a long-term basis to ensure alignment between the BADR EEM monitoring framework and ICBM workplans based on western science methods. For 2022-23, engagement efforts have been scoped, in collaboration with the AU Facilitation Centre, with a number of communities in a separate ICBM workplan submitted to the TBM TAC. We expect many of these efforts will span multiple years and will inform protocols and approaches for future CBM work.

Does this project include an Integrated Community Based Monitoring Component?

Yes

6.0 Measuring Change

Evaluation of Measuring Change Criteria (Information Box Only- No action required)
Your workplan will be evaluated against the criteria below. A successful workplan would potentially:

- assess changes in environmental conditions compared to baseline (e.g., validation of EIA predictions)
- report uncertainty in estimates and monitoring is of sufficient power to detect change due to oil sands development on reasonable temporal or spatial scales
- include indicators along the spectrum of response (e.g., individual, population, community)
- focus on areas of highest risk (where change is detected, where change is greater than expected, where development is expected to expand (collection of baseline)
- measure change along a stressor gradient or a stressor/reference comparison

Explain how your monitoring identifies environmental changes and can be assessed against a baseline condition. As relevant give consideration for the EEM framework and the approved Key Questions.

The BADR EEM design identifies environmental change attributable to oil sands activity against a reference or baseline condition. It achieves this by:

1. Using ecologically relevant spatial units that align with other TACs;
2. Examining environmental response along stressor gradients at various spatial scales;
3. Including reference/baseline sampling units in both space and time;
4. Including ecologically relevant indicators at the individual, population, and community level;
5. Incorporating areas of planned oil sands expansions; and
6. Producing results which can be used for model validation and forecasting purposes.

This approach requires both on the ground data collection related to terrestrial biological response indicators combined with up to date, detailed footprint and habitat monitoring in order to implement a meaningful and robust monitoring program.

BADR EEM BASICS

Details on the approach used under the BADR EEM design are provided in Bayne et al. 2020. The two key elements of this design that contribute to measuring change against a baseline are:

1. Before-After: Monitoring at different phases of oil sands development (before and after development occurs); and
2. Dose-Response: Monitoring along a gradient of current oil sands disturbance (high to low).

Both of these elements require highly detailed stressor monitoring across time and space as the foundation for the program design.

MEASURING CHANGE ALONG STRESSOR GRADIENTS

Habitat loss is a known outcome of oil sands development. The BADR EEM framework is designed to assess whether any observed change is greater in magnitude than expected from habitat loss alone. This effectively tests for functional habitat loss due to fragmentation, edge effects, avoidance of light/noise, contamination, etc. Within the EEM framework, this determination of "is a change expected or observed?" drives whether such observations necessitate focused monitoring / investigation of cause (if the source of the change needs to be determined), or whether monitoring returns to a surveillance approach (if the change is expected). The dose-response used under the BADR EEM design ensures balanced sampling of individual stressors and combinations of stressors (i.e., cumulative effects). This is achieved by targeting monitoring along a gradient of spatially-defined disturbance strata:

1. Control: a site with low energy sector disturbance;
2. Soft linear: a site with high density of seismic lines, pipelines, etc.;
3. Road: a site with high density of energy sector roads;
4. Low activity: a site with energy sector disturbance without light or noise impacts (e.g., exploration well pads);
5. High intensity: sites with high intensity disturbances (varying combinations of high human activity, light, noise and atmospheric deposition).

Adding contaminants, including from aerial deposition, on top of the spatially-defined disturbance strata allows cumulative effects and the relative influence of different stressors to be investigated.

ASSESSING CHANGE AGAINST BASELINE

Observed data quantifying pre-disturbance condition in the oil sands region does not exist for most priority indicators, necessitating either a space-for-time substitution or back-cast modelling approach to assessing change against baseline based on habitat models or based on emission backcasting approaches or historical contaminants release reporting. We note that Indigenous Knowledge should play an important role in defining baseline conditions over time (see Section 10.4).

Historically, western science biological monitoring in the oil sands region has defined terrestrial biological baseline as the ecological conditions present, or those that would be present, in the absence of human footprint. This was typically calculated by (1) monitoring sites free from human footprint; (2) empirically predicting landscape habitat conditions if footprint was not present; and (3) completion of multi-indicator surveys at random, systematic sites throughout the entire OSR. The field effort of ABMI's systematic grid is now complete and in combination with collated data from other research and monitoring has resulted in baseline species-habitat models for multiple species groups that should be validated and/or improved by adaptive sampling in areas with higher model uncertainty.

The BADR EEM framework further develops baseline specific to oil sands footprint (and different types of oil sands footprint) by monitoring along a gradient of oil sands stressors in three contexts:

1. Landscape units where oil sands development (surface mining and in-situ) is already extensive, providing the high end of a dose-response gradient and contaminant loads;
2. Landscape units where oil sands exploration has occurred, but development has not yet occurred, providing (in short term) both the middle of the dose-response gradient and (in long term if developed) validation of dose-response models by confirming biodiversity changes over time as development proceeds; and
3. Landscape units where oil sands activities are minimal and unlikely to occur in the future, providing controls to observe any changes associated with non-oil sands pressures such as climate change, extra-regional effects, forest fire, forest harvest, etc.

Dose-response models developed from such data can also be used in backcasting and forecasting what biodiversity looked like in the past or might be under future development scenarios based on the availability of habitat or emission modeling at different time periods; numerous examples of such models exist for areas within the OSR (see Leston et. al. 2020). Such models can be used to assess the range of natural variability in relation to natural disturbances like fire and hydrological cycles. By combining data collected under the BADR EEM design with historical datasets, we will further improve habitat models for use in backcasting and forecasting scenarios to estimate the magnitude of change based on known species-habitat relationships. Data from future field collections can be compared to these forecast triggers to monitor for unexpected change, magnitude of change, or when development is reaching a point where an ecological threshold is being reached (i.e. the number of individuals of a species based on habitat models and/or trend estimates reach a minimum acceptable level).

STATISTICALLY DRIVEN CHANGE DETECTION

Effect size is a statistical concept that measures the strength of the relationship between stressors and responses. Effect size, statistical power, sample size, and critical significance are essential components of the BADR EEM design. In other words, sampling must be designed so that there is sufficient confidence that we can detect a change from baseline, analyse correlations between oil sands stressors and responses, report measured exceedances of critical significance levels, and produce validated model predictions of exceedances of critical significance levels. Sensitivity analyses are used under the BADR EEM design to determine the level of monitoring effort required to confidently detect change. These analyses are used to identify the most efficient approach to return interval and replicates for monitoring.

For most taxa, we have an emerging understanding of spatial variation but need more information on spatial and inter-annual variation in order to attribute stressor-induced effects. This year's data collection will contribute substantially to the overall approach and will fill some known gaps in monitoring on oil and gas-related footprint in space and time. Future monitoring plans will take into account all data collected to date along with recommendations arising from the sensitivity analysis. The flexibility of the BADR EEM design allows for year to year changes while incorporating all data collected previously under the design.

CONTROLLING FOR CONFOUNDING FACTORS

The BADR EEM design minimizes the impacts of potential confounding factors though habitat and disturbance stratification (Bayne et al. 2020). Stratification of this nature controls for unwanted sources of variation which could impact our ability to detect change due to oil sands activity. Habitat and disturbance stratification are both adaptive elements of BADR EEM in that the habitat types and disturbance types targeted can be adapted over time to adjust to new information and needs.

For the first phase of BADR EEM, habitat stratification will focus on the two dominant habitat types in the OSR: 1) upland deciduous/mixedwood at least 40 yrs old, and 2) treed lowlands at least 20 yrs old. These two habitat types represent groupings of finer habitat and age types that are common across the majority of the oil sands region. Both these habitat strata have been mapped across the entire OSR. Rare habitats of focus will include 1) graminoid fen/meadow marsh, 2) old-growth forest, 3) shallow open water wetlands, and 4) pine forest. The rare habitats are important components of the biological landscape with limited areas that are home to rare, sensitive, and at-risk species. Where possible, these habitats will be sampled within LUs but may require that we sample more broadly across the entire OSR to ensure sufficient replication to document change and ensure the entire disturbance gradient is sampled.

Groups of similar oil sands features have been identified as a local disturbance gradient and mapped across the OSR into 7 strata. These mapped features are used to select monitoring sites that are stratified by disturbance type, controlling for natural variation, and allowing for predictive scaling up of results from local sites to the regional level.

PREDICTIVE MODELLING

The use of spatially defined disturbance and habitat strata allows us to model responses in un-sampled areas of these strata within each LU and across the broader OSR. We will use observations from monitoring sites as a stratified sample of the LU to make LU-level estimates of effects of oil sands disturbance. The total cover of treatment strata across the OSR will be used to infer the overall regional effect of oil sands disturbance, and how that changes over time. This will allow us to extend the results of the study throughout the OSM region. For instance, the plant buffer treatment may reduce a particular species' abundance by 50%, but if that treatment only covers 1% of that habitat strata in the region, it would relate to only a 0.5% drop in abundance regionally.

In addition, dose-response regression models created from JEM site data can be mapped at larger regional extents to predict the abundance of species at un-sampled locations in order to estimate regional population sizes. This work cannot be initiated until we have at least one year of data collection within the BADR EEM design, and the level of accuracy in these spatial predictions will increase over time as we collect additional data. It is anticipated that multiple years of data collection will be required in order to complete this task.

There is also an opportunity to conduct future scenario modelling to assess the biodiversity outcomes of different development scenarios. A limiting step to this work is access to future development plans which are not publicly available. To advance this work will require access to data for the TBM science team, and strong involvement from relevant partners on approach.

7.0 Accounting for Scale

Evaluation of Accounting for Scale Criteria (Information Box Only- No action required)
Your workplan will be evaluated against the criteria below. A successful workplan would potentially be:

- appropriate to the key question and indicator of interest
- relevant to sub-regional and regional questions
- relevant to organism, population and/or community levels of biological organization
- where modelled results are validated with monitored data
- where monitoring informs on environmental processes that occur at a regional scale. e.g. Characterizing individual sources to gain a regional estimate of acid deposition and understand signal from individual contributing sources.

Explain how your monitoring tracks regional and sub-regional state of the environment, including cumulative effects. As relevant give consideration for the EEM framework and the approved Key Questions.

RELEVANT MONITORING SCALES

We address two types of scale within the TBM workplan:

1. Scale of ecological organization. Data are collected on individual behaviour and health as well as populations and communities. The details on the selected levels of biological organization are provided in Section 10.5 Indicators.
2. Spatial scale. Monitoring locations were intentionally selected to represent local and regional disturbance, such that program data and analyses provide knowledge relevant to local, landscape, and regional questions, efficiently addressing indicators at several relevant organizational scales (organisms, communities, and populations). The BADR EEM design integrates data across scales and address regional and sub-regional questions by using two levels of disturbance gradient:
   a. First, a regional disturbance gradient is generated by dividing the OSR into watershed or landscape units and assigning them a score based on cumulative oil sands footprint. Sub-sampling occurs across the region to ensure balanced dose-response sampling at the landscape level. Four landscape units will be added to the program in 2022-23 (see the Landscape Unit figure in Appendix 1 Sub-Workplans), with monitoring activity in these and in a subset of LUs incorporated in the program to-date included in the 2022/2023 workplan (e.g., MAPS is an annual program).
   b. Second, within each landscape unit, sites are selected to fill in a local disturbance gradient within each targeted habitat type. This local gradient is a set of spatially mapped disturbance strata which are described in brief under Section 6.0.

The BADR EEM can be adaptively implemented for different taxa to align with biological and logistical variations. For example, different levels of effort, differing habitat targets, and differing sample sizes may be needed for different indicator groups. Details on implementation for different taxa are provided in the sub-workplans. Further details on the BADR EEM design are presented in Bayne et al. 2021.

MODEL VALIDATION

As noted above, species habitat models that describe relative abundance in response to oil sands disturbance and other stressors have been established with varying degrees of detail for species within all indicator groups. Results generated by the BADR EEM design will validate and advance existing predictive models. Within an EEM framework, discrepancies between predicted and observed impacts on indicators (i.e. forecast triggers) may trigger focused monitoring and/or investigation of cause.

8.0 Transparency

Evaluation of Transparency Criteria (Information Box Only- No action required)
Your workplan will be evaluated against the criteria below. A successful workplan would potentially include:

- a plan for dissemination of monitoring data, including appropriate timing, format, and aligns with OSM program data management plan
- demonstrated transparency in past performance
- identified an annual progress report as a deliverable
- reporting of monitoring results occurs at timing and format that is appropriate for recipient audience.

Explain how your monitoring generates data and reporting that is accessible, credible and useful. As relevant give consideration for the EEM framework and the approved Key Questions.

OVERALL

Based on guidance from the OSM Program Office, TBM PIs will prepare raw, QAQC'ed and derived data products generated from this workplan for dissemination through priority venues and platforms, such as the OSM data portal. As part of the process, TBM PIs will confirm the target audience of each product to ensure content is delivered in an appropriate format and with meaningful documentation, to support its active uptake by end users. Data will be made available on an annual basis, although timing may be adjusted based on user input and data processing timelines. TBM PIs will also provide access to these data and information products through their own organizational websites, and guide users to the location of OSM-program related content.

DATA

Currently, many TBM project collaborators (e.g., ABMI, ECCC, OMEI) host and distribute data in a variety of formats via their own publicly accessible repositories and interactive portals, which provide access to a significant accumulated data asset. The TBM team also continues to work with OSM Program staff, AEP geospatial staff and Service Alberta to make data accessible and discoverable in a timely manner through the OSM data portal. Service Alberta is leading discussions on data standards and metadata requirements with TBM PIs to ensure data can be effectively integrated and support OSM data objectives and processes. This includes the Open Geospatial Data Portal, also scoped in the Service Alberta workplan; OSM Data Services Workplan (#D-2-2122).

PUBLICATIONS AND REPORTING

Results generated by this workplan will be compiled, analysed, and shared in multiple formats in order to reach target OSM program audiences. In 2022-23, this will include multiple manuscripts intended for scientific publication, technical reports to advance results of relevance to decision-makers, as well as annual reporting for the TBM program.

PUBLIC DISSEMINATION

Some members of the TBM team have access to expertise in the production of lay language products within their organizations (notably ABMI, ECCC, and OMEI). These organizations will continue to generate content for public release to enhance awareness of the activities and outcomes of the OSM program overall, but also for specific purposes including outreach to communities.

9.0 Efficiency

Evaluation of Efficiency Criteria (Information Box Only- No action required)
Your workplan will be evaluated against the criteria below. A successful workplan would include:

- appropriately addressed a risk-informed allocation of resources
- identified the role and justification for each staff member on the proposed work plan
- identified in-kind and leveraged resources (e.g., resources and approaches are appropriately shared with other OSM projects where possible)
- established partnerships (value-added) and demonstrated examples of coordinated efficiencies (e.g., field, analytical)
- identified co-location of monitoring effort
- demonstrated monitoring activities and information collected are not duplicative
- considered sampling/measurement/methods compatibility to other data sources (e.g., AER)

Explain how your monitoring is integrated with other OSM projects and incorporates community-based participation and/or engagement in proposed monitoring activities. As relevant give consideration for the EEM framework and the approved Key Questions.

The TBM team has made enormous strides on integration within TBM, with other Theme areas, and with Indigenous communities, and will continue to expand on these efforts in the upcoming year. The BADR EEM design integrates all of the monitoring efforts of TBM under a unifying disturbance gradient. The design facilitates co-location of monitoring efforts at nested spatial scales, which further facilitates integrated data analysis for more effective investigation of cause and cumulative effects assessment. Our approach to data collection is integrated at the sub workplan level to maximize efficiency, share resources, and capitalize on the strengths of the individual organizations involved.

Indigenous communities and land users have been involved in wildlife contaminants and toxicology monitoring since the initiation of the JOSM monitoring program in 2012 and continue to be highly integrated into sample and data collection and reporting both individually and through CBMPs. Additional work will be done with interested communities to achieve stronger integration of Indigenous communities within TBM to meet stated deliverables regarding indicator identification, data collection and reporting.

In addition to the collaborations with the Wetlands, Air, and Groundwater theme areas (e.g., exploration of alignment of study design and data collection protocols), the TBM team also has several ongoing, established partnerships outside of OSM, that contribute to the overall value of the OSM program. These include (1) Participation in broader research collaborations such as the Boreal Ecological Recovery Assessment (BERA), Alberta Biodiversity Chairs (ABC) and the Boreal Avian Modelling (BAM) project, (2) Organization-level partnerships with delivery agencies and collaborators that contribute value such as the Royal Alberta Museum, InnoTech Alberta, and the University of Alberta, among numerous other universities, and (3) Industrial 'within fenceline' monitoring programs that align with TBM protocols, supporting industrial environmental management.

10.0 Work Plan Approach/Methods

10.1 List the Key Project Phases and Provide Bullets for Each Major Task under Each Project Phase *

PHASE 1 - Terrestrial monitoring in alignment with adaptive framework using the BADR EEM design

Task 1 - Site selection & logistics planning
- Site selection for upcoming monitoring year(s)
- Site access permissions
- Logistics planning
- Protocol review and finalization

Task 2 - Field data collection
- Timing and methodologies specific to each sub-workplan/indicator

Task 3 - Data management
- Data processing and QAQC
- Working with Service Alberta on data catalogue,
- Compliance with OSM Program data management framework

Cross-cutting/shared deliverables:
- List of monitoring sites
- Data deliverables
- Reporting deliverables

PHASE 2 - Analysis and evaluation of change

Task 1 - Analysis of historical and new data as available
- Ongoing analysis of existing datasets to address identified questions

Task 2- Stressor and habitat monitoring using geospatial approaches
- Surveillance monitoring of stressors
- Forest regeneration monitoring
- Assessing the spatial variability and temporal change in receptors
- Supporting clarification of the ecological pathways that link stressors to receptors

Cross-cutting deliverables:
- Analytical and reporting deliverables
- Human footprint data and reporting deliverables (baseline, sectorization, exploration vs production)
- Habitat monitoring of forest regeneration data and reporting deliverables
- Geospatial data of monthly Leaf Area Index (LAI) data for the Oil Sands Region
- Geospatial data of Vegetation Height data for 2022 condition (Poplar Creek watershed)
- Geospatial data of vegetation greenness and wetness trend over 37 years (Poplar Creek watershed; a reference site)
- OSM Geospatial Data & Analysis Portal: Geospatial technology services and systems support including data assembly in geospatial databases, and web mapping and web services set-up and maintenance

PHASE 3 - Refine TBM's adaptive EEM framework

Task 1 - Baseline and triggers - knowledge and data inventory
- Data assessment/inventory for priority terrestrial indicators
- Gap identification

Task 2 - Baselines and triggers - development for terrestrial indicators
- Baseline and trigger development framework for OS terrestrial indicators
- Develop statistical/empirical baselines and monitoring triggers for a subset of priority terrestrial indicators with adequate data

Cross-cutting/shared deliverables:
- Draft framework for the development of baseline conditions and monitoring triggers (where possible) for priority terrestrial biological indicators using the outcomes of the literature review completed in 2021/22 and through engagement of the TAC and PIs, as jointly determined.

PHASE 4 - Evaluation and Scoping

Task 1 - Evaluation and refinement of the adaptive BADR EEM design
- Identify successes and challenges from field monitoring

Task 2 - Integrated planning for 2023-2024
- Adjustments to monitoring design (if necessary)
- Collaborative site selection for 2023-2024 monitoring
- Validation of calculated baselines with new field data

Cross-cutting/shared deliverables:
- Annual report, including assessment of BADR EEM transition year 1
- Proposed sites for 2023-2024 field monitoring

10.2 Describe how changes in environmental Condition will be assessed *

Changes in environmental conditions will be assessed along multi-stressor gradients which include reference conditions. Multiple analytical tools will be used to assess the results, including key tools such as regression and multivariate analysis. The main assessment approach of BADR EEM will be the use of dose-response curves, which plot environmental response against an increasing gradient of oil sands disturbance. Such models will be used to assess how species are likely to change in the future to assess risk (see Section 6.0); however this work cannot be initiated until we have sufficient data collection. Similarly, the data will be used in conjunction with ongoing efforts to understand the natural range of variation caused by natural disturbances, such as fire, through academic partnerships (e.g., the Boreal Avian Modelling project; BAM) and through the Alberta Land-Use Framework planning process.

10.3 Are There Benchmarks Being Used to Assess Changes in Environmental Condition? If So, Please Describe, If Not, State "NONE" *

The proposed terrestrial monitoring design includes monitoring in low-impact areas to establish a comparative reference condition against which to assess monitoring data from higher stress regions and locations. Implementation of the design will include consideration of effect size (i.e., what constitutes a significant change from reference) and the sample sizes needed to detect the effect size within a specified degree of confidence. Resources will be dedicated this fiscal year towards developing and testing approaches to baseline and trigger development for priority indicators. Engagement of key stakeholders will be completed as part of these processes to ensure awareness and solicit input and feedback from all OSM caucuses.

(e.g., objectives, tiers, triggers, limits, reference conditions, thresholds, etc.)

10.4 Provide a Brief Description of the Western Science or Community-Based Monitoring Indigenous Community-Based Monitoring Methods by Project Phase *

PHASE 1 - Terrestrial monitoring in alignment with adaptive framework using the BADR EEM design

- Most field monitoring and data analysis will be implemented as described in the BADR framework (Bayne et al. 2020), which represents a western science approach, including standardized data collection protocols using remote sensing, wildlife cameras, autonomous recording units, quadrat sampling, mist netting, contaminant passive samplers, and tissue samples. Details are provided in the indicator descriptions in Section 10.5.
- Indigenous community involvement in the collection of animal and tissue samples for contaminant analysis, and in the use of wildlife cameras and acoustic recording units for population monitoring.

PHASE 2 - Analysis and evaluation of change

- Geospatial approaches, including remote sensing and various spatial analyses, will be employed in the development of landscape-level stressor data.
- A number of quantitative statistical approaches will be employed across the team of PIs, such as species-habitat modelling, regression modelling, and multivariate analysis.

PHASE 3 - Refine TBM's adaptive monitoring (AM) framework

- Western science methods for knowledge and data inventory (systematic or comprehensive review of peer-reviewed and other grey literature).
- Western science (statistical/quantitative/modelling) approaches to guide baseline and trigger development.
- Workshops and questionnaires to gather Indigenous input and perspectives on the development of Indigenous-led indicators, baselines, and triggers.

PHASE 4 - Evaluation and Scoping

- Western science evaluation of BADR including approaches such as sensitivity analyses, community analysis, trigger development, and literature review.

10.5 List the Key Indicators Measured, If Not Applicable, State N/A *

See Appendix 2 – Indicators
202223_supp02_IntegratedTerrestrialBiologicalMonitoring_RobertsDavid.docx

11.0 Knowledge Translation

In the space below, please provide the following:

- *Describe the plan for knowledge transfer and distribution of learnings from the project. This could include workshops, publications, best practice documentation, marketing plan, etc.*
- *Demonstrate that the knowledge transfer plan is appropriate for the intended end-users.*

There are a number of end-users of TBM monitoring data and information products, including members of the oil sands industry, the Governments of Alberta and Canada, Indigenous communities, and the general public. OSM program participating organizations also utilize program data and information to adjust annual workplans under an adaptive monitoring framework. To ensure that data and information effectively reach the intended end-users and are used to meet their own needs, appropriate knowledge translation tactics will be employed. These include:

FOR THE WESTERN SCIENTIFIC COMMUNITY

To mobilize TBM monitoring results, PIs constantly prepare and release conference and workshop presentations, technical reports, and peer-reviewed publications. Data will become available, as per the OSM Program data management framework, via Service Alberta's Data Catalogue, as well as via individual agency/institution websites (e.g., ABMI, WBEA).

FOR THE GENERAL PUBLIC

The TBM team will provide materials and products in support of the OSM program-level communications plan and/or in response to direct requests from the OSM Program Office. TBM PIs will develop lay summaries of monitoring findings and results as part of required program annual reporting, and for use as website content, if requested. When feasible and with OSM program oversight, monitoring activities and outcomes will be communicated in public-friendly formats such as blogs, social media, and multimedia reports. These formats support deeper engagement and appreciation of the OSM program goals and objectives, and findings. Individual agency/institution websites will also host this content to further share TBM program results.

FOR INDIGENOUS COMMUNITIES

Many on the TBM team are already involved in the development and implementation of Indigenous community-based monitoring programs, as scoped in the 2021/22 TBM workplan. Efforts in 2022/23 will focus on continued development of existing ICBM projects (e.g. with Beaver Lake FN, Chipewyan Prairie FN) as well as supporting the development and integration of monitoring work by new communities, in collaboration with the ICBMAC and the AU Facilitation Centre, both of whom we are already working with for this workplanning cycle. This work is scoped in detail in a separate 2022/23 workplan "202223_TBM Integrated ICBM_RobertsDavid".

FOR INDUSTRY AND THE REGULATOR

TBMI PIs are keen to deliver data and information to industry members that can inform their own operational activities in the OSR. Currently, TBM activities generate data and information that can support land management decision making, such as: species distributions, locations of rare habitats, and the current status of species and habitats, indicating those that are predicted to have decreased or increased abundance relative to reference conditions. Furthermore, TBM activities and data satisfy various regional-scale approval conditions. Data derived from this 'outside fenceline' monitoring activities can be compared and contrasted against data collected from 'within fenceline' monitoring activities to identify biodiversity risks and management opportunities. As data accrues from implementation of the BADR EEM design, TBM PIs will work with the appropriate parties (industry representatives or associations, such as COSIA) to develop additional products and tools that meet industry needs. As we collect data using the BADR EEM design, we will also generate predictive models to assess foreseeable risks and opportunities for biodiversity (See Section 6.0).

FOR GOVERNMENT

Data collected under TBM has multiple potential applications to government, including providing information on species at risk, status of species and habitats that can inform regional land use plans, and baselines/ranges of natural variation to support policy development around thresholds and/or triggers. Data are provided to government branches as requested, but also through established mechanisms including online data portals, peer-reviewed publications, and technical papers.

FOR THE TECHNICAL ADVISORY COMMITTEE (TAC)

We propose regular engagement of the TBM TAC, focused on the ongoing development and testing of approaches to identifying baselines and monitoring triggers for priority TBM indicators. The TAC Terms of Reference identifies that the TBM TAC has a leadership role to play in the development of technical design and reporting. This meeting will help ensure their guidance is captured and reflected in associated deliverables.

12.0 External Partners

List by project or project phase each component that will be delivered by an external party (including analytical laboratories) and name the party. Describe and name the associate work plan/grant/contract for these services. * state none if not required

CROSS-CUTTING
- Alberta Biodiversity Monitoring Institute (ABMI) - Existing grant (#22GRRSD07)
- InnoTech Alberta - Existing grant (#22GRSSD25)

AMPHIBIANS
- Environment and Climate Change Canada (ECCC Pauli) - No grant or contract required

COLONIAL WATERBIRDS
- Environment and Climate Change Canada (ECCC Pauli) - No grant or contract required

LANDBIRDS
- Bayne Lab at the University of Alberta (UofA Bayne)- Existing grant (#22GRRSD18)
- Owl Moon Environmental Inc. (OMEI) - Existing multi-year contract (#20AEM853)
- Alberta Biodiversity Monitoring Institute (ABMI) - Existing grant (#22GRRSD07)
- Environment and Climate Change Canada (ECCC Toms) - No grant or contract required

MAMMALS
- University of Victoria (UVic Fisher) - Existing grant (#22GRRSD16)
- Alberta Biodiversity Monitoring Institute (ABMI) - Existing grant (#22GRRSD07)
- Environment and Climate Change Canada (ECCC Thomas) - No grant or contract required

VEGETATION & SOIL HEALTH
- Nielsen Lab at the University of Alberta (UofA Nielsen) - Existing grant (#22GRRSD17)
- Alberta Biodiversity Monitoring Institute (ABMI) - Existing grant (#22GRRSD07)

*To ensure complete work plan proposal submission, all grants and contracts listed in this section should also be captured in Grants & Contracts.

13.0 Data Sharing and Data Management

For 2022-23 the following approach will be taken by the OSM Program related to data sharing.

For all work plans of a **western science** nature funded under the OSM Program, data sharing is a condition of funding and must align with the principle of **"Open by Default"**. In this case, all data is to be shared with the OSM Program as directed by the OSM Program Data Management work plan.

For all work plans involving **Indigenous Knowledge** as defined below and funded under the OSM Program, data sharing is a condition of funding and the Indigenous Knowledge components of the work plan must align with the principle of **"Protected by Default".** In this case, all data as defined as Indigenous Knowledge, are to be retained by the Indigenous community to which the Indigenous Knowledge is held.

Indigenous Knowledge is defined as:

"The knowledge held by First Nations, Inuit and Métis peoples, the Aboriginal peoples of Canada. Traditional knowledge is specific to place, usually transmitted orally, and rooted in the experience of multiple generations. It is determined by an Aboriginal community's land, environment, region, culture and language. Traditional knowledge is usually described by Aboriginal peoples as holistic, involving body, mind, feelings and spirit. Knowledge may be expressed in symbols, arts, ceremonial and everyday practices, narratives and, especially, in relationships. The word tradition is not necessarily synonymous with old. Traditional knowledge is held collectively by all members of a community, although some members may have particular responsibility for its transmission. It includes preserved knowledge created by, and received from, past generations and innovations and new knowledge transmitted to subsequent generations. In international or scholarly discourse, the terms traditional knowledge and Indigenous knowledge are sometimes used interchangeably."

This definition was taken from the Canadian Government's Tri-council Policy Statement for Ethical Research involving Humans (Chapter 9, pg. 113) and is an interim definition specific to the Oil Sands Monitoring Program.

Data Sharing and Data Management Continued

13.1 Has there, or will there be, a Data Sharing Agreement established through this Project? *

NO

13.2 Type of Quantitative Data Variables:

Both

13.3 Frequency of Collection:

Other

13.4 Estimated Data Collection Start Date:

2021-04-01

13.5 Estimated Data Collection End Date:

2022-03-31

13.6 Estimated Timeline For Upload Start Date:

2022-09-01

13.7 Estimated Timeline For Upload End Date:

2022-12-31

13.8 Will the data Include traditional knowledge as defined by and provided by an Indigenous representative, Community or Organization?

YES

TABLE 13.9 Please describe below the Location of Data and Data Type:

Add a Data Source by clicking on the table and then clicking on the blue "+" symbol on the bottom right side of table

Name of Dataset	Location of Dataset (E.g.: Path, Website, Database, etc.)	Data File Formats (E.g.: csv, txt, API, accdb, xlsx, etc.)	Security Classification
SEE SUPPLEMENTARY FILE 4 for data descriptions	Click or tap here to enter text.	Click or tap here to enter text.	Choose an item.

14.0 2022/23 Deliverables

Add an additional deliverable by clicking on the table and then clicking on the blue "+" symbol on the bottom right side of table.

Type of Deliverable	Delivery Date	Description
Choose an item.	Choose an item.	SEE SUPPLEMENTARY FILE 5 for deliverables and descriptions

15.0 Project Team & Partners

In the space below please provide information on the following:

- *Describe key members of the project team, including roles, responsibilities and expertise relevant to the proposed project.*
- *Describe the competency of this team to complete the project.*
- *Identify any personnel or expertise gaps for successful completion of the project relative to the OSM Program mandate and discuss how these gaps will be addressed.*
- *Describe the project management approach and the management structure.*

See SUPPLEMENTARY FILLE #6 for complete list of personnel by sub-project and partner organization.

16.0 Project Human Resources & Financing

Section 16.1 Human Resource Estimates

Building off of the competencies listed in the previous section, please complete the table below. Add additional rows as necessary. This table must include **ALL staff involved** in the project, their role and the % of that staff's time allocated to this work plan. The AEP calculated amount is based on an estimate of $120,000/year for FTEs. This number cannot be changed. The OSM program recognizes that this is an estimate.

Table 16.1.1 AEP

Add an additional AEP Staff member by clicking on the table and then clicking on the blue "+" symbol on the bottom right side of table. The total FTE (Full Time Equivalent) is Auto Summed (in Table 16.2.1) and converted to a dollar amount.

Name (Last, First)	Role	% Time Allocated to Project
Roberts, David	Workplan Lead / Analytical Science	100%
Geospatial Scientist	Stressor Monitoring / Geospatial Science Support	25%

Table 16.1.2 ECCC

Add an additional ECCC Staff member by clicking on the table and then clicking on the blue "+" symbol on the bottom right side of table. The total FTE (Full Time Equivalent) is Auto Summed in Table 16.2.2

Name (Last, First)	Role	% Time Allocated to Project
Mundy, Lukas	Amphibians: Field and technical lead	60%
Pauli, Bruce	Amphibians: Principal Investigator	50%
Freemark, Maureen	Amphibians: Project oversight, technical suport, liaison with OSM	50%
Hebert, Craig	Colonial Waterbirds: Principal Investigator	75%
Chételat, John	Colonial Waterbirds: research scientist, metals	50%

Dolgova, Svetlana	Field support, sample preparation and analysis	100%
McClelland, Christine	Field support, sample preparation and analysis	100%
Technician TBD	Colonial Waterbirds: sample processing, analyses	100%
Technician TBD	Colonial Waterbirds: sample processing, analyses	100%
Technician TBD	Mammals: sample processing, analyses	100%
Technician TBD	Mammals: sample processing, analyses	100%
Technician TBD	Mammals: sample processing, analyses	100%
Thomas, Philippe	Hunter/Trapper Mammals: Principal Investigator	75%
Toms, Judith	Landbirds: Analysis of existing data	15%
Ball, Jeff	Landbirds: Project oversight	5%
Technician TBD	Landbirds: Support for Toms & her work	50%

The tables below are the financial tables for Alberta Environment & Parks (AEP) and Environment & Climate Change Canada. All work plans under the OSM Program require either a government lead or a government coordinator.

Section 16.2 Financing

The OSM Program recognizes that many of these submissions are a result of joint effort and monitoring initiatives. A detailed "PROJECT FINANCE BREAKDOWN" must be provided using the Project Finance Breakdown Template provided, accessible here (ctrl + click the link below). Please note that completion of this Project Finance Breakdown Template is mandatory and must be submitted along with each workplan.

PROJECT FINANCE BREAKDOWN TEMPLATE (CTRL+CLICK HERE)

Table 16.2.1 Funding Requested BY ALBERTA ENVIRONMENT & PARKS

Organization – Alberta Environment & Parks ONLY	Total % time allocated to project for AEP staff	Total Funding Requested from OSM
Salaries and Benefits *(Calculated from Table 16.1.1 above)*	**125.00%**	**$150,000.00**
Operations and Maintenance		
Consumable materials and supplies		$0.00
Conferences and meetings travel		$1,000.00
Project-related travel		$0.00
Engagement		$500.00
Reporting		$5,000.00
Overhead		$975.00
Total All Grants *(Calculated from Table 16.4 below)*		**$7,098,861.00**
Total All Contracts *(Calculated from Table 16.5 below)*		**$945,000.00**
Sub- TOTAL *(Calculated)*		**$8,201,336.00**
Capital*		$0.00
AEP TOTAL *(Calculated)*		**$8,201,336.00**

* The Government of Alberta Financial Policies (*Policy # A600*) requires that all **capital asset** purchases comply with governmental and departmental legislation, policies, procedures, directives and guidelines. **Capital assets** (*Financial Policy # A100*, Government of Alberta, January 2014) are tangible assets that: have economic life greater than one year; are acquired, constructed, or developed for use on a continuing basis; are not held for sale in ordinary course of operations; are recorded and tracked centrally; have a cost greater than $5,000.

Some **examples of capital asset equipment include:** laboratory equipment, appliances, boats, motors, field equipment, ATV's/snowmobiles, stationary equipment (pier/sign/weather), fire/safety equipment, pumps/tanks, heavy equipment, irrigation systems, furniture, trailers, vehicles, etc. (*Financial Policy # A100*, Government of Alberta, January 2014).

Table 16.2.2 Funding Requested BY ENVIRONMENT & CLIMATE CHANGE CANADA

Organization – Environment & Climate Change Canada ONLY	Total % time allocated to project for ECCC staff	Total Funding Requested from OSM
Salaries and Benefits FTE ***(Please manually provide the number in the space below)***		
Salaries and Benefits		$1,511,526.00
Operations and Maintenance		
Consumable materials and supplies		$499,510.00
Conferences and meetings travel		$0.00
Project-related travel		$28,000.00
Engagement		$200,000.00
Reporting		$5,000.00
Overhead		$165,044.00
ECCC TOTAL ***(Calculated)***		**$2,409,080.00**

* ECCC cannot request capital under the OSM program. Any capital requirements to support long-term monitoring under the OSM program should be procured by Alberta and captured in that budget table.

Table 16.3

Complete ONE table per Grant recipient.

Add a Recipient by clicking on the table and then clicking on the blue "+" symbol on the bottom right side of table. The total of all Grants is Auto Summed in Table 16.2.1

GRANT RECIPIENT - ONLY: Name	Monica Kohler / Shannon White
GRANT RECIPIENT - ONLY: Organization	Alberta Biodiversity Monitoring Institute (ABMI)
Category	**Total Funding Requested from OSM**
Salaries and Benefits	$3,652,583.29
Operations and Maintenance	
Consumable materials and supplies	$527,447.65
Conferences and meetings travel	$25,748.32
Project-related travel	$764,492.64
Engagement	$54,708.62
Reporting	$231,306.48
Overhead	$525,628.70
GRANT TOTAL *(Calculated)*	**$5,781,915.70**
GRANT RECIPIENT - ONLY: Name	Emily Herdman / Neal Tanna
GRANT RECIPIENT - ONLY: Organization	InnoTech Alberta
Category	**Total Funding Requested from OSM**
Salaries and Benefits	$98,000.00
Operations and Maintenance	
Consumable materials and supplies	$0.00
Conferences and meetings travel	$0.00
Project-related travel	$2,000.00
Engagement	$5,000.00
Reporting	$15,000.00
Overhead	$0.00
GRANT TOTAL *(Calculated)*	**$120,000.00**
GRANT RECIPIENT - ONLY: Name	Erin Bayne
GRANT RECIPIENT - ONLY: Organization	University of Alberta – Bayne Lab
Category	**Total Funding Requested from OSM**
Salaries and Benefits	$175,000.00
Operations and Maintenance	
Consumable materials and supplies	$5,000.00
Conferences and meetings travel	$0.00
Project-related travel	$50,000.00
Engagement	$0.00
Reporting	$0.00
Overhead	$46,000.00
GRANT TOTAL	**$276,000.00**

(Calculated)	
GRANT RECIPIENT - ONLY: Name	Scott Nielsen
GRANT RECIPIENT - ONLY: Organization	University of Alberta – Nielsen Lab
Category	**Total Funding Requested from OSM**
Salaries and Benefits	$151,000.00
Operations and Maintenance	
Consumable materials and supplies	$64,700.00
Conferences and meetings travel	$1,000.00
Project-related travel	$45,400.00
Engagement	$2,500.00
Reporting	$500.00
Overhead	$53,020.00
GRANT TOTAL *(Calculated)*	**$318,120.00**
GRANT RECIPIENT - ONLY: Name	Jason Fisher
GRANT RECIPIENT - ONLY: Organization	University of Victoria – Fisher Lab
Category	**Total Funding Requested from OSM**
Salaries and Benefits	$254,000.00
Operations and Maintenance	
Consumable materials and supplies	$160,800.00
Conferences and meetings travel	$11,500.00
Project-related travel	$55,960.00
Engagement	$0.00
Reporting	$0.00
Overhead	$120,565.00
GRANT TOTAL *(Calculated)*	**$602,825.00**

Table 16.4

Complete ONE table per Contract recipient.

Add a Recipient by clicking on the table and then clicking on the blue "+" symbol on the bottom right side of table. This section is only to be completed should the applicant intend to contract components or stages of the project out to external organizations. The total of all Contracts is Auto Summed in Table 16.2.1

CONTRACT RECIPIENT - ONLY: Name	Ken Foster / Chris Godwin
CONTRACT RECIPIENT - ONLY: Organization	Owl Moon Environmental Inc.
Category	**Total Funding Requested from OSM**
Salaries and Benefits	$679,100.00
Operations and Maintenance	
Consumable materials and supplies	$18,500.00
Conferences and meetings travel	$14,700.00
Project-related travel	$182,900.00
Engagement	$0.00
Reporting	$4,700.00
Overhead	$45,100.00
CONTRACT TOTAL *(Calculated)*	**$945,000.00**

Table 16.5 GRAND TOTAL Project Funding Requested from OSM Program

The table below is auto calculated, please do not try to manually manipulate these contents.

Category	Total Funding Requested from OSM
Salaries and Benefits ***Sums totals for salaries and benefits from AEP and ECCC ONLY***	$1,661,526.00
Operations and Maintenance	
Consumable materials and supplies *Sums totals for AEP and ECCC ONLY*	$499,510.00
Conferences and meetings travel *Sums totals for AEP and ECCC ONLY*	$1,000.00
Project-related travel *Sums totals for AEP and ECCC ONLY*	$28,000.00
Engagement *Sums totals for AEP and ECCC ONLY*	$200,500.00
Reporting *Sums totals for AEP and ECCC ONLY*	$10,000.00
Overhead *Sums totals for AEP and ECCC ONLY*	$166,019.00
Total All Grants (from table 16.2.1 above) *Sums totals for AEP Tables ONLY*	$7,098,861.00
Total All Contracts (from table 16.2.1 above) *Sums totals for AEP Tables ONLY*	$945,000.00
Sub- TOTAL	$10,610,416.00
Capital* *Sums total for AEP*	$0.00
GRAND PROJECT TOTAL	$10,610,416.00

Some **examples of capital asset equipment include:** laboratory equipment, appliances, boats, motors, field equipment, ATV's/snowmobiles, stationary equipment (pier/sign/weather), fire/safety equipment, pumps/tanks, heavy equipment, irrigation systems, furniture, trailers, vehicles, etc. (*Financial Policy # A100*, Government of Alberta, January 2014).

17.0 FINANCIAL MANAGEMENT

The OSM Program reserves the right to reallocate project funding during the current fiscal year on the basis of project performance and financial overspend or underspend.

☒ *Please check this box to acknowledge you have read and understand*

In the space below please describe the following:

- *Discuss how potential cost overruns and cost underruns will be managed.*
- *If this is a continuing project from last year, identify if this project was overspent or underspent in the previous year and explain why.*
- *Describe what risks and/or barriers may affect this project.*

All partners will follow good financial management practices as required by their agencies, institutions or corporations, and will submit quarterly (or more frequent) financial reports to the OSM Program Office as per OSM requirements and schedule.

Determining precise financial over/underspending of the 2021/22 Terrestrial Biological Workplan is difficult as not all contracts are in place and thus invoicing is not yet complete and up-to-date. That said, we anticipate no major cost over/underruns from 2021/22 and all invoicing and reporting to date has been on schedule and on budget.

The major risks to this project include, but are not limited to unforeseen barriers to fieldwork completion, including actions of non-stakeholders or natural incidents such as wildfires or floods or public health measures associated with the COVID pandemic.

18.0 Alternate Sources of Project Financing – In-Kind Contributions

Table 18.1 In-kind Contributions

Add an In Kind Contribution by clicking on the table and then clicking on the blue "+" symbol on the bottom right side of table.

DESCRIPTION	SOURCE	EQUIVALENT AMOUNT ($CAD)
Salary	ECCC	$200,000.00
ECCC lab analysis and sample archiving and retrieval	ECCC	$35,000.00
ECCC Colonial Waterbirds: Parks Canada salary, sharing of logistics costs, field support	Parks Canada	$10,000.00
NSERC Scholalships to UVIC students working on OSM	NSERC / UVic	$40,000.00
UVIC scholarships to Rebecca Smith, MSC candidate	UVic	$15,000.00
ECCC Mammals: Honorarium paid inkind	Participating communities	$50,000.00
ECCC Mammals: Salary for project coordinator at Alberta Trappers Association	Alberta Trappers Association	$17,000.00
ECCC Mammals: Student stipends	NSERC Discovery	$12,000.00
ECCC Mammals: Shipping costs	University of Alberta	$2,500.00
ECCC Mammals: Chemical analyses (POPs)	Alberta Conservation Association	$7,000.00

ECCC Mammals: Hazardous and biological waste disposal	University of Alberta	$8,000.00
Salary for Erin Bayne	University of Alberta	$20,000.00
Salary for Taylor Hart (Bayne Lab)	NSERC	$16,000.00
Administration and purchasing	Alberta Biodiversity Monitoring Institute (ABMI)	$45,000.00
Lab and office space (InnoTech and Universit of Alberta)	Alberta Biodiversity Monitoring Institute (ABMI)	$58,000.00
In-kind technical expertise	Alberta Biodiversity Monitoring Institute (ABMI)	$15,000.00
	TOTAL	**$550,500.00**

19.0 Consent & Declaration of Completion

Lead Applicant Name

David Roberts

Title/Organization

Cumulative Effects Analytical Scientist, Alberta Environment and Parks

Signature

David Roberts

Date

2021-10-05

Government Lead / Government Coordinator Name (if different from lead applicant)

Click or tap here to enter text.

Title/Organization

Click or tap here to enter text.

Signature

Click or tap here to enter text.

Date

Click or tap to enter a date.

PROGRAM OFFICE USE ONLY

Governance Review & Decision Process

this phase follows submission and triggers the Governance Review

TAC Review (Date):

Click or tap to enter a date.

ICBMAC Review (Date):

Click or tap to enter a date.

SIKIC Review (Date):

Click or tap to enter a date.

OC Review (Date):

Click or tap to enter a date.

Final Recommendations:

Decision Pool:

Choose an item.

Notes:

Click or tap here to enter text.

Post Decision: Submission Work Plan Revisions Follow-up Process

This phase will only be implemented if the final recommendation requires revisions and follow-up from governance

ICBMAC Review (Date):

Click or tap to enter a date.

SIKIC Review (Date):

Click or tap to enter a date.

OC Review (Date):

Click or tap to enter a date.

Comments:

Decision Pool:

Choose an item.

Notes & Additional Actions for Successful Work Plan Implementation:

Click or tap here to enter text.