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 Atmospheric Deposition Monitoring
Lead Applicant, Organization, or Community:	Alberta Environment and Parks
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***	A-PD-6-2223
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***	N/A
Total 2022/23 Project Budget: *For the 2022/23 fiscal year*	$9,423,175.70
Requested OSM Program Funding: *For the 2022/23 fiscal year*	$5,823,551.70
Project Type:	Longterm Monitoring
Project Theme:	Air & Deposition
Anticipated Total Duration of Projects (Core and Focused Study (3 years))	Choose an item.
Current Year	**Focused Study:** Choose an item.
	Core Monitoring: Choose an item.

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.	Greg Wentworth
Job Title:	Atmospheric Scientist
Organization:	AEP
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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.

Atmospheric deposition is a critical pathway that links stressors to responses. Deposition monitoring data are used by the Oil Sands Monitoring Program to assess responses, and to help determine the source(s) of stressors. The primary objectives for atmospheric deposition long-term monitoring are to:

(1) Determine levels and changes of atmospheric deposition for specific pollutants that pose a likely risk for forest, river, lake, and wetland ecosystem function, (OSM Objective #1 and #2)
(2) Quantify the contribution of OS emissions to deposition of pollutants of concern, particularly at ecological monitoring sites, and provide these data to ecological effects monitoring projects, (OSM Objectives #1 and #2)
(3) Improve integration within and across themes, including continued model comparison and delivering deposition maps required by other themes. (OSM Objective #3)

This work plan monitors the spatial and temporal changes in deposition of pollutants of concern at relevant ecological monitoring sites: acidifying (e.g., nitrogen, sulphur, and base cations) and eutrophying (e.g., nitrogen) pollutants at forest and wetland sites; and contaminants (i.e., polycyclic aromatic compounds (PACs) and trace metals) at forest, wetland, and aquatic sites. Supplement Attachment #10 shows how this work fits within an EEM framework. This work plan continues to employ adaptive monitoring philosophies by adapting monitoring in light of recent findings. For example, the Terrestrial Ecological Effects Monitoring (TEEM) program has begun addressing 75 recommendations to improve deposition and effects monitoring in the AOSR. These recommendations are based on a comprehensive analysis of ~20 years of data.

Source apportionment analyses and chemical transport models can both determine the contribution of specific OS and non-OS sources to deposition. Deposition modelling and GIS techniques will support the estimation of deposition at ecological monitoring sites where deposition could be a significant pathway for stressors but is not actually measured, and allow for determination of contribution of OS sources. The key modelling tool that will enable the above is GEM-MACH, which is an observation-evaluated tool that simulates emissions, transport, transformation, and deposition, and is used for scenario testing. The oil sands version of GEM-MACH will be used in a core monitoring role by 2023, with transition to that role finishing 2021-22, including comparison against surface observations.

Integration is an on-going and iterative process. The focus for 2022/23 will be: (i) completion of model comparison to surface monitoring network data, (ii) improvement using data from past studies and long-term monitoring, (iii) configuration of the model and its inputs to provide deposition maps and output to estimate change and for adaptive monitoring purposes, (iv) further alignment of deposition monitoring methods and approaches across the OS Regions, and (iv) continued transitioning, as appropriate, to the adaptive monitoring framework including formalizing baseline and limits of change for ambient deposition surveillance monitoring and modelling.

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 EEM FRAMEWORK:
The key driver of this work plan is the need for the OSM Program to link stressors and their sources (i.e., pressures) to responses. Supplemental Attachment #10 shows how monitoring activities in this work plan fit within an EEM-style (adaptive monitoring) framework. Ambient deposition surveillance monitoring is conducted through forest health deposition monitoring (i.e., passive air samplers, ion exchange resins, denuder/filter pack samplers, lichen sampling, remote ozone monitors, and meteorological towers), long-term PACs snowpack sampling, deposition modelling (GEM-MACH), and PACs passive air samplers. GEM-MACH provides a quantitative link between atmospheric emissions from oil sands activities and deposition/exposure, including odour and pollution events. The deposition surveillance monitoring activities are explicitly linked to on-going effects surveillance monitoring including forest health (soil and vegetative) monitoring, health assay measurements, aquatic ecosystem health monitoring, and amphibian health monitoring. GEM-MACH concentration and deposition outputs, combined with observation data and expertise from the OSM Geospatial work plan are leveraged to generate deposition maps. Adaptive monitoring needs are met through the generation of these deposition maps for multiple past years, future-year maps incorporating expected future emissions changes, and short-term event maps which may highlight the need for additional monitoring stations. Monitoring activities within this work plan (i.e., lichen samples, snowpack samples, PACs passives) are also used in source apportionment analyses to investigate cause. It is important to note here that PACs in this work plan refer to the 16 USEPA priority PAHs that other work plans are targeting in other media, in addition to hundreds of other PACs that are characteristic of raw bitumen and have greater utility for specific source tracking, and have been implicated in toxic effects.

A focused study led by Smith's Landing First Nation (SLFN) adopts the EEM framework within the OSMP to study whether air contaminants released from approved oil sands emission sources are transported and deposited within SLFN traditional territory. The proposed multi-year focused study integrates the Air TAC core monitoring activities by leveraging existing data sets and western science expertise to address SLFN community concerns and attempting to answer questions around deteriorated air quality and observed impacts to vegetation, specifically decreased forest health and changes in mint potency. Year 1 (approved 21/22 work plan) focuses on review of available datasets (AEP, ECCC, OSM) to determine if data is sufficient to understand air quality in SLFN traditional territory and will be co-interpreted by SLFN, AEP and ECCC researchers to determine if oil sands stressors are contributing to deteriorated air quality which SLFN members have identified. The 2nd phase of this study, as proposed here, is dependent on results from the 21/22 work plan and if oil sands air emissions are detected or suspected of intercepting SLFN traditional territory phase 2 will focus on source apportionment and support decision making for whether deposition monitoring is required as Phase 3 in the 23/24 work plan.

These activities are explicitly addressing Key Questions provided by the OSM Program Office: 'Has deposition of airborne contaminants changed?', 'Is there an effect on the receiving environment?', and 'What is the extent of deposition of compounds of concern?'. Baseline and change have been reported in various publications and papers; however, 'baseline' and 'limits of change' have not been 'formalized' within the OSM EEM framework. The Air and Deposition TAC will continue to develop baseline and limits of change for surveillance monitoring activities using consensus decision-making. Furthermore, GEM-MACH can be used as a tool to answer EEM questions by providing quantitative maps of change relative baseline, the spatial and temporal extent of these changes, the extent to which changes are or may in the future become a concern, and how the monitoring network

may be adapted to better detect change.

KNOWLEDGE GAP WITHIN SOURCE-PATHWAY-RECEPTOR MODEL:
Atmospheric deposition is a critical pathway that connects pressures, stressors and responses. This work plan fills the knowledge gap of the deposition pathway by delivering data required by this theme, and others within OSM (i.e., surface aquatics, groundwater, terrestrial biological, and wetland monitoring) to assess responses and to link any changes back to a specific stressor/pressure. Other key drivers include a need to: i) understand contribution of various sources and enroute transformation to deposition, ii) provide data for comparison and improvement of air quality models which in turn provide deposition data to other themes, and iii) inform other OSM programs on patterns of stressor exposure/deposition.

FULFILLMENT OF OSM PROGRAM MANDATE:
1) Assess accumulated environmental condition – spatial and temporal patterns of deposition are monitored and modelled, which are used to assess potential environmental changes both directly (through comparison to critical loads, critical levels, and co-located vegetation data) and indirectly (through other OSM themes).
2) Determine relationships between OS-related stressors and effects – deposition monitoring (e.g., lichen samples, PAC passives, snowpack samples) and modelling data are used to conduct source attribution studies to quantify contribution of specific OS and non-OS source categories to deposition. Monitoring data are also used to evaluate and improve the GEM-MACH model which in turn quantifies source-specific contribution to deposition where monitoring data are not available.
3) Assess cumulative effects – the monitoring in this work inherently measures the cumulative impact of all sources on deposition. Information on source attribution (Result #2) and integration with other OSM themes targeting effects provides a programmatic view on the combined effects of OS and non-OS stressors on ecological responses delivered through the deposition pathway.

KEY RESULTS TO DATE:
•Spatial patterns of atmospheric deposition vary by stressor but are enhanced within tens (e.g., base cations, mercury, trace metals, and PACs) and beyond 100 km (e.g., SO2, NO2) of the surface mineable area.
•Spatial patterns of atmospheric deposition outside of the surface mineable area are less well characterized by direct observation and more uncertain than deposition estimates in the surface mineable area. Model estimates are an easy means of quantifying the entire downwind area impacted by emissions where measurements do not exist.
•Acidification has been observed in some streams during spring snow melt, as well as some soils in the Fort McMurray and Cold Lake region. There has been no observed large-scale acidification in soils or lakes surrounding the surface mineable region; however, modelling predicts acidification in some lakes (an area of 387,000 km2) and forests (69,900 km2) in the future in this region.
•Vegetative changes have been observed at forest and wetland bog sites due to nitrogen and potentially sulphur and base cation deposition.
•Neutralization of acidifying deposition is caused by base cations deposited via fugitive dust, and this occurs within 10s of km of the surface mines. However, this effect drops off with increasing distance from sources.
•Deposition for sulphur and nitrogen compounds close within and near the oil sands area may be enhanced by base cation deposition (Hayden et al., 2021).
•Stressor-Pathway-Response links are difficult to assess for PACs, mercury, and trace metals, although there is some evidence of elevated levels of these stressors in some biota and abiotic ecosystem components (e.g., soil, sediment, surface water) around the surface mineable region.
•Contribution of Oil Sands emissions to deposition varies by stressor, and is better characterized for stressors dominated by point sources for sulphur and nitrogen (e.g., SO2, NOx) and area sources for NOx (off-road mine fleet) relative to other area sources (e.g., base cations, NH3).
•Substituted PACs have great value in tracing atmospheric deposition specific to mining operations and are not captured in the standard suite of 16 PAHs reported by commercial labs. Preliminary data from the Aquatic Ecosystem Health work plan suggests PACs are driving changes in fish health in the region.
•Hydrogen sulphide (H2S) strongly correlates with odour event reports, though reported H2S emissions are insufficient to account for measured values at the Oski-ôtin station.
•Additional details and findings have been presented in numerous reviews of atmospheric deposition monitoring and effects in the OS Regions (Davidson et al., 2020; Harner et al. 2018; Horb et al., 2021; Kirk et al., 2018; Wentworth and Zhang, 2018).

MAJOR CHANGES TO THIS WORK PLAN from 2021/22:
•Deposition monitoring will be expanded in the Cold Lake Region in response to new regional regulatory requirements and the fact deposition monitoring in the Cold Lake Region has been identified as a gap in the OSM Program (e.g., Wentworth and Zhang, 2018; Swanson 2019; Horb et al., under review). Monitoring will be regional in nature and address the three OSM Objectives/Outcomes. The expected increase in cost is ~$150,000.
•The evaluations of GEM-MACH model simulations for two different configurations, carried out in Q3 and Q4 of FY2021/2022, are expected to be largely completed in that year, though presentation of results to stakeholders, TAC, SIKIC , and submission of journal papers on this activity are likely to continue into FY2022/2023. GEM-MACH related activities in FY2022/2023 are expected to include:
oDistribution of model-generated deposition maps to Deposition and other OS Themes as GIS data.
oUse of the model output to meet Adaptive Monitoring needs through: (i) maps showing predicted cumulative impacts relative to current monitoring station locations, and (ii) preparation of model inputs to generate deposition maps showing change (additional past years and projected future years)
oUpdating model science and inputs based on evaluation results, and communicating results in internal presentations and scientific journal papers
•Use dispersion modelling and updated emissions inventory to assess the relative contributions of OS industry and non-OS emissions to the total concentration and atmospheric deposition of trace elements and PACs in the whole OSR.
•Health assay work will be extended to include additional health endpoints (other than just oxidative stress), through an existing collaboration with Health Canada. This is one of the few direct health-based indicators of air quality in the OSR.
•Progress and work-to-date on the GEM-MACH modelling, including evaluation against measurements, is detailed in Supplemental Attachment #12.
•Cost estimate differences for 2022/23 relative to 2021/22 for the WBEA are summarized in Supplemental Attachment #2.

2.0 Objectives of the Work Plan

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

OSM atmospheric deposition monitoring is a long-term effects-based surveillance program with the objective of answering the scientific question of whether air quality and/or atmospheric deposition occurring in the oil sands region is having an effect on the receiving environment, and if so, to identify the geographic extent, magnitude, frequency, source, and reversibility of the effect(s). Receptors, indicators, and endpoints are based on their suitability for assessing the effects of changes in air quality and atmospheric deposition, with a focus on acidic deposition, nutrient deposition, and contaminant deposition. Some of the effects-based monitoring occurs in other work plans (noted below where applicable).

The following objectives relate to ambient deposition and effects surveillance monitoring (and should not be conflated with the OSM Program Objectives noted previously):

1) Monitor air concentrations and deposition of nitrogen, sulphur, base cations, and ozone at forest and wetland sites in the Oil Sands Regions, as well as nitrogen and sulphur deposition at two downwind transboundary sites. These data are directly used with data from Objective #2 for assessing stressor-response links, as well as for model comparison (see Objective #9).

2) Monitor soil and vegetation parameters in the Athabasca and Cold Lake regions for indicators of vegetative changes and acidification. Soil measurements are integrated with measured and/or modelled deposition data to assess stressor-response linkages.

3) Monitor air concentrations and deposition of PACs at selected forest, wetland, and continuous air quality monitoring sites in all three Oil Sands regions. These data are needed by this TAC, as well as the Terrestrial TAC, for assessing stressor-response links and source attribution. The number of proposed sites has been reduced to adapt to the fact that PAC levels in ambient air have not changed in a statistically significant way since these measurements began in 2012.

4) Monitor wintertime deposition of PACs, mercury, and trace metals in the Athabasca Oil Sands Region at near river and ecologically important sites, and provide samples to the Groundwater work plan for isotopic analysis. These data are needed by the Surface Water, Wetland, and Groundwater TACs to evaluate the impact of contaminant input to ecosystems during snowmelt, as well as to attribute deposition to specific sources. The data needed to calculate deposition and conduct source attribution analysis are collected using snowpack sampling followed by lab analyses.

5) Collect monthly precipitation samples in Fort Chipewyan, Fort McKay, and Maskwa (Cold Lake region) for analysis of isotopes in water. These data are needed by the Groundwater TAC to assess the input of precipitation to groundwater reservoirs. The equipment and analytical costs of this sampling are covered by the Groundwater TAC.

6) Analyze extracts from PACs passive samplers (Objective #3) using chemical health assays, a surrogate for effects of PACs exposure on human health.

7) Monitor temporal and spatial changes in deposition through regional collection of lichen samples for trace metals, PAHs, total nitrogen, and total sulfur. Data derived from this biomonitoring provides critical information about the extent of stressors entering ecosystems via the deposition pathway. These data are also necessary for the Groundwater, Surface Water, and Terrestrial TACs to investigate effects and attribute these effects to specific sources.

The following objectives relate to model development/comparison, and testing new methodologies:

8) Use a modelling approach developed in FY2021/22 to produce total (wet + dry) deposition maps for trace metals. Emissions databases of trace elements and PACs will be split into OS-related and non-OS emissions to assess their relative contributions to the total concentration and atmospheric deposition of these pollutants in the whole region. NOTE: this is a different model than GEM-MACH, since GEM-MACH does not include trace metals.

9) The GEM-MACH model will quantify the deposition of pollutants onto downwind ecosystems, including the production of deposition maps using model-measurement fusion (the combination of model maps and observation station data to generate improved maps). Changes in deposition, exposure, and ecosystem impacts will also be predicted, with a model version updated using past focused study and satellite data. Evaluation of model outputs generated in FY2021/22 against surface monitoring data will start in that year and are expected to be completed (documented and peer-reviewed) by Q2 of FY2022/23 (see Objective #10). In addition, GEM-MACH and weather forecast model back-trajectories will be used to determine the contributions of specific sources to deposition and odour events.

10) Reconfiguring of GEM-MACH and its inputs to provide ongoing annual deposition maps. The products from these simulations are to include deposition maps of additional years in the past, future (i.e. projected) simulations (Adaptive Monitoring), as case studies to determine source-receptor relationships (Adaptive Monitoring). A significant part of this effort will be in the generation of emissions data for use as model inputs. Supplementary Attachment #12 summarizes recent GEM-MACH improvements and progress over the last few years.

11) Further improvement of model science based on evaluation results (e.g. based on work to date), including improvements to model emissions (for example, for odour event chemicals, PM2.5, and other VOCs, etc…), as well as the model's treatment of chemical processing within clouds, organic aerosol formation, total hydrocarbon deposition, sulphur and nitrogen deposition, and particle emissions. In addition, post-processing of model outputs to generate improved model deposition maps and for Adaptive Monitoring purposes.

12) Continue operating a monitoring site where all deposition measurement methods are co-located with an existing continuous monitoring station for the purpose of ensuring measurement comparability.

13) Test surrogate surface samplers, a method to quantify fugitive dust deposition, at a subset of air monitoring

stations for the spring, summer and fall. If validated, these data will complement the wintertime snowpack measurements allowing for direct year-round quantification of fugitive dust deposition.

14) Support SLFN in investigating linkages (source apportionment) for OS emissions which are observed in SLFN territory or to address gaps in monitoring data which limited results from phase 1 (21/22 work plan). Project Team Members will continue to work with SLFN experts and community members to further interpret GEM-MACH, snowpack, and ambient air quality data at Fort Chipewyan to determine the extent to which OS emissions contribute to air pollutant and deposition levels in SLFN. This work, originally planned for 1-year, extends into 2022/23 due to delays in 2021/22 funding decisions and expands the study to address source apportionment and/or monitoring data gaps depending on results. Contact ICBMP for the EOI describing details on SLFN CBM components (core and focused studies).

15) Complete analysis of 2017/18 AEP-NOAA flights, as well as release technical summary of report of findings and submit peer-review journal publication(s).

The following objectives relate to improving within theme and cross-theme integration, and ensuring this work plan aligns with the priorities of the OSM Program and the EEM framework:

16) Continue bi-weekly meetings amongst TAC Leads to help ensure existing deposition data needs are filled, as well as identify new deposition data needs as they arise. Continue participating in cross-thematic workshops (e.g., Geospatial workshop) to ensure deposition maps and related information required by other TACs is being provided, including provision of long-term deposition trends to other theme areas. For example, PACs snowpack deposition data were provided upon request by the OSM fish monitoring leads to study a potential link between PACs exposure and fish health.

17) Continue to review the existing monitoring network and document the purpose or objective for each parameter monitored at each station.

18) Develop a shared understanding of regulatory and community expectations for monitoring that will guide the adjustment of the current long-term surveillance program to fit the OSM adaptive monitoring framework. This work will be supported by discussions at the SIKIC and OC on whether specific EPEA requirements are fulfilled by the OSM Program.

19) Continue to formalize baseline and limits of change for deposition surveillance monitoring parameters. This work will be carried out through the Air and Deposition TAC.

20) Contribute to annual State of Environment (SoE) reporting, as required.

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:

Air

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:

Deposition

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?

Spatial and temporal changes in deposition as a result of oil sands emissions have been reported in the surface-mineable area. An abundance of monitoring and modelling data show a pattern of increased deposition for nitrogen, sulphur, base cations, total mercury, methylmercury, most PACs, and most trace metals surrounding the surface mines. The extent of reported change in deposition varies by contaminant and is affected by the relative amount of non-OS emissions (e.g., wildfires, long-range transport). Source attribution and modelling studies have revealed a major contribution of OS emissions to cumulative deposition for some stressors (e.g., sulphur, nitrogen, alkylated-PACs), whereas the contribution for other stressors (e.g., ammonia) is less clear. Spatial changes for deposition in the other OS regions (i.e., southern Athabasca, Cold Lake, and Peace River) is less well characterized than for the surface-mineable region.

Recent advancements in technology for real-time measurements have enhanced the understanding of complex atmospheric processes and the ability to verify and validate changes observed in the region. Instruments with better detection limits and improved speciation of compounds help verify and validate historical monitoring methods and results, hence there is an on-going need to evaluate emerging monitoring methods for efficacy in the Oil Sands Regions.

The Air and Deposition TAC will continue to formalize limits of change within the context of EEM framework.

2. Are changes informing Indigenous key questions and concerns?

Most data generated by this work plan are focused on quantifying spatial and temporal changes in stressor deposition (a pathway for exposure) and the contribution from OS emissions. These data are directly used by other themes (e.g., wetlands, terrestrial biological, and surface water) to examine stressor-response linkages, which inform Indigenous concerns and health. For example, snowpack data are used to quantify the input of PACs, trace metals, and mercury into streams during spring snowmelt. Nitrogen, sulphur, and base cation deposition data are used to assess changes in forest and wetland ecosystems, as well as berry health. GEM-MACH modelling can identify locations where deposition exceeds ecosystem capacity for both concentration (critical levels) and deposition (critical loads), and be used to predict or forecast change. The GEM-MACH work also includes model and emissions improvements to predict and provide source attribution for odour events. This work plan was developed in collaboration with airshed organizations (i.e., WBEA, LICA, and PRAMP) that have Indigenous communities as members. There is also participatory community involvement in the snowpack sampling.

The WBEA's long-term surveillance program was initiated due to concerns expressed by local Indigenous community members about the potential impacts of atmospheric deposition on forest health and they have continued to be key participants in the technical and general membership that oversees this surveillance program.

The focused study led by SLFN included in this work plan explicitly informs Indigenous key questions and concerns. Existing GEM-MACH, snowpack, and ambient air quality data collected by the core long-term monitoring will support the investigation by SLFN to assess linkages between OS sources, transport/deposition pathways, and observed effects (e.g., deteriorated forest health and decreased mint potency in areas with observed odours and air quality changes).

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

Data are produced following OSM Program requirements and are posted publicly after QA/QC checks have been completed. Data are available on the Alberta Air Data Warehouse (https://www.alberta.ca/alberta-air-data-warehouse.aspx), WBEA website (www.wbea.org) and the WBEA time-integrated data search tool (https://wbea.org/network-and-data/integrated-data-search/), and the Canada-Alberta Oil Sands data portal (https://www.canada.ca/en/environment-climate-change/services/oil-sands-monitoring.html). The OSM Program data management system also has direct links to these data.

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

Yes. Information on Standard Operating Procedures and Best Management Practices are available at the above links, or upon request. Unless noted otherwise, the methods used in this work plan are considered 'standard' and commonly used for air and deposition monitoring. Methodologies used in this work plan have also been repeatedly published in the peer-review scientific literature.

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

Integration amongst projects and themes is shown in Supplemental Attachment #10, which shows existing linkages between monitoring activities within this work plan, between work plans in Air and Deposition, and with other themes. Monitoring data described in this work plan are needed by other projects and themes to support effects surveillance monitoring. A webinar/workshop has been proposed to discuss the mapping and data needs of other TACs. In particular, there is significant integration with the Atmospheric Pollutant Active Monitoring Network work plan (A-LTM-S-1-2223) to which this project will produce source information for the observations made at the Oski-otin site in Fort McKay, and to explore possible forecasting and source attribution for odour events. Continuous and integrated data from A-LTM-S-1-2223 are also used to assess forest health effects monitoring and compare to model output. There is already substantial integration with other themes through site co-location and clear data uses by other themes (e.g., Wetlands using PACs, N and S deposition at bog sites; Surface Water using snowpack data to estimate snowmelt contaminant input to streams and rivers; Groundwater using precipitation and snow samples for isotopic analysis). Integration with communities is implicitly achieved through community membership with airshed organizations, which collaboratively developed this work plan. Several community members from the Mikisew Cree First Nation also participate in the snowpack sampling every March, and deposition data has been used as part of the Fort McKay Berry Health project. Monitoring in this work plan directly integrates with and supports the SLFN-led focused study, which is also included in this work plan.

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?

See Supplemental Attachment #10 for a graphical description of how monitoring activities described in this work plan fit within the EEM framework. This work plan will continue to transition to an EEM framework by continuing to develop baselines and limits of change, via the TAC, for deposition surveillance monitoring. The modelling component of this work plan can provide quantitative answers to EEM questions such as the extent to which change has occurred, the extent to which change is due to oil sands sources, regions expected to be most sensitive to change for potential monitoring network adaptation, predict the effectiveness of potential mitigation strategies in advance of their implementation, and provide advice on Adaptive Monitoring.

In addition, a preliminary EEM (adaptive management) framework approach has been drafted for the WBEA's long-term surveillance monitoring which includes the identification of key drivers, stressors, pathways, and indicators for the program, as well as a decision-making process for use when considering changes to monitoring activities. Please see Supplemental Attachment #11 for examples of these preliminary tools.

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?

Deposition monitoring is explicitly listed on the theme area conceptual model. It also provides information on stressors (i.e., criteria air contaminants (CACs), non-CACs, PACs, mercury, aerosols, and trace elements) as well as atmospheric dispersion/transport. Monitoring data and model simulations are used to quantify the contribution of relevant pressures on stressor air concentrations and deposition. All of these conceptual model components also appear on the OSM Programmatic model, as well as in the EEM framework. This work will continue to provide necessary data for linking stressors to responses and determine the relative impact of various pressures on deposition and ecosystem responses.

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

Yes, monitoring and modelling from previous iterations of this work plan are being used in the Programmatic State of Environment reporting. Project team members from this work plan contributed data, analyses, figures, and text to the 2021 SoE report, and will continue to do so as required.

3.3.5 Terrestrial Biology Theme

3.3.5.1 Sub Themes:

Choose an item.

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?

Click or tap here to enter text.

2. Are changes in terrestrial ecosystems 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.

3.3.6 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 deposition monitoring program addresses multiple objectives and scientific questions as identified in the EPEA approvals, Acid Deposition Management Framework, 2009 Alberta Ambient Air Monitoring Strategy, 2019-2024 Alberta Science Strategy, and OSM Monitoring Objectives.

In particular, some recent EPEA approvals for some OS facilities require the approval holder to submit a deposition monitoring plan for wet and dry deposition. Monitoring captured under this work plan, specifically the expansion of the forest health monitoring network in the southern region of the AOSR, fulfill this regulatory requirement. Some EPEA approvals also require snow contaminant monitoring, which might be fulfilled by the snowpack contaminant monitoring in this work plan. Monitoring data are also used to evaluate a provincial deposition model that calculates acid critical load exceedances through the provincial Acid Deposition Management Framework (ADMF). Team members of this work plan will ensure that proponents of the ADMF are kept informed, through the Acid Deposition Assessment Group (ADAG), about results of acidic critical load exceedances work detailed in this work plan, and will work together to promote alignment and resolve any differences related to methodology or reporting results.

The vegetative changes linked to deposition recently observed at Jack Pine and wetland bog sites are emerging issues that require on-going monitoring to track changes. Atmospheric deposition monitoring is a key component of the comprehensive provincial ambient air quality management plan as outlined in the 2009 Ambient Air Monitoring Strategy for Alberta. In addition, the monitoring activities in this work plan address the 2019-2024 Alberta's Science Strategy "Priority Area of Environmental Monitoring for Chemical Contaminants and Biological Stressors in the Environment" by producing timely, credible monitoring and reporting of chemical contaminants and/or biological stressors of concern entering the environment in order to assess whether, through exposure, there are potential or observed impacts on human and/or ecosystem health. The deposition and exposure to contaminants (e.g., trace metals, PACs) are also an emerging issue, in the sense they are less well characterized and of concern to communities. GEM-MACH simulations can also be used to compare pre- and post-mitigation deposition, thus providing a quantitative estimate of effectiveness of mitigation, prior to the introduction of the mitigation action itself.

Supplement Attachment #10 shows how this monitoring program fits within the EEM Framework. The approved Key Questions are actively being addressed by the monitoring program:

1) "Has deposition of airborne contaminants changed?" This is addressed by the spatial design of the deposition network (i.e., sites centered around major emission sources extending to 'background' areas) as well as the length of time monitoring data have been collected for (i.e., over 20 years in some cases). GEM-MACH is also able to answer this question. An on-going TAC priority is to formalize 'baseline' and 'limits of change' within the context of the EEM framework.
2) "Different methods currently being used but require further consideration." This is being addressed by Objective #9 that will evaluate measurement data against each other, and to GEM-MACH output, as well as the development of a test site to co-locate all the different methods currently being used to monitor deposition (Objective #10).
3) "Is there an effect on the receiving environment?" This is being addressed by soil/vegetation monitoring (this

work plan), health assays (this work plan), and monitoring conducted in other work plans and theme areas (see Supplement Attachment #10). Modelling of critical load exceedances also provide an estimate of potential future change, and of locations where change is most likely to occur, for possible adaptive monitoring.
4) “What is the extent of deposition of compounds of concerned?” This is addressed by the spatial design of the deposition network and GEM-MACH output, as noted in response to Key Question #1.

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 work plan monitors a wide range of contaminants (e.g., PACs, trace metals) that are of concern to communities. There are potential impacts of contaminants on wildlife health and human health through consumption of country foods. Deposition monitoring data are also used to assess ecological changes to forests, wetlands, and surface water quality, which are relevant to communities and contain resources of importance. GEM-MACH's capabilities are being assessed in regards to predicting odour events and attributing the sources of these events. Exposure to a range of pollutants can be provided through the use of GEM-MACH simulations. Participatory community involvement is undertaken during snowpack sampling and through membership in airshed organizations.

The WBEA's long-term surveillance program was initiated due to concerns expressed by local Indigenous community members about the potential impacts of atmospheric deposition on forest health and they have continued to be key participants in the technical and general membership that oversees this surveillance program.

The SLFN focused study embedded within this core work plan directly investigates Indigenous community key questions and concerns and is driven by SLFN. The focused study will first document effects experienced by community members, as well as analyze existing data sets (i.e., GEM-MACH, snowpack, and ambient air data) to assess linkages between OS sources and receptors. If a linkage is found and validated by source apportionment investigation or a monitoring is identified, then surveillance or core monitoring will proposed in subsequent work plans.

Project team members will continue to coordinate and liaise with ICBM Facilitation Centre, and support a consistent approach and implementation of engagement and/or integration of Indigenous community based monitoring, where appropriate. Members from the ICBM FC are invited to Air and Deposition TACs to help identify opportunities for collaboration and integration.

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.

This work plan monitors along a spatial gradient of deposition around the surface-mineable region, and can use reference sites to ascertain background deposition. The TAC is formalizing definitions for 'baseline' and 'limits of change' to assess the extent to which change has occurred. Temporal changes have been assessed for a handful of parameters with a sufficiently long historical data set (e.g., SO2 and NO2 passives, Ion Exchange Resins, metals/ions/total suspended sediment/total organic carbon in snowpack samples, and PACs in dated sediment cores). Source attribution techniques and GEM-MACH modelling scenarios have been used to delineate change in deposition due to OS and non-OS sources. Deposition data (measured and modelled) are also used by other themes to identify environmental changes, such as vegetative changes at wetland bog sites, and PACs loadings in specific biota or ecosystem compartments (e.g., sediments). Deposition monitoring is focused on the surface-mineable region where the change in deposition and risk for ecological response from deposition is the greatest. Modelling is used for estimating deposition in both the surface mineable region and for ecosystems much further downwind, and has suggested impacts may potentially occur in sensitive ecosystems hundreds of kilometres downwind of the sources. Spatial maps of deposition generated by GEM-MACH and/or measurement data (if available) may be used to identify regions of highest risk, allowing for adaptive monitoring as defined by the EEM framework.

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.

Deposition monitoring at ecological sites where deposition is causing an observed or likely response helps to track sub-regional state of the environment. Hence, monitoring the deposition of key stressors at forest, wetland, and near-river sites are appropriate (and necessary) for answering "are changes occurring?" and "are these changes related to OS emissions?". As noted in Objective #9, deposition data are, and will continue to be, used for comparing to modelled data. Monitored and modelled deposition data are also used, and in some cases combined (model-measurement fusion), to create deposition maps which provide a regional perspective to inform on environmental processes (e.g., acidification, eutrophication, contaminant exposure). These depositions maps are needed, and currently used, by other work plans and theme areas for informing site selection and understanding contaminant exposure via deposition. Evaluated GEM-MACH deposition maps provide deposition estimates in areas without monitoring, thereby allowing EEM endpoints and cumulative effects to be assessed across the entire oil sands region and impacted regions further downwind. These maps identify regions at greatest risk of environment change, hence feed into EEM's adaptive monitoring concept.

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.

Monitoring data are made publicly available on appropriate timescales in appropriate formats at the following websites: https://www.alberta.ca/alberta-air-data-warehouse.aspx, WBEA website (www.wbea.org) and the WBEA time-integrated data search tool (https://wbea.org/network-and-data/integrated-data-search/), and https://www.canada.ca/en/environment-climate-change/services/oil-sands-monitoring.html. Some data are available within months of collection (e.g., passive gas samplers), whereas other samples (e.g., snowpack, lichen) require extensive lab analysis and QA/QC prior to being posted. Data are also available on the OSM data portal. Annual progress reports are delivered by each airshed organization and through this work plan. Project team members listed in this work plan provided data, figures, analyses, and text for the programmatic State of Environment (SoE) report. Data and findings are shared during TAC and other working group meetings as well as publicly available via the oil sands data portal. Journal paper drafts will continue to be submitted for information and comment to stakeholders and TACs, as well as through the formal OSM publication review process.

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 allocation of resources in this work plan is focused on deposition monitoring where evidence for a link between an OS-related stressor and an ecological effect is greatest. Specifically, the majority of the proposed budget is allocated to monitoring and modelling nitrogen, sulphur, and base cation deposition at jack pine and wetland bog sites, where changes in vegetation as a result of deposition of these stressors has been reported. The next largest allocation of resources is for snowpack and lichen sampling of nitrogen, sulphur, base cations, PACs, trace metals, and mercury, which is used by the Aquatic Ecosystem Health work plan to assess contaminant input into nearby rivers and input of snowmelt into groundwater reservoirs (via a mass balance approach). This work plan is also integrated with the Atmospheric Pollutant Active Monitoring Network work plan (A-LTM-S-1-2223). Data from each program informs the collective understanding of the impact of oil sands development on air quality and atmospheric deposition.

The cost of purchasing, implementing, operating, and maintaining atmospheric deposition monitoring stations is significant and, in many cases, more expensive in the oil sands region because of challenges with power and road access. The monitoring sites have multiple monitoring objectives and management frameworks that need to be addressed (EPEA approvals, ADMF, 2009 Alberta Ambient Air Monitoring Strategy, 2019-2024 Alberta Science Strategy, OSM Monitoring Objectives). Addressing these have led to higher than anticipated cost. These costs are compounded by remote site access, power availability, and overall higher cost of services.

This work include a significant degree of in-kind and leveraged resources (equivalent to $3,599,624). Through ECCC's participation, the OSM Program accesses a team of over 70 research scientists, as well as additional work by university researchers funded under ECCC's Grant and Contribution Research program. This in-kind contribution includes access to ECCC's Cray XC-50 computer systems for the modelling work, and the analysis laboratories within the processes section. The data collected by past focused studies conducted under the OSM program continue to be leveraged in the improvement and application of GEM-MACH.

Specific roles are provided in Section 15, and the specific in-kind contributions from ECCC for equipment and staff time are listed in Section 18. There are coordinated efficiencies between partner organizations on this project, such as coordinated sample change out at sites with multiple types of samplers. Most of the deposition monitoring sites are co-located at sites that monitor some form of ecological response. Based on previous workshops and reports (i.e., Wentworth and Zhang, 2018; Swanson 2019a,b), there is little-to-no duplicative deposition monitoring in the OS Regions.

10.0 Work Plan Approach/Methods

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

Note: these phases occur concurrently

PHASE 1: Ambient Deposition Surveillance Monitoring
•Deploy and/or maintain, and analyze/interpret:
oOpen and throughfall IERs to calculate wet and total nitrogen, sulphur, and base cation deposition at jack pine and bog sites.
oPassive gas samplers to calculate dry deposition of SO2, NO2, NH3, HNO3, and O3 at jack pine, bog, Peace River, and Cold Lake soil sites.
oAnnular denuders and filter packs to calculate dry deposition of NH3, HNO3, and particulate matter components at selected jack pine sites.
oPortable ozone monitors to calculate dry deposition of O3 at selected jack pine sites.
oPACs passive samplers to calculate dry deposition at selected jack pine, wetland, and air quality stations.
oSnowpack samples for PACs, trace metals, nitrogen, sulphur, phosphorous, and speciated mercury to calculate accumulated wintertime deposition across the surface-mineable region. These data are required by the Aquatic Ecosystem Health work plan. Samples are also shared with the Groundwater program for isotopic analysis.
oContinuous nitrogen and sulphur species, combined with existing CAPMoN filter pack and precipitation measurements, to calculate total deposition at two transboundary sites. These two transboundary sites also have base cation and precipitation monitoring that is not funded by the OSM Program. This work will be adapted (reduced/removed) in 2023 if analysis (completed by 2022) shows minimal influence from OS-related emissions.
oCollect monthly precipitation samples at three sites for isotopic analysis, on behalf of the Groundwater TAC.
oCollect lichen samples to understand deposition patterns of N, S, base cations, trace metals, and PACs in the Athabasca Oil Sands region.
oGenerate deposition maps for stressors in collaboration with the Geospatial work plan, and conduct source attribution studies, as required by other themes.
oCompile and interpret relevant GEM-MACH, snowpack, and ambient air quality data to assess exposure of SLFN to OS emissions, and/or identify monitoring data gaps within the air monitoring network.

PHASE 2: Effects Surveillance Monitoring
•Collect soil samples for acidification indicators at a soil plot in the Cold Lake region.
•Analyze PACs passive samplers using health assays to assess potential health effects from exposure to PACs and trace metals.
•Perform annual site maintenance at forest health monitoring sites (intensive soil and vegetation sampling occurs on a 1-in-6 year cycle with the next cycle being scheduled for 2024; however, sites require annual maintenance).

PHASE 3: Model Development and Comparison to Observations
•Develop a deposition approach to be used in a dispersion model to generate gridded air concentration and deposition maps for trace metals, and to improve our understanding of specific emission sources.
•GEM-MACH Modelling: the intent is for GEM-MACH deposition output to be used as a core component of the OSM Program during 2022, such that the model will have been sufficiently evaluated and will be used to provide annual deposition maps and other model scenarios/forecasts on an on-going basis.
-During 2021/22, the following activities took place (see Supplemental Attachment #12 for more details): (i) emissions update, (ii) model process improvements, (iii) odour event source analysis and forecasting, (iv) model-measurement comparison, (v) generation of model-measurement fusion deposition maps, (vi) stakeholder consultation on desired model scenario runs and forecasts, and (vii) transition of modelling products to a routine (core) part of the OSM Program.
-During 2022/23, the following activities will take place: (i) the documentation of model evaluation carried out in 2022/2023 will be completed, (ii) model deposition maps, including those generated from model-measurement fusion from the 2021/2022 simulations will be provided to stakeholders and other TACS, (iii) Adaptive Monitoring products will be generated using model output, (iv) emissions will be updated for ongoing annual deposition maps, to improve odour event forecasts, and in response to evaluation results, (iv) model process

improvements based on evaluations will continue, and (v) stakeholder consultation via TAC on desired core model scenario runs and forecasts will continue.

•Generate deposition maps for stressors in collaboration with the Geospatial work plan, and conduct source attribution studies, as required by other themes.
•Support the SLFN focused study by providing relevant GEM-MACH output (and expertise in interpreting), as required and feasible.

PHASE 4: Improving deposition sampling and further aligning with the EEM framework
•Continue to deploy all deposition monitoring technologies at a single "test site" (e.g., AMS18 Stony Mountain) to continually assess the comparability of data generated by complementary deposition monitoring techniques.
•Continue testing surrogate surface samplers for quantifying and characterizing fugitive dust deposition.
•Ambient PACs levels in air have not changed significantly since 2012. The number of PACs passive air monitoring sites were reduced, and some are being redeployed to the Cold Lake and Peace River OSRs.
•Spatial maps of lichen concentrations and snowpack deposition will be integrated to better understand annual deposition rates of fugitive dust, PACs, and trace metals.
•Use model estimates of critical load and critical level exceedances to identify locations most at-risk for change, and hence possible adaptation of surveillance monitoring.
•Continue to develop definitions for "baseline" and "limits of change" for deposition indicators. This will be done through the Air and Deposition TAC.
•Continue to review the existing monitoring network and document the purpose or objective for each parameter monitored at each station
•Develop a shared understanding of regulatory and community expectations for monitoring that will guide the adjustment of the current long-term surveillance program to fit the OSM adaptive monitoring framework.

10.2 Describe how changes in environmental Condition will be assessed *

In general, changes in the environment are assessed in three different ways: i) analyzing changes in observed and modelled deposition over time, ii) analyzing changes in observed and modelled deposition over space, and iii) conducting "zero-out", past, and projected future year emissions scenarios with models (i.e., setting specific sources in the model to zero and comparing modelled data with and without a specific source). Deposition monitoring sites are primarily set up along a spatial gradient around known emission sources allowing for the detection of change in deposition across the landscape. Modelling is used to identify locations where ecosystem change is most likely to occur or may have occurred in the past. Deposition monitoring is used to assess change over time for at least as far back as the monitoring data are available, and in some cases even further (e.g., using tree cores, sediment cores). Changes in deposition are linked to assessing environmental effects indicators through co-location of deposition monitoring at jack pine, wetland bog, and soil sites. Chemical transport and dispersion models, as well as source attribution techniques, are used to quantify changes in deposition based on specific emission sources. The potential for future change is assessed using model and projections of future emissions and/or mitigation activities.

However, "baseline" and "change" have not been formally defined within the context of the OSM EEM framework. Hence, the TAC will continue to develop baseline and limits of change for deposition indicators.

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

There are only a few Alberta-specific benchmarks for deposition: critical loads of acidity (e.g., WBEA, 2015; Makar et al., 2018), and critical levels for annual sulphur dioxide and nitrogen dioxide air concentrations (i.e., Alberta's Ambient Air Quality Objectives, and Lower Athabasca Regional Plan annual limits/triggers). The CEMA Acid Deposition Management Framework (ADMF) and Interim Nitrogen (Eutrophication) Framework also have some relevant regional thresholds for acidification and eutrophication, respectively. Team members of this work plan will ensure that proponents of the ADMF are kept informed, through the Acid Deposition Assessment Group (ADAG), about results of acidic critical load exceedances work detailed in this work plan, and will work together to promote alignment and resolve any differences related to methodology or reporting results.

Most relevant benchmarks are for concentrations or loadings within the ecosystem after a substance has deposited – these benchmarks are assessed by other themes. Spatial, temporal, and source-specific changes have been assessed against a "background" benchmark, which is what the deposition would be in the absence of anthropogenic emissions, and may be quantitatively assessed through model scenario simulations. Change in ecological indicators (i.e., a response) is often assessed by other themes using, in part, deposition monitoring data and/or GEM-MACH modelling. Some effects surveillance monitoring (i.e., soil acidification, vegetation changes, human health assays) is done under this work plan.

(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: Ambient Deposition Surveillance Monitoring
•Ion Exchange Resin (IER): a precipitation collector that contains resin beads which retain sulphate, ammonium, nitrate, and base cations over a 6-month period. Samples are extracted in a lab and wet or throughfall deposition is calculated.
•Passive Gas Samplers: a diffusive membrane collects a single air pollutant onto a sampling medium over a 1-month, 2-month, or 3-month time period. Samples are extracted in a lab and average air concentrations over the sampling period are calculated. An inferential model (requiring meteorological data) is then used to estimate dry deposition.
•Annual Denuders and Filter Packs: air is actively pumped through an annular denuder to capture gases in the air. Filter packs are located behind the denuder to capture particulate matter. Denuders and filters are collected monthly and provide a more accurate measurement than passive samplers, as well as particulate matter composition. Denuders and filters simultaneously monitor multiple pollutants, including: nitric acid, ammonia, and particulate matter composition. Samples are extracted in a lab and average air concentrations over the sampling period are calculated. An inferential model (requiring meteorological data) is then used to estimate dry deposition.
•Portable Ozone Monitors: air is actively pulled through a continuous analyzer (using a pump) to monitor 15-minute averaged ozone concentrations. Data are reported in near-real time and the monitors only need to be visited for maintenance and repair (i.e., no lab extraction or analysis is needed). An inferential model (requiring meteorological data) is then used to estimate dry deposition.
•Snowpack Sampling: collect snow samples with members of Mikisew Cree First Nation and quantify PACs, mercury, and trace metals using state-of-the-science techniques described in Kirk et al. (2014). Calculate wintertime deposition using snowpack concentrations, depth, and density. Data are required by the Aquatic Ecosystem Health work plan to calculate contaminant mass balance in rivers and tributaries, and provide background values for metals deposition.
•Meteorological Towers: continuously measure standard meteorological parameters (e.g., temperature, wind speed, wind direction) at heights within and above the canopy. These data are used to calculate dry deposition and to provide input data to dispersion models.
•Wet Deposition Sampling: collect weekly wet-only precipitation samples using an automated collector. Isotopic analysis of precipitation is covered under the Groundwater Monitoring work plan (GW-LTM-S-3-2122).
•Continuous Analyzers: a variety of continuous and integrated air sampling monitors are deployed at the two long-range deposition sites in Saskatchewan. The continuous measurements complement the existing Canadian Air and Precipitation Monitoring Network (CAPMoN) instrumentation at these sites. The integrated sample parameters are monitored through an in-kind contribution from CAPMoN.
•Lichen Sampling: lichen samples are collected from ~130 sites around the Athabasca OSR every 6 years, and at a smaller spatial scale during forest health monitoring sampling campaigns, and analyzed for sulphur, nitrogen, trace elements, PACs, and lead isotopes. These data are used to estimate atmospheric deposition patterns and to conduct source apportionment modelling. Activities for this fiscal year are restricted to analysis of previously collected samples.

PHASE 2: Effects Surveillance Monitoring
•Soil Sampling: collect soil samples at 7 different depths and a leaf litter sample in the Cold Lake OSR. Analyze samples for indicators of potential acidification (e.g., pH, total C, total N, total S, and cation exchange capacity) using standard analytical techniques.
•Forest Health Monitoring: soil and vegetation sampling occurs every sixth year in the Athabasca OSR. In 2021-

22, two new forest health sites were established in the southern area of the Athabasca OSR due to gaps in this area of the network and new requirements of southern operators to participate in a regional deposition program. Activities for this fiscal year are limited to annual site maintenance, as well as analysis of the soil and needles collected during site establishment.
•Health Assays: extracts of PACs and PM are taken from air samplers (see Phase 1) and subjected to chemical assays that are a proxy for human health. These data give a relative indication of potential health effects from airborne contaminants.

PHASE 3: Model Development and Comparison to Observations
•Measurement data of air concentrations and wet deposition of trace metals at four sites are used to develop an approach for calculating dry and wet deposition based on air concentrations and precipitation. This approach is then used in a dispersion to develop an annual deposition map of trace metals across the surface-mineable region. This approach is analogous to the approach used for generating PACs deposition maps for this work plan in previous fiscal years.
•GEM-MACH work will include provision and dissemination of: (i) model evaluation results against monitoring network and other data from simulations carried out in FY2021/2022, (ii) model deposition maps (including model-measurement fusion results) in GIS format for stakeholders and other groups, (iii) model post-processing of maps aimed at Adaptive Monitoring needs, (iv) odour event and other FN-relevant model products. Based on the model evaluation in (i), additional activities will include improvement of model science and prediction capabilities, and improvements in model input emissions data.
•FY2022/2023 will see the completion of GEM-MACH deposition output as a core component of the OSM Program, characterized by an annual cycle of (i) model simulations of past and projected years; (ii) simulation evaluation against monitoring network data, (iii) provision of model-measurement fusion deposition and other Adaptive Monitoring-relevant maps as GIS data to other TACs and stakeholders; (iv) provision of odour event and other FN-relevant model products to stakeholders; (v) updates and improvements to model science based on evaluation results and stakeholder and client consultation via TAC and other meetings.
•Complete analysis and reporting of 2017/18 AEP-NOAA flights. Measurement data have been posted publicly on the OSM Data Catalogue and two manuscripts have been drafted. This work will complete in 2022/23.

PHASE 4: Improving deposition sampling and further aligning with the EEM framework
•Surrogate surface samplers have been developed to quantify and characterize fugitive dust deposition (see Hall et al., 2017). These samplers are being tested at a handful sites in the Athabasca OSR to verify the efficacy for use in the AOSR. If validated, these samplers will provide critical complementary information to snowpack and lichen sampling, and improve regional estimates of fugitive dust deposition.
•Methodology described above will be co-located at a test site (e.g., AMS18 Stony Mountain) for the purposes of on-going validation to understand the extent of data comparability.
•The review and documentation of the existing monitoring network objectives, as well development of baselines and limits of change, will be done through the Air and Dep TAC. Consideration will be given to regulatory and Indigenous criteria for monitoring as it is understood by the Project team and TAC members.

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

In some cases, deposition data are used directly to assess potential ecological effects (e.g., acid critical loads). However, more often than not, deposition data are used by other projects to assess causal linkages to changes in biological indicators. The following bullet points detail which stressors are measured and/or modelled:

•Air concentrations of trace gases (i.e., SO2, NO2, HNO3, NH3, O3, and dozens of polycyclic aromatic compounds) and particulate matter composition (sulphate, nitrate, ammonium, calcium, magnesium, potassium, sodium, and dozens of polycyclic aromatic compounds). These air concentrations are used to calculate dry deposition using an inferential model. Air concentrations of most of these parameters are also provided as GEM-MACH maps.
•Quasi-wet (i.e., open) and throughfall deposition of ions in precipitation (i.e., sulphate, nitrate, ammonium, calcium, magnesium, potassium, and sodium) around the surface-mineable area.
•GEM-MACH maps of wet and dry deposition fluxes of sulphur, nitrogen, and base cation species are provided at 2.5km resolution over all of Alberta and Saskatchewan, as well as maps of critical levels and critical load exceedances.

•Total accumulated wintertime deposition of dozens of PACs, trace metals, mercury, and methylmercury around the surface-mineable area. •Wet deposition measurements of ions in precipitation (in-kind) at two long-range CAPMoN sites in Saskatchewan, as well as three sites in the OSR used for isotope analysis (covered by the Groundwater TAC).

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.*

Knowledge transfer will occur through several means: TAC meetings, an OSM annual report, peer-reviewed publications, contribution to OSM State of Environment (SoE) reporting, and airshed annual reports. It is expected that TAC members will disseminate pertinent information from these meetings to their respective organizations. Peer-review publications listed in Section 14 will transfer knowledge to the OSM Program through internal review processes, as well as the broader scientific community thereby providing a degree of scientific credibility to OS deposition monitoring program. Airshed and project annual reports will contain high-level summaries of data that have been collected.

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

•Airshed organizations (WBEA, LICA, and PRAMP) will deliver components of all four phases. The associated contracts for WBEA, LICA, and PRAMP are 20AEM842, 20AEM843, and 20AEM844, respectively. Airshed organizations are also contracted to swap out passive air samplers and collect precipitation samples on behalf of ECCC and the Groundwater TAC.
•The SLFN focused study work will be led by SLFN through a grant.
•Portions of the modelling component of this proposal (Phase 3) will be delivered through external contractors hired by ECCC. Emissions data for model simulations are gathered with the assistance of AEP and industry sources, as well as ECCC's National Pollutant Release Inventory. Additional collaborators may be identified as the project proceeds.

*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:

2022-04-01

13.5 Estimated Data Collection End Date:

2023-03-31

13.6 Estimated Timeline For Upload Start Date:

2022-06-01

13.7 Estimated Timeline For Upload End Date:

2023-09-30

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

NO

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
Ion Exchange Resin	*https://wbea.org/network-and-data/integrated-data-search/*	.csv	Open by Default
Passive Air Samplers (NO2, NH3, HNO3, SO2, O3)	https://wbea.org/network-and-data/integrated-data-search/	.csv	Open by Default

Passive Air Samplers (NO2, NH3, HNO3, SO2, O3)	*https://lica.ca/airshed/report-tracking/non-continuous-monitoring-data-reports/*	.csv	Open by Default
Denuders and Filter Packs	*https://wbea.org/network-and-data/integrated-data-search/*	.csv	Open by Default
Portable Ozone Monitors	*https://wbea.org/network-and-data/integrated-data-search/*	.csv	Open by Default
Enhanced N&S Measurements at CAPMoN Sites	ECCC OSM data portal	.csv	Open by Default
Snowpack Samples	ECCC OSM data portal	.csv	Open by Default
PAC Passive Samples	ECCC OSM data portal	.csv	Open by Default
Soil Samples	www.lica.cahttps://wbea.org/network-and-data/integrated-data-search/	.xslx	Open by Default
Lichen Samples	*https://wbea.org/network-and-data/integrated-data-search/*	.csv	Open by Default
GEM-MACH Output	*ECCC OSM data portal*	GIS files	Open by Default
2018 ECCC Flight Data	*ECCC OSM data portal*	.csv	Open by Default

2017 ECCC Settling Pond Data	*ECCC OSM data ortal*	.csv	Open by Default

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
Other (Describe in Description Section)	Q1	On-going sample collection, site maintenance, analysis, and data processing for routine monitoring
Other (Describe in Description Section)	Q2	On-going sample collection, site maintenance, analysis, and data processing for routine monitoring
Other (Describe in Description Section)	Q3	On-going sample collection, site maintenance, analysis, and data processing for routine monitoring
Other (Describe in Description Section)	Q4	On-going sample collection, site maintenance, analysis, and data processing for routine monitoring
OSM Program Annual Progress Report (required)	Q4	OSM Annual Progress Report
Condition of Environment Report	Q4	Contribute to OSM State of Environment report, as required
Technical Report	Q3	Summary of results from the 2017-18 AEP-NOAA Greenhouse Gas Measurement Flights
Peer-reviewed Journal Publication	Q2	Manuscript(s) about algorithm comparison and/or VOC canister data from AEP-NOAA flights
Other (Describe in Description Section)	Q2	GEMMACH model products delivered as GIS files to the OSM Data Catalogue: deposition maps, critical load and level exceedances, adaptive monitoring maps
Conference Presentation	Q4	Conference presentations on GEM-MACH evaluations, odour event analysis, process improvement related analysies (likely 4+, to occur throughout fiscal year)

Peer-reviewed Journal Publication	Q4	ECCC-led journal publications from model-measurement evaluation, odour event analysis and prediction, cumulative effects estimation, model science improvements, and focus study measuremeants (i.e., aircraft derived emissions and transformation) to be delivered throughout the fiscal year
Stakeholder or Community Presentation	Q2	Webinar on GEM-MACH evaluation using monitoring data
Key Engagement/Participation Meeting	Q3	Stakeholder/TAC discussion on next steps for modelling: desired maps and Adaptive Monitoring products. This will also be a topic of discussion at a TAC meeting in Q3 of 2021/22.
Peer-reviewed Journal Publication	Q1	Draft manuscript describing an emission database of trace elements
Peer-reviewed Journal Publication	Q2	Draft manuscript describing total (dry+wet) deposition of trace elements (deposition maps will be available)
Peer-reviewed Journal Publication	Q4	Materials (data, table and figures) for assessing the relative contributions of oil sands emissions and other emission sources to the ambient concentrations and atmospheric deposition of trace elements
Peer-reviewed Journal Publication	Q4	Baseline data for PACs in air in Cold Lake and Peace River: comparison of open pit and in-situ mining areas
Peer-reviewed Journal Publication	Q3	Health Assessment of PM at community sites in the oil sands region
Peer-reviewed Journal Publication	Q4	Assessing oxidative stress in air across the oil sands region

Key Engagement/Participation Meeting	Q4	Continue TEEM program development and collaboration with science advisors and Knowledge Holders. This includes engagement with communities, science advisors, and stakeholders on FHM program findings and path forward (on-going throughout the year)

Other (Describe in Description Section)	Q4	Analysis of surrogate surface sampler media and correlation with active air samling data to support the evaluation of the methodology

Peer-reviewed Journal Publication	Q4	Draft manuscript on the temporal and spatial change of deposition based on most recent data

Technical Report	Q3	Final report on GEM-MACH model-measurement comparison

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.*

•Greg Wentworth (Project Lead) – provide co-ordination between team members, as well as facilitate alignment with the OSM Program and integration with other themes
•Erin Horb (Project Management) – support project lead in managing contracts, SoE development, and development of station objectives, baselines, and limits of change
•Bob Myrick (Project Management) – support project lead in managing contracts
•Carla Davidson (SIKIC Support) – provide programmatic oversight
•Sanjay Prasad (Component Lead) – complete deliverables linked to the WBEA
•Michael Bisaga (Component Lead) – complete deliverables linked to LICA and PRAMP
•Lily Lin (Component Lead) – complete deliverables linked to LICA and PRAMP
•Tom Harner (Component Lead) – complete deliverables linked to PACs in air and deposition
•Jane Kirk (Component Lead) – complete deliverables linked to snowpack sampling
•Leiming Zhang (Component Lead) – complete deliverables linked to inferential deposition modelling and dispersion modelling
•Jason O'Brien (Component Lead) – complete deliverables linked to enhanced N&S measurements at downwind enhanced CAPMoN sites
•Paul Makar (Component Lead) – complete deliverables linked to GEM-MACH modelling
•John Liggio (Component Lead) – complete deliverables linked to emissions, transformation, and fate data analyses used for GEM-MACH improvements
•Mandy Olsgard and Becky Kostka (Component Lead) – complete deliverables linked to SLFN focused study

This team consists of experts who possess substantial knowledge and experience monitoring and modelling each component they lead. There are no major gaps in personnel or expertise, although subject matter experts will be brought in, if required, on an as needs basis for specific issues. There is also a risk of expertise gaps developing if suitable postdoctoral personnel are not found and hired.

The Project Lead is primarily a coordination role, and leads the development of the work plan as well as deliverables associated with improving integration and further aligning the project with the EEM framework. Component Leads directly oversee and deliver on specific components of the work plan, due to their expertise and knowledge. Additional personnel are listed in subsequent sections and assist with sample collection, field work, data analysis, data interpretation, and reporting. There are significant in-kind contributions for staffing and capital costs (equivalent to $3,599,624). Most of the ECCC staff, including component leads, are providing their expertise in-kind.

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
Wentworth, Greg	Project Lead and Scientific Support for AEP-NOAA Flights	50%
Myrick, Bob	Project Management	5%
Horb, Erin	Project Management and Support	50%
Adams, Cristen	Scientific Support for AEP-NOAA Flights	10%
Zhang, Lucas	Scientific Support for AEP-NOAA Flights	10%

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
Schuster, Jasmin	Scientific Support for PACs	50%
Post-Doc (RES-01)	Scientific Support for PACs (PM Assays)	100%

Part-time Casual (CH-02)	Scientific Support for PACs (PM Assays)	25%
Ngo, Jimmy	Technician for N+S Transboundary Measurements	100%
Part-time Casual (PC-02)	Scientific Support for Trace El	25%
Leonardelli, Sandro	OSM Coordination	100%
Wentzell, Jeremy	Scientific Support for Transformation	100%
Post-Doc (RES-01)	Scientific Support for GEM-MACH	100%
Post-Doc (RES-01)	Scientific Support for GEM-MACH	100%
Post-Doc (RES-01)	Scientific Support for GEM-MACH	100%
Scientist (PC-02 or RES-01)	Scientific Support for GEM-MACH	100%
Majdzadeh, Mahtab	Scientific Support for GEM-MACH	100%
Scientist (PC-02)	Scientific Support for GEM-MACH	100%
Scientist (PC-02)	For additional GEM-MACH simulations (250 m modelling, scenarios, back-trajectories, adaptive monitoring) by REQA	100%
Post-Doc (RES-01)	Satellite Data Analysis	100%
Scientist (PC-02)	Snowpack field work and analysis	100%

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		$0.00
Project-related travel		$0.00
Engagement		$0.00
Reporting		$3,000.00
Overhead		$0.00
Total All Grants *(Calculated from Table 16.4 below)*		**$26,900.00**
Total All Contracts *(Calculated from Table 16.5 below)*		**$3,014,328.00**
Sub- TOTAL *(Calculated)*		**$3,194,228.00**
Capital*		$0.00
AEP TOTAL *(Calculated)*		**$3,194,228.00**

* 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		$1,644,968.92
Operations and Maintenance		
Consumable materials and supplies		$666,442.00
Conferences and meetings travel		$45,000.00
Project-related travel		$50,000.00
Engagement		$1,000.00
Reporting		$42,000.00
Overhead		$179,912.88
ECCC TOTAL *(Calculated)*		**$2,629,323.80**

* 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	Becky Kostka
GRANT RECIPIENT - ONLY: Organization	Smith's Landing First Nation
Category	**Total Funding Requested from OSM**
Salaries and Benefits	$16,200.00
Operations and Maintenance	
Consumable materials and supplies	$0.00
Conferences and meetings travel	$5,300.00
Project-related travel	$3,000.00
Engagement	$2,400.00
Reporting	$0.00
Overhead	$0.00
GRANT TOTAL *(Calculated)*	**$26,900.00**

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	Sanjay Prasad
CONTRACT RECIPIENT - ONLY: Organization	Wood Buffalo Environmental Association
Category	**Total Funding Requested from OSM**
Salaries and Benefits	$595,000.00
Operations and Maintenance	
Consumable materials and supplies	$1,215,490.00
Conferences and meetings travel	$0.00
Project-related travel	$0.00
Engagement	$40,000.00
Reporting	$167,799.00
Overhead	$540,676.00
CONTRACT TOTAL *(Calculated)*	**$2,558,965.00**
CONTRACT RECIPIENT - ONLY: Name	Michael Bisaga
CONTRACT RECIPIENT - ONLY: Organization	Lakeland Industry and Community Association
Category	**Total Funding Requested from OSM**
Salaries and Benefits	$25,545.05
Operations and Maintenance	
Consumable materials and supplies	$311,139.60
Conferences and meetings travel	$1,935.00
Project-related travel	0
Engagement	0
Reporting	$60,510.00
Overhead	$6,233.25
CONTRACT TOTAL *(Calculated)*	**$405,362.90**
CONTRACT RECIPIENT - ONLY: Name	Mike Bisaga
CONTRACT RECIPIENT - ONLY: Organization	Peace Reiver Area Monitoring Program
Category	**Total Funding Requested from OSM**
Salaries and Benefits	$28,901.63
Operations and Maintenance	
Consumable materials and supplies	$19,787.10
Conferences and meetings travel	0
Project-related travel	0
Engagement	0
Reporting	$1,311.27

Overhead	0
CONTRACT TOTAL *(Calculated)*	**$50,000.00**

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***	$1,794,968.92
Operations and Maintenance	
Consumable materials and supplies *Sums totals for AEP and ECCC ONLY*	$666,442.00
Conferences and meetings travel *Sums totals for AEP and ECCC ONLY*	$45,000.00
Project-related travel *Sums totals for AEP and ECCC ONLY*	$50,000.00
Engagement *Sums totals for AEP and ECCC ONLY*	$1,000.00
Reporting *Sums totals for AEP and ECCC ONLY*	$45,000.00
Overhead *Sums totals for AEP and ECCC ONLY*	$179,912.88
Total All Grants (from table 16.2.1 above) *Sums totals for AEP Tables ONLY*	$26,900.00
Total All Contracts (from table 16.2.1 above) *Sums totals for AEP Tables ONLY*	$3,014,328.00
Sub- TOTAL	$5,823,551.80
Capital* *Sums total for AEP*	$0.00
GRAND PROJECT TOTAL	$5,823,551.80

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.*

It is challenging to assess whether this project was overspent or underspent in 2020/21, since Q3 has just started. However, there are no significant budget discrepancies anticipated. Potential risks and barriers include delays in the contract approval process, travel restrictions for government personnel, and delays in hiring new personnel (if applicable).

Detailed budgets and other information are available as the following Supplemental Attachments:

•Sup01: Total budget breakdown by sub-project
•Sup02: Detailed WBEA budget
•Sup03: Detailed LICA budget
•Sup04: Detailed PRAMP budget
•Sup05: Detailed ECCC budget for snowpack sampling
•Sup06: Detailed ECCC budget for PACs passives, health assay, dispersion modelling, and transboundary sites
•Sup07: Detailed ECCC budget for GEM-MACH and transformation studies
•Sup08: Detailed Smith's Landing First Nation budget
•Sup09: Field sampling schedule
•Sup10: Schematic diagram of air and deposition monitoring activities within the EEM Framework
•Sup11: Draft WBEA Forest Health Monitoring adaptive management framework
•Sup12: Summary of GEM-MACH progress-to-date

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)
Harner, Tom	Component Lead - PACs	$54,141.00
Su, Ly	Technician - PACs	$121,817.00
O'Brien, Jason	Component Lead - CAPMoN	$42,207.00
Enhanced N&S Instrumentation	ECCC	$43,280.00
CAPMoN Sites (Operators and Infrastructure)	ECCC	$61,825.00
Zhang, Leiming	Component Lead – Trace Element Modelling	$40,606.00
Cheng, Irene	Scientist – Trace Element Modelling	$13,535.00
To be hired (using ECCC funds)	Scientist – Trace Element Modelling	$40,606.00
Liggio, John	Component Lead - Transformation	$67,676.00
Wheeler, Michael	Scientist - Transformation	$54,141.00
Leithead, Amy	Scientist - Transformation	$54,141.00

Moussa, Samar	Scientist - Transformation	$67,676.00
Hayden, Katherine	Scientist - Transformation	$54,141.00
Makar, Paul	Component Lead – GEM-MACH Modelling	$60,908.00
Lee, Colin	Scientist – GEM-MACH Modelling	$135,352.00
Stroud, Craig	Scientist – GEM-MACH Modelling	$40,606.00
Gong, Wanmin	Scientist – GEM-MACH Modelling	$27,070.00
Zhang, Junhua	Scientist – GEM-MACH Modelling	$27,070.00
Zheng, Qiong	Scientist – GEM-MACH Modelling	$27,070.00
Pabla, Balbir	Scientist – GEM-MACH Modelling	$27,070.00
Chen, Jack	Scientist – GEM-MACH Modelling	$13,535.00
Cheung, Phillip	Scientist – GEM-MACH Modelling	$13,535.00
Boutzis, Elisa	Scientist – GEM-MACH Modelling	$33,838.00
Lupu, Alex	Scientist – GEM-MACH Modelling	$6,768.00
Gordon, Mark (G&C – York U)	Scientist – acidification/critical loads	$72,770.00
Aherne, Julian (G&C – Trent U)	Scientist – acidification/critical loads	$72,770.00

Small fraction of annual ECCC development of GEM-MACH + supercomputer processing	GEM-MACH + deposition maps	$1,892,000.00
McLinden, Chris	Lead Scientist – Satellite Data	$78,592.00
Griffin, Debora	Scientist – Satellite Data	$26,197.00
Napolitano, Daniella	Project Coordination	$44,936.00
Boyer, Nora	Project Coordination	$31,070.00
Santos, Evarose	Project Coordination	$31,070.00
Cober, Stewart	Project Coordination	$31,070.00
Kirk, Jane	Component Lead - Snowpack	$78,000.00
Technical Support (ECCC-WSTD)	Snowpack Technical Support	$100,535.00
Nasr, Mina	Geospatial Technical Support	$12,000.00
	TOTAL	**$3,599,624.00**

19.0 Consent & Declaration of Completion

Lead Applicant Name

Greg Wentworth

Title/Organization

Atmospheric Scientist (AEP)

Signature

Greg Wentworth

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.