Work Plan Application

Project Information	
Project Title:	Integrated Geospatial Program
Lead Applicant, Organization, or Community:	Zhibang Lv
Work Plan Identifier Number: If this is an on-going project please fill the identifier number for 24/25 fiscal by adjusting the last four digits: **Example:** D-1-2425 would become D-1-**2425**	CC-2-2425
Project Region(s):	Oil Sands Region
Project Start Year: First year funding under the OSM program was received for this project (if applicable)	2024
Project End Year: Last year funding under the OSM program is requested **Example: 2024**	2025
Total 2024/25 Project Budget: From all sources for the 2024/25 fiscal year	1,474,500
Requested OSM Program Funding: For the 2024/25 fiscal year	6,545,550
Project Type:	Focus Study
Project Theme:	Cross-Cutting
Anticipated Total Duration of Projects (Core and Focused Study (3 years))	Year 1
Current Year (choose one):	Focused Study Year 2 of 3
	Core Monitoring -Select One-

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.	Zhibang Lv
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Project Summary

In the space below, please provide a summary 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 and **should not exceed 300 words**.

This project is driven by the need to establish an integrated centralized system for adaptive and comprehensive monitoring, evaluation, and reporting within the OSM Program. The goal of this project is to facilitate critical cross-cutting geospatial science support necessary to fulfill the overarching vision of the OSM Program, which emphasizes integration, transparency, and effectiveness.

The OSM Oversight Committee (OC) expressed a desire to have a programmatic approach to the delivery of geospatial science support for the OSM also expressed in the 2022-2023 funding conditions related to geospatial work plan. In response to this, a cross-cutting geospatial work plan was submitted in 2023-2024, and approved by the OC for delivery in 2023-2024, in which the OC indicated hosting “an all TACs meeting (or a series of TAC meetings) in Q1 to discuss geospatial products”. To this end, an all-TAC Geospatial Workshop was held on October 25th, 2023. Feedback from participants recommended holding future workshops involving both TAC and SIKIC, to further assess the geospatial needs of each TAC and the program as a whole. Building on insights from the workshop, which included maintaining a similar scope of work relative to 2023-2024, the work proposed for 2024-2025 consists of geospatial deliverables structured to align with this framework. Further, a series of workshops are proposed for delivery in 2024-2025, to develop the scope of an enhanced program-wide geospatial program and exploring collaborative geospatial projects tailored to the unique requirements of each TAC. It is expected that these upcoming workshops in 2024-2025 will result in a roadmap for a future OSM geospatial program that is collaborative, integrated, takes advantage of synergies, and devoid of duplicative work.

OSM TACs identified geospatial science needs for 2024-2025 theme-area programs. They compiled essential geospatial deliverables (Sup01), reviewed, and confirmed projects to avoid redundancy (or duplication). Data and products for OSM core/surveillance programs focus on key priorities: updating high-priority geospatial data (e.g., human footprint), acquiring earth observation data (e.g., LiDAR), and developing/updating geospatial tools/models (e.g., stressor mapping). GIS and remote sensing analyses address ongoing tasks, supporting site selections and environmental change assessments for theme-area programs. Direct access to these products and services will be available through the OSM Program's future Geospatial Data Portal.

The project remains committed to a science plan (Sup02) encompassing data production, integrated geospatial analysis, and needs assessment. This plan ensures program-wide geospatial deliveries align with OSM program needs and the adaptive monitoring framework, supporting geospatial deliverables tied to various TACs' 2024-2025 work plans.

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 Adaptive Monitoring 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 Adaptive Monitoring 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 or areas of limited knowledge is the work being designed to answer with consideration for the TAC specific Scope of Work Document (attached) and the Key Questions (attached)?
- Discuss results of previous monitoring/studies/development and what has been achieved to date. Please identify potential linkages to relevant sections of the State of Environment Report.

Geospatial data hold significant information including geographic coordinates, attribute information (the characteristics of the object, event, or phenomena concerned), and temporal information (the time or life span at which the location and attributes exist) (Stock et al. 2016), all play a critical role in monitoring and understanding how oil sands development impacts the environment in the Oil Sands Region. It helps identifying the source of change, the pathways through which these changes occur, and the responses of ecosystem to such alterations. Though a set of essential geospatial data production and analysis, this project is driven by several key drivers within the Adaptive Monitoring Framework, emphasizing surveillance, confirmation, and setting boundaries for acceptable changes in line with the OMS-approved key questions. Monitoring conducted by the theme areas (wetlands, terrestrial biological, surface water and aquatic biological, groundwater, air and atmospheric deposition) is explicitly spatial and requires coordinated data collection and analysis (Nasr and Monk 2022; Swanson 2019a,b). As a result, this project includes a collection of cross-cutting geospatial science needs compiled by OSM TACs.

In addressing the knowledge gap in Adaptive Monitoring, this project seeks to enhance the spatial and temporal resolution of geospatial data (e.g., high resolution human footprint disturbances data; detailed snow deposition maps). This will facilitate a more comprehensive understanding of the impacts of oil sands activities, which may have an adverse effect on the region's delicate ecosystems. Furthermore, the project aims to integrate the Geospatial Stressor-based Approach for the Assessment of Cumulative Effects (Sup03), providing a more holistic perspective on individual and combined effect of various stressors/ pressure indicators as a result of oil sands development and activities.

This project aligns seamlessly with the mandate of OSM Program, as it focuses on areas with limited knowledge, making strides in addressing TAC-specific requirements and key questions. It builds upon the results of previous monitoring and studies, leveraging past experiences and data to provide a robust foundation for comprehensive geospatial data and advance analysis tools.

The assessment of the aggregate response of ecosystem attributes (e.g., area and extent of water, forest regeneration, groundwater dependent ecosystem) to oil sands development activities is an on-going effort within the OSM Program. Field-based surveillance monitoring (e.g., estimates of vegetation regrowth; vegetation and biological health and status) of many sites across the Oil Sands Region and across time is cost prohibitive and often cannot be generalized across spatial domains. Geographic Information System (GIS) and remotely sensed technologies provide cost-effective and consistent measurements of some environmental attributes over large geographies, through time (Chasmer et al. 2020a,b) that can facilitate better understanding of impacts caused by oil sands activities at broader spatial scales.

The OSM source-pathway-effect based approach for the assessment of oil sands development effects on various ecosystems (i.e., air, terrestrial, wetlands, water) informs the identification of geospatial data for sources, pathways and ecosystem responses, and appropriate geospatial analyses and modelling to assess these relationships (Sup05). The three key oil sands source groups including Hydrologic Alteration (e.g., industrial water usage), Land Disturbance (e.g., human footprint inventory) and Contaminants (e.g., annual atmospheric deposition) are common environmental pressure groups identified by OSM conceptual models (Ficken et al. 2021), and a basis for OSM stressor mapping (Nasr 2021).

The OSM geospatial stressor-based approach for the assessment of cumulative effects (Sup03) supports problem formulation by identifying geospatial data for pressure/stressors and appropriate geospatial analysis and modelling to assess pathways and cause-effect relationships. This approach identifies pressure/stressor groups related to Hydrologic Alteration, Land Disturbance, Contaminants (e.g., air emissions/depositions and leaks/spills on land), and Human Pressure (e.g., population; light at night; noise). Using geospatial data, characterization of stressors and geospatial analyses conducted at a local scale are generalized across the entire Oil Sands Region. This stressor mapping is updated on annual basis based on new/updated data to further inform study design and site selection criteria, identifying areas that are high risk and low risk to oil sands development impacts. This information informs site selection and field monitoring design, and provides a means to update and optimize monitoring designs within the scope of OSM Program.

Ecological change associated with stressors such as hydrologic change is likely to be detected at the boundaries of habitat units, at a relatively fine scale. It is important to increase the spatial and temporal resolution of geospatial products and deliverables (including improved monitoring designs) for the Oil Sands Region. This can be achieved by using high-resolution LiDAR-derived landscape data as well as high-resolution temporal satellite images (e.g., LANDSAT, SENTINEL, RADARSAT) and other aerial data for assessing change (e.g., habitat mapping and vegetation cover changes, water extent and level mapping) over time and space. Watershed-level assessments using nested hierarchical watersheds are comparable with local projects (i.e., on-lease sites). However, existing topographic models, delineated watersheds/wetlands, and hydro features are not yet broadly available at suitable spatial resolution for regional and local assessments of environmental conditions in the Oil Sands Region.

Using OSM programmatic conceptual model, an additional effort could be made to finalize OSM Geospatial Stressor-based Approach for the Assessment of Cumulative Effects and integrate it with the assessment of spatial variabilities and changes of climate, unexpected events (e.g., wildfire), hydrological variabilities, and inherent characteristics of natural environment (i.e., landscape features and topography) as part of a watershed integrity approach to assess the Valued Component of ecosystem structure and function in OSM programmatic conceptual model (Flotemersch et al. 2015). This approach is not included in the activities of this work plan, but the data it offers allows OSM theme-area projects for the entire Oil Sands Region as well as local projects to analyze the links and routes between stressors and receptor/response indicators. This also allows careful collection, acquisition, and evaluation of OSM geospatial data in a form of an inventory that can be available through OSM Geospatial Portal for data sharing, visualization, mapping, and cross-cutting geospatial tools and analysis/modelling.

In summary, this project is at the forefront of OSM Program's mission to determine whether changes in the oil sands Region are occurring, understand the causes behind these changes, and evaluate their cumulative effects. It achieves this by utilizing advance geospatial techniques and by addressing critical knowledge gaps in the realms of adaptive monitoring. Through rigorous identification of program-wide geospatial science needs, this project will commit to carry on ongoing OSM geospatial needs discussions and workshops.

References:

Chasmer, L., Cobbaert, D., Mahoney, C., Millard, K., Peters, D., Devito, K .2020a. Remote sensing of boreal wetlands 1: data use for policy and management. Remote Sensing. 12 (8), 1320.

Chasmer, L., Mahoney, C., Millard, K., Nelson, K., Peters, D., Merchan, M., Cobbaert, D., et al. 2020b. Remote sensing of boreal wetlands 2: methods for evaluating boreal wetland ecosystem state and drivers of change. Remote Sensing. 12 (8), 1321.

Ficken, C.D., Connor, S.J., Rooney, R. et al. 2021. Drivers, pressures, and state responses to inform long-term oil sands wetland monitoring program objectives. Wetlands Ecological Management. https://doi.org/10.1007/s11273-021-09828-2.

Flotemersch J.E., Leibowitz S.G., Hill R.A., Stoddard M.C., Thoms J.L., Tharme R.E. 2015. A Watershed Integrity Definition and Assessment Approach to Support Strategic Management of Watersheds. https://doi.org/10.1002/rra.2978.

Nasr M. OSM State of Environment Reporting: Chapter 2: Introduction to the Oil Sands Monitoring (OSM) Integrated Geospatial Framework: Mapping Human Activities. Submitted in 2021. Not published yet.

Nasr, M., and Monk, W. 2022. Geospatial Science Support and Activities for Environmental Monitoring, Evaluation and Reporting in the Oil Sands Area: Summary of User Needs. Government of Alberta, Ministry of Environment and Protected Areas. ISBN 978-1-4601-5574-5. https://open.alberta.ca/publications/geospatial-science-support-activities-for-environmental-monitoring-evaluation-reporting-oilsands.

Stock, K. and Guesgen, H., 2016. Geospatial reasoning with open data. In Automating Open Source Intelligence (pp. 171-204). Syngress.

Swanson, S. 2019a. Oil Sands Monitoring Program: Integration Workshop Reports (Part 1 of 2). OSM Technical Report Series No. 7.1. https://open.alberta.ca/publications/9781460144947.

Swanson, S. 2019b. Oil Sands Monitoring Program: Recommendation Report (Part 2 of 2). OSM Technical Report Series No. 7.2. https://open.alberta.ca/publications/9781460144954.

2.0 Objectives of the Work Plan

List in point form the objectives of the 2024/25 work plan below

Objective 1. Acquire, process, and release geospatial data required to characterize oil sands sources/stressors, habitat (ecosystem) responses/effects, and source-effect pathways in the Oil Sands Region

• In accordance with the OSM theme-specific conceptual models, Objective 1 aligns with compiled OSM geospatial requirements for geospatial data development/acquisition in 2024-2025 (Sup01)

Objective 2. Geospatial science and collaborative analysis across OSM TACs

• Geospatial data analysis and modelling are undertaken through a series of projects (tasks) identified by theme area programs (Sup01)

Objective 3. Identify, assess, and strategize program-wide geospatial needs required for an integrated OSM geospatial program

• Host a series of workshops to identify program-wide geospatial science needs and planning out OSM future Geospatial Data Portal for data sharing and access

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)
- consider the TAC-specific Scope of Work document and the key questions
- integrate western science with Indigenous Community-Based Monitoring)
- address the Adaptive Monitoring 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 Theme

Please select the theme(s) your monitoring work plan relates to:

- [ ] Air
- [ ] Groundwater
- [ ] Surface Water
- [ ] Wetlands
- [ ] Terrestrial Biology
- [ ] Data Management Analytics & Prediction
- [x] Cross Cutting

3.2 Core Monitoring, Focused Study or Community Based Monitoring

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.

Focused Study

Themes

Please select the theme from the options below. Select all that apply.

- [ ] Air
- [ ] Groundwater
- [ ] Surface Water
- [ ] Wetland
- [ ] Terrestrial
- [x] Cross-Cutting

3.3.6 Cross-Cutting Across Theme Areas

3.3.6.1 Sub Themes

Geospatial/ Remote Sensing

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

3.3.6.2 Cross-Cutting - Key Questions:

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

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

All the produced geospatial data will be subject to audit to ensure that data is fit for purpose and meets the data quality requirements of the OSM Program. The produced geospatial data will be provided to the OSM Program Data Services team for ingestion with proper metadata aligned with OSM data management system.

Geospatial data quality, resolution, and uncertainty information for various parameters (e.g., physical distance, stressor/natural indicator) will be documented to inform proper use and sound interpretation.

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

Standard Operating Procedures (SOPs) specific to the geospatial sciences will be developed in accordance with the quality assurance requirements of the OSM Program, which are in line with Government of Alberta's policies and protocols. The SOPs will include standard operation guidelines and template for OSM gospatial data management. Current geospatial standards developed by the Government of Alberta and/or the ECCC will be considered.

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

This work plan is a cross-cutting project that takes a programmatic view of the OSM Program and inherently integrates among all OSM theme-area programs in three main ways:

• This work plan quantifies the magnitude and distribution of oil sands pressure/stressors within the three Oil Sands Designated Areas of Athabasca Oil Sands, Cold Lake Oil Sands, and Peace River Oil Sands; and develops geospatial tool that can be used for (geo)statistical exploration of relationships between regional landscape stressors and monitoring receptor (or response) data. Such information and tools can be used by all theme areas to stratify and evaluate monitoring designs in an adaptive way.

• The work under this work plan is producing a curated, high quality package of OSM specific data that, in collaboration with Service Alberta could become available to all OSM theme areas and Community Based Monitoring projects in addition to the public. This will ensure that all OSM teams are using a standardized high quality data to undertake analysis, allowing for direct comparison and integration of data between theme areas.

• This work plan aims to identify and develop (internally or externally) high priority data critical to the OSM Program. As such, this work plan will ensure programmatic co-ordination and generation of high priority data and incorporation of advanced geospatial science in analysis, evaluation/assessment, and reporting activities. This will ensure that any data produced can be leveraged by all OSM teams, ensuring a coordinated and integrated approach to the development and updates of key geospatial data and tools.

• This project hosts a number of workshops (meetings) with participation of OSM TACs and SIKIC to create a roadmap for identifying cross-cutting geospatial needs across the Program.

With consideration for adaptive monitoring, where does the proposed monitoring fit on the conceptual model for the theme area relative to the conceptual model for the OSM Program?

This work plan was developed based on a systematic process to identify various TACs' needs for geospatial science support. As each TAC identifies its geospatial priorities based on a theme-specific conceptual model, this work plan will co-ordinate the development of geospatial data and products that may include pressure/stressor (e.g., human footprint disturbances). This data is a common need among various theme areas' conceptual models. A future development of OSM integrative/central geospatial platform will provide a consistent central resource for both regional and local projects (e.g., on-lease sites), which is expected to aim evaluating and assessing relationships/correlations among various parts of the theme area central models.

This work plan largely will aim to quantify the magnitude and distribution of pressures and stressors within the Oil Sands Region, and as such largely falls on the left hand side of the conceptual model. Starting in 2020-21, the development of additional geospatial data of natural landscape (e.g., vegetation health parameters) as well as inquiring and collecting other available landscape data (e.g., LiDAR and satellite image) enables us to assess pathways and receptors (the middle part of the conceptual model). As per some prior work, the time-series analysis of surface water level (lakes and wetlands) is included to address the geospatial needs of OSM TACs for identifying change over time and space. The aim is to specifically develop an advanced methodological approach that can be utilized all across OSM various projects where needed.

How will this work advance understanding transition towards adaptive monitoring?

This work plan will aim to conduct geospatial science activities that are supported and identified as priority needs by various TACs. These activities align with the TACs' goal for an adaptive approach for cumulative assessments and surveillance monitoring design updates, assessment, and reporting. The development of high resolution geospatial data through this project will aim to the development of stressor-based monitoring designs for all theme areas (Sup03), as it will continue to quantify the magnitude and distribution of stressors within the Oil Sands Region spatiotemporally. The geospatial science activities and outcomes of this work plan will be communicated with OSM teams through OSM Program's TACs.

Is the work plan contributing to Programmatic State of Environment Reporting? If yes, please identify potential linkages to relevant sections of the State of Environment Report.

The OSM Integrated Gospatial Program (Sup04) has collaborated with OSM State of Environment (SoE) Reporting's technical team and project's PIs since 2020-21, producing over 50 SoE maps. This task is still in progress as PIs require new maps and updates to existing maps.

Additionally, a SoE chapter on OSM geospatial science projects (Chapter 2) including cumulative effects analysis of multiple stressors in the Oil Sands Region, a regional time-series analysis of Human Footprint data (2010-2018), and ranking results for regional stream connectivity. In future SoE reports, updated analysis results will be prepared using new data (e.g., trend analysis results for human footprints for 2022 and beyond) as well as new geospatial science products (e.g., water quality risk mapping, vegetation health monitoring by remote sensing).

The OSM Integrated Gospatial Program will continue supporting future SoE reporting by providing cartography and analysis support, web (online) mapping, and updates on SoE's geospatial chapter.

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 consider adaptive monitoring and the approved Key Questions in your response.

The geospatial data and reporting products delivered by this work plan are multi-purpose by design.

The outlined geospatial data and products advance the OSM Program's vision, they are aligned with multiple objectives listed in the Operational Framework Agreement (Oil Sands Monitoring Program 2018), and they are essential to addressing several of the Oil Sands Monitoring Key Questions (DRAFT) released by the OSM Program office on November 23, 2020. Examples include data products that characterize regional variability and temporal change in vegetation removal and alteration, vegetation recovery, habitat mapping, watershed boundaries, Human Footprint Inventory, and other data; and evaluation and reporting products.

By characterizing the current state of multiple stressors, receptors, and stressor-response pathways identified in conceptual models published by the OSM Program (Swanson 2019a,b), these geospatial data and science products are essential to providing assurance that existing regulatory and non-regulatory mechanisms are effective in protecting the health of people and the environment in the region. Ongoing advancement of geospatially characterized stressor-response pathways specific to OSM identified needs and foci will be enhanced based on an existing tool that characterizes relative environmental pressure at multiple scales. This tool was developed under a provincial platform commitment and is in the process of being refined and tested but aspects of the approach are directly relevant to the OSM Program.

These same data and science products also support the development and calculation of several indicators within the draft Biodiversity Management Framework (BMF) for the Lower Athabasca Region. OSM geospatial data and products are used to augment and refine existing BMF indicators (e.g., species indicators) and are widely used to support development of the Biodiversity Management Framework within and beyond the Lower Athabasca Region (Indicator Reporting Protocols, Science Support Documentation, Supporting Focal Studies developed by the BMF Science-Technical Committee and sponsored by the BMF Core Team).

Geospatial data and science products that characterize the structure, composition and function at the regional, subregional and local scales, are also essential to investigations of potential exceedances of indicators within the Surface Water Quality Management Framework for the Lower Athabasca Region. These same data and science products are also appropriate for use in investigations of cause of changes in surface water quality, aquatic biological, and other indicators monitored within the OSM Program.

References:
Oil Sands Monitoring Program. 2018. Letter of Agreement and Operational Framework. 53 pp. ISBN: 978-1-4601-4236-3. https://open.alberta.ca/publications/9781460142363.

Swanson S. 2019a. Oil Sands Monitoring Program: Integration Workshop Reports (Part 1 of 2). (OSM Technical Report Series No. 7.1). Retrieved from: https://open.alberta.ca/publications/9781460144947.

Swanson S. 2019b. Oil Sands Monitoring Program: Recommendation Report (Part 2 of 2). (OSM Technical Report Series No. 7.2). Retrieved from: https://open.alberta.ca/publications/9781460144954.

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

It is important that Indigenous communities are involved in both the identification of indicators and key geospatial products and/or services important to Indigenous communities.

This work plan is closely communicated to OSM TACs, which includes Indigenous representatives, in order to ensure that communities are engaged in a meaningful and productive way. Additionally, ICBMAC representatives were invited and participated in All-TAC Geospatial workshop which took place in October 23rd, 2023. Similarly, but on a larger scale, this work plan will host a series of geospatial workshops (or meetings) including TAC and SIKIC members including Indigenous representatives, and the Indigenous Community Based Monitoring Advisory Committee (ICBMAC) representatives for integration and addressing community concerns.

The co-development of indicators and metrics with Indigenous communities will be an important focus of future TAC workshops. Such an engagement will be informed by the process that is currently being developed with the theme area programs, and by support from the ICBMAC.

The work outline in this project has also been reviewed and supported by various TACs, including Indigenous representatives.

Does this project include an Integrated Community Based Monitoring Component?

No

If YES, please complete the ICBM Abbreviated Work Plan Forms and submit using the link below

ICBM WORK PLAN SUBMISSION LINK

5.1 Alignment with Interim Ethical Guidelines for ICBM in the OSM Program

Are there any community specific protocols that will be followed?

Does the work plan involve methods for Indigenous participants to share information or knowledge (e.g. interview, focus group, survey/structured interview), or any other Indigenous participation? If yes, describe how risks and harms will be assessed, and the consent process that will be used.

Do the activities include any other collecting/sharing, interpreting, or applying Indigenous knowledge? Please describe how these activities will be conducted in alignment with the Interim Ethical Guidelines, and any community-based protocols and/or guidelines that may also apply.

Indicate how Indigenous communities / Indigenous knowledge holders will be involved to ensure appropriate analysis, interpretation and application of data and knowledge.

How are Indigenous communities involved in identifying or confirming the appropriateness of approach, methods, and/or indicators?

How does this work plan directly benefit Indigenous communities? How does it support building capacity in Indigenous communities?

How is the information from this work plan going to be reported back to Indigenous communities in a way that is accessible, transparent and easy to understand?

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 how can be assessed against a baseline condition. As relevant, consider adaptive monitoring, the TAC specific Scope of Work document and the Key Questions in your response.

This work plan is designed to measure change in both space and time, and to provide this information to all theme areas to support field-based monitoring, site selection, assessment, and evaluation activities. In particular, this work plan will (Sup01):

• Increase the attribution of human footprint data to include dates on certain features will allow us to calculate the rate of human footprint change over time, and establish the baseline human footprint conditions that existed within the three Oil Sands Designated Areas of Athabasca Oil Sands, Cold Lake Oil Sands, Peace River Oil Sands as far back as spatial data/information is available (1950s). The human footprint data are high priority products that provide detailed information on landscape disturbance stressors required by all theme areas.

• Identify and quantify oil sands pressure/stressors from available high quality geospatial data using OSM conceptual models. This information has and will be provided to all theme area leads, which can be used to ensure that monitoring is undertaken along known stressor gradients that are assessed and quantified programmatically.

• Characterize pressure/stressors over the entire Oil Sands Region will allow us to measure change relative to a spatial baseline by using analogous reference conditions. Furthermore, this effort supports statistically evaluation of all current and historic monitoring undertaken by the OSM Program against calculated stressor gradients in the region. One example is the development of snow deposition maps spanning several years, illustrating regional changes in both space and time.

• Map habitat recovery as a result of temporal forest regeneration using high resolution earth observation such as satellite imagery and LiDAR, coupled with human footprint of seismic lines, well pads, and other disturbances associated with oil sands exploration and production will aim measuring the effectiveness of existing regulations related to oil sands exploration and production activities in the Oil Sands Region. According to the TBM TAC, this mapping effort is a high priority due to observed shifts in wildlife communities in the Oil Sands Region.

• Aim to measure environmental changes by incorporating natural landscape characteristics including hydrological variability that will distinct stressors-receptor (or response) relationships from one watershed to another and over time. These products are essential to the Program and will be the basis for analysis and modeling of OSM projects. The Wetland TAC has identified a knowledge gap as a priority for water surface changes that may be adversely affected by a variety of factors, including landscape disturbances and oil sands-related water withdrawals.

• Evaluate and keep record of data quality, methodology, and uncertainty. This is a very important and critical task in long-term assessment of change using geospatial data.

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, consider adaptive monitoring, the TAC specific Scope of Work document and the Key Questions in your response.

This work plan has started a stressor-based approach to map cumulative effects from oil sands development and operations, and as such directly quantifies the regional and subregional state of the environment and cumulative effects. The development of a geospatial stressor-based cumulative effects model is by characterizing stressors derived from local developments (e.g., lease mining sites), individual contributing sources of atmospheric emissions (e.g., emission stacks) and operational leak/spill or accidents and tailing seepage, local watercourse road crossings, and others (e.g., roads; pipelines; seismic lines). Using this approach, stressors will be individually and cumulatively quantified at multiple spatial scales, using nested hierarchy watersheds. This will allow us to assess the environmental conditions in the Oil Sands Region for microbasins (small watersheds for local assessments) to larger watersheds or Hydrologic Unit Code of 10 or 8 for larger sub-regional and regional assessments.

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, consider adaptive monitoring, the TAC specific Scope of Work document and the Key Questions in your response.

In the past, the Integrated Geospatial Program has started working in collaboration with Service Alberta to develop a high quality curated geospatial data package that will be open and publicly available and accessible. Once programmatic scope and implementation plan are developed, this work will be included in the 2025-2026 work plan in collaboration with the Data Services work plan. As a result, it is envisioned that any geospatial data products directly developed under the Integrated Geospatial Program will be included within this data package, including the enhanced Human Footprint Inventory which will be delivered annually by the end of each fiscal year, high resolution imageries, and other data products included in 2024-2025 deliverables.

It is expected that in collaboration with Service Alberta, OSM geospatial data package will be hosted publicly for the OSM Program through a Geospatial Data Portal that can be linked to OSM Catalogue (under construction by Service Alberta) and will include geospatial data that are systematically arranged in a folder structure (air, water resources, biomes & micro-Biomes, soil, sub-surface and landform, land cover, access and development, human social, and exceptional events; Sup06). The OSM geospatial folder includes data developed through the OSM Program as well as data collected/acquired from other sources. In addition, to assure quality-driven products and deliveries in OSM Program, this work plan will make an effort for proper documentation of data quality, methods, and uncertainties.

It is provioned that through future (2025-2026 and beyond) collaboration with Data Services work plan, the development of an online web mapping, data visualization tool, and web geospatial analysis services will be implemented to effectively communicate the results of the geospatial stressor-based cumulative effects model to the public at large while the OSM teams and collaborators could access geospatial data, geospatial tools, and OSM mapping templates.

In addition to the development and delivery of publications as outlined in this project, there are several technical documents and peer-reviewed scientific manuscripts for publication that will be produced in support of the OSM geospatial science delivery, OSM annual progress report, and State of Environment (SoE) reporting.

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, consider adaptive monitoring, the TAC specific Scope of Work document and the Key Questions in your response.

This work plan will aim to support geospatial data development/collection/acquisition and assessment of stressors affects. The goal is to support all theme areas programs and to ensure the spatial data products used by the OSM Program are consistent among OSM teams. Specifically, through this project, we will develop geospatial data of oil sands pressure/stressors that will support all theme areas of the OSM program. In 2019-20, we developed a conceptual framework for the analysis of geospatial stressors, and quantified stressors across the Oil Sands Region to support site selection by the terrestrial biological, wetland, and groundwater theme areas. Since then, the model has been refined by identifying and prioritizing key pressure/stressors selected (or identified) by the OSM theme areas (this work is included in 2020-2021 Sate of Environment (SoE) reporting; Nasr 2021).

Moving forward with the new Program's direction to an adaptive approach for environmental monitoring and assessment, the pressure/stressor mapping will be further updated to characterize landscape disturbances (Nasr and Orwin 2023). This approach ensures the OSM geospatial data products and model outcomes are useful to all theme , especially in developing and optimizing monitoring designs in the Oil Sands Region.

The OSM Integrated Geospatial Program have supported and will continue to support advancing GIS/remote sensing methodological approaches and developing mapping templates for the OSM Program. This is specifically useful to all core, focus and Community Based Monitoring projects, and SoE data analysis and mapping.

Reference:

Nasr M. Submitted in 2021. OSM State of Environment Reporting: Chapter 2: Introduction to the Oil Sands Monitoring (OSM) Integrated Geospatial Framework: Mapping Human Activities. Not published yet.

Nasr M., Orwin J.F In Prep (2023). A Geospatial Approach to Identifying and Mapping Areas of Relative Environmental Pressure on Ecosystem Integrity.

10.0 Work Plan Approach/Methods

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

Objective 1. Acquire, process, and release geospatial data required to characterize oil sands sources/stressors, habitat (ecosystem) responses/effects, and source-effect pathways in the Oil Sands Region

Objective 1 - Task 1. Cross-cutting OSM geospatial data and products (Tasks 1.1 – 1.3)

Aligned with previous years, the scope of work document for future contracts related to Task 1.1 to Task 1.3 will include the following information about the three phases of the development process for geospatial data and products:
Phase 1: compilation and evaluation of primary datasets/information;
Phase 2: development of geospatial data including data attributes and metadata; and
Phase 3: geospatial data submission and technical reporting.

- Task 1.1 Historical (Circa 1950) and 2022 enhanced human footprint inventory

- Task 1.2 Anthropogenic Noise Modeling Calibration

- Task 1.3 Acquisition of high-resolution earth observation products

Objective 2. Geospatial science and collaborative analysis across OSM TACs

Task 2.1 Geospatial mapping for the assessment of cumulative effects of pressure/stressors

- Task 2.1.a Update OSM stressor maps based on new/updated data
- Task 2.1.b Summary of landscape-level disturbance and air deposition within microbasins, in support of benthic invertebrate monitoring

- Task 2.2 Habitat mapping of forest regeneration

- Task 2.3 Water surface mapping of lakes and wetlands

- Task 2.4 Snowpack/wintertime contaminant deposition mapping

- Task 2.5 Geospatial support to the State of Environment (SoE) reporting

Task 2.1 (Task 2.1.a and Task 2.1b), Task 2.4, and Task 2.5 will be conducted internally by OSM geospatial team: Task 2.1 includes producing stressor maps and preparing a summary technical report for effective communications with OSM projects; Task 2.5 will require collaboration with various OSM projects, and the specific project phases will be determined during the project initiation.

Tasks 2.2 - 2.3 will be conducted by external partners. The following details regarding the three phases of the analysis, processing, and output delivery will be included in the scope of work documents for any future contracts:

Phase 1: data collection and analysis;
Phase 2: geospatial analysis and geospatial data development; and
Phase 3: submission of geospatial data products, analysis/models including programming scripts and tools, producing mapping packages such as GIS map projects and Google Earth Engine data inventory, and technical report(s) or manuscript-style report(s).

Objective 3. Identify, assess, and strategize program-wide geospatial needs required for an integrated OSM geospatial program

• Task 3.1 Host workshops to discuss OSM programs' geospatial science needs and priorities

• Task 3.2 Host workshops to review and analyze Task 3.1's information gathering and joint review of initial concept of program-wide geospatial support

• Task 3.3. Plan out a geospatial portal for providing essential geospatial services for OSM TACs and OSM data users

Specific work flow of Tasks 3.1 - 3.3 will be done by three phases as follows:
Phase 1: initial workshops;
Phase 2: post-gathering information review workshops; and
Phase 3: wrap-up and final presentation.

First, the work flow of Phase 1 and Phase 2 will be determined by close collaborations with OSM TACs and based on SIKIC guidance for identifying workshops' objectives, goals, and expected outcomes (Sup07). After completing this task, OSM geospatial team will be able to (a) host group discussions through series of workshops in Phase 1 and Phase 2, and (b) gather, summarize, and analyze the information in collaboration with TACs and based on SIKIC guidance. In Phase 3, the results from Phase 1 and Phase 2 will be communicated and presented through a final gathering (meeting), along with a request for confirmation and direction on the next steps.

Describe how changes in environmental Condition will be assessed

The development and implementation of geospatial standards is one mechanism to assist with the detection of change in environmental conditions that can be assessed. Data standards will be developed to consider the level of accuracy (as well as spatial/temporal resolution and attribute/thematic depth) required to detect meaningful change in environmental conditions in the Oil Sands Region arising from oil sands activities.

The development of geospatial tools and automation of such tools in a future OSM Geospatial Data Portal will support a program-wide consistent and reliable process for assessing change in the Oil Sands Region. Changes in environmental condition will be assessed by quantifying the cumulative effects associated with multiple pressure/stressors for each unit of analysis (i.e., HUC10 watershed) within the Athabasca Oil Sands, Cold Lake Oil Sands, and Peace River Oil Sands Areas. This will support ecosystem-level risk assessment in a cost effective, repeatable, and scientifically rigorous manner.

In the assessment of cumulative effects, we envision a future application of a watershed integrity approach by which human activities and ecosystem-related factors are used to assess watershed condition, health, resiliency and sustainability (Flotemersch et al. 2015). At the national level, USEPA has already adapted this process. Within the scope of this work plan, we will examine (add/remove) and group stressors for the Oil Sands Region. Then all the stressors will be integrated at a hydrologic or watershed level (e.g., HUC10 units) for developing stressor maps useful for OSM projects' assessment activities.

Reference:
Flotemersch J.E., Leibowitz S.G., Hill R.A., Stoddard M.C., Thoms J.L., Tharme R.E. 2015. A Watershed Integrity Definition and Assessment Approach to Support Strategic Management of Watersheds. 2015 https://doi.org/10.1002/rra.2978.

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

Benchmarks are being developed as a part of this project. Additional benchmarks as developed by other theme areas, or identified through literature review will be assessed and incorporated into the geospatial stressor-based and geospatial models as appropriate.

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

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

This section provides detailed descriptions of tasks associated with each objective of this work plan. The tasks' interdependencies and priority levels were identified based on the information provided by the theme area TACs (Sup01). Please review individual OSM TACs work plan proposals (2024-2025) for more information.

Objective 1 - Task 1. Cross-cutting OSM geospatial data and products (Tasks 1.1 – 1.3)

• Task 1.1 Historical (Circa 1950) and 2022 enhanced human footprint inventory. Develop an inventory of human footprint (HFI; land disturbances) for 1950s and 2022 conditions in the Oil Sands Region. This is a core dataset for the oil sands pressure of land disturbance that is updated annually, including enhancements for oil sands specific attribution. HF data are needed to establish reference conditions for land disturbance and conditions during key development periods to assess changes in land disturbances over time attributable to oil sands development. TBM TAC's recommendation is "Approved by the TBM TAC, during the November 1, 2023 TBM TAC meeting…".

Note on Interdependencies: a cross-cutting TBM geospatial project; Delivered by ABMI in collaboration with the Government of Alberta's Ministry of Environment and Protected Areas (EPA)- the Alberta Human Footprint Monitoring Program (AHFMP) and OSM Integrated Geospatial Program. These data are cross-cutting geospatial products that are utilized in several OSM Program's projects.

Status: Continuing from 2019-2020; identified as "High Priority" by OSM TBM TAC (Sup01); completed in 2024-2025.

Description: The TBM TAC 2024-2025 Scope of Work (SoW) identified "human footprint monitoring and mapping" as the first element of the core/surveillance monitoring associated with the land disturbance stressor. In the monitoring approach for the 2023-2024 TBM core program, one of the required components is to integrate geospatial HF monitoring into TBM activities and expand the program to include qualitative assessments of oil sands HF, and targeted footprint attribution. The Wetland TAC 2024-2025 SoW identified HF monitoring and mapping as high priority for wetland site network expansion (land disturbance is a key variable of the site selection criteria), and is a priority dataset for assessing and reporting change in wetland area and extent through state of the environment reports. The updated and new historical HF will be used to update the SoE geospatial chapter (Chapter 2: stressor mapping, human footprint mapping; Task 2.1), and will be included in future OSM Geospatial Portal for access by OSM data users.
The development of HF products involves visualization, manual interpretation, and heads-up digitization of primary data and products. This development will be based on using specifically designed Standard Operating Procedures (SOPs) and HF delineation protocols, identified by AHFMP). The updates of enhanced HF inventory (eHFI) of the Oil Sands Region for 2022 condition will be by using a few primary essential data products including provincially-funded high-resolution Alberta-wide SPOT6 satellite imagery mosaic, which represents in-kind contributions from EPA. The eHFI includes 115 feature types classified into 20 sublayers such as well sites, mines, roads, seismic lines and pipelines, etc. Indirect pressures of noise and light, identified as concern by Indigenous communities and part of the TBM Conceptual Model, are also included as additional data attributes for some specific features. Similar to previous eHFI, the updated 2022 inventory will include continuing to add (a) "Year of Origin" attribute to all HF features in the Oil Sands Region; age attribution will support time-series analysis, including trend and change detection, (b) "Sector" attribute to all HF features in the Oil Sands Region, e.g., to differentiate roads used by forestry from roads used by the oil sands industry, (c) "Light" value for 2022; support time-series analysis, including trend and change detection, (d) "Noise" value for 2022; support change detection analysis between 2019 and 2022 conditions, (e) "NDVI" (Normalized Difference Vegetation Index) value for 2022; support time-series analysis, including trend and change detection, (f) "Exploration vs Production" – this

work was initiated in 2022 to accurately assess environmental impacts of regional oil and gas activities. Consistent with 2023-2024 activities, this work continues assembling, developing, analyzing, and reporting on oil and gas exploration and production variables with the objective of separating exploration disturbance from production disturbance for conventional oil and gas, surface mining and, if possible, in-situ production. These two development types (exploration vs. production) operate under different regulatory frameworks and have differing approaches to long term mitigation. This task will also scope and develop a roadmap for additional attribution and information needs on oil sands stressors with the TBM TAC, e.g., oil sands production timelines, disturbance status, spatial resolution, and temporal information needs. For historical HF, historical aerial imagery orthophotos (with 1.65m and 1.25 m spatial resolution, respectively) will be used instead of contemporary satellite imagery (e.g., SPOT6 imagery with 1.5 m spatial resolution).

• Task 1.2 Anthropogenic Noise Modeling Calibration. In order to update the annual attribution information, this task will generate stand-alone noise data that can be utilized individually as one stressor data which will be incorporated in eHFI development (Task 1.1). The TBM TAC's recommendation is "Approved by the TBM TAC, during the November 1, 2023 TBM TAC meeting..."

Note on Interdependencies: a cross-cutting TBM TAC's geospatial project (Integrated Terrestrial Biological Monitoring: B-LTM-TB-1-2425).

Status: Proposed in 2024-2025; identified as "Medium Priority" by OSM TBM TAC (Sup01); completed in 2024-2025.

Description: The 2023 TBM TAC's SoW highlights the significance of noise as a key stressor within the core human footprint mapping. One of the pertinent inquiries regarding landscape disturbance stressors in the 2023 TBM TAC SoW is "2.b.iii) What is the extent and magnitude of noise, light, and habitat alteration, and might it affect animals, including predator-prey dynamics?" Indirect pressures such as noise pollution from oil sands activities are incorporated in the TBM Conceptual Model and have been recognized as a concern by Indigenous communities.

The production of noise data will be done under a separate OSM geospatial task to ensure that this product is applicable to OSM projects. This is primarily because the the production of human footprint is handled through the AHFMP and the development of noise data is outside the scope of this program. Based on the human footprint's SOPs and protocols (Task 1.1), this data will be included in the updated version of human footprint for 2022 condition by ABMI.

This task builds upon the anthropogenic noise maps integrated into the annually updated eHFI for the Oil Sands Region. The current eHFI noise maps represent modeled probabilities of noise levels, derived from data including Autonomous Recording Units (ARUs). It's important to note that these noise attributions do not provide exact decibel levels at specific locations but offer an index indicating areas with varying noise levels. The advantage of using ARUs lies in their capacity to monitor noise over extended periods, enabling the assessment of cumulative effects from multiple noise sources.

In 2024-2025, this project will calibrate the relative noise index provided by ARUs with recognized ISO standards, establishing a correlation between ARU measurements and these standards. This calibration will be conducted at various noise-generating facilities, encompassing roads, pump jacks, compressor stations, processing facilities, and SAGD injection wells, by utilizing standardized noise monitoring equipment. This correlation will bridge the gap between the ARU-generated relative index and a precise decibel standard, enhancing the modeling of noise levels using the extensive ARU datasets available.

Fieldwork will be executed across the Oil Sands Region, spanning from the mineable to the Cold Lake region, encompassing a series of different noise-generating facilities. The calibration data using ISO standard equipment will be a one-time endeavor during the 2023-24 monitoring year, without plans for repetition in subsequent years.

This undertaking is a valuable component of the eHFI for the Oil Sands Region, shedding light on how the modeled probability of noise on human footprint features can be employed in cumulative noise monitoring. The simultaneous summer fieldwork, coinciding with ARU monitoring under the TBM program, ensures operational efficiency between the two programs. This data will be used for assessing mammal and landbird species' distribution and abundance in the area.

The audio recording data will be provided as a separate dataset to the OSM Program in the same way the analogous OSM TBM ARU (and camera) data are handled (metadata and direct download links in the OSM Data Catalogue to wildtrax). Audio recordings from ARUs will be stored on Wildtrax as WAV files (open source: https://portal.wildtrax.ca/data-discover.html). Field measurements from standardized ISO recording equipment will be stored as tables in the WildTrax project designated for this dataset. These collected data are anticipated to benefit not only the OSM Program but also Indigenous communities, industry stakeholders, government scientists, academic researchers, and environmental non-governmental organizations (ENGOs).

• Task 1.3 Acquisition of high-resolution earth observation products. Acquire high-resolution LiDAR and aerial imagery in the Oil Sands Region by close consultation with OSM project leads for identifying ESSENTIAL data products and areas of interest.

Note on Interdependencies: collaboration with OSM programs to identify suitable data and site(s) for data acquisition.

Status: Proposed 2024-2025 work plan; completed in 2024-2025.

Description: High-resolution LiDAR and aerial imagery is a critical and foundational data need across multiple theme areas of OSM to support characterization of stressors and changes in environmental endpoints. LiDAR data is being collected across much of the Oil Sands Region by multiple groups including forestry, oil sands sector, and government. These efforts are anticipated to provide broad spatial coverage, but some gaps in high priority monitoring locations, in particular adjacent to the mineable region, are expected. High resolution LiDAR and aerial imagery coverage in this area is required to support multiple initiatives (Habitat Mapping of Forest Regeneration (Task 2.2); surface vater monitoring (Task 2.3); GDE project in Groundwater Monitoring work plan (GW-LTM-S-3-2425); watershed analysis). This task is to ensure priority geospatial data products of “LiDAR and high-resolution temporal aerial products” are available for OSM priority projects. This task does not include commercial satellite data purchase for OSM projects since most satellite data are available through public domains for access and processing purposes.

Objective (Task) 2. Geospatial analysis and assessment projects, identified and supported by OSM TACs (Tasks 2.1 – 2.6)

Task 2.1 Geospatial mapping for the assessment of cumulative effects of pressure/stressors. OSM stressor mapping is one of the key programmatic geospatial science activities for supporting monitoring design, evaluation, and reporting. These stressor map updates are directory tied to Task 1.1 (eHFI) deliverables of this work plan, atmospheric deposition data from Integrated Atmospheric Deposition Monitoring (A-PD-6-2425) workplan, and integrated snow deposition maps developed in Task 2.4 of this work plan. The updates are based on geospatial analysis for characterizing oil sands specific pressure/stressors in the Oil Sands Region: Task 2.1a is dedicated to regional stressor mapping, while Task 2.1b is centered on the integration component that supports the invertebrate monitoring program within the Surface Water TAC.

• Task 2.1.a Update OSM stressor maps based on new/updated data

Note on Interdependencies: delivered by OSM Integrated Geospatial Program; collaboration with the theme area TACs.

Status: Continuing from 2019-2020; completed during 2024-2025.

Description: In 2024-2025, this task will continue refining and updating OSM geospatial stressor-based approach (Sup03) for the assessment of cumulative effects based on updated geospatial data for pressure/stressors. The updates will leverage a similar relative environmental pressure tool and approach developed under the Provincial Geospatial Science Framework: Quality-Driven Data Development, Geospatial Modelling, Evaluation and Assessment in response to Platform Commitment 2.15.7 to improve data collection on environmental outcomes for parks and public lands across the Province. A manuscript based on this provincial project is currently being prepared (Nasr and Orwin 2023). This approach identifies and uses relative pressure data related to hydrologic alteration, land disturbances, contaminants (e.g., air emissions/depositions and leaks/spills on land), and human pressure (e.g., population, light at night, noise), of which many align with the OSM programmatic conceptual model (Sup05).

Since this project is at a regional-scale approach, a collection of information will be done to identify historically identified areas of concern, baseline conditions, and limit of change in the Oil Sands Region based on theme area programs' input. This way, the geospatial analysis of cumulative effects assessment will be further refined by including additional data metrics calculations to capture oil sands specific stressors/pressure (e.g., assessment of oil and gas exploration and extraction dynamics in the oil sands region) and to incorporate appropriate weighting factors in distinguishing oil sands development and activity effects in the region. The geospatial analysis is based on a programming multicriteria analysis in Geographic Information System (GIS) (Eastman 1999) which develops scalable stressor maps showing spatial characterization of hierarchy watersheds in the region (SoE Chapter 2 Mapping Human Activities). The stressed areas (or areas of concern) will be identified based on a stress rank grouping of watersheds or hydrologic units.

In collaboration with Service Alberta in 2024-2025, a plan will be developed to implement OSM stressor mapping as a geospatial tool in a future OSM Geospatial Portal for sharing with OSM theme area programs. Manuscript-format reporting will be provided for future OSM publications.

References:
Eastman R. 1999. Multi-criteria evaluation and GIS. Chap. 35. Longley P.A., Goodchild M.F, aguire D.J., Rhind D.W. (eds). Geographical information systems. Wiley, New York. pp. 493-502.

Nasr M., Orwin J.F In Prep (2023). A Geospatial Approach to Identifying and Mapping Areas of Relative Environmental Pressure on Ecosystem Integrity.

• Task 2.1.b Summary of landscape-level disturbance and air deposition within microbasins, in support of benthic invertebrate monitoring. Develop environmental stressor/pressure maps to support monitoring site selections by the Benthic program. The Surface Water TAC confirmation of this project is "Yes".

Note on Interdependencies: a cross-cutting Surface Water TAC's geospatial project (OSM Surface Water Quality Monitoring work plan: W-LTM-S-2-2425); delivered by OSM Integrated Geospatial Program (collaboration with OSM Benthic Invertebrate Biomonitoring under the Surface Water TAC).

Status: Proposed in 2023-2024 and 2024-2025 work plans; identified as "Medium Priority" by OSM Surface Water TAC (Sup01); completed in 2024-2025.

Description: The Surface Water TAC has identified this task as a priority to fulfill the OSM Program mandate to deliver analyses and adaptive study design in both mineable and in situ regions, and related reference locations in the Oil Sands Region. This task is to support expansion of Benthic monitoring program in the Oil Sands Region and is closely linked to Task 2.1.a.

For the 2024-25 period, a primary focus of the benthic program is to assess changes in disturbance levels (e.g., seismic lines and watercourse crossings), air deposition, and other relevant stressor data within specific waterbodies such as Steepbank, Ells, McKay, and Firebag rivers; and long the full extent of these rivers and within their watersheds. This involves analysis using Alberta hydrologic unit codes of HUC8, HUC10, or HUC12 within the study area, or at a finer spatial scale within delineated microbasins (or watersheds/sub-watersheds). A new study design addition for 2024-2025, is the inclusion of the Peace River and its tributaries, which would be valuable as a product similar to those in Athabasca Oil Sands Area. Quantifying landscape-level impacts by microbasin will provide insights into how development type and level influence benthic communities. While the benthic biomonitoring group has historically relied on external contractors or resources within ECCC to assess anthropogenic disturbance, the Program would benefit from the consistency provided by the OSM geospatial team in generating and disseminating these assessments. This would greatly support ongoing analyses and adaptive study design in both oil sands mineable and in situ regions, as well as the related reference areas.

This task will develop GIS projects in Google Earth and ArcGIS packages to visualize the spatial extent of stressors at different levels. This project will deliver a technical report and geospatial data models (e.g., shapefiles, Google Earth) for visualization of potential impacts and supporting the selection of monitoring sites (new/revised monitoring locations), especially in the in situ region south of Fort McMurray.

Task 2.2 Habitat mapping of forest regeneration. Quantify spatial and temporal trends of forest regeneration on oil sands footprint that support the assessment of ecological response to changing habitat units.

Note on Interdependencies: a cross-cutting TBM TAC’s geospatial project (Integrated Terrestrial Biological Monitoring: B-LTM-TB-1-2425). TBM TAC confirmation of this project is “Approved by the TBM TAC, during the November 1, 2023 TBM TAC meeting…”.

Status: Continuing from 2022-2023; identified as “High Priority” by OSM TBM TAC (Sup01); completed during 2024-2025.

Description: Habitat change is identified by the TBM TAC in the 2024-2025 SoW as one of the primary pathways that requires Core/Surveillance monitoring for human footprint and other land disturbance effects using selected indicator species. Habitat regeneration in the boreal forest of Alberta is instrumental in addressing several key questions such as “has the nature and quality of habitat deviated from the baseline? What is the extent and intensity of noise, light, and habitat modification, and how might it impact animals, including predator-prey dynamics? How has the human footprint expansion due to oil sands development affected the accessibility of terrestrial biological resource harvesting for s. 35 rights?”

Within Alberta's boreal forest, human land-use activities linked to various sectors, including energy and forestry, have resulted in habitat loss and modification for multiple species. Simultaneously, these activities have created new habitat for other species. Notably, the features associated with resource exploration and extraction have contributed to the Woodland Caribou's (Rangifer tarandus caribou) decline —a threatened species of critical conservation concern in boreal Alberta (Caribou Habitat Tracking Program - an initiative carried out by EPA's Planning Branch). These features are impacting habitat availability and the relative abundance of various species across different trophic levels (Lankau et al. 2013, Tattersall 2020). Linear features, in particular, play a significant role in caribou declines, as they enhance predator hunting efficiency and facilitate predator utilization of caribou habitat, leading to increased caribou predation. The "permanence" or post-use status of oil sands footprint features varies. Some remain unused and have the potential to naturally revert to forest cover, although this natural revegetation process is not guaranteed. Features that do not naturally revegetate necessitate restoration efforts.

To support land-use and habitat restoration planning, it is essential to gather information about the vegetation status on non-permanent footprint features. The pace of habitat regeneration can influence how various taxa respond to disturbance features, making it critical to assess changes based on the quality and duration of the effects of the footprint on indicator species. Ignoring vegetation recovery on disturbance features could lead to misinterpretations or overestimations of local impacts for many species if regeneration is overlooked. In many respects, the initial human use of a feature is of secondary importance compared to the ecological characteristics of the feature. Therefore, transitioning from merely mapping and attributing disturbances to evaluating the character and ecological quality of disturbances can yield more robust explanatory models, incorporating variables such as regeneration (Roberts et al. 2022).

The first two years of this work, i.e., 2023-2024 and 2024-2025 has involved/involves (i) collation of existing lidar data; (ii) new lidar data collection to fill gaps; and (iii) development and piloting of a vegetation regeneration workflow that maps forest regeneration on oil sands disturbances. In 2024-2025, this project will have completed lidar data collection for roughly 85% of the Oil Sands Region, and have produced an updated habitat map for up to 25% of the region.

The 2024-2025 activities will continue to focus on the measurement of indicators related to habitat recovery on seismic lines, well pads, and other footprint associated with oil sands exploration and production. In 2024-2025, it is proposed that the ABMI's Habitat Monitoring program continues in the Athabasca Oil Sands Region and the Cold Lake Oil Sands Region, and expands to the Peace River Oil Sands Region. This work continues to operationalize approaches being developed by the Boreal Ecosystem Recovery and Assessment group (BERA group; http://beraproject.org/) by using several different sensing techniques combined with ground-truthing. This project leverages existing lidar data from other industrial sectors in Alberta.

References:

Lankau H.E., Bayne E.M., Machtans C.S. 2013. Ovenbird (Seiurus aurocapilla) territory placement near seismic lines is influenced by forest regeneration and conspecific density. Avian Conservation and Ecology. 8(1). doi:10.5751/ACE-00596-080105.

Roberts, D.R., Bayne, E.M., Beausoleil, D.L., Dennett, J.M., Fisher, J.T.,Hazewinkel, R.R.O., Sayanda, D., Wyatt, F., & Dubé, M. G. 2022. "A synthetic review of terrestrial biological research from the Alberta oil sands region: ten years of published literature." Integrated Environmental Assessment and Management. 18(2): 388-406.

Tattersall E.R., Burgar J.M., Fisher J.T., Burton A.C. 2020. Mammal seismic line use varies with restoration: applying habitat restoration to species at risk conservation in a working landscape. Biological Conservation. 241:108295. doi:10.1016/j.biocon.2019.108295.

• Task 2.3 Geospatial surface vater level mapping in lakes and wetlands. Utilize a well-established geospatial analysis methodology to generate surface water level maps within the Oil Sands Region. This process is designed to enhance the accuracy of water and wetlands monitoring, enabling the comprehensive assessment of changes resulting from the direct and cumulative impacts of oil sands activities on these vital ecological systems. Wetland TAC recommendations indicate that "The Wetland TAC supports the development and reporting of water level and surface mapping remote sensing products. These products are identified as valuable by Wetland TAC members and dovetail with the wetlands remote sensing vision aligned with goals for scaling-up of remote sensing data which is detailed in the wetlands work plan."

Note on Interdependencies: a cross-cutting Wetland TAC's geospatial project (Wetland Ecosystem

Monitoring work plan: WL-PD-10-2425).

Status: Proposed in 2024-2025 work plan; Identified as "Medium Priority" by OSM Wetland TAC (Sup01); completed in 2024-2025 and 2025-2026.

Description: The surface water dynamics of lakes and wetlands are affected by various disturbances within the watersheds and surrounding areas that may lead to rapid changes affecting habitats in the area. The remote sensing of water dynamics analysis provides a useful insight of where has changed occurred, and to what extend (Brisco et al. 2015; Palomino-Ángel et al. 2022). The geospatial surface water mapping is a continuation from 2022 in the scoping and analysis phase (GW TAC's water level project in collaboration with OSM Geospatial Program in 2021-2022; gap identified in OSM's 2021 geospatial workshops outcome – Nasr and Monk 2022). This project is structured around two main objectives including monitoring seasonal and multi-year changes in surface water area through the integration of optical and Synthetic Aperture Radar (SAR) data (Objective 1), and tracking seasonal and multi-year variations in water levels within lakes and wetlands using Interferometric SAR (InSAR) data (Objective 2).

This project plays a vital role in mapping the temporal extent of wetland water and water levels in lakes and wetlands. In the 2024-2025 period, the primary focus will be on defining and assessing surface water boundaries and changes by using publicly available or accessible earth observation data, including satellites (and where applicable, aerial and LiDAR data), all within a consistent remote sensing framework (Objective 1). This effort will involve evaluating seasonal and multi-year changes in surface water area and water levels within the Oil Sands Region, with particular attention to wetlands and lakes.

In 2024-2025, the project will leverage a combination of radar and optical remote sensing techniques to detect alterations in surface water for both wetlands and lakes. The workflow encompasses data collection, pre-processing, identification of water bodies and changes, and characterization of water features based on their specific dynamics, such as expansion, contraction, or stability. The validation of the products will heavily rely on existing data and information gathered from OSM projects and trusted sources like the Government of Alberta and the Water Survey of Canada's data repositories.
Following the completion of the 2024-2025 analysis, the project intends to continue into 2025-2026, where the primary focus will be on employing topographical-driven methods to delineate water levels (Objective 2), building upon the findings from 2024-2025.

An additional aim is to establish an automated and continuous remote sensing monitoring process for lakes and wetlands based on available geospatial data and products, making this as a cross-cutting integrated geospatial tool that can be used by various projects and be implemented in a future OSM Geospatial Data Portal upon OSM Program's approvals. The outcomes of this project will be delivered in the form of peer-reviewed manuscript(s), providing a comprehensive assessment of the methods employed and the results obtained. The use of this work is/will be scoped in future OSM projects' assessment and reporting efforts.

References:

Brisco, B. 2015. Mapping and monitoring surface water and wetlands with synthetic aperture radar. Remote Sensing of Wetlands: Applications and Advances, 119-136.

Nasr M., Monk, W. 2022. Geospatial science support and activities for environmental monitoring, evaluation and reporting in the oil sands area: summary of user needs.

Palomino-Ángel, S., Vázquez, R. F., Hampel, H., Anaya, J. A., Mosquera, P. V., Lyon, S. W., & Jaramillo, F. 2022. Retrieval of Simultaneous Water-Level Changes in Small Lakes With InSAR. Geophysical Research Letters, 49(2), e2021GL095950.

Task 2.4 Snowpack/wintertime contaminant deposition mapping. Develop and update snowpack/

wintertime contaminant deposition maps for 2015, 2017, 2020 in the Oil Sands Region. "Air and Deposition TAC's recommendation "The Air TAC supports the development and reporting of deposition maps. These products have been requested through previous OC funding conditions and have been identified as important by Air TAC members, as well as other TACs, at the June 29, 2023 GEM-MACH workshop."

Note on Interdependencies: a cross-cutting Air and Deposition TAC' geospatial project (Integrated Atmospheric Deposition Monitoring (A-PD-6-2425); delivered by OSM Integrated Geospatial Program.

Status: Proposed in 2023-2024 and 2024-2025 work plans; identified as "High Priority" by OSM Air and Deposition TAC (Sup01); completed in 2024-2025.

Description: The Air and Deposition TAC has identified this task as a high priority to fulfill the OSM Program mandate to deliver deposition maps, as directed by the SIKIC and OC in funding decisions. As required by the Air Deposition work plan proposal, this task builds on the preliminary work begun in 2023–2024 air deposition mapping for the development and updates of snowpack/wintertime pollutant deposition maps for 2015, 2017, and 2020. These maps reflect on snow monitoring in the Oil Sands Region through the OSM Program and all contribute to the major objectives of the Air Deposition program to determine levels and changes of atmospheric deposition for specific pollutants that pose a likely risk for forest, river, lake, and wetland ecosystem function (Air Deposition work plan: Objective #1 and #2). Additionally, these maps are considered an important part of program-wide integration within and across OSM theme areas such as supporting ecological monitoring site selections (Air Deposition work plan: Objectives 1 and 2), stressor analysis (Tasks 2.1.a and 2.1.b of this work plan), and improving continued model comparison and delivering deposition maps required by other theme area projects (Air Deposition work plan: Objectives 1). Lastly but as importantly, this task will improve integration within and across OSM Program's themes, including continued model comparison and delivering deposition maps required by other themes.

The analysis and outcome of this project will be included in a peer-reviewed manuscript and/or reporting products, developed by Air Deposition TAC. The snow deposition maps will be included in OSM Program's future Geospatial Data Portal for access and use by other OSM projects, including surface aquatics, groundwater, terrestrial biological, and wetland for supporting an adaptive monitoring framework. Additionally, it is expected that the inclusion of these maps in the Geospatial Portal, stakeholders (industry, Indigenous groups, and the general public) use these maps, as they not only provide key scientific information to other OSM projects, they also provide a visual representation of data that is understandable to a general audience. The maps will include data attributes and metadata information and will become available on the Geospatial Portal by support from Service Alberta.

Task 2.5 Support State of Environment (SoE) reporting. Provide geospatial support to the development of SoE by producing static and interactive maps and providing updates to the geospatial chapter. This task aligns with the OSM program's commitment to transparency and reporting on OSM monitoring activities to both stakeholders and the public.

Note on Interdependencies: Delivered by OSM Integrated Geospatial Program in collaboration with OSM programs.

Status: Proposed 2021-2022 work plan and beyond; completed during 2023-2024 and beyond.

Description: This Task will support the SoE by conducting geospatial analysis and producing maps. This will require close collaboration with the technical committee and OSM project PIs through various OSM TACs. Additionally, the SoE geospatial chapter on stressor mapping, human footprint mapping, and stream connectivity), will be updated primarily based on updated and new data developed through this project (e.g., Task 1.1).

Objective Task (3). OSM geospatial workshop series (Tasks 3.1 – 3.3) - Aligned with 2023-2024 approval conditions indicating "Host an all TACs meeting (or a series of TAC meetings) in Q1 to discuss geospatial products", and All-TAC Geospatial workshop (held on October 25th, 2023)'s recommendation to host additional workshops in the future.

The OSM Oversight Committee (OC) expressed a desire to have a programmatic approach to the delivery of geospatial science support for the OSM also expressed in the 2022-2023 funding conditions related to geospatial work plan. In response to this, a cross-cutting geospatial work plan was submitted in 2023-2024, and approved by the OC for delivery in 2023-2024, in which the OC indicated hosting “an all TACs meeting (or a series of TAC meetings) in Q1 to discuss geospatial products”. To this end, an all-TAC Geospatial Workshop was held on October 25th, 2023. Feedback from participants recommended holding future workshops involving both TACs and the Strategic Integration of Knowledge and Information for Compliance (SIKIC), to further assess the geospatial needs of each TAC and the program as a whole. Building on insights from the workshop, which included maintaining a similar scope of work relative to 2023-2024, the work proposed for 2024-2025 consists of geospatial deliverables structured to align with this framework. Further, a series of workshops are proposed for delivery in 2024-2025, to develop the scope of an enhanced program-wide geospatial program and exploring collaborative geospatial projects tailored to the unique requirements of each TAC. It is expected that these upcoming workshops in 2024-2025 will result in a roadmap for a future OSM geospatial program that is collaborative, integrated, takes advantage of synergies, devoid of duplicative work.

• Task 3.1 Host workshops to discuss OSM programs' geospatial science needs and priorities

• Task 3.2 Host workshops to review and analyze Task 3.1's information gathering and joint review of initial concept of program-wide geospatial support

• Task 3.3. Plan out a geospatial portal for providing essential geospatial services for OSM TACs and OSM data users

Note on Interdependencies: delivered by OSM Integrated Geospatial Program in collaboration with OSM TACs and according to the Program's guidance.

Status: Proposed 2024-2025 work plan; completed during 2024-2025.

Description: The objective of this task is to delineate the future trajectory of the OSM geospatial program by assessing its current status, identifying existing gaps, and prioritizing areas of focus for program-wide geospatial science delivery. To achieve this, a series of TAC meetings and workshops will be scheduled (Sup07), coordinated through the OSM Program Office. This effort will be done in three phases:

Phase 1: initial workshops;
Phase 2: post-gathering information review workshops; and
Phase 3: wrap-up and final presentation.

First, the work flow of Phase 1 and Phase 2 will be determined by close collaborations with OSM TACs and based on SIKIC guidance for identifying workshops' objectives, goals, and expected outcomes (Sup07). After completing this task, OSM geospatial team will be able to (a) host group discussions through series of workshops in Phase 1 and Phase 2, and (b) gather, summarize, and analyze the information. In Phase 3, the results from Phase 1 and Phase 2 will be communicated and presented through a final gathering (meeting), along with a request for confirmation and direction on the next steps.

Phase 1: Initial workshops to explore individual TAC's cross-cutting geospatial science needs: these workshops will play a crucial role in pinpointing the unique cross-cutting geospatial needs of each TAC, with the intention of integrating these needs into the synthesis of OSM integrated geospatial program. Since OSM geospatial program collects, acquires, and produces number of OSM priority geospatial data, the workshops will also cover defined objectives geared towards addressing the continuous geospatial requirements of the program, particularly concerning high-priority stressor products, receptor/response products, and crucial geospatial science tasks such as a centralized geospatial platform for data access and sharing for supporting OSM programs. Overall, the workshops will gather information on perspectives, needs, requirements, etc. and will focus on specific objectives required to fulfill the ongoing geospatial support of the OSM Program. Please see Sup07 for more details. The initial workshops are expected to be held before the end of Q2.

Phase 2. Post-gathering information review workshops: the purpose and specific objectives of these secondary workshops are to revisit the discussion summaries in Phase 1, as well as being informed by the guidance provided by the Strategic Integration of Knowledge and Information for Compliance (SIKIC). This collaborative approach aims to ensure the efficient and productive delivery of the workshops outcomes while ensuring the outcomes are aligned with OSM Program's direction for an integrated program-wide geospatial program. In this phase, the gathered information through Phase 1 will be analyzed and a joint review effort will be made on the initial concept of program-wide geospatial support. Please see Sup07 for more details.

Phase 3. Wrap-up and final presentation to communicate findings from Phase 1 and Phase 2, present a proposed geospatial program, and seek confirmation and guidance on path forward. The outcome of this phase will be summarized in a report for the Program's review and further guidance. The results are expected to be helpful for future geospatial work plan proposals, the delivery of the OSM integrated geospatial program, and a roadmap for an integrative geospatial support for the OSM programs. Please see Sup07 for more details.

The workshops will be hosted by the OSM geospatial team, who will also organize the schedules with assistance from the University of Calgary support team. The purpose and specific objectives of these workshops will be identified through close collaboration with OSM TACs, as well as being informed by SIKIC and the OC. This collaborative approach aims to ensure the efficient and productive delivery of the workshops. The participation in these workshops will include OSM TAC members and members of SIKIC. Additionally, representatives from the Indigenous Community Based Monitoring Advisory Committee (ICBMAC) program will be involved in the workshops to ensure the integration of program-wide geospatial deliverables.

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

As a part of cumulative assessments of pressures, stressors and receptors (responses), this project will collect geospatial data from external and internal sources. These data are grouped as follow:

Hydrologic Alteration:

- N/A

Land Disturbance:

- Land Modification
- Surface mining lease
- Transportation / Service Corridors

Contaminants:

- Air deposition and emissions
- Disposal (e.g. deep well disposal)
- Operational spill/leak, accidents, and tailing seepage

Human Pressure:

- Human Settlement (population)
- Human Activities (e.g., light, noise, traffic volume)

Natural Landscape / Vegetation Cover:

- water surface extent

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.

The knowledge produced under this work plan will be made available to the public using five main knowledge translation techniques, appropriate for different end users including:

• Presenting results of all analyses to the scientific community at regional/national/international conferences and in peer reviewed scientific journals. These products will be targeted to end-users with strong scientific and technical knowledge.

• Developing technical reports targeting scientific and technical audiences. These technical reports will be targeted to end-users with intermediate scientific and technical knowledge.

• Future production of publicly available curated OSM geospatial data package. This data package will be suitable for use by end users interested in accessing the raw data, typically scientists and end users with specialist technical skills.

• Future development of geospatial web (online) mapping will allow end users with no technical skills or specialist software to view and interact with the curated OSM geospatial data package. This product will be targeted toward the public at large, with no need for technical or scientific skills.

• A pilot public reporting tool will be planned for development under this project to present the results of the geospatial stressor analysis to the public at large using an online data visualization and interactive mapping tool when developed in 2025-2026. These tools will be targeted toward end-users with no need for technical or scientific skills, presenting the knowledge with summaries and interactive data visualization targeted to end users with no need for technical or scientific skills.

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

• Task 1.1 Historical (Circa 1950) and 2022 enhanced human footprint inventory for the Oil Sands Region through Alberta GRANT for Alberta Biodiversity Monitoring Institute (ABMI)

The following geospatial tasks will be completed by contractors selected through submitted proposals, or the TACs and geospatial team will identify potential contractors.
• Task 1.2 Anthropogenic Noise Modeling Calibration
• Task 1.3 Acquisition of high-resolution earth observation products
• Task 2.2 Habitat mapping of forest regeneration
• Task 2.3 Geospatial surface water level mapping in lakes and wetlands

Please note the details of cost categories of the above contracts will be updated at the time of contract development (Sup08).

The OSM Geospatial team will deliver the following tasks, which don't require contracts with external parties through this work plan:
• Task 2.1.a Update OSM stressor maps based on new/updated data
• Task 2.1.b Summary of landscape-level disturbance and air deposition within microbasins, in support of benthic invertebrate monitoring
• Task 2.4 Snowpack/wintertime contaminant deposition mapping

• Task 2.5 Geospatial support to the State of Environment (SoE) reporting
• Task 3.1 Host workshops to discuss OSM programs' geospatial science needs and priorities
• Task 3.2 Host workshops to review and analyze Task 3.1's information gathering and joint review of initial concept of program-wide geospatial support
• Task 3.3. Plan out a geospatial portal for providing essential geospatial services for OSM TACs and OSM data users

*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 2024-25 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.

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:

Annually

13.4 Estimated Data Collection Start Date:

Apr 1, 2024

13.5 Estimated Data Collection End Date:

Mar 31, 2025

13.6 Estimated Timeline For Upload Start Date:

Apr 1, 2024

13.7 Estimated Timeline For Upload End Date:

Mar 31, 2025

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 add row 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
2022 enhanced human footprint inventory	https://www.abmi.ca/home/data-analytics/da-top/da-product-overview/Human-Footprint-Products.html; OSM's future Geospatial Data Portal	Shapefile / Feature class	Open by Default
Historical human footprint inventory (Circa 1950)	https://www.abmi.ca/home/data-analytics/da-top/da-product-overview/Human-Footprint-Products.html;OSM's future Geospatial Data Portal	Shapefile / Feature class	Open by Default
Anthropogenic Noise Modeling Calibration	OSM's future Geospatial Data Portal	Shapefile / Feature class / Raster / Audio / Table	Open by Default

14.0 2024/25 Deliverables

Add an additional deliverable by clicking on the add row on the bottom right side of table

Type of Deliverable	Delivery Date	Description
OSM Program Annual Progress Report (required)	Q4	Report by the work plan lead on this work plan's activities and deliverables using OSM annual report template
Other (Describe in Description Section)	Q4	Task 1.1 delivered by ABMI (1) Geospatial Data for the entire Oil Sands Region: • 2022 human footprint inventory including data attributes (e.g., Age; Sector; Noise; Light; State of Vegetation (NDVI)) and metadata; • circa 1950s human footprint inventory data (2) Technical Report: methodological report summarizing 2022 HFI enhancements and circa 1950s HFI

Type of Deliverable	Delivery Date	Description
Key Engagement/Participation Meeting	Q2	Tasks 3.1 Host workshops to discuss OSM programs' geospatial science needs and priorities discuss a roadmap for identifying and delivering OSM cross-cutting geospatial needs through OSM integrated geospatial program, based on participation of the TACs and SIKIC at a series workshops
Key Engagement/Participation Meeting	Q4	Tasks 3.2 - 3.3 Host workshops series by the work plan lead (1) analyze Task 3.1's information gathering and joint review of initial concept of program-wide geospatial support (2) A report including findings, a proposed geospatial program, and request for confirmation and guidance on the path forward
Other (Describe in Description Section)	Q4	Task 2.2 Habitat mapping of forest regeneration - delivered by a future contractor (1) Geospatial data and analytical models/scripts (2) Technical Report by a future contractor on methodological approaches and summary of fundings
Other (Describe in Description Section)	Q4	Task 2.3 Geospatial surface water level mapping - delivered by a future contractor (1) Geospatial data and analytical models/scripts (2) Technical Report in a manuscript format for OSM peer-review publications on methodological approaches and summary of fundings

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.

Dr. Zhibang Lv, Geospatial Scientist, Ph.D. – Resource Stewardship, Alberta Environment and Protected Areas, Edmonton Alberta: Zhibang has over 15 years of experience in remote sensing and GIS, with applications across the fields of hydrology and ecology. Zhibang's role in this work plan is to support the implementation of OSM geospatial science program by (i) developing partnerships and collaborations within and outside OSM Program and (ii) leading the development of geospatial data collection and acquisition, services, and management for the OSM Program. Additionally, Zhibang will lead geospatial support to OSM State of Environment reporting, OSM Office, and OSM teams. He will participate in conferences and workshops and will contribute to OSM peer-review publications as an author/co-author. As part of this work plan, he will develop contracts and work directly with OSM TACs, OSM scientists, and projects PIs for delivering this work plan.

Dr. Mina Nasr, Senior Geospatial Scientist, Ph.D. – Resource Stewardship, Alberta Environment and Protected Areas, Calgary Alberta: Mina is experienced in geospatial/image analytics, data interpretation, and synthesis of information for comprehensive visualization and project planning and delivery in a variety of environmental fields such as water resources, soil/sediment, watershed assessments, contaminants and acid rain loads, and climate change and hydrological limits. Mina will support the delivery of this work plan as required.

ABMI has been receiving grants from EPA and OSM Program for many years, and the Integrated Geospatial Program will continue this collaboration with ABMI's Geospatial Centre led by Dr. Cynthia McClain. The ABMI work will be done by a team of scientists and geospatial technologists.

Additional human resources will be seek after within the Government of Alberta's Ministry of Environment and Protected Areas (e.g., Provincial Geospatial Centre, Policy, Planning). Some of the internal data collection and assessment will be done in collaboration with Environment and Protected Area's internal teams including Geographic Science Team in Policy and Climate Systems Branch.

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 AEPA 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 AEPA

Add an additional AEPA Staff member by clicking on the add row below the 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
Geospatial Scientist	Work Plan Lead	100
Senior Geospatial Scientist	Geospatial support as required	40

Table 16.1.2 ECCC

Add an additional ECCC Staff member by clicking on the add row below the table. The total FTE (Full Time Equivalent) is Auto Summed (in Table 16.2.2) and converted to a dollar amount.

Name (Last, First)	Role	%Time Allocated to Project

The tables below are the financial tables for Alberta Environment & Protected Areas (AEPA) 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. Please note that completion of this Project Finance Breakdown Template is mandatory and must be submitted along with each workplan.

PROJECT FINANCE BREAKDOWN TEMPLATE

Table 16.2.1 Funding Requested BY ALBERTA ENVIRONMENT & PROTECTED AREAS

Organization - Alberta Environment & Protected Areas ONLY	Total % time allocated to project for AEPA staff	Total Funding Requested from OSM
Salaries and Benefits (Calculated from Table 16.1.1 above)	140	$168,000.00
Operations and Maintenance		
Consumable materials and supplies		$2,000.00
Conferences and meetings travel		$4,000.00
Project-related travel		$3,000.00
Engagement		
Reporting		$5,000.00
Overhead		
Total All Grants (Calculated from Table 16.4 below)		$0.00
Total All Contracts (Calculated from Table 16.5 below)		$1,292,500.00
Sub-Total (Calculated)		$1,474,500.00

Capital*	
AEPA TOTAL (Calculated)	$1,474,500.00

* 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)	0	$0.00
Operations and Maintenance		
Consumable materials and supplies		
Conferences and meetings travel		
Project-related travel		
Engagement		
Reporting		
Overhead		
ECCC TOTAL (Calculated)		$0.00

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

Table 16.3

Complete ONE table per Grant recipient.

Add a Recipient by clicking on add table below the table. The total of all Grants is Auto Summed in Table 16.2.1

GRANT RECIPIENT - ONLY: Name	
GRANT RECIPIENT - ONLY: Organization	
Category	Total Funding Requested from OSM
Salaries and Benefits FTE	
Operations and Maintenance	
Consumable materials and supplies	
Conferences and meetings travel	
Project-related travel	
Engagement	
Reporting	
Overhead	
GRANT TOTAL (Calculated)	$0.00

Table 16.4

Complete ONE table per Contract recipient.

Add a Recipient by clicking on add row below the 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	To be identified (Task 1.2 Anthropogenic Noise Modeling Calibration)
CONTRACT RECIPIENT - ONLY: Organization	To be identified
Category	Total Funding Requested from OSM
Salaries and Benefits	$32,500.00
Operations and Maintenance	
Consumable materials and supplies	
Conferences and meetings travel	
Project-related travel	
Engagement	
Reporting	
Overhead	
CONTRACT TOTAL (Calculated)	$32,500.00
CONTRACT RECIPIENT - ONLY: Name	To be identified (Task 1.3 LiDAR and aerial products acquisition)
CONTRACT RECIPIENT - ONLY: Organization	To be identified
Category	Total Funding Requested from OSM
Salaries and Benefits	$350,000.00
Operations and Maintenance	
Consumable materials and supplies	
Conferences and meetings travel	
Project-related travel	
Engagement	
Reporting	
Overhead	
CONTRACT TOTAL (Calculated)	$350,000.00
CONTRACT RECIPIENT - ONLY: Name	To be identified (Task 2.2 Habitat Mapping)

CONTRACT RECIPIENT - ONLY: Organization	To be identified
Category	Total Funding Requested from OSM
Salaries and Benefits	$785,000.00
Operations and Maintenance	
Consumable materials and supplies	
Conferences and meetings travel	
Project-related travel	
Engagement	
Reporting	
Overhead	
CONTRACT TOTAL (Calculated)	$785,000.00
CONTRACT RECIPIENT - ONLY: Name	To be identified (Task 2.3 water surface mapping)
CONTRACT RECIPIENT - ONLY: Organization	To be identified
Category	Total Funding Requested from OSM
Salaries and Benefits	$125,000.00
Operations and Maintenance	
Consumable materials and supplies	
Conferences and meetings travel	
Project-related travel	
Engagement	
Reporting	
Overhead	
CONTRACT TOTAL (Calculated)	$125,000.00

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 AEPA and ECCC ONLY	$168,000.00
Operations and Maintenance	
Consumable materials and supplies Sums totals for AEPA and ECCC ONLY	$2,000.00
Conferences and meetings travel Sums totals for AEPA and ECCC ONLY	$4,000.00
Project-related travel Sums totals for AEPA and ECCC ONLY	$3,000.00
Engagement Sums totals for AEPA and ECCC ONLY	$0.00
Reporting Sums totals for AEPA and ECCC ONLY	$5,000.00
Overhead Sums totals for AEPA and ECCC ONLY	$0.00
Total All Grants (from table 16.2.1 above) **Sums totals for AEPA Tables ONLY**	$0.00
Total All Contracts (from table 16.2.1 above) **Sums totals for AEPA Tables ONLY**	$1,292,500.00
SUB-TOTAL (Calculated)	$1,474,500.00
Capital* **Sums total for AEPA**	
GRAND PROJECT TOTAL	$1,474,500.00

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

17.0 FINANCIAL MANAGEMENT

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

☑ Please check this box to acknowledge you have read and understand

In the space below please describe the following:

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

The work plan lead will diligently monitor and manage expenses to prevent potential cost overruns, adhering to the approval conditions indicated by the OSM Program. In the event that costs are lower than budgeted, the lead will ensure the recording of underspending and promptly report it to the Program.

There is a potential risk associated with delays in the approval announcement of the work plan by the Program, leading to a delayed project commencement and, subsequently, partial deliveries by the end of the fiscal year. To mitigate this risk, we will maintain open communication with project PIs to tailor contracts to specific deliverables, budgets, and expected timelines. Any necessary changes will be integrated into the contracts through the development of scope of work documents aligned with OSM quarterly reporting and the project phases and deliverables outlined in this work plan.

In cases where projects face challenges in meeting their deliverables, the contractors/PIs will be first consulted to find solutions. If not successful, the challenges/shortcomings will be documented in the quarterly reports of each project and reported to the OSM Program. This will enable the Program to provide guidance on finding solutions or, if necessary, to terminate the contracts.

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 add row on the bottom right side of table.

Description	Source	Equivalent Amount ($CAD)
Task 1.1 Human footprint mapping	Government of Alberta through	$717,500.00
	TOTAL	$717,500.00

19.0 Consent & Declaration of Completion

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.

Lead Applicant Name

Zhibang Lv

Title/Organization

Geospatial Scientist / Ministry of Environment and Protected Areas, Government of Alberta

Signature

Zhibang Lv Digitally signed by Zhibang Lv
Date: 2024.04.30 11:52:09 -06'00'

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

Title/Organization

Signature

Please save your form and refer to the instructions page for submission link.

Program Office Use Only

Governance Review & Decision Process

this phase follows submission and triggers the Governance Review

TAC Review (Date):

ICBMAC Review (Date):

SIKIC Review (Date):

OC Review (Date):

Final Recommendations:
Decision Pool:

Notes:

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):

SIKIC Review (Date):

OC Review (Date):

Comments:
Decision Pool:

Notes & Additional Actions for Successful Work Plan Implementation:

Signature