IIP: KEY QUESTIONS REPORT

Key Questions Report

ABSTRACT

The definition of a monitoring question is among the most difficult tasks in establishing a monitoring program, but also among the most crucial (Arciszewski et al., 2017; Likens & Lindenmayer, 2018). Indigenous communities of the Wood Buffalo Indigenous Sub-Caucus are interested in how the Oil Sands Monitoring Program (OSMP) can address their concerns regarding oil sands development in the Athabasca Oil Sands Region. This means clearly defining what key questions the communities expect core monitoring to address.

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2025

In Memorium

This report is dedicated to the memory of Sheryl Huppie, a dear friend, member of our committee and a key contributor to this work.

From McMurray Métis:

With profound sadness, we share the news of the unexpected passing of our Member and staff Member, Sheryl Huppie, on Sunday, March 9, 2025, in Fort McMurray, AB.

She was born in British Columbia on June 1, 1974, and raised on the Kikino Métis Settlement until she moved to Fort McMurray in 1996.

Sheryl had 25 years of oil sand experience in health and safety, welding inspection, and project management.

Sheryl was a blessing to our Nation. She was one of our longest-running employees, having worked for us since 2017 in many roles, including Traditional Knowledge Educator.

Our award-winning garden thrived because of her hard work and devotion. She also helped create the Summer Student Program with McMurray Métis.

Sheryl was passionate about gardening, harvesting, and helping people get healthy. She shared her Traditional Knowledge, preparing foods and making oils, salves, and sprays so our Members could access traditional medicines.

Cooking was another passion of hers. She cooked with her special ingredients, love, and prayer and ensured everyone had a full belly and heart.

She was a force of nature and was deeply connected to her Indigenous Culture. She made personal connections to everyone she met and made everyone feel valued and special in their own way. She fostered a family dynamic at the office.

As part of her role, she also worked with Industry and Regulatory Affairs, advocating for Métis rights and collaborating with Western scientists to braid Traditional Knowledge into various projects and committees, including the Ronald Lake Bison Herd, Seed, Berry, Clam Study, Reclamation Engagement Focus Group, Crown-Indigenous Working Group, Impact Assessment Guide & Toolkit for Indigenous Communities and the aquatic manual.

As a true steward of the land, Sheryl cared for the waters, the earth, and all the animals.

Sherly is lovingly survived by her life partner, Bryan Fayant; her three daughters, Chantelle (James), Mackenna (Justin), and Melanie; and granddaughter Aurora, along with her mother, Judy Cardinal,

and her two sisters, Laura Cardinal, and Crystal Ladouceur, many aunts, uncles, nieces, nephews, cousins, family, friends, and colleagues.

She is predeceased by her father, Silas Cardinal, and her sister, Melanie Cardinal.

Sheryl's legacy was that she was the best mother and best friend that her three daughters could ask for.

We know Sheryl is now with Creator in the most beautiful garden of all. We send our prayers to them and to all her family and friends here on Mother Earth. Please join us in praying. 🖤🪶

Executive Summary

The definition of a monitoring question is among the most difficult tasks in establishing a monitoring program, but also among the most crucial (Arciszewski et al., 2017; Likens & Lindenmayer, 2018). Indigenous communities of the Wood Buffalo Indigenous Sub-Caucus are interested in how the Oil Sands Monitoring Program (OSMP) can address their concerns regarding oil sands development in the Athabasca Oil Sands Region. This means clearly defining what key questions the communities expect core monitoring to address.

The OSMP has had a suite of key monitoring questions that have been converging on questions that are more targeted and trackable. However, they remain quite broad and can support a wide variety of monitoring approaches.

The communities of the Wood Buffalo Indigenous Sub-Caucus engaged with their members from February 2024 - March 2025 to identify which key questions, monitoring principles, locations and indicators they would like core monitoring to address. The intent of this work is to inform the OSMP on how it can better address Indigenous key questions. While it is not the role of the OSMP to monitor impacts to rights directly, answering these key questions may inform Indigenous communities' interpretation of impacts to their rights. Thus, our work is grounded in an understanding of rights, culture, and driven by the communities.

We summarized that feedback to four key principles, conceptual models, and a suite of key monitoring questions for air, aquatics, and terrestrial biodiversity monitoring. Indigenous communities are interested in monitoring that tracks stressors and effects, that includes measures of how they experience the landscape, that have a link to compliance monitoring and have the potential to inform environmental management. This report, with the Gap Analysis and Knowledge Translation Reports, forms the basis of work intended to more clearly define how the OSMP core monitoring can address Indigenous concerns.

Contents

Acronyms

AAAQO – Alberta ambient air quality objectives
AER – Alberta Energy Regulator
AOS – Athabasca Oil Sands
AQHI – air quality health index
AR – Athabasca River
CEMA – Cumulative Environmental Management Association
CNOOC – China National Off-Shore Oil Corporation
CNRL – Canadian Natural Resources Ltd.
COPC – constituents of potential concern
COSIA – Canadian Oil Sands Innovation Alliance (Now Pathways Alliance)
EIA – Environmental Impact Assessment
EPA – Environmental Protection Agency
EPEA – Environmental Protection and Enhancement Act
FWW – fresh wet weight
GHG – Greenhouse gases
GoA – Government of Alberta
HIS – Habitat Suitability Index
IK – Indigenous knowledge
KCAC – keep clean areas clean
LSA – local study area
NMHC – non-methane hydrocarbons
NOx – Oxides of nitrogen, mostly NO and NO_2
OC – Oversight Committee
OSM – Oil Sands Monitoring
OSMP – Oil Sands Monitoring Program
PAD – Peace Athabasca Delta
$PM_{2.5}$ – Particulate matter less than 2.5 microns
PM_{10} – Particulate matter less than 10 microns
PVA – population viability analysis
RAMP – Regional Aquatics Monitoring Program
ROW – Right of way
RSA – regional study area
RSC – reduced sulfur compounds
SAGD – steam assisted gravity drainage
SD – standard deviation
SIKIC – Science and Indigenous Knowledge Integration Committee
SOx – Oxides of sulphur, the most common of which is SO_2
SPEI – standardized precipitation evaporation index
TAC – Technical Advisory Committee
THC – total hydrocarbons
TLU – Traditional land use
TRS – total reduced sulphur compounds

TSC – total sulfur compounds
TSP – total suspended particulate matter
VOC – volatile organic compounds
WBEA – Wood Buffalo Environmental Association
WBISC – Wood Buffalo Indigenous Sub Caucus
WHO – World Health organization
WQCIU – Water Quality Criteria for Indigenous Use

1. Introduction

> *... when I think of environment, maybe that's also truth and reconciliation ... even just with myself going through this journey and really understanding it myself, the truth being, the populations are becoming decimated. The land isn't nutrient-rich the way it used to be. The air quality isn't there. That's truth. Where's reconciliation? Where's reclamation? ... This is truth. This is our truth. This is our truth today. And ... how do we reconcile, how do we reclaim, how do we regrow? How do we heal the land?*
>
> *-(Willow Lake Métis Nation, 2025)*

> *Posing good questions lies at the heart of good science and hence is essential to effective monitoring (Nichols and Williams 2006). This is far from being a trivial task – 90% of a problem is often defining the problem.*
>
> *-(Likens & Lindenmayer, 2018)*

All participants in the Oil Sands Monitoring Program (OSMP) share the goal of developing a program that is effective, responsive and meaningful, that informs management and policy, and that provides needed information to Indigenous peoples including their approaches, knowledge and perspectives. To do so, the program needs to be clear about what questions it intends to answer, and what approach it will take to answer them. To date, the program's focus and key questions have not been clear in driving the monitoring work, and this has impacted the value, quality and timeliness of the monitoring data. Further, core monitoring often does not address key concerns of Indigenous peoples of the region.

The OSMP focus has been influenced by multiple factors that have determined much of the work the program is currently funding, including the inheritance of legacy monitoring programs and federal research, and the inclusion of some regional compliance monitoring, such as air. Further, there appears to be a perception that the OSMP is a funding body where various individual research and monitoring projects can be addressed without sufficient attention to ensuring these projects are well-integrated with the OSMP key questions and objectives or aligned with the OSMP's role in regional cumulative effects management. As such, the monitoring workplans within OSMP have not focused enough on what we are monitoring and *why*. More effort is needed to develop the key questions of the program to direct effective and integrated workplans.

The development of key questions to drive the OSMP would require understanding what Indigenous, government, regulatory, and industry participants need from the program to track potential impacts from oil sands and to ensure that management action is taken when needed. As it stands, the current OSMP key questions are too broad to direct specific work planning within the core and community-based monitoring projects and there is more opportunity to integrate Indigenous Knowledge (IK) to inform core program monitoring.

2. Indigenous Indicator Prioritization

The Indigenous Indicator Prioritization Project (IIP) is designed to more clearly identify Indigenous concerns and questions, and to determine if the OSMP core monitoring is collecting data that can address Indigenous community concerns of oil sands impacts in the region. In year one, we have addressed three key components:

1) Key Questions: outlining results of community engagement and the development of Indigenous key questions, principles and conceptual models for participating communities,
2) Gap Analysis: an analysis of potential gaps in core monitoring that should be addressed to answer these questions, and
3) Knowledge Translation Plan: outlining how Indigenous decision makers and data users can be involved in and be informed by the OSMP.

It is a multi-community, multi-year effort including Indigenous participants in the Wood Buffalo Indigenous Sub Caucus (WBISC):

- Athabasca Chipewyan First Nation
- Chipewyan Prairie First Nation
- Fort Chipewyan Métis Community
- Fort McKay First Nation
- Fort McMurray Métis Local 1935
- McKay Métis Nation
- Mikisew Cree First Nation
- Fort McMurray #468 First Nation
- Conklin Métis
- Owl River Métis
- Chard Métis Nation
- Willow Lake Métis Nation
- Lakeland Métis Nation [1]

It is very important to note that this project only included twelve (now thirteen) Indigenous communities, all in the Wood Buffalo Region. As such, these results are not representative of all communities in the OSMP. More work is required to understand the concerns of all communities participating in the OSMP.

These three reports inform phase I of the IIP project. In future years, we will continue to develop Indigenous approaches to monitoring indicators and locations, limits of change, and to identify how Indigenous priorities can be addressed by the OSMP core monitoring.

2.1 History of the OSMP

It is worth reviewing how the OSMP was developed to understand what key questions it is currently trying to answer. From the late 1990s to 2012, monitoring in the oil sands region was executed by multi-stakeholder organizations including Wood Buffalo Environmental Association, the Regional Aquatics Monitoring Program, and the Cumulative Environmental Management Association. These organizations, while struggling with inclusion (Tanner & Frideres, 2008), attempted to become truly multi-stakeholder processes, with participation from industry and government, and governed by a decision-making process that included Indigenous representatives (Dubé et al., 2021). However,

[1] Lakeland Métis Nation joined the WBISC in February of 2025.

considerable controversy was generated by the 2009 and 2010 publication of two influential papers by Erin Kelly and David Schindler (Kelly et al., 2009, 2010). They found significant concentrations of metals and organic compounds in snow deposition and in tributaries. The resulting widespread media attention, including pictures of David Schindler holding a fish with a prominent tumor on its back (CBC News, 2010), was widely felt by Indigenous communities to vindicate their observations and concerns that had been voiced for years. It also initiated two federal and one provincial review of oil sands management and monitoring (Dowdeswell et al., 2010; Gosselin et al., 2010, Kvisle et al., 2011) which found that existing monitoring had not been extensive enough [2] to detect any changes in water quality because of oil sands development.

The federal Oil Sands Advisory Panel, established by the Environment Minister on September 30, 2010, reviewed the existing monitoring and noted that failures to clearly outline the objectives and goals of the monitoring program was of utmost importance:

> *Of primary importance is asking the right questions to which the monitoring system should be designed to respond. For example, have predefined thresholds been exceeded in all relevant environmental media? How much change in space and time has occurred in a critical environmental parameter? In our view, the current system has not been able to address questions like these adequately.*
>
> - *(Dowdeswell et al., 2010)*

In response, the federal government drafted a new monitoring plan as a solution to the patchwork monitoring that preceded it (Wrona F. et al., 2010). [3] These were brand-new monitoring approaches, largely developed by federal scientists, that had no relationship to the existing provincial and multi-stakeholder monitoring programs, and that were focused on largely the mineable, or Athabasca, region. The 2011 Integrated Monitoring Plan for the Oil Sands largely collated and expanded upon existing federal research approaches, resulting in a collection of disparate monitoring and research approaches that have formed the backbone of today's OSMP core monitoring. The original program design had three core outcomes, which were focused on largely the Athabasca region with an emphasis on the mineable region:

> *1. Assess environmental condition or state and whether there been changes from baseline reference in the oil sands region;*
>
> *2. Determine relationships between stressors and responses and evaluate the extent to which responses are caused by oil sands-related stressors; and,*
>
> *3. Assess cumulative effects.*
>
> *- (Wrona F. et al., 2010)*

[2] The reports found that oil sands monitoring did not have the design, including frequency of sampling, to capture episodic changes in water quality. They also found that there needed to be more monitoring of other media to capture all impacts.

[3] Note that Dr. Fred Wrona was a lead of the Northern River Basin Study, which informed the development of the JOSM Integration Plans.

However, these outcomes, and their key question counterparts, are high-level and can include almost any study related to trying to detect, document, or understand oil sands environmental effects. It is also unclear how these questions would be answered, and how those answers would inform and/or trigger management or policy. The resulting media-specific implementation plans had very different approaches to narrowing these outcomes to objectives, questions, or goals. Some had key questions (air and aquatics), some had goals of developing a program with key questions (acid sensitive lakes), and some had neither of these. Further, it was not clear how Indigenous concerns would be addressed within these high-level objectives.

In 2011, Environment and Climate Change Canada published monitoring plans for each of three media, Air Quality, Aquatics, and Terrestrial Biodiversity. Their approach to defining monitoring questions varied.

Air quality(Government of Canada, 2011a) had key questions focused on emissions, transformation, and fate:

- *What is being emitted from the oil sands operations, how much and where?*
- *What is the atmospheric fate (transport, transformation, deposition) of oil sands emissions?*
- *What are the impacts of oil sands operations on ecosystem (water, biota) and human health? (to be done in collaboration with water, biota and human health experts while providing information on the deposition and exposure due to oil sands emissions)*
- *What additional impacts on ecosystem health and human exposure are predicted as a result of anticipated future changes in oil sands development (to inform regulatory needs)*

  - *(Government of Canada, 2011a)*

These questions are not explicitly hypothesis-driven but lend themselves easily to developing hypotheses that clearly focus on both the information needs of managers and documenting the complete pathway from stressor to effects.

Aquatics (Government of Canada, 2011b) had detailed key questions focused on water quality, benthic communities and fish health. Note that there is a linkage to human use in the questions on fish health, but no other consideration of impacts to humans:

Water Quality and Quantity

- *Are oil sands related contaminants present in the aquatic environment of the Peace Athabasca Delta, Lake Athabasca, Peace River, Slave River and Slave River Delta?*
- *What are the long-term trends in contaminant concentrations and fluxes in the Peace-Athabasca Delta, Peace River, Slave River and Slave River Delta?*

- *What are the cumulative impacts of oil sands development on the water quality (including sediments) and quantity in the Peace-Athabasca Delta, Peace River, Slave River and Slave River Delta?*

Benthic Invertebrate Monitoring

Ecosystem Health

- *What is the current status of benthic communities in these ecosystems?*
  - *What is the baseline against which future change will be assessed?*
  - *What baseline data need to be collected in areas of future development?*
  - *Are there significant changes since historical studies?*
- *Are there existing differences in benthic communities among reference and potentially impacted sites?*

Cumulative Effects

- *Do predictive relationships exist that link system drivers (including development stress) and variability within sites in benthic community responses?*
- *Is there evidence of cumulative effects of development on benthic communities in the Lower Athabasca River?*
- *Is there evidence of cumulative effects further downriver?*

Fish Health

Environmental Health

- *What is the current status of fish populations in the Lower Athabasca Region?*
  - *What are the baseline conditions for fish populations against which future change will be judged?*
  - *Which baseline data need to be collected in areas of future oil sands development?*
  - *Are there significant changes since historical studies?*
- *Are there existing differences in fish populations among sites in the Lower Athabasca Region?*
- *Are there trends/changes in fish health?*

Human Use

- *What is the status of fish populations in high use areas?*
- *Is the incidence of fish abnormalities elevated or changing?*
- *What are contaminant levels in fish?*
  - *How do they compare to historical levels?*
  - *Are contaminant concentrations in fish increasing or decreasing downstream of oil sands development or in areas of natural geological exposure?*
  - *Does other development influence these concentrations?*
  - *Are contaminants at levels in the fish that are safe for human consumption?*

Cumulative Effects

- *Are there any predictive relationships between system drivers (including development stress) and variability within sites in fish responses?*
- *Is there evidence of cumulative effects of development on fish in the Lower Athabasca Region?*
- *Is there evidence of cumulative effects further downriver?*

These questions are hypothesis-driven (comparing endpoints against oil sands stressors), geographically specific, and include aspects of the stressor and effects, though the extent to which they were integrated is unclear.

However, the other proposed monitoring programs either did not have questions (Government of Canada, 2011c) or had objectives to develop a model or sampling approach to test an implied hypothesis (Government of Canada, 2011b).

Having unclear questions at the beginning of a monitoring program need not be fatal. Where the relationships between stressors, or the suitability of certain indicators is unknown, an initial period of monitoring an abundance of indicators at a high level can inform analyses and understanding so that program participants can examine the data based on initial observations and invest time planning and developing key questions that guide a more rational, integrated, and powerful monitoring program. This approach was intended for the OSMP development but has not come to fruition. For example, the Phase I Lower Athabasca Water Quality Monitoring Plan anticipated the development of a "decision framework" as part of its adaptive monitoring approach (Government of Canada, 2011b). Similarly, the intention for program rationalization for the OSMP was also clear from "[i]n the first three years, as the program is being put in place, the total cost of enhanced monitoring beyond what the two governments currently spend would be up to $50 million per year… In subsequent years, the costs would be lower, as the monitoring program matures, our knowledge will be improved, and the work plan can be refined to focus on issues of current concern (Government of Canada, 2012)." However, for various reasons, this program-wide rationalization [4] did not occur.

A first step at rationalizing the program was the 2018-2019 Integration Workshops and resulting 2019 Integration Report (Swanson, 2019). Conceptual models of each thematic area (terrestrial biological monitoring, groundwater, surface water and aquatic biology, atmospheric deposition, geospatial science, mercury and predictive modelling) were developed to guide discussions and ultimately, core monitoring workplans. This was an enormous advance.

The workshops focused on three Core OSM Outcomes, which were a restatement of the original three outcomes from the 2011 Implementation Plans:

1. *Assess accumulated environmental condition or state (have things changed?);*
2. *Determine relationships between oil sands-related stressors and effects (are the observed changes caused by the oil sands industry?); and,*

[4] Note that water quality did do its own rationalization exercise, which proposed focused studies to address information gaps and a decision tree to guide selection of new sites. (Chambers et al., 2018) However, it did not result in the development of an adaptive monitoring approach with clear questions and a decision tree arising from the answers derived from monitoring.

3. *Assess cumulative effects (what are the combined effects of oil sands stressors across regions and over time?)*

   - *(Swanson, 2019)*

Each Integration Workshops had up to 40 practitioners in each area and focused on the extent to which the Core OSMP Results could be answered. The breadth of the Core Outcomes resulted in a great deal of disagreement over prioritization of monitoring activities, because virtually anything could fall under their umbrella. Nonetheless, the working groups made great strides in integrating monitoring and developing conceptual models that could guide the development of key questions. The groups identified important uncertainties and developed key questions to answer them. However, these were not necessarily all monitoring questions, for example questions that focused on how to make the program more effective, such as 'how do we build trust in communities?'

In 2020, OSMP participants worked to develop key questions by caucus (Table 1). Government and industry caucuses both outlined sets of questions related to their regulatory and operating obligations, such as 'is air quality within the Alberta Ambient Air Quality Objectives?' These key questions relate to industry compliance; however, they're not monitoring questions. Adaptive monitoring questions should have the power and focus to detect change before it becomes a management issue (Dubé et al., 2013; Munkittrick, 2000). Furthermore, their questions did not focus on stressor/response pathways, so would have limited ability to inform cause in the event change is detected. Finally, all caucuses focused on biophysical questions, with limited consideration of how biophysical impacts translate to socio-cultural impacts on communities.

Table 1. 2020 Key Questions for the OSMP. Questions were compiled from key questions provided by government, industry, and Indigenous caucuses. At the time, the Interim Indigenous Caucus included all participating Indigenous communities.

CATEGORY		AIR QUALITY	DEPOSITION	WATER QUALITY (RIVERS, LAKES & WETLANDS)	WATER QUANTITY (RIVERS, PAD)	GROUNDWATER	WETLANDS & TERRESTRIAL
1. SURVEILLANCE	**Source**	Has air quality changed from baseline?	Has deposition of airborne contaminants changed?	Has water quality changed from baseline?	Has water quantity changed from baseline?	Has groundwater quality and quantity changed from baseline?	What is the extent of the human footprint?
	Effects	Are there effects on receiving environment (endpoints relating to ecological health, odours, human health, endpoints relating to indigenous Rights: wellbeing, culture and Rights)?	Is there an effect on the receiving environment? (endpoints relating to pathway: eutrophication, acidification, toxicity and endpoints relating to Rights ie bog cranberry, berries)	Do contaminants of concern have effects on aquatic resources, ecological and human health and wellbeing? (endpoints relating to pathway: fish and benthos, and endpoints relating to Rights)	Do changes in water quantity have effects on aquatic resources, ecology, human health and wellbeing? (endpoints relating to pathway: recharge frequency, ice thickness etc, endpoints relating to Rights: muskrat habitat, navigation)	Do changes in groundwater have effects on the receiving environment? (Endpoints relating to aquifer draw down, groundwater quality, endpoints relating to Rights ie groundwater taste and smell)	How have wetland and terrestrial ecosystems changed from baseline (species distributions, communities, populations, health)? (Endpoints relating to stressor: disturbance, noise and contaminants. Note that some contaminants questions are largely covered in air and water. Endpoints relating to Indigenous

CATEGORY	AIR QUALITY	DEPOSITION	WATER QUALITY (RIVERS, LAKES & WETLANDS)	WATER QUANTITY (RIVERS, PAD)	GROUNDWATER	WETLANDS & TERRESTRIAL
						concerns: populations of key species (high value species such as clams, berries, pitcher plant, muskrat, beaver, fisher, moose, caribou, rat root) in preferred locations and at relevant scale, accessibility, health of resources? Results must be at local level, and relative to either pre-development baseline, modeled populations, or an assessment of the population required to support the community)

CATEGORY		AIR QUALITY	DEPOSITION	WATER QUALITY (RIVERS, LAKES & WETLANDS)	WATER QUANTITY (RIVERS, PAD)	GROUNDWATER	WETLANDS & TERRESTRIAL
2. CONFIRMATION		What are frequency and extent of odour events?	What is extent of deposition of compounds of concern?				What is the extent of the human footprint? What is the extent and magnitude of noise? What is the extent and magnitude of deposition (from deposition program)?
3. FOCUSED		Do we have the right technology to detect odour events? How does meteorology contribute to odours? Does air quality impact Indigenous wellbeing and ability to be out on the land?		How does changes to aquatic resources impact Indigenous health, wellbeing and culture? What are unanticipated pathways of affect? What is the role of sediment transport in the water quality and aquatic health downstream (Peace	Are there areas that cannot be accessed now due to water quantity changes? How has landscape alteration changed waterflows? How has aquifer draw down affected water flows?	Where are areas of groundwater connectivity to surface water? Is there evidence of effects from: deep well disposal, thermal release of contaminants and vapour injection using solvents, reclamation sites, surface storage of process water? Is there evidence of biodegradatio geochemical transformation or dilution reduce contamination? Do changes in hydraulic	What is the contamination burden of key resources? Do odours impact distribution of species? How do waterfowl interact with tailings and process water? What are social and cultural barriers to increased harvesting? What are barriers to accessing resources? What is critical level of

CATEGORY	AIR QUALITY	DEPOSITION	WATER QUALITY (RIVERS, LAKES & WETLANDS)	WATER QUANTITY (RIVERS, PAD)	GROUNDWATER	WETLANDS & TERRESTRIAL
			Athabasca Delta)?		gradients associated with industrial development affect groundwater?	disturbance before s. 35 Rights cannot be exercised?

CATEGORY		AIR QUALITY	DEPOSITION	WATER QUALITY (RIVERS, LAKES & WETLANDS)	WATER QUANTITY (RIVERS, PAD)	GROUNDWATER	WETLANDS & TERRESTRIAL
3. FOCUSED	**Indigenous Rights and Culture**	Do changes to air quality impact harvesting and occupancy patterns, harvesting volumes (food security), intergenerational transfer of knowledge (i.e., identification, harvesting protocols, processing skills, ethno-taxonomy), sharing of resources linked to the reinforcement of kinship bonds, people's relationship and obligations to the land? Develop Indigenous limits of change.	Do changes to air quality impact harvesting and occupancy patterns, harvesting volumes (food security), intergenerational transfer of knowledge (i.e., identification, harvesting protocols, processing skills, ethno-taxonomy), sharing of resources linked to the reinforcement of kinship bonds, people's relationship and obligations to the land? Develop Indigenous limits of change.	Do changes to water quality impact harvesting and occupancy patterns, harvesting volumes (food security), intergenerational transfer of knowledge (i.e., identification, harvesting protocols, processing skills, ethno - taxonomy), sharing of resources linked to the reinforcement of kinship bonds, people's relationship and obligations to the land? Develop Indigenous limits of change.	Do changes to water quantity impact harvesting and occupancy patterns, harvesting volumes (food security), intergeneration al transfer of knowledge (i.e., identification, harvesting protocols, processing skills, ethno-taxonomy), sharing of resources linked to the reinforcement of kinship bonds, people's relationship and obligations to the land? Develop Indigenous limits of change.	Do changes to groundwater impact harvesting and occupancy patterns, harvesting volumes (food security), intergenerational transfer of knowledge (i.e., identification, harvesting protocols, processing skills, ethno-taxonomy), sharing of resources linked to the reinforcement of kinship bonds, people's relationship and obligations to the land? Develop Indigenous limits of change.	Do changes to groundwater impact harvesting and occupancy patterns, harvesting volumes (food security), intergenerational transfer of knowledge (i.e., identification, harvesting protocols, pro cessing skills, ethno-taxonomy), sharing of resources linked to the reinforcement of kinship bonds, people's relationship and obligations to the land? Develop Indigenous limits of change. How have the social and ecological baselines for

CATEGORY		AIR QUALITY	DEPOSITION	WATER QUALITY (RIVERS, LAKES & WETLANDS)	WATER QUANTITY (RIVERS, PAD)	GROUNDWATER	WETLANDS & TERRESTRIAL
							these indicators changed over time? Accessibility: how have disturbance and operations impacted people's ability to access important areas? Assess hunting effort, distance required to access locations.
4. INVESTIGATION OF CAUSE	**Stressor**	What are regional sources of contaminants in air?	What are the sources (and amounts) of compounds that may lead to atmospheric deposition?	What are the sources and amounts of compounds that may affect surface water quality? Do we know all outfalls on the river?	What are the sources and amounts of water used in oil sands activity?	What are sources of groundwater draw down and contaminants entering groundwater?	human footprint mapping (including noise, deposition)

CATEGORY		AIR QUALITY	DEPOSITION	WATER QUALITY (RIVERS, LAKES & WETLANDS)	WATER QUANTITY (RIVERS, PAD)	GROUNDWATER	WETLANDS & TERRESTRIAL
	Modeling	What are pathways and fate of contaminants (modeling)	What are pathways and fate of airborne particles (modeling)? Can we use predictive modeling to understand the current state and make predictions?	What are pathways and fate of waterborne contaminants (modeling)	What are contributors to water quantity changes (modeling)?	What are pathways of groundwater contamination, and pathways for changes in groundwater quantity (drawdown etc)	What are pathways of effect for terrestrial systems? (modeling)
5. INVESTIGATION OF SOLUTIONS		How do management of odours, tailings ponds emissions, mine fleets, stack emission management affect air quality?	BATEA to help with supressing particulates resulting in dust?	How do water release and treatment options, including watershed restoration, affect water quality?	How would modifying water withdrawals, watershed restoration or dredging affect downstream water quantity?	Do mitigations for groundwater contamination work?	Do wildlife mitigation measures work?
6. MONITORING OBSERVATIONS VS EIA PREDICTIONS		How do the OSM data compare with EIA-based predictions of air quality and are the mitigation measures working as planned?	How do OSM data compare with EIA-based predictions of deposition?	How does OSM data compare to EIA predictions?	How does OSM data compare to EIA predictions?	How does OSM data compare to EIA predictions?'	How does OSM data compare to EIA predictions?'

CATEGORY		AIR QUALITY	DEPOSITION	WATER QUALITY (RIVERS, LAKES & WETLANDS)	WATER QUANTITY (RIVERS, PAD)	GROUNDWATER	WETLANDS & TERRESTRIAL
7. LIMITS OF CHANGE	**Triggers, including: CCME, Provincial and Federal objectives and guidelines, EPA, and Indigenous indicators, criteria and thresholds**	What is ambient air quality compared to limits of change, including government standards and Indigenous indicators? For example, FMAQI, EPA, provincial and federal.	What is deposition load compared to limits of change, including government standards and Indigenous indicators? For example, critical loads, CEMA N deposition, acid deposition thresholds	what is water quality compared to limits of change, including government standards and Indigenous indicators? For example, CCME guidelines, Indigenous guidelines, EPA guidelines, EEM fish and benthic end points?	what is water quantity compared to limits of change, including government standards and Indigenous indicators? For example, CCME guidelines, Indigenous guidelines, Aboriginal Base Flow and Aboriginal Extreme Flow?	what is groundwater quantity and quality compared to limits of change, including government standards and Indigenous indicators? For example, CCME guidance.	What is the population status of species of concern compared to limits of change, including government standards and Indigenous indicators?

The Indigenous key questions (Interim Indigenous Caucus, 2020), drafted by the then Interim Indigenous Caucus [5], included perspectives on how oil sand impacts to Indigenous people cannot be viewed from a purely biophysical lens (explored more in Section 3), and included a list of Indigenous key questions. The 2020 document was a compilation of communities' expressed concerns about how oil sands development and resulting impacts affect their Rights and culture. However, even with this effort, the questions remained quite broad, very Western science-driven and biophysically focused, and required more refinement to guide OSM core programs.

To begin to address these gaps in previous core monitoring key questions and clarify what the communities of the WBISC would like core monitoring to address, we focused on developing key questions of importance to participating Indigenous communities. Implementing this work with the communities was essential because:

1. Clear key questions are the foundation of good science and effective monitoring;
2. WBISC communities want monitoring to inform management and to address their concerns regarding oil sands impacts. To do so, the key questions for monitoring must link to management actions and policy that can be addressed by policy makers and industry; and,
3. Indigenous communities have been repeatedly told that the OSMP is how their regional concerns of cumulative effects will be addressed. These concerns around cumulative effects are often raised by Indigenous communities during regulatory application process for oil sands projects; however, there has been no work done to ensure that the OSMP is indeed addressing these concerns.

2.2 Clear Questions are the Foundation of Good Science and Effective Monitoring

Effective monitoring should be driven by clear questions, clear experimental design, and conceptual models (Likens & Lindenmayer, 2018; Lindenmayer & Likens, 2010). Indeed, as stated by (Likens & Lindenmayer, 2018): "A paucity of questions is a serious problem because it often results in monitoring programs being poorly focused and incapable of delivering effective outcomes … In other cases, this deficiency means that it is not possible to diagnose the cause of a change which, in turn, limits predictive capability either through time or spatially to other landscapes or environments." The OSMP has several components across many different media, each of which are guided by disparate questions that have varying degrees of clarity. The OSMP needs to move to a place where the program's objectives and hypotheses are clearly stated and result in focused key questions that directly inform the experimental design. These questions should be linked to a conceptual model that outlines how measured effects are clearly linked to oil sands stressors in the environment (Davidson et al., 2020; Lindenmayer & Likens, 2010).

What makes a monitoring question a 'good' monitoring question is difficult. According to (Lindenmayer & Likens, 2010), a good question should indicate quantifiable objectives, be rigorous and testable, and be relevant to decision makers (note that decision makers in the OSMP context includes Indigenous communities. See the Knowledge Translation Plan for more details.) Building on a conceptual model, the key questions should be developed in partnership with policymakers,

[5] In 2020, the Interim Indigenous Caucus included all participating Indigenous communities in the OSMP.

oil sands industry, and Indigenous communities. This ensures that the questions are relevant and more likely to result in outcomes that influence management and land use decisions of all Rightsholders and stakeholders. Finally, the monitoring program should be designed with rigorous statistical support and include a cycle of data analysis and refinement of the program (Figure 1). Without these key questions, and a framework for regularly refining the program, it is very easy for a monitoring program to balloon into a program where much of what is being monitored may not be the best indicators of change, or there are so many moving parts that the process of implementation, analyzing data and assessing change is too slow to be meaningful (Lindenmayer et al., 2022; Lindenmayer & Likens, 2010). This is of particular concern in the oil sands region, where cumulative development is extensive and rapid, and the monitoring takes place over a large area with different stressors. Therefore, it is critical to have a monitoring program that is sensitive to detecting change, focused on areas of highest risk, and has the power and specificity to inform management.

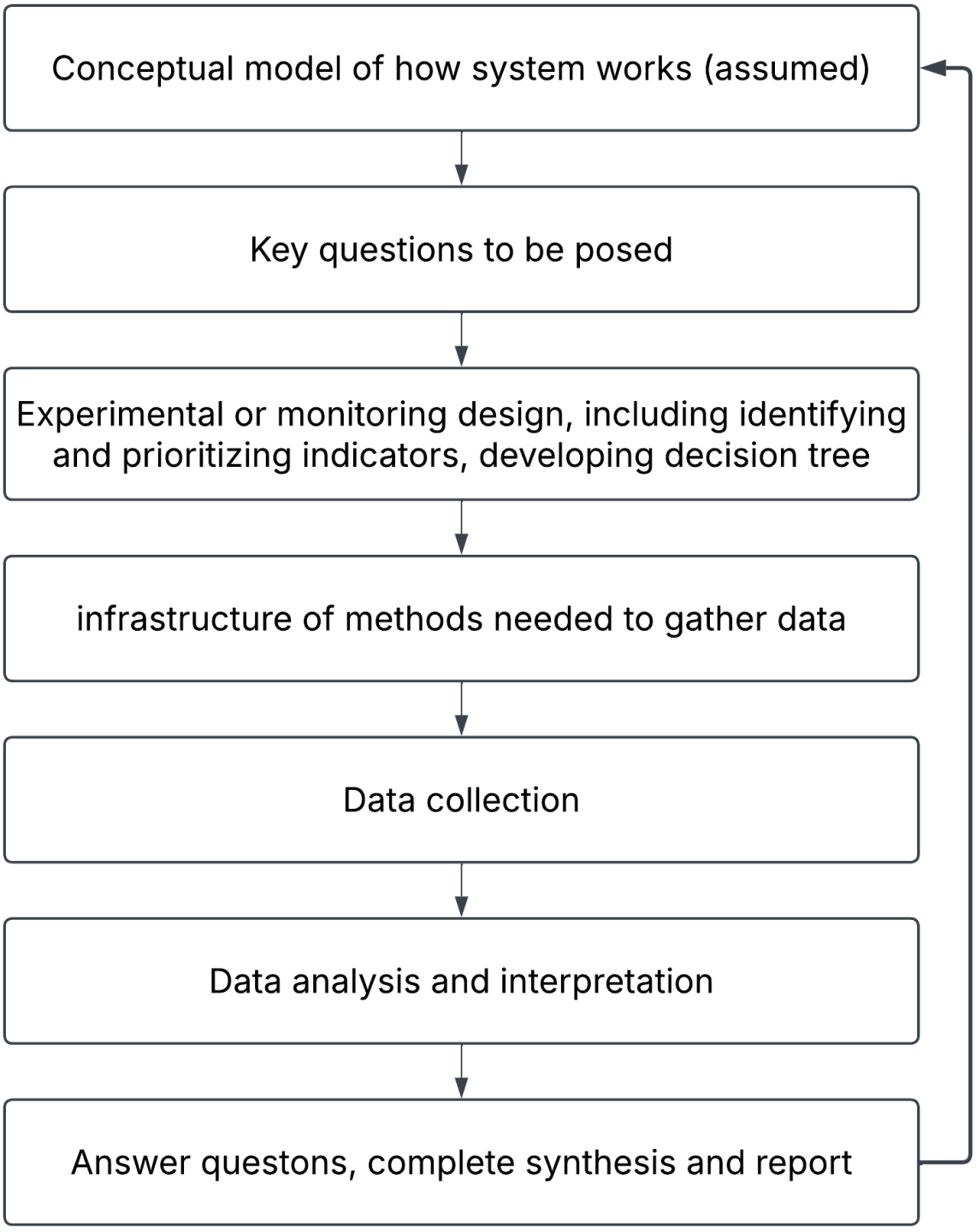

Figure 1. Flow diagram of the sequence of key steps in a monitoring program. Adapted from (Lindenmayer & Likens, 2010)

Because taking the time to rigorously identify key questions and design a monitoring program from these questions is difficult, time consuming, and requires partnerships between policymakers, industry, and Indigenous communities, it is challenging to do well. What frequently happens is that arguments over what to monitor are never resolved, and as a result, a program monitors a wide variety of indicators. When programs are focused on a large area and a large industry, this issue is even more pressing. This 'laundry list' approach to monitoring dilutes and slows efforts to detect real change, loses its link to management, and can create large budgets and unrealistic expectations of what the monitoring program can fulfill (Likens & Lindenmayer, 2018)

Having no or vague monitoring questions remains a significant failure mode for monitoring programs worldwide (Arciszewski et al., 2017; Lindenmayer et al., 2022). Collecting data before knowing how it will be analyzed is a common problem, leading to the collection of data for its own sake. Similarly, posing questions that are too broad leads to the development of programs that are not able to really address the concerns they were designed to address. A clear question can be simple, such as: 'Is weed control reducing the number of weeds at a site?' Or: "Is a population at a certain site increasing?" (Lindenmayer et al., 2022). Though simple, these example questions outline how the question should be answered (experimental addition of weed control and comparison to control sites, or measurement of population changes over time), are site-specific, and are suitable to guiding the development of monitoring designs. The overarching goal of the OSMP is to determine if oil sands development is impacting the environment and the resources that support Indigenous cultural activities (Dube et al., 2018). As such, the key questions must link directly to this goal and be refined enough to direct core monitoring workplans. For example, many components of wetlands may be important to stakeholders in OSMP, but the focus of monitoring should be on wetland indicators that we know are likely to be stressed by oil sands activities, and that are sensitive to these stressors where change can be detected early before major harm occurs. The development of conceptual models is essential to support this process.

Conceptual models typically outline stressors, pathways and effects. Monitoring programs frequently struggle with determining what indicators are appropriate for detecting change in this system: monitoring stressors is expensive, and generates a great deal of data, but it's difficult to determine their biological relevance. The effects are usually what people are concerned about, however, monitoring only effects risks detecting change after a great deal of stress has accumulated in the system, making determining cause difficult. A monitoring program should include questions that address important parts of the stressor pathway (Likens & Lindenmayer, 2018). The tension between monitoring stressor pathways versus monitoring important indicators was evident in the Integration Workshops, where some questions focused specifically on 'important indicators:' or 'what species should we monitor?' and 'what pathways should be priorities for understanding effects on receptor species?' (Swanson, 2019 page 187). If monitoring is intended to inform management, then there must be some focus on the stressor pathway. In this case, the question should be 'what receptor species are most sensitive to different oil sands stressors?' By focusing on the most sensitive receptors, monitoring is more likely to be able to detect change, relate it to a cause, and initiate a management response in a meaningful timeframe. By focusing on 'important' or 'key' receptors, monitoring programs run the risk of "developing a laundry list of indicators that dilutes the effectiveness of the program" (Likens & Lindenmayer, 2018, Lindenmayer & Likens, 2010). The OSMP must take care to balance monitoring for effects

that are important to people, while also monitoring stressor pathways that inform management as quickly as possible of any potential issues.

The Integration Workshops made great strides in developing conceptual models that could help guide OSMP key question development (Swanson, 2019), and the experience informs how key questions to guide the monitoring program should be developed. Both monitoring stressors and effects are necessary; monitoring stressors is crucial information to determine the source of ecological impacts, while monitoring effects both addresses the needs of program participants and can detect unanticipated impacts. What is needed is a suite of questions based on both a) understanding the information needs of the stakeholders and Rights-holders, often focused on effects, and b) determining the most sensitive indicators of stress along the stressor pathway.

2.3 Monitoring from OSMP Should Inform Timely Adaptive Management

Environmental monitoring is an exercise in informing management. Communities participating in WBISC are very clear that monitoring should not be done for its own sake but should instead inform management of oil sands development (see Key Principles, section 6.1.) Community members frequently expressed that they did not want to monitor simply to watch as their resources disappear, their landscapes change, and their ways of life are lost. These concerns are not without basis, indeed, outside of the OSMP there are sadly many examples of species that were monitored until their extinction (Lindenmayer et al., 2013). Community members are extremely sensitive to the possibility that monitoring may be the only 'action' being taken to address their concerns about oil sands development, and frequently express questions addressing the effectiveness of the OSMP in informing management:

- *Is oil sands monitoring resulting in changes to government policies, regulations, or guidelines that will foster sustainability of the exercise of s. 35 Rights?*
- *Is oil sands monitoring resulting in changes to industry practices that will foster sustainability of the exercise of s. 35 Rights?*
    - *(Willow Lake Métis Nation, 2025)*

Monitoring is supposed to be an integral part of a resource management system (Dubé et al., 2013; Likens & Lindenmayer, 2018; Lindenmayer et al., 2022; McDonald-Madden et al., 2010; Nichols & Williams, 2006). Ideally, monitoring forms part of a watershed or airshed management approach that includes assessing the accumulated state, predictive modeling (particularly for project development or management scenarios), and ongoing monitoring to determine whether predicted impacts are being realized and detect unanticipated outcomes (Dubé et al., 2013). In Alberta, the OSMP is intended to support policy decision makers in their assessment of cumulative effects under the Land Use Frameworks (Government of Alberta, 2008). Together with predictive modeling used during the project approval process overseen by the Alberta Energy Regulator, the OSMP is intended to be part of a cohesive cumulative effects management approach (Government of Alberta, 2008). The extent to which the OSMP is integrated within a larger management system is addressed in the Gap Analysis Report, though the effectiveness of the system is beyond the scope of this project. The work to identify what monitoring is required to meet management and policy

objectives has not been done for the OSMP (Cronmiller & Noble, 2018; Dowdeswell et al., 2010; Dubé et al., 2021).

It is common that scientists assume that simply providing data will inform policy makers; however, without the necessary work to understand the information needs of policy makers and managers, the information can be mismatched to decision makers (Garlick & Fallon, 2023; Wellstead et al., 2018). Data should not be "gathered with a vague hope that somehow they will prove useful" (Nichols & Williams, 2006) but gathered to answer clearly focused questions important to decision makers. While there has been a great deal of focus on barriers to the uptake of science and evidence in the policy sphere (Cook et al., 2013; Cvitanovic & Hobday, 2018; Jagannathan et al., 2023; Oliver & Cairney, 2019; Walsh et al., 2019), less has been said about what information policy makers need and how to integrate those needs into determining what questions need to be answered through monitoring programs such as the (Cooke et al., 2020; Cvitanovic & Hobday, 2018; Wellstead et al., 2018). Doing this well requires the involvement of decision makers in the development and focusing of key questions for monitoring. This helps ensure that key questions address causal mechanisms that drive change such that monitoring results can directly link to different management or policy interventions (Lindenmayer & Likens, 2010). Note that the link between monitoring and management is more pressing in a post-Yahey reality where it is increasingly recognized that monitoring for its own sake is not sufficient mitigation (Yahey v British Columbia 2021 BCSC 1287, 2021).

Finally, the danger is not just that the OSMP is unfocused, but also that unfocused monitoring can be seen as a 'displacement activity' that provides a veneer of management action without actually addressing issues around resource development (Nichols & Williams, 2006). Indeed, Indigenous communities have routinely had their concerns downplayed by government or industry by reference to monitoring results at such broad or coarse scales that they obscure impacts at a more local level. Thus, Indigenous communities are concerned not just that monitoring should be useful and inform management, but also that the OSMP not obscure their environmental concerns or become a false narrative that undermines their real observations. This can happen when monitoring questions are not defined in a manner that can adequately address Indigenous concerns or provide meaningful input into realistic management scenarios.

2.4 The role of the OSMP in the Regulatory Process

Any discussion of the role of OSMP in decision making is incomplete without addressing how Indigenous concerns about impacts to their Rights are directed to the OSMP. A crucially important consideration for the OSMP is the role the program plays in both governments' commitments to uphold the honour of the Crown.

During the project application and approval process, as well as all other regulatory processes for oil sands operators, Indigenous communities may submit Statements of Concern which outline community members' concerns with respect to a proposed development. These concerns can be addressed by the Crown [6] in one of two ways: First, the AER can include approval conditions that

[6] The Alberta Energy Regulator, the provincial and federal governments, the federal Impact Assessment Agency and the Aboriginal Consultation Office all have roles in this process. Outlining their roles is beyond

require monitoring to be undertaken by the OSMP. Prior to ~2012 these conditions were often worded as commitments to support regional monitoring initiatives and now are often worded as commitments to either monitor specific concerns, or commitments to participate in the OSMP. Alternatively, concerns that the Crown considers 'out of scope,' being regional, related to cumulative effects, or to effects beyond the fence line of a particular operation, are relegated to Regional Planning. Regional Planning has no mechanisms to address impacts to s. 35 Rights or Indigenous people (Gilmour et al., 2016) but has vague relationships to the OSMP. Thus, it is not clear to what extent communities participate in the OSMP because of their interest in or desire to support the Program, or how many communities have been *sent* to the OSMP to have their concerns addressed. For these reasons, inclusion of Indigenous peoples in setting monitoring questions and associated relevant indicators is essential and urgent, especially if the OSMP is the only multi-stakeholder venue where Indigenous concerns of cumulative oil sands impacts can be monitored and potentially addressed, if the government uses monitoring data to make policy decisions.[7]

The Crown, industry and the OSMP often tend to see impacts to Indigenous peoples through a purely biophysical lens and assume that monitoring regional environmental change thus *de facto* addresses Indigenous concerns. However, Indigenous key questions are more likely to focus on community members' concerns and their lived experiences at local-regional scales (Thompson et al., 2020). Core OSMP monitoring may not monitor at these relevant scales and may not monitor relevant indicators that characterize the state and condition of cultural resources that support cultural activities and Rights. We must either adjust monitoring design to address appropriate scales or make it abundantly clear that OSMP core monitoring cannot detect impacts at relevant scales. In addition, Indigenous peoples have questions around potential impacts to human health, culture, livelihoods, and s. 35 Rights; ignoring these diminishes Indigenous community members' real experiences(Westman & Joly, 2019). It is the communities' role to characterize impacts to culture and Rights, however the role of the OSMP is to ensure that community IK and key questions inform the core monitoring in a way that provides the relevant information to communities to assess the state and condition of the environment that supports their cultural activities and Rights.

The OSMP has the expressed goal of addressing Indigenous concerns (Dube et al., 2018; Dubé et al., 2021). Furthermore, initiatives that include Indigenous peoples through question setting to execution and reporting were more likely to positively impact management (Thompson et al., 2020). We therefore worked with communities participating in the WBISC to identify their key questions and begin the work of understanding how they could be answered in the OSMP, how they could inform the core programs and identify appropriate and community-relevant indicators. We note that these questions represent the input of only twelve communities participating in the WBISC; more work must be done to reach communities who did not participate in this project at this time. We do not suggest that the results herein represent all Indigenous communities throughout the

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the scope of this project, so for the purposes of this discussion we will collectively call all government organizations involved in project decision making 'the Crown.'

[7] Note that the OSMP's lack of link to management or policy is a problem from an adaptive monitoring perspective, as well as from a legal perspective (*Yahey v British Columbia 2021 BCSC 1287*, 2021). The lack of legal framework for cumulative effects management that includes the OSMP is partially addressed in the Gap Analysis report.

OSMP. We also acknowledge that, a) some questions brought forward by communities are common between communities and are therefore relevant for core monitoring; and, b) some questions are very specific to individual communities and are more appropriately answered by CBM initiatives under ICBMAC. The OSMP needs to support both questions common between all communities and therefore relevant for core monitoring, and questions specific to individual communities, as cumulative effects are expressed at both regional and local spatial levels, and at finer temporal scales. Furthermore, there needs to be some consideration of different key questions in different parts of the OSMP boundaries; in the Athabasca Region, where there is the greatest amount of development and impact, there will be different key questions. In this project, we focus on common questions that have the potential to be answered by or integrated into core monitoring. These questions were focused at either regional or local scales, but all related to important issues to multiple communities and had clear links to the monitoring of environmental conditions necessary to support the exercise of Rights and culture.

3 Indigenous Perspectives on the Humans and the Environment

The OSMP is designed to monitor for environmental impacts of oil sands development that is inclusive of and responsive to Indigenous communities in the region (Dube et al., 2018.) The vision outlined in the Oil Sands Monitoring Framework is:

> *An integrated monitoring, evaluation and reporting system inclusive of and responsive to Indigenous Communities, that includes the acquisition and reporting of regional and sub-regional data on baseline environmental conditions, tracking any environmental impacts, and the assessment of cumulative environmental effects from oil sands development to inform management, policy and regulatory action and respects potential impacts to section 35 Rights.*
>
> *- (Dube et al., 2018, emphasis added.)*

Oil sands development has been growing in the region for over 60 years on the Traditional Territories of Indigenous communities who have lived there since time immemorial. The effects of this development have been felt by the Indigenous communities over two to three generations, and there is overwhelming concern that impacts of the development are not being adequately tracked or managed. Furthermore, the OSMP still lacks understanding of how biophysical changes in the environment are experienced by Indigenous peoples, through impacts to well being, cultural relationships and activities and concerns about impacts to health.

3.1 The Wholeness of Indigenous Culture's Understanding of the Environment.

As Métis elder, Maria Campbell explains:

> *There is a word in my language that speaks to these issues: 'wahkotowin.' Today it is translated to mean kinship, relationship, and family as in human family. But*

> *at one time, from our place it meant the whole of creation. our teachings taught us that all of creation is related and inter-connected to all things within it. Wahkotowin meant honoring and respecting those relationships. They are our stories, songs, ceremonies, and dances that taught us from birth to death our responsibilities and reciprocal obligations to each other. Human to human, human to plants, human to animals, to the water and especially to the earth. And in turn all of creation had responsibilities and reciprocal obligations to us.*
>
> *- (O'Reilly-Scanlon et al., 2004)*

For Campbell, and many other Cree/Métis thinkers, *wahkotowin*[8] organizes how Cree/Métis people see the world, including, but not limited to the human, natural, and spiritual worlds. Perhaps most important, it helps Cree/Métis communities understand what it means to be "home" (Wildcat, 2019).

Similarly, Dene people recognize the wholeness of the environment through their Dene Laws.

> *Elders emphasized that Dene people take care of each other and of strangers in times of need by living in respectful relation to the land and water and sharing what they have. ACFN member Leslie Laviolette explained, "You know, the sharing part is: we take what we need, and if we have too much, we go give our Elders that taught us all these tools." As Dene laws state, sharing "is an umbrella law; under it sit all the other laws. It was of absolute importance that people share what they had long ago for survival. Share all the big game you kill. Share fish if you catch more than you need for yourself and there are others who don't have any." Helping flows from this: "Help others cut their wood and other heavy work. Help sick people who are in need; get them firewood if they need it. Visit them and give them food. When you lose someone in death, share your sorrows with the relatives who are also affected by the loss. Help out widows as much as possible and take care of orphaned children."12 Dene laws depend on sharing, helping, and living in loving relation with the land and water, and with all human and non-human kin. Under Dene law, living in good relations with the land and water is closely interconnected with living in reciprocal and caring relationships with community and kin.*
>
> - *(Athabasca Chipewyan First Nation et al., 2018)*

The OFA includes principles that encourage the OSMP to bridge the gap between a purely biophysical approach to one that is more meaningful to Indigenous peoples. One of the key

[8] As Métis scholar Brenda Macdougall notes, for *wahkotowin* 'there is considerable variation in spelling, including *wahkootowin*, *wakottuwin*, and *wahko'towin*, reflecting the newness of roman orthography's application of the Cree language and the lack of standardization." For this report we have chosen to use *wahkotowin* as this is the spelling most commonly used within northeastern Alberta (MacDougall, 2006).

principles of the OSMP is to be "Risk-based", "Inclusive and Collaborative", and "Relevant and Ethical" where these principles are defined from the OFA below:

> *Risk-based -*
>
> *Prioritizes monitoring effort according to the magnitude of environmental impacts, including* ***cumulative impacts****, from oil sands development. Long-term monitoring, geographic scope, and intensity will be proportional to the assessed* ***risk to ecosystem health and exposure pathways potentially affecting human health and well-being,*** *based on the most reliable and robust evidence available.*
>
> *Inclusive and Collaborative -*
>
> *Treats planning, implementation, evaluation and reporting as open, collaborative processes informed by both scientific and* ***Indigenous knowledge****.*
>
> *Relevant and Ethical –*
>
> *Ensures monitoring is relevant to a variety of priorities and concerns related to the environmental effects of oil sands development including* ***linkages to human health and culture****.*
>
> - *(Dube et al., 2018, emphasis added)*

It is noteworthy that these OSMP principles include addressing risk to "human health and well-being" where the program is "informed by scientific and Indigenous Knowledge" to address "concerns related to the environmental effects of oil sands development including linkages to human health and culture." In addition, the scope of the OFA (Dube et al., 2018) includes the following key areas, showing that including Indigenous people as part of the environment, and not separate from it, has always been in scope of the program:

- *Ensuring monitoring is relevant to a variety of priorities and concerns related to the environmental effects of oil sands development including linkages to human health and culture (Relevant and Ethical principle, OFA section 2.2).*
- *Adoption of the precautionary principle to ensure effects to human health and well-being are avoided, minimized or reduced (Precautionary principle, OFA section 2.2)*
- *Seeking and integrating a multiple evidence-based (MEB) approach (Objective 2, OFA section 2.3)*
- *The identification of monitoring indicators of relevance to Indigenous communities that respect potential impacts to section 35 Rights, and evaluate environmental condition relative to tiers, triggers, limits, thresholds and other*

limits of change (Objectives 2 and 9, OFA section 2.3; Action 11, OFA section 2.5)

- *Meaningful inclusion and consideration of Indigenous community concerns (Outcome 4, OFA section 2.5.)*

- (Dube et al., 2018.)

To achieve this, it is critical to ensure that *wahkotowin*, the Dene Laws and other Indigenous ways of understanding the environment are respected, and that monitoring about the state and condition of the biophysical environment is explicitly connected to impacts on Indigenous cultural resources and Rights. This would help ensure that the core monitoring programs are IK informed, and the core data can support community key questions that relate to impacts on culture and Rights. Note that a multiple evidence-based approach (MEB) was developed as an approach to guide collaborations between knowledge systems (Tengö et al., 2014). The MEB approach strives for the creation of a greater understanding of a particular problem or issue of concern through the contribution of multiple knowledge systems. This way of seeing is closely aligned with the Cree concept of *wahkotowin*, where it is recognized that all things are connected through good relations, and when those relations are not fully respected, they can negatively influence all other relationships. Similarly, the Dene Laws govern Dene people's relationships with one another and the environment, when they are not respected, negativity takes hold and dominates the known and unknown world. For Dene and Cree people, these connections include natural science knowledge, social science knowledge, and Indigenous knowledge and when woven together provide a comprehensive understanding of the wider environment. When analyzed separately, the results are not comprehensive and do not provide a full understanding of wider environment (Figure 2.)

That means that the OSMP would benefit from understanding the Indigenous perspective on how environmental change includes people, human health, Rights and culture. As Marie Campbell outlines above, *wahkotowin* for Cree/Métis people, (and Dene Laws for Dene people) represents the relationships and connections between people and the land, where the land includes environmental and cultural resources that support way of life and culture. The *wahkotowin* also relates to human health and well-being, which is often directly related to relationship with the land and cultural activities. Many of the resources that support Indigenous culture and way of life are thematic areas monitored by OSMP core programs, including air, water, land (terrestrial and wetlands), wildlife, and vegetation. The state and condition of these environmental components are critical to supporting Indigenous people's cultural activities and way of life, but do not in and of themselves describe all impacts. A community's way of life (worldview) is linked to cultural values, which in turn are expressed through cultural activities and ultimately the ability to practice constitutionally protected Rights. To sustain this, the land and its resources must be healthy and safe, accessible, and available in culturally preferred and significant areas – allowing for the creation of *miyowahkotowin* or having good relations in a good environment. Confidence in the health and safety of the land and these cultural resources is also essential for community members to support their health and well-being and land use.

Indigenous participants in the OSMP do not consider impacts from oil sands development to be purely environmental. For example, a program focused only on the presence and abundance of

cultural resources like moose, fish, and berries ignores other pathways that affect Indigenous land users such as if these resources are safe for consumption, if the harvesting experience was enjoyable, if the quality of the food is desirable for consumption, if they are present in areas of cultural significance and these harvesting areas are easily accessible. Berry quality and abundance may be good, but if a land user cannot access the berry patch to pick due to gates, then a study focused on contaminants in berries is not relevant because the opportunity to harvest berries has already been impacted. Further to this, fish quality may be good, but if the land users avoid fishing at a favorite location because of fear of negative interactions with oil sands workers staying in camp then again, the study misses the mark. Communities have identified a variety of concerns from oil sands activities, including impacts to access and navigability, impacts to quality of traditional resources, impacts to cultural practices, impacts to food sharing networks and food security, and impacts to cultural keystone species.

There is a broad evidence base in the peer-reviewed literature that supports consideration of the direct and indirect social and cultural dimensions of environmental impacts, and the relationship between ecological integrity and human wellbeing. These linkages are especially relevant in contexts such as the OSMP that aim to meaningfully include IK, since *miyowahkotowin* requires good relations with plants, animals, water, and landscapes are often important parts of Indigenous environmental epistemologies that can influence desired project methods and knowledge applications.

This perspective is illustrated in ICBMAC's conceptual model (Dersch, Indigenous Community Based Monitoring Advisory Committee, 2020) that illustrates how a broad suite of pathways (how Indigenous land users experience oil sands development stressors) should be considered when designing a monitoring program to answer key community questions. These pathways include:

- *Physical loss of harvesting or occupancy sites/areas*
- *Loss of access to or onerous/uncomfortable/inappropriate access requirements to harvesting and occupancy sites/areas*
- *Negative impacts on quality, quantity and biodiversity of lands and resources (i.e., loss of confidence in the quality and usability of resources)*
- *Sensory disturbance while at or one route to harvesting and occupancy sites/areas- noise, odours, traffic, lights, and other aesthetic impacts*
- *Increased access to harvesting and occupancy sites/areas by outsiders (oil sands workers staying at camps or non-Indigenous recreationalists sportsmen) leading to competition for lands and resources and conflict (abuse, harassment, vandalism, theft)*
    - *(Dersch, Indigenous Community Based Monitoring Advisory Committee, 2020)*

To best integrate community concerns and IK into the OSMP, both biophysical and cultural use lenses need to be considered. Currently, the OSMP core workplans focus only on the biophysical and the intent of this IIP Project is to guide and inform the OSMP workplans to better address biophysical linkages with cultural activities and to consider how indicators of *miyowahkotowin* and Dene Law can be addressed in the program as guided by ICBMAC.

There is a delicate balance in how this lens should be applied in the OSMP. The OSMP core monitoring could better support key community questions and concerns by integrating IK into

programs. Many western science indicators and metrics are relevant to community key questions (e.g. water quality and quantity, air quality), but additional IK indicators and metrics are required to adequately inform community key questions. Examples of IK-informed indicators that could be part of the core monitoring include dust and odour sampling in areas of community concern; chemistry analysis of key cultural plants (e.g., pitcher plant) to assess for contaminants; water quantity in navigable waters; water quality in key harvesting areas; and fish health/contamination. The locations and frequency of sampling can also be informed by IK to ensure community concerns are being addressed, especially on local scales where traditional use occurs. IK indicators may be western-science based and follow western science methods but may require interpretation by Indigenous communities using community-developed thresholds (e.g., odours). In other cases, IK indicators may be more specifically related to cultural activities (e.g. fishing or plant harvesting) and would require community development of the indicators, metrics and samplings methods, where ideally community members are also conducting the sampling (e.g., fish colour and flesh firmness, taste, color, and juiciness of berries.)

Taking the interpretation of Indigenous concerns further is the inclusion of socio-cultural impacts, an overlooked area of pathways of effect/stressors and impacts experienced by Indigenous communities in the oil sands region. Examples include psychological, livelihood and wellbeing impacts, and demographic changes. These characterize potential impacts to Indigenous cultural activities and way of life where these depend on a *miyowahkotowin* where good relations are maintained and upheld. Socio-cultural indicators relate to the ability to practice culture (e.g., intergenerational knowledge transfer of traditional place names and harvesting protocols while on the land). Tracking change in socio-cultural indicators is rooted in social science and Indigenous research methodologies. Workplans should be developed and implemented directly by communities, findings should inform the development of thresholds and policy change. Where these changes impact the s. 35 Rights of the community is a responsibility of the community to determine, not the OSMP. This reliance on and relationship with the community experience means that socio-cultural indicators are more likely to be relevant in monitoring driven by individual communities through community-based monitoring. Thus, while it is not the responsibility of the OSMP core program TACs to directly interpret how IK indicators inform community key questions or may impact cultural activities, the TACs can use IK thresholds and guidelines for assessing monitoring data (e.g., Indigenous water quality guidelines) and these IK thresholds can be used to support Investigation of Cause (IOC) and/or trigger the need for management action.

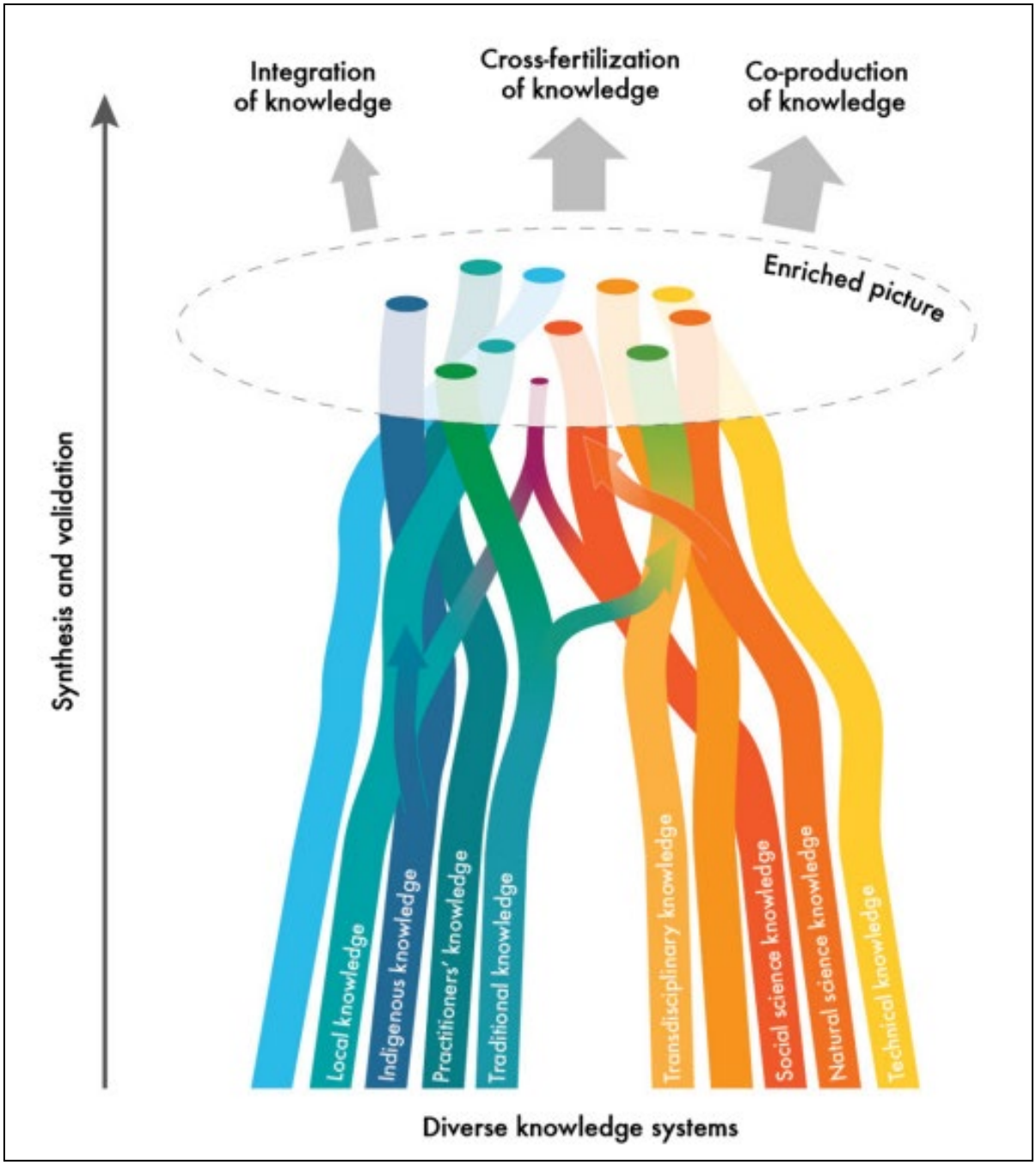


Figure 2: An illustration of the multiple evidence-based approach, where diverse knowledge systems contribute to an enriched picture of a particular problem or concern. From (Tengö et al., 2014.)

3.2 Case Study: Fort Chipewyan Métis Nation Lands and Regulatory Department – Answering Key Community Questions and Concerns through a Cultural Framework

3.2.1 Background

Fort Chipewyan is the oldest historic settlement in Alberta, situated on the northwest side of Lake Athabasca. The Fort Chipewyan Métis Nation (FCMN) have occupied Fort Chipewyan since before it was established in 1788, and their traditional territory includes the lands and waters referred to as the Athabasca Oil Sands (AOS).

The pace of oil sands development over a short span of time and associated cumulative impacts continue to raise serious alarm among FCMN members regarding traditional foods and water security, cultural sustainability, and value of future practice of Rights (Spencer et al., 2020). As a result, the FCMN Lands and Regulatory Department (LRD), guided by FCMN members, began the process of developing a framework to allow the Community the ability to assess and understand effects to and from the social-ecological system that supports their culture and Rights and ultimately, their way of life, through space and time.

FCMN have been a member of the Oil Sands Monitoring Program (OSMP) since its formal inception. FCMN signed a Letter Agreement in 2018 that states that monitoring considers Indigenous community and stakeholder concerns or issues as priorities, utilizes appropriate scientific and Indigenous expertise, incorporates and monitors Indigenous designed and led community-based monitoring and indicators that are relevant to Indigenous communities (Dube et al., 2018).

3.2.2 Way of Life Framework (WOLF):

The Way of Life Framework (WOLF) is a cultural framework (Figure 3) that assists FCMN Lands and Regulatory Department (LRD) ensure that potential impacts, including cumulative impacts, to FCMN Rights, culture and way of life are considered during decision-making processes, including those related to environmental impact assessments, policy reviews, and consultation on various proposals and activities.

The WOLF is a cultural framework designed to reflect FCMN:

- Worldview and Cultural Values
- Indigenous Rights and responsibilities
- Relationships and connections between people and the land where land represents land, water and the ecological and cultural resources they support (plants and wildlife).

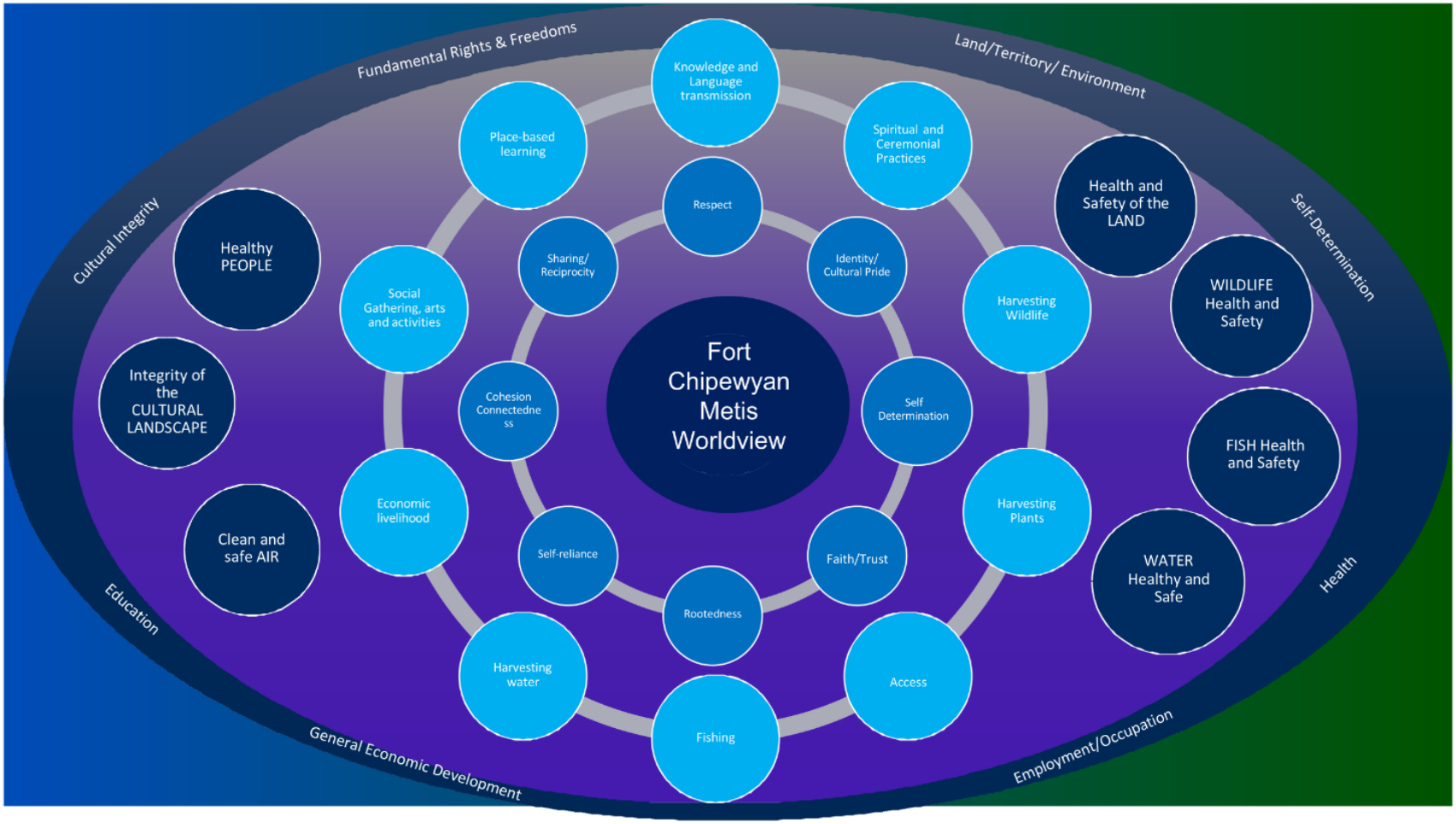


Figure 3: Fort Chipewyan Métis Nation Way of Life Framework (WOLF).

At the centre of the WOLF is the **FCMN worldview**:

- FCMN's worldview is governed by natural laws and respect for Mother Earth and the Creator. These laws and fundamental understandings are reflected in belief systems, customs and protocols. These belief systems, customs and traditions instil the cultural values that influence how cultural activities are carried out, and how culture is expressed. (See Table 2.)

FCMN's worldview is reflected in **FCMN's cultural values**, which are represented in WOLF as the first set of concentric circles surrounding the FCMN worldview:

- these are the intrinsic values that have been articulated by FCMN members and are transferred and maintained when community members are engaged in cultural activities associated with the FCMN Way of Life.

FCMN's cultural values are expressed through **cultural components** (or activities), which are represented in WOLF as the second set of concentric circles surrounding the values:

- because the relationship with the land is foundational to FCMN culture, it is common for social, spiritual, and cultural values to be expressed through cultural activities.

Surrounding the inner concentric circles in WOLF are **social and ecological system requirements**:

- the system requirements (e.g., water, air, land, fish, wildlife, plants, cultural landscape, people) may differ through space and time (e.g., spatially they can be assessed at local or regional scales and temporally they can be represented in time such as pre-oil sands development, current conditions, future conditions). These system requirements are often referred to as ecological and cultural resources that support cultural activities, representing the linkage between the biophysical environment and culture. The state and condition of these system requirements is what drives changes in cultural activities on the land.

The outermost sphere of the WOLF represents **FCMN Rights**:

- the state of the linkages between cultural components and cultural values, and between cultural components and social-ecological system requirements reflect the ability for FCMN to exercise their Rights as Indigenous peoples in Canada.

To understand how FCMN way of life might be affected by an industrial project, government policy, or piece of legislation, there are two kinds of relationships and connections that must be considered:

- cultural components and cultural values, and;
- cultural components and social-ecological systems components.

These aspects of the FCMN way of life are inextricably linked –they cannot be separated. Impacts vis-á-vis system requirements affecting relationships to one part of the FCMN way of life can affect many different interrelated system requirements and cultural components. Figure 4 illustrates in tabular form FCMN's cultural values, culture components and system requirements as defined by FCMN members. In addition, Valued Components corresponding to System Requirements are also provided. The arrows in red denote the linkage between the Cultural Values and Cultural Components as well as the Cultural Components and System Requirements.

Table 2: Fort Chipewyan Métis Cultural Values and Definitions

Cultural Value (Cree)	**Definition**	**Cultural Value (English)**
Manacītowin Manacisowin Kîhicitatowin	Respect for yourself, your family/community, the land, waters, air, rights	Respect
Kiskîhtakosowin	Knowing your culture, history and achievements of Fort Chipewyan Métis Peoples	Identity/cultural Pride
Otipemisiwak	To own yourself, to be the boss of yourself	Self Determination
Tapokihtamowin (faith) Mamisiwin (trust)	Belief that wildlife, plants, fish, waters and people are safe and Mother Nature can provide for us	Faith/Trust
Mamawīhtamowin	Being "of" the land, "part" of the circle of life – not separate from nature	Rootedness
Nakatīhtaniowin Nakatīmisowin	Being able to look after yourself and your family/community	Self-Reliance
Mamawīy Atoskiwin (working together)	Working together and feeling close to family, friends and relations including the ancestors and future generations	Cohesion connection
Kanīsohkamatohk Nīsohkamatowin	Sharing of food, and resources to look after family and the community. Valuing collective well-being over individual gain	Sharing/Reciprocity

Cultural Values		Cultural Components		System Requirements	Valued Components
Respect		Knowledge and Language Transmission		Healthy PEOPLE	People
Identity/Cultural Pride		Spiritual and Ceremonial Practices		Integrity of the CULTURAL LANDSCAPE	Cultural Landscape
Self Determination	↔	Harvesting Wildlife	↔	WILDLIFE Health and Safety	Wildlife
Faith/Trust		Harvesting Plants		Health and Safety of the LAND	Land
Rootedness		Access		Clean and Safe AIR	Air
Self-Reliance		Fishing		FISH Health and Safety	Fish
Cohesion/Connectedness		Harvesting Water		WATER that is Healthy and Safe	Water
Sharing/Reciprocity		Economic Livelihood			
		Social Gatherings, Arts and Activities			
		Place-based Learning			

Figure 4: WOLF Cultural Values, Cultural Components, System Requirements.

3.2.3 Using WOLF to Inform OSMP Key Questions

Core monitoring within the OSMP is thematically comparable to ecological system requirements in the WOLF as illustrated in Table 3 below. To facilitate engagement with FCMN knowledge holders and land users as part of the IIP Project, the OSMP core monitoring themes were related to the ecological system requirements in the WOLF. The OSMP is effectively intended to monitor the 'state and condition' of these thematic areas or ecological system requirements in WOLF. Both the OSMP core monitoring and the WOLF recognize that there are integration and linkages between thematic areas (e.g., air deposition is also linked to aquatic and terrestrial conditions or surface water conditions are also related to wetlands condition). Community members do not experience the landscape according to these thematic areas, rather it's the relationship between the environment and cultural activities that members discuss during engagement (e.g., how levels of water affect their ability to navigate waterway to get on the land).

Table 3: OSMP Core Monitoring and WOLF Environmental System Requirements

OIL SANDS MONITORING CORE MONITORING	WOLF STATE AND CONDITION - ENVIROMENTAL
Air and Deposition	AIR – CLEAN AND SAFE
Surface Water (aquatics)	WATER – HEALTHY AND SAFE FISH – HEALTH AND SAFETY
Groundwater	WATER – HEALTHY AND SAFE
Wetlands	LAND – HEATH AND SAFETY
Terrestrial Biodiversity Monitoring	LAND – HEATH AND SAFETY WILDLIFE – HEALTH AND SAFETY

3.2.4 FCMN Community Engagement on the IIP Project:

FCMN LRD manages all their files (including projects, committee work, consultations, etc.) using the WOLF. Each file, or group of files, are associated with the system requirements defined under the WOLF. As a framework, new data and information allows the system requirements to become more robust – populating the current or 'accumulated' state of the system and providing the assessment of impacts to the cultural components to be more deeply understood. This allows the LRD to develop and validate management and mitigation options to support and strengthen impacted cultural activities and ultimately, FCMN's ability to practice their Rights in confidence.

Given the above, FCMN community members, including knowledge holders and land users, are familiar with the WOLF process as well as the indicators and endpoints that have been developed to support WOLF, understanding that their input continues to add to the robustness of the framework and the value of its application. For example, in the context of OSMP the WOLF can drive identification of key monitoring indicators, species and locations important to answer key community questions and concerns around oil sands impacts.

As part of the IPP Project community engagement initiative, the LRD met with community members in early January 2025 to:

- review OSMP core monitoring questions, measured parameters (broadly) and locations, by thematic area;
- review existing WOLF identified endpoints by thematic area in the form of FCMN key questions for the OSMP
    - revise and refine FCMN key questions
    - validate FCMN key questions

For each validated key question, we:

- reviewed existing western science-based and IK-based indicators already developed under WOLF, by thematic area
- reviewed the OSMP core monitoring indicators (by theme area) in comparison to the WOLF IK-based indicators that link to the validated community key questions for OSMP. In this comparison, we identified gaps in the OSMP core monitoring where IK indicators from WOLF are needed to address community key questions;
- identified key cultural species for wetlands and terrestrial biodiversity OSMP core areas (habitats, plants and wildlife);
- identified key areas to monitor that would address community key questions, by thematic area – note that these are not included in this case study to protect sensitive IK around locations, however this information can be provided upon request and consent by FCMN members

Engagement focused on OSMP core environmental monitoring, viewed through the cultural lens of the WOLF ecological system requirements. Because the IPP Project is focused on the OSMP core monitoring, FCMN community engagement did not focus on the cultural system components in WOLF or the development of socio-cultural indicators. The monitoring of socio-cultural indicators should be community-led in the OSMP CBM programs and is not appropriate for OSMP core programs at this time. However, the state and condition of WOLF ecological system requirements are inextricably linked to cultural activities. FCMN provided a presentation on how the WOLF is used to inform the integration of socio-cultural and biophysical elements at the OSMP Social Sciences Workshop on January 29, 2025. Should the OSMP include social sciences into its core monitoring going forward, this presentation could help inform how integration can be accomplished.

3.2.5 Community Engagement Results to inform the IPP Project:

Air Quality based on WOLF: AIR – CLEAN AND SAFE

AIR QUALITY: Is air quality creating heath risks for community members?

INDICATORS: air quality (ambient air concentrations of criteria air contaminants (CACs) and benzene; Air Quality Health Index)

AIR QUALITY: Is the air free of industrial odours so community members can enjoy spending time outside and use traditional lands?

INDICATORS: odours (odour events/complaints – frequency, intensity, location; ambient air concentrations of reduced sulphur compounds(RSC), total hydrocarbons (THC)/non-methane hydrocarbons (NMHC)

AIR QUALITY: Is dust creating health risks for people and wildlife (including deposition on plants and berries)?

INDICATORS: dust (ambient air concentrations of particulate matters ((PM2.5, PM10), and total suspended particulates (TSP)); dustfall measurements; particulate matter deposition, dust observations/complaints –frequency, location, opacity)

AIR QUALITY: Is industrial deposition creating health risks (deposition on plants and medicine/food sources)?

INDICATORS: environmental health (nitrogen and acid deposition)

LIGHT: How far from industrial footprints is light affecting people (cabins, harvesting areas) and wildlife?

LIGHT: Is light impacting wildlife and wildlife habitat including interference with wildlife migration patterns and connectivity of wildlife corridors?

INDICATORS: light spillage (light observations and measurements

– frequency, spatial extent, intensity, location)

NOISE: How far from industrial footprints is noise affecting people?

NOISE: Is noise impacting wildlife and wildlife habitat including interference with wildlife migration patterns and connectivity of wildlife corridors?

OSM: air monitoring stations, deposition monitoring, forest health

WOLF: culturally important areas, harvesting

INDICATORS: noise (noise observations and measurements– frequency, type, location; noise level above basic sound level – daytime and night time – at receptor locations, trapping areas, and 1.5 km from fenceline)

Water Quantity based on WOLF: SURFACE WATER QUANTITY – HEALTHY AND SAFE

WATER LEVELS: Is the water deep enough to support travel/access to cabins and harvesting areas, fish habitat, wildlife habitat and ecological processes within the traditional territory including the Peace Athabasca Delta (PAD)?

INDICATORS: water depth and flow in rivers/creeks, lakes and perched basins

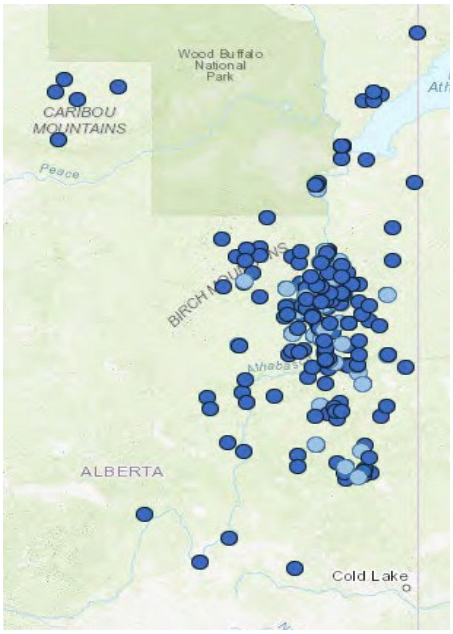
INDICATORS: shifts in shoreline vegetation (width of floodplain/riparian characteristics) and condition of waterways (creek/river channel width)

WATER LEVELS: Is ice affected by water level fluctuation, or industrial water releases (affecting water temperature and water quality that can affect freezing)?

WATER LEVEL: Is there enough ice to maintain natural systems on the Athabasca River and in the PAD (the way it used to be…. thick ice, dramatic break-up, with ice jams, back flooding, etc.)?

INDICATORS: ice condition/formation (ice thickness, ice colour, spatial extent, connectivity of ways)

INDICATORS: time of freeze/thaw/ice jams, ice roads (opening/closing dates)



OSM: monitoring stations in light blue

WOLF: culturally important areas, access

Water Quality based on WOLF: SURFACE WATER QUALITY – HEALTHY AND SAFE

WATER QUALITY: Is the water safe for drinking, cooking, bathing and ceremonial purposes?

WATER QUALITY: Is industrial water affecting fish, animals, plants?

INDICATORS: nutrient levels, organic matter, temperature, pH, conductivity

INDICATORS: contaminants (metals/trace elements, polycyclic aromatic hydrocarbons (PAHs) and hydrocarbons-F1-F4), radionuclides, tainting compounds, phenols and phenolics, organic matter content)

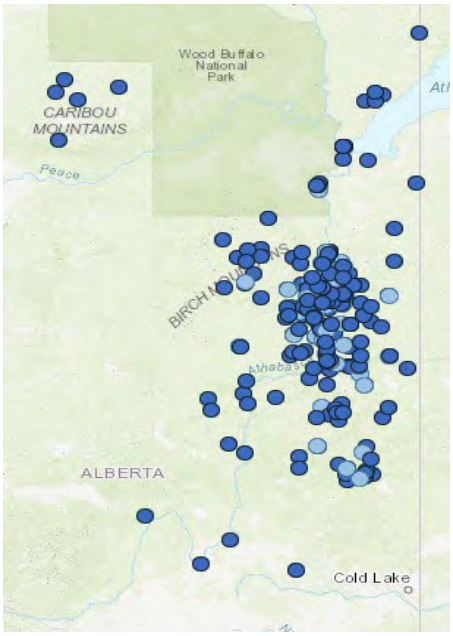
WATER QUALITY: Does the water look clear enough (clean enough) for people to use?

INDICATORS: colour/clarity

INDICATORS: visual quality (murkiness, sheen)

WATER QUALITY: Does the water have an industrial smell - will people use the water?

INDICATORS: water odour



OSM: water quality monitoring stations in dark blue

WOLF: culturally important areas, harvesting

Fish in LAKES based on WOLF: FISH in lakes – HEALTH AND SAFETY

FISH IN LAKES: Is there good habitat to support healthy fish populations?

INDICATORS: available/quality of fish habitat in regional lakes (Landscape level), available/quality of fish habitat in specific lakes (Local level)

FISH IN LAKES: Do Community members have access to fresh, nutritious, and culturally significant species (whitefish, burbot, suckers, goldeye)?

INDICATORS: species abundance and distribution and population dynamics

FISH IN LAKES: Are fish populations healthy? Are fish safe to eat?

INDICATORS: fish health: amount of fat - on belly, along spine, base of head; presence/absence of deformities, sores, parasites; contaminants; color of flesh; texture; taste

OSM: monitoring weight, length, condition, and sometimes gonad and liver size

Fish in RIVERS based on WOLF: FISH in rivers – HEALTH AND SAFETY

FISH IN RIVERS: Is there good habitat to support healthy fish populations?

INDICATORS: available/quality of fish habitat in regional rivers (Landscape level), available/quality of fish habitat in specific rivers (Local level)

FISH IN RIVERS: Are there abundant healthy fish populations?

INDICATORS: species abundance and distribution and population dynamics (including diversity)

FISH IN RIVERS: Are fish populations healthy? Are they safe to eat?

INDICATORS: fish health: size/age of fish; amount of fat; presence/absence of deformities, sores, parasites; contaminants; color of flesh; texture; taste

WOLF: culturally important areas, fishing

Wetlands based on WOLF: WETLANDS (LAND) – HEATH AND SAFETY

WETLANDS: Are peatlands (bogs/muskeg and fens) sustainable and healthy?

INDICATORS: peatland types (loss of peatlands [bogs/muskeg and fens]), thickness of peat, moisture, plant composition, disturbance

WETLANDS: Are wetland habitats that support plant harvest present, accessible, and undisturbed in the landscape?

INDICATORS: abundance and distribution and healthy wetlands

WETLANDS: Do plants for medicine and food meet the quality required for members use?

INDICATORS: wetland plants (quality [contaminants - chemical tissue residues, persistence, biomagnification], diversity, health [acute and sub-lethal endpoints for contaminants in plant tissues] and abundance)

OSM: monitoring disturbance, wetland area, water table, soil moisture, abundance and diversity of vegetation and water bugs, water and soil chemistry, tissues of plants and water bugs

***CULTURAL SPECIES TO MONITOR INCLUDE:** sphagnum moss, cranberries, frogpants (pitcher plant), ratroot, cattail, beaver root (yellow-flowered pond lily), lake apples (also found in shallow open water wetlands) willow, rose, rosehip, tamarack, black spruce, Labrador tea, birch, black poplar. *Also important to monitor invasive species (i.e. hitch- hiker plant).

WOLF: culturally important areas, harvesting

Habitats based on WOLF: HABITATS (LAND) – HEALTH AND SAFETY

HABITATS: Is intact land impacted by adjacent disturbance, such as air, light and sound pollution, etc.?

INDICATORS: ecosites and ecosite phases (amount of disturbed land, direct loss and indirect disturbance)

HABITATS: Are invasive species displacing locally common species in intact areas?

INDICATORS: presence, abundance and distribution invasive species

HABITATS: Are rare species and culturally important species being lost in intact areas?

INDICATORS: rare and culturally important species and habitats: presence and abundance of rare/listed species (lichens, bryophytes and vascular plants), culturally important species and ecological communities

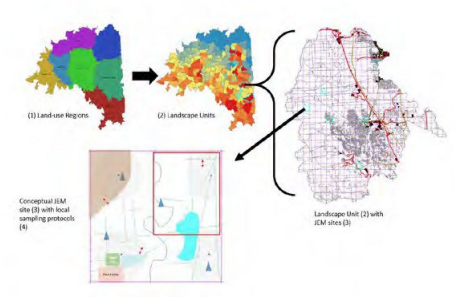
HABITATS: Are there enough old growth areas to support cultural use and wildlife?

INDICATORS: old growth areas: presence, abundance and distribution of old growth

HABITATS: Are there enough riparian areas to support cultural use and wildlife?

INDICATORS: riparian areas: change in distribution and abundance of riparian areas

HABITATS: Are cultural landscape features remaining intact and support cultural use?



OSM: monitoring disturbance/footprint

WOLF: culturally important areas (habitats), harvesting

INDICATORS: shifts in landscape level markers (width of shorelines - rivers and Lake Athabasca); changes in sand dunes; flood and fire history; width/edges are shrinking/expanding in wetland areas (muskeg, swamps, fens etc.); changes in the % and distribution of key harvesting habitats

HABITATS: Are key habitats that support plant and wildlife harvest present, accessible and undisturbed in the landscape?

INDICATORS: health of jackpine forests (colour and thickness of the caribou moss; area and distribution of habitats that contain chickenberry bushes, the size of the chickenberries; area and distribution of habitats that contain caribou moss as well as abundance and distribution and health of caribou moss within that habitat; size of the blueberries in community patches; area and distribution of habitats that contain blueberry as well as abundance and distribution and health of

these blueberry within that habitat; amount of deadfall for firewood harvesting; amount of ‘clean sand’)

INDICATORS: health of aspen/birch forests (size/health of birch trees; area and distribution of habitats that contain birch trees as well as abundance and distribution; presence/absence/ size of root of wild sasparilla; area and distribution of habitats that contain wild sasparilla as well as abundance and distribution and health; soil is good [quality])

Plants based on WOLF: PLANTS (LAND) – HEATH AND SAFETY

PLANTS: Do the presence and abundance of culturally important plants represent natural condition?

INDICATORS: plant harvesting (presence and abundance of plants)

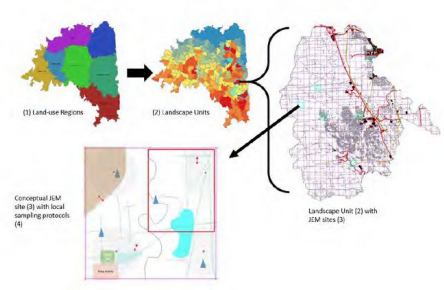
PLANTS: Are plant tissues safe for wildlife and Community members to consume?

INDICATORS: plant health (quality - chemical tissue residues, persistence, biomagnification)

PLANTS: Do plants for medicine and food meet the quality required for members use?

INDICATORS: plant health (quality [chemical tissue residues, persistence, biomagnification], diversity, health [acute and sub-lethal endpoints] and abundance)

***CULTURAL SPECIES TO MONITOR INCLUDE:** wild mint, harebell, sweetgrass, soapberry, blueberry, cranberry, raspberry, saskatoon berry, strawberry, pincherry, chokecherry, yarrow, fiddlehead, rabbit root, goldenrod, Lady's slipper, old man's beard, puffball, caribou lichen, poplar (resin), spruce (tips and gum)



OSM: monitoring disturbance/footprint

WOLF: culturally important areas, harvesting

Wildlife based on WOLF: WILDLIFE – HEALTH AND SAFETY

WILDLIFE: Are wildlife resources are safe for consumption?

INDICATORS: mammal health (body condition, fur/coat quality, parasite load, organ appearance, biomagnification in diet, chemical concentrations in tissues); waterfowl/gull health (body condition, parasite load, organ appearance, condition of egg shells - contaminants, shell "hardness")

WILDLIFE: Are there sufficient wildlife resources to support and maintain hunting and trapping?

INDICATORS: cultural wildlife species (age/sex, specific survival rates, recruitment, mortality)

WILDLIFE: Is there access to wildlife that are healthy and productive?

INDICATORS: wildlife harvesting (habitat distribution [number of patches, patch size, linear density] and quality)

***CULTURAL SPECIES TO MONITOR INCLUDE:** moose, porcupine, wood bison, black bear, lynx, beaver, mink, muskrat, spruce grouse, great gray owl, eagle, songbirds, Canada goose, common loon, boreal chorus frog, garter snake

OSM: monitoring mammals, mammal health; land birds, colonial waterbirds

WOLF: culturally important areas, harvesting

3.2.6 Summary and Next Steps

FCMN values its participation in the IIP project and is of the view that this was an important first step in providing the OSMP core environmental monitoring programs with guidance on not only what FCMN's key questions are but also how IK based indicators can play an important role in supporting the monitoring data and information collected to support answering those questions. As explained within this case study, community key questions are linked to not only monitoring ecological system requirements (air, water, land, fish, wildlife and plants) through space and time but how the state and conditions of that system is inextricably linked to and affects FCMN way of life as expressed through their cultural activities. While indicators for environmental core monitoring should include both the right western science indicators in the right places as well as IK indicators through integration with CBM, the monitoring of socio-cultural indicators should be community-led in the OSMP CBM programs and is not appropriate for OSMP core programs at this time. Only together can both sources of information inform decision-making by FCMN on the exercise of their Rights.

4 Adaptive Monitoring and Indigenous Concerns

In 2018 the Oversight Committee (OC) of OSMP passed a motion requiring the OSMP to adopt an adaptive monitoring approach. Adaptive monitoring is a risk-based, tiered program intended to inform resource management by efficiently and powerfully identifying change, determining its cause and potential solutions (see Table 4). The OC wanted to focus on the monitoring on indicators relevant to management, relevant to Indigenous peoples, and with a clear cycle of evaluation and assessment that would regularly inform monitoring actions. Done well, adaptive monitoring helps monitoring programs avoid over-expanding by focusing on sensitive and detectible change that links to management and answers the key questions provided by stakeholders and Rightsholders.

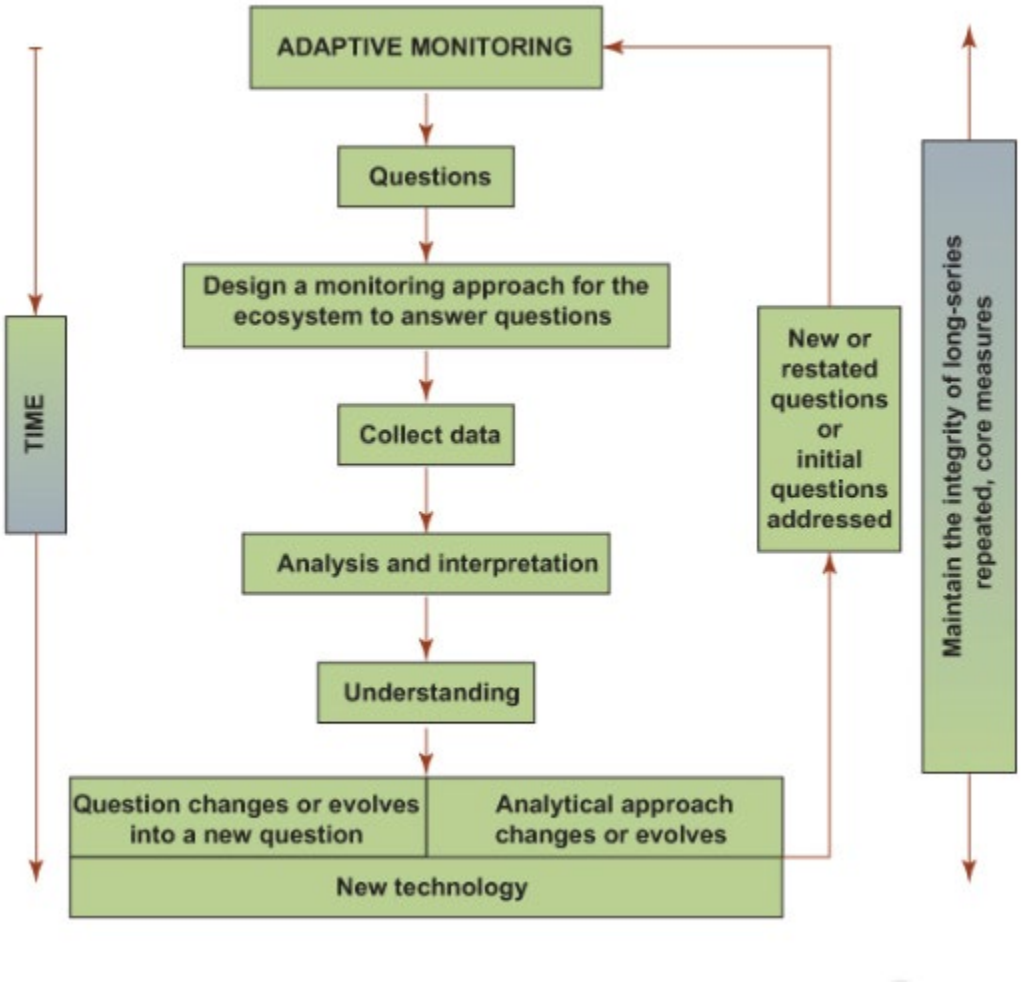


Figure 5. Adaptive monitoring framework. (Likens & Lindenmayer, 2018)

There is a large body of literature outlining the philosophy, structure, and execution of adaptive monitoring (Arciszewski et al., 2017; Likens & Lindenmayer, 2018; Lindenmayer et al., 2022; Lindenmayer & Likens, 2009, 2010; Munkittrick, 2000; Munkittrick et al., 2019). In the OSMP context, an adaptive monitoring framework would be built by identifying key questions, evaluating existing OSMP data to design a powerful monitoring approach to answer these questions, then implementing data collection (Figure 5.) Ongoing analysis and comparison of data against limits of change established by the program would provide a powerful basis for frequent reporting of results and informing decision makers and triggering management action.

Adaptive monitoring includes simple steps of surveillance monitoring that can be increased in frequency or spatial extent if change is detected. This is governed by a decision tree that uses those limits of change to determine when monitoring needs to focus on an area of change or risk (Government of Canada, 2011b). Exceedance of a limit of change may trigger a decision to move

monitoring to a subsequent tier such as investigation of cause (Table 4.) Ideally, this would be linked to an adaptive management framework.

Table 4. Tiers of an adaptive monitoring approach. Adapted from (Munkittrick et al., 2019)

Tier	**Question(s)**	**Frequency**	**Activity**	**Trigger**
Baseline	What is the pre disturbance state and natural range of variability?	Initial	Establishment of predisturbance reference conditions Establishment of natural range of variability	
Accumulated state	What are the key components? What is the current state and range of variability?	Initial	Establishment of accumulated state and condition Establishment of current natural range of variability	
Surveillance	Are there changes?	Regular cadence – hourly to 3-6 year intervals, depending on indicator	Baseline data and design completed	Completion of baseline and accumulated state
Confirmation	Can we confirm them?	More often	Difference beyond a limit of change	Limits of change established based on (a) sustainability of the component and (b) acceptability of degree of change
Extent and Magnitude	What is the extent and magnitude of the change?	Episodic when triggered	Using additional sites and sampling frequency to determine extent and magnitude of change	Confirmation of changes
Investigation of Cause	What is the cause?	Episodic when triggered	Research oriented	Change across a sufficient area or of a sufficient magnitude, or is getting worse (temporal consistency)

Tier	Question(s)	Frequency	Activity	Trigger
Investigation of Solutions	What is the solution, and do I have to mitigate or compensate?	Episodic, when cause of change is determined	Research oriented, guided by linkage to policy and management	Change exceeds "ecological relevance" or cultural thresholds
Focused Study	Refinement of technologies or approaches, or addressing specific and time-limited questions	Episodic, when required	Research oriented, intended to answer specific questions	

The OSMP has twelve years of data across a wide range of indicators and themes. It is therefore well placed to evaluate data for the core programs to determine the current accumulated state, assess the power of indicators to detect change and rationalize the monitoring approach, develop statistical limits of change, surveillance and confirmation of any change that may have been observed. Based on this analysis, the core programs can then determine the best experimental approach for detecting change and build a decision tree that would guide adaptive monitoring and link to management. The IIP project is designed to begin this work to determine a monitoring approach meaningful for Indigenous communities.

5 Methods

We report on work for the first of three main components:

1. Community Engagement to identify Key Questions:
a. Development and refinement of Indigenous key questions for OSMP through community engagement and feedback from Indigenous representatives at the Indigenous Summit.
b. Development of Indigenous conceptual models to provide a logical framework for designing a monitoring program to meaningfully address community concerns and integrate IK.

The community engagement for this work included:

- WBISC workshops in 2024
- Ongoing engagement with WBISC community reps and the IIP Project Team (reviewing of documents, etc.)
- In-community engagement led by individual community representatives to identify key questions, indicators and important monitoring areas/sites. This involved the engagement of community members, knowledge holders, and land users.
- IIP Summit workshop in winter 2025 to review all IIP Project outcomes, refine and validate results with community representatives.

5.1 Development of Key Questions and Guiding Principles

Community representatives at the WBISC participated in a workshop in the winter and summer of 2024 (July 29, 2024 and October 31, 2024) to plan engagement approaches. The group agreed that communities would be responsible for their own engagement and would provide a written report to the study team that: a) identified community key questions, b) identified locations of interest, and c) described how community members would like to be involved in monitoring, reporting, and what information (indicators) would most help them answer their questions. An engagement guide and presentation (Appendix A) were developed that explained the IIP Project and what OSMP core monitoring was ongoing.

5.1.1 Individual Community Engagement

Community representatives engaged with their members using community specific approaches between February 2024 and March 2025. The community representatives remained the point of contact between community members and the IIP project team and were responsible for ensuring protection of any IK. Communities designed their own process that included working with community members and land users to address the questions outlined in the engagement guide, which was drafted by the project social scientist.

Two communities (Fort McKay First Nation and Fort McKay Métis Nation) who have a great deal of history and experience with oil sands development, and whose members have been surveyed and interviewed extensively about their concerns, opted not to do community engagement. Rather, these communities reviewed several historic and recent Statements of Concern and other regulatory filings and relevant studies to identify community concerns and questions that related to environmental monitoring.

Following community engagement with members, the community representatives submitted reports to the IIP project team for compilation.

5.1.2 Compilation of Community Engagement Results

Community reports were reviewed and all community questions compiled. The questions were sorted by theme area, and classified by:

- location within their conceptual model - stressor, pathway, receptors, effects health, culture,
- where they fit within an adaptive monitoring approach- baseline, surveillance, accumulated state, confirmation, investigation of cause, or investigation of solutions, or focused study, or
- whether they related to another aspect of resource management – compliance and enforcement monitoring (monitoring on-site to ensure that operators are operating within approval conditions, normally done by operator and reported to the Alberta Energy Regulator), validation of environmental impact assessment predictions, or modeling.

This sorting represented a best fit approach to collate questions in a manner consistent with the OSMP theme areas, including air and deposition, aquatics, terrestrial biodiversity, wetlands, and groundwater. The exercise was intended to provide a broader understanding of community concerns and assess the degree to which there are concerns that are common between

communities. The original questions did not always neatly fit within these categories or there were questions that were cross-cutting and included more than one theme area (for example, aquatics and groundwater.) We also took care to make sure that while sorting questions, we did not lose linkages to the original concerns (i.e., de-contextualize), observations or concept that gave rise to that question. Some communities provided answers that are currently outside of the scope of the existing program (socio-economic concerns related to housing for example). All questions, including socio-economic, are in Appendix 2.

Because these questions were the most common, we focused on questions relating to air quality, aquatics, or terrestrial biodiversity, and identified questions that were common between communities. These were then combined and revised in a manner that a) addressed community expressed concerns, b) were suitable for guiding a monitoring program, c) related to a concern, observation or cultural priority. We tried to select questions that represented stressors, pathways and effects on the conceptual model.

We did additional analysis to expand on key questions to provide guidance to the program on how core monitoring could address these questions. For example, some communities suggested indicators, locations, frequency or considerations for how key questions should be monitored. Where possible, we provided guidance on indicators, locations, and frequency of monitoring, and whether outside data may be required to answer the questions.

We did not prioritize the questions provided in the tables here. That will be done in the future, where we will calculate the power and specificity of different indicators to answer key questions. Some questions may also require a focused study to scope the monitoring or determine methods for undertaking the monitoring. These were noted in the tables as well. We also have not compiled locations onto a core map outlining key areas for monitoring; this will be work for year two of the program.

The list of revised key questions was reviewed and validated at the IIP Summit.

Most communities also submitted principles that expressed their communities' interests and approaches to monitoring. These were also compiled, and four overarching principles were identified and developed that captured the sentiments of the participating communities. The principles were later refined and validated with community representatives during the IIP Summit.

5.2 Development of Conceptual Models

Community representatives provided input into how they would like their key concerns around impacts to their Rights and culture represented in conceptual models in early IIP workshops and ongoing meetings. The project team developed draft conceptual models which were reviewed during regular meetings with community representatives. They were then presented and revised in the IIP Summit workshop.

5.4 Community Validation of IIP Project Results

The project team hosted an Indigenous Indicator Prioritization Summit on February 24 and 25, 2025. Community representatives and community members from participating communities attended to review project results. The monitoring principles, key questions and conceptual models

were presented to the summit for feedback and validation. Following the summit, all reports were reviewed and approved by participating communities.

6 RESULTS AND DISCUSSION

6.1 IIP Principles

The four principles below were developed by the WBISC communities to guide the OSMP's core programs. Draft principles arose from community submissions that arose from community engagement and were then refined and validated at the IIP Summit. These principles express how Indigenous communities look at monitoring and how OSMP core monitoring could be further developed to integrate Indigenous concerns and needs. The principles were discussed and refined in facilitated large and small group exercises at the IPP Summit, and workshop feedback was then incorporated to produce the four principles below. These principles should be considered 'living' and subject to revision as required by the WBISC.

1. **Everything is connected**
   The environment is not just categories of air, water, plants, animals, and land – it is an interconnected network of cultural and ecological systems that include Indigenous people. For some communities this is expressed through the Cree term *wahkotowin*, while Dene communities believe the Dene Laws outline how communities are to maintain good relations. Through kinship with plants and animals and reciprocal relationships with and obligations to the land and water, Indigenous people are interwoven into the fabric of the land. What happens to the land is felt by Indigenous peoples and vice versa.

2. **Monitoring must lead to action**
   Ambient monitoring needs to be linked to on-site monitoring, inform management, and drive the development of policy. Monitoring is a critical component of responsible management action required for reconciliation. Both federal and provincial governments and oil sands producers have an obligation to take management action based on monitoring outcomes and explain to all OSMP members how data will be used to inform policy development.

3. **We must monitor the endpoints that Indigenous people are concerned about**
   Monitoring must include components that Indigenous people care about and provide the necessary information to empower land use and land management decisions. Indigenous Knowledge (IK) must directly inform the monitoring design, sampling locations and frequency, indicators and metrics, and the establishment of baseline and thresholds of change. This must be balanced with monitoring those stressors and pathways that will trigger the necessary management action. It is also critical that all aspects of monitoring programs are translated and presented to Indigenous communities in ways that are meaningful and empowering to youth, land users, and Elders, and do not cause harm.

4. **Monitoring is Sacred**
   As the Dene Laws and *wahkotowin* recognize, people's relationship to the land is sacred, and as such, monitoring the impacts people cause to the land is a sacred obligation. This inherent Right, recognized in federal policy and law (Mason, 2024). This stewardship in the

form of ICBM is grounded in IK that informs everything from key questions to design and methods, as well as results and interpretation. As such, all monitoring that addresses Indigenous concerns and includes IK should be treated as sacred through careful adherence to community protocols surrounding IK. It is our aspiration that core monitoring will also be informed by and meaningfully integrate IK.

The following outlines ideas for how these four IIP principals could be implemented within the OSMP.

1. **Everything is connected**
    - Revisit TAC/theme structure and consider other organizational structures (i.e., based on geography, key community questions, or pathways rather than on themes) and/or to better address cross-cutting workplans.
    - Organize inter-TAC meetings to increase integration.
    - Consider regional differences in Indigenous priorities; for example, Indigenous communities in the Athabasca Region experience different and more significant oil-sands related impacts than in some other regions.
    - Develop an approach and guidelines to ensure IK informs and is integrated into the TAC core program work. This may require a social scientist regularly participating on these committees.
    - Prioritize integrated workplans across TACs that address impacts identified by participating Indigenous communities (and creation of social science TAC or Working Group to guide this work).
    - Re-evaluate the funding and approval model to allow for better integration across TACs. For example, it is hard to understand linkages across themes when one theme is not funded or cut back.
    - Re-evaluate the annual funding model to allow for multi-year funding to ensure that there is sufficient funding and data from a project to conduct analysis for change (e.g., one-year is typically not sufficient for detecting change in most indicators).
    - Develop an adaptive monitoring framework to ensure monitoring focuses on areas and/or receptors where there is the most concern and where program elements can be scaled back or re-evaluated when change is not observed
    - Ensure a balance between monitoring stressors and effects in an adaptive framework where information from stressor-, pathway- and effects-based indicators are used to focus monitoring on areas/receptors of highest concern.
    - Develop an integration framework for the overall OSMP that connects the TACs and ICBMAC conceptual models. This should include a demonstration of the interconnected network of cultural and ecological systems and detail how environmental components relate to cultural activities and exercise of Rights.
    - Expedite existing integration work such as: Integrated Contaminants Effects Working Group, ICBMAC geospatial work (which would allow for the inclusion of key cultural species and places across TACs and OSMP), and air modelling.
    - Give more thought to the integration of sample locations across the core monitoring and CBM programs to reduce duplication and support linkages and integration among core sampling and CBM sampling. For example, this is currently being done with the Surface Water TAC and Wetlands TAC to some extent, where measurements from both core program are needed to support the overall program objectives.

2. **Monitoring must lead to action**
   - Identify information needs of Indigenous communities, industry, government and regulatory decision makers so that there is a clearer linkage between monitoring and management and policy development.
   - Establish a monitoring framework that focuses monitoring effort on areas of highest concern. Increased monitoring attention could be triggered by indicators exceeding a limit of change.
   - Develop Indigenous limits of change that identify areas and receptors of concern to Indigenous communities to allow focused monitoring.
   - Improve reporting so that exceedances of management triggers such as Alberta Ambient Air Quality Objectives (AAAQOs), water quality thresholds, and LARP thresholds are detected and reported with as little lag as possible. Yearly or longer reporting of exceedances is too long.
   - Support community development of Indigenous thresholds or triggers that inform communities when environmental change has the potential to impact Indigenous Rights.
   - Request review of policy or regulatory instruments based on recommendations of the OC or monitoring results, develop formal feedback to the Crown and industry to inform management.
   - Encourage the and federal and provincial governments and their regulatory bodies to develop management or development scenarios, and predictive modeling to estimate what environmental impacts arise from these scenarios. Monitoring can then be designed to detect these impacts (Nichols & Williams, 2006),
   - Implement a Management Action Log for the federal and provincial governments, their regulatory bodies, and industry that can provide key performance indicators of the ability of the OSMP to inform management and policy.

3. **We must monitor the endpoints that Indigenous people are concerned about**
   - Establish co-location and/or coordination of sites between core monitoring and CBM monitoring through creation of a sharable geospatial mapping tool containing core sites and CBM sites. This can be followed by integration workshops to increase program efficiency. Ensure that co-location supports evaluation of key community questions at a local and regional level.
   - Improve communication between TACs and CBM programs. This will help ensure that core monitoring receives relevant community input and will support better integration across the OSMP.
   - Priority should be given to establishing appropriate baselines (i.e., pre-oil sands development) that integrate IK and address the decades of cumulative effects felt the by communities in the region (see section 3).
   - Ensure that Indigenous key questions inform the development of an overarching OSMP framework (Oil Sands Monitoring Program, 2024). This framework will help TACs and SIKIC prioritize workplans and guide rationalization of the monitoring program to more efficiently answer key questions.
   - Indigenous science indictors and western science metrics may have different outcomes, so it is important to measure both to ensure that Rightsholders' needs are

being met and that observed changes and/or impacts are driving management action. This may mean that core monitoring include IK-based metrics in cooperation with CBM. Results should be interpreted with corresponding cultural indicators identified and monitored through ICBMAC workplans that are community-led.

4. **Monitoring is Sacred**
   - Incorporate key concepts such as *wahkotowin* and the Dene Laws into the monitoring program.
   - Document and refer to Elders stories. Ensure that this is done ethically, with community participation and approval.
   - Encourage workplans and TACs to engage with Indigenous community members on the land to better understand their perspectives and questions.
   - Adhere to the *Ethical Guidelines for Indigenous Community-Based Monitoring in the Oil Sands Monitoring Program(Banister K et al., 2021)*.
   - Understand community priorities in terms of understanding change at the appropriate spatial and temporal scales. Longer term cumulative effects are often more aligned with community lived experience. Detecting change at the spatial scale of the individual herds, sacred places, or at the community-local level is more meaningful than regional change.

6.2 Conceptual Models

Conceptual models are an integral part of establishing a logical framework for designing a monitoring program. The development of the model forces the designers to explicitly state and evaluate each of their assumptions on how the system interacts and how stressors contribute to changes in the receiving environment. Done well, conceptual models provide a backbone on which to design key questions (Likens & Lindenmayer, 2018)

As outlined before, the OSMP Integration Workshops made a very large contribution to the program by developing thematic conceptual models. They were intended to:

> *(1) identify the most likely critical source-pathway-receptor linkages which would drive oil sands-related changes;*
>
> *(2) generate hypotheses regarding relative contribution of stressor sources, the fate and transport mechanisms of chemical stressors, effects mechanisms, and cumulative interactions (synergistic, antagonistic, additive); and,*
>
> *(3) identify critical gaps in our understanding of stressor-pathway-response linkages.*
>
> *- (Swanson, 2019)*

The conceptual models developed for this IIP Project were created to integrate Western science and Indigenous perspectives, providing a conceptual model that captures a more fulsome

perspective of the impacts experienced by Indigenous peoples as a result of oils sands impacts to the environment (Figures 6-8.) The center of each model is a diagram based on existing core TAC conceptual models that are based on a Western scientific viewpoint. Around the diagram each model includes "magnified" images that provide a detailed look at the various ways that Indigenous land users experience impacts. These illustrations reflect concerns raised by the communities and individuals who participated in this IIP Project and who experience these effects in their daily lives.

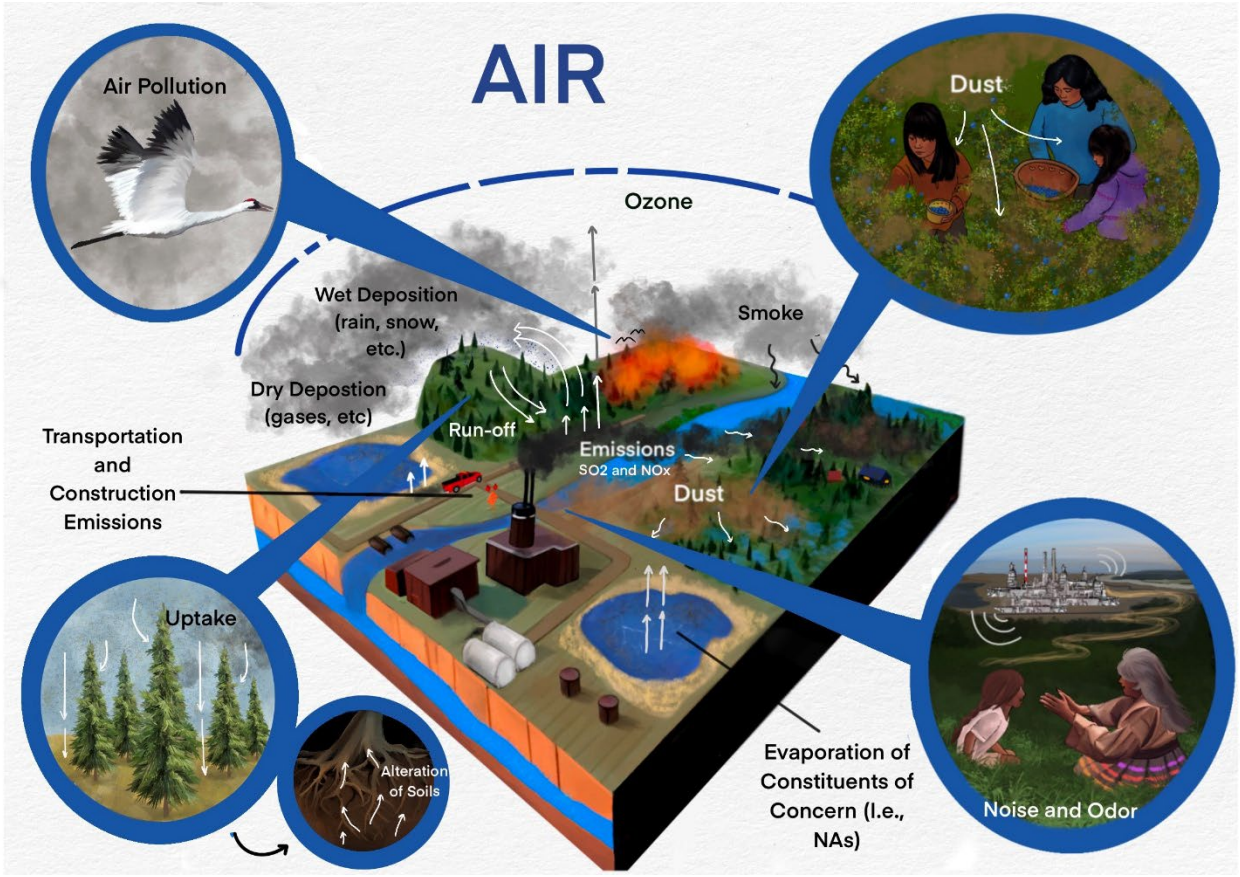


Figure 6. Air Conceptual Model.

The air conceptual model (Figure 6) combines the Air TAC approach to tracking stressors such as stack, transportation and construction emissions, evaporation from tailings ponds, forest fires and dust. Pathways include deposition of dust, acidifying compounds, and wet and dry deposition. In this conceptual model, the focus is on effects of concern to Indigenous peoples. The top-left scene illustrates a whooping crane flying through polluted air, highlighting the potentially detrimental effects of constituents of potential concern (COPCs) that it is inhalation, dermal contact and particulate matter that could adhere to its feathers. The top-right scene depicts a mother and her children picking berries, with dust settling around them and on the berries that will be digested, whether in whole or concentrated such as with making jam or syrup. The bottom-left image illustrates the process of deposition to soils and potential alteration of the soil nutrient cycle and its associated effects to ecosystem function and health. The bottom-right image shows an Elder teaching or telling stories to her grandson while on the land, and in the context of industrial

nuisances (air, noise and light pollution) from nearby plants that disrupt their interactions with the land and their perceptions of safety.

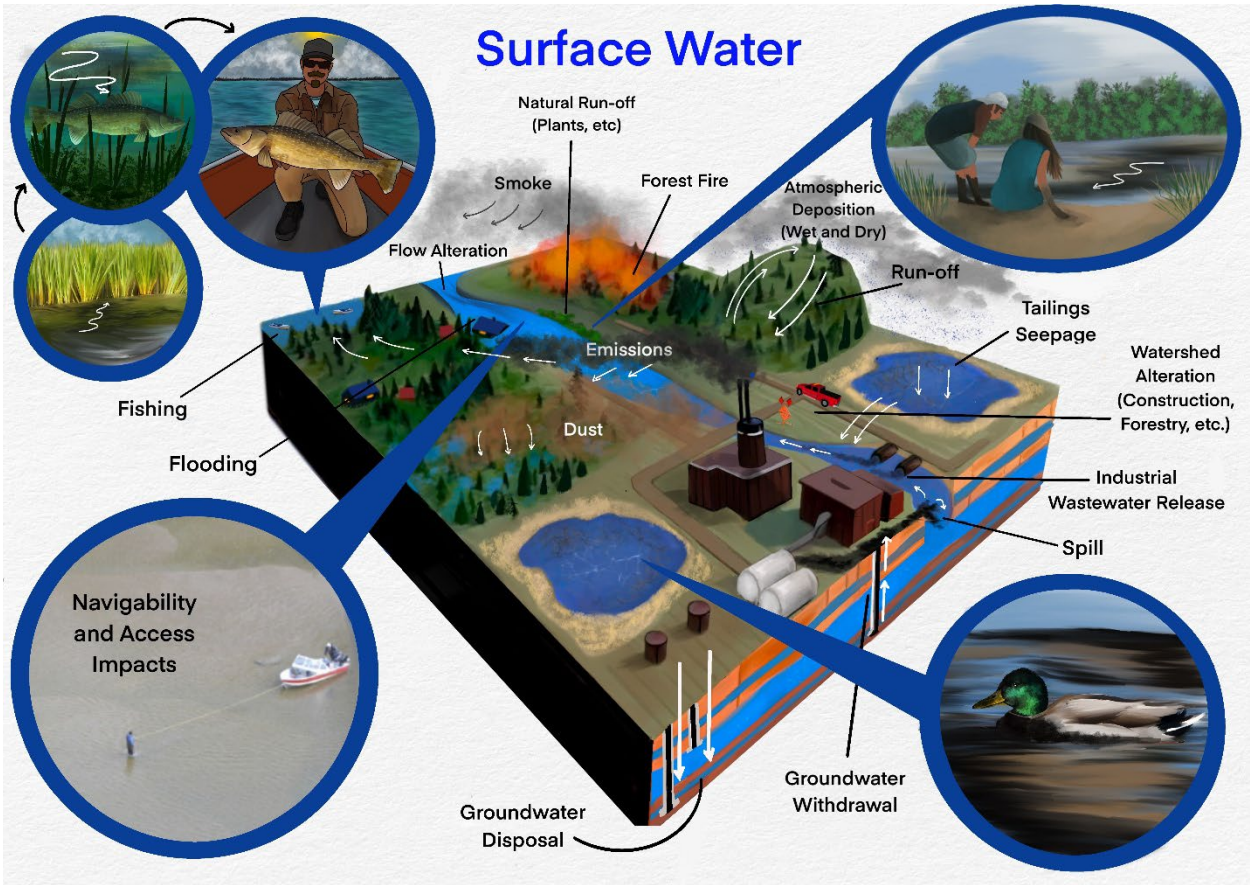


Figure 7. Surface water conceptual model.

The surface water conceptual model (Figure 7) combines the draft Surface Water TAC conceptual model and the TAC's approach to tracking stressors including seepage, industrial wastewater release, watershed alteration, deposition, groundwater withdrawals and disposal. Pathways include run off, flows and flow alteration. The top-left image portrays rat root growing in potentially contaminated soils, a walleye swimming in water impacted by oil sands related COPCs, and the potential for these, and surface water, to then be harvested and consumed for water, traditional medicine and food. The top-right image shows two youth playing near the water, and concerns about oiling on and in the water. The bottom-left scene is a photo of a man attempting to pull a stranded boat to shore, a result of significantly lower water levels. These reduced water levels have led to navigational and access challenges for Indigenous land users. The final scene depicts a bird that has flown into a tailings pond and has been oiled. Photograph of member stranded on sand bar from (Associates, 2016).

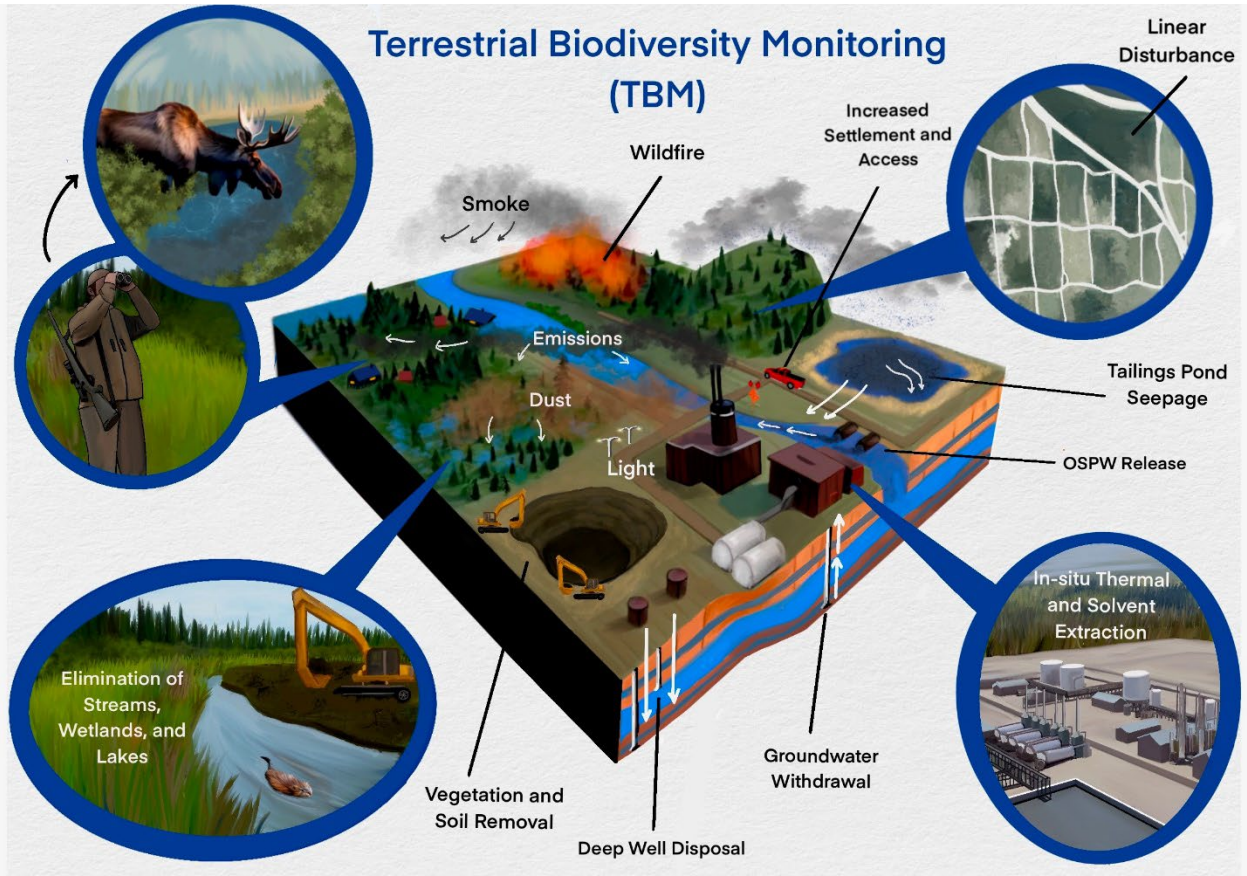


Figure 8. Terrestrial Biodiversity Conceptual Model.

The terrestrial biodiversity conceptual model (Figure 8) combines the Terrestrial Biodiversity TAC conceptual model and the TAC's approach to tracking stressors including wildfire, landscape alteration including changes to access, vegetation and soil removal, linear disturbance, and elimination of streams, wetlands and lakes. It also illustrates concerns related to potential sources of COPCs. The top-left image depicts a moose drinking from a river impacted by COPCs, with a hunter who will eventually harvest and consume the moose, showing the impact to traditional hunting practices and concerns around resource health. The top-right image illustrates linear disturbances, which impacts the balance between ungulates and predators, affect access for traditional use and allows increased access of non-Indigenous hunters who compete for resources. The bottom-left image portrays a muskrat swimming in a stream, with wetlands being gradually destroyed in the background, emphasizing that alterations to waterways and wetlands and the impacts to culturally important resources supported by these ecosystems. The bottom-right image represents in-situ thermal and solvent extraction processes, which create noise and linear disturbance which impact wildlife as well as Indigenous use and access to the land.

6.3 Indigenous Key Questions

Eleven of twelve (91.7%) communities submitted reports based on either community engagement or review of existing engagements. In total, we collated 350 individual questions (Appendix B) asked

by community members relating to oil sands' impacts on the environment, their culture and practice of their Rights.

Questions were well distributed between monitoring themes, with communities expressing the most interest in terrestrial biodiversity (119,) aquatics (118) or with aquatics combined with groundwater or wetlands (3). There were 67 questions related to air and deposition, and 11 for wetlands. There were several questions about groundwater, but they all were cross-cutting and related to impacts to surface water or wetlands. There were 4 questions specifically about human health, but 27 about the relationship between environmental effects and human health. While most questions about effects related specifically to impacts to Indigenous Rights and culture, there were 23 questions that were explicitly about social or economic impacts.

Questions were often clearly classified as either relating to stressor, pathway, or effects, but there were also questions that combined effects with socio-cultural impacts (6), potential impacts to health (26), or an integration of effects and pathway (3), pathway and stressor (2), or stressors and effects (1). Indigenous participants asked many questions focused on the effects of oil sands development, consistent with a focus on the effects side of the conceptual models (179.) As noted by one community, in Western science-driven monitoring, air and water quality monitoring frequently focus on assessment of stressors in the receiving environment, rather than focusing on effects to receptors (Fort McKay First Nation and Fort McKay Métis Nation, 2024). This is consistent with a monitoring philosophy aimed at determining whether ambient concentrations of compounds of potential concern are in danger of exceeding some assimilative or health-based threshold (Munkittrick, 2000). For Indigenous communities, stressors and effects are very much interconnected and the community concern is often how those stressors will affect the health and safety of cultural resources and human health and well-being. Thus, community members often note effects in their daily lives and while on the land and derive questions from these observations (Fort McKay First Nation and Fort McKay Métis Nation, 2024)

Indigenous communities often asked about how specific stressors impacted the environment and resources. In fact, Indigenous community members were very likely to ask questions relating a specific stressor to an observed effect, such as "is water quantity sufficient to support populations of Arctic grayling?" (Willow Lake Métis Nation, 2025). Thus, there were a great deal of questions on oil sands stressors (39) and the pathways of effects (69.) To address Indigenous community concerns there's a need to approach monitoring from both effects and stressors starting points.

A distrust of industry management and policy was apparent throughout the community submissions. There were questions relating to management, including questions about compliance (21), the need for confirmation of environmental impact assessments (3) or the need for cumulative effects assessment or modeling (3). This informed our Gap Analysis Report and emphasizes the need to link compliance monitoring to OSMP monitoring.

In the oil sands, compliance monitoring refers to monitoring done by the operator, on site, to ensure that it is operating within approval conditions. This includes monitoring such as continuous emissions monitoring, monitoring of bird landings or wildlife interaction with tailings ponds, groundwater monitoring to detect seepage, or water quality monitoring from industrial wastewater releases. While every other Environmental Effects Monitoring Program starts with chemical and toxicological monitoring of effluent at the end of pipe (Metal and Diamond Mining Effluent

Regulations, 2002; Pulp and Paper Effluent Regulations, 1992), in the OSMP these compliance monitoring data are considered separate and there is no mechanism for providing compliance monitoring data to the OSMP to inform effects. Monitoring without fully understanding the stressors impairs the ability to inform management. Not only would a more explicit link to compliance monitoring better inform our understanding of stressors, but it would also improve trust from Indigenous Rightsholders and the public.

Some of the key questions start from the same place as existing core monitoring questions which are more general in nature, such as 'is air quality changing?' (Table 5.) However, as discussed earlier, these general questions are not sufficient to direct effective monitoring and need further refinement to ensure that monitoring focuses on sensitive receptors that are likely to detect and relate to cause to initiate a management response in a meaningful timeframe. For this reason, we provide guidance on how the OSMP core monitoring should be evaluated to answer these more general questions for Indigenous communities. For example, annual reporting of regional averages for air quality does not reflect the impact on community members. However, a more meaningful metric of air quality to communities would be reporting more frequently on results from community stations, reporting the frequency of odour events, reporting the frequency of air quality exceedances, and reporting observations from community members on whether air quality impaired their ability to go out on the land or posed health concerns.

For core theme areas, we use community key questions and feedback to recommend locations for monitoring, what measurements or indicators could address the key questions, and how to analyze and how often to report on these indicators (Tables 5-7). Finally, we did not want to lose the connection to the key concern or original key question, which often was broader and related to how community members experience change on the landscape. For example, a question asked by all participating communities was 'is the air safe to breathe' and 'is the water safe to drink.' We broke these questions into their surveillance component: water and air quality monitoring at very frequent intervals, and in very specific locations, as well as the stressor component, by recommending monitoring of emissions or industrial wastewater releases. Thus, the resulting key questions are a more focused and specific statement of the original concern. However, we do not want to lose that original concern as it is what links the monitoring findings back to the experience of community members. Therefore, these are retained in the column cultural component/concern.

The results in tables 5-7 are a step forward in further defining Indigenous key questions but require additional refinement. WBISC communities at the IIP summit expressed the view that these questions as a step forward that require some ongoing work to further develop. This includes filling in gaps in locations and indicators, doing the needed statistical analyses to determine if indicators have the power to detect change, prioritizing indicators based on feedback from the communities, and exploring whether there are additional IK informed indicators that may have more power or specificity to detect changes of interest to Indigenous community members. Furthermore, as information becomes available to answer these questions, community priorities may change. The prioritization will be based not only on community feedback, but on analyses to determine the power of indicators to detect change. For example, while communities may be interested in understanding the population dynamics of moose, if the monitoring approach cannot provide an answer on the moose population at the scale of wildlife management unit in reasonable timeframes, or in locations close to communities, then the monitoring approach may need to be

changed. This analysis and prioritization will be informed by the Gap Analysis and form the basis of our work in year two.

In addition, in future years we will extend this analysis to better recommend how the data should be analyzed for change, and what limits of change should drive decision making between different tiers of monitoring. Mechanisms for detecting change are difficult and require both statistical analysis and further work with communities. 'Limits of change' is a term specific to the OSMP (OFA, 2018) and is intended to indicate a level of change that warrants some sort of action. The OSMP has not established whether these are intended to be the same as monitoring triggers (Munkittrick et al., 2019). Our working assumption is that the a 'limit of change' denotes a magnitude of change significant enough that monitoring should shift to focus on areas of highest risk with increased monitoring or an investigation of cause. Limits of change should be more sensitive than management triggers, so investigation can be initiated before the change becomes large enough to warrant management intervention. Monitoring triggers can be based on statistical analysis or IK, or both. The development of Indigenous limits of change is the work of future years, so in this table, we have identified 'limits of change' as either 'statistical limits of change' or 'Indigenous knowledge' to indicate which approach we think the OSMP should take to define these.

The OSMP currently has no Indigenous limits of change, though the Water Quality Criteria for Indigenous Use (Olsgard et al., 2023), Aboriginal Base Flow and Aboriginal Extreme Flow (Aqua Environmental Associates, 2016; Candler et al., 2010), the Fort McKay Air Quality Index (Spink, n.d.) and pre-industrial baseline for air quality (Spink D et al., 2024) are developed indices that are familiar to their respective TACs. However, we have not done the work to assess their suitability for other communities. While these indices and thresholds may be suitable for Indigenous limits of change, that requires more work and the endorsement of all communities if they are to be applied broadly.

Table 5. Air and Deposition Key Questions

Cultural Component/ Concern	Key Question(s)	Locations	Measurement	Outside Data Source	Monitoring Tier	Suggested Frequency	Limit of Change
Is the air safe to breathe?	Has ambient air quality changed since development?	All stations	NOx, SOx, O_3, $PM_{2.5}$, total hydrocarbons, reduced sulfur compounds		Focused Study	Once	Statistical comparison to pre-disturbance Indigenous knowledge – how has air quality changed peoples' relationship with the land, cultural practices and health and well-being
Is the air safe to breathe?	Is air quality changing now?	All stations	NOx, SOx, O_3, $PM_{2.5}$, total hydrocarbons, reduced sulfur compounds, dust		Surveillance	Hourly, reported monthly as number of deviations, and monthly interpretation to trigger IOC	Statistical limits of change Exceedances
Is the air safe to breathe?	Are odours reaching communities? Are odour events increasing?	Community Stations, and further monitoring in key locations throughout	NOx, SOx, O_3, $PM_{2.5}$, total hydrocarbons, reduced sulfur compounds, dust		Surveillance	Hourly, reported monthly as number of deviations, and monthly	Statistical limits of change Exceedances

Cultural Component/ Concern	Key Question(s)	Locations	Measurement	Outside Data Source	Monitoring Tier	Suggested Frequency	Limit of Change
	Are odours impacting Indigenous cultural activities and/or quality of life?	traditional territories.	Community observations			interpretation to trigger IOC	Indigenous knowledge – are odors affecting quality of life and cultural practices?
Does industrial noise impact wildlife or people?	Are noise levels changing? Are noise levels impacting Indigenous cultural activities and/or quality of life?	Communities, important locations TBD	Frequency, type, location of noises; noise level above basic sound level – daytime and nighttime – at receptor locations, trapping areas, and 1.5 km from fence line	Map showing industrial noise extent as developed by ABMI Comparison to D083. Distance until noise no longer impacts wildlife.	Focused study to determine methods and feasibility. Surveillance if feasible.		Indigenous knowledge – is noise affecting quality of life and cultural practices? Is noise affecting wildlife behaviour?
Is deposition impacting important resources?	Has there been a change in deposition?	Forest uplands and, wetlands, snow – focus on sensitive receptors in key ecosystems of interest	Denuders, passives, IERs, concentrations of COPCs in snow, lichen bioindicators		Surveillance	Yearly	Statistical limits of change Indigenous knowledge
Is deposition impacting	Is there an impact of deposition on	Forest Health	Lichen, understory vegetation, blueberries,		Surveillance	Every six years	Statistical limits of change

Cultural Component/ Concern	Key Question(s)	Locations	Measurement	Outside Data Source	Monitoring Tier	Suggested Frequency	Limit of Change
important resources?	upland forest ecosystems?		trees, soils and nutrient cycling, needles Indigenous knowledge to develop key indicators and metrics				Indigenous knowledge
Is deposition impacting important resources?	Is there an impact of deposition on wetlands? Is there an impact of deposition on wetland plants?	Integrated deposition/ wetlands, ecosystem health/wetland sites – focus on sensitive receptors in key wetlands of interest (e.g., bogs are sensitive to deposition)	Wetland water quality, ombrotrophic bog pore water chemistry, plant tissue chemistry, changes plant community composition Indigenous knowledge to develop key indicators and metrics (wetland water quality – safety for plants and for drinking; dust on berries)		Surveillance Return frequency unknown		Statistical limits of change Indigenous knowledge

Cultural Component/ Concern	Key Question(s)	Locations	Measurement	Outside Data Source	Monitoring Tier	Suggested Frequency	Limit of Change
Is deposition impacting human health and well-being? [9]	What is the risk from deposition through ingestion of plants and animals by community members? What is the risk of bioaccumulation of pollutants? What is the risk of deposition of pollutants to human health and quality of life?	Focus on sites where levels of pollutant deposition are of greatest concern.	Concentration of COPCs in berries, chemistry and toxicology assessment of culturally important plants		Surveillance		Statistical limits of change Indigenous knowledge
How is industry impacting air quality?	Are oil sands emissions impacting air quality?	Mineable region on site, fleet emissions. Stacks for both mineable and SAGD.	NOx, SOx, $PM_{2.5}$, TRS, THC, Source apportionment. Emissions inventories and modelling.	Emissions inventories. Access CEMS data from AER/Operator	Surveillance.	Monthly	Statistical limits of change

[9] Health and well-being should be defined by the communities. Health metrics are based on a western interpretation of health, and while generally applicable for all people, miss important aspects of health that include well-being. For example, dust and/or odours may not really affect respiratory health in a medical sense, just more of a nuisance, but they often affect mental health and well-being, because they are a nuisance and they insight a perceived risk to health and safety. Additionally, safety may be defined from a toxicology perspective, but that is only one piece from a Western science lens. Equally important are IK metrics that address the quality and condition of the cultural resources that people consume for food and/or medicine. While Western science may define an acceptable limit of concentration of COPCs, from an IK perspective the contaminants have compromised the quality and desirability of the resource.

Cultural Component/ Concern	Key Question(s)	Locations	Measurement	Outside Data Source	Monitoring Tier	Suggested Frequency	Limit of Change
How is industry impacting air quality?	Are tailings ponds/mine faces impacting odours or air quality?	Mineable, on site	TRS, THC, NMHC, VOCs, Source Apportionment, Odour Exceedances	Access reporting from AER/Operator	Focused study to establish methods and feasibility Surveillance if feasible		Statistical limits of change
How is industry impacting air quality?	What is the impact of mine operations and haul roads on dust deposition?	Mineable and throughout	NOx, $PM_{2.5}$, PM_{10}, dust, source apportionment, dust exceedances		Surveillance	Monthly	Statistical limits of change
How is industrial development impacts on air impacting how land-user's experience while harvesting resources?	How does air quality impact land-user's experiences?	Mineable and throughout	Qualitative interviews and surveys to determine who industrial development is impacting people's use of the land.		Focused study to establish a baseline followed by surveillance to monitor change over time.	Yearly/seasonally	Indigenous knowledge

Table 6. Aquatics key questions

Cultural Component/ Concern	Key Question	Locations	Measurement	Outside Data Source	Monitoring Tier	Suggested Frequency	Limit of Change
Is the water safe to drink? To touch and swim in?	Has water quality changed since predevelopment?	Throughout	Indigenous knowledge, Pre-development water quality data is not available.		Focused Study	Once	Indigenous knowledge
Is the water safe to drink? To touch and swim in?	Is water quality changing now?	Throughout	Water chemistry		Surveillance	Report monthly on exceedances, yearly on change.	Statistical limits of change Indigenous knowledge
Is the water safe to drink? To touch and swim in?	Is the water safe to drink? To touch and swim in?	Throughout	Water chemistry		Surveillance	Monthly	Comparison against guidelines protective of human health

Cultural Component/ Concern	Key Question	Locations	Measurement	Outside Data Source	Monitoring Tier	Suggested Frequency	Limit of Change
Is water quality impacting important resources?	Is water quality impacting the receiving environment?	Throughout	Benthic community change, fish health (gonad and liver weight, fish condition) Indigenous knowledge		Surveillance	Yearly for benthic communities and Indigenous fish camps, three-year return frequency for fish health.	Statistical limits of change Indigenous knowledge
Are fish safe to eat?	Are fish safe to eat? (key species)	Fish camps as identified	COPC concentration in fish flesh, tainting, Indigenous knowledge		Surveillance	Yearly	Comparison against guidelines protective of human health Indigenous knowledge
Are you able to fish as you used to?	Are there changes in fish availability or quality?	Throughout	Fish community changes, Indigenous interviews		Surveillance	Yearly	Statistical limits of change Indigenous knowledge
Are you able to fish as you used to?	Are there changes in access or competition from non-Indigenous fishers?	Throughout	Indigenous interviews, mapping gate locations and barriers to access		Surveillance	Yearly	Statistical limits of change Indigenous knowledge

Cultural Component/ Concern	Key Question	Locations	Measurement	Outside Data Source	Monitoring Tier	Suggested Frequency	Limit of Change
Why are rivers, lakes and wetlands becoming so dry?	Are there changes in water quantity?	Throughout	Water level, flow, shoreline plant presence/absence, wetness of wetlands		Surveillance	Yearly	Statistical limit of change, Indigenous knowledge
How is industry impacting the water?	What is the impact of industrial activity on water quality, particularly effluent release?	IWW outfalls	Water quality upstream and downstream of outfalls, flow rates	Industrial wastewater outfall reports	Surveillance	Monthly	Statistical limit of change,
How is industry impacting the water?	What is the impact of industrial activity on sediment quality? Where dot these sediments land?	Athabasca River, Muskeg River, Firebag River.	Sediment quality		Surveillance	Yearly	Statistical limit of change, Indigenous knowledge
Are you able to navigate and access the land as you used to?	What is the impact of industrial activity on water quantity?	Throughout	Hydrometric data Indigenous knowledge		Surveillance	Weekly during low-flow/hunting season (fall) Yearly for interviews	Statistical measures of change, Indigenous knowledge
Why is muskeg drying?	Is there a change in muskeg hydrology, and is this related to oil sands development?	Throughout	Muskeg water levels, climate data, changes in local hydrology	Climate data	Focused study	Once	Statistical or IK finding of change in muskeg hydrology driven by oil

Cultural Component/ Concern	Key Question	Locations	Measurement	Outside Data Source	Monitoring Tier	Suggested Frequency	Limit of Change
							sands stressors.
How is industrial development impacting land-user's experience while harvesting resources on wetlands, lakes and rivers.	How are water quality and quantity changes impacting land users' experiences?	Mineable and throughout	Qualitative interviews and surveys to determine who industrial development is impacting people's use of the land.		Focused study to establish a baseline followed by surveillance to monitor change over time.	Yearly/seasonally	Indigenous knowledge

Table 7. Key questions for Terrestrial Biodiversity

Cultural Component/ Concern	Key Question	Locations	Measurement	Outside Data Source	Monitoring Tier	Suggested Frequency	Limit of Change
Do community members have access to culturally significant plants and animals?	Are there changes in wildlife populations? (key species)	Indigenous land use areas and community owned RFMAs, within 100km of population centres At meaningful scale (WMU, trapline)	Abundance Indigenous knowledge		Surveillance		Statistical limit of change Indigenous knowledge
Do community members have access to culturally significant plants and animals?	Are country foods safe to eat? (key species)	land use areas and community owned RFMAs, within 100km of population centres At meaningful scale (WMU, trapline)	Levels of COPCs, nutrients, Indigenous knowledge		Surveillance		Comparison against guidelines protective of human health Indigenous knowledge
Do community members have access to culturally significant plants and animals?	Are medicines available and safe to use?	land use areas and community owned RFMAs within 100km of population centres	Levels of COPCs, nutrients, Indigenous knowledge		Surveillance		Comparison against guidelines protective of human health Indigenous knowledge

Cultural Component/ Concern	Key Question	Locations	Measurement	Outside Data Source	Monitoring Tier	Suggested Frequency	Limit of Change
		At meaningful scale (WMU, trapline)					
Is industrial development impacting wildlife?	Are there changes in wildlife habitat? (key species)	Throughout, at meaningful scale (WMU, trapline)	Habitat suitability Human footprint Indigenous knowledge		Surveillance		Statistical limits of change Indigenous knowledge

Cultural Component/ Concern	Key Question	Locations	Measurement	Outside Data Source	Monitoring Tier	Suggested Frequency	Limit of Change
Is industrial development impacting wildlife?	Are there changes in wildlife populations? (key species)	Throughout, at meaningful scale (WMU, trapline)	Human footprint Wildlife populations Indigenous knowledge		Surveillance		Statistical limits of change Indigenous knowledge
What is the impact of industry on the landscape?	Is industrial development increasing disturbance?	Throughout	Human footprint		Surveillance	Yearly	Statistical limits of change Indigenous knowledge
Is industrial development affecting people, their relationship with the land, or ability to exercise their Rights?	Have there been changes in noise, access or light?	Throughout At scale relevant to Indigenous communities (WMU, traplines)	Locations of barriers to access, light pollution and noise pollution mapping		Focused study to establish methodology		Statistical limits of change Indigenous knowledge

Cultural Component/ Concern	Key Question	Locations	Measurement	Outside Data Source	Monitoring Tier	Suggested Frequency	Limit of Change
Do community members have access to culturally significant plants and animals?	Is linear disturbance impacting the ability to hunt?	Throughout, At scale relevant to Indigenous communities (WMU, traplines)	Noise, access, competition from non-Indigenous hunters		Surveillance		Statistical limits of change Indigenous knowledge
Is industrial development impacting wildlife?	Are mitigation attempts/ proposed wildlife zones impacting resources?	Throughout	Wildlife population		Investigation of Solutions		Statistical limits of change Indigenous knowledge
Why are birch trees dying?	Is the health of birch trees changing, and is this related to oil sands development?	Throughout	Tree and forest health		Focused study	Once	Statistical or IK finding of change in birch tree health driven by oil sands stressors.
Why are freshwater clams no longer found?	Are there changes in freshwater clam populations or health, and is this related to oil sands development?	Throughout, with losses noted at Athabasca River, Clearwater River	Populations of clams, community health		Focused study	Once	Statistical or IK finding of change in clam population health driven by oil sands stressors.

Cultural Component/ Concern	Key Question	Locations	Measurement	Outside Data Source	Monitoring Tier	Suggested Frequency	Limit of Change
How is industrial development impacting land-user's experience while harvesting resources on the land?	How is disturbance, noise, and changes in wildlife populations changing land-users' experience?	Mineable and throughout	Qualitative interviews and surveys to determine who industrial development is impacting people's use of the land.		Focused study to establish a baseline followed by surveillance to monitor change over time.	Yearly/seasonally	Indigenous knowledge

6.4 Considerations for Indigenous Key Questions

Including Indigenous perspectives and addressing Indigenous key questions is difficult to do within a Western, colonial management system. While scientists may approach Indigenous communities and consider the collection of IK with the best of intentions, it can be ethically thorny to do so if IK is being used to inform land management based on Western goals and a Western land management paradigm that sidelines Indigenous peoples and prioritizes resource extraction. As stated by Max Libroiron, Director of the Civic Laboratory for Environmental Action Research (CLEAR), Memorial University:

> *A lot of research is colonial... Colonialism is not just about taking Land, though it certainly includes taking Land. Yellowknives Dene political scientist Glen Coulthard argues that colonialism is a way to describe relations characterized by domination that keeps land available for settler goals, that gives settlers "ongoing access to land as resource" (Coulthard 2014). These relations include the type of knowledge that is valued (like Western science), the type of knowledge that is extracted for that value (like Indigenous knowledge), the type of relationships with Land and the environment that are privileged (like resource management).*
>
> - *(Libroiron, 2017)*

Key to ethical inclusion of Indigenous peoples in monitoring is making sure that it is focused on Indigenous values and information needs, and that Indigenous people have a role in directing the process. Importantly, inclusion should empower communities and support sacred obligations to the land, not simply fulfill the goals of Western land management. Communities should help direct all steps, from study design, through data collection, to interpretation and reporting. Most importantly, interpretation of IK metrics with respect to potential impacts to cultural activities and Rights should be left to the communities and their decision-makers.

Indigenous people conduct environmental monitoring through a variety of mechanisms. Communities that drive their own program may list 'enacting Indigenous governance,' as a monitoring objective and those programs that have strong Indigenous participation are more likely to lead to positive management outcomes. Other monitoring goals include empowering Indigenous members to meaningfully participate in monitoring and management (Thompson et al., 2020). Inclusion of Indigenous knowledge in the management of wildlife in the Canadian North was shown to improve management outcomes, as Indigenous monitoring can 'improve the detection of emerging trends and the understanding of changes in wildlife health and ecology' (Peacock et al., 2020)

In the OSMP, this is difficult as the program has no management mandate. In fact, though the program is required to morph into an adaptive monitoring program as per OC direction, there is thus far no mechanism to support "investigations of solutions," a key component of adaptive monitoring that links to management (Arciszewski et al., 2017; Likens & Lindenmayer, 2018; Munkittrick et al., 2019). One thing that the OSMP can do however, is to determine what key questions are most likely to be sensitive to oil sands impacts and will inform management and policy decisions, ensuring that these are monitored and reported in a timely manner.

Determining whether questions are informing management or decision-making means identifying the knowledge end users. For the IIP Project, we focused on Indigenous communities as knowledge end users. Communities' decisions include determining whether community members can go out on the land, whether the landscape and cultural resources are safe and healthy, whether members safely and easily conduct cultural activities, and how the community interacts with the regulatory system (see Knowledge Translation Plan.) Framing the key questions as we have is intended to empower Indigenous peoples within this context while also recognizing that this is a long way from truly improving Indigenous stewardship of their lands and sustainability of s. 35 Rights and culture.

Another tension in addressing Indigenous key questions is the extent to which the OSMP is assumed to assess impacts to Rights and culture. Rights Impact Assessments (Impact Assessment Agency of Canada, n.d.) and Cultural Impact Assessments (McKenzie Valley Review Board, 2009) have specific methodologies that are outside the scope of the OSMP. More importantly, the act of determining whether an environmental change impacts a Nation's or community's Rights is the responsibility and jurisdiction of the Nation or community, not the OSMP. Thus, the OSMP should provide monitoring results that inform these assessments but should not be the arbiter of whether those impacts constitute an impact to a right.

A final tension is how to choose indicators. Ideally, the initial stages of the program would be used to inform the experimental design and selection of indicators. After completion of the gap analysis and determination of key questions, the IIP will move towards evaluating existing monitoring data to identify indicators with the most power to address Indigenous key questions at appropriate temporal and spatial scales. This may alter the locations and reporting frequencies currently recommended in tables 5-7.

Indicator selection is extremely difficult. On the one hand, Indigenous community members have identified several culturally important species. When the question associated with them is "are there sufficient safe resources of [identified species]" it is reasonable and appropriate to monitor them for their own sake. However, many of these species are endangered or rare (yellow rail, caribou, clams) and notoriously difficult to monitor (Maxwell & Jennings, 2005; Nielsen et al., 2009), and monitoring all of them risks splitting resources and focus until nothing is monitored well (Likens & Lindenmayer, 2018; Lindenmayer et al., 2022; Lindenmayer & Likens, 2010). If the question associated with any of these species is "is oil sands development (disturbance, deposition, seepage) having an effect on the receiving environment?" then choosing an indicator becomes extremely difficult (Likens & Lindenmayer, 2018; Munkittrick, 2000). When species or taxonomic groups are chosen as indicators, it is rarely defined what they are indicators of (Lindenmayer & Likens, 2010). Combined with questions about whether a particular indicator is specific to a stressor, and whether it has the power to detect change, using species or taxa as an indicator of change requires significant thought and analysis.

Finally, careful thought must be given to monitoring socio-cultural indicators. Asking people about their experience is inherently subjective, with one community member or community's experience on the landscape being "acceptable" while another's experience, for a multitude of reasons, might be "unacceptable." Despite this limitation, people are part of the environment, and their Rights are experienced on the land. To remove the monitoring the impact of oil sands development on those experiences is to remove the people from the landscape – a final act of colonial displacement. As

such, it is vitally important to monitor Indigenous land-users' qualitative experiences and to ensure that those experiences are given due consideration when decisions regarding current and future industrial development are made. The ICBMAC social science work and ongoing development of Indigenous limits of change may help inform discussions on how best to address socio-cultural indicators.

There is a balance between choosing indicators that are related to an effect (i.e., sensitive to nitrogen deposition), that indicate a cultural value or have inherent value (bog cranberry, which is sensitive to nitrogen deposition (Wieder et al., 2019), or that indicate a stressor (concentration of nitrogen species in rain or wetlands porewater.) Choosing indicators that meet all three of these objectives involves additional community engagement and guidance to prioritize and choose culturally relevant indicators that are sensitive, determine the statistical power to detect effects, identify pathways-based indicators to both detect change and their specificity to specific stressors, and identify gaps in our understanding of stressor-effect pathways. This will be the work of future years.

7. Conclusion

The Indigenous Nations and communities of the Wood Buffalo Indigenous Sub-Caucus undertook this work to improve their input into core monitoring of the OSMP and to ensure that the core monitoring is informed by IK and addresses Indigenous key questions. Other Indigenous communities and Nations of the OSMP also require the opportunity to inform the program of their key questions, to better ensure the representation of Indigenous participants in OSMP. This report, along with input from the other communities and Nations, can form the basis of attempts to integrate Indigenous perspectives and needs into the OSMP core monitoring.

Indigenous Nations and communities clearly expressed the need for their questions to be clearly addressed through the program. The clarity of key questions is of the utmost importance. The existing questions of the OSMP vary from theme to theme, with some being more high level than others. If the program agreed to a suite of key questions that meet the needs of Rights-holders and stakeholders, it would greatly assist the development of a monitoring framework that can move the program towards a highly integrated, effective and efficient monitoring program.

To understand the key questions, it's important to understand the needs of decision-makers who rely upon these data. In this IIP Project report, and the associated Knowledge Translation Plan, we focused on the information needs of Indigenous decision makers. However, we recommend that the program undergo a similar exercise with industry, government and regulatory participants to understand their information needs. The WBISC members clearly expressed that oil sands monitoring not just document changes in the environment but contribute towards timely management. Until we have clear linkages to management and regulatory policy, this cannot be fulfilled.

Finally, it is critically important that the program gain a better understanding of how environmental changes impact Indigenous community members' experiences while on the land. Community members expressed a great deal of concern, loss, grief and fear when discussing the changes they have seen because of oil sands development. Community members have travelled to familiar sites to find them destroyed and found themselves lost. Odours and noise, lost access, and decline of

resources have all been experienced. These experiences and the underlying environmental changes causing them have yet to be systematically documented by the OSMP or addressed through management. The OSMP needs to work with communities to understand these impacts, otherwise there is a risk that the results from core monitoring, instead of informing or supporting Indigenous participants, contradict or downplay their experiences. True two-eyed seeing requires not only including Indigenous knowledge in the OSMP but includes Indigenous people in the design and interpretation of monitoring, and most importantly, defining what monitoring is intended to answer and how.

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