Joint Canada | Alberta Implementation Plan for Oil Sands Monitoring

Canada

Government of Alberta

Contents

Joint Canada-Alberta
Implementation Plan for Oil Sands Monitoring

The oil sands are a strategic natural resource and a key driver of economic development, and their rapid expansion has led to a need for a more comprehensive understanding of their potential cumulative environmental impacts. A strengthened scientific understanding of these impacts can help guide effective and responsible environmental management of this valuable resource. The Governments of Canada and Alberta are committed to working together to ensure that future development of the oil sands takes place in an environmentally sustainable manner.

It is important to recognize that considerable monitoring work is already taking place in the oil sands through the efforts of the Governments of Alberta and Canada as well as industry. This work provides a solid foundation on which to build, but there remains a need for a scientifically credible, integrated approach to environmental monitoring, including an improved understanding of how the different types of impacts – on air, water, land, and biodiversity - affect one another. An enhanced monitoring system will provide information on the state of the air, water, land and biodiversity, ultimately supporting the responsible development of the resource.

Following extensive discussions between the Governments of Canada and Alberta, a *Joint Canada-Alberta Implementation Plan for Oil Sands Monitoring* ("the Implementation Plan") has been developed for monitoring in the oil sands area. The Implementation Plan builds on a foundation of monitoring that is already in place, and is intended to enhance existing monitoring activities. It reflects the *Integrated Monitoring Plan for the Oil Sands* released by Environment Canada on July 21, 2011, and will be consistent with the Government of Alberta's plans for a province-wide environmental monitoring system, including the oil sands region. Both orders of government are committed to building an integrated monitoring program and commit to working together to implement this program.

The Implementation Plan describes a phased implementation with monitoring activities over the next three years. The result will be an improved characterization of the state of the environment in the oil sands area and an enhanced understanding of cumulative effects and environmental change, including future impacts arising from multiple stressors – which will become more important to understand as development continues.

Objectives

The purpose of the joint implementation plan is to describe how the Governments of Alberta and Canada will put in place a world class monitoring program for the oil sands to provide assurance of environmentally responsible development of the resource.

The Plan has a number of objectives:

- Support sound decision-making by governments as well as stakeholders.;
- Ensure transparency through accessible, comparable and quality-assured data;
- Enhance science-based monitoring for improved characterization of the state of the environment and collect the information necessary to understand cumulative effects;
- Improve analysis of existing monitoring data to develop a better understanding of historical baselines and changes, and;
- Reflect the trans-boundary nature of the issue and promote collaboration with the Governments of Saskatchewan and the Northwest Territories.

Approach

The Implementation Plan outlines how the Governments of Alberta and Canada will work together as partners to implement a world class monitoring program for the oil sands that integrates air, water, land and biodiversity elements.

The approach to implementation is both phased and adaptive. Monitoring activities will be phased in over the next three years to ensure installation of necessary infrastructure, incremental enhancement of activities and appropriate integration with existing monitoring activities in the region. The approach is also adaptive to ensure governments are responsive to the priorities that emerge through new information and knowledge, and input from key stakeholders. Governments will work on an ongoing basis with stakeholders on implementation and adaptation of the Plan.

The monitoring commitments contained in the Implementation Plan are intended to further our understanding of current conditions and changes that have already occurred, improve characterization of the state of the environment on an ongoing basis and provide information to understand what is contributing to the cumulative effects in the oil sands area. The monitoring commitments contained in the Implementation Plan are in addition to compliance monitoring requirements already outlined in regulatory approvals.

Funding

The Governments of Canada and Alberta currently commit resources to environmental monitoring in the oil sands area, as does the oil sands industry. This Implementation Plan represents a significant enhancement in monitoring in the area relative to what is currently done and consequently requires additional financial resources. The purpose of the integrated monitoring plan is to provide assurance of environmentally-responsible production, and the importance of doing this is driven in part by the ongoing expansion of the oil sands industry. As a result, it is anticipated that additional costs would be funded by industry. The Governments of Canada and Alberta will work with the oil sands industry to develop a sustainable, ongoing funding arrangement to support the Plan. To ensure funding transparency, both governments will share full costing information with industry.

In 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. It is important to note that the incremental costs to industry would be less than $50 million per year, as they already contribute significantly to monitoring of cumulative effects in the oil sands region. 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.

Accountable Administration and Review

The Implementation Plan will be managed in a way that delivers integrated, credible and transparent environmental monitoring. Oil sands monitoring will be integrated into the broader provincial and federal monitoring systems. The approach being taken is consistent with the planned developments in Alberta's province-wide monitoring system, including commitments on land use planning and cumulative effects management.

Under this Plan, the current constellation of monitoring arrangements will be rationalized and integrated into a single, government-led program under the joint management of the two governments. This program will be co-led by the Assistant Deputy Minister of Science and Technology, Environment Canada and the Assistant Deputy Minister of Science and Monitoring, Alberta Environment and Water. In carrying out their responsibilities, they will work with other government departments responsible for terrestrial and aquatic biodiversity, lands, forests and fish habitat.

The two government co-leads will directly manage all aspects of the monitoring program, including the oil sands monitoring activities currently managed by independent organizations. The government co-leads will consolidate the relevant monitoring activities of these

organizations, and integrate them into the new government-led program. With this change, the challenges created by multiple independent monitoring programs will be resolved. The co-leads will work with these organizations, with independent scientists and industry in developing the change management plans for these organizations needed to deliver on this fundamental transformation.

Early in the process, the two governments will engage with industry, independent scientists, Aboriginal Peoples, and other stakeholders on the content of the Implementation Plan and on the appropriate mechanisms to incorporate the advice of industry, independent scientists, Aboriginal Peoples, and other stakeholders on an ongoing basis.

To maximize transparency, an annual report on the status of implementation will be made public. In addition, the monitoring system will undergo external expert peer review after year three, and at five-year intervals thereafter, to ensure that scientific integrity is maintained. Each external peer review will be accompanied by an internal review of the scope, the operations and the cost of the monitoring program. This review, carried out jointly by the two governments, will ensure the monitoring program remains as cost effective and efficient as possible.

Adaptive Management

Monitoring in the oil sands area will be managed in an adaptive manner. A detailed plan is set out for the first year, and, reflecting the intentions of the Integrated Monitoring Plan of July, 2011, establishes a clear approach for years 2 and 3. Consistent with adaptive management, plans and activities will evolve to reflect experience gained from the initial work, as well as discussions with industry and other stakeholders. Details will be refined and adjusted based on this adaptive approach.

The monitoring program will be evaluated at regular intervals and will be improved as scientific and technical knowledge evolves and as circumstances change. In addition to maintaining a certain degree of long-term monitoring capacity, additional monitoring can and will be added if important changes are detected at a given site or region, or alternatively, reduced where repeated sampling has shown no significant changes are occurring, no new activity is planned, and monitoring in the area is not needed for control purposes.

The adaptive management approach will also help to ensure that the program is implemented in as cost-effective a manner as possible.

Transparent and Accessible Results

A strong commitment to transparency and accessibility as core scientific principles is the foundation of the integrated monitoring program.

To ensure consistency and the ability to integrate data, standardized quality assurance and quality control (QA/QC) procedures and standard operating protocols (SOPs) will be developed. All parties conducting environmental monitoring under the Implementation Plan will utilize these procedures and protocols. If they do not already exist, they will be developed for areas including sample collection, analysis, data archiving, and reporting.

The Implementation Plan will produce a data management framework that will allow information to be uploaded, organized and publicly-available in a timely, standardized, coordinated manner such that it is transparent and freely accessible. The framework will enable concerned parties to conduct their own analysis and draw their own conclusions from the integrated monitoring program.

Combined with the periodic external peer review outlined above, this data management framework will ensure the monitoring program sustains the transparency needed to support the on-going production of rigorous, comprehensive and scientifically-credible information on the human disturbance footprint of the industry.

Implementation of the Plan Component Areas

The oil sands operations could have environmental impacts of two distinct natures – release of substances that are potentially harmful to the environment (referred to as contaminants) and direct disruption of the landscape. Both of these impacts need to be considered in an integrated fashion as their effects can be cumulative.

Contaminants emitted from oil sands development and operations can impact the environment both close to and distant from the point of emission. Contaminants emitted from oil sands activities, such as industrial stacks, open mine faces, tailings ponds, exhaust from large trucks and the burning of brush to clear land, may move away from the source through the movement of air masses or water currents. These contaminants undergo chemical reactions in the environment as they are transported away from the sources. Finally they are deposited through rain, snow or dry deposition to water and land surfaces, potentially impacting ecosystems as well as people in populated areas.

Both mineable oil sands and *in-situ* developments could affect fish and wildlife through habitat loss, or landscape fragmentation. Beyond clearing of habitat, there is disturbance to habitat through factors such as altered water regimes arising from disturbance to hydrological systems.

A key aspect of this monitoring program is its holistic nature, where the results are interpreted and linked across environmental media to relate emissions and habitat disturbance to cumulative, long-term and acute effects on receptors, both ecosystems and human health. The Implementation Plan will be delivered based on the principle of inclusion of Traditional Ecological Knowledge, and the training and involvement of members of local communities in the actual monitoring activities.

The Implementation Plan addresses the following components:

- Air quality
- Acid sensitive lakes and accumulated aerial deposition
- Water quantity/quality
- Aquatic ecosystem health – Fish status and health, benthic invertebrates and other aquatic biota
- Wildlife toxicology
- Terrestrial biodiversity and habitat disturbance
- Data management

Figures 1a and 1b illustrate the existing monitoring in the oil sands area in 2010-2011, as well as proposed monitoring in year 2015. The figures illustrate the integrated nature of the planned monitoring, where monitoring across multiple media at near proximity will inform how the impacts on air, water, land and biodiversity are inter-related and will allow for the assessment of potential cumulative ecosystem effects outside of the immediate oil sands area.

Brief descriptions of each of the components and some general examples of the types of activities that will be undertaken are outlined in the following sections. Details of how the Implementation Plan would roll out over three years are provided in the Appendix.

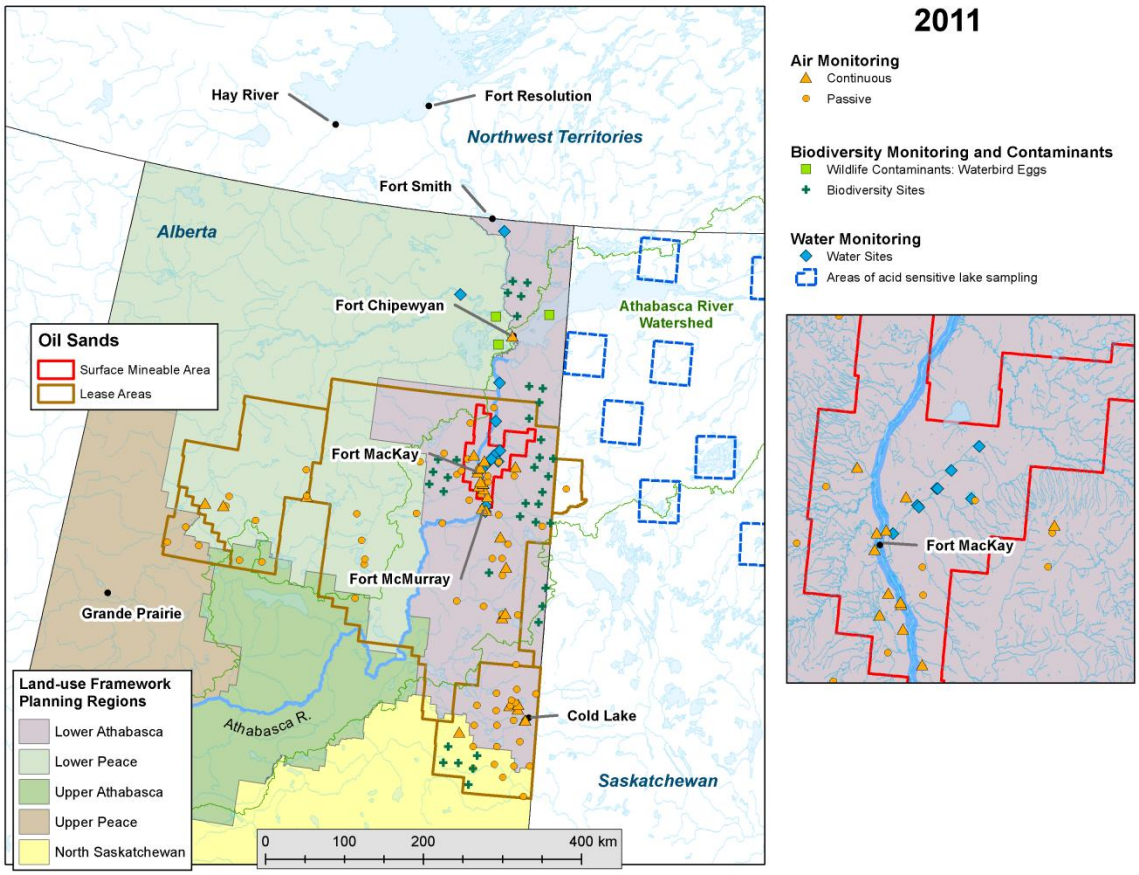

Figure 1a. Existing monitoring during the 2010-11 baseline year

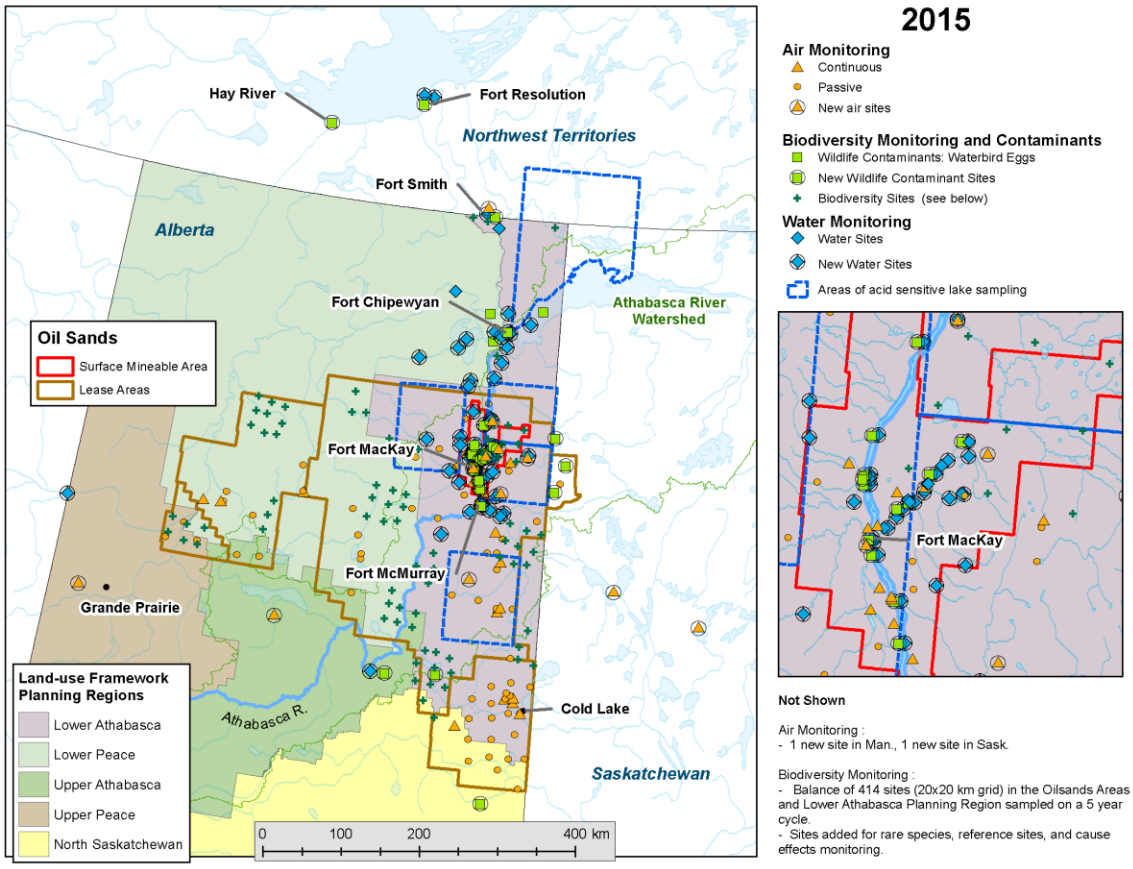

Figure 1b. Proposed monitoring by 2015

Air quality

There are many sources of air contaminant emissions from oil sands developments, including industrial smokestacks, tailings ponds, transportation, and dust from mining operations. In general, these emissions are projected to increase into the future with increasing industrial development. Current air monitoring efforts in the region have been undertaken primarily for compliance purposes, in support of provincial regulations. Significant questions remain regarding the emissions from point and non-point sources, the chemical transformation of these emissions in the atmosphere, their long-range transport and their effects on the ecosystem and human health.

The monitoring of air quality will address the fate of contaminants from the point of emission to the point of deposition into aquatic and terrestrial ecosystems. Air quality monitoring includes enhanced effort to determine emission from industrial stacks, mobile sources and area sources (e.g. tailings ponds). The use of satellite images, remote sensing and air quality models to integrate the data is incorporated into the overall monitoring activities to build a comprehensive inventory of emissions as well as to assess current status of contaminants in the area (e.g. concentrations, trends, transport pathways), especially in areas where there is limited in-situ monitoring. Ground-level ambient monitoring consists of a phase-in of additional monitoring sites that supplement existing monitoring.

When implemented, the new sites will span a large spatial range, from upwind sites to long-range transboundary sites; this broad spatial range will allow a greater understanding of the distinction between natural, point and non-point sources and the long-range effects of air emissions downwind, such as on acid sensitive lakes and terrestrial vegetation. The new stations will be phased in as short-term monitoring studies are conducted to assess and guide the implementation of the new monitoring sites in locations best suited to address outstanding knowledge gaps.

The implementation of a network of air and precipitation concentration monitoring sites providing data from which wet and dry deposition over large spatial scales will be determined through application of air quality modeling is a focal point of integration across air and water quality and has direct links to effects on aquatic biota.

Acid Sensitive Lakes and Accumulated Aerial Deposition

Air contaminants released by industrial activities into the atmosphere can be carried over a relatively wide area and deposited on to the landscape and into lakes and rivers through rain, snow and dry deposition. The monitoring of the snowpack and acid sensitive lakes is designed to assess the linkages between atmospheric deposition and impacts on water quality. Rivers

and lakes downwind of the oil sands region may be susceptible to contaminants arising from oil sands development, including degradation by nitrogen and sulphur contaminants in acid sensitive systems.

Aerial deposition of emissions, including to the Lower Athabasca River and to downwind acid sensitive lakes, is a key area in which integration of air and water quality and water quantity sampling at appropriate spatial and temporal scales will occur. Lake waters and accumulated snowpack will be sampled. Data will be analyzed to determine, where possible, baseline conditions to which changes in atmospheric deposition as well as chemical and biological changes can be detected and explained.

Water Quantity/Quality

The quality and quantity of the water in the Athabasca River and throughout the oil sands region has been a key concern due to the range of contaminants produced by industrial activities that could end up in lakes and rivers in the region. While there are currently efforts undertaken by government, academic and industry groups to acquire some water monitoring data, the sampling approach is poorly designed for the purposes of providing an integrated understanding of the impacts of the oil sands industry on the aquatic environment. Water monitoring will be done through a comprehensive and integrated approach as described in the *Integrated Monitoring Plan for the Oil Sands*, released in July, 2011, that quantifies and assesses the sources, transport, loadings, fate, and types of oil sands contaminants in the Athabasca River system and effects on key aquatic ecosystem components (both within the oil sands development area and in downstream receiving environments) that are measures of ecosystem health and integrity (fish, invertebrates).

A mass-balance approach was used to define the network of sites to be monitored for key water quality, hydrometric and aerial deposition variables. An expansion of the current water quality and quantity monitoring sites will be undertaken. This provides a more systematic and comprehensive quantification and modeling of the sources, transport, flux, and fate of materials and contaminants entering the watersheds. By necessity this also requires a more comprehensive network of hydrometric and suspended and bed sediment measurements, better quantification of historical background conditions, and improved estimates of atmospheric contributions. The expanded water quantity/quality program will increase the amount of site-specific, reach-specific and regional-scale information, and the spatial and temporal status and trends in contaminant loadings.

Relative to the current level of monitoring efforts conducted by the Governments of Alberta and Canada as well as others in 2011-12 (see Figure 2), the monitoring program will significantly increase its overall scope and coverage over a number of years (see Figure 3). In addition,

supportive technical workshops will be necessary to address knowledge and analytical gaps that are core to the successful implementation of the plan.

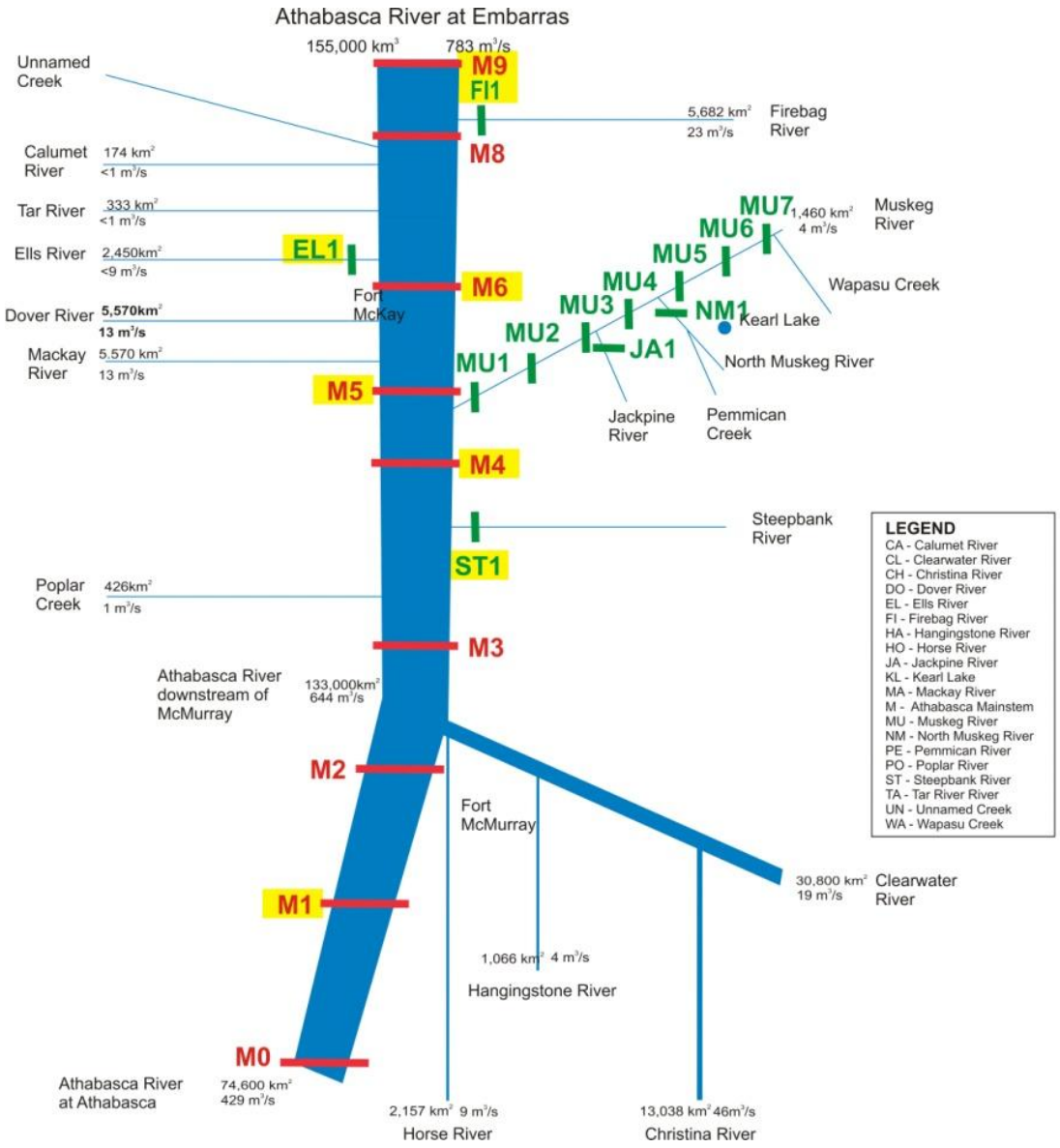

Figure 2. Schematic representation of the key sampling locations on the Lower Athabasca mainstem, its tributaries, and downstream receiving environments in 2011-12.

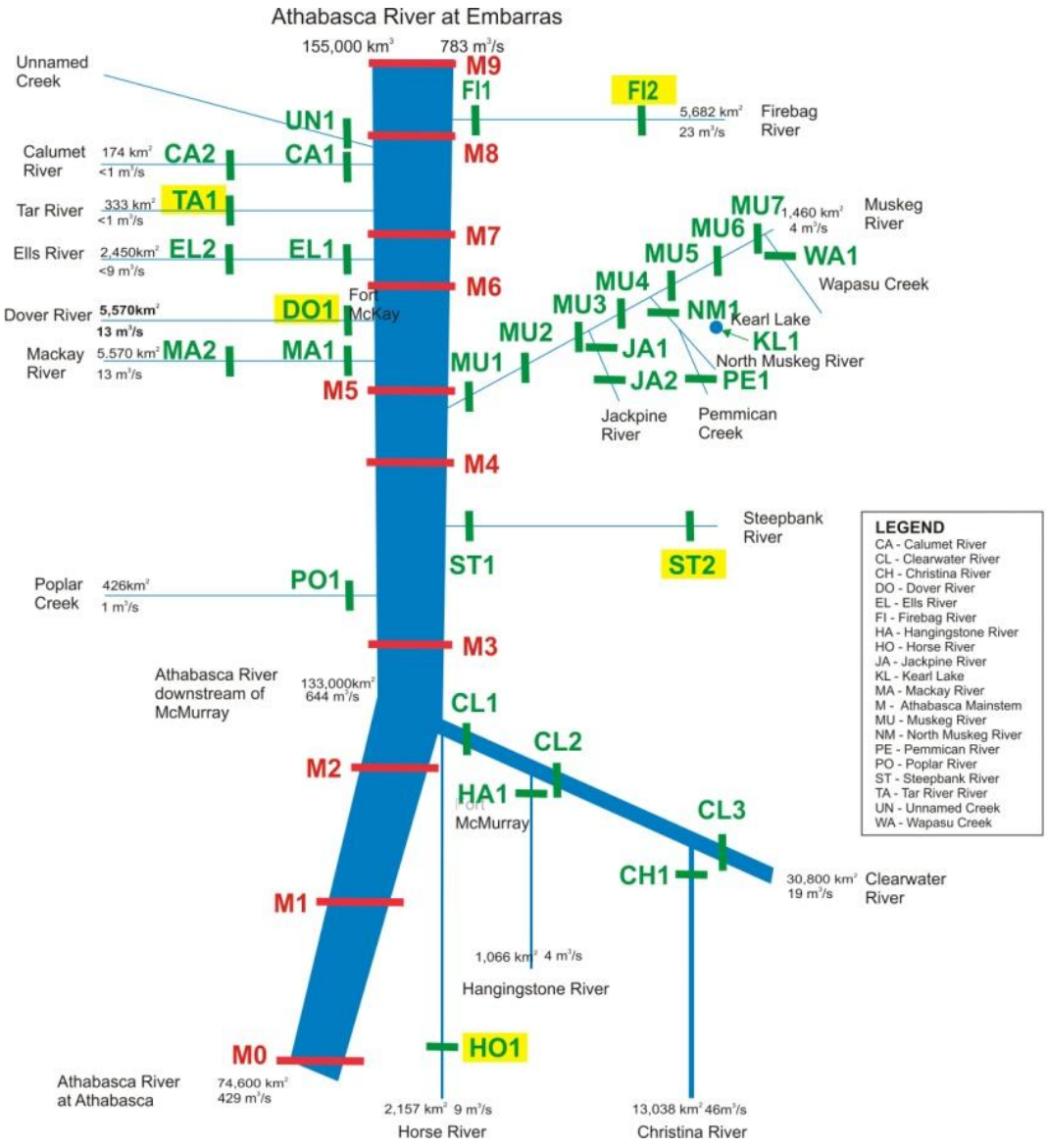

Figure 3. Schematic representation of the key sampling locations on the Lower Athabasca mainstem, its tributaries, and downstream receiving environments as anticipated by 2015, as described in the Integrated Monitoring Plan for the Oil Sands released by Environment Canada, July 2011.

Aquatic ecosystem health – Fish Status and Health, Benthic Invertebrates and other Aquatic Biota

Along with concerns about water quality in the Lower Athabasca and its tributaries, there are concerns about the health of the aquatic ecosystems. There is a risk that contaminants from industrial activities entering rivers and lakes could have an adverse effect on the overall healthy functioning of the aquatic ecosystems. Efforts will focus on monitoring a set of fish, invertebrates and other species that are indicators of overall aquatic ecosystem health.

This will be done through establishing

- the current status of fish population health and benthic communities structure and function in the Lower Athabasca region;
- the baseline against which future change can be assessed;
- the differences among reference and potentially impacted sites;
- the health status of fish populations in high use areas;
- whether the incidence of fish abnormalities is elevated or changing;
- and whether contaminant concentrations in fish are increasing or decreasing downstream of oil sands development.

Wildlife toxicology

Wildlife may be exposed to oil sands-generated compounds primarily via the consumption of contaminated food and water. Elevated exposures may result in health impairments observable at the population level. The purpose of this program is to assess the health of sensitive wildlife species that may be exposed to oil sands-generated contaminants, and to make the results of these assessments available to decision makers.

The initial focus will be on the identification of a variety of wildlife indicators (including birds, mammals, amphibians and plants) to select species most suitable for monitoring contaminant exposure and impacts. The monitoring of a variety of wildlife classes occupying different positions along the food web will allow the extrapolation of data and trends observed in a select group of wildlife indicators to develop a broader understanding of the impacts of oil sands contaminants on terrestrial biodiversity and ecological integrity in the area. Data collected will include measurements of oil sands-related contaminants of concern in wildlife tissues at various locations (e.g. PAHs, mercury, arsenic, etc.). The data will also be assessed to

identify wildlife populations that may be at risk of health impairment by comparing to published threshold levels for contaminant effects.

Terrestrial Biodiversity and Habitat Disturbance

A key consideration related to the development of the oil sands is that of habitat disturbance. Development of the oil sands alters landscapes and results in the degradation or loss of habitat. It also impacts conservation efforts.

Current monitoring activities are providing good information-however, geographic coverage will be expanded and the monitoring sensitivity will be increased, particularly for species at risk. The additional monitoring will provide an improved understanding of the status and trends of species occurring in the oil sands area and the cumulative and individual effects of land disturbance by oil sands on terrestrial biodiversity.

Further, the monitoring is designed to identify cause-effect relationships between stressors and targets. The intent of the program is to make the necessary information available to decision makers to inform land-use planning, environmental assessment, conservation and recovery planning. It can also be used to assess the efficacy of mitigation efforts. The cumulative effects assessment will be a key component of managing biodiversity through Alberta's regional planning process.

The vast area, the diversity of habitat types and the great variety of species that inhabit and interact throughout the area represents significant challenges to implementing a comprehensive biodiversity monitoring program.

Data Management

In addition to increased monitoring efforts, both governments are working cooperatively to develop and implement an integrated data management system. A new Oil Sands Data Management Network (OS_DMN) will allow open and transparent public access on-line to credible, comprehensive oil sands environmental monitoring data and supporting information. Network partners will be responsible for management of data and will adhere to a framework outlining a core set of data management policies. This will ensure that data is managed consistently across all partners. A phased implementation will be required to address the full scope of the data to be managed.

Summary

The end result of this Implementation Plan will be a world-leading program, fully integrated into national and provincial monitoring systems, providing reliable data on environmental conditions in the oil sands area. An integrated approach to air, water, land and biodiversity monitoring will yield compelling information on the state of the environment and environmental performance.

APPENDIX: Details of Implementation Activities by Component

Table 1 – Air Quality Implementation Plan Activities

Element	2011-2012 (Current year activities)	2012-2013	2013 to 2015
Ambient Air Quality	Ambient Air Monitoring Existing airshed monitoring Remote sensing and modelling: Develop remote sensing analysis tools. Build on existing tools to develop high resolution modelling capacity for oils sands region to inform monitoring Focused studies Nitrogen and oxygen isotopic fingerprinting of particles and gases from non-oil sands sources	Ambient Air Monitoring Continuation and expansion of ambient monitoring network, consistent with the Integrated Monitoring Plan Fixed Platforms: Installation of 3 ecosystem sites downwind of oil sands region Enhanced measurements at a site in vicinity of sources Monitoring pollutant transformation: Seasonal campaign via mobile labs and/or aircraft Remote sensing and modelling: Use remote sensing to produce maps of sulphur dioxide and nitrogen dioxide ; use models to produce high-resolution air pollutant maps Focused studies Continued nitrogen and oxygen isotopic fingerprinting from non-oil sands sources	Ambient Air Monitoring Continuation and expansion of ambient monitoring network, consistent with the Integrated Monitoring Plan Fixed Platforms: Installation of 3 additional ecosystem, transformation and deposition sites in and around the oil sands area. Continuation of measurements at 4 existing sites. Development of oil sands upwind site Monitoring pollutant transformation: Continue seasonal studies on pollutant transformation Remote sensing and modelling: Use remote sensing to produce maps of additional pollutants ; use models to produce high-resolution air pollutant maps Focused studies Studies on odours, degraded visibility, tree rings and fingerprinting data from oil sands specific sources
Source Emissions Monitoring	Emissions inventories: Air emissions reported by industry to the province and federal government Emission inventory development and coordination	Emissions inventories: Compile all existing emissions databases. Continued emissions inventory development for modelling Initiate and validate methods to derive activity and topography data and emissions locations from satellite photos,	Emissions inventories: Identify gaps in emission inventories and begin to address information needs

Element	2011-2012 (Current year activities)	2012-2013	2013 to 2015
	Point Sources (stacks and fugitive): Provision of industry continuous emission monitoring data Determination of emissions factors for stack emissions Tailings Ponds: Flux measurements near tailings ponds. Special studies at 3 tailings ponds to characterize emissions Mobile and Area Sources: Obtaining emissions data for on-road trucks; providing emissions data for off-road mining vehicles Measuring emissions from heavy haulers while they are in operation	Point Sources (stacks and fugitive): Initiate process to request additional stack emissions parameters Obtain satellite-based emissions estimates of sulphur dioxide and nitrogen dioxide over the entire surface mining region Tailings Ponds: Continuation of intensive studies of tailings ponds including LIDAR technology Mobile and Area Sources: Study design and initial testing of on-road vehicle fleet Source characterization of dust from mines, roads, coke piles	Point Sources (stacks and fugitive): Obtain additional point source data to develop/validate emission factors Additional monitoring to address gaps in emissions inventories Tailings Ponds: Continuation of studies on tailings ponds emissions Mobile and Area Sources: On-board measurement on buses Development of emissions factors for heavy haulers
Deposition	Ecosystem Exposure Monitoring: 4 forest tower continuous sites; 20 passive sites in the boreal forest, deployment of VOC passive samplers with full chemical speciation analysis Forest critical loads: Measurements of nitrogen-containing pollutants to determine deposition to forests Enhanced Deposition: Measurement of polycyclic aromatic compounds and particulate metals at 3 sites. Special studies measuring and reporting on PACs and metals in ambient air and snow Deposition Modelling: Modelling in support of deposition monitoring and understanding ecosystem impacts of chemical deposition.	Ecosystem Exposure Monitoring: Measurement of pollutants in ecosystem settings to determine deposition and exposure. Link to wildlife monitoring in Table 3 below. Forest critical loads: Continuation of critical load studies. Measurements of forest soils Enhanced Deposition: Continue measurement of polycyclic aromatic compounds and particulate metals at 3 sites Deposition Modelling: Continuation of deposition modelling. Modelling to understand emission, transport and fate of air pollutants	Ecosystem Exposure Monitoring: Measurement of pollutants in ecosystem settings to determine deposition and exposure. Link to wildlife monitoring in Table 3 below. Measurement of dry deposition flux. Forest critical loads: Improve forest critical load and exceedance maps Enhanced Deposition: Continue measurement of polycyclic aromatic compounds and particulate metals at 3 sites. Add 2 additional sites. Deposition Modelling: Deposition modelling using most recent data.

Table 2 – Water Implementation Plan Activities

Element	FY 2011-2012 (Current year activities)	FY 2012-2013	FY 2013-15
Surface Water Quality / Surface Water Quantity/ Sediment	<u>Mainstem Water Quality</u> Initiate one site; one ongoing long-term site. Benthos/CABIN and fish work generate supporting water quality data at most mainstem sites. Under-ice water sampling at three sites. Under-ice sampling using passive samplers at one site. Continue to monitor at AEW Long-term River Network (LTRN) sites (five appear in the Integrated Monitoring Plan). Continue to monitor 25 sites (through RAMP) that appear in the Plan, at the frequency in RAMP's current program. <u>Tributary Water Quality</u> One site initiated. Benthos/CABIN and fish work to generate supporting WQ data – seven tributaries (Ells, Jackpine, MacKay, Steepbank, Firebag, Joslyn, Muskeg), representing 37 sites. Continue sampling for Muskeg River Framework. Implementing monthly sampling at mouths of Clearwater, Ells, Firebag, Steepbank. <u>Expanded Geographic Extent (PAD; Slave River; Lake Athabasca)</u> Passive samples: PAH's (Slave River) Under-ice water sampling (Peace, Slave Birch River sites)	<u>Mainstem Water Quality</u> Continue to monitor items identified in current (2011-12) year. Initiate quarterly sampling at three sites. Initiate detailed method comparison and quality management of field methods and data comparability studies between AEW and EC. Also review ongoing role for one AEW LTRN site. Conduct technical workshops with appropriate parties to address the technical/logistical details to operationalize the Implementation Plan. Align current RAMP program with this joint Implementation Plan, and reflecting the Integrated Monitoring Plan <u>Tributary Water Quality</u> Continue Benthos/CABIN and fish work supporting water quality. Add three additional monitoring sites on the tributaries, including the MacKay. <u>Expanded Geographic Extent (PAD; Slave River; Lake Athabasca)</u> Increase number of locations; establish sampling frequency.	<u>Mainstem Water Quality</u> Increase sampling frequency to monthly at specific sites; initiate sampling in the Peace Athabasca Delta (PAD). Continue and increase comparability studies and laboratory round-robin. Continue to implement items identified in year 1; Phase in monitoring of additional sites. <u>Tributary Water Quality</u> Continue Benthos/CABIN and fish work supporting water quality. Implementation of remaining upstream and headwater trib sites. <u>Expanded Geographic Extent (PAD; Slave River; Lake Athabasca)</u> Implementation of up to 10 additional sites

Element	FY 2011-2012 (Current year activities)	FY 2012-2013	FY 2013-15
	Under-ice passive samplers (Slave, Peace River sites) <u>Passive Sampler Program</u> 8 sites. <u>Groundwater Quality</u> Groundwater assessment proximate to Suncor Pond 1 (~80 sample stations) and Muskeg & Athabasca River proximate to Shell's Tailings Area (~20 sample stations) <u>Water Quantity</u> Mainstem: Core monitoring at 4 sites Begin planning for expansion of hydrometric network. Expanded Geographic Extent: Hydrometric sites on Birch, Slave Rivers; also in PAD and Peace River. Trib sites: Monitoring of tributaries occurs under Canada-Alberta Hydromet Agreement; and RAMP. <u>Sediment</u> Benthos/CABIN and fish work generate supporting sediment quality data – Mainstem: 8 sites; 7 tributaries, representing 37 sites. 5 sediment cores from small lakes within 50 km of the Kelly et al. AR6 site for paleo-analyses	<u>Event-based Sampling</u> Initiate sampling program sites and monitoring frequency. <u>Passive Sampler Program</u> Increase sampling frequency at existing sites. <u>Groundwater Quality</u> Continue monitoring program as per Baseline year <u>Water Quantity</u> Mainstem: Continue core monitoring (4 sites) Enhance current AEW water level sites. Undertake detailed planning and budgeting (locations, operating periods, manual measurements) for expansion of hydrometric network. Initiate validation of comparability of RAMP Climate & Hydrology Program methods. Trib sites and Expanded Geographic Extent: evaluate as part of detailed planning and budgeting exercise. <u>River Ice Monitoring</u> Establish initial sites and monitoring frequency. <u>Sediment</u> Benthos/CABIN and fish work generate supporting sediment quality data. Collect 5 more sediment cores from lakes for Paleo-analyses Initiate sediment sampling using historical WSC methods at one site.	<u>Event-based Sampling</u> Continue monitoring program as established. <u>Passive Sampler Program</u> Increase number of sites to full implementation and increase sampling frequency. <u>Groundwater Quality</u> Continue monitoring program as per Baseline year <u>Water Quantity</u> Mainstem: consider new hydromet station at a key location to be determined. Trib sites and Expanded Geographic Extent: Add additional tributary hydromet measurement coincident with water quality monitoring sites, as per the Integrated Monitoring Plan. <u>River Ice Monitoring</u> Implement up to 8 more sites on the Athabasca mainstem; increase monitoring frequency. <u>Sediment</u> Benthos/CABIN and fish work generate supporting sediment quality data. New mainstem hydromet station indicated to collect sediment samples. Continue mainstem historic-method sediment sampling. Expand sediment sampling at mainstem sites.

Element	FY 2011-2012 (Current year activities)	FY 2012-2013	FY 2013-15
		Initiate sediment sampling research/surveillance studies. Increase the number of sediment cores from small lakes. Process-based sediment monitoring in mainstem/ tribs: Initiate sampling program.	Full scope of sampling of sediment cores from small lakes implemented. Process-based sediment monitoring in mainstem/ tribs: Implement remaining sites
Benthic Invertebrates (inverts, algae & seston, water chemistry, sediment phys/chem.)	Mainstem Six sites Tributaries 30 sites in the Ells, Jackpine, McKay, and Steepbank, Firebag, Joslyn Rivers Continue to monitor through RAMP: ~15 sites Deltaic Ecosystem Health Biota/WQ/Sediments at 8 sites	Mainstem Implement up to 10 sites Tributaries Implement up to 6 additional sites Initiate detailed comparison of existing and proposed monitoring programs and integrate where appropriate for both mainstem and tributary sites. Deltaic Ecosystem Health Biota/WQ/Sediments continue at Base sites; increase sample frequency	Mainstem Continue all sites Tributaries Implement up to 30 additional sites, focusing on enhanced coverage of reference locations Deltaic Ecosystem Health Biota/WQ/Sediments: Complete implementation of all sites as per Plan at the increased sample frequency.
Snow / Wet Precipitation	135 snow sites in an asterisk shaped pattern centered around and within 50km of the Kelly et al. AR6 site 3 sites wet precip sites: Co-located with 3 WBEA sites	Continue to monitor items identified 2011-12 year In addition, expand coverage to all snow sites on mainstem, tributary and landscape locations. Wet precip sites co-located with 3 WBEA sites: continue.	All snow sites continue monitoring Wet precip sites co-located with 3 WBEA sites: ongoing.
Fish Health / Toxicology/ Contaminant	Wild Fish Health Mainstem: 5 sites Tributaries: 7 sites on 3 Tributaries: Steepbank, Firebag, Muskeg Wild Fish Communities / Spp. Diversity Mainstem – 17 sites currently monitored 3 times/yr Tributaries – 15 sites currently monitored sites once/yr. Fish Toxicology Tributaries - 6 sites Snow - 8 sites Ponds - 2 sites	Wild Fish Health Mainstem: Increase to 6 sites Tributaries: Increase to 8 sites Wild Fish Communities / Spp. Diversity Continue Mainstem and Tributary monitoring as per 2011/12. Align RAMP program with the program under the Integrated Monitoring Plan Fish Toxicology Tributaries – implement all sites Snow – maintain current sampling Ponds - ponds, seeps and groundwater to be determined	Wild Fish Health Mainstem: All sites fully implemented by Year 2 Tributaries: All sites fully implemented by Year 3 Wild Fish Communities / Spp. Diversity Mainstem – All sites fully implemented at existing frequency Tributaries – All sites fully implemented at existing frequency Fish Toxicology Tributaries - sampling program to continue Snow - cf snow sites Ponds - ponds, seeps and groundwater to be determined

Element	FY 2011-2012 (Current year activities)	FY 2012-2013	FY 2013-15
		Riverine In-situ Bioassays Establish sampling program as per the Integrated Monitoring Plan. Lake Health (Fish/Invertebrates) Establish sampling program as per the Integrated Monitoring Plan.	Riverine In-situ Bioassays Continue sampling program Lake Health (Fish/Invertebrates) Continue sampling program
Acid Sensitive Lakes	250 (as specified in the Integrated Monitoring Plan) sites Continue current monitoring of acid sensitive lakes.	More than 250 sites Continue to monitor lakes in RAMP program. Initiate assessment of existing lake data to support long-term lake monitoring Conduct an extensive survey of lakes in NE Alberta to identify additional lakes for long term acid deposition monitoring	300 sites or more Align work under RAMP with results from assessment and lake surveys Conduct additional tiered sampling of lake systems as informed by previous years' status and trends analyses.

Additional Research/Site-Specific Monitoring	2011-2012 (Current year activities)	2012-2013	2013-15
Representative Sub-basin Studies (REPS)	Under study	Analyses / integration of REP work in Muskeg River Basin: water, hydrology, sediments, groundwater, aerial deposition.	Examine other potential REP candidates; ongoing analyses/sampling.
Mainstem - paired buoys	Current capital acquisition.	Deploy buoys with multiple WQ, sediment, hydraulic instruments at two sites, open-water season.	Continue buoy deployment during open-water season. Add further instrumentation as feasible.

Table 3 – Wildlife Contaminants and Toxicology Monitoring Program Implementation Plan Activities

Element	2011-2012 (Current year activities)	2012-2013	2013-2015
Wild Bird Health and Contaminants	Colonial Waterbird Health and Contaminants Gulls and Terns: Nest locations determined Insectivorous Bird Health and Contaminants. Swallows: Nest locations determined.	Colonial Waterbird Health and Contaminants Gulls and Terns: Eggs collected at Rocky Point (WBNP), Mamawi Lake (WBNP) and Egg Island (Lake Athabasca) Insectivorous Bird Health and Contaminants. Swallows: Eggs collected N of Fort MacKay, S of Fort MacKay, S of Fort McMurray (reference)	Colonial Waterbird Health and Contaminants Gulls and Terns: Eggs collected at least at the following locations: Rocky Point (WBNP), Mamawi Lake (WBNP) and Egg Island (Lake Athabasca) Insectivorous Bird Health and Contaminants. Swallows: Eggs collected at least at the following locations: N of Fort MacKay, S of Fort MacKay S, N of Fort McMurray (reference)
Amphibian Health/ Toxicology/ Contaminants	Wild Amphibian Health and Contaminants Amphibian samples collected from ponds in the Fort McMurray area (7 ponds) Laboratory Exposures and Effects Assessing impacts of water quality on amphibians	Amphibian Health and Contaminants Amphibian samples collected from ponds in the Fort McMurray area and from ponds over an expanded geographical area at increasing distances from Fort McMurray Laboratory Exposures and Effects Assessing impacts of water quality on amphibians using pond water	Amphibian Health and Contaminants Amphibian samples collected from ponds in the Fort McMurray area and from ponds over an expanded geographical area at increasing distances from Fort McMurray with continued monitoring at 2 sites in NWT and various sites in Alberta (up to 40 ponds) Laboratory Exposures and Effects Assessing impacts of water quality on amphibians using pond water, snow melt and *in situ* exposures
Bird Health and Toxicology	Laboratory Exposure and Effects - Air Emissions Exposures of laboratory birds to VOCs and SO_2	Laboratory Exposure and Effects - Air Emissions Exposures of laboratory birds to VOCs and SO_2 Field Exposure and Effects - Air Emissions/PAHs Nest boxes installed radially around one processing plant and in a reference location	Laboratory Exposure and Effects - Air Emissions Exposures of laboratory birds to VOCs and SO_2 Field Exposure and Effects - Air Emissions/PAHs Nest boxes installed radially around three processing plants and in a reference location

Element	2011-2012 (Current year activities)	2012-2013	2013-2015
Wild Bird and Hunter/Trapper Harvested Wildlife Toxicology and Contaminants	Dead and Moribund Bird Contaminants and Toxicology Birds collected from tailings ponds near Fort McMurray (event-based, none submitted)	Dead and Moribund Bird Contaminants and Toxicology Birds collected from tailings ponds near Fort McMurray (event-based) Hunter/Trapper Harvested Wildlife Contaminants and Toxicology Animals harvested/trapped at various locations processed for contaminants and toxicology	Dead and Moribund Bird Contaminants and Toxicology Birds collected from tailings ponds near Fort McMurray (event-based) Hunter/Trapper Harvested Wildlife Contaminants and Toxicology Mallards, otters harvested/trapped at locations in NWT and northern Alberta. Target sample of 20 animals at each location and up to 100 mallards and 60 otters processed for contaminants and toxicology.
Plant Health and Contaminants	Laboratory Phytotoxicity and Contaminants Greenhouse exposures to Na_2SO_4 and naphthenic acids	Laboratory Phytotoxicity and Contaminants Greenhouse exposures to Na_2SO_4 and naphthenic acids Field Vegetation Assessment/Contaminants Vegetation assessments undertaken at various locations along the Athabasca River	Laboratory Phytotoxicity and Contaminants Greenhouse exposures to Na_2SO_4 and naphthenic acids Field Vegetation Assessment/Contaminants Vegetation assessments undertaken at up to 10 sites in NWT, northern Alberta and Saskatchewan, including along the Athabasca River and in reference sites.

Table 4 – Biodiversity & Land Disturbance Monitoring Implementation Plan Activities

Element	FY 2011-2012 (Current year activities)	FY 2012-2013	FY 2013-15
Core terrestrial biodiversity monitoring	Operation of core terrestrial biodiversity monitoring in portions of Athabasca oil sands area 40-50 sites). Gap analysis of existing status and trends monitoring program. Periodic population or trend assessments of key provincial species (e.g., moose, deer, wolf).	Enhancement of monitoring effort into other oil sands areas and all areas within the Lower Athabasca regional planning area (70-80 sites). Periodic population or trend assessments of key provincial species (e.g., moose, deer, wolf).	Fully implemented biodiversity program across 20X20km regularized grid with site visits every 5 years. Fully monitored area includes 3 oil sand areas (Athabasca, Cold Lake, Peace) and all areas within the Lower Athabasca regional planning area (up to 90-100 sites/year). Periodic population or trend assessments of key provincial species (e.g., moose, deer, wolf).
Cause-effect monitoring	Design of cause-effects monitoring for migratory songbirds.	Cause-effects monitoring of key migratory songbirds. Design of cause-effects monitoring program for wetland-associated birds.	Cause-effects monitoring for key migratory songbirds and wetland-associated birds. Initial predictions of avian response to current and future land-use.
Measurement harmonization		Development of an approach to integrate biodiversity monitoring efforts in the oil sand areas by industry and other stakeholders (i.e. biodiversity monitoring data by oil sands developers, universities, etc.)	On-going system to coordinate biodiversity monitoring efforts by industry and other stakeholders into the core biodiversity monitoring program Development of standard protocols and process for monitoring efforts in the oil sands areas for boreal songbirds.
Species at Risk (SAR) and rare/difficult species monitoring	Annual caribou tracking and assessment of recruitment. Monitoring of Whooping Crane	Annual caribou tracking and assessment of recruitment. Monitoring of Whooping Crane	Surveys of boreal woodland caribou. Monitoring of Whooping Crane.

Element	FY 2011-2012 (Current year activities)	FY 2012-2013	FY 2013-15
	Gap analysis of existing programs to monitor status and trends and cause-effects for species at risk and rare/difficult species. Development of monitoring protocols for species at risk and rare/difficult species that are inadequately monitored by core program. Survey design for cause-effects monitoring to understand impacts of oil sands on species at risk and rare/difficult species.	Design of augmented biodiversity core program to address gaps in status and trend and cause-effects monitoring of species at risk and rare/difficult species (e.g. increase detection probability of key species).	Full implementation of status and trends and cause-effects monitoring for other key provincially and federally listed species and improved monitoring for rare/difficult to detect species. Implementation of specialized protocols for collecting data on key provincially and federally listed species Coordinated data collection of priority provincially and federally listed species.
Human disturbance footprint monitoring	Mapping of human disturbance footprint at 3x7 km survey panels and coarse scale wall-to-wall mapping. Evaluation of existing efforts to monitor human disturbance footprint and design of coordinated approach to footprint mapping involving key data sources.	Mapping of human disturbance footprint at 3x7 km survey panels and coarse scale wall-to-wall mapping. Augmented fine-scale wall-to-wall footprint mapping for oil sands regions and other reference areas, with participation of cooperating agencies	Development and Implementation of wall-to-wall footprint mapping (extension from panels) with continued refinement. Refinement of footprint types for key provincial species, forest songbirds and species at risk.
Habitat monitoring	Collection of vegetation and other ground-based habitat data.	Collection of vegetation and other ground-based habitat data.	On-going augmented program to collect vegetation and other ground-based habitat data.

Element	FY 2011-2012 (Current year activities)	FY 2012-2013	FY 2013-15
	Land cover mapping at 3x7 survey panels.	Expand core land cover monitoring, with participation of cooperating agencies and initiatives to collect remote-sensed and high resolution photo data.	On-going augmented wall-to-wall land cover mapping.
	Evaluation of existing efforts to monitor land cover, climate and other biophysical variables, and consider range of approaches to complement and improve efforts, ensuring relevancy to biodiversity monitoring in oil sands.	Continue work to assess potential of remote-sensed and high resolution photo data for biodiversity prediction. Assess ability to interpret and classify data sources to provide key habitat features relevant to key species that are the focus of cause-effects monitoring.	Continue work to assess potential of remote-sensed and high resolution photo data for biodiversity prediction. Assess ability to interpret and classify data sources to provide key habitat features relevant to key species that are the focus of cause-effects monitoring. Through species-habitat modelling, identify key sources and sets of land cover, productivity, climate and other biophysical variables required for biodiversity prediction. Continue building library of land cover, productivity, climate and other biophysical data layers required for biodiversity prediction.