RAMP
Regional Aquatics Monitoring Program

2006 Technical Report

REGIONAL AQUATICS MONITORING PROGRAM

2006 Technical Report

FINAL

Prepared for:

RAMP STEERING COMMITTEE

Prepared by:

The RAMP 2006 Implementation Team

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The RAMP chairperson during the 2006 program year was Fred Kuzmic (Albian Sands). Stephen Full (Petro-Canada) was chair of the Technical Program Committee, Neil Rutley (Syncrude) was chair of the Finance Sub-committee and Melissa Pennell was the Communications Coordinator for RAMP and the Joint Communications Committee held jointly with CEMA and WBEA.

RAMP is a multi-stakeholder environmental monitoring program that is composed of representatives from industry; municipal, provincial and federal governments; local aboriginal groups and environmental organizations. Effective implementation of the RAMP requires a number of contributors. We would like to thank the following:

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EXECUTIVE SUMMARY

OVERVIEW

The Regional Aquatics Monitoring Program (RAMP) was initiated in 1997 in association with mining development in the Athabasca oil sands region near Fort McMurray, Alberta. RAMP is an industry-funded, multi-stakeholder initiative that monitors aquatic environments in the region. The intent of RAMP is to integrate aquatic monitoring activities so that long-term trends, regional issues and potential cumulative effects related to oil sands development can be identified and assessed. In 2006, RAMP was funded by Suncor Energy Inc., Syncrude Canada Ltd., Albian Sands Energy Inc., Shell Canada Limited, Canadian Natural Resources Limited, Imperial Oil Resources, Petro-Canada Oil and Gas, OPTI Canada Inc./Nexen Inc., Husky Energy, Deer Creek Energy Ltd., Synenco Energy Inc., and Birch Mountain Resources Ltd.

The Regional Municipality of Wood Buffalo in northeastern Alberta is the RAMP Regional Study Area (RSA). Within this area, a Focus Study Area (FSA) has been defined and includes watersheds where oil sands and other developments are occurring or planned, including:

- Lower Athabasca River and Athabasca River Delta;
- Major tributary watersheds/basins of the lower Athabasca River including the Clearwater-Christina rivers, Hangingstone River, Steepbank River, Muskeg River, MacKay River, Ells River, Tar River, Calumet River, and Firebag River;
- Select minor tributaries of the lower Athabasca River (McLean Creek, Mills Creek, Beaver River, Poplar Creek, and Fort Creek);
- Specific wetlands and shallow lakes in vicinity of current or planned oil sands and related developments; and
- A selected group of 50 regional acid-sensitive lakes.

RAMP incorporates both stressor- and effects-based monitoring approaches. Using impact predictions from the various oil sands environmental impact assessments, specific potential stressors have been identified that are monitored to document baseline conditions, as well as potential changes related to development. Examples include specific water quality variables and changes in water quantity. In addition, there is a strong emphasis in RAMP on monitoring sensitive biological indicators that reflect the overall condition of the aquatic environment. By combining both monitoring approaches, RAMP strives to achieve a more holistic understanding of potential effects on the aquatic environment related to oil sands development.

The scope of RAMP focuses on key components of boreal aquatic ecosystems, including:

- Climate and hydrology – monitors changes in the water level of selected lakes and in the quantity of water flowing through rivers and creeks in the Athabasca oil sands area;
- Water quality in rivers, lakes and the delta – reflects potential exposure of fish and invertebrates to organic and inorganic chemicals;
- Benthic invertebrate communities and sediment quality in rivers, lakes and the delta – reflect habitat quality, serve as a biological indicators, and are important components of fish habitat;
- Fish populations in rivers and lakes – biological indicators of ecosystem integrity and are a highly valued resource in the region; and
- Water quality in regional lakes sensitive to acidification – early warning indicator of potential effects related to acid deposition.

With the addition in 2006 of Birch Mountain as a member of RAMP, RAMP is now funded by companies that are not exclusively constructing and operating oil sands projects in the RAMP FSA. Therefore, the term "focal projects" has been introduced to the RAMP 2006 Technical Report; focal projects are defined as those projects owned and operated by the 2006 RAMP funders listed above which were under construction or operational in 2006 in the RAMP FSA. For 2006, these projects include a number of oil sands projects and a limestone quarry project (in the case of Birch Mountain).

2006 RAMP funders do have other projects in the RAMP FSA that were in the application stage as of 2006 (e.g., Imperial's Kearl project), or which received approval in 2006 (or earlier), but were not in the construction phase as of 2006 (e.g., Suncor's Voyageur project). These projects are noted throughout the 2006 Technical Report, but are not designated as focal projects, as these projects in 2006 would not have potentially influenced aquatic resources covered by RAMP components.

The overall analytical approach for the 2006 RAMP Technical Report builds on the methodology used in previous years and the RAMP Technical Design and Rationale document. The analysis:

- Is conducted at the watershed/river basin level, with an emphasis on watersheds in which development has already occurred, as well as the lower Athabasca River at the regional level;
- Uses a set of measurement endpoints representing the health and integrity of valued environmental resources within the component;
- Uses where possible, specific criteria (e.g., criteria used in focal project EIAs, AENV, CCME guidelines, generally-accepted EEM effects criteria) for determining whether or not a change in the measurement endpoints has occurred and is significant with respect to the health and integrity of valued environmental resources; and
- Uses an analysis of land change to determine which RAMP stations and monitoring years are to be designated as operational or baseline for the purposes of data analysis.

Satellite imagery was used in 2006 in conjunction with more detailed maps of Athabasca oil sands operations provided by a number of RAMP industry members to estimate the type, location, and amount of land changed by oil sands and other development activities. It is estimated that there were approximately 58,000 ha of land change attributable to focal projects within the RAMP FSA as of 2006. The percentage of the watersheds with land change from focal project activities varies from less than 1% for many watersheds (Steepbank, MacKay, Ells, Christina, Firebag, Horse, and Hangingstone), slightly more than 1% for the Calumet and Poplar Rivers, 5% to 10% for the Muskeg River and Fort Creek, and more than 10% for the McLean, and Tar watersheds, as well as the smaller lower Athabasca River tributaries from Fort McMurray to the mouth of the Firebag River taken together.

The following sub-sections summarize results of the monitoring assessment for each watershed evaluated as part of the 2006 RAMP. Results are also presented for the Acid-Sensitive Lakes component, which focuses on regional lakes.

Lower Athabasca River

Monitoring activities on the Athabasca River mainstem in 2006 consisted hydrology, water quality, and Athabasca River fish inventories.

The large size and flow of the lower Athabasca River means that there is high year-to-year variation in aquatic resources represented by the RAMP components, much of which is due to natural factors; the much lower than average flow year for the lower Athabasca River in 2006 was no exception in this regard. The differences between hydrologic measurement endpoints for estimated baseline

hydrologic conditions and measured operational hydrologic conditions were greater in 2006 than in 2005. This was due almost completely to the lower overall flows in the lower Athabasca River in 2006. It is estimated that focal project activities as of 2006 decreased 2006 mean open-water season discharge by 0.45%, lowered 2006 mean winter discharge by 1.5%, decreased annual maximum daily discharge by 0.21%, and lowered open-water season minimum daily discharge in 2006 by 0.76%. The cumulative effects of focal project activities plus all other active oil sands projects in the RAMP FS are estimated to be only marginally greater. Based on criteria used in previous oil sands project EIAs, these differences would have been assessed as negligible, with the exception of the incremental mean winter discharge which would have been assessed as a low effect. There were no discernable changes in water quality conditions due to focal project activities in 2006 and there is little evidence to suggest that characteristics of key indicator fish populations have changed during the period of increasing focal project activity in the RAMP FSA.

Athabasca River Delta

There was no monitoring conducting in the Athabasca River Delta in 2006. There were no plans to conduct water quality sampling in the Athabasca River Delta in 2006 and, while there were plans to conduct benthic invertebrate community and sediment quality monitoring in the Athabasca River Delta in 2006, very low water levels during the benthic invertebrate community sampling campaign prevented access to the sampling sites.

Muskeg River Watershed

Monitoring activities in the Muskeg River basin in 2006 included hydrology, water quality, benthic invertebrate community surveys, sediment quality, the Muskeg River fish fence, and part of the 2006 sentinel fish species survey for the Athabasca River tributaries.

The cumulative effects of focal projects in the Muskeg River watershed for 2006 are assessed as follows:

- There appear to be some effects on watershed hydrology, with large differences in two of the four hydrologic measurement endpoints (mean winter discharge and open-water season minimum daily discharge) between potentially influenced conditions and estimated reference conditions. It must be noted that these differences have been estimated under the assumption that all Aurora Clean Water Diversion discharge waters would not have entered the Muskeg River under *reference* conditions;

- Water quality remains largely unaffected by focal project activities, with few exceedances of water quality guidelines throughout the watershed and concentrations of most water quality measurement endpoints throughout the watershed that remained within historical regional baseline ranges. The exceptions to these overall results for water quality is an indication of greater variability of water quality in fall 2006 in *potentially influenced* areas of the Muskeg River watershed than in *reference* areas, as well as elevated concentrations of a number of water quality measurement endpoints in measured in Stanley Creek in fall 2006 as a results of the Aurora Clean Water Diversion discharge;

- There is little evidence of effects of focal project activities on benthic invertebrate communities. Values of all benthic invertebrate community measurement endpoints in 2006 at all reaches sampled in the Muskeg river watershed were within the normal range of values observed from regional baseline reaches, and there continues to be consistency across years in values of all benthic invertebrate community measurement endpoints with respect to regional baseline reaches. In addition, there may be little contribution of changes in sediment quality to differences in benthic invertebrate communities in the Muskeg River watershed;

- Any influence of focal project activities on fish utilizing the Muskeg River during the spring spawning season remains largely undetectable and unknown, given the few years of information available from Muskeg River fish fence studies; and
- The results of the sentinel fish species survey indicate there are no clear differences in sculpin population measurement endpoints between reference and potentially *influenced* sites that would suggest possible effects of focal project activities on these populations.

Steepbank River Watershed

Monitoring activities in 2006 in the Steepbank River watershed included hydrology (Water Survey of Canada station), water quality, a benthic invertebrate community survey, and a major component of the 2006 sentinel fish species survey for the Athabasca River tributaries.

There is little evidence in 2006 of watershed-level effects of focal project activities on RAMP aquatic resources in the Steepbank River watershed. Cumulative, watershed-level changes in hydrologic conditions in the Steepbank River caused by focal project activities in the watershed as of 2006 have been negligible. In 2006, there were few exceedances of water quality guidelines throughout the watershed, concentrations of almost all water quality measurement endpoints in the watershed were within historical regional baseline ranges, and ion balance in fall 2006 was generally consistent throughout the watershed with ion balance in previous years. There were some significant, though statistically weak differences in some benthic invertebrate community measurement endpoints between sampled reaches designated as *potentially-influenced* and *reference*, but values of all benthic invertebrate community measurement endpoints in 2006 at all reaches sampled were within the normal range of values observed from regional reference reaches. Finally, similar to results for the Muskeg River, the results of the sentinel fish species survey indicate there are no clear differences in sculpin population measurement endpoints between *reference* and *potentially influenced* sites that would suggest possible effects of focal project activities on these populations.

Tar River Watershed

Monitoring activities in the Tar River watershed in 2006 included hydrology, water quality, as well as a benthic invertebrate community survey and sediment quality.

The Tar River watershed in 2006 continued to show some effects of focal project activities. The effects of focal project activities on hydrologic conditions in 2006 was assessed as low to moderate based on effects criteria used in oil sands EIAs for mean open-water season discharge, annual maximum daily discharge, and open-season minimum daily discharge. Concentrations of water quality measurement endpoints in fall 2006 were generally within regional ranges of concentrations for baseline conditions and there were few instances of concentrations of water quality measurement endpoints exceeding water quality guidelines, although there was some evidence of possible effects on water quality in the lower Tar River of wastewater treatment facility discharge. Finally, generally lower values of benthic invertebrate community measurement endpoints in 2006, and recent downward trends in a number of these measurement endpoints in areas of the watershed designated as *potentially influenced*, indicate possible effects of focal project activities on benthic invertebrate communities in the lower parts of the Tar River watershed.

MacKay River Watershed

Monitoring activities in the MacKay River watershed in 2006 included hydrology, water quality, a benthic invertebrate community survey, and a sentinel fish species reconnaissance.

Data collected in the MacKay River watershed in 2006 indicated negligible changes in hydrological conditions as a result of focal project activities, little measurable change in water quality and possible subtle effects on benthic invertebrate communities. These results indicate that focal project

activities have had, to 2006, little effect on RAMP aquatic resources at the watershed level in the MacKay River watershed. Results from the 2006 reconnaissance sampling suggest suitable conditions for a non-lethal sentinel program do not exist on the MacKay River.

Calumet River Watershed

Monitoring activities in the Calumet River watershed in 2006 included hydrology, water quality, a benthic invertebrate community survey, and sediment quality.

RAMP aquatic resources were measured in the Calumet River watershed in 2006 as being similar to previous years. Values of few measurement endpoints in 2006 exceeded existing environmental guidelines, and few selected measurement endpoints were outside the range of expected reference conditions for similar river systems and habitats in the RAMP FSA. Effects of focal project activities in the watershed were negligible in 2006 in the case of hydrologic conditions, and any effects of focal project activities on water quality were not detected.

Firebag River Watershed

Monitoring activities in the Firebag River watershed in 2006 included hydrology, water quality, a benthic invertebrate community survey, and sediment quality.

At a watershed level, the conditions of RAMP aquatic resources of the Firebag River watershed were similar in 2006 relative to previous years. There were few exceedances of water quality environmental guidelines in 2006, and almost all water quality and benthic invertebrate community measurement endpoints for RAMP aquatic resources that were sampled in 2006 were within the range of expected reference conditions for similar river systems and habitats in the RAMP FSA.

Ells River Watershed

Monitoring activities in the Ells River watershed in 2006 included hydrology, water quality, a benthic invertebrate community survey, and sediment quality.

Conditions in the Ells River in 2006 were generally similar to previous years. Cumulative, watershed-level changes in hydrologic conditions caused by focal project activities in the Ells River watershed as of 2006 have been negligible. Water quality conditions were similar in 2006 to water quality conditions in previous years. Conditions in the two reaches at which benthic invertebrate communities were sampled in fall 2006, one depositional and one erosional, were representative and typical of depositional and erosional reaches in the RAMP FSA, and values of benthic invertebrate community measurement endpoints were generally consistent with values measured in previous years in the watershed. Values of most sediment quality measurement endpoints were within the range of previously-measured values for the watershed.

Clearwater-Christina River System

Monitoring activities in the Clearwater River and Christina River watershed in 2006 consisted of hydrology, water quality, benthic invertebrate community surveys sediment quality, fish inventories, and fish tissue quality assessment.

While hydrologic measurement endpoints for the Christina River watershed could not be estimated because there is no hydrometric station at the mouth of the Christina River, estimated effects of focal project activities in 2006 were to remove 0.075 mm of runoff depth from the watershed. Estimated effects of focal project activities plus oil sands projects in the Christina River watershed that were under construction or operation in 2006 but which were not owned by 2006 RAMP funders were to remove 0.128 mm of runoff depth from the watershed. Water quality measurement endpoints were generally within historical ranges and within the range for regional

reference stations. Guideline exceedance of selected water quality measurement endpoints was restricted to nutrients and metals. Values of benthic invertebrate community measurement endpoints were similar to previous years and there have been no unusual trends in these measurement endpoints since sampling began in 2002.

A fourth year of fish inventory work on the Clearwater River was conducted to expand the baseline dataset for this river. Fish community composition, length-frequency relationships external fish health indices, and condition factors were similar to what was found in previous years. Mercury tissue concentrations in northern pike from the Clearwater River measured in 2006 are consistent with the natural range of concentrations observed in this region of northern Alberta and, as in previous years, mercury and arsenic levels in sampled northern pike fish tissue exceeded USEPA screening criteria. No fish tissues effects thresholds for fish and fish health were exceeded and all potential tainting compounds in sampled Clearwater River fish tissue were present at concentrations well below the 1 mg/kg threshold for palatability.

Hangingstone River Watershed

Monitoring activities in the Hangingstone River watershed in 2006 included hydrology, water quality, and a benthic invertebrate community survey.

2006 results confirm that the Hangingstone River is a typical Athabasca River basin watershed, with RAMP aquatic resources in 2006 within the range of regional baseline conditions for similar watersheds and habitat types. As of 2006, there have been no detectable effects of focal projects or cumulative, watershed-level changes in the Hangingstone River watershed.

Miscellaneous Aquatic Systems

Miscellaneous aquatic systems designated as *potentially influenced* in 2006 included Mills Creek, Poplar Creek, McLean Creek, Fort Creek, Beaver River, Isadore's Lake, and Shipyard Lake, while miscellaneous aquatic systems designated as *reference* in 2006 included Kearl Lake, McClelland Lake, and the Susan Lake outlet. The OPTI lakes were also sampled in 2006. The effect of focal project activities on the hydrology of Poplar Creek is assessed as High, due to the hydrologic effects of the Poplar Creek spillway, while the effect of focal project activities on the hydrology of Fort Creek is assessed as Negligible. There was little to distinguish 2006 water quality conditions in these aquatic systems from previous years, with the exception of possible increased influence of groundwater on water quality due low precipitation in the RAMP FSA and reduced surface runoff north of Fort McMurray in 2006. There was little evidence of effects on focal project activities on water quality conditions in these aquatic systems in 2006. Benthic invertebrate communities in miscellaneous aquatic systems that were sampled in 2006 had values of benthic invertebrate measurement endpoints that were in the range of regional baseline conditions. The exception was Isadore's Lake, in which lower diversity and the absence of sensitive faunal species in 2006 is indicative of a stressed benthic community.

Acid-Sensitive Lakes

These results of the analysis of 2006 RAMP ASL lake data in conjunction with historical RAMP ASL lake data suggest that there has been no significant change in the overall chemistry of the 50 RAMP ASL lakes in 2006 compared to previous years. In addition, the inconsistent results of the trend analysis with respect to any conceivable regional acidification scenario indicate there is no evidence of any significant changes in lake chemistry in the RAMP ASL lakes over the period of the ASL component of RAMP.