ALBERTA ENVIRONMENT
FISHERIES AND OCEANS CANADA

WATER MANAGEMENT FRAMEWORK:

INSTREAM FLOW NEEDS AND WATER MANAGEMENT SYSTEM FOR THE LOWER ATHABASCA RIVER

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AENV/DFO WATER MANAGEMENT FRAMEWORK: INSTREAM FLOW NEEDS AND WATER MANAGEMENT SYSTEM FOR THE LOWER ATHABASCA RIVER

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AENV/DFO WATER MANAGEMENT FRAMEWORK: INSTREAM FLOW NEEDS AND WATER MANAGEMENT SYSTEM FOR SPECIFIC REACHES OF THE LOWER ATHABASCA RIVER

1.0 EXECUTIVE SUMMARY

This Water Management Framework is designed to protect the ecological integrity of the lower Athabasca River during oil sands development. It represents the work of Alberta Environment and Fisheries and Oceans Canada. The Cumulative Environmental Management Association (CEMA), a multi-stakeholder group that includes environmental groups, First Nations, industry and regulators has also contributed to this framework.

Alberta Environment and Fisheries and Oceans Canada are taking a precautionary approach in managing the river and have divided water management objectives into two phases. This approach preserves the river over the short-term while allowing for innovation and leading research to help guide future management actions to safeguard the river.

Phase 1 incorporates the large body of work provided by CEMA, a group that makes recommendations to the Alberta government on how to protect the environment during oil sands development. This phase takes into account current demand and available water management options and will balance these with leading scientific work on the in-stream flow needs of the Athabasca.

Phase 2 will determine what modifications are required to meet environmental and socio-economic goals over the long-term. It will be based on a review and an adaptive management process with set timelines and regulatory backstop dates. This phase will allow for the additional development of science, integrated water management options and socio-economic considerations.

History

In 2003, the Federal/Provincial Panel reviewing the Shell Jackpine Phase 1 and Canadian Natural Resources Limited Horizon oil sands mine applications stressed the importance of CEMA completing an in-stream flow needs recommendation for the Athabasca River. The panel further directed that Fisheries and Oceans Canada and Alberta Environment complete the in-stream flow needs framework if CEMA could not provide a recommendation by December 31, 2005. In January 2006, Alberta Environment issued an interim framework for public review and comment. Fisheries and Oceans Canada and Alberta Environment subsequently began a joint process to improve the initial draft and presented a two-phase framework to CEMA in April 2006. This current framework document is a synthesis of the Alberta Environment interim framework, the Fisheries and Oceans work on in-stream flow needs and stakeholder concerns brought forward during the framework review period

A Phased Approach

The Phase 1 Water Management Framework uses scientific information on in-stream flow needs as well as information on water use to outline management actions for varying flow conditions in the lower Athabasca River. The fundamental concept behind the framework is to balance high levels of protection for the river with water needs. Monitoring and assessment of the protective and socio-economic goals will continue throughout the life of the oil sands projects and the framework will be adjusted as necessary to ensure water use does not threaten ecosystem sustainability.

The Phase 1 Framework consists of three river flow conditions - green, yellow, and red - for each week of the year. For each flow condition there are differing environmental implications and corresponding management actions. The management actions include reductions in water withdrawals if necessary to meet the withdrawal limits for each week of the year. The yellow and red management actions include the potential requirement for a Canada *Fisheries Act* authorization from Fisheries and Oceans Canada for impacts to fish habitat.

Phase 1 objectives include providing a high level of protection, while ensuring water use restrictions are realistic and the framework can be administered efficiently. The framework applies increasingly stringent standards during more sensitive time periods and during lower flows.

The framework achieves managed withdrawals from the Athabasca River and low risk to the aquatic ecosystem but allows some withdrawals during sensitive periods. These habitat losses at low flow during Phase 1 are believed to be a small risk in the near-term. Risks are additionally minimized by requiring comprehensive monitoring and research followed quickly by a review to determine if more stringent restrictions on withdrawals are required.

While current oil sands water use has generally been below the most stringent limits identified within the Phase 1 Framework, current licences have allowed for maximum amounts that could cumulatively exceed them. Further project development will add to the cumulative demands that are now subject to the Phase 1 limits. Water sharing or other integrated water management options will be required to meet Phase 1 limits. The first licensed additional withdrawal will be by Canadian Natural Resources Limited in mid-2007. Alberta Environment and Fisheries and Oceans Canada have directed the oil sands industry to submit a plan for meeting the requirements of the Phase 1 Framework by January 2007. Should industry fail to deliver a plan, the provincial and federal governments will make the necessary decisions to ensure that the Phase 1 requirements are met by May 31, 2007.

The Phase 1 Water Management Framework is being released to guide regulatory decision-making in upcoming applications. It will challenge industry to respond to adaptive and cooperative management principles to meet the framework's goals. Alberta Environment and Fisheries and Oceans Canada expect CEMA, or a similarly inclusive stakeholder process, will be instrumental in providing the input required for Phase 2. More detailed and technical information can be found in the main body of this document.

Protecting the ecological integrity of the rivers is a priority for Alberta Environment as part of its *Water for Life* strategy. The policy identifies the importance of developing and implementing water management frameworks, which are based on in-stream flow needs.

2.0 INTRODUCTION

AENV led the development of the 1999 Regional Sustainable Development Strategy for the Athabasca Oil Sands Area (the RSDS). The RSDS provides a framework for balancing development with environmental protection and provides for government and stakeholders to work together to set new, specific regional resource goals and targets. RSDS is being implemented in partnership with the Cumulative Environmental Management Association (CEMA), a non-profit organization of stakeholders from government, industry and the public. In 2003, the Federal/Provincial Panel reviewing Shell Jackpine Phase 1and Canadian Natural Resources Limited Horizon applications stressed the importance of the Cumulative Environmental Management Association (CEMA) completing an in-stream flow needs (IFN) recommendation for the Athabasca River. The Panel further indicated that Fisheries and Oceans Canada (DFO) and Alberta Environment (AENV) complete an IFN Framework if CEMA could not provide a recommendation by December 31, 2005.

This Water Management Framework (the Framework) defines Instream Flow Needs (IFN) as the scientific recommendation for water requirements to achieve ecological protection of the Athabasca River. The Framework uses the term “Water Management System” to refer to the method of applying the IFN to the Athabasca River in a way that minimizes impacts from human water use. The Water Management System goes beyond the scientific recommendation to consider how best to meet water requirements while protecting the biological integrity of the Athabasca River.

This document is a synthesis of the Alberta Environment (AENV) interim framework that was presented for public comment in January 2006, Fisheries and Oceans Canada (DFO) work on Instream Flow Needs, and stakeholder concerns brought forward during the AENV framework review period. The Framework will be used for regulatory decision-making and lays out a procedure for adaptive management of oilsands water withdrawals.

In implementing the Framework, AENV and DFO recognize the existence of competing needs for water resources. The Framework achieves a high level of protection while balancing aquatic ecosystem needs with those of community and industry. The goal is to ensure low impact to the river ecosystem as well as water conservation and innovation on the part of water users.

The Framework consists of two components: Phase 1 and Phase 2.

- Phase 1 provides protection during the Phase 2 review period given current water demands. The Framework incorporates the large body of work that the CEMA group facilitated and it will be used for managing water withdrawals in the immediate future. It fulfills the requirement of the joint Federal/Provincial panel, considers current demand and available water management options, and balances these with the current scientific work on IFN.
- Phase 2 will determine what modifications are required to meet environmental and socio-economic goals over the long-term. Phase 2 will be based on a review and adaptive management process, with set timelines and regulatory backstop dates, for additional development of the science, integrated water management options, and socio-economic considerations. Currently accepted IFN methods, which incorporate science and professional judgment, indicate a more restrictive withdrawal regime may be required to achieve protection of the River in Phase 2 with greater water withdrawals. A primary goal of Phase 2 is to refine the IFN methodology for the lower Athabasca River.

Several objectives will be achieved by the Framework in both Phase 1 and 2:

1) To provide a high level of protection of the aquatic ecosystem over the long-term.
2) To provide incentive to develop cooperative management options for water in the Athabasca River
3) To provide incentive for achieving more efficient water use.
4) To provide a reliable supply of good quality water.
5) To ensure water use restrictions are realistic and the framework is straightforward to administer.

One component of adaptive management, as used in the context of the Framework, is the tracking of effects of water withdrawals on the aquatic ecosystem through rigorous monitoring programs. Monitoring results will then be used to modify the Framework as required to meet the objectives above.

Alberta Environment and Fisheries and Oceans Canada believe that the phased, adaptive management approach presented in this Framework is consistent with the Regional Sustainable Development Strategy for the Athabasca Oil Sands (RSDS):

> *"The RSDS provides a framework for balancing development with environmental protection.*
>
> - *The use of Alberta's natural resources shall be sustainable.*
> - *The management of Alberta's natural resources shall support and promote the Alberta economy.*
> - *Alberta's environment shall be protected.*
> - *Resources shall be managed on an integrated basis.*
> - *Alberta's natural resources shall be managed for multiple benefits.*
> - *First Nations and Aboriginal communities requirements for a traditional lifestyle—Land, plants and animals will continue to be available to support a traditional lifestyle for current and future generations."*

It is also consistent with Alberta's Water for Life Strategy:

> *"Albertans reaffirmed three goals of a provincial water strategy:*
> - *Safe, secure drinking water supply*
> - *Healthy aquatic ecosystems*
> - *Reliable, quality water supplies for a sustainable economy."*
>
> Alberta has made the development and implementation of IFN-based water management frameworks a priority for Alberta rivers through the Water for Life Strategy. Consideration of the impact on the aquatic environment is also a legislated part of decision-making on new applications for withdrawals under the *Water Act*.

The framework is also consistent with DFO's Strategic Plan

> *Sustainable development is an ongoing priority for DFO to support the building of a strong economy while protecting Canada's natural environment. The Government of Canada states that development is essential to satisfy human needs and improve the quality of human life, but must be based on the efficient and environmentally responsible use of all of society's scarce resources - natural, human and economic. Fisheries and Oceans Canada has an important role to play in the federal government's sustainable development agenda. It is therefore important to view programs from the perspective of an approach that integrates environment, economic, and social analysis and to practise the principles of sustainable development in decision-making (Fisheries and Oceans Canada 2005-2010 Strategic Plan).*

AENV and DFO appreciate the complexity of developing a Water Management Framework (an IFN and a water management system), and recognize the indispensable contribution of the Cumulative Environmental Management Association (CEMA) stakeholders. AENV and DFO remain committed to the use of multi-stakeholder processes in support of the Framework.

This document presents a description of the Framework in Section 3.0, definitions in Section 4.0, and contact information in Section 5.0. Appendix 1 provides a general non-technical overview of what an IFN is and why one should be established. Appendix 2 presents the context for determining IFN threshold values for the lower Athabasca River. Detail on the science and management decisions behind the Framework can be found in Appendix 3.

3.0 THE JOINT AENV-DFO WATER MANAGEMENT FRAMEWORK

The goal of the Framework is to minimize risk to the aquatic ecosystem while balancing water requirements for human use. The Framework was developed following certain principles:

1. Minimize risk to the aquatic ecosystem by providing a high level of protection supported by appropriate research, monitoring, habitat compensation, and mitigation where required.
2. Provide greater protection for sensitive periods relative to less sensitive periods.
3. Provide for adequate operational withdrawals and enough time for industry to build the required infrastructure and develop new operating procedures if a more stringent management system is required.
4. Establish a water management system that is adaptive to new information with an open process for incorporating changes on a defined schedule.
5. Allow flexibility to issue limited approvals to deal with short-term “upset conditions” (including emergencies or other situations that require a change in operations). A process for evaluating temporary approvals and associated compensation requirements will be delivered early in Phase 2.

Current ecological thought on IFN indicates that natural processes are maintained by minimizing changes in the natural flow pattern so that variability of flows within and between years, is maintained. Referred to as the natural flow paradigm, maintenance of seasonal flow magnitude, frequency, timing and duration should create conditions that are generally protective of aquatic ecosystems (Golder 2004, Poff et al. 1997). While the maintenance of natural hydrologic patterns may provide some protection of natural ecosystem processes, this concept does not tell us how much water the river requires to maintain its natural character or, in other words, how much water we can remove while maintaining the natural aquatic ecosystem. Better understanding of the effects of reduced flow on aquatic ecosystems is needed to make these decisions. Therefore, appropriate monitoring programs need to be designed and implemented, and the effects of reduced flows need to be identified and investigated, especially given the increasing demand for water use.

AENV and DFO are recommending a precautionary approach, implemented in phases with ongoing review, so that monitoring which improves the understanding of the effects of water withdrawals can be incorporated in a water management system that will protect the ecological integrity of the aquatic ecosystem of the lower Athabasca River.

3.1 Description of Framework Phases

3.1.1 Phase 1 of the Water Management Framework (September 2006 to September 30, 2010)

Table 1 presents the Phase 1 Water Management Framework. Three management zones (*green, yellow* and *red*) have been designated to manage the increasing risk of impacts as river flows decrease. These zones are defined by the flow conditions within the river. Maximum withdrawals for each management zone have been established that are increasingly restrictive, according to the increasing risk to the aquatic ecosystem.

Table 1. The Phase 1 Water Management Framework

Flow Condition/Season	Environmental Implication	Management Action
When River Flow is Above the Cautionary Threshold (CT) - Maximum of HDA80 or Q90 **Green**	• Flows are sufficient-impacts to aquatic ecosystem are negligible.	• All licensees operate normally and operate within the conditions of their licences. • Maximum cumulative withdrawal is 15% of instantaneous flow. • Not likely to result in impacts to fish habitat, not likely to require a *Fisheries Act* Authorization (See Section 3.3 for details)
When River Flow is Below the CT - Maximum of HDA80 or Q90 but Above Q95 **Yellow**	• Natural low flows occurring. • Assume aquatic ecosystem may experience stress from a 15% withdrawal	• Total cumulative diversion rate is 10% of the average of the HDA80 and Q95. • Maximum cumulative withdrawals: ▪ Winter = 15 m^3/s, ▪ Spawning = 5% of the HDA80 flow or 34 m^3/s, whichever is less, ▪ Summer = 34 m^3/s. • Recent and new licences will include conditions that mandate incremental reductions. • Is likely to result in impacts to fish habitat and may require a *Fisheries Act* Authorization (See Section 3.3 for details)
When River Flow is Below Q95 **Red**	• Natural low flows may limit habitat availability. • Increased duration and frequency of habitat loss due to water withdrawals should be minimized	• Mandatory reductions and use of storage. • Total cumulative diversion rate is 5.2% of historical median flow in each week. • Maximum cumulative withdrawals: ▪ Winter = 15 m^3/s, ▪ Spawning = 5% of the HDA80 flow or 34 m^3/s, whichever is less, ▪ Summer = 34 m^3/s. • Applies to all licences in a variety of ways. • Is likely to result in impacts to fish habitat and may require a *Fisheries Act* Authorization (See Section 3.3 for details)

Note: Definitions of terms used in this table can be found in Section 4.0

In all cases in Phase 1, when a withdrawal for a given flow condition results in the Athabasca River dropping down to a lower flow condition, the management action applied will be that of the lower flow condition. For example, if the river was 1 m^3/s above the CT and therefore still in the green zone, the yellow condition restrictions would take effect if total withdrawals were greater than 1 m^3/s.

The Green Management Zone - water availability is sufficient

Most of the time, there is enough flow in the River to meet environmental and human needs. In this zone water flow is sufficient, therefore up to 15% of the instantaneous flow in the river will be available for industry use. This 15% maximum cumulative diversion rate was determined by applying the chronic (long-term), intermediate and acute (short-term) metrics developed for the South Saskatchewan River Basin (SSRB)[1] to the most sensitive fish life stage and reach in the lower Athabasca River (see Appendix 3 for details).

The Yellow Management Zone - Cautionary Threshold

The IFN for the Athabasca River identifies a threshold, which the Phase 1 Framework has used as a Cautionary Threshold (CT). This threshold is defined by flows corresponding to the 80% habitat area exceedence. Habitat area values below this level occur 20 percent of the time.

- A target of 10% of instantaneous flow was determined as a protective level of withdrawal during yellow conditions. For ease of implementation, the maximum withdrawal has been pre-calculated as 10% of the average of the HDA80 flow and the Q95, which historically through winter weeks is within +/- 1 m^3/s of the instantaneous values. The weekly values are presented in Table 5.
- Maximum withdrawal caps have been implemented for flows during yellow conditions allowing no more than 15 m^3/s (winter) to a maximum of 34 m^3/s (spawning and summer).

The Red Management Zone - Potential Sustainability Threshold

The Framework identifies a Potential Sustainability Threshold (PST) that is consistent with the thresholds where the ecosystem is expected to experience significant change, according to international contributions to IFN determination (e.g. Hardy 2005). The PST is defined by the 95% flow exceedence. Flows below this value occur five percent of the time. Details for establishing both the CT and the PST are presented in Appendix 3.

- A target for maximum withdrawals of 5.2% of historical median flow in each week has been adopted to ensure the sustainability of the aquatic ecosystem is not threatened.
- Maximum withdrawal caps have also been implemented for flows during red conditions allowing no more than 15 m^3/s (winter) to a maximum of 34 m^3/s (spawning and summer).

Allowance For Dynamic Ice Behaviour

Due to substantial stakeholder concern, the draft recommendations (AENV January 2006) for relaxed thresholds during ice formation and break-up have been removed.

3.1.2 Phase 1 Effects On Modeled Habitat Availability

The amount of habitat loss under Phase 1 is shown in Table 2 and contrasted with habitat loss using an accepted IFN method that fully protects the lowest flows. In Table 2, both the IFN and Phase 1 result in habitat losses from natural flow conditions. Phase 1 minimizes losses as far as is possible, balancing the current understanding of infrastructure constraints and water needs with low additional risks to the aquatic ecosystem. These habitat losses at low flow during Phase 1 are believed to be a small risk in the near-term. Continued monitoring will be used to better characterize these risks.

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[1] Instream Flow Needs Determinations for the South Saskatchewan River Basin, Alberta, Canada (Dec. 2003), available on-line at: http://www3.gov.ab.ca/env/water/regions/ssrb/IFN_reports.asp

Table 2. Comparison of habitat losses (%) from Natural for an IFN and for the Phase 1 Framework.

Habitat Metric (% Change from Natural)	IFN - Reach 4			Phase 1 - Reach 4		
	Winter	Spawning	Summer	Winter	Spawning	Summer
Mean Loss	-4.2	-2.3	-3.8	-5.1	-3.2	-5.3
Max Weekly Loss	-5.6	-5.6	-6.4	-6.4	-6.9	-8.1
Max Instantaneous Loss	-10.0	-13.1	-17.4	-10.0	-13.1	-17.4
Mean 80-100% Exceedence Loss	0.1	0.2	6.4	-3.3	-3.4	2.8
Max Weekly 80-100% Exceedence Loss	0.0	0.0	0.0	-4.6	-6.0	-7.5
Max Instantaneous 80-100% Exceedence Loss	0.0	0.0	0.0	-5.8	-13.0	-10.1

See Appendix 3 - Habitat Metrics for definitions

3.1.3 The Phase 2 (Long-term) Water Management Framework Process

A water management regime for the Framework is based on the concept that the aquatic ecosystem of the lower Athabasca River and its associated fisheries will be protected. The Framework will undergo review and modification in Phase 2 as ecosystem knowledge improves and socio-economic considerations are taken into account. Phase 2 will continue to provide a high level of protection for the lower Athabasca River while evaluating water management options and our understanding of the complex ecosystem, through western science and traditional knowledge. Phase 2 also provides a process for incorporating an adaptive management approach based on new information, and improvement in the Framework where required. As previously stated, current IFN methods suggest that a more restrictive withdrawal regime may be required during sensitive time periods and flows to achieve protection in Phase 2 with greater water withdrawals.

The specific details of the Phase 2 process will be determined through consultation with regional stakeholders in 2007 (see Table 3).

Table 3. Phase 2 Timelines.

Activity	Completion Date	Regulatory Backstop Deadline
Workplans for Habitat Requirements Group (including plan for addressing Ecosystem Base Flow), Water Requirements Group Engineering/Procedural Requirements and Socio-economic Group	January 1, 2007	March 31, 2007
Industry integrated water management plan for implementing Phase 1	January 31, 2007	May 31, 2007
Consultation on Phase 2 Process	July 1, 2007	October 31, 2007
Collection and Review of information; develop Phase 2 Framework and Implementation plan	July 1, 2009	October 31, 2009
Final Consultation on Phase 2 Framework and Implementation Plan	June 30, 2010	August 1, 2010
Begin Implementation	September 30, 2010	

If stakeholders cannot agree on the path forward by the deadline dates, the regulators (DFO and AENV) will make the required decisions by the regulatory backstop dates indicated in Table 3.

As more science and traditional knowledge is collected, the assumptions used to develop Phase 1 will be verified, and information on four key areas – water requirements, habitat requirements, engineering requirements and water resource values will be incorporated. Water requirements include determining how much water is used for normal operation, now and in the future. It does not include emergency requirements. Habitat requirements will include gathering of information to better determine what the Athabasca River requires to ensure that its aquatic environment is maintained during oilsands operation. Engineering requirements will include gathering of technical and economic information to determine what mitigation is most feasible for industry. Water resource values will address the importance of the water to all users.

In Alberta's Draft Framework (January 2006), there was a recognition that some level of low flow could occur in the Athabasca River where water withdrawals for industry would effectively stop. This level of flow is typically referred to as the ecosystem base flow (EBF). Research will be directed towards addressing the definition of an EBF in Phase 2.

Phase 2 development and implementation will include, but not be limited to:

- Development of monitoring program(s) to test if changes occur and provide for further implementation of IFN metrics/ methods
- Development of research program(s) to test the assumptions and new hypotheses of IFN for the Athabasca River
- Developing an understanding of technical solutions for water use including enhanced efficiency and reduction in inventory in tailings material
- Acquisition of socio-economic information and cost-benefit analyses
- Consultation and Review

Activities that are already underway or that are expected to begin, in support the Framework, include:

<u>1) Assessment of Routine Operation Water Requirements – Led by industry</u>

- Determine existing (2005) water use.
- Determine planned water use.
- Estimate undisclosed water requirements.
- Identify non-routine water requirements that may be a concern – e.g., are time-sensitive.

<u>2) Assessment of Habitat Requirements - Led by regulators</u>

- Investigate improvements in habitat modelling and complete modeling for all reaches of the lower Athabasca River.
- Develop a better understanding of relationships between instream water availability (river flow) and aquatic ecosystem requirements (e.g. habitat).
- Develop a monitoring program that detects fish population response to changes in river flow and other industrial developments in the lower Athabasca River.

<u>3) Assessment of Engineering/Procedural Requirements - Led by industry</u>

- Develop a complete assessment of mitigation alternatives.
- Address technical issues associated with their implementation.
- Provide a cost/benefit analysis of mitigation alternatives.

<u>4) Assessment of Water Resource Values/Socio-Economic Assessment – Led by multi-stakeholder group (e.g. WPAC or CEMA)</u>

The assessment of social, traditional, recreational and commercial values of the Athabasca River have been on-going for decades with respect to oil sands development. However, these have largely been in relation to project specific outcomes and a comprehensive assessment with respect to water allocations is considered to be the most poorly developed of the four topics listed here. An appropriate lead for synthesizing existing studies and embarking on a specific understanding with respect to water allocations has not yet been identified.

Each working group is responsible for completing their workplan by January 31, 2007. The workplans should include deliverables, proposed budget, and timelines for completion of work by the Framework deadline of July 1, 2009

Development of Monitoring and Research programs

The Framework was chosen recognizing the substantial complexity in directly equating low river discharge with impacts on the aquatic ecosystem. Definitive relationships between low flow rates and impacts do not exist for the lower Athabasca River and are rare in the international scientific literature, particularly for large rivers like the Athabasca River. Thus, the Phase 1 Framework has defined zones of risk (green, yellow, red) that are approximations of protective targets for the maintenance of in-stream flow needs. Within these zones, the framework has identified withdrawal rates that are believed to limit the risk to acceptable levels. However, these risks are acceptable under the understanding that strong research and monitoring programs are in place to support adaptive management.

The Framework has adopted protective targets on the assumption that habitat is limiting under all flow conditions. However, the withdrawals permitted under the Framework are not risk-free. Because some level of risk is inherent in allowing even limited withdrawals at low natural flows, strong research and monitoring programs must be designed immediately with the goals of relating flow and habitat conditions with biotic success and sustainability. Suitable indices of biotic health and sustainability, and of ecosystem health in general must also be identified.

a) Monitoring program: A monitoring program, such as the Regional Aquatics Monitoring Program (RAMP), should be augmented to adequately detect change in fish populations due to loss of habitat and connectivity. The monitoring program should be open to external review by river ecosystem and fisheries specialists. Data should be available to the public, an expert panel should review the monitoring program regularly, and changes deemed necessary to accomplish the objective of detecting change and supporting basic research should be incorporated.

b) Research: Research should be conducted to reduce uncertainties in IFN determination for the lower Athabasca River. Uncertainties should be identified by a group such as the CEMA – Surface Water Working Group (SWWG), reviewed by stakeholders, and used to develop research projects with river ecosystem and fish experts to reduce these key uncertainties.

Develop technical solutions

There are many potential methods for meeting the future water demands of the Wood Buffalo region. For oilsands, enhancing the efficiency of water use is by far the most attractive as it reduces withdrawals at the same time as reducing the amount of water stored in tailings. Water stored in tailings may represent the most pressing environmental liability in this region and this can be addressed by enhancing the efficiency of water use, and finding ways to either recycle or treat and discharge these waters. Off-stream storage, one potential solution to alleviate water shortages in the winter only increases the pressure on summer weeks, reduces the need to find water efficiency solutions and relocates environmental liability to the storage site while not addressing the future liability of tailings water.

Alberta Environment and DFO requested that oil sands developers provide an outline of initiatives that would support the goal of reducing the impacts of water requirements on the Athabasca River. An industry workshop, with attendance from water management experts for the mining operations, was held on May 11, 2006 to develop an inclusive list of water management options. This list of initiatives will form the basis for investigation of feasibility, benefit, practicality and cost and have been broadly categorized into:

- Integrated water management
- Technological/operational improvements
- Education/awareness
- Habitat loss and mitigation technical improvements

The process for delivering a recommendation on best practices and management options to meet industrial water needs has formally begun. It is important to note that a considerable amount of existing and planned technological/operational improvement related research is currently underway by the oil sands industry largely directed through the Canadian Oil Sands Network for Research and Development (CONRAD). As large research efforts are already underway, it is expected that new information on innovations will be available in the near future.

With respect to the integrated water management component, AENV and DFO have requested a recommendation on implementing Phase 1 from industry by January 2007.

Acquisition of socio-economic information and cost-benefit analyses

The Framework does not adequately include socio-economic considerations in the Phase 1 implementation. However, both AENV and DFO are bound by regulatory requirements to include socio-economic considerations. Socio-economic assessment of balancing water needs, environmental impacts of those needs and the environmental and social costs of mitigative/ management options is essential in developing Phase 2. The appropriate forum for initiating a socio-economic assessment may be through a combination of Watershed Stewardship Groups (WSG) and a Watershed Planning and Advisory Committee (WPAC) for the lower Athabasca River as outlined in *Alberta's Water Strategy.*

Consultation and Review

Critical to the successful adaptation to a Phase 2 Framework and its potential evolution into an approved Water Management Plan is the consultation and review process. Consultation and review will continue on an as requested basis until a formal process is established.

An overview of the timelines for the Phase 2 process are presented in Table 3. There will be a number of decision points and sub-timelines within this broad overview. At all times, AENV and DFO will be prepared to backstop the process to ensure the schedule remains on track.

3.2 Implementation of the Framework

3.2.1 Area of the Framework

The Framework will guide regulatory decision-making in upcoming applications and will provide a challenge to adaptive and cooperative management principles. The Framework will be adapted as needed based on further knowledge. Reaches 4 and 5 of the lower Athabasca River are in the area of increasing oil sands and industry activity (Figure 1) but, based on current knowledge, Reach 3 contains spawning habitat and appears to be more sensitive to withdrawals. Reach 5 begins slightly downstream of Fort McMurray and ends upstream of the confluence with the Steepbank River. Reach 4 is downstream of Reach 5, ending upstream of the confluence with the Firebag River. Reach 3 is downstream of Reach 4, ending upstream of the confluence with the Embarras River.

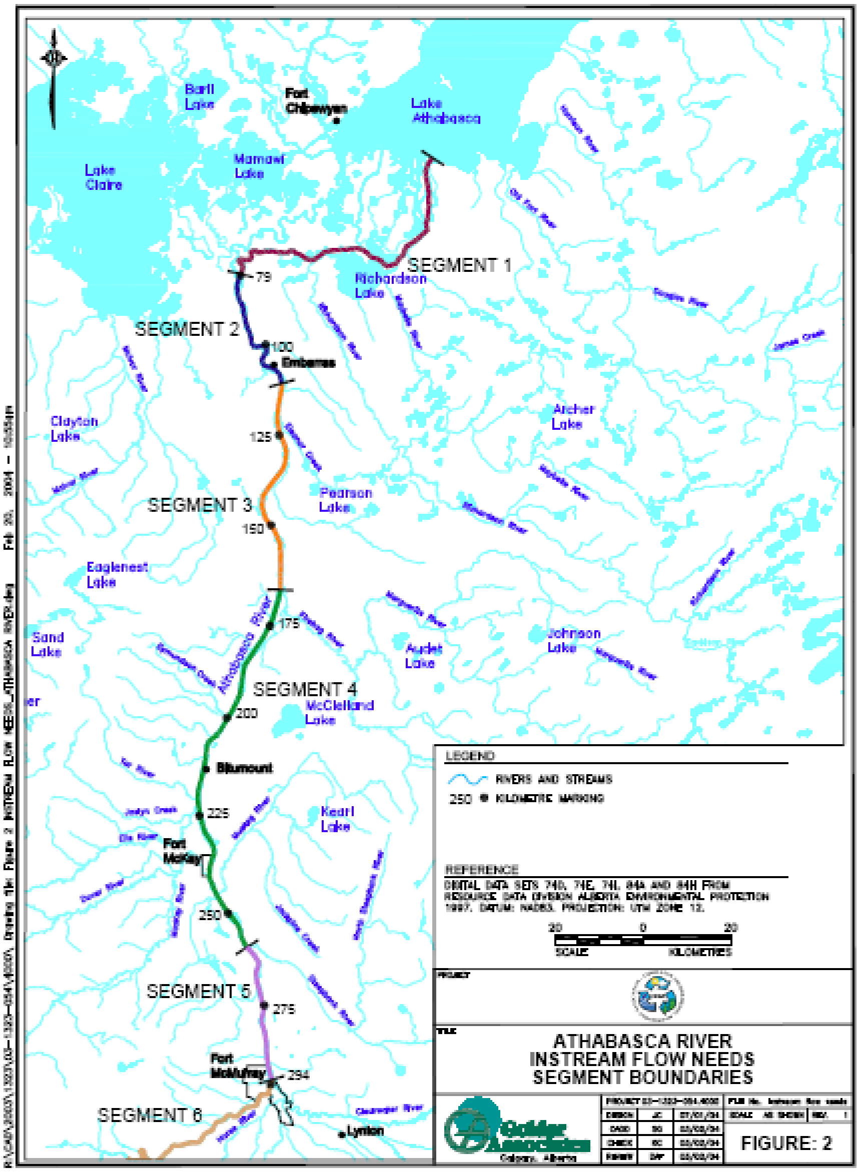

Figure 1. Athabasca River Instream Flow Needs Reach (Segment) Boundaries.

Reaches 4 and 5 have each been assigned two Framework values for each week of the year. These values separate the green-yellow Cautionary Threshold (CT - HDA80 flow) and the yellow-red Potential Sustainability Threshold (PST - Q95) condition boundaries (Table 4).

3.2.2 Phase 1 Flow Boundaries and Withdrawal Restrictions

Instantaneous flows for applying the Framework will be determined as follows:

- Reach 5: Daily recorded flows at the Athabasca River gauge below Fort McMurray.
- Reach 4: The sum of daily flows from the Athabasca River gauge below Fort McMurray and the gauge at the mouth of the Steepbank River.

Table 4. Phase 1 Values (m^3/s) for defining green-yellow and yellow-red boundaries on a weekly basis.

	Reach 4		Reach 5	
Week	Yellow	Red	Yellow	Red
1	135	106	137	106
2	129	108	128	106
3	129	100	129	101
4	128	108	127	108
5	124	107	123	106
6	120	109	119	108
7	120	103	120	102
8	120	103	119	103
9	120	102	117	101
10	121	97	120	97
11	123	100	123	100
12	130	105	130	105
13	142	111	140	111
14	148	121	145	121
15	191	139	162	140
16	286	164	295	168
17	433	261	436	264
18	506	395	504	395
19	569	445	570	434
20	605	436	602	429
21	715	496	697	488
22	721	560	734	559
23	834	656	840	648
24	862	662	932	656
25	852	685	898	675
26	928	848	994	843

	Reach 4		Reach 5	
Week	Yellow	Red	Yellow	Red
27	879	796	966	781
28	884	749	1049	731
29	816	748	942	745
30	882	680	890	675
31	801	677	812	661
32	730	598	715	588
33	715	572	704	564
34	700	539	686	533
35	598	506	596	495
36	562	463	556	460
37	517	427	513	421
38	500	368	485	360
39	466	346	451	344
40	420	328	412	327
41	395	304	388	302
42	369	295	357	290
43	362	264	358	260
44	293	246	287	244
45	271	221	245	218
46	233	176	223	169
47	201	152	175	150
48	167	118	152	120
49	156	116	149	113
50	152	109	151	108
51	149	115	146	114
52	144	107	141	107

- Yellow is defined by an amount of habitat loss which is specific to the reach for which it was calculated and is therefore not comparable between reaches.
- Red is defined by flow and should be comparable between reaches except during weeks of rapidly changing flow when numbers can be lower in Reach 4. This occurs in week 35 (Aug 27), when late summer precipitation consistently causes a rapid but short-lived increase in flow.

Table 5: Phase 1 maximum withdrawal in Reach 4 for each week

Week	Yellow m^3/s	Red m^3/s	Week	Yellow m^3/s	Red m^3/s
1	12	10	**27**	34	34
2	12	9	**28**	34	34
3	11	9	**29**	34	34
4	12	9	**30**	34	34
5	12	9	**31**	34	34
6	11	8	**32**	34	34
7	11	8	**33**	34	34
8	11	8	**34**	34	34
9	11	8	**35**	34	34
10	11	8	**36**	34	34
11	11	8	**37**	34	34
12	12	9	**38**	34	34
13	13	9	**39**	33	33
14	13	10	**40**	32	32
15	15	13	**41**	31	31
16	15	15	**42**	28	28
17	22	22	**43**	27	27
18	25	25	**44**	15	15
19	28	28	**45**	15	15
20	30	30	**46**	15	15
21	34	34	**47**	15	12
22	34	34	**48**	14	11
23	34	34	**49**	14	10
24	34	34	**50**	13	10
25	34	34	**51**	13	10
26	34	34	**52**	13	10

3.2.3 Short-Term AENV Diversion Licences

Companies may encounter unforeseen complications that require more water than planned. Collectively these are termed “upset conditions” and include emergencies or other situations that require changes in operations. Under these conditions, short-term diversion licences may be granted on a case specific basis. Guidelines for the review of short-term diversion licence applications, their longevity and levels of “Best Management Practices” while operating under a short-term diversion licence will be developed early in the Phase 2 process.

3.2.4 Proposed Implementation Methods for Phase 1

While current oilsands water use has generally been below the most stringent limits identified within the Phase 1 Framework, current licences have allowed for maximum amounts that could cumulatively exceed them. Further project development will add to the cumulative demands that are now subject to the Phase 1 limits. Water sharing or other water management options will be required to meet Phase 1 limits. The first licensed additional withdrawal will be by Canadian Natural Resources Limited in mid-2007. The Phase 1 Framework addresses cumulative withdrawals and recognizes that each company has a different capacity to deal with restrictions in water availability. AENV and DFO have directed industry to provide a plan to implement this framework by January 2007 in regards to water sharing generally and with respect to meeting the restrictions imposed by Phase 1. Pending this recommended implementation plan, the following text provides an initial view on how water sharing might occur while recognizing that the final recommendation may be different:

- Senior (Syncrude, Suncor), recent (Albian, CNRL, Shell, UTS) and new licence holders will not be impacted in green conditions given current and projected allocations.
- During yellow conditions, the Phase 1 (Table 1) cumulative maximum withdrawal criteria will be met. All licence holders will implement water use efficiencies that limit their withdrawals. All license holders will contribute to monitoring for adaptive management and monitoring programs will be implemented.
- During red conditions, the Phase 1 (Table 1) cumulative maximum withdrawal criteria will be met. Oil sands water users are currently developing a plan for allocating restricted water availability among licence holders. The industry developed plan has been requested by January 2007.

AENV is currently evaluating restrictions, as a percent of average annual allocation for each licence holder, as one method to meet the Framework should industry fail to deliver a working implementation plan by January 2007. In consultation with industry, a draft conceptual plan has been established that balances existing and proposed licensed withdrawal rates, allocations and the full utilization of on-site water storage capacity to meet the red-zone restriction during the worst years on record. This draft is currently being reviewed for accuracy, and a more detailed water balance accounting by AENV is underway. If this backstop approach is required, it will be open for review in early 2007.

3.3 Fisheries Act (Canada) Section 35(2) Authorization Requirements under the Phase 1 Framework

The Framework specifies water diversion limits that industry will be expected to meet. The proposed limits will minimize the harmful alteration of fish habitat to levels expected to maintain healthy and productive fish habitat and fisheries. However there will likely be some reduction in fish habitat from natural levels. Section 35 of the *Fisheries Act* prohibits the harmful alteration disruption or destruction (HADD) of fish habitat unless authorized by the Minister of Fisheries and Oceans (DFO). A reduction in the amount of fish habitat due to flow diversion could be considered a harmful alteration and may require authorization under the federal *Fisheries Act*. According to DFO’s Policy for the Management of Fish Habitat, no such authorizations are issued where the HADD is unacceptable. Where the HADD is considered acceptable in the circumstances, habitat compensation for the habitat loss will be required.

Based on DFO’s best current information, the Athabasca River IFN defines the river flows below which diversions could result in impacts to fish habitat and would therefore require authorization under S.35(2) of the Fisheries Act. Diversions that do not reduce flows to levels below the IFN would not be expected to result in impacts to fish habitat. Water diversions will be evaluated based on their expected diversions above and below the IFN, and authorizations or authorization amendments will be issued as appropriate. The paragraphs below outline likely Fisheries Act authorization requirements for oilsands projects under the Framework.

Existing Water Withdrawals
Since Syncrude and Suncor obtained licences to withdraw water from the Athabasca River prior to the implementation of the habitat provisions of the Fisheries Act they did not require Fisheries Act authorizations. However, any future change in operations that results in increased impacts on fish and fish habitat is subject to current legislation and may result in the requirement of a Fisheries Act authorization. As indicated above, based on current instream flow modelling and current scientific understanding, increased impacts to fish habitat are likely to occur if current diversion rates reduce the Athabasca River flows below the IFN (i.e., in the yellow or red zone according to the Phase 1 recommendation).

Previously Authorized Projects
The Albian Sands withdrawal is authorized under the *Fisheries Act*. There are specific conditions in the authorization dealing with diversion rates (maximum diversion of 4.17 m^3/s, or 1.8% of river flow, whichever is lower). Any increase in Albian Sands water withdrawals that exceed the existing authorization when flows are below the IFN would likely require a new *Fisheries Act* authorization or an amendment of the existing authorization.

New Projects
Water withdrawals from the Athabasca River by future oilsands projects may require *Fisheries Act* authorization if withdrawals are expected to reduce the instantaneous river flow below the IFN.

Authorization Conditions
Each *Fisheries Act* authorization will include mitigation, monitoring and fish habitat compensation conditions that the proponent will be required to develop and implement. Required monitoring will likely include: reporting on water withdrawals and river flows; monitoring of fish habitat impacts as a result of flow change; completion of instream flow and habitat modelling studies; and monitoring of habitat compensation works. Letters of credit may be required, and would be expected to be adequate to complete monitoring and compensation conditions of the Authorization.

Authorization Expiry
Any Fisheries Act authorizations issued during Phase 1 will be subject to review and appropriate action by DFO to ensure consistency with the Framework post-2010. New authorizations or authorization amendments may be issued at that time for each project as required, incorporating any changes coming out of the Phase 2 process. DFO will work with AENV to coordinate the respective regulatory processes to the greatest degree possible.

4.0 DEFINITIONS

For the purposes of this document, the following definitions apply:

Allocation – The volume, rate and timing of a diversion of water. When water is redirected for a use other than for household purposes use by an owner of property adjacent to a water body or from an aquifer, it is referred to as an allocation. All water users (except household users) apply to Alberta Environment for a licence to use a set allocation of water.

Aquatic Environment –The components related to, living in, or located in or on water or the beds or shores of a water body, including but not limited to all organic and inorganic matter, and living organisms and their habitat, including fish habitat, and their interacting natural systems. (As defined in Alberta's *Water Act*)

Authorization - An Authorization under the *Fisheries Act* is a legal document that allows the named proponent to cause a HADD defined in the Authorization according to subsection 35(2) of the *Fisheries Act*. See HADD for definition.

Biology - Refers to the entire living component of an ecosystem and includes the fish community, organisms upon which fish may feed (e.g., insects and periphyton), riparian vegetation and other organisms both large and small.

Conditions on Licences – The terms of the licence under the *Water Act* that must be followed.

Connectivity - Applies to the movement of energy, water, organisms and sediment to and within a riverine system through lateral, longitudinal, and vertical pathways, and also through time.

Cubic metres per second – measure of the rate of streamflow by volume, expressed as m^3/s, $m^3 \cdot s^{-1}$, cms, etc.

Ecosystem – Any complex of living organisms interacting with nonliving components that form and function as a natural environmental unit.

Ecosystem Base Flow (EBF) – Refers to a threshold streamflow value below which a component of the aquatic ecosystem is believed to be under increased stress. In Phase 1 of this Water Management Framework, the EBF is considered a critical threshold flow rate below which additional withdrawals are carefully prescribed.

Exceedence (habitat or flow) - Describes the percentage of time for which an observed amount of habitat area or streamflow is greater than or equal to a defined amount of habitat area or streamflow. Exceedences are constructed by sorting the data from highest to lowest, and expressing each data point as a percentile of the total number of values. For example, all flow values are sorted from high to low, then the 95% flow exceedence value would be the flow value that is equalled or exceeded 95% of the time, i.e. a low flow at which 95% of all flows are equal or greater. An HDAxx (e.g. HDA80) is based on a habitat exceedence calculated in this way. A Qxx (e.g. Q80) is based on a flow exceedence calculated in this way.

***Fisheries Act* -** A federal government act designed to protect fish and fish habitat.

Fish Habitat - defined in the *Fisheries Act* as spawning grounds and nursery, rearing, food supply, and migration areas on which fish depend directly or indirectly in order to carry out their life processes. Refers to aquatic environments that directly or indirectly support fish stocks or fish populations that sustain, or have the potential to sustain, subsistence, commercial or recreational fishing activities.

Geomorphology – The scientific study of patterns and processes that structure the surface of the earth. For rivers, this includes the distribution and movement of substrate (sediment and larger material) that makes up the channel bed and banks.

HADD (Harmful Alteration Disruption or Destruction) of fish habitat - Any change in fish habitat that reduces its capacity to support one or more life processes of fish. Prohibited by the *Fisheries Act* unless authorized by DFO under subsection 35(2) of the *Fisheries Act*.

HDA80 (see Exceedence)

Hydrology – The study of the distribution and movement of water quantities within a system. Streamflow is measured (m^3/s) over a time period and the natural flow pattern of a river, within years and between years, can be estimated. An understanding of natural flow patterns is required to be able to manage withdrawals and still maintain hydrological flow conditions that are appropriate for riverine ecosystems.

IFN - Instream Flow Needs / Instream Needs – This is the amount of water, flow rate, water level, or water quality that is required in a river or other body of water to sustain a healthy aquatic ecosystem.

Instantaneous Flow Reduction – A reduction in flow due to a withdrawal at one point in time, not averaged over time.

Instream Flow – The rate of flow in a river, without reference to its purpose.

Metric - A numerical index to measure loss of habitat with corresponding reductions in flow.

Natural Flow / Natural Rate of Flow – Natural flow is the flow in rivers that would have occurred in the absence of any anthropogenic effects on, or regulation of, flow. For purposes of water management, natural flow is a calculated value based on the recorded flows of contributing rivers; a number of factors concerning the river reaches (e.g. evaporation, channel losses, etc.); and water diversions. This is also known as “re-constructed flow” and “naturalized flow.”

No Net Loss Guiding Principle - DFO will strive to balance unavoidable habitat losses with habitat replacement on a project-by-project basis so that further reductions to Canada’s fisheries resources due to habitat loss or damage may be prevented.

Q80 (see Exceedence)

Reach – A portion of the entire length of a stream.

Riparian – Pertains to anything connected with or adjacent to the bank of a stream.

Riverine – Of or relating to systems that are influenced by a river.

Sediment – Solid material, both mineral and organic, that is in suspension within the streamflow or deposited on the streambed.

SSRB – South Saskatchewan River Basin.

Water Act – The purpose of Alberta's *Water Act* is to support and promote the conservation and management of water, including the wise allocation and use of water.

Water Approval – Under the *Water Act*, an approval provides authority for constructing works or for undertaking an activity within a water body. The approval includes conditions under which the activity can take place.

Water Licence – A water licence provides the authority for diverting and using surface water or ground water. The licence identifies the water source, the location of the diversion site, an amount of water to be diverted and used from the source, the priority of the "water right" established by the licence, and the condition under which the diversion and use must take place.

Water Quality – A generic term for the physical and chemical characteristics of water. Factors considered include such things as temperature, dissolved oxygen and the concentration of toxic substances or nutrients. Aesthetic characteristics such as taste, odour and turbidity are also considered.

Withdrawal – Water taken from a stream for off-stream use.

5.0 CONTACTS FOR FURTHER INFORMATION

If you have technical or scientific questions about the setting of instream flow values, the above Framework, or if you would like to request source data used in this Framework, please contact:

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If you have water licensing or approval questions regarding implementation of the Framework, please contact:

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APPENDIX 1 Instream Flow Needs: General Overview for Non-technical Readers

What is Instream Flow?

There is a difference between a general understanding of the term "instream flow" and the meaning it has in a legal and regulatory sense.

In general terms, "instream flow" refers to the amount of water flowing in a stream or river at any given time. It can vary widely due to season, snowmelt, recent rainfall, and temperature. It can also vary due to vegetative cover, characteristics of the soil and geology, and the amount of water moving through the soil (groundwater) that feeds the stream or river. In the lower Athabasca River flows are naturally low during the winter.

However, the legal or regulatory meaning of the term "instream flow" refers to a recommended flow for a stream or river that is determined through scientific studies that result in an Instream Flow Need (IFN) recommendation. An IFN recommendation is scientifically defensible and identifies the amount of water necessary to maintain and protect an aquatic ecosystem. An accepted ecological principle used to determine instream flow needs is the maintenance of flow variation over time that mimics natural cycles of high, medium, and low flows, and thus addresses the needs of the multiple components of an aquatic ecosystem. Specifically, a recommended flow for a stream or river is expressed as a volume of water per unit time, such as cubic meters per second (m^3/s, $m^3 \cdot s^{-1}$, or cms), at a specific location for a specified time period. Instream flow recommendations are determined relative to the natural flow and natural habitat (the flow and habitat that would have occurred in the river without the intervention of humans).

How is an Instream Flow Need Recommendation Determined?

Determining how much water a stream or river needs is a complex task. Many scientifically supported methods exist to determine an IFN. The process begins with the establishment of a technical team that works together to evaluate a number of approaches. The team then selects what they consider to be the best approach for setting an IFN to protect the aquatic ecosystem and determine an instream flow need. The technical team would be comprised of experts from various fields that are relevant to the river system in question.

It is increasingly recognized that effective river management must consider all river components. The *Instream Flow Council* suggests the following river components be considered when determining an IFN recommendation:

- hydrology
- biology
- geomorphology
- water quality
- connectivity

While each of these components is its own distinct science, each is clearly interrelated with the others in complex ways making the science-based part of an instream flow determination a challenging process. For the lower Athabasca River IFN determination, all 5 components were considered. However, the main focus was on hydrology and biology since hydrology directly measures what is changed (reduction in flows due to withdrawals) and biology, particularly fish, were considered to be the most sensitive indicators of stress from low flow conditions.

Determining IFN threshold values for streams and rivers and evaluating impacts due to human influence on them is a developing science. Research over the last decade suggests that a river's natural flow regime both within and between years has a major influence on the overall health of a river. Although we have gained a broad understanding of river ecosystems, much work remains to better understand the relationships between the amount of water in streams at different times of year and stream health.

It is important to remember that setting an instream flow does not ensure that the specified amount will actually be available. Setting an IFN recommendation is a complicated process. Although the scientific part of an IFN recommendation is essential, both public involvement and legal / institutional requirements must also be considered. A water management system or framework uses the IFN recommendation in addition to economic, social, political and societal values to determine how the river will be managed.

Why is an Instream Flow Need Recommendation Important?

Fresh water is a limited and precious resource. Water withdrawals create the challenge of balancing water uses that reduce or alter stream flow with the human activities and ecological values that depend upon this flow. Sufficient water in streams is necessary to sustain the aquatic environment. Flows affect water levels in streams, rivers, wetlands, lakes, and ponds and are an important aspect of water quality. Instream flow need determinations help water managers plan for future water needs by protecting stream flows.

APPENDIX 2 Context for the Water Management Framework

Regional Sustainable Development Strategy (RSDS) for the Athabasca Oil Sands Area

Oil sands activities in northeastern Alberta have become increasingly important as part of Alberta's overall economic development. In the late 1990's the Alberta Government took steps to initiate a strategy to address potential environmental cumulative effects in the oil sands region. The *Regional Sustainable Development Strategy for the Athabasca Oil Sands Area* identified and prioritized 72 environmental issues within the region. Among these were water related issues. A stakeholder group, the Cumulative Environmental Management Association (CEMA), was formed in partnership with Alberta Environment and Alberta Sustainable Resource Development with the goal of providing recommendations to Regulators that address potential environmental cumulative effects. CEMA members include government, industry, NGOs (non-governmental organizations), and Aboriginal representatives.

CEMA was tasked with developing a year-round instream flow needs (IFN) framework recommendation for the lower Athabasca River and providing government regulators with a recommendation for approval by the end of 2005. The recommendation would establish environmental criteria and management systems to guide future allocations for water withdrawal from the lower Athabasca River. The IFN Task Group of the Surface Water Working Group of CEMA was formed to address IFN issues on the lower Athabasca River based on the following objective: *Develop a defensible, science-based IFN recommendation that provides full, long-term protection to the aquatic ecosystem for the lower Athabasca River*.

Regulatory Hearings

The Alberta Government and Fisheries and Oceans Canada (DFO) made commitments in 2003 to provide recommendations for an IFN and a water management system for the lower Athabasca River if CEMA could not provide a recommendation by the end of December 2005. These commitments were made during federal-provincial regulatory hearings for the Canadian Natural Resources Horizon Project and the Shell Jackpine Phase 1 Project. The establishment of a Framework and water management system for the lower Athabasca River would preserve the future integrity of the river and ensure that limits are in place to manage the cumulative impacts of existing and future water withdrawal allocations prior to water withdrawals by new water licence holders.

CEMA Work

CEMA's work to establish environmental criteria to address the instream flow needs of the lower Athabasca River has followed the latest thinking in the IFN scientific community. It has also significantly advanced IFN methodology because an IFN determination for an ice-covered river system has never before been completed. Major challenges in the CEMA work have included a lack of national and international resources on IFN methodology for ice covered rivers in northern climates, development of ice-covered hydrodynamic models, collection of fish habitat use information during winter, understanding the implications of the results, and workplan adaptations.

CEMA stakeholders have worked actively to develop the recommendations. However, CEMA had forecast a delay in providing the recommendations by the target date of December 2005. The IFN Task Group of CEMA's Surface Water Working Group was on track with their workplan and timeline until a May 2005 scientific workshop produced key results that pointed to additional unknowns, additional data, alternative approaches, and habitat structures such as eddies / backwaters identified by Aboriginal participants that must be considered in the lower Athabasca River IFN determination.

These additions to the workplan were addressed, but this delayed finalization of an IFN and overall water management framework recommendation. As a result, CEMA was unable to meet the December 31, 2005 deadline, and AENV and DFO developed this Water Management Framework to meet commitments made at hearings.

APPENDIX 3 Methodology Behind the Water Management Framework

The Water Management Framework

The purpose of the Framework is to protect the aquatic ecosystem of the lower Athabasca River while allowing development to occur. For Alberta, the maintenance of healthy sustainable aquatic ecosystems is enshrined in the *Alberta Environmental Protection and Enhancement Act* (EPEA) and the *Alberta Water Act*. Fisheries and Oceans Canada policy aims for no net loss of fish habitat on a project by project basis.

The Framework contains two components:

1) An IFN recommendation designed to provide protection of the aquatic ecosystem,

2) A water management system that allows withdrawals below the IFN recommendation but defines thresholds that trigger management responses. It also provides a path forward for future monitoring and research and a process to develop an adaptive management system based on that information.

Determining the IFN Recommendation

A comprehensive IFN examines the impacts that future water withdrawals and discharges will have on water quality, fish habitat, river geomorphology and riparian vegetation. The IFN is meant to provide guidance for the near future and is based on the historical flow record. A re-evaluation of the water management system threshold values will be required if the current flow record is no longer representative of future flows. Table A1 identifies the components and relevant studies on which the IFN is based.

Given the low total projected withdrawals, impacts are most likely to occur during low flow conditions and thus only pose significant threat to the water quality and biology (fisheries) components. Although some preliminary work was done on river geomorphology and riparian vegetation, it was not sufficient to make IFN recommendations. It was acknowledged that at the scale of withdrawals for the oil sands industry, river geomorphology and riparian vegetation is very unlikely to be affected. Current water quality modeling using extreme drought conditions (flows as low as 50 m^3/s were modelled, minimum recorded flow from 1957-2004 is 75 m^3/s) indicates that water quality is not likely to be a limiting factor because:

1) Release (discharge) from reclaimed areas and on-site storage of process affected water will not become significant until the future when most withdrawals will have subsided and,

2) The quality of future releases will meet guidelines for the protection of aquatic life.

Therefore, to date the IFN has been based on fish habitat results from reaches 2 to 5 during open water and reaches 4 and 5 during ice cover. Riparian vegetation requirements were considered when setting the cautionary threshold (CT) during the freshet by using the SSRB (South Saskatchewan River Basin) riparian minimum flow recommendation. It is expected that the CEMA work will continue and will address all components and all reaches of the lower Athabasca River.

Table A1. Studies providing the basis for establishment of the IFN.

Component	Studies	Author	Date
Hydrology	Description of River ice Processes	KGS Group	Apr-01
	Overview of Numerical Hydraulic Models of River Ice Conditions	KGS Group	May-01
	Survey of Athabasca River at Fort McKay	Trillium	Oct-01
	Survey of Athabasca River at Peter Lougheed Bridge	Trillium	Jun-02
	R2D-ICE module for RIVER2D version 0.01 and Users Manual ("R2D-ICE")	U of A	Sep-02
	Manual of River Ice Analysis: Rule of Thumb Manual On Ice Processes	KGS Group	Jan-03
	Athabasca River Model Update and Reach Segmentation	Golder Associates Ltd.	Mar-04
	Comparison of the one-D and cdg1-D models in the lower Athabasca River Basin to estimate high flows during open water season	Environment Canada	NA
	2004 Summer and Winter Bathymetric Surveys on the Lower Athabasca River	Trillium	2004 - 2005
	A Compilation of Information and data on water supply and demand in the Lower Athabasca River Reach	Golder Associates Ltd	Oct-05
Water Quality	Development of reach specific water quality guidelines for variables of concern in the lower Athabasca River	Western Resource Solutions	Aug-03
	Future water concentrations and investigation levels for water quality constituents pertinent to IFN determination in the lower Athabasca River	Golder	Draft Jan 06
Geomorphology	Method to Determine Channel Structure flows for the Lower Athabasca River	Golder	Sep-05

Component	Studies	Author	Date
Biology	Habitat Use by Over Wintering Fish in the Lower Athabasca River: 2001 Pilot Field Study	RL&L	Feb-02
	Evaluating Fish Overwintering Use of the Lower Athabasca River: Site Selection and Recommendations	RL&L	Feb-02
	Fish Overwintering Use Of The Lower Athabasca River: Winter / Spring 2002. Progress Report #1	Golder Associates Ltd	Apr-02
	Fish Overwintering Use Of The Lower Athabasca River: Winter /Spring 2002.Progress Report #2	Golder Associates Ltd	Jun-02
	Winter Fish Use and Movement Using Radio Tags	RL&L/ Golder Associates Ltd	Jun-03
	Fish Overwintering Use of the Lower Athabasca River (2001 to 2003)	RL&L/Golder Associates Ltd	Oct-03
	Fish Overwintering Use of the Lower Athabasca River 2001 - 2004	Golder Associates Ltd	Sep-04
	Fish Overwintering use of Lower Athabasca River	Golder (RL&L Environmental)	May-05
	Instream Flow Needs Habitat Suitability Curve Development Workshop	Watershed Systems Group	Jun-05
	Flow Simulations and Fish Habitat Evaluation for the Athabasca River at Bitumount (Reach #4)	Trillium Engineering	Jan-05
	Flow Simulations and Fish Habitat Evaluation for the Athabasca River at Northlands (Reach #5)	Trillium Engineering	Mar-05
	Flow Simulations and Fish Habitat Evaluation for the Athabasca River at Embarras (Reach #2) for Summer Flow Conditions	Trillium Engineering	Jun-05
	Flow Simulations and Fish Habitat Evaluation for the Athabasca River at Poplar Point (Reach #3) for Summer Flow Conditions	Trillium Engineering	Feb-06
Connectivity	IFN Needs Study Scoping in the Lower Athabasca River	Golder Associates Ltd.	Aug-04

Biology (Fish Habitat)

Methods for directly determining the impact of reduced water availability on the aquatic ecosystem are not available for the lower Athabasca River and to our knowledge are rare in the international scientific literature. Typical of most IFN studies, modelled fish habitat area versus flow relationships were used for the lower Athabasca River. While the use of fish habitat is the current best practice, future IFN development should include:

- Other ecosystem indicators such as riparian vegetation or benthic invertebrates if these are determined to be sensitive to changes in flow.
- The fish habitat modelling considered only depth and velocity. Other fish habitat characteristics of importance like substrate, particularly for spawning life stages, need to be investigated.
- The winter under-ice modelling CEMA and its partners developed for the lower Athabasca River was a first for IFN studies. There is interest in refining the models to more realistically simulate under ice and ice formation conditions

There is an Instream Flow Needs Technical Task Group (IFNTTG) within the CEMA umbrella that is addressing the future monitoring requirements and research needs. This work will be a key component for adaptation to the Phase 2 IFN.

Natural Flow Regime

The prevailing scientific literature on instream flow needs indicates that a natural flow regime is the best way to protect the aquatic ecosystem (Poff et al. 1997). Preserving seasonal cycles is important, as a river and the ecosystem it supports is a product of the energetic forces dissipated over the natural range of variability. The life histories of fish and other aquatic species are adapted to high and low flows at appropriate times of year. For example, high flows are required in spring for fish that spawn at this time while fish that spawn in the fall do best with typical low flows in fall.

Preserving year-to-year fluctuations is important for maintaining the diversity of species in the aquatic ecosystem. Some species do best in dry years while others do best in wet years. To maintain these species in their natural proportions, fluctuations in flow from year to year need to be preserved.

The natural flow regime is reproduced by using a percent withdrawal approach. As long as the percent withdrawal is not too severe, the IFN will mimic the natural hydrograph, providing wet and dry seasons and wet and dry years at the appropriate time.

At the same time, it is recognized that the potential impact from water withdrawal is greatest at low flows. The allowable percent withdrawal is therefore reduced at low flows to accommodate this increased ecosystem sensitivity. This is accomplished through the use of an ecosystem base flow (EBF) or cautionary threshold (CT). An EBF is a flow below which no withdrawals are recommended. It is based on the premise that at low flows, the aquatic ecosystem is more sensitive to water withdrawals.

Habitat Metrics

To evaluate the risk to fish habitat, a series of habitat metrics have been developed in Alberta to help define an IFN prescription. The method compares the change in suitability-weighted habitat area (weighted usable area or WUA) using the natural flow record compared to a proposed withdrawal scenario. To define the IFN, the maximum of the:

1. flow corresponding to an 80% habitat exceedence (HDA80 flow), or
2. the Q90 (to protect riparian vegetation following the SSRB recommendation)

was used for the cautionary threshold (CT) for each week of the year. The IFN was set at the largest percent reduction in flow that does not exceed any of the metrics assuming no water withdrawal below the CT. This approach and metrics were developed for the South Saskatchewan River Basin (SSRB). The approach has been generally adopted across Alberta but is referred to as the SSRB method. The metrics of the SSRB method are:

- **Mean Loss** - A 10% reduction in average habitat from natural habitat for the most sensitive fish life stage for the entire simulation period. This metric requires that high flows be stripped from the simulation period (simulation period is 1957-2004 for the lower Athabasca River). This metric checks overall or chronic impacts from water withdrawal.

- **Maximum Weekly Loss** - A 15% reduction in average habitat from natural habitat for any week of the year. The metric is calculated for the average change in simulated habitat for each week of the year for all years (1957-2004 flow record for each of week 1, 2, 3, etc.). It is a check to determine if certain seasons or weeks are being unduly impacted by the withdrawal.

- **Maximum Instantaneous Loss** - A 25% reduction in habitat from natural habitat for any week of any year. This metric independently evaluates each week of the period of record to look for any habitat bottlenecks. Every week of every year in the simulated withdrawal is compared to natural for the corresponding week (e.g., week 43, 1964). This metric is a check on habitat bottlenecks or acute habitat impacts from water withdrawal.

The premise for stripping high flows is that the model is not properly simulating fish habitat at these very high flows. All of the fish habitat curves peak at some value and then decline at higher flows. For example, Goldeye Adults in Reach 5 peak at 1500 m^3/s. Reducing flow from 2000 m^3/s to 1800 m^3/s mathematically results in a habitat gain. The model boundaries are restricted by surveying methods and at high flows the margins of the river are not realistically simulating velocity and depth. In addition, the model does not address the moderating influence of floodplain vegetation on fish habitat at high flows.

For the Athabasca River, the method of stripping was modified slightly from the SSRB approach. All flows higher than the peak of the habitat-flow curve for each life stage were stripped from the period of record. The SSRB approach stripped all flows (high and low) in weeks where the median exceeded the peak of the habitat-flow curve.

Unlike the SSRB approach, the Phase 1 Framework allows withdrawals in the 80 to 100% exceedence range. Therefore, it is important to determine what habitat impacts are occurring during those more sensitive periods. The three SSRB metrics were applied to the 80 to 100% exceedence habitat range. However, high flows were not stripped from the period of record when calculating the 80 to 100% mean loss. The results for the overall and 80 to 100% exceedence habitat metrics are presented in Table 2 of the main body of the Framework.

The weight of opinion from international work supports between 10 to 20% reductions in flow at the 80% to 90% flow exceedence as the basis for assessing shifts to high-risk conditions (e.g., Brizaga and Arlington 2001, Tharme and King 1998, Clipperton et al. 2003). The same studies consistently indicate that there is a low flow below which withdrawals should not occur similar to the EBF concept in the SSRB approach. Again, each of these studies are consistent in suggesting that between the 80% and 95% flow exceedence there exists a range of potential impacts from measurable but recoverable to critical and unsustainable.

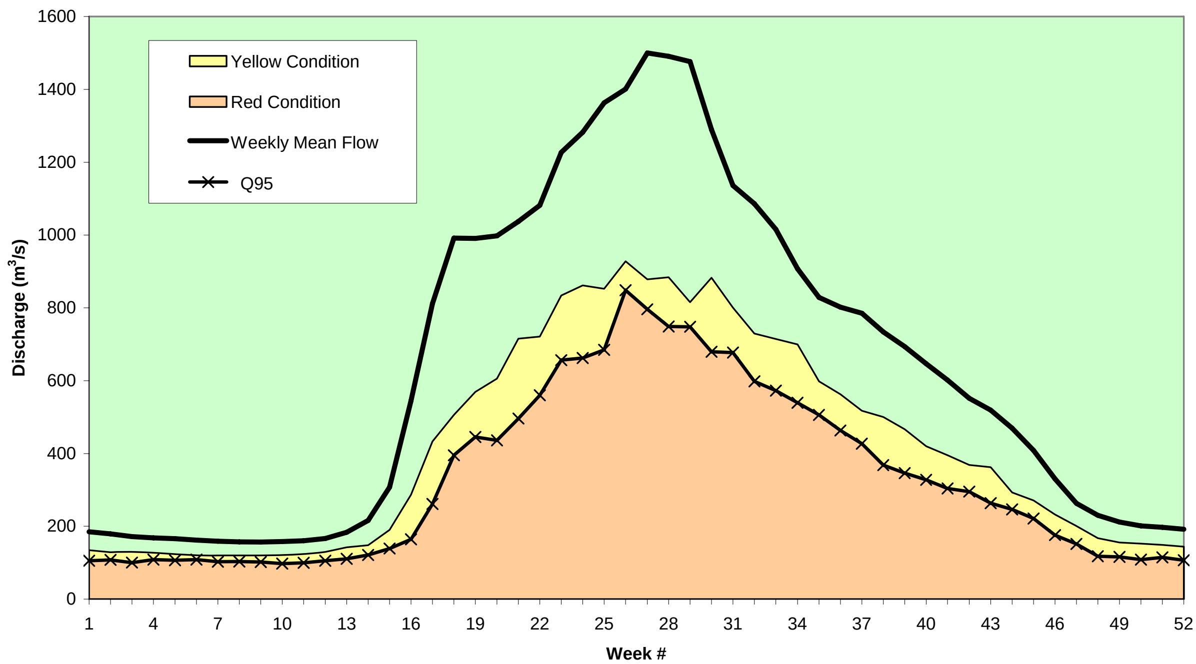
AENV, SRD (Alberta Sustainable Resource Development) and DFO jointly reviewed the habitat simulation data, the international contributions to IFN determination, and performed additional threshold assessment and statistical comparisons of habitat loss. These tests indicated increased risk of impacts to aquatic ecosystems begin to occur at the 80% habitat exceedence flow (HDA80 flow).

Summary of the IFN Threshold Values – Phase 1

The results of the habitat simulation indicated a 15% withdrawal is allowable until flow is lowered to values corresponding to the Cautionary Threshold (CT). The definition of the CT is the higher flow value of either the 80% habitat exceedence (HDA80) or the 90% flow exceedence (Q90). The 90% flow exceedence was adopted from the South Saskatchewan River Basin recommendation that this was a minimum required for maintenance of riparian vegetation. The HDA80 was calculated for each week and for each species and lifestage for which habitat suitability curves were available. The highest value, representing the most sensitive species or lifestage, was chosen for each week. For Reach 4, adult longnose sucker were most sensitive and therefore defined the HDA80 in most weeks except later summer weeks, which were determined by adult goldeye.

Below the CT there exists a critical flow threshold termed the Potential Sustainability Threshold (PST). The PST was defined as the 95% flow exceedence. An example of the derived management zones in relation to typical flows in the lower Athabasca River is presented in Fig. A1.

Figure A1: Lower Athabasca River IFN indicating flows for the mean year (1958-2004)



Note: The intent of this figure is to graphically display the values presented in Table 2 of the main body of the Framework. In the green zone, a maximum of 15% of the instantaneous flow would be available for withdrawal, not the difference between instantaneous flow and the green-yellow line (the CT).

The Cautionary Threshold – Yellow zone

The yellow zone is where impacts may begin to appear, providing the green zone restrictions are met. It is believed that water withdrawal impacts in this zone, if they occur, would be short-lived. When flows are within the yellow zone, maximum cumulative withdrawals should not exceed 10% of instantaneous river flow. Given the difficulty in implementing instantaneous restrictions the method was modified to use 10% of the mid-point between the green-yellow and yellow-red boundaries. The difference of this approach from an instantaneous approach during winter weeks is within rounding errors. The 10% reduction is consistent with international scientific literature where effects are expected when hydrologic properties are altered by more than 10% between the 80% and 90% flow exceedence (Brizga and Arthington 2001). The 10% reduction is further restricted by maximum withdrawal limits. Maximum cumulative withdrawals are limited to 15 m^3/s during winter ice-covered conditions and 5% of the HDA80 flow or 34 m^3/s, whichever is less during spawning and 34 m^3/s during the remainder of the ice-free time period.

Winter weeks are weeks 1 through 15 (Jan 1 to early April) and weeks 44 through 52 (late Oct. to Jan.), spawning occurs during weeks 16 through 24 (April through early June) and the remaining open water weeks (summer) are weeks 25 through 43.

Figure A2

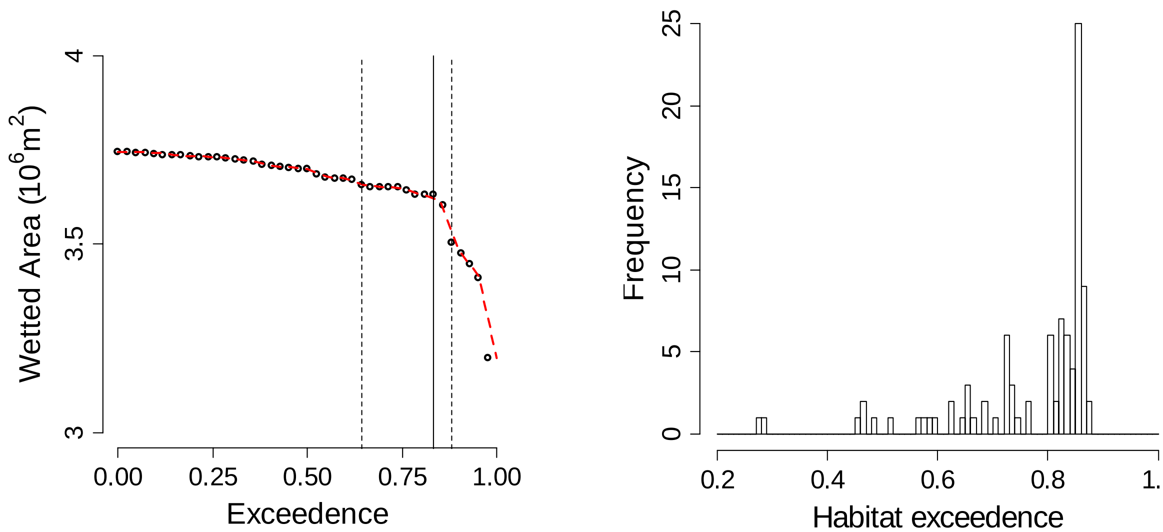


Figure A2. a) Threshold analysis demonstrating the rapid decline in wetted area at low flows corresponding to the 80% flow exceedence for a given week and segment. b) A summary of thresholds for reaches 4 and 5 for all weeks.

Threshold Analysis – The following text is adapted from: Andrew J. Paul (2006 DRAFT) Determining an Ecosystem Base Flow for Full Protection of the Aquatic Environment in the Lower Athabasca River. Alberta Sustainable Resource Development

Sale et al. (1981) proposed a method to defining minimum flow recommendations using habitat duration curves which incorporate both: a) the relationship between discharge and available habitat (i.e., the habitat response curve); and, b) variability in natural discharge. Accounting for magnitude and frequency of habitat availability through duration curves is important as it imposes conditions under which communities have evolved and adapted (Sale et al. 1981). For example, a population can be resilient to severe low flow conditions even when recruitment is eliminated within that year if the frequency of low flow events is much less than the generation time for the population.

The threshold analysis can be used to define flow thresholds in the absence of process-driven information for populations by identifying breakpoints in habitat duration curves (Figure A2a). An EBF [CT] for the lower Athabasca River was developed by assessing breakpoints in habitat duration curves for different segments of the river. Habitat was measured as wetted area as it: 1) maintains a constant relationship with discharge provided channel morphology is not altered; 2) increases monotonically with discharge (i.e., it never decreases with increasing discharge); and, 3) is not based on subjective opinion. Breakpoints in the habitat duration curves were identified quantitatively using the methods of Bai (1997) and Bai and Perron (2003). Confidence intervals (CI) for breakpoints were based on Bai (1997).

Figure A2b summarizes the thresholds for all weeks and segments tested. The majority of thresholds occur at habitat exceedences between 80% and 90%.

The Potential Sustainability Threshold - Red Zone

The yellow – red demarcation is termed the Potential Sustainability Threshold (PST) and was defined as the 95% exceedence flow. This is a zone where withdrawal impacts are potentially significant and long-term, depending on duration and frequency withdrawals. Consequently, withdrawals have to be carefully managed in this zone. Two analyses were used to determine the total cumulative withdrawal allowed in the red zone:

1) A confidence interval approach for determining limits of significant change to ensure the severity of existing low flow conditions are not increased significantly.
2) An assessment of change in frequency and duration of red and yellow conditions to ensure the length of exposure to low flow does not increase significantly.

To assess the significance of increasing the severity of low flow conditions, the historic range of weekly mean flows was used to construct 90% confidence intervals (CI_{90}) for the habitat available to the most sensitive species during winter (Longnose Sucker - LNSC). The range in habitat enclosed in the CI_{90} was converted back to the corresponding range in flow. The range in flows was consistently between +/- 6.6 and 7.7 m^3/s for winter weeks 1 through 13 and up to 25 m^3/s when all winter weeks are included. For ease of implementation the one-sided confidence interval flow for each week was converted to a percentage of the median weekly flow. This ranged between 4% and 8% not including the most extreme variable spring weeks and averaged 5.23% of median weekly flow across all winter weeks, excluding weeks 44 and 45. Weeks 44 and 45 could not be included because flows occurring during these two weeks are outside the range (too high) of the winter habitat curves used to predict habitat loss. Not including these two weeks results in a more protective water management framework because the extreme variation in these weeks would increase the CI interval. A withdrawal limit within the PST of 5.2% of median weekly flow was considered to be within a reasonable level of statistical detectability. This approach effectively employs statistical significance as a proxy for biological significance. In addition to the 5.2% withdrawal limit within the PST, AENV and DFO propose an upper limit of 15 m^3/s ice-covered conditions and 5% of the HDA80 flow or 34 m^3/s, whichever is less during spawning and summer ice-free time periods.

To validate this approach, AENV and DFO considered changes in frequency and duration of yellow and red conditions under incremental reductions in median weekly flow of 1 to 15 m^3/s. A flow reduction of 5.2% of median weekly flows to a maximum of 15 m^3/s results in a maximum increase of red zone frequency and duration less than 15%, and a 4% mean decline in habitat availability for combined yellow and red conditions.

Climate Change

The development of the IFN and water management system is based on available information on historical flows in the Athabasca River. If flows were to generally decrease due to climate change, restrictions of the Framework would be invoked more frequently. If flows were to generally increase, there would be fewer instances that restrictions on withdrawals would be necessary.

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