North Saskatchewan Watershed Alliance

Preliminary Steps for the Assessment of Instream Flow Needs in the North Saskatchewan River Basin

March 31, 2014

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The North Saskatchewan Watershed Alliance (NSWA) is a non-profit society whose purpose is to protect and improve water quality and ecosystem functioning in the North Saskatchewan River watershed in Alberta. The NSWA is guided by a Board of Directors elected from its membership, which includes organizations and individuals. It is the designated Watershed Planning and Advisory Council (WPAC) for the North Saskatchewan River under the Government of Alberta's *Water for Life Strategy*.

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We would like to gratefully acknowledge the Government of Alberta for their continued support of WPACs in Alberta.

Acknowledgements

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Alberta Environment and Sustainable Resource Development contributed financial support through the *Water for Life* program. Andrew Schoepf and Dave Mussel of AESRD facilitated the funding process.

A key element of this project was the Expert Advisory Group workshop, ably facilitated by Jim Gendron. We gratefully acknowledge the contribution of time, knowledge and experience provided by the participants:

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Executive Summary

This project, "*Preliminary Steps for the Assessment of Instream Flow Needs in the North Saskatchewan River Basin*", is intended to provide further guidance to the NSWA and its stakeholders on the assessment of Instream Flow Needs (IFN) in the North Saskatchewan River (NSR) watershed. This project is also intended to support an ongoing discussion of water resources management in this river basin and assist in long-term planning.

The report includes a brief history of Alberta's water management legislation, the current water management system, and the use of IFN assessments in that system. It also outlines the range of instream water uses to be considered and existing guidance for assessing Instream Flow Needs.

A major element of the project was convening an expert advisory group to review IFN needs and priorities for the NSR watershed. The result was the identification of three broad priorities: leadership and engagement of stakeholders in IFN discussions; access to more hydrologic information and development of water management models; and more information on the state of aquatic and riparian ecosystems, and fisheries, throughout the watershed.

This report also contains a preliminary assessment of environmental flow requirements, calculated using the *Alberta Desktop Method,* for certain locations on the mainstem NSR where natural flow data were available. The effects of hydro-electric dams on the annual hydrograph were characterized in this assessment, as were diurnal flow fluctuations. A comparison of recorded flows versus environmental flow requirements was also conducted for the Sturgeon River.

Several recommendations for further work are presented.

1.0 Introduction

The North Saskatchewan Watershed Alliance (NSWA) was appointed by Alberta Environment in 2005 as the *Watershed Planning and Advisory Council* for the North Saskatchewan River basin under the terms and concepts embodied in *Water for Life: Alberta's Strategy for Sustainability*. The NSWA has made substantial progress under this mandate and in 2012 released an *Integrated Watershed Management Plan* (IWMP) for the North Saskatchewan River basin. This major undertaking provides advice and direction to protect the long-term supply and quality of water resources for future generations. Implementation of IWMP recommendations is now underway through the development of watershed partnerships with local authorities and stewardship groups, and the development of expert working groups to deal with scientific issues and needs across the basin.

The NSWA advocates that the water resources of the NSR basin require a comprehensive approach to management in which future supply, future demand, Instream Flow Needs and trans-boundary commitments are carefully evaluated in systematic, ongoing planning and management processes. Water quantity management needs for the NSR are addressed specifically under IWMP Goal 2:

Goal 2: Instream Flow Needs of the NSR Watershed Are Met

Watershed Management Directions**:**

2.1. Evaluate existing and future risks to surface water supply in the NSR watershed.

2.2. Assess and develop Instream Flow Needs for the North Saskatchewan watershed.

Action 2.2.1 Evaluate Instream Flow Needs for the protection of a healthy aquatic ecosystem, water quality, fish habitat, riparian zones, channel maintenance and water intake structures.

2.3. Manage water quantity in NSR watershed to meet Instream Flow Needs.

To support the implementation of recommendations under Goal 2, the NSWA proposed that an IFN information/methodology review be completed in 2013-14 for the NSR and its major tributaries. The NSWA also proposed the development of an Expert Working Group to lead the work and thereby improve our regional capacity to undertake IFN studies.

The NSWA advocates the development of Instream Flow Needs (IFN) for multiple uses to provide the targets to guide future water resources management. However, evaluating flow needs for all uses, for all reaches, for the NSR mainstem and for all its tributaries is an enormous task. This challenge is reflected in the report "*North*

Saskatchewan River Instream Flow Needs Scoping Study" (NSWA 2007) prepared as part of the IWMP process. It identified a significant range of IFN tasks, methodologies, time frames and costs required to develop site-specific Water Conservation Objectives for the mainstem of the NSR alone.

This project, "*Preliminary Steps to the Assessment of Instream Flow Needs in the North Saskatchewan River Basin*", is intended to provide further guidance to the NSWA and its stakeholders on the assessment of Instream Flow Needs (IFN) in the North Saskatchewan River (NSR) watershed. This project is also intended to support an ongoing discussion of water resources management in this river basin and assist in long-term planning.

This project has several components:

- Identifying current and future instream issues related to flow management within the NSR basin
- Reviewing IFN methodologies and guidance that may be applicable to the NSR basin
- Assessing recorded flows in the NSR watershed in relation to environmentally protective flows calculated using the *Alberta Desktop Method* (AENV 2011)
- Developing work priorities to guide future action

2.0 Water Management Legislation in Alberta

This section provides historical background related to the development of Alberta's surface water management system. Instream Flow Needs are developed according to the technical assessment and requirements of various instream uses, but can only be implemented through the delivery mechanisms embedded in Alberta's current water management legislation and policies.

Water management in Canada was originally based on the "doctrine of riparian rights", meaning the right to use water was restricted to those who owned property adjacent to a water body. This changed in 1894 when the Government of Canada passed the *Northwest Irrigation Act,* followed by its successor the *Irrigation Act* in 1898. Within what would become the Provinces of Alberta and Saskatchewan these Acts implemented a publicly administered system of allocating and licencing water rights to all landowners, including those not adjacent to a water body. Each licence specified source, an annual water volume, maximum diversion rate, point of diversion and purpose of use.

A fundamental part of this system was the concept of "first in time first in right". This means that in times of a water shortage the most senior (earliest) licences can continue to divert up to their maximum diversion rate before junior (more recent) licences are allowed to divert any water. During shortages this system does not necessarily promote sharing or conservation, and may not leave enough water to protect the aquatic ecosystem.

Ownership and management of Alberta's water resources was transferred by the Federal Government to the Province by the 1931 *Natural Resources Transfer Act*. At the same time Alberta adopted new legislation, the *Water Resources Act*, which continued with the pre-established water allocation and licencing system.

The concept of "minimum flows" was first incorporated into the terms and conditions of a licence under the *Water Resources Act* in 1969. The minimum flow concept gradually grew into the more comprehensive Instream Flow Needs concepts developed in the 1990's. The development of Instream Flow Needs recommendations requires considerable technical information; the implementation of such advice also requires the consideration of associated social and economic impacts.

Major changes were made to the water resource management system when the *Water Resources Act* was replaced by the *Water Act* in 1999. The new act "grandfathered" water rights previously granted under the *Water Resources Act* and continued the "first in time first in right" system. Among the changes made were: the concept of public consultation as part of water management planning; protection of the aquatic environment; and the development of new water management tools (Water Conservation Objectives and Water Management Plans).

2.1 Water Management Planning

Direction for water management planning under Alberta's *Water Act* (1999) is currently provided by the "*Framework for Water Management Planning*" (2001) which also contains the "*Strategy for the Protection of the Aquatic Environment*". The criteria to set priorities for undertaking water planning initiatives are provided in the document and it requires these priorities to be developed with public consultation.

The first criterion is the pressure on the resource, which includes: current and future water demands; water quantity, quality, and aquatic ecosystem issues; and the extent or impact of the pressure. Another criterion is the extent of public concerns: health, environmental, economic or social; and their urgency.

"*Water for Life: Alberta's Strategy for Sustainability*" has also guided water resource management in Alberta since its inception in 2003. It continues to do so through the *Water for Life Renewal* released in 2008. Among the management principles outlined in these documents, several relate directly to the issue of Instream Flow Needs:

- All Albertans must recognize there are limits to the available water supply

- Healthy aquatic ecosystems are vital to a high quality of life for Albertans and must be preserved
- Alberta will operate the water management system to meet transboundary agreements

One of the three goals of the strategy is that Alberta's aquatic ecosystems are maintained and protected. One of the outcomes for this goal is: "*Management and allocation of water to sustain aquatic ecosystems … is maintained*" and a key action is to: "*Set water conservation objectives on all major basins*".

Water Conservation Objectives are defined in the *Water Act* as follows:

> "water conservation objective" means the amount and quality of water established by the Director under Part 2, based on information available to the Director, to be necessary for the
> (i) protection of a natural water body or its aquatic environment, or any part of them,
> (ii) protection of tourism, recreational, transportation or waste assimilation uses of water, or
> (iii) management of fish or wildlife,
>
> and may include water necessary for the rate of flow of water or water level requirements.

Water Conservation Objectives can be stipulated in a Water Management Plan (a plan authorized by a Director), or in an Approved Water Management Plan (a plan approved by the Government of Alberta Cabinet).

2.2 Instream Uses

Sustaining natural, diverse, and healthy aquatic and riparian ecosystems is a fundamental instream water use and a specific goal of "*Water for Life: Alberta's Strategy for Sustainability*". These ecosystems have evolved within the natural variability of their flows and the interactions between flow and other basic features of the ecosystem. The more human intervention changes flow and its natural variability, the greater the impact on the aquatic and riparian ecosystems is likely to be.

Important aspects of the hydrology or flow regime include:

- Typical flow rates and ranges
- Scale, frequency, and timing of extreme high and low flows
- Rates of changes in flows
- Ice formation and movement
- Annual and inter-annual flow patterns

Basic features of an aquatic ecosystem, including the riparian zone, that are directly or indirectly related to the flow regime are:

- Instream Biological Habitat
  - Habitat quality reflects physical, chemical and other attributes
- Connectivity
  - The pathways that move organisms, energy and materials through aquatic and riparian ecosystems
- Geomorphology
  - Channel and floodplain formation and maintenance
  - Sediment movement
  - Bank stability and erosion
- Water Quality
  - Dissolved oxygen, pH, temperature, major ion chemistry, dissolved and suspended solids
  - Nutrient concentrations
  - Natural concentrations of trace inorganic and organic chemicals

Instream flows may also be required to support a variety of human uses that will depend on the specific stream, or portion of it, being considered. These could include:

- Operation of water intakes for municipal, industrial, or agricultural purposes, each of which may require specific minimum flows and/or water levels. Intakes may also be affected by ice conditions, channel location and depth, and bank conditions, which are in turn influenced by instream flow rates and patterns.
- Maintenance of channels and banks so that infrastructure such as bridges, roads, intakes, outfalls and pipelines are not damaged
- Maintenance of satisfactory water quality for: potable raw water supply; agricultural, commercial and industrial water supply; and recreational purposes. This is generally related to having sufficient flow to dilute and assimilate contaminant discharges
- Navigation and aesthetics

In the case of the North Saskatchewan River, there is also a legal, minimum, instream flow requirement. The *Master Agreement on Apportionment* between the Federal Government and the Provinces of Alberta, Saskatchewan and Manitoba stipulates that Alberta must allow 50% of the river's natural flow to pass into Saskatchewan, calculated on an annual basis.

A conceptual diagram of the many factors and considerations that are involved in the development of Instream Flow Needs, and incorporating them into Alberta's water resources planning and management system, is presented in Figure 1.

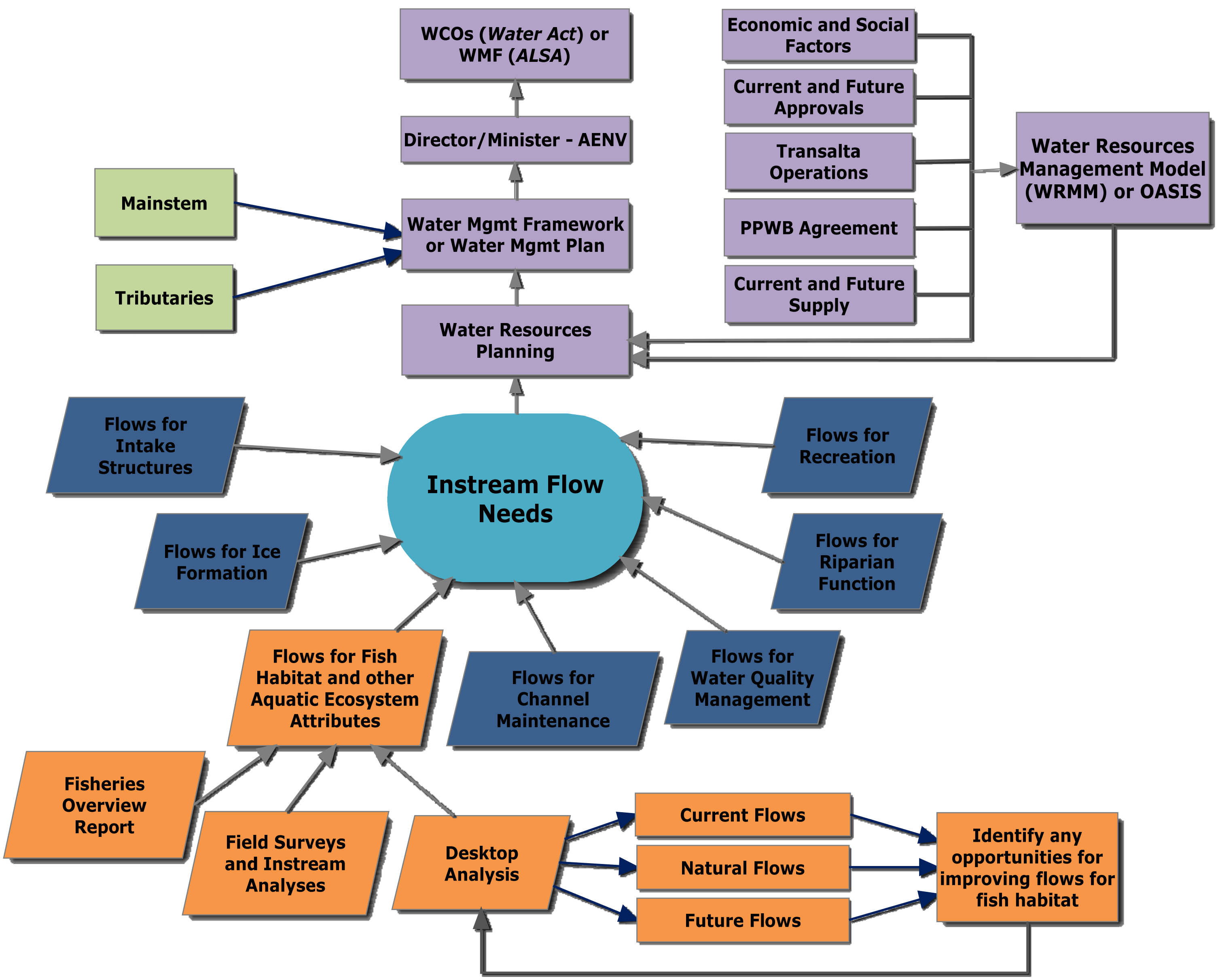

Figure 1. Instream Flow Needs Assessment as a Component of the Water Resources Management System in Alberta.

3.0 Water Supply and Demand

3.1 Current Water Supply and Demand

The mean annual discharge of the NSR at the Alberta/Saskatchewan boundary is approximately 7.3 billion cubic meters. Most of this annual supply (6.7 billion cubic meters) is generated in the headwaters of the basin, above the Brazeau River confluence. The uppermost hydrologic region (above Lake Abraham) contributes approximately 3.6 billion cubic meters annually from an area that represents only 7.2% of the watershed area (Golder Associates 2008).

The North Saskatchewan River is a partly regulated system. Seasonal flows in the middle and lower reaches of the North Saskatchewan River are affected by two hydro-electric dams in the headwaters: the Brazeau Dam on the Brazeau River which became operational in stages during 1965-67; and the Bighorn Dam, upstream of Rocky Mountain House on the North Saskatchewan River mainstem, which became operational in 1972.

These dams change the annual pattern of the river flow. Compared to the natural regime, flows are now lower in the summer and higher during winter (Figure 2). Water is stored by these dams during the spring and early summer high-flow period and released during the fall and winter to generate hydro-electric power. Higher winter flows also improve the reliability of the drinking water supply and support the dilution and assimilation of point-source effluents, particularly from the Capital Region. These hydroelectric operations are owned and operated by TransAlta Corporation.

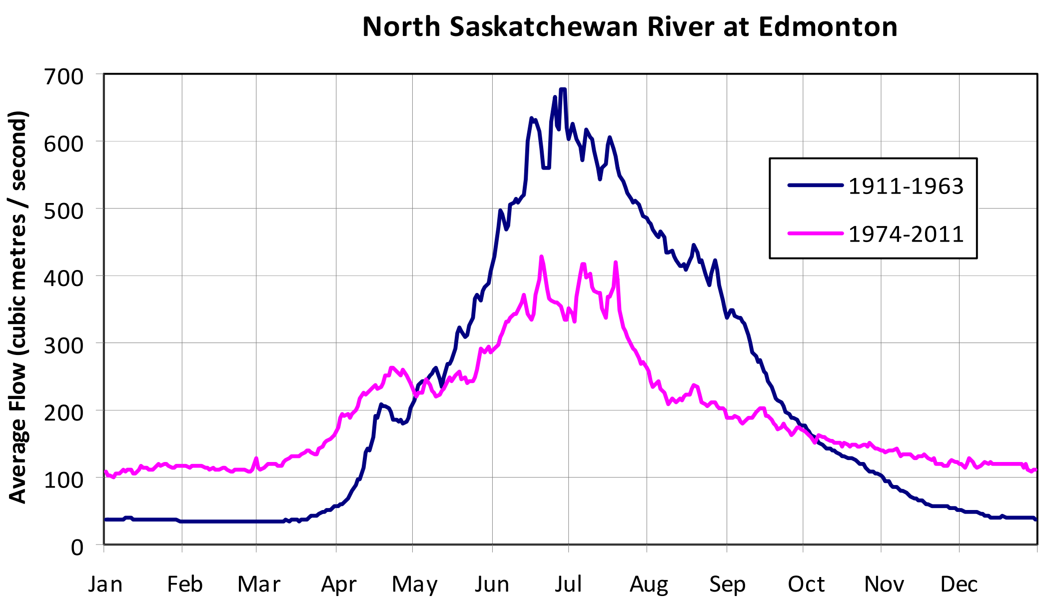

Figure 2. Change in Average Weekly Flows Between 1911-1963 (natural period) and 1974-2011 (regulated period) from Water Survey of Canada Data.

The total annual surface water allocation to all sectors in the North Saskatchewan River Basin (NSRB) has been estimated at approximately 2 billion cubic meters, or about 27% of the river's mean annual discharge (AMEC 2007). Of this figure, the annual consumptive water use was estimated at about 0.19 billion cubic meters, or 2.6% of the annual supply.

The annual volumes of allocation and use, by sector, are summarized in the following table. Overall, the level of consumption remains low at the basin-scale of analysis. Water consumption data for major tributaries have not been developed and require further analyses.

Sector	Allocation (m^3 x 10^9/yr)		Actual Use (m^3 x 10^9 /yr)	
Industrial	1.660	84%	0.092	49%
Municipal	0.158	8%	0.007	4%
Petroleum	0.089	5%	0.034	18%
Agriculture	0.016	1%	0.016	9%
Commercial	0.014	1%	0.011	6%
Other	0.034	2%	0.026	14%
TOTALS	1.971	100%	0.187	100%

3.2 Future Water Supply and Demand

Long-term changes to the water supply arising from natural climate cycles, land use effects and climate change must be considered in future water resources planning and management processes. Under the most probable climate change scenarios available Alberta would experience up to a 15% increase in annual precipitation and an increase in mean annual air temperature. The surface water hydrograph would be affected, both in terms of volume and in timing of flow, depending on how rainfall and snowfall patterns change. Increased air temperatures would likely extend the summer season allowing more evaporation to occur. In summary, most predictions show less snowfall, more rainfall, and drier late summer and fall periods. Long-term

An analysis of future water demand in the NSRB was also prepared by AMEC (2007). In that analysis certain assumptions were made. Since the extent of future water conservation initiatives remains unknown, future water use projections were based on a "business as usual" approach. Future water use was projected for low/medium/high rates of population and economic growth. Projections were made at five year intervals up to 2025.

Based on a medium growth rate, annual surface water use was expected to increase from 0.19 to about 0.26 billion cubic meters by the year 2025. In relation to the annual river discharge of 7.3 billion cubic meters, actual water use was therefore projected to increase from 2.6% to 3.5%, assuming average river discharge rates remain unchanged. Nearly all of the projected increase in surface water use was predicted to be in the Petroleum sector, and would be due to bitumen upgraders and coal gasification projects proposed at that time for the Capital Region. However, most of these projects have been deferred indefinitely.

Population growth and economic development present the greatest and most immediate pressures on the water resources of the NSRB. However, climate change has the potential to complicate management expectations as current infrastructure and water management allocation systems are built around the analyses of historic flow patterns. An ongoing surveillance of water supply and demand patterns in the NSRB is warranted.

4.0 Existing Flow Management Guidance

NSWA has produced a detailed IFN Framework (NSWA 2007) that outlines IFN evaluation methodologies that could be employed to determine flow needs for the protection of riparian ecosystems, fisheries habitat, water quality and channel morphology. The application of the methodologies proposed for the NSRB in this report has not proceeded, but significant related progress has been made via Government of Alberta initiatives: the publication of *"A Desktop Method for Establishing Environmental Flows in Alberta Rivers and Streams"* AENV (2011); and "*The Water Management Framework for the Industrial Heartland and Capital Region"* AENV (2008).

4.1 The Alberta Desktop Method

The report entitled "*A Desktop Method for Establishing Environmental Flows in Alberta Rivers and Streams*" was published by Alberta Environment as a *Water for Life* support document in 2011. The report describes a generic flow management approach that is intended to fully protect the aquatic environment in the absence of detailed, site-specific, technical information needed to establish a protective flow.

Meeting the *Desktop* limits is intended to ensure a very low probability of affecting the aquatic ecosystem. It does so by minimizing departures from natural flow variability, including peak events. The Desktop IFN formula, when applied to the statistical natural flow record for a given flow period (weekly, monthly) provides an environmental flow recommendation (that flow required for the protection of the aquatic environment, including fish and fish habitat). It was developed primarily for rivers that have natural flows and for which site-specific Instream Flow Needs data are not available. However, it can also be used "*…to assess the degree of impact on flows in highly regulated* *systems…"* such as the NSR, and in systems where there is a high degree of flow allocation.

The Desktop IFN value is defined as the greater of either:

- A 15 per cent instantaneous reduction from natural flow, or
- The lesser of either the natural flow or the 80% exceedance natural flow

Exceedance refers to the percentage of time that measured stream flow is greater than or equal to a specified, specific stream flow. Low flow events have high exceedance percentages because most observed flows exceed a specific low flow. Similarly, high-flow events have low exceedance percentages because most observed flows are lower than the high flow levels.

In effect, this formula means flow should not be reduced at all when it is less than the natural flow experienced 20% of the time for a particular week or month of the year. This provides a minimum base flow for the ecosystem. At the higher natural flows which occur 80% of the time the flow can be reduced up to 15% so long as the base flow (i.e. the flow experienced 20% of the time) is maintained.

4.2 Industrial Heartland Water Quantity Guidelines

The proposed development of up to seven bitumen upgraders in the Capital Region Industrial Heartland in the first decade of 2000 prompted Alberta Environment to examine potential cumulative environmental effects. Although water supply from the NSR mainstem was deemed adequate to sustain considerable growth, weekly "targets" for maximum water consumption were developed and reported in "*The Water Management Framework for the Industrial Heartland and Capital Region*" published in 2008. These water consumption targets were based on the recorded flows (post-hydroelectric dam construction) and were determined for each week of the year as follows:

- Flow > 80% exceedance < 15% of flow
- Flow < 80% but > 95% exceedance < 10% of flow
- Flow < 95% exceedance < 5% of flow

During very low flow periods (i.e. < 95% exceedance) the most restrictive consumption target was calculated to be 4 m^3/s for some weeks in winter, but ranged as high as 10 m^3/s for a few weeks in mid-summer. Current consumptive use (i.e. surface water withdrawn and not returned to the watershed) was estimated to be 3.5 m^3/s.

4.3 Sturgeon River Basin Water Management Plan

A report entitled "*Sturgeon River Basin Water Management Plan Phase 1 Water Management Analysis Current Conditions"* (Unitech Solutions Inc 2005) was prepared for AENV to support development of Water Conservation Objectives for instream flow as part of a proposed Water Management Plan for the Sturgeon River. It documents the process of setting up and verifying the *Alberta Water Resources Management Model* for the Sturgeon River watershed, including runoff, evaporation, lake levels, lake storage volumes and consumptive water use.

Part of this work evaluated the ability to maintain a selected minimum instream flow of 5 ft^3/s (0.14 m^3/s) at a number of points throughout the Sturgeon River watershed. The report concluded that this minimum flow was very often "not met" upstream from Lake Isle, and in all five of the main tributary creeks. Downstream of the four lakes in the system flow was only occasionally less than 5 ft^3/s, and thus the proposed flow target was met more frequently. This Water Management Plan was not completed.

4.4 Other Alberta River Basins

Most of the IFN studies in Alberta have been done for the South Saskatchewan River Basin (SSRB) due to the scale of water management and use, primarily for irrigation agriculture, and the effects this has had on the aquatic and riparian environment. Some studies, for example "*Instream Flow Needs Determinations for the South Saskatchewan River Basin, Albert, Canada"* (AENV 2003) evaluated flows needed to fully protect key ecosystem components. Other reports, such as "*Aquatic Environment Impact Ratings: a Method for Evaluating SSRB Flow Scenarios Red Deer River Case Study"* (AENV 2007), evaluated the ecosystem impacts of adopting a range of alternative flow management scenarios relative to the fully protective scenario. Results of these studies were considered in the process leading to the finalization of Water Conservation Objectives contained in the "*Approved Water Management Plan for the South Saskatchewan River Basin (Alberta) August 2006*" under the *Water Act*.

5.0 IFN Work Priorities

A workshop with an Instream Flow Needs Expert Advisory Group was held at the offices of Alberta Environment and Sustainable Resource Development (AESRD) on February 13, 2014. The purpose of the workshop was to:

- Share technical information and perspectives on IFN issues in the North Saskatchewan River watershed.
- Identify and set priorities for IFN requirements within the NSR watershed.
- Prepare project work plan guidance for each of the agreed IFN priorities.

The workshop included a presentation and orientation to the history of the science supporting IFN work, the water management system, water allocation and use within the North Saskatchewan River mainstem, as well as planning considerations and similar experiences in other watersheds in Alberta, North America and internationally. This was followed by the identification of IFN research requirements that the group believed should be the focus for the NSR mainstem and tributaries. The listing was reviewed, assessed for priority, grouped and requirements described to begin to develop a work plan to address the recommended priorities. The full report prepared by LTG Consulting is attached. (See Appendix 1: "*NSWA Instream Flow Needs Workshop Draft Report of Results"*). The detailed presentation by Allan Locke is attached as Appendix 2.

5.1 Engagement and Communication

The need to engage stakeholders in supporting IFN implementation was identified as the first priority by the Expert Advisory Group. This recognizes technical work will likely not proceed unless stakeholders collectively recognize the need and are prepared to provide the necessary resources, or work with AESRD to do so. The NSWA Board provides a key multi-sector forum that could further review this recommendation and seek endorsement from the stakeholders represented.

The current municipal partnership initiative to develop a management plan for the Sturgeon River Watershed has been identified as an opportunity to continue with a full IFN determination and recommended water conservation objectives. The "*Sturgeon River State of the Watershed Report* (City of St. Albert 2012) discussed this topic and noted that an instream flow needs scoping study was done in 2004. This study found hydrologic data and evaluation were incomplete, water quality was a concern, and aquatic ecosystem data was insufficient for a detailed IFN. However, additional hydrologic, water management, and watershed modeling were subsequently conducted by AENV in 2005. This combination of active watershed management planning with significant existing investment in hydrologic and water management studies makes this the most viable opportunity to start implementing the Directions and Actions under Goal Two of NSWA's IWMP.

5.2 Develop Water Use Data and Water Management Models

Current information on actual water use, particularly at monthly or weekly increments, is generally not available to calculate natural flows, support IFN development or the systematic use of the Water Resources Management Model (WRMM) in the NSR watershed. Adequate current flow data are also required for these purposes, but are lacking at many locations.

The costs of developing natural flow data for each sub-basin were estimated to be in the \$30,000 - \$50,000 range. AESRD were also identified as the most appropriate agency to lead this work given their authority and responsibility for the hydrometric network and the reporting of water use.

Such information would be particularly valuable for the Sturgeon River Watershed planning that is currently underway. Similar information has been developed for the Sturgeon watershed in the past by AESRD, but needs to be updated using the most recent data available. An effort will therefore be made by NSWA, in conjunction with the Sturgeon River Watershed Alliance Steering Committee, to have AESRD reflect this priority in their 2015-16 work planning. Alternatively, it may be possible for NSWA to access an AESRD for a *Water for Life* project grant to undertake this work.

Another zone where updated, detailed water use information and WRMM development would be valuable is for the diverse Industrial Heartland and Capital Region, and for the energy producing utilities in the Wabamun region. As noted in Section 4.2, limitations on water consumption within this portion of the NSR have been published. Also some initial work was done on developing WRMM during the early stages of the Industrial Heartland Cumulative Effects Management Project. However, the model is not in use and weekly water use data are necessary to be able to evaluate current water use with respect to the limits proposed in the IH-CR Water Management Framework. AESRD would be the appropriate agency to undertake this work.

5.3 Environmental Monitoring and Assessment

The Expert Advisory Group identified that current levels of environmental monitoring and assessment on the NSR mainstem and major tributaries were not adequate to assess key components of the aquatic ecosystem. The areas where more information is needed included tributary water quality, status of fish resources and habitat, and geomorphology.

At the scale of the entire watershed, the work and cost involved would be enormous and it would be unrealistic to expect that it could all be done in the foreseeable future. However, such work would be reasonable to propose at the scale of the Sturgeon River watershed and is necessary to support the watershed planning that is currently underway.

The other area where additional aquatic monitoring would be very useful is in the NSR mainstem downstream of the dams. As noted previously, the dams have altered the flow regime such that it differs significantly from the Desktop IFN throughout most of the year and under most flow conditions. An overview study of fish species and community structure, abundance, migration patterns, spawning habitat and health could provide an initial assessment of the affects on the aquatic ecosystem. It may also provide an indication of how sensitive the existing system could be to future increases in water consumption or to changes in the flow regime. A detailed protocol for this type of work is available: *Fish Survey Methods for Rivers: AESRD, ABMI and ACA Collaboration*

AESRD (2011). Leadership from AESRD and significant resources are required for such a study.

At some point in the future a more detailed and comprehensive approach to Instream Flow Needs assessment, such as the site-specific physical habitat assessments and instream analyses conducted for the South Saskatchewan River Basin (AENV 2003), may be needed for the NSRB. However, the Alberta Desktop Method (AENV 2011)provides an optional first step in the overall approach and can be used to screen tributaries to identify potential problem areas.

6.0 Flow Evaluations using the Alberta Desktop Method

To provide context and further background for discussing these IFN issues and priorities, NSWA contracted Sal Figliuzzi and Associates Ltd. to calculate Desktop IFN flows for three gauged sites on the NSR and one on the Sturgeon River where natural flow data were available (see Appendix 3: "*North Saskatchewan Basin - Comparison of Historical Observed Flows to Desktop Instream Flow Needs*"). The IFN flows were then compared with recent measured flow data to identify locations or time periods when IFN flows were not met. Natural flow data are unavailable for all other major tributaries, precluding any widespread assessment of environmental flow requirements.

6.1 North Saskatchewan River Mainstem

The Bighorn and Brazeau Dams regulate the flow of the NSR by storing water from mid-May to mid-October. Stored water is then released over the late fall to early spring period for the purposes of generating hydroelectric power and maintaining sufficient flows for municipal and industrial water supply, as well as for effluent dilution and assimilation.

To illustrate the effect of the dams on the NSR, three gauged sites (Rocky Mountain House, Edmonton, and the Alberta-Saskatchewan Border) were evaluated for the period 1973-2010 (Figures 3, 4 and 5). Naturalized flow data (defined as measured flows that are adjusted for upstream water licences or uses to approximate the flows that would occur in the absence of regulation and extraction) were used to compute weekly instream flow requirements using the Desktop method. Measured flows were then compared to these environmentally protective flows to determine how frequently the latter were being met. Also, the scale of impact was quantified for each week using the median, maximum and minimum of the ratio of measured flow to the Desktop flow requirement. The results of these screening analyses are as follows:

- Median weekly winter flows (November – April) in the North Saskatchewan River at Rocky Mountain House, Edmonton and the Alberta-Saskatchewan Border exceed the calculated Desktop IFN flow rates in nearly all years and are in the order of 250-350% of the weekly Desktop IFN (Figures 3, 4 and 5).

- Median weekly summer flows (June – August) in the North Saskatchewan River at Rocky Mountain House meet the calculated Desktop IFN flows in less than 5% of all years, and were on the order of 55-80% of weekly Desktop IFN (Figure 3).

- Median weekly summer flows in the North Saskatchewan River at Edmonton and at the Alberta Saskatchewan Border meet the calculated Desktop IFN flows in less than 10% of all years and were about 60-80% of weekly Desktop IFN (Figures 4 and 5).

Operation of the dams also causes diurnal flow fluctuations of 0.2-0.3 metres in river water level throughout much of the year at both the Rocky Mountain House and Edmonton gauge sites. Larger fluctuations of up to 0.5 metres are associated with ice formation and break-up conditions.

These evaluations suggest flow regulation may be having some effect on the aquatic ecosystem. However, the analyses do not give any indication of how significant that effect might actually be; as noted in the workshop report, more detailed information on *in situ* ecosystem responses is required.

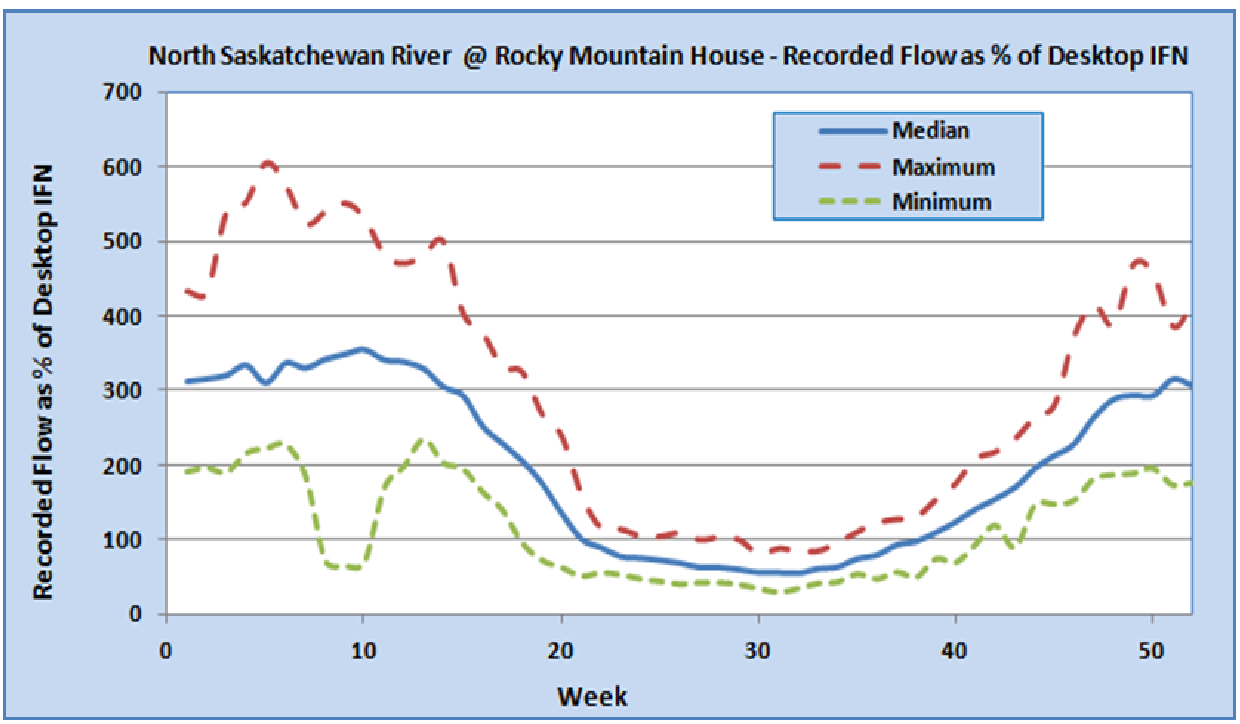

Figure 3 – North Saskatchewan River at Rocky Mountain House – Recorded flow as percent of "Desktop IFN".

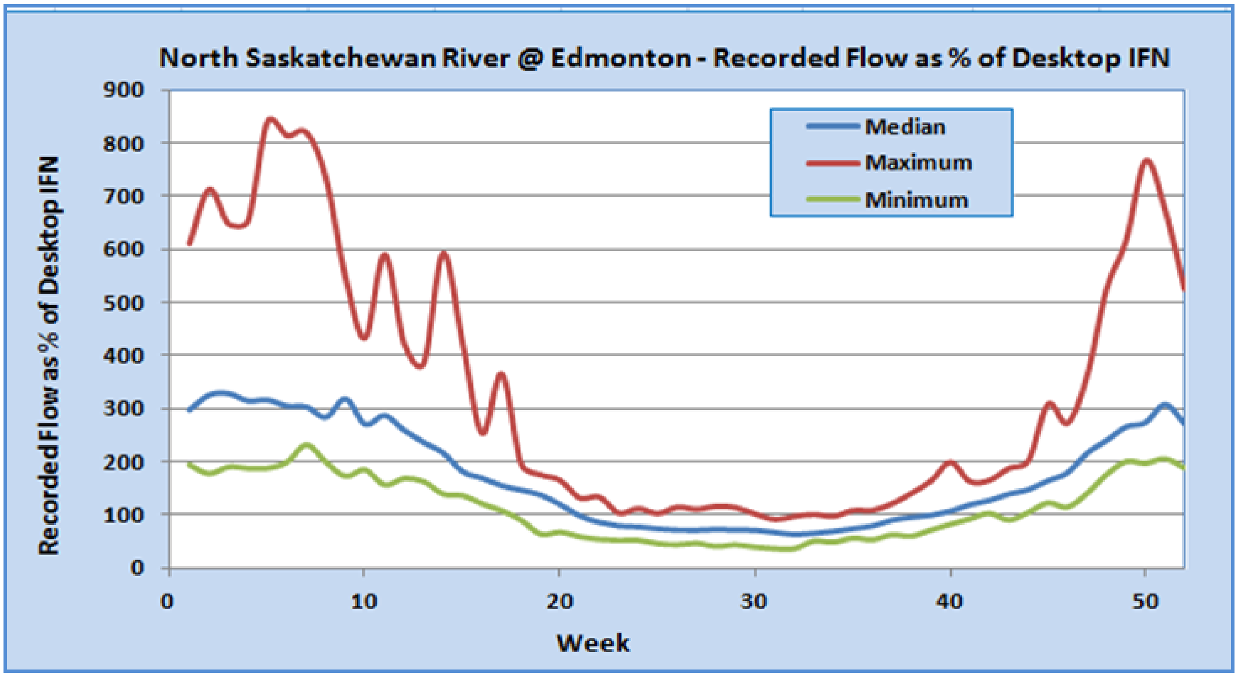

Figure 4 – North Saskatchewan River at Edmonton – Recorded flow as percent of "Desktop IFN".

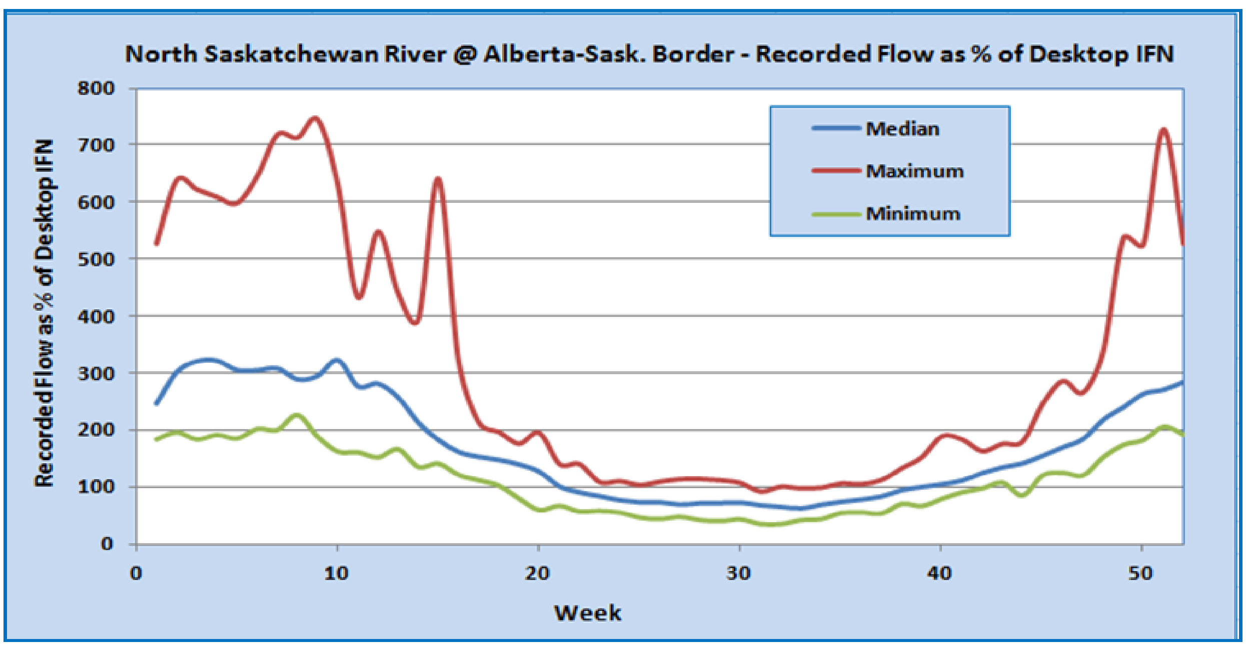

Figure 5 – North Saskatchewan River at Alberta-Saskatchewan Border – Recorded flow as a percent of "Desktop IFN".

6.2 Sturgeon River

A similar comparison of the ratio of recorded flows to environmentally protective flows calculated using the Desktop method was prepared for the Sturgeon River at its confluence with the NSR (near Fort Saskatchewan). The most recent 20 year period of available natural flow data, 1972 to 1991, was evaluated. The analysis did not include the period from November through to March as the flow monitoring gauge is only operated during the open water season. The result of this screening analysis is a follows:

- The recorded median weekly flow in the Sturgeon River at Fort Saskatchewan is in the order of 110% of the Desktop IFN.

- The minimum recorded median weekly flow has been as low as 15% of the Desktop IFN and the maximum has ranged from about 115% during most weeks to about 280% in March (weeks 10-12) and about 140% in October (weeks 40-43).

- The maximum ratios in March and October are attributed to historic releases from municipal wastewater lagoons that were in place at that time and from the pumping of groundwater to lower the water table within the Town of Stony Plain. It is noted that since the formation of the Capital Region Wastewater Commission in 1986, the release of Stony Plain and Spruce Grove wastewater lagoons into the Sturgeon River system no longer occurs. The March and October flow peaks would likely be much lower now.

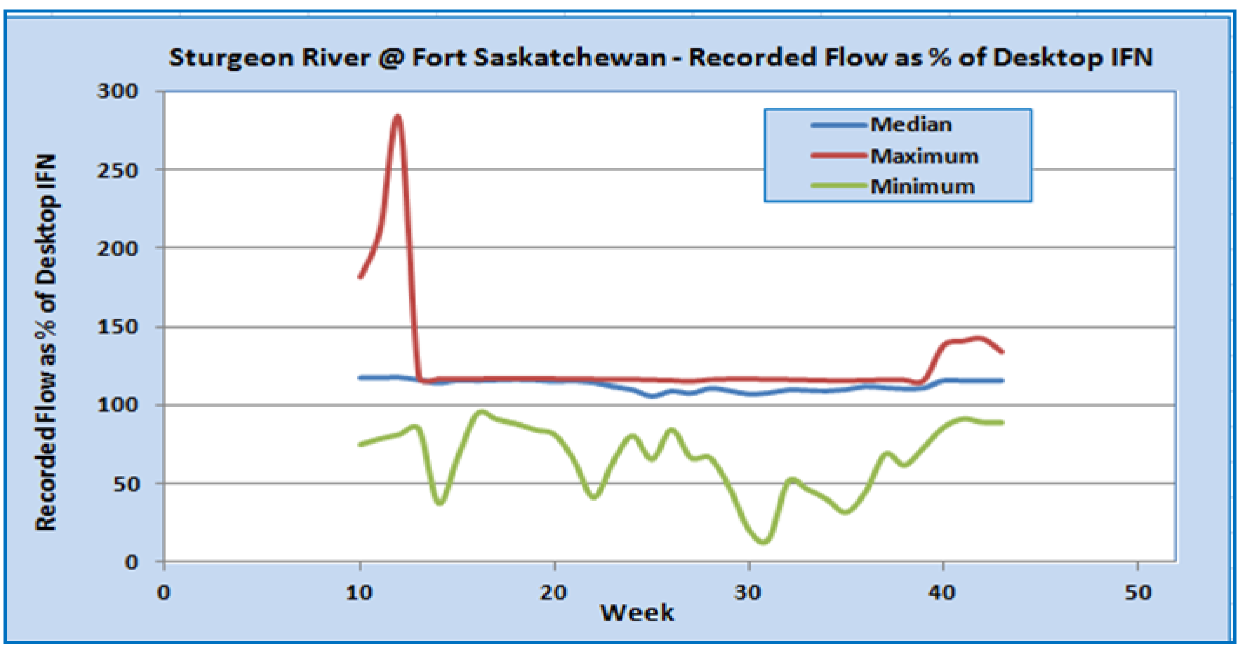

Figure 6 – Sturgeon River at Fort Saskatchewan (1972-1991) – Recorded flow as percent of "Desktop IFN".

Most of the lower values were observed in August to mid-September which coincides with largest licenced consumptive water uses in the watershed (irrigation and water level stabilization). This suggests that consumptive water uses in the Sturgeon River basin might be affecting aquatic ecosystem health, but again the analysis gives no indication as to the degree of impact.

Twenty two years have elapsed since the last data year used in this analysis and additional water allocations have been made since then. It is speculated that current recorded flows, as a percentage of environmental flows, may be significantly lower than is indicated by Figure 6.

These analyses using the Desktop method are presented to offer preliminary insights into current flow patterns for the mainstem NSR and one major tributary. Natural flow data are unavailable for all other major tributaries, precluding any widespread assessment of environmental flow requirements.

7.0 Recommendations and Proposed Work Plan

The purpose of this project was to initiate a broad discussion on the topic of Instream Flow Needs development for the mainstem and tributaries of the North Saskatchewan River. In order to support this discussion a review of information sources dealing with water policy, NSR water supply and demand, IFN methodologies and aquatic ecological information was conducted, and expert advice was solicited. Priorities for further work were proposed and evaluated.

Significant technical information deficiencies must still addressed throughout the NSR basin in order to proceed with IFN development. Many of these deficiencies were identified previously in Golder (2007).

The Expert Advisory Group workshop resulted in the identification of three broad work priorities: leadership and engagement of stakeholders in IFN discussions; access to more hydrologic information and development of water management models; and more information on the state of aquatic and riparian ecosystems, and fisheries, throughout the watershed.

In consideration of advice received, the following projects are recommended for the three year period 2014-17:

- Calculation of the natural flow record to 2014 and Desktop IFN assessment for key sites in the Sturgeon River Watershed. ***Year 1***

- Assessment of current water supply and demand information for other key tributaries, the latter to be prioritized according assessments in the AMEC (2007) report and discussions with AER/AESRD regulatory staff. Calculation of the natural flow record to 2014 and Desktop IFN assessment for these prioritized tributaries. ***Year 2***

- Assessment of current water supply and demand information for the Industrial Heartland and Capital Region, and for the energy producing utilities in the Wabamun region. Development of the Water Resources Management Model to support ongoing management. ***Year 2***

- Conduct water quality assessments for prioritized tributaries to support IFN evaluations. ***Years 2, 3***

- Conduct riparian zone assessments, in relation to flow needs, for the mainstem and prioritized tributaries of the NSR. ***Years 2, 3***

- Preparation of a basin overview of fisheries in the NSR addressing attributes such as species distributions and community structure, fish health, seasonal migration patterns, overwintering areas, spawning and rearing habitats, flow-dependent habitat issues, etc. ***Years 2, 3***

- Prepare an assessment of infrastructure, flow dependencies and low flow risks in both mainstem and tributaries. ***Years 2, 3***

- Provide methods for the estimation of flows in low order streams to support the evaluation of water diversion applications. ***Years 2, 3***

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Water Act. R.S.A. 2000, c. W-3.

Appendix 1

Instream Flow Needs Workshop Results

North Saskatchewan Watershed Alliance

In-stream Flow Needs Workshop

Draft Report of Results – Version 2

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LTG Consulting

February 27, 2014

Table of Contents

Introduction

A workshop was convened with an In-stream Flow Needs (IFN) Expert Advisory Group and held at the offices of Alberta Environment and Sustainable Resource Development (AESRD) on February 13, 2014. The purposes of the workshop were to:

- Share technical information and perspectives on IFN in the North Saskatchewan River (NSR) watershed.
- Identify and set priorities for IFN requirements within the NS watershed.
- Prepare project work plan guidance for each of the agreed IFN priorities.

The workshop included a presentation and orientation to the history of the science, assessment, water allocation and use within the North Saskatchewan River (NSR) mainstem as well as planning considerations and similar experiences in other watersheds in Alberta, North America and internationally. This was followed by identification of a listing of IFN research or program requirements that the group believed should be the focus for the NSR main stem and tributaries. The listing was reviewed, assessed for priority, grouped and requirements described to begin to develop a work plan to address the recommended priorities.

Participants

There were sixteen (16) workshop participants representing a range of interests, experience and technical perspectives. They included:

Name	*Role and Affiliation*
Allan Locke	Biologist and Consultant
Andrew Schoepf	Senior Planner, Integrated Resource Management Planning Division, AESRD and NSWA Board Member
Cal Kullman	Outdoor Education, RiverWatch Institute of Alberta
Dave Curran	Senior Engineer, City of Edmonton and NSWA Board Member
Dave Trew	Executive Director, NSWA
Ed Hoyes	NSWA Member and former water resources engineer, AESRD
Gordon Thompson	Technical Coordinator, NSWA
John Tchir	Fisheries Biologist, AESRD, Rocky Mountain House, AB
Ken Crutchfield	NSWA Board Member and former Director of Fisheries, AESRD
Les Gammie	NSWA Member and former EPCOR Director of Water Quality Assurance
Mark Lund	Outdoor Education Leader and Faculty Member, MacEwan University
Melissa Logan	Basin Planner, NSWA
Roger Drury	Hydroelectric Operations, Trans Alta Corporation
Sal Figuliuzzi	Hydrologist and Consultant

Name	*Role and Affiliation*
Stephen Spencer	Fisheries Biologist, AESRD, Spruce Grove, AB
Yaw Okyere	Hydrologist, AESRD, Edmonton, AB

Process and Facilitation Support was provided by Jim Gendron, LTG Consulting, Edmonton, AB.

Orientation to the Watershed – Two Presentations

- Sal Figliuzzi, consulting hydrologist, presented background on water hydrology and management of supply in the NSR watershed.
- Ed Hoyes, NSWA Member and an AESRD water resources engineer, provided a presentation on the history of water regulation in Alberta and current water allocation and use in NSR main stem and tributaries.

After the presentations, participants were asked if there were any points of clarity or information that had been provided they believed needed to be reinforced for the next steps in workshop discussion. The following comments were provided:

- There is a need to ensure consistent interpretation and application of information related to water use and allocation – the definition and understanding of water licencing terminology (e.g. water allocation; actual use; rate of diversion; return flow; losses; licence priority) will be important for communicating and assessing IFN requirements.
- There may be a shift to more complex water management systems where reporting is localized and on a more frequent basis (e.g. weekly).
- It appears that there isn't a lot of current or specific information regarding water allocation, use and in-stream flow within the NSR main-stem and on tributaries. Based on the presentations it looks like:
  - Currently collected data needs to be updated.
  - Data collection from the tributaries is required.
  - There needs to be more information reported more frequently (e.g. possibly monthly / weekly / daily) depending on the local conditions within the NSR main stem and tributaries.

Watershed Planning and Process – Accounting for Environmental Flow Requirements

- Allan Locke, consulting biologist, provided an overview of watershed planning and decision processes, some applied examples, along with important factors to be considered in determining environmental flow requirements.

The group was asked if there were any points of clarity, information that needed to be reinforced or ideas that should be noted for the next steps in workshop discussion. The items raised were:

- The "new hydrograph" for the NSR (i.e. changing seasonal flows due to climate change) and the issues of risk will need to be accounted for in environmental flow requirements.
- Consideration for the influence of increasing populations and human use in the NSR basin based on identified values that have to be protected must be factored in to watershed planning and environmental flow requirements.

- There will be a new base case with water allocation and use along with flow changes due to climate that may influence regulated flows in the NSR.
- Consider that scale of allocation and use and trade-offs that might be required.
- All decisions will be a function of the information available.
- An evaluation of in-stream water use will be important.
- There should be an examination of both the NSR and its tributaries.

IFN and the NSR Watershed / Main Stem – Interests, Needs and Issues

- Gordon Thompson, NSWA, presented a summary of the results of interests, needs and issues provided by participants in advance of the workshop to help frame and set up the next discussion. Responses and comments included:
    - multiple flow effects of dams on fish, channel, and floods
    - possible future flow pattern changes
    - tributary water use, water quality, and land use/clearing effects
    - need for more flow monitoring
    - flows required for ongoing effluent dilution
    - flow related problems are difficult to address

Following the summary of responses prior to the workshop, the group was divided into 5 smaller groups and asked to provide a list of at least 3 interests, needs or issues that they believed need to be addressed within the NSR Basin.

A list of 14 items were provided, reviewed, priorities set and they were grouped. This resulted in three priority areas with related items included with each. The three, with the sub sets of similar items (in no particular order) were:

- *Need a Game Plan for Water Management in the North Saskatchewan River Basin*
    - Regulatory tools and policy at the local scale – IFN requirements and water withdrawl.
    - Update information on all tributaries (flows, water quality, allocation, use riparian conditions).
    - Propose a current (post dam) hydrograph with variability and propose to formally set as the limit for IFN.
    - Include all stakeholders.
    - Establish values that will guide IFN work.

- *Monitoring Flows – get a baseline and monitor it.*
    - Better data for natural tributary flows – base data set.
    - Model for evaluating management decisions.
    - Flow monitoring at local scales – tributaries and smaller.

- Status of the NSR by Reach – fish habitat; water quality; geomorphology; water level fluctuation
    - Screening of health of tributary sub-basins – white versus green zones.
    - Biological (fish) monitoring at local (tributaries and smaller) scales.
    - Fisheries resource updates including tributaries – endangered and critical species.
    - Stay on top of water quality improvement and standards.

Following the consolidation of the 14 items into the three priorities for focus, participants were assigned, based on their interest, to develop *to develop* an initial work planning guide for each.

Each group determined what aspects of the priority item they wished to discussed. The provided a description, an assessment and recommendations for:

- The IFN Priority for Consideration
- A brief description of the priority
- Research / action / product requirements to address the priority
- Recommended lead to deliver on the research / action / product for the priority
- Recommended partners (i.e. investors and / or participants)
- Estimated Costs (order of magnitude)
- Potential barriers to initiating the requirement to address the priority
- Potential contingencies to address the barriers.

Each group had a representative present to the larger group so that other members could get clarification or offer additional ideas.

The results along with additional comments provided by the larger group have been transcribed and included here:

Group 1

IFN Priority:	Timely understanding of importance and engagement by leaders.
Description:	A "game plan" is an issue selling plan not a technical plan. It runs parallel to support technical work. It makes a case for "why now" and "why everyone" has a vested interest.
Research / action / product requirements to address the priority:	Build on the Sturgeon River Watershed initiative, the best chance of making progress right now. Aim at determining how to leverage the Sturgeon River project. The WPAC summit in October is an opportunity to address this priority.
Recommended lead:	The NSWA has a watershed management plan that can support the NSWA Board in working with smaller local groups at a scale and discussion of local relevance. The NSWA provides advice and has influence. The NSWA makes recommendations based on credible information, analysis and reporting. How to have increased influence when the NSWA makes recommendations is important to this priority.
Recommended partners (i.e. investors and / or team members):	Municipal governments and their representatives on the NSWA Board are key in the White Zone of the Province. In the Green Zone provincial and federal partners are needed. Industrial partners such as TransAlta are relevant whether or not they are on the NSWA Board right now.
Estimated Costs (order of magnitude):	Possibly leverage costs? "Paid Lobbyists" focused on education, learning and stakeholder groups. Expansion of NSWA staff or a consultant to support the initiative with an estimated cost of $300,000 annually for 2 to 3 people.
Potential barriers:	Vested interests can be blockers.
Contingencies to address the barriers:	More municipal elected officials / influence on the NSWA Board.
Comments Provided:	No additional comments from the group.

Group 2

IFN Priority:	Develop historic water flows and water management models
Description:	Collect historical water flow data to populate water management models to support water management decision-making in both the North Saskatchewan River main stem and tributaries.
Research / action / product requirements to address the priority:	1. Evaluate the hydrometric network to determine adequacy for developing historic natural flows and water management models based on long term weekly flow data (models to evaluate water management options). 2. For basins where data are adequate, develop historic natural flows, and 3. Develop water management models. 4. For basins with inadequate data, determine requirements for new monitoring.
Recommended lead:	Alberta Sustainable Resource Development since the Ministry has an existing hydrometric network, database and the authority to authorize the project.
Recommended partners (i.e. investors and / or team members):	▪ NSWA – important linkage to municipalities and industry. ▪ Alberta Energy Regulator (AER) ▪ Alberta Environmental Monitoring Evaluation and Reporting Agency (AEMERA)
Estimated Costs (order of magnitude):	$30,000 to $50,000 per basin for up to 8 sub basins
Potential barriers:	▪ Inadequate existing hydrometric monitoring. ▪ Lack of recognition of the need for natural flows and water management models.
Contingencies to address the barriers:	▪ Initiate new monitoring. ▪ Spread costs over multiple years.
Comments Provided:	▪ Given that there are potentially 8 sub-basins, priority setting for funding may be helpful. ▪ Consider the use of 3rd party data – there are some that are already monitoring as part of industrial approvals, for example. ▪ Access utility levy funding, if possible, to finance the activities.

Group 3

IFN Priority:	Status of the North Saskatchewan River by Reach
Description:	The status of the river by reach would include an assessment of fish habitat, water quality, geomorphology and water level fluctuations.
Research / action / product requirements to address the priority:	Water Quality: ▪ Propose water quality objectives for major tributaries and a monitoring plan. ▪ Where data gaps exist in mainstem address them to develop a baseline. ▪ Align monitoring with fisheries work to find possible linkages Fish: ▪ Stream order, elevation – need to stratify the watershed; random sampling; biologically meaningful stratification (White Zone versus Green Zone; headwaters versus downstream) ▪ Species "break points" need to be determined. ▪ Collect a suite of parameters at each site not just fish (WQ data etc.) ▪ Seasonal sampling important (spatial and temporal stratification); occupancy sampling - all down to rare species split into juvenile and adult populations ▪ Historical versus current analysis – historical survey of residents for anecdotal data. ▪ Identify critical tributaries for habitat ▪ Develop "report card" for watersheds ▪ Consider connectivity of water bodies; identify barriers and set priorities Geomorphology: ▪ Recent report released to build on ▪ Examine silt deposition and effect of dams. ▪ Air photon interpretation Water Levels: Flow gauging on tributaries
Recommended lead:	Government of Alberta
Recommended partners (i.e. investors and / or team members):	NSWA, TransAlta, municipalities, industry
Estimated Costs (order of magnitude):	Estimates are included in NSWA scoping document; estimate $500,000 to $1,000,000 per topic for basin wide assessment of fish, water quality and geomorphology.
Potential barriers:	▪ Funding ▪ Government acceptance for leadership role.
Contingencies to address the barriers:	▪ Prove the need for the work; problem identification. ▪ Need proper information for water allocation and temporary diversion licences.
Comments Provided:	▪ Reinforce the investment and in kind resources from municipalities, industry and business sectors.

Next Steps

Dave Trew, NSWA Executive Director, thanked all of the participants for their time and effort in beginning to start the process of identifying IFN activities within the NSR River Basin.

A report of results will be drafted and reviewed by Dave Trew and Gordon Thompson, NSWA. Following their review the report will be distributed to workshop participants for their comment and to the IFN Technical Working Committee for reference and use as they develop more detailed workplans, budgets and proposals to address priority items.

Appendix – IFN Workshop Presentations

Presenters:

- Sal Figliuzzi, Hydrological Consultant
- Ed Hoyes, Water Resource Management Professional
- Allan Locke, Biological Consultant

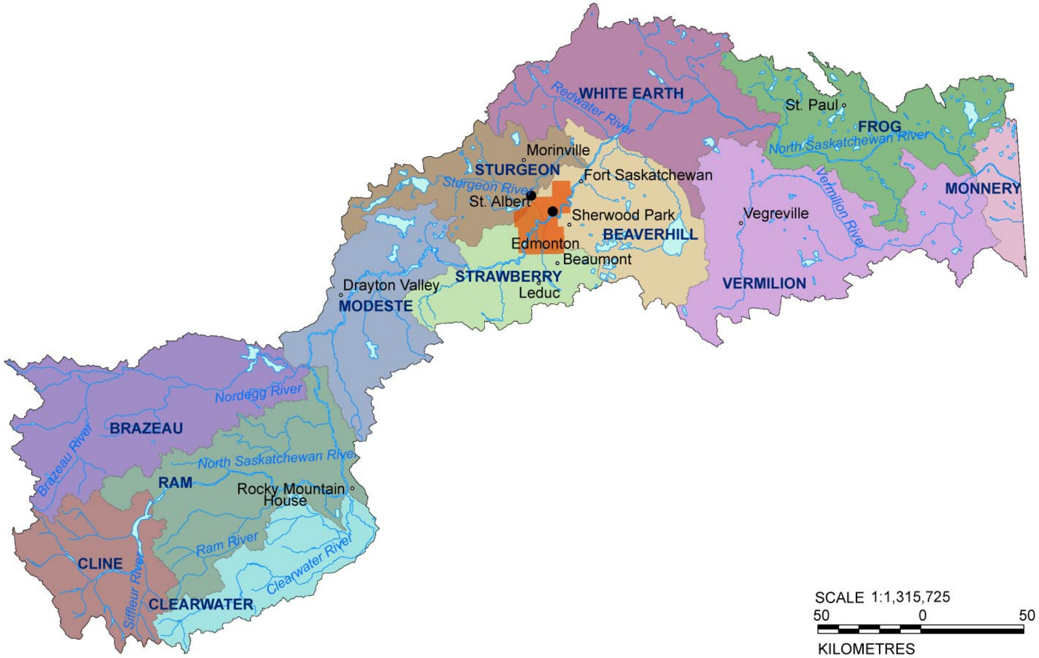
Appendix 2

Environmental Flows and Water Management Planning

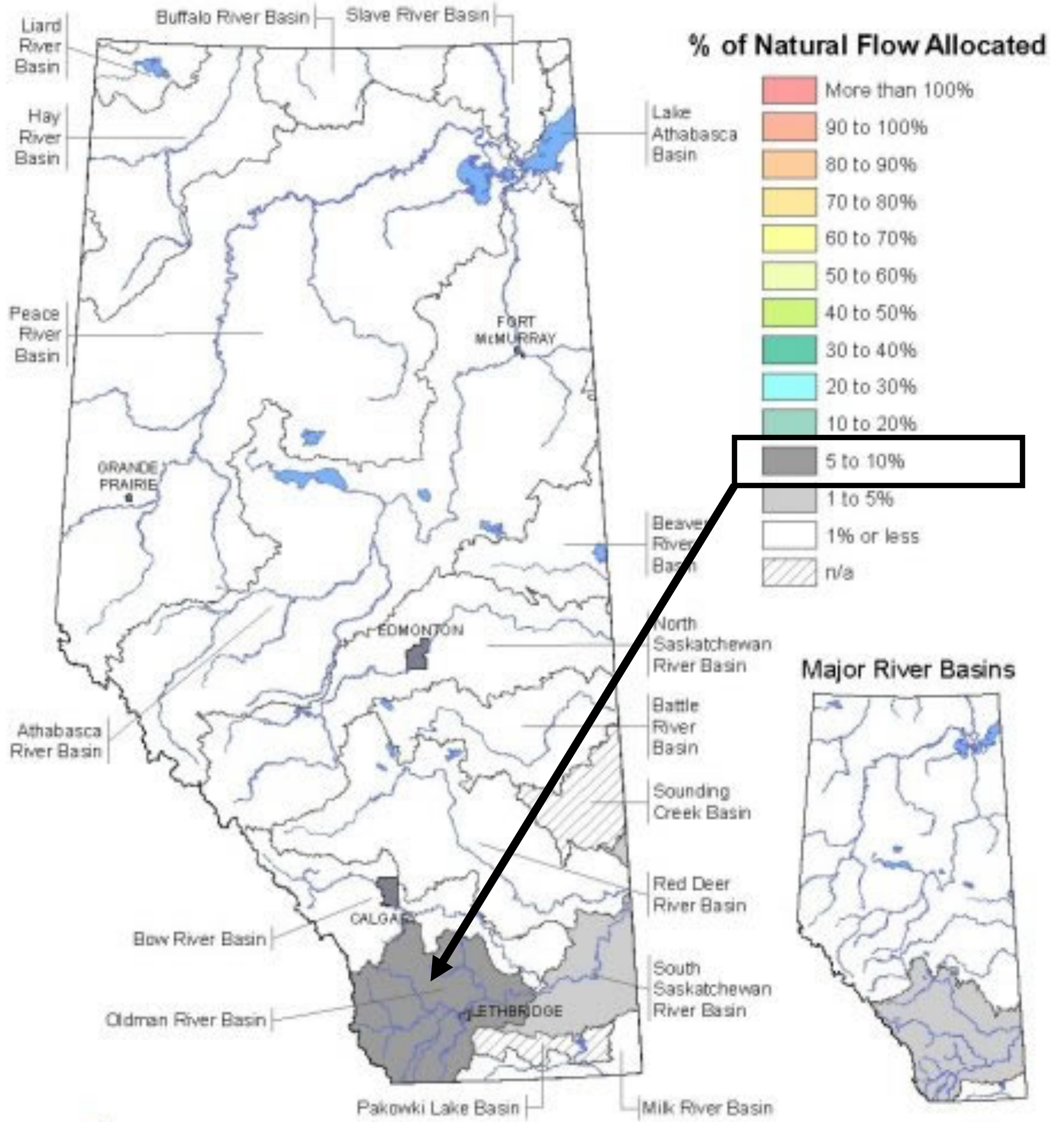
Environmental Flows & Water Management Planning

Environmental Flows: Background

Considerations for Water Management Planning



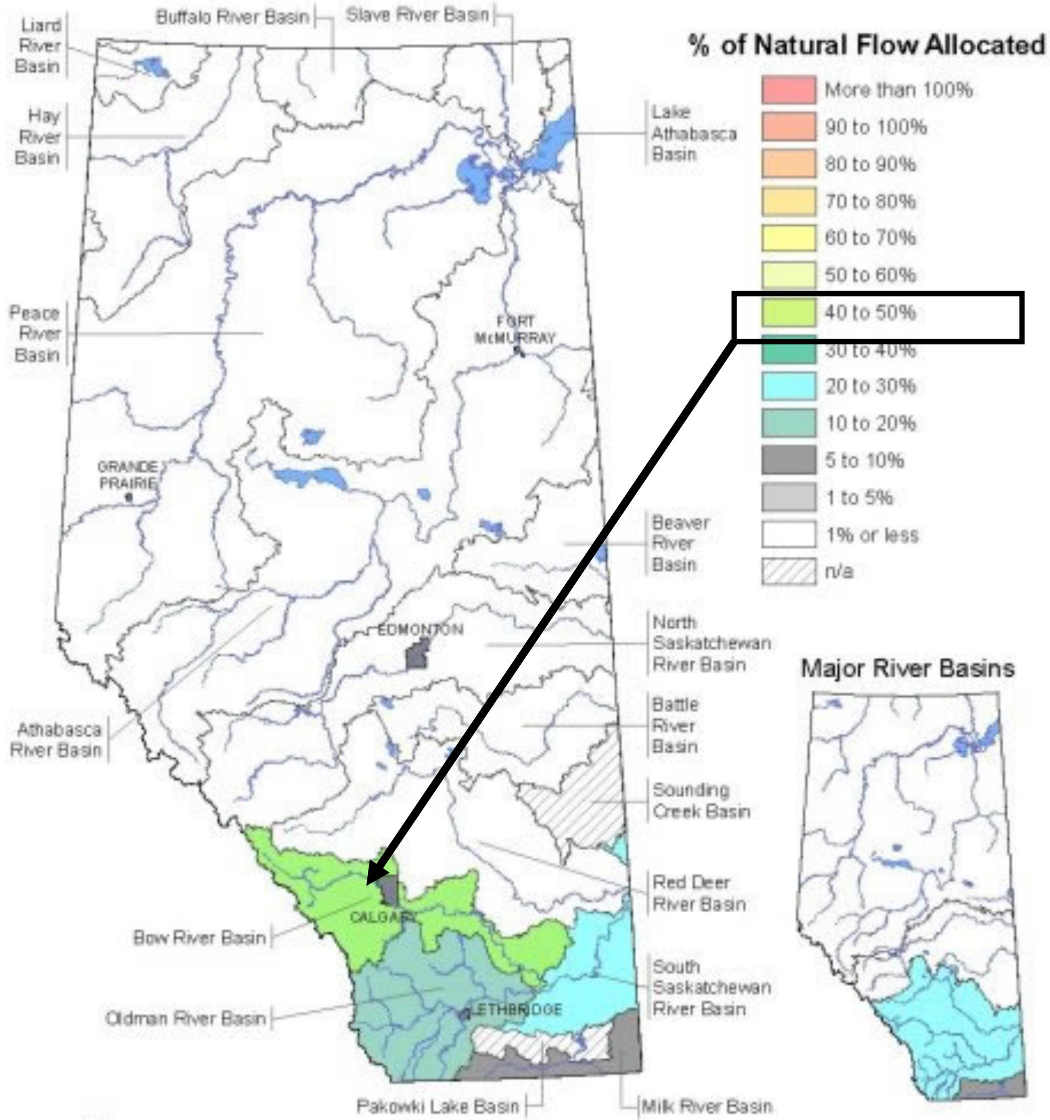
Allocations in 1900 by River Basin Compared to Average Natural Flow



Alberta Environment

Note that allocations do not represent actual water use - only the maximum amount that can be used under the terms of a license. For further explanation please refer to the text in the section "Why is it important?"

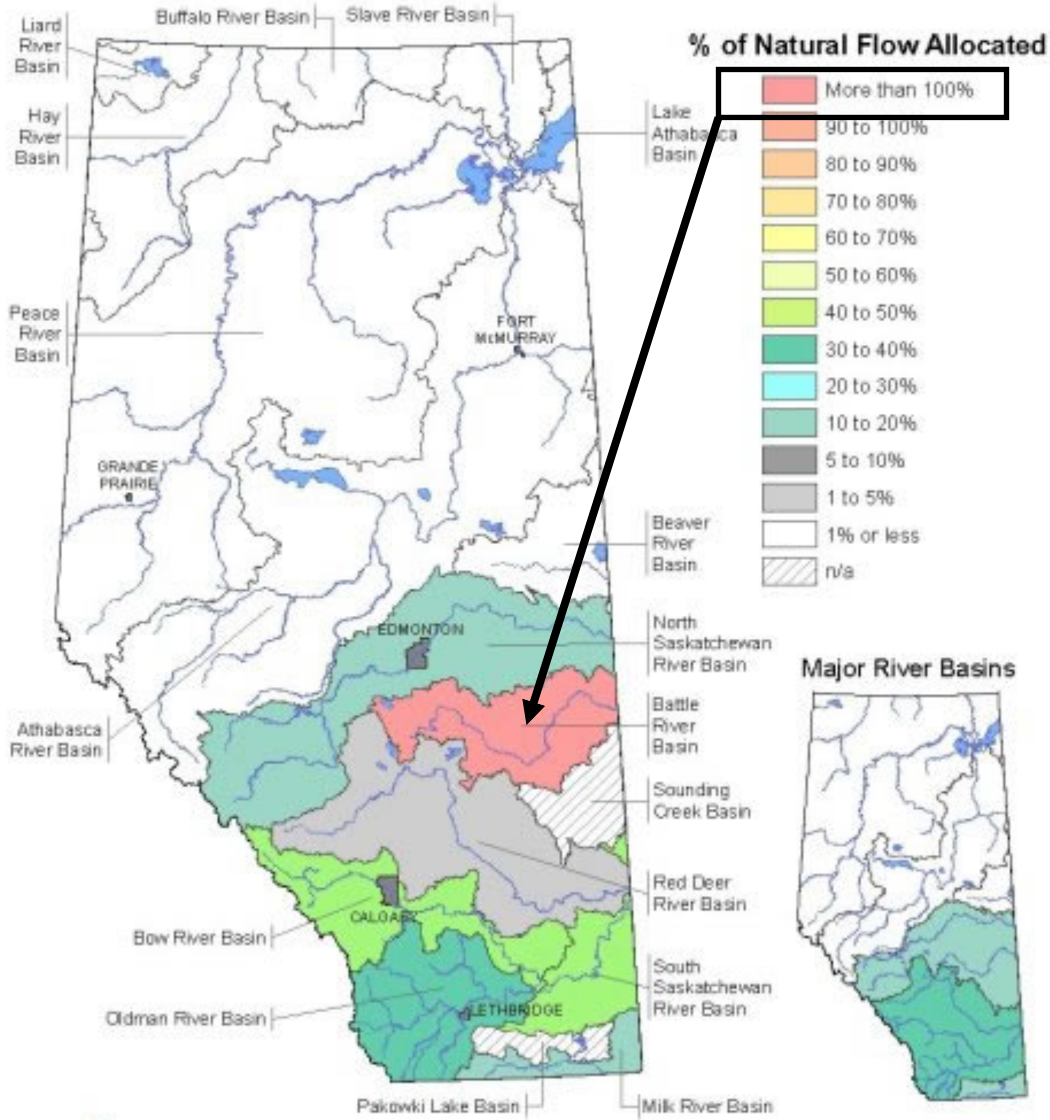
Allocations in 1930 by River Basin Compared to Average Natural Flow



Alberta Environment

Note that allocations do not represent actual water use - only the maximum amount that can be used under the terms of a license. For further explanation please refer to the text in the section "Why is it important?"

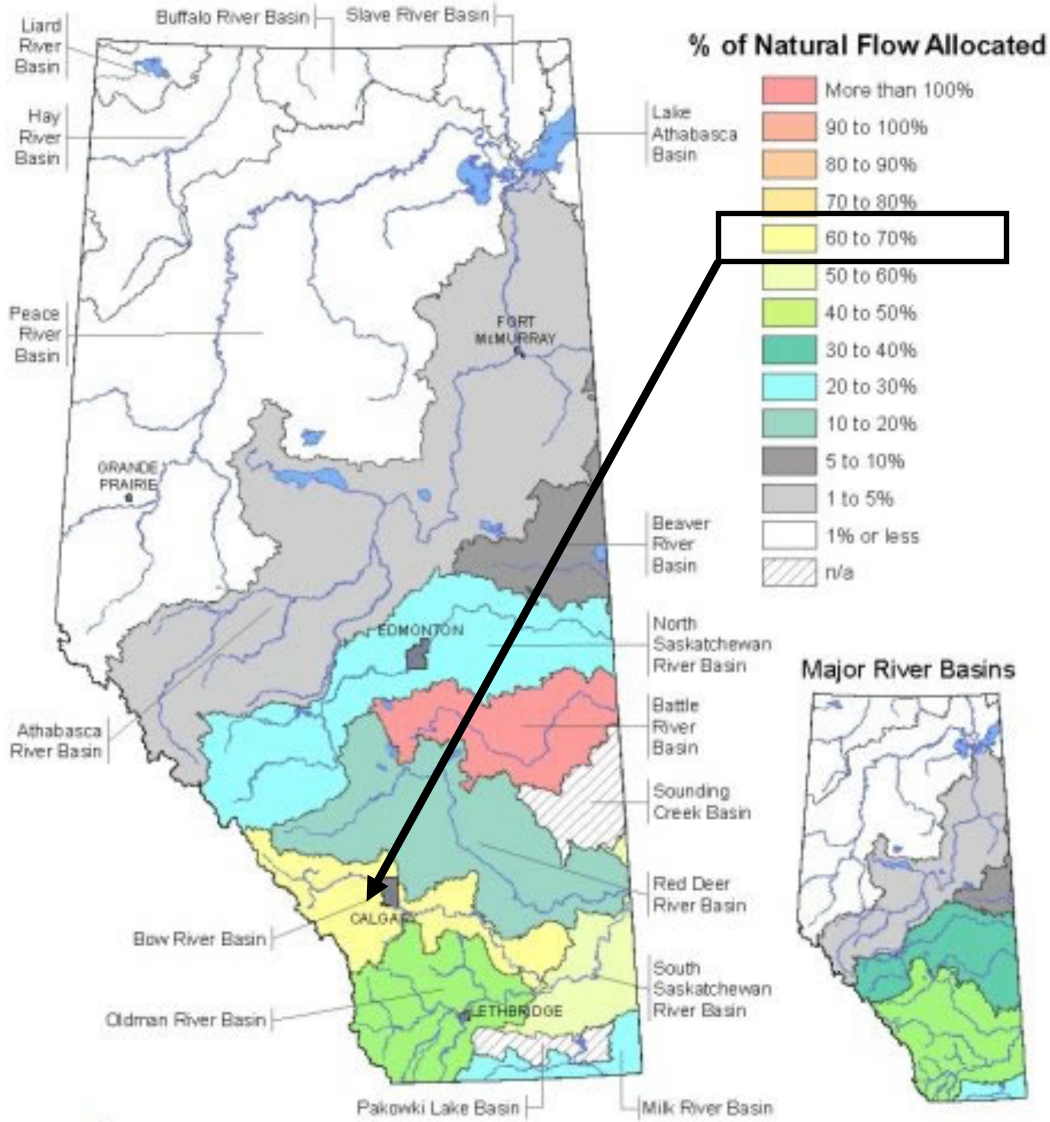
Allocations in 1960 by River Basin Compared to Average Natural Flow



Alberta
Environment

Note that allocations do not represent actual water use - only the maximum amount that can be used under the terms of a license. For further explanation please refer to the text in the section "Why is it important?"

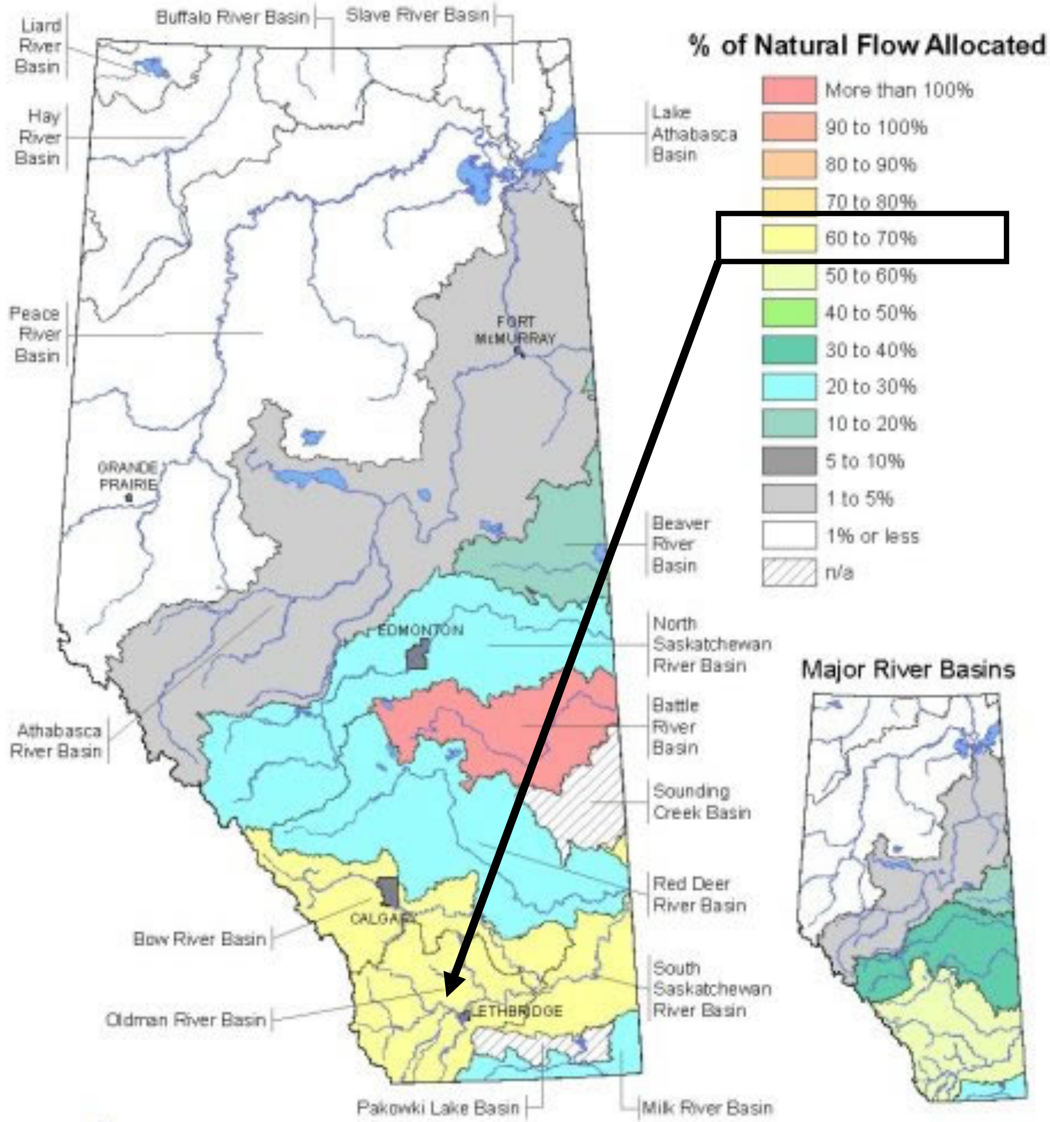
Allocations in 1990 by River Basin Compared to Average Natural Flow



Alberta Environment

Note that allocations do not represent actual water use - only the maximum amount that can be used under the terms of a license. For further explanation please refer to the text in the section "Why is it important?"

Allocations in 2005 by River Basin Compared to Average Natural Flow



Alberta Environment

Note that allocations do not represent actual water use - only the maximum amount that can be used under the terms of a license. For further explanation please refer to the text in the section "Why is it important?"

Why Develop a Water Plan?

Planning can…be done when a more comprehensive approach is needed to address a number of issues …which considers multiple issues such as water supply, water quality, fish habitat needs, aesthetics and recreational use.

- AENV 1999

Environmental Flows & Water Management Planning

The water management planning process can result in:

1) a Water Management Plan
2) an Approved Water Management Plan or,
3) a Water Conservation Objective

- AENV 1999

Science: Fish Habitat Models

- Athabasca River
- Bow River
- Battle River
- Belly River
- Elbow River
- Highwood River
- Kananaskis River
- Lesser Slave River
- Oldman River
- Pekisko Creek
- Red Deer River
- Sheep River
- South Heart River
- St. Mary River
- Sturgeon River
- Vermillion River
- Waterton River
- Willow Creek

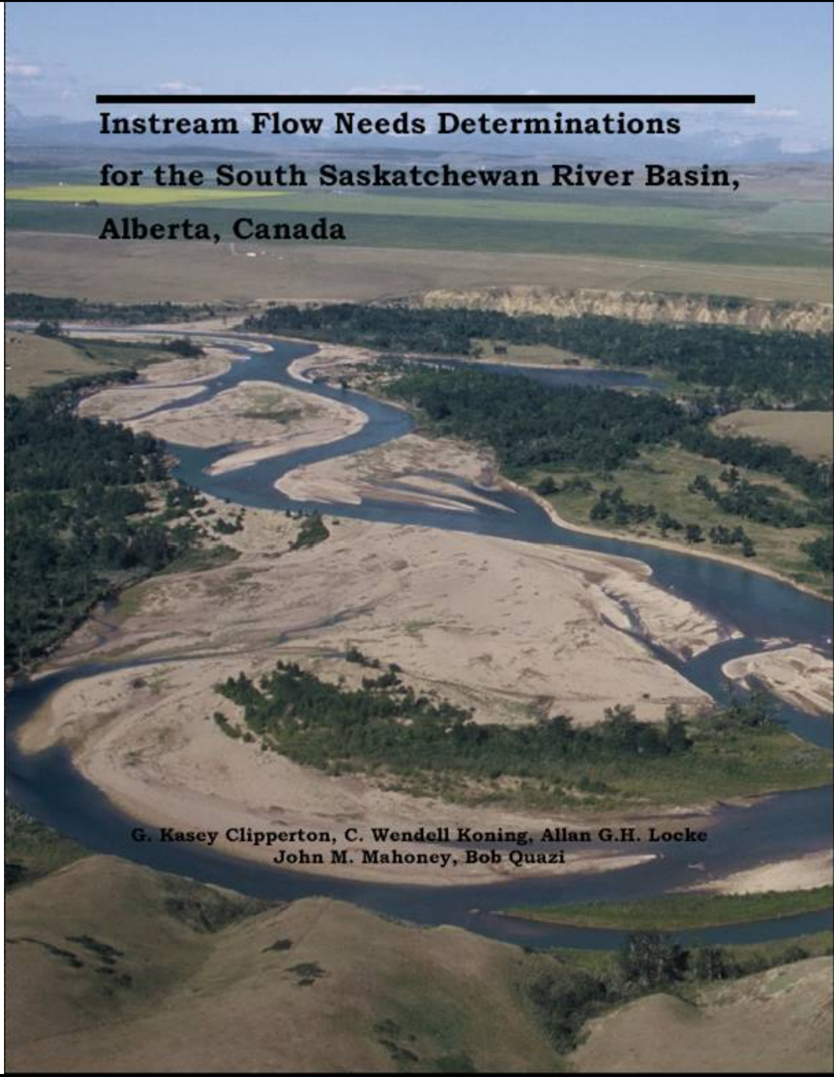
Science: Dissolved Oxygen & Temperature

- Athabasca River
- Bow River
- Belly River
- Elbow River
- Highwood River
- Kananaskis River
- Lesser Slave River
- Oldman River
- Red Deer River
- St. Mary River
- Waterton River
- Willow Creek

Science: Riparian Vegetation, Water Quality, Fish Habitat, Channel Maintenance

- Bow River
- Belly River
- Highwood River
- Oldman River
- Red Deer River
- Sheep River
- St. Mary River
- Waterton River
- Willow Creek

Environmental Flows & Water Management Planning



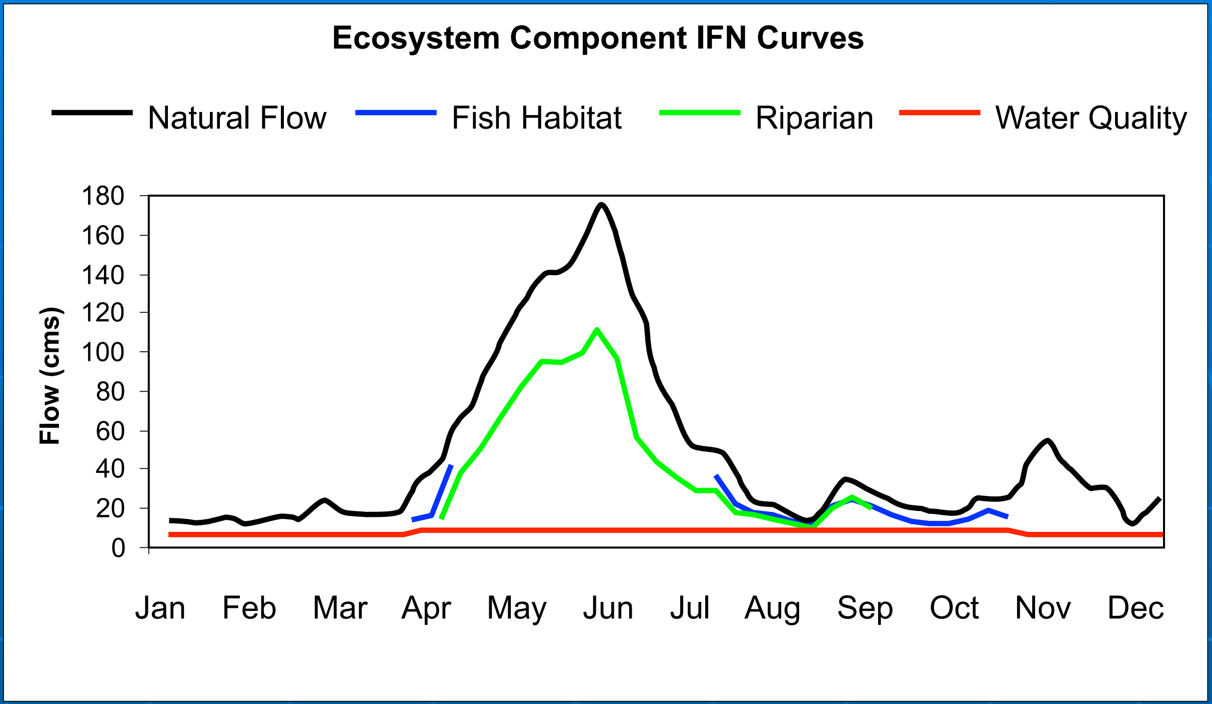
South Saskatchewan River Basin IFN Report - 2003

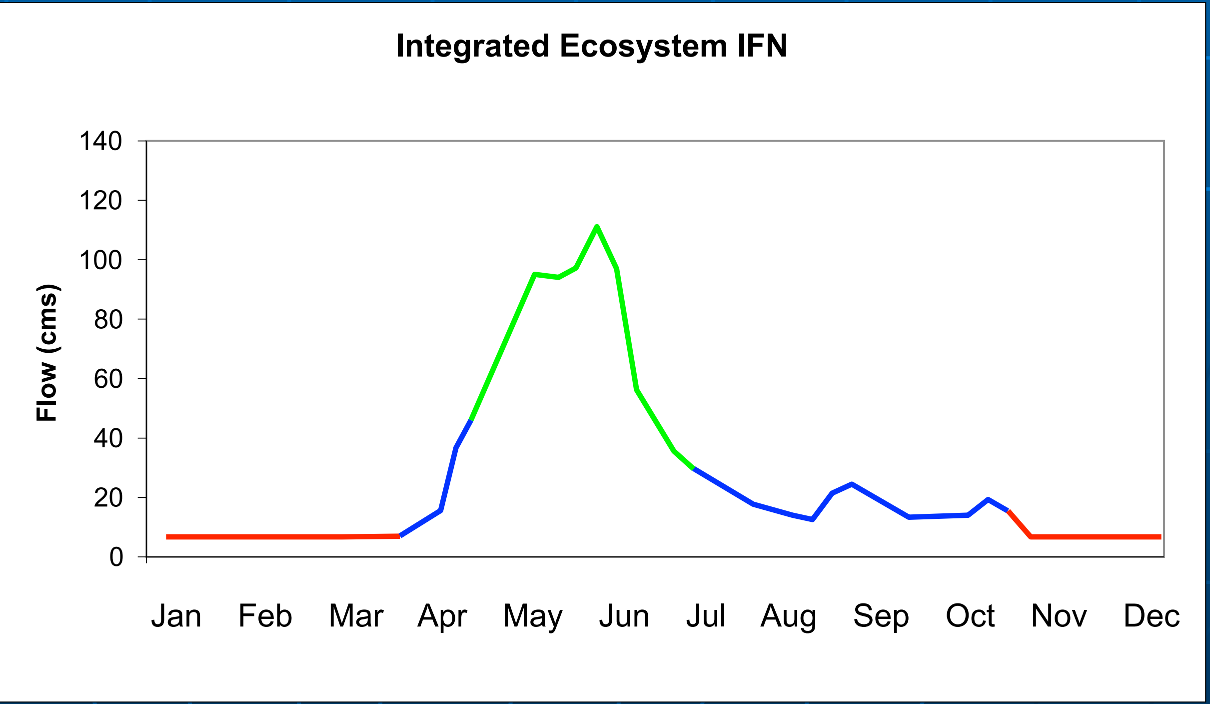
Recommendation for "full protection" of the aquatic ecosystem.

South Saskatchewan River Basin

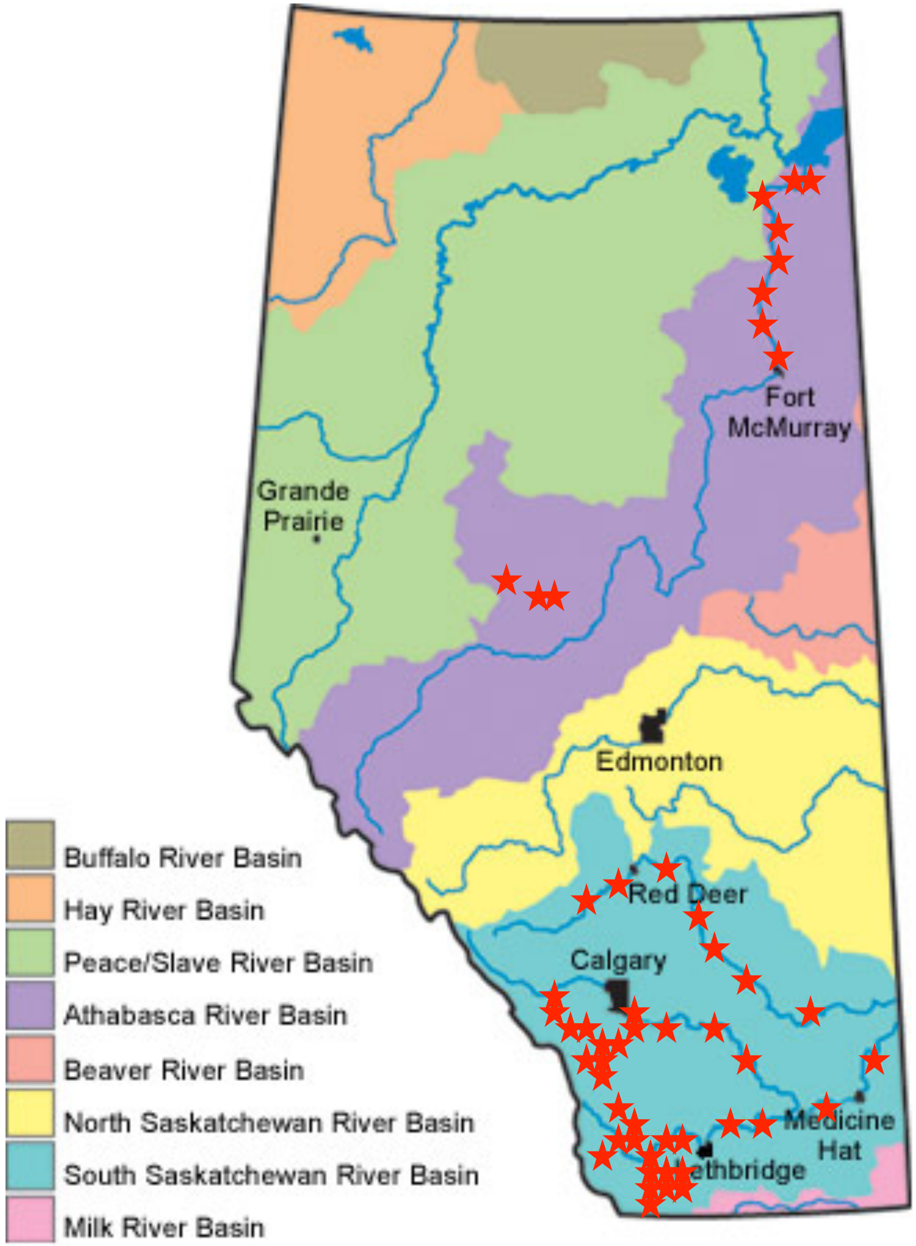
Integrate all

riverine components





Site Specific IFN Studies



Alberta IFN Classification Assessment Project

March 2000 – March 2003

Environmental Flows & Water Management Planning

Alberta IFN Classification Assessment Project

Since there are criticisms of standard setting methods,

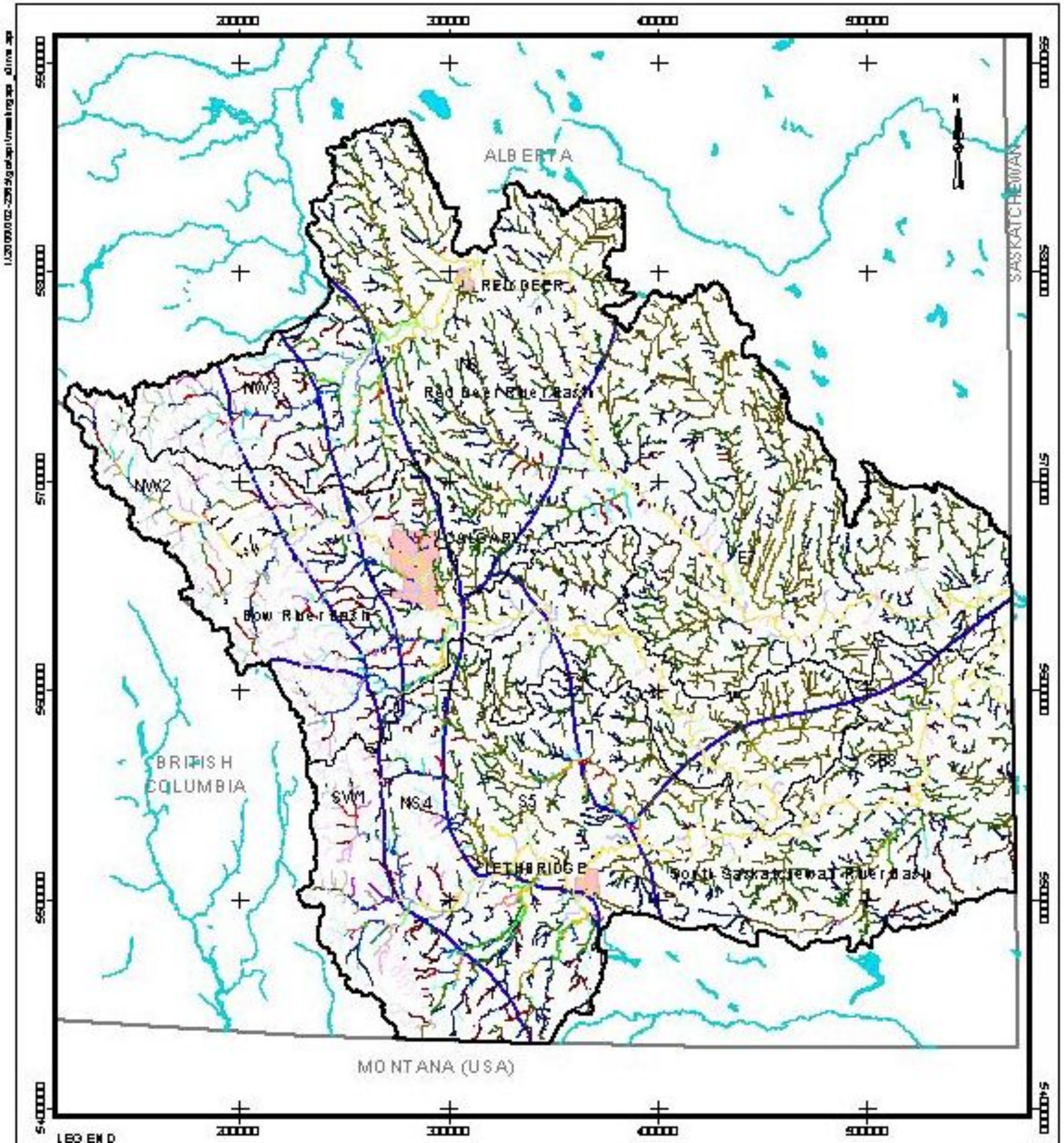
and applying site specific studies province-wide is very costly,

then we need an efficient, economical, and scientifically defensible IFN method to meet requirements under the *Water Act.*

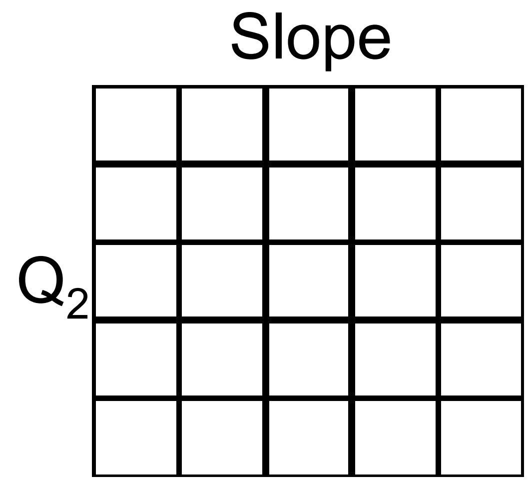
Goal of the IFN Classification System

- Provide a mechanism to extrapolate measured site specific data (a flow recommendation) to another “similar” unmeasured river reach.

South Saskatchewan River Basin



Stream Classes based on a 5x5 Matrix of Slope and Q2



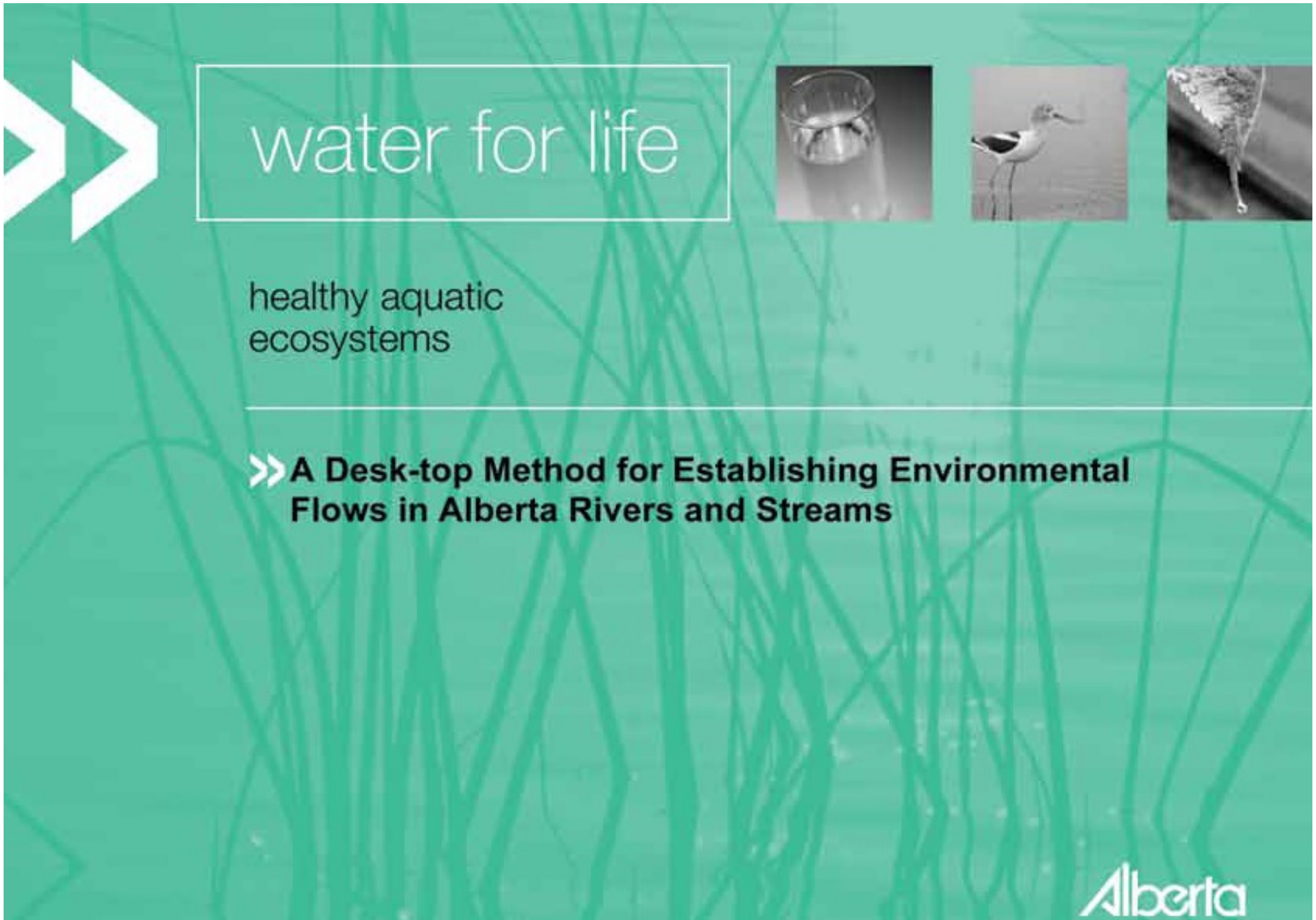
IFN Classification System was not Completed

- Stream classification based on Q2 and slope was partially validated.
- More detailed validation was required.

Classification Project ended in the spring of 2003

First draft of desktop guideline – October of 2003

Environmental Flows & Water Management Planning



water for life

healthy aquatic ecosystems

A Desk-top Method for Establishing Environmental Flows in Alberta Rivers and Streams

Alberta

The Environmental Flow Guideline Formula

The formula for the desktop environmental flow guideline is the greater of either:

1) A 15% instantaneous reduction from natural flow; or

2) The lesser of either the natural flow or the 80% exceedance natural flow based on a weekly or monthly time step.

ALBERTA DESKTOP METHOD FOR DETERMINING ENVIRONMENTAL FLOWS

When does it apply?

1) Developed primarily for rivers that have ***natural flows*** and to make a ***full protection*** flow recommendation where site specific instream flow data is not available.

2) Can also be used to qualitatively assess the degree of impact on flows in regulated systems (dams, weirs) and in systems where there is flow allocation.

ALBERTA DESKTOP METHOD FOR DETERMINING ENVIRONMENTAL FLOWS

How will the Department of Alberta Environment and Water use the Desktop Method recommendation?

The Alberta Desktop Method is a tool that will **assist in water management and licensing decisions** by describing a full level of protection for what would otherwise require a complex environmental assessment. It is not a substitute for site-specific evaluation. However, conducting reach- or site-specific Environmental Flow determination typically requires a high level of effort and significant resources. For many applications, the level of effort may not be justified, yet there is still a **need to assure environmental protection in each licence that is issued**.

Alberta's *Water Act*

- The exact number of licences issued that impose conditions satisfying the Desktop Method is not explicitly tracked by database.
- Approximately a dozen licences (mostly in Northern Region with one in the Central Region) have been issued based on the Desktop Method recommendation.

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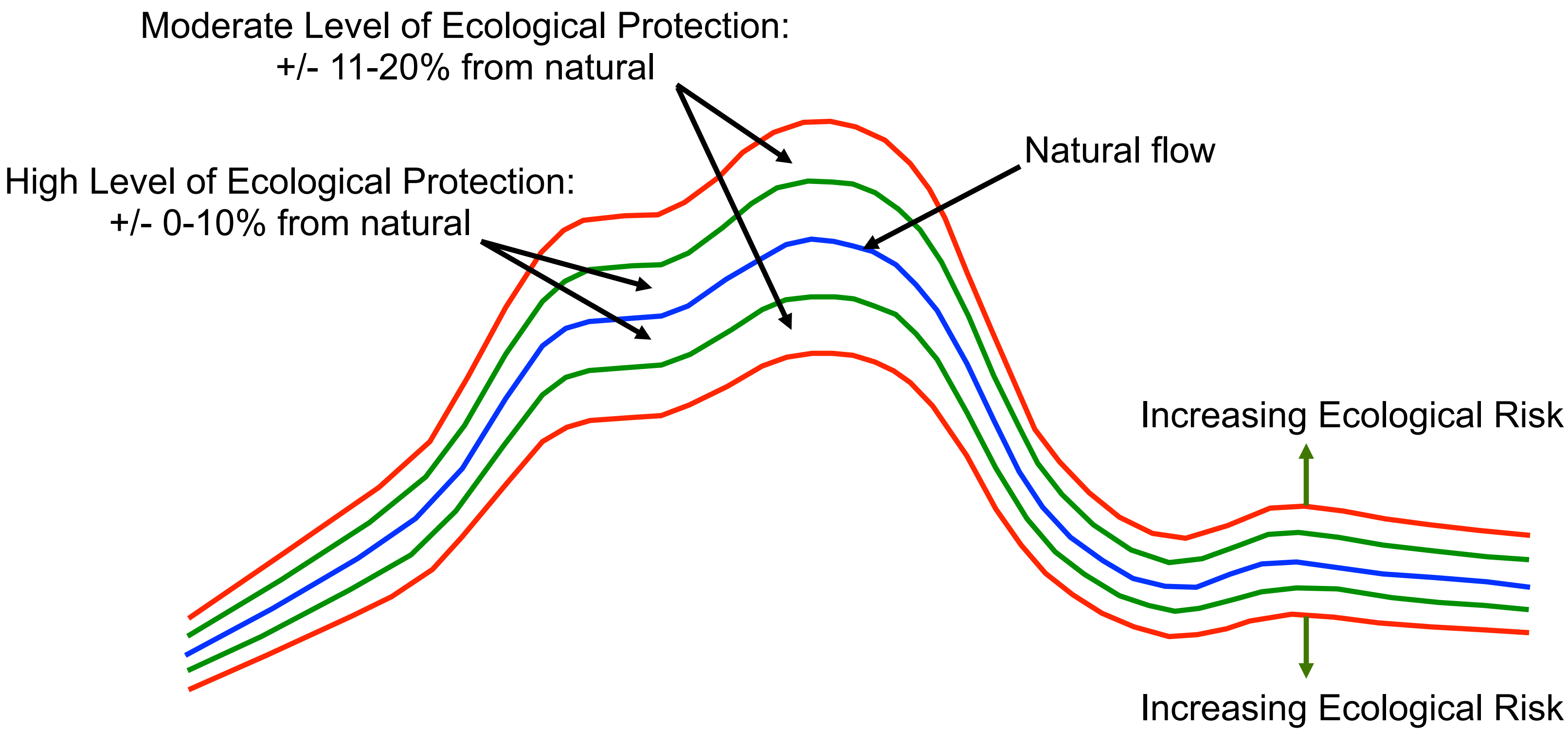
A PRESUMPTIVE STANDARD FOR ENVIRONMENTAL FLOW PROTECTION



- Richter et al. 2011

Environmental Flows & Water Management Planning

RIVER RESEARCH AND APPLICATIONS

River Res. Applic. (2011)

Published online in Wiley Online Library
(wileyonlinelibrary.com) DOI: 10.1002/rra.1571

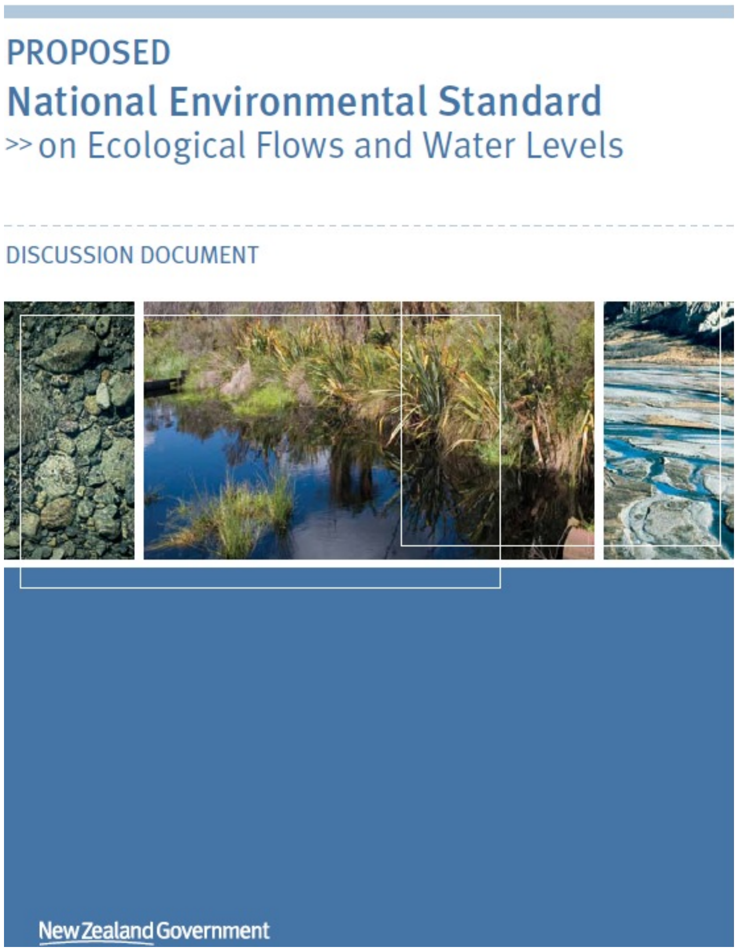
DEFINING MINIMUM ENVIRONMENTAL FLOWS AT REGIONAL SCALE: APPLICATION OF MESOSCALE HABITAT MODELS AND CATCHMENTS CLASSIFICATION

P. VEZZA[a*], P. PARASIEWICZ[b], M. ROSSO[c] and C. COMOGLIO[a]

[a] *Department of Land, Environment and Geo-engineering, Politecnico di Torino, Turin, Italy*
[b] *Rushing Rivers Institute, Amherst, Massachusetts, USA*
[c] *Department of Hydraulics, Transport and Civil Infrastructures, Politecnico di Torino, Italy*

Minimum e-flow = 1.42 X Q_{95}

Environmental Flows & Water Management Planning


PROPOSED

National Environmental Standard

>> on Ecological Flows and Water Levels

DISCUSSION DOCUMENT

New Zealand Government

For rivers and streams with mean flows less than or equal to 5 m^3/s:
A minimum flow of 90% of the mean annual low flow (MALF) and an allocation limit of 30% of MALF.

For rivers and streams with mean flows greater than 5 m^3/s:
A minimum flow of 80% of MALF and an allocation limit of 50% of MALF.

Minimum flow *– a flow at which the abstraction of water ceases.*

MALF *- The mean annual seven-day low flow.*

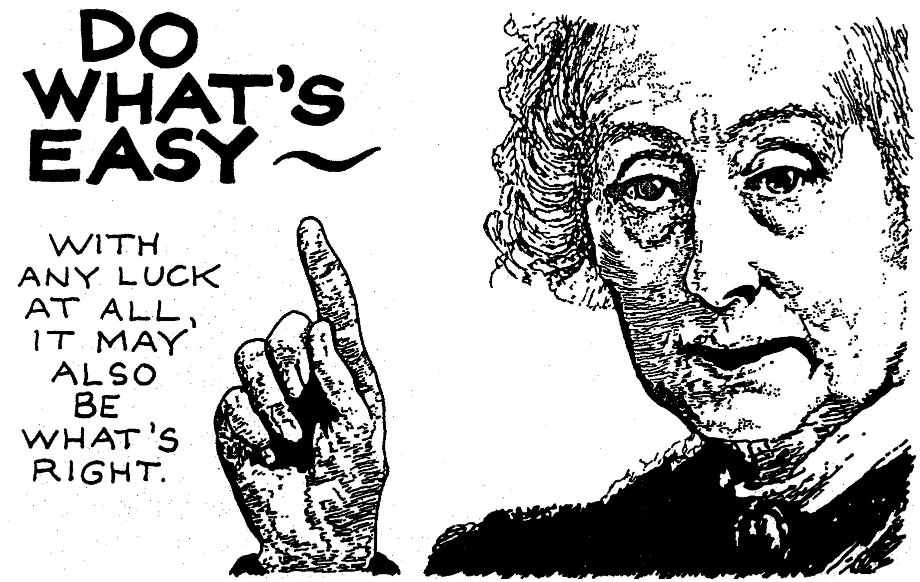
(New Zealand Ministry for the Environment 2008)

Environmental Flows & Water Management Planning

ALBERTA DESKTOP METHOD FOR DETERMINING ENVIRONMENTAL FLOWS

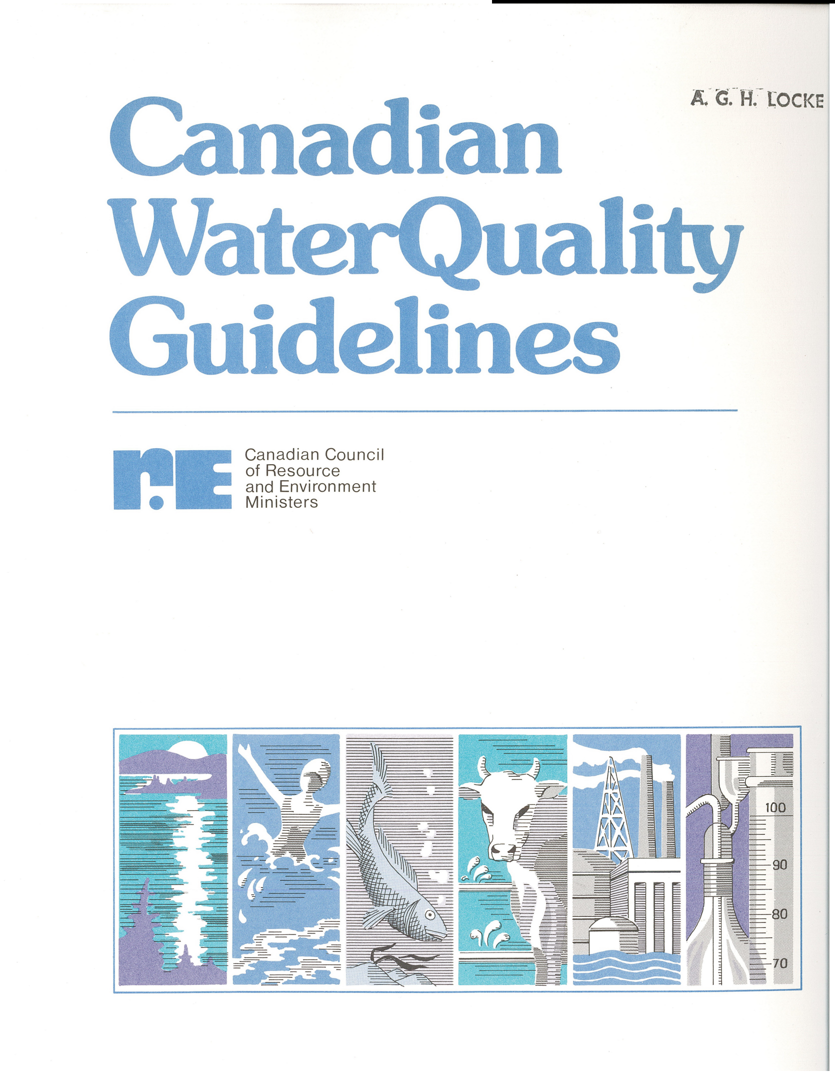
! CAUTION

One size does *<u>not</u>* fit all.



Hatfield & Bruce 2000; Snelder et al. 2011

Environmental Flows & Water Management Planning



"The guidelines should not be regarded as blanket values for national water quality. Variations in environmental conditions across Canada will affect water quality in different ways and many of the guidelines reported here will need to be modified according to these local conditions."

"For waters of superior quality, impairment to guideline concentrations should not be acceptable. Such considerations should form part of the rationale for site-specific water quality objectives."

Value of the Environmental Flow Guideline Document

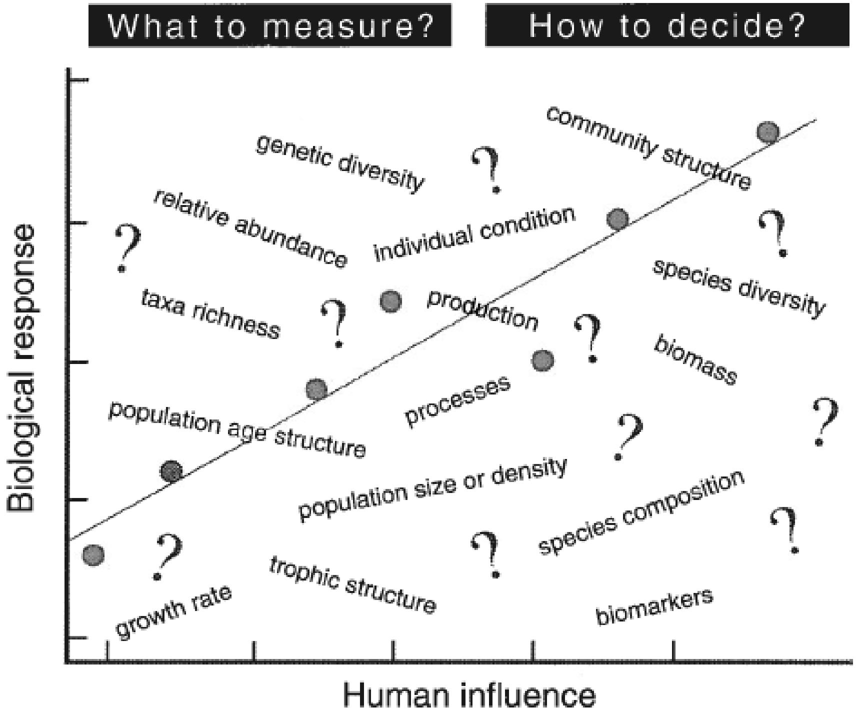
- Inform and educate GoA staff and the public.
- Streamline the water licence referral process.

The guideline serves as a good starting point for the economic versus environmental values trade-off discussion.

Environmental Flows & Water Management Planning

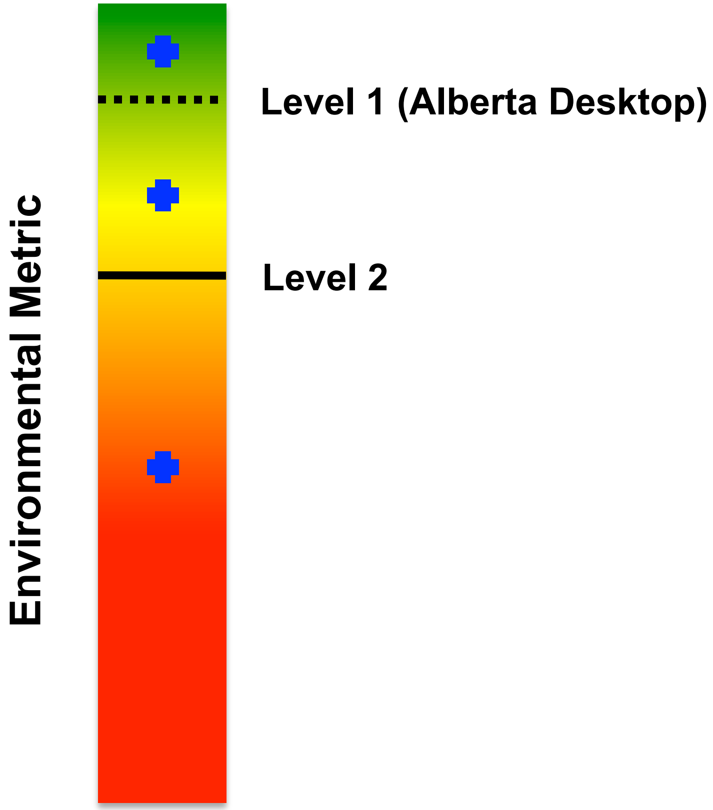
Decision Makers Would Like

A Guideline That Explains Everything

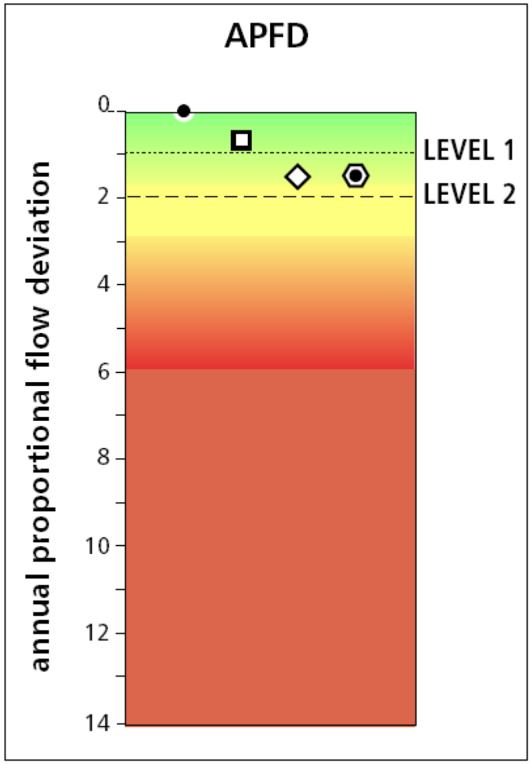


(Source: Karr and Chu 1997)

We need an Environmental Impact Assessment Tool



Environmental Flows & Water Management Planning



Benchmarking Methodology

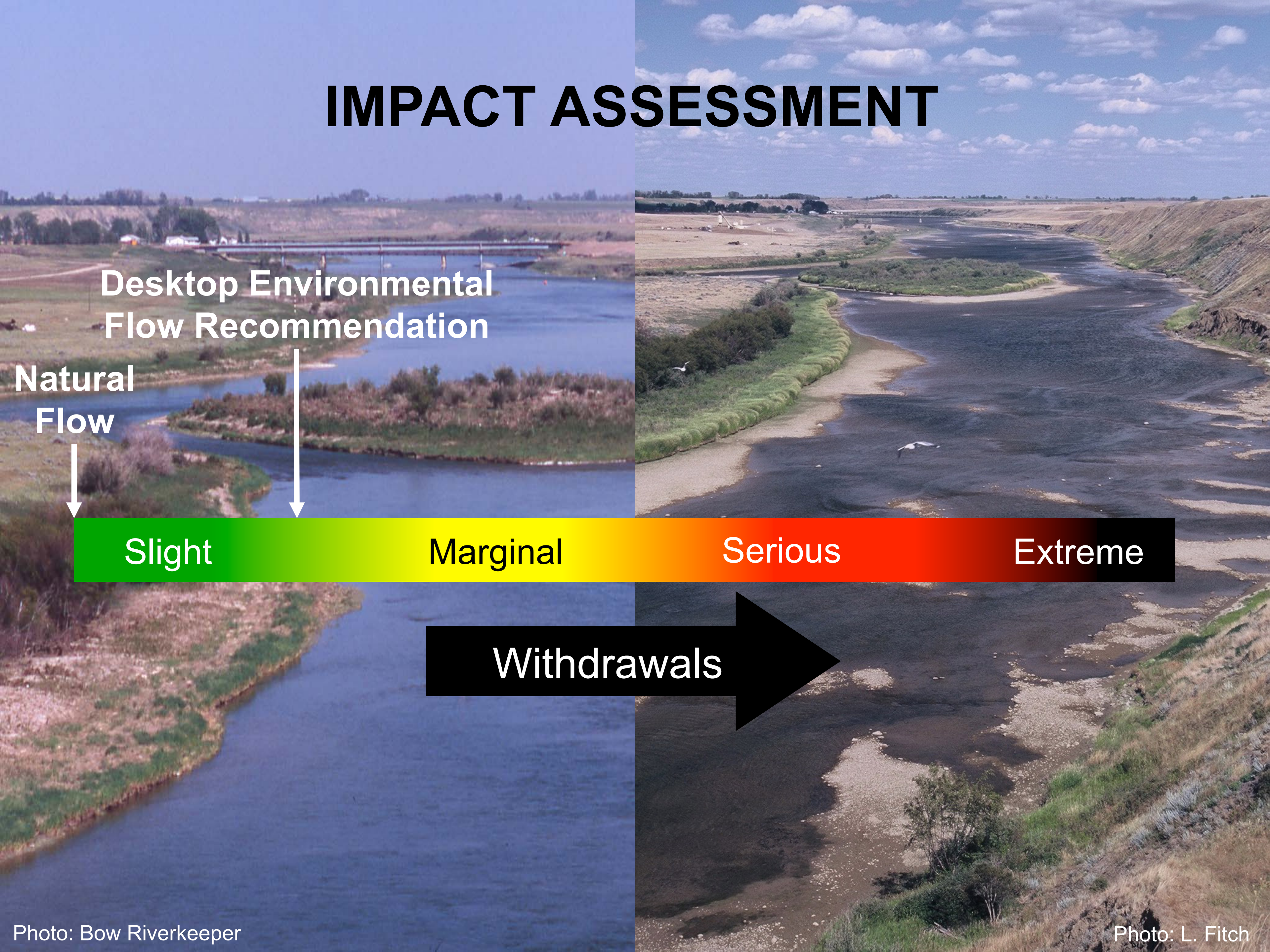
Benchmarking involves compiling information on geomorphological and ecological changes from natural condition associated with various degrees of departure from the natural flow regime.

(Source: Brizga at al. 2001)

Environmental Flows & Water Management Planning

Trout Flow-Ecology Relationships		
Percentage of Mean Annual Flow During Low Flow Summer Months	Ecological Risk Level	Description
>55%	Low	May very seldom limit trout
26-55%	Minimal	May occasionally limit trout numbers
16-25%	Moderate	May severely limit trout stock every few years
10-15%	Significant	Potential for trout support is sporadic
<10%	High	Inadequate to support trout

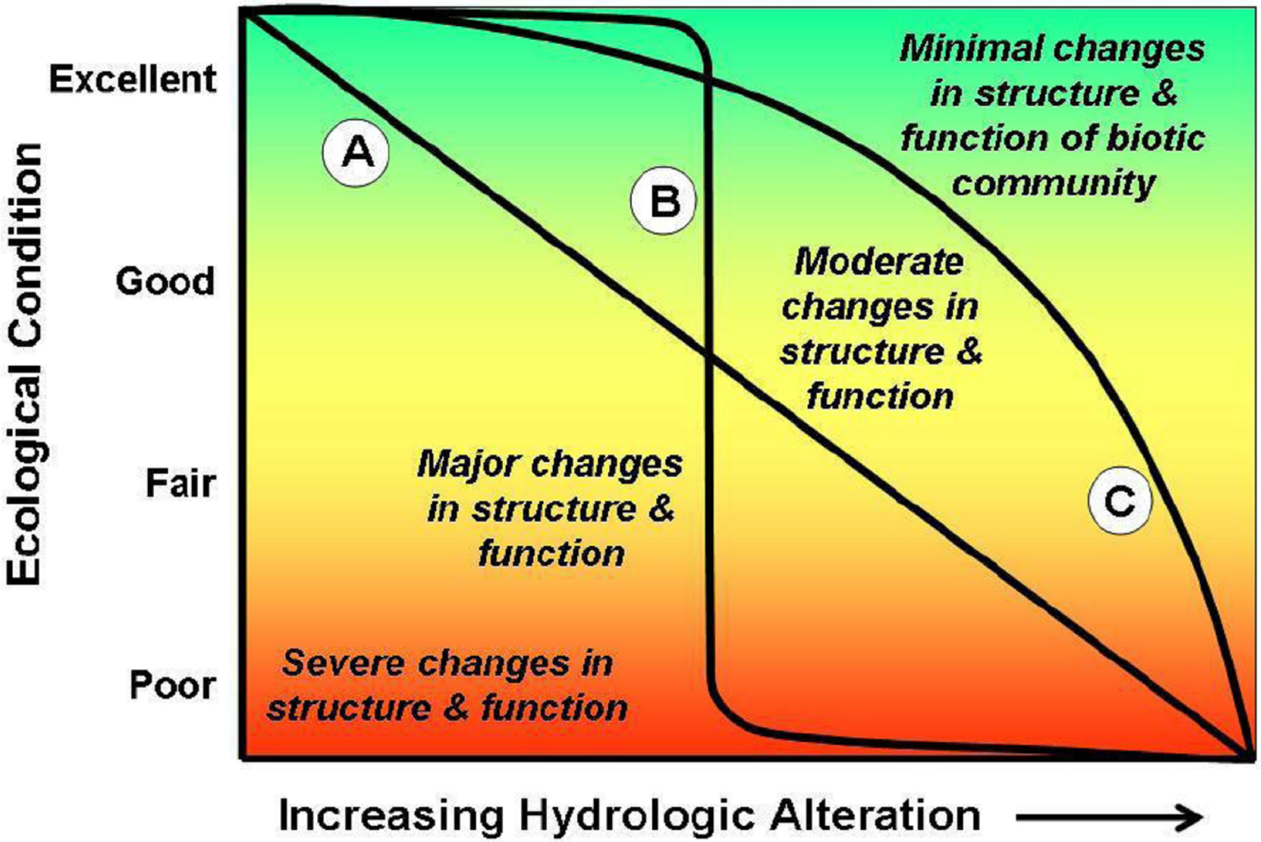
Bledsoe, B., B. Miller, L. Poff, J Sanderson, and T. Wilding. 2009. Draft Report July 2009. Watershed Flow Evaluation Tool Pilot Study for Roaring Fork and Fountain Creek Watersheds and Site-Specific Quantification Pilot Study for Roaring Fork Watershed. Prepared for the Colorado Water Conservation Board.



IMPACT ASSESSMENT
Desktop Environmental Flow Recommendation
Natural Flow
Slight
Marginal
Serious
Extreme
Withdrawals
Photo: Bow Riverkeeper
Photo: L. Fitch

Environmental Flows & Water Management Planning

Thresholds



(Adapted from Davies & Jackson 2006)

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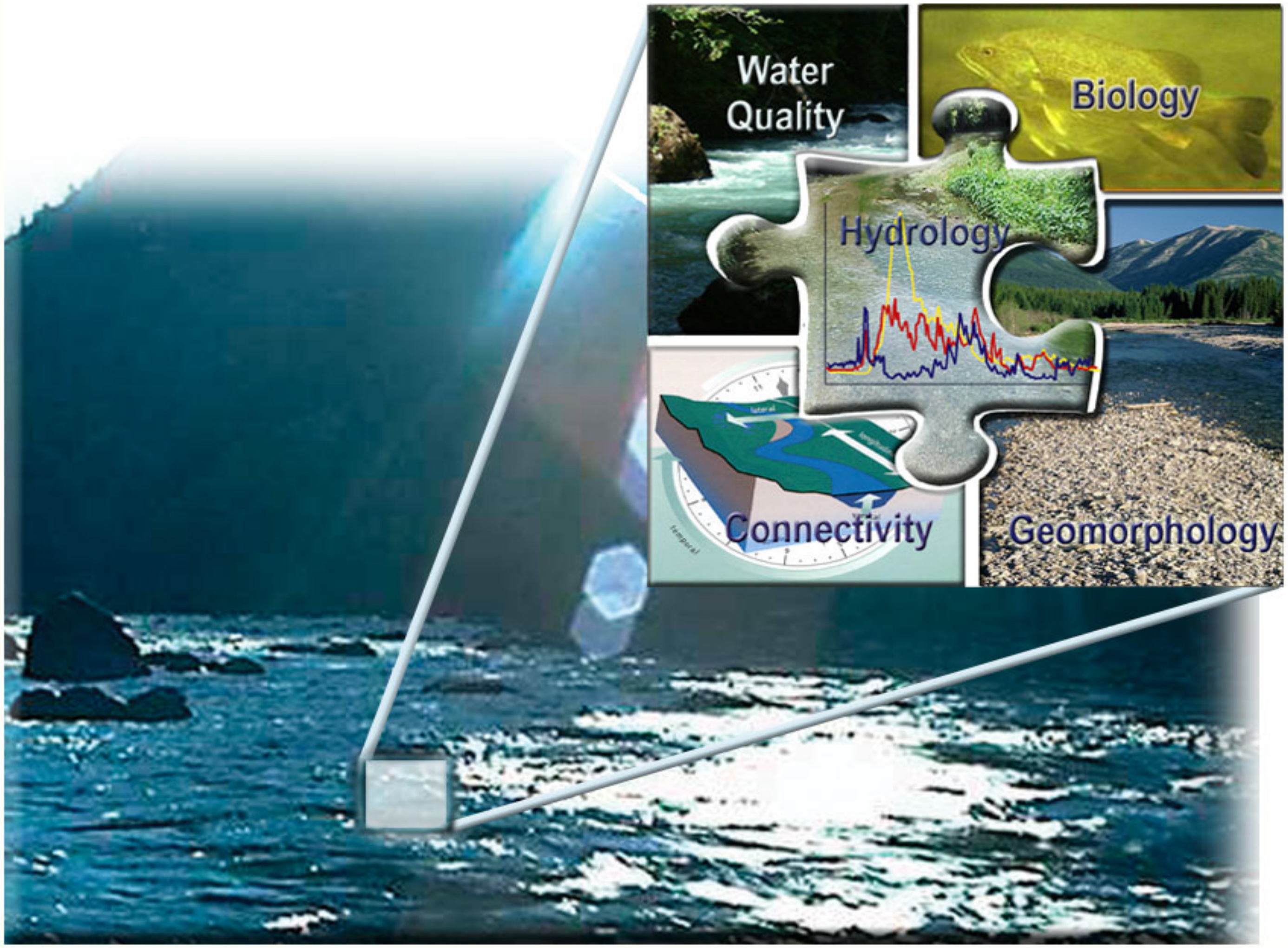
Three Essential Pieces

Environmental Flows & Water Management Planning



Scope of Work

1) Science

- Summary of existing data
- Identify data gaps
- Propose range of alternative methods, spatial and temporal scope and estimated budget

2) Process

3) Institutional

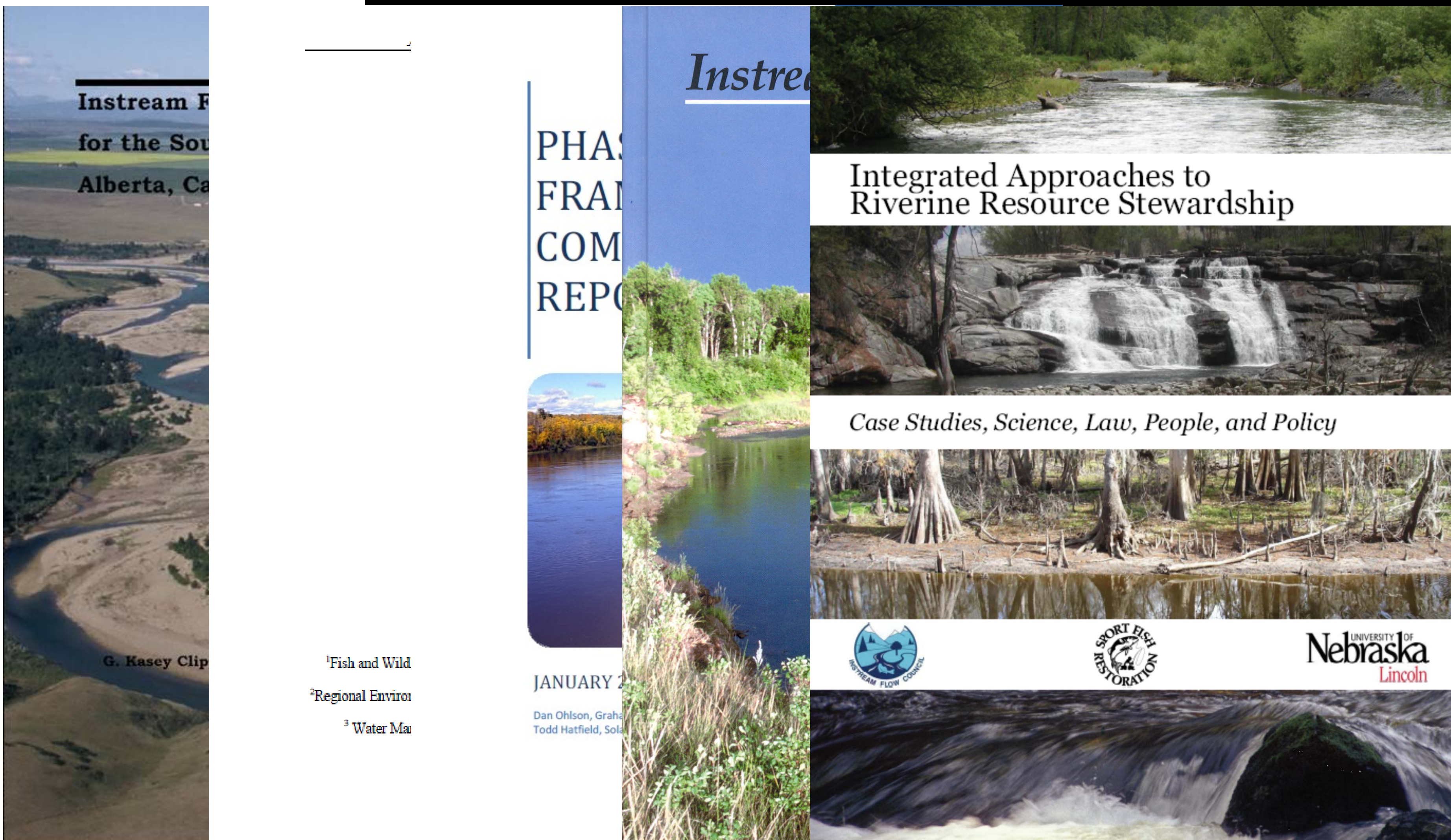
Environmental Flows & Water Management Planning

Lesser Slave Watershed Council Technical Work Plan

Codes			
1	Task pending funding or agency assignment	4	Task complete
2	Funding available for task	5	Task done outside WPAC
3	Task underway	6	Project milestones/decisions

Task		2007												2008												Budget	
No.	Description	J	F	M	A	M	J	J	A	S	O	N	D	J	F	M	A	M	J	J	A	S	O	N	D	2007/08	2008/09
	Monitor water quality																										
2	Paleolimnology Report																										AENV
	Lakeshore and Riparian Condition																										
5	Shoreline and riparian assessments																		1	1	1	1					TBD
	Assess the Conditions of Wetlands																										
6	Alberta Biodiverisy Monitoring Program																										
	Environmental Flows																										
	Hydrology																										
7	Natural lake levels and flow files to 2007																		1	1	1	1	1				AENV
9	Integrated Hydrologic Model - Lake										3	3	3	3	3	3	3	3	3	3	3	3				$35,000	
	Morphology																										
11	Ice Monitoring	3	3	3																							
13	Bathymetry - LS Lake (Littoral sonar collection)																										TBD
	Water Quality																										
14	Integration of WQ model for IFN																					1	1	1	1		$30,000
	Biology																										
15	Riparian Assessment - LS River																										
16	Invertebrate Assessment - LS River																									ENV	
17	Fish winter use - LS River	3	3	3	3	6																				$2,400	
19	Hydraulic Surveys Open-Water - LS River								3	3	3											1	1			$30,000	$60,000
23	Hydraulic Modelling - S. Heart																3						3			$10,000	
	Connectivity																										
30	Cut-off Channel Assessment																										
	IFN Integration																										
31	IFN Determination Report																										
	Sediment Yield																										
32	Estimate Sediment Yield - Watershed																										
	Aggradation/Degradation																										
33	Measure Agg/Deg - East And West Praire	3																									
35	Measure Agg/Deg - Swan & Driftpile R.																			1	1	1					$25,000
	WPAC Management																										
43	Meetings/Reporting/Finances				3	3	3	3	3	3	3	3	3	3	3	3	1	1	1	1	1	1	1	1	1	$38,000	$40,000

Environmental Flows & Water Management Planning



Tame Problems

- Problem of mathematics, such as solving an equation
- Problem of organic chemistry, such as analyzing the structure of an unknown compound

Wicked Problems

- the location of a freeway
- the adjustment of a tax rate
- the modification of school curricula
- the confrontation of crime
- the use of water

Science Does ***not*** Answer Social Value Questions

Widening the scope of environmental flows from a scientific concept to a water management approach is challenging. Generating and discussing the impacts of alternative scenarios is a socio-political process, not just a matter for technical experts.

- IUCN (2011)

"Science cannot give us all the answers. In fact, the most difficult questions, the most persistent problems are not matters of science, but of values. Science can tell us what is happening, but it cannot make us do anything about it."

"Welfare Ranching: The Subsidized Destruction of the American West"

- Mollie Matteson, Co-editor

Structured Decision Making

- structuring the process – clear steps
- structuring judgments
- directly addressing what matters
- linking analysis and consultation
- providing a sound technical basis for decisions
- providing an explicit values-basis for decisions
- exposing trade-offs
- exploring creative solutions
- clarifying risk

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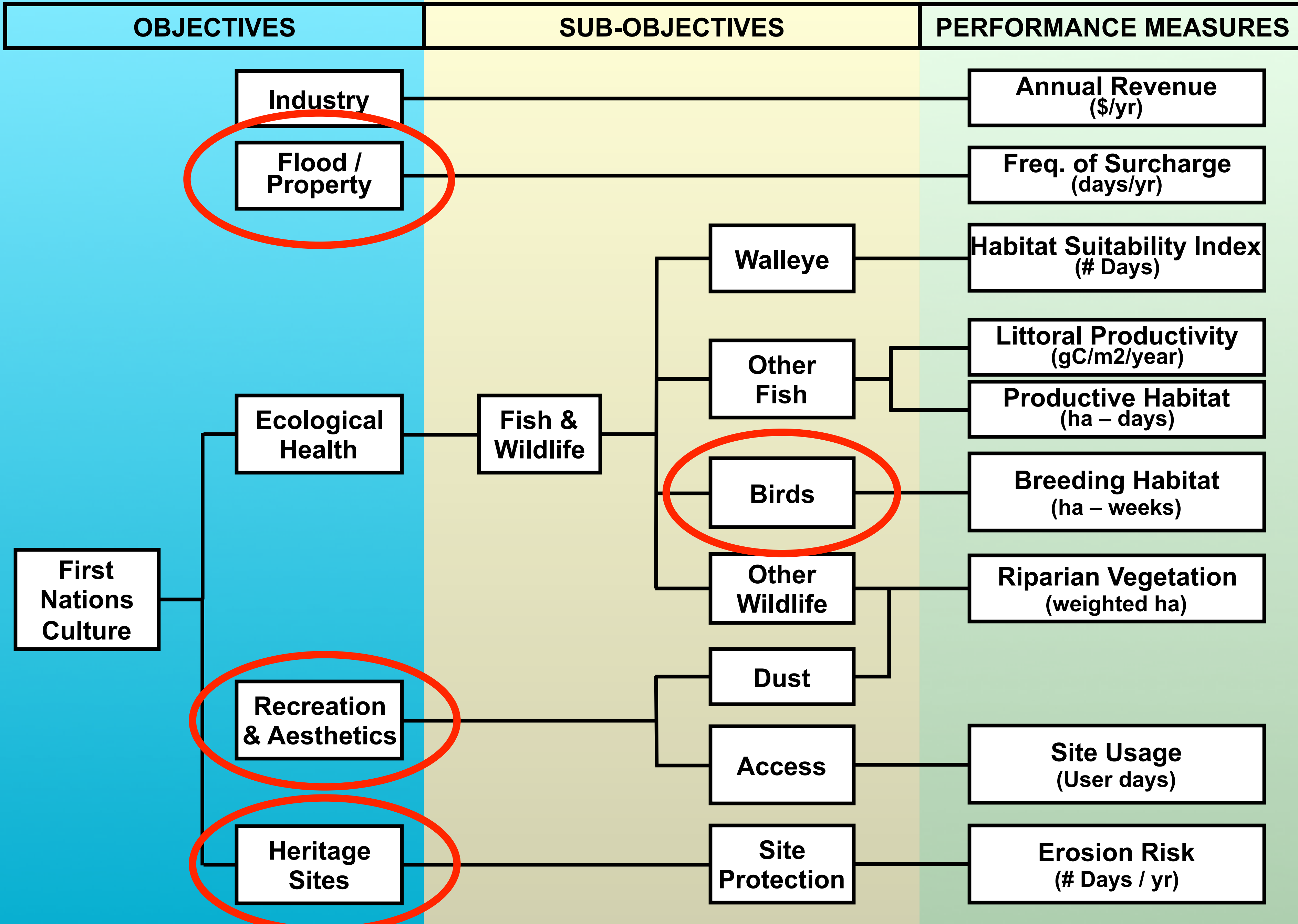
Structured Decision Making

- Defining the scope and bounds for the process and decision(s) to be made,
- Identifying the constraints within which the process will be undertaken, and
- Clarifying the roles and responsibilities of all participants.

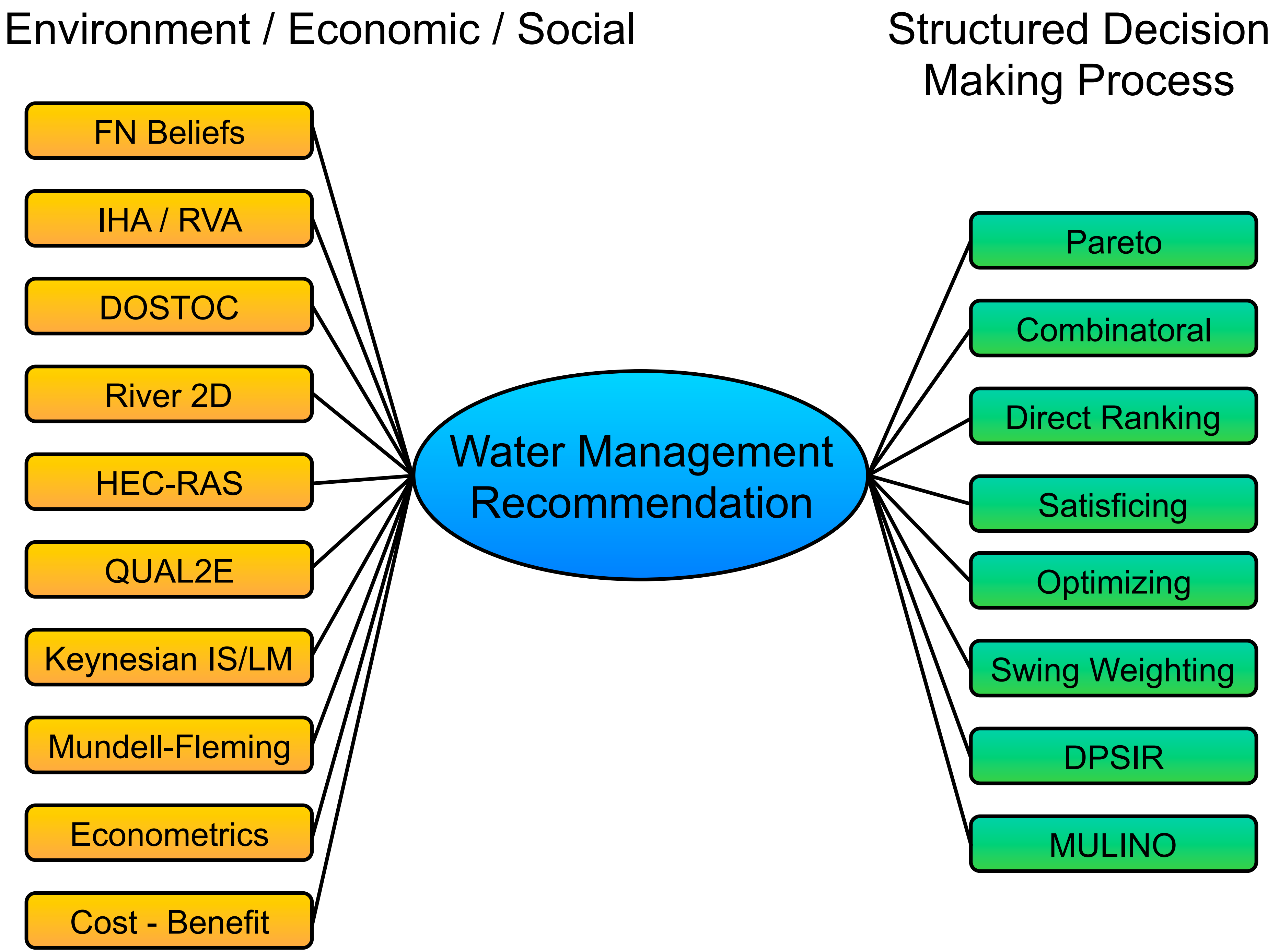
Environmental Flows & Water Management Planning

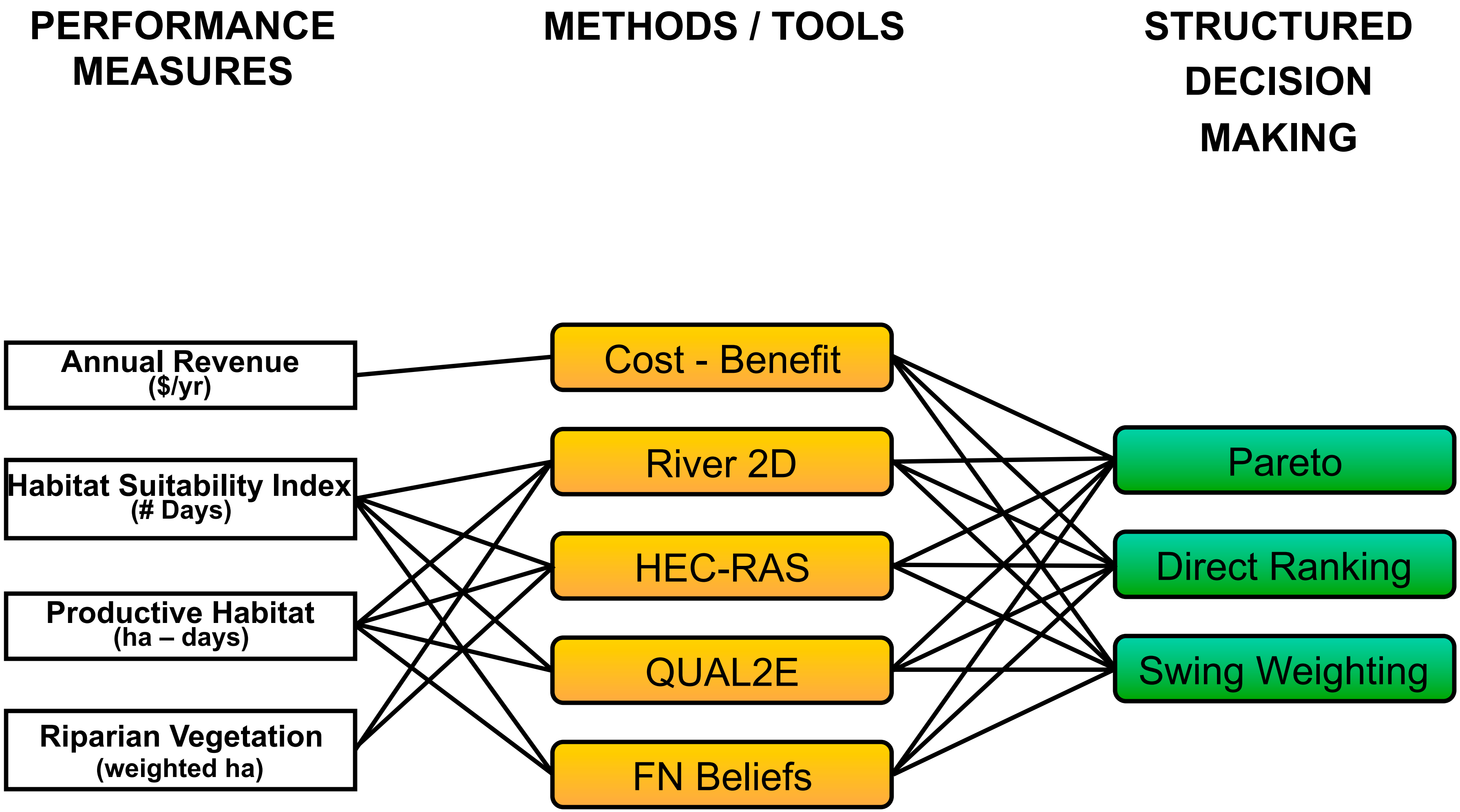
Structured Decision Making

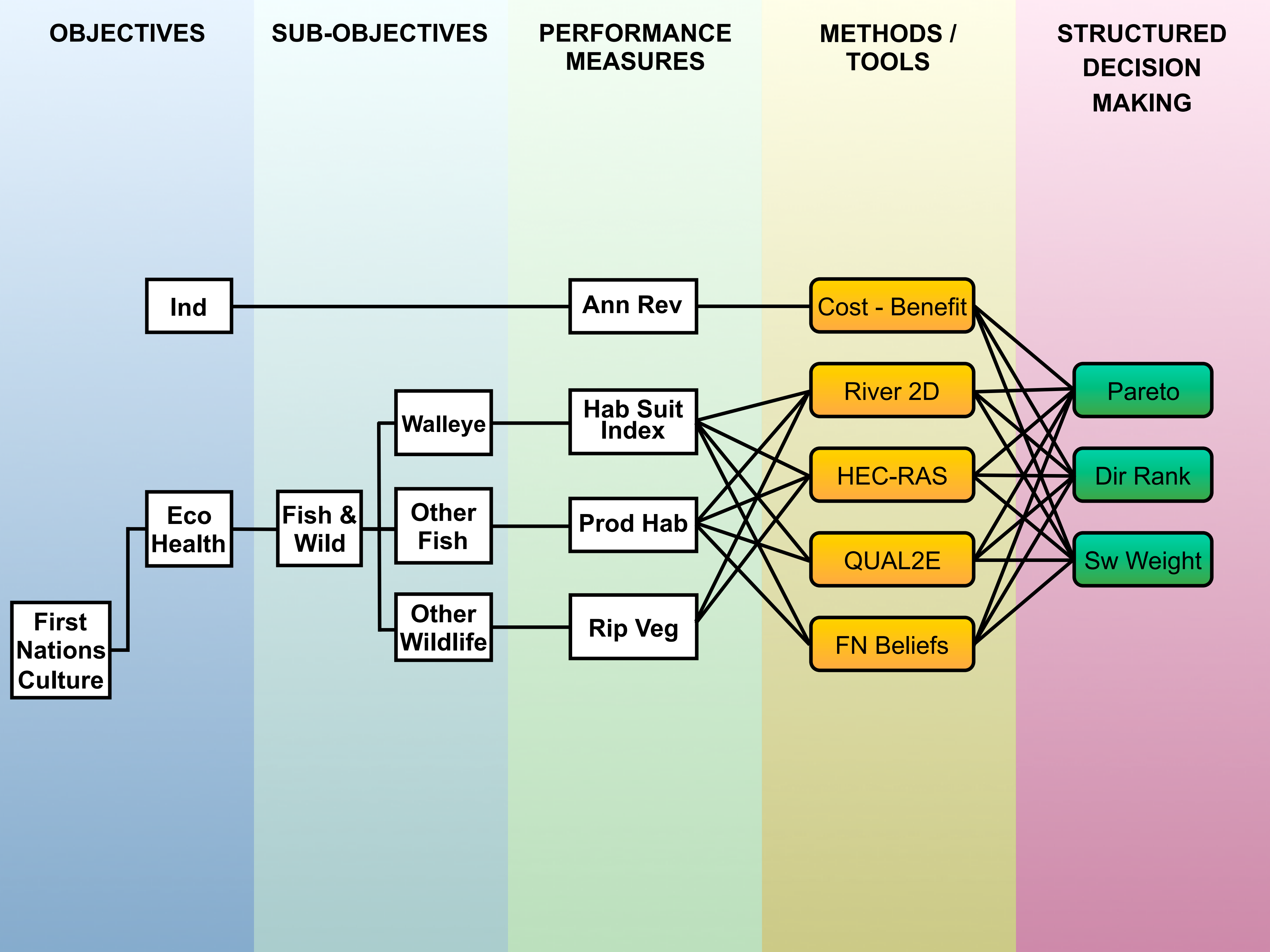
Managing uncertainty can be achieved by having all stakeholders involved in all decision making from the beginning of the project (Scope of Work) through to the final recommendation.



http://www.structureddecisionmaking.org/ToolsValueTrees.htm


Environment / Economic / Social
Structured Decision Making Process
FN Beliefs
IHA / RVA
DOSTOC
River 2D
HEC-RAS
QUAL2E
Keynesian IS/LM
Mundell-Fleming
Econometrics
Cost - Benefit
Water Management Recommendation
Pareto
Combinatoral
Direct Ranking
Satisficing
Optimizing
Swing Weighting
DPSIR
MULINO

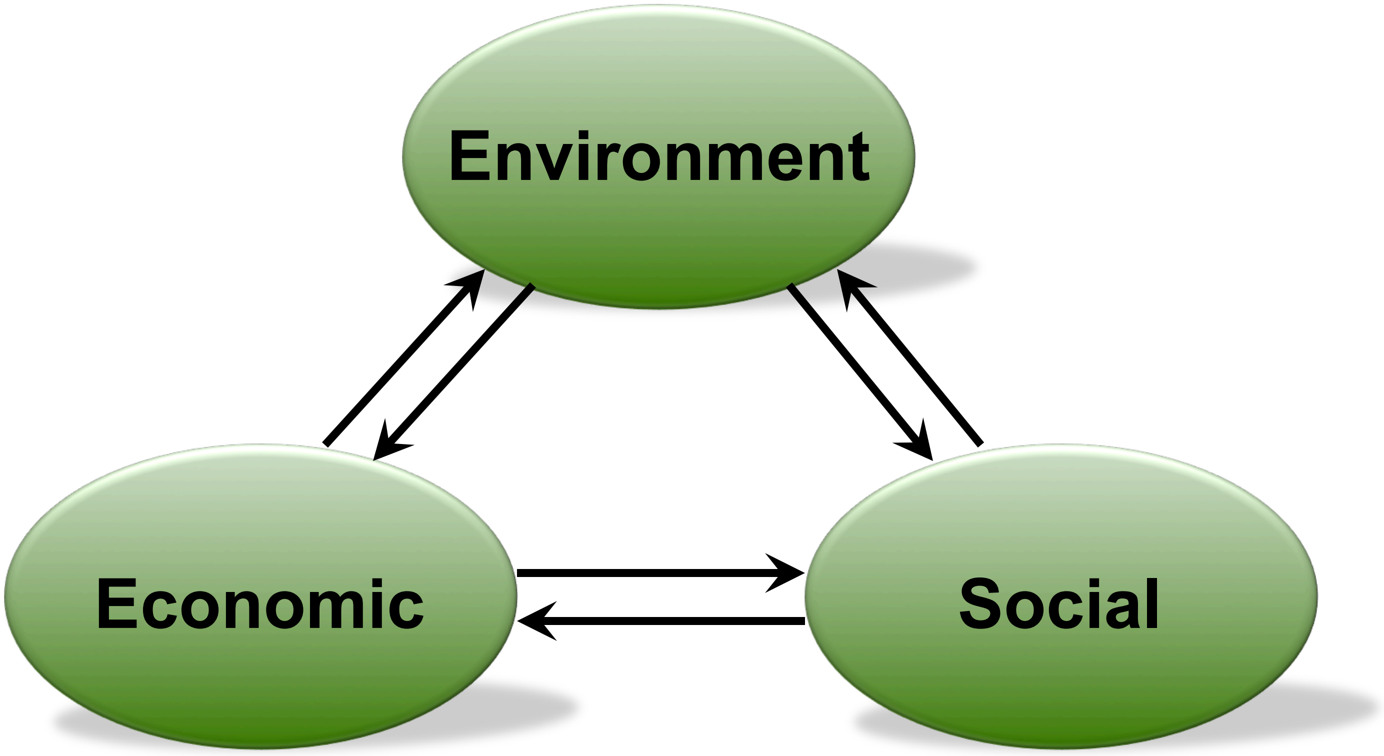

PERFORMANCE MEASURES
METHODS / TOOLS
STRUCTURED DECISION MAKING
Annual Revenue
($/yr)
Habitat Suitability Index
(# Days)
Productive Habitat
(ha – days)
Riparian Vegetation
(weighted ha)
Cost - Benefit
River 2D
HEC-RAS
QUAL2E
FN Beliefs
Pareto
Direct Ranking
Swing Weighting



OBJECTIVES
SUB-OBJECTIVES
PERFORMANCE MEASURES
METHODS / TOOLS
STRUCTURED DECISION MAKING
Ind
Ann Rev
Cost - Benefit
Walleye
Hab Suit Index
River 2D
Pareto
HEC-RAS
Dir Rank
Eco Health
Fish & Wild
Other Fish
Prod Hab
QUAL2E
Sw Weight
First Nations Culture
Other Wildlife
Rip Veg
FN Beliefs

Environmental Flows & Water Management Planning

A Water Management Plan is Making a Trade-off Decision Between Three Competing Interests



How much is enough?

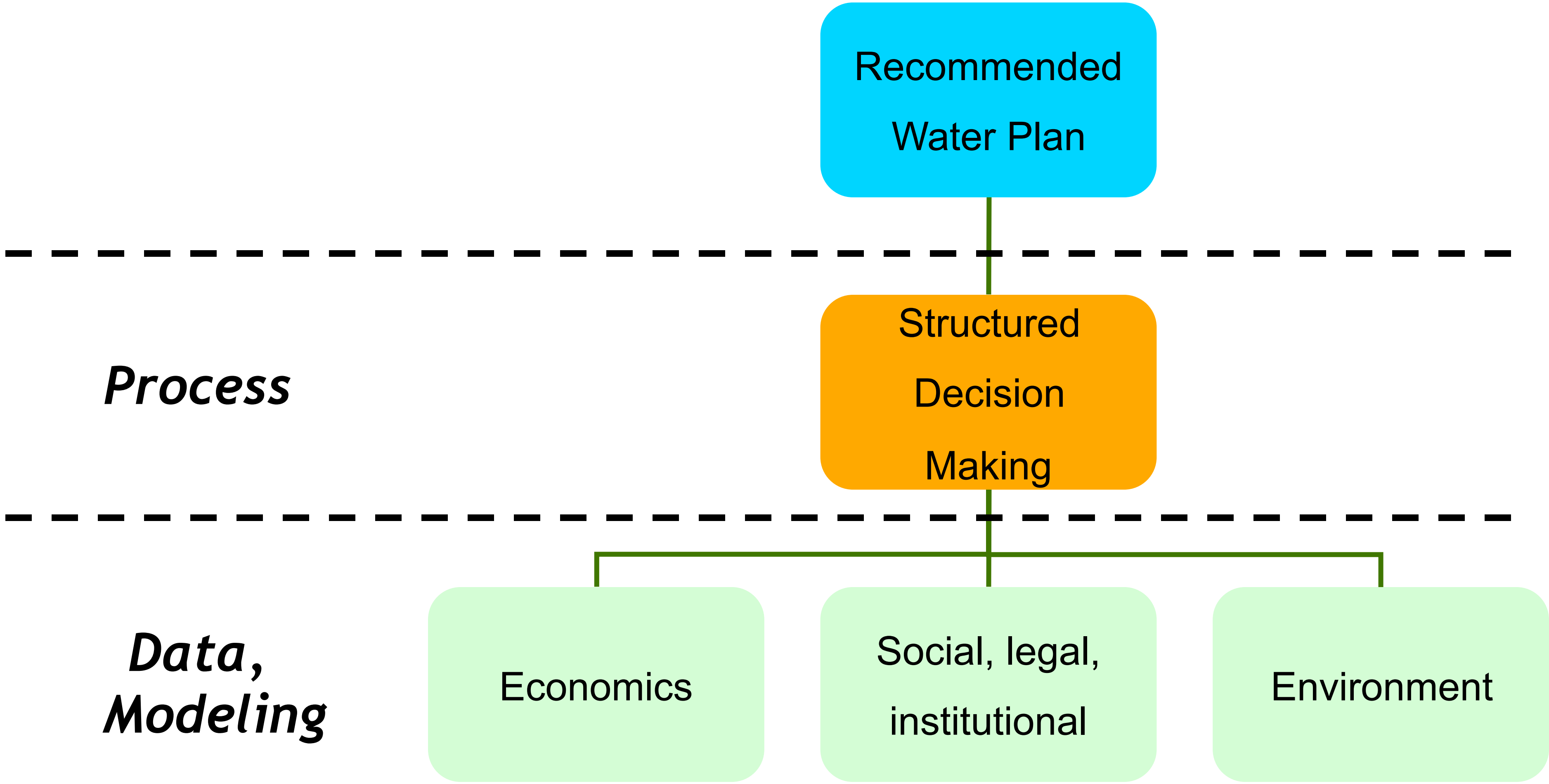
- This is the million dollar question that plagues environmental regulators everywhere.
- There is much effort put into the science of thresholds, dose-response relationships and indicators, but there is limited success with implementation.
- There is no line between ‘enough’ and ‘not enough’.

How much is enough?

- The inconvenient truth - there is no objectively right answer to the question of ‘how much is enough’.
- Regulators must acknowledge the answer to the question ‘how much is enough’ will be inescapably value-based and will need to reflect trade-offs among multiple objectives.

- Gregory et al. 2012

Process is Critical!

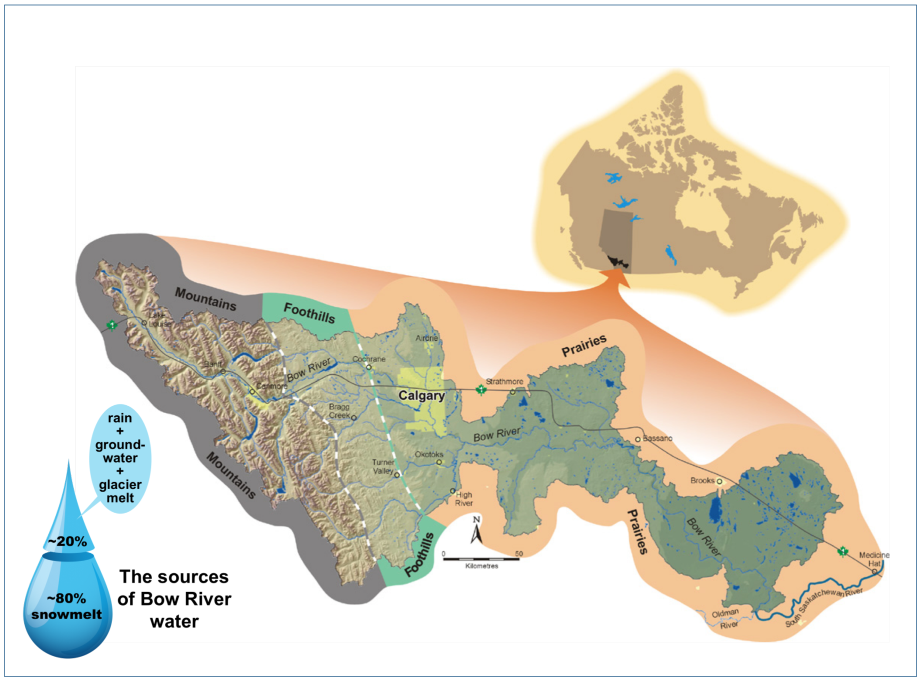


Bow River Project

Final Report

Prepared by | The Bow River Project Research Consortium

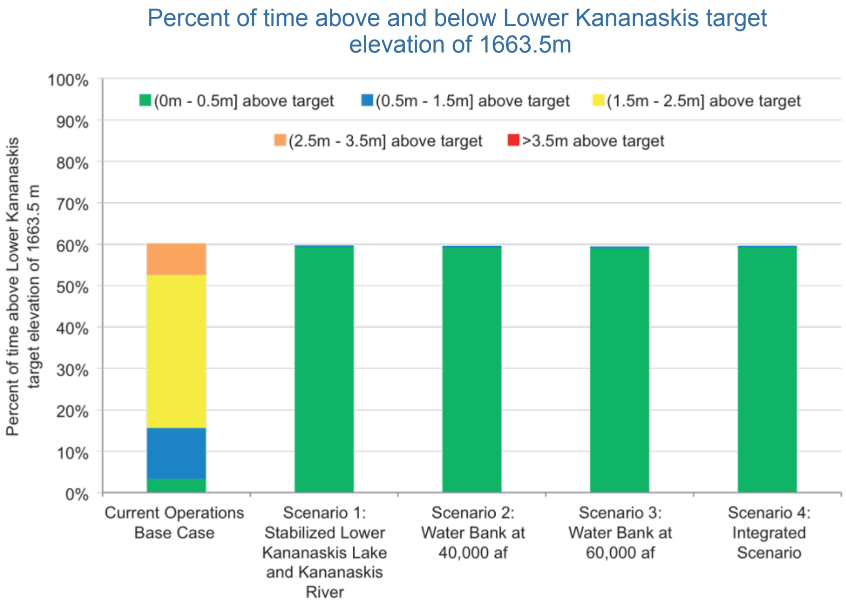
December 2010

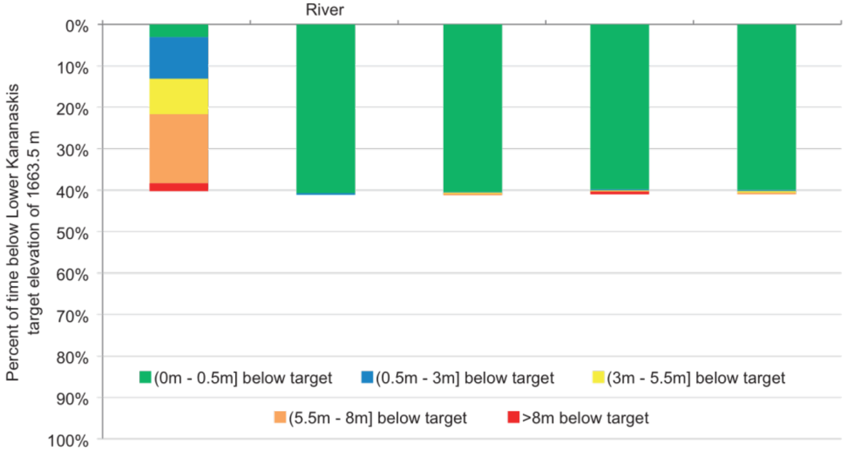


Multiple Impacts in a Renewed Kananaskis (I)

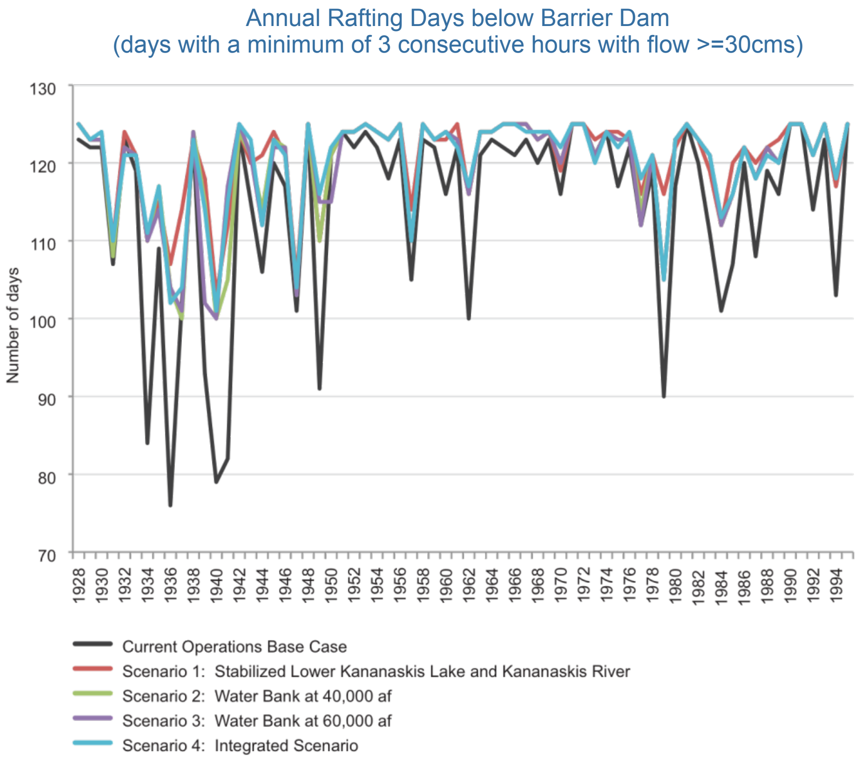
Bow River at Calgary - Natural vs. Managed Flows (1960 - 1997)

Significantly stabilized Lower Kananaskis Lake

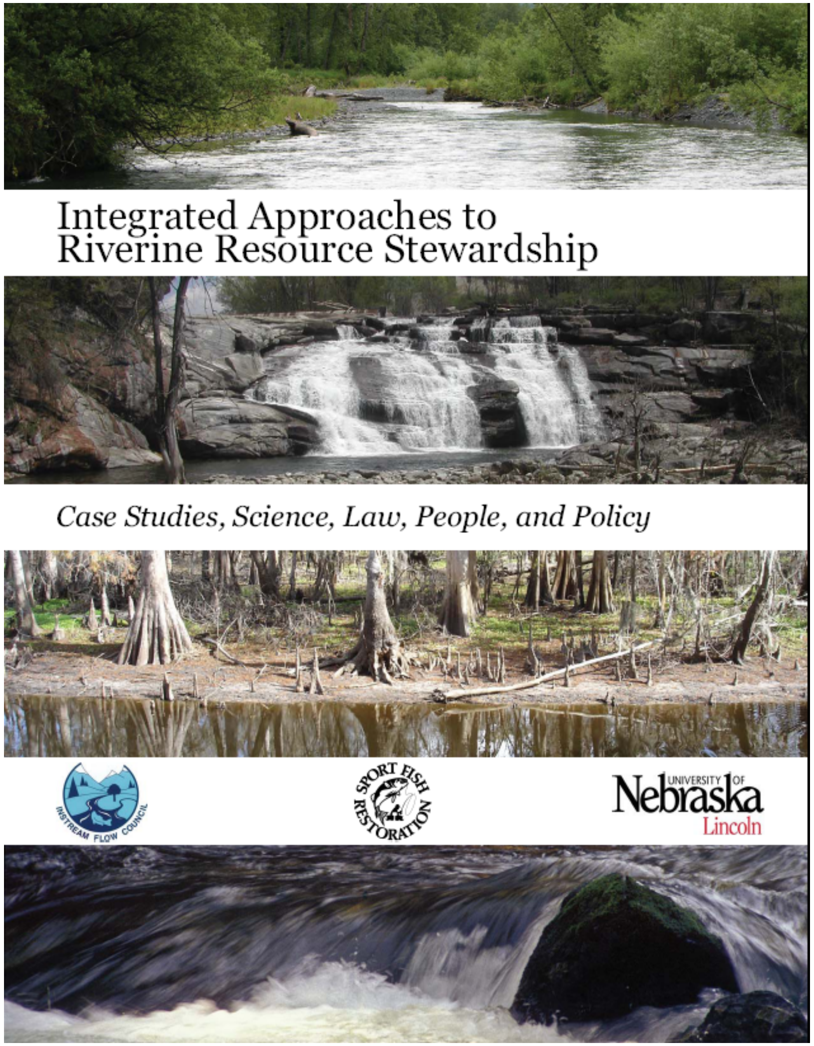




Substantial enhancements for recreation e.g. rafting



Environmental Flows & Water Management Planning



Chapter 9

Trinity River, California

Box 9-1
Trinity River facts

Length: 200 miles (333 km)

Drainage basin: approximately 3,000 square miles (7,800 km²)

River flow includes both spring snowmelt dominated hydrology and winter storm dominated hydrology

Trinity River Division of the Central Valley Project: From 1958–1964, two dams and two diversion tunnels were constructed on the Trinity River for the storage and transfer of water to the Central Valley

The Trinity River was a typical alluvial river system of the coastal western United States. As a naturally flowing river, it was home to a great diversity of plant, animal and fish species and was a rich resource for Native Americans through the centuries. Discovery of gold brought settlers who were also dependent on the Trinity River's wealth of resources. The salmon fishery and other fisheries developed, along with mining, and became a key part of the area's economy.

As with many river systems in western North America, local and regional growth rapidly brought additional demands upon the finite and fragile resources of the Trinity River. Energy needs, agriculture and commerce demanded water system development. Over time, these pressures greatly reduced the river's rich fisheries and habitats. Now, with the persistence and perseverance of many dedicated individuals, the stage is set for a remarkable comeback.

What is unique about the Trinity River story is the continued commitment, dedication, and creative problem solving of multiple and diverse entities to develop a management strategy to restore and maintain a viable fishery resource. The strategy has required the integration of 30 years of scientific study, public policy and (at times) rancorous public involvement. Though far from completed, this project may provide a model for other large-scale riverine restoration projects.

Introduction

The Trinity River headwaters are in northeastern Trinity County in northwestern California. It is the longest tributary of the Klamath River (Figure 9-1), approximately 200 miles (333 km) long. It drains approximately 3,000 square miles (7,800 km²) of the southern Klamath Mountains, northwest of the Sacramento Valley.

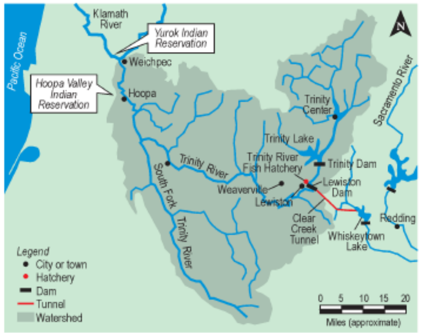


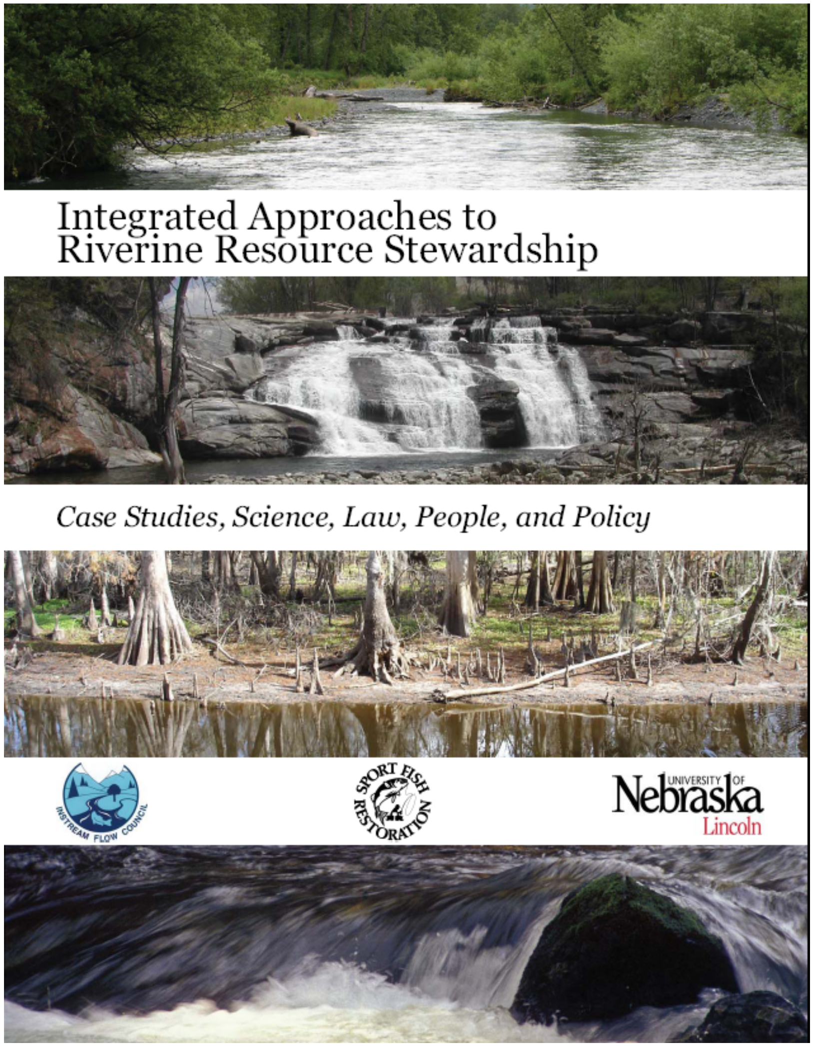
Figure 9-1. Location of Trinity River Division components.

Water and land use development

The Trinity River once supported large runs of Chinook salmon, coho salmon, and steelhead trout. Adults spawned in the gravel beds of the mainstem river, then millions of young fish emerged in the late winter and early spring to rear in the river's diverse habitats. Some juvenile fish began their downstream migration to the Pacific Ocean within months of emergence, while others remained in the river for a year or more before migrating to the sea.

For thousands of years, the people of the Hoopa Valley and Yurok tribes depended on the Trinity ecosystem, using fish, plants, and animals for subsistence, cultural, ceremonial, and commercial purposes. Salmon and other fish were their primary diet. Prior to the arrival of non-native settlers, reports indicated

Environmental Flows & Water Management Planning



Chapter 2

Campbell River, British Columbia

Box 2-1
Campbell River watershed facts

- 1,698 km² (656 square miles) excluding input from BC Hydro diversions
- Second largest drainage basin on Vancouver Island
- Elevation: sea level at mouth, headwater mountains over 2,000 m (6,562 feet)
- All five species of salmon (chinook, coho, pink, chum and sockeye) as well as sea-run trout (steelhead and cutthroat)
- High diversity of plant and wildlife species
- High recreation use: fishing, canoeing, kayaking, boating, bird watching, hiking and nature study
- Industrial activities including logging
- Three reservoirs, three diversions, and three generating stations

Box 2-2
Plant and wildlife species in the Campbell River watershed

- grasses
- sedges
- coniferous trees
- deer
- elk
- cougar
- bear
- wolves
- river otters
- mink
- raccoons
- many species of smaller mammals
- high diversity of birds and water birds

From the top of the house on down. That was the battle cry in the halls at BC Hydro. After months of legal wrangling with regulators, BC Hydro staff knew they needed a bold and innovative strategy to deal with the instream flow issues surrounding the operation of their dams.

BC Hydro is British Columbia's major supplier of electricity. In response to public outcry, the federal regulator took BC Hydro to court over environmental concerns about the way they operated their dams. Court costs were rising, yet both sides were dissatisfied with the results from the legal proceedings. A solution was required.

BC Hydro middle management developed a plan but knew it could only succeed if it had broad support—*from the top of the house on down*. After taking the necessary time and effort to get management acceptance, BC Hydro then presented the plan to the public and to both the provincial and federal regulators.

The plan was ambitious. It integrated broad stakeholder involvement and rigorous targeted technical assessments together in a planning process designed to identify the best balance among competing management objectives. Previously the water management planning process had been confrontational and acrimonious; the new plan turned it into one of the most successful in Canada.

Figure 2-1. Campbell River watershed, Vancouver Island.

9

Appendix 3

NSR Basin: Comparison of Historical Observed Flows to Desktop IFN

North Saskatchewan Basin

Comparison of Historical Observed Flows

To Desktop Instream Flow Needs

Prepared for:

The North Saskatchewan Watershed Alliance

Prepared by:

Sal Figliuzzi and Associates Ltd.

December, 2013

EXECUTIVE SUMMARY

The North Saskatchewan Watershed Alliance (NSWA) is the official WateredPlanning and Advisory Council (WPAC) for the North Saskatchewan River watershed in Alberta. As one of the partnerships under the Government of Alberta's "***Water for Life Strategy***", the NSWA has a mandate to prepare an Integrated Watershed Management Plan (IWMP) for the NSR and may make recommendations towards the development of Water Conservation Objectives (WCOs), these being a stakeholder consensus between the flow that should be left in the river for environmental considerations and the flow that can be consumed for economic activity. A starting point in the discussion and reaching consensus on WCO's is the Instream Flow Needs (IFN's); this being the science based flow quantities and qualities required to sustain the integrity of riverine environments at a given ecological-based objective.

"*The Government of Alberta and Alberta's* ***Water Act*** *and* ***Water for Life*** *strategy support and encourage the establishment of IFNs. However, as it is impossible to develop detailed IFN's for all stream reaches they have developed and recommended a simple "Desktop Method" for computing IFN's. The Desktop method is intended to be fully protective of the aquatic environment* ***in the absence of having site-specific information that could otherwise be used to establish an Environmental Flow****. The Alberta Desktop Method was developed primarily for rivers that have* ***natural flows*** *and to make a full protection flow recommendation where site specific instream flow data is not available. However, the Alberta Desktop Method can also be used to assess the degree of impact on flows in highly regulated systems (dams, weirs) and in systems where there is a high degree of flow allocation."* [1]

Within the above context, this report carried out an assessment comparing the recorded mean weekly flows in the North Saskatchewan River at Rocky Mountain House, Edmonton, and the Alberta-Saskatchewan Border and for the Sturgeon River at Fort Saskatchewan to the Desktop IFN to determine the impact that regulation and water allocations have had on the North Saskatchewan River and one of its tributaries in terms of their ability to meet or exceed Instream Flow Needs. The assessment concludes the following:

North Saskatchewan River

- Due to releases from the Brazeau and Bighorn Reservoirs, recorded mean weekly winter (approximately November to April) flows in the North Saskatchewan River at Rocky Mountain House, Edmonton and the Alberta-Saskatchewan Border exceed the Desktop IFN in nearly 100% of all years and are in the order of 250-350% of the Desktop IFN.

- Due to the capturing of upstream runoff by the Brazeau and Bighorn Reservoirs during the summer (June-August) high elevation snowmelt period, mean weekly flows in the North Saskatchewan River at Rocky Mountain House exceed the Desktop IFN flows in less than 5% of all years and on average are in the order of 55-80% of the Desktop IFN. During this period, mean weekly flows in the North Saskatchewan River at Edmonton and at the Alberta Saskatchewan Border exceed the Desktop IFN flows in less than 10% of all years and were about 60-80% of the Desktop IFN.
- Water levels within the North Saskatchewan River at Rocky Mountain House and at Edmonton have a diurnal fluctuation of about 0.2-0.3 metres. On occasion these fluctuations can be as high as 0.5 metres. The larger fluctuations appear to occur during the ice build-up and break-up conditions rather than during the open water period.

Tributaries of the North Saskatchewan River

- The Sturgeon River is the only prairie tributary of the North Saskatchewan River for which natural flows are available. The reconstructed natural flows, however, are only available for the 1912-1991 period. It is recommended that natural flows for the Sturgeon River be updated to recent years and that natural flows be reconstructed for other major tributaries of the North Saskatchewan River.
- A comparison of 1972-1991 recorded mean weekly flows to Desktop IFN's for the Sturgeon River at Fort Saskatchewan shows that in the spring and late fall Desktop IFN was equalled or exceeded in about 80-90% of all years while late spring and summer Desktop IFN was only equalled or exceeded in about 65-80% of years. Given that over 20 years have elapsed since the period used in the simulation and that additional water allocations were granted during that period, the percent of time that summer flows in Sturgeon River currently exceeds the Desktop IFN is likely significantly less than the 65-80% of years computed for the 1972-1991 period.

ACKNOWLEDGEMENTS

The author gratefully acknowledges the contribution of Ernst Kerkhoven of Alberta Environment and Sustainable Resource Development for providing estimates of historical natural flows for the North Saskatchewan River and the Sturgeon River.

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North Saskatchewan River Basin

Comparison of Historical Observed Flows to Desktop IFN's

1.0 INTRODUCTION

The North Saskatchewan River (NSR) originates from the Columbia Icefields and Saskatchewan Glacier in Banff and Jasper National Parks. From its source, the North Saskatchewan River flows north-east for a distance of about 62Km before emptying into Lake Abraham – a man-made lake created in 1972 by the construction of the Bighorn Dam. From the outlet of Lake Abraham, the river flows east for a distance of about 110 Km to the Town of Rocky Mountain House, along this reach the NSR is joined by two major tributaries; the Ram River and the Clearwater River. At Rocky Mountain House the NSR swings into a northerly direction and flows for a distance of 110 Km to Drayton Valley. Along this distance the NSR is joined by the Brazeau River, which was regulated in 1965 by the construction of the Brazeau Hydroelectric Plant and Reservoir, by the Nordegg River, and by the Baptiste River. From Drayton Valley the NSR flows east for a distance of 125 Km to the City of Edmonton, it then flows in a north-east direction for about 80 Km and is joined by the Sturgeon and Redwater River before swinging into an east direction and being joined by the Vermilion River as it flows the additional 210 Km to the Alberta-Saskatchewan Border (Figure 1) .

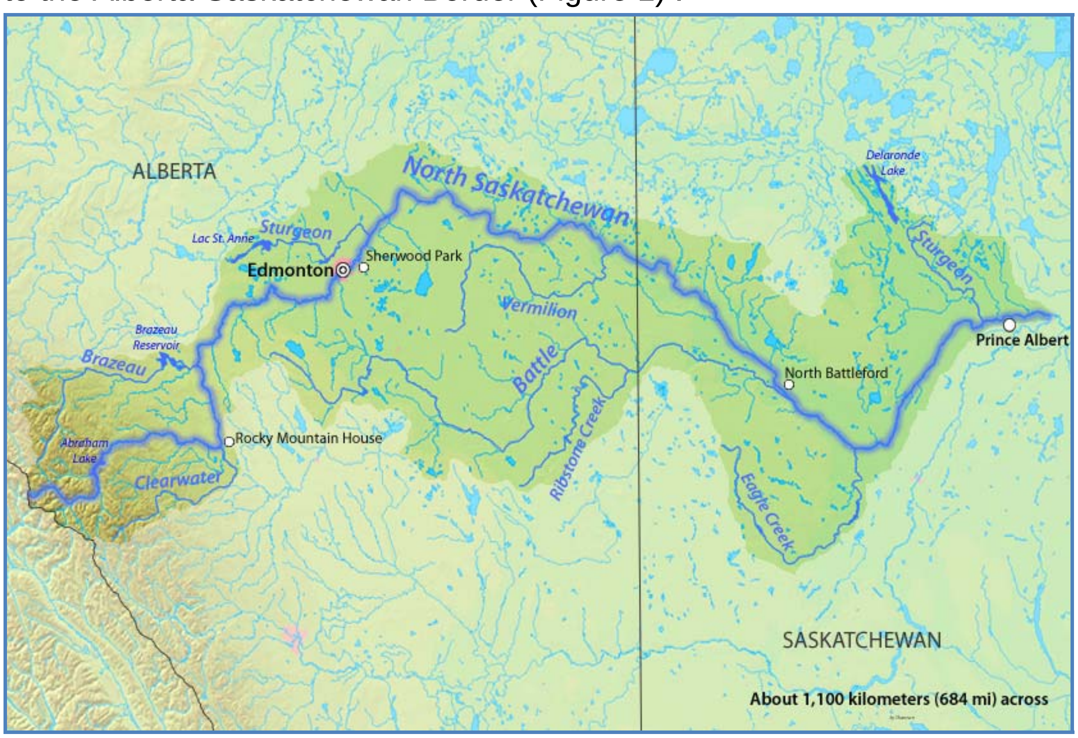

Figure 1 – Map of the North Saskatchewan River Basin.

The North Saskatchewan Watershed Alliance (NSWA) is the official Watershed Planning and Advisory Council (WPAC) for the North Saskatchewan River watershed in Alberta. As one of the partnerships under the Government of Alberta's "***Water for Life Strategy***", the NSWA has a mandate to prepare an Integrated Watershed Management Plan (IWMP) for the NSR and may make recommendations for the development of Water Conservation Objectives (WCOs); these being a stakeholder consensus between the flow that should be left in the river for environmental considerations and the flow that can be consumed for economic activity. A starting point in the discussion and reaching consensus on WCO's is the Instream Flow Needs (IFN's); these being the science based flow quantities and qualities required to sustain the integrity of riverine environments at a given ecological-based objective.

"*The Government of Alberta and Alberta's **Water Act** and **Water for Life** strategy support and encourage the establishment of IFNs. However, as it is impossible to develop detailed IFN's for all stream they have developed and recommended a simple "Desktop Method" for computing IFN's. The Desktop method is intended to be fully protective of the aquatic environment **in the absence of having site-specific information that could otherwise be used to establish an Environmental Flow**. The Alberta Desktop Method was developed with the intent that by staying within recommended limits, there is a very low probability of ecological effects to the aquatic environment (full aquatic ecosystem protection). It achieves this by limiting water allocations to flows above recommended limits so as to preserve not only water quantity within the stream, but also the natural fluctuations that occur day to day, including peak events. The Alberta Desktop Method was developed primarily for rivers that have **natural flows** and to make a full protection flow recommendation where site specific instream flow data is not available. However, the Alberta Desktop Method can also be used to assess the degree of impact on flows in highly regulated systems (dams, weirs) and in systems where there is a high degree of flow allocation."* [1]

Within the above context, the North Saskatchewan Watershed Alliance has retained Sal Figliuzzi and Associates to:

i. Review the existing historical natural flows and recorded flows for three sites on the North Saskatchewan River Main stem and one site on the Sturgeon River, the only stream courses within the basin for which natural flows are available, so as to assess the degree of impact that regulation and water allocations have had on Instream Flow Needs. The sites to be analyzed are:
    a. North Saskatchewan River at Rocky Mountain House,
    b. North Saskatchewan River at Edmonton,
    c. North Saskatchewan River at the Alberta-Saskatchewan Boundary,
    d. Sturgeon River at Fort Saskatchewan.
ii. As water storage reservoirs on the North Saskatchewan and Brazeau Rivers are primarily used for peaking hydro production, to examine the diurnal fluctuations for the North Saskatchewan River at Rocky Mountain House and at Edmonton.

2.0 DEGREE OF IMPACT REGULATION AND WATER ALLOCATIONS HAVE HAD ON INSTREAM FLOW NEEDS IN THE NORTH SASKATCHEWAN AND STURGEON RIVERS

The assessment of the degree of impact regulation and water allocations have had on the North Saskatchewan and Sturgeon River was carried out by applying the Desktop method of computing IFN's to the historical weekly natural flows, previously generated by Alberta Environment, and by then comparing the historical recorded weekly flows to the Desktop IFN's to determine the degree of impact.

The formula for computing the Desktop Method IFN is as follows

a. For weekly natural flows less than or equal to the 80% exceedence natural flow the IFN is equal to the natural flow;
b. For weekly natural flows greater than the 80% exceedence natural flow the IFN is equal to the greater of either:
    i. A 15% reduction from the instantaneous natural flow (85% of natural) or,
    ii. The 80% exceedence weekly natural flow.

The range controlled by each of the clauses within the Desktop Method is shown graphically in Figure 2.

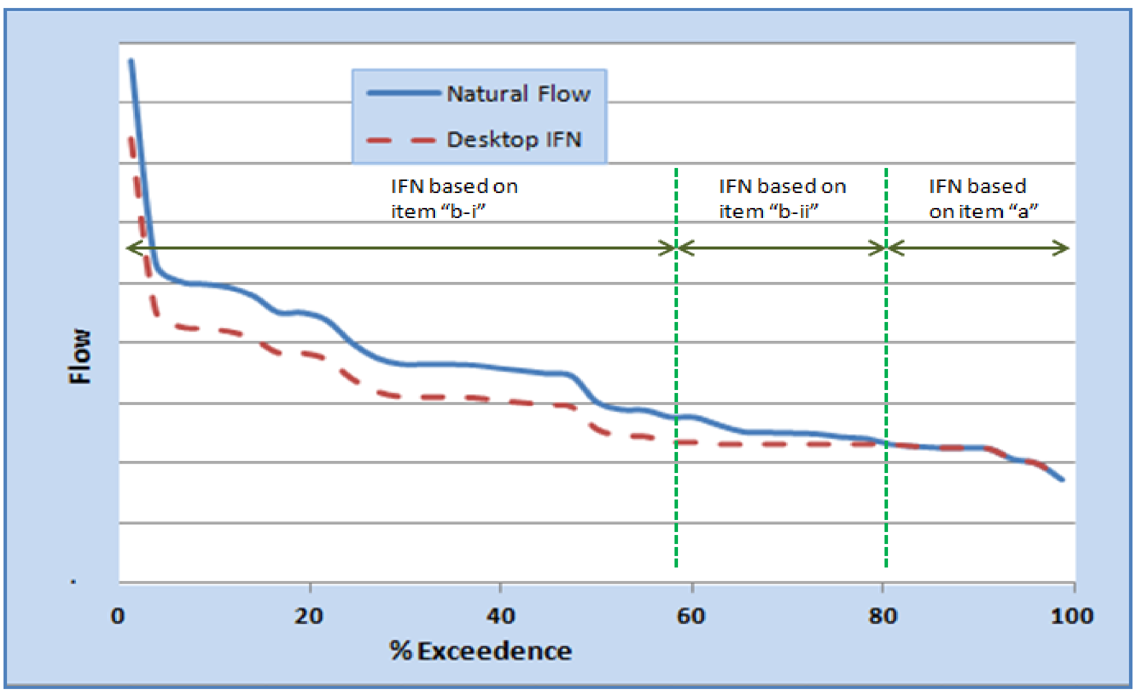

Figure 2 – Graphical representation of Desktop Method.

2.1 Degree of Impact on Instream Flow Needs for the North Saskatchewan River

The North Saskatchewan River is regulated by two major structures, the Brazeau Dam and hydro plan, constructed in 1965, and the Bighorn Dam and hydro plant, completed in mid 1972. The Bighorn Dam, the larger of the two reservoirs, is located on the North Saskatchewan River upstream of Rocky Mountain House. The Brazeau Dam is located on the Brazeau River, a tributary which joins the North Saskatchewan River about 75 Km downstream of the Town of Rocky Mountain House. The assessment as to the degree of impact that water allocations and regulation have had on the flows of the North Saskatchewan River at Rocky Mountain House, Edmonton, and the Alberta-Saskatchewan Boundary was based on an analysis of solely the 1973-2010 period of record; the period having the full impact of upstream regulation for which natural flows were available. In computing the Desktop IFN's, the 80% exceedence natural flows for each week of the year were first computed using the "Hazen plotting positions" (where probability of a recorded flow is computed using the formula (m-0.5)/n where "m" is the rank and "n" is the number of observations). The formula for computing the Desktop Method IFN, along with the 80% exceedence flow was then applied to the weekly natural flows to determine the Desktop IFN for each week in the 1973-2010 period. The Desktop IFN's were then compared to the weekly observed flows to determine:

i. The percent of years for which the recorded mean weekly flows exceeded the Desktop IFN in each week of the year, and
ii. The distribution (median, maximum and minimum) in the recorded flows, as a percentage of the Desktop IFN.

The results are discussed in the following Sections.

2.1.1 Assessment of Impact on IFN's for the North Saskatchewan River at Rocky Mountain House

The percent of years, in the 1973-2010 period in which the recorded mean weekly flows exceeded the desktop IFN is summarized in Table 1 and Figure 3.

Table 1 - North Saskatchewan River at Rocky Mountain House (1973-2010)
. Percent of years in which the recorded mean weekly flow exceeded the "Desktop IFN"

Week	1	2	3	4	5	6	7	8	9	10	11	12	13
% of years IFN is exceeded	100	100	100	100	100	100	100	97	97	97	100	100	100
Week	14	15	16	17	18	19	20	21	22	23	24	25	26
% of years IFN is exceeded	100	100	100	100	97	95	82	55	21	5	3	3	3
Week	27	28	29	30	31	32	33	34	35	36	37	38	39
% of years IFN is exceeded	0	3	3	0	0	0	0	0	5	16	32	45	74
Week	40	41	42	43	44	45	46	47	48	49	50	51	52
% of years IFN is exceeded	92	95	100	97	100	100	100	100	100	100	100	100	100

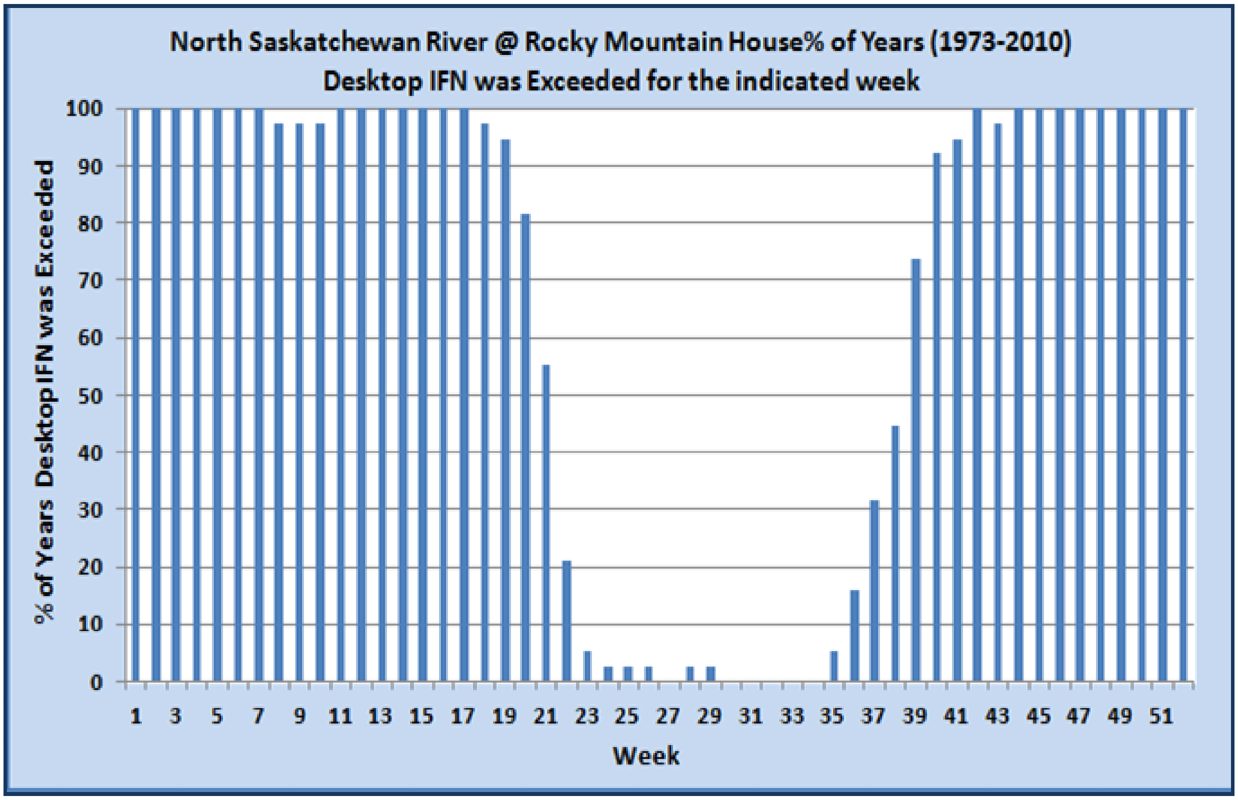

Figure 3 – North Saskatchewan River at Rocky Mountain House – Percent of years . (1973-2010) recorded flows exceeded "Desktop IFN".

Table 1 and Figure 3 show that for weeks 42-52 and 1-19 (mid October to mid May) the recorded mean weekly flow in the North Saskatchewan River at Rocky Mountain House equalled or exceeded the Desktop IFN in nearly all years. This is as expected as this is the period during which releases for hydropower production are made from the Bighorn Reservoir. Table 1 and Figure 3 further show that during weeks 23 to 35 (June – August) the recorded mean weekly flow within the North Saskatchewan River at Rocky Mountain House met the Desktop IFN in less than 5% of all years. Again, this is expected as June to August is the period when high elevation snowmelt occurs and the period during which runoff is being captured in the Bighorn Reservoir. Figures 4a and 4b show the 2004 and 2010 natural, recorded, and Desktop IFN flow for the North Saskatchewan at Rocky Mountain House provides an example of the impact water allocations and regulation have had on flows.

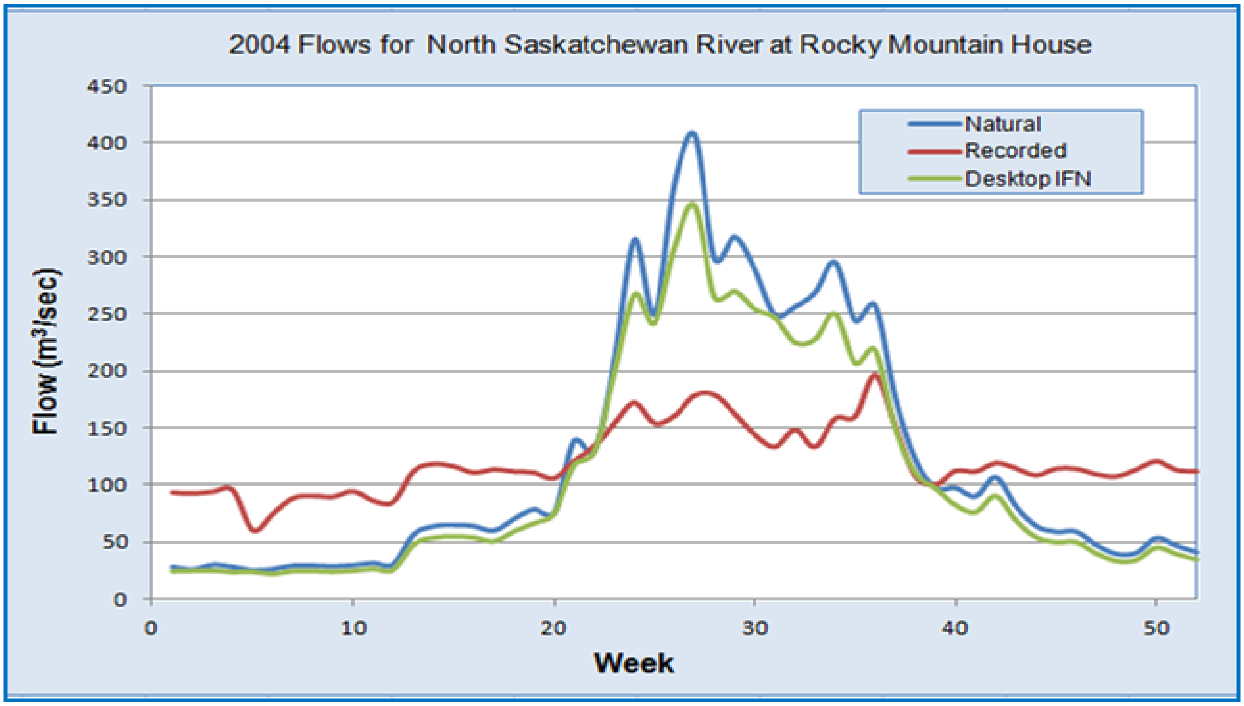

Figure 4a – North Saskatchewan River at Rocky Mountain House – 2004 weekly natural . recorded and Desktop IFN flows

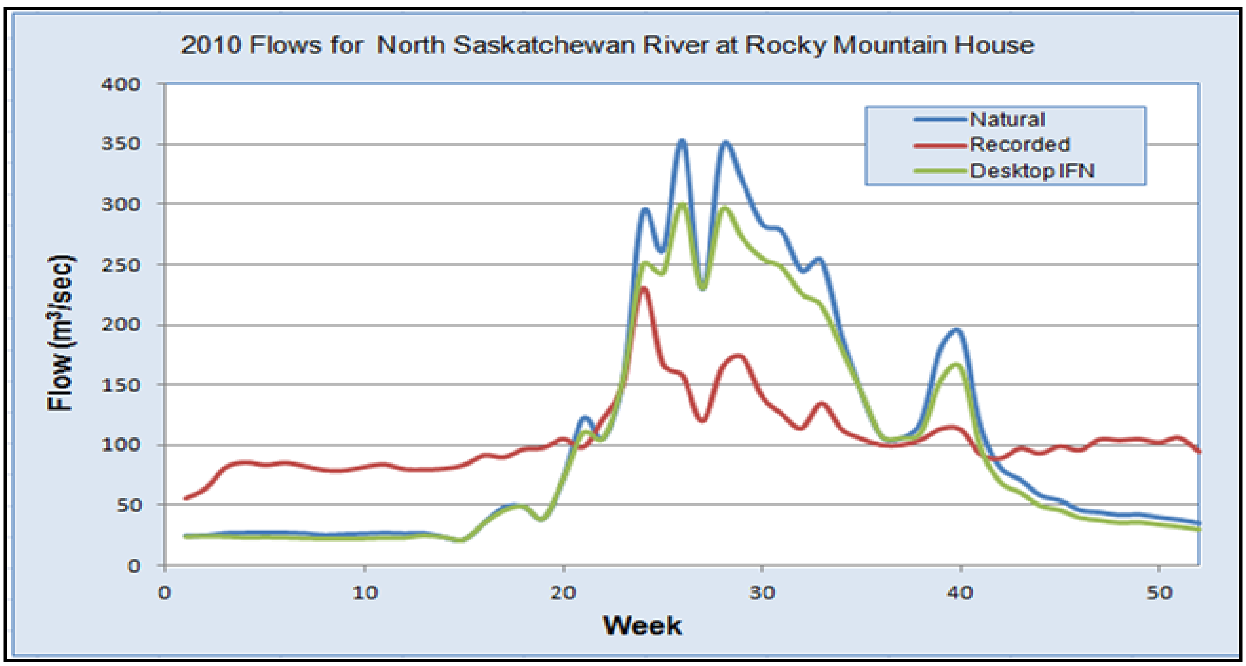

Figure 4b – North Saskatchewan River at Rocky Mountain House – 2010 weekly natural . recorded and Desktop IFN flows.

Table 2 and Figure 5 show the range (median, maximum and minimum) of recorded mean weekly flows as a percentage of the Desktop IFN for each week of the year.

Table 2 - North Saskatchewan River at Rocky Mountain House (1973-2010)
. Recorded flows as a percent of "Desktop IFN"

Week	1	2	3	4	5	6	7	8	9	10	11	12	13
Median	313	316	321	335	311	338	331	342	349	356	342	339	330
Maximum	433	430	538	551	604	574	523	538	550	530	481	469	480
Minimum	191	196	190	216	222	227	185	72	64	69	169	198	235
Week	14	15	16	17	18	19	20	21	22	23	24	25	26
Median	306	293	252	229	206	176	136	101	90	78	76	73	69
Maximum	499	402	376	331	324	268	239	161	116	114	105	104	109
Minimum	203	195	163	139	95	72	62	50	55	52	46	43	39
Week	27	28	29	30	31	32	33	34	35	36	37	38	39
Median	63	63	60	56	56	55	61	64	75	80	93	98	110
Maximum	100	103	100	81	88	85	85	96	110	123	127	131	154
Minimum	41	42	39	33	29	34	40	42	53	46	56	49	74
Week	40	41	42	43	44	45	46	47	48	49	50	51	52
Median	124	141	155	171	196	213	229	265	289	294	294	316	308
Maximum	175	208	217	235	264	280	372	413	387	468	457	386	414
Minimum	69	93	119	89	146	147	152	181	187	188	195	173	176

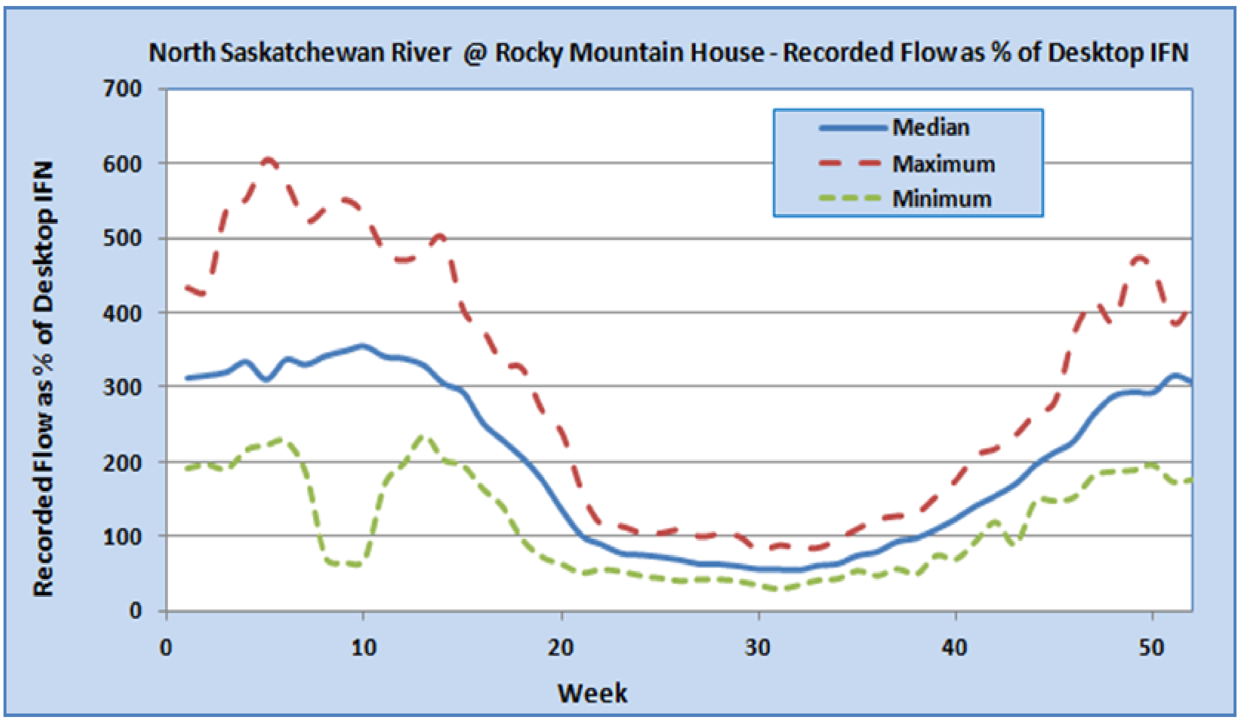

Figure 5 – North Saskatchewan River at Rocky Mountain House – Recorded flow as . percent of "Desktop IFN".

While the natural flow ranges from 100% to 118% of the Desktop IFN, Table 2 and Figure 5 show that during weeks 47-52 and 1-16 (November to April) the recorded flows were in the order of 250-350% of the Desktop IFN and have been as high as 600% and as low as 64%. During weeks 23-35 (June-August) the recorded flows on average were in the order of 55-80% of the Desktop IFN although on occasion they have been as high as 123% and as low as 28% of the Desktop IFN.

2.1.2 Assessment of Impact on IFN's for The North Saskatchewan River at Edmonton

The percent of years, during the 1973-2010 period for which the recorded weekly mean flow for the North Saskatchewan River at Edmonton exceeded the Desktop IFN in each week of the year is summarized in Table 3 and Figure 6.

Table 3 - North Saskatchewan River at Edmonton (1973-2010)
. Percent of years in which the recorded mean weekly flow exceeded the "Desktop IFN"

Week	1	2	3	4	5	6	7	8	9	10	11	12	13
% of years IFN is exceeded	100	100	100	100	100	100	100	100	100	100	100	100	100
Week	14	15	16	17	18	19	20	21	22	23	24	25	26
% of years IFN is exceeded	100	100	100	100	92	92	79	45	18	8	5	8	5
Week	27	28	29	30	31	32	33	34	35	36	37	38	39
% of years IFN is exceeded	11	5	3	3	0	0	3	0	5	8	24	37	47
Week	40	41	42	43	44	45	46	47	48	49	50	51	52
% of years IFN is exceeded	61	82	100	97	100	100	100	100	100	100	100	100	100

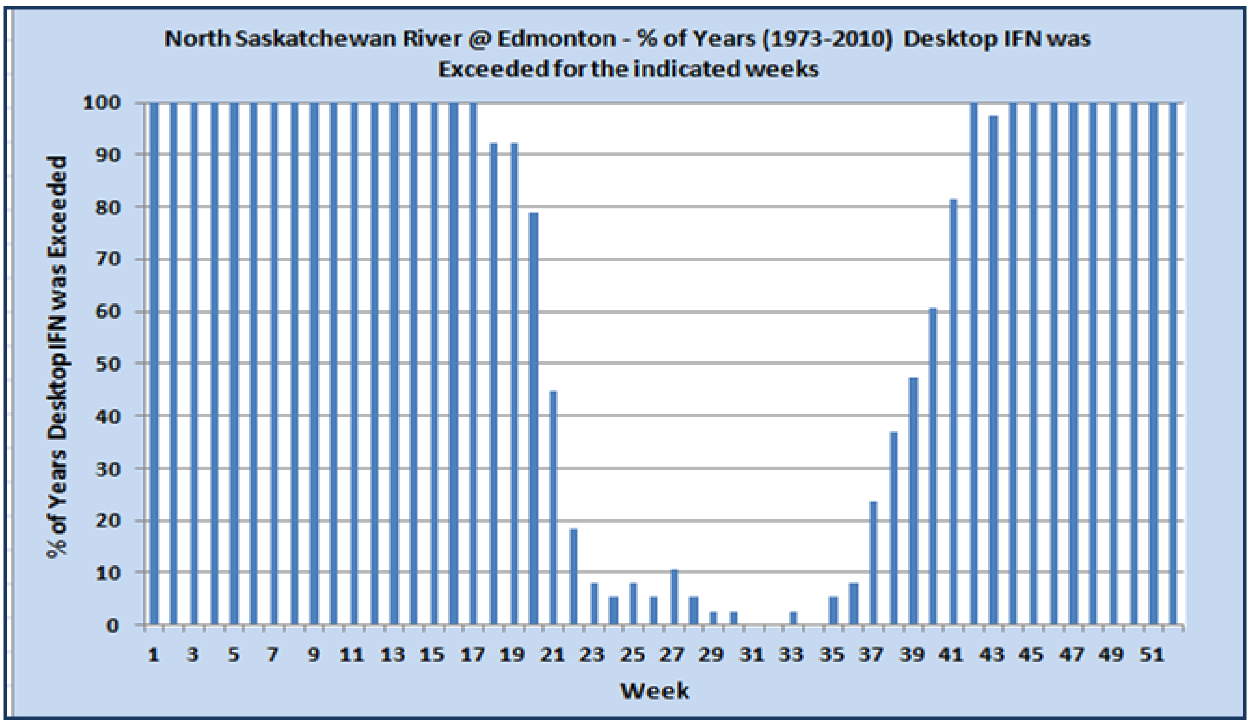

Figure 6 – North Saskatchewan River at Edmonton – Percent of years . (1973-2010) in which the "Desktop IFN" was exceeded.

Table 3 and Figure 6 show that for weeks 43-52 and 1-17 (mid October to early May) the recorded mean weekly flow in the North Saskatchewan River at Edmonton equalled or exceeded the Desktop IFN, in nearly all years. This is expected as this is the period during which releases for hydropower production are made from both the Brazeau and Bighorn Reservoirs. Table 3 and Figure 6 further show that during weeks 23 to 36 (June – August) the recorded mean weekly flows in the North Saskatchewan River at Edmonton met the Desktop IFN in less than 10% of years. Again, this is expected as June to August is the period when high elevation snowmelt occurs and runoff is being captured in the Brazeau and Bighorn Reservoirs.

Table 4 and Figure 7 show the range (median, maximum and minimum) of recorded mean weekly flows in the North Saskatchewan River at Edmonton as a percentage of the Desktop IFN for each week of the year.

Table 4 - North Saskatchewan River at Edmonton (1973-2010)
. Recorded flows as a percent of "Desktop IFN"

Week	1	2	3	4	5	6	7	8	9	10	11	12	13
Median	297	325	328	314	316	305	303	283	318	270	287	259	236
Maximum	612	714	649	655	842	815	821	734	547	433	591	424	385
Minimum	195	179	191	189	189	201	234	200	174	186	157	170	164
Week	14	15	16	17	18	19	20	21	22	23	24	25	26
Median	216	181	169	154	146	137	119	98	85	79	77	73	71
Maximum	593	423	253	366	196	175	165	131	133	103	111	102	114
Minimum	139	137	121	108	90	63	67	58	53	51	51	45	43
Week	27	28	29	30	31	32	33	34	35	36	37	38	39
Median	71	72	71	71	66	62	65	69	74	79	89	95	99
Maximum	110	116	113	101	91	97	100	97	108	108	120	140	163
Minimum	46	40	43	38	35	36	50	48	56	52	62	59	71
Week	40	41	42	43	44	45	46	47	48	49	50	51	52
Median	107	119	127	139	147	164	179	216	239	265	273	307	271
Maximum	199	162	165	188	202	309	273	362	525	618	768	675	526
Minimum	82	92	103	90	105	123	115	141	177	202	198	207	189

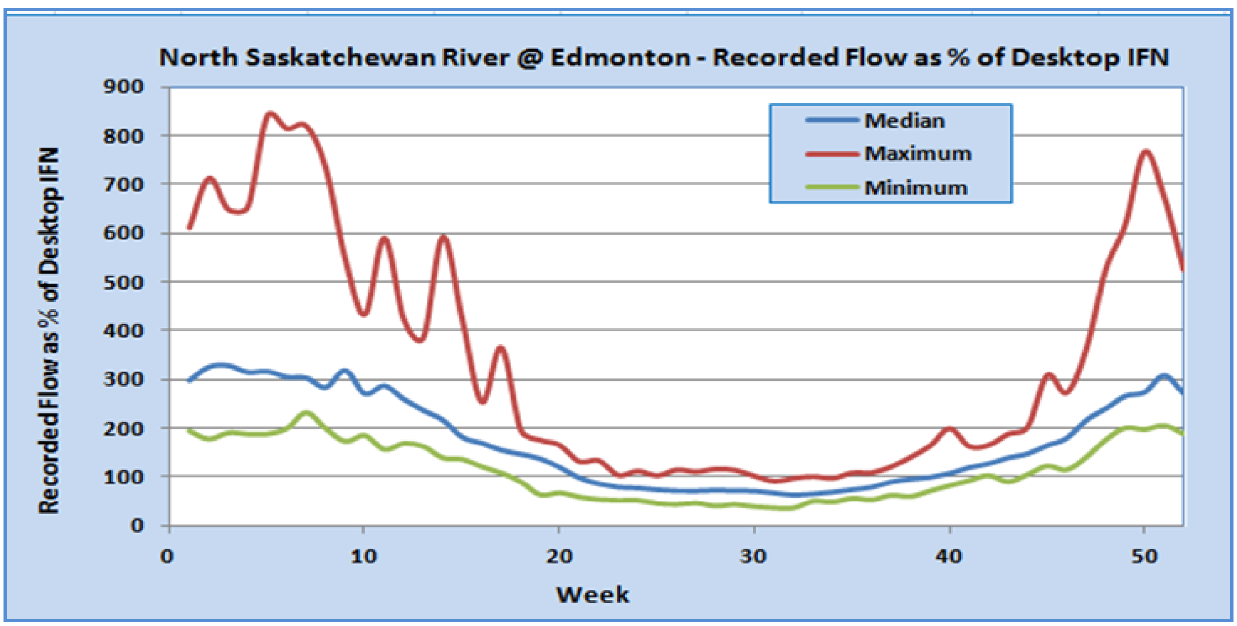

Figure 7 – North Saskatchewan River at Edmonton – Recorded flow as percent of
. "Desktop IFN".

While the natural flow ranges from 100% to 118% of the desktop IFN, Table 4 and Figure 7 show that during weeks 48-52 and 1-12 (December to late March) the recorded mean weekly flows are in the order of 250-350% of the Desktop IFN but have been as high as 820% and as low as 160%. It is noted that this period is about 3-4 weeks shorter than at Rocky Mountain House, which is likely due plains area snowmelt contributions downstream of the two reservoirs. Table 4 and Figure 6 further show that for weeks 23-35 (June-August) the recorded men weekly flows are in the order of 60-80% of the Desktop IFN but have been as high as 115% and as low as 35% of the Desktop IFN.

2.1.3 Assessment of Impact on IFN's for The North Saskatchewan River at the Alberta-Saskatchewan Border

The percent of years, in the 1973-2010 period for which the recorded mean weekly flow in the North Saskatchewan River at Alberta-Saskatchewan Border exceeded the Desktop IFN in each week of the year is summarized in Table 5 and Figure 8.

Table 5 - North Saskatchewan River at Alberta-Sask. Border (1973-2010)
. Percent of years in which the recorded mean weekly flow exceeded the "Desktop IFN"

Week	1	2	3	4	5	6	7	8	9	10	11	12	13
% of years IFN is exceeded	100	100	100	100	100	100	100	100	100	100	100	100	100
Week	14	15	16	17	18	19	20	21	22	23	24	25	26
% of years IFN is exceeded	100	100	100	100	100	92	87	55	32	18	5	11	8
Week	27	28	29	30	31	32	33	34	35	36	37	38	39
% of years IFN is exceeded	8	5	8	5	0	3	0	0	5	13	24	32	53
Week	40	41	42	43	44	45	46	47	48	49	50	51	52
% of years IFN is exceeded	66	82	95	100	97	100	100	100	100	100	100	100	100

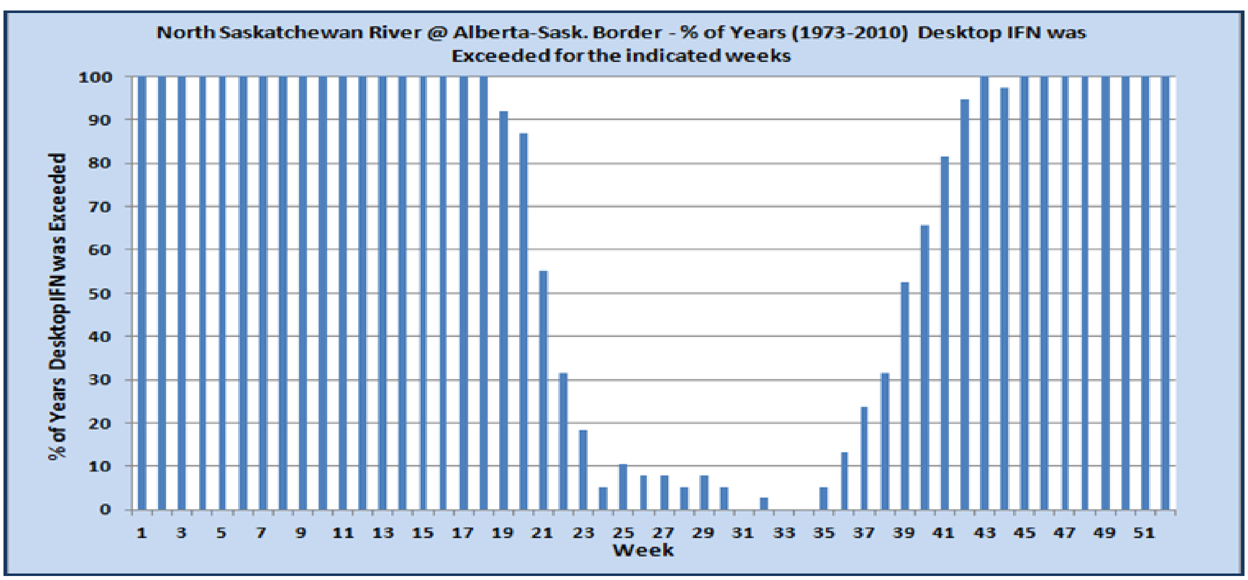

Figure 8 – North Saskatchewan River at Alberta-Saskatchewan Border – Percent of years . (1973-2010) in which the "Desktop IFN" was exceeded.

Table 5 and Figure 8 show that for weeks 43-52 and 1-18 (mid October to mid May) the recorded mean weekly flow in the North Saskatchewan River at the Alberta-Saskatchewan Border equalled or exceeded the Desktop IFN in nearly all years. This is expected as this is the period during which releases for hydropower production are made from both the Brazeau and Bighorn Reservoirs. Table 5 and Figure 8 further show that during weeks 24 to 35 (June – August) the recorded mean weekly flows in the North Saskatchewan River at the Alberta-Saskatchewan Border met the Desktop IFN in less than 10% of years. Again, this is expected as the June to August period is the period when most of the flow in the North Saskatchewan River would have been from high elevation snowmelt upstream of the Brazeau and Bighorn Reservoirs and which they now capture.

Table 6 and Figure 9 show the range (median, maximum and minimum) of recorded mean weekly flows for the North Saskatchewan River at the Alberta-Saskatchewan Border as a percentage of the Desktop IFN for each week of the year.

Table 6 - North Saskatchewan River at Alberta-Saskatchewan Border (1973-2010)
. Recorded flows as a percent of "Desktop IFN"

Week	1	2	3	4	5	6	7	8	9	10	11	12	13
Median	246	301	320	321	304	304	307	288	294	322	277	281	257
Maximum	527	637	622	609	598	645	718	712	744	630	433	548	440
Minimum	184	196	184	192	185	202	200	226	188	162	161	152	166
Week	14	15	16	17	18	19	20	21	22	23	24	25	26
Median	213	182	162	153	148	140	128	102	91	85	78	74	74
Maximum	394	640	320	213	197	176	195	141	140	109	110	104	110
Minimum	136	142	122	112	103	81	61	68	58	59	56	47	45
Week	27	28	29	30	31	32	33	34	35	36	37	38	39
Median	70	73	73	74	69	66	64	70	75	79	84	95	101
Maximum	114	114	112	107	92	101	98	99	106	105	113	133	153
Minimum	48	43	41	44	36	36	43	44	55	56	54	71	68
Week	40	41	42	43	44	45	46	47	48	49	50	51	52
Median	105	112	125	135	142	155	170	184	218	239	263	270	284
Maximum	189	183	163	176	180	246	286	266	338	536	526	727	526
Minimum	80	91	98	108	86	121	126	121	153	174	183	206	192

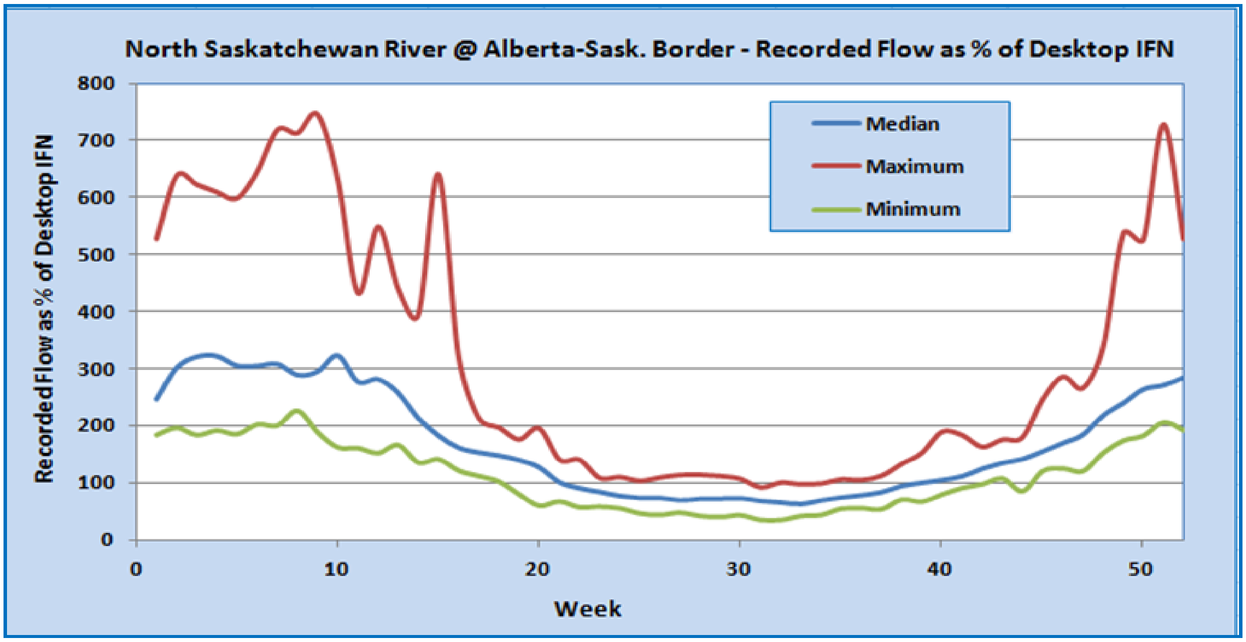

Figure 9 – North Saskatchewan River at Alberta-Saskatchewan Border – Recorded flow . as a percent of "Desktop IFN".

Table 6 and Figure 9 show that during weeks 49-52 and 1-13 (December to late March) the recorded mean weekly flows are in the order of 250-320% of the Desktop IFN but have gone as high as 744% and as low as 152%. It is noted that this period is about 8 weeks shorter than at Rocky Mountain House and is likely due to natural flows, and thereby IFN's, being higher at the Alberta-Saskatchewan Border during the April and October-November period due to plains area contributions. Table 6 and Figure 9 show that for weeks 24-36 (June-August) the recorded mean weekly flows are in the order of 60-80% of the Desktop IFN but have gone as high as 115% and as low as 35% of the Desktop IFN.

2.2 Degree of Impact on Instream Flow Needs of Sturgeon River

The Sturgeon River, a tributary of the North Saskatchewan River, is located in central Alberta to the west and north of the City of Edmonton (Figure 10)[2]. The River originates to the southwest of Isle Lake and flows in an easterly direction through four large shallow lakes – Isle Lake, Lac Ste Anne, Matchayaw Lake and Big Lake. The river passes through the City of St Albert and the Town of Gibbons on its way to its confluence with the North Saskatchewan River, northeast of the City of Fort Saskatchewan.

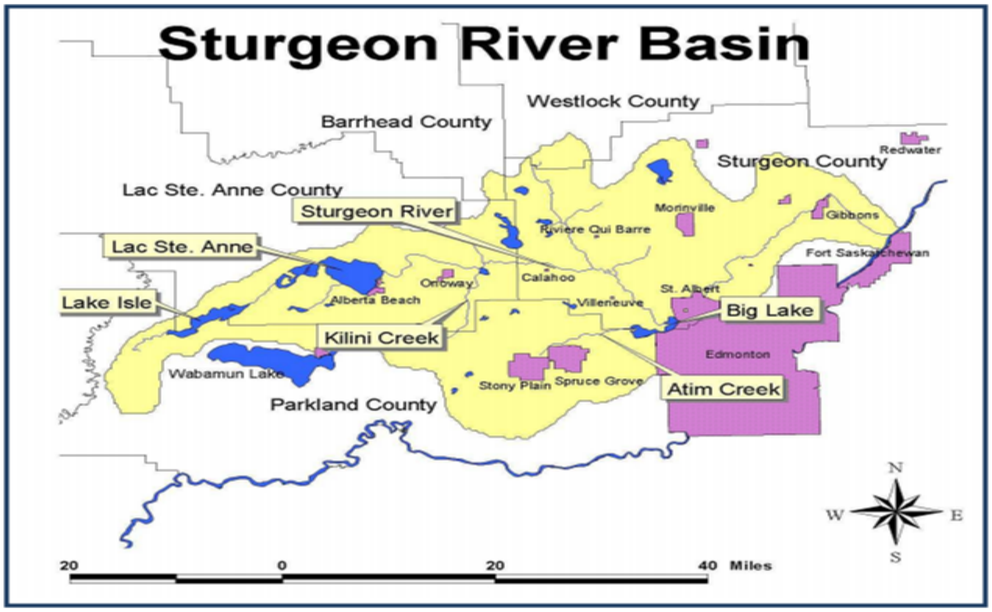

Figure 10 – Location map of Sturgeon River Basin

Historical weekly natural flows for the Sturgeon River at Fort Saskatchewan, St Albert and a number of additional locations had been previously computed for the 1912 to 1991 period by Alberta Environment.[3] While the data is not up to date, it was felt that an indication as to the degree of impact that water allocations and regulation have had on flows in the Sturgeon River could be obtained by assessing the most recent 20 years of available data (1972-1991) for the Sturgeon River at Fort Saskatchewan.

Based on the above, the assessment as to the degree of impact that water allocations and regulation have had on flows in the Sturgeon River was carried out by analysing solely the 1972-1991period; the most recent 20 year period for which naturalized flows were available. In computing the Desktop IFN's, the 80% exceedence natural flows were computed for each week of the year using a Hazen probability distribution. The formula for computing the Desktop Method IFN, along with the 80% exceedence flow was then applied to the weekly natural flows to determine the Desktop IFN for each week in the 1972-1991period. The Desktop IFN's were then compared to the observed mean weekly flows to determine:

iii. The percent of years for which the recorded mean weekly flow exceeded the Desktop IFN in each week of the year, and
iv. The distribution (median, maximum and minimum) in the recorded mean weekly flows as a percentage of the Desktop IFN.

As the hydrometric gauging station on the Sturgeon River near Fort Saskatchewan is only operated during the open water period, generally March to October, the comparison could only be carried out for weeks 10 to 43. The results are discussed in the following Section.

2.2.1 Assessment of Impact on IFN's for the Sturgeon River at Fort Saskatchewan

The percent of years during the 1972-1991 period for which the recorded mean weekly flow in the Sturgeon River at Fort Saskatchewan exceeded the desktop IFN in each of weeks 10 to 43 is summarized in Table 7 and Figure 11.

Table 7 - Sturgeon River at Fort Saskatchewan (1972-1991)
. Percent of years in which the recorded mean weekly flow exceeded the "Desktop IFN"

Week	1	2	3	4	5	6	7	8	9	10	11	12	13
% of years IFN is exceeded										90	95	90	100
Week	14	15	16	17	18	19	20	21	22	23	24	25	26
% of years IFN is exceeded	85	80	85	85	85	85	80	80	80	80	85	70	75
Week	27	28	29	30	31	32	33	34	35	36	37	38	39
% of years IFN is exceeded	65	75	70	70	75	80	75	80	80	80	75	75	75
Week	40	41	42	43	44	45	46	47	48	49	50	51	52
% of years IFN is exceeded	85	85	85	85									

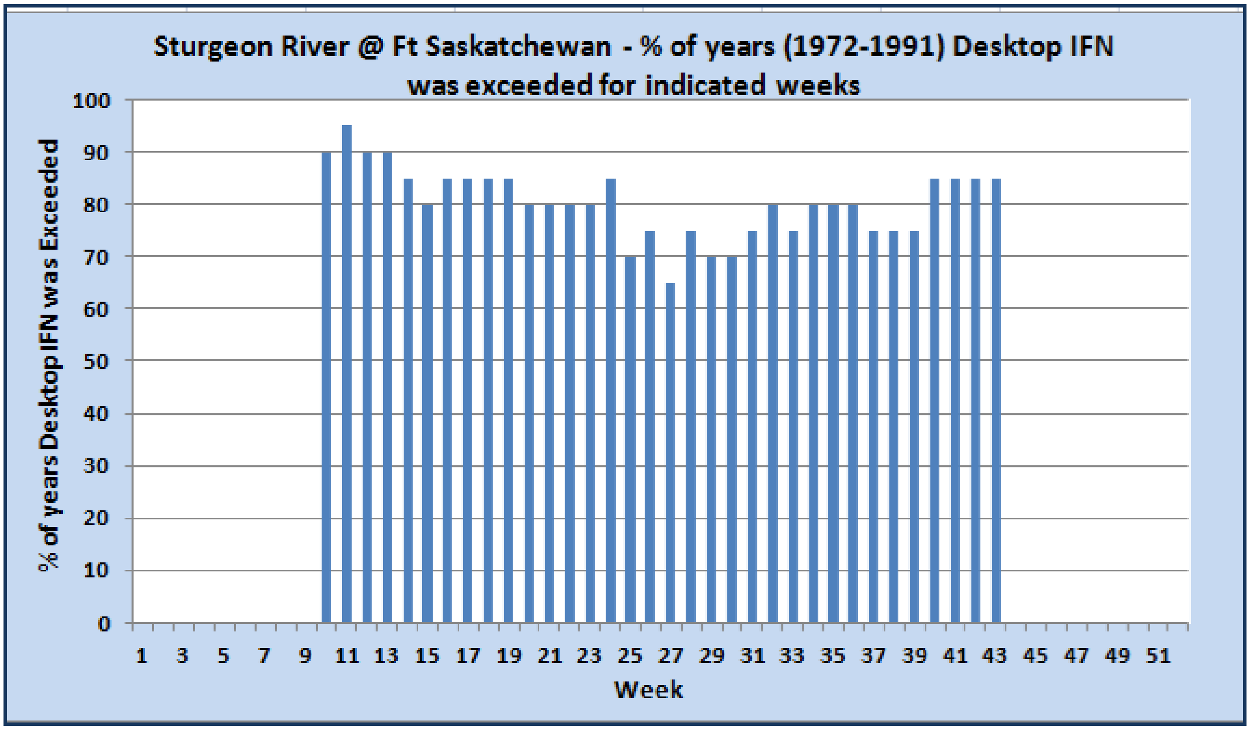

Figure 11 – Sturgeon River at Fort Saskatchewan – Percent of years (1972-1991)
. recorded mean weekly flows exceeded "Desktop IFN".

Table 7 and Figure 11 show that during the 1972-1991 period the recorded mean weekly flow in the Sturgeon River at Fort Saskatchewan equalled or exceeded the Desktop IFN in approximately 60-90% of years. In the late fall (weeks 40-43) and early spring (weeks 10-19) the Desktop IFN was exceeded in 80-90% of years while in the late spring and summer period (weeks20-39) the Desktop IFN was only equalled or exceeded in 65-80% of years. Given that 22 years have elapsed since the last year used in the analysis and that additional water allocations have been made during these years, it is believed that the percent of time the Desktop IFN is equalled or exceeded in 2013 is likely significantly lower than is indicated by Table 7 and Figure 11.

Table 8 and Figure 12 show the range (median, maximum and minimum) of recorded mean weekly flows in the Sturgeon River at Fort Saskatchewan as a percentage of the Desktop IFN for each week of the year.

Table 8 - Sturgeon River at Fort Saskatchewan (1972-1991)
. Recorded flows as a percent of "Desktop IFN"

Week	1	2	3	4	5	6	7	8	9	10	11	12	13
Median										117	117	118	116
Maximum										182	212	281	118
Minimum										75	78	81	85
Week	14	15	16	17	18	19	20	21	22	23	24	25	26
Median	114	116	116	116	116	116	115	116	115	112	110	106	109
Maximum	117	117	117	117	117	117	117	117	117	117	117	117	116
Minimum	38	66	94	91	88	84	81	64	41	64	80	65	84
Week	27	28	29	30	31	32	33	34	35	36	37	38	39
Median	108	111	110	107	108	110	110	109	110	112	111	111	111
Maximum	116	117	117	117	117	117	116	116	116	116	116	116	116
Minimum	66	66	47	20	14	51	46	40	32	45	69	62	73
Week	40	41	42	43	44	45	46	47	48	49	50	51	52
Median	116	116	115	116									
Maximum	138	141	143	135									
Minimum	85	91	89	89									

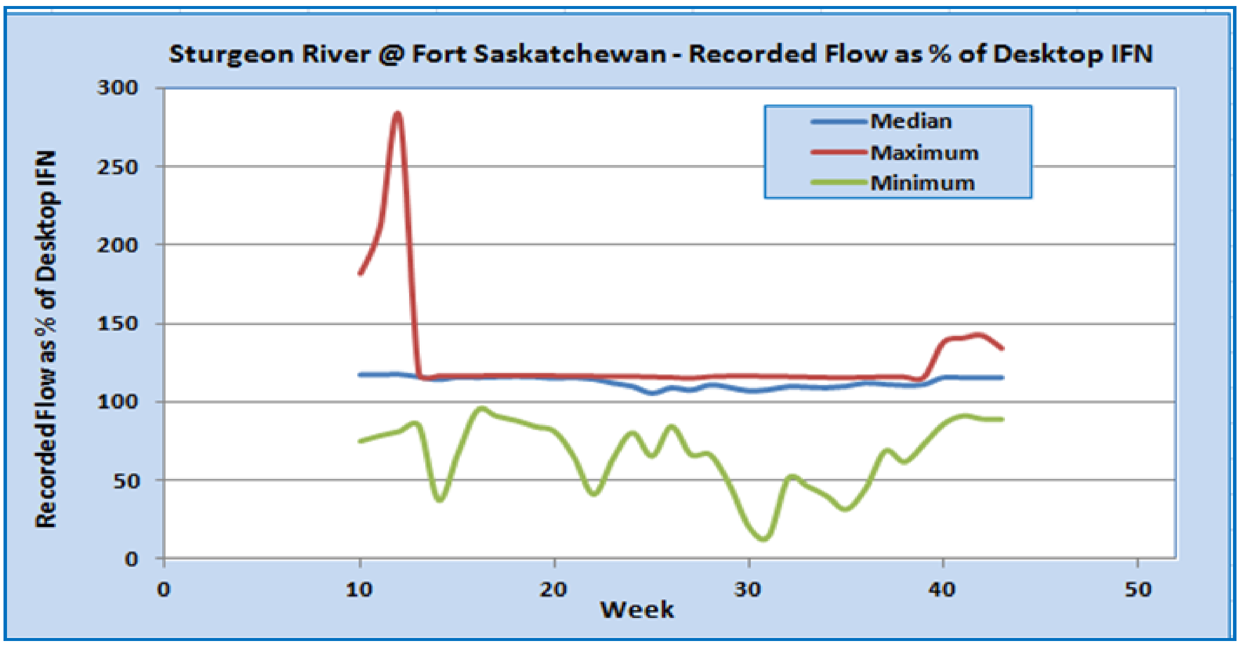

Figure 12 – Sturgeon River at Fort Saskatchewan (1972-1991) – Recorded flow as . percent of “Desktop IFN”.

Table 8 and Figure 12 show that that the recorded mean weekly flow in the Sturgeon River at Fort Saskatchewan is in the order of 110% of the Desktop IFN. While the minimum recorded mean weekly flow has been as low as 15% of the Desktop IFN and the maximum has ranged from about 115% of Desktop during most of the weeks to about 280% in March (weeks 10-12) and about 140% in October (weeks 40-43). The maximums in March and October are attributed to releases from wastewater detention ponds that were in place at the time and from the pumping of groundwater to lower the water table within the Town of Spruce Grove. It is noted that due to the introduction of regional waste water collection system since 1991, the release of waste water is no longer a practice and the March and October peaks would likely be much lower.

3.0 DIURNAL FLUCTUATIONS FOR THE NORTH SASKATCHEWAN RIVER RESULTING FROM STORAGE RESERVOIR RELEASES

As noted previously, the North Saskatchewan River is regulated by two reservoirs, the Brazeau and the Bighorn, both of which are used for peaking power production which require highly variable releases depending on power demands throughout the day. In order to assess the potential implications of these diurnal fluctuations in releases, the North Saskatchewan Watershed Alliance has requested that an example of the diurnal fluctuations in water level be provided for the North Saskatchewan River at Rocky Mountain House and at Edmonton.

3.1 Diurnal fluctuations for the North Saskatchewan River at Rocky Mountain House

Figures 13a, 13b and 13c provide a plot of water levels for the North Saskatchewan River at Rocky Mountain House for the for the March-April 2012 period, the May-July 2012 period, and the August-Oct 2012 period respectively.

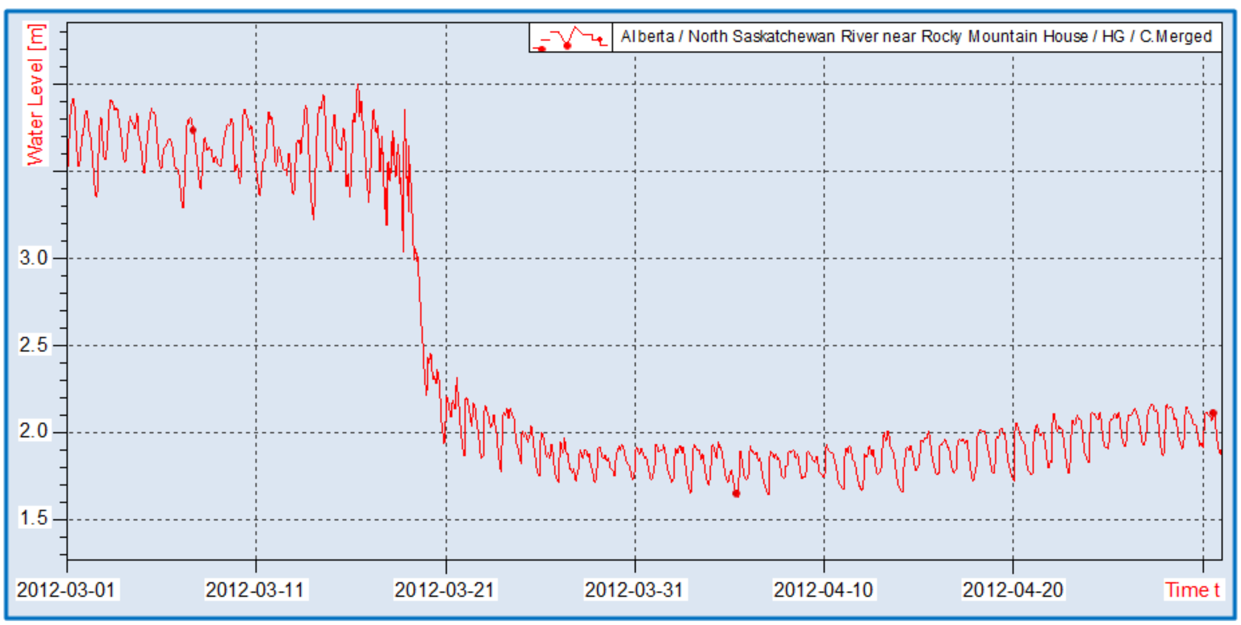

Figure 13a – North Saskatchewan River at Rocky Mountain House - March1-April 30, 2012 . water levels.

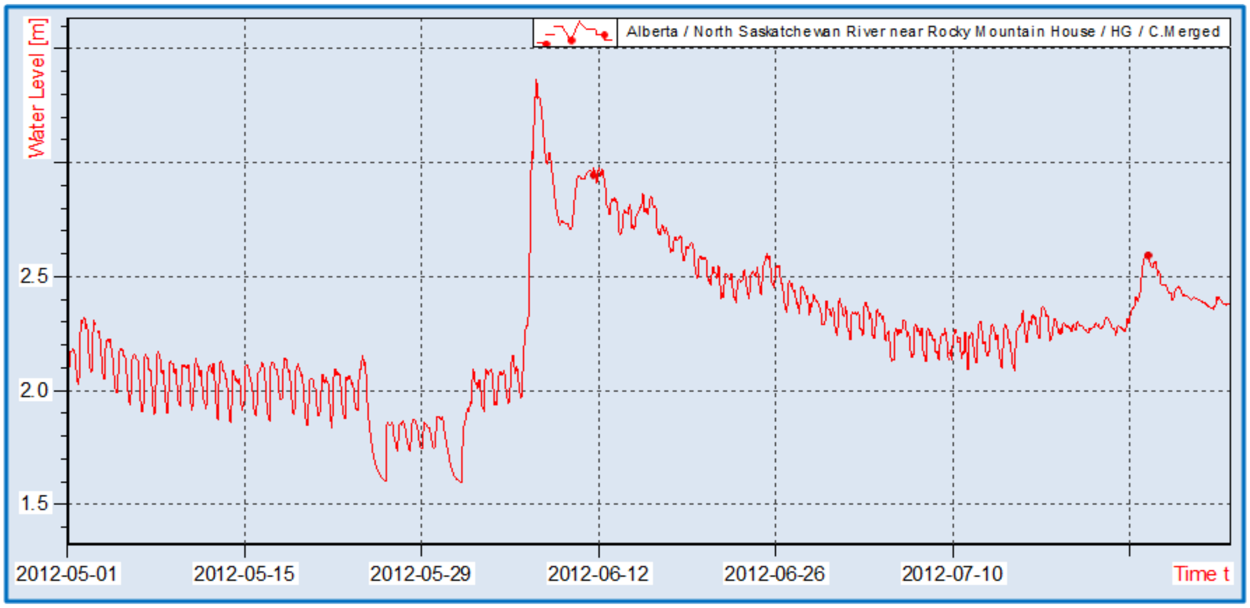

Figure 13b – North Saskatchewan River at Rocky Mountain House - May1- July 25, 2012 water levels.

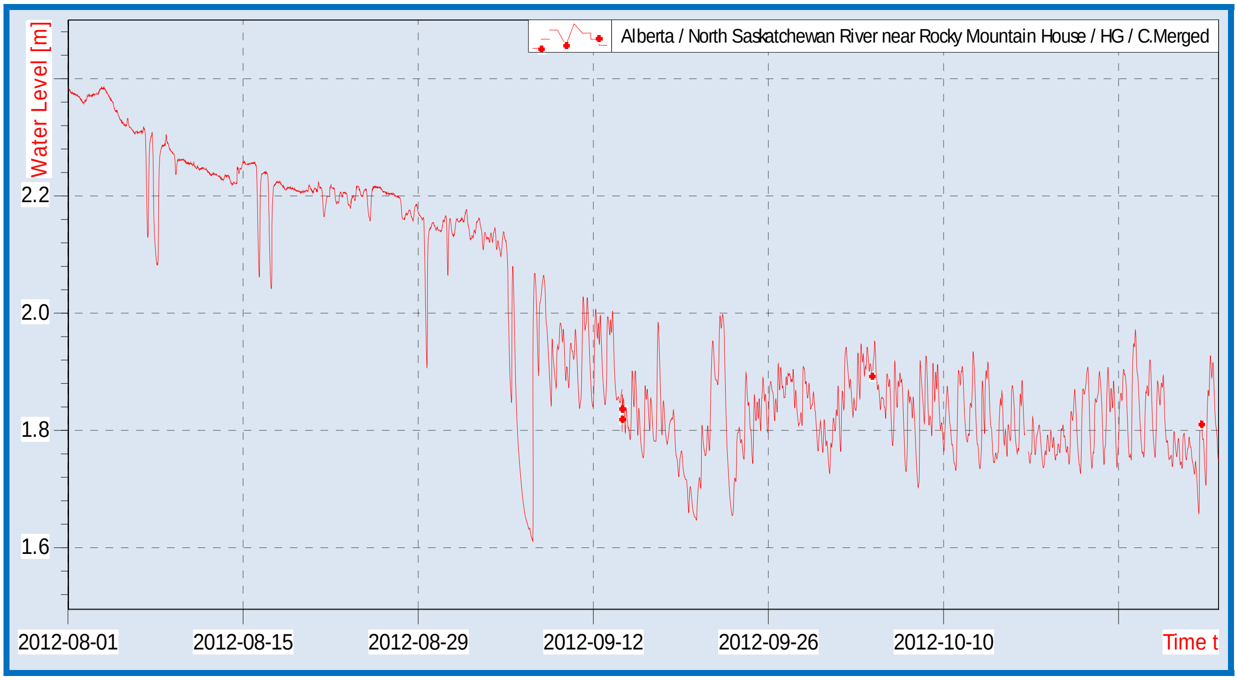

Figure 13c – North Saskatchewan River at Rocky Mountain House – Aug 1 - Sept 25, 2012 water levels.

Figures 13a-13c show that the water levels within the North Saskatchewan River at Rocky Mountain House have a diurnal fluctuation of about 0.2-0.3 metres each day and that on occasion these fluctuations can be as high as 0.5 metres. The larger fluctuations appear to occur during the ice build-up and break-up conditions rather than during the open water period.

3.2 Diurnal Fluctuations for the North Saskatchewan River at Edmonton

Figures 14a, 14b and 14c provide a plot of water levels for the North Saskatchewan River at Edmonton for the for the March-April 2012 period, the May-June 2012 period, and the August-Sept 2012 period respectively.

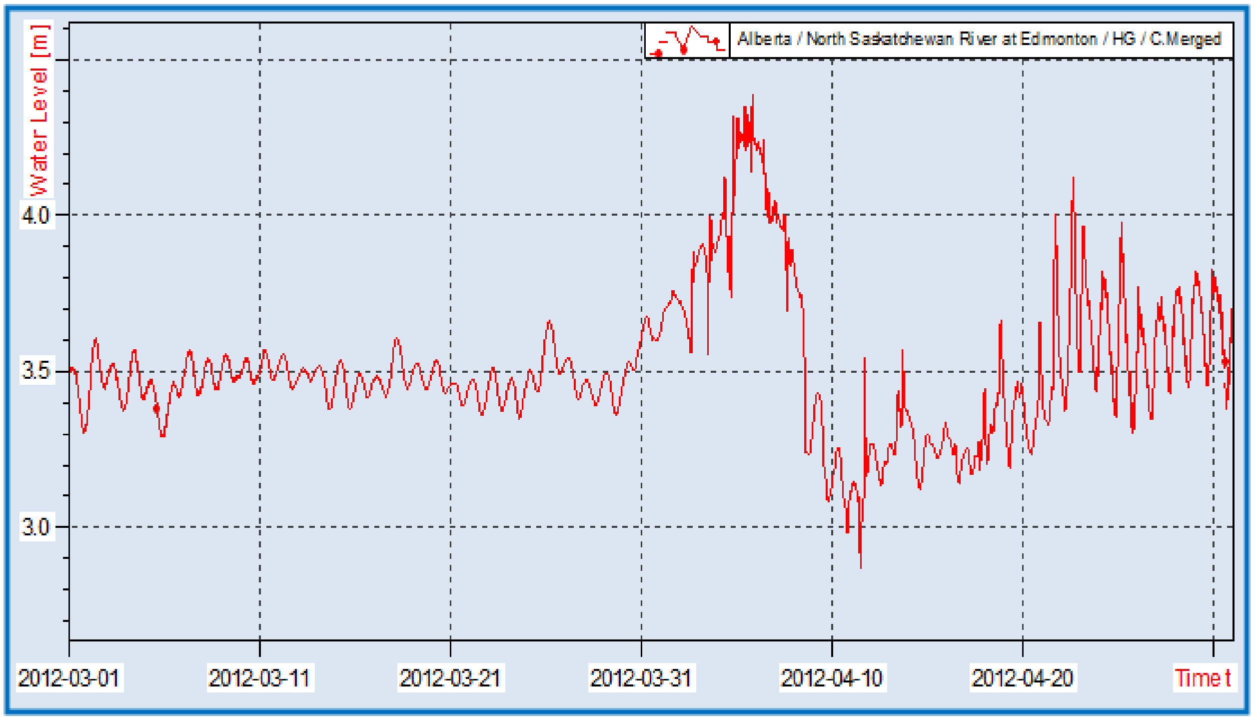

Figure 14a – North Saskatchewan River at Edmonton - March1-April 30, 2012 water levels.

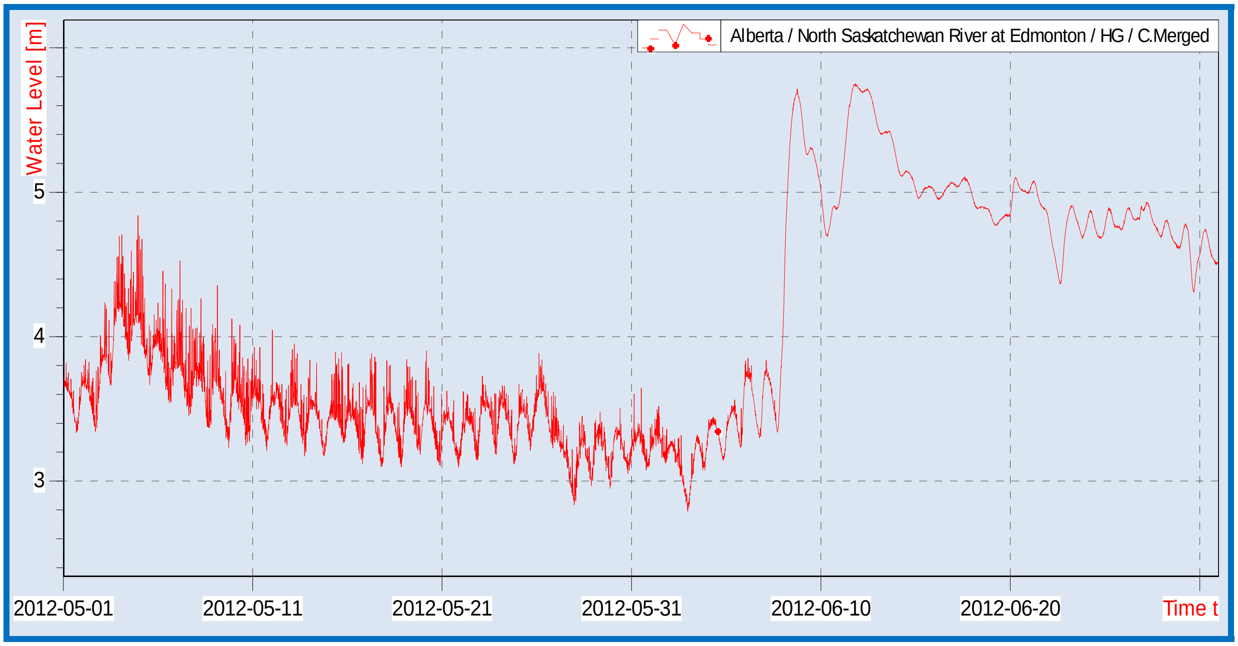

Figure 14b – North Saskatchewan River at Edmonton - May1- June 30, 2012 water levels.

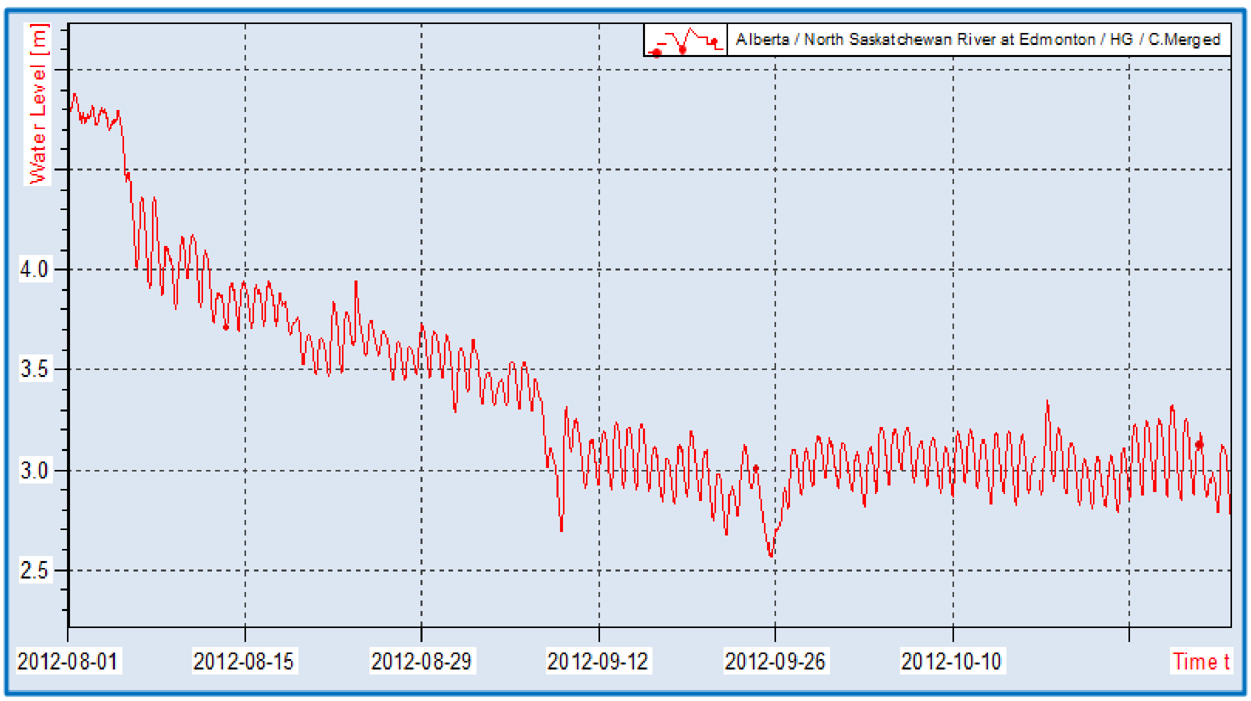

Figure 14c – North Saskatchewan River at Edmonton – Aug. – Sept. 2012 water levels.

Figures 14a-14c show that the water levels within the North Saskatchewan River at Edmonton have diurnal fluctuation of about 0.2-0.3 metres each day, essentially unreduced from the fluctuations at Rocky Mountain House and that on occasion these fluctuations can be as high as 0.5 metres. The larger fluctuations appear to occur during the ice build-up and break-up conditions rather than during the open water period.

4.0 CONCLUSIONS AND RECOMMENDATIONS

This report carried out an assessment to determine the impact that regulation and water allocations have had on the North Saskatchewan River and on its tributaries in terms of their ability to meet or exceed Instream Flow Needs. The assessment was carried out by comparing the recorded flows for the North Saskatchewan River at Rocky Mountain House, Edmonton, and the Alberta-Saskatchewan Border and for the Sturgeon River at Fort Saskatchewan to the Desktop IFN – a quick and simple procedure developed by Alberta Environment and Sustainable Resource Development for determining when more detailed IFN analysis may be warranted. The assessment which was carried out based on 1973-2010 recorded and naturalized flows for the indicated locations on the North Saskatchewan River and the 1972-1991 data for the Sturgeon River at Fort Saskatchewan concludes the following:

North Saskatchewan River

- Due to releases from the Bighorn Reservoir, winter (November to April) flows in the North Saskatchewan River at Rocky Mountain House exceed the Desktop IFN in nearly 100% of all years and on average are in the order of 250-350% of the Desktop IFN.
- Due to the capturing of upstream runoff by the Bighorn Reservoir during the high elevation snowmelt period, summer (June-August) flows in the North Saskatchewan River at Rocky Mountain House exceed the Desktop IFN flows in less than 5% of all years and on average are in the order of 55-75% of the Desktop IFN.
- Water levels within the North Saskatchewan River at Rocky Mountain House have a diurnal fluctuation of about 0.2-0.3 metres. On occasion these fluctuations can be as high as 0.5 metres. The larger fluctuations appear to occur during the ice build-up and break-up conditions rather than during the open water period.
- Due to releases from the Brazeau and Bighorn Reservoirs and local contributions, winter (October to early May) flows in the North Saskatchewan at Edmonton exceed the Desktop IFN in nearly 100% of all years and on average are in the order of 250-350% of the Desktop IFN.
- Due to the capturing of upstream runoff by the Brazeau and Bighorn Reservoirs during the high elevation snowmelt period, summer (June-August) flows in the North Saskatchewan River at Edmonton exceed the Desktop IFN flows in less than 10% of years and on average are in the order of 60-80% of Desktop IFN.
- Water levels within the North Saskatchewan River at Edmonton have a diurnal fluctuation of about 0.2 - 0.3 metres. On occasion these fluctuations can be as

high as 0.5 metres. The larger fluctuations seem to occur during ice build-up and break-up conditions and not during the open water periods.

- As a result of releases from the Brazeau and Bighorn Reservoirs, winter (mid October to mid May) flows in the North Saskatchewan at the Alberta-Saskatchewan Border exceed the Desktop IFN in nearly 100% of all years and on average are in the order of 250-320% of the Desktop IFN.
- The capturing of upstream runoff by the Brazeau and Bighorn Reservoirs during the high elevation snowmelt period results in summer (June-August) flows in the North Saskatchewan River at the Alberta-Saskatchewan Border exceeding the Desktop IFN flows in less than 10% of all years and on average are in the order of 60-80% of the Desktop IFN.

Tributaries of the North Saskatchewan River

- The Sturgeon River is only prairie tributary of the North Saskatchewan River for which natural flows are available. The reconstructed natural flows, however, are only available for the 1912-1991 period. It is recommended that natural flows for the Sturgeon River be updated to recent years and that natural flows be reconstructed for other major tributaries of the North Saskatchewan River.
- A comparison of 1972-1991 recorded flows to Desktop IFN's for the Sturgeon River at Fort Saskatchewan shows that in the winter period the Desktop IFN was equalled or exceeded in about 80-90% of all years while during the late spring and summer period it was only equalled or exceeded in about 65-80% of years. Given that over 20 years have elapsed since the period used in the simulation and that additional water allocations were granted during that period, the percent of time that summer flows in Sturgeon River currently exceeds the Desktop IFN is likely significantly less than 80% of years.

5.0 REFERENCES

1) "*The Alberta Method for Determining Environmental Flows (Instream Flow Needs)"* . Alberta Water Policy Branch, Alberta Environment. June 2011. http://environment.gov.ab.ca/info/library/8372.pdf

2) *"Sturgeon River Basin Water Management Plan – Phase One Water Management Study – Current Conditions*". Unitech Solutions Inc. March 2005.

3) "Historical Weekly Natural Flows, Sturgeon River Basin". Alberta Environmental Protection, Surface Water Assessment Branch. April 1994.