2016

Water Quality, Availability and Consumptive Use in the Peace-Slave Watershed

Working Group Report to the MPWA IWMP Steering Committee

Water Working Group
3/18/2016

EXECUTIVE SUMMARY

The Mighty Peace Watershed Alliance Integrated Watershed Management Plan Steering Committee struck a multi-sector *Water Quality, Availability and Consumptive Use Working Group* to investigate a number of water-related topics and provide recommendations to the Committee for consideration in their planning process. The Working Group met four times, sharing sector perspectives and information, before drafting this report.

Overall, the Working Group concluded that ***water quality*** is generally good on the Peace River main stem, with its large volume and relatively few point and nonpoint source pollution inputs. Some issues do arise on smaller tributaries and lakes, however, processes are in place to address such issues to some degree. A more extensive and accessible monitoring, assessment and reporting system would benefit our understanding of water quality throughout the basin. This might be realized, at least in part, through the monitoring and assessment work of Alberta Environment and Parks and its partners.

Water ***availability*** is not an issue for communities that draw source water from the Peace River main stem. However, due to their location throughout the watershed, many communities draw from smaller tributaries, lakes or from groundwater that may not provide optimal source quality or volume. Partnerships, such as NEW Water Ltd, can see communities, including First Nations reserves and Métis Settlements, work together to find solutions to drinking water treatment and distribution challenges. Collaborations can also address a number of issues faced by communities throughout Alberta, including the cost of building and maintaining drinking water and wastewater treatment and distribution infrastructure, and recruiting, training and retaining drinking water and wastewater staff. Both federal and provincial municipal infrastructure funds are available to communities in the Peace-Slave watershed.

Although limited by time for this expansive and complex topic, the Working Group did look briefly at ***consumptive water use***. While there are several ways water may be 'consumed' and not returned to its source in a timely manner, the consumptive use of water for oilfield injection and hydraulic fracturing has recently been growing in prominence in the Peace-Slave watershed. The discussion about consumptive use is made more complex by the source (surface water or groundwater; saline or non-saline); timing of flows and withdrawals (particularly for small, seasonal tributaries and lakes), and the need for timely monitoring of the cumulative effects of multiple withdrawals at multiple diversion points on downstream aquatic health. Topics such as the use of recycled water or treated effluent or of using storage versus continuous pumping, also add complexity to the tracking and management of available supply versus demand, both now and in the future under a changing climate scenario. Like other watersheds in the province, the Peace watershed would benefit from a more comprehensive, cumulative effects management approach to all water allocation and supply issues, including consumptive use.

Finally, in looking at its recommendations, the Working Group noted that many of its conclusions are similar to what other groups have indicated is needed to manage water in this and other watersheds. That is, going forward, efforts should be directed to having a sound knowledge base specific to the Peace-Slave watershed; sharing this knowledge with others through education and collaboration such that a system of iterative and adaptive management planning and implementation becomes effective; resulting in a healthy watershed, now and in the future.

ACRONYMS

AAMDC	Alberta Association of Municipal Districts and Counties
ABMI	Alberta Biodiversity Monitoring Institute
AEP	Alberta Environment and Parks
AER	Alberta Energy Regulator
ALMS	Alberta Lake Management Society
AWC	Alberta Water Council
CEP	Conservation, Efficiency and Productivity
EPEA	Environmental Protection and Enhancement Act
GOA	Government of Alberta
IFN	Instream Flow Needs
IWMP	Integrated Watershed Management Plan
MPWA	Mighty Peace Watershed Alliance
MRBB	Mackenzie River Basin Board
NPSP	Non-point Source Pollution
TDL	Temporary Diversion Licence
WG	Working Group

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Introduction

Background and Methodology

After completing a '*state of the watershed report*' and in developing their terms of reference for an Integrated Watershed Management Plan (IWMP), the Mighty Peace Watershed Alliance (MPWA) identified a number of topics relevant to future areas of work, including *'water quality, water availability (away from the Peace main stem) and consumptive use of water'*.

To investigate these topics further, the IWMP Steering Committee struck a multi-sector Water Working Group (WG). Membership of this group is listed in Appendix 1. The Steering Committee also developed a terms of reference (Appendix 2) listing a number of water-related topics for the WG to research further.

***Consumptive water use** is water removed from available supplies without return to a **water** resource system (e.g., water used in manufacturing, agriculture, and food preparation that is not returned to a stream, river, or water treatment plant).*

The WG met four times between December 2015 and March 2016. After sharing sector perspectives and information on water and water management in the Peace-Slave watershed, the WG then developed recommendations for the Steering Committee. This includes a workplan with future water-related activities for consideration in the MPWA IWMP.

While they endeavored to work in a multi-sector, consensus-seeking manner, the WG was limited by the short amount of time provided to undertake their tasks. Thus while this report provides a summary of what was learned and what was discussed, as well as a number of suggested recommendations for consideration for further work, it by no means implies WG consensus or broad sector approval. Further sector engagement and consultation on water quality, availability and consumptive use and other related topics will be beneficial as the IWMP process moves forward.

Dinosaur Lake above the Peace Canyon Dam near the headwaters of the Peace River. Courtesy Petra Rowell.

Working Group Findings

As per their terms of reference, the Working Group discussed a number of topics related to water quality, availability and consumptive use. Their findings about each of these topics are provided below:

Current water quality and availability issues by location

Current Water Quality

As per Alberta's River Water Quality Index, ambient water quality in the Peace-Slave watershed is generally rated as "good to excellent" (real-time data is provided from five monitoring stations throughout the watershed. See also Alberta's River Basins). However, like many "muddy" or "silty" northern rivers, this system experiences some exceedances for some parameters (e.g. metals, Total Suspended Solids), particularly after large precipitation events. Non-point source pollutants might include sediments from natural erosion as well as nutrients and bacteria from anthropogenic activities.

Treated drinking water from provincially regulated treatment plants in the Peace-Slave watershed usually meet required standards. Monthly statistics for regulated systems can be viewed on the Government of Alberta's Community Finder (See also the AEP authorization viewer). The water quality of un-regulated private systems is unknown. However, Alberta Health Services and others undertake work to assess the state of private systems and initiatives like the Working Well program seek to educate users of such systems. Drinking water on First Nation's reserves is managed federally. As per Health Canada, boil water advisories (BWA) exist for some of these communities in northern Alberta. Note that BWAs also occur in other communities in the watershed. They may be systemic and long term or they may be incidental due to short-term system breakdowns (e.g. recent BWAs have occurred in Valleyview, Spirit River and Rycroft.)

First Nation	Community	System Name	Type of Advisory	Date Set	Date Revoked	Population
Dene Tha	Bushe	Bushe Food and Gas Semi-Public Water System	BWA	2015/07/31	None	unknown
Horse Lake	Horse Lake	Horse Lake Public Water System	BWA	2015/11/13	None	01-500 people
Little Red River - John D'or	Little Red River - John D'or	John D'or Prairie Public Water Supply	BWA	2016/01/15	None	501-1000 people
Sturgeon Lake	Sturgeon Lake	Timberwolf Store Semi-Public Water System	BWA	2015/10/22	None	unknown
Sturgeon Lake	Sturgeon Lake	Western Cree Complex SL Resources Semi-Public Water System	BWA	2015/10/19	None	unknown
Whitefish Lake	Atikameg	Whitefish River Public Water System	BWA	2011/05/24	None	101-500 people

WATER QUALITY ISSUES

When discussing water quality issues, the WG looked mainly at surface waters, as directed by the IWMP Steering Committee, which plans to strike a Groundwater Working Group in the fall of 2016. Note however that groundwater is often the only viable source of water for many communities away from the Peace mainstem or major tributaries. Protection of major aquifers, such as the Grimshaw Gravel Aquifer, was noted to be of the utmost importance. Additionally, it was noted that issues affecting the protection and management of both ground and surface waters, such as the risk of contamination from a spill, industrial activities, or improperly treated wastewater, are similar. Additionally, ground and surface waters interact, particularly at wetland and other recharge and discharge areas.

Issues around drinking water quality are usually associated with the quality of source waters (which may require more or less treatment to meet potable standards); the cost of maintaining drinking water infrastructure, training and retaining qualified personnel, maintaining standards, etc. for small communities without a larger tax base to draw offset revenues from; and the issue of private systems which rely on owner testing and maintenance. All of these issues are likely present to some degree in communities throughout the Peace-Slave watershed. However, most are being managed to varying degrees by their respective jurisdictions. A role for the MPWA may be to encourage and facilitate discussions about the benefits of collaborative regional networks for drinking water and wastewater systems.

While anthropogenic point sources of pollution in the Peace-Slave watershed are generally managed by federal, provincial and sometimes municipal regulatory systems, less is known about non-point source pollution (NPSP) in this basin. According to work commissioned by the Alberta Water Council, NPSP, including both natural and anthropogenic pollutants, can occur in the Peace-Slave watershed from several land use activities such as:

- agriculture (e.g. fertilizers and manure, pesticides, erosion from cropping and livestock grazing, etc.), particularly in the Upper Peace and Smoky-Wapiti sub-basins;
- coal mining in the headwaters of the Peace main stem as well as the Smoky-Wapiti sub-basin and the downstream effect of the release of parameters of potential concern including nutrients and selenium; and
- roads and other linear disturbances from industry, urban and rural development and recreation without proper erosion and sediment controls and/or improper setbacks and buffers around water bodies.

Fortunately, there are a number of tools for managing point and non-point source pollution. A role of the MPWA is to promote and encourage the use of such tools as:

- Watershed, regional, municipal and source water protection plans
- Plan implementation tools such as water quality management frameworks, bylaws, environmental reserves, setbacks, etc.
- Agriculture best/beneficial management practices
- Industry standards and guidelines, operating practices, regulations, directives, codes of practice

- Low impact development, stormwater and impervious surface management
- Riparian, wetland, and flood plain protection and restoration
- Regional networks, staff training (e.g. Circuit Rider Program), Working Well program, etc.

Events like floods and droughts can further exacerbate water quality. Note that Alberta Environment and Parks, through its Watershed Resiliency and Restoration Program, undertook an assessment of flood, drought and water quality risk for the province. Several areas in the Upper Peace and Smoky-Wapiti sub-basins were rated as high risk. Maps are available for viewing online. This program provides grants to priority areas to mitigate risks and restore degraded watersheds.

Water Quality Monitoring Issues

In the past and today, ambient water quality in Alberta is largely monitored by the Provincial Government through its Surface Water Quality Program and its Groundwater Observation Well Network. Some industries (e.g., pulp mills, oil and gas, etc.) voluntarily, or as a condition of their Environmental Protection and Enhancement Act (EPEA) approval, undertake water quality monitoring. Additionally, municipalities test source and treated drinking waters, as well as wastewaters before they are released to receiving bodies. While there may be a fair amount of data available, it is a challenge to access this data from all sources and to compare and interpret it for the entire basin.

Similarly, treated drinking water from regulated systems is monitored by operators, with information on each water treatment plant publicly available. All treatment plants must meet certain standards and follow specific protocols (see Alberta Environment's Drinking Water Program). Owners of private drinking water systems (dugouts or wells) are responsible for their own water quality but are encouraged to test their water regularly.

Another issue around water quality monitoring is that it largely occurs on the main stem but less so on smaller tributaries (and lakes) which because of their seasonal, limited flow, may be more sensitive to degradation. However, monitoring is costly and needs to be weighed against the benefits. There is also a great deal of source water variability in the basin where many rural private systems such as dug-outs, may only require periodic testing, compared to larger public treatment systems (e.g. City of Grande Prairie) that require continuous monitoring. Thus, there appears to be a need for greater monitoring density and baseline information to inform water quality management as well as to provide information on related issues such as instream flow needs and fisheries management.

Current Water Availability Issues

On an average annual aggregate basis, sufficient water appears to be available, for the most part, throughout the basin. However, conflicts may arise where seasonal or instantaneous demand cannot be met. Water managers need to be prepared to manage these localized events, particularly as such events increase in timing or severity with future climate change scenarios. Solutions such as conservation, storage and improved distribution may be required. While availability may not be a major problem in the basin today, it is important to understand future supply and demand, by all sectors. Unfortunately,

information, tools and resources to support basin wide modelling are sparse, leaving WPACs throughout Alberta to struggle with this knowledge gap.

Water availability, for both domestic and economic activities, varies throughout the Peace-Slave watershed. As mentioned previously, not all communities, individuals or businesses are in proximity of the main stem and instead must rely on smaller, less reliable, seasonal tributaries, lakes or small ponds, non-saline groundwater, dugouts, or rainwater collection systems.

All source waters can be affected by: seasonal flows; climatic events like floods and droughts; licensed (with priority), temporary and unlicensed withdrawals; upstream return flows; and the cumulative effects of all of these factors. Additionally, some communities have quality issues with their source waters and/or with their infrastructure and treatment processes making adequate source supplies unavailable. Finally, contamination events, like a spill, can make supplies unavailable for a period of time until clean up has occurred.

Case Study of a Regional Drinking Water System – NEW Water Ltd.

When released in 2003, Alberta's Water for Life strategy encouraged drinking water and wastewater regionalization in order to address a number of issues faced by small communities throughout the province. NEW Water Ltd. is one such example of a multi-partner regional drinking water network in the Peace-Slave watershed. NEW Water Ltd. is a revenue neutral organization and is unique in that one of the partners in the corporation is a First Nation. It services Northern Sunrise County, Woodland Cree First Nation and the Village of Nampa. It also collaborates with Shell Canada, using their existing source water intake infrastructure from the Peace River as well as a 22-kilometer pipeline repurposed as part of the East Transmission Main. A system of desiltation and storage ponds, pumphouses, a water treatment plant, and a system of raw and potable pipelines delivers the water to each community as well as to an extensive rural water co-op system. Water is also available via nine truckfill sites within the County and First Nation communities.

This new system replaces older systems that were no longer sustainable (insufficient quantity and poor source waters) or meeting current (2006) Alberta Environment & Parks standards for water quality. Despite diverse interests, different levels of government and legislation, all parties recognized the need for long-term reliable, sustainable, high quality potable water supply. All federal, provincial and municipal regulatory requirements were met by this system, which was also funded by all three levels of governments. Infrastructure was also designed with both water and energy efficiency in mind and the Water Treatment Plant is certified as LEED Silver.

When asked what their formula for success was, project participants in the project indicated the importance of having a project 'champion'; mutual respect and open communication between technical advisors, stakeholders, regulators, decision-makers and funders; and everyone being open and keeping the 'big picture' in focus. The champion of this particular project was the late Bob Miles, former CAO of Northern Sunrise County.

Cost-sharing programs like the Alberta Municipal Water / Wastewater Partnership/Water for Life provide support to communities to improve their drinking water and wastewater systems. In the past, several northern communities have received funding from this source. To address issues associated with timing of flows, communities and industries may utilize storage. The WG noted that while some users like the City of Grande Prairie maintain some storage, others might not have any excess storage built into their facilities. Several oil and gas initiatives are using, or planning, storage as a means of providing certainty to their operations, particularly when these operations are reliant on small tributaries with seasonal low flows or groundwater sources with inadequate discharge rates.

METRICS FOR MEASUREMENT AND THEIR COMPARABILITY TO OTHER JURISDICTIONS IN CANADA

Federally, Canada measures water quality using the Canadian Council of Environment Ministers (CCME) Canadian Water Quality Index. Provinces, however, may have tailored versions of this index to fit provincial needs. That is, provincial indexes use the same mathematical formula (calculation of scope, frequency and amplitude) but differ in the monitoring programs that support them, the variables and objectives they use, the format they are presented in and their specific purpose. In Alberta, water quality in all basins is measured against the Alberta Water Quality Index. The Alberta index includes metals (up to 22 variables measured quarterly), nutrients (6 variables measured monthly), bacteria (2 variables measured monthly) and pesticides (17 variables measured 4 times during open-water season).

The Peace-Slave watershed, with its headwaters arising in British Columbia (BC), is also monitored by British Columbia (BC). In the past, BC used the British Columbia Water Quality Index. In recent years, they have adopted the CCME Water Quality Index. While the Alberta and BC indexes are not easily comparable, there have been efforts through the Mackenzie River Basin Board (MRBB) Transboundary Bilateral Water Negotiations, to compare water quality throughout the Peace-Slave watershed, as well as throughout the entire Mackenzie watershed (see MRBB state of report). The MRBB and its member jurisdictions have also undertaken work to look at both air and water-borne contaminants throughout the basin.

Throughout its work, the WG did not identify the need to include any other parameters/metrics, specific to the Peace-Slave watershed, that are not currently included in the Alberta Index. However, no extensive literature search or discussion with water quality experts and monitoring agencies (e.g. Alberta Environment and Parks) were undertaken to confirm this conclusion.

Photo courtesy Adam Norris.

MITIGATION AND ADDRESSING OF LAKE WATER QUALITY ISSUES

The WG noted that there have been several recent examples of local lake issues in the Peace –Slave watershed such as low water levels (George Lake), blue-green algae outbreaks (Sturgeon Lake), fish kills (Wadlin Lake) and fish health (wormy whitefish in Utikuma Lake). They also noted the importance of managing lakes by developing lake *watershed* management plans with the appropriate jurisdictions involved to address issues like NPSP, fish habitat fragmentation, etc. The WG identifed the need to include fish/fisheries as both an indicator of watershed health and a stakeholder in the IWMP process, which needs to address fish sustainability and include fish management objectives for lakes and rivers in the Peace-Slave watershed.

While Alberta has witnessed localized lake issues (e.g., lake level declines, blue-green algae, fisheries collapse, etc) for decades, the topic has recently become one of provincial scope. The GOA Water Conversations included lakes as one of four major topics. The resulting Action Plan commits the province to developing a provincial lake policy.

The GOA has asked the Alberta Water Council (AWC) to provide advice on a provincial lake management approach. After assessing the current state of lake management in the province and engaging stakeholders at the annual Alberta Lake Management Society (ALMS) workshop, the Alberta Water Council Lake Management Project Team is currently (2016) drafting its recommendations.

Lake monitoring has occurred throughout Alberta for several decades. Today, Alberta Environment and Parks, in conjunction with Alberta Lake Management Society (ALMS), continue to support the provincial lake monitoring program. Similarly, Alberta Environment and Parks operates the Respect Our Lakes program, which provides a number of lake resources. The Association of Summer Villages of Alberta also provides lake resource management materials.

Lake stewardship groups often play an important role in assessing and mitigating lake issues. The MPWA can play a role by helping such groups to form and undertake activities such as monitoring and promoting best management practices around shorelines. Provincial conservation groups and initiatives like the Alberta Fish and Game Association, Alberta Stewardship Network, Cows and Fish, Environmental Farm Plan and Living by Water can also support stewardship activities.

EXISTENCE AND EFFECTIVENESS OF CURRENT SOURCE WATER PROTECTION PLANS

While some utilities supplying drinking water to some of Alberta's larger urban centres, like Edmonton, have developed source water protection plans, many have not. As the largest supplier of treated drinking water in the Peace-Slave watershed, Aquatera Utilities, which supplies the City of Grande Prairie, and some parts of the County, does not have a source water protection plan for the Wapiti River per se. However, they do monitor aquatic life at their diversion point. Aquatera also participated in the

Wapiti Corridor Planning process for developing a long-term vision for that specific reach of the River (completed in 2013). However, this work does not include other tributaries in the Smoky-Wapiti. Additionally, AEP is leading a Montney Duvernay Policy and Regulatory Implementation Pilot (PRIP), which overlaps the Alberta Energy Regulator's (AER) play-based regulation Duvernay pilot project in the same area. It is too soon to tell if these multiple planning initiatives will lead to improved source water protection or NPSP management in this area.

Similarly, the Town of Peace River does not have a source water protection plan. Due to proximity to head waters and the relative volume of flow, upstream threats are likely minimal for these two communities. However, in the future, source water protection plans might be prudent to ensure this stays the case.

The Town of Grande Cache has created a Source Water Protection Plan and is currently implementing it. The MPWA can help facilitate the development of such plans through the work of its IWMP process.

It should also be noted that Alberta Agriculture and Forestry, through the federal *Growing Forward II On Farm Water Management program*, promotes the use of Long Term Water Management Plans. Although these plans focus on water supply security, they do have a water quality element to them as well.

Relation of water quality and availability to Treaty Rights

The Working Group acknowledged that the Peace-Slave Watershed occurs in Treaty 8 lands. As well, they heard from First Nations how water, like traditional lands, is significant to maintaining their way of life. However, given the complexity and legality of this subject, the WG did not explore this topic specifically nor did it make any recommendations on this topic. Any work the MPWA would like to do in this area in the future should be through collaboration with the appropriate federal, provincial, and First Nations governments.

Review of drinking water safety plans and the new regulations and their ability to address concerns noted in the State of the Watershed

Drinking Water Safety Plans are a tool to help drinking water managers assess and mitigate potential risk. In Alberta, all regulated drinking water operators must produce a plan as a requirement of their approval under EPEA. An assessment of challenges for small communities to undertake planning found that the development of such plans can be beneficial and will occur more readily if both leadership and stakeholders are focused on safety and a "willingness to do things differently". A number of templates and tools are available to assist operators with this task. Additionally, Alberta Health Services works with facility owners and communities to provide notification if there is a health concern related to local drinking water quality.

PRESENCE OF CONTAMINANTS THAT ARE NOT DEALT WITH BY CURRENT WASTE (WATER) TREATMENT AND THE MITIGATION OF THEIR ENTRANCE INTO WATER

Some research has been done on potential contaminants of concern in Alberta and elsewhere across the world. The IISD Experimental Lakes Area in Ontario has done some research on these specific topics but it is not related specifically to Alberta. Such studies include looking at pharmaceuticals, personal care products, antibiotics, steroids, surfactants, and plasticizers in municipal wastewater and receiving waters. Many such compounds occur in Alberta wastewater, however, concentrations tend to be diluted further downstream of outfalls. Surface water guidelines have not yet been determined for many of these substances, or for their combined presence. To date, no such work that we are aware of has been carried out in the Peace-Slave watershed.

WATER LICENSING – ISSUING AUTHORITY, COORDINATION OF LICENCES, TIME FRAME OF LICENCES

Water use is an important element of achieving social, economic and environmental objectives. While there are many different water users in the Peace-Slave watershed, there is a process in place to manage allocation of this resource.

Through the *Water Act*, all water in Alberta belongs to the Crown and the Government of Alberta authorizes its use through licences. Licensing is administered by the Alberta Energy Regulator for the energy industry and by Alberta Environment and Parks for all other applicants.

The WG was provided an overview on water allocation in the Peace River Basin by Alberta Environment and Parks. This presentation included the number of licences (term and temporary), categories of water use (e.g. agricultural, commercial, industrial, municipal and water management and other use), the water use reporting system, return flows, etc.

Industrial Activity	**Surface Water** (dam^3)	**Groundwater** (dam^3)	**Total** (dam^3)
Agricultural	7,720	2,378	10,098
Commercial	96,280	593	96,873
Industrial	9,924	9,568	19,492
Municipal	28,740	4,783	33,523
Water Management and Other Use	32,550	1,385	33,935
Total Allocations	175,213	18,708	193,921
Mean Peace River Flow / Yield (dam^3)	655,948,802,080 at Peace Point		

In addition to the above table of term licences, currently (December 2015) there are 1730 Temporary Diversion Licences (TDL) /Applications in the Peace-Slave watershed with 2896 points of diversion and 3864 points of use. Total volume allocated in these TDLs is 36,193 dam^3.

> Water *flow* is measured as cubic metres per second (cms or m^3/s). Total *discharge* (or yield) is measured in cubic decameters (dam^3). One dam^3 cube has 10-metre long sides and is about three stories tall.

Total water allocations (surface and ground water) for the Peace-Slave watershed are not large compared to available supply (less than 1% of annual discharge). However, many withdrawals are made from smaller tributaries, lakes, aquifers and wetlands rather than the mainstem. These smaller waterbodies may have smaller seasonal flows and aquatic ecosystems that may be more sensitive to cumulative and instantaneous withdrawals, particularly when withdrawals are not returned to the source but are consumed elsewhere or during natural low-flow periods. A variety of conditions on a licence (e.g. limiting the rate of withdrawal, restricting the timing of withdrawal based on instream flow needs, priority, etc.) is used to manage this impact.

In the time provided, the WG was not able to look in detail at allocation on several key tributaries. They did, however, identify a number of questions for the IWMP to forward to AEP/AER. That is, for each of the tributaries listed below:

- How much water is allocated versus actually withdrawn (including both term and temporary licences)?
- How much water is returned (available for downstream use) versus consumed?
- How does quantity and timing of withdrawals and returns compare to annual and seasonal streamflow and instream flow needs?

The above questions should be answered for any tributaries believed to be moderately utilized including, at a minimum:

- Beaverlodge River
- Cutbank River
- Heart River
- Kakwa River
- Little Smoky River
- Notikewin River
- Smoky River
- Wapiti River

Both AEP and AER noted that they are working together to build tools to answer these questions. New tools and technologies can help make such exercises a part of everyday business, leading to improved decision-making and certainty for all.

SUCCESS OF NON-REGULATORY METHODS FOR WATER REDUCTION FOR INDUSTRY, RESIDENTIAL AND AGRICULTURAL USES

When the *Water for Life* strategy was released in 2003, it included a goal for water conservation. To achieve this goal, the Alberta Water Council (AWC) struck a Project Team that included Alberta's seven largest water-using sectors. This team developed definitions for water conservation, efficiency and productivity (CEP). They also developed a framework for each sector to voluntarily produce and implement Water CEP plans. For the most part, all seven sectors are on track to meet their CEP goals.

Alberta Forest Products Association worked with all seven of Alberta's pulp and paper mills to produce their sector's water CEP plan. This includes the DMI plant in Peace River and Weyerhaeuser in Grande Prairie. Collectively, this industry only withdraws about 60% of its allocated licence. Furthermore, about 97% of water withdrawn is returned to its source. Not only have they reduced water use, this industry, through investment in technology, has also improved its productivity measured by cubic meters of water used to produce one metric tonne of product.

The remaining six sectors with CEP plans include the chemical sector, power generation, upstream oil and gas, downstream oil and gas, urban municipalities and irrigation. These plans can be viewed on the AWC website.

Aerial view of an oil and gas lease. Courtesy Adam Norris.

STRATEGIES TO REDUCE CONSUMPTIVE USE

Many industries are looking at how to reduce water use and improve efficiencies. Historically, withdrawals of water for conventional crude oil production (i.e. injection for enhanced recovery) were a focus in the Peace-Slave watershed. The province developed the Water Conservation and Allocation Guideline for Oilfield Injection (2006) to guide water use for this activity. The guide requires consideration of alternatives to fresh water (e.g. saline versus non-saline groundwater) for oilfield injection (See also Water and Oil: An Overview of the Use of Water for Enhanced Oil Recovery in Alberta.)

Today, another source of consumptive use of water in the basin is hydraulic fracturing, where fluids are injected at high pressure and volume to fracture rock and release hydro-carbons including oil, condensate, natural gas liquids, natural gas, etc. The WG heard a presentation from Seven Generations Energy on this topic, learning what is meant by the term 'hydraulic fracturing'; the different types of fluids used in this activity (water versus hydrocarbon-based; saline and fresh, treated wastewaters, surface and groundwater, etc.); and the issues such as availability, cost, waste disposal, safety, well performance, etc. associated with each type. They heard that one size does not fit all - different fluids are better suited to different regions and different formations.

A lack of water supply can delay hydraulic fracturing activities, costing businesses and leading to uncertainty. To reduce this uncertainty, companies may use a number of options including:

- Water withdrawals during high flow periods and the use of water storage (using borrow pits, reservoirs, modular units, water 'hubs') during low flow periods
- Water re-use and recycling of treated municipal and commercial (e.g. pulp mill) wastewaters
- Treatment and re-use of industrial flowback and produced waters
- Pipeline distribution networks from a more reliable source
- Regional collaborations to increase certainty, reduce demand, and decrease footprint, particularly on small sensitive streams

The regulator (Alberta Energy Regulator / Alberta Environment and Parks) has a role to play in protecting smaller tributaries and lakes by requiring stream flow monitoring during withdrawals (so as not to exceed a certain volume of daily flow), by restricting withdrawal timing and rates, requiring screens on intakes, etc. Such restrictions are often a condition of an individual operator's licence, with reporting and compliance components.

> *"Hydro-fracking and Shale Fracking uses of water are expected to continue to grow, associated with successful exploration and development activities in the Montney, Duvernay, Cardium and other plays in the region. While industry is committed to seeking out fresh water alternatives where possible, including the use of deep saline aquifers and recycled waste water sources, surface water resources will likely continue to play an important part in the water sourcing picture, especially at early stage developments in an area."*
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> From Water Allocation and Usage Report: Surface Water Integrated Assessment of Water Resources for Unconventional Oil and Gas Plays, West-Central Alberta, Foundry Spatial Ltd.

Regulators also manage the cumulative effects of multiple companies withdrawing from the same or multiple diversion points on the same system. Hence streams with heavy use may be modeled or further investigated to refine our understanding of instream flow needs and other aquatic ecosystem health considerations. Both AER and AEP are utilizing technology to develop new decision-support tools to improve cumulative effects management. Managers also need to take a systems approach to ensure environmental net effects are balanced where a solution in one area (water conservation) might affect another factor (green house gas emissions or land disturbance).

Modeling Potential Development Water Needs – Conceptual Scoping Study

The WG was given a presentation by Seven Generations Energy on an industry *Water Needs Conceptual Scoping Study* to determine future fresh water needs by the oil and gas industry in the Montney formation area in the Smoky-Wapiti sub-basin. The study looked at potential future well density, fresh water requirements per well, water recycling, etc. Preliminary estimates appear to indicate that water needs over the next 40 years are probably within the carrying capacity of the region however, management (storage, re-use, etc.) may be needed to manage seasonal limitations and to protect instream flow needs. More importantly, this exercise showed the value of using scenarios and looking forward. In the future, it would be useful for both industry and others (government, regulators, researchers, etc) to undertake more of this work to improve our understanding of supply and demand and reduce our risk of over-allocation and harming aquatic ecosystems in the Peace-Slave watershed.

IDENTIFICATION OF COMPETING VALUES IN AREAS WITH WATER AVAILABILITY CONCERNS

For the most part, water is available where it is needed in the Peace-Slave watershed. Note however, that some communities, like Red Earth Creek (M.D. Opportunity), are challenged to find a suitable drinking water supply. Similarly, LaCrete has experienced groundwater issues that have led to the need to haul water from other areas. As previously mentioned, provincial infrastructure, funds and regional networks can help address these local challenges.

The WG also recognized there are some areas within the Peace-Slave watershed where there are a growing number of water users and issues. With a limited supply available for all, these areas must be managed carefully to ensure water, and other landscape values, are managed sustainably. The Grimshaw Gravel Aquifer is an example of one such area requiring sound allocation management and protection from potential contamination. Fox Creek is another example of an area with concerns about the potential risk of contamination to local municipal groundwater supplies from surrounding land use activities. As mentioned previously, planning efforts within the Montney-Duvernay oil and gas field within the Smoky-Wapiti sub-basin is a third example where multiple users must consider cumulative effects on water, as well as a number of other values important to this area including species at risk, fisheries management, biodiversity, forest health, recreation, etc.

Where there are a number of interests in an area with limited supply, a watershed management planning exercise can help to identify competing values and resolve water quantity, quality and aquatic ecosystem health issues. This is currently occurring under the Wapiti River Water Management Plan. Similarly, the Heart River and Redwillow Watershed Restoration Projects seek to address the cumulative effects of multiple land use activities that affect water quality, quantity and aquatic ecosystem health in these sub-basins.

Although the Peace-Slave watershed is large and sparsely populated, the potential for water conflicts may grow in the future with continued population growth and industrial development, as well as climate variability and change. To ensure supply continues to meet demand, a sound knowledge base with accurate water data availability, demand and use is needed. The ability to model inputs and outputs would also be beneficial, as would predictive tools to estimate future trends over time. Some of this forward-looking, strategic scenario work may occur under the Land Use Framework regional planning exercises for the Upper and Lower Peace regions.

Case Study – Red Earth Creek, M.D. of Opportunity

The Hamlet of Red Earth maintains a raw water intake facility using the Red Earth Creek as a raw water source, two raw water storage ponds, a water treatment plant with a treated water reservoir, a distribution pump station, a truck fill facility and a water distribution system. The water distribution mains are 150mm and 300mm in diameter. Municipally treated water is available to those areas within the Hamlet located to the west of Highway 881 and to those properties, which are located directly adjacent to the eastern boundary of Highway 881. The water treatment system also provides potable water to the Loon Lake First Nation, which is located adjacent the western boundary of the Hamlet. The waterworks system in the Hamlet has been developed to meet the water demand for peak hour and day water consumption and for firefighting purposes.

In 2004, EXH prepared a Water System Assessment Report for the Hamlet of Red Earth Creek. The report indicates that there are there are some deficiencies with the current system's servicing capacities and upgrades are expected to be required.

Of note, Northern Sunrise County is located 1 km south of Red Earth. Northern Sunrise County has a regional partnership project, approved by the Province, to construct a new water treatment plan to service all Hamlets and settlements in the area. Piping water from Loon Lake might also be a future option for this community.

ADEQUACY OF CURRENT WITHDRAWAL RULES FOR THE PROTECTION OF ECOSYSTEM FUNCTION

In a discussion about term and temporary diversion licences (TDL), the WG identified that there is insufficient data and / or analysis publicly available to assess if the cumulative rate of diversion may be exceeding instream flow needs downstream of diversion points on some smaller tributaries. Hence, there is a need for AER/AEP to provide improved 'assurance' of environmental performance.

Term licences and TDLs may be issued with monitoring and reporting conditions, with which the proponent must comply. Reporting of actual volumes of water is usually done through the Water Use

Reporting online system. An example of a condition that may be written into a TDL is to restrict the maximum rate of diversion. In addition, the instantaneous flow of water is often requested to be monitored. All proponents requested to monitor the instantaneous flow are required to divert water at a rate less than 10% of the instantaneous flow. When a proponent is diverting water from the river, the maximum rate of diversion has to be lower than the approved maximum rate of diversion *and* 10% of the instantaneous flow – whichever is lower. To compare total diversions, AER and AEP could estimate Desktop IFN calculations using a regional analysis, where insufficient direct monitoring information is available.

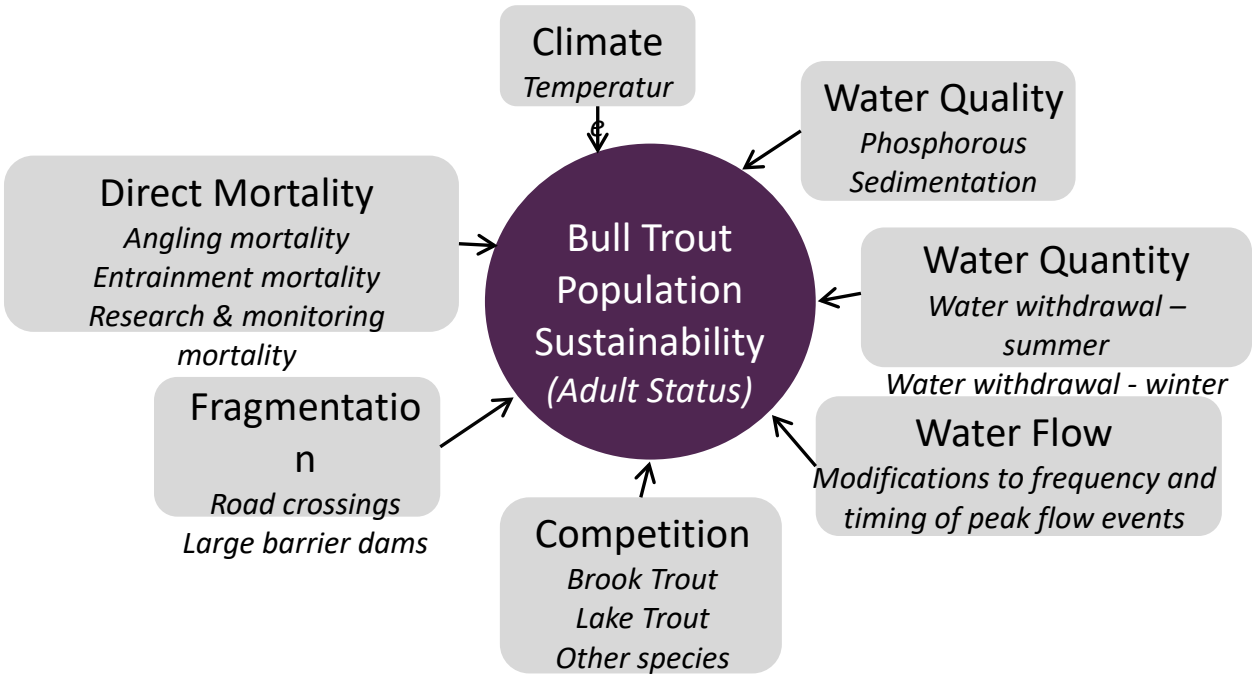
The occurrence of unauthorized diversions is unknown. If unauthorized diversions occur, they pose a potential risk of causing cumulative withdrawals to drop the water levels (ex: instream flow, pond/lake depths) below what is ecologically sustainable for the aquatic ecosystems, even temporarily. However, companies are unlikely to violate knowingly regulations that may risk the chance of losing access to a water source. Therefore, compliance to licensing, monitoring, and reporting requirements is believed to be fairly high, supported by 'sweeps' done in the field by AER and AEP compliance staff.

Adequacy of Protection of Ecosystem Function

Note: Although this topic was not specifically included in the WG terms of reference, it was discussed by the WG as an extension of the previous topic (the ability of the water allocation system to protect ecosystem function), after hearing a presentation from the Alberta Fish and Game Association member on the ENGO perspective, and after the exchange of several documents to inform the discussion.

From the presentation, the WG heard how watersheds are molded by complex geographical, geological and climatic variables that support diverse terrestrial and aquatic ecosystems. Human disturbance may result in changes to overall ecosystem function. Disturbance levels have been linked to the way wildlife behave or respond. Some species such as wolves (linear disturbance utilized for more effective hunting and leads to prey diversity) or whitetail deer (habitat diversity) have responded positively provided the disturbances do not lead to the elimination of key habitat elements. On the other hand, species such as arctic grayling, bull trout and woodland caribou have shown declines as the human footprint (anthropomorphic disturbance) increases. The cause of such declines is seldom a single factor. As shown in the bull trout graphic below, the interrelationship of many factors, often called cumulative effects, includes changes in human use of the landscape, changes in land cover and habitat (type, productivity, area) and behavior of species.

> The Alberta Biodiversity Monitoring Institute defines Human Footprint as the temporary or permanent transformation of native ecosystems to support residential, recreational or industrial land uses. Under this definition, human footprint includes the geographic extent of areas under human use that either have lost their natural cover for extended periods of time (e.g., cities, roads, agricultural land, and surface mines) or whose natural cover is periodically reset to earlier successional conditions by industrial activities (e.g., cut blocks and seismic lines).

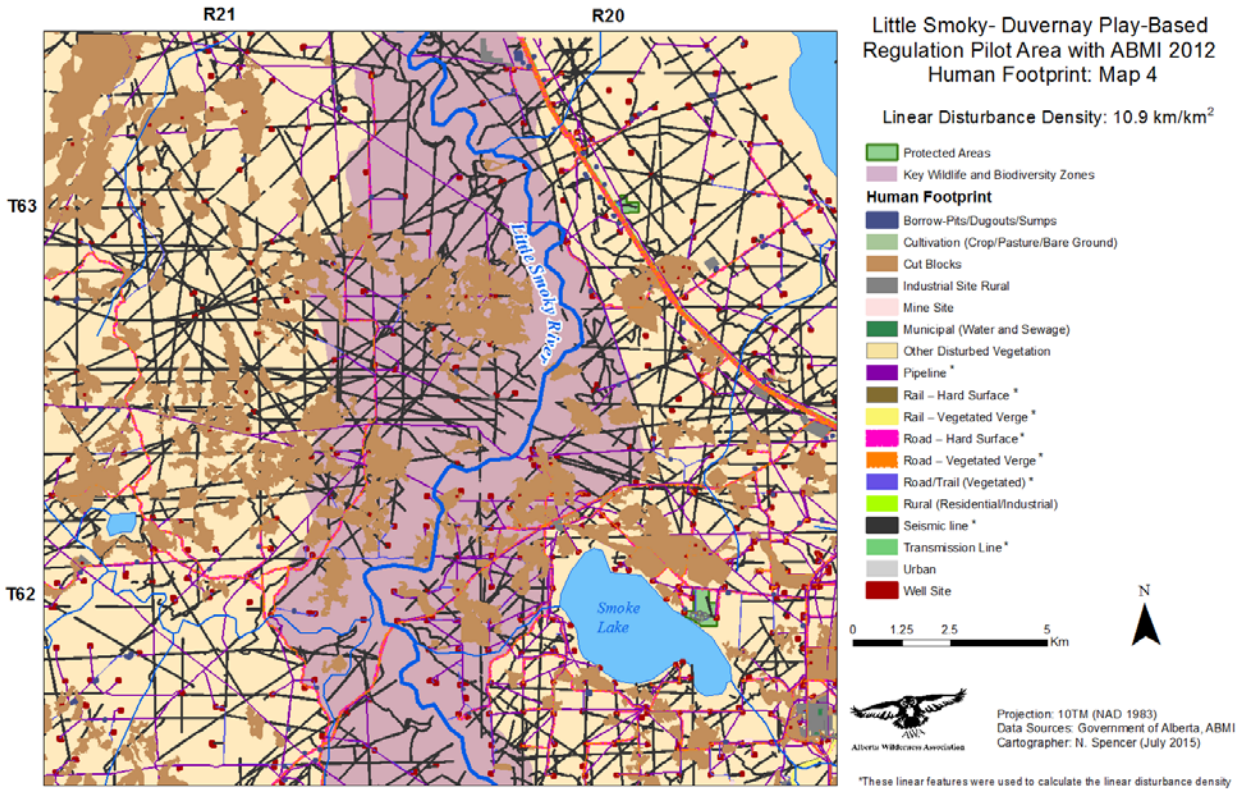


Linear disturbance[1] measurements are one way of describing the human footprint at a watershed level. Simplest models consider only road density while more complex models take into account additional disturbances such as timber harvest, industrial/ recreational/ oil/gas sites, utility right of ways or seismic lines. There is growing evidence that as linear disturbance increases, there is change in health, productivity and species composition at the aquatic ecosystem level. [2]

Human disturbance comes with both benefits and costs. As access increases so does the potential for direct mortality of fish from angling, poaching or accidental spills of contaminants. Fragmentation of habitat occurs if road crossings create barriers due to culverts not being properly installed or maintained. Water quality can be affected due to sedimentation related to roadways or phosphorous loading increases related to activities such as cattle feedlots. Upstream dams lead to barriers and changes to water flow, which can lead to species composition shifts. Thermal effects due to rapid runoff from heated road surfaces[3] or loss of riparian cover[4] can both have lethal consequences.

[1] Note that linear disturbance is also sometimes expressed as disturbance or footprint as a percentage of the watershed.
[2] For more information about the effects of watershed disturbance on fish communities, see Cumulative Effects of Watershed Disturbances on Stream Fish Communities in the Kakwa and Simonette River Basins, Alberta http://www.ab-conservation.com/go/default/custom/uploads/reportseries2/NWP%20REPORT%203.pdf.
[3] For more on heat islands and their impact on Minnesota trout streams, see http://www.ncbi.nlm.nih.gov/pmc/articles/PMC1257665/.
[4] For more about the role of riparian cover, see http://www.fishsciences.net/reports/Transactions/Tr_123_p627-40_Cumulative_effects_riparian_disturbances_high_desert_trout.pdf

Without a watershed (landscape) approach to planning, unexpected consequences to ecosystem health may result. Some areas within the forested areas of the Little Smoky River watershed today have an overall cumulative footprint of disturbances of up to 11 linear km per sq. km[5]. A similar study was done in the upper part of the Peace watershed and noted that the physical footprint from human disturbance totaled 20.2% of the study area, with the Upper Peace-Kiskatinaw (45.9%) and the Beatton (22.5%) sub-basins having the largest area disturbed by total area and by percent of the watershed.[6]



This graphic was generated by the Alberta Wilderness Association using ABMI data.

The current Grizzly Bear Management Plan for the province suggests maximum road density thresholds in core ranges at .6 km per sq. km (see graphic below). There is growing evidence that cold water species such as bull trout and arctic grayling show declines when disturbance density increases even when strict harvest protection is in place. The inference is that ecosystem change due to cumulative effects is altering the habitat for these species.[7]

[5] Note that the Federal Caribou recovery strategy notes that 95% of caribou habitat has been disturbed in the Little Smoky caribou herd range. See http://www.sararegistry.gc.ca/default.asp?lang=En&n=33FF100B-1#_Toc337193700

[6] http://www.davidsuzuki.org/publications/downloads/2012/Peace_region_20120812_HR-optimized.pdf

[7] See Cumulative Effects of Watershed Disturbances on Stream Fish Communities in the Kakwa and Simonette River Basins, Alberta http://www.ab-conservation.com/go/default/custom/uploads/reportseries2/NWP%20REPORT%203.pdf.

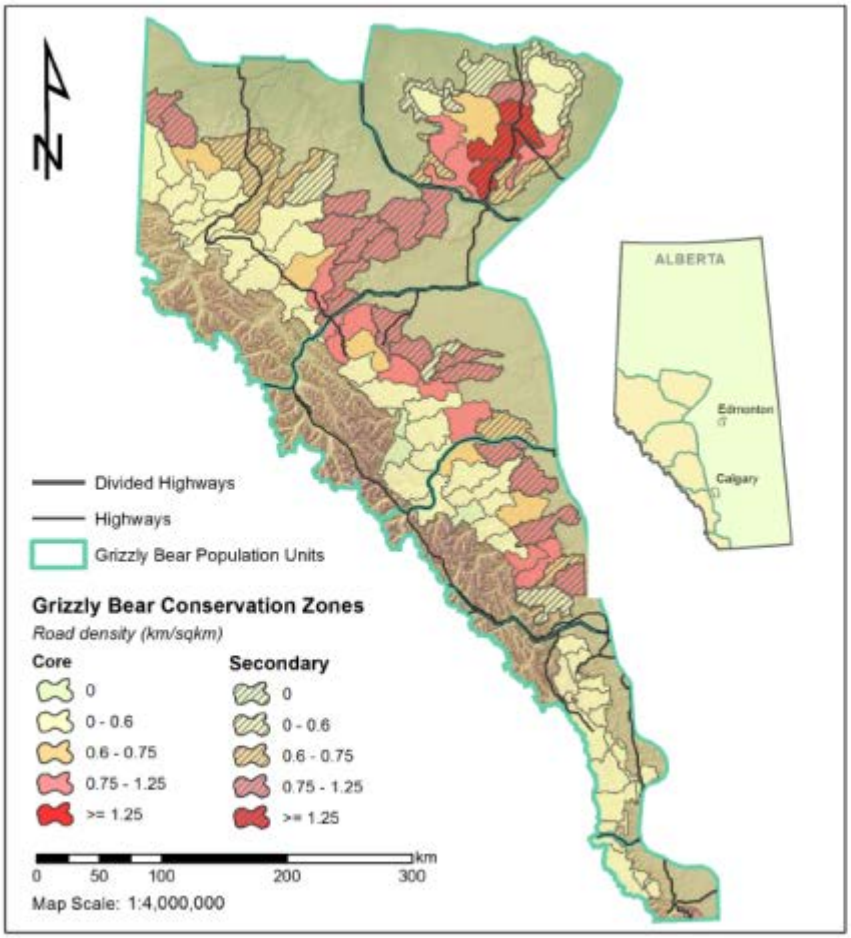


Fig. 5. Road density for watershed units as subdivided by core and secondary areas for grizzly bear range in Alberta [17]. Mountainous areas (to the west of core secondary areas) were primarily protected parklands with low (<0.6 km roads/km^2) road densities.

doi:10.1371/journal.pone.0115535.g005

For the purposes of this WG, it is prudent to consider aquatic species of wildlife (e.g. fish) as a stakeholder in the discussion of water quality, availability and consumptive use. The general health and resiliency of fish populations can be used as an excellent indicator for the health and resiliency of the watershed in which they live.

It is also prudent to integrate land-use and water management planning with the overall protection of a watershed. Fish habitat protection is yet one more reason why a systems approach is necessary for future planned disturbances, linear or otherwise. Protecting instream flow needs, putting environmental management frameworks in place, improving monitoring, assessment and reporting, and ensuring compliance and enforcement are all tools that can and should feed into regional planning.

RECOMMENDATIONS

After learning about the water topics discussed above, the WG was asked "What does future water management in the Peace/Slave watershed look like? Responses included:

- Everybody has access to good water
- Transparency, good communication between all water users, regional collaborations
- Shared understanding of the water balance = inputs and outputs
- Best available technology
- Flexibility in decision-making and the ability to address current and future variability (in users needs; in the physical environment)
- An understanding of cumulative effects, protection of source waters and instream flow needs
- Water is managed in concert with energy, Green House Gas management and Environmental Net Effects

From this discussion, the WG came up with a vision for the Steering Committee to guide future work in this area as follows:

> *"Water in the Peace-Slave watershed is adaptively managed for current and future generations such that the water resource is well understood, quality source and drinking waters are available where and when they are needed and aquatic ecosystems are healthy."*

The WG then discussed at length what they would do to improve current water management. Suggested actions were many but can be grouped into the following six outcomes:

1.0 Accessible, timely and accurate baseline information on water quality, availability and consumptive use supports knowledge-based decision-making and adaptive management such that aquatic ecosystem health and ecological integrity are sustained.

2.0 Land use and water managers and the public are knowledgeable about the water balance (inputs and outputs) and share accountability for managing current and future water use demands sustainably in the Peace-Slave watershed.

3.0 Source water yield is recognized as a value to be managed by the Crown ensuring source waters are protected.

4.0 The water allocation system is comprehensive, transparent, efficient and effective and protects aquatic ecosystem health and ecological integrity in the Peace-Slave watershed.

5.0 Source water availability is a key consideration of current and future population growth and development.

6.0 Consumptive use of fresh water is managed sustainably and economically.

Further strategies, actions, leads, partners and timelines, for each of the outcomes above, is detailed in a proposed water workplan (Table 2). In addition to the water workplan, the WG also made a number of recommendations to the Steering Committee as they move forward with the IWMP as follows:

- Be a leader in ensuring science and a science-based approach informs your work and the work of others.
    - Address data gaps to inform planning. Data, information, analysis, knowledge-building are all needed. Ensure data we have is useable, collated, shared, answers a question, is managed appropriately, such that it is effective.
    - Ensure information informs decision-making (science-, evidence-based decision-making)
    - Improve funding to manage data/water systems: put a tax/levy on
    - However, do not wait to gather all the data wanted/needed; start making management decisions/changes on the ground today to protect ecosystems.
    - Monitor to assess if we are making progress towards our goal (adaptive management).
- Promote compliance and educate about the use of best management practices throughout the watershed.
- Be a conduit and ensure there is integration between the various GOA departments, regulators, industry, etc. at both a policy level down through the operating level regarding water issues in the Peace-Slave watershed.
- Continue to work with AEP to ensure there is a clear process for watershed objectives to feed into and integrate with the LUF Upper and Lower Peace regional plans.
- Ensure cooperation between water users: create a water collaboration platform for water users in the Peace-Slave watershed.
- Be adaptable. The future and all its technologies, growth, challenges, climate, needs etc. is unpredictable and the knowledge we gain tomorrow may change how we chose to build a plan yesterday.
- Put the ecosystem first.
- Be creative. The issues are complex and it is challenging to understand them all – finding solutions might require out-of-the-box thinking.

Table 2. MPWA Integrated Watershed Management Plan – Water Quality, Availability and Consumptive Use

Vision: Water in the Peace-Slave watershed is adaptively managed for current and future generations such that the water resource is well understood, quality source and drinking waters are available where and when they are needed and aquatic ecosystems are healthy.			Project initiated and completed Short = 2 yrs, Medium = 5 yrs, Long = 10 yrs		
Outcomes	STRATEGIES	ACTIONS	Lead	Other partners	Time-frame
1.0 Accessible, timely and accurate baseline information on water quality, availability and consumptive use supports knowledge-based decision-making and adaptive management such that aquatic ecosystem health and ecological integrity are sustained.	1.1. Develop an accessible water database(s) and/or portals. (Build on existing databases like the water use reporting system, AEP, etc.)	1.1.1 Identify a 3rd party neutral multi-stakeholder database host (e.g. MPWA, AEP, etc.)	MPWA	AEP / academia	short
		1.1.2 Develop a communications strategy to raise awareness of available data.	MPWA	AEP	medium
	1.2 Find funds for database support and for research to fill data gaps.	1.2.1 Create a database of available funding sources.	MPWA		short
		1.2.2 Investigate and leverage existing Water for Life and other provincial initiatives (e.g. AB Innovates, WRRP program) for funds.	MPWA	AI, AEP-WRRP, AAF	medium
		1.2.3 Explore the use of a levy or donation from water users to fund a shared publicly available database.	MPWA	Water licencees	medium
		1.2.4 Collaborate with University researchers	MPWA	academia	long
	1.3 Decide what parameters, indices will be monitored and assessed for water quality, quantity/use and aquatic ecosystem health (including ecological goods and services).	1.3.1Survey current indices and parameters and select best fit.	MPWA	AEP / ABMI	short
		1.3.2 Standardize collection and assessment methods and timelines.	MPWA	AEP / ABMI	medium
		1.3.3 Establish baseline and begin collecting data for these indices and/or parameters and make findings publicly accessible.			long
		1.3.4 Identify triggers, responses.			
	1.4 Promote mandatory water use reporting by all.	1.4.1 Link water use reporting data to the publicly available database and ensure compliance.	AEP	MPWA	medium
	1.5 Improve our understanding of historical and future flows and demands.	1.5.1 Encourage First Nations and community elders to share traditional and historical knowledge.	MPWA	Treaty 8	medium
		1.5.2 Back cast the past 100 years of flow data; forecast the next 100 years to gain a better understanding of seasonal flows on smaller tributaries and compare to projected instream and industry needs, in the face of climate change.	AER-AEP	academia, BC Hydro,	medium

Vision: Water in the Peace-Slave watershed is adaptively managed for current and future generations such that the water resource is well understood, quality source and drinking waters are available where and when they are needed and aquatic ecosystems are healthy.			Project initiated and completed Short = 2 yrs, Medium = 5 yrs, Long = 10 yrs		
Outcomes	STRATEGIES	ACTIONS	Lead	Other partners	Time-frame
2.0 Land use and water managers and the public are knowledgeable about the water balance (inputs and outputs) and share accountability for managing current and future water use demands sustainably in the Peace-Slave watershed.	2.1 Develop an education and outreach strategy that identifies target audiences, key messages and appropriate communication tools (e.g. tradeshows, Sister City, school curriculum, etc).	2.1.1 Develop a mainstream media education campaign for a public audience.	MPWA	GOA	short
		2.1.2 Develop a more industry-focussed campaign promoting compliance, stewardship, best practices, etc. for water haulers, road builders, construction, grader operators, etc. Work through certification and training programs to improve water awareness.	MPWA	Industry associations, Trade schools	short
		2.1.3 Develop, or tap into existing, municipally focussed campaigns.	MPWA	AAMDC, AUMA, ASVA	medium
	2.2 Ensure accountabilities by building processes into the Water Act allocation and licensing system that assure cumulative effects are known and impacts are lessened.	2.2.1. Make it a condition of a licence that the water hauler, or other user, has to prove training/ certification, etc. (Many TDL applicants note that they have their haulers complete online training at www.surfacewaterdiversion.com.)	AER / AEP	Accreditation bodies	medium
		2.2.2 Ensure and report on compliance with water use reporting, conditions on licences such as monitoring, etc.	AER/AEP		medium
		2.2.3 Put a more formal system in place with resources to monitor / model licence withdrawals and timing of flows on any small tributary with multiple term or temporary diversion licences on it.	AER-AEP	applicants	long

Vision: Water in the Peace-Slave watershed is adaptively managed for current and future generations such that the water resource is well understood, quality source and drinking waters are available where and when they are needed and aquatic ecosystems are healthy.			Project initiated and completed Short = 2 yrs, Medium = 5 yrs, Long = 10 yrs		
Outcomes	STRATEGIES	ACTIONS	Lead	Other partners	Time-frame
3.0 Source water yield is recognized as a value to be managed by the crown ensuring source waters are protected.	3.1 Raise awareness and promote the use of source water protection plans for all source waters (existing and new) in the Peace/Slave watershed.	3.1.1 Define, locate and map source waters (surface and groundwater) in the watershed.	MPWA	AAMDC	short
		3.1.2 Promote existing tools and programs that are currently available to municipalities and private system owners to develop plans (technical advice, templates, etc.)	MPWA	AAMDC	medium
	3.2 Mitigate anthropogenic point and non-point source pollution (sediments, nutrients, etc).	3.2.1 Identify current and potential pollutants and sources (both natural and anthropogenic).	MPWA	academia	medium
		3.2.2. Create and implement an education plan about NPSP and how to mitigate its impacts.	MPWA	Agriculture, industry	short
		3.2.3 Promote the use of agricultural BMPS (e.g. off-site watering systems) particularly in the Upper Peace and Smoky-Wapiti sub-basins.	MPWA	Agriculture	medium
		3.2.4 Investigate trade-able credits / offsets / cap and trade systems for their ability to affect cumulative effects. (See provincial policy on conservation off-sets)	academia	MPWA	long
	3.3 Promote passive ecosystem management with buffers, setbacks, conservation easements, municipal and environmental reserves, etc. around waterbodies, wetlands, riparian lands, floodplains and aquifer recharge and discharge areas.	3.3.1 Investigate the ALUS or a similar incentive program (ecological goods and service payments) for the Peace.	AB Land Institute	MPWA, academia	medium
		3.3.2 Identify (delineate) crown lands (bed and shore) on title before land sales. (or at the referrals stage) (see the new guide on establishing permanence)	AEP	AAMDC	
		3.3.3 Map floodplains and limit development on and restore; see WRRP program	AEP	Town of Peace River	

Vision: Water in the Peace-Slave watershed is adaptively managed for current and future generations such that the water resource is well understood, quality source and drinking waters are available where and when they are needed and aquatic ecosystems are healthy.			Project initiated and completed Short = 2 yrs, Medium = 5 yrs, Long = 10 yrs		
Outcomes	STRATEGIES	ACTIONS	Lead	Other partners	Time-frame
4.0 The water allocation system is comprehensive, transparent, efficient and effective and protects aquatic ecosystem health and ecological integrity in the Peace-Slave watershed.	4.1 Determine the IFN (using the desktop method) for any priority (e.g. over a particular volume) tributary with an allocation licence on it with available data and/or a surrogate.	4.1.1 Determine what needs to be protected for instream flow needs, including wetland / ecosystems how much water is allocated in each basin; what remains for allocation, seasonal issues, etc.	GOA-AEP	MPWA	Long
	4.2 Promote the water use reporting system and ensure compliance such that all TDLs and term licence-holders (e.g. ag users, irrigation, larger licences etc) are tracking and reporting water use.	4.2.1 Look at current monitoring and compliance systems to ensure water allocations are appropriate through sensitive periods, compliance is 100%, including cumulative effects monitoring (to be defined) and reporting.	AER-AEP	industry	Long
	4.3 Understand limits (carrying capacity) for tributaries and manage the cumulative effects of Water Act approvals.	4.3.1 Start a pilot project with smart meter real time monitoring in critical areas (to be defined).	AER-AEP	Industry, MPWA	Long

Vision: Water in the Peace-Slave watershed is adaptively managed for current and future generations such that the water resource is well understood, quality source and drinking waters are available where and when they are needed and aquatic ecosystems are healthy.			Project initiated and completed Short = 2 yrs, Medium = 5 yrs, Long = 10 yrs		
Outcomes	STRATEGIES	ACTIONS	Lead	Other partners	Time-frame
5.0 Source water availability is a key consideration of current and future population growth and development.	5.1 Integrate land and watershed planning.	5.1.1 Ensure a MPWA board member sits on the Upper and Lower Peace planning processes.	MPWA	AEP	Med
		5.12 Investigate designating the watershed plan as a sub-regional plan.	AEP	MPWA	med
	5.2 Forecast future growth and development of the watershed (all future needs) to inform decision-making on all source waterbodies particularly priority source tributaries under demand.	5.2.1 Engage consultant to model watershed (e.g. ALCES) or those tributaries believed to be under pressure.	MPWA	Municipalities, industry	medium
	5.3 Identify and support communities with critical water supply and or treatment issues.	5.3.1. Create a list of communities and issues (including First Nations communities with boil water advisories).	AAMDC	Federation of Canadian Municipalities, GOA, Treaty 8	Short
		5.3.2. Prioritize communities for action.	AAMDC		medium
		5.3.3. Outline possible actions to improve supply and/or treatment options, in particular, looking at regional collaborations.	AAMDC		medium
		5.3.4. Conduct feasibility studies.	AAMDC		medium
		5.3.5. Select on option.	AAMDC		long
		5.3.6. Fund and implement through existing federal and provincial municipal infrastructure programs.	AAMDC		long

Vision: Water in the Peace-Slave watershed is adaptively managed for current and future generations such that the water resource is well understood, quality source and drinking waters are available where and when they are needed and aquatic ecosystems are healthy.			Project initiated and completed Short = 2 yrs, Medium = 5 yrs, Long = 10 yrs		
Outcomes	STRATEGIES	ACTIONS	Lead	Other partners	Time-frame
6.0 Consumptive use of fresh water is managed sustainably and economically.	6.1 Empower water use managers and planners to achieve shared objectives from an agreed to watershed management plan.	6.1.1 Use incentives and compliance, in the right balance.	GOA	Municipalities Industry, First Nations	Long
		6.1.2 Monitor and assess (using performance measures) the achievement of objectives.	GOA		Long
		6.1.3 Ensure instream flow needs are set on all waterbodies with allocations to guide decision-making.	GOA		Long
		6.1.4 Set and educate on a common terminology (e.g. waste, unrefined product, etc).	GOA		Long
		6.1.5 Create a forum for transparent discussions about trade-offs.	MPWA	All stakeholders	Long
		6.1.6 Promote best available technology, CEP planning, water reuse and recycling of source and wastewaters (to be defined).	GOA	AB Innovates	medium
		6.1.7 Understand demand and timing of demand (instantaneous and annual, and long term) as well as long-term supply cycles and trends.	GOA	Academia, municipality industry	long

APPENDIX 1 – WORKING GROUP MEMBERSHIP

Name	Surname	Job Title or Perspective	Affiliation
Dollie	Anderson	Municipality with water shortage	MD of Opportunity
Bill	Berzins	Energy Industry Water User	K-Nowbe/ CAPP
Rod	Burr	Approvals Team Lead	Alberta Environment & Parks
Leland	Jackson	Academic	University of Calgary
Rick	Keillor	IWMP Steering Committee	Mighty Peace Watershed Alliance
Gregory	Pippus	Environmental Lead	Weyerhaeuser
Brent	Schapansky	Municipal water management	NEW Water Ltd
Darryl	Smith	Conservation organization	Alberta Fish and Game Association
Natalia	Thornton	Oil and Gas Industry	Seven Generations Energy Ltd.
Jim	Webb	Aboriginal Perspective on water policy	North Peace Tribal Council
Petra	Rowell	Project Manager	Consultant
Adam	Norris	Watershed Coordinator	Mighty Peace Watershed Alliance
Megan	Graham	Education & Outreach Coordinator	Mighty Peace Watershed Alliance
David	Doucet	Recorder	Consultant
Bob	Cameron	Alternate – IWMP SC	Mighty Peace Watershed Alliance

APPENDIX 2 – TERMS OF REFERENCE

Integrated Watershed Management Plan Working Group Terms of Reference

The following document describes the purpose and structure of the working groups including what they should achieve, who will participate, how work will be done and when it will be completed. The Board of Directors approved these Terms of Reference on

Context

The Mighty Peace Watershed Alliance Society (MPWA) is a multi-stakeholder not-for-profit organization registered under Alberta's Society Act. The MPWA is one of several *Watershed Planning and Advisory Councils* created under Alberta's *Water for Life* strategy. The MPWA is committed to achieving and implementing the three goals of the strategy:

- Safe, secure drinking water supply
- Healthy aquatic ecosystems
- Reliable, quality water supplies for a sustainable economy.

The implementation of these goals is guided by the vision, mission and shared values of the MPWA:

Vision – The Peace is a healthy, sustainable watershed that supports our social environmental and economic objectives.

Mission – To promote watershed excellence, the Mighty Peace Watershed Alliance will monitor cumulative effects from land use practices, industry and other activities in the watershed and work to address issues through science, education, communication policy and by supporting watershed stewardship.

Shared Values - The Mighty Peace Watershed Alliance will:

Respect a diversity of peoples and values	*By demonstrating individual and collective respect for the air, land and water and by appreciating the diversity of values and opinions found in the Peace watershed.*
Be an ambassador	*By promoting our vision and mission, demonstrating integrity, accountability and practicality, and practicing effective communication, knowledge-building and consensus decision-making.*
Be a trustworthy and credible source of information	*By being well-informed and providing sound advice through an adaptive watershed approach*

	that integrates traditional local and scientific knowledge in information-gathering and problem solving.
Be fair and transparent to all	*By seeking balanced representation and listening to all stakeholders in an open, transparent manner.*
Be inclusive and collaborative	*By facilitating inclusive and collaborative processes and partnerships, promoting membership and interaction and providing opportunities for all stakeholders to be involved.*
Be action-oriented and innovative	*By being motivated, resourceful and action-oriented in finding new, innovative ideas and win-win strategies.*
Foster stewardship	*By encouraging and enabling individuals and organizations to be good stewards of the watershed.*

Objectives

The working groups will work through the Issues of Concern as directed by the Integrated Watershed Management Plan Steering Committee (IWMP SC) in a consensus process. The end goal for each Issue of Concern is a set of concrete recommendations to the IWMP SC on how to improve water quality and quantity in pursuit of the 3 goals of the *Water for Life* strategy. This includes statements about the Issue of Concern and potential options for addressing this, which are ranked.

Working Group Task

1. To review the information presented by the Integrated Watershed Management Plan Steering Committee (IWMP SC), review and assess for completeness and data gaps.

2. The working group will ensure that Issue of Concern is properly framed through discussion and brainstorming.

3. The working group will develop statements for their assigned Issues of Concern to clarify and frame the issue. Subsequent to this, the working group will identify and evaluate potential management options of how to address the issues.

4. Finally, recommendations will be made by the Working Group to the IWMP SC on how best to move forward on their designated Issue of Concern. This recommendation will include ranked management options and indications of the consensus achieved within the Working Group.

What is in scope?

The IWMP SC will indicate to each working group what the Issue(s) of Concern they are to deal with is/are. Each issue is to be considered, diagnosed and potential management options for addressing are to be sought out, collected and evaluated. Please see Appendix I for more detail on each Issue of Concern.

What is out of scope?
Issues of Concern not assigned to a particular Working Group are out of scope, as is engaging consultants without the approval of the IMWP SC or implementation activities. The Working Groups will not engage is lobbying or promotion of a particular management option.

Membership

1. Membership of the Integrated Watershed Management Plan Working Groups must be approved by the IWMP SC and shall consist of the following classifications:

- Water Quality Expert
- Water Quality Academic
- Energy Regulator
- Municipal Water Management
- Forestry Industry Water User
- Energy Industry Water User
- First Nations Water Policy Expert
- Municipality member who is experiencing a water shortage
- Expert on alternatives for the use of water in fracking
- IWMP SC member
- NGO

2. The Working Group can, with approval from the IWMP SC, call upon the expertise of people outside the Working Group and outside the MPWA.

Meetings

Meetings will be set as required and notification will be provided electronically.

Reporting

1. The Working Groups is responsible to and reports to the Integrated Watershed Management Plan Steering Committee, which in turn is responsible to and reports to the MPWA board (MPWA Process Guide section 6.1).
2. The Working Group will report to the IMWP SC after every meeting and the IWMP SC will report to the Board at minimum at every regular Board meeting.

Quorum

A simple majority of committee members shall constitute quorum.

Delegation

The Working Group may, with permission from the IWMP SC, delegate tasks to other qualified individuals or groups.

Timelines

The Working Group will convene in December 2015 and complete their work by March 2016.

Appendix I – Comments and questions for each Issues of Concern

Water quality and availability away from the mainstem

1. Current water quality and availability issues by location
2. Metrics for measurement and their comparability to other jurisdictions in Canada
3. Mitigation and addressing of lake water quality issues
4. Existence and effectiveness of current source water protection plans
5. Relation of water quality and availability to Treaty Rights
6. Review of drinking water safety plans and the new regulations and their ability to address concerns noted in the State of the Watershed
7. Identification of competing values in areas with water availability concerns
8. Strategies to reduce consumptive use
9. Water licensing – issuing authority, coordination of licenses, timeframe of licences

- effect of use on issuance of license
- distinction between temporary and permanent licensing and eligibility of different applicants

10. Success of non-regulatory methods for water reduction for industry, residential and agricultural uses
11. Adequacy of current withdrawal rules for the protection of ecosystem function
12. Presence of contaminants that are not be dealt with by current waste (water) treatment and the mitigation of their entrance into water