MIGHTY PEACE WATERSHED ALLIANCE

State of the Watershed

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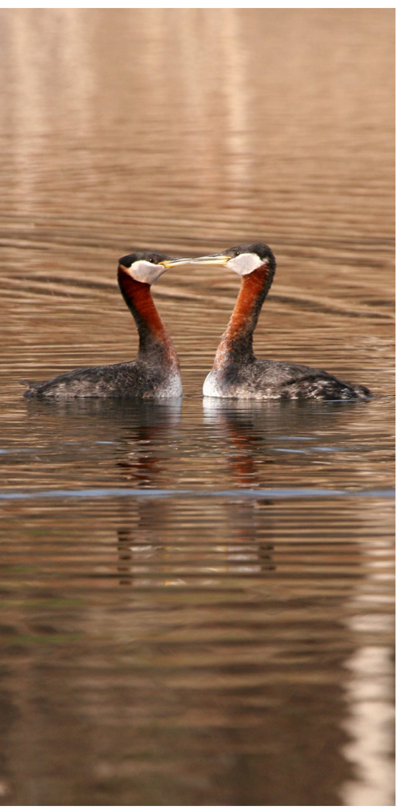
The **Mighty Peace Watershed Alliance** *is a multi-sector, not-for-profit society committed to planning for an ecologically healthy watershed while ensuring environmental, economic and social sustainability.*

The Alliance is a group of active stakeholders and communities that use consensus, adaptive management, and innovation to understand and promote living within the watershed. The Board will report on the state of the watershed, lead watershed planning activities, promote best management practices and develop educational programs.



Executive Summary

Everyone lives within a watershed, even those far from a major waterway. Watersheds influence the character of a landscape and in turn are influenced by the land and human activities. All we do on the land, how we care for the soil, the forests and wildlife, and every other aspect of the watershed has an impact, not just on the local watershed, but far downstream.

The Mighty Peace Watershed Alliance (MPWA) is committed to increasing public understanding of trends affecting the Peace and Slave Watershed. The Alliance is the designated Watershed Planning and Advisory Council for the Peace/Slave River Water Basin. This report is the first attempt to document the state of the watershed and identify significant stewardship challenges and options. It is a snapshot of the watershed today — what we know and don't know. Our goal is to engage the public and stakeholders with an interest in preserving the water resources of the region.

The MPWA commissioned three technical reports and a directory on water quantity and quality and aquatic ecosystems of the watershed. The complexity of watershed dynamics makes it impossible to measure all the influential factors, but it is possible to identify representative elements of the region. Measurements should be based on sound science and be relevant to the overall health of the watershed and its people, plants and animals. Drawing on research and consultations with stakeholders, the Alliance chose six categories of indicators: Landscape, Biological Community, Surface Water Quantity, Surface Water Quality, Groundwater Quantity, and Groundwater Quality.

Overall, research shows that the Peace and Slave rivers, as well as their larger tributaries (Smoky and Wabasca) are relatively healthy. They have good water quality and strong fish populations. Less than 1% of the natural flow of the Peace is allocated for use, given that the river is large and the population is relatively small (4% of the provincial total). The most important freshwater aquifer in the watershed, the Grimshaw Gravels Aquifer, is still a reliable supply of clean water. This aquifer and its source areas must be protected, as at least four municipalities and many rural residents rely on it.

Most riparian areas show good health, and they are largely untouched in the Wabasca, Lower Peace, and Slave River sub-watersheds, and to a lesser extent in the Central Peace. On the other hand, some of the 12 aquifers that are monitored on an ongoing basis show signs of over-use. Certain areas that are highly valued by the watershed's stakeholders are also under threat. The critical riparian areas of the Smoky/Wapiti and Upper Peace that are associated with streams of all sizes are highly disturbed. Invasive plant species coverage in riparian areas is surprisingly high — up to 30% in some areas. Smaller tributaries in areas with significant human footprints are in poor health. In many cases, fish populations are under stress, certain species are extirpated and lake and stream water quality are poor. As with many areas of the province, fish population densities in most monitored lakes, particularly for those with easy access, are low due to fishing pressure stress and loss or alteration of habitat.

Point sources of pollution from the Aquatera and Weyerhaeuser wastewater streams and non-point sources of pollution from the City of Grande Prairie have caused a slight reduction in water quality. Impacts from point sources of pollution have been a management priority for many years and those impacts have been kept to a minimum due to significant technological improvements over time. Non-point sources of pollution require some attention in the future.

Informed water and watershed management planning in the watershed remains a challenge. For one, a full accounting of water quantity is impossible due to a lack of data on groundwater resources. This is particularly important, as some freshwater aquifers appear to be under stress. Similarly, insufficient information is available on wetlands, and an accounting of wetland loss for the entire watershed and hotspots of highest loss is lacking. More studies are also needed on the extent of invasive species.

This report identifies the most vulnerable parts of the watershed — which areas should be examined more closely and which appropriate management actions considered. Just as watersheds change, so does our understanding, making a state of the watershed report part of a process, not an endpoint. The health of watersheds and the impact, sustainability and interaction of the activities within them should all be considered and updated regularly. Adopting this strategy can help managers plan for and adjust to changes (both good and bad) in the health and sustainability of a watershed.

Geography and Ecology of the Mighty Peace

Water

From its shores, the Peace River can seem limitless. The Mighty Peace, as it is known to many, is the largest river in Alberta, meandering nearly 2,000 kilometres from its source in the Rocky Mountains of British Columbia until it joins the Slave River near the Northwest Territories. At some points approaching two km in width, it drains nearly a third of Alberta, and contributes over 68 trillion litres of water annually to a river system that eventually flows into the Arctic Ocean.[1]

But just as the global supply of water remains constant, whether in the form of water vapour, ice, snow or rain, so the Peace is a finite resource. The world's need for freshwater will only grow with expanding populations and economies, as will the urgency for cooperative and effective water stewardship. Water management must take into account where the water is found, where it is needed, and who uses it, keeping in mind that:

- About 60% of the water flowing in Canada's rivers drains towards the north.
- Health problems related to water pollution in general are estimated to cost Canadians $300 million per year.
- Canada is estimated to have 20% of the world's freshwater — and 2.2% of Canada's freshwater is found in Alberta.
- More than 80% of Alberta's water supply is found in the northern part of the province, but 80% of the demand is in the south.
- The majority of Alberta's population and industries draw their water from surface water sources.
- Alberta has about 40,000 cubic kilometres (km^3) of groundwater — enough to cover the entire province in about 60 metres of water. But only 0.01% of this groundwater is thought to be recoverable.
- In many Alberta cities, water running off lawns, driveways, sidewalks, and streets into storm drains is not treated. Rain can wash fertilizers, oil, salt, and soap directly into local rivers and streams. These wastes harm aquatic ecosystems and water quality.[2]

Water for Life

Goals	Key Directions
Safe, secure drinking water	Knowledge and research
Healthy aquatic ecosystems	Partnerships
Reliable, quality water supplies for a sustainable economy	Water conservation

More information on Alberta's Water for Life strategy is available at **waterforlife.alberta.ca** and in Appendix 4.

A Shared Resource and a Shared Responsibility

In 2003, the Government of Alberta adopted a strategy to tackle some of these challenges. Known as *Water for Life,* its three goals and three key directions are an attempt to balance the social and economic needs of the people of Alberta with the need for environmental protection.

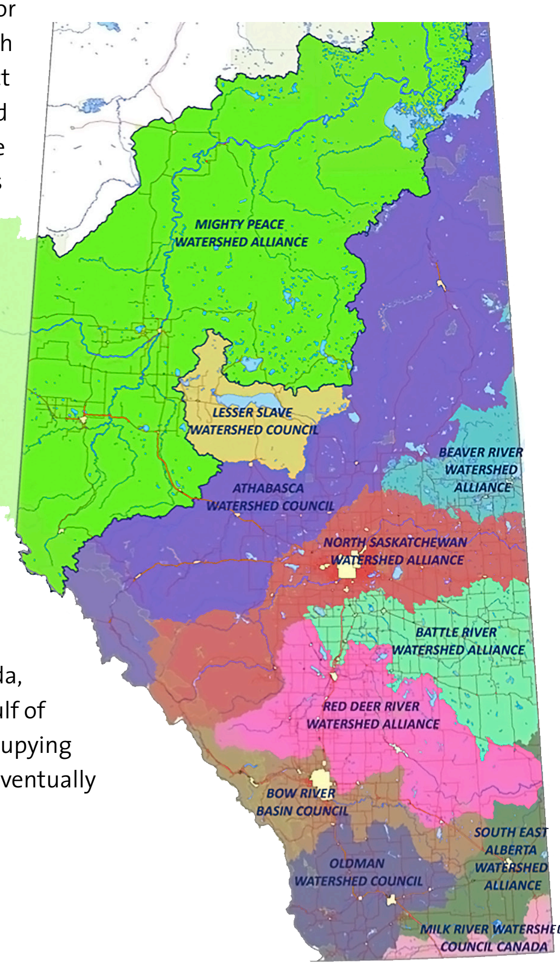
More about these watersheds: environment.alberta.ca/apps/basins

Watersheds

A Natural Management Approach

The Water for Life Strategy applies a natural organizing principle — the watershed — to managing the province's water. There are seven major river watersheds in Alberta: Hay, Peace/Slave, Athabasca, Beaver, North Saskatchewan, South Saskatchewan, and Milk, each with its own distinct water management challenges. Because those most affected by water-related challenges are often best equipped to find solutions, the Strategy called for the creation of 11 community-based Watershed Planning and Advisory Councils (WPACs — see map at right).

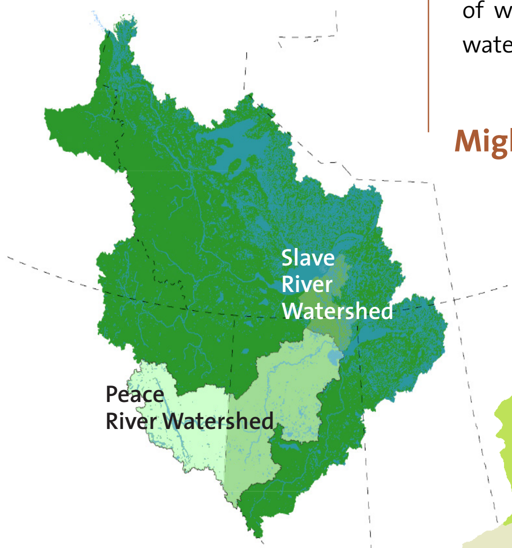
While final responsibility for implementing the Water for Life strategy rests with the Government of Alberta, the participation of citizens, communities, industries, non-governmental organizations and government is essential. The Mighty Peace Watershed Alliance is the designated WPAC for Alberta's portions of the Peace and Slave River watershed.



What is a Watershed?

A watershed channels water from precipitation, runoff and tributaries into a particular lake, river or set of rivers. Every creek, stream, river and lake in the drainage area, as well as all of the surface lands, is part of a watershed. Watersheds are separated by mountains, ridges and hills. The largest watersheds are often defined by the ocean into which they drain. In Canada, there are five main watersheds: Pacific Ocean, Hudson Bay, Atlantic Ocean, Gulf of Mexico, and Arctic Ocean. The Arctic watershed is the largest in Canada, occupying almost a fifth of the country. The Mackenzie, into which the Peace River eventually flows, is the main river.

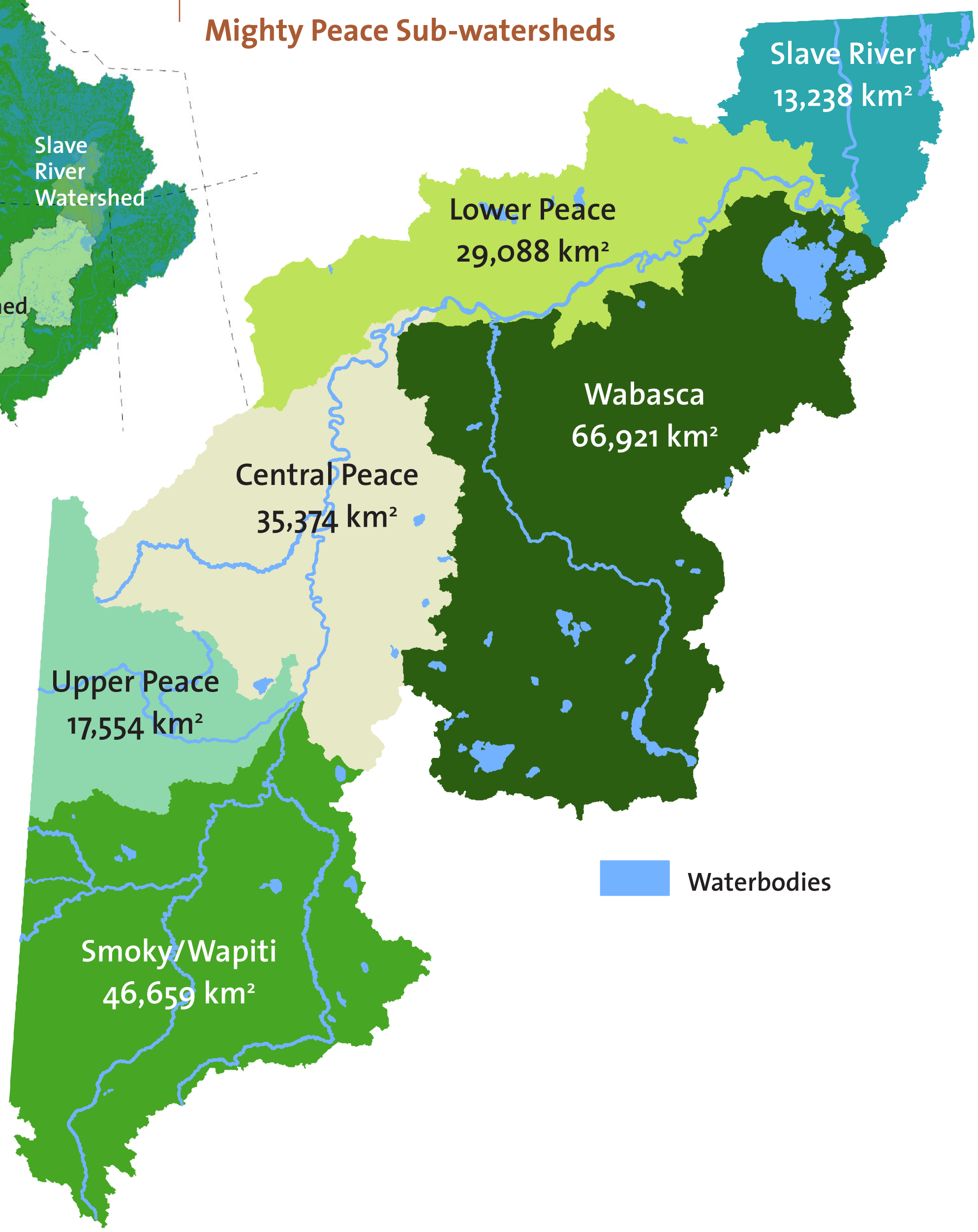
The Mackenzie Watershed



Watersheds within a watershed

Within each main watershed are many sub-watersheds, which in turn have their own sub-watersheds. The Mackenzie River has six main sub-watersheds, including the Peace and the Slave rivers. Within the Peace and Slave watershed are several major sub-watersheds, five of which are within Alberta. Three of them, the Upper, Central and Lower Peace sub-watersheds, all lie along the mainstem of the Peace. Two others are named for rivers that flow into the Peace, the Smoky/Wapiti and the Wabasca. The Slave River watershed, which adjoins the northern part of the Peace and Slave watershed, is a sub-watershed of the Great Slave River, but a portion lies within Alberta and is considered part of the Peace River watershed for the purposes of watershed planning. Together they are often referred to as the Mighty Peace watershed, which covers a total area of 208,834 km².

Mighty Peace Sub-watersheds



The Peace and Slave Watershed

The land cover of the Peace and Slave watershed is often described by the National Ecological Framework. The framework takes into account climate, landforms, soils and plants. Areas that contain similar associations of these components are grouped in progressively more detailed categories. The broadest is the Natural Region, which is sufficient to provide an overview of the character of the watershed.

The Mackenzie River

The longest river in Canada is the Mackenzie, which runs for more than 4,241 kilometres. It is the fourth-largest river system to flow into the Arctic Ocean, to which it discharges approximately 306 cubic kilometres of water each year and 100 million tons of sediment.

Natural Regions in the Peace and Slave Watershed

Boreal Forest: The Peace and Slave watershed is mostly boreal forest, also known as Taiga — a vast circumpolar zone characteristic of the northern latitudes. It varies greatly, but the dominant trees are cold-hardy pine, spruce, larch, aspen, poplar, fir and birch. It also features treeless areas, lakes and rivers, extensive wetlands and, in the drier areas, grasslands. Overlying formerly glaciated areas, the zone consists of extensive hills created by glacial moraines and lowland plains where glaciers deposited sands and gravels. The bedrock is typically deep, with outcrops only along major waterways that have eroded the overlying layers.

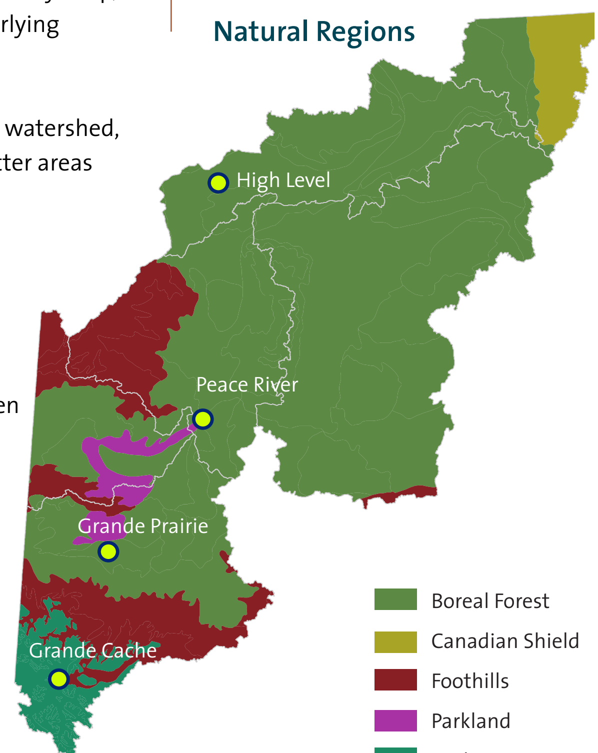
Canadian Shield: Restricted to the extreme northeastern part of the watershed, this consists of open forests of jack pine with black spruce in the wetter areas and outcroppings of granite bedrock.

Foothills: The lower slopes of the mountains are characterized by extensive forests, principally composed of lodgepole pine.

Parkland: Found only within a small portion of the Peace and Slave watershed, parklands are dominated by a mix of grasslands and aspen forests.

Rocky Mountains: Found only at higher elevations in the southwestern part of the watershed, this region is characterized by a mix of closed forests and vegetated areas, bare rock and, above the tree line, glaciers. The headwaters of many streams and rivers begin here.

Natural Regions



Alberta's Boreal Forest

- *Covers 465,000 km² (115 million acres, which is larger than Sweden).*
- *Comprises 8% of Canada's Boreal Forest.*
- *Stores 14 billion tonnes of carbon in its soils, peat and forests – an amount equivalent to 72 years of Canada's annual carbon emissions.*
- *Wetland-rich, supporting more than 3 million waterfowl annually.*
- *Home to Wood Buffalo National Park and the Peace-Athabasca Delta.*[3]

Wood Buffalo National Park

Wood Buffalo National Park, a United Nations Educational, Scientific and Cultural Organization (UNESCO) World Heritage Site, lies partly within the Peace and Slave watershed. It is home to the largest population of wild bison in North America and is the natural nesting place of the whooping crane.

Disturbance is a critical but normal component throughout the ecoregions of the Mighty Peace. Fire, insects, wildlife, ice storms and disease all play roles in the process. A functioning watershed is resilient and able to respond and adapt. The current state of the watershed cannot be compared to an ideal or static state but it is possible to gauge whether any element is within the natural range of variation. The concept of a natural range of variation should be considered when choosing the indicators to describe the health of a watershed.

The Peace-Athabasca Delta

- Approximately 3,820 km^2 in size, in the southeast corner of Wood Buffalo National Park.
- Includes three river deltas, four large freshwater lakes and rich growths of aquatic vegetation.
- One of the continent's last relatively undisturbed deltas.
- A product of periodic flooding.
- One of the most important nesting, resting and feeding areas for numerous species of water birds and a key link in four major flyways for migratory birds.
- Plays host to 400,000 birds during spring migration, and more than a million in the fall. The Delta meadows provide grazing for several hundred free-roaming bison, one of 44 mammal species recorded.
- A wetland of global importance, also known as a Ramsar site.[4]

The Peace and Slave Rivers

The waters of the Peace River begin as streams in the watersheds of the Finlay and Parsnip rivers of the Rocky Mountains of British Columbia and then flow into Williston Lake, the large reservoir created in 1967 to supply the WAC Bennett hydroelectric dam. From there, the Peace flows into Dinosaur Lake, the reservoir feeding the Peace Canyon dam. Below the Peace Canyon Dam, the Beatton and East Pine rivers join the Peace and, approximately 25 km farther downstream, the Peace River enters Alberta.

The Smoky River, with headwaters near Mount Robson in the Rocky Mountains, is a major tributary of the Peace River, flowing into the Peace near the Town of Peace River. The Smoky drains the Wapiti River, Little Smoky River, and a number of smaller rivers. The headwaters of the Wapiti also originate in the Rocky Mountains.

The Cadotte River empties into the Peace from the east downstream of the Town of Peace River, followed by the Notikewin, the Buffalo, and the Boyer. Nearly 500 km from the Town of Peace River, and downstream of the hamlet of Fort Vermilion, the Wabasca River enters the Peace. Next the Mikkwa joins the Peace, and then the Wentzel, which flows into the Peace just downstream of Fox Lake. The Peace then enters Wood Buffalo National Park and another 311 km downstream comes to Peace Point.

The river then passes Carlson Landing before reaching the junction with the Rivière des Rochers, which is one of the main channels for water from the Athabasca watershed and the Peace-Athabasca Delta. The Slave River begins at this point, flowing north into the Northwest Territories downstream of Fitzgerald. More than 300 km later, it reaches Great Slave Lake, which eventually drains into the Arctic Ocean down the Mackenzie River.

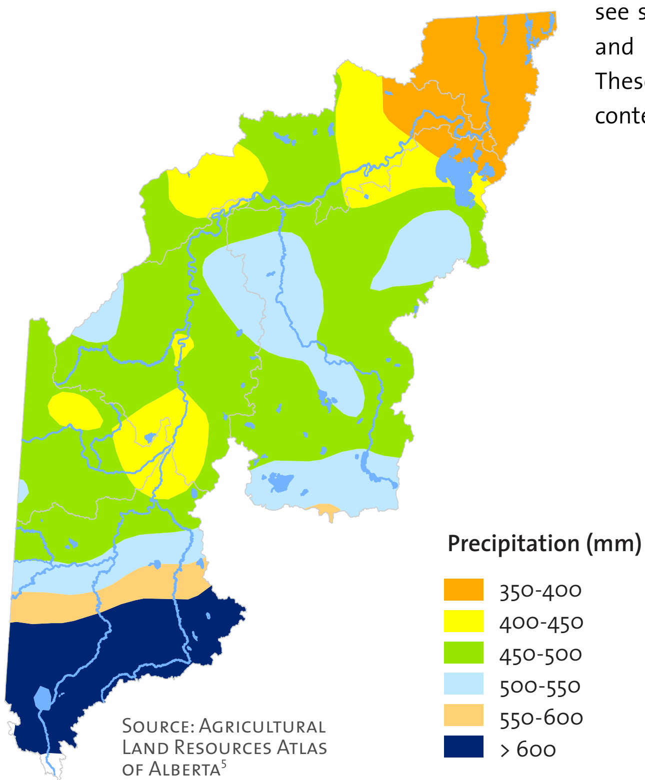
For more details, see page 15.

Climate

From its most southerly tip in the mountains to its northernmost extent, the Mighty Peace watershed spans nearly seven degrees of latitude, so it is not surprising that the climate varies. Summers tend to be cool and short and the winters long and cold across most of the watershed, but slightly warmer and more humid conditions can be found along some stretches of the Peace River. The northern regions enjoy long summer days, with enough sunshine for those areas to comprise the most northerly agricultural region in Canada. Precipitation is greatest at the higher elevations in the south, with less falling in the northeast.

Climate Change

It is generally accepted that global climate change will bring major changes to the hydrological cycle, with temperature changes the most pronounced in high latitudes. The entire watershed will likely see significant changes in water quantity and quality and seasonal flow patterns. These should be considered within the context of planning for future needs.



Source: Agricultural Land Resources Atlas of Alberta[5]

Water and Climate

Weather and climate are to a large extent determined by water. For example, the Mackenzie River and its tributaries, which run through parts of five Canadian provinces and territories, have often been described as a massive global air conditioning system.

People

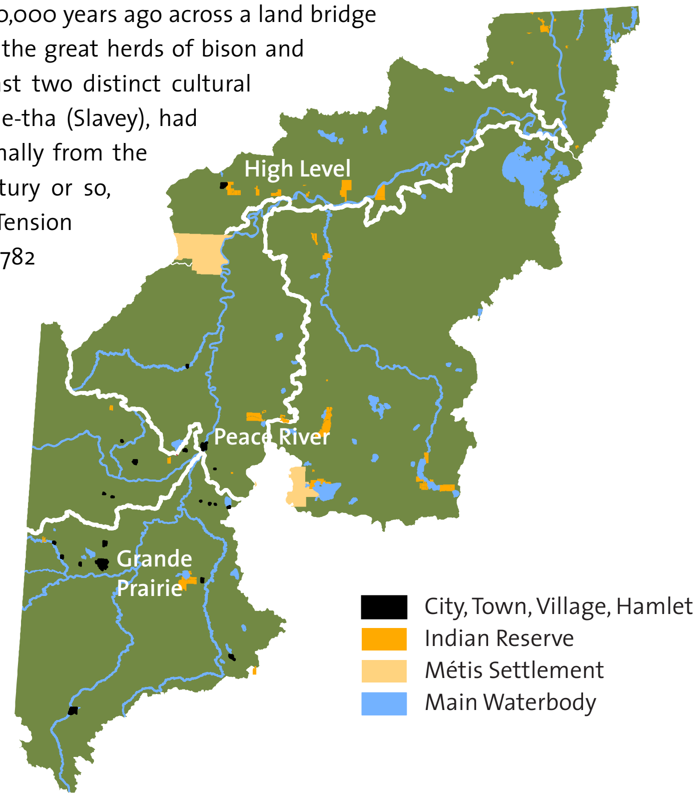
The first humans arrived in the Peace River region more than 10,000 years ago across a land bridge between Asia and North America. It is thought they followed the great herds of bison and other grazing animals. By the time Europeans arrived, at least two distinct cultural groups, the Athapaskan-speaking Dunne-za (Beaver) and Dene-tha (Slavey), had been living in the area for generations. Woodland Cree, originally from the Hudson Bay region, moved into the area over the next century or so, working as trappers and middlemen for European fur traders. Tension between the Cree and Beaver were reportedly settled around 1782 at Peace Point in what is now Wood Buffalo National Park. The "River of Beavers" that divided their territories became known as "Unchaga," the Beaver word for Peace. Today that river's watershed is known as the Peace River Country.[6]

By 1788, both Fort Vermilion and Fort Chipewyan, the two oldest European settlements in Alberta, were attracting fur traders. This was accompanied by a growing number of children born of Indian mothers and fur-trading fathers. They would become the Métis Nation in Northern Alberta.[7]

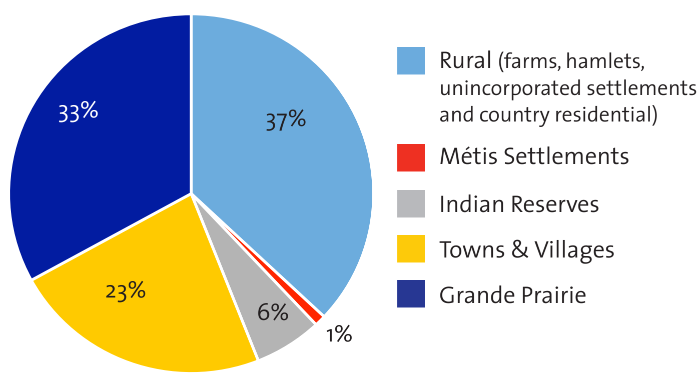
Missionaries followed the fur trade as it expanded westward, building churches and schools. In the late 1800s and early 1900s, treaties established Aboriginal reserves and provincial statutes established Métis settlements. Gold-seekers and European settlers opened up land for homesteading, using steamboats on the river, and building networks of roads and railways.[8]

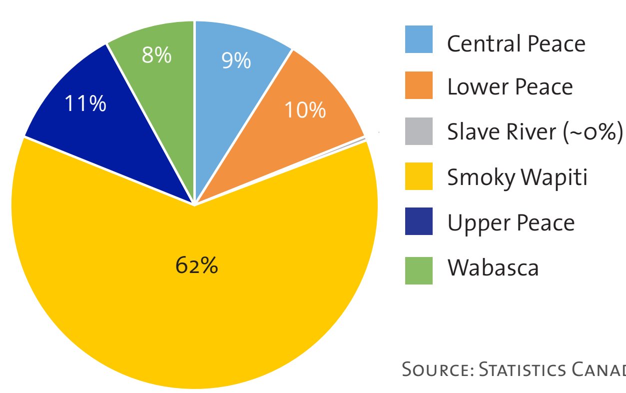
According to the 2011 census, some 165,000 people live in the watershed. Grande Prairie, with a population of slightly more than 55,000, is the only city in the watershed and ranks as one of the fastest-growing municipalities in the province. Towns, villages, hamlets, First Nations reserves and Métis settlements are scattered throughout the watershed. For a more detailed look at population distribution, see Appendix 1 beginning on page 44.

Many people in the region are employed by resource-based industries, including agriculture, conventional and in situ oil and gas, forestry, mining (aggregate and coal), tourism, and recreation. The combined effects of water use, infrastructure needs, agriculture, industry, forestry, and resource extraction impose stresses on the water, the lands and the ecosystem. Measuring, evaluating and comparing stresses and understanding how they interact will be an ongoing challenge.



Where People Live





Source: Statistics Canada

Get to Know the Mighty Peace Watershed

Peace River headwaters, now Williston Lake (1), which was created in 1967 to power the new WAC Bennett Dam (2).
Peace Canyon dam (3).
Beatton (4) and East Pine Rivers (5), two major tributaries in B.C.
Peace River enters Alberta (6), bringing in approximately 48.6 billion m^3 of water each year (roughly 3 times the combined amount of all of the rivers in southern Alberta).

Major Tributaries

Little Smoky River (7)
Wapiti River (8)
Smoky River (9) (contributes approximately 11 billion m^3 water annually)
Cadotte River (10)
Notikewin River (11)
Buffalo River (12)
Boyer River (13)
Wabasca River (14)
Mikkwa River (15)
Wentzel River (16)
Rivière des Rochers (17)
Slave River (18), which flows into the Northwest Territories then Great Slave Lake, the Mackenzie River and, finally, the Arctic Ocean

Key Points in Time

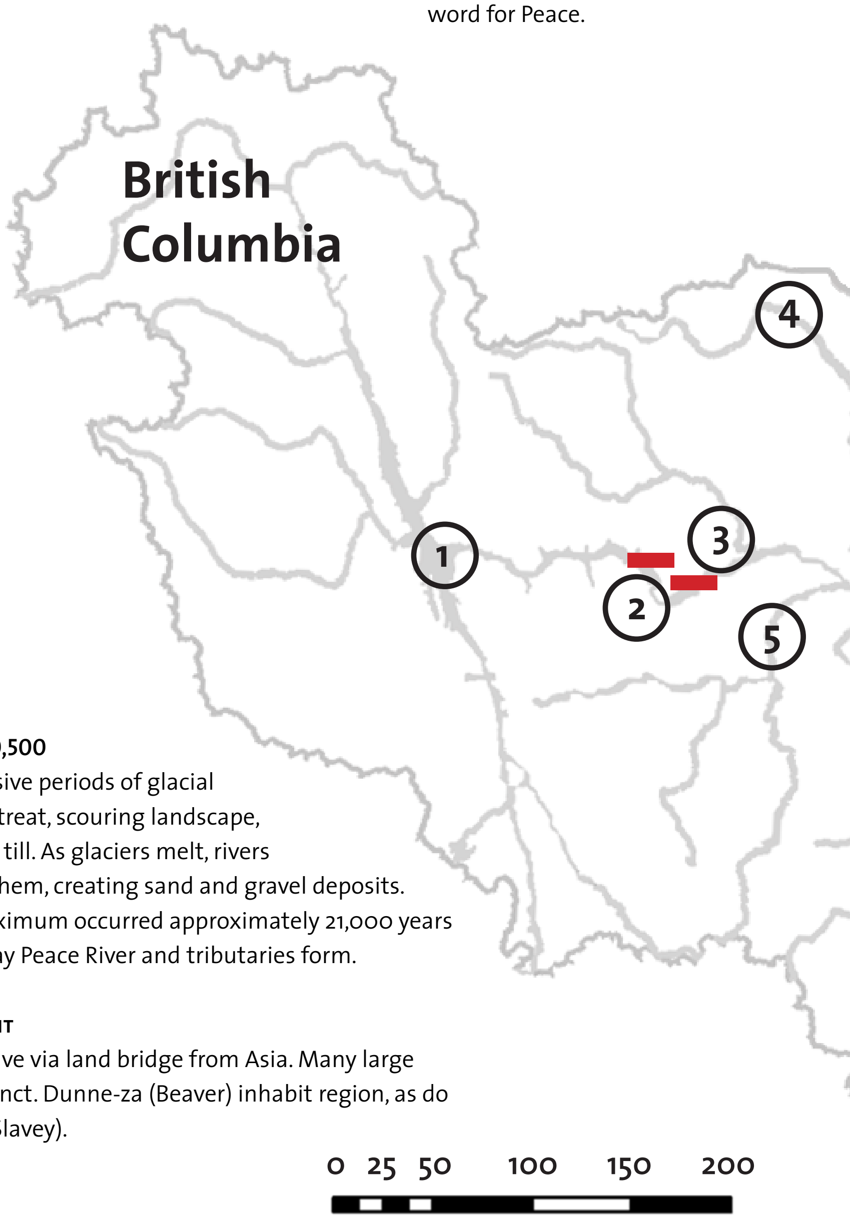
1785 (approx)
Beaver and Cree reputedly negotiate peace at Peace Point. River becomes known as "Unchaga," the Beaver word for Peace.

What Shaped the Land

145 – 2.5 Million (years before present)
Climate warm. Dinosaurs, marine animals and primitive plants the dominant life forms. Entire region frequently covered by a great inland sea. Bedrock and major hydrocarbon deposits created. Coal beds formed. Mountains rise to the west, changing drainage patterns from west to north. Rocky Mountains rise, major land forms established. Dinosaurs disappear, mammals, birds, insects and flowering plants dominate. Mastodons, sabre-toothed cats and giant bears are common, followed by horses, bison, mammoths, wapiti and camels as the climate becomes cooler and drier.

2.5 million – 10,500
Ice Age. Successive periods of glacial advance and retreat, scouring landscape, creating glacial till. As glaciers melt, rivers form beneath them, creating sand and gravel deposits. Last glacial maximum occurred approximately 21,000 years ago. Modern-day Peace River and tributaries form.

10,500 – Present
First people arrive via land bridge from Asia. Many large animals go extinct. Dunne-za (Beaver) inhabit region, as do the Dene-tha (Slavey).

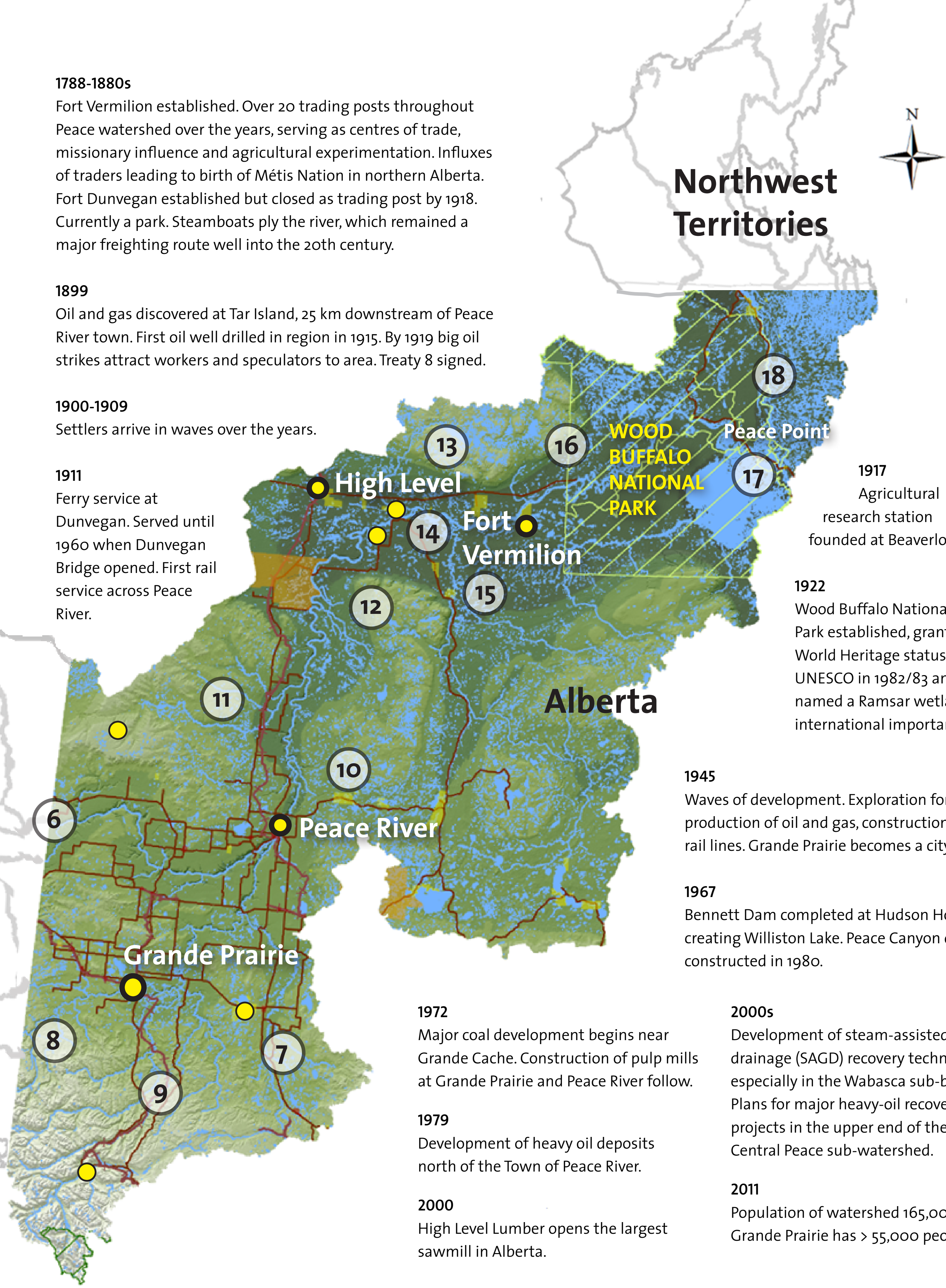


1788-1880s
Fort Vermilion established. Over 20 trading posts throughout Peace watershed over the years, serving as centres of trade, missionary influence and agricultural experimentation. Influxes of traders leading to birth of Métis Nation in northern Alberta. Fort Dunvegan established but closed as trading post by 1918. Currently a park. Steamboats ply the river, which remained a major freighting route well into the 20th century.

1899
Oil and gas discovered at Tar Island, 25 km downstream of Peace River town. First oil well drilled in region in 1915. By 1919 big oil strikes attract workers and speculators to area. Treaty 8 signed.

1900-1909
Settlers arrive in waves over the years.

1911
Ferry service at Dunvegan. Served until 1960 when Dunvegan Bridge opened. First rail service across Peace River.



1917
Agricultural research station founded at Beaverlodge.

1922
Wood Buffalo National Park established, granted World Heritage status by UNESCO in 1982/83 and named a Ramsar wetland of international importance.

1945
Waves of development. Exploration for and production of oil and gas, construction of roads, rail lines. Grande Prairie becomes a city in 1958.

1967
Bennett Dam completed at Hudson Hope creating Williston Lake. Peace Canyon dam constructed in 1980.

1972
Major coal development begins near Grande Cache. Construction of pulp mills at Grande Prairie and Peace River follow.

1979
Development of heavy oil deposits north of the Town of Peace River.

2000
High Level Lumber opens the largest sawmill in Alberta.

2000s
Development of steam-assisted gravity drainage (SAGD) recovery technology, especially in the Wabasca sub-basin. Plans for major heavy-oil recovery projects in the upper end of the Central Peace sub-watershed.

2011
Population of watershed 165,000. Grande Prairie has > 55,000 people.

The Indicators

Introduction

The MPWA commissioned three technical reports and a directory on the aquatic ecosystems, and water quantity and quality, of the Mighty Peace watershed. The reports identify knowledge and information gaps to help focus future work. The Alliance held 22 open houses to survey stakeholder opinions and knowledge about water-related issues in the area. Participation rates were insufficient to make the survey's findings comprehensive. But common concerns included the availability and security of drinking water, ecosystem health, and the industrial use of water. Stakeholders also expressed interest in the impacts of dams on the Peace, the effects of agricultural runoff and forestry practices, and the treatment of industrial effluent. The open houses supported two key goals of reporting on the state of the watershed: increasing awareness of conditions in the watershed and inspiring participation.

On the basis of the technical reports and the public input, the MPWA used indicators that are:

- relevant to the watershed and the people associated with it;
- align with their goals, vision and mission statement;
- measurable according to similar standards at future dates;
- accessible in terms of data availability;
- applicable at various scales of watershed; and
- likely to contribute to a basic understanding of watershed health.

The indicators fall into six main categories: Landscape, Biological Community, Surface Water Quantity, Surface Water Quality, Groundwater Quantity, and Groundwater Quality.

Stay Informed About the Work of the MPWA

To learn more about the science behind this report, or sign up for the MPWA newsletter, please visit the website of the Mighty Peace Watershed Alliance at: mightypeacewatershedalliance.org *or call the staff at the MPWA office: (780) 324-3355.*

Landscape

Land Cover

Many variables can reflect changes in land cover. This section looks at the status of wetland and riparian areas.

Wetland Area

Wetlands provide many cultural and ecological benefits. They supply food and recreational opportunities, and fulfill spiritual and inspirational needs. They store water, mitigate floods and droughts, moderate water flow, stabilize shorelines, and discharge and recharge groundwater. Moreover, wetlands play a critical role in water purification, especially those that contain herbaceous plant species such as cattails (*Typha latifolia*), sedges (*Carex* spp.) and bulrushes (*Schoenoplectus* spp.).

Wetlands also moderate weather and climate, and process and store greenhouse gases. The accumulation of carbon in bog and fen sediments is of global importance. Wetlands' high biological productivity and aquatic components provide diverse wildlife habitats. In northern Alberta, wetlands provide key rearing and overwintering habitat for fish and are primary habitats for birds, amphibians, beavers, mink, muskrats, otters and plants. Wetlands provide important supplementary habitat for moose, caribou, and songbirds.

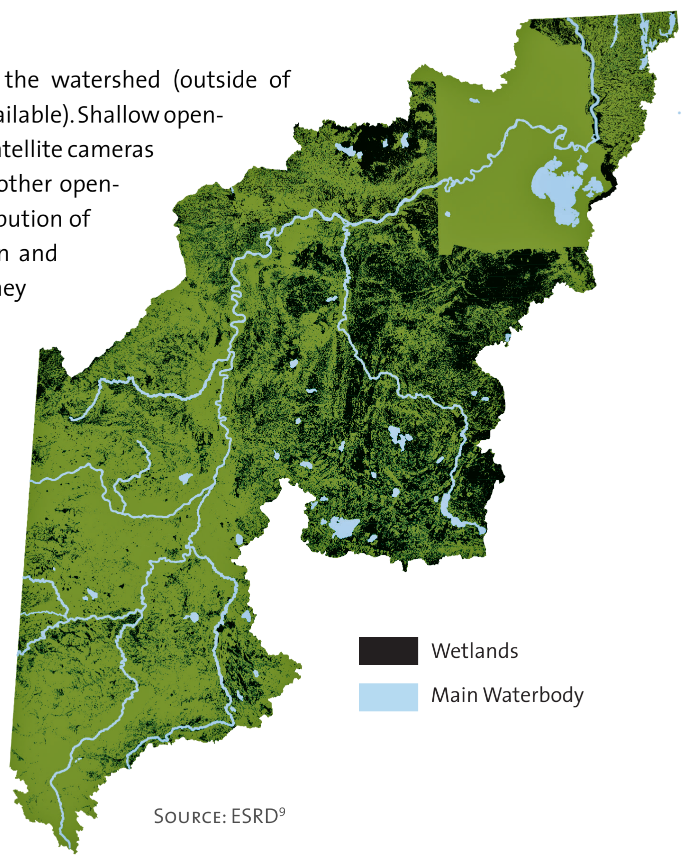
Measuring wetlands repeatedly over time can identify changes to local hydrological patterns and water quality. Unfortunately, few measurements exist in the Mighty Peace watershed that could indicate how much wetland area has been converted from its natural state. The baseline information in this report should serve as a monitoring tool for the future.

INFO GAP

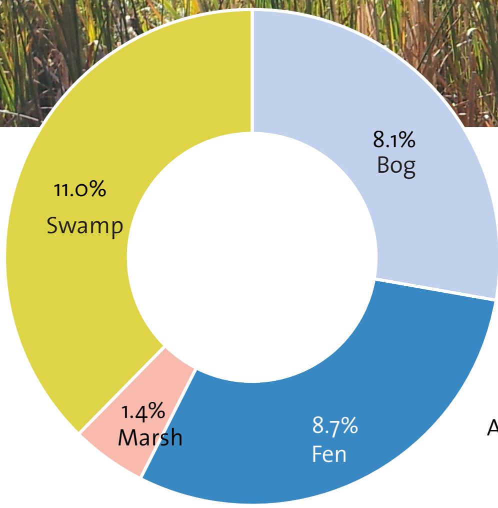
Wetland data for Wood Buffalo National Park

Wetlands

Wetlands cover nearly 30% (52,898 km²) of the watershed (outside of national parks, for which information was unavailable). Shallow open-water areas are also not covered, because the satellite cameras used cannot differentiate between lakes and other open-water areas. The map at right shows the distribution of wetlands across the watershed. The mountain and foothills regions have few wetlands because they are steep enough that surface water tends to drain off. The less well-drained flatlands have more wetlands. The extent of wetland area is a reflection of the natural land cover and land use. The regions with high coverage of wetlands correspond with extensive boreal forest areas and little human activity.



SOURCE: ESRD[9]



Source: ESRD[10]

Wetlands Types

Not all wetlands perform the same function. Different wetlands provide habitat for different species, with marshes tending to have a greater diversity of wildlife. And although all wetlands act as carbon sinks, bogs and fens can sequester carbon for longer than marshes and swamps. The figure at left provides the percentage of each type of wetland within the entire watershed. Combined, all four classes of wetlands cover just over 29% of the watershed. For more details on each type of wetland, see Appendix 4.

Typha: "of the bog"

*Although forests tend to receive most of the credit for storing atmospheric carbon dioxide (a greenhouse gas), the common cattail (*Typha latifolia*) does all that and more. Too often the casualties of drainage and cultivation practices, cattails also provide shoreline stability and food and habitat for wildlife. They remove nitrogen and phosphorus from water and can absorb cadmium, mercury and lead. Typha is of tremendous historical importance to humans – every part of this plant has a use: as food, fibre or medicine. For many Native North Americans, Typha represented peace and prosperity, and was used for ceremonial and religious purposes.*

Riparian Health

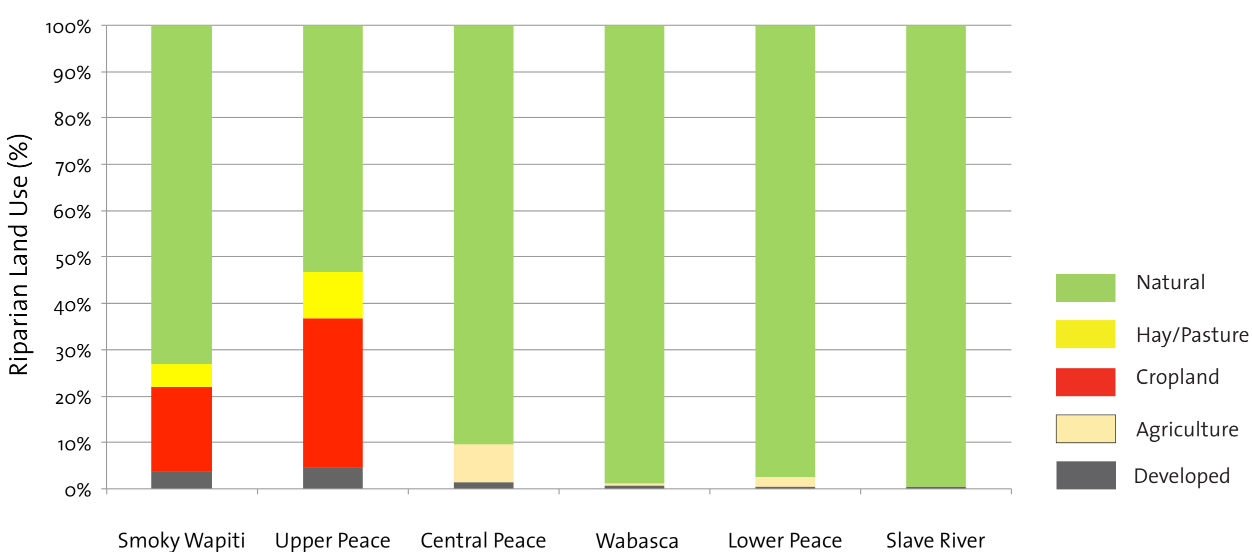
Riparian areas are the lush, highly diverse and productive areas that border rivers, streams, lakes and wetlands. They serve as traditional buffers between the aquatic area and the terrestrial, or upland, region. Healthy riparian areas:

- Trap and store sediment;
- Build and maintain banks and shores;
- Store water and energy;
- Recharge aquifers;
- Filter and buffer water; and
- Maintain biodiversity.[11]

The health of riparian areas is largely determined by human disturbance. Measuring these impacts is expensive and time-consuming and is usually only performed for small areas. In the Mighty Peace watershed, the Alberta Habitat Management Society (popularly known as Cows and Fish) has completed various riparian health assessments, but only for small portions of the watershed. The results cannot be used to draw conclusions about the whole watershed.[12]

Computer mapping and a combination of datasets selected for their compatibility were used to estimate riparian land cover in the sub-watersheds chart below. The land cover in riparian areas associated with streams varied, ranging from 53% to 100% natural within the sub-watersheds. Areas with the greatest natural cover — such as the Slave River — have low levels of disturbance and high forest cover. In the Smoky/Wapiti and Upper Peace sub-watersheds, both agriculture and development are widespread, and riparian areas have less natural cover.

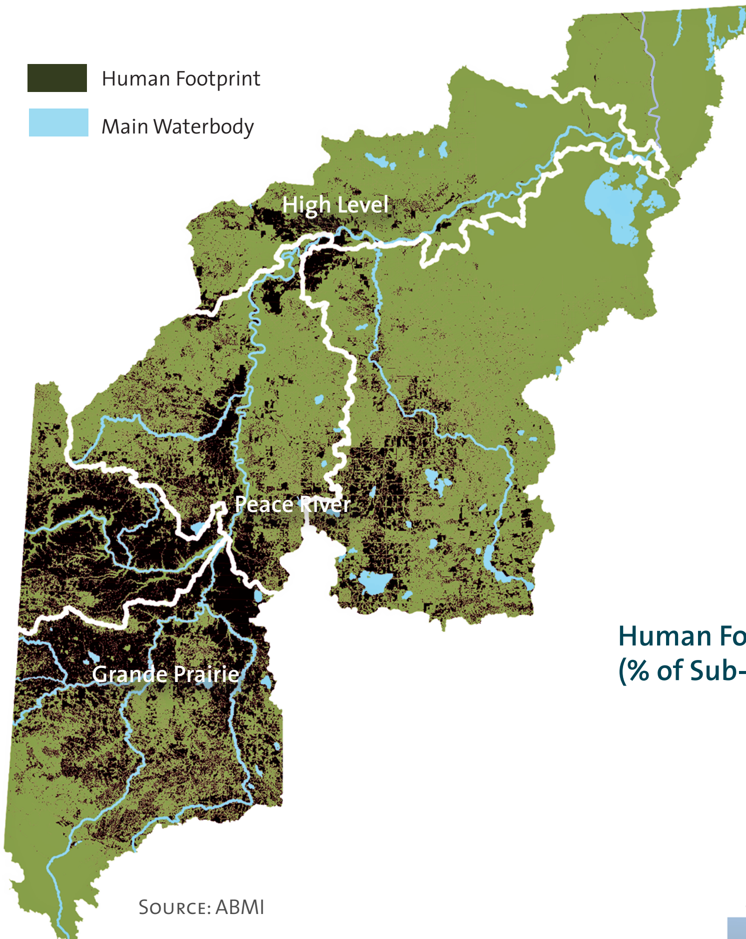
Land Cover in Riparian Areas[13]



Land Use

Human influence on watersheds can be measured using an index developed by the Alberta Biodiversity Monitoring Institute called the Human Footprint. The index combines data on several variables to identify the extent of the impact. By updating the index over time, researchers can spot trends and identify ways to mitigate undesirable impacts through management plans and practices.[14]

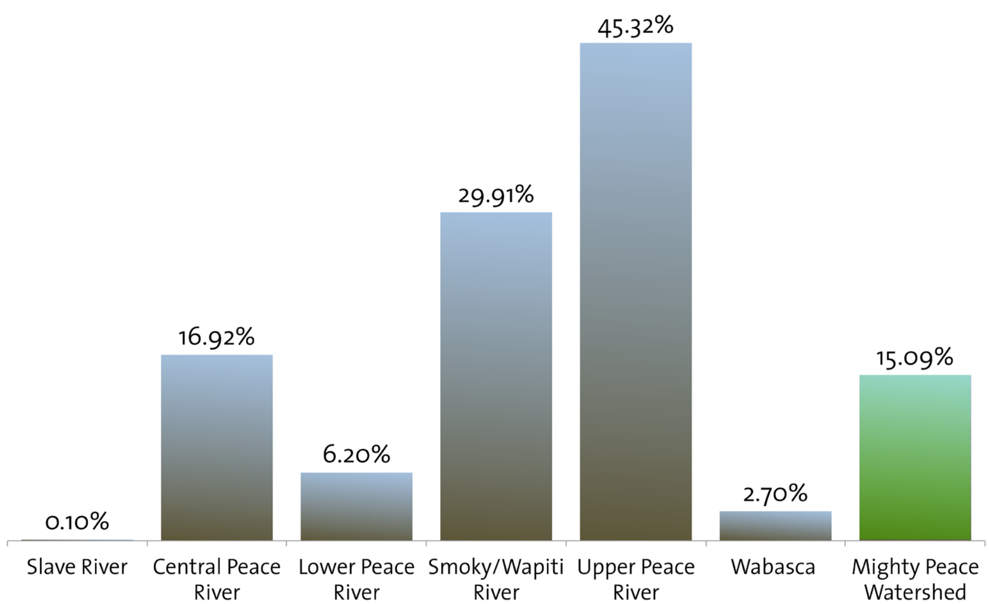
According to the Human Footprint from 2010, the Peace and Slave watershed is largely undisturbed. The Human Footprint covers only about 15% of the entire watershed (31,534 km²), although most of this disturbance is concentrated in the Upper Peace and Smoky/Wapiti sub-watersheds.



Source: ABMI

Agriculture is the primary contributor to the Human Footprint in the watershed. It plays a major role in the watershed's economy and is expected to expand with growing populations. Agricultural practices and impacts vary from one farm to another. In combination, these impacts can have a greater impact on the overall health of the watershed. Farm managers and watershed planners can ensure agricultural and ecosystem sustainability by employing best practices consistent with the Water for Life goals.

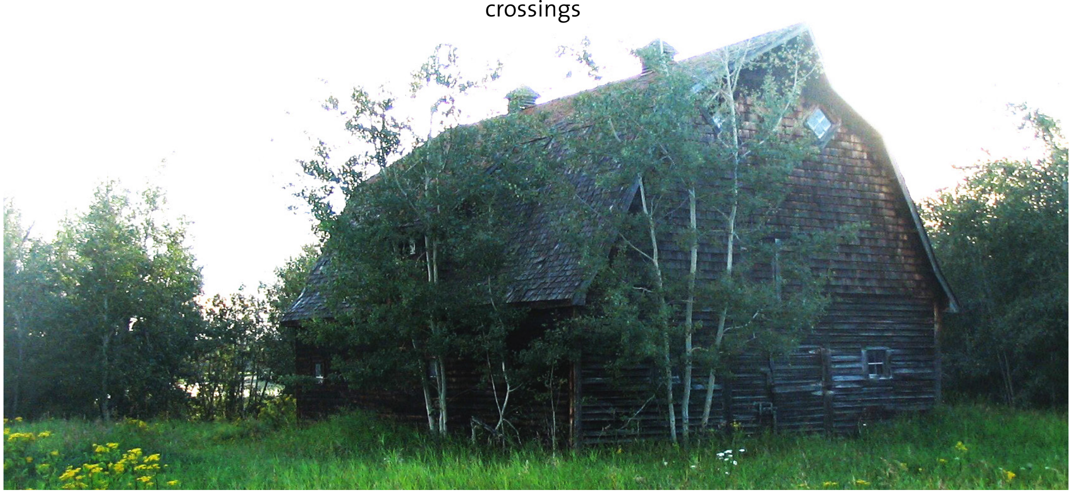
Human Footprint (HFP) in Each Sub-watershed (% of Sub-Watershed Affected)



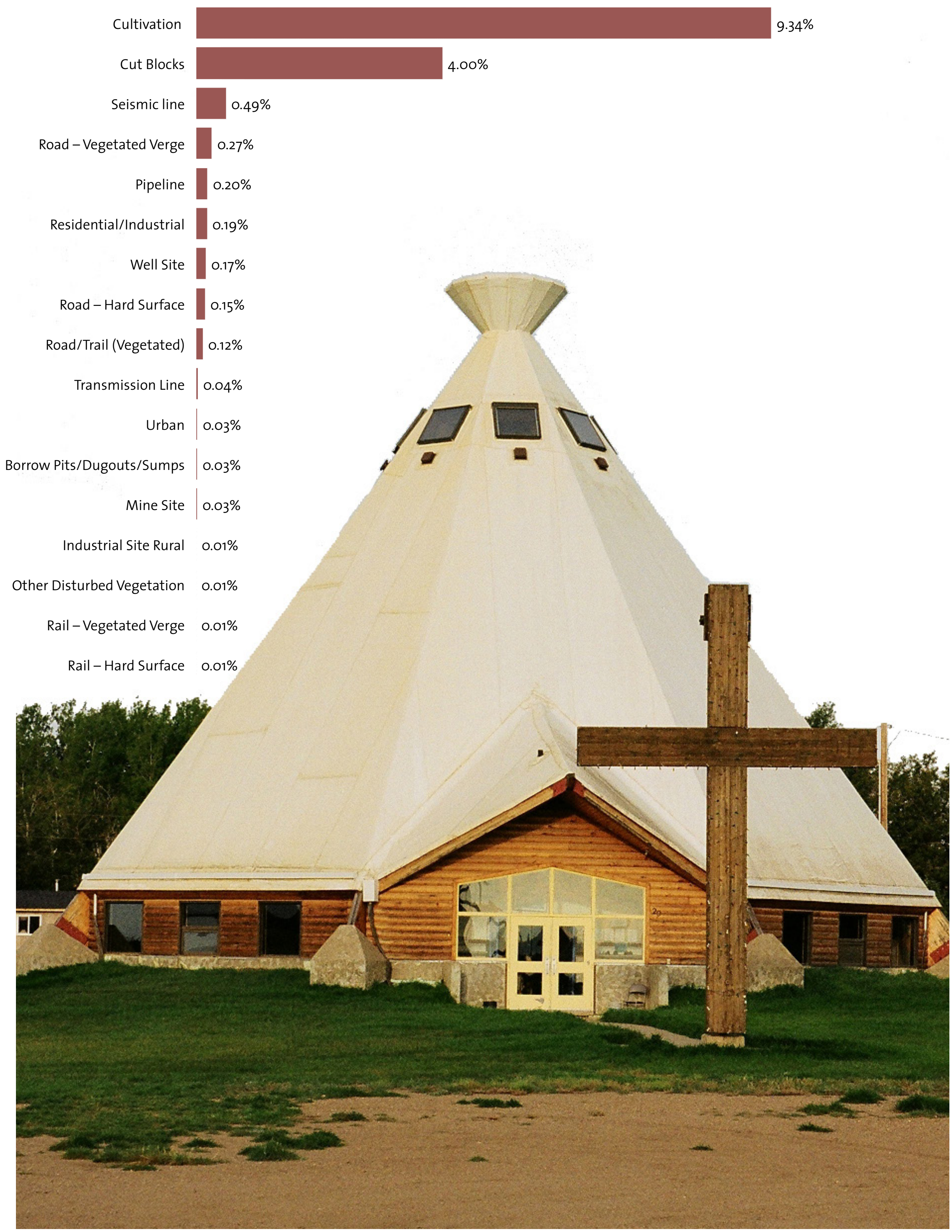
Source: ABMI

SAMPLE USES, IMPACTS, CAUSES AND POLLUTANTS/AFFECTED WATER QUALITY COMPONENTS

	IMPACTS	CAUSES	POLLUTANTS
Agriculture	• land disturbance • animal and plant wastes • substances applied to enhance production such as manure, chemical fertilizers and pesticides	• poorly located or managed animal feeding operations • overgrazing • tilling too often or at the wrong time • improper, excessive, or poorly timed application of pesticides, irrigation water, and fertilizer	• sediment • nutrients • bacteria • pesticides • metals • salts
Forestry	• increased run-off • increased sedimentation	• land disturbance • road construction and use; heavy equipment operation	• substances applied to enhance production (pesticides)
Mining	• Point source pollution	• run-off from mine sites/ settling ponds • land disturbance	• specific to mine but can include pH (from acid mine drainage) • total suspended solids and associated metals • total dissolved solids • nitrogen, selenium
Built-up Areas	• erosion • pollution into storm sewers or directly to lake, stream, river or wetland	• concentrated flow at discharge from storm sewers • pollutants picked up by run-off	• sediment • nutrients, bacteria • hazardous wastes such as pesticides, solvents, motor oil • higher water temps
Oil and Gas	• soil erosion • contamination of groundwater • point-source pollution	• heavy machinery use • saltwater injection wells or disposal wells • spills from roads, well sites, and exploration	• oil and oil by-products • gas and gas by-products
Recreation	• trail damage • erosion of soil • sedimentation of stream beds • risk to fish	• increased and/or unregulated access to wilderness areas due to infrastructure development • motorized vehicles • increased stream crossings	• Solvents, and motor oil from boats and quads, litter, total disolved solids (sediments)



Human Footprint by Category in the Mighty Peace Watershed (% of watershed affected). Total affected area in watershed is 15.1%



Biological Community

Wildlife

While a complete biological inventory of the watershed is unfeasible, fish act as a useful indicator of aquatic ecosystem health. Fish are valuable to people, sensitive to disturbance, and often have a recorded history. They are sensitive to the quality and quantity of water in rivers and streams. They can be affected by harmful substances and by the habitat fragmentation that results from removing vegetation along waterways or building stream crossings and water-control structures. Comparing the density of sensitive fish species between sub-watersheds can help managers prioritize conservation activities.

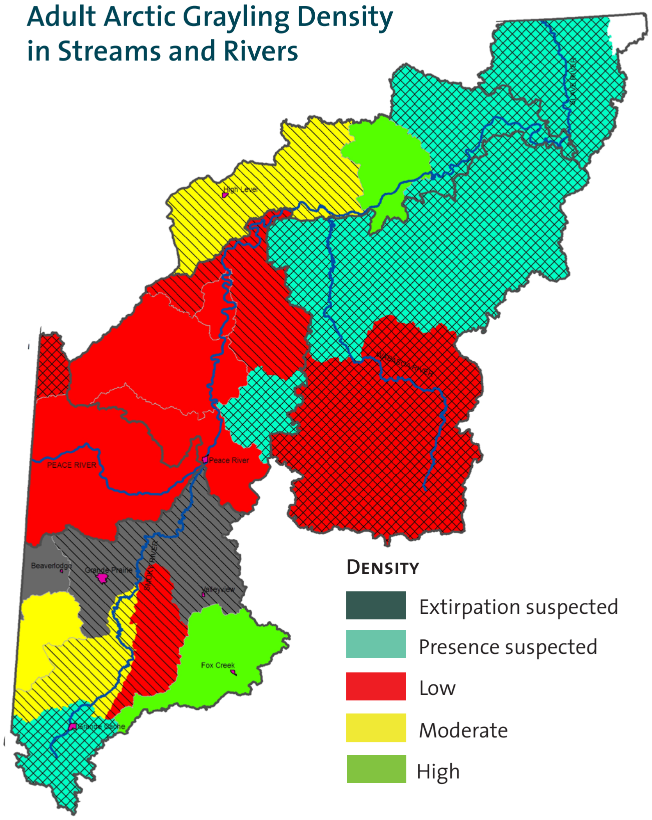
The densities of two species sensitive to human activities, arctic grayling and walleye, suggest populations in the Peace River are relatively healthy. They are also healthy in the larger tributaries, such as the Smoky, Little Smoky, and Wabasca rivers. Densities in smaller tributaries, where fish are strongly affected by land use, are moderate to low. In spite of human land use, arctic grayling continues to occur in moderate to high densities in the Little Smoky River, most likely due to fishery restrictions. However, densities are low to moderate where cumulative land uses have caused declines in spite of fishery restrictions. Local extirpations of arctic grayling have occurred in highly developed areas adjacent to the City of Grande Prairie, in the Beaverlodge River system, and next to the Town of Peace River, in the Heart River system.

Fish populations in some lakes are under stress from fishing, loss or alteration of habitat, and lack of oxygen resulting from nutrient loading. Population status in lakes is typically correlated with proximity to urban development (representing fishing pressure) and surrounding land use. The following two figures are from *Peace & Slave State of the Watershed Aquatic Ecosystems* (February 2014) . White areas indicate no data.

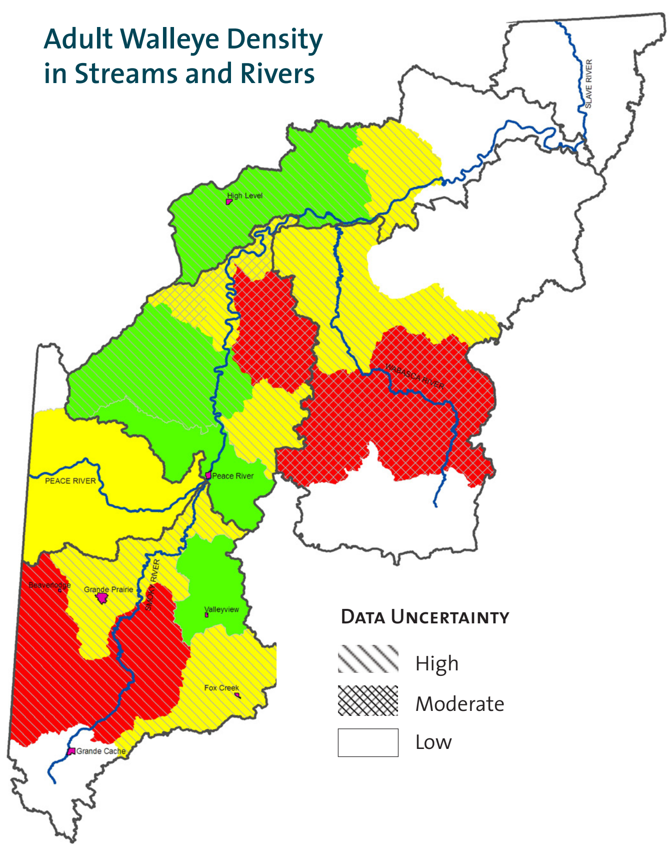
Arctic grayling

Walleye

Adult Arctic Grayling Density in Streams and Rivers



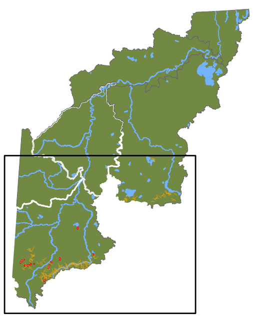
Adult Walleye Density in Streams and Rivers

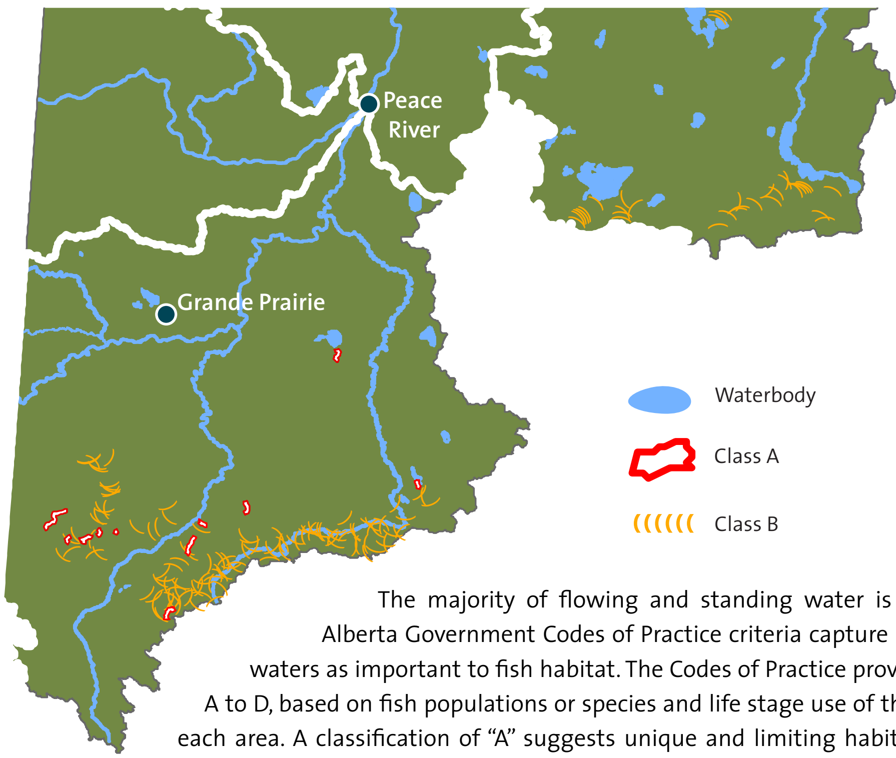


Estimated Densities of Adult Walleye

Sub-Basin	Lake	Density	Data Uncertainty
Smoky/Wapiti	Snipe	Low	Low
	Iosegun	Moderate	Low
	Smoke, Sturgeon	High	Low
Wabasca	Loon, Vandersteen	Low	High
	Wadlin	Low	Moderate
	Gods, South Wabasca	Low	Low
	Utikuma	Low	Low
	Peerless	Moderate	High
	Graham	Moderate	Low
	North Wabasca, Round	Moderate	Low
	Utikumasis	Moderate	Low
Central Peace	Sawn	Low	Low
	Haig	High	Low
Lower Peace	Wentzel	Low	High
	Caribou	Moderate	High

Class A and B fish habitat areas





Source: ESRD Code of Practice for Watercourse Crossings

The majority of flowing and standing water is fish habitat. The Alberta Government Codes of Practice criteria capture and classify these waters as important to fish habitat. The Codes of Practice provide rankings from A to D, based on fish populations or species and life stage use of the habitats within each area. A classification of "A" suggests unique and limiting habitat and prescribes restrictions on many activities, while "D" acknowledges that habitat is present but restrictions are not necessary. In specific cases, some flowing waters with recognized water allocation pressures may determine minimum flows to protect fish populations.[15] The map above shows the distribution of class A and B fish habitat areas, as mapping all fish habitat is impractical at this scale.

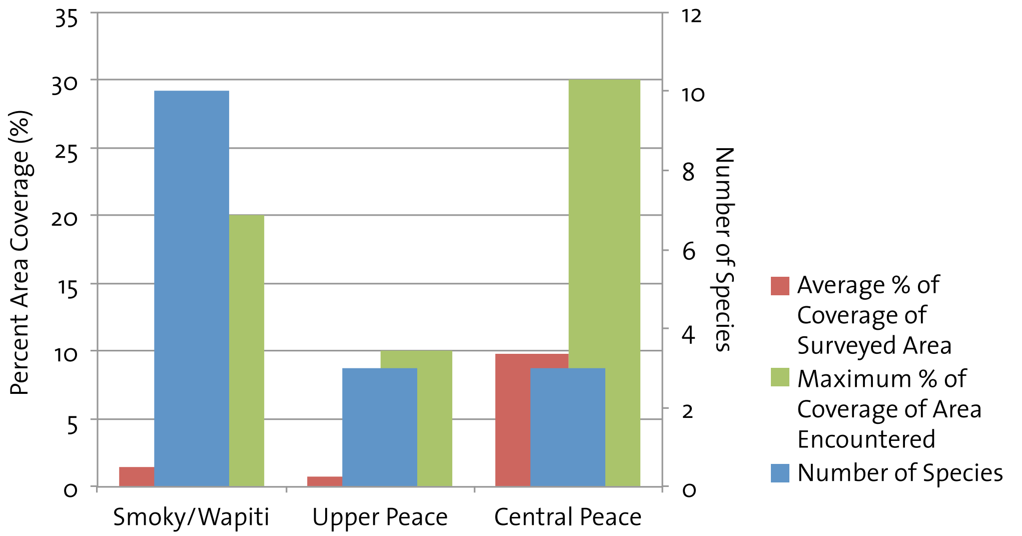
Invasives

Invasives, also often called exotic species, are plants and animals that evolved elsewhere but thrive in their new environment. They can feed on native species, or take over their habitat and cause local extirpations. Not only do invasives affect native flora and fauna, but they can have economic costs. For example, crops may require expensive applications of herbicides to kill invasive weeds. Herbicide use also increases the risk of contaminated waterways. Governments and stewardship organizations monitor and control invasives, but it is a challenging task, and data are sparse.

This section addresses only invasive species in waterways, wetlands and riparian areas. Findings from stewardship groups and government monitoring agencies are included. However, given the size of the watershed and the lack of coordination among monitoring programs, these findings are not comprehensive. Invasive plants are introduced by vegetative means, seeds and spores which may be transported by birds, animals, wind, water and human activities including agriculture, forestry, and recreation to name a few. Aquatic species are often introduced through the release of exotic baitfish and worms, and non-inspected boat transfer.

To learn more about invasive species in the Mighty Peace watershed, see State of the Watershed Aquatic Ecosystems. *February 2014, available on the Alliance website at* **mightypeacewatershedalliance.org**

Invasive Plant Species in Riparian Areas



Source: CPP Environmental, Hutchinson Env. Sci. Ltd. (2014)

Aquatic Invasive Species

Brown trout and brook trout are not native to the Mighty Peace watershed. However, they are not considered an invasive species as they are stocked by the Government of Alberta to provide public angling opportunities. The northern crayfish (*Orconectes virilis*) has been observed in the Peace River, likely due to illegal introductions.

Wetland Invasive Species

Wetland surveys conducted by the ABMI found no invasive plants. An invasive aquatic macrophyte, the Eurasian milfoil (*Myriophyllum spicatum*), has only been reported at one location in the watershed so far, the Wapiti River watershed.[16]

Status of Species of Particular Concern

Zebra and quagga mussels, invasives that pose problems in many areas in Canada, have not been detected in any Alberta lakes to date. The spiny water flea has not been reported in any rivers, streams, lakes or wetlands in the watershed. The invasive algae *Didymosphenia geminata* has not been reported in the watershed, but it has been reported in Saskatchewan, BC, and the southern Albertan foothills, so it is possible that it is already present.

To participate in reporting and controlling invasives, see:

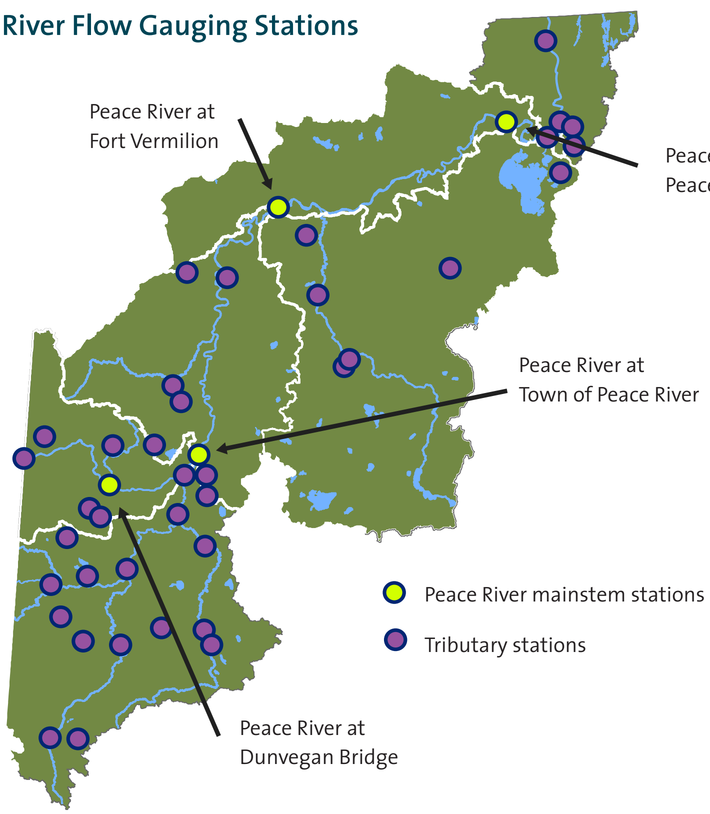
- **anpc.ab.ca/wiki/index.php?title=Main_Page**
- **esrd.alberta.ca/recreation-public-use/invasive-species/default.aspx**
- **www.ec.gc.ca/eee-ias**
- **www.abinvasives.ca**
- **mywildalberta.com**
- **www.cowsandfish.org**

Surface Water Quantity

The Mighty Peace

Each year, about 48.6 billion m^3 of water flow into Alberta via the Peace River, or roughly three times the combined amount of all the rivers in southern Alberta.[17] The river's largest tributary in Alberta, the Smoky River, contributes an additional 11 billion m^3 annually. The Little Smoky and Wapiti rivers, and numerous smaller creeks and rivers, also make contributions. Farther downstream, the Notikewin and Wabasca rivers and their tributaries add even more to the flow. Finally, the Peace contributes approximately 65% of the average flow of the Slave River.

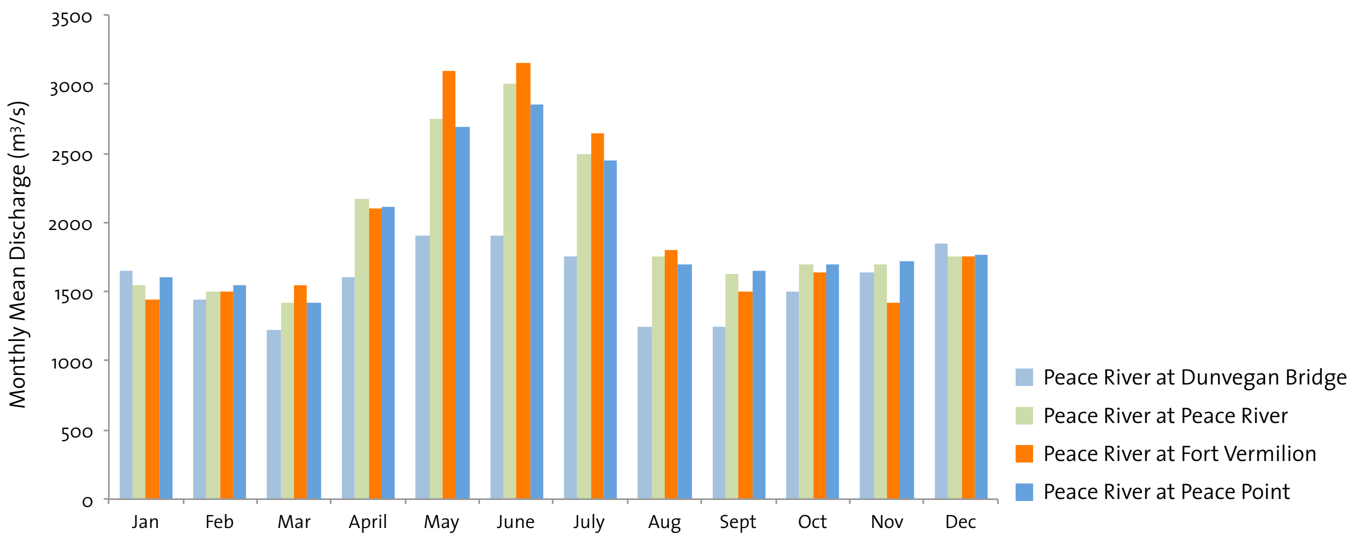
River Flow Gauging Stations



At both Peace Point and Fort Vermilion, flows increase slighty due to surface runoff/tributaries other than the Smoky River.

The quantity of water in the Peace and other major rivers in Canada are measured regularly, so that significant changes can be investigated. Like most rivers, the flows of the Peace are seasonal, with higher flows in early summer and lower flows in the fall and winter. The flow of the Peace rises dramatically after it is joined by the Smoky River.

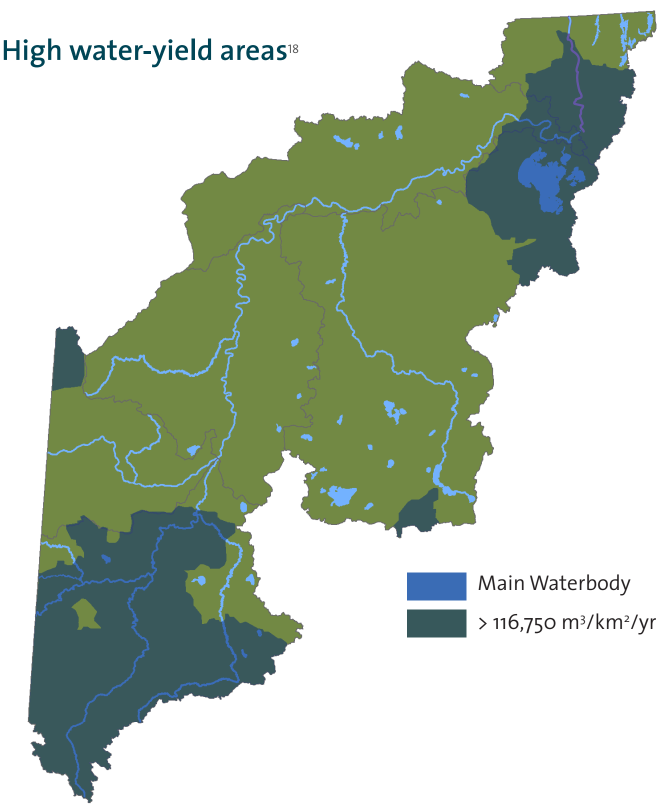
Average flow in the Peace River from 1977 – 2010
(Historical records from 4 stations)



SOURCE: WATER SURVEY OF CANADA

Much of the water feeding the Peace River originates in the mountains and foothills, where the Smoky and Wapiti tributaries begin. These areas are particularly important for protecting the freshwater supply and should be carefully managed. The map at right shows high water-yield areas for the watershed (those with the top 25% yields per square kilometre in the entire watershed). These areas generally have a surplus of water, which benefits downstream rivers and lakes.

High water-yield areas[18]

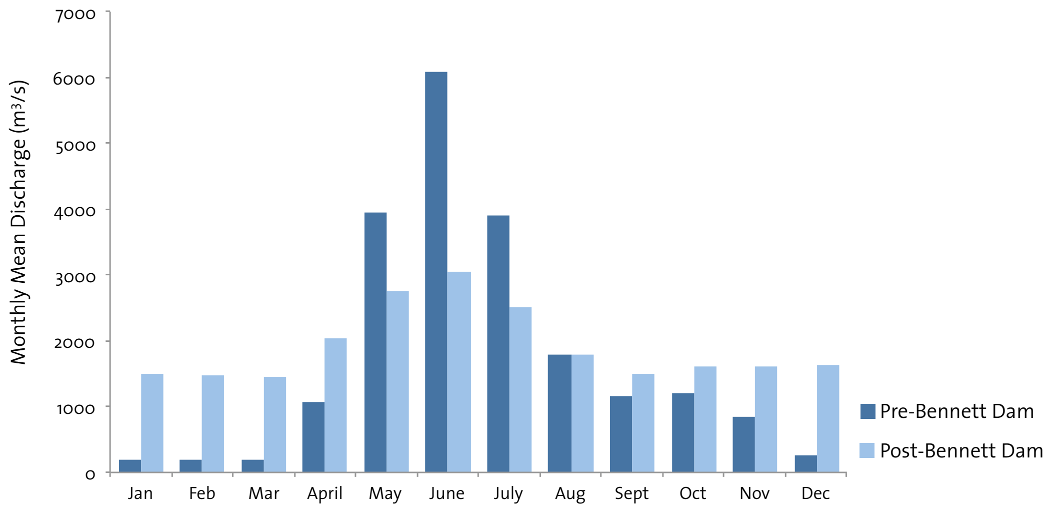


A Regulated River

The Peace is considered a "regulated" river because it is controlled by dams. The largest of these, the W.A.C. Bennett Dam, has changed the natural flow of the Peace River. As shown in the chart on the following page, the dam has levelled the flow, making it lower in summer and higher in winter. Peace River flows at Dunvegan (above the confluence with the Smoky River) show a change following dam commissioning in 1968. Since then, there has been no long-term change. The impact of the dam can be considered when management practices that adjust the flows are contemplated. The specific effects of the dam on aquatic ecosystems of watersheds have not been fully characterized.

Predicted Natural Flow at the Town of Peace River

(Calculated by modelling and comparing against mean monthly flows measured since the Bennett Dam was constructed)[19]



Source: Water Survey of Canada

Dams on the Peace[20]

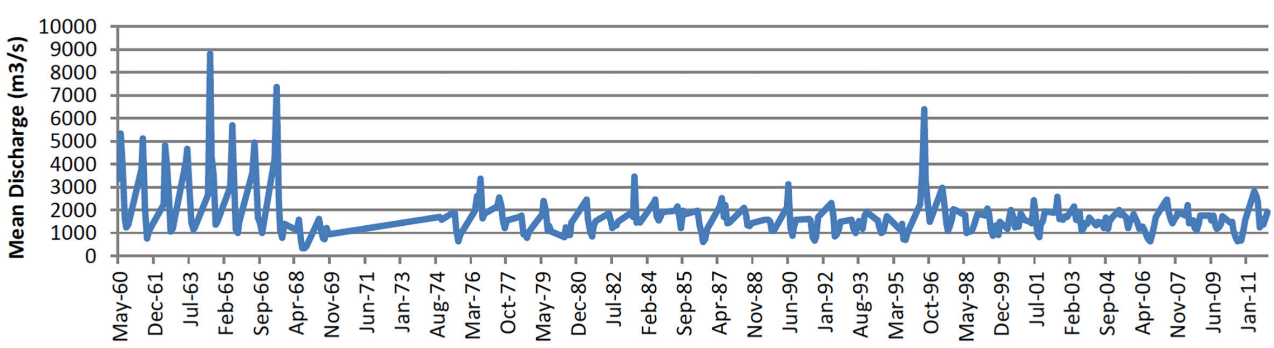
- The W.A.C. Bennett Dam has altered the flow patterns of the Peace River. Annual flow has not changed significantly, but peak spring and summer flows at Peace Point are about 50% of natural flows, and flows in the winter can be 7.5 times greater than under pre-dam conditions.
- Behind the dam is British Columbia's largest reservoir, Williston Lake, which covers an area of 166,000 ha.
- The dam can store the equivalent of 1.5 times the mean annual flow of the Peace River at the BC-Alberta border.
- It is one of the world's largest earthfill structures, stretching two km across the head of the canyon and standing 183 metres.
- The Peace Canyon Dam, downstream from the Bennett Dam, does not regulate flow, but it can still influence water quality. [21]
- A third dam and hydroelectric generating station, known as Site C, is scheduled to be constructed on the Peace River in northeast BC.[22]
- Glacier Power received approval in 2009 to complete a run-of-river hydroelectric dam on the Peace River near Fairview, but it has not yet been built.[23]

Flow, Weather and Climate

Sudden changes in water level in rivers and lakes can occur because of rainfall, seasonal snow melt and periods of drought. The largest seasonal fluctuation occurs during the spring snow melt, when large volumes of meltwater fill the rivers and lakes in the watershed. Gradual changes in the amount of surface water can be attributed to a changing climate as well as the effect of human activities, or a combination of the two. There is also a connection between surface water and groundwater quantities. For example, a drop in the groundwater table or water level in surficial aquifers can affect lake and river water levels. How quickly this happens depends upon how porous the ground is in the area.

Long-term Water Quantity in the Peace River and Its Tributaries

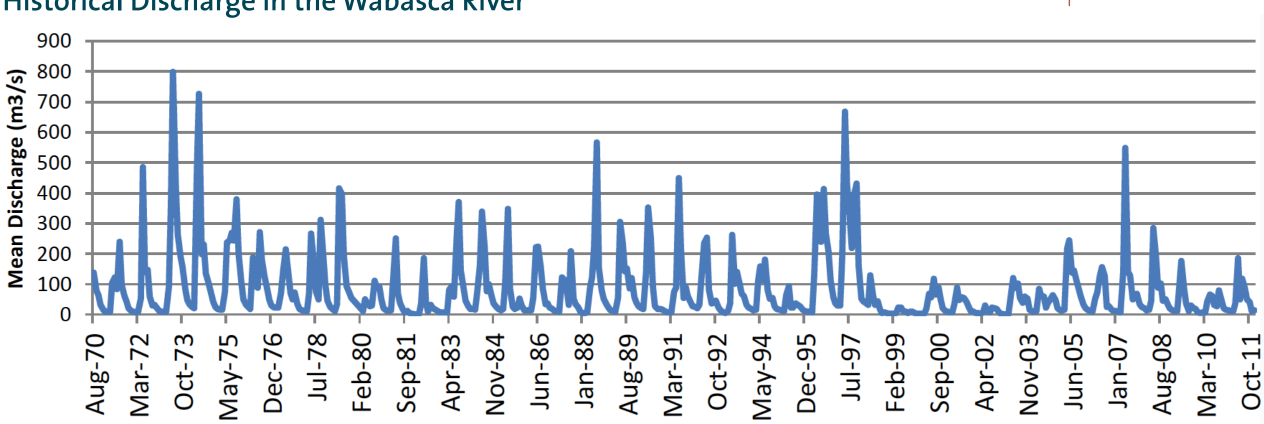
The Peace River flows at Dunvegan (above the confluence with the Smoky River) show a change following dam commissioning in 1968. Otherwise, there is no long-term change in Peace River flows.[24]



SOURCE: ESRD

Water supply in most tributaries does not generally appear to have changed over the past 40 years. However, formal trend analyses should be completed on streamflow and lake-water levels in the watershed. For instance, water quantity in the Wabasca River appears to have dropped since 2000 (see chart below). A trend analysis could be used to identify the causes of the trend, and what consequences a trend could have for management actions. Existing technology can be used to conduct these analyses rapidly on an annual basis.

Historical Discharge in the Wabasca River



SOURCE: ESRD

Surface Water Allocations

All diversions of ground or surface water in Alberta require an allocation license under the Water Act, unless the water is to be used for one of the following purposes:

- statutory household use
- traditional agriculture use
- firefighting
- wells equipped with hand pumps
- alternate watering systems that use surface water for livestock and/or types of dugouts

The Peace River is one of the least allocated rivers in the province, with less than 1% of its surface waters allocated.[25] In the Mighty Peace watershed, the total volume of surface water allocated in 2013 was 194,643,903 m^3. There are no surface or groundwater allocations licensed in the Slave River Watershed.

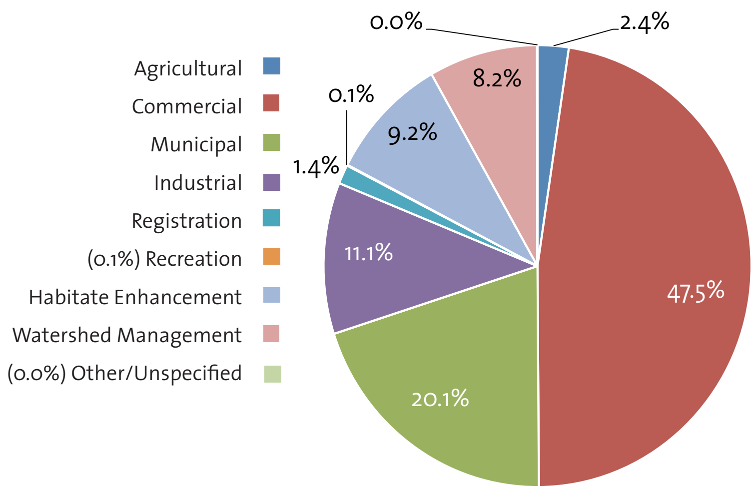
INFO GAP

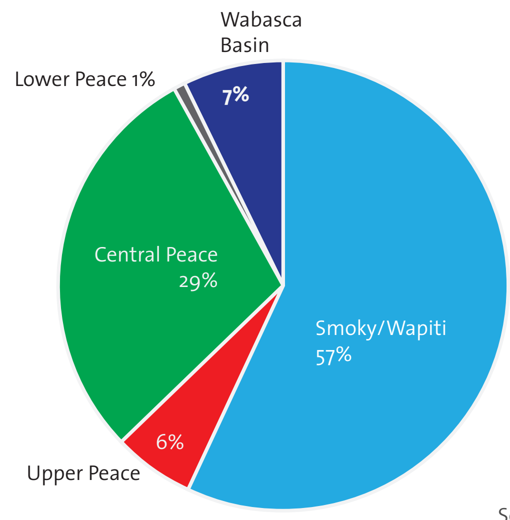
Ongoing trend analysis on tributaries.

Learn more about Water Licenses, Transfers, and Allocation: **esrd.alberta.ca/water/education-guidelines/documents/AlbertaWaterAct-FactSheet.pdf**

Licensed Surface Water Allocation

In 2015, water use in the Peace River watershed is expected to increase by 40% from 2011 levels. More than 60% of this growth will be due to development of the in situ oil sands and heavy oil deposits within the Central Peace and Wabasca sub-watersheds.[26] The potential impact of such growth should be examined closely.





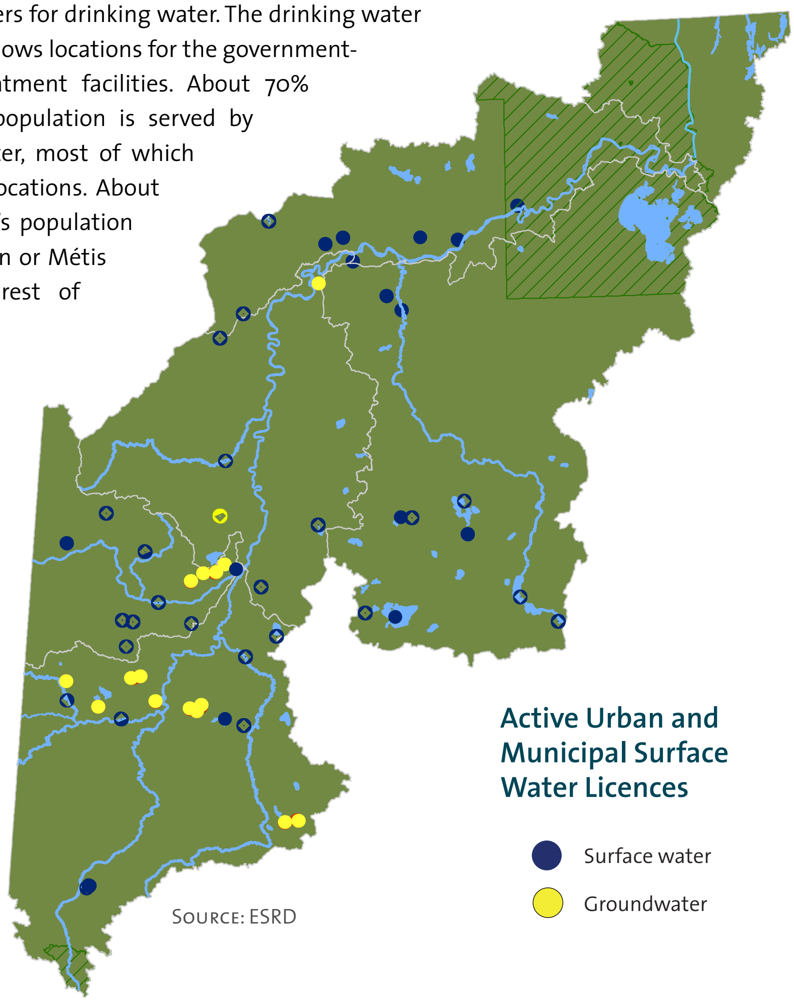
Source: ESRD

These allocations follow the Government of Alberta's categorization. "Commercial" includes pulp, thermal generating plants and coal mines, whereas "Industrial" covers oil and gas. "Registration" is all ground and surface water use that landowners have voluntarily registered since the proclamation of the Water Act in 1999. Some of the allocations require that the licensee return a certain amount to the body of water from which it was drawn.

Drinking Water

The majority of the municipalities and counties in the watershed rely on the Peace, Smoky and Wapiti rivers for drinking water. The drinking water intake map at right shows locations for the government-regulated water treatment facilities. About 70% of the watershed's population is served by these sources of water, most of which are surface water allocations. About 7% of the watershed's population is living in First Nation or Métis communities.[27] The rest of the population relies on private sources, including dugouts, private wells and rainwater collection systems. Some communities have boil-water advisories in effect.[28]

Little information is available on the location of drinking water sources and the status of treatment.



Source: ESRD

Active Urban and Municipal Surface Water Licences

INFO GAP

Better accounting of actual water use is required.

Sources of Drinking Water

In Canada, the waterworks system is maintained and operated to produce and distribute water that meets the maximum acceptable concentrations of constituents specified in the guidelines for Canadian drinking water quality. National and international experts have placed increasing emphasis on taking a broad view of the management of drinking water supplies. They recommend implementing multiple barriers that reduce disease-causing organisms and contaminants, not only at the treatment plant and the distribution system, but in source water as well.

This involves the identification of potential treatment and contamination risks in the source's contributing area, or watershed. In Alberta, common treatment challenges involve high organic concentrations and turbidity in source water. Contaminants may include chemicals or biological agents stored or produced as a result of activities in a watershed.

Net Water Use

Not all water allocated is used and not all water used leaves the river system. Wastewater treatment plants, for example, are expected to return a significant portion of their water to the river. Only a small number of users (e.g., industrial users) are required to report the actual volume of water used to the provincial government, making net usage impossible to gauge.

Communities that draw water from surface water sources other than the Peace River

Community	Source
Beaverlodge	Beaverlodge River
Boyer River First Nation	Boyer River
Bushe River First Nation	Footner Lake
Child Lake First Nation	Boyer River
Cadotte Lake	Cadotte Lake
Clairmont	Wapiti River
Cleardale	Trib. To Eureka River
Donnelly	Little Smoky River
Eaglesham	Fox Creek
Falher	Little Smoky River
Fort Smith First Nation	Slave River
Gift Lake Métis	Gift Lake
Girouxville	Little Smoky River
Grande Cache	Victor-Grande Cache Lake
Grande Prairie	Wapiti River
Guy	Little Smoky River
High Level	Footner Lake
Hines Creek	Jack Creek
Jean Cote	Little Smoky River
John D'Or Prairie FN	Lawrence River
Keg River	Keg River
Loon Lake	Loon Lake
Manning	Notikewin River
McLennan	Winagami-Girouxville Canal
Nampa	Heart River
Paddle Prairie Métis	Boyer River
Peerless Lake	Peerless Lake
Red Earth Creek	Red Earth Creek
Rycroft	Spirit River
Spirit River	Tributary to Spirit River
Sturgeon Lake First Nation	Sturgeon Lake
Tangent	Fox Creek
Tall Creek First Nation	Wabasca River
Trout Lake	Trout Lake
Utikoomak Lake	Utikoomak Lake
Valleyview	Little Smoky River
Wabasca	Wabasca Lake
Wanham	Fox Creek
Woking	Unnamed River

Did you know?

Private water well owners in Alberta are responsible for managing and maintaining their own wells. The Working Well Program provides owners with the information and tools they need to properly care for their wells. Private systems should be tested regularly to ensure they meet drinking water standards. Public Health inspectors with Alberta Health Services can advise private homeowners with wells, cisterns or dugouts about the safety of their water and possible treatment options. More information at:
workingwell.alberta.ca

Surface Water Quality

Surface water is all the water in rivers, streams and lakes. Groundwater is all of the water below the surface of the Earth. In the Mighty Peace, the source and the quantity of flow are the biggest factors influencing surface water quality. When flow volumes change, as they typically do with the seasons, water quality also tends to change. High energy and large volumes of water have a greater capacity to move soil particles that have nutrients, metals and chemicals bound to them. By contrast, low-flow conditions often accentuate point sources of pollution due to a reduced dilution capacity. This is particularly evident in the Wapiti River as it flows past Grande Prairie.

Alberta River Water Quality Index

The Alberta River Water Quality Index (ARWQI) combines measurements taken regularly throughout the year of metals, nutrients, bacteria and pesticides. This allows for long-term comparisons of river water quality. Measurements used in the index all come from sites forming part of the Long-Term River Network (LTRN). There are 28 LTRN sites in Alberta, usually upstream and downstream of areas with significant human activity. Within the watershed, there are five LTRN sites.

What the ARWQI Measures and Why

Bacteria: The number of bacteria detected is recorded and analyzed because bacterial contamination of rivers may pose a risk to human, animal, and ecosystem health.

Nutrients: Large inputs of nutrients, such as phosphorus and nitrogen, can lead to increased aquatic plant growth, causing changes in the flora and fauna of a river system. Excessive plant growth often results in an increase in organic decomposition, which lowers dissolved oxygen and changes pH, causing problems for aquatic life.

Pesticides: Pesticides are intended to kill certain plants and animals but can pose risks to aquatic ecosystem health as well. Direct impacts on aquatic life and human health are not clear, but the presence of pesticides in the watershed's rivers is of significant concern.

Metals: Up to 22 variables are measured in the metals category. Many occur naturally in the environment and their amounts vary according to many factors.

Alberta River Water Quality Scoring

96-100	**Excellent**	Guidelines almost always met; best quality
81-95	**Good**	Guidelines occasionally exceeded, but usually by small amounts; threat to quality is minimal
66-80	**Fair**	Guidelines sometimes exceeded by moderate amounts; quality occasionally departs from desirable levels
46-65	**Marginal**	Guidelines often exceeded, sometimes by large amounts; quality is threatened, often departing from desirable levels

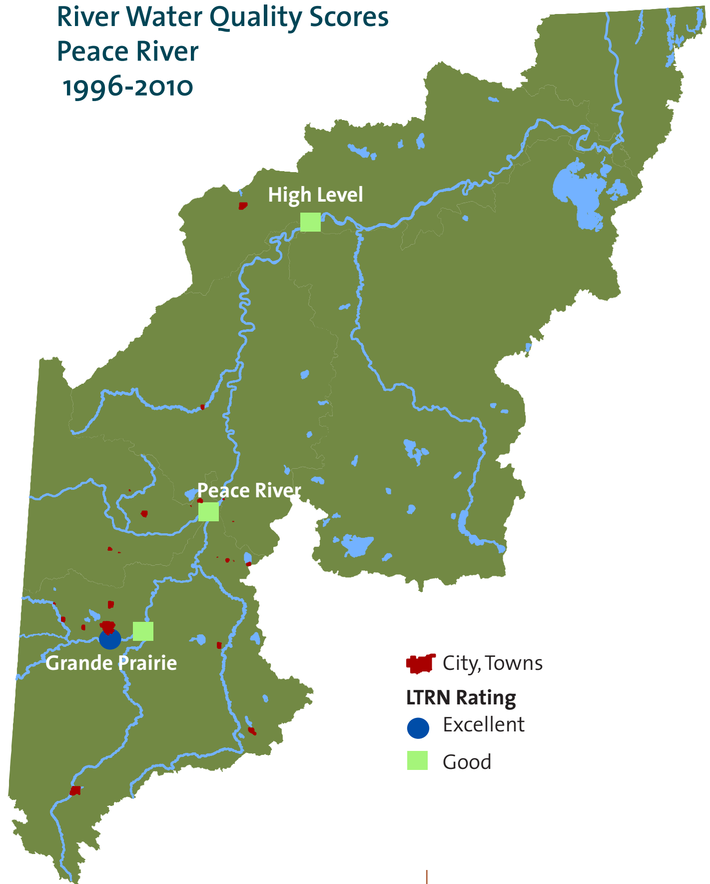
The map on the next page shows the locations of LTRN monitoring sites in the watershed and their ratings averaged over the years from 1996 to 2010. All sites received scores of good to excellent. While the ARWQI results are favourable, this index does not represent conditions in smaller tributaries; it is a broad overview of the water quality in the major rivers.

More about the Alberta River Water Quality Index is online at: **environment.alberta.ca/apps/basins/Map.aspx?Basin=/&DataType=7**

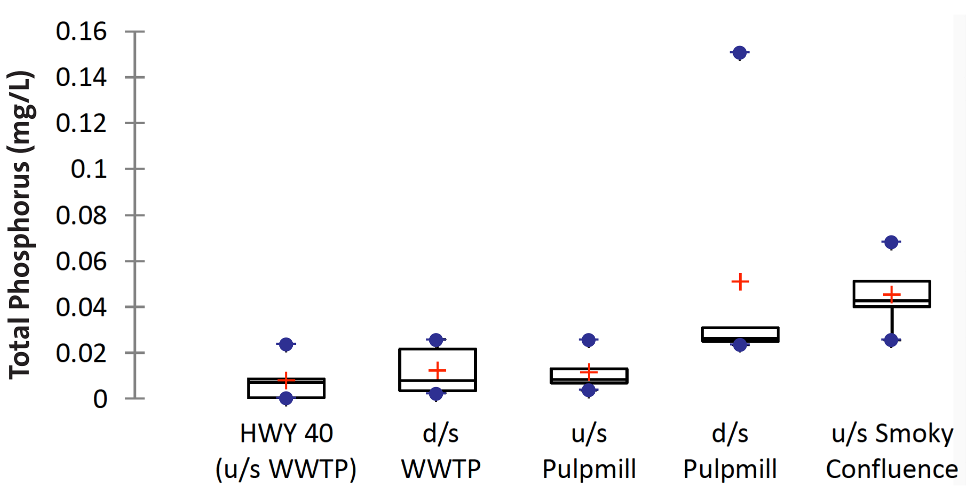
A change in the ARWQI occurs as the Wapiti River flows past the City of Grande Prairie and Weyerhaeuser's pulp mill, as shown in the graph below. Treated effluent discharge has an impact on this decrease in ARWQI score, although non-point sources of pollution (for example, from Bear Creek) also play a role. Treated wastewater typically contains elevated levels of metals, bacteria and nutrients. Nutrients (in both municipal and mill discharges) and bacteria (municipal only) appear to cause the decrease in water quality. Elevated nutrient levels have resulted in higher production but lower biodiversity in aquatic invertebrates and increased aquatic plant production.

All these effects occur to a certain degree downstream of treatment. The nutrient-enrichment effect continues in the Smoky River, particularly during periods of low flow. Although the combined treated effluent discharge from Aquatera (which collects wastewater from the City of Grande Prairie and its surroundings) and Weyerhaeuser have measurable effects, both facilities are highly regulated. They have adopted advanced treatment technologies and greatly improved treatment efficiencies over the years. The other pulp mill in the watershed, the Daishowa-Marubeni mill near the Town of Peace River, has made similar improvements.

River Water Quality Scores Peace River 1996-2010



Phosphorus along the Wapiti River

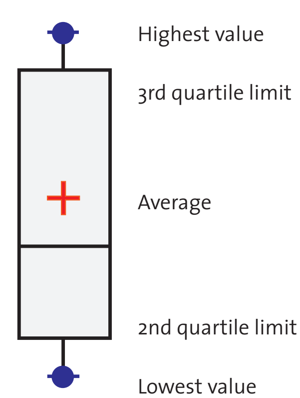


u/s = upstream; d/s = downstream

Source: ESRD

Note: *Nutrient concentrations, in this case phosphorus, increase along the Wapiti River from upstream (HWY 40) to downstream (d/s Pulpmill) of effluent discharge from the Aquatera and Weyerhaeuser wastewater treatment plants. This effect has been documented over the past 50 years but is decreasing over time due to improvements in wastewater treatment technology.*

Reading Box Plots



The Effects of Human Activities in the Watershed on Water Quality

Human activities in the watershed are correlated with the water quality of aquatic ecosystems. These relationships tend to be more apparent in lakes and smaller tributaries rather than major rivers.

- As agricultural intensity increases (in the form of chemical and fertilizer expenses and manure production), nutrients in small streams increase while compliance with surface water quality guidelines decreases. [29]
- As the density of disturbance in the watershed increases, nutrient concentrations increase.[30]
- Land-clearing effects depend on many factors, such as the density of the disturbance, slope, the presence of wetlands in the watershed, and differences in forest management practices. In general, two decades of research in the foothills and boreal regions of Alberta suggest that nutrients in surface water are affected if over half of a watershed is cleared.[31] Below this value, only relatively minor effects are expected.

Nutrients

The amount of phosphorus and other nutrients in rivers and streams is a product of several variables, including the source water, the local natural environment, and point- and non-point-source pollution. Nutrients typically fluctuate more than other ARWQI sub-indices. At all monitoring sites downstream of Grande Prairie, the 10-year averages for nutrients have worse scores than the sampling station upstream of the city. Monitoring nutrient levels makes it possible to recognize problems in water quality as they occur and adjust management practices according to the results.

Non-point-source pollution

Point-source pollution comes from specific places, such as a processing or wastewater-treatment plant. The effects of point-source pollution can be measured by taking samples both upstream and downstream of the source. Non-point-source pollution is much more difficult to measure because it doesn't come from a single, identifiable source, but from many diffuse sources. The pollutants are distributed through seepage and by rain and snowmelt moving over and through the ground into lakes, rivers, and wetlands. Common examples include:

- Excess fertilizers, and pesticides from agricultural lands and residential areas;
- Oil, grease, and toxic chemicals from urban runoff and energy production;
- Sediment from improperly managed construction sites, crop and forest lands, and eroding stream banks;
- Salt from irrigation practices and acid drainage from abandoned mines;
- Bacteria and nutrients from livestock, pet wastes, and faulty septic systems.

Bacteria

Measurements of fecal coliforms and *Escherichia coli* provide an indication of bacterial contamination that may pose a risk to humans, animals, and ecosystems. For the major rivers, fecal coliforms and *E. coli* counts measured were generally low. However, there was a sharp increase in bacteria (that is, a drop in the bacterial score) in 2008/09 on the Wapiti River at the confluence of the Smoky, which is downstream of Grande Prairie. This may have been caused by a combination of factors. It is likely that effluent from the Aquatera plant played a role, as it is known to significantly increase fecal coliforms in the Wapiti River. [32] Such irregularities provide clues as to the stresses on the river and allow managers to take corrective action. For instance, some jurisdictions in Alberta have implemented disinfection in their treatment process to address this issue.

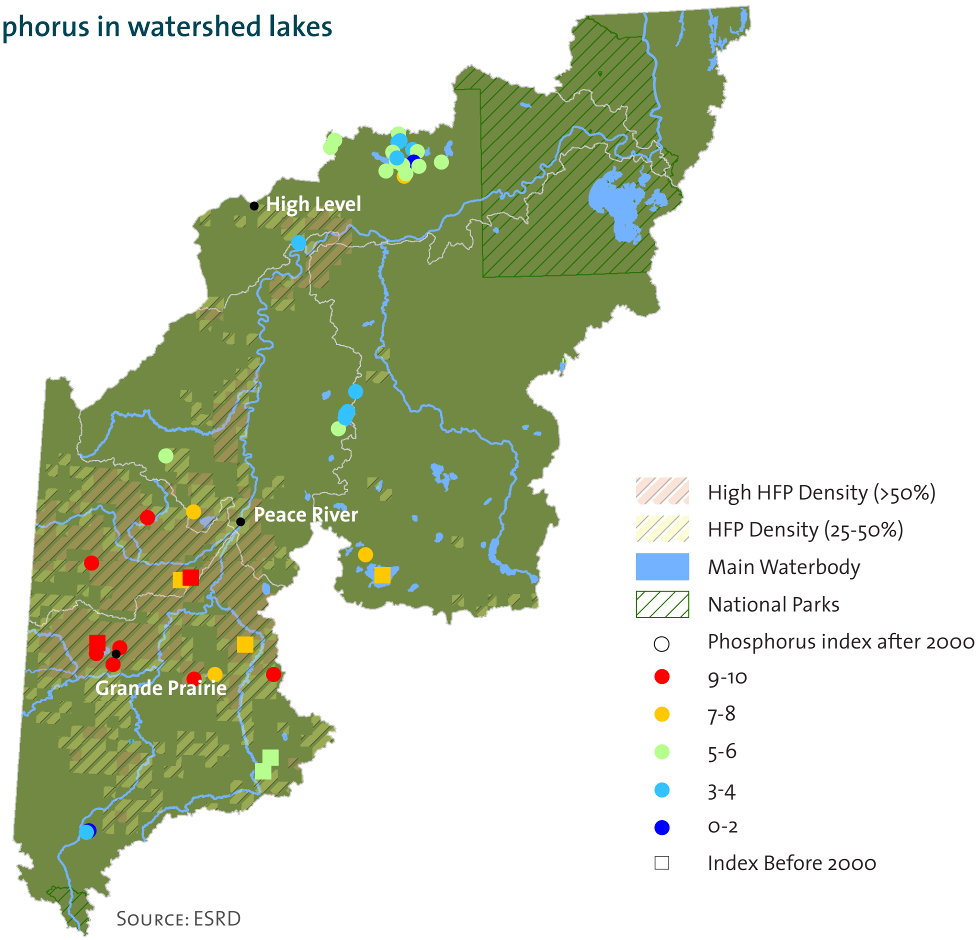
Lake Water Quality

Lake water quality is an excellent indicator of the intensity of activities in the watershed. Monitoring these activities over time provides insights into the overall health of the watershed.

Phosphorus

As with rivers, the presence and amount of phosphorus in lakes is a result of a combination of variables, including the source water and the local natural environment, as well as human impacts. The map below shows the results from measurements of a number of lakes, and gives an indication of comparative phosphorus amounts in different parts of the watershed.[33] The amount of phosphorus in lakes is related to the intensity of the human footprint in the watershed.

Phosphorus in watershed lakes



***Note**: The index represents the lowest (0) to the highest (10) lake phosphorus concentrations in Alberta. Water quality of lakes in the Peace & Slave River Watershed were plotted on this scale. Each point represents a lake that was sampled at least three times during a summer either before or after the year 2000.*

Bacteria

No bacteria data were available for lakes in the watershed. The northernmost samples are from Alberta Health's recreational beach monitoring program in the vicinity of Edmonton.

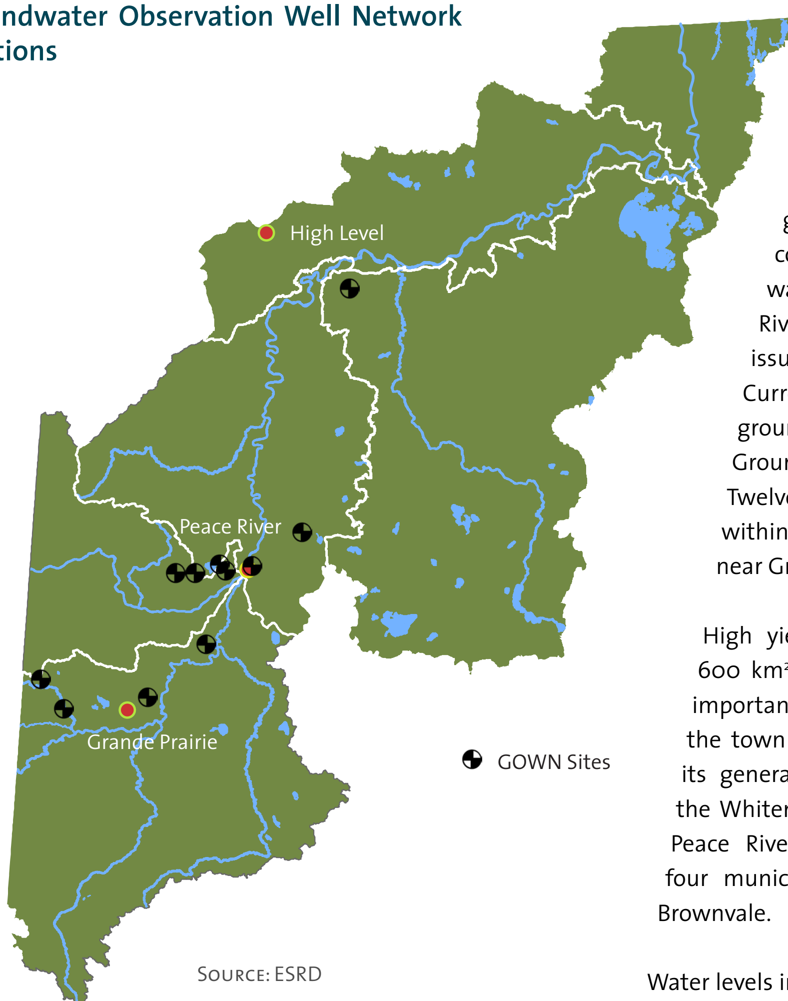
INFO GAP

Additional lake sampling throughout the watershed.

Groundwater Quantity

Groundwater cannot be described by sub-watershed boundaries, as it does not respect these topographically defined areas. Rather, groundwater is placed in western and eastern groupings of sub-watersheds. In general, the western grouping has a shortage of high-yield freshwater aquifers. High-yield aquifers are typically associated with permeable sand and gravel deposits in the surficial geology, which allows groundwater to flow at significant rates. Groundwater resources in the eastern grouping appear to be abundant, but mapping this area is challenging.

Groundwater Observation Well Network Locations



Source: ESRD

The Mighty Peace watershed has less groundwater monitoring information available compared with the province's southern watersheds, such as the Bow River and Oldman River watersheds. But the water resource issues facing the watershed are also less urgent. Currently, the most comprehensive regional groundwater-monitoring program in place is ESRD's Groundwater Observation Well Network (GOWN). Twelve groundwater observation wells are active within the watershed, the majority of them located near Grande Prairie and the town of Peace River.

High yields and excellent water quality make the 600 km² Grimshaw Gravels aquifer one of the most important aquifers in the watershed. Located west of the town of Peace River and adjacent to Lac Cardinal, its general flow is in a southeasterly direction from the Whitemud Hills, which recharge the aquifer, to the Peace River. The aquifer provides drinking water for four municipalities: Berwyn, Grimshaw, Whitelaw, and Brownvale.

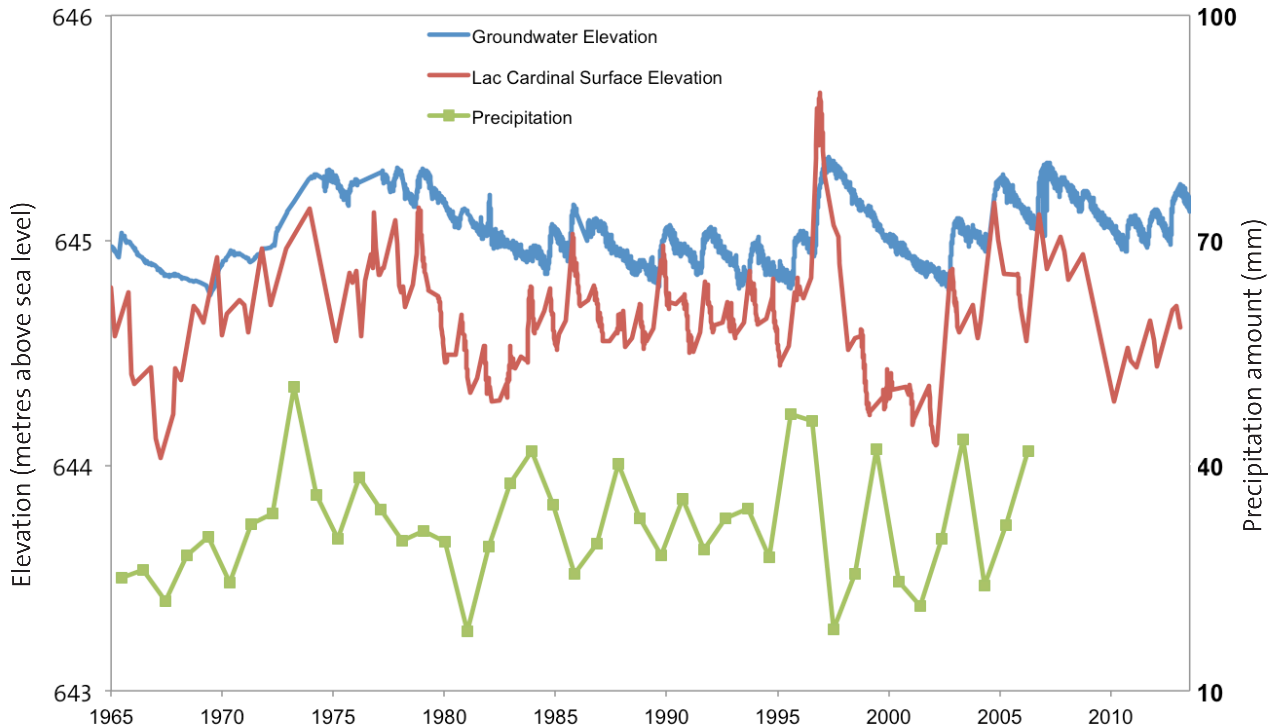
Water levels in the Grimshaw Gravels aquifer can change by about a metre following changes in precipitation and in the levels of Lac Cardinal. Because it is shallow, there is strong interaction between water in the aquifer, precipitation, and Lac Cardinal levels. Despite the aquifer's changing levels, supply from this aquifer continues to be good, and no long-term decline is apparent.

To learn more about the Groundwater Observation Well Network, visit: **esrd.alberta.ca/water/programs-and-services/groundwater/groundwater-observation-well-network/default.aspx**

What Is an Aquifer?

An aquifer is a water-bearing geologic unit below the groundwater table. Although most of these locations are fully saturated with water, only those with materials permeable enough to allow groundwater to flow at a significant rate are considered an aquifer. Because of these properties, aquifers can be important sources of water. Loosely stacked, non-consolidated, course-grained materials (such as sand and gravel) are the most common aquifer-forming mediums. Aquifers are often classified as surficial (shallow) and bedrock (deep). Surficial aquifers are a source of freshwater for drinking and agricultural uses. Bedrock aquifers often contain saline and brackish water used mainly for industrial purposes. The upper boundary of an unconfined aquifer is the water table, and confined aquifers have little if any connection to the water table. —Wikipedia

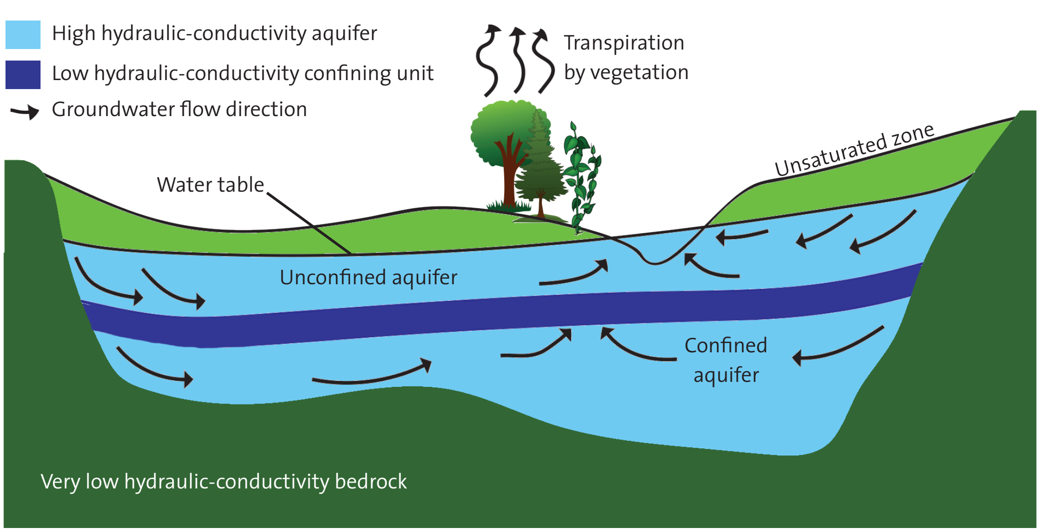
Precipitation and groundwater and Lac Cardinal elevation trends associated with the Grimshaw Gravel Aquifer



Source: ESRD

Where does aquifer water come from?

Deeper aquifers are recharged as part of the regional groundwater flow regime; groundwater may travel a great distance and take many years to reach the aquifer. Shallow aquifers are recharged directly by infiltrating surface water. Residence time of groundwater in shallow aquifers tends to be short and local flow regimes fluctuate in response to surface conditions, compared with the slow and methodical flow trends in deeper aquifers. Groundwater in shallow aquifers retains many of the characteristics of the infiltrating surface water.



INFO GAP

Although the western groupings of sub-watersheds are reasonably well-mapped for groundwater, proper watershed management would necessitate expanding mapping of groundwater aquifers to the rest of the watershed.

What Is an Aquitard?

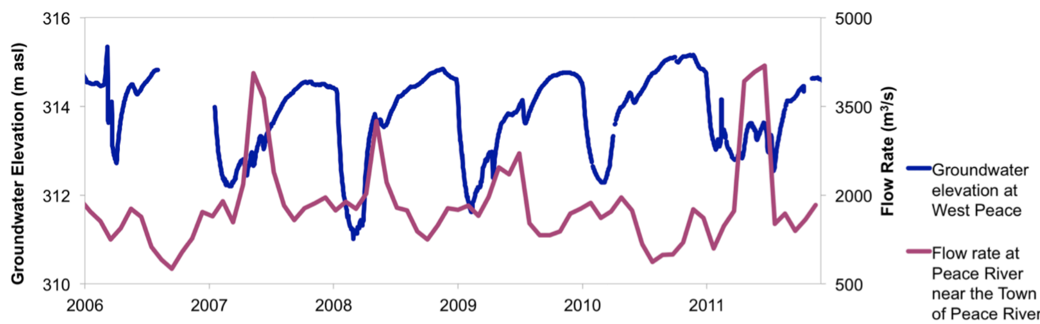
Fine-grained, well-sorted silt and clay have low permeability and can form a layer that limits groundwater movement. These areas are known as "aquitards."

INFO GAP

Expansion of the Groundwater Observation Well Network (GOWN) program is needed in anticipation of rising water demand from industries and a growing population, particularly in the Smoky/Wapiti and Wabasca areas, which accounts for 80% of groundwater allocation in the watershed. The southern Wabasca sub-watershed is a hot spot for in situ oil sands operations, as is the region east of the town of Peace River. In the near future, pilot projects are expected to begin operating at Husky's McMullen and Cenovus Energy's Pelican Lake, and Shell has one is in production at Carmon Creek. There is no evidence industrial and commercial usage is affecting the quantity of groundwater in the southern Wabasca sub-watershed, although that may be due to insufficient data.

The chart below demonstrates interesting patterns from the Groundwater Observation Well Network dataset, showing the value of the network and the need for a more extensive groundwater network. This shallow gravel aquifer, located on the western bank of the Peace River at the town of Peace River, shows the seasonal patterns of groundwater elevation compared to the river's flow rate.

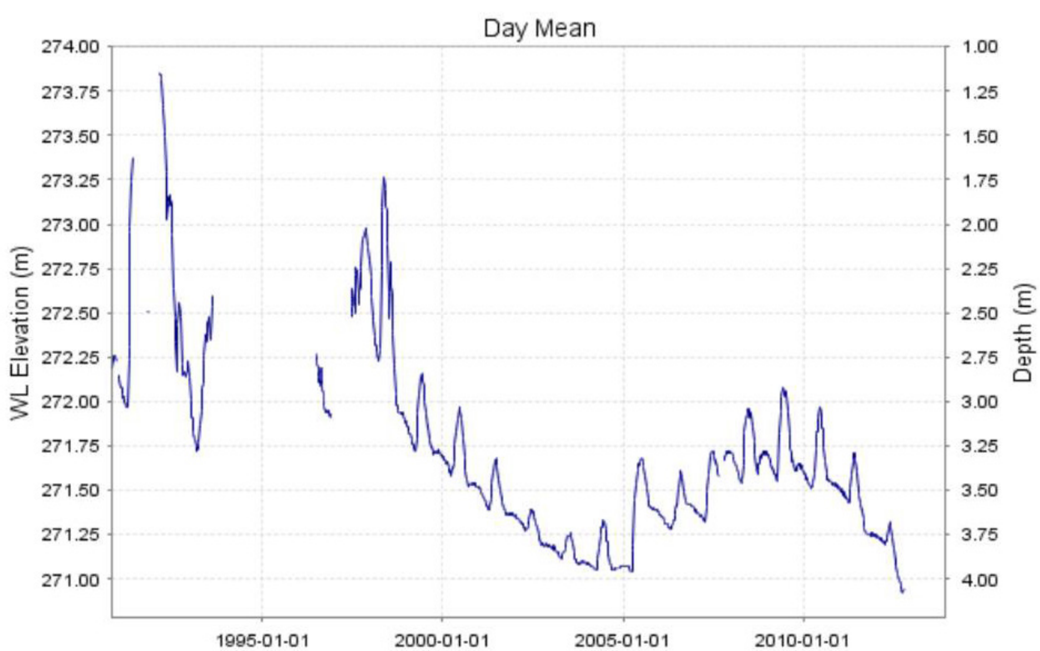
Seasonal patterns in groundwater and flow rates



Source: ESRD

As shown in the next chart, the shallow (8.5-metre) aquifer near La Crete appears to be under long-term stress (approximately 20% reduction in original available supply). Further study is required to determine the causes of this decrease and its sustainability over time.

Historical Water Levels in La Crete Shallow Aquifer



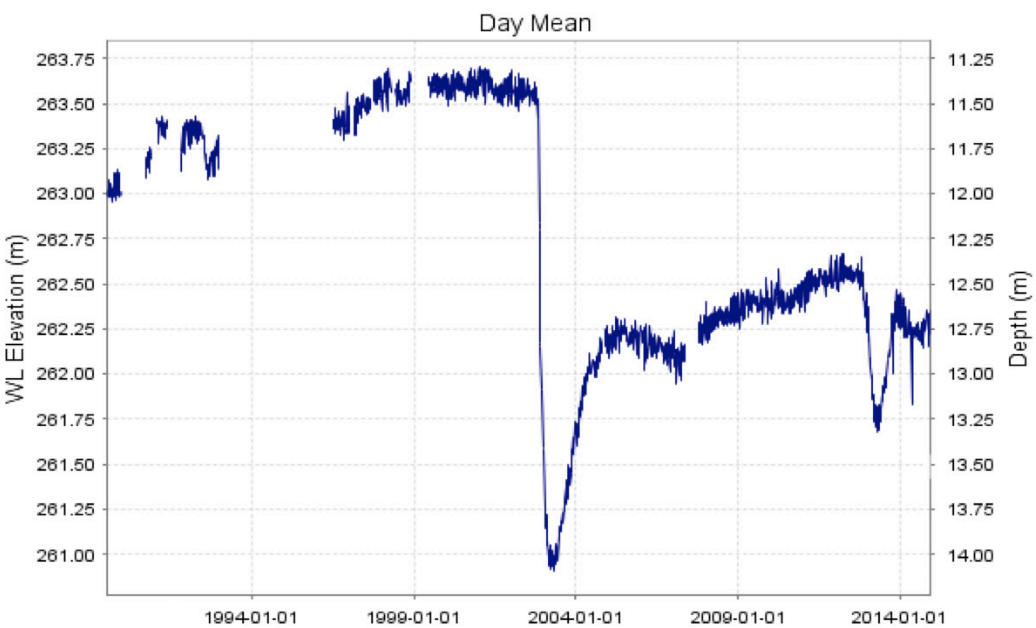
Source: ESRD

Regulatory Shift

ESRD is phasing out the use of freshwater for oil field injections at in situ oil sands operations in favour of saline groundwater. Allocation of saline groundwater is under the jurisdiction of the Alberta Energy Regulator (AER), while ESRD oversees fresh groundwater and surface water. It is still unclear exactly how AER intends to regulate the saline groundwater of the deeper aquifers.

The deeper (83.5-metre) aquifer near La Crete, shown in the chart below, indicates two clear decreases in aquifer water levels. In this case, groundwater levels fell rapidly, with a slower recovery. Groundwater levels have not returned to normal levels in this aquifer.

Historical Water Levels in La Crete Deeper Aquifer



Source: ESRD

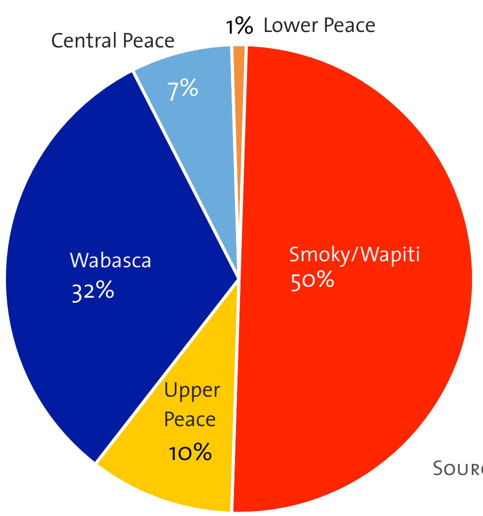
Groundwater Allocations

In the Mighty Peace, the total volume of groundwater allocated in 2013 was 20,940,065 m³. There are no surface or groundwater allocations licensed in the Slave River watershed.

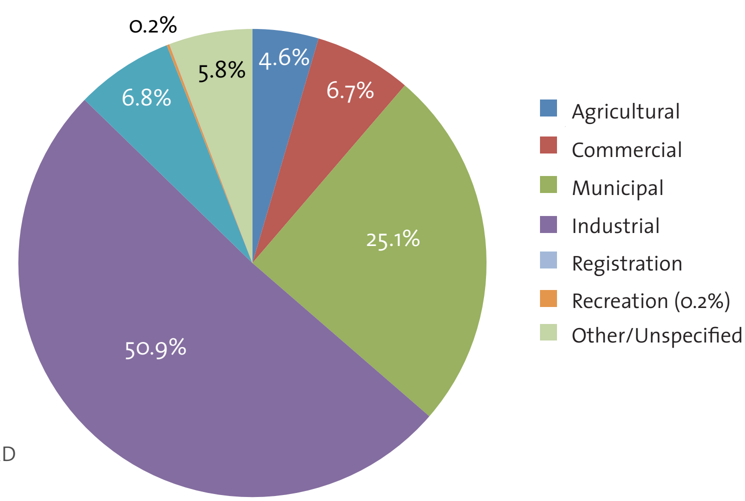
Increase in Groundwater Use

Groundwater allocations in the watershed increased 10% from 2011 to 2013. Use is greatest in the Wabasca and Smoky/Wapiti sub-watersheds, which together account for more than 80% of groundwater allocations in the entire watershed.

Licensed Groundwater Allocation



Source: ESRD

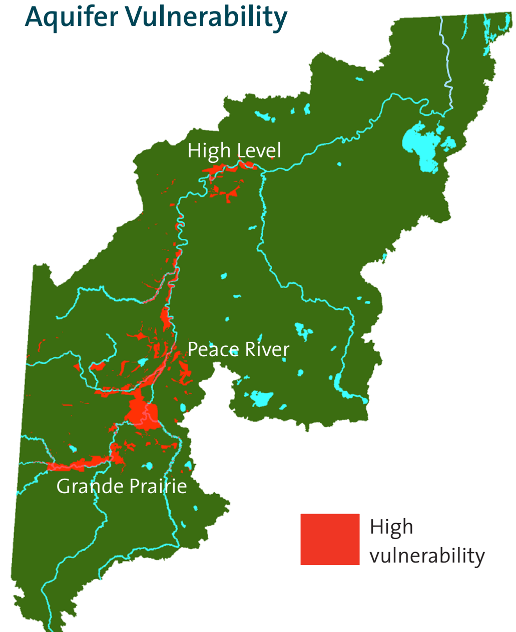


Groundwater Quality

Surficial aquifers exhibit extensive variability in depth, extent and quality. They tend to have the best water quality, but are also the most vulnerable to contamination because they are near the surface and often covered by material that has high infiltration rates. Groundwater in shallow aquifers retains many of the characteristics of the infiltrating surface water, and can become a pathway for contaminants to reach groundwater after rain.

For example, viruses and bacteria (such as *E. coli*) associated with livestock manure production may pose a threat to the water source. Contaminants can travel with runoff or stream water and infiltrate a shallow aquifer some distance away. Further groundwater movement could carry the contaminants to a drinking water source. Tracking where contaminants originate is difficult, and those who rely on shallow wells for drinking water need to understand the highly variable and sometimes vulnerable nature of shallow groundwater. Only the areas where most of the watershed's population and human development are located have been mapped for aquifer vulnerability. This mapping should be expanded to the rest of the watershed.

Aquifer Vulnerability



Source: Agricultural Land Resource Atlas of Alberta.[34]

In deeper aquifers, water quality tends to decline and become saline. Saline groundwater (TDS > 4000 mg/L) is used for industrial purposes. Allocation of saline groundwater is under the jurisdiction of the Alberta Energy Regulator (AER), which will phase out the usage of freshwater for oil field injections for in situ and SAGD operations. Little monitoring data are available on groundwater quality in the watershed. Most information

INFO GAPS

Mapping of groundwater resources in the watershed, including delineation of areas that recharge groundwater to derive relationships between climate and water resources (river flow, lake water levels and quality, and aquifer levels). In addition, groundwater vulnerability mapping is required in less settled areas of the watershed.

exists in baseline data that describe aquifers in their natural state between the late 1960s and early 1980s. In the Wabasca sub-watershed, approved industrial facilities produce groundwater monitoring reports that are available from the Government of Alberta. However, these are locally specific and should not be used for assessing regional water quality. The impact of climate change and various land uses on groundwater quality and aquifers are unknown. Municipal growth, along with agricultural, industrial and commercial activities, could all have an effect. The watershed could benefit enormously from a monitoring program.

The Alberta Centre for Toxicology has an active well-testing program. Groundwater samples from 1,258 wells were collected over the past decade and compared with Canadian Drinking Water Quality Guidelines. Of particular concern in the watershed are documented cases of arsenic concentrations above the Canadian Drinking Water Guideline.[35] The table below summarizes that information.

	Number of wells exceeding guideline values		Guideline values (mg/L)	
Parameters	Maximum Acceptable Concentrations (MAC)	Aesthetics Objective	MAC	Aesthetics Objective
Chloride		20		250
Fluoride	249		1.5	
Nitrate	6	27	45	3.2
pH		637		6.5-8.5
Sodium		1005		200
Sulphate		118		500
TDS		1125		500
Trace Metals				
Antimony	2		0.006	
Arsenic	4		0.01	
Barium	0		1	
Boron	0		5	
Cadmium	0		0.005	
Lead	4		0.01	
Mercury	0		0.001	
Selenium	0		0.01	

Source: Alberta Health and Wellness; Data Obtained December 2013

Two regions in particular face significant stress on groundwater quality, with little monitoring: The southern Smoky/Wapiti basin around Grande Cache and the area north of Wapiti River from Grande Prairie to Beaverlodge. Three active GOWN wells are in the area between Grande Prairie, Beaverlodge, Hythe and up to the Spirit River area. This region is underlain by a large natural gas reserve in the Montney geologic formation and has become a hot spot for both conventional hydrocarbon recovery as well as hydraulic fracturing. For example, Encana planned to expand operations to 80-85 wells in the Montney formations alone in 2014.

The area surrounding Grande Cache in the Southern Wapiti Basin has a history of coal mining. Studies highlight the effect of selenium levels on streams and fish populations in the region. The Upper Wapiti Formations (Horseshoe Canyon, Oldman, Foremost) underlying the region have low yields and poor water quality, making groundwater vulnerable to stress. There is no active monitoring well along the Smoky River. Water levels in some wells (for example, near La Crete) have significantly declined and do not currently show signs of recovery. These should be examined further.

Value and Vulnerability: Applying the Data

This section identifies management priorities for the Mighty Peace watershed in accordance with the provincial Water for Life goals:

1. **Safe, secure drinking water;**
2. **Healthy aquatic ecosystems; and**
3. **Reliable, quality water for a sustainable economy.**

The information can be used for regional and sub-regional water and land resource management planning and decision-making. Using criteria identified by regional stakeholders, it identifies the most valuable areas in terms of watershed management. The current human disturbance footprint was overlaid on these areas to identify valued areas that are also potentially vulnerable. The purpose is not to create a new land use management zone, but to improve watershed management planning by highlighting "hot spots" that may require more attention. This approach is repeatable over time. It can ensure that future state of the watershed reporting is responsive, adaptable, and supportive of environmental planning in the Mighty Peace. As priorities evolve, additional valuable areas may be identified by stakeholders and easily added as a layer in this assessment.

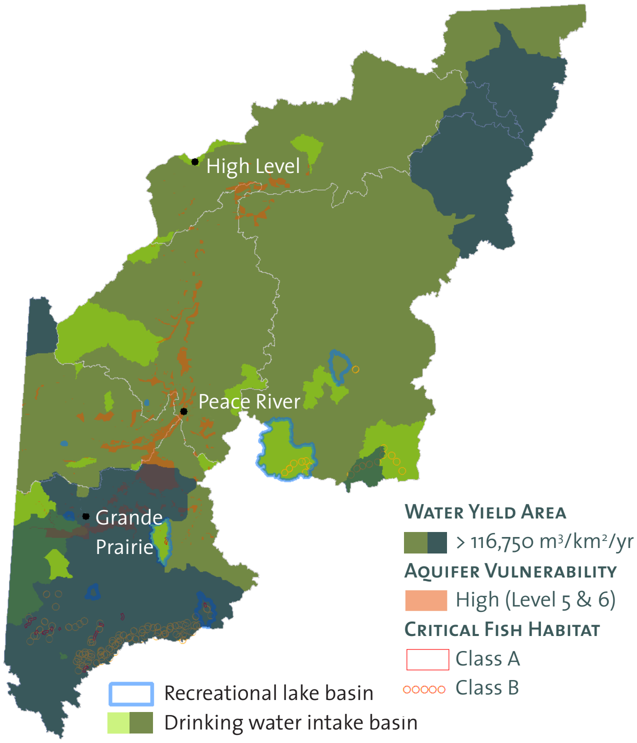
Regionally Valuable Landscape Areas

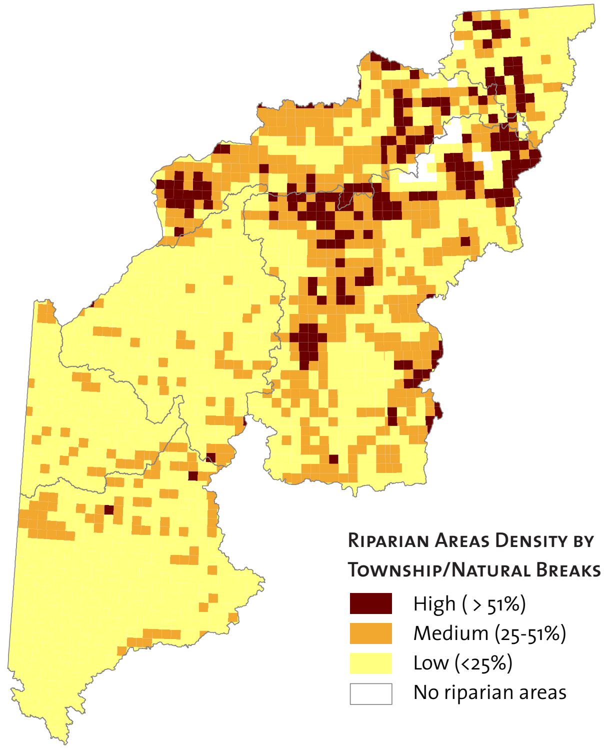
The three maps that follow display areas that are important for the maintenance and conservation of freshwater aquatic resources. The first map illustrates:

- **Source areas** (watersheds) for municipalities that take water from smaller, less reliable surface drinking waters, such as smaller tributaries and lakes, which are more vulnerable to land disturbances or pollution (page 33).
- **High water-yield areas** with a high rate of flow that protect freshwater supplies for human and wildlife use. In these areas, land disturbances or pollution are also more likely to move to aquatic ecosystems (page 27).
- **Areas above near-surface groundwater aquifers** and vulnerable to contamination (page 36).
- **Critical fish habitats** that are the most significant and sensitive in the province and thus have the highest level of protection (page 23).
- **Important recreational lakes**, as listed in the Atlas of Alberta Lakes.[36] Lac Cardinal is particularly important because of its connection with the Grimshaw aquifer (page 37).

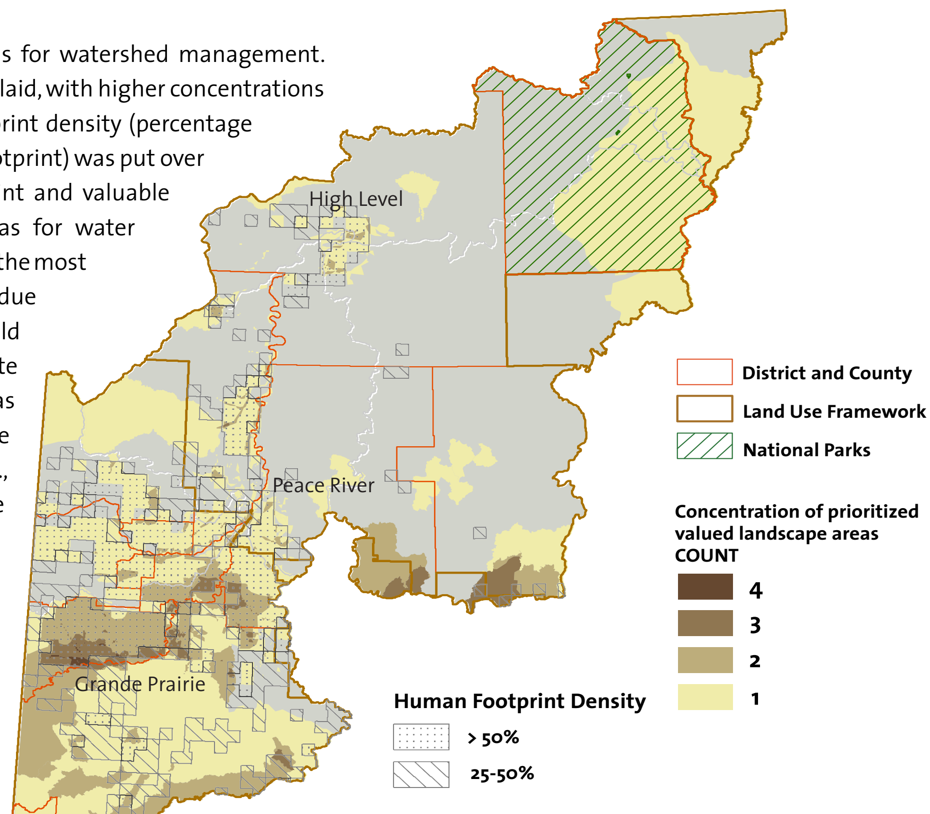
The second map highlights the density of riparian areas associated with running water. Riparian areas are important buffers between activities on uplands and water bodies. They are high in diversity and productivity, are critical for fish habitat, and serve as important travel corridors for wildlife. Aquatic ecosystems with highly disturbed riparian zones typically have poor health. The "high," "medium," and "low" classes were derived by using the Jenks method, which maximizes differences between classes and minimizes difference within classes.

Wetlands are important for numerous reasons, such as improving water storage, mitigating flooding and drought events, water purification, carbon accumulation, biodiversity, providing areas for groundwater recharge, and providing habitat for a multitude of species. Unfortunately, regional mapping of lost or impaired wetlands has not been completed for the watershed. Addressing this information gap is imperative as part of the exercise of determining hotspots of vulnerability.





The map at the right shows important areas for watershed management. Regionally valuable landscape areas were overlaid, with higher concentrations corresponding to more overlap. Human footprint density (percentage of a township covered by the ABMI Human Footprint) was put over these areas. The areas where human footprint and valuable landscape areas overlap are important areas for water supply and aquatic ecosystem health. They are the most likely to be under stress (excluding wetlands due to lack of data). These high-priority areas should be examined more closely and appropriate management actions considered. For areas with a high concentration of valued landscape areas but low human footprint density (e.g., Wabasca and Utikoumak areas, upper Little Smoky River), conservation and protection from future disturbance may be the focus of management. For other areas, different strategies may be employed. For example, while the majority of existing wetlands occur in areas with a relatively low human footprint, many such areas face expanding industrial activity. These activities should be discussed as part of regional Land Use Framework planning, as land management actions are likely to be generated through that process.

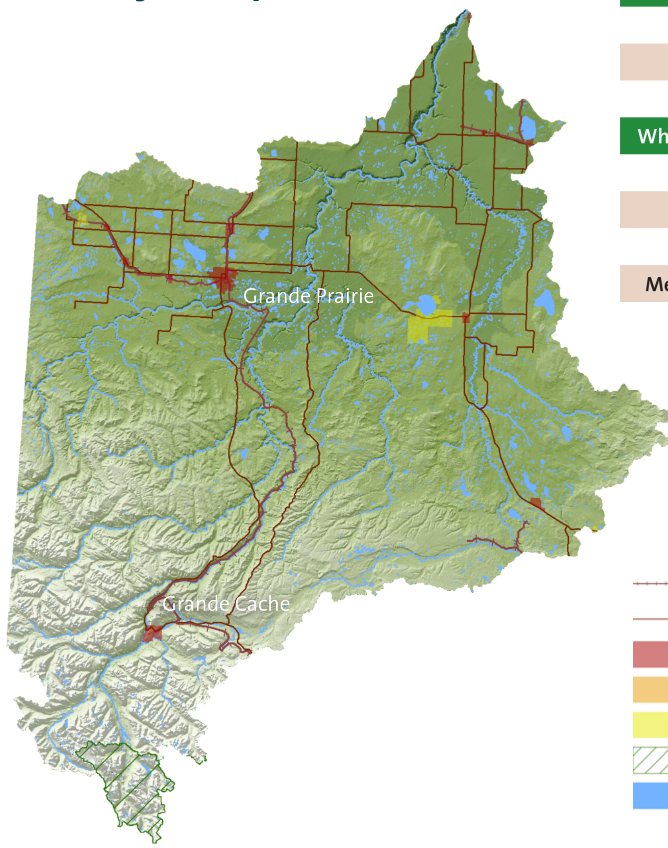


A more detailed, interactive version of this map is available online at mightypeacewatershedalliance.org

Appendix 1

Sub-Watersheds at a Glance

Smoky/Wapiti



- Railway
- Road
- City
- Métis Settlement
- Indian Reserve
- National Park
- Waterbody

	Demographics	% of MP
Area	46,659 m²	22 %
Population	101, 585	62 %

Where People Live		
City	55,032	54 %
Towns	17,465	17 %
Rural	27,500	27 %
Métis Settlement		
Reserve	1,588	2%

NOTES

All population data were derived from Canada Census 2011.

Where Métis settlements or reserves occupy parts of more than one sub-watershed, populations may have been assumed to be divided equally among sub-watersheds.

Please note that percentages may not always total 100% due to rounding.

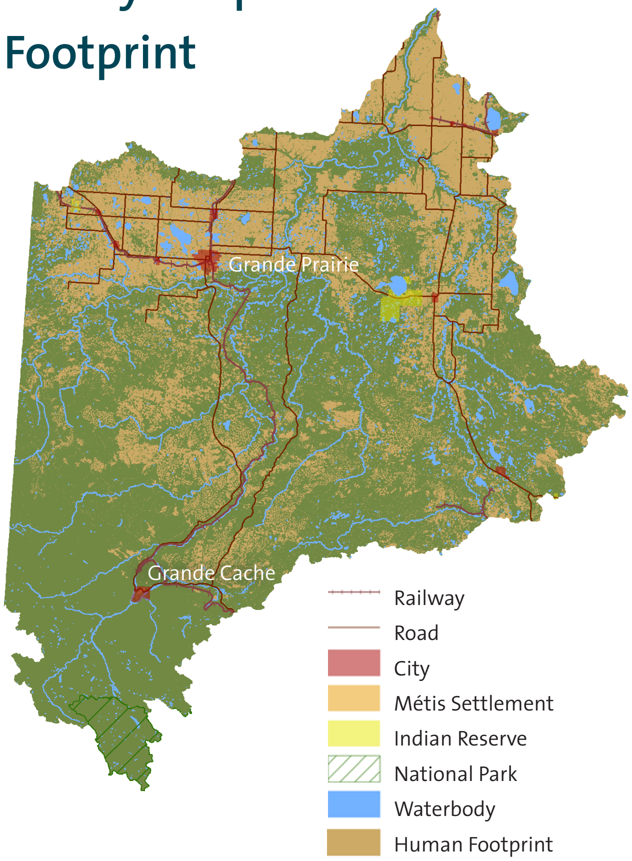
Commercial water allocation is for pulp mills, thermal generating plants and coal mines.

Industrial water allocation is for oil and gas operations.

Watershed Management Allocation is the license for water used to create habitat and manage lakes and/or wetlands, among other things.

Surface Water Allocation (m³)			Groundwater Allocation (m³)		
Total Volume	**109,628,821**		**Total Volume**	**10,476,478**	
Agricultural	2,267,422	2.07%	Agricultural	769,565	7.35%
Industrial	17,151,083	15.64%	Industrial	4,004,941	38.23%
Municipal	25,060,097	22.86%	Municipal	2,706,091	25.83%
Commercial	48,948,271	44.65%	Commercial	1,244,668	11.88%
Watershed Management	10,327,940	9.42%	Other	523,372	5.00%
Habitat Enhancement	4,426,665	4.04%	Recreation	29,230	0.28%
Registration	1,266,823	1.16%	Registration	1,193,965	11.40%
Recreation	61,670	0.06%	Habitat Enhancement	4,648	0.04%
Other	94,900	0.09%			

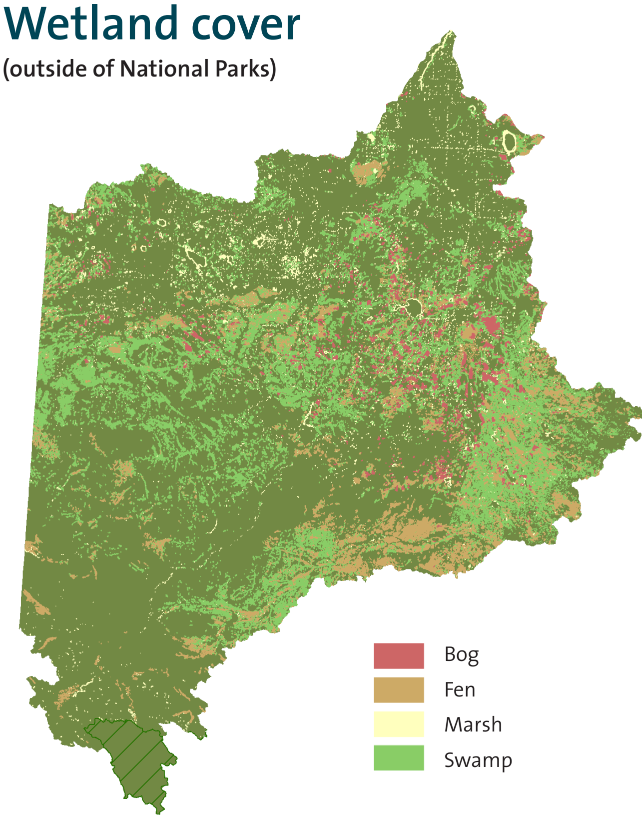
Smoky/Wapiti Footprint



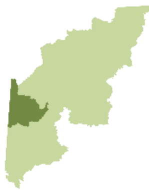
Total Footprint	**29.91%**
Cultivation (Crop/Pasture/Bare Ground)	17.05%
Cut Blocks	9.29%
Seismic line	0.80%
Road – Vegetated Verge	0.56%
Pipeline	0.46%
Rural (Residential/Industrial)	0.39%
Well Site	0.37%
Road – Hard Surface	0.33%
Road/Trail (Vegetated)	0.27%
Transmission Line	0.07%
Urban	0.10%
Borrow-Pits/Dugouts/Sumps	0.04%
Mine Site	0.09%
Industrial Site Rural	0.03%
Other Disturbed Vegetation	0.03%
Rail – Vegetated Verge	0.02%
Rail – Hard Surface	0.01%
Undisturbed	**70.09%**

Wetland cover

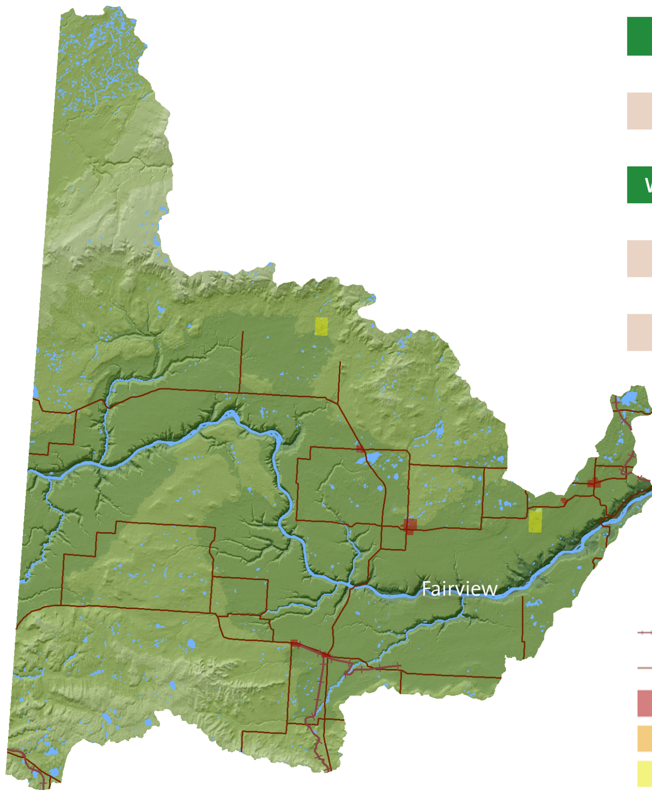
(outside of National Parks)



	11%	5,198 km²
Wetland type within sub-watershed		
Bog	11%	572 km²
Fen	28%	1,475 km²
Marsh	4%	198 km²
Swamp	57%	2,953 km²



Upper Peace Sub-Watershed



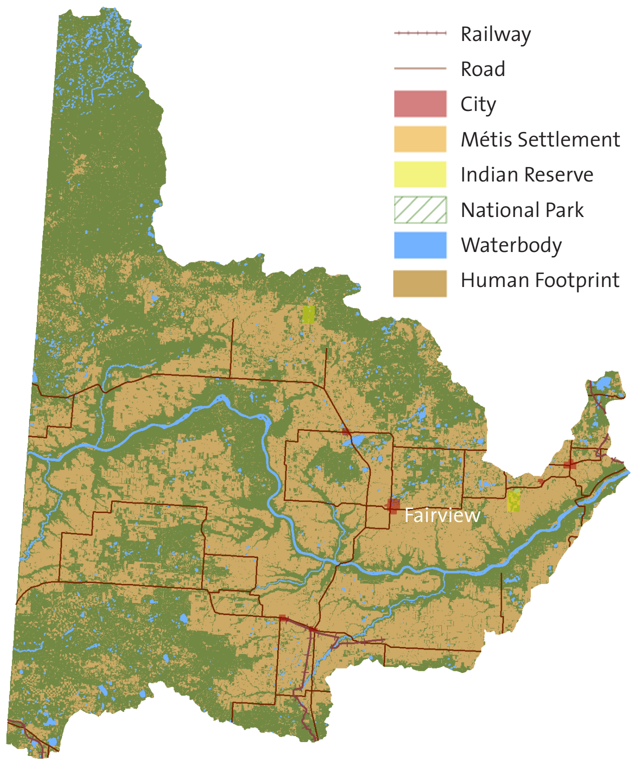
Demographics		% of MP
Area	17,554 m²	8 %
Population	18,010	11%

Where People Live		
City		
Towns	8,236	44%
Rural	9,610	52%
Métis Settlement	562	3%
Reserve	164	1%

Surface Water Allocation (m³)		
Total Volume	**11,596,284**	
Agricultural	1,695,338	14.26%
Industrial	310,840	2.61%
Municipal	3,324,112	27.95%
Commercial	1,379,515	11.60%
Watershed Management	2,466,147	21.27%
Habitat Enhancement	1,478,458	12.75%
Registration	887,479	7.46%
Recreation	46,870	0.40%
Other	7,525	0.06%

Groundwater Allocation (m³)		
Total Volume	**2,062,682**	
Agricultural	66,494	3.22%
Industrial	382,150	18.53%
Municipal	1,402,643	68.00%
Commercial	98,407	4.77%
Other	9,610	0.47%
Recreation	6,160	0.30%
Registration	97,218	4.71%
Habitat Enhancement		

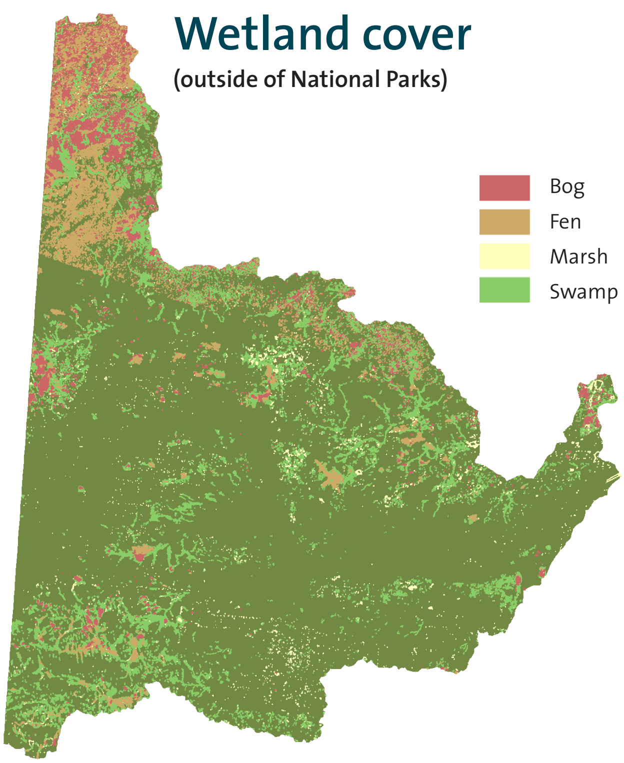
Upper Peace Footprint



Total Footprint	45.32%
Cultivation (Crop/Pasture/Bare Ground)	36.61%
Cut Blocks	4.71%
Seismic line	0.78%
Road – Vegetated Verge	0.76%
Pipeline	0.36%
Rural (Residential/Industrial)	0.55%
Well Site	0.52%
Road – Hard Surface	0.44%
Road/Trail (Vegetated)	0.35%
Transmission Line	0.04%
Urban	0.03%
Borrow-Pits/Dugouts/Sumps	0.07%
Mine Site	0.03%
Industrial Site Rural	0.01%
Other Disturbed Vegetation	0.01%
Rail – Vegetated Verge	0.01%
Rail – Hard Surface	0.01%
Undisturbed	**54.68%**

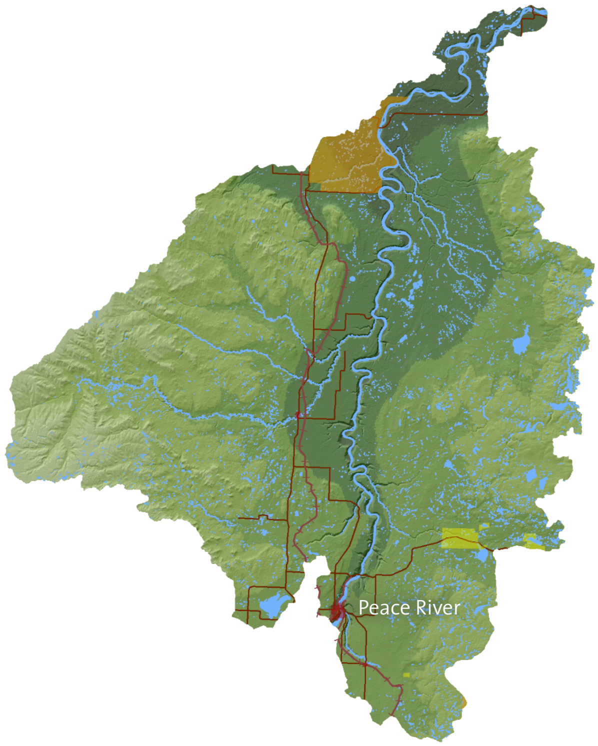
Wetland cover

(outside of National Parks)



	10%	1,836 km²
Wetland type within sub-watershed		
Bog	23%	425 km²
Fen	29%	530 km²
Marsh	3%	55 km²
Swamp	45%	825 km²

Central Peace Sub-Watershed



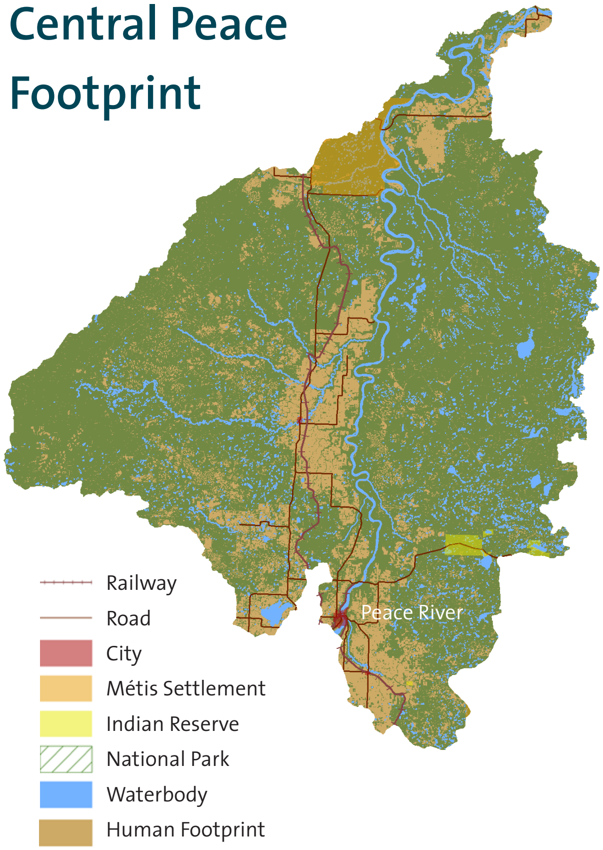
Demographics		% of MP
Area	35,374 m²	17 %
Population	14,481	9%

Where People Live		
City		
Towns	8,270	57%
Rural	5,362	37%
Métis Settlement	562	3
Reserve	849	6%

Railway
Road
City
Métis Settlement
Indian Reserve
National Park
Waterbody

Surface Water Allocation (m³)			Groundwater Allocation (m³)		
Total Volume	**56,951,051**		**Total Volume**	**1,479,329**	
Agricultural	497,477	0.87%	Agricultural	113,259	7.66%
Industrial	3,331,850	5.85%	Industrial	298,135	20.15%
Municipal	7,816,418	13.72%	Municipal	887,323	59.98%
Commercial	39,089,299	68.64%	Commercial	52,200	3.53%
Watershed Management	2,536,410	4.45%	Other	0	0.00%
Habitat Enhancement	506,352	0.89%	Recreation	2,470	0.17%
Registration	474,662	0.83%	Registration	123,482	8.35%
Recreation	0	0.00%	Habitat Enhancement		
Other	27,226	0.05%			
Water Act Hydraulic Testing	52,826	0.09%			

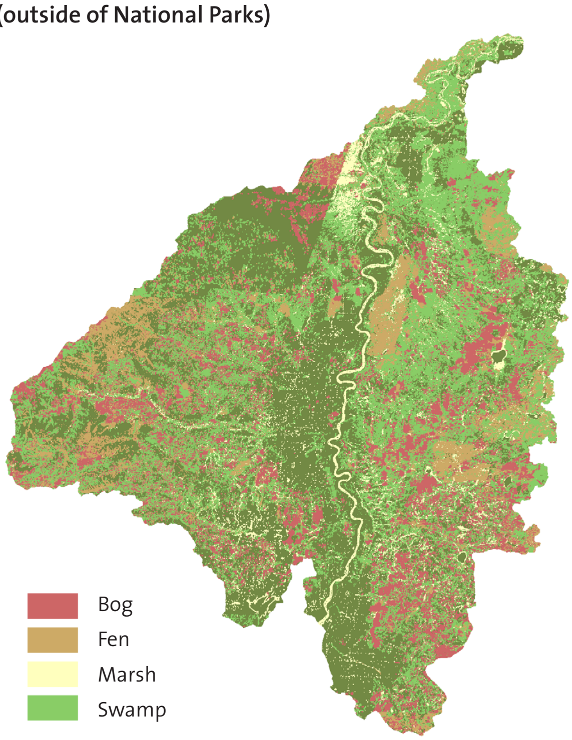
Central Peace Footprint



Total Footprint	16.92%
Cultivation (Crop/Pasture/Bare Ground)	9.49%
Cut Blocks	5.22%
Seismic line	0.99%
Road – Vegetated Verge	0.29%
Pipeline	0.18%
Rural (Residential/Industrial)	0.19%
Well Site	0.15%
Road – Hard Surface	0.16%
Road/Trail (Vegetated)	0.09%
Transmission Line	0.06%
Urban	0.01%
Borrow-Pits/Dugouts/Sumps	0.03%
Mine Site	0.01%
Industrial Site Rural	0.02%
Other Disturbed Vegetation	0.00%
Rail – Vegetated Verge	0.01%
Rail – Hard Surface	0.01%
Undisturbed	83.08%

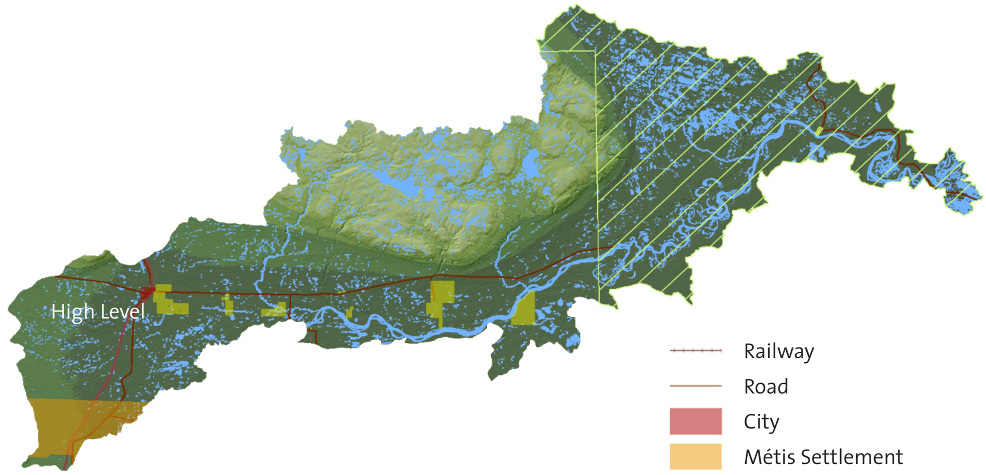
Wetland cover

(outside of National Parks)



	24%	8,393 km²
Wetland type within sub-watershed		
Bog	28%	2,376 km²
Fen	20%	1,704 km²
Marsh	7%	597 km²
Swamp	44%	3,716 km²

Lower Peace Sub-Watershed

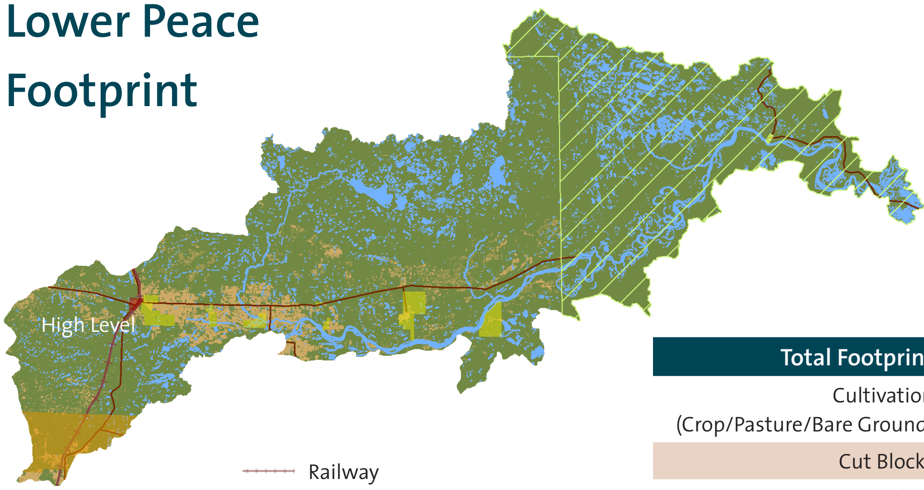


	Demographics	% of MP
Area	29,088 m²	14 %
Population	16,485	10%

Where People Live		
City		
Towns	3,641	22%
Rural	8,840	54%
Metis Settlement		
Reserve	4,004	24%

Surface Water Allocation (m³)			Groundwater Allocation (m³)		
Total Volume	**2,411,925**		**Total Volume**	**140,460**	
Agricultural	12,610	0.52%	Agricultural	3,700	2.63%
Industrial	0	0%	Industrial	0	0%
Municipal	14,588,839	60.48%	Municipal	8,630	6.14%
Commercial	47,674	19.68%	Commercial	0	0%
Watershed Management	426,780	17.69%	Other	128,100	91.20%
Habitat Enhancement	0	0%	Recreation	0	0%
Registration	37,757	1.57%	Registration	30	0.02%
Recreation	0	0%			
Other	1,265	0.05%			

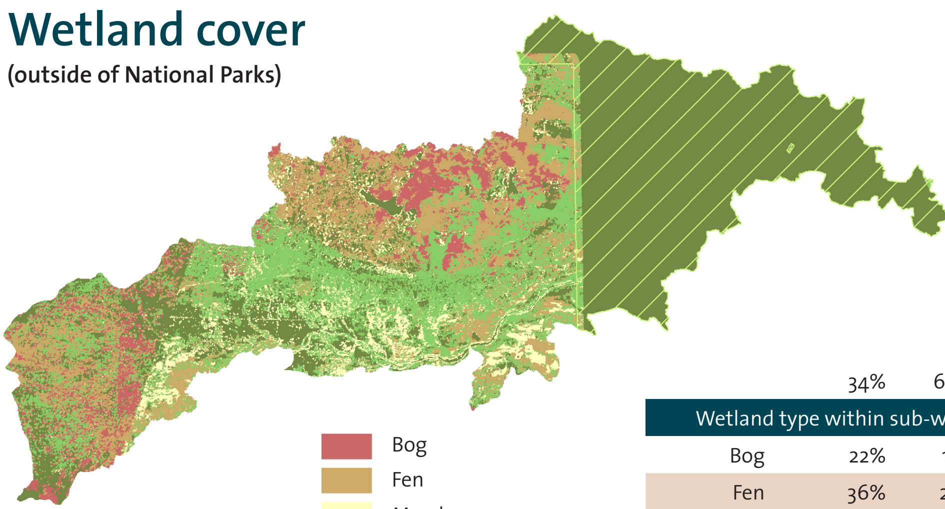
Lower Peace Footprint



Total Footprint	6.20%
Cultivation (Crop/Pasture/Bare Ground)	3.05%
Cut Blocks	2.33%
Seismic line	0.29%
Road – Vegetated Verge	0.10%
Pipeline	0.12%
Rural (Residential/Industrial)	0.07%
Well Site	0.06%
Road – Hard Surface	0.06%
Road/Trail (Vegetated)	0.04%
Transmission Line	0.03%
Urban	0.01%
Borrow-Pits/Dugouts/Sumps	0.02%
Mine Site	0.00%
Industrial Site Rural	0.02%
Other Disturbed Vegetation	0.00%
Rail – Vegetated Verge	0.00%
Rail – Hard Surface	0.00%
Undisturbed	93.80%

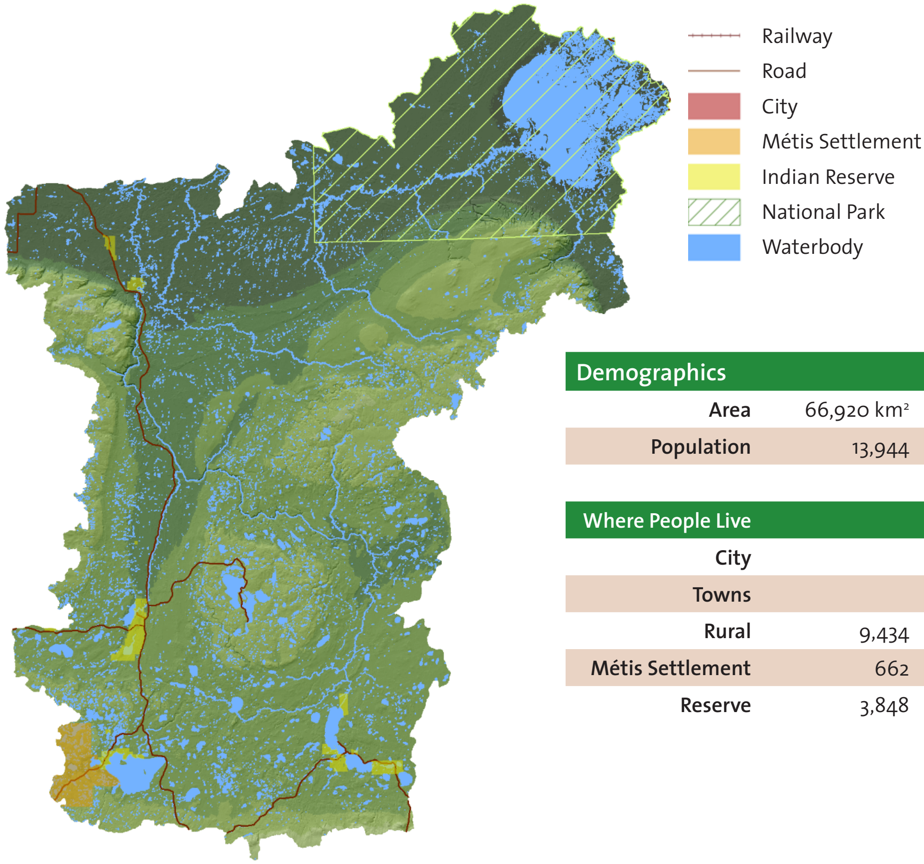
Wetland cover

(outside of National Parks)



	34%	6,660 km²
Wetland type within sub-watershed		
Bog	22%	1,436 km²
Fen	36%	2,368 km²
Marsh	10%	676 km²
Swamp	33%	2,180 km²

Wabasca Sub-Watershed



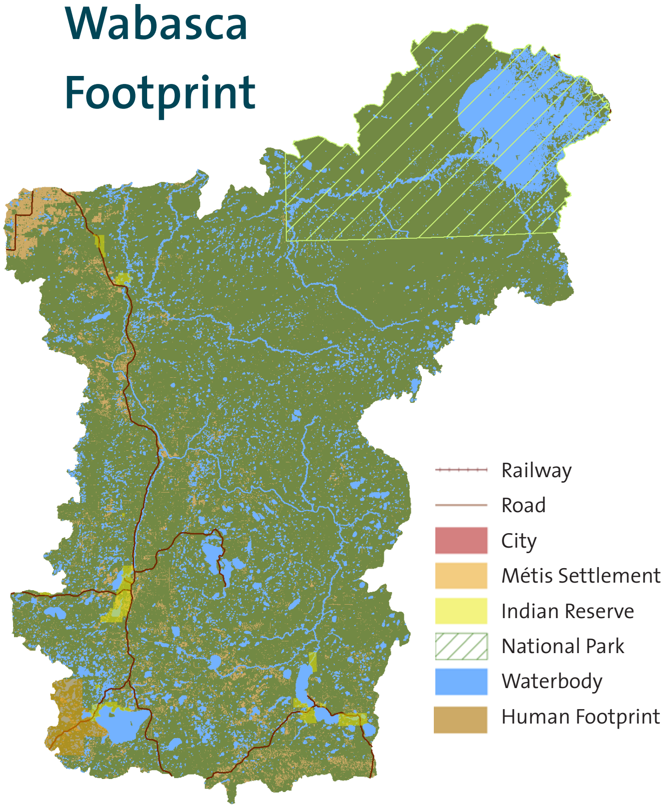
Demographics		% of MP
Area	66,920 km²	32%
Population	13,944	8%

Where People Live		
City		
Towns		
Rural	9,434	68%
Métis Settlement	662	5%
Reserve	3,848	28%

Surface Water Allocation (m³)		
Total Volume	14,055,822	
Agricultural	36,000	0.26%
Industrial	470,910	3.35%
Municipal	983,970	7.00%
Commercial	1,328,425	9.45%
Other	33,390	0.24%
Water Management: Utikima Lake Enhancement Project	11,182,266	79.56%

Groundwater Allocation (m³)		
Total Volume	6,781,116	
Agricultural	1,803	0.03%
Industrial	5,975,521	88.12%
Municipal	244,512	3.61%
Commercial	13,726	0.20%
Other	545,554	8.05%

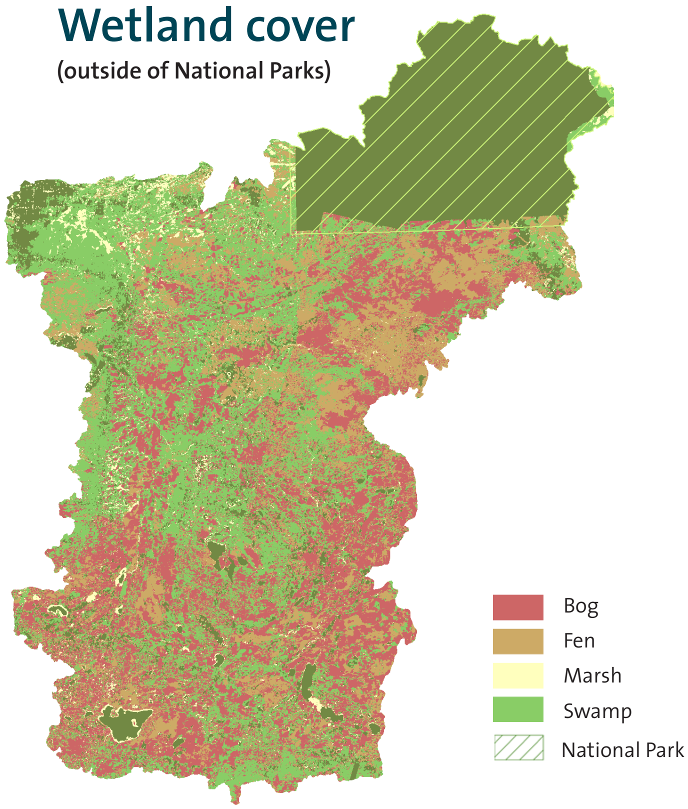
Wabasca Footprint



Total Footprint	2.70%
Cultivation (Crop/Pasture/Bare Ground)	1.33%
Cut Blocks	1.01%
Seismic line	0.12%
Road – Vegetated Verge	0.04%
Pipeline	0.05%
Rural (Residential/Industrial)	0.03%
Well Site	0.02%
Road – Hard Surface	0.02%
Road/Trail (Vegetated)	0.02%
Transmission Line	0.01%
Urban	0.01%
Borrow-Pits/Dugouts/Sumps	0.01%
Mine Site	0.00%
Industrial Site Rural	0.01%
Other Disturbed Vegetation	0.00%
Rail – Vegetated Verge	0.00%
Rail – Hard Surface	0.00%
Undisturbed	**97.30%**

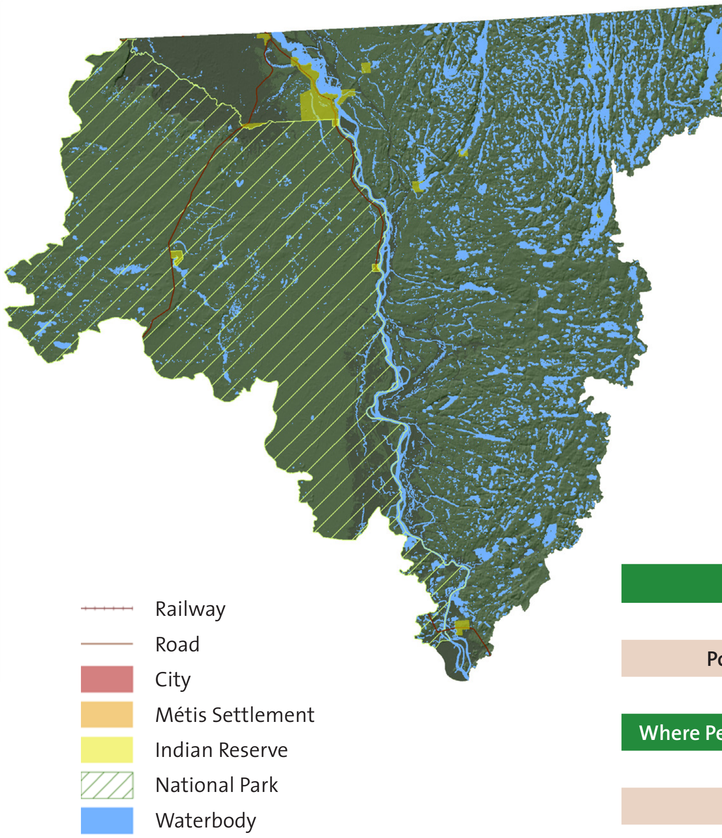
Wetland cover

(outside of National Parks)



	54%	29,565 km²
Wetland type within sub-watershed		
Bog	33%	9,870 km²
Fen	30%	8,807 km²
Marsh	3%	952 km²
Swamp	34%	9,936 km²

Slave River Sub-Watershed

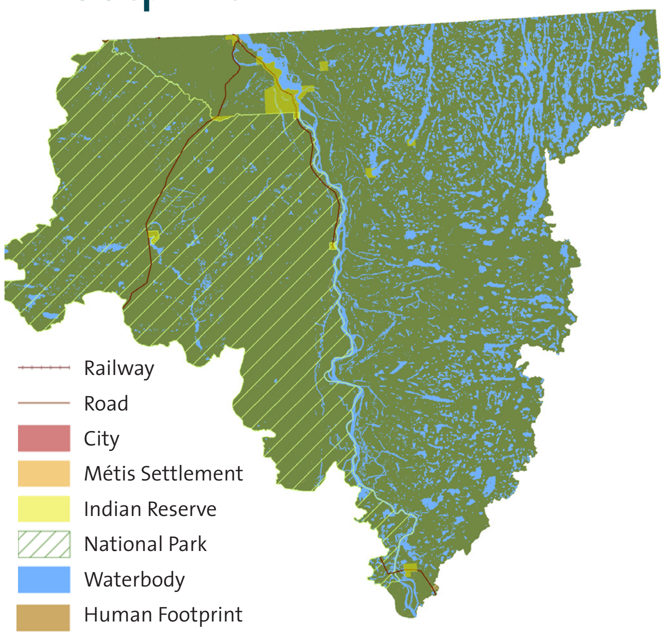


	Demographics	% of MP
Area	13,238 m^2	6 %
Population	100	~0 %

Where People Live		
City		
Towns		
Rural	70	70%
Métis Settlement		
Reserve	30	30%

There are no water allocations in the Slave River Sub-Watershed.

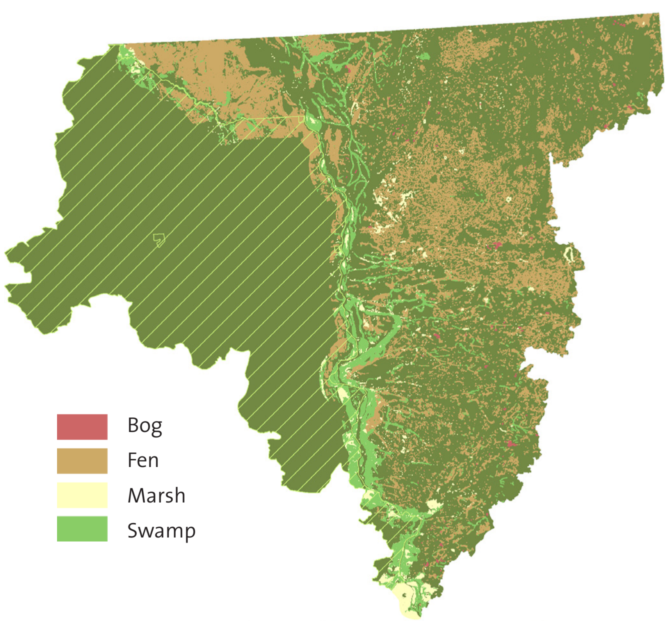
Slave River Footprint



Total Footprint	0.10%
Cultivation (Crop/Pasture/Bare Ground)	0.00%
Cut Blocks	0.00%
Seismic line	0.02%
Road – Vegetated Verge	0.02%
Pipeline	0.00%
Rural (Residential/Industrial)	0.01%
Well Site	0.00%
Road – Hard Surface	0.01%
Road/Trail (Vegetated)	0.03%
Transmission Line	0.00%
Urban	0.00%
Borrow-Pits/Dugouts/Sumps	0.00%
Mine Site	0.00%
Industrial Site Rural	0.00%
Other Disturbed Vegetation	0.00%
Rail – Vegetated Verge	0.00%
Rail – Hard Surface	0.00%
Undisturbed	**99.90%**

Wetland cover

(outside of National Parks)



	16%	1,247 km²
Wetland type within sub-watershed		
Bog	1%	11 km²
Fen	66%	821 km²
Marsh	9%	118 km²
Swamp	24%	297 km²

Appendix 2

Summary of Findings

This State of the Watershed report supports watershed management planning in the Mighty Peace watershed of Alberta. This report has three objectives:

1. Synthesize existing information for indicators in six categories (landscape, biological community, surface water quantity, surface water quality, groundwater quantity, groundwater quality), thereby providing a snapshot that illustrates the current condition of the watershed;
2. Identify information gaps for future considerations; and
3. Provide background information and appropriate communication methods to engage the public and stakeholders in watershed management planning.

The main results of this report can be summarized as follows:

- The Peace River and Slave River mainstems, as well as the larger tributaries (Smoky, Wabasca) are relatively healthy. They have good water quality and strong fish populations.
- The Peace River brings more water into Alberta than all of the southern rivers combined. Less than 1% of the natural flow of the Peace is allocated for use because the river is large and the population relatively small (approximately 165,000 or 4% of the provincial total).
- The Grimshaw Gravels Aquifer, the most important freshwater aquifer in the watershed, continues to provide a reliable supply of very good quality water. Because of its regional importance, this aquifer and its source areas must be protected to maintain integrity. At least four communities and numerous private users rely on this supply.
- Riparian areas associated with streams of all sizes are largely untouched in the Wabasca, Lower Peace, Slave River, and to a lesser extent, the Central Peace sub-watersheds, indicating good health.
- Riparian areas are critically important as areas of high biodiversity and buffers between human use and aquatic ecosystems. Riparian areas associated with streams of all sizes are highly disturbed in the Smoky/Wapiti (greater than 25% of all riparian areas) and Upper Peace (greater than 45% of all riparian areas) sub-watersheds.
- Smaller tributaries (tertiary tributaries and smaller) in areas with high intensity of human footprint (greater than 50% of township area) are in poor health. In many cases, fish populations are under stress, certain species are extirpated and lake and stream water quality are poor. These vulnerable areas were highlighted in the report for follow-up.
- As with many areas of the province, fish population densities in most monitored lakes, particularly for those with easy access, are low due to fishing pressure stress and loss/alteration of habitat.
- Of the dozen aquifers that are monitored on an ongoing basis, some show signs of over-use. That is, use is higher than supply, causing declined supply that has not recovered completely. The extent of this phenomenon should be investigated for the entire watershed.

- Point sources of pollution from the Aquatera and Weyerhaeuser wastewater streams and non-point sources of pollution from the City of Grande Prairie (e.g., from Bear Creek), in combination, have caused a slight reduction in water quality (from "Excellent" to "Good" on the Alberta River Water Quality Rating Index). Impacts from point sources of pollution have been a management priority for many years and those impacts have been kept to a minimum due to significant technological improvements over time. Non-point sources of pollution require attention in the future.
- Certain areas that are highly valued by the stakeholders of the watershed are currently under threat. Monitoring of water quality and fish in these areas has indicated impairment. Overlap between these areas and high human footprint intensity is identified in the report and should be targeted for monitoring.
- Invasive plant species in riparian areas are surprisingly high — up to 30% of coverage in some areas.
- Water quantity in a major tributary of the watershed, the Wabasca River, appears to have substantially decreased. This is consistent with a climate response seen throughout the province in the late 1990s, but requires further investigation.
- Groundwater quality varies greatly depending on the source aquifer and drilling location. Arsenic concentrations in freshwater aquifers continue to be a concern for drinking water quality.

Appendix 3

Data Gaps and Unknowns

As the first state of the watershed report for the Peace and Slave watershed, substantial information gaps were inevitable. The list of information gaps provides a solid foundation on which to base future updates of the report. Critical information gaps that greatly hinder informed water and watershed management planning include:

- The absence of a full accounting of water quantity due to the lack of comprehensive information on groundwater resources. This is particularly important as there is evidence that certain freshwater aquifers are currently under stress. Groundwater allocations are presented in the report, but this information has little value without knowing how much water is available as a comparison.
- An accounting of wetland loss for the entire watershed and hotspots of highest loss. Wetlands are part of the identity of the watershed. They are pervasive and extensive features on the landscape that perform many critical ecosystem services including water filtration, flood management, groundwater recharge and habitat for biodiversity. This information is critical for assigning priorities and generally managing wetland resources in the watershed.
- A near-absence of information on invasive species. Invasive plants in riparian areas do not appear to be a problem, but little information is available on invasive wildlife or other areas.
- Aquifer vulnerability mapping has been completed for the "White Zone" of the watershed. This type of mapping is extremely valuable in identifying critical areas for shallow groundwater protection and should be expanded to the rest of the watershed.

Other Data Gaps and Sources of Uncertainty

Surface Water Quality

- Small and medium-size river and stream water quality
- Diurnal datasets for major rivers, except Wapiti River
- Long-term trends in water quality
- Instream flow needs
- Lake beach bacteria monitoring
- Synoptic river surveys
- Estimates of natural water quality in impacted areas
- Seasonal water quality objectives
- Site-specific water quality objectives
- Nutrient guidelines

Wetlands

- Extent and locations of wetland loss
- Wetland health and function

Riparian Health

- Better coverage of individual riparian health assessments
- Lake riparian health

Invasive Species

- Terrestrial invasive species in riparian areas
- Freshwater diatom algae Didymo (*Didymosphenia geminata*)
- Invasive species in wetlands

Fish

- Population status of species that lack good data (goldeye, northern pikeminnow, and flathead chub)
- Population status for many fish in the Lower Peace, Central Peace (portions) and Wabasca sub-basins
- Stressor-Response relationships/thresholds of fish populations with
  - Cumulative human impacts
  - River regulation
  - Instream-flow needs for habitat
- Standard survey techniques for data inclusion to the Fish Sustainability Index
- Differentiate habitat use (resident vs. migrant populations, spawning, rearing, overwintering)
- Quantify fish barriers
- Review fish contaminants

Surface Water

- Overland flow and drainage patterns on a sub-catchment basin scale
- Lake water levels: Number of lakes in monitoring program and frequency of sampling have been drastically reduced
- Other than the Peace River, flow trends of major tributaries correlated with basin yield, climate and allocation data are not available

Climate

- Potential/Actual Evapotranspiration for the majority of eastern basins

Aquifers

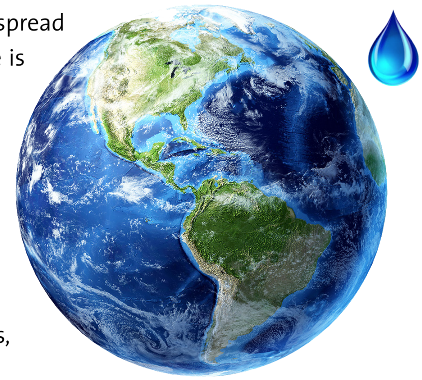
- Baseline groundwater chemistry studies are limited; most of the studies were carried out in the 1960s and 1970s
- Existing numerical models of the basins in the watershed were not available for this study
- Aquifer response to hydrological events is not well understood and hydrographs are limited
- Surface/groundwater interactions are not well understood. Only aquifers with high risk of surface contaminations are identified for a limited area
- Regional groundwater monitoring programs are limited. Southern Smoky/Wapiti basin around Grande Cache is noticeably lacking observation and monitoring wells
- Groundwater monitoring reports from industrial and commercial facilities are mostly unavailable to the public
- There have not been any comprehensive studies looking at the results of groundwater monitoring reports

Appendix 4

Geographical Background

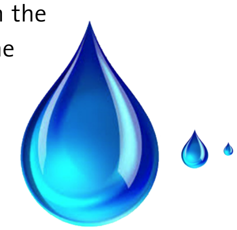
Global Water Supply

The global water supply seems plentiful because it is spread over two thirds of the Earth's surface. But its total volume is relatively small — equivalent to the drop shown here.

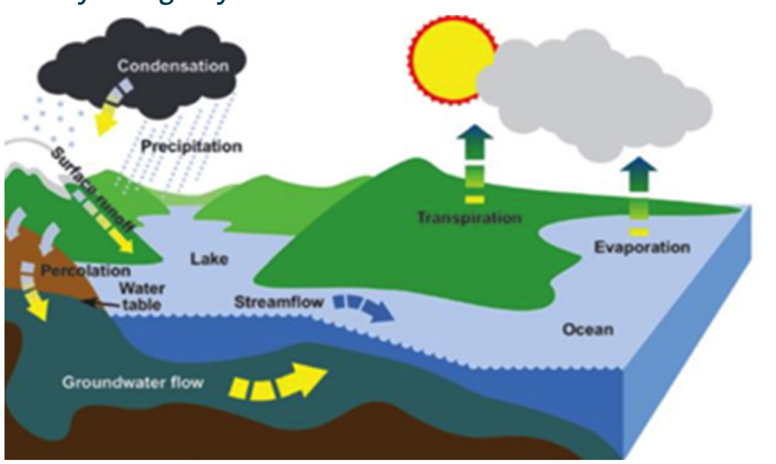


The world's total water supply is estimated to be approximately 1,386,000,000 cubic kilometres, over 96% of which is saltwater. The rest is mostly freshwater, but two-thirds of that is in ice caps, glaciers, and permanent snow, while close to one-third lies underground. Ground ice, permafrost and lakes constitute much of what remains, and still more is held by atmosphere, wetlands and soils.

In the image at right, the largest drop represents all the water on Earth in the oceans, lakes and rivers, the atmosphere, the ice and snow, as well as all of the groundwater, and the water within living things. The middle drop represents liquid freshwater in groundwater, wetlands, rivers, and lakes. Most of this water is in the ground. The smallest drop represents all the freshwater in lakes and rivers. Most of the water that sustains all terrestrial plants and animals comes from these surface-water sources.[37]



The Hydrologic Cycle



Source: Environment Canada

Rivers, the source of fresh surface water for most of humanity, account for only about 1/10,000th of one percent of all of the world's water.

Rivers

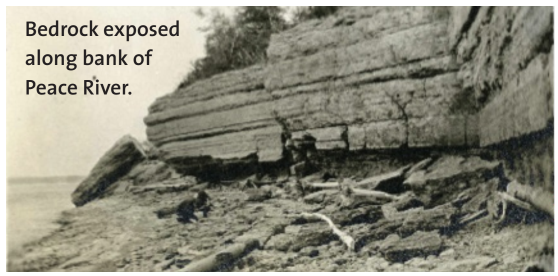
Rivers provide water for drinking, hydroelectricity, agriculture, industry, and travel routes for exploration, commerce and recreation. They are also vitally important to nature. They provide drainage channels for precipitation, nourish and protect plants and animals, deposit sediments, disperse organisms, and create beautiful scenery. They also play an integral role in The Hydrologic Cycle. Atmospheric water falls to earth as precipitation, percolates into the ground, is stored as ice or snow, or is taken up into the atmosphere by evaporation and transpiration to begin the cycle again.

Geology of the watershed

The Mighty Peace watershed was once a much different place. One hundred million years ago, the climate was warmer. Dinosaurs, ammonites, clams, sea stars and primitive plants such as conifers, cycads and ferns were the first inhabitants. An inland sea covered a huge area now called the Western Canada Sedimentary Basin. These waters provided habitat for marine animals and deposited the sediments that became the bedrock and the fossil fuels that now support the oil, gas and coal industries.

Gradually, mountains rose along the western margins of what is now British Columbia, forcing many west-draining patterns northward. Eventually, the Rocky Mountains rose up and many of the major landforms as we know them today were established.

For the last 3 million years, Ice Ages have regularly scoured the landscape, leaving behind the glacial till of sands, clays and gravels that now cover much of the region. The Peace River and its tributaries emerged in the wake of the most recent Ice Age, 12,000 years ago.



Bedrock exposed along bank of Peace River.

Wetlands

Four classes of wetlands are typically found in the watershed.

Bogs

- peatland with the water table at or near the surface
- generally acidic and low in nutrients
- treed or treeless, usually covered with sphagnum mosses, and heath-like shrubs
- form in cool wet areas where drainage is poor
- supplied with water mostly by precipitation
- characterized by a high accumulation of peat (greater than 40 centimetres)

Fens

- peatland with water table typically at or above the surface
- waters mainly nutrient-rich, from mineral soils
- vegetation mostly sedges, grasses, reeds, and brown mosses, shrubs and sometimes a sparse tree layer
- receive most of their water from groundwater
- water that is less acidic and contains more nutrients than bogs
- high accumulation of peat (greater than 40 centimetres), but because they are less acidic, they can accommodate different vegetation, like sedges, grasses, and wildflowers
- fens can look like open, grassy fields or can be wooded

Marshes

- mineral wetland or peatland
- periodically inundated by standing or slowly moving waters
- surface waters may fluctuate
- matted vegetation or mudflats
- waters are nutrient rich
- pools or channels interspersed with sedges, grasses, rushes, and reeds, bordering grassy meadows and peripheral bands of shrubs or trees

Swamps

- peatland or mineral wetland
- standing or gently flowing waters in pools or channels
- water table is usually at or near the surface
- waters are rich in nutrients
- vegetation characterized by a dense tree or shrub cover of deciduous or coniferous species, herbs, and some mosses[38]

INFO GAPS

Amount of wetland loss is unknown in the watershed as too few studies have been undertaken in the region.

The Water for Life Strategy

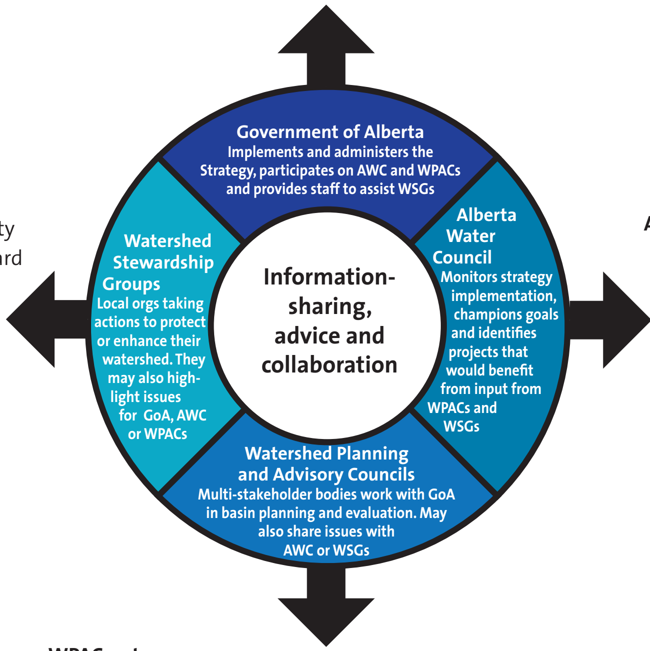
Key Partnerships in the Water For Life Strategy[39]

GoA outcomes:

- Timely response to AWC recommendations
- Review and approval of water management plans
- Technical and administrative support for partnerships

WSG outcomes:

- Taking community action to safeguard Alberta's water resources
- Input into WPAC activities and submission of issues to AWC



AWC outcomes:

- Timely and strategic advice given to governments, industry and NGOs
- Body of knowledge expertise on specific water issues

WPAC outcomes:

- Maintaining leadership in watershed assessment and planning
- Advice and support for WSGs and presentation of issues to AWC

Looking for a Watershed Stewardship Group in Your Watershed?

The Stewardship Directory helps individuals find community stewardship groups, and helps stewardship groups, other organizations, businesses and government find one another. For more information, contact the Land Stewardship Centre at directory@landstewardship.org

Did you know?

- *All water in Alberta is owned by the Crown and managed by the province.*
- *Albertans living adjacent to a water body or above a source of groundwater have the statutory right to use up to 1,250 m3 of water per year for human consumption, sanitation, and other smaller household uses.*
- *Activities affecting water in wetlands, such as infilling, are regulated by the Water Act. Alberta Environment and Sustainable Resource Development must approve any activity, before it is undertaken in a wetland.*

More about water and water legislation in Alberta is available online at: **www.albertawater.com/alberta-water-legislation-regulations-guidelines** and **environment.gov.ab.ca/info/library/6364.pdf**

Appendix 5

More Information and How To Get Involved

One of the objectives of the MPWA is to give people an opportunity to participate in watershed management. At the provincial scale, this is accomplished through involvement with the other Watershed Planning and Advisory Councils (WPACs) as well as sending a WPAC representative to the provincial Water Council.

Local stewardship groups are encouraged to address water issues at a local scale, through groups such as the West County Watershed Society, Clear Hills Watershed Initiative, Heart River Watershed Advisory Council and Grimshaw Gravels Aquifer Management Advisory Association. These organizations provide opportunities for citizens to become involved. Many others, including researchers, environmental groups and other organizations, are engaged in water-related work in the watershed.

Many organizations active in water and watershed issues in the watershed are identified in the MPWA-commissioned Peace Watershed Directory of Water Organizations and Information Sources.

Information Resources

1. For more on the Government of Alberta's Water for Life strategy, see http://www.waterforlife.Alberta.ca
2. For more information about the work of the MPWA, see http://www.mightypeacewatershedalliance.org
3. MPWA technical reports are available for download at: http://www.mightypeacewatershedalliance.org/reports
4. For more information about the Mackenzie River Watershed, see http://www.mrbb.ca/
5. Information on all regulated systems in the province can be found online at http://environment.Alberta.ca/apps/regulateddwq/Default.aspx
6. For a listing of boil water advisories, see http://www.albertahealthservices.ca/1926.asp
7. For more information about the Working Well program, see http://esrd.alberta.ca/water/education-guidelines/working-well/default.aspx
8. For more information about well water safety and possible treatment options, see http://www.Albertahealthservices.ca/services.asp?pid=service&rid=1052212
9. For an example of a watershed management plan developed to address source protection, see the Heart River Watershed Management Plan at http://www.aquality.ca/uploads/news/id93/Heart_River_WMP.pdf
10. Under Water for Life, a number of projects on aquatic ecosystem health have been carried out. For more information about these projects, see http://www.waterforlife.Alberta.ca/03325.html

11. For more information about the WAC Bennett Dam, see http://www.bchydro.com/community/recreation_areas/w_a_c_bennett_dam_visitor_centre.html
12. For more information about bilateral negotiations, see http://www.waterforlife.Alberta.ca/03330.html
13. One example of a major study was the Northern River Basins Study/ Northern Rivers Ecosystem Initiative. For more on this, see http://www.ec.gc.ca/nature/default.asp?lang=En&n=9F1F07FE-1
14. For a state of the watershed of the entire Mackenzie River basin, of which the Mighty Peace watershed is a part, see http://www.mrbb.ca/information/34/index.html
15. CPP Environmental and Hutchinson Environmental Sciences. *Aquatic Ecosystem Health of the Peace Watershed Project*: final report June 2012. Prepared for the Mighty Peace Watershed Alliance, June 2012. 102 pp. Available on the MPWA website.
16. Watrecon Consulting, Ellehoj Redmond Consulting, Aquality Environmental Consulting Ltd. and Duane McNaughton, P. Geol. The Peace Watershed: Current and Future Water Use and Issues. Prepared for the Mighty Peace Watershed Alliance, March 2012. 125 pp. Available on the MPWA website.
17. For information about water management planning in Alberta, see http://environment.gov.ab.ca/info/library/6367.pdf
18. For more information about Water Use Reporting, see Alberta Environment and Sustainable Resource Development webpage at http://www.waterforlife.Alberta.ca/02642.html
19. For more information about the Alberta Water Council, see http://www.Albertawatercouncil.ca/
20. For more about water CEP plans, see http://www.Albertawatercouncil.ca/Projects/WaterConservationEfficiencyandProductivity/tabid/115/Default.aspx
21. Guide to Reporting on Common Indicators used in State of the Watershed Reports. This guide is available at http://environment.gov.ab.ca/info/library/8713.pdf
22. To learn more about Alberta Lakes, visit the Alberta Lake Management Society website at http://alms.ca
23. Glossary of Terms for Water and Watershed Management in Alberta: http://environment.gov.ab.ca/info/library/8043.pdf

Appendix 6
Glossary

This glossary is adapted from the Glossary of Terms for Water and Watershed Management in Alberta (http://environment.gov.ab.ca/info/library/8043.pdf). Only terms used in this report have been included in this reproduction.

Alberta Water Council — A provincial advisory body, including sector representatives from industry, non-government organizations (NGOs), the Government of Alberta and Provincial Authorities, and other governments, established as part of the Water for Life strategy to provide advice to the Government of Alberta regarding water issues.

Algae — Simple single-celled (phytoplankton), colonial, or multi-celled, mostly aquatic plants, containing chlorophyll and lacking roots, stems and leaves. Aquatic algae are microscopic plants that grow in sunlit water that contains phosphates, nitrates, and other nutrients. Algae is either suspended in water (plankton) or attached to rocks and other substrates (periphyton). Their abundance, as measured by the amount of chlorophyll a (green pigment) in an open water sample, is commonly used to classify the trophic status of a lake. Algae are an essential part of the lake ecosystem and provides the food base for most lake organisms, including fish.

Algal bloom — A heavy growth of algae in and on a body of water that is often triggered by environmental conditions such as high nitrate and phosphate concentrations. The decay of algal blooms may reduce dissolved oxygen levels.

Aquatic ecosystem — An aquatic area where living and non-living elements of the environment interact. This includes the physical, chemical, and biological processes and characteristics of rivers, lakes, and wetlands and the plants and animals associated with them.

Aquatic macrophyte — Large (in contrast to microscopic) plants that live completely or partially in water.

Aquatic species — The plants and animals living in, or associated with, water bodies, wetlands, and riparian areas.

Aquifer — An underground water-bearing formation that is capable of yielding water. Aquifers have specific rates of discharge and recharge. As a result, if groundwater is withdrawn faster than it can be recharged, the underground aquifer cannot sustain itself.

Bacteria — A diverse group of microorganisms that occur naturally in aquatic environments. Bacteria that occur naturally in surface water generally are not harmful to humans, but pathogenic bacteria can be introduced into surface waters from wastewater, particularly from municipal sewage effluents.

Baseline data — An initial set of observations or measurements used for comparison; a starting point.

Bog — A wetland characterized by peat deposits, acidic water, and extensive surface mats of sphagnum moss. Bogs receive their water from precipitation rather than from runoff, groundwater, or streams, which decreases the availability of nutrients needed for plant growth.

Cistern — A tank for storing water or other liquids, usually placed above the ground.

Code of practice — A document governing an activity or a portion of an activity. One example is the Code of Practice for Pipelines and Telecommunication Lines Crossing A Water Body.

Coliform bacteria — Micro-organisms that typically inhabit the intestines of warm-blooded animals. Drinking water quality assessments commonly include tests for coliform bacteria to determine if water has been polluted by human or animal waste.

Concentration — The amount of a substance in a given volume of water. For most substances, the concentration is expressed as milligrams per litre (mg/L), which is the same as parts per million (ppm). Technology now exists that can measure substances at the parts per trillion or quadrillion level.

Conservation — 1. The planning, management, and implementation of an activity with the objective of protecting the essential physical, chemical, and biological characteristics of the environment against degradation.

2. The process of managing biological resources (e.g., timber, fish) to ensure replacement by re-growth or reproduction of the part harvested before another harvest occurs. A balance between economic growth and environmental and natural resource protection.

Contaminant — A substance that, in a sufficient concentration, will render water, land, fish, or other things unusable or harmful.

Cumulative effects — The combined effects on the aquatic environment or human developments arising from the combined environmental impacts of several individual projects.

Dam — A barrier constructed on a water body for storage, control, or diversion purposes. A dam may be constructed across a natural watercourse or on the periphery of a reservoir. Natural barriers formed by ice, landslides, or earthquakes are excluded.

Discharge — Refers to the outflow, and is used as a measure of the rate at which a volume of water passes a given point. Therefore, the use of this term is not restricted as to course or location, and it can be used to describe the flow of water from a pipe or a drainage basin.

Disinfection A process that has as its objective destroying or inactivating pathogenic micro-organisms in water.

Disposal well A deep well used for the disposal of liquid wastes.

Dissolved oxygen A measurement of the amount of oxygen available to aquatic organisms. Temperature, salinity, organic matter, biochemical oxygen demand, and chemical oxygen demand affect dissolved oxygen solubility in water.

Diversion of water 1. The impoundment, storage, consumption, taking or removal of water for any purpose. This does not include removal for the sole purpose of removing an ice jam, drainage, flood control, erosion control or channel realignment.

2. The transfer of water from a stream, lake, aquifer, or other source of water by a canal, pipe, well, or other conduit to another watercourse or to the land, as in the case of an irrigation system. Also, a turning aside or alteration of the natural course of a flow of water, normally considered physically to leave the natural channel.

Drinking water Water that has been treated to provincial standards and is fit for human consumption.

Drought Periods of less than average precipitation over a certain period of time. Drought is naturally occurring and can cause imbalances in the hydrologic system.

Ecosystem A community of interdependent organisms together with the environment they inhabit and with which they interact.

Effluent 1. The liquid waste of municipalities, industries, or agricultural operations. Usually the term refers to a treated liquid released from a wastewater treatment process.

2. The discharge from any on-site sewage treatment component.

Environment The components of the earth, including air, land, and water, all layers of the atmosphere, organic and inorganic matter, living organisms, and their interacting natural systems.

Erosion The natural breakdown and movement of soil and rock by water, wind, or ice. The process may be accelerated by human activities.

Evapotranspiration The combination of evaporation from the surface of soils and vegetation, plus the transpiration of water through plant leaves and vegetation.

Fen A wetland characterized by slow internal drainage from groundwater movement and seepage from upslope sources. Fens are characterized by peat accumulation, but due to the seepage of nutrient-rich water, fens are typically less acidic and more nutrient-rich than bogs.

Fish habitat	Spawning grounds and nursery, rearing, food supply and migration areas on which fish depend directly or indirectly in order to carry out their life processes.
Fishery	An area of water inhabited by fish.
Flood	An overflow of water onto lands that are used or usable by humans and not normally covered by water. Floods have two essential characteristics: it is temporary; and the land is adjacent to and inundated by overflow from a river, stream, lake, or ocean.
Groundwater	All water under the surface of the ground whether in liquid or solid state. It originates from rainfall or snowmelt that penetrates the layer of soil just below the surface. For groundwater to be a recoverable resource, it must exist in an aquifer. Groundwater can be found in practically every area of the province, but aquifer depths, yields, and water quality vary.
Groundwater recharge	Inflow of water to a groundwater reservoir (zone of saturation) from the surface. Infiltration of precipitation and its movement to the water table is one form of natural recharge. Also, the volume of water added by this process.
Guideline	A specific performance measure that is not legally binding unless designated in legislation. It is a guide or indication of a future course of action. It describes how something will be accomplished. It may contain numerical performance measures and may deal with multiple uses of water.
Habitat	The natural home of a living organism. The three components of wildlife habitat are food, water, shelter.
Headwaters	The source and upper tributaries of a stream or river.
Household purposes	Water used for human consumption, sanitation, fire prevention, and watering animals, gardens, lawns and trees.
Hydrologic cycle	The process by which water evaporates from oceans and other bodies of water, accumulates as water vapor in clouds, and returns to oceans and other bodies of water as rain and snow or as runoff from this precipitation or groundwater.
Indicator	A direct or indirect measurement of some valued component or quality in a system, including an ecosystem or organization. For example, an indicator can be used to measure the current health of the watershed or to measure progress toward meeting an organizational goal.
Instream flow needs (IFN)	The scientifically determined amount of water, flow rate, or water level that is required in a river or other body of water to sustain a healthy aquatic environment or to meet human needs such as recreation, navigation, waste assimilation, or aesthetics. An in-stream flow need is not necessarily the same as the natural flow.

Intake Any structure on the upstream face of a dam or within a reservoir created for directing water into a confined conduit, tunnel, canal, or pipeline.

Irrigation The controlled application of water for agricultural purposes through man-made systems to supply water requirements not satisfied by rainfall.

Legislation Laws such as Acts and Regulations that are established by an elected official.

Mainstem
1. The primary channel of a river.
2. The primary river in a drainage basin.

Marsh A water body covered by water for at least part of the year and characterized by aquatic and grass-like vegetation, especially without peat-like accumulation.

Non-point source pollutant Contaminants that enter a water body from diffuse or undefined sources and are usually carried by runoff. Examples of non-point sources include agricultural land, coal mines, construction sites, roads, and urban areas. Because non-point sources are diffuse, they are often difficult to identify or locate precisely, and are therefore difficult to control.

Nutrient An element essential for plant or animal growth. Major plant nutrients include nitrogen, phosphorus, carbon, oxygen, sulphur, and potassium.

Partnership A relationship in which individuals or organizations share resources and responsibility to achieve a common objective, as well as any resulting rewards or recognition. It often includes a formal contract, new resources and shared risks and rewards. The structure includes a central body of decision-makers whose roles are defined. The links are formalized. Communication is frequent, the leadership is autonomous and the focus is on specific issues. Partnerships are a form of collaboration.

Peatland Permanent wetlands characterized by a bed made of highly organic soil (»50% combustible) composed of partially decayed plant material.

Pesticide Any chemical compound used to control unwanted species that attack crops, animals, or people. This diverse group of chemicals includes herbicides, fungicides, and insecticides.

pH A measure of the intensity of the acid or base chemistry of the water. A pH of 7 is neutral, while below 7 is acidic and above 7 is basic. pH in surface water is regulated by the geology and geochemistry of an area and is affected by biological activity. The distribution of aquatic organisms and the toxicity of some common pollutants are strongly affected by pH.

Point-source pollution	
Policy	1. A governing principle, plan, or consistent course of action developed to meet recognized needs and to achieve specific measurable outcomes. Policies are normally broad, conceptual documents that outline approaches and/or considerations to be taken into account by decision makers. Policies do not act as constraints, but provide information. 2. A statement of intent that is not legally binding. It sets direction and expectations for activities.
Pollutant	A contaminant in a concentration or amount that adversely alters the physical, chemical, or biological properties of the natural environment.
Public and stakeholder Involvement	The process used by government to obtain advice or recommendations from a community and engage them in decision-making. Public and stakeholder involvement is an umbrella term that includes a range of interactive approaches including information and education, consultation, collaboration, partnerships and delegated authority.
Regulation	Created under authority granted by a law, a regulation presents more specific requirements than the legislation itself.
Reservoir	A man-made lake that collects and stores water for future use. During periods of low river flow, reservoirs can release additional flow if water is available.
Riparian	Pertaining to the banks of a river, stream, waterway, or other, typically, flowing body of water as well as to plant and animal communities along such bodies of water.
Riparian area	The area of water-loving vegetation beside a stream, river, lake, or pond. Riparian areas are critical in reducing the negative effects of various land-uses on adjacent waters.
Riparian health assessment	An educational tool used by the Cows and Fish Program. It involves using visual observation to interpret the health of a riparian area and making comparisons over time.
River basin	An area of land drained by a river and its associated streams or tributaries. Alberta's Water Act identifies seven Major River Basins within the province: (1) Peace/Slave River Basin, (2) Athabasca River Basin, (3) North Saskatchewan River Basin, (4) South Saskatchewan River Basin, (5) Milk River Basin, (6) Beaver River Basin, and (7) Hay River Basin.
Runoff	Water that moves across (or through) soils on the land during snowmelt or rainstorms.
Saline Groundwater	Groundwater that has more than 4,000 mg/L of total dissolved solids.
Sediment	Eroded soil, rock and plant debris, transported and deposited by water.
Sedimentation	The process of material settling out of water.

Seepage	The flow or movement of water through a dam, its foundation, or abutments.
Septic system	A combination of underground pipe(s) and holding tank(s) which are used to hold, decompose, and clean wastewater for subsurface disposal.
Settling pond	An open lagoon into which wastewater contaminated with solid pollutants is placed and allowed to stand. The solid pollutants suspended in the water sink to the bottom of the lagoon and the liquid is allowed to overflow out of the enclosure.
Sewer	Any system of pipes, drains, pumping works, equipment, structures, and other things used for the collection, transportation or disposal of wastewater, but does not include any building drain, plumbing, or building sewer.
Shallow open water	Small bodies of standing water less than 2m deep that act as transitional areas between lakes and marshes. Shallow open water does not contain emergent aquatic vegetation like cattails and reeds, but may support floating vegetation like lily pads.
Shore	The edge of a body of water and includes the land adjacent to a body of water that has been covered so long by water as to wrest it from vegetation or as to mark a distinct character on the vegetation where it extends into the water or on the soil itself.
Source water	Raw/untreated water received for treatment to provide potable water to municipal, industrial or private users. Sources may include high quality groundwater, groundwater under the influence of surface water and surface water from lake, stream, river or watercourse.
Stakeholder	An individual, organization, or government with a direct interest in a particular process or outcome.
Standard	A definite rule established by authority. They are legally enforceable numerical limits or narrative statements found in a regulation, statute, contract, or other legally binding document, which have been adopted from a criterion or objective. Environmental standards often take the form of prescribed numerical values that must be met.
State of the Watershed Report	A document that identifies the current condition of a watershed including the physical, chemical, and biological characteristics of its surface and groundwater and the pressures acting on it.

Stewardship A principle or approach whereby citizens, industry, communities, and government work together as stewards of the province's natural resources and environment. In general terms, stewardship means managing one's life, property, resources, and environment with regard for the rights or interests of others. This can apply to a person, company, community, government or group. Stewardship is an ethic and a value that results from public education and partnerships. It is people-focused in the sense that it relies on the desire and ability of people to make good decisions on their own accord that help resources and environmental outcomes.

Strategy A perspective, position, or plan developed and undertaken to achieve goals. It is the bridge between policy and concrete actions that outlines how a policy will be implemented to achieve its goals.

Sub-basin Part of a river basin drained by a tributary or with significantly different characteristics than the other areas of the basin.

Sub-watershed A smaller watershed that is a piece of a much larger watershed.

Surface water Water bodies such as lakes, ponds, wetlands, rivers, and streams, as well as groundwater with a direct and immediate hydrological connection to surface water (for example, water in a well beside a river).

Suspended solids Materials, such as fine particles of soil, that neither dissolve nor settle out of water, but instead are held or carried along in the water.

Sustainability The balancing of opportunities for growth with the need to protect the environment. It reflects a vision of a vibrant economy and a healthy environment. Regarding renewable resources (e.g., water, timber, fish, and wildlife), sustainability involves managing renewable natural resources so that their status, condition, or use is maintained over time. In this context, the use of a renewable resource, or impacts on it from other human activities, should not exceed its capacity to maintain itself through re-growth, reproduction, and management practices. Regarding non-renewable resources (e.g., coal, oil, gas, and minerals), sustainability involves the development of resources in a responsible manner. This means protecting the environment during the construction and operation phases and ultimately reclaiming the land disturbed by development. In this context, non-renewable resource development is a temporary land use.

Threshold The value of an indicator that reflects a problem condition.

Total dissolved solids (tds) 1. A measure of the concentration of dissolved matter in water. Total Dissolved Solids measurements are often used to estimate a water body's salinity, which may affect the distribution of aquatic organisms.

2. Calcium, magnesium, sodium, potassium, bicarbonate, sulfate, chloride, and silica are typical dissolved solids.

Total suspended solids (tss) A measurement of the quantity of matter suspended, but not dissolved, in a unit of water. Suspended solids include a wide variety of materials such as silt, decaying plant matter, industrial wastes, and sewage.

Traditional agricultural registration Provides the authority for diverting and using groundwater to an agricultural landowner for the purpose of raising animals or applying pesticides to crops, as part of a farm unit. A registration of a diversion of water may not exceed 6250 cubic metres of water per year or the maximum amount specified in an applicable approved water management plan. The landowner must prove first diversion of such water occurred prior to January 1, 1999.

Treated Wastewater Effluent/discharge from a wastewater treatment plant that meets the quality outlined in the wastewater treatment plant approval prior to discharge to the receiving environment or the quality specified for reuse.

Turbidity The cloudiness of water. It is determined by the presence of suspended matter such as clay, silt, organic matter, and living organisms. High turbidity may reduce light transmission, and therefore reduce photosynthesis of aquatic plants.

Upland An area of dry land surrounding or upstream of a waterbody.

Waste Any solid or liquid material, product, or combination of them that is intended to be treated or disposed of or that is intended to be stored and then treated or disposed. This does not include recyclables.

Wastewater A combination of liquid and water-carried pollutants from homes, businesses, industries, or farms; a mixture of water and dissolved or suspended solids.

Wastewater treatment Any of the mechanical or chemical processes used to modify the quality of waste water in order to make it more compatible or acceptable to humans and their environment.

Wastewater treatment plant A system of sewers, valves, fittings, pumping stations, and accessories that is used to collect wastewater and transfer it to a wastewater treatment plant.

Water Act A piece of provincial legislation in Alberta used to protect the quality of water and manage its distribution. The Water Act regulates all developments and activities that might affect rivers, lakes, or groundwater.

Water allocation The permitted volume, rate, and timing of a diversion of water outlined in a water license. When water is permitted to be redirected for a use other than for domestic purposes, it is referred to as an allocation. Agricultural, industrial, and municipal water users must apply to AENV for a license to use a set allocation of water.

Water body	Any location where water flows or is present, regardless of whether or not the flow or the presence of water is continuous, intermittent, or occurs only during a flood. This includes, but is not limited to, wetlands and aquifers.
Water conservation	Any beneficial reduction in water use, loss, or waste. Water management practices that improve the use of water resources to benefit people or the environment.
Water for Life	The Government of Alberta's water management approach, outlining a comprehensive set of strategies and actions that will ensure Albertans have safe, secure drinking water, healthy aquatic ecosystems, and a reliable, quality water supply for a sustainable economy.
Water license	A water license provides the authority for diverting and using surface water or groundwater. The license identifies the water source, the location of the diversion site, an amount of water to be diverted and used from that source, the priority of the "water right" established by the license, and the conditions under which the diversion and use must take place.
Water management	The protection and conservation of water and aquatic ecosystems, including their associated riparian area. In Alberta, several agencies have a mandate in this area. Alberta Environment is responsible for water quality and quantity monitoring and water allocations. Under the Water Act, a director can set Water Conservation Objectives to protect minimum flow and aquatic ecosystem health. Stakeholders can recommend Water Conservation Objectives to a director via a Water Management Plan or an Approved Water Management Plan. Alberta (SRD) manages Crown lands, including the bed and shores of all water bodies. SRD, through its Fish and Wildlife Division, is also responsible for fisheries and wildlife management. In addition, the federal Department of Fisheries and Oceans upholds a no-net-loss policy in its mandate to protect fisheries habitat under the Federal Fisheries Act.
Water Management Plan	A document developed under the Water Act that provides broad guidance regarding water conservation and management, sets clear and strategic directions regarding how water should be managed, or results in specified actions. Alberta's Framework for Water Management Planning outlines the process for water management planning and the components required for water management plans. The process applies to all water bodies in Alberta, including streams, rivers, lakes, aquifers, and wetlands. The plans may be considered by a director when making license and approval decisions.
Water quality	The chemical, microbiological, and physical characteristics of water.
Water quality guidelines	The allowable contaminant concentration in water. Guidelines are used to define water quality according to the use of the water source. For example, water quality guidelines are developed for drinking water, agricultural, industrial, and recreational water use and for the protection of aquatic life.

Water quantity	The volume or amount of water.
Water table	The top of the saturated zone in the ground, where water fills the spaces in the soil and rock.
Water well	An opening in the ground, whether drilled or altered from its natural state, that is used for the production of groundwater, obtaining data on groundwater, or recharging an underground formation from which groundwater can be recovered. By definition in the provincial Water Act, a water well also includes any related equipment, buildings, and structures.
Watercourse crossing	A permanent or temporary crossing and any associated permanent or temporary structures that are or will be constructed to provide access over or through a waterbody.
Watershed	The area of land that catches precipitation and drains into a larger body of water such as a marsh, stream, river, or lake. A watershed is often made up of a number of sub-watersheds that contribute to its overall drainage.
Watershed management	The protection and conservation of water and aquatic ecosystems, including their associated riparian area. Because land use activities on the uplands of a watershed can affect ground and surface water quality and quantity, a broader, more comprehensive approach to planning is often required. A Watershed Management Plan may look at water quantity, water quality, aquatic ecosystems, riparian area, as well as a variety of land use issues as they impact water. Watershed management plans require water and land use managers to work together to ensure healthy watersheds.
Watershed management plan	A comprehensive document that addresses many issues in a watershed including water quantity, water quality, point and non-point-source pollution, and source water protection. It may or may not include a Water Management Plan. It may also examine ways to better integrate land and resource management within a watershed.
Watershed management planning	A comprehensive, multi-resource planning process involving all stakeholders within the watershed, who, together as a group, cooperatively work toward identifying the watershed's resource issues and concerns, and develop and implement a watershed plan with solutions that are environmentally, socially and economically sustainable.
Watershed Planning and Advisory Council	Collaborative, independent, volunteer organizations with representation from all key partners within the watershed. Their mandate is to engage governments, stakeholders, other partnerships, and the public in watershed assessment and watershed management planning, while considering the existing land and resource management planning processes and decision-making authorities.

Watershed Stewardship Group

Community-based groups made up of volunteer citizens, often supported by local businesses and industries, who have taken the initiative to protect their local creek, stream, stretch of river, or lake. These proactive groups develop on-the-ground solutions to ensure the protection of their specific watersheds.

Waterworks system

A scheme providing potable water to a city, town, municipality, village, summer village, hamlet, or settlement area as defined in the Métis Settlements Act, municipal development, industrial development, or private development or private utility. The term includes: water wells, surface water intakes, water supply lines, water storage facilities, water pumphouses, water treatment plants, potable water transmission mains, potable water storage facilities, potable water pumping facilities, water distribution systems, and watering points.

Wetland

Land that is saturated with water long enough to promote wetland or aquatic processes as indicated by poorly drained soils, water-loving vegetation, and various kinds of biological activity which are adapted to a wet environment.

Wetland loss

Includes infilling, altering, or physically draining a wetland, any impact to the riparian area or buffer strips, and any type of interference with the hydrology to and from a wetland.

White area (white zone)

1. The settled regions of Alberta where agriculture is the most significant land use, including the grasslands and parklands of southern and central regions, and the Peace Country in the north.

2. The White Area includes nearly 40% of the total area of Alberta.

In contrast, the Green Area (Green Zone) is the mainly public, forested lands of northern Alberta and the Eastern Slopes that are not available for agricultural development, other than grazing.

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Mighty Peace Watershed Alliance

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.

mightypeacewatershedalliance.org

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