North Saskatchewan Watershed Alliance

Mayatan Lake State of the Watershed Report

November 2011

North Saskatchewan Watershed Alliance
9504-49 Street
Edmonton, AB
T6B 2M9
Tel: (780) 442-6363
Fax: (780) 495-0610
Email: water@nswa.ab.ca

http://www.nswa.ab.ca

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

This report was prepared by Melissa Logan, P.Biol., Billie Milholland, B.A., and David Trew, P.Biol., of the North Saskatchewan Watershed Alliance.

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1.0 Executive Summary

The purpose of this report is to summarize all available environmental information for Mayatan Lake and its surrounding watershed. This report also provides a benchmark against which future stewardship activities and best management practices aimed at maintaining and improving watershed health can be assessed. The information will provide landowners, stakeholders, Parkland County and the Mayatan Lake Management Association (MLMA) with the information needed to support sound management decisions and develop solutions to protect or enhance land and water resources in the watershed. It also serves as a localized component and example of NSWA's larger basin planning initiative, the *Integrated Watershed Management Plan for the North Saskatchewan River Basin*.

Mayatan Lake is located approximately 68 km west of the City of Edmonton in Parkland County. It is a small, secluded lake located west of Range Road 25 on Township Road 522 (53°29'9.00"N 114°17'55.61"W). It is a part of the larger Modeste Creek watershed, which is a sub-watershed of the North Saskatchewan River (NSWA, 2005). The lake is located in the Dry Mixedwood Sub-region of the province, which is characterized by hummocky terrain underlain by glacial till (NSC, 2006).

Mayatan Lake is largely undeveloped compared to other recreational lakes within central Alberta. The land around the lake is a mix of forested and agricultural lands, and there is one development on the north side of the lake. It is a part of a larger complex of lakes and wetlands in an area known as the "*Jackfish and Johnny's Lakes Area (L31*)" (Westworth, 2004). Wetlands are important features on the landscape, providing water and carbon storage, groundwater recharge, wildlife and waterfowl habitat, and removal of excess nutrients and contaminants from surface water (Mitsch and Gosselink, 2000). Wetlands and wetland complexes have been greatly impacted by agricultural activities within Alberta, with many wetlands in the Central region of Alberta have been drained for agricultural production (Wray and Bayley, 2006). The area around Mayatan Lake has been identified as a locally Environmentally Significant Area (ESA) by Parkland County in its municipal planning documents. As seen in the County surveys, residents in the County are fully supportive of the protection of Environmentally Significant Areas, while allowing for judicious recreational use (Parkland County, 2006).

Historic water quality data (from 1983) indicate that the lake was in relatively good condition at that time, with total phosphorus and chlorophyll a levels within the mesotrophic (or moderately productive) range. New data, being collected in summer 2011, will provide a good database for comparison against the earlier data. The lake is in a groundwater recharge area, which means water generally infiltrates from the landscape down into the underlying aquifers. There are considerable numbers and varieties of birds and waterfowl in the area, but little is known about specific habitat and breeding areas, or mammal populations within the watershed.

Future recommendations for Mayatan Lake include regular monitoring of lake water quality, continuation of stewardship activities around the lake, as well as promotion of shoreline management best management practices. In future, the Mayatan Lake Management Association should consider completion of a Watershed Management Plan for the lake, which would be developed in consultation with all residents and stakeholders in the watershed, and which would ideally align with the goals and directions of the larger *Integrated Watershed Management Plan for the North Saskatchewan River Basin*.

2.0 Introduction

Purpose of Report

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Scope of Report

This report begins by summarizing public perceptions and concerns, and then describes the various planning processes that have been undertaken in this area. The history and characteristics of the Mayatan Lake watershed are also presented. The report covers technical information on the watershed such as geology and land cover, resource extraction, wildlife populations, surface and groundwater quality and quantity. Finally, data gaps, conclusions and recommendations are listed.

3.0 Public Perception and Concerns

2009 Municipal Census

A census of the population of Parkland County was completed in 2009. At that time, the County had a population of 30,089 residents (Parkland County, 2009), which was an increase of 1.38% since the last survey in 2005. The closest hamlets are Duffield (69 inhabitants), Mewassin (population unavailable at time of report), Carvel (19 inhabitants) and Keephills (51 inhabitants). An aerial photo of the lake is shown in Figure 1, and a map of the general location of the Mayatan Lake watershed is shown in Figure 7**.**

According to the census, there were currently 51 properties in Mayatan Lake Estates, located on the northeast side of the lake (Figure 2), with a total population of 48 individuals.

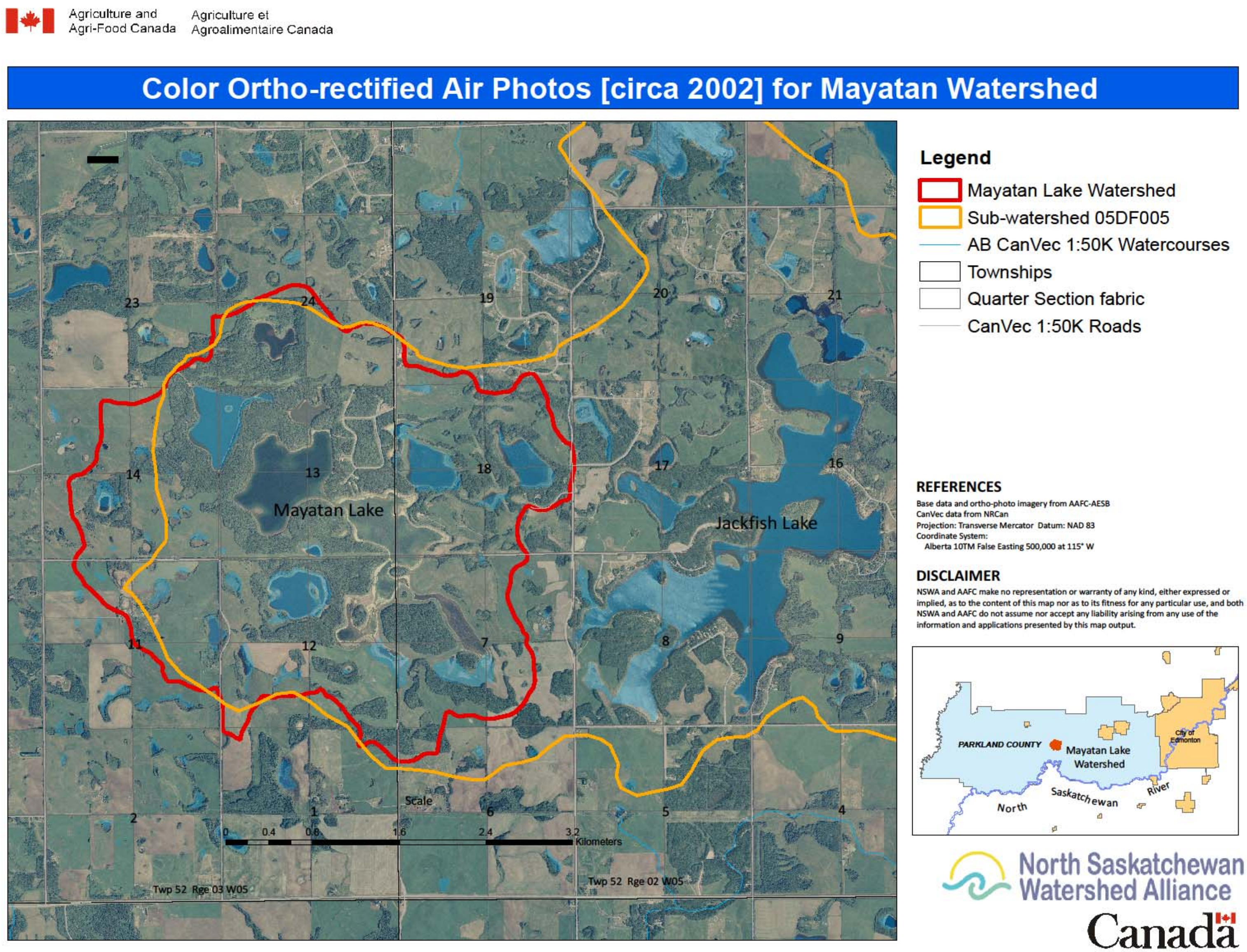

Figure 1. Aerial photo of Mayatan Lake, circa 2002. The red outline indicates the Mayatan Lake watershed, while the orange line indicates a larger sub-subwatershed of the North Saskatchewan River (AAFC, 2011).

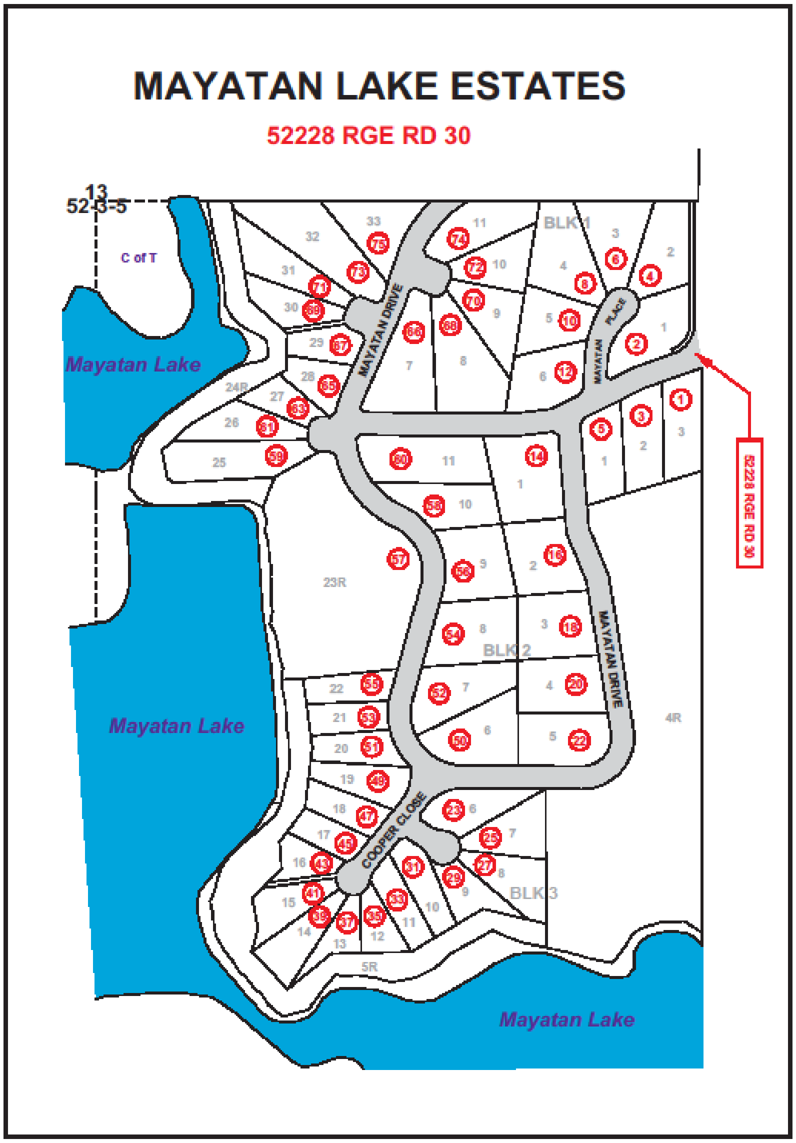

Figure 2. Map of Mayatan Lake Estates (MLMA, 2011).

There is a proposed 70 acre, 200 RV resort planned on the southeast portion of the watershed (Figure 3). A number of public meetings have been held regarding this development, and it is still in the approvals phase with the County. Residents in the area are concerned about potential issues associated with the development; some of the issues mentioned have included overcrowding, high road traffic volume, ATV use, water use and wastewater management. The developer has retained an engineering firm to complete a Biophysical Inventory on the proposed development site to help assess the potential for environmental impacts. Newspaper articles pertaining to the development are provided as background in Appendix A.

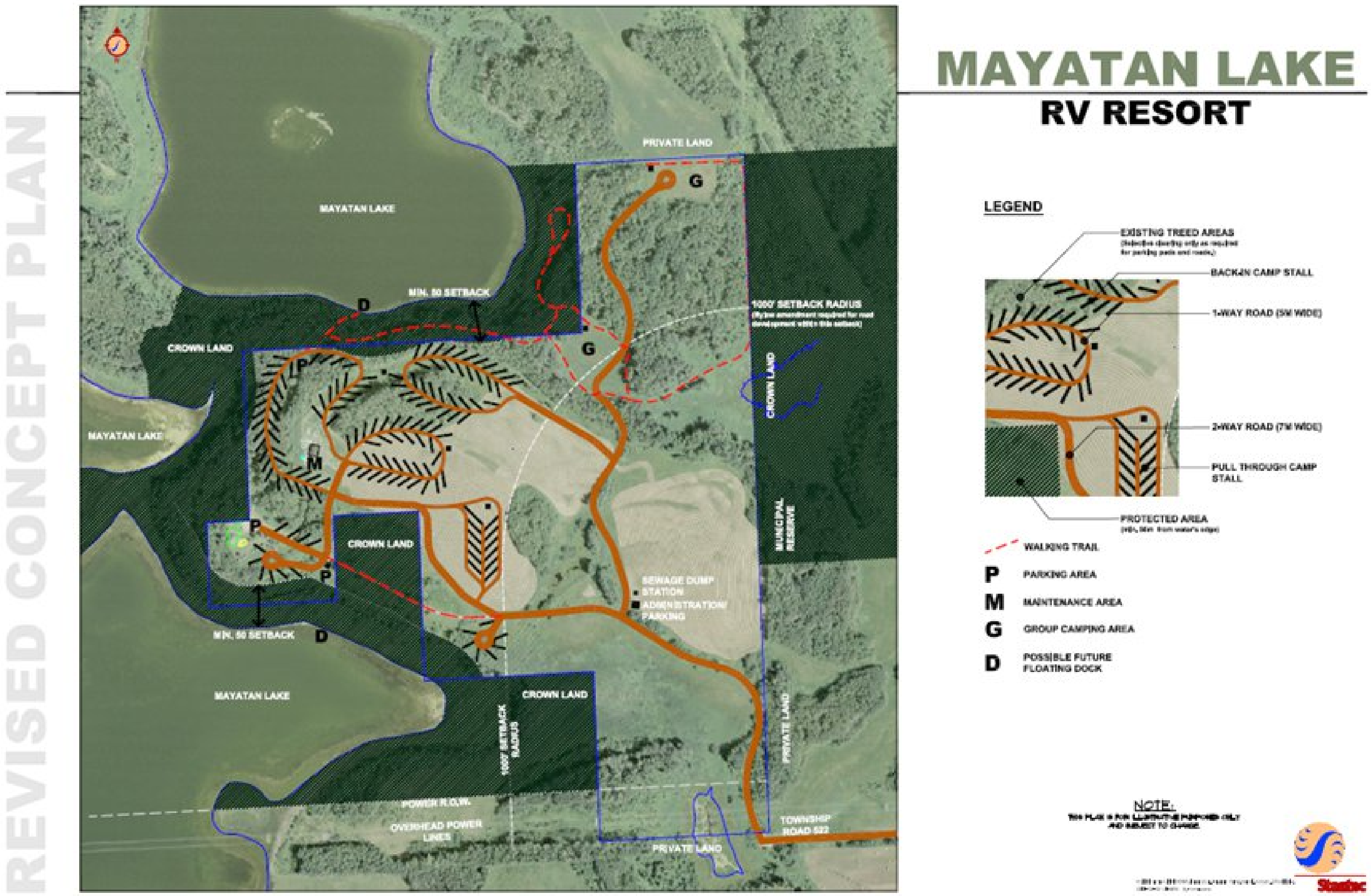

Figure 3. Proposed RV development at Mayatan Lake. Map provided by MLMA, 2011.

2006 Issues and Policy Implications Discussion Paper – Parkland County

A portion of the Parkland County pre-Municipal Development Plan work included a telephone survey of residents in the County. The results of this survey were not available at the time of this report, but some findings were reported in the 2006 Discussion Paper. Some highlights are listed below:

- The public strongly supports protecting the environment, environmentally sensitive areas and wildlife corridors.
- The public considers agriculture as an important part of the County's heritage and feel that both the agricultural land base and the agricultural lifestyle should be preserved.
- The public strongly supports integration of the natural environment in designing new subdivisions, and desires opportunities for walking trials and green space between subdivisions. Some resistance to new subdivision is evident.
- Public support for trails is strong although a concern exists that use of trails be controlled and enforced so that adjacent landowners and livestock are not negatively impacted. Some support is evident for a trail network and for separate trails for non-motorized and motorized uses. ATV's are a concern for many residents but are also popular with many. Considerable interest is evident for more park space as well as open space in the form of natural areas.
- The public supports the continued clustering of industrial and commercial developments in designated areas. Buffering and proper screening of industrial areas is considered desirable. Resource extraction activities in particular should be separated from other non-compatible uses.

4.0 Existing Planning Documents

1981 Jackfish Mayatan Area Structure Plan

An Area Structure Plan (ASP) was prepared for Jackfish and Mayatan lakes in 1981 by Parkland County. The goal of the plan was to identify suitable land uses for the area, while protecting the natural aesthetics and recreational potential (Parkland County, 1981). The plan stated that the area was well suited for medium to high density country residential and recreational development, with limited commercial uses being allowed. Country residential lots were to be in the half acre to three acre size range, and development designs were to be in "harmony with the natural landscape" (County of Parkland, 1981). Density of developments is to be based on the carrying capacity of the land, relating to domestic water supplies and waste disposal (County of Parkland, 1981), with capacity to be determined on the basis of information provided by Alberta Environment. It was assumed that the area could accommodate a population of approximately 8,500 (County of Parkland, 1981). Development of residential or active recreational areas was to be prohibited on environmentally sensitive areas. The plan also identifies an inter-connecting network of open space areas that were to be intended to protect drainage courses, catchment basins and other environmentally sensitive areas from development activities and to provide for a continuous natural open space system (Parkland

County, 1981). These areas were identified based on topographic mapping, air photo interpretation and visual evaluation. One paragraph of note states that:

> "*Drainage courses, major water bodies, catchment basins and those adjacent lands which must be protected to retain and promote the natural function of these areas and which must remain accessible at all times in the future to ensure that proper surface run-off, collection and dispersal is maintained within the plan area. It should be noted that even the best planned and controlled development activities will alter the surface runoff characteristics of the terrain and that the importance of drainage courses and all related features and facilities cannot be overemphasized.*"

The ASP also states that the capability of the soil to handle the disposal of wastes will be determined by the County and Alberta Environment. The County:

> "….*will not support or approve any privately owned and operated piped water and/or sewer systems in the Jackfish-Mayatan Lakes area beyond that which already exists*…".

2004 Parkland County Environmental Conservation Plan

In 2004 Parkland County completed an Environmental Conservation Plan, which was composed of three volumes:

Volume 1: Inventory of Environmentally Significant Areas
Volume 2: Public Consultation
Volume 3: Land Use Policy Review

The Inventory identifies Mayatan Lake within the *Jackfish and Johnny's Lakes Area*, which covers approximately 550 ha of natural area (Figure 4) (Westworth, 2004). The area is a complex of lakes and smaller wetlands, some surrounded by natural stands of aspen, poplar, and small pockets of spruce, with agriculture as the dominant surrounding land use. The report listed this area as a locally Environmentally Significant Area (ESA), providing production and staging habitat for waterfowl, undisturbed habitat areas for wildlife, and opportunities for fishing and wildlife viewing (Westworth, 2004). The area was rated as being moderately sensitive to disturbance, particularly to shoreline alteration, erosion (siltation) and introduction of nutrients and agricultural chemicals (Westworth, 2004). The report suggests that measures aimed at preserving remaining shoreline habitat and controlling agricultural runoff (e.g. vegetated buffers) would help to maintain ecological functions and recreational values.

The purpose of the Public Consultation program was to obtain views from County taxpayers, various interest groups, and the general public on a number of matters with respect to identified ESAs in Parkland County. This included people's understanding of ESAs; the importance of conserving ESAs; alternative conservation techniques; where ESAs rank with respect to other County priorities; how the County should pay for an ESA Conservation Program should there be a cost; comments about the identified ESAs; and whether or not people wished to volunteer their time to implement an ESA policy in Parkland County (IPS, 2004). A random sample of households in the County were contacted via telephone and a total of 45 surveys were completed. Other methods for soliciting public input included two open houses, newspaper reporting, emails and letters to interest groups, feature articles on the County website, and copies of the ESA inventory were placed in the local libraries (IPS, 2004). Based on the telephone survey, people generally saw preserving ESAs as either being “very important” (74%) or “important” (22%). However, when asked about how high a priority should the County place upon conserving ESAs, only 50% saw this as a top priority for the County (IPS, 2004). Conservation methods including prohibiting, modifying and restricting development on or next to ESAs were most favored (IPS, 2004).

The third volume of this report, the Land Use Policy Review, looks at existing County bylaws and policies and makes recommendations for changes or additions. This report identifies the need for landowner education and tax reduction incentives for conservation easements on private land (IPS, 2004). It also recommends considering the implementation of numerical setbacks for developments (including agriculture) next to waterbodies, escarpments and hills, and mandatory Environmental Screening within 1.6 km of an ESA (IPS, 2004).

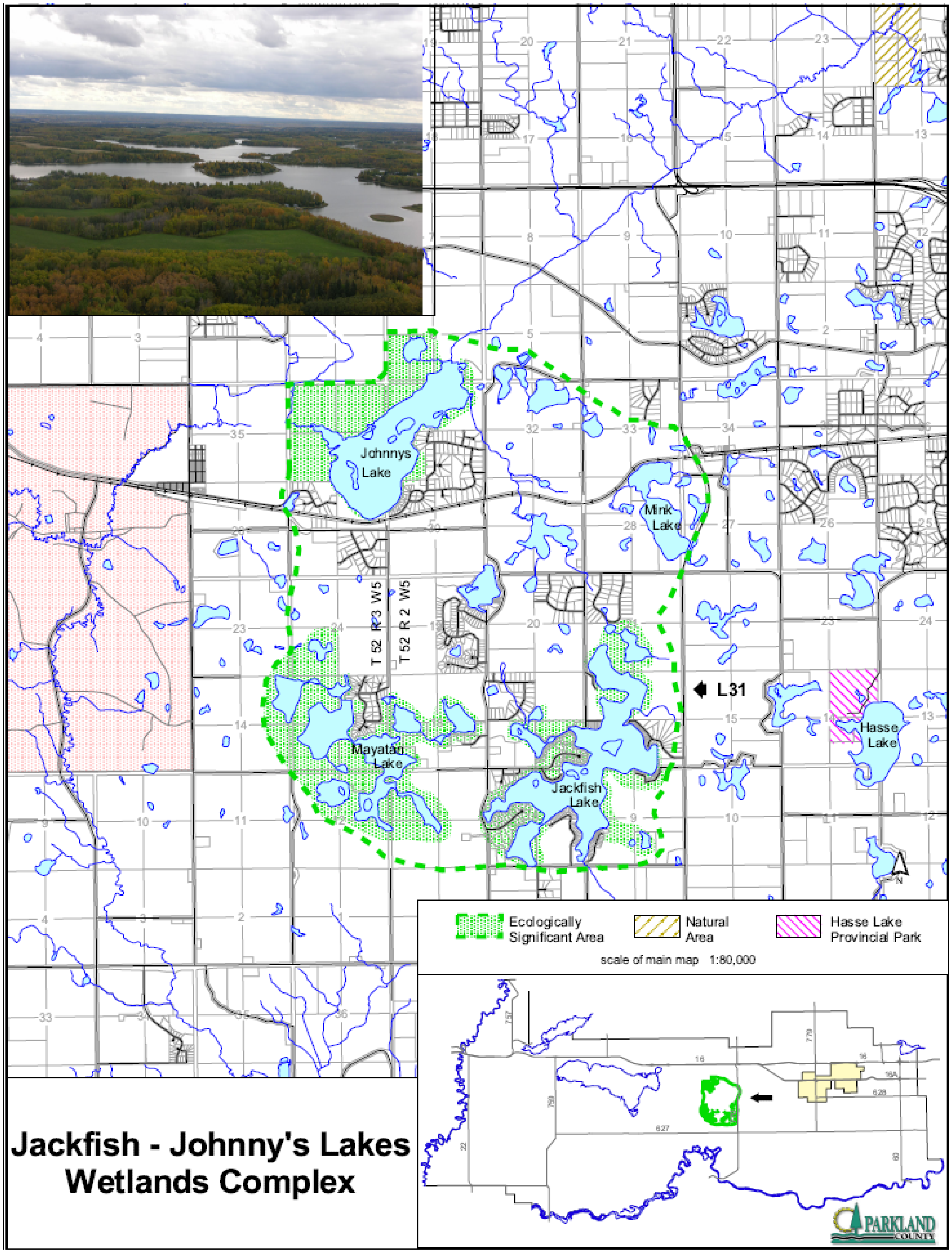

Figure 4. Jackfish-Johnny's Lakes Wetlands Complex, which includes Mayatan Lake. Adapted from Westworth, 2004.

2006 Municipal Development Plan Environmental Scan

This environmental scan was undertaken by the Parkland County and planning consultants in order to provide background knowledge and information for a planned Growth Study and draft Municipal Development Plan. The scan focussed on the following areas:

- Population and Demographics
- Development and Economic Activity
- Existing Statutory and Non-Statutory Plans
- Infrastructure
- Statutory Plans of Adjacent Municipalities

The study finds that the majority (72%) of development permits issued within the County in the period of 2002-2005 were for Country Residential development (Lovatt, 2006). It was recommended in the report that other development, such as industrial, multi-family and commercial, be encouraged in order to balance the tax base within the County. Agricultural activities accounted for 75% of the land use within the county, a decrease from a level of 97% level in 1971 (Lovatt, 2006). This drop was due to increased resource extraction activities, urban and country residential expansion and golf course creation.

Based on the input provided by the public through the pre-MDP consultation process, the most effective and publicly supported method of protecting or integrating Environmentally Significant Areas (ESAs) in new developments and subdivisions is through strong policies included in a statutory plan such as the MDP. It was the public's opinion that policies "with teeth" are required to safeguard the interests of both property owners and the general public (Lovatt, 2006).

Recommendations in the study for amending the MDP based on ESA inventory, public consultation, and Land Use Policy Review are as follows:

1. Mandatory environmental screening required for any subdivision or development within 1.6 km of an ESA.
2. Require all public works and utility projects on or within 0.6 km of an ESA to be environmentally screened for their impact upon the ESA.
3. Require Development Permits for all permitted agriculture uses on or within 1.6 km of an ESA.
4. Consider specific distances for setbacks for major river banks, lakes and rivers, and creeks as guidelines.

2006 Municipal Development Plan Growth Study

The purpose of this Growth Study was to consider options for growth and resulting land use policy implications for Parkland County, and to provide a basis for the MDP. Three growth scenarios are presented in the report and were based on the following goals that were conceived considering input from local residents:

- Support environmental sustainability
- Support fiscal sustainability
- Support social sustainability
- Emphasize economic development
- Respect community character
- Land use certainty

The three options for growth included status quo, a balanced growth option and a nodal growth option (Lovatt, 2006). Nodal growth has been identified as the preferred option for environmental protection. Nodal growth encourages the placement of local level services in order to increase accessibility and reduce the need for driving; it reduces sprawl and preserves open spaces. No specific mention of Mayatan Lake area is made in this report.

Municipal Development Plan 2007 – Parkland County

The Municipal Development Plan (MDP) written by the County of Parkland in 2007 promotes the notion of "smart growth" and the need to continue to protect environmentally sensitive areas. Smart growth is defined in the MDP as growth that applies development principles that promote enhanced quality of life, efficient use of land to preserve the natural environment to the extent possible, and that result in healthy, sustainable communities that are fiscally responsible (Parkland County, 2007).

Based on the goals described in the 2006 Growth Study, the MDP "promotes social, environmental and fiscal sustainability, while emphasizing economic development, respecting community character and maintaining land use certainty" (Parkland County, 2007). With respect to the environment, the MDP guiding principles aim to minimize air, water and soil pollution, reduce resource consumption and waste, and protect natural systems (Parkland County, 2007). The plan supports the implementation of new best management practices, such as the maintenance of green spaces in subdivisions, reducing the use of fossil fuels, brownfield development, the recycling and re-use of water and the use of waste products for energy (Parkland County, 2007). The plan also encourages the enhancement of existing wetlands for use as stormwater treatment facilities (Parkland County, 2007). Mayatan Lake and its associated wetlands are identified as locally environmentally significant (Figure 5). At the time of the MDP, the County listed the 1981 Mayatan ASP as one that may be revisited in the future.

Bylaws specific to land use and environmental conservation are discussed in the Land Use Bylaw section below.

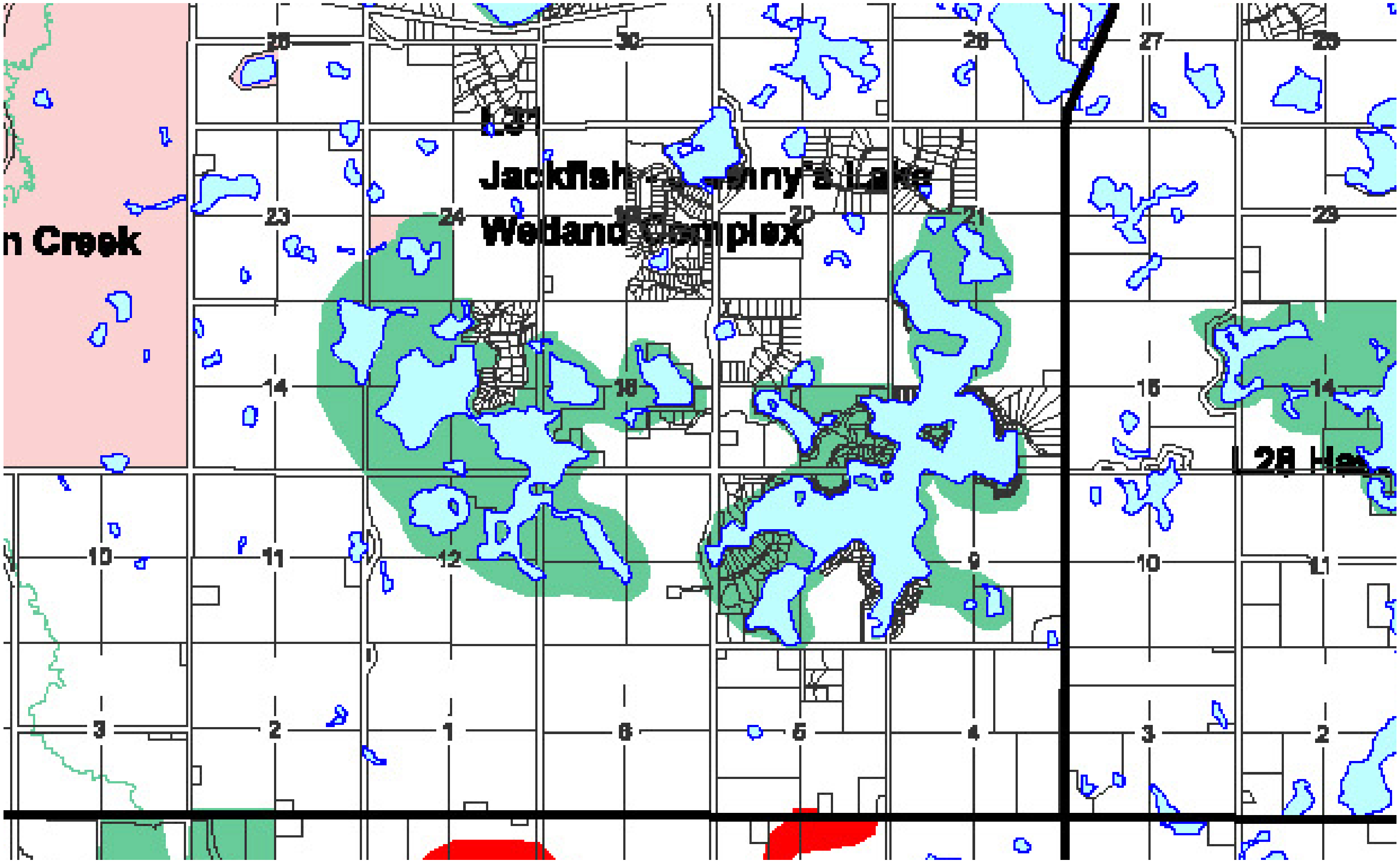

Figure 5. The land surrounding Mayatan Lake (green) has been identified as a wetland complex of local environmental significance to the County (Parkland County, 2007).

Land Use Bylaw Consolidation 2009

The Land Use Bylaw Consolidation (2009) provides a summary of all of the County's Land Use Bylaws. Land Use Bylaws regulate the type, location and intensity of land use and buildings, and also outline the process for rezoning land and applying for permits to develop property.

There are some Bylaws specific to environmentally sensitive areas within the County of Parkland, and many of these Bylaws were listed originally in the 2007 MDP. In particular:

- A biophysical assessment is required for a site proposed for a multi-parcel subdivision or a major development if all or part of the site is located within areas defined as environmentally significant in the *Environmental Conservation Plan*, and may be required within 0.8 km of areas defined as environmentally significant in the *Environmental Conservation Plan*, or if the site contains natural features such as sloughs or extensive tree cover.
- The biophysical assessment shall identify and evaluate the environmental significance and sensitivity of existing vegetation, wetlands, other water features, wildlife habitat and unique physical features, and shall recommend appropriate measures for protecting significant features.
- A 30.0 m (98.5 ft) of setback from water bodies shall be restricted from tree clearing
- Minimum side and rear yard setbacks for lakeshore residential developments shall be 6.1 m (20.0 ft) for those parcels where the yard is adjacent to environmental reserve or lake shore
- For development on or next to "hazard lands', no development shall be permitted within the 1 in 100 year Flood Plain of a water body or natural feature
    - As part of a development permit application, or Land Use Bylaw amendment application, the location of the top of bank shall be determined by survey of a geotechnical engineer, or any other method determined to be satisfactory to the Development Authority
    - A development permit application may be subject to a Slope Stability Assessment, Biophysical Assessment, Environmental Risk Assessment or Environmental Impact Assessment that reviews the suitability of the resulting development to the subject site and considers the effect of the resulting development on the stability of the slope, including potential mitigation measures for the site and proposed structure(s).
    - Minimum building setbacks are 30 m and 50 m for industrial land use.

Draft Recreation, Parks and Open Space Master Plan 2009

The Draft Recreation, Parks and Open Space Master Plan of 2009 was created in order to guide the provision, enhancement and maintenance of recreational programs and facilities within the County. Based on the 2006 resident survey, the top 5 priorities for recreational development within the County included bicycle trails, off-road terrain, sports fields, multi-purpose park land and hiking/horseback riding trails (RC Strategies, 2009). The draft plan suggests improvements in many areas, including but not limited to trail systems, signage, parking lots, community associations, indoor and outdoor recreational facilities, and lists approximate budgetary commitments and funding sources required for the work to be completed. The plan specifically mentions Jackfish Lake but does not mention Mayatan Lake.

Capital Region Growth Plan 2009

In 2008, The Government of Alberta created the Capital Region Board and called upon the Board to create a Capital Region Growth Plan. The six policies of the plan are:

- Protect the environment and resources
- Minimize regional footprint
- Strengthen communities
- Increase transportation choice
- Ensure efficient provision of services
- Support regional economic development

Feedback from the public during the development of the plan showed that residents in the Capital Region felt that close consideration needed to be given to the environment as part of regional planning and public policy, to support growth and to address water management and air quality.

The *Land Use Framework* for the Province was used as the guiding document for the Capital Region Growth Plan. As part of the roles and responsibilities of municipalities in the Capital Region, all MDPs and/or IDPs must be submitted within three months of ministerial approval (Municipal Affairs) to the Capital Region Board to ensure compliance with the overarching Capital Region Growth Plan policies.

Municipal Development Plan 2010

The County released a consolidated MDP in July 2010, which included 2008 and 2009 amendments to the 2007 MDP. The Environmental Management section of the MDP lists the following goals, objectives and policies (Parkland County, 2010):

> **Goals**
> The County supports communities that are designed to minimize air, water, and soil pollution, reduce resource consumption and waste, and protect natural systems that support life.
> The County supports protecting environmentally significant areas and, in particular, it supports maintaining the environmental integrity of the County's rivers, streams and lakes.

Objectives

Protect environmentally significant areas, as identified by the Environmental Conservation Plan, from inappropriate development.

Reduce the impact of development on the natural environment to the extent possible.

Apply Environmental Reserve and other provisions to protect environmentally significant areas.

Protect water quality and quantity through effective subdivision design.

Require a Biophysical Assessment as part of the development process.

Promote public awareness regarding the impact of development on the environment.

The Policy section indicates that lands deemed to be environmentally significant will be protected using a variety of legislative and voluntary techniques such as Environmental Reserve dedication or the use of Conservation Easements and/or Land Trusts with a particular emphasis on the protection of lakes, streams and rivers within the County (Parkland County, 2010). Setbacks from the high water mark of lakes or stream banks are to be applied, and the appropriate distance determined by a qualified engineer (Parkland County, 2010).

2011 North Saskatchewan Watershed Alliance Discussion Paper for the Development of an Integrated Watershed Management Plan

In 2005, the North Saskatchewan Watershed Alliance (NSWA) was appointed by the Government of Alberta as the Watershed Planning and Advisory Council (WPAC) for the North Saskatchewan River basin. As one of the partnerships under *Water for Life: Alberta's Strategy for Sustainability* (2003), the NSWA was given a mandate by the government to prepare an Integrated Watershed Management Plan (IWMP). The IWMP will provide watershed management advice to address issues raised by stakeholders and to achieve the three goals of the *Water for Life* Strategy: safe, secure drinking water; healthy aquatic ecosystems; and reliable, quality water supplies for a sustainable economy.

An IWMP Discussion Paper was prepared in 2010 and contains 5 overarching goals, along with associated watershed management directions and specific actions. The goals of the draft plan are as follows:

Goal 1: Maintain or improve water quality in the North Saskatchewan River watershed
Goal 2: Maintain or improve water quantity (flow) conditions in the North Saskatchewan River
Goal 3: Maintain or improve aquatic ecosystem health in the North Saskatchewan River watershed
Goal 4: Protect groundwater quality and quantity in the North Saskatchewan River watershed
Goal 5: Water and land-use planning are aligned at the regional scale

The IWMP Discussion Paper has been through an extensive public consultation process during 2011, and will be finalized for submission to stakeholders and Alberta Environment in early 2012.

5.0 Provincial and Federal Legislation

There are a number of pieces of legislation applicable to water and watershed management in Alberta. The applicable Acts and their descriptions are listed in the table below.

Table 1. Provincial and federal legislation applicable to water and watershed management in Alberta (Haag et al., 2010).

Legislation/policy	Description
Federal *Fisheries Act* - Fisheries and Oceans Canada (FOC) R.S.C. 1985 cF-14	Regulates and enforces on harmful alteration, disruption and destruction of fish habitat in Section 35.
Canada Water Act, R.S.C. 1985, c.C-11 *Canada Shipping Act*, 2001, 2001, c.26	Currently used to enable joint flood control and agricultural water projects.
Migratory Birds Convention Act 1994, 1994, c.22	Regulates activities that could harm migratory birds or their nests, and prohibits deposits of certain materials that might be harmful in water frequented by migratory birds.
Federal Navigable Waters Protection Act - FOC R.S.C.1985 c.N-22	Protects the public's right of navigation in Canadian waters, by prohibiting the building, placing or maintaining of any work whatsoever in, on, over, under, through or across any such navigable water, without the authorization of the Minister of Fisheries and Ocean Canada.
The *Species at Risk Act*, S.C. 2002, c.29	Prohibits the destruction of critical habitat for species at risk. Provides stewardship opportunities of critical habitat. Prohibits killing, harming or harassing endangered species as defined.
Provincial *Water Act,* R.S.A. 2000, c.W-3	Governs the diversion, allocation and use of water. Regulates and enforces actions that affect water and water use management, the aquatic environment, fish habitat protection practices, in-stream construction practices, storm water management.
Provincial *Environmental Protection and Enhancement Act (EPEA)* R.S.A. 2000, c.E-12	Management of contaminated sites, storage tanks, landfill management practices, hazardous waste management practices, wastewater management, and enforcement.

Provincial *Alberta Land Stewardship Act*, S.A 2009, c.A-	This legislation supports implementation of the Land-use Framework. It creates the seven land-use regions, establishes the Land-use Secretariat and gives authority for regional plans, creation of Regional Advisory Councils and addresses the cumulative effects of human and other activity.
Provincial *Agricultural Operations Practices Act* (AOPA) – Natural Resources Conservation Board (NRCB)	Regulates and enforces confined feedlot operations and environment standards for livestock operations.
Historical Resources Act – Culture and Community Spirit	Concerns any work of humans that is primarily of value for its prehistoric, historic, cultural or scientific significance, and is or was buried or partially buried in land or submerged beneath the surface of any watercourse or permanent body of water.
Provincial *Municipal Government Act* R.S.A. 2000, c.M-26	Provides municipalities with authority to regulate water on municipal lands, management of private land to control non-point sources, and authority to ensure that land use practices are compatible with the protection of aquatic environment.
Provincial *Public Lands Act,* R.S.A. 2000, c.P-40	Regulates and enforces activities that affect Crown-owned beds and shores of water bodies and some Crown-owned uplands that may affect nearby water bodies.
Provincial *Safety Codes Act*- Municipal Affairs	Regulates and enforces septic system management practices, including installation of septic field and other subsurface disposal systems.
Regional Health Authorities Act – Alberta Health	RHA have the mandate to promote and protect the health of the population in the region and may respond to concerns that may adversely affect surface and groundwater.
Wildlife Act, R.S.A. 2000 c.W-10	Regulates and enforces protection of wetland-dependent and wetland-associated wildlife, and endangered species (including plants).
Weed Control Act, R.S.A. 2000, c.W-5	Municipalities are delegated authority to pass local bylaws to control restricted, noxious and nuisance weeds on municipal lands and on certain public lands such as highway corridors.
Provincial Parks Act & Wilderness Areas, Ecological Reserve and Natural Areas Act – ASRD and Community Development	Both Acts can be used to minimize the harmful effects of land use activities on water quality and aquatic resources in and adjacent to parks and other protected areas.
Land Titles Act, R.S.A. 2000, c.L-4	Provides for boundary changes when the “natural boundary” changes through erosion or accretion when the title to lands is a “natural boundary”. Public lands are excluded from titles; also see *Law of Property Act*, R.S.A. 2000, c.L.-7

Provincial Wetlands Policy	This policy will be used to protect wetlands and mitigate losses through a "No Net Loss" policy.
Land Use Bylaws (Municipal)	The bylaw that divides the municipality into land use districts and establishes procedures for processing and deciding upon development applications. It sets out rules that affect how each parcel of land can be used and developed and includes a zoning map.
Area Structure Plans (Municipal)	Adopted by Council as a bylaw pursuant to the *Municipal Government Act* that provides a framework for future subdivisions, development, and other land use practices of an area, usually surrounding a lake.
Municipal Development Plans	The plan adopted by Council as a municipal development plan pursuant to the *Municipal Government Act.*

6.0 Social/Cultural Resources

History of Area

Most of Alberta's lakes were formed after the last glaciation, which ended about 12,000 years ago. Glacial Lake Leduc and Glacial Lake Wildwood formed from large areas of stagnant ice left behind by the receding main ice front. "Part of a sequence of lakes that covered north central Alberta", they were specifically instrumental in the creation of Mayatan and neighbouring lakes. Till deposited during that time created the "large areas of rolling uplands, characterized by numerous small lakes and sloughs" (Stony Plain Historical Committee, 1976).

Historical Land Use

Bison remains from about 6,500 years ago have been found in the Mayatan Lake area, along with proof of related human activity. This area appears to have provided rich protein harvesting right up until the end of the 19th Century. It fueled the western fur trade from between 1799, with the establishment of the Upper Terre Blanche Trading Post, and 1875, when White Mud House was abandoned. The last large buffalo hunt in the area left the trading post at Lac Ste Anne in 1876. After that, until the general establishment of tilled land for agriculture in the early 20th Century, an abundance of fish and small game fed the population of European settlers, which began to arrive after 1877 when Treaty Number 6 allowed whites to settle in "Hills of Hope region" (Stony Plain Historical Committee, 1976).

There was a lumber camp on Jackfish Lake in 1901, so it is likely that timber harvest also took place in the Mayatan Lake watershed around the same time. The first European habitation on Mayatan Lake might have been the Indian Agent's house, which would have been built soon after Treaty 6 was signed. Delbert Earl Blewett, the first white baby born on the Reserve (1895), live in the house "on the edge of Mayatan (Bad) Lake" when his father was a farm instructor. The house was moved to the east shore of Wabamun Lake in 1911. In 1900, William J. Fuller, his wife, Martha and their five sons arrived by covered wagon from the United States and built a log house on the southwest edge of Bad Lake (NW 12-52-3-W5) (Stony Plain Historical Committee, 1976). The area that included Mayatan Lake became Local Improvement District No. 520 in 1913, Municipal District of Inga in 1918 and the Municipal District of Stony Plain in 1942.

Historical Fish Harvesting

Before Europeans and during the fur trade, fishing must have been good in Bad Lake, because the early settlers, although they didn't settle next to the lake, used it regularly to add to their food stores. A photo from 1912 shows six members of the Eatock family standing on their veranda, posing behind a long string of "157 jackfish taken from Bad Lake." After World War I, young people from "Holburn and Inga sometimes came in wagons to Bad Lake, camping in tents for the weekend and going home with a wagon loaded with fish." Between 1922 and 1942 Richard Collins (Collie) Burton (one of three Burton brothers) rented out boats on Mayatan Lake where good times were "had on weekends at Bad Lake and jackfish and perch were the main course for dinner" (Stony Plain Historical Committee, 1976).

Name Origin

Before modern times, Mayatan Lake was called Bad Fish Lake. This name had been shortened to Bad Lake by the turn of the 20th Century when the first wave of European settlers arrived. A 1906 map of the area includes Mayatan (Bad) Lake, where the lake is shown as part of "Indian Reserve (Stony) #133A at White Whale or Wabamun Lake." There is a story about the origin of the lake's name, told by the Bowser family, who claimed to have heard it from local First Nation's people. It is about an incident on the lake when a big fish over-turned a canoe and ate the occupant when he fell out.

7.0 Watershed Characteristics

General Description

Mayatan Lake is located approximately 68 km west of the City of Edmonton, in Parkland County. It is a small, secluded lake located accessed from the north by Range Road 30 (53°29'9.00"N 114°17'55.61"W). It is part of the Modeste Creek subwatershed, in the larger North Saskatchewan River watershed (Figures 6 and 7) (NSWA, 2005; AAFC, 2011). The Modeste Creek subwatershed lies in both the Foothills and Boreal Forest natural regions of Alberta, and encompasses 482,746 hectares including 21,461 hectares of natural and artificial water bodies which include lakes, quarries, reservoirs, rivers, wetlands and canals (NSWA, 2005).

Mayatan Lake lies in a hydrologic *non-contributing area* of the North Saskatchewan River watershed, located on the north side of the North Saskatchewan River (Figure 8). Mayatan Lake is comprised of two nearly equal sized basins, a western and eastern, joined by a narrow channel. The lake is landlocked and has no outlet channel. The lake is not subject to hydrologic flushing by surface water throughput; the role of groundwater on flushing remains unknown at this time. Bathymetric surveys of Mayatan Lake (Figure 9) indicate that the western body of water has a maximum depth of about 26.5 metres (87 feet) while the eastern water body has a maximum depth of about 6.1 metres (20 feet). The two cells combined have a water surface area of about 1.38 square kilometres (Figliuzzi, 2011).

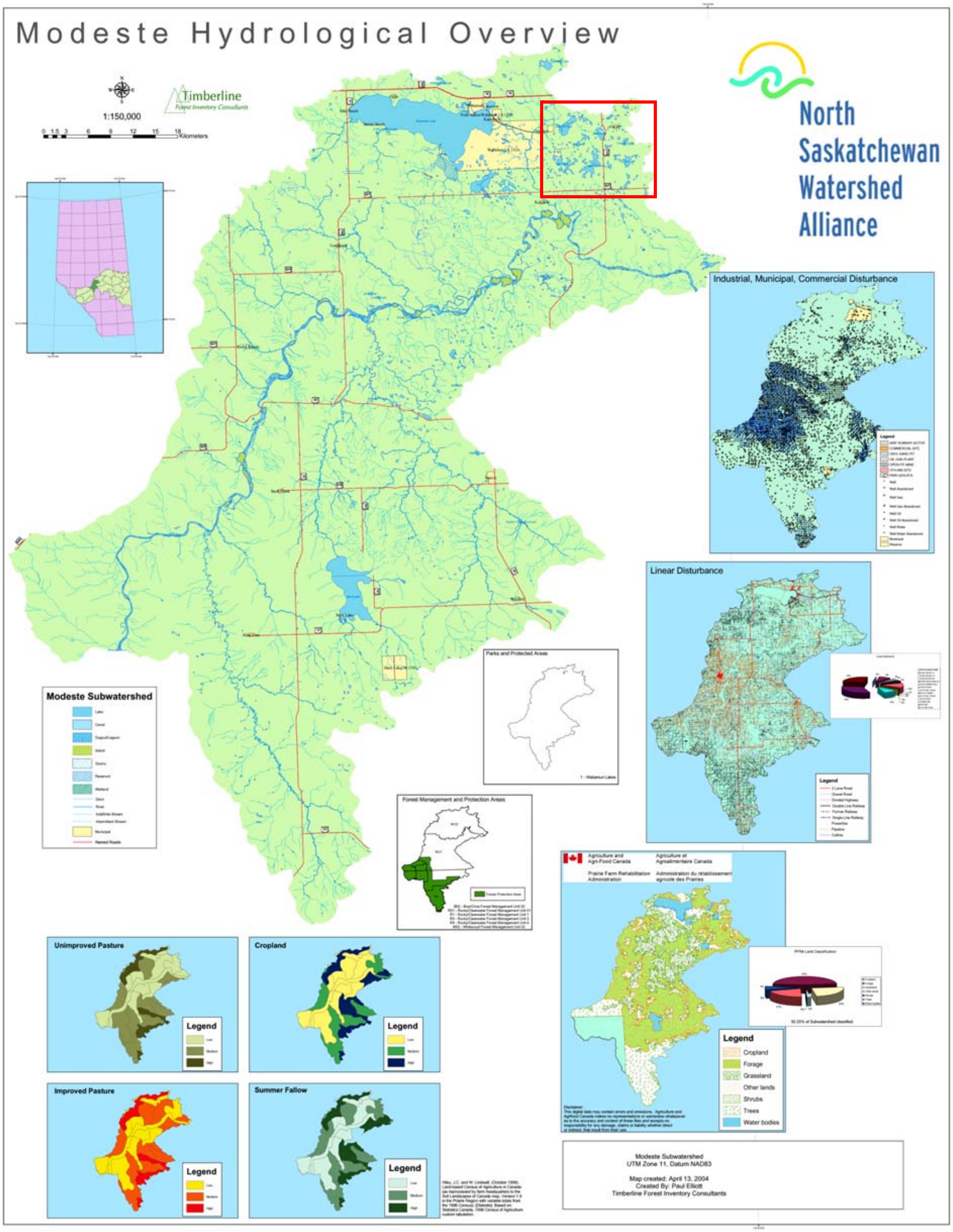

Figure 6. Map of the larger Modeste subwatershed, adapted from NSWA (2005). Red square indicates location of Mayatan Lake.

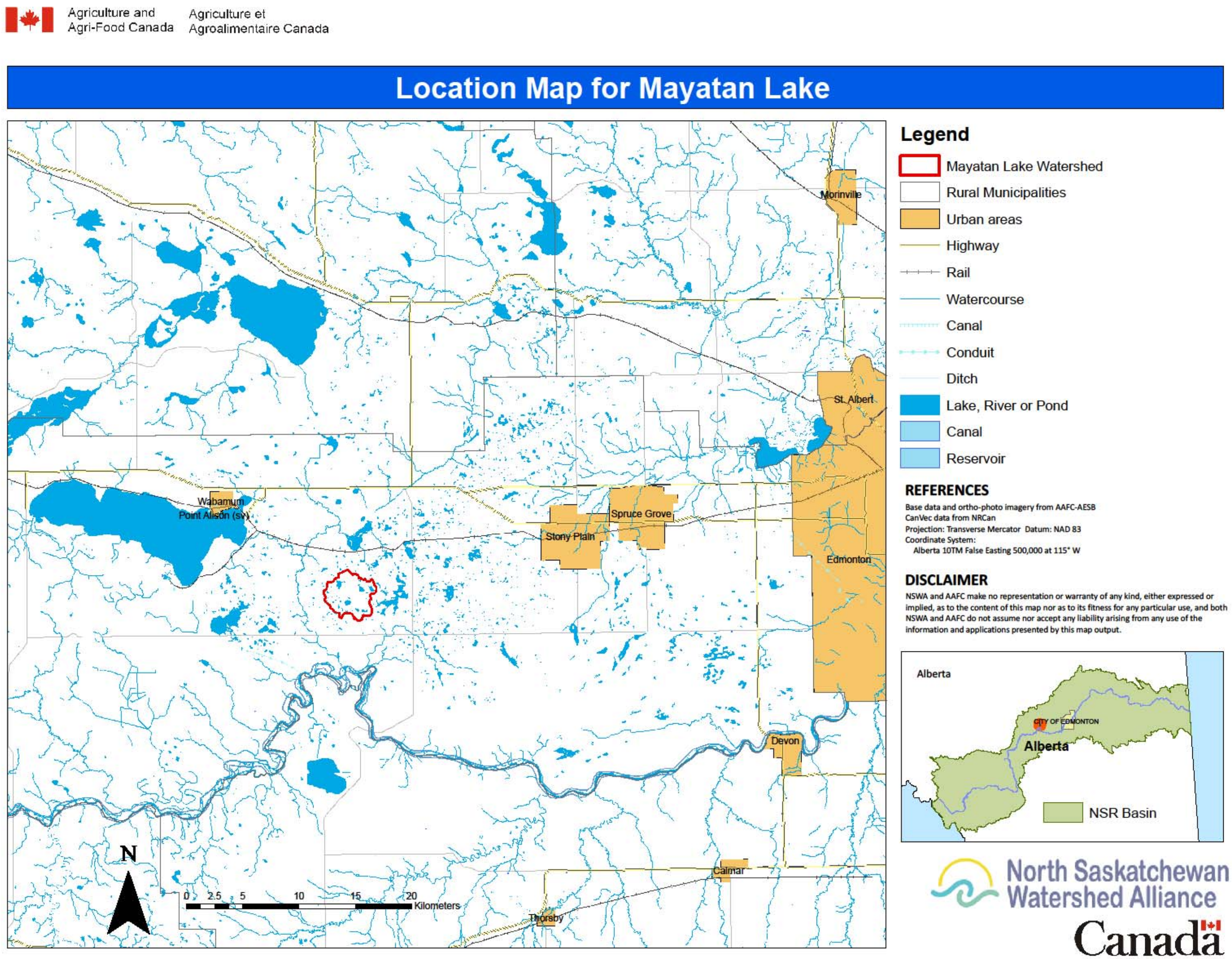

Figure 7. Location of Mayatan Lake watershed (red outline). To the west of Mayatan is Wabamun Lake, and to the east are Stony Plain and Spruce Grove. (AAFC, 2011).

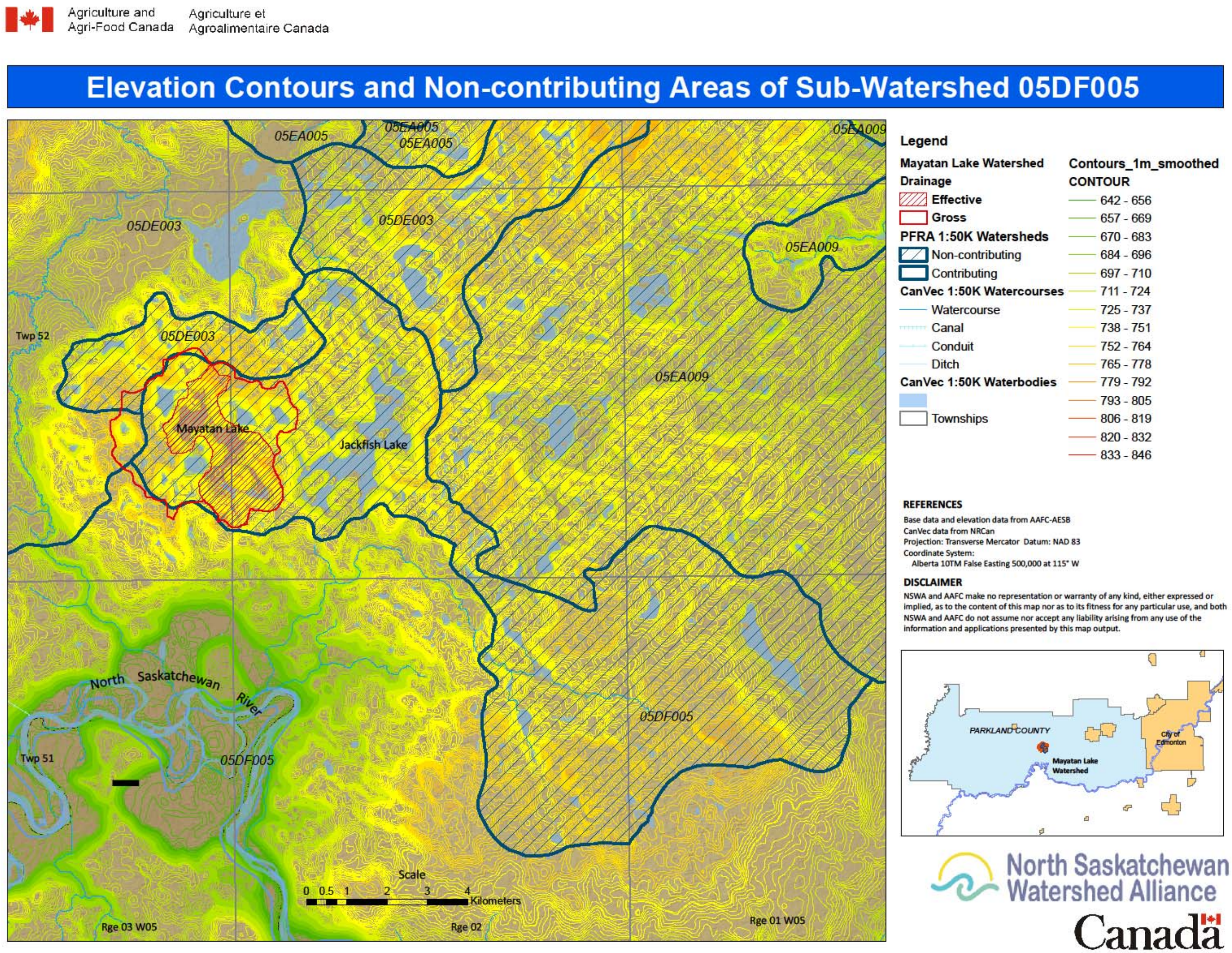

Figure 8. Map demonstrating contributing and non-contributing areas (blue outline, area is named 05DF005) of the Mayatan Lake area. The Mayatan Lake watershed (outlined in red) is located within a larger, non-contributing area of the North Saskatchewan River watershed (AAFC, 2011).

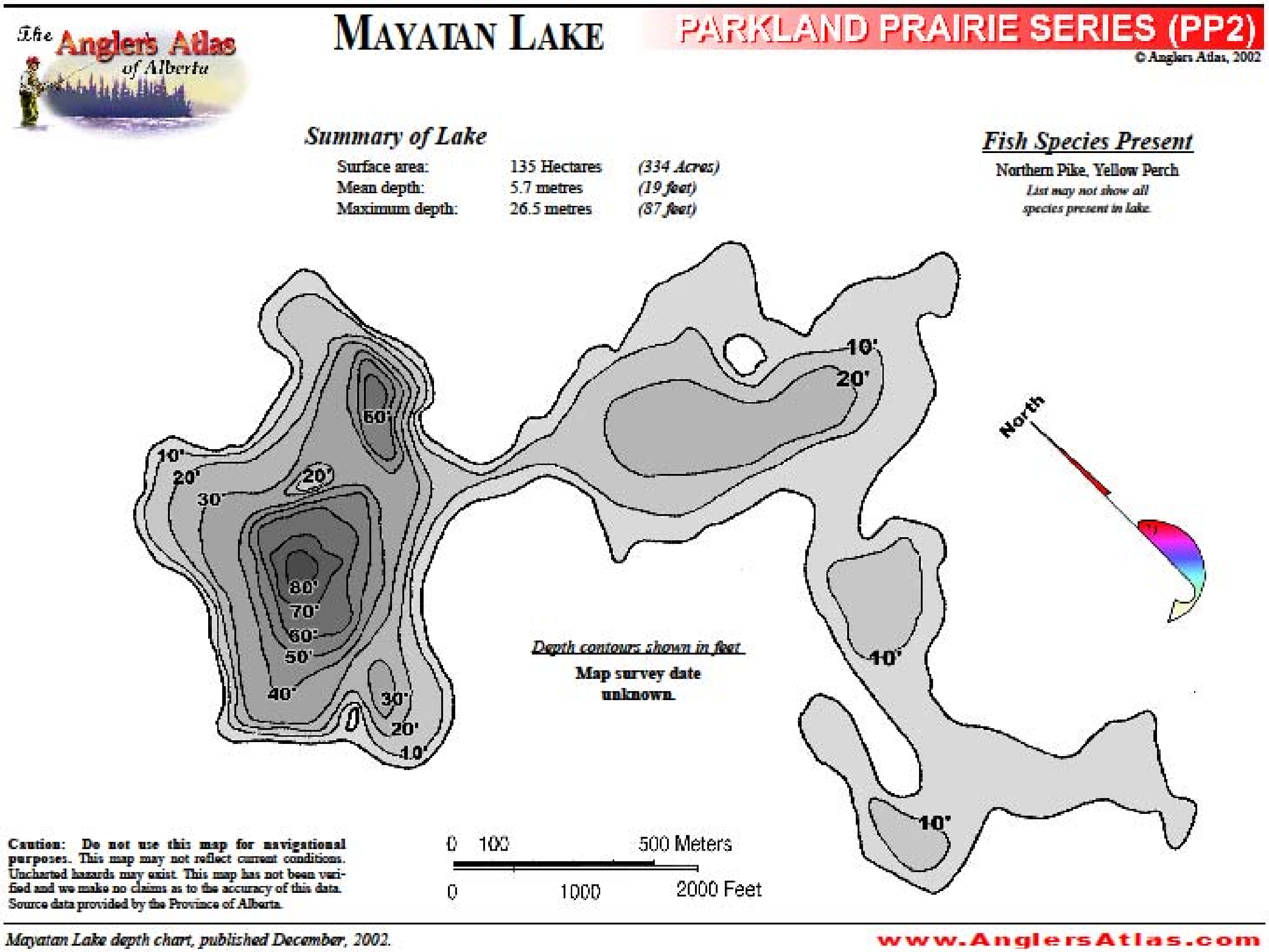

Figure 9. Depth contours of Mayatan Lake. Adapted from the Angler's Atlas (2002).

Climate

The County of Parkland and Mayatan Lake are located in the Dry Mixedwood sub-region Figure 11). This sub-region typically has warmer, drier summers and milder winters than other sub-regions in the larger Boreal Natural Region, which can lead to some moisture deficits.

Climate data from the nearby Stony Plain weather station (1997-2007) shows a mean annual temperature of 4.6°C, with summer (May-September) temperatures averaging 14.1°C, and winter (October-April) temperatures averaging -2.44°C (Figure 10) (Environment Canada, 2011). Mean annual precipitation averaged from three nearby weather stations (1971-2010) is 530 mm (S. Figluzzi, 2011). Annual evaporation is estimated at 675 mm, which exceeds annual precipitation amounts (S. Figluzzi, 2011).

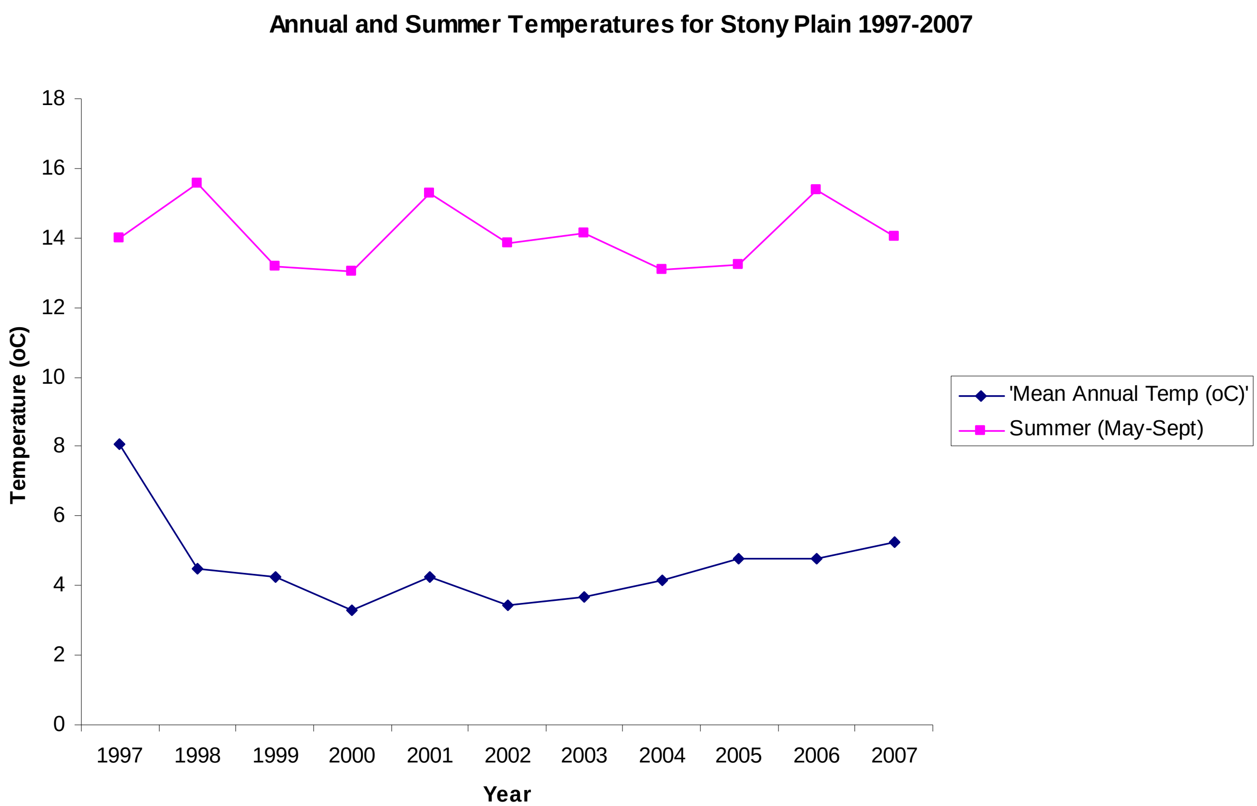

Figure 10. Average annual and summer temperatures for Stony Plain, 1997-2007. Adapted from Environment Canada, 2011.

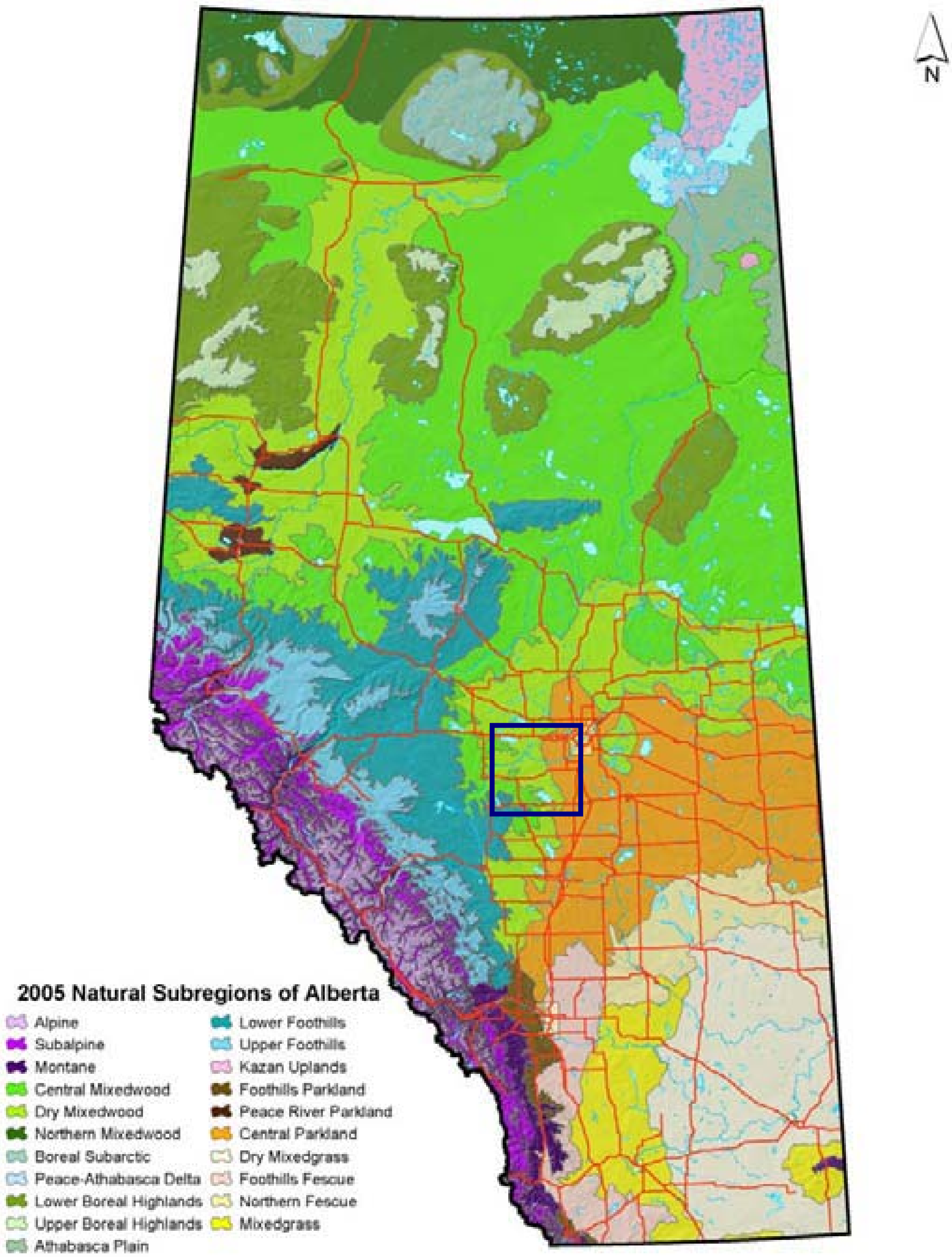

Figure 11. Natural Subregions of Alberta. The blue box indicates approximate location of Mayatan Lake, in the Dry Mixedwood subregion. Adapted from Natural Subregions Committee, 2006.

Geography, Soils and Topography

The Central Alberta portion of the Dry Mixedwood subregion has undulating plains and hummocky uplands, based on bedrock formations that include Upper Cretaceous shale, sandstone and siltstone formations. The region in central Alberta is dominated by a moderately fine textured, moderately calcareous glacial till (Figure 12). There is a significant component (10%) of glacio-fluvial sands and organic deposits but only minor inclusions of glacio-lacustrine materials (NSC, 2006). Soils are typically medium to fine textured gray and dark gray luvisols (NSC, 2006). Organic soils underlying wetlands are usually terric mesisols, while poor fens and bogs typically have fibric mesisols. Peaty and orthic gleysols are also common wetland soils, particularly on level to gently undulating landforms (NSC, 2006).

Figure 12. Glacial till is commonly medium textured with included stones (left) but it can also be stony (right), particularly in mountain regions. Photos courtesy of NSC, 2006.

Land Cover

The Dry Mixedwood subregion is characterized by aspen (*Populus tremuloides*) stands with scattered white spruce (*Picea glauca*) interspersed with fens; there are also cultivated areas on suitable soils throughout. Approximately 15% of this subregion is covered by wetlands (NSC, 2006). Wetlands are important features on the landscape, providing water and carbon storage, groundwater recharge, wildlife and waterfowl habitat, and removal of excess nutrients and contaminants from surface water (Mitsch and Gosselink, 2000). Wetlands and wetland complexes have been greatly impacted by agricultural activities within Alberta, with many wetlands in the Central region of Alberta drained for agricultural production (Wray and Bayley, 2006).

On moist, rich sites, balsam poplar (*Populus balsamifera*), aspen and white spruce occur as pure or mixed stands. Understories contain red-osier dogwood (*Cornus stolonifera*), prickly rose (*Rosa acicularis*), and a diverse array of herbaceous species in deciduous and mixedwood stands, or a carpet of feathermosses (*Hypnaceae* spp.) and horsetails (*Equisetum* spp.) in coniferous stands (NSC, 2006). Within the Mayatan watershed itself, there is a mix of coniferous and deciduous trees, perennial hay/pasture land, cropland, shrubs and wetland areas (Figure 13) (AAFC, 2011). As seen in Figures 14 and 15, major changes in land cover have taken place, mainly in the categories of annual crops and pasture land. Since 2003, there has been a dramatic decrease in cattle populations, and as a result, there has been a conversion of land from pasture to cropland.

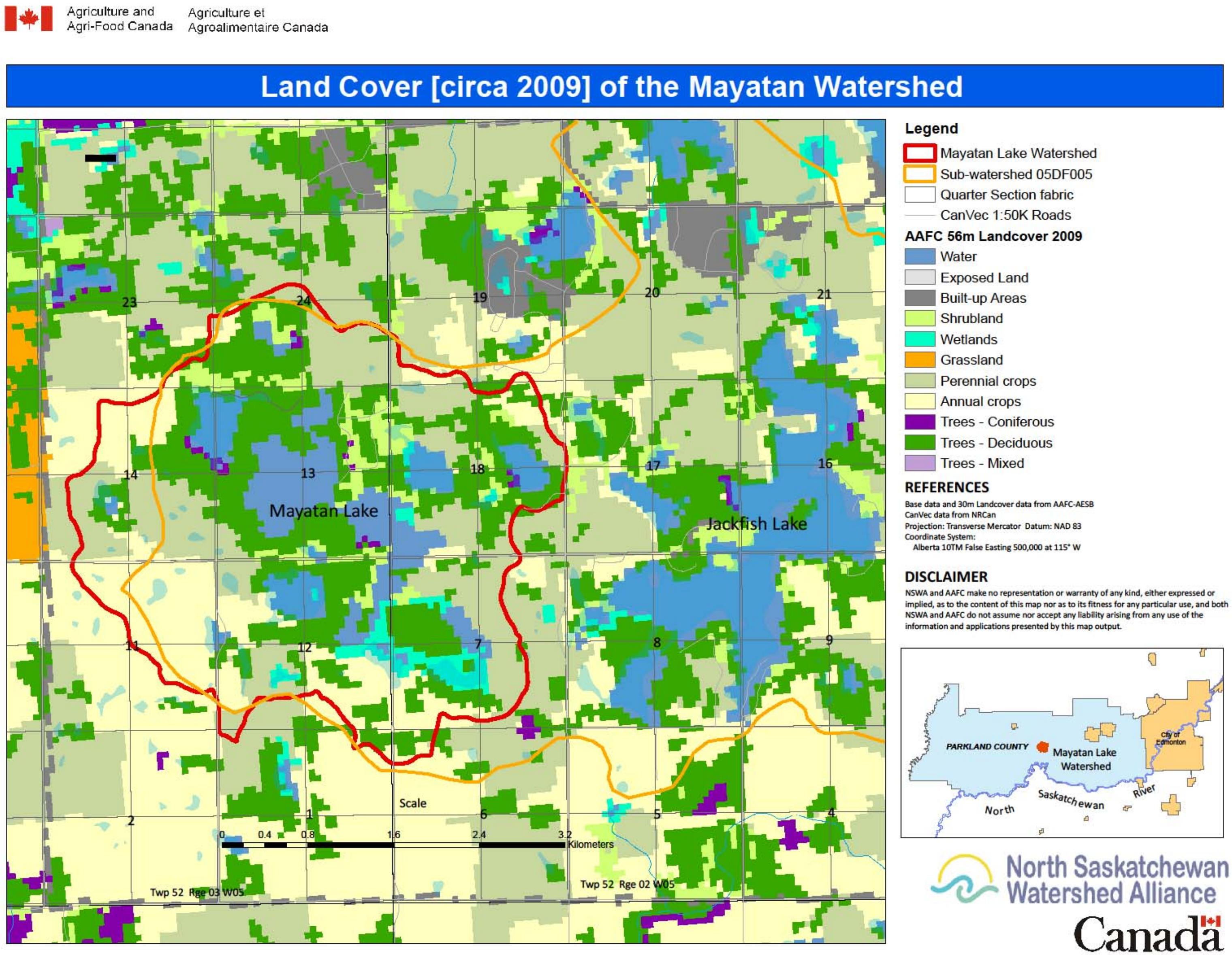

Figure 13. Land cover in the Mayatan Lake watershed, circa 2009 (AAFC, 2011).

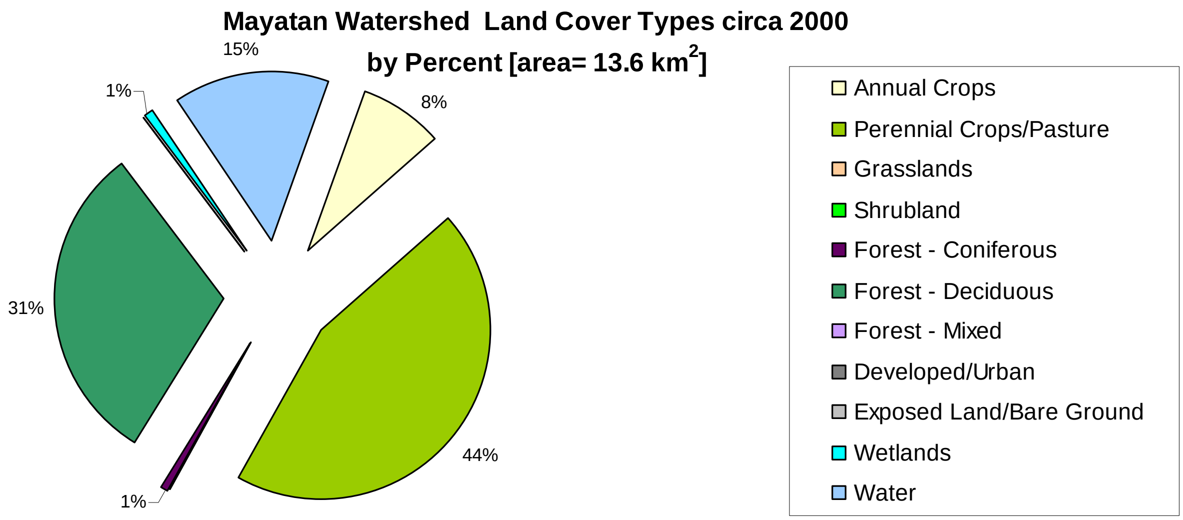

Figure 14. Land cover in the Mayatan watershed, circa 2000 (AAFC, 2011).

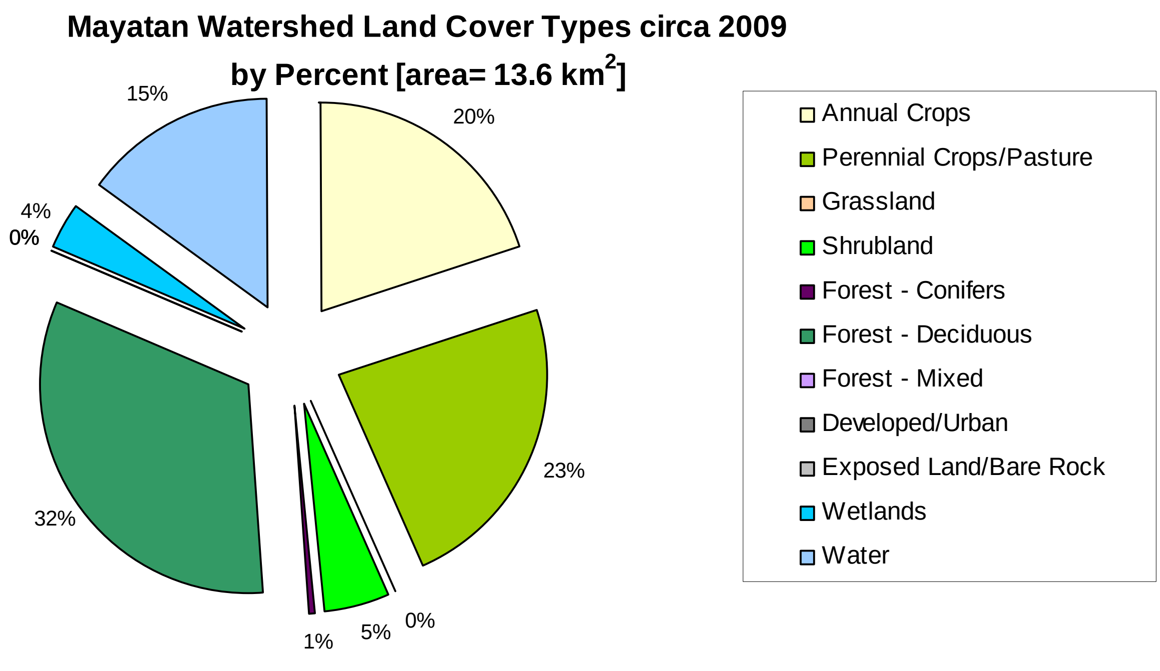

Figure 15. Land cover in the Mayatan watershed, circa 2009 (AAFC, 2011).

Figures 16 and 17 demonstrate land cover changes in the larger subwatershed area of the North Saskatchewan River (as shown in Figure 8, blue outline, area 05DF005). The major changes in this larger area have also been within the pasture land and cropland land cover types, likely due to the drop in cattle numbers and the increase in market values for commodity crops (C. Vanin, pers. comm., 2011).

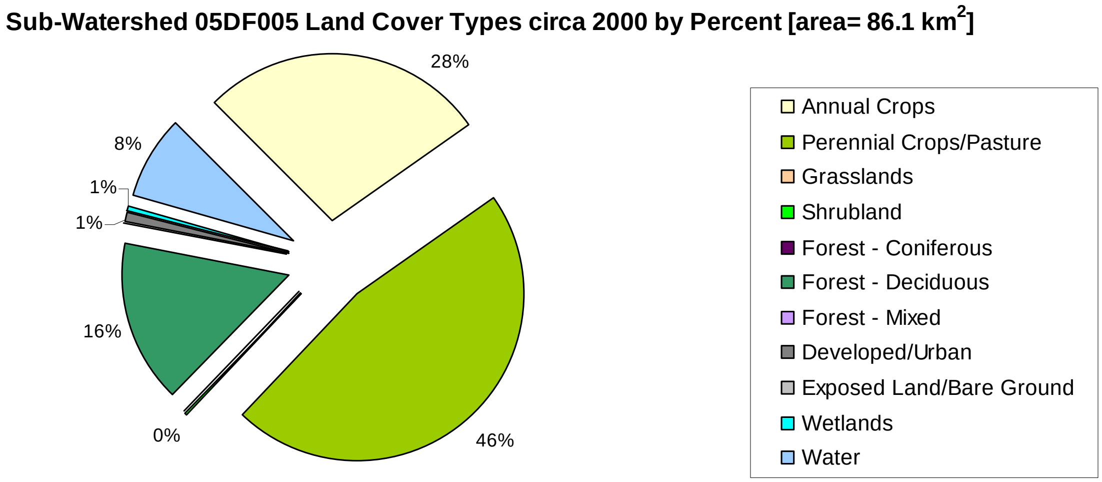

Figure 16. Land cover in the larger North Saskatchewan River subwatershed area, circa 2000 (AAFC, 2011).

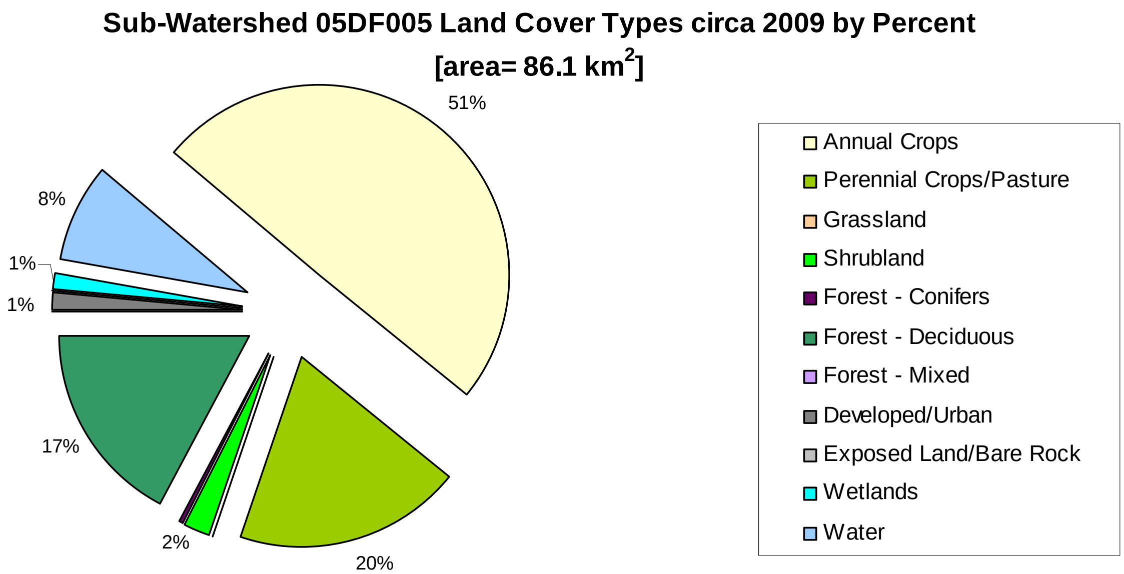

Figure 17. Land cover in the larger North Saskatchewan River subwatershed area, circa 2009 (AAFC, 2011).

Emergent macrophytes seen in Mayatan Lake include greater bulrush (*Schoenoplectus tabernaemontani*), common cattail (*Typha latifolia*), reed grass (*Calamagrostis acutiflora*) and sedge (*Cyperaceae* spp. (Figure 18). In addition, arrowhead (*Sagittaria latifolia*) was reported. Among the submergent vegetation species in Mayatan Lake, the most abundant were stonewort (*Chara globularis*), northern watermilfoil (*Myriophyllum exalbescens*) and large-sheath pondweed (*Potamogeton vaginatus*) (Figure 18). In addition, sago pondweed (*Potamogeton pectinatus)* was abundant (R.L & L, 1987).

Figure 18. Photos of some common plants in Mayatan Lake. Left to right, top to bottom: greater bulrush, arrowhead, stonewort, northern watermilfoil and sago pondweed. Photos adapted from Wikipedia, 2011.

Land Use

There is a large portion of the Mayatan watershed that is in pasture, hay, or cropland (Figure 14). The Land Use District Map from the Parkland County MDP (2007) shows the land around Mayatan to be classified as General Agricultural Land (Figure 19).

The 2001 Census of Agriculture collected information about the numbers of all livestock raised in the province. Using research by Culley and Barnett (1984), Statistics Canada calculated the amount of manure produced by the total number of livestock. A formula that weighted the different livestock based on animal size and average manure output was used. The numbers of each type of livestock reported in the Census, multiplied by its manure factor, were totalled to give the total manure produced in tonnes. The values for each soil polygon were ranked with the lowest value assigned a new value of 0.0 and the soil polygon with the maximum ratio assigned a new value of 1.0 (Alberta Agriculture, 2006). All other values were assigned a new value between 0.0 and 1.0 based on their rank order. As seen in Figure 20 below, manure production in the area of Mayatan Lake ranks in the higher end of the scale, at 0.6-0.8 (Alberta Agriculture, 2006). Improperly managed manure can influence the quality of surface water runoff within the watershed, and can be a source of excess nutrients, pathogens and bacteria to surface water bodies.

Currently there are no large campgrounds or RV parks located around Mayatan Lake, but there is a small boat launch. No data are currently available for usage rates for camping or other recreational activities in the Mayatan Lake watershed. There is a RV development proposed on the eastern portion of the lake which would have 200 RV camp sites on 72 acres of land (MLMA, 2011). The proposed site is currently pasture/hayland, surrounded by Crown land.

There is a proposed AltaLink transmission line from Jackfish Lake to Wabamun Lake whose preferred route would cross directly over Mayatan Lake (Figure 21) (AltaLink, 2009). Hearings for this project took place in 2010 and 2011, in which landowners and the MLMA expressed their concerns about the project. The new transmission line will follow the "preferred" line (red, Figure 21) and was approved for construction as of August 12, 2011 (AUC, 2011). It is uncertain at this point when construction will begin on this project.

There appears to be 5 oil and gas wells within the Mayatan watershed and a number of wells in the surrounding area. One well is very close to the east shoreline of the shallow basin of the lake (Figure 22). Oil and gas wells affect the landscape due to the clearing of vegetation for the construction of well pads, which can lead to habitat loss and fragmentation, increased erosion and the potential for the invasion of noxious weeds (Tribal Energy, date unknown). There are also cut lines in the northern and eastern portions of the watershed, which can exacerbate these same issues. Oil and gas well activity increases the risk of contamination to the environment, either from hydrocarbon or salt spills, drilling mud or heavy metals.

There are no data available regarding wastewater management or riparian health assessments for the Mayatan watershed.

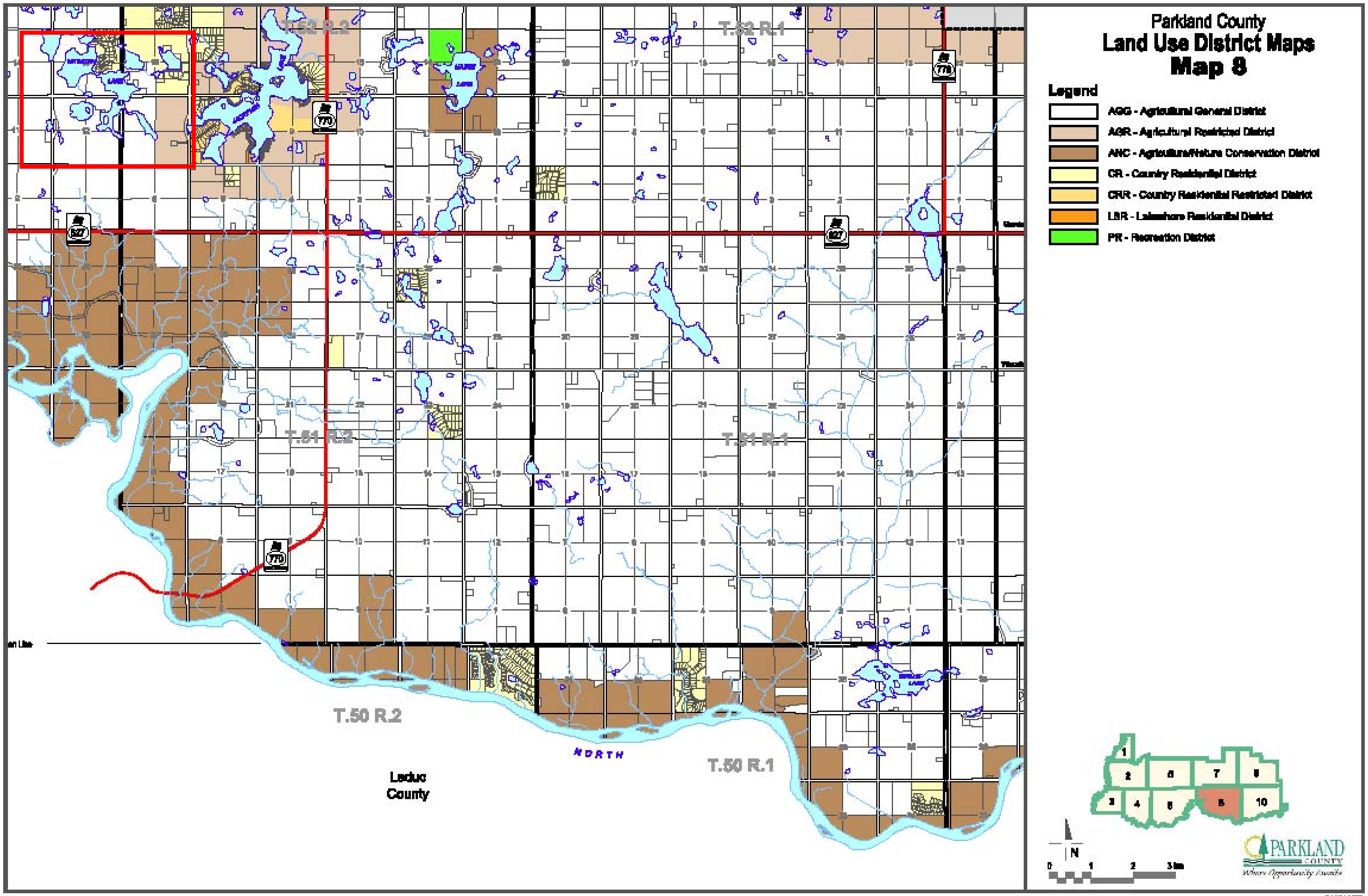

Figure 19. Land uses in the Mayatan and Jackfish Lake areas (Parkland County, 2007). Mayatan is outlined in red.

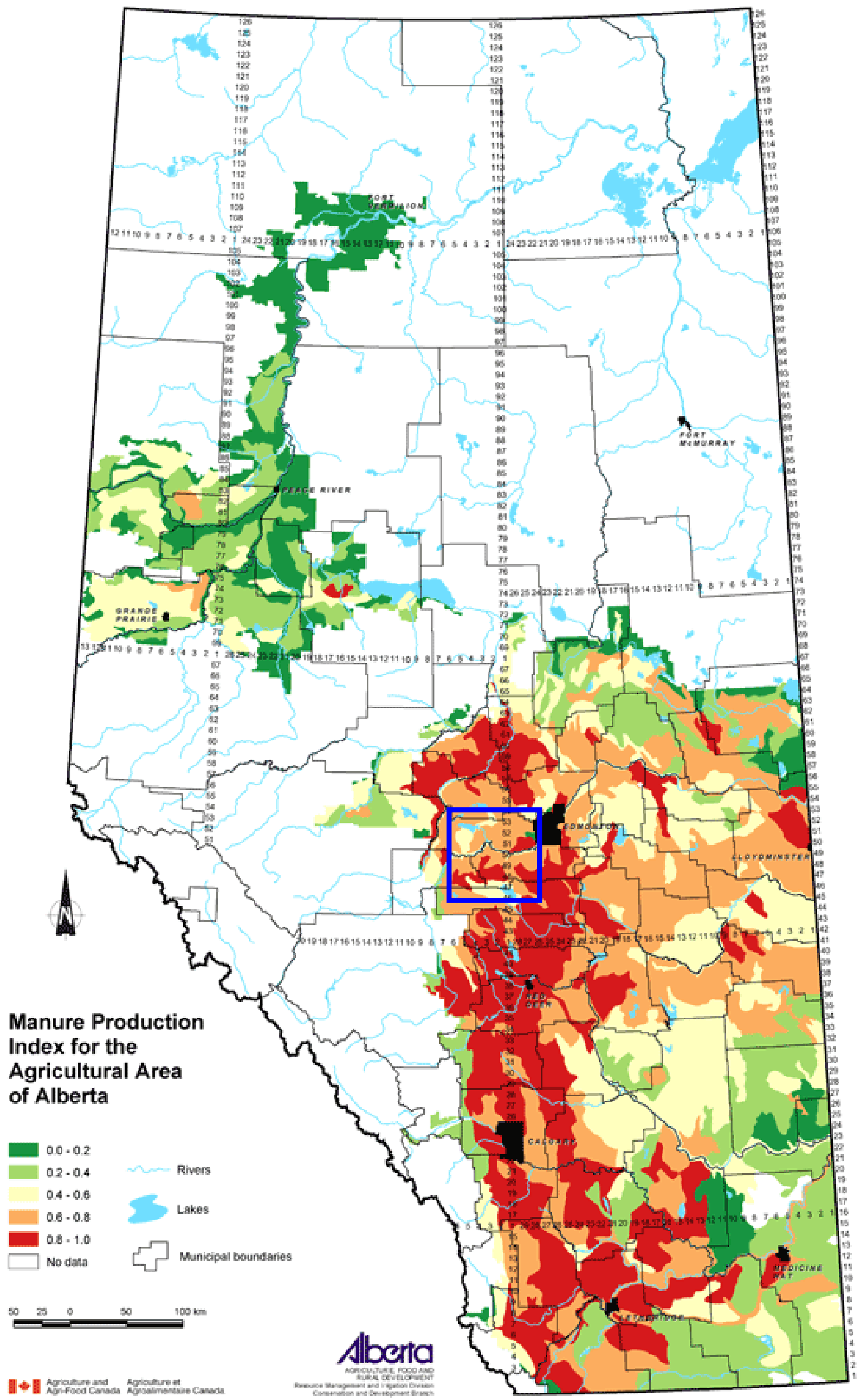

Figure 20. Manure production Index for Alberta. The blue square indicates the approximate location of the Mayatan watershed (Alberta Agriculture, 2006).

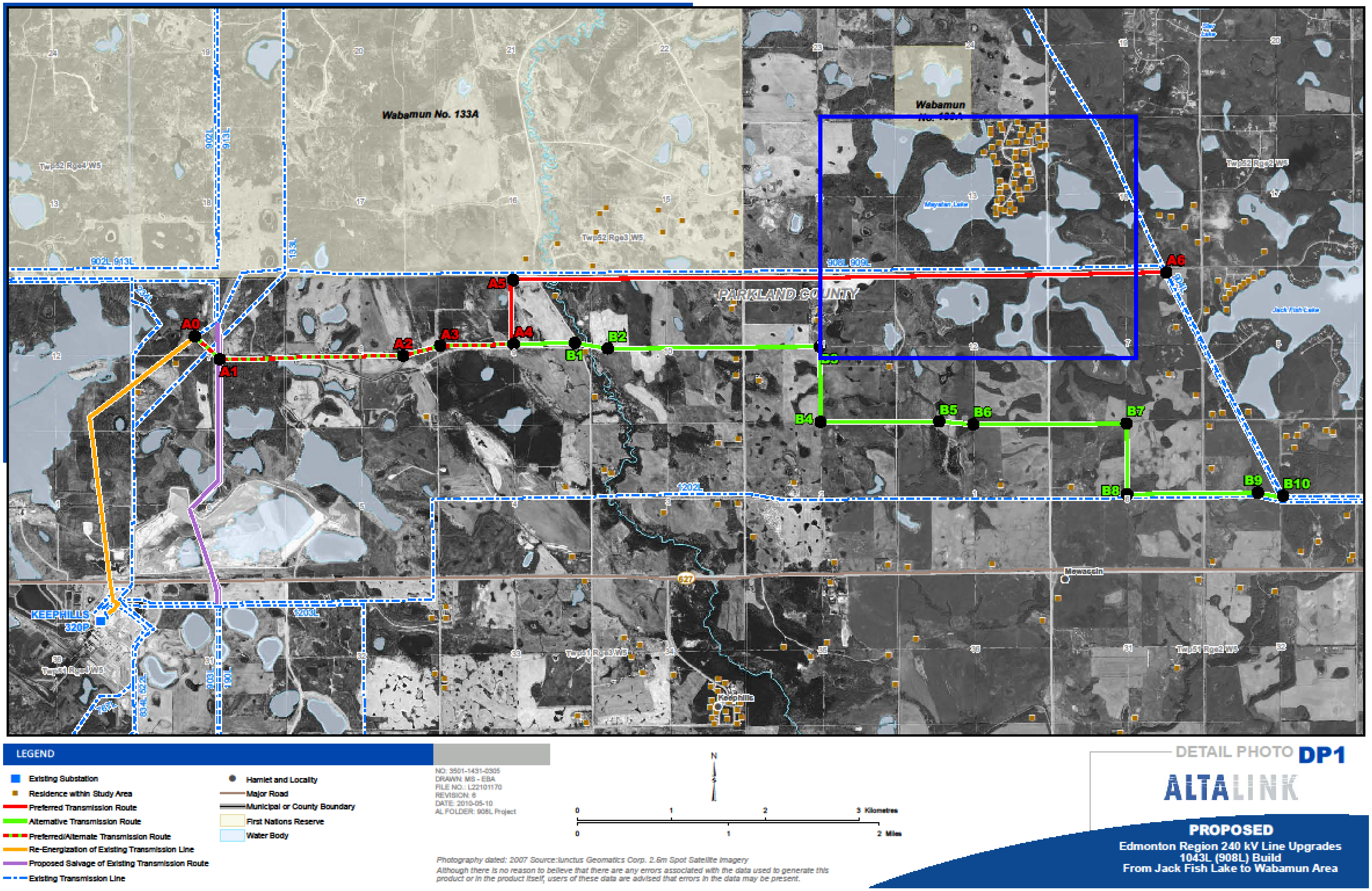

Figure 21. Approved upgraded transmission line from Jackfish Lake to Wabamun Lake. The route that will be used is indicated in red. Mayatan Lake is within the blue square. Altalink, 2011.

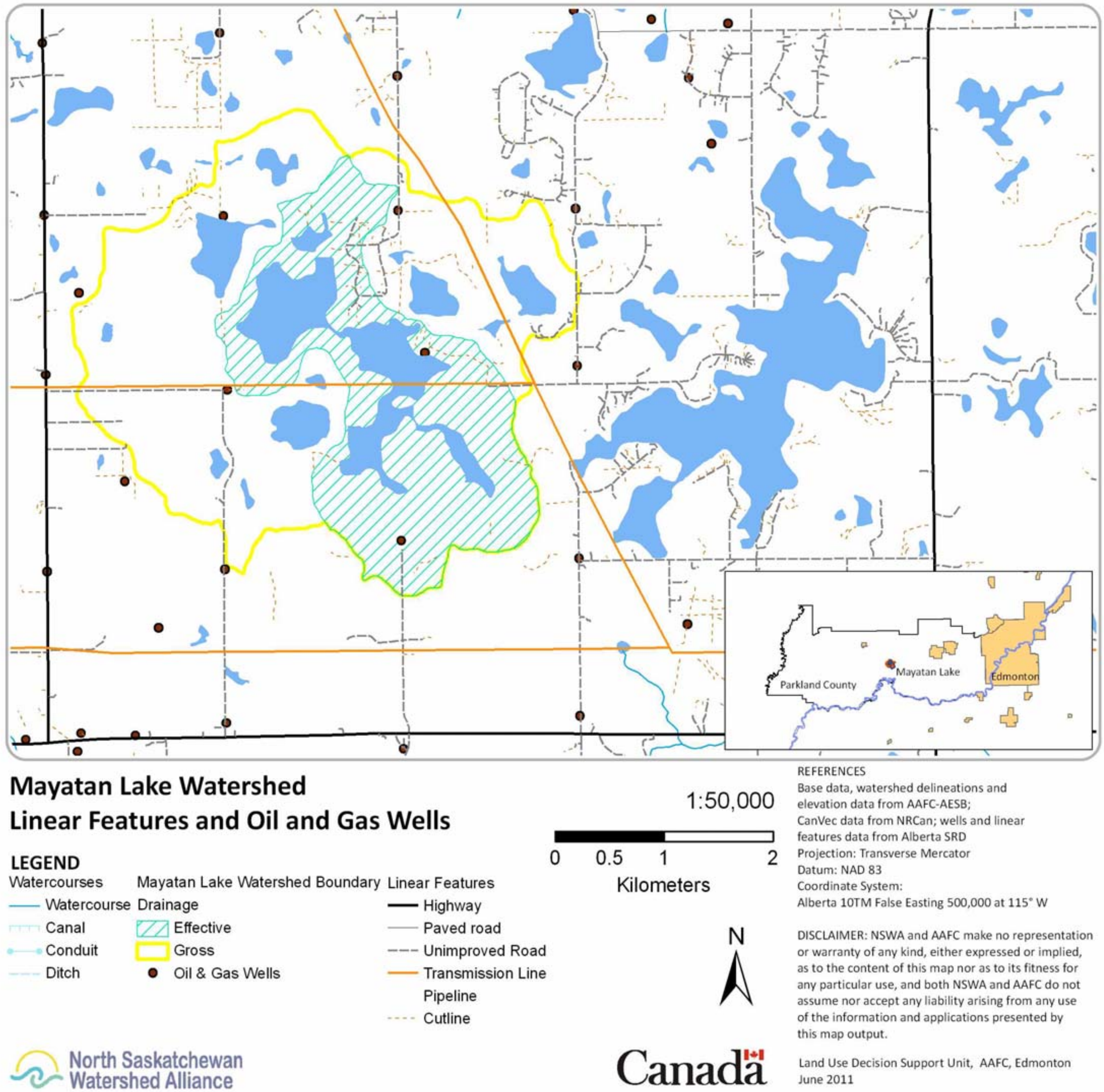

Figure 22. Oil and gas wells and linear disturbances within the Mayatan watershed (AAFC, 2011).

Wildlife

According to the Committee on the Status of Endangered Wildlife in Canada (COSEWIC) data, there are 4 to 6 species at risk in the region of the province within which Mayatan is located (Figure 24), but unfortunately the exact species that are at risk were not listed for that region. Mayatan Lake was surveyed from the air in July, 2001 for the presence of Western (Figure 23) (*Aechmophorus occidentalis*) and eared (*Podiceps nigricollis*) grebes (Hanus et al, 2002). Western grebes are listed as "sensitive", a ranking given to them by Alberta Sustainable Resource Development in 2000. No adults, nests or colonies were reported in the survey, and later surveys did not include Mayatan Lake.


Figure 23. Western grebe (L) and Canadian toad (R). Photos courtesy of Idaho Fish and Game (L) and Wikipedia (R) (2011).

Canadian toads (Figure 23) *(Bufo hemiophrys)* were reported as being in the Mayatan area in 1950 (Hamilton et al, 1998). Wildlife commonly seen in the Dry Mixedwood subregion include beaver (*Castor canadensis*), moose (*Alces alces*), hares (*Lepus* spp.), wolves (*Canis lupus*) and many bird species including least flycatcher (*Empidonax minimus*), house wren (*Troglodytes aedon*), ovenbird (*Seiurus aurocapilla*), red-eyed and warbling vireos (*Vireo* spp.), baltimore oriole (*Icterus galbula)* and rose-breasted grosbeak (*Pheucticus ludovicianus*) (NSC, 2006). Species of birds found in mixedwood forests include yellow-bellied sapsucker (*Sphyrapicus varius*), Swainson's thrush (*Catharus ustulatus*), solitary vireo (*Vireo solitarius)*, magnolia warbler (*Dendroica magnolia*), white-throated sparrow (*Zonotrichia albicollis*), pileated woodpecker (*Dryocopus pileatus*) and northern goshawk (*Accipiter gentilis*) (NSC, 2006).

According to residents in the area, many different species of birds in addition to those listed above are seen in the watershed, including Great Blue Herons (*Ardea herudias herodias* Linnaeus), common loons (*Gavia immer*), hummingbirds (*Archilochus* spp.), ruffed grouse (*Bonasa umbellus*), evening grosbeaks (*Coccothraustes vespertinus*), bald eagles (*Haliaeetus leucocephalus*), swans (*Cygnus* spp.) and white pelicans (*Pelecanus erythrorhynchos*) (MLMA, 2011).

Fisheries data taken from the Fish and Wildlife Management Information System website (2011) show that aquatic assessments of the lake were completed in 1986, 2001, 2002 and 2003, and that the species of fish that were captured included brook stickleback (*Culaea inconstans*) and northern pike (*Esox lucius*), but more details about the populations are unknown at this time (e.g. population numbers, age class, size, etc.). On many sampling events there were no fish species captured. Yellow perch (*Perca flavescens*) have also been captured in Mayatan Lake (Angler's Atlas, 2002). In 2011, horsehair worms (also known as Gordiids, or Nematomorpha) were found during the course of the LakeWatch sampling program. These worms are not common in Alberta lakes, and are parasites of grasshoppers and crickets. No other information about aquatic organisms within the lake is available at this time.

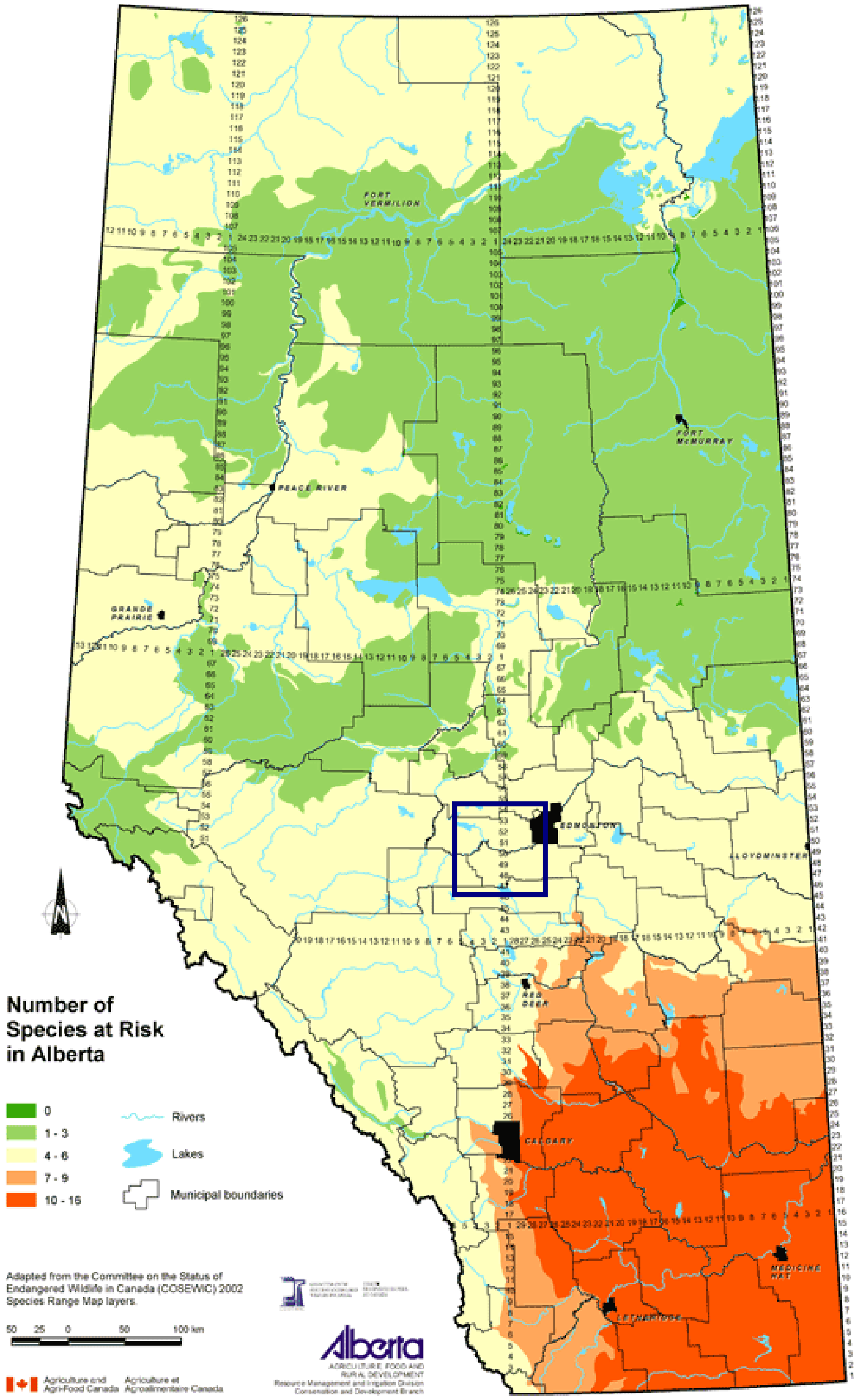

Figure 24. Species at risk in Alberta. The blue square indicates the approximate location of the Mayatan watershed. Adapted from Alberta Agriculture, 2006.

Groundwater Resources

Mayatan Lake is underlain by the Upper, Middle and Lower Horseshoe Canyon Formations. Water wells drilled into the Upper Horseshoe can yield between 10-100 m^3/day of water, while the Middle Horseshoe yields 10-30 m^3/day (HCL, 1999). The Upper Horseshoe groundwater contains mainly sodium-bicarbonate and calcium-magnesium-carbonate, with total dissolved solids (TDS) in the range of 500-1,000 mg/L (HCL, 1999). Sulfide and chloride concentrations are generally low (<250 and <100 mg/L, respectively) (HCL, 1999). TDS and sulfate concentrations are generally slightly higher in the Middle Horseshoe. Groundwater from the Lower Horseshoe contains sodium-bicarbonate or sodium-sulfate, while yields from this formation are in the 10-100 m^3/day range (HCL, 1999). Data from the Lower Formation are minimal due to its depth.

There are currently records for 3,107 water wells in the groundwater database for Parkland County. Of the 3,107 water wells, 2,755 are for domestic/stock purposes (HCL, 1999). The remaining 352 water wells were completed for a variety of uses, including investigation, observation and industrial purposes. Specifically in the immediate Mayatan Lake area, there are 43 groundwater wells drilled; 41 for domestic use, one investigation well drilled by Alberta Environment, and one flowing shot hole for industrial use (AENV, 2011).

Mayatan Lake is located in a groundwater recharge area (Figure 25), which means that water from the landscape infiltrates down into sub-surface aquifers. Groundwater is therefore at risk for contamination from surface land use and management (Figure 26). The interaction between surface water, groundwater and land uses should be considered when planning new developments.

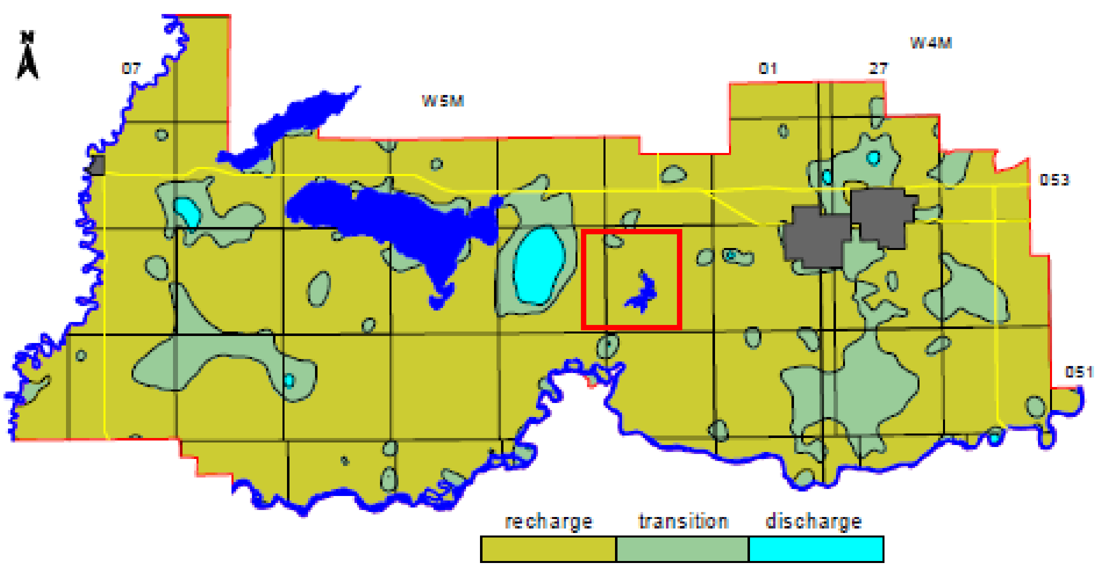

Figure 25. Groundwater recharge, discharge and transition areas in Parkland County. Mayatan Lake is indicated by the red square. Adapted from HCL, 1999.

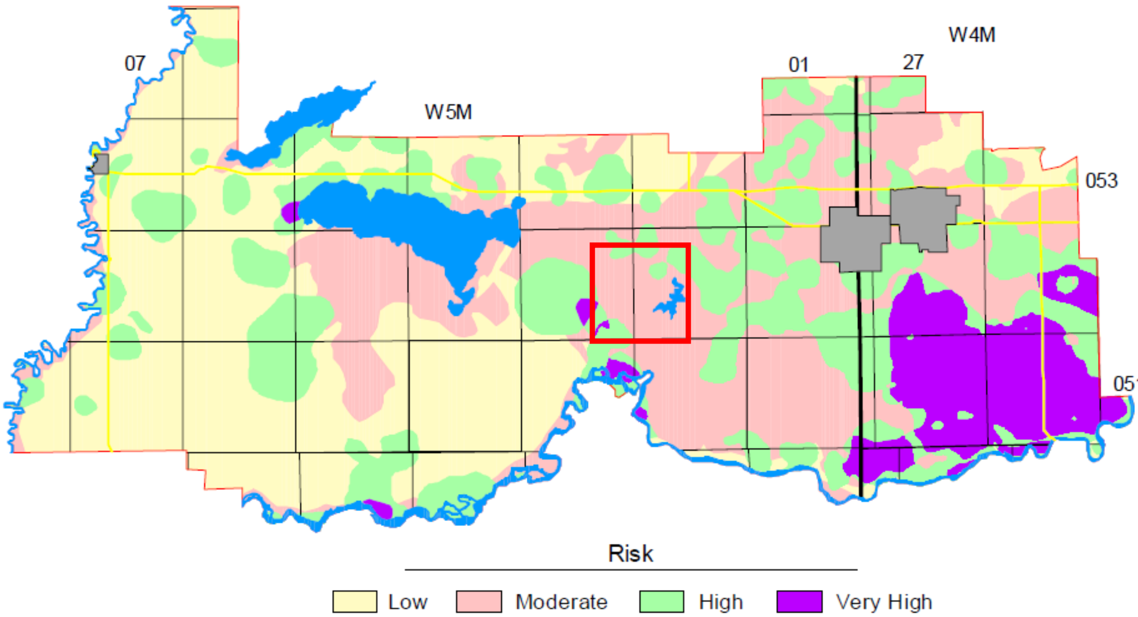

Figure 26. Groundwater contamination risk in Parkland County (HCL, 1999). The approximate location of Mayatan Lake is indicated by the red square.

Air Quality

There are no data available on the air quality specific to the Mayatan watershed, but there is a map produced by Alberta Agriculture that demonstrates air quality risk in the agricultural areas of Alberta, and some data regarding industrial emissions within Parkland County. The air quality risk assessment procedure utilized 2001 Census of Agriculture data related to livestock numbers and tillage practices. Odour was considered directly correlated to manure production, and particulate matter in the air was considered directly correlated to cultivation intensity. When the manure ratings and cultivation ratings were combined, each area in the province was given an air quality risk ranking of 0 to 1. The area around Mayatan Lake is ranked as having a moderate to high degree of air quality risk (Figure 27).

According to the National Pollutant Release Inventory maintained by Environment Canada, there is one plant in Stony Plain that has permitted releases into the atmosphere. In the 2009 report, the Border Paving Ltd – Stony Plain Batch Plant released 1.6 tonnes of sulphur dioxide, 3.7 tonnes of carbon monoxide, 1.6 tonnes of nitrogen oxides, 5.7 tonnes of total particulate matter and 1.6 tonnes of volatile organic compounds (NPRI, 2009). The power plants (3 total) near Wabamun also release a number of substances into the air, including 5,882 tonnes of sulphur dioxide, 344 tonnes of carbon monoxide, 4,255 tonnes of nitrogen oxides, 296 tonnes of total particulate matter and 41 tonnes of volatile organic compounds (NPRI, 2009). It is not clear from the NPRI if this data is for one plant, or for all three. There are no other recorded releases of air pollutants within the immediate vicinity of Mayatan Lake.

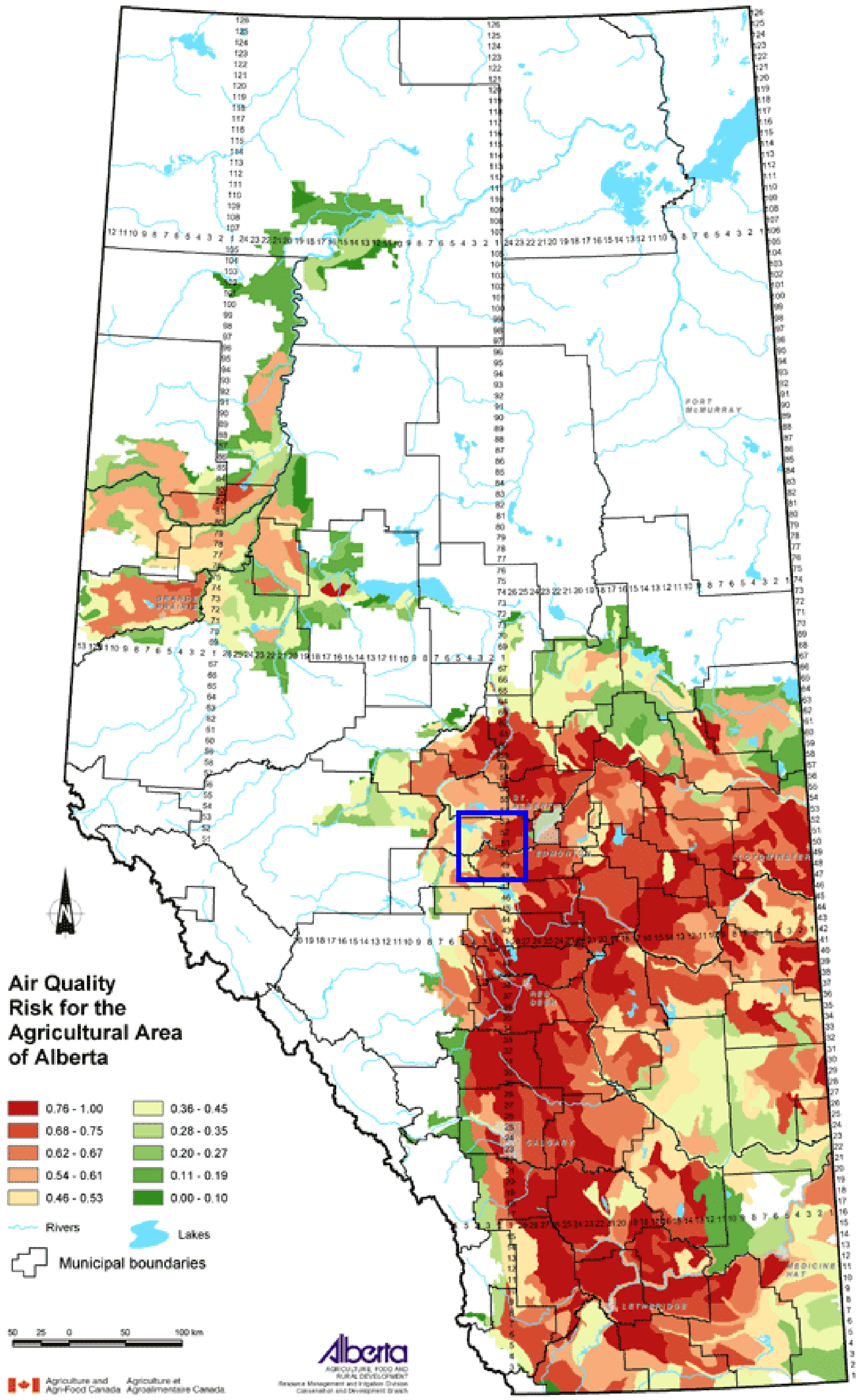

Figure 27. Air quality risk based on tillage practices and manure production (Alberta Agriculture, 2006). The blue square indicates the approximate location of Mayatan Lake.

Dr. David Schindler, E. W. Allen and Dr. William Donahue completed a study in 2006 regarding the impacts of coal fired plants on trace metals and polycyclic aromatic hydrocarbons (PAHs) on lake sediments in central Alberta. The study examined the effect of the plants near Wabamun on the lake sediments in Lac Ste. Anne and Pigeon Lake. The study found that sediment concentrations of mercury, copper, lead, arsenic and selenium have increased by 1.2- to 4-fold since the Wabamun power plants have been built (Donahue et al, 2006). Total mercury flux to Wabamun Lake sediments has increased 6-fold since 1950, compared to 2- and 1.5-fold increases in Lac Ste. Anne and Pigeon Lake, respectively, since circa 1900 (Donahue et al, 2006). Total PAH flux to surface sediments was 730–1100 µg m^{-2} yr^{-1} in Wabamun Lake, 290–420 µg m^{-2} yr^{-1} in Lac Ste. Anne, and 140–240 µg m^{-2} yr^{-1} in Pigeon Lake (Donahue et al, 2006). The study suggested without improvements in pollution abatement technologies, continued expansion of coal burning power plants would result in increased contaminant deposition.

8.0 Water Quantity

Water Balance

A water balance for Mayatan Lake was completed by S. Figliuzzi, P.Eng. (Sal Figluzzi and Associates, 2011) The water balance considered evaporative losses, surface runoff, groundwater inputs, precipitation, water licenses and drainage area. The following is a summary of the findings of the report; the full report is available in Appendix 1.

Computation of Drainage Area

Mayatan Lake is a landlocked waterbody and has no outlet channel. The land area surrounding the lake whose surface runoff drains into the lake is called the drainage area, catchment area or watershed area. Because of the glacial landscape and climate of the Canadian Prairies, the watershed area which contributes to the runoff actually reaching a waterbody can vary significantly from event to event and from year to year due to local depressions or storage areas. Ideally, a water balance would be carried out for each of these storage and depression area towards identifying the actual quantity of runoff reaching the water body under consideration for each time step. However, as this level of analysis is not practical or possible in most instances, the concept of “gross” and “effective” area have come into common use to account for this variability in the “contributing drainage area”. These terms are defined as follows:

- Gross drainage area is the land surface area which can be expected to contribute runoff to a given body of water under extremely wet conditions. It is defined by the topographic divide (height of land) between the water body under consideration and adjoining watersheds.

- Effective drainage area is that portion of the gross drainage area which can be expected to contribute runoff to a given body of water under average conditions. The effective drainage area excludes portions of the gross drainage area which drain to peripheral marshes, sloughs and other natural depressions or storage areas which would prevent runoff from reaching the water body under consideration in a year of average runoff.

The gross drainage area (including the lake surface area) for Mayatan Lake was computed as 13.60 km^2 from the Canadian Digital Elevation Data (Figures 28 through 31). However, as much of this area drains to other ponds, sloughs and storage which likely would not contribute to the runoff reaching Mayatan Lake other than it wet years, it was necessary to compute the effective area or area which would contribute to Mayatan Lake in average years. The effective drainage area, including the surface area of the lake, was estimated at 5.61 km^2 thus resulting in a contributing effective drainage area of (5.61 - 1.38) = 4.23 km^2.

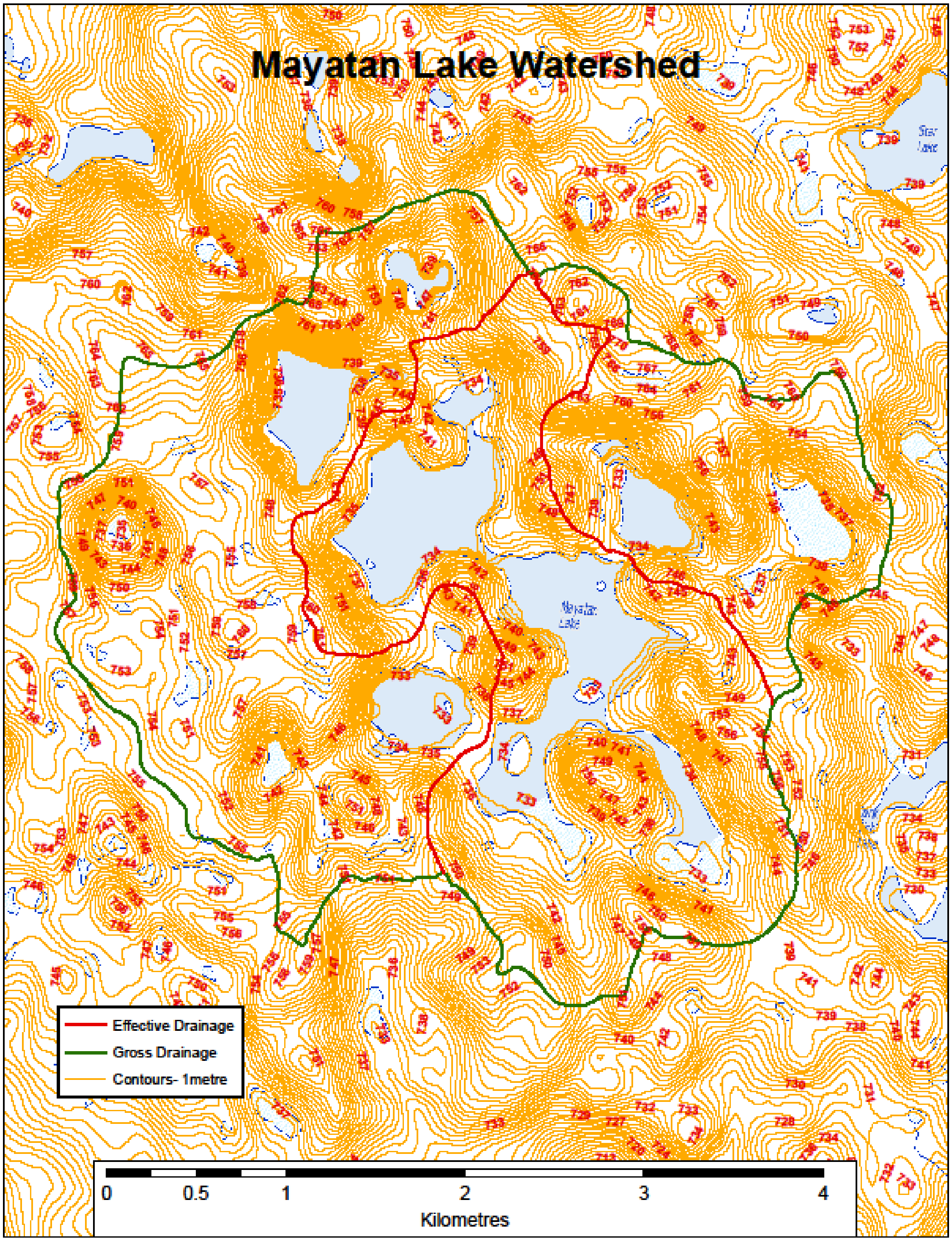

Figure 28. 1 meter contour map of the Mayatan Lake watershed (AAFC, 2011).

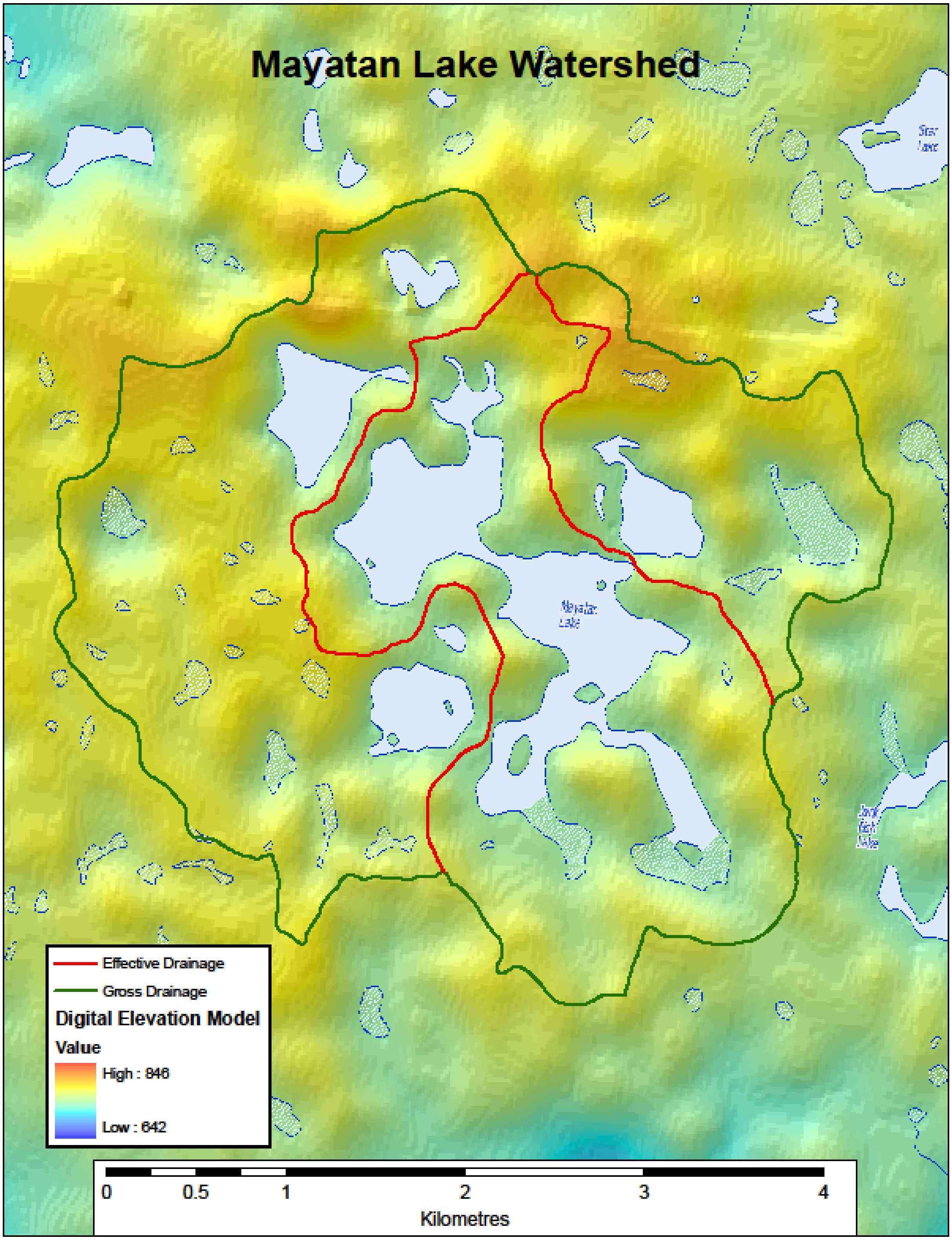

Figure 29. Digital elevation model of the Mayatan watershed (AAFC, 2011).

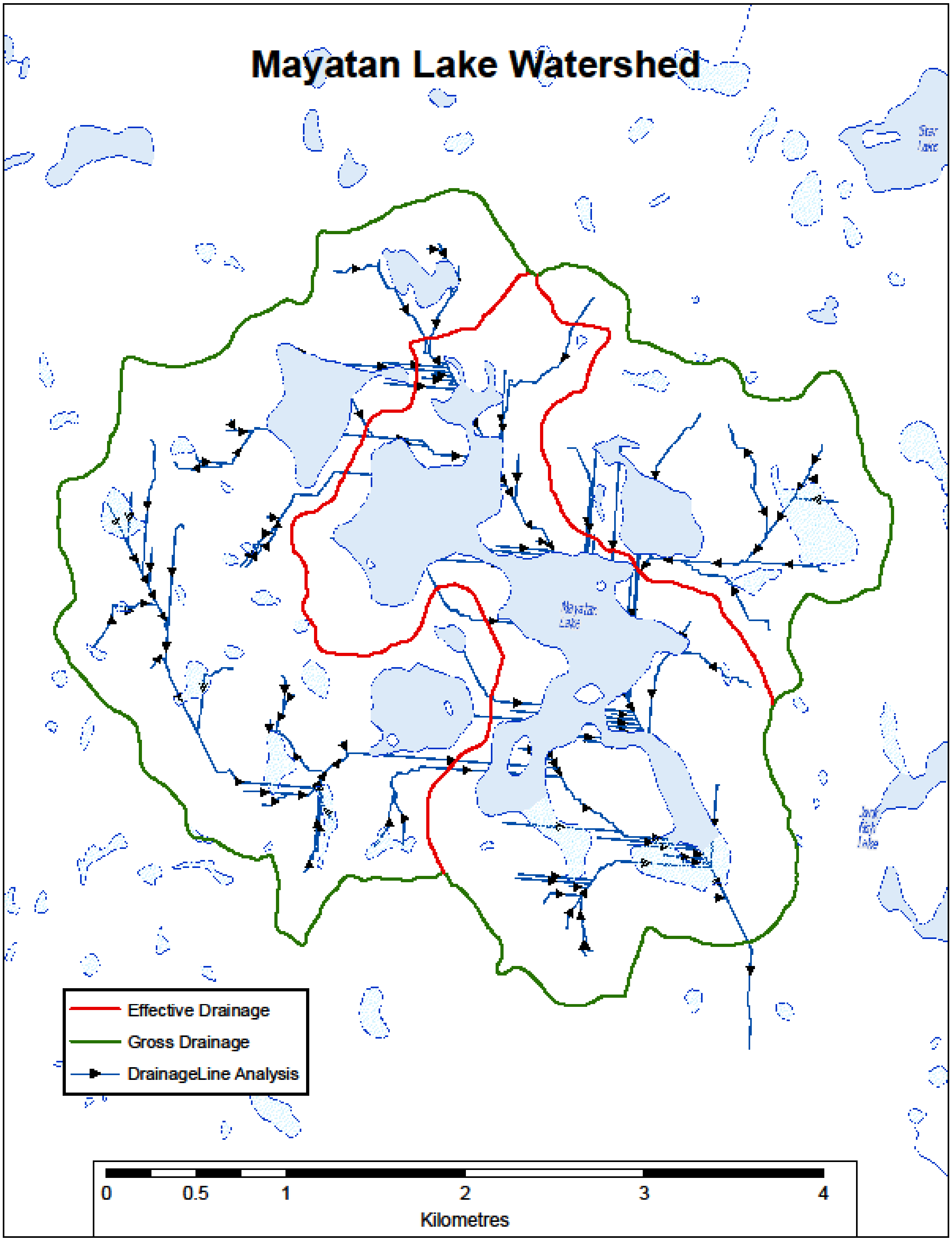

Figure 30. Drainage line analysis for Mayatan watershed (AAFC, 2011). This demonstrates the direction of flow for all streams and drainage channels within the Mayatan watershed.

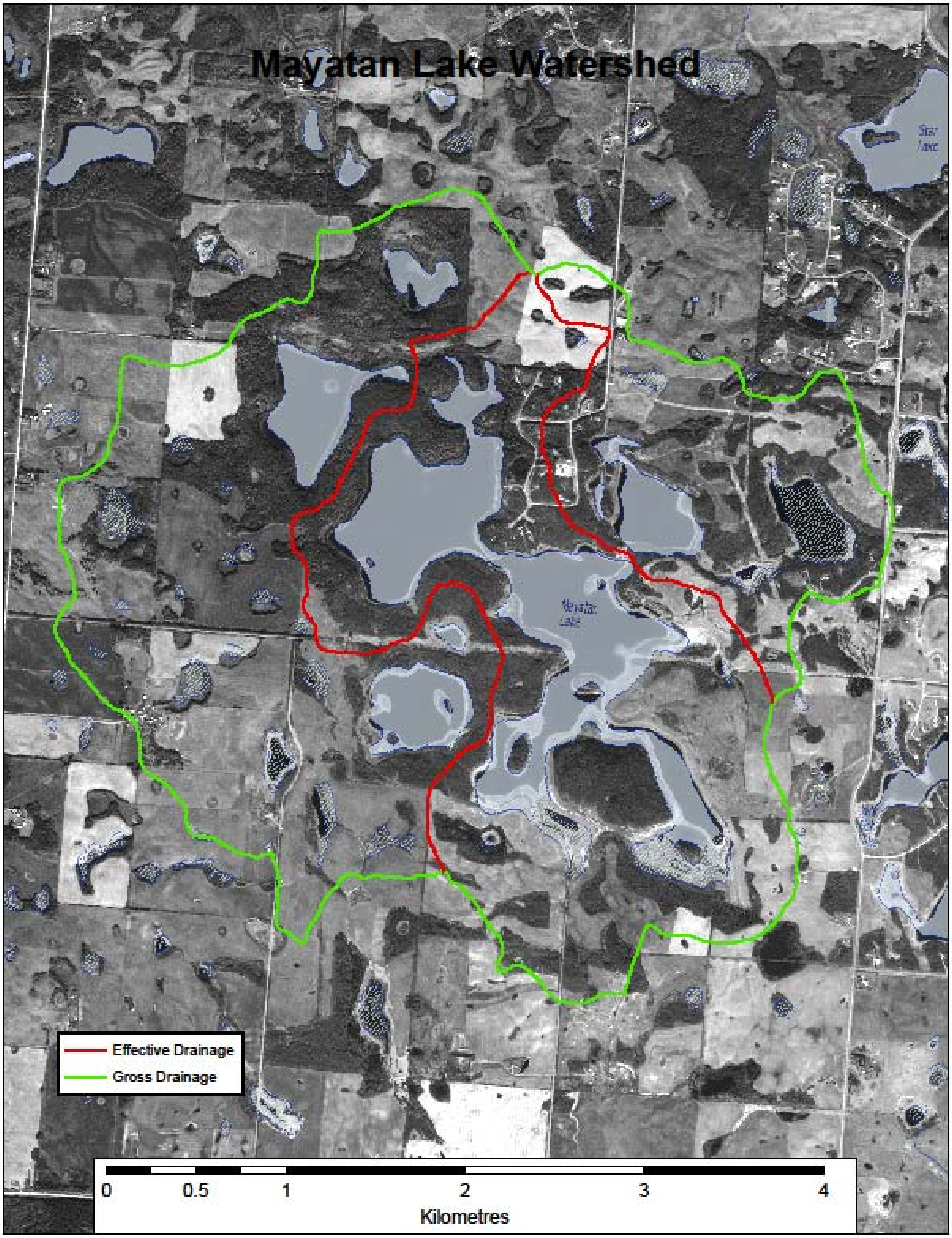

Figure 31. Gross and effective drainage area for Mayatan Lake (AAFC, 2011).

Given the consistency of specific yield for the three nearby, gauged basins, the specific surface runoff for Mayatan Lake was estimated at 58.7 dam^3/km^2 of effective area (58,700 m^3/km^2), the average for the three gauged sites. Therefore, total annual surface runoff contribution to the Mayatan Lake water balance was calculated at 248.3 dam^3 (248,300 m^3).

COMPUTATION OF PRECIPITATION INPUTS

The direct precipitation amount onto Mayatan Lake was set at 530 mm, the average of data taken from three local weather stations. The annual precipitation input to the Mayatan Lake water balance was, therefore, estimated at 731.4 dam^3 (731,400 m^3).

COMPUTATION OF EVAPORATION LOSSES

Data sources indicate a relatively consistent depth of lake evaporation, therefore the annual lake evaporation for Mayatan Lake was estimated at 675 mm. The mean annual water loss due to lake evaporation for the Mayatan Lake water balance was estimated at 931.5 dam^3 (931,500 m^3).

ASSESSMENT OF DIVERSIONS

A search of Alberta Environments EMS system indicates a total of three licensed allocations within the gross drainage area of Mayatan Lake. Two of these water allocations Priority #'s 19481231080 and 19501231323, having a combined total annual allocation of 620 m^3 are located outside of the effective drainage area for Mayatan Lake and will not influence the long- term water balance. The third, Priority #19481231080, is for an annual allocation of 252 m^3 directly from Mayatan Lake.

It is noted that the licensed allocation represents the maximum diversion that is allowed during any one year and since actual diversions and consumption often depend on a number of factors, including weather conditions, in most instances the actual diversion or consumption is substantially lower than the water allocation. However, in the absence of information as to actual consumption, the full allocation has been assumed to be a consumptive diversion.

GROUNDWATER INFLOWS AND OUFLOWS

Mayatan Lake is in a groundwater recharge area although little information is available on the movement of groundwater through the lake. Isotopic studies could be used to explore the question in more detail.

ANNUAL WATER BALANCE

The findings of the water balance can be summarized as follows:

Physical Parameters:

- Gross drainage area (including lake surface area) = 13.6 km^2
- Effective drainage area (excluding lake surface area)= 4.23 km^2
- Lake surface area (S.A.) = 1.38 km^2
- Mean Depth (M.D.) = 5.7 m
- Volume (S.A. times M.D.) = 7,695,000 m^3

Hydrologic Parameters

- Mean annual specific runoff = 58.7 dam^3/km^2 or 58,700 m^3/km^2
- Mean annual precipitation = 530 mm
- Mean annual gross evaporation = 675 mm

Water Balance Parameters

- Surface water inflow = 248.3 dam^3 or 248,300 m^3
- Surface water outflow = 0 m^3
- Precipitation inputs = 731.4 dam^3 or 731,400 m^3
- Evaporation losses = 931.5 dam^3 or 931,500 m^3
- Net groundwater inflow (GI-GO) = 48.9 dam^3 or 48,900 m^3

The water balance results in a small positive residual, probably within the error of the estimates of the other components. Therefore, given the approximate annual equivalencies of surface water inputs and output, the overall volume of the lake is likely sustained by groundwater influences.

9.0 Surface Water Quality

Water Quality

Only one detailed water quality report was located for Mayatan Lake. The study was conducted from April to August 1983 by Bierhuizen and Prepas (1985) as a part of a study on other nearby, shallow lakes (Hasse and Mink lakes). Samples were collected weekly from the shallow, eastern basin of Mayatan. No historic data are available for the deeper, western basin

Mean summer trophogenic zone total phosphorus concentration in Mayatan was 27.3 mg/m^3 and mean summer chlorophyll a concentration was 7.1 mg/m^3 (Table 2). Based on the total phosphorus and chlorophyll a levels, Mayatan Lake would be classified as mesotrophic according to Alberta Environment’s lake trophic status classification (AENV, 2009). This means that nutrient and algal levels are moderate.

Table 2. Background data for the eastern basin of Mayatan Lake, 1983, adapted from Bierhuizen and Prepas (1985). Data include location (latitude and longitude), surface area, maximum depth (z_{max}), mean depth (z), mean summer trophogenic TP (TP_{su} in mg/m^3) and mean summer trophogenic Chl a ($Chla_{su}$ in mg/m^3).

Lake	Lat.- (N)	Long.- (W)	Area (m^2)	z_{max} (m)	z (m)	TP_{su}	$Chla_{su}$
Hasse	53°29'	114°10'	898 000	9	3.7	21.4*	3.3*
Mayatan			398 439	10	3.3	27.3†	7.1†
Mink N.	53°31'	114°14'	240 886	9	3.7	26.9*	5.3*
Mink S.	53°31'	114°14'	467 963	9	5	26.9*	5.3*
Wizard	53°07'	114°55'	2 440 500	11	5.8	44.2*	26.4*

*Data from Prepas and Trew (1983)
† Data from Bierhuzen and Prepas (1985)

The shallow eastern basin underwent intermittent vertical mixing during June, July and August of the study year; thermal stratification was weak and unstable. Mayatan became anoxic below 5 meters depth as early as June and anoxia persisted throughout the sampling period (Table 3) (Bierhuizen and Prepas, 1985).

Table 3. Dissolved oxygen profiles (mg/L) for the eastern basin of Mayatan Lake, 1983. Blanks indicate no data were collected. Adapted from Bierhuizen and Prepas (1985).

Depth (m)	Date							
	18/5	27/5	2/6	16/6	23/6	30/6	7/7	14/7
2	10.2	10.9	10.5	10.4	9.3	10.6	10.6	9.4
4							3.3	1.4
4.5								1.4
5			4.0	1.4	6.0		1.3	1.4
5.5			0.6	1.0			0.9	0.8
6	9.3	4.2	0.5	1.1	3.2	3.4	0.5	0.6
6.5		2.8	0.2	0.0	0.5	2.6		0.6
7	0.0	0.0	0.0		0.0	0.0	0.0	0.0
7.5								

Cont'd depth (m)	Date						
	21/7	26/7	4/8	11/8	18/8	23/8	29/8
2	9.1	8.0	10.4	9.8	5.6	6.1	8.1
4	4.6	7.6			5.6	4.0	
4.5							
5	2.8			0.2	4.0	3.8	0.9
5.5	1.2	1.2	0.5	0.2	0.2		0.3
6	0.9	0.8	0.4	0.8	0.1	1.4	0.1
6.5	0.9	0.9	0.6	1.0		0.2	0.0
7	0.4	0.0	0.0	0.0	0.0	0.0	
7.5	0.0						

Table 4. Vertical profiles of total phosphorus (mg/m³) in the eastern basin of Mayatan Lake, 1983. Adapted from Bierhuizen and Prepas (1985).

Depth (m)	Date							
	18/5	27/5	2/6	9/6	16/6	23/6	30/6	7/7
0	25.2	25.3	24.3	20.8	23.5	26.4	29.1	24.0
2	28.9	27.1	25.0	22.7	24.8	26.7	28.8	26.8
3								
3.5								
4	32.8	35.5	41.2	25.2	23.3	24.2	28.0	32.7
4.5								33.4
5			40.9	50.3	31.9	24.9		30.1
5.5			73.3	68.9	39.8			38.6
6	31.8	37.7	101.5	65.0	98.8	27.4	24.9	36.8
6.5			61.0	64.8	110.9	180.7	24.2	52.8
7	66.5	114.6		78.2	109.3	126.3	142.8	149.6
7.5		94.7	94.0	108.4	119.0	140.9	150.2	150.5
8		101.4		141.8	142.4		180.1	226.3
8.5		100.0						292.4

Cont'd depth (m)	Date							
	14/7	21/7	26/7	4/8	11/8	18/8	23/8	29/8
0	23.4	23.5	22.1	22.1	20.0	24.5	29.9	23.6
2	22.5	25.0	23.0	20.2	20.5	23.8	32.0	23.7
3		23.9	23.0					
3.5	34.0							
4	27.2	26.3	23.2	25.5	28.4	23.4	26.5	22.5
4.5	29.7							
5	30.3	26.1	31.8	34.1	37.7	30.3	29.3	25.5
5.5	48.7	26.6	38.7	34.9	34.4	50.8		35.7
6	70.4	59.4	60.7	51.4	53.9	54.4	33.8	35.9
6.5	63.9	88.8	96.4	93.3	116.6	116.0	154.2	82.4
7	192.6	141.0	167.8	176.0	181.0	146.8	151.2	128.6
7.5	162.6	211.6	202.2	154.4	136.0	138.0	151.0	122.4
8	277.4	311.2		329.0	259.2	343.6	399.6	238.6
8.5	360.4	344.4			33.2	428.0	468.8	

Vertical profiles of total phosphorus concentrations indicate concentrations increasing below the 5 meter mark in the water column (Table 4). Concomitantly, the dissolved oxygen levels decline below 5 meters depth, which may induce anaerobic phosphorus release from the sediments. The phosphorus released from the sediments can then move into the upper layers of the lake during mixing events, which may increase algal and plant productivity in the lake. It should be noted that the depth of the euphotic, or productive zone of the lake extends down to nearly 7 meters, which means there is plenty of light available for primary productivity throughout the majority of the lake. Total phosphorus levels in the euphotic zone in May to August varied from 23.7 to 32.4 µg/L during the study period (Table 4) (Bierhuizen and Prepas, 1985). The generic Alberta Surface Water Quality Guideline for the Protection of Aquatic Life (ASWQG PAL) for total phosphorus is 50 µg/L (AENV, 1999).

Mayatan demonstrated a more dramatic build up of dissolved phosphorus over the sediments than the other study lakes, and the release rates were also higher. On average, the entire lake sediment base of Mayatan released 4.5 $mg/m^2/day$ of phosphorus, which is approximately 2 times the release amount from the other study lakes (Bierhuizen and Prepas, 1985).

Table 5. Average chlorophyll a (mg/m^3) in the trophogenic zone of Mayatan Lake, 1983. Adapted from Bierhuizen and Prepas (1985).

		Lake			
Date		**Hasse**	**Mayatan**	**Mink N.**	**Mink S.**
April	29	8.6		13.3	10.4
May	4			8.6	
	11	22.8		7.6	4.8
	18		8.2	7.1	6
	26–27	8.4	6.8	3.4	2.8
June	1–2	9.8	7.6	5	1.4
	8–9	5.4	3.5	7.5	1.5
	15–16	4.7	6.8	7.4	2
	22–23	2.8	7.4	2.2	3
	29–30	5.9	8.6	4.6	3.9
July	6–7	5.9	9.4	4	4.5
	13–14	4.4	9.4	4	4.3
	20–21	5.4	6.9	3.5	4.5
	26–27	4.4	5.5	5.3	6.5
August	1–2	4.8	5.2	6.3	9.4
	8–9	3.4	8.3	6.4	7.3
	17–18	4.7	8.5	6.6	8.7
	23	5.5	6.2	7.1	11.8
	29	4.9	6.6	8.4	16.7

Chlorophyll a is a photosynthetic pigment found in plants and algae, and is often measured as an indicator of productivity in waterbodies. Chlorophyll a levels during May to August of the study period ranged from 3.5 to 9.4 mg/m^3 (Table 5) which puts the lake in the mesotrophic to low eutrophic level of productivity, with peak productivity seen in early July. Chlorophyll a levels in Mayatan are very similar to the other lakes in the study area.

Water quality data from a single sampling event in 1986 by Alberta Sustainable Resource Development are presented in Table 6.

Table 6. Summary of water quality data for Mayatan Lake taken from ASRD FWMIS (1986) and associated water quality guidelines for reference.

Parameter	Concentration	ASWQ/CCME/USEPA Guidelines (PAL/Recreation/Agriculture)
Colour	7.5	Cannot exceed 30 colour units over background levels
Ca	26.5 mg/L	1000 mg/L for livestock watering
Na	18.5 mg/L	N/A
K	18.9 mg/L	N/A
Mg	59.0 mg/L	N/A
Fe	0.012 mg/L	5.0 mg/L ASWQG (irrigation water), 0.3 mg/L CCME PAL (interim), 1.0 mg/L USEPA PAL (continuous)
Cl	0.26 mg/L	860 mg/L USEPA PAL (max conc), 230 mg/L USEPA (continuous conc), 100-700 mg/L CCME irrigation water
SO_4	132.3 mg/L	1000 mg/L CCME (livestock watering)
Alkalinity ($CaCO_3$)	204.0 mg/L	20 mg/L USEPA (continuous concentration)
HCO_3	224.8 mg/L	N/A
CO_3	5.76 mg/L	N/A
Hardness ($CaCO_3$)	276.0 mg/L	N/A
Si	0.2066 mg/L	N/A
TN	1.7116 mg/L	1.0 mg/L ASWQG PAL
$NO_3 + NO_2$	0.0152 mg/L	100 mg/L CCME (livestock watering)
TN	1.6964 mg/L	1.0 mg/L ASWQG PAL
TP	0.0271 mg/L	0.05 mg/L ASWQG (PAL – chronic)
Chl a	5.76 µg/L	N/A

These data suggest that total phosphorus levels and chlorophyll a levels had not changed much from the 1983 study, but the single sample does not permit any statistical comparison between years. Mayatan Lake is being sampled by the Alberta Lake Management Society in 2011 as part of the LakeWatch Program. These new data will provide an update to basic water chemistry parameters for the lake.

Preliminary Phosphorus Budget for Mayatan Lake

Phosphorus is considered to be the most common limiting chemical factor for algal growth in freshwater lakes in central Alberta (Prepas and Trew, 1983). The nitrogen content of our freshwater lakes can also be an important factor, and may influence the types of algal species succession that occur during the open-water growing season (Prepas and Trimbee, 1988). Other factors such as salinity, turbidity and physical mixing patterns are also important determinants of the quantity and types of algae that develop (Bierhuizen and Prepas, 1985). Algal blooms are a major feature of summer water quality in Alberta lakes, affecting water transparency and aesthetics directly, and other internal lake processes such as deoxygenation and cyanotoxicity. Therefore, the control of excessive algal growth, and the prevention of blooms, is an important goal of lake management.

The use of phosphorus budgets have become commonplace in the lake research and management literature, and they are used as diagnostic tools to identify pollution problems and point the way to long-term management options for both the watershed and the lake (Rast et al., 1989; OECD, 1982). The development of phosphorus budgets and models has been an ongoing field of limnological research since the first watershed/lake nutrient relationships were hypothesized in the 1960s. Today, many computerized phosphorus models are available to provide rapid assessments of current lake conditions and the effects of future management scenarios.

The essence of phosphorus modeling is to relate annual or seasonal phosphorus loadings to hydrologic flushing and internal lake sedimentation processes, and thereby arrive at a prediction of the phosphorus concentrations available for plant growth in the water column. As a preliminary step for Mayatan Lake, an estimated phosphorus budget has been developed using the 1983 empirical data from Mayatan Lake (Bierhuizen and Prepas, 1985) and from studies conducted on Lake Wabamun in 1981-82 (Mitchell, 1985). These studies were carefully done and provide useful data for the estimated budget. Morphometric and hydrologic data have been taken from Figliuzzi (2011). Annualized phosphorus loading estimates have been developed for atmospheric loading directly to the lake surface, overland runoff from agricultural and forested lands. Summer bottom sediment release processes (internal loading) have also been estimated. Groundwater and sewage phosphorus inputs have not been included in this budget.

Atmospheric deposition rates of phosphorus on to lake surfaces were measured in a number of studies in Alberta in the 1970s and 1980s. A figure of 23.7 mg/m^2/year (Bierhuizen and Prepas 1985) was combined with the surface area of Mayatan Lake (1.38 km^2) to provide an annual loading estimate from this source of 33 kg.

The internal loading of phosphorus via summer sediment release was estimated directly in the shallow basin of Mayatan at 4.5 mg/m^2/day by Bierhuizen and Prepas (1985). For the purposes of this preliminary budget this rate has been extrapolated to the west basin in Mayatan as well. Acknowledging that the thermal regime and mixing patterns of the west (deeper) basin are different and would influence internal loading rates somewhat, it has nevertheless been assumed that a large portion of the west basin could be represented by the release rate presented. The figure of 4.5 mg/m^2/day was therefore combined with a 90-day estimate for the summer release period, and a sediment surface area of 1.38 km^2. The multiplication of these three figures provides a summer internal loading estimate of 559 kg. Winter internal loading has been assumed to be negligible in this analysis.

An important point to note is that this large mass of phosphorus is released to the water from the bottom sediments in summer (during warm and anoxic conditions), but almost all returns to the sediments during the autumn cooling phase via sedimentation of particulate phosphorus tied up in phytoplankton and other materials. The net contribution for the years is likely close to zero, but the loading comes during the critical summer growing period, akin to summer fertilization of land plants, and does have a major influence on plant and algal growth. This internal loading process is a very common and dominant process in shallow Alberta lakes.

The final loading component estimated was for surface runoff. The quality of runoff varies from forested to agricultural lands, and also according to the type of agricultural activity. As a first estimate we have averaged to annual flow-weighted mean concentrations of phosphorus for forested (0.167 mg/m^3) and agricultural (0.409 mg/m^3) sub-watersheds published by Mitchell (1985) for nearby Wabamun Lake.

AAFC land cover data (Figure 14) were used to define the proportion of agricultural and forested lands in the effective drainage area of Mayatan. Forest cover was set as 38% and agricultural land use at 43%. The annual inflow of 248,300m^3/yr was also proportionally assigned to each land use type. The estimate for agricultural phosphorus loading is therefore:

$(0.409\ mg/m^3/yr \times 106{,}769\ m^3/yr) = 44\ kg.$

The estimate for forested phosphorus loading is therefore:

$(0.167\ mg/m^3/yr \times 94{,}354\ m^3/yr) = 16\ kg.$

Based on these data and assumptions, the annual phosphorus loading regime to Mayatan Lake is estimated to be as follows (Figure 32):

Atmospheric deposition = 33 kg
Summer internal loading = 559 kg
Surface runoff from forested land = 16 kg
Surface runoff from agricultural land = 44 kg

Total phosphorus loading for the lake from external and internal sources is as follows:

Total external loading = 93 kg/yr
Total internal loading = 559 kg/yr

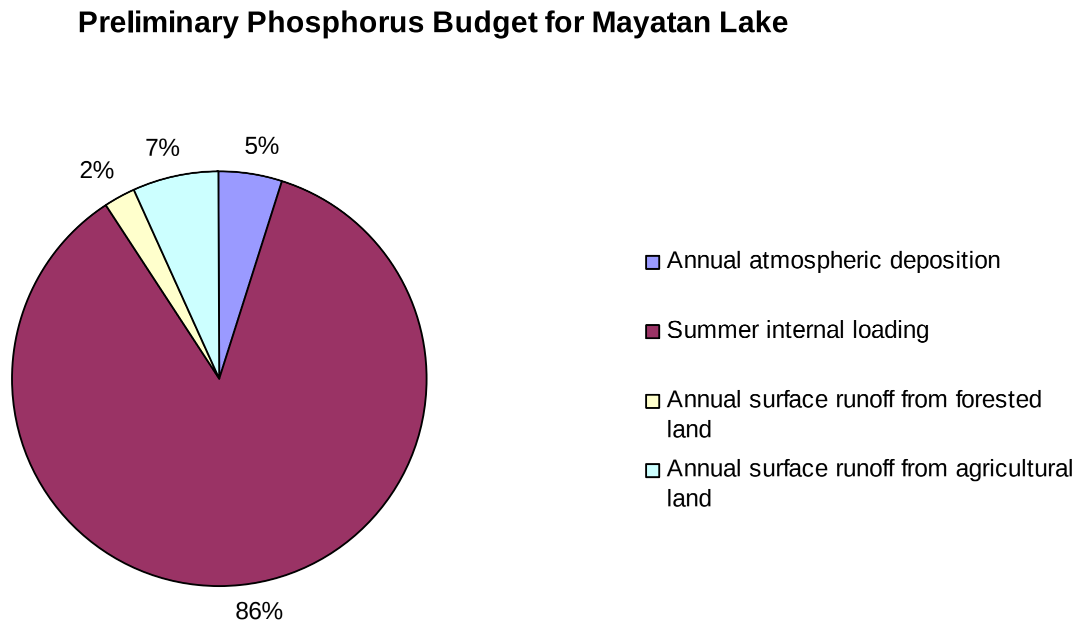

Figure 32. Proportion of phosphorus loading to Mayatan Lake from various sources. Data adapted from Mitchell (1985) and Bierhuizen and Prepas (1985).

An important point to note is that Maytan is not hydrologically flushed by surface water throughput. Therefore, all external phosphorus loading will theoretically accumulate over time in the bottom sediments and may contribute to the ongoing sediment release processes which drive summer algal production in this lake. It is therefore important to prevent any further increases in external phosphorus loading to the lake.

10.0 Conclusions and Recommendations

Limited data were available to be used in this report. It is apparent that very little study has been done within the watershed, and that data gaps are present. The lake is actually part of a large lake and wetland complex that is likely highly interconnected above and below ground and may be affected by changes in land use. The water quality within the lake is quite good in comparison to other lakes within the province and the shoreline has been minimally disturbed.

Future initiatives for the Mayatan Lake watershed could include, but are not limited to, the following:

- Conduct a regular lake water quality monitoring program, perhaps through the Alberta Lake Management Society LakeWatch Program; test for parameters that have not been addressed before, such as fecal bacteria, metals, pesticides and others to increase baseline data
- Estimate phosphorus loadings from residential development and groundwater, revise the estimated phosphorus budget as necessary
- Investigate the interactions between surface water and groundwater in the area to more accurately determine lake flushing rates
- Develop a suite of indicators to be used (biological, physical and chemical) to monitor the health of the lake (see Wray and Bayley, 2006)
- Encourage stewardship activities around the lake
- Address data gaps in report – riparian health, up to date water quality, mapping of wildlife and waterfowl habitat/nesting/breeding/staging specific to the watershed
- Development of a Watershed Management Plan for the lake and its watershed, in alignment with the North Saskatchewan Watershed Alliance Integrated Watershed Management Plan
- Participate in programs such as "Living by Water" (http://www.livingbywater.ca/main.html)
- Public education about water quality, shoreline management, maintenance of natural vegetation
- Track annual recreational use of the lake and watershed by campers, anglers, others

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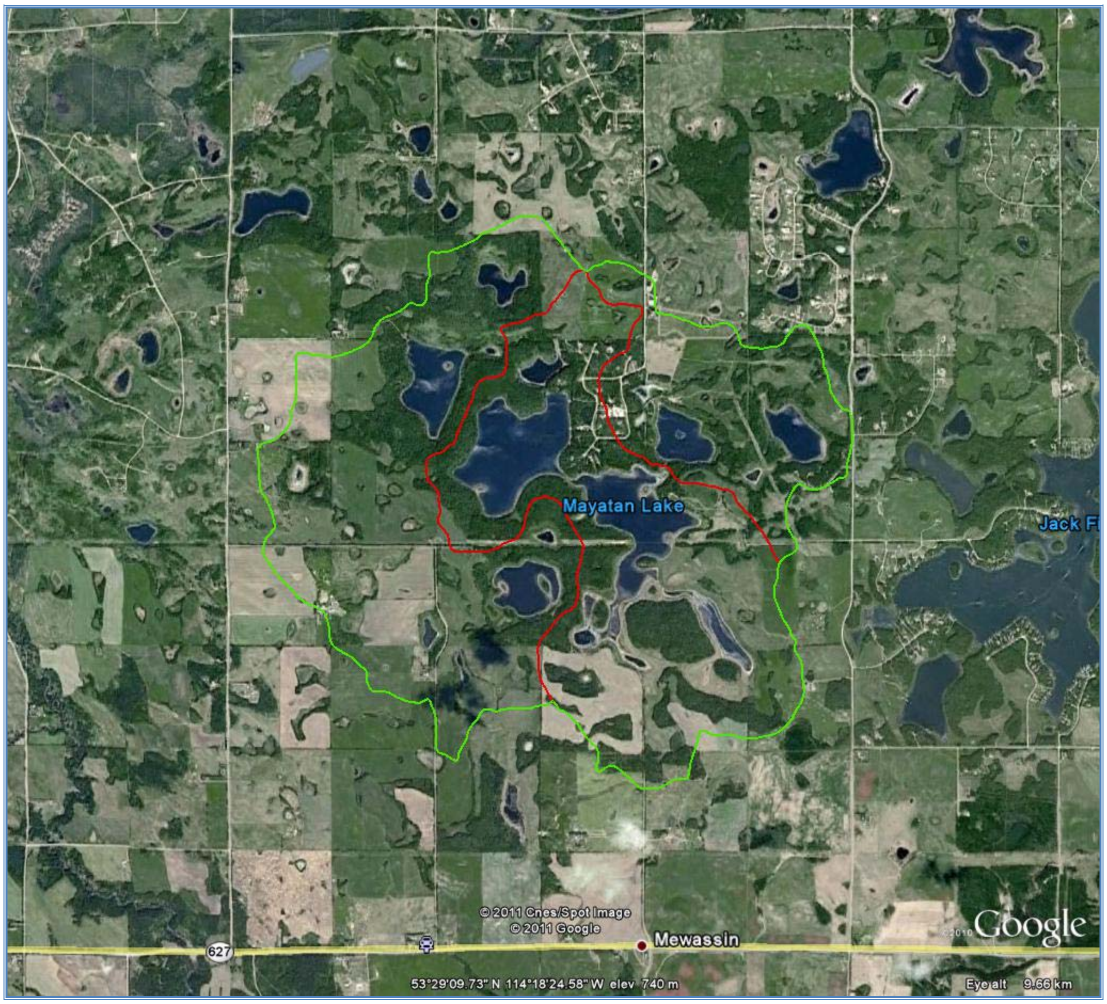
Appendix 1 – Water Balance

WATER BALANCE
for
MAYATAN LAKE, ALBERTA



Water Balance
For
Mayatan Lake, Alberta

Prepared for:
The North Saskatchewan Watershed Alliance

Prepared by:
Sal Figliuzzi P. Eng.

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1.0 INTRODUCTION

Mayatan Lake is located in the North Saskatchewan River watershed in central Alberta about 70 Km west of the City of Edmonton (Figure 1).

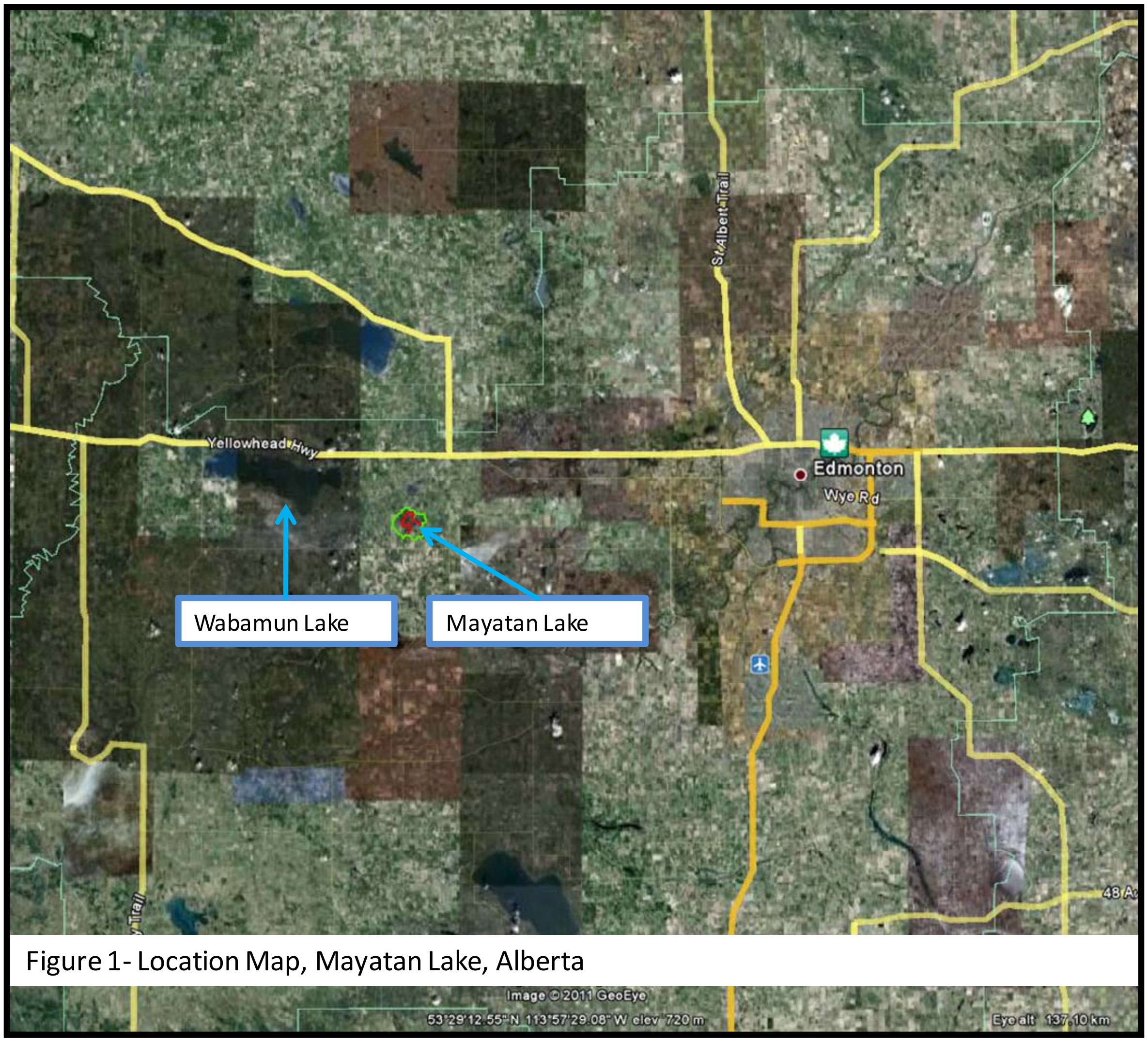


Figure 1 - Location Map, Mayatan Lake, Alberta

Mayatan Lake is comprised of two nearly equal sized water bodies, a western and eastern, joined by a narrow channel. The Lake is landlocked and has no outlet channel. Bathymetric surveys of Mayatan Lake (Figure 2) indicate that the western body of water has a maximum depth of about 26.5 metres (87 feet) while the eastern water body has a maximum depth of about 6.1 metres (20 feet). The two cells combined have a water surface area of about 1.38 square kilometres (334 acres).

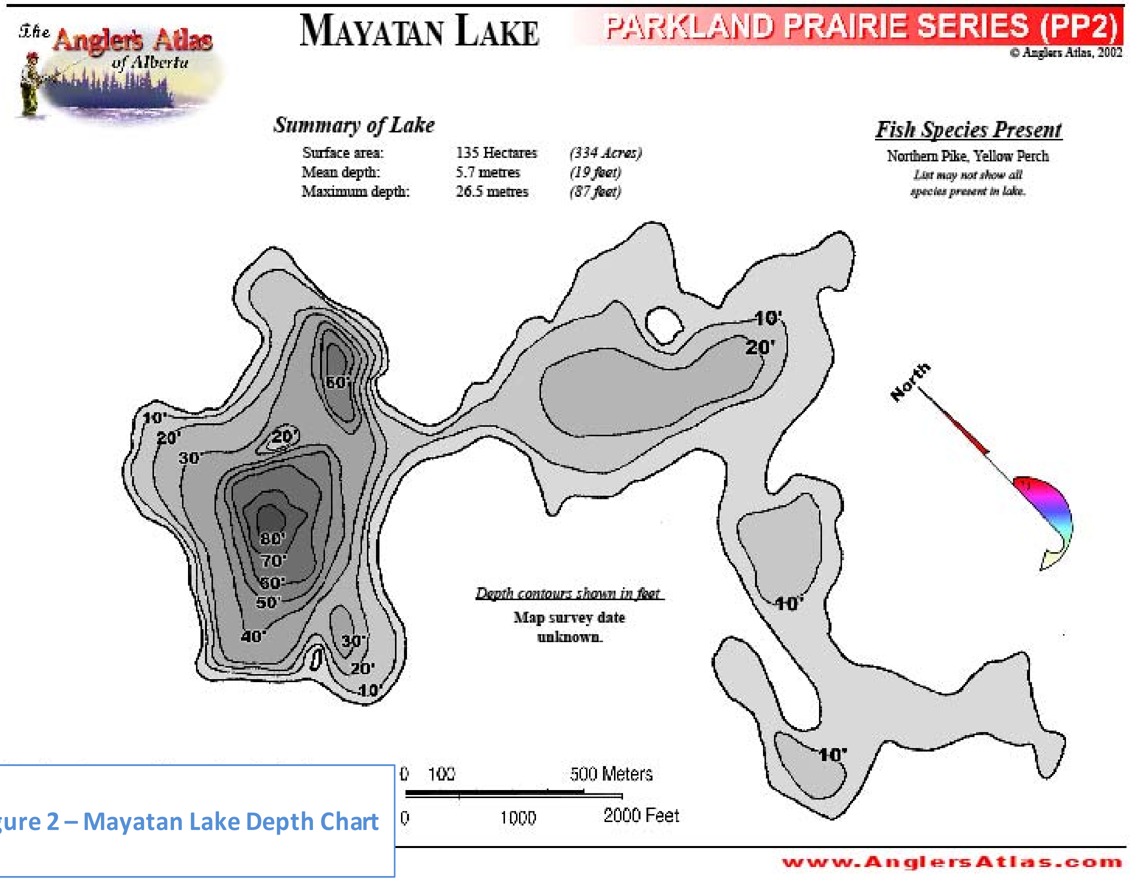


Figure 2 – Mayatan Lake Depth Chart

The North Saskatchewan Watershed Alliance (NWSA) is a non-profit society whose purpose is to protect and improve water quality and ecosystem functioning in the North Saskatchewan River watershed in Alberta. Due to proposed recreational development adjacent to Mayatan Lake, the NWWA has requested that a water balance be carried out so that may have a better understanding of Mayatan Lake.

The objective of this report is to conduct a water balance for Mayatan Lake so as to increase the general understanding as to the relative contribution to Mayatan Lake from each of the hydrologic components.

2.0 WATER BALANCE

A water balance is simply an accounting of all water inputs to and outflows from a water body. In its simplest form the water balance can be represented by the following equation:

$$\Delta S = I - O \qquad (1)$$

Where:

ΔS= the change in lake water storage,

I = water inputs to the lake, and

O = water outflows from the Lake.

For any given time period, Equation 1 can be expanded to its individual components and expressed as follows:

$$\Delta S=(DA*SR-SO) + LSA*(P-E) + (GI-GO) - D \qquad (2)$$

Where:

DA = the land area that drains into the lake through defined streams and channels or through the upper soil layers.

SR = the specific surface runoff - the runoff per square kilometre from the lake's catchment or drainage area

SO= Surface outflow – generally through a channel leaving the lake.

P = Precipitation – rain and snow falling directly on the Lake Surface Area (LSA)

E = Evaporation – water evaporated from the lake surface area.

GI = Groundwater inflow –water entering the lake via buried channels and connections to aquifers.

GO= Groundwater outflow - water leaving the lake through the groundwater system.

D = Diversions – water diverted into or from the lake due to human activity.

In general, the largest components of the water balance are precipitation, evaporation and surface runoff. As these parameters are the result of climatic conditions, wet or dry weather conditions can create temporary imbalances between inflows and outflows which cause the lake to rise or drop temporarily thus resulting in a significant change in lake storage for the period under consideration, be it a day, a month or several years. However, over a large number of years the lake will return to its “normal balanced condition” and any changes in storage that may persists will be a relatively minor component of the overall water balance. In the absence of water levels from which to estimate the change in storage, it is therefore common practice to carry out the water balance for a sufficiently long period of time such that the change in storage can be assumed to be “zero”. As there are no water levels for Mayatan Lake, the generalized water balance will be carried out based on at least 20 year averages of all other parameters such that the change in storage can be assumed as negligible or “zero’.

As indicated previously, Mayatan Lake is a landlocked and has no outlet channel. As such, the surface water outflow component within equation (2) can be set to zero.

Given these considerations, the water balance equation for Mayatan Lake can be reduced to the following:

$$0=DA*SR + LSA*(P-E) + (GI-GO) - D \qquad (3)$$

where all parameters are as previously defined.

The remaining parameters within the above equation are estimated in the Sections of this report that follow.

3.0 COMPUTATION OF LAKE SURFACE AREA (LSA)

Lake surface area has been computed from three different sources. These include:

1. The National Hydrography Network- Waterbody Coverage which indicates a lake surface area of 1.64 square kilometres (km^2) (date unknown) (source – Agriculture and Agri-Food Canada, Prairie Farm Rehabilitation Administration PFRA),
2. The Canadian Digital Elevation Data (CDED) which based on 2006 orthophotos indicates a lake surface area of 1.14 km^2, and
3. A bathymetric Survey of Mayatan Lake (Figure 2 – date unknown) which indicates a lake surface area of 1.35 km^2.

The long term average lake surface area for Mayatan Lake has been estimated at 1.38 km^2, the average of the three measurements.

4.0 COMPUTATION OF DRAINAGE AREA (DA)

The land area surrounding the lake whose surface runoff drains into the lake is called the drainage area, catchment area or watershed area. Because of the glacial landscape and climate of the Canadian Prairies, the watershed area which contributes to the runoff actually reaching a waterbody can vary significantly from event to event and from year to year due to local depressions or storage areas. Ideally, a water balance would be carried out for each of these storage and depression area towards identifying the actual quantity of runoff reaching the water body under consideration for each time step. However, as this level of analysis is not practical or possible in most instances, the concept of “gross” and “effective” area have come into common use to account for this variability in the “contributing drainage area”. These terms are defined as follows:

- Gross drainage area is the land surface area which can be expected to contribute runoff to a given body of water under extremely wet conditions. It is defined by the topographic divide (height of Land) between the water body under consideration and adjoining watersheds.
- Effective drainage area is that portion of the gross drainage area which can be expected to contribute runoff to a given body of water under average conditions. The effective drainage area excludes portions of the gross drainage area which drain to peripheral marshes, sloughs and other natural depressions or storage areas which would prevent runoff from reaching the water body under consideration in a year of average runoff.

The gross drainage area (including the lake surface area) for Mayatan Lake was computed at 13.60 km^2 from the Canadian Digital Elevation Data. However, as much of this area drains to other ponds, sloughs and storage which likely would not contribute to the runoff reaching Mayatan Lake other than it wet years, it was necessary to compute the effective area or area which would contribute to Mayatan Lake years. The effective drainage area, including the surface area of the lake, was estimated at 5.61 km^2 thus resulting in a contributing effective drainage area of (5.61 - 1.38) =4.23 km^2.

Figures 3 and 4 show the delineated gross and effective drainage for Mayatan Lake.

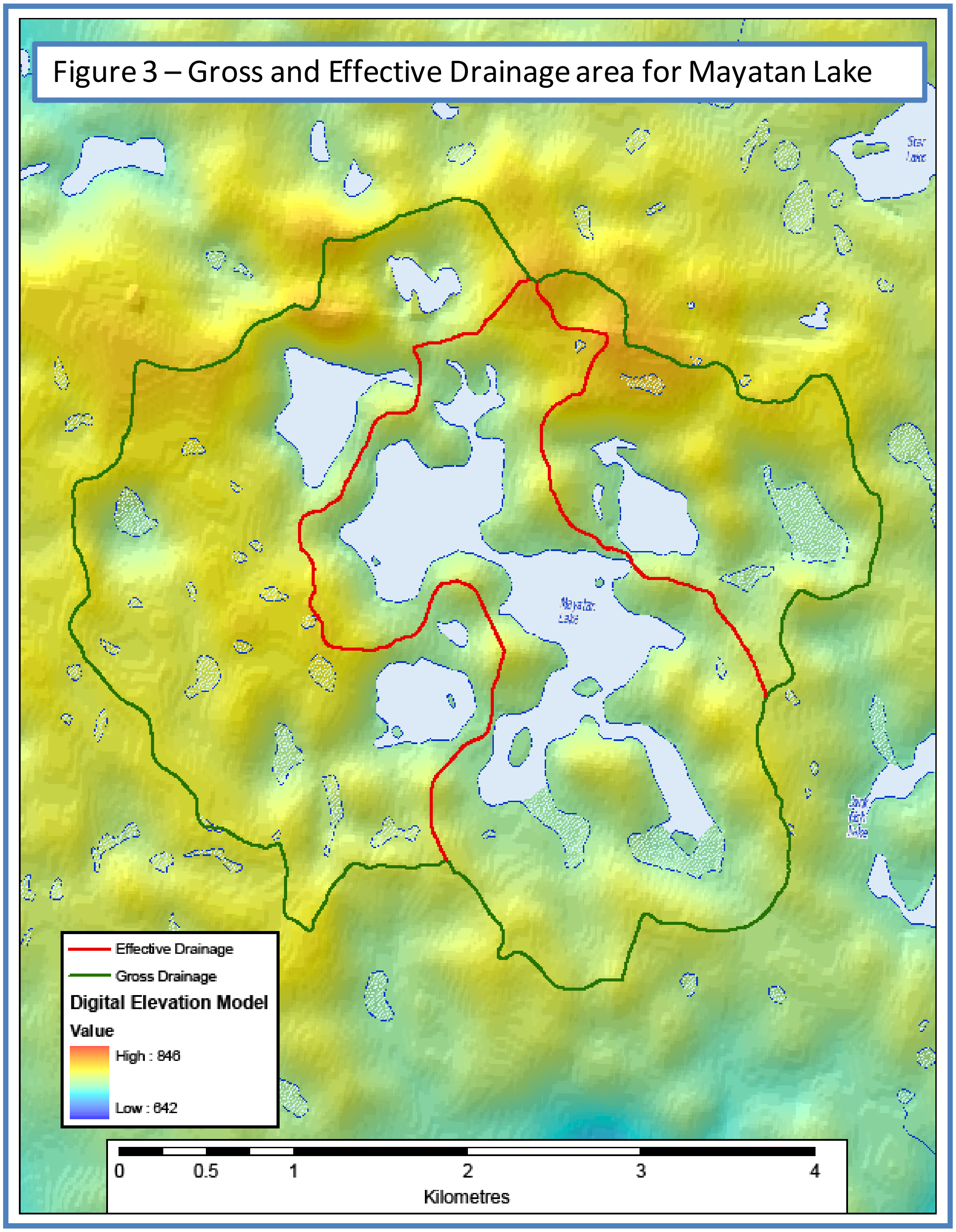


Figure 3 – Gross and Effective Drainage area for Mayatan Lake
Effective Drainage
Gross Drainage
Digital Elevation Model
Value
High : 846
Low : 642
0
0.5
1
2
3
4
Kilometres

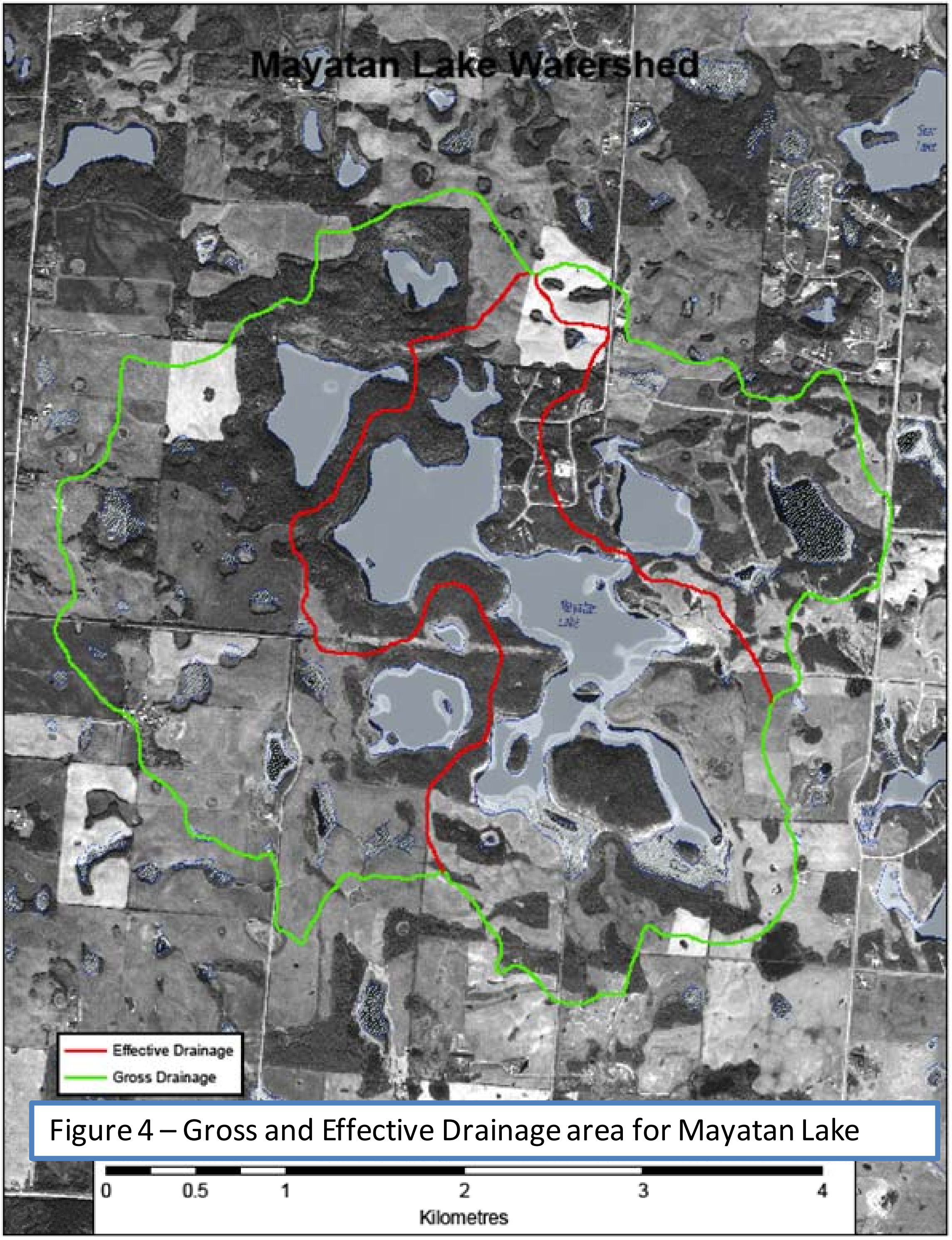


Figure 4 – Gross and Effective Drainage area for Mayatan Lake

5.0 COMPUTATION OF SURFACE RUNOFF INPUTS (DA*SR)

The runoff for Mayatan Lake is not measured. The procedure generally used to estimate surface runoff for ungauged areas is to determine the specific yield (runoff per unit area) for nearby gauged basins and to apply the specific surface runoff from the gauged basin to the drainage area of the ungauged basin.

The nearest hydrometric stations to Mayatan Lake which can be used for the estimation of runoff include;

- Sturgeon River near Magnolia Bridge,
- Tomahawk Creek near Tomahawk, and
- Atim Creek near Spruce Grove, and near Century Road.

Figure 5 shows the location of these hydrometric stations relative to Mayatan Lake.

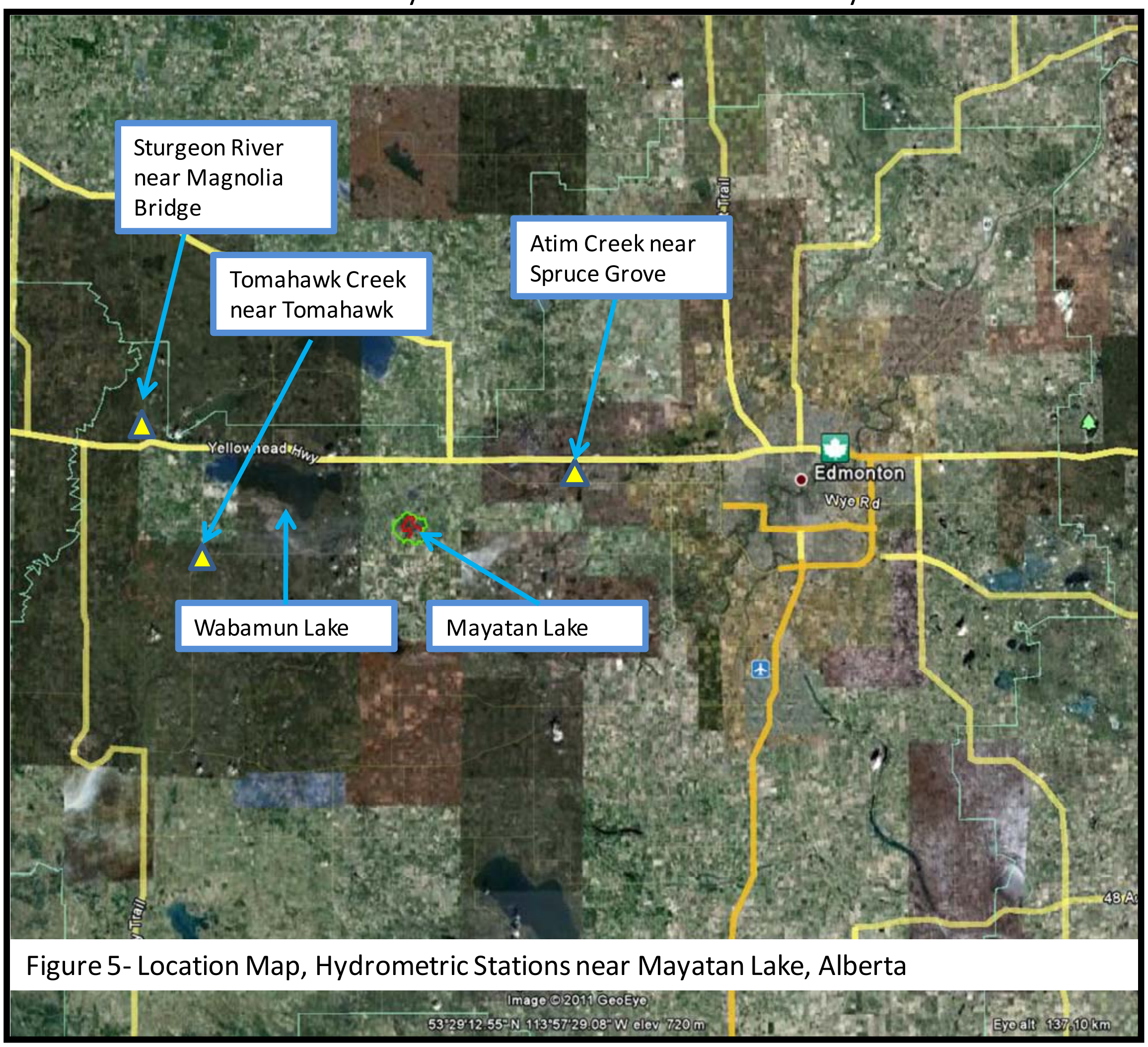


Figure 5- Location Map, Hydrometric Stations near Mayatan Lake, Alberta

The historical runoff for each of these stations along with the gross and effective drainage areas computed by PFRA is summarized in Tables 1, 2, and 3. The specific surface runoff for each of these basins is shown in Table 4.

Table 1 - Runoff for Sturgeon River near Magnolia Bridge - Water Survey of Canada Station No. 05EA010

Gross Drainage Area =121.24 Km^2 Effective Drainage Area = 121.4 Km^2

Monthly Mean Discharges in m^3/s for the Period January 1984 - December 2010													Annual
	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	(dam^3)
1981	-	-	-	-	-	-	-	0.144	0.046	0.09	-	-	
1982	-	-	0	2.95	0.605	0.058	2.63	0.138	0.103	0.07	-	-	**17,285**
1983	-	-	0.031	1.44	0.106	0.172	0.776	0.036	0.015	0.056	-	-	**6,909**
1984	-	-	0.374	0.209	0.864	0.443	0.017	0.004	0.078	0.09	-	-	**5,505**
1985	-	-	0.349	3.21	0.191	0.273	0.038	0.023	0.051	0.025	-	-	**10,837**
1986	-	-	0.885	0.562	0.541	0.055	2.47	0.087	0.026	0.121	-	-	**12,659**
1987	-	-	0.073	0.515	0.179	0.046	0.037	0.826	0.028	0.061	-	-	**4,676**
1988	-	-	0.04	0.048	0.023	0.154	1.89	0.167	0.023	0.062	-	-	**6,427**
1989	-	-	0.003	1.66	0.811	0.846	2.72	1.45	0.436	0.35	-	-	**21,912**
1990	-	-	0.832	0.781	0.363	0.681	1.21	0.003	0.002	0.007	-	-	**10,263**
1991	-	-	0.093	1.39	1.64	0.152	0.125	0.021	0	0.01	-	-	**9,056**
1992	-	-	0.648	0.173	0.074	0.047	0	0	0.001	0	-	-	**2,507**
1993	-	-	0.313	0.179	0.019	0.064	0.087	0.007	0.007	0.007	-	-	**1,808**
1994	-	-	0.489	0.643	0.239	0.278	1.26	0.02	0.04	0.006	-	-	**7,885**
1995	-	-	0.273	0.059	0.064	0.208	0.096	0.788	0.087	0.029	-	-	**4,266**
1996	-	-	0.409	2.14	0.175	2.07	0.113	0.227	0.018	0.047	-	-	**13,560**
1997	-	-	0.32	2.51	0.451	3.1	0.235	0.022	0.035	0.057	-	-	**17,538**
1998	-	-	0.33	0.06	0.03	0.142	0.42	0.094	0.008	0.038	-	-	**2,987**
1999	-	-	0.08	2.18	1.09	0.134	0.166	0.017	0.003	0.004	-	-	**9,640**
2000	-	-	0.101	0.028	0.039	0.341	0.408	0.11	0.139	0.014	-	-	**3,117**
2001	-	-	0.007	0.041	0.034	0.006	2.21	0.464	0.01	0.006	-	-	**7,436**
2002	-	-	0.001	0.767	0.221	0.022	0	0	0	0	-	-	**2,640**
2003	-	-	0.054	1.18	0.193	0.051	0.037	0.009	0.005	0.03	-	-	**4,069**
2004	-	-	0.088	0.144	0.009	0.066	0.532	0.015	0.118	0.067	-	-	**2,755**
2005	-	-	0.767	1.08	0.265	0.201	0.092	0.029	0.004	0.039	-	-	**6,523**
2006	-	-	0	0.156	0.029	0.009	0	0	0.002	0.005	-	-	**524**
2007	-	-	0.153	1.1	2.01	0.052	0.025	0.007	0.01	0.003	-	-	**8,899**
2008	-	-	0.005	0.073	0.069	0.004	0.001	0.001	0	0	-	-	**403**
2009	-	-	0	0.051	0.012	0.001	0.023	0.002	0	0	-	-	**234**
2010	-	-	0.021	0.017	0.032	0.067	0.003	0	0.001	0.003	-	-	**378**
Average (cms)			**0.232**	**0.874**	**0.358**	**0.336**	**0.608**	**0.157**	**0.043**	**0.042**			
Average (dam3)			**622**	**2,265**	**958**	**871**	**1,627**	**422**	**112**	**111**			**6,990**

Table 2 - Runoff For Tomahawk Creek Near Tomohawk - Water Survey Of Canada Station NO. 05DE009

Gross Drainage Area = 94.2 Km^2 Effective Drainage Area = 94.2 Km^2

	Monthly Mean Discharges in m^3/s for the Period January 1984 - December 2010												Annual
	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	(dam^3)
1984	------	------	------	------	------	------	0.061	0.004	0.217	0.255	------	------	
1985	------	------	0.049	2.64	0.246	0.147	0.03	0.031	0.096	0.132	------	------	**8,780**
1986	------	------	0.614	0.318	0.352	0.039	2.47	0.218	0.135	0.273	------	------	**11,793**
1987	------	------	0.076	0.255	0.216	0.192	0.132	1.44	0.117	0.052	------	------	**6,594**
1988	------	------	0.042	0.05	0.015	0.094	1.41	0.135	0.151	0.112	------	------	**5,355**
1989	------	------	0.039	0.781	0.617	0.437	2	1.33	0.163	0.185	------	------	**14,751**
1990	------	------	0.487	0.587	0.431	0.671	1.54	0.037	0.018	0.034	------	------	**10,081**
1991	------	------	0.136	1.14	1.19	0.246	0.155	0.02	0.014	0.034	------	------	**7,740**
1992	------	------	0.446	0.177	0.124	0.064	0.063	0.042	0.06	0.049	------	------	**2,719**
1993	------	------	0.276	0.139	0.068	0.099	0.163	0.047	0.025	0.02	------	------	**2,219**
1994	------	------	0.361	0.509	0.15	0.309	1.21	0.148	0.042	0.048	------	------	**7,364**
1995	------	------	0.177	0.057	0.027	0.117	0.059	0.397	0.114	0.063	------	------	**2,683**
1996	------	------	0.313	1.37	0.26	1.69	0.202	0.2	0.041	0.057	------	------	**10,802**
1997	------	------	0.25	2.29	0.34	1.67	0.191	0.031	0.055	0.076	------	------	**12,785**
1998	------	------	0.296	0.041	0.026	0.048	0.264	0.024	0.027	0.102	------	------	**2,208**
1999	------	------	0.081	2	0	0	0.126	0.02	0.01	0.013	------	------	**5,853**
2000	------	------	0.146	0.138	0.051	0.25	0.393	0.016	0.043	0.014	------	------	**2,778**
2001	------	------	0.006	0.055	0.013	0.016	1.11	0.301	0.007	0.012	------	------	**4,064**
2002	------	------	0.003	0.605	0.206	0.011	0.003	0.036	0.006	0.013	------	------	**2,311**
2003	------	------	0.038	0.979	0.267	0.163	0.02	0.006	0.005	0.018	------	------	**3,908**
2004	------	------	0.111	0.075	0.009	0.13	0.612	0.012	0.124	0.082	------	------	**3,065**
2005	------	------	0.96	1.22	0.321	0.225	0.043	0.011	0.021	0.02	------	------	**7,429**
2006	------	------	0.012	0.049	0.019	0.009	0.004	0.002	0.007	0.012	------	------	**300**
2007	------	------	0.195	1.18	1.84	0.122	0.027	0.019	0.025	0.03	------	------	**9,094**
2008	------	------	0.024	0.102	0.133	0.025	0.003	0	0	0.005	------	------	**771**
2009	------	------	0.005	0.06	0.017	0.009	0.005	0	0	0	------	------	**251**
2010	------	------	0.012	0.033	0.037	0.029	0.015	0.01	0.019	0.019	------	------	**459**
Average (cms)			**0.198**	**0.648**	**0.268**	**0.262**	**0.471**	**0.174**	**0.051**	**0.057**			
Average (dam^3)			**531**	**1,680**	**719**	**679**	**1,262**	**467**	**132**	**152**			**5,621**

Table 3 - Runoff For Atim Creek Near Spruce Grove and Atim Creek Near Century Road - WSC StationNO 05AE009 and 05AE012

Atim Creek near Spruce Grove Gross Drainage Areas = 284.4 Km^2, Effective Drainage Area =77.78 Km^2

Atim Creek near Spruce Grove Gross Drainage Areas = 287.7 Km^2, Effective Drainage Area =80.45 Km^2

	Monthly Mean Discharges in m^3/s for the Period January 1984 - December 2010												Annual
	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	(dam^3)
1979	-	-	-	-	0.409	0.233	0.262	0.223	0.178	0.16	-	-	**3,888**
1980	-	-	-	0.812	0.222	0.303	0.115	0.229	0.115	-	-	-	**4,704**
1981	-	-	-	0.561	0.234	0.138	0.166	0.105	0.112	-	-	-	**3,455**
1982	-	-	-	-	0.6	0.13	0.382	0.102	0.144	0.146	-	-	**4,005**
1983	-	-	-	0.442	0.159	0.226	0.299	0.045	0.041	0.185	-	-	**3,680**
1984	-	-	-	0.175	0.386	0.297	0.156	0.101	0.299	0.17	-	-	**4,176**
1985	-	-	0.329	0.846	0.347	0.245	0.109	0.127	0.115	0.237	-	-	**6,203**
1986	-	-	0.705	0.404	0.231	0.152	0.493	0.051	0.128	0.183	-	-	**6,227**
1987	-	-	0.054	0.316	0.268	0.099	0.089	0.127	0.108	0.096	-	-	**3,054**
1988	-	-	0.135	0.15	0.107	0.202	0.474	0.261	0.115	0.12	-	-	**4,149**
1989	-	-	-	0.456	0.316	0.324	0.43	0.21	0.132	0.128	-	-	**5,267**
1990	-	-	-	0.464	0.345	0.23	0.681	0.108	0.113	0.1	-	-	**5,397**
1991	-	-	-	0.798	0.639	0.418	0.226	0.138	0.155	0.066	-	-	**6,417**
1992	-	-	-	0.335	0.247	0.012	0.004	0.001	0.053	0.075	-	-	**1,913**
1993	-	-	0.167	0.273	0.163	0.165	0.192	0.181	0.103	0.104	-	-	**3,564**
1994	-	-	0.44	0.451	0.191	0.348	0.182	0.312	0.152	0.113	-	-	**5,781**
1995	-	-	-	0.164	0.145	0.126	0.128	0.197	0.1	0.126	-	-	**2,607**
1996	-	-	-	0.599	0.187	0.544	1.08	0.279	0.168	0.17	-	-	**7,994**
2005	0.107	0.095	1.13	0.729	0.222	0.25	0.261	0.079	0.075	0.117	0.13	0.117	**8,744**
2006	0.12	0.109	0.258	0.399	0.237	0.228	0.11	0.096	0.163	0.161	0.12	0.089	**5,491**
2007	0.11	0.113	0.464	1.06	0.992	0.538	0.215	0.092	0.111	0.103	-	-	**9,996**
2008	-	-	0.141	0.3	0.501	0.127	0.116	0.103	0.077	0.108	-	-	**3,902**
2009	-	-	0.109	0.371	0.143	0.068	0.106	0.102	0.009	0.05	-	-	**2,527**
2010	-	-	0.061	0.257	0.306	0.218	0.33	0.095	0.11	0.097	-	-	**3,897**
Average (cms)	**0.112**	**0.106**	**0.333**	**0.471**	**0.317**	**0.234**	**0.275**	**0.140**	**0.120**	**0.128**	**0.125**	**0.103**	
Average (dam^3)	**-**	**-**	**891**	**1,221**	**848**	**607**	**737**	**375**	**311**	**343**	**-**	**-**	**4,877**

Table 4 -Computation of Specific Runoff						
Watersdhed	Gross Darainage Area		Runoff Volume		specific runoff per unit Effective Area	
	gross	effective				
	Km^2	Km^2	(dam^3)	(m^3)	(dam^3/Km^2)	(m^3/Km^2)
Sturgeon River near Magnolia Bridge	121.4	121.4	6,990	6,990,000	57.6	57,578
Tomahawk Creek near Tomahawk	94.2	94.2	5,621	5,621,000	59.7	59,671
Atim Creek Near	.	.	.	.	.	.
a) Spruce Grove	284.4	77.78	4,582	4,582,000	58.9	58,900
b) Century Road	287.7	80.45	5,759	5,759,000	71.6	71,600
weighted avg	.	.	.	.	62.8	62,800

As shown in Table 4, all three hydrometric stations in the vicinity of Mayatan Lake indicate a relatively consistent specific surface runoff, with the exception of Atim Creek near Century Road which indicates a somewhat higher yield likely due to the influence of urban runoff.

Given the consistency of specific yield for the three surrounding basins, the specific surface runoff for Mayatan Lake was set at 58.7 dam^3/km^2 of effective area (58,700 m^3/km^2), the average for the three gauged sites. Therefore, total surface runoff contribution to the Mayatan Lake water balance is calculated at 248.3 dam^3 (248,300 m^3), by multiplying the effective drainage area (4.23 km^2) by specific surface runoff (58.7 dam^3/km^2).

6.0 COMPUTATION OF PRCECIPITATION INPUTS (LSA*P)

The total precipitation input to Mayatan Lake is computed as the lake surface area multiplied by the mean annual precipitation, where the lake surface area was previously calculated at 1.38 Km^2.

The only precipitation station within a 50 Km radius of Mayatan Lake having a complete set of monthly precipitation is Edmonton Stony Plain, about 20 miles east of Mayatan Lake. The mean annual precipitation for this site is 493.8 mm (Table 5).

As precipitation in the area increases from east to west, a second table of monthly and annual precipitation was constructed from partial records of stations to the west and south of Mayatan Lake. The mean annual precipitation for these sites is estimated at 544.9 mm (Table 6).

Table 5 - Monthly and Annual Precipitation (mm) for Stony Plain													
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual
1980	30.2	23.5	26.2	7.5	60.2	169.8	142.3	125.2	57.9	23.7	9.6	55.8	731.9
1981	9.7	15.9	15.3	14.1	38.8	42.7	146.0	14.3	39.0	34.3	4.8	18.5	393.4
1982	73.7	22.7	53.2	16.5	38.5	17.4	190.2	77.1	36.0	35.2	19.1	5.8	585.4
1983	10.1	17.3	33.8	27.0	8.9	130.0	134.4	18.3	52.7	30.8	19.0	22.4	504.7
1984	31.8	6.7	23.7	2.4	82.1	108.1	32.3	43.1	115.3	55.4	23.4	37.0	561.2
1985	14.8	30.1	4.4	48.0	39.8	91.9	61.3	96.4	70.0	25.0	29.3	32.9	543.9
1986	12.2	16.2	35.5	47.2	37.8	70.6	190.5	29.4	94.1	25.8	32.2	11.2	602.7
1987	7.6	11.3	41.2	17.3	80.4	59.3	82.3	118.7	15.5	5.3	2.8	17.9	459.6
1988	11.9	34.2	8.4	12.5	23.9	140.8	185.0	116.2	57.3	2.7	14.0	16.5	623.4
1989	45.3	10.6	7.3	17.9	89.6	87.3	143.9	118.2	29.7	32.7	35.0	20.3	637.8
1990	14.1	16.6	16.2	60.3	50.6	52.7	159.6	85.6	14.6	32.6	32.3	31.9	567.1
1991	30.5	30.3	16.5	36.5	98.7	105.5	24.0	78.8	19.8	86.6	5.0	18.3	550.5
1992	30.9	41.6	4.6	31.8	32.6	19.7	60.5	51.0	68.9	5.8	25.1	21.0	393.5
1993	2.8	9.8	21.2	22.4	49.7	103.0	79.5	69.8	22.1	12.8	24.3	12.1	429.5
1994	60.1	16.7	0.8	3.8	53.7	119.3	83.9	84.9	44.2	15.7	18.0	10.4	511.5
1995	1.4	10.1	5.0	19.3	19.6	67.0	94.5	79.5	12.6	12.0	42.8	16.2	380.0
1996	20.8	6.6	12.8	42.8	44.2	132.4	110.6	68.0	82.4	13.8	55.6	16.2	606.2
1997	11.0	9.0	26.4	33.4	54.0	159.3	60.9	54.6	50.4	49.3	2.4	3.4	514.1
1998	16.6	0.0	10.8	12.4	54.6	109.5	42.1	52.0	52.2	42.3	24.6	21.2	438.3
1999	43.2	6.2	14.3	25.8	56.9	58.2	91.3	74.3	16.0	8.6	9.6	6.0	410.4
2000	18.2	8.0	16.8	19.2	73.0	107.2	142.2	45.7	51.4	5.4	12.6	10.6	510.3
2001	0.6	4.0	9.6	3.8	26.2	68.8	195.2	49.2	30.2	21.8	15.8	1.8	427.0
2002	6.1	4.6	24.8	35.2	14.8	18.0	56.4	55.2	10.6	19.8	9.8	7.0	262.3
2003	37.9	21.0	24.4	49.0	43.8	76.2	68.2	69.2	28.0	27.0	12.4	14.4	471.5
2004	43.6	5.0	17.0	31.8	51.6	47.6	116.2	70.2	77.6	36.8	2.8	27.2	527.4
2005	22.6	14.0	34.6	6.8	52.8	104.4	66.2	56.0	38.0	22.6	7.2	9.0	434.2
2006	2.4	16.4	19.8	50.5	100.8	87.2	68.4	40.8	102.0	53.5	41.0	6.8	589.6
2007	14.6	25.0	0.4	65.4	85.8	104.8	104.2	41.2	12.4	9.0	12.4	15.2	490.4
2008	15.2	10.4	14.2	47.9	52.3	31.8	88.2	30.0	23.1	9.6	4.4	22.2	349.3
2009	28.6	16.7	15.6	23.7	26.6	24.9	73.6	27.0	4.6	28.6	4.8	32.6	307.3
2010	7.6	0.2	7.0	31.2	102.1	68.4	120.8	54.4	57.4	8.2	16.8	19.4	493.5
Average	**21.8**	**14.9**	**18.1**	**27.9**	**53.0**	**83.3**	**103.7**	**64.3**	**44.7**	**25.6**	**18.4**	**18.1**	**493.8**

Table 6 - Monthly and Annual Precipitation (mm) for other station in the Vicinity of Mayatan Lake

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual
1980	20.0	17.0	23.0	13.4	69.7	139.3	70.1	127.5	60.8	18.0	4.8	61.1	624.7
1981	12.0	15.0	18.9	15.8	38.8	56.9	141.0	26.0	55.9	35.4	0.6	22.9	439.2
1982	68.0	10.7	52.6	5.8	30.0	29.8	277.4	60.5	41.8	34.2	8.0	1.5	620.3
1983	8.0	14.5	30.0	20.0	8.4	107.3	91.8	20.2	50.2	27.2	10.4	17.2	405.2
1984	27.5	3.7	24.4	0.4	98.6	93.8	39.4	35.8	116.0	56.6	21.5	31.0	548.7
1985	23.2	17.5	3.3	49.4	38.4	73.2	43.6	111.8	69.2	25.3	16.9	33.4	505.2
1986	12.5	13.7	29.3	41.3	44.4	59.2	219.2	19.0	94.8	27.6	22.0	4.0	587.0
1987	3.5	5.6	14.6	88.8									
1988	5.5	34.6	3.2	15.5	46.1	150.6	114.5	91.5	66.4	4.2	7.4	11.2	550.7
1989	58.9	6.0	6.6	4.2	83.8	97.8	148.3	154.4	42.6	29.8	27.5	5.0	664.9
1990	14.0	16.4	2.0	22.9	52.2	66.0	124.6	106.4	8.8	26.0	27.6	27.3	494.2
1991	13.0	38.2	9.6	77.3	120.4	120.0	86.3	46.1	25.9	73.8	6.2	13.6	630.4
1992	19.4	22.4	1.8	14.2	66.0	29.2	47.0	49.7	57.8	1.4	17.0	25.5	351.4
1993	10.0	15.0	21.0	15.2	66.0	72.8	78.2	79.2	36.6	2.6	18.8	14.8	430.2
1994	94.4	16.6	5.2	7.0	55.2	89.6	113.2	90.2	40.0	17.1	29.0	5.0	562.5
1995	11.6	12.0	11.0	24.2	50.0	87.5	94.0	110.1	28.8	13.2	63.0	13.0	518.4
1996	37.0	5.0	37.2	26.5	40.3	127.8	85.7	118.3	71.2	11.7	86.0	22.5	669.2
1997	26.0	20.0	41.0	31.1	37.5	135.0	123.1	76.7	75.6	39.8	15.6	9.2	630.6
1998	17.0	0.0	21.0	8.0	40.7	131.8	117.1	81.2	61.0	48.0	38.0	26.0	589.8
1999	76.5	13.5	39.0	29.5	61.8	69.4	169.1	122.0	14.7	12.0	21.8	10.1	639.4
2000	16.5	11.5	30.1	25.6	95.5	112.3	152.2	33.3	39.7	8.2	21.0	18.6	564.5
2001	1.0	20.3	7.9	6.6	36.5	107.2	118.3	40.0	15.0	15.7	34.0	10.5	413.0
2002	16.0	19.0	54.0	46.3	16.2	14.4	53.0	58.4	35.4	28.9	20.0	12.0	373.6
2003	55.5	46.5	28.5	35.8	54.7	83.7	53.7	31.6	47.5	37.0	35.5	6.0	516.0
2004	41.7	4.5	25.7	70.7	86.2	72.0	138.1	101.2	74.4	24.5	20.5	66.0	725.5
2005	26.0	5.6	3.0	5.2	40.0	80.8	63.8	64.0	36.8	26.2	5.0	7.0	363.4
2006	3.2	2.8	0.6	56.4	64.0	66.0	75.2	49.3	135.3	48.6	48.1	21.4	643.9
2007	21.7	37.8	5.5	81.8	126.2	129.8	94.0	77.1	28.6	5.0	27.3	15.2	650.0
2008													
2009													
2010													
Average	26.4	15.9	19.6	30.0	58.1	89.0	108.6	73.4	53.0	25.9	24.2	18.9	544.9

Data Source		
	xxx.x	Highvale data
	xxx.x	Darwell data
	xxx.x	Breton data
	xxx.x	other stations

A third source for the estimation of precipitation is PFRA's map of "Mean Annual (1971-2000) Precipitation for the Canadian Prairies" developed from precipitation stations across the prairie provinces having complete or near complete records for the 1971-2000. PFRA's map of Mean Annual precipitation for the Canadian Prairies (Figure 6) indicates Mayatan Lake as having a mean annual precipitation of about 550 mm.

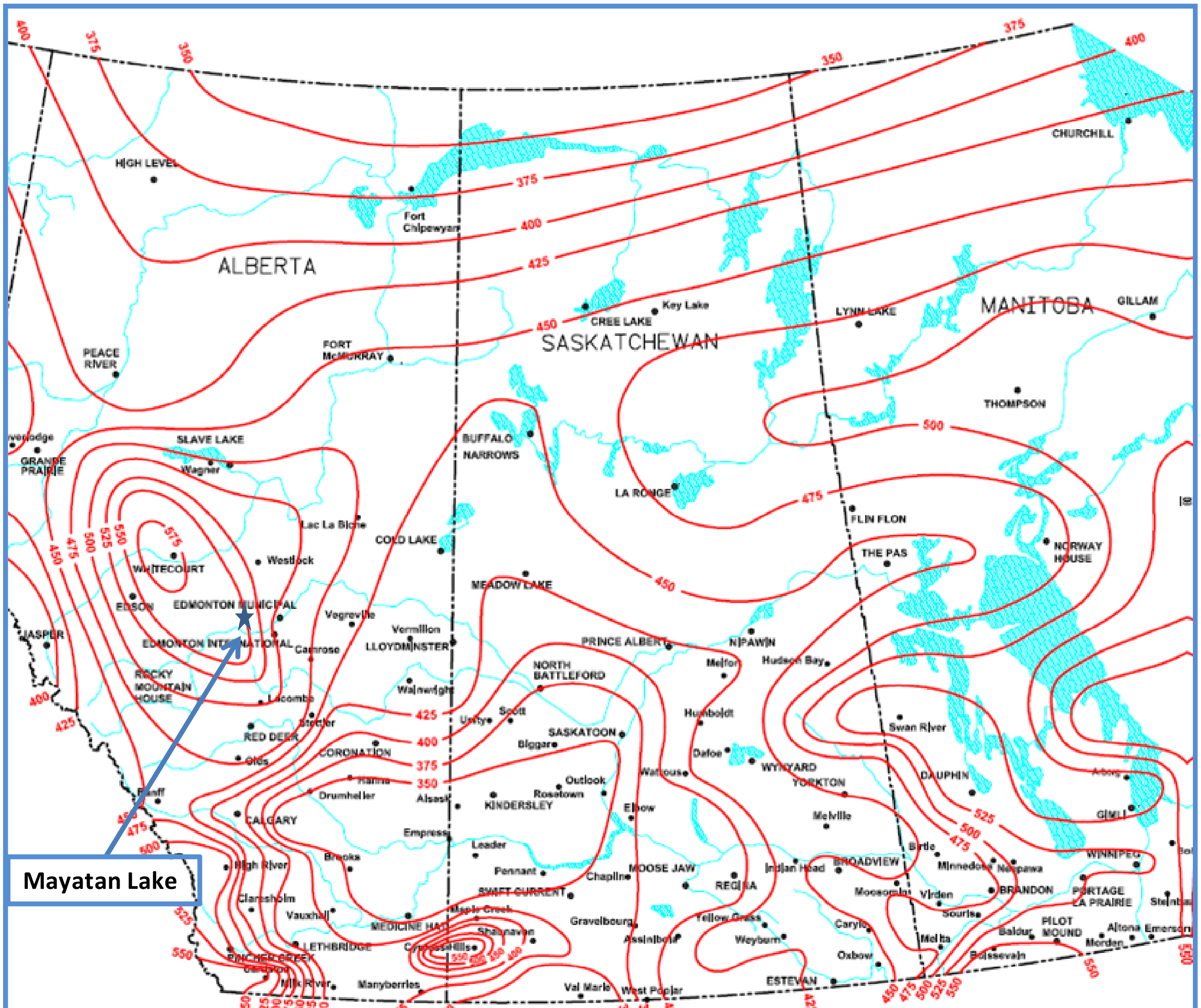


Figure 6 – Mean Annual (1971-2000)Precipitation (mm) in the Canadian Prairies

As all three sources indicate a relatively consistent depth of precipitation, the precipitation for Mayatan Lake was set at 530 mm, the average of the three estimates.

The precipitation input to the Mayatan Lake water balance is, therefore, estimated at 731.4 dam^3 (731,400 m^3), by multiplying the lake surface (1.38 km^2) by the mean annual precipitation (530 mm).

7.0 COMPUTATION OF EVAPORATION LOSSES (LSA*E)

Evaporation or lake evaporation is the water that evaporates from the water body due to the warming effect of solar radiation, mild to hot temperatures and wind. The total evaporation loss from input to Mayatan Lake is computed as the lake surface area multiplied by the mean annual depth of evaporation, where the lake surface area was previously calculated at 1.38 km^2.

Unlike precipitation, evaporation from a lake cannot be measured directly and must be estimated using energy balance calculations. It can be calculated using a variety of formulas that include temperature, wind, solar radiation, sunshine, relative humidity, etc.

Alberta Environment which uses the “Morton CRLE” model to estimate has recently updated its lake evaporation estimates for all major sites across Alberta. Tables 7 and 8 present the monthly and annual Morton Lake Evaporation estimates for Edmonton (east of Mayatan Lake) and Edson (west of Mayatan Lake) respectively.

Table 7 - Morton Lake Evaporation for Edmonton International Airport (mm)

Source - Alberta Environment

Year	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual
1980	-2	-2	11	81	114	118	146	99	45	26	6	0	**642**
1981	-7	6	36	70	96	124	123	133	60	19	4	-3	**661**
1982	0	1	10	66	107	130	127	97	57	26	0	-2	**619**
1983	0	4	22	65	112	105	135	126	47	23	3	-2	**640**
1984	0	8	25	82	79	123	145	126	44	20	-3	-2	**647**
1985	-5	0	32	76	128	148	155	102	41	21	-3	-2	**693**
1986	0	-1	32	64	113	135	123	127	45	27	-2	-4	**659**
1987	-1	4	19	80	125	154	130	95	76	30	2	-1	**713**
1988	-1	8	37	90	131	145	144	119	56	31	4	-1	**763**
1989	-2	-2	2	76	113	144	161	89	64	26	3	-1	**673**
1990	-3	2	37	65	104	127	147	119	77	24	2	-1	**700**
1991	-6	9	-1	75	108	106	158	120	63	21	-3	1	**651**
1992	4	8	39	68	99	130	129	113	49	24	6	1	**670**
1993	1	5	27	61	113	125	119	105	56	28	7	3	**650**
1994	2	1	38	69	100	121	143	106	67	23	5	-2	**673**
1995	-3	4	31	51	109	126	123	97	65	22	1	-2	**624**
1996	-1	3	11	55	74	120	143	127	44	23	-1	0	**598**
1997	0	6	18	67	96	131	154	122	64	19	2	2	**681**
1998	0	-1	19	83	137	122	143	130	61	22	4	-1	**719**
1999	0	2	23	71	101	129	127	112	68	25	4	3	**665**
2000	0	4	29	62	105	126	148	111	57	25	5	0	**672**
2001	4	5	36	77	120	122	143	137	64	22	4	-4.6	**729**
2002	-4.3	5.6	3.3	59.8	105.5	144.6	147.1	96	50.7	18.4	5.8	0.9	**633**
2003	0.3	-1.2	20	59.8	109.4	120.7	149	129.7	53.7	22.3	-2.8	-2	**659**
2004	-1.8	0.2	33.3	74.3	113.5	136.5	136	102.6	50.4	19.8	5.3	-3.8	**666**
2005	-4.9	2	30.4	79.2	123.9	114.6	145.3	103.1	51.4	22	3.8	-5.8	**665**
2006	-8.8	10.8	2.7	84.1	126.8	134.4	172.8	133.1	66.8	23.9	-6.6	-6.2	**734**
2007	-3.9	-3.8	29	66	114.1	149.6	180.8	122.9	65.6	32.8	7.3	-6	**754**
2008	-4.6	0.3	42.5	80.4	104.3	141.7	159.6	130.2	72.7	31.3	6.7	-4.7	**760**
2009	-2.7	-2.9	4.2	68.5	118.6	139.4	143.8	116.8	74.2	19.1	6.4	-3	**682**
average	**-1.7**	**2.8**	**23.3**	**70.9**	**110.0**	**129.8**	**143.3**	**114.9**	**58.5**	**23.9**	**2.5**	**-1.6**	**677**

Table 8 - Morton Lake Evaporation for Edson (mm)													
Source - Alberta Environment													
Year	**Jan**	**Feb**	**Mar**	**Apr**	**May**	**Jun**	**Jul**	**Aug**	**Sep**	**Oct**	**Nov**	**Dec**	**Annual**
1980	-2	0	24	84	106	117	136	89	41	25	5	-2	**623**
1981	-4	9	36	71	92	125	125	130	56	19	2	-5	**656**
1982	-1	-1	11	63	103	122	118	86	53	24	-2	-3	**573**
1983	-3	2	13	68	111	102	125	127	45	19	-3	-3	**603**
1984	2	11	28	61	81	111	148	101	39	16	-2	-2	**594**
1985					59	117	123	155	97	37	19	-2	
1986	0	1	0	29	52	98	127	92	124	45	23	-1	**590**
1987	-4	-2	6	23	75	114	128	112	87	68	11	4	**622**
1988	0	-2	9	31	81	110	120	125	99	53	25	2	**653**
1989	-2	-2	0	24	73	102	129	135	84	52	21	6	**622**
1990	-1	-2	5	37	59	82	111	142	102	66	23	-1	**623**
1991	-1	-2	10	29	63	102	108	142	112	57	17	1	**638**
1992	0	0	9	37	55	89	119	124	109	43	20	-2.8	**602**
1993	-2	10	36.4	76.3	123.1	128.1	122.3	98.8	63.6	22.2	5.1	-5.2	**679**
1994	-1.9	-0.5	39.6	79.4	108.1	140.3	146.3	108.5	70.1	23.8	1.1	-7.1	**708**
1995	-7	4	35.8	64.8	128.6	144	130.6	94	72.1	24	-1.7	-1.7	**687**
1996	-0.4	15.1	32.1	75	97.2	131.5	137	121.1	50.2	23.5	-1.3	-2.6	**678**
1997	-2.2	13	33.9	73.5	118	133.2	145.5	114.5	61.5	20.6	1.6	2.3	**716**
1998	-3.7	7.4	31.5	87	139.5	129.2	149.9	122.6	65.1	20.8	-4.4	-3.9	**741**
1999	-5.7	5	36.3	73.6	119.1	133.3	133.8	114.2	64.1	25.8	1.9	4.3	**705**
2000	-1.7	3.1	36.9	77.8	105.1	135.1	144.4	101.4	59	23.5	6.7	1.8	**693**
2001	5.9	2	36.6	73.3	127.3	130	134.5	128.7	69.1	24.7	1.8	-4.4	**729**
2002	-2.7	12.8	12.4	59.9	112.2	163.6	155.5	113.6	58.1	21.7	5.6	-8	**705**
2003	-6	-1	34.6	66.9	114	137.9	158	123.1	60.4	26.4	5.9	3.2	**723**
2004	1.9	13.6	36.5	83	111.9	145.2	141.7	105.3	52.8	23	6.3	-0.2	**721**
2005	-4.4	14	36.6	82.4	129.3	125.6	143.3	110.8	57.3	24.7	5.4	-6.7	**719**
2006	-7.1	10	15.4	88.6	130.9	148.9	157	116.9	64.8	22.3	-2	-2	**744**
2007	4.5	-2	37	67.1	116.8	139	165.3	100.7	60.6	25	5.5	-0.8	**719**
2008	1.3	14.7	39.9	67.1	124.9	137.5	146	117.3	65.5	27.1	5.6	-2.7	**744**
2009	2.5	2	33.9	73.1	126.2	148	151.2	116.4	73.4	19.2	6.1	-6.7	**745**
average	-1.5	4.7	24.7	63.0	101.4	124.7	136.0	115.6	70.5	30.7	6.9	-1.6	674

As shown in Tables 7 and 8, the Morton estimate of mean annual lake evaporation for Edmonton and Edson is 677 mm and 674 mm respectively, or an average of about 675 mm.

PFRA has computed ”Meyer” estimates of mean annual (1971-2000) gross evaporation for all sites across the prairie provinces having sufficient data. The resulting mean annual gross evaporation for these sites was then used to produce a map of mean annual gross (lake) evaporation for the Canadian Prairie (Figure 7).

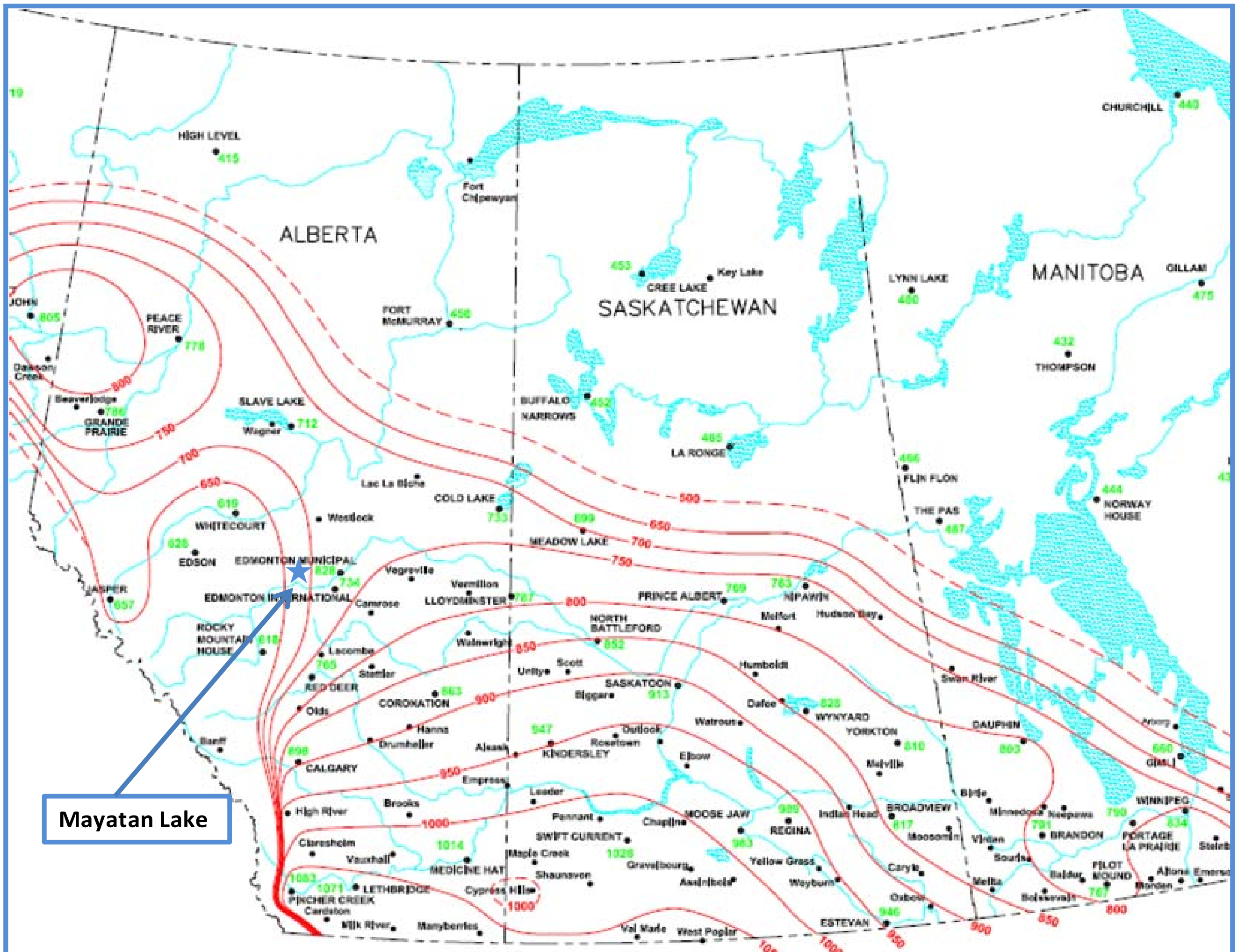


Figure 7 – Mean Annual (1971-2000)Gross Evaporation (mm) in the Canadian Prairies

Figure 7 indicates a mean annual gross (lake) evaporation of about 675 mm for the Mayatan Lake area, the same as Alberta Environment's estimate.

As all both sources indicate a relatively consistent depth of lake evaporation, the lake evaporation for Mayatan Lake is estimated at 675 mm.

The mean annual water loss due to lake evaporation for the Mayatan Lake water balance is, therefore, estimated at 931.5 dam^3 (931,500 m^3), by multiplying the lake surface (1.38 km^2) by the mean annual lake evaporation (675 mm).

8.0 ASSESMENT OF DIVERSIONS

The lake water balance can be significantly affected by human activities which divert water into or away from a lake. With the exception of domestic use, in Alberta all water diversions must obtain an approval from Alberta Environment, and are therefore documented.

A search of Alberta Environments EMS system indicates a total of three licensed allocations within the gross drainage area of Mayatan Lake. Two of these water allocations Priority #'s 19481231080 and 19501231323, having a combined total allocation of 620 m^3 are located outside of the effective drainage area for Mayatan Lake and will not influence the long term water balance. The third, priority #19481231080, is for an allocation of 252 m^3 directly from Mayatan Lake.

It is noted that the licensed allocation represents the maximum diversion that is allowed during any one year and since actual diversions and consumption often depend on a number of factors, including weather conditions, in most instances the actual diversion or consumption is substantially lower than the water allocation. However, in the absence of information as to actual consumption, the full allocation has been assumed to be a consumptive diversion.

9.0 GROUNDWATER INFLOWS AND OUFLOWS (GI-GO)

Groundwater inflow to and outflow from a lake are generally small compared to the other parameters because of the relatively low speed at which groundwater moves. Groundwater inputs are also difficult to quantify because of the difficulty in obtaining enough data to describe the how the geology of an area varies both vertically and horizontally and how the various layers or aquifers interact with each as well as with the lake under consideration. While sophisticated computer models are at times used to estimate groundwater inflows and outflows, estimates often have very large associated errors, even under conditions where there is a significant amount of data upon which to calibrate the models. As such, groundwater inflow (GI-GO) is often back calculated as the residual in a lake water balance.

To conduct a back calculation, equation (3) in Section 2 is rearranged as follows:

$$\mathbf{(GO\text{-}GI) = DA*SR + LSA*(P\text{-}E) - D \qquad (4)}$$

Applying all previously computed inflows and outflows to equation 4 results in the following estimate of "net groundwater input:

$$\mathbf{(GO\text{-}GI) = 248{,}300\ m^3 + 732{,}400\ m^3 - 931{,}500\ m^3 - 252\ m^3}$$

$$\mathbf{= 48{,}948\ m^3 \text{ or } 48.9\ dam^3}$$

The above computation would seem to indicate that Mayatan lake is a groundwater recharge area (groundwater outflow is greater than inflow). Caution is advised in the use of this estimate as it can be out significantly due to inaccuracies in other more significant parameters.

10.0 SUMMARY AND CONCLUSIONS

This report has conducted a generalized water balance for Mayatan Lake towards getting a better understanding of the Lake and the relative values of each of the water balance components. The findings, with can be summarized as follows:

Physical Parameters:

- Gross drainage area (including Lake surface area) = 13.6 km^2
- Effective drainage area (excluding lake surface area)= 4.23 km^2
- Lake surface area = 1.38 km^2

Hydrologic Parameters

- Mean annual specific runoff = 58.7 dam^3/km^2 or 58,700 m^3/km^2
- Mean annual precipitation = 530 mm
- Mean annual gross evaporation = 675 mm

Water Balance Parameters

- Surface water inflow = 248.3 dam^3 or 248,300 m^3
- Surface water outflow = 0 m^3
- Precipitation inputs = 731.4 dam^3 or 731,400 m^3
- Evaporation losses = 931.5 dam^3 or 931,500 m^3
- Net groundwater inflow (GI-GO) = 48.9 dam^3 or 48,900 m^3

Appendix 2 - Newspaper Articles Related to RV Development

Round 2 for Mayatan

By Séamus Smyth

Posted 6 days ago

KEEP HILLS - Rainbow Beach Developments held a second open house this past Thursday to hopefully generate approval for a preliminary plan to develop an RV resort on the eastern shores of Mayatan Lake.

Developers Sandra and John McNab hosted the information session at the KeepHills community centre inviting all curious residents of the area, including members of the Mayatan Lake Management Association (MLMA) who have been against the proposal since the original open house.

"This second open house appeased a lot of concerns and we gathered a lot of positive feedback; I'm glad we had it," said McNab. The group counted 26 people who signed in at the door and McNab was content with the improved outlook that he received from the majority of those in attendance.

When asked if holding the second open house was to appease his opposition, he responded, "No it's to appease everyone. It's to start answering concerns. You come prepared; people need time to accept the information," he continued.

McNab said the group made one adjustment based on feedback they received from the original open house, which was regarding an influx of traffic.

Stantec Engineering is currently conducting a traffic analysis for the group, which is a requirement of any development, but McNab said it would be best to have it completed sooner rather than later.

Although the development group said they have listened to the concerns from the residents, MLMA President Walter Neilson said that the presentation failed again to demonstrate how the community would benefit from the proposed development.

"We have no answer to that question. From our perspective, all we see is uncontrollable traffic on small county roads, noise, potential drunken partying, fire hazards, security problems and most importantly, the loss of a lake which is currently a healthy part of the North Saskatchewan River Watershed," Neilson said.

He argued that not only had several of the concerns not been addressed, but that the development proposal had actually escalated in size.

"Back in Nov. there was no boat launch (proposed.) Now there is to be a boat launch plus two floating docks. These will have a detrimental effect on the lake," he continued. A store was also included in the retooled plan, which he said would add more traffic to the miniscule roads.

What Rainbow Beach Developments Inc. said the MLMA was failing to recognize was that the population in the area has dropped steadily over the past few years and this RV resort will help offset that negative impact.

McNab pointed to the closure of several coal mines that has led to the dwindling population and that it was time to bring awareness to the community.

"This type of development isn't bringing residents, but brings community awareness which may lead to other possible developments in the community that can grow and maybe offset some of the negative impact that may have come forward from the loss of some of these families," he said.

He acknowledged the disapproval from MLMA, but insisted that despite being quite verbal, they are quite a small group of people involved. He said that the area will not fall into crisis if the development fails to go through, but that someone else will eventually come along and develop the property instead.

With an RV park, he said that it offers a number of opportunities for the area to blossom.

"If we didn't have oil in Alberta, what would you want to have? Tourism. If you come into a depressed or depopulated community and offer tourism, it offers opportunities. It gives the chance for the community to grow. That is all we are suggesting."

Séamus.Smyth@bowesnet.com

A 16 Stony Plain Reporter/Grove Examiner • Friday, December 3, 2010

Mayatan residents gather to discuss implications of proposal

By Séamus Smyth
Staff Writer

Residents of Mayatan Lake and the surrounding area gathered this past Saturday at the Mink Lake community hall to discuss the possibility of an RV park being placed in the Mayatan area.

"They are talking about destroying our country value. What the hell is the point? It's a little bit foolish that we have to go through this," said Floyd Young, a resident of Star Lake Estates whose property is on the road that would lead directly to the proposed venue.

John McNab brought the concept to the forefront in late November, when he gave a preliminary rundown on what would be a 200 unit RV lot spread out over 70 acres in the Mayatan region. McNab said that he intends on going through every necessary step to ensure that he abides by all regulations in hopes that his proposal comes to fruition. However, his plan has been met with the discontent of some in the area, even pushing a group of residents to begin forming an association to better represent the needs and desires of residents of Mayatan Lake.

Pete Marshall, who lives on the east end of the lake and will be involved with the association, hosted the discussion by going over some of the key points that struck him as noteworthy including the idea that there would be no servicing (food store) on site.

"It's not possible to control the drinking on a campground. You don't make the money camping; you make it off the store. Don't get me started on the pollution. I also warn about the trouble it will bring," said Frank McCollum, who is associated with the Mink Lake camping grounds. McCollum stressed how simple issues such as noise complaints may take as long as three to four hours to control due to the distance it takes to make it out to the remote location as well as where it falls on the priority list for the authorities.

The issue of water transportation was discussed due to the fact that many in attendance interpreted McNab's solution to providing water was to haul fresh water in and to truck waste water out.

"To truck in water like that; I'm not buying it. That's an exorbitant amount of water," said Patty Helten, who voiced her discontent on the project throughout the meeting.

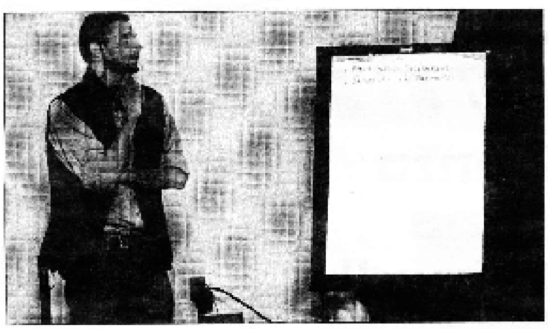
Denis Paul, a representative from the Paul Band First Nation arrived halfway through the discussion to provide feedback from the local reserve.

"I am going to be sending a stern letter. I really don't like it when activities like this are planned without our input," said Paul, who stressed that nothing should be proceeded with until certain laws were dealt with appropriately.

One of the most heated issues was in regard to the roads, which local farmer, Wayne Lutz, said need plenty of work. This raised safety issues as well.

"We used to drive herds of cattle up and down these roads. Now we can barely drive farm equipment down these roads. It's dangerous these days and it's not fair. How much can we take?" asked Lutz.

Séamus Smyth
howesnet.com



Séamus Smyth Reporter/Examiner
Pete Marshall leads a presentation discussing certain factors that did not sit well with locals this past Saturday at the Mink Lake Community Hall.

Everyone is a genius at least once a year. The real geniuses simply have their bright ideas closer together.
– *Georg Christoph Lichtenberg*

A 20 Stony Plain Reporter/Grove Examiner • Friday, November 26, 2010

Feelings mixed on Mayatan Lake development

By Séamus Smyth
Staff Writer

An information session was held this past Saturday at Rainbow Lake Lodge by the Mayatan Lake development group to discuss a possible 70-acre, 200 unit RV resort, that caused some locals to walk out in frustration.

"It will be horrific. It's a money-making business pure and simple. I will fight this until I can't fight this anymore," said local resident Conny Schuster.

Schuster along with others plan on getting Environment Canada involved to ensure that the development does not get off the ground.

Developer John McNab held the information session to determine where the public stood, and although he sensed discontent, he felt it was due to residents not being aware of what was going on.

"We have been following all the rules. The province is not against it. They want smart development. We know that the first input is always negative," said McNab.

McNab envisions an on route campground and a destination campground and mentioned this plan is still very much in the preliminary stages. He explained the goal of the park is to provide a campground that everyone can benefit from.

"We are trying to provide a place for recreation not just for the wealthy, but a place where you don't have to dish out a lot of money to experience camping in Alberta," said McNab.

He hopes that the resort will eliminate "squatters," people who camp on crown reserve grounds without permission, and mentioned that with a growing population in Alberta, many people are on the lookout for new places to camp.

"The population in Alberta has doubled in the past 13 years. Eighteen per cent of all people in Alberta currently have an RV. These people need a place to go camping," he said.

Another disgruntled resident, whose land will be the closest in proximity to the possible RV park, Phillip Roeder, bought his property three years ago because of the tranquility and quiet neighbourhood that Mayatan Lake provided.

"If they build this thing I will sell my land. The developers said there are not enough RV places in Parkland County; Wabamun is a big one and it's half full. There is no need for another RV park," said Roeder.

Roeder lived in Germany for 54 years before moving to Parkland County and couldn't get over how beautiful the property in the Mayatan area currently is.

"It was so overcrowded in Germany. This is beautiful here. The lake is small, there are plenty of birds, from loons to pelicans," said Roeder. Along with the possible destruction of the environment, Roeder and Schuster both stressed their concern for the wildlife, specifically the birds, in the area.

Jackfish Lake resident and former councilor Ken Darby, who is in favour of the development said that a similar situation occurred 12 years ago, where many thought that nature would be disturbed when Rainbow Beach Estates began development.

"Of course none of those things we feared materialized. Including the disappearance of wildlife. This development is not going to chase one pelican, one duck, one goose, one heron, one rabbit or one squirrel away."

Darby said that judging from the meeting held, there were only a few people who were vocal about their discontent. He continued saying that he hoped the present Parkland council would not be swayed by the efforts of those opposed to the development.

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