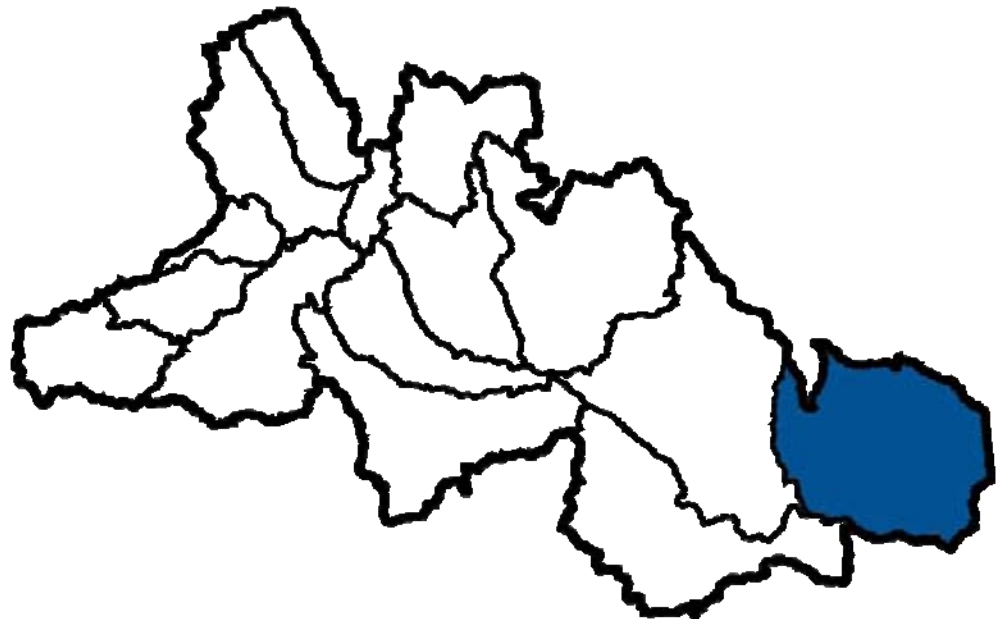


Alkali Subwatershed



4.15 Alkali Creek Subwatershed

4.15.1 Watershed Characteristics

The Alkali Creek subwatershed encompasses about 601,368 ha and is located in Cypress County, the Municipal District of Acadia No. 34 and Special Areas 2 and 3 (Figure 379).

The Alkali Creek subwatershed is the easternmost extend of the Red Deer River watershed before the Red Deer River enters Saskatchewan and merges with the South Saskatchewan River. This subwatershed lies in the Dry Mixedgrass Subregion (Figure 380). Natural vegetation is dominated by spear grass (*Piptochaetium* spp.), blue grama (*Bouteloua gracilis*), western wheat grass (*P. smithii*) and northern wheat grass (*E. lanceolatus*). Although much of the natural vegetation has been replaced by agricultural crops, extensive areas of native rangeland remain, which are managed primarily for grazing by domestic livestock (Heritage Community Foundation, 2008).

The subwatershed is characterized by a generally flat topography. The geology is dominated by the Bearpaw and Oldman Formations, both of Upper Cretaceous in origin (65-100 million years old). The former consists of blocky and silty shales as well as sandstone, ironstone and bentonite beds. The latter consists of feldspathic sandstone, siltstone, mudstone, ironstone and carbonaceous shale (Alberta Geological Survey, 2006).

The climate of the Alkali Creek subwatershed is typical continental, with a mean annual temperature of about 3-4 °C. The average summer temperature is about 16 °C. The total annual precipitation ranges from 260-320 mm, with about two-thirds of the annual precipitation falling as rain, mostly in June (Environment Canada, 2006).

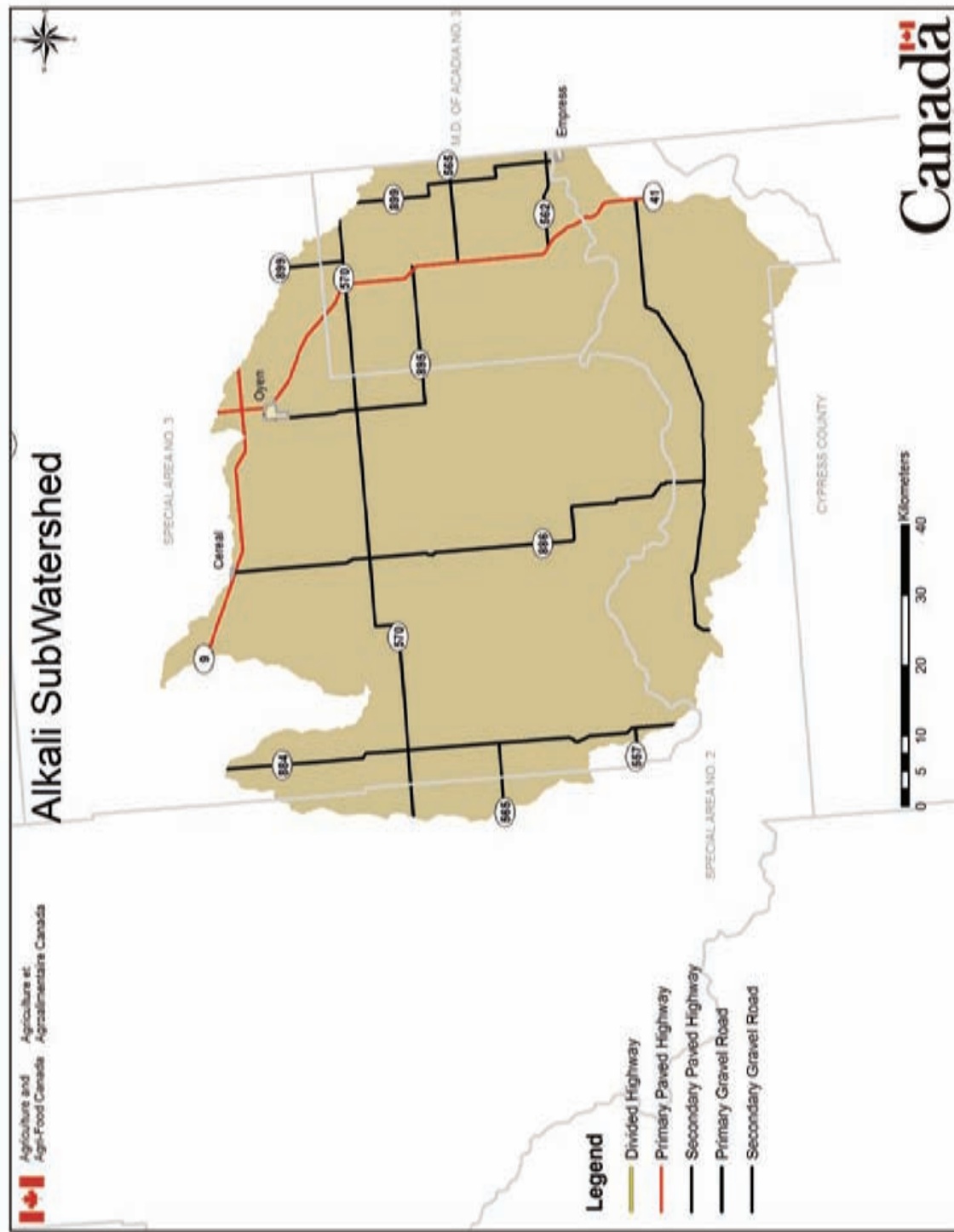


Figure 379. Location of the Alkali Creek subwatershed (AAFC-PFRA, 2008).

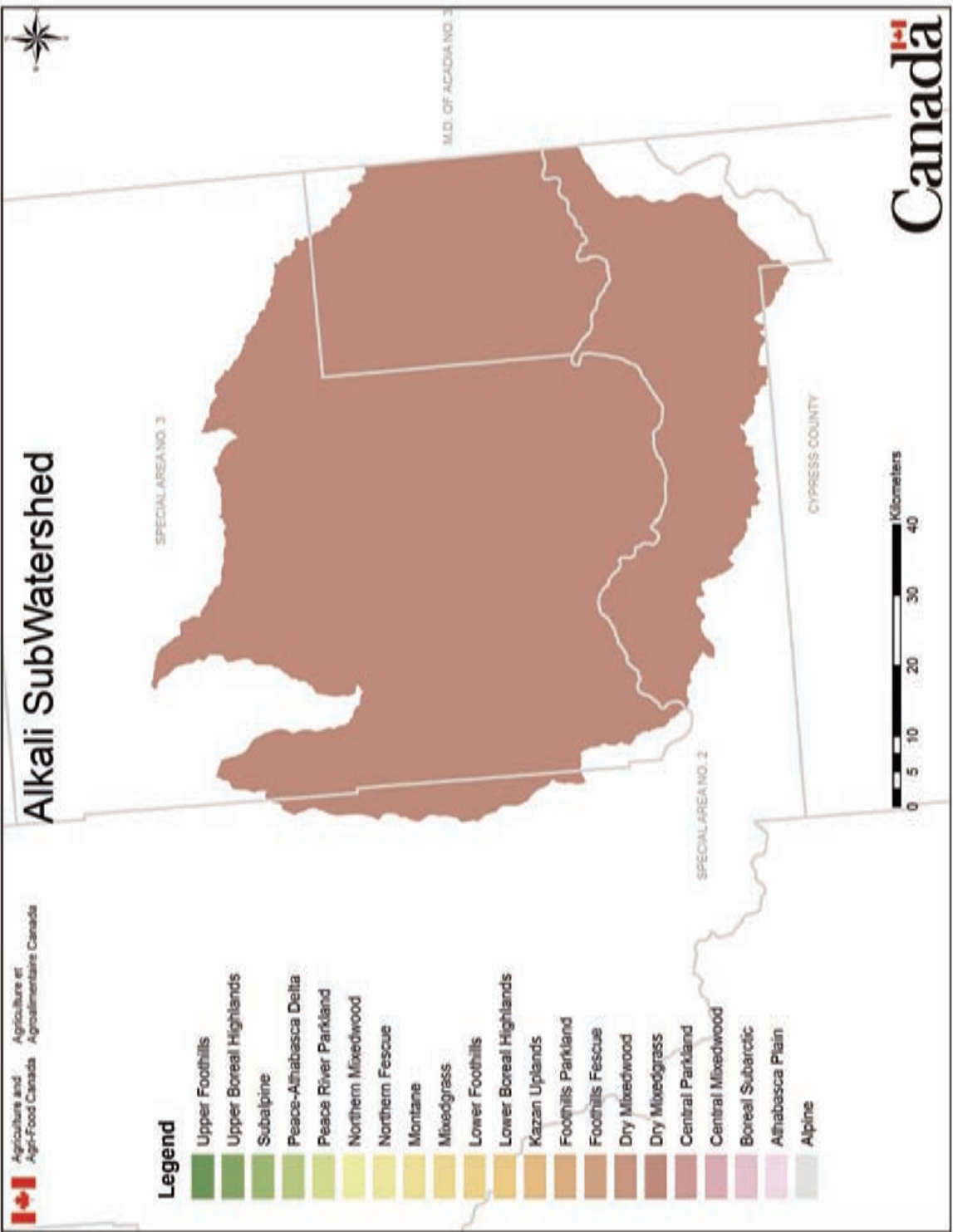


Figure 380. Natural subregions of the Alkali Creek subwatershed (AAFC-PFRA, 2008).

4.15.2 Land Use Indicators

Changes in land use patterns reflect major development trends, such as forested lands converted to agriculture and agricultural lands developed and lost to urban sprawl. Land use changes and the subsequent changes in management practices impact both the quantity and quality of water within the Red Deer River watershed. Six metrics were used to indicate changes in land use and land use practices in the Red Deer River watershed and its 15 subwatersheds:

- Wetland Loss – Condition Indicator
- Riparian Health – Condition Indicator
- Livestock Manure Production – Risk Indicator
- Urban, Rural and Recreational Developments – Risk Indicator
- Linear Developments – Condition Indicator
- Oil and Gas Activities – Risk Indicator

These six land use change indicators also reflect socioeconomic growth in a region. Hence, while human activities in a region can have negative environmental impacts, it is important to strive for a balance between socioeconomic growth and the sustainable management of natural ecosystems to ensure their long-term health and enjoyment by future generations.

4.15.2.1 Wetland Loss

Wetlands serve many functions in the natural landscape including water storage, flood attenuation, wildlife habitat, groundwater recharge and general water quality improvements (e.g., nutrient uptake, degradation of pesticides, sediment retention). Additionally, wetlands provide a cost effective and sustainable alternative to engineered treatment options. The loss of wetlands to development and/or agriculture can be deleterious to surface and groundwater quantity and quality.

Land cover data indicate the presence of 8,578 ha of wetlands (1.43% of the total subwatershed area) in the Alkali Creek subwatershed (AAFC-PFRA, 2008); however, there are no data on the classes, forms and types of wetlands (*sensu* National Wetlands Working Group, 1997) within the subwatershed. Given the presence of lentic (lakes) and lotic (streams and rivers) systems, marshes and shallow open water wetlands are likely present in the subwatershed. In addition, ephemeral, temporary, seasonal and semi-permanent wetlands (*sensu* Stewart and Kantrud, 1971) are likely present in the subwatershed as well.

The Prairie Habitat Joint Venture program (a partnership between federal and provincial governments, organizations and conservation groups in Manitoba, Saskatchewan and Alberta) has assessed the loss of wetlands in the Grassland Natural Region (in the Dry Mixedgrass Subregions) from 1985-2001 (Watmough and Schmoll, 2007). In Alberta, the Grassland Natural Region has lost 7% of its total wetland area and 9% of its total number of wetlands due to anthropogenic disturbances in that 16-year period. There appears to be no change in the rate of wetland loss in the Prairie Parkland Region over the past 50-70 years. Caution must be taken when extrapolating these data to the entire subwatershed, since the Prairie Habitat Joint Venture program has assessed wetland losses along only one transects in this subwatershed (Watmough and Schmoll, 2007).

4.15.2.2 Riparian Health

Riparian areas are an important transition zone between uplands and water. They act as buffer zones, protecting water quality and attenuating floods. Contaminants are adsorbed onto sediments, assimilated by vegetation and transformed by soil microbes into less harmful forms. They have long been proven effective in reducing nutrients, sediments and other anthropogenic pollutants that enter surface waters via overland and subsurface flow.

Riparian health has not been assessed in the Alkali Creek subwatershed.

4.15.2.3 Livestock Manure Production

Areas of higher livestock density within a subwatershed, and their associated higher manure production, are expected to have greater impacts on downstream water quality. Streams that drain land with high intensity livestock operations have higher nutrient concentrations, dissolved nutrients, mass loads, fecal bacteria and exports of total dissolved phosphorus than streams with medium or low intensity livestock operations and manure production.

There are three feedlots/intensive livestock operations in the Alkali Creek subwatershed (Figure 381) (AAFC-PFRA, 2008). These feedlots finish cows and poultry (1 feedlot each) and feed swine (1 feedlot).

Cattle density is low throughout the subwatershed, ranging from 0-0.20 cattle/ha (Figure 382) (AAFC-PFRA, 2008). Manure production ranges from 0.2-2.5 tonnes manure/ha throughout the entire subwatershed (Figure 383) (AAFC-PFRA, 2008), which is considered low relative to the remainder of the Red Deer River watershed.

Agricultural intensity, expressed as the percent land cover used as croplands, is low throughout most of the Alkali Creek subwatershed (0-20%) and only increase to 20-40% in the northwestern area of the subwatershed. Near Oyen, agricultural intensity is highest at 40-60% (Figure 384) (AAFC-PFRA, 2008).

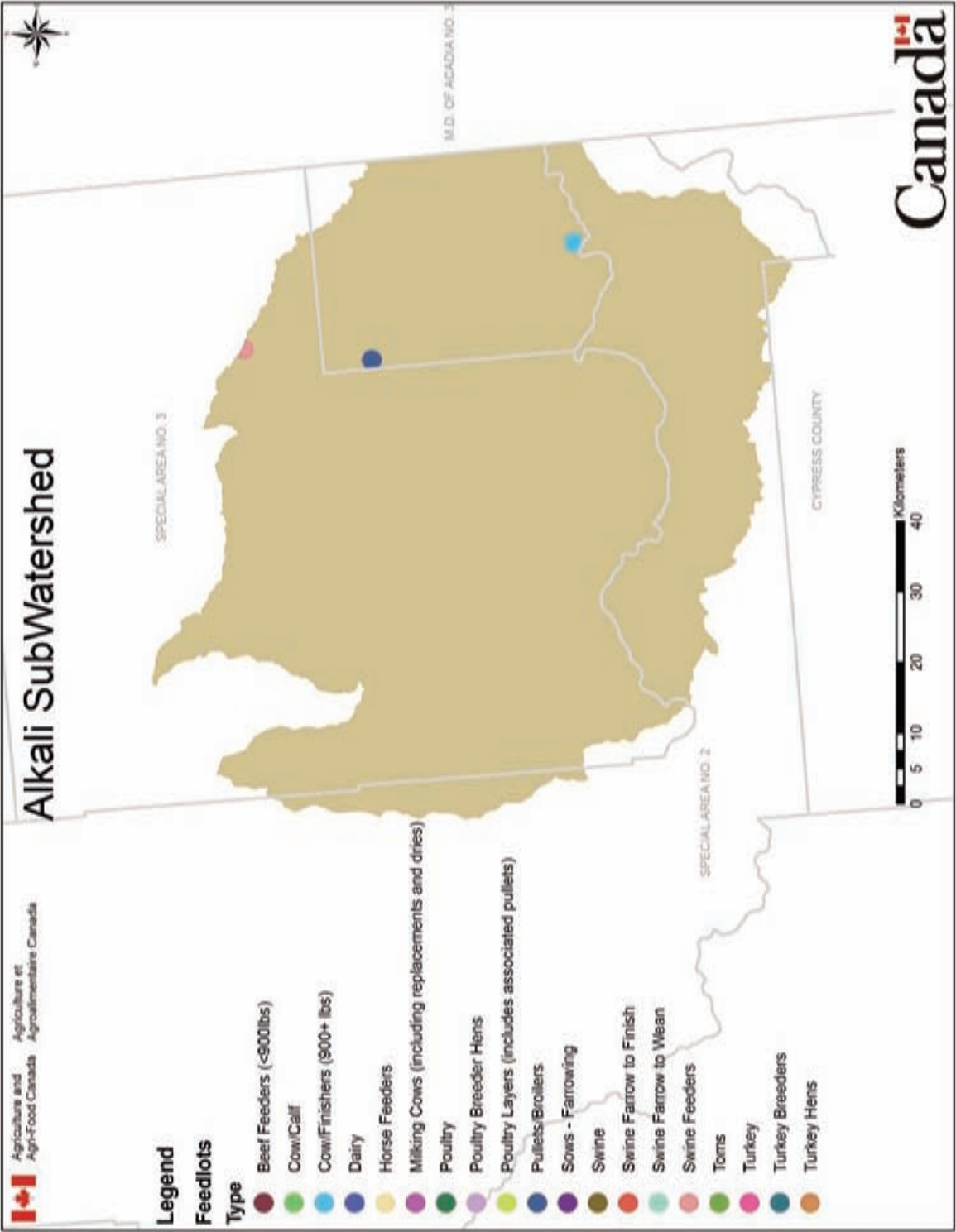


Figure 381. Feedlots and intensive livestock operations in the Alkali Creek subwatershed (AAFC-PFRA, 2008).

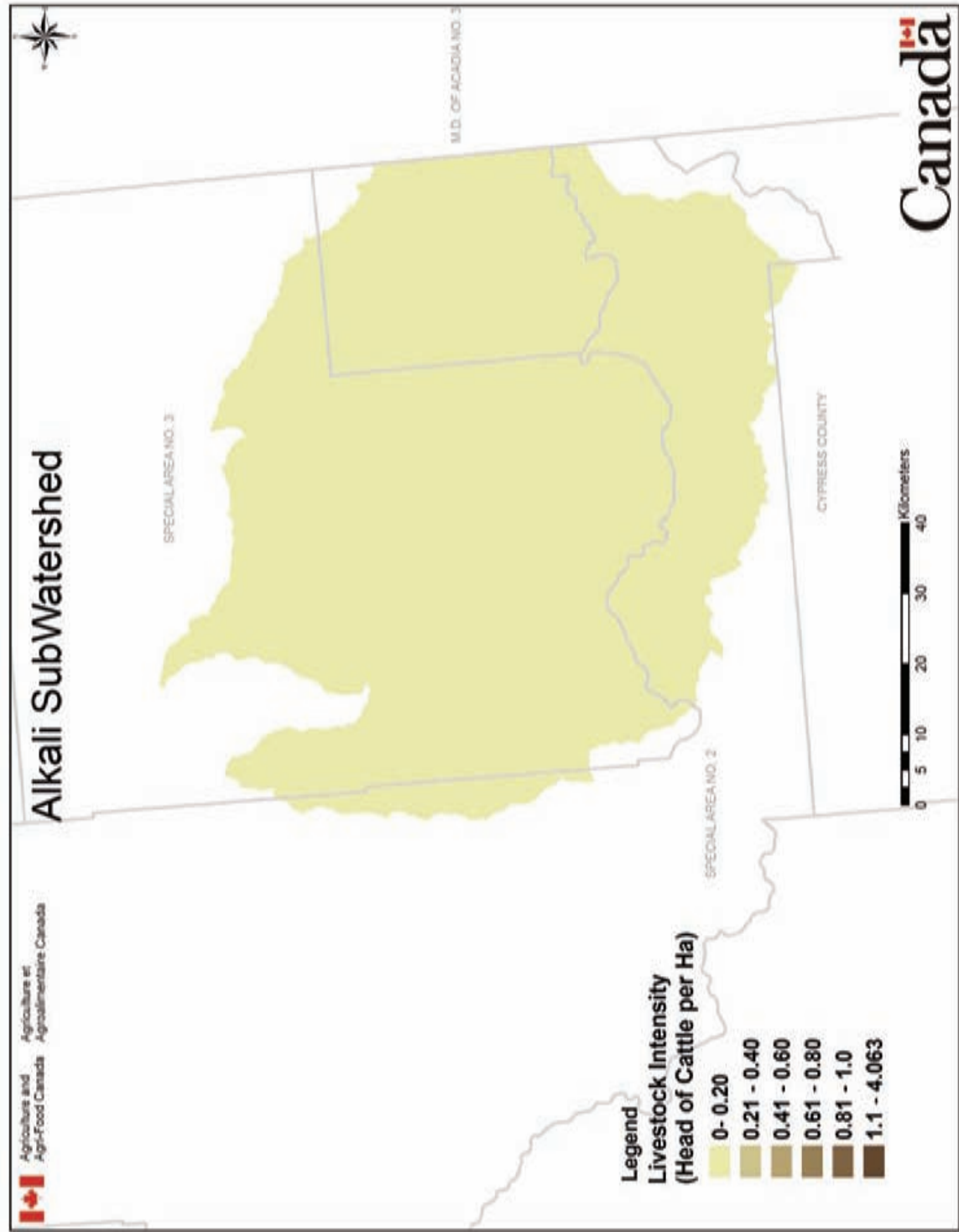


Figure 382. Cattle density (cattle/ha) in the Alkali Creek subwatershed (AAFC-PFRA, 2008).

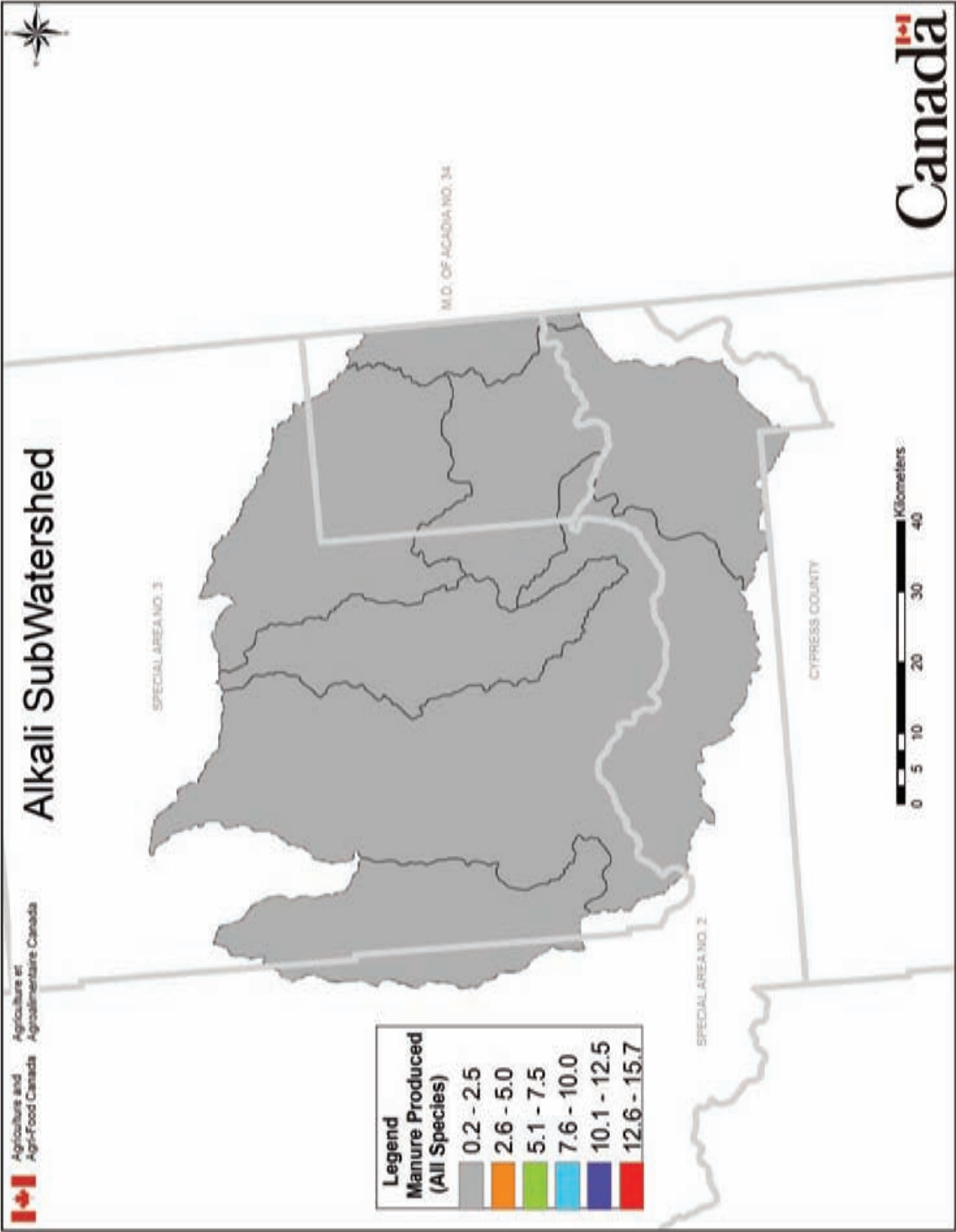


Figure 383. Manure production (tonnes/ha) in the Alkali Creek subwatershed (AAFC-PFRA, 2008).

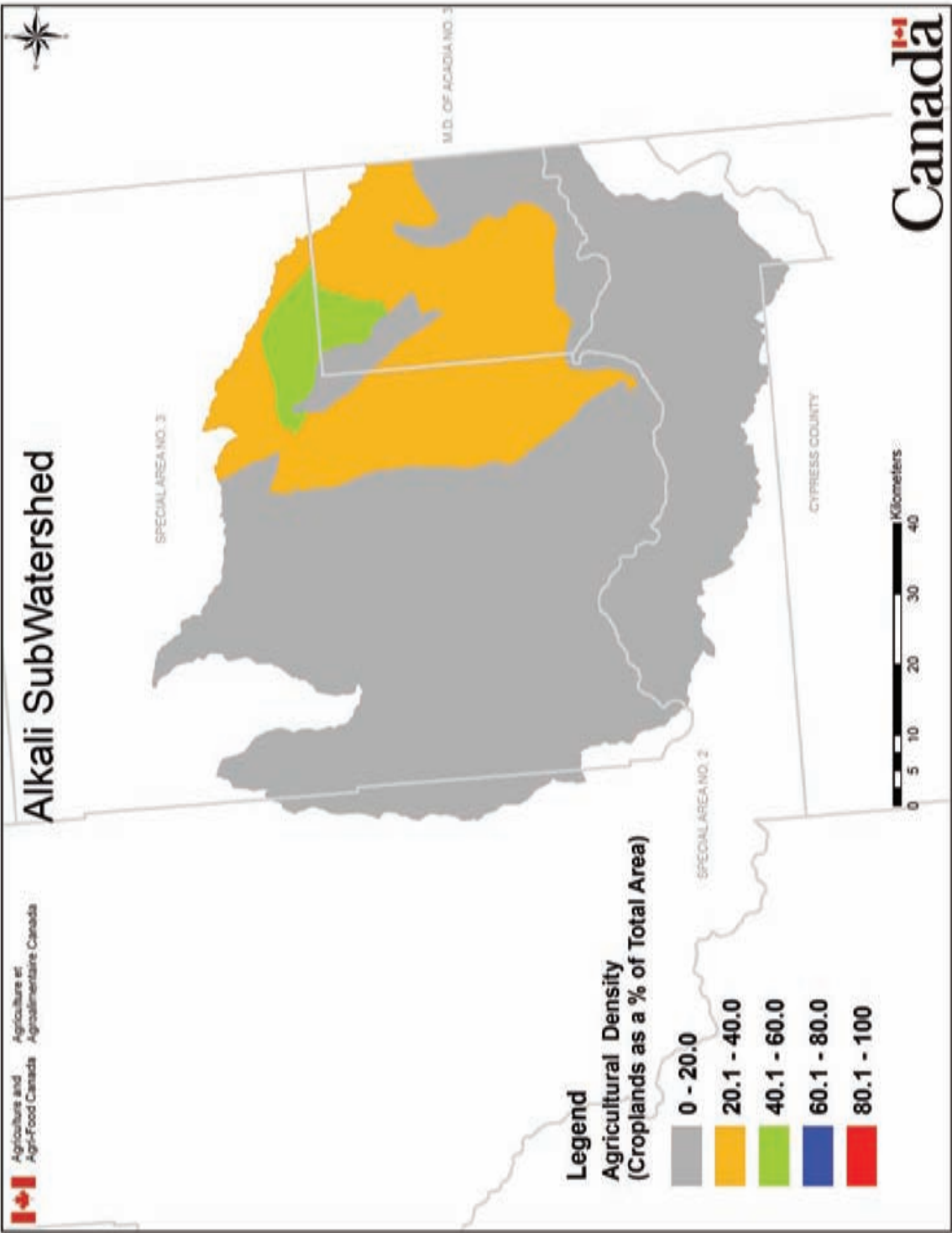


Figure 384. Agricultural intensity (% cropland) in the Alkali Creek subwatershed (AAFC-PFRA, 2008).

4.15.2.4 Urban, Rural, Agricultural and Recreational Developments

Urban sprawl, rural and recreational development is the expansion of urban areas, rural subdivisions and recreational areas into surrounding landscape. This expansion can have many negative effects on the environment, including the loss of wetlands, riparian areas, intermittent streams and wildlife habitat, as well as increased surface runoff into neighboring creeks, rivers and lakes.

The Town of Oyen, the Villages of Empress and Cereal and numerous hamlets, including Acadia, Acadia Valley, Benton, Big Stone, Bindloss, Buffalo, Cabin Lake, Cappon, Cavendish, Helmsdale, Lanfine and Sunnydale, are located in the subwatershed. One campground is located north of Buffalo on the Red Deer River (Government of Canada, 2006). There are no Provincial Parks, Provincial Natural Areas or Provincial Recreation Areas in the subwatershed (Alberta Tourism, Parks and Recreation, 2008b).

4.15.2.5 Linear Developments

Linear developments include seismic lines, pipelines, roads, railways and utility right of ways. Quantifying linear development will help us understand potential changes in water quality and fish and wildlife populations, e.g., wildlife corridors can be interrupted by roads, and watersheds can have their drainage patterns permanently altered by increases in impervious or compacted surfaces.

The most prominent linear developments in the Alkali Creek subwatershed are urban and rural roads, which have a total length of 3,100 km and cover 49.6 km² of the subwatershed's landbase. Other major linear developments include pipelines and cutlines/trails (Table 157). In total, all linear developments cover an area of 115.0 km², or 1.9% of the total area of the subwatershed (Figure 385) (AAFC-PFRA, 2008).

Table 157. Linear developments in the Alkali Creek subwatershed (AAFC-PFRA, 2008). The dominant linear development is highlighted.

Linear Development	Length (km)	Width (m)	Area (km ²)	Proportion of total linear disturbances (%)
All roads	3,100	16	49.60	43.1
Cutlines/trails	4,600	6	27.60	24.0
Pipelines	1,960	15	29.40	25.6
Powerlines	200	30	6.00	5.2
Railways	156.9	15	2.35	2.0
Total	10,017		114.95	

In addition to linear developments, the Alkali Creek subwatershed has 92 bridges that cross waterbodies, mostly streams and creeks, or culverts that connect waterbodies. These are primarily associated with Blood Indian Creek and Alkali Creek (Figure 386) (AAFC-PFRA, 2008). Pipeline crossings are distributed throughout the Alkali Creek subwatershed, although their density is lower east of Majors Lake in the west-central area and south of Acadia Valley in the eastern area of the subwatershed. Pipeline crossing densities are particularly high north and south-west of Buffalo in the vicinity of the Red Deer River near the confluence with Alkali Creek (Figure 387) (AAFC-PFRA, 2008).

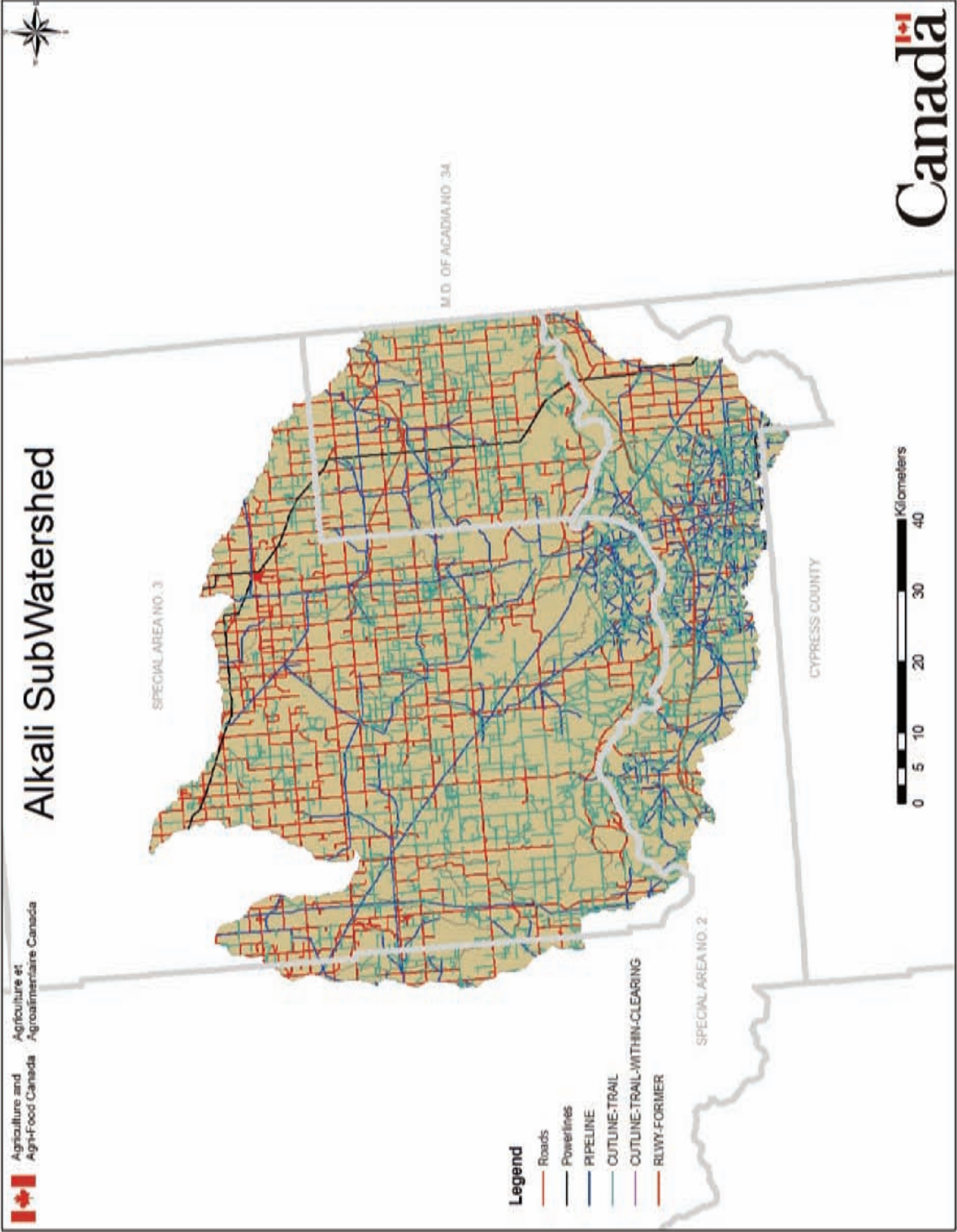


Figure 385. Linear developments in the Alkali Creek subwatershed (AAFC-PFRA, 2008).

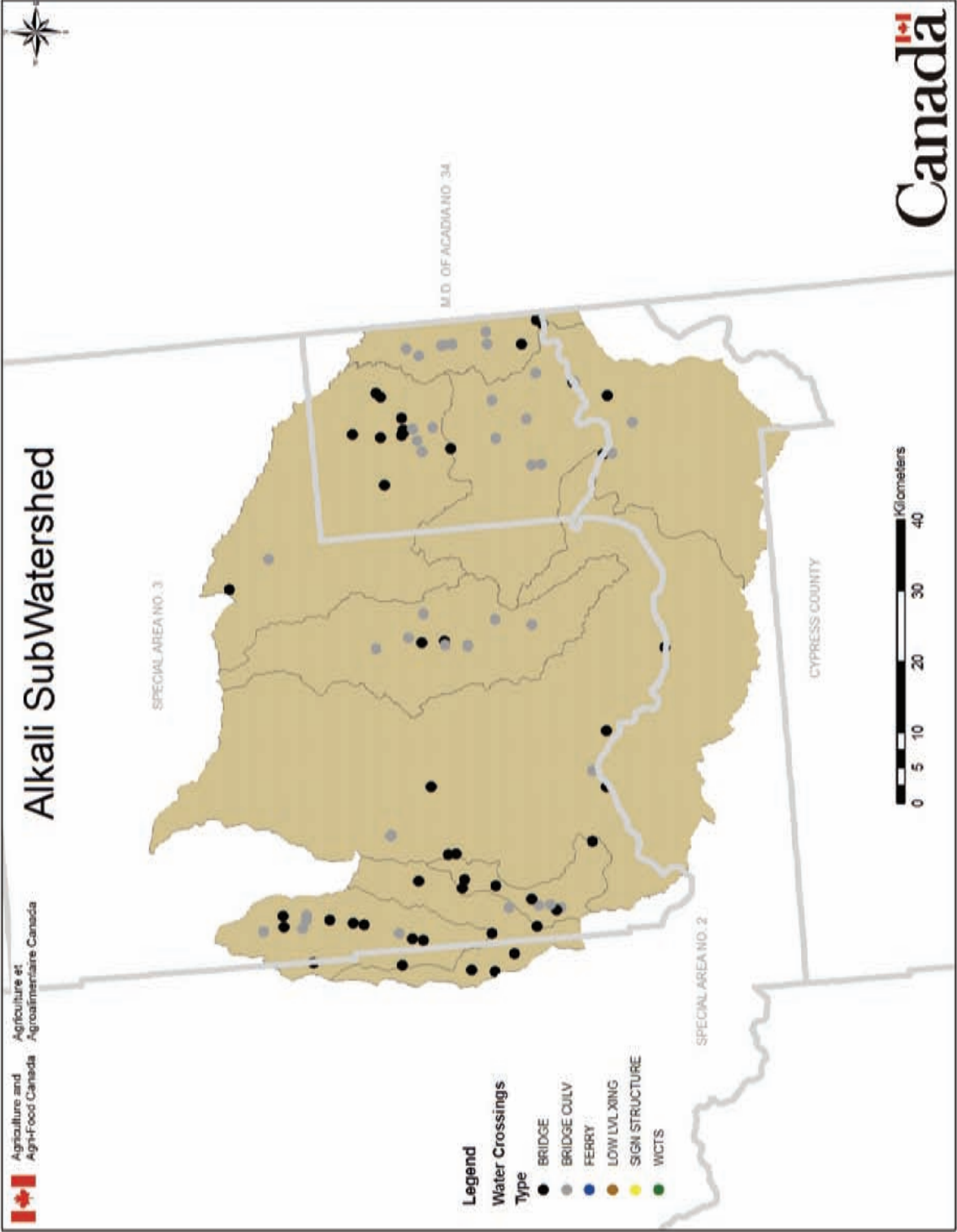


Figure 386. Waterbody crossings in the Alkali Creek subwatershed (AAFC-PFRA, 2008).

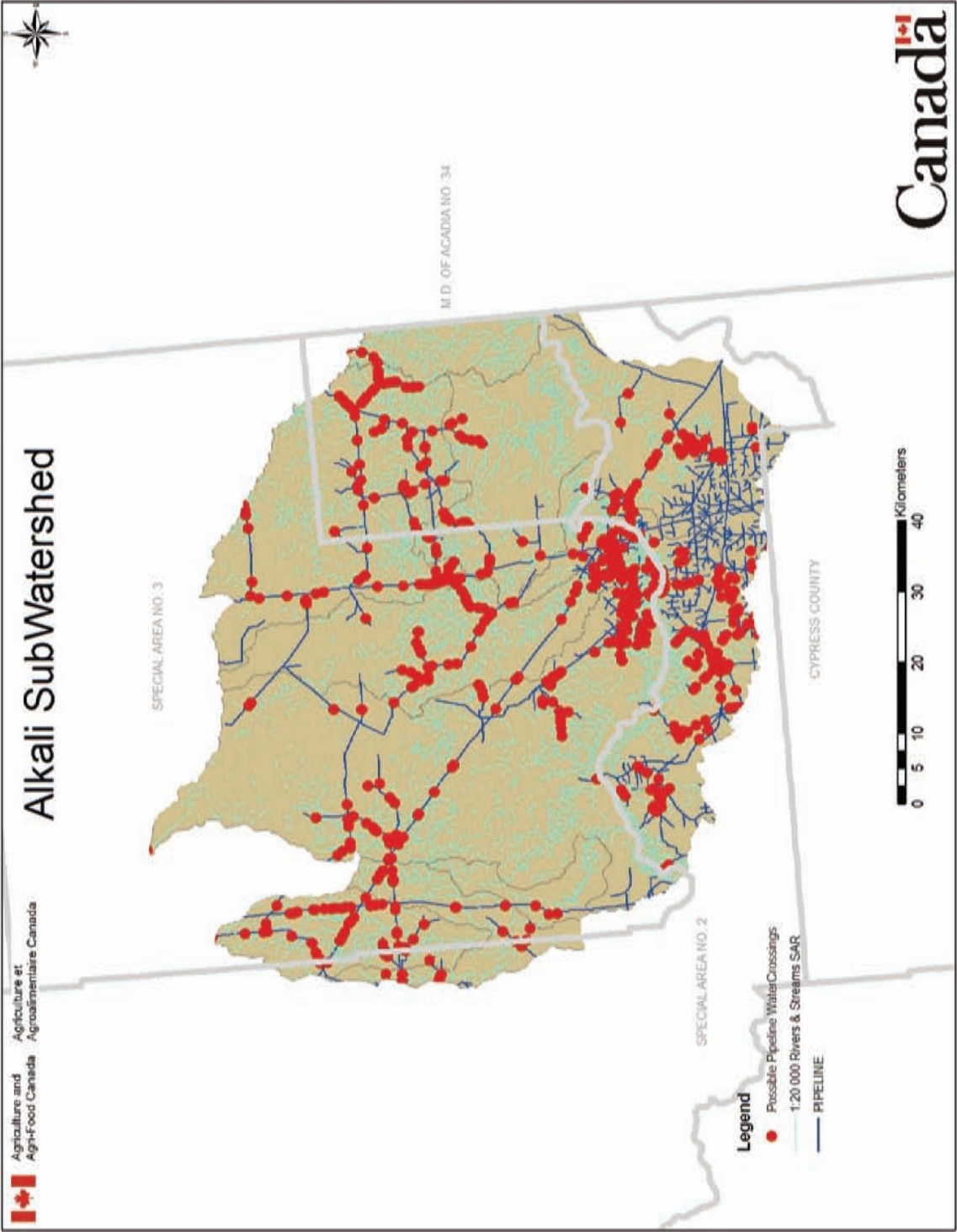


Figure 387. Pipeline crossings over waterbodies in the Alkali Creek subwatershed (AAFC-PFRA, 2008).

4.15.2.6 Oil and Gas Activities

Oil and gas activity is very common throughout the province of Alberta. With oil and gas development there can be a number of associated impacts, including loss of wetlands, habitat fragmentation, increased water use and surface water and groundwater contamination (Alberta Centre for Boreal Studies, 2001).

The Alkali Creek subwatershed has an average well density of 1.27 wells/km²; however, the well density increases up to 5 wells/km² near the Red Deer River and up to 10 wells/km² near Bindloss, Buffalo and Jenner south of the Red Deer River and west of Blood Indian Creek (Figure 388). About 63% of all wells are active, with the majority being gas wells, followed by unspecified and oil wells (Table 158) (AAFC-PFRA, 2008).

Table 158. Number of known active and abandoned oil, gas, water and other wells in the Alkali Creek subwatershed (AAFC-PFRA, 2008).

Well type	Quantity
Wells – active *	937
Wells – abandoned *	1,948
Total	2,885
Gas wells – active	3,660
Gas wells – abandoned	779
Total	4,439
Oil wells – active	159
Oil wells – abandoned	105
Total	264
Water wells – active	41
Water wells – abandoned	4
Total	45
Total active wells in subwatershed	4,797
Total abandoned wells in subwatershed	2,836
Total wells in subwatershed	7,633

* The purpose of these wells is undefined and may include standing, newly licensed, flowing coalbed methane, testing coalbed methane, carbon dioxide injector or general exploration wells.

Coal bed methane (CBM) is natural gas that is found within coal formations. It has received attention recently as an additional source of energy; however, it brings with it potential environmental impacts, some of which are similar to conventional oil and gas exploration and production endeavors. Conversely, some potential impacts it brings with it are new, including an increased intensity in wells, compressors, pipeline infrastructure and completion and production of natural gas from formations above the base of groundwater protection. Some CBM wells are estimated to produce over 65,000 L of waste water per day (Lennon, 2008). In addition, common to oil, gas and unconventional gas (CBM and Shale gas) production is the risk of groundwater contamination through fracturing. Fracturing results from pumping fluids or gases into bedrock formations at high rates and pressures to 'fracture' the bedrock and increase gas or oil production. Fracturing fluids may contain toxic or carcinogenic compounds, which may leach into groundwater sources and pose a threat to human health through contaminated drinking water (Natural Resources Defense Council, 2002).

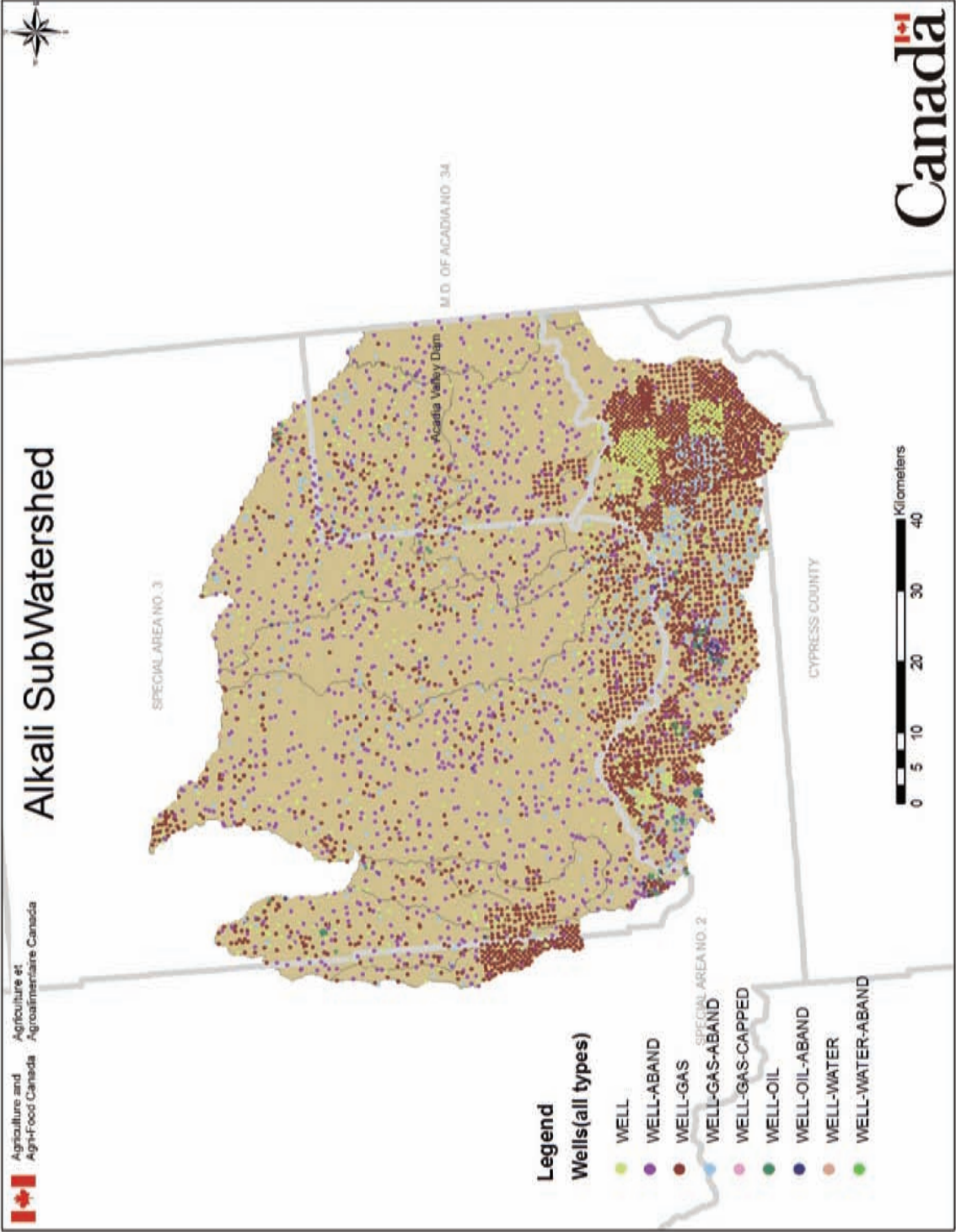


Figure 388. Known active and abandoned oil, gas, water and other wells in the Alkali Creek subwatershed (AAFC-PFRA, 2008).

4.15.3 Water Quality Indicators

Changes in water quality indicate either a deterioration or improvement in the condition of the watershed and demonstrate specific areas that require further attention or protection. Changes in water quality result from changes in land use or land management practices, landscape disturbance and natural events. The major anthropogenic impacts on water quality result from natural resource extraction and processing, wetland drainage, dredging, dam construction, agricultural runoff, industrial wastes, municipal wastes, land erosion, road construction and land development. Five metrics were used to indicate changes in water quality in the Red Deer River watershed and its 15 subwatersheds:

- Nutrients – Condition Indicator
- Bacteria – Condition Indicator
- Parasites – Condition Indicator
- Pesticides – Condition Indicator
- Point Source Inputs

These five water quality indicators reflect socioeconomic growth in a region. Hence, while human activities in a region can have negative impacts on aquatic ecosystems, it is important to strive for a balance between socioeconomic growth and the sustainable management of these aquatic ecosystems to ensure their long-term health and enjoyment by future generations.

4.15.3.1 Nutrients

Nitrogen and phosphorus are essential nutrients for most aquatic plants, whereby excess nutrients can lead to eutrophication, i.e., an excessive amount of aquatic plant and phytoplankton growth. Concomitant with increased plant and phytoplankton growth, oxygen levels may significantly decrease in the water column, which may negatively impact aquatic organisms, including fish. In addition, excessive phytoplankton growth, particularly of cyanobacteria, can lead to the release of toxins into the water column, which may be harmful to aquatic organisms, waterfowl, livestock and humans.

Water quality assessments in the Alkali Creek subwatershed have been carried out sporadically from 1983 to 2000. Only TN concentrations in Blood Indian Creek exceeded CCME PAL guidelines (1.287 mg/L vs. 1.000 mg/L) (Table 159). Sources of nitrogen may include surface application of manure and/or fertilizer by agricultural producers (Carpenter et al., 1998; Chambers et al., 2001), municipal wastewater effluents (Servos et al., 2001) and urban run-off (Marsalek et al., 2001), all of which have been demonstrated to be a source of excess nutrients to surface waterbodies. The densities of agricultural and livestock operations are low in the Blood Indian Creek area of the Alkali Creek subwatershed, and a potential source of nutrients to the creek cannot be determined.

4.15.3.2 Bacteria

Coliforms are a broad class of bacteria found in human and animal wastes. Total coliforms include *Escherichia coli*, fecal bacteria and other coliforms that occur naturally in warm blooded animals. *E. coli* is one of three bacteria commonly used to measure the direct contamination of water by human or other mammal wastes. Ingestion of or exposure to fecal bacteria can have negative health impacts.

Sources of this type of bacteria include agricultural and municipal runoff, wildlife, faulty septic systems and septic fields.

Five water samples have been collected and analyzed for bacterial concentrations in the entire subwatershed. In Blood Indian Creek, average fecal coliform concentrations exceeded CCME-Agriculture/Irrigation guidelines; fecal and total bacterial concentrations were below CCME-Agriculture/Irrigation guidelines in Alkali Creek, although only one sample has been collected to date (Table 159).

Table 159. Water quality in the Alkali Creek subwatershed. n = sample size. All concentrations in mg/L unless otherwise noted. Concentrations exceeding water quality guidelines are highlighted *.

Parameter	Alkali Creek		Blood Indian Creek	
	Mean	n	Mean	n
TP	0.028	1	0.031	3
TDP	---	---	0.016	2
TN	0.410	1	1.287	3
NO ₃ ⁻ -NO ₂ ⁻	0.010	1	0.534	3
NH ₃	0.05	1	0.80	3
DO	---	---	9.06	4
Chl. <i>a</i> (µg/L)	---	---	---	---
pH	8.60	1	8.16	4
Specific Conductivity (µS/cm)	1,486	1	1,564	4
TDS	989	1	1,402	1
Total coliforms (CFU/100 mL)	0	1	---	---
Fecal coliforms (CFU/100 mL)	0	1	131	4

* TN from ASWQG PAL chronic exposure guideline; fecal and total coliforms from CCME-Agriculture/Irrigation guideline; all others from CCME PAL. In Alkali Creek, water samples were collected in April 2000; in Blood Indian Creek, water samples were collected in April 1983, July 1996 and July 1998 (data from Alberta Environment). Variable abbreviations as in Table 10.

4.15.3.3 Parasites

Waters that are polluted may contain several different disease-causing organisms, commonly called parasites. Enteric parasites, those that live in the intestine of warm blooded animals, can carry or cause a number of infectious diseases. *Cryptosporidium* and *Giardia* spp. are two such parasites. Both occur in almost all environments, including lakes, rivers, reservoirs and groundwater. They come from the feces of rodents, birds, cows, pigs and humans, and the ingestion of these parasites causes gastrointestinal conditions known as cryptosporidiosis and giardiasis.

Parasite data were not located for any waterbody in the Alkali Creek subwatershed.

4.15.3.4 Pesticides

Pesticides are a group of chemicals, including herbicides, insecticides, rodenticides and fungicides, used for many purposes, including pest control and aesthetics in urban areas, golf courses and in forestry and agricultural production. Pesticides are a common contaminant of streams and dugouts in the high intensity agricultural areas of Alberta.

Pesticide data were not located for any waterbody in the Alkali Creek subwatershed.

4.15.3.5 Point Source Inputs

Point source inputs include effluents from waste water treatment plants (WWTP), stormwater outfalls and industry. Effluent from WWTP's, although regulated, generally has higher concentrations of certain compounds (e.g., nutrients, solids, pharmaceuticals, metals, etc.) than the receiving environment. Similarly, stormwater outfalls contain elevated levels of nutrients, salts and solids compared to the receiving environment, and industrial effluents can contribute elevated levels of a suite of different contaminants, such as metals, solids, hydrocarbons and/or salts, as well as other chemicals used in processing or manufacturing, to aquatic ecosystems.

About 25 upstream oil/gas facilities, 2 oil/gas refining/storage facilities and 1 oil sands/heavy oil facility have released pollutants continuously or sporadically into the air in the Alkali Creek subwatershed since 2002. Pollutants from the upstream oil/gas and oil/gas refining/storage facilities include carbon monoxide (CO), nitrous oxide (N₂O) and particulate matter < 10 µm in size. Pollutants from the oil sands/heavy oil facility include N₂O, CO and volatile organic compounds (VOCs) (NPRI, 2008). No pollutants were released directly into aquatic ecosystems according to the National Pollution Release Inventory.

4.15.4 *Water Quantity Indicators*

Water quantity is important for the maintenance of aquatic habitat, it has functions related to water quality and it is essential for the treatment and production of sufficient volumes of drinking water to meet current demands. Irrigation, industry and livestock production are highly dependent on a minimum amount of water. Sufficient water quantity is necessary for many recreational activities, and in recent years many cottagers and recreational lake users across Alberta have voiced concerns about the decreasing volumes of water seen across the province. Five metrics were used as water quantity indicators in the Red Deer River watershed and its 15 subwatersheds:

- Volume
- Minimum Flows to Maintain Ecological Integrity – Condition Indicator
- Contributing Areas to the Watershed
- Allocations
- Groundwater Recharge/Discharge

Water discharge rates, allocations and minimum flow rates to maintain ecological integrity can reflect socioeconomic growth in a region. Human activities in a region frequently reduce available water quantities required to maintain healthy aquatic ecosystems. It is important to balance socioeconomic

growth and the sustainable management of these aquatic ecosystems to ensure their long-term health and enjoyment by future generations.

4.15.4.1 Volume

Water volume is the amount of water flowing past one point over a given time, or in the case of lakes or other standing waterbodies, the total amount of water present in the waterbody at a given time. This amount varies seasonally and annually with shifts in weather patterns. Water withdrawals for consumptive uses have increased dramatically in recent years and have resulted in some watersheds within the province being closed to new water licenses.

The total length of all water courses in the Alkali Creek subwatershed is about 3,614 km (Figure 389) (AAFC-PFRA, 2008). The dominant streams in the subwatershed are Alkali Creek, Blood Indian Creek and Empress Creek. The largest lakes include Armitage's Lake, Cabin Lake, Green's Lake and Majors Lake. In addition, the subwatershed is characterized by numerous intermittent streams and sloughs (Government of Canada, 2006).

Environment Canada has monitored water discharge rates at seven locations in the Alkali Creek subwatershed: in the Blood Indian Creek (active, 05CK001 and 05CK007; discontinued, 05CK003), in Alkali Creek near the confluence with the Red Deer River (real-time active, 05CK005), in Kennedy's Coulee near Acadia Valley (active, 05CK006) and in the Red Deer River (real-time active, 05CK005; discontinued, 05CK002) (Government of Alberta, 2008c).

Water discharge rates from Alkali Creek into Red Deer River are very low or absent. In 2008, the creek discharged water into the Red Deer River only in June, with discharge rates of about 0.4 m³/sec (Figure 390) (Government of Alberta, 2008c).

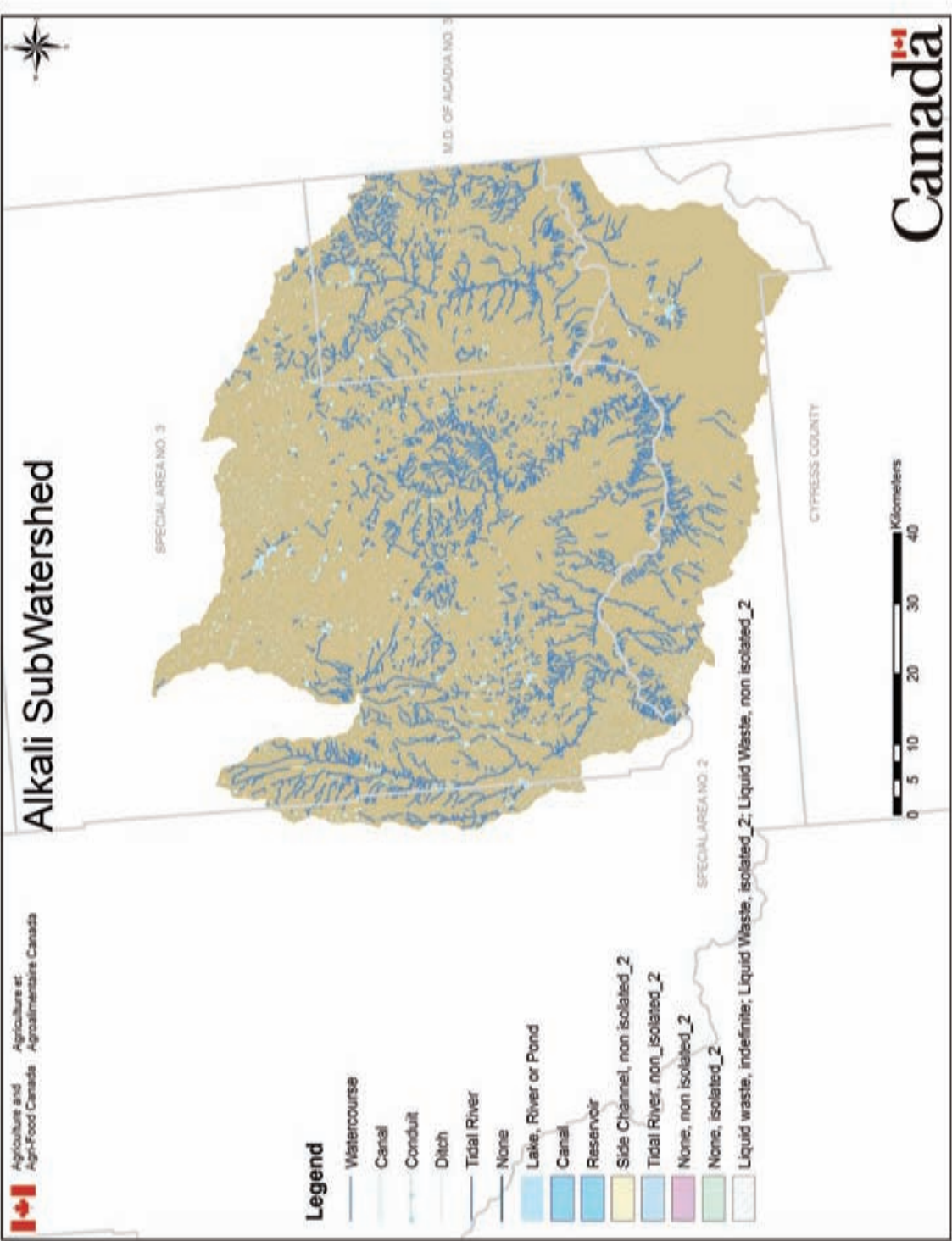


Figure 389. Waterbodies in the Alkali Creek subwatershed (AAFC-PFRA, 2008).

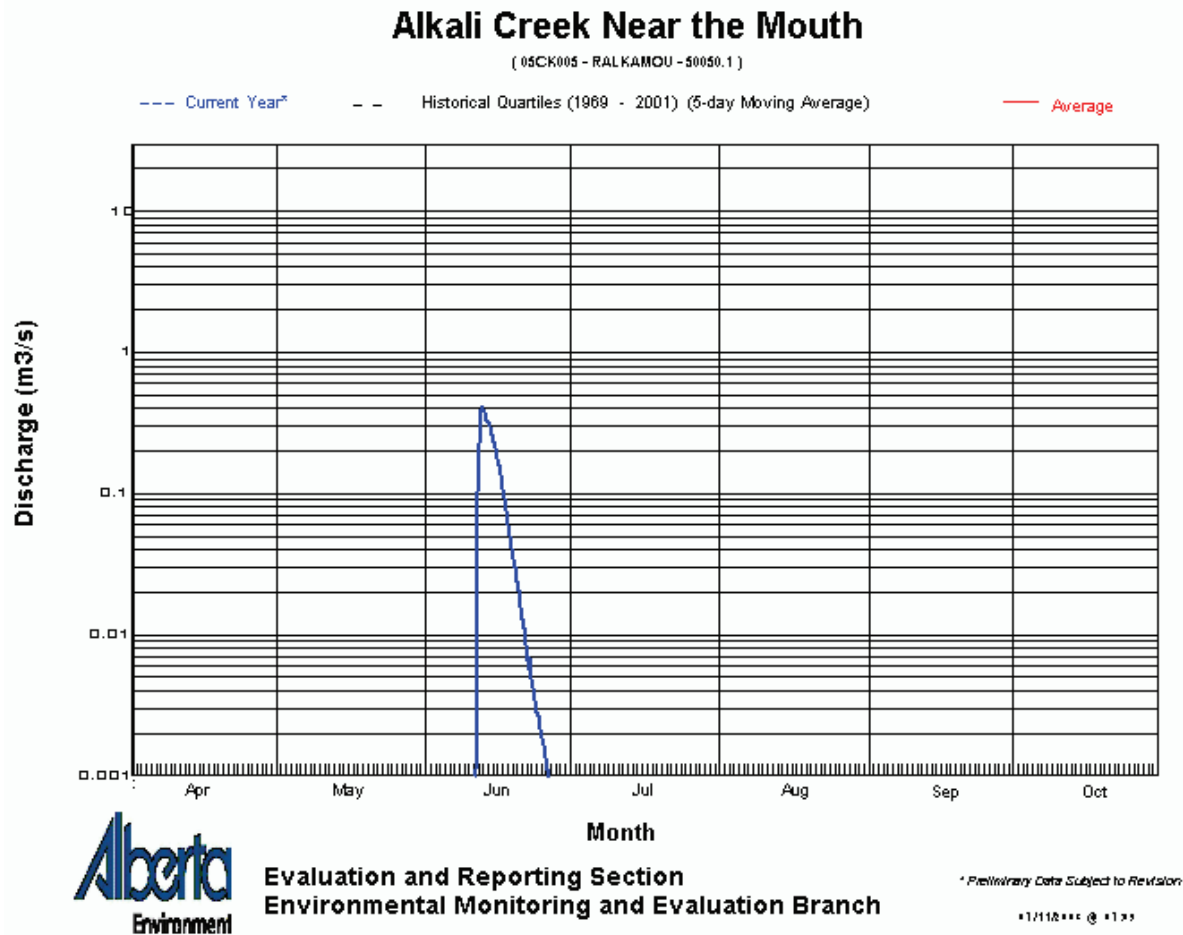


Figure 390. Discharge rates of Alkali Creek (Government of Alberta, 2008c). “Current year” indicates water discharge rates in 2008.

There are two major dams in the Alkali Creek subwatershed (Figure 391). Blood Indian Creek Reservoir is located north of Big Stone and resulted from the Blood Indian Creek Dam. In the east of the subwatershed, Acadia Valley Dam is located on Kennedy’s Coulee near Acadia Valley. In addition, there are numerous smaller water infrastructures in the subwatershed, e.g., small dams, sluices, weirs and dykes, which control water flow.

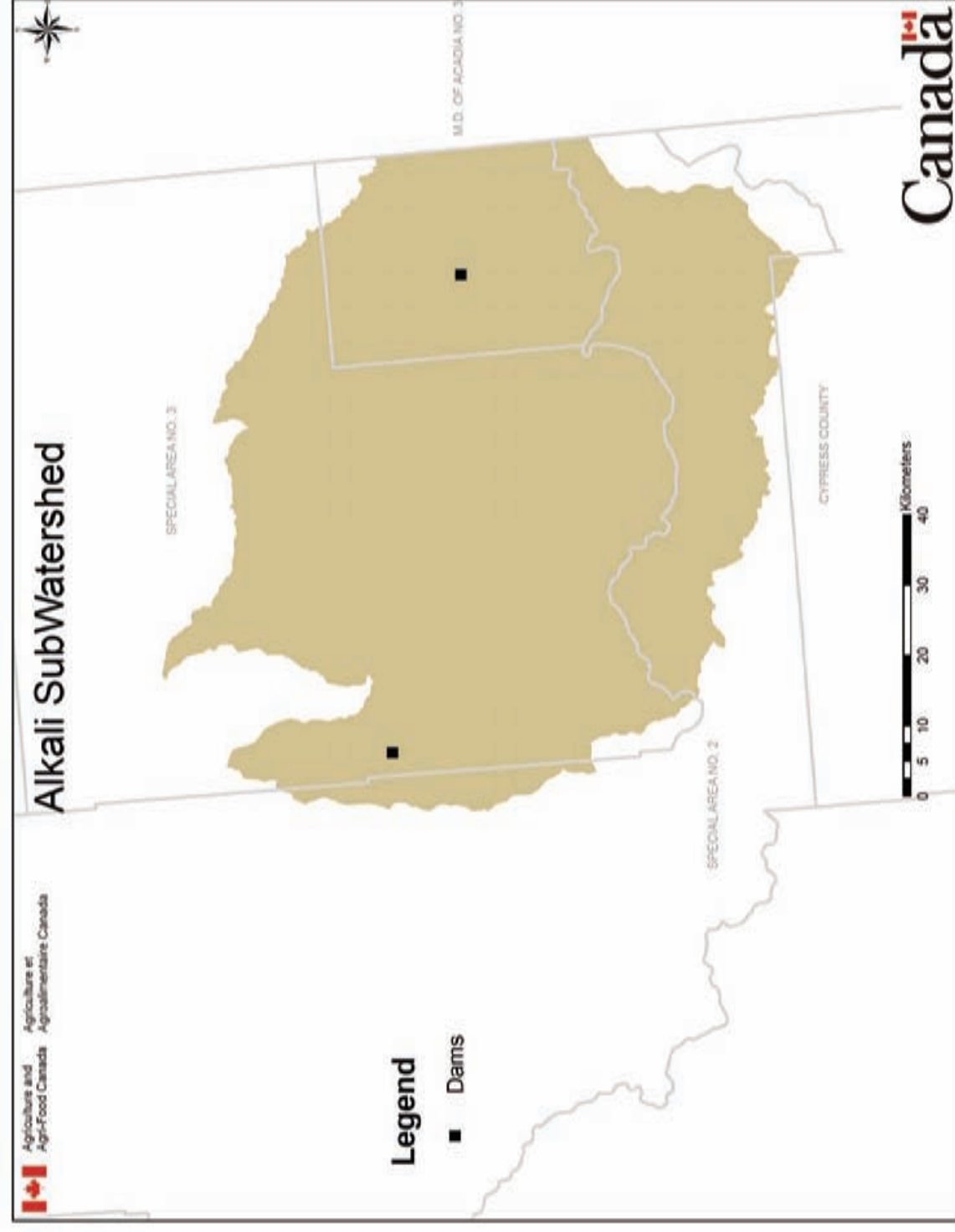


Figure 391. Major dams in the Alkali Creek subwatershed (AAFC-PFRA, 2008).

4.15.4.2 Minimum Flows to Maintain Ecological Integrity

Minimum flows to maintain ecological integrity are the lowest flows or volumes (lakes) required to sustain native aquatic species and natural ecosystem functions. Minimum flows must be determined before allocation of water can safely take place to preserve the ecological functionality of aquatic ecosystems.

Minimum flow requirements for the maintenance of ecological integrity have not been determined in the Alkali Creek subwatershed.

4.15.4.3 Contributing Areas to the Watershed

Contributing areas to the watershed are areas from which runoff flows into the lakes, creeks and rivers of the watershed. These data are used to determine an estimated volume of water contributed to the river on an annual basis.

In the Alkali Creek subwatershed, 387,680 ha (or 64.4% of the total area of the subwatershed) of land do not contribute to the drainage of the subwatershed (Figure 392). These areas are located throughout the subwatershed and exclude areas in the vicinity of Alkali Creek, Blood Indian Creek and Empress Creek. The areas that do not contribute to the drainage area of the subwatershed are characterized by an undulating topography (Figure 393) that does not facilitate the run-off of precipitation into nearby waterbodies (AAFC-PFRA, 2008).

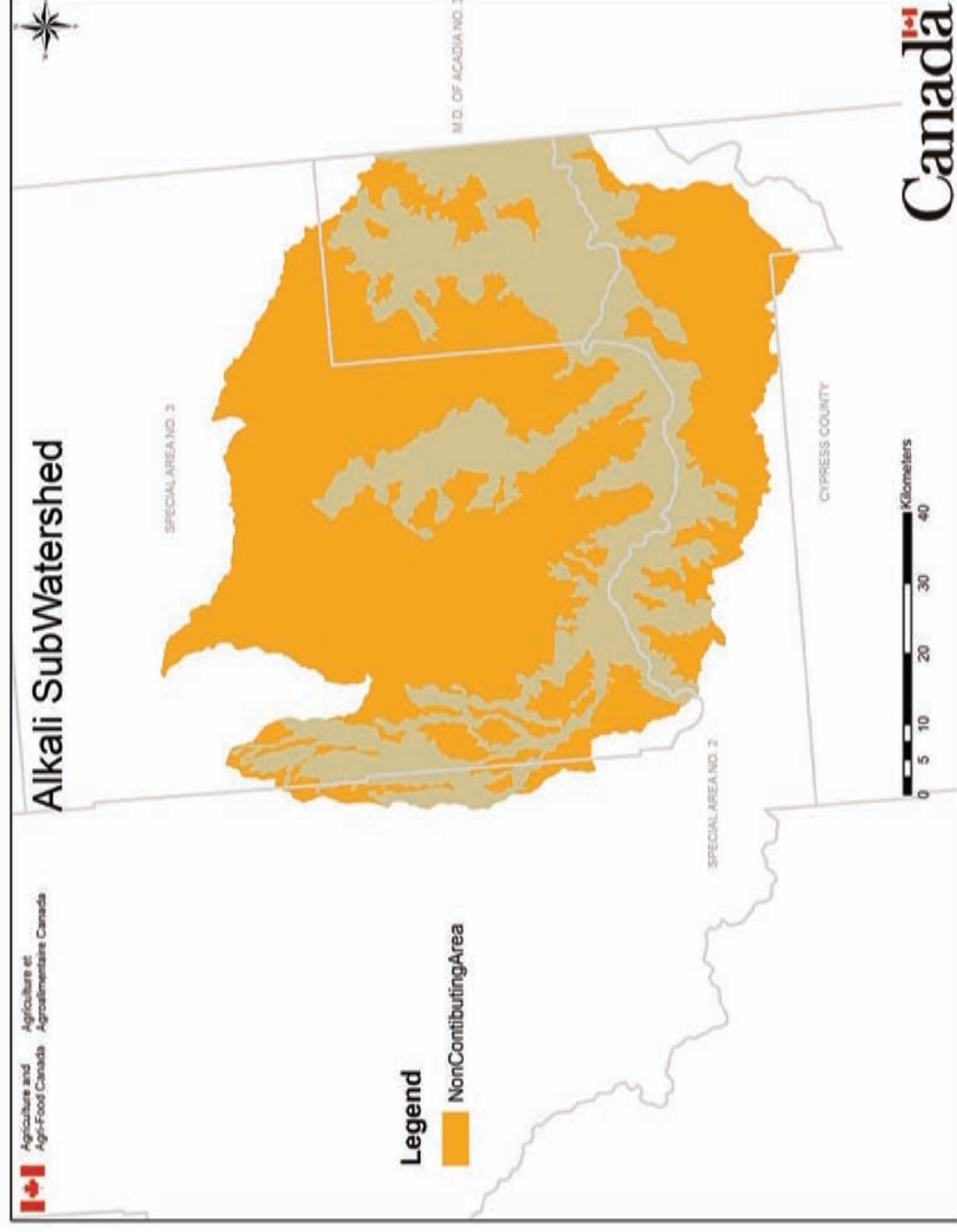


Figure 392. Non-contributing drainage area in the Alkali Creek subwatershed (AAFC-PFRA, 2008).

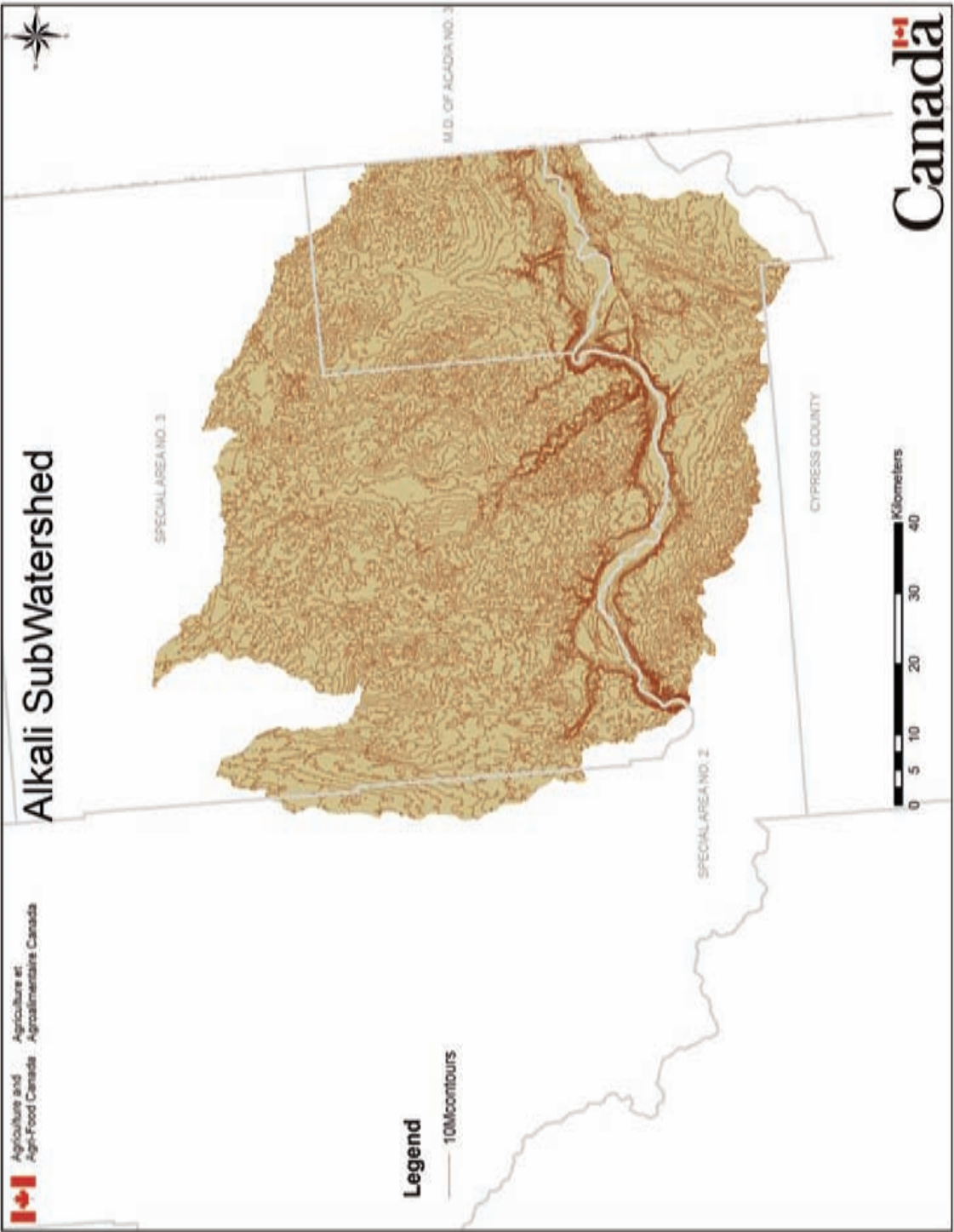


Figure 393. Topography (10-m contour intervals) of the Alkali Creek subwatershed (AAFC-PFRA, 2008).

4.15.4.4 Allocations

Surface and groundwater water withdrawal permits for the watershed are quantified by user sector along with information on licenses, consumption and return flows. This information will be used along with water flow data to identify areas of potential future constraints on surface water availability, which may have implications for future development.

In the Alkali Creek subwatershed, 1,723 surface water licenses and 367 groundwater licenses have been issued for water diversion projects (Figures 394, 395, respectively) (AAFC-PFRA, 2008). They are distributed throughout the entire subwatershed.

About 12 million m³ of surface and groundwater are diverted annually within in Alkali Creek subwatershed (Government of Alberta, 2008d). The most prominent use of surface water is for irrigation (40% of total surface water diversions) and dewatering processes (27% of total surface water diversions), while the most prominent user of groundwater are agricultural operations (70% of total groundwater diversions) (Table 160). The majority of water diverted in the entire subwatershed comes from surface water sources, e.g., lakes, streams and rivers (95%) (Government of Alberta, 2008d). Additional groundwater diversion information is provided in HCL (2000b, 2001b).

Table 160. Surface and groundwater diversions in the Alkali Creek subwatershed (Government of Alberta, 2008d). The highest uses for water have been highlighted. Data reported exclude any water diverted from the Red Deer River mainstem.

Purpose	Surface water (m ³ /yr)	Groundwater (m ³ /yr)
Agriculture	2,405,838	454,506
Commercial	18,500	---
Dewatering	3,083,710	---
Habitat enhancement	2,563,190	---
Industrial	740,090	---
Irrigation	4,600,605	---
Management of wildlife	9,251	---
Municipal	---	191,284
Recreation	61,670	---
Water management	467,480	---
Total	11,387,144	645,790
Grand total		12,032,934

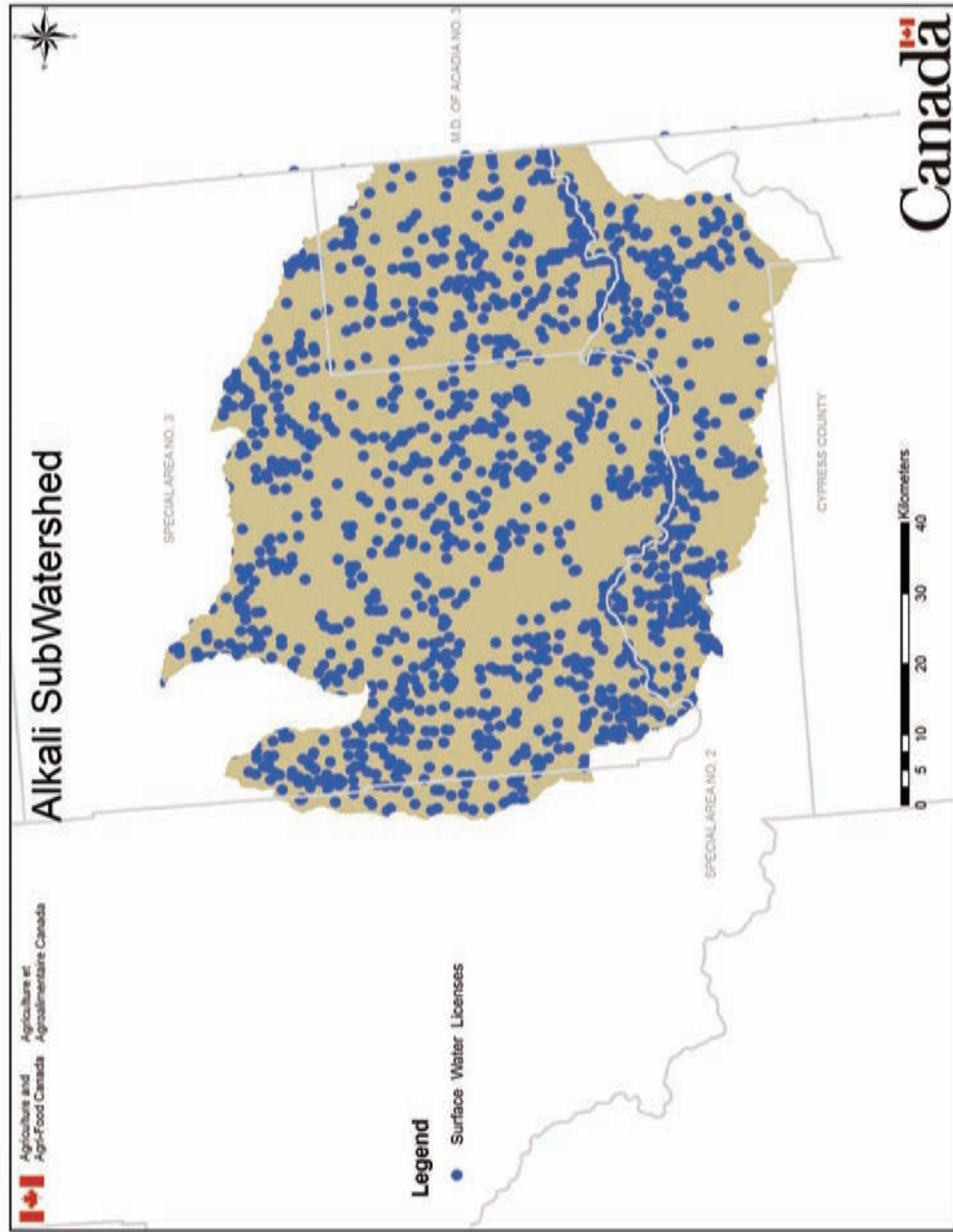


Figure 394. Surface water licenses in the Alkali Creek subwatershed (AAFC-PFRA, 2008).

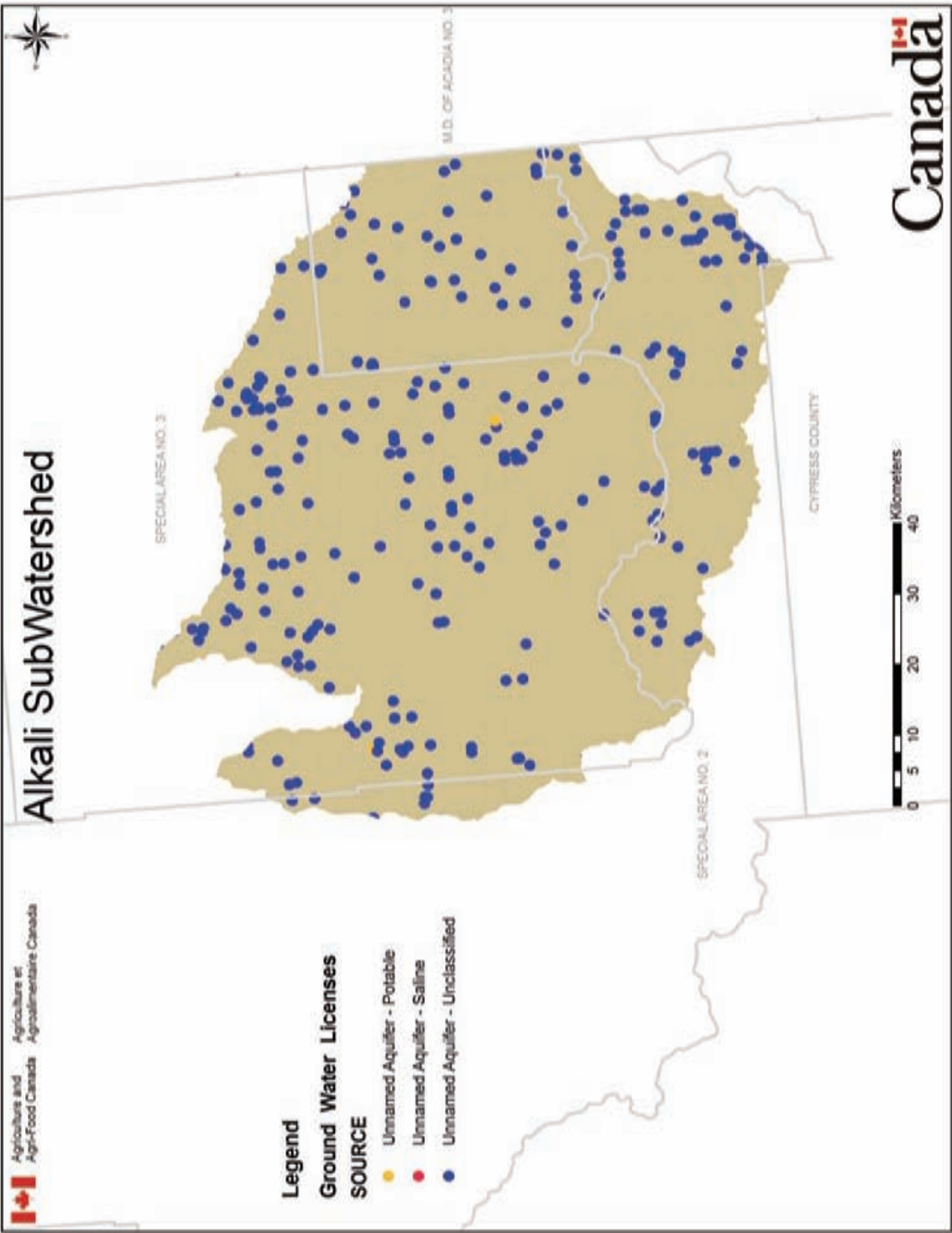


Figure 395. Groundwater licenses in the Alkali Creek subwatershed (AAFC-PFRA, 2008).

4.15.4.5 Groundwater Recharge/Discharge

Areas where groundwater gets recharged or discharges to the surface indicate areas where the groundwater table is close to the surface and the soils are generally more permeable. These areas are at greater risk of becoming negatively impacted from development or agricultural and/or industrial activities. Knowing where groundwater recharges and discharges occur will help to identify areas requiring special protection and limitations to land use.

Freshwater springs are points in the landscape where the aquifer surface meets the ground surface, i.e., freshwater springs are areas of groundwater discharge. The Alkali Creek subwatershed has about 35 freshwater springs, of which most are located in the headwaters of Alkali Creek (south and west of the Town of Oyen) and along the Red Deer River. Numerous springs appear not be associated with any permanent waterbodies (creeks, streams, lakes or sloughs), particularly in the northern area of the subwatershed.

The Alkali Creek subwatershed lies in Cypress County, the Municipal District of Acadia No. 34 and Special Areas 2 and 3. Groundwater assessments for these municipalities have been conducted by HCL (2000b, 2001b). The assessments indicated that most of the subwatershed is a groundwater recharge area (i.e., water moves from the surface into groundwater reservoirs). There are only a small number of isolated groundwater discharge areas near the Red Deer River (i.e., water moves from groundwater reservoirs to the surface). Specific areas of groundwater recharge include small depressions in the landscape and temporary and ephemeral wetlands, which collect rainwater and snow melt and release a proportion of this accumulated water into shallow groundwater and regional aquifers (van der Kamp and Hayashi, 1998; Hayashi et al., 2003). Additional information on aquifers, water quantity and quality of the groundwater associated with each aquifer, hydraulic relationship among aquifers and possible groundwater depletion areas associated with each upper bedrock aquifer is in HCL (2000b, 2001b).

4.15.5 *Biological Indicators*

Bioindicators are biological (plant and animal) data from which various aspects of ecosystem health can be determined or inferred. The presence, absence and abundance of such data can be linked to water quality, quantity and ultimately to overall watershed health. Four metrics were used as biological indicators in the Red Deer River watershed and its 15 subwatersheds:

- Wildlife Biodiversity
- Fish
- Land Cover – Condition Indicator
- Species at Risk

Changes in biological populations often reflect socioeconomic growth in a region. Human settlement and the subsequent exploration and extraction of natural resources alters the landscape and with it the habitat of the indigenous flora and fauna. It is important to balance socioeconomic growth with the preservation of natural habitat integrity to ensure the long-term health of natural biological populations.

4.15.5.1 Wildlife Biodiversity

Wildlife inventories to determine the biodiversity within the watershed will indicate changes in environmental conditions (e.g., habitat fragmentation, loss of nesting and breeding sites, nutrient enrichment, etc.). A loss of biodiversity can cause an ecosystem to become less stable and more vulnerable to environmental change. A change in diversity may also affect nutrient cycling and/or energy flow through the ecosystem.

Wildlife biodiversity assessment data have not been located for the Alkali Creek subwatershed.

4.15.5.2 Fish

Inventories of selected fish populations may show increases or declines through introductions or changes in environmental conditions. Indicator species sensitive to environmental pollution may show areas of concern through their absence, while others may show similar with their presence. Invasive species, if present, will indicate areas of concern requiring future monitoring.

Fish population data were not located for any waterbody in the Alkali Creek subwatershed.

4.15.5.3 Land Cover

Land cover is the type of vegetation, or lack thereof, covering the landscape. Inventory of vegetation populations may show increases or declines through introductions or changes in environmental conditions. Indicator species that are sensitive to environmental pollution may show areas of concern with their absence, while others may show areas of concern with their presence. Changes in land cover can indicate a change in land use and identify areas that need restoration, are at risk of erosion and/or areas with rare plant species that need protection. Land cover is a separate measurement from land use even though these two terms are sometimes used interchangeably.

The majority of the land base of the Alkali Creek subwatershed is covered by grassland (54%) and annual croplands (34%). Perennial croplands/pastures cover about 8% of the land base in the subwatershed. The remaining land cover types cover < 1.5% individually (Figure 396, Table 161) (AAFC-PFRA, 2008).

There are eight Ecologically Significant Areas in the Alkali Creek subwatershed: Alkali Creek Moraine, Empress Creek, Jenner Moraine, Lanfine White-tailed Deer Habitat, Brostem Reservoir Native Prairie, Major Lake Native Prairie, Remount and Sounding Creek Native Prairie (Table 162). There are no internationally designated Ecologically Significant Areas in the subwatershed (Alberta Environmental Protection, 1997).

Table 161. Land cover in the Alkali Creek subwatershed (AAFC-PFRA, 2008). The most prominent land cover types are highlighted.

Land cover type	Area (ha)	Proportion of subwatershed area (%)
Waterbodies	4,204	0.70
Exposed land	1,309	0.22
Developed land	2,174	0.36
Shrubland	931	0.15
Wetland	8,578	1.43
Grassland	324,437	53.95
Annual cropland	207,343	34.48
Perennial cropland/pastures	50,125	8.34
Coniferous forests	1,474	0.25
Deciduous forests	793	0.13
Total	601,368	

4.15.5.4 Species at Risk

Identifying species at risk and their habitats will help to determine sensitive areas and level of protection required. The *Species at Risk Act (SARA)* was introduced in June 2003 to provide legal protection of wildlife species and conservation of biological diversity. The Act aims to prevent Canadian indigenous species, subspecies and distinct populations from becoming extirpated or extinct, to provide for the recovery of endangered or threatened species and encourage the management of other species to prevent them from becoming at risk. Currently, there are 363 species listed as either endangered (169 species), threatened (110 species) or of special concern (84 species) (Species at Risk, 2008).

“Endangered species” are those species that face imminent extirpation or extinction, while “threatened species” are those that are likely to become an endangered species if nothing is done to reverse the factors leading to its extirpation or extinction. “Species of special concern” are those species that warrant special attention to ensure their conservation.

The Alkali Creek subwatershed is home to three endangered species (burrowing owl, *A. cunicularia*; piping plover, *C. melodus circumcinctus*; tiny cryptanthus, *C. minima*), two threatened species (loggerhead shrike, *L. ludovicianus excubitorides*; Sprague’s pipit, *A. spragueii*) and four species of special concern (great plains toad, *B. cognatus*; long-billed curlew, *N. americanus*; monarch butterfly, *D. plexippus*; yellow rail, *C. noveboracensis*). Detailed treaties of these species can be found in section 3.1.3.7.

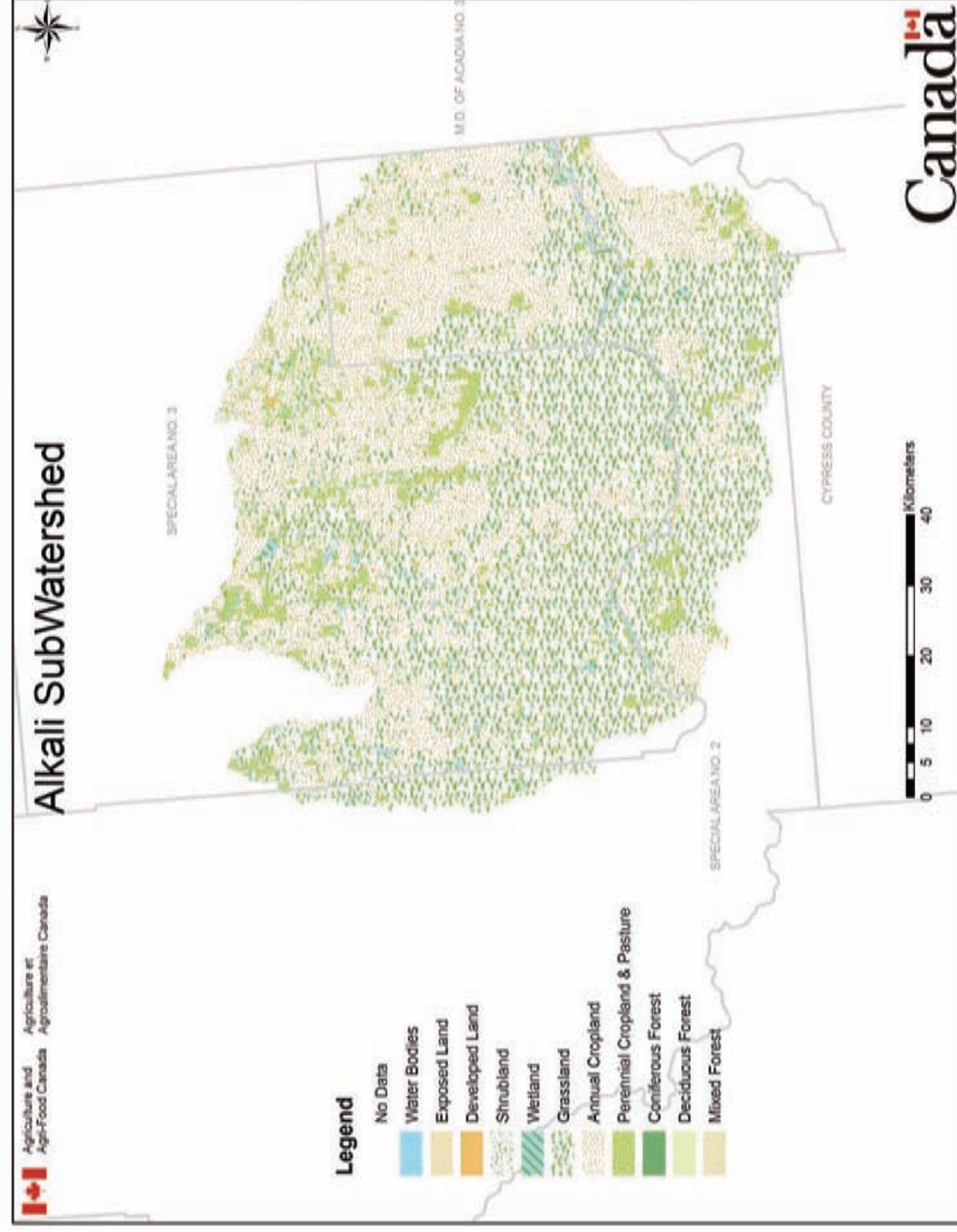


Figure 396. Land cover of the Alkali Creek subwatershed (AAFC-PFRA, 2008).

Table 162. Ecologically Significant Areas in the Alkali Creek subwatershed (Alberta Environmental Protection, 1997).

Ecologically Significant Area	Location	Area (ha)	Significance	Description
Alkali Creek Moraine and upland adjacent to Alkali Creek and north of the Red Deer River	Twp. 22-25, Rge. 3-5, W 4, Municipal District of Acadia No. 34 and Special Area 3	41,097	Provincially	Extensive block of native mixed grassland (rare in Alberta), low shrubbery and ephemeral wetlands on rolling hummocky moraine; important upland habitats for mule deer, pronghorn, sharp-tailed grouse, rare birds of prey, including ferruginous hawk, a COSEWIC vulnerable species, prairie falcon, and loggerhead shrikes, a COSEWIC endangered species; nesting habitat for sharp-tailed grouse; large ephemeral wetland, potentially productive for waterfowl and shorebirds in wetter years
Empress Creek	Twp. 21-23, Rge. 6-10, W 4, Municipal District of Acadia No. 34	874	Provincially	Shallow valley with gently sloping to steep sides, grasslands and permanent water; the lower portion of this unit may be one of the more productive leopard frog, a potentially threatened species in Alberta, breeding areas in Alberta; dense tall and low shrubbery; diverse breeding bird habitat; nesting area for rare birds of prey, including prairie falcons
Jenner Moraine	Twp. 21-23, Rge. 6-10, W 4, Special Area 2	164,297	Provincially	Extensive mixed grassland and ephemeral wetlands on hummocky moraine; provincially significant goose staging habitat; key pronghorn habitat in eastern section; nesting and feeding areas for prairie falcons (yellow A-listed species in Alberta), golden eagles, ferruginous hawks (a COSEWIC vulnerable species and a blue-listed species in Alberta) and burrowing owls (a COSEWIC endangered species and a red-listed species in Alberta)

Lanfine White-tailed Deer Habitat	Twp. 27, Rge. 6, W 4, Special Area 3	18,068	Provincially	Hummocky moraine area within dry mixed grassland that is relatively undisturbed; a number of small lakes, extensive, relatively intact blocks of native grassland (rare in Alberta); waterfowl staging and production site; significant nesting habitat for dabblers; evidence of loggerhead shrike breeding (a COSEWIC endangered species in Canada and a yellow A-listed species in Alberta); critical white-tailed deer habitat; some sharp-tailed grouse dancing grounds
Brostem Reservoir Native Prairie	Twp. 28, Rge. 8, W 4, Special Area 3	15,940	Provincially	Relatively undisturbed, extensive dry mixed grassland communities (rare in Alberta), a number of wetland types, including wet meadows, and alkali ponds; alkali ponds important shorebird staging habitat; loggerhead shrike nesting area (a COSEWIC endangered species in Canada and a yellow A-listed species in Alberta)
Major Lake Native Prairie	Twp. 25, Rge. 9, W 4, Special Area 3	67,600	Provincially	Relatively undisturbed, extensive mixed grassland communities (rare in Alberta), wet meadow, ephemeral ponds and alkali wetlands; supports a number of grassland species, including Baird's sparrow (a yellow A-listed species in Alberta) and upland sandpiper (a red listed species in Alberta); potential habitat for burrowing owls (a COSEWIC endangered species in Canada and a red listed species in Alberta); nesting habitat for long-billed curlew (a COSEWIC vulnerable and Alberta blue-listed species); two staging and production waterfowl lakes included within site

Remount	Twp. 22, Rge. 3, W 4, Special Area 2	27,776	Nationally	Extensive native mixed grassland habitats and ephemeral wetlands (rare in Canada); key pronghorn habitat; rare birds, including prairie falcon, golden eagle, ferruginous hawk (a COSEWIC vulnerable species), loggerhead shrike (a COSEWIC endangered species in Canada and a yellow A-listed species in Alberta) and burrowing owl (a COSEWIC endangered species in Canada); sand plain habitats for plains hognose snake (an Alberta blue-listed species)
Sounding Creek Native Prairie	Twp. 30, Rge. 5, W 4, Special Area 3	35,651	Provincially	Extensive block of dry mixed grassland (rare in Alberta) with associated terrestrial bird species, some shrub cover in poorly drained areas; key mule and white-tailed deer habitat; high potential for rare avian species, although none reported for area

4.15.6 Subwatershed Assessment

The Alkali Creek subwatershed is the easternmost extend of the Red Deer River watershed before the Red Deer River enters Saskatchewan and merges with the South Saskatchewan River. This subwatershed lies in the Dry Mixedgrass Subregion and is characterized by low livestock and agricultural intensities relative to the Alberta average. Its major urban centres include the Town of Oyen and the Villages of Empress and Cereal. Resource exploration and extraction activities have contributed to a complex network of linear developments (primarily roads) and the establishment of 4,797 wells (primarily natural gas wells). These land uses have affected the water quality in Blood Indian Creek, where TN concentrations frequently exceed CCME PAL guidelines and fecal coliform concentrations frequently exceed CCME Agriculture/Irrigation guidelines. Parasite and pesticide data were not located for any waterbody in the Alkali Creek subwatershed. The majority of the subwatershed is a groundwater recharge area and does not contribute to the drainage within the subwatershed. Consequently, water discharge rates in Alkali Creek are virtually absent and only occur after heavy precipitation events. A total of 2,090 water diversion licenses have been issued, which permit the diversion of 12.03 million m³ of water annually. Most of this water is used for irrigation and dewatering activities. No biodiversity or fish community data were located for this grassland and annual cropland-dominated subwatershed, although it contains eight ecologically significant areas and is home to three endangered species, two threatened species and four species of special concern.

An Indicator Workshop held in March 2008 identified a total of 20 indicators to be used to assess the overall health of the Red Deer River watershed and its 15 subwatersheds. These indicators included land use, water quality, water quantity and biological indicators. In November 2008, a subset of these indicators was selected to indicate the overall condition of, or risk to, the individual subwatersheds. There were nine “condition indicators” and three “risk indicators”. The condition indicators were ranked “good”, “fair” or “poor” based on existing guidelines, while risk indicators were ranked “low”, “medium” or “high” relative to the other subwatersheds. The overall subwatershed ranking is based on an “A”-“B”-“C” ranking system with “+” and “-” subrankings. The overall ranking system is based on a subjective evaluation of the combined rankings of the condition and risk indicators.

Based on the available data, the Alkali Creek subwatershed receives a rating of “good” for the condition indicators and a rating of “low” for the risk indicators (Tables 163, 164). Overall, this subwatershed receives a ranking of “A-”. There are substantial data gaps, and several of the condition rankings are based on limited data. Consequently, it is recommended to implement a detailed water quality sampling program, conduct a wetland inventory and regularly monitor riparian health conditions along the major waterbodies in the subwatershed. The only concern in this subwatershed is the loss of wetlands, which likely occurred as a result of agricultural land conversions, drainage, infilling and the disruption of their hydrology following linear developments. It is recommended to conduct a wetland inventory.

Table 163. Condition and risk indicator summary for the Alkali Creek subwatershed. Gray logos indicate data gaps.**Condition Indicators****Risk Indicators****Table 164.** Condition and risk assessments of the Alkali Creek subwatershed.

Indicators		Rating
Condition	Wetland loss	POOR
	Riparian health	---
	Linear developments	GOOD
	Nutrients	
	Total phosphorus	GOOD
	Total nitrogen	GOOD
	Bacteria	GOOD
	Parasites	---
	Pesticides	---
	Minimum flows to maintain ecological integrity	---
	Land cover	GOOD
Overall		GOOD
Risk	Livestock manure production	LOW
	Urban, rural, agricultural and recreational developments	LOW
	Oil/gas wells	MEDIUM
Overall		LOW