



NUCLEAR WASTE SOCIÉTÉ DE GESTION
MANAGEMENT DES DÉCHETS
ORGANIZATION NUCLÉAIRES

Phase 1 Desktop Assessment Environment Report

TOWN OF CREIGHTON, SASKATCHEWAN



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PHASE 1 DESKTOP ASSESSMENT

Environment Report Town of Creighton, Saskatchewan

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REPORT



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1.0 INTRODUCTION

The Town of Creighton in Saskatchewan is considering hosting a facility to manage Canada's Used Nuclear Fuel through the Nuclear Waste Management Organization's (NWMO) Adaptive Phased Management Site Selection Process (NWMO, 2010). This process is seeking to find a site for a deep geological repository that will provide safe long-term containment and isolation with an informed and willing host community. The process is presently at an early stage.

Part of the process is focussed on determining if there are environmental features that would preclude the potential for a facility to be constructed in the vicinity of Creighton. To this end, this report provides a general description of the environment in the Town of Creighton and surrounding area. It is complemented by reports prepared in parallel which characterize the geoscientific conditions and community well-being profile of the area. These reports are summarized, with other information, in an integrated Preliminary Assessment Report.

This report is not an environmental assessment. Its purpose is to provide a high level description of the current human and natural environment based on readily available sources of data. Additional detailed information for specific locations will be sought at subsequent phases of the work.

The area considered here is similar to that used for the Phase I Geoscientific Assessment for Creighton. This area is shown on Figure 1, and includes the Town of Creighton, as well as areas to the north, west and south of the Town, and east to the Manitoba border.



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2.0 COMMUNITIES AND INFRASTRUCTURE

2.1 Communities

The Town of Creighton is approximately 16 km² in size (GeoSask, 2012) and is located on the east-central edge of Saskatchewan adjacent to the Manitoba border, a few kilometres from Flin Flon, Manitoba (Figure 1). The village of Denare Beach is located on the northeast shore of Amisk Lake, which is 18 km southwest of the settlement area of Creighton along Highway 167. The nearest large center is the City of Prince Albert, about 400 km to the southwest via Highway 106 (the Hanson Lake Road) and Highway 55. Figure 2 presents satellite imagery for the area taken in 2006. Table 1 summarizes the total population and population density for the Town of Creighton, Division No. 18, CDR¹ and the City of Flin Flon.

Table 1: Population Statistics for Creighton Area

Political Boundary	Population	Population Density per km ²
Town of Creighton	1,498	104.1
Division No. 18, CDR	36,557	0.1
City of Flin Flon	5,363	386.4

Source: 2011 Census of Population (Statistics Canada, 2012)

Land ownership within the Creighton area, including areas of Crown land managed by the Saskatchewan Ministry of the Environment, Crown Reserve² areas, parks and recreation areas and private lands, is shown on Figure 3. Areas where ownership is not currently classified are also identified.

There are a number of Aboriginal communities and organizations in the Creighton area including Cumberland House Cree Nation (Treaty 5) and Peter Ballantyne Cree Nation (Treaty 6). Métis Locals in the area include: Creighton #89, Cumberland House #42 and Sandy Bay #90; all are located within Métis Nation-Saskatchewan Eastern Region 1.

Further information on Creighton and its surrounding communities, including First Nations and Métis communities, is provided in the Community Profile Report for Creighton.

2.2 Infrastructure

Figure 1 shows the location of the primary infrastructure corridors in the Creighton area. The main transportation routes include Highway 167 which heads northeast from Denare Beach to the Town of Creighton and into Manitoba. As well, Highway 106 runs northwest from the Town of Creighton (Figure 1). There is a rail line north of Creighton connecting to the rail network in Flin Flon and one airport near the east border of the Creighton area, immediately south of Flin Flon, Manitoba. A transmission line corridor is located approximately 2 km south of Highway 167 between Denare Beach and Creighton, which continues north of Creighton. There are several branches that interconnect with the Manitoba transmission grid. No gas pipelines were identified within the Creighton area. There are three operating landfills within the Creighton area and a wastewater treatment plant.

¹ CDR is defined as census division / division de recensement and is a geographic unit created as equivalent to a census division by Statistics Canada, in cooperation with applicable provinces, for the purpose of disseminating statistical data.

² Crown Reserves are Crown lands that have been withdrawn from disposition under Section 21 of the Crown Minerals Act. Note that in Saskatchewan, Crown Reserve lands could also include freehold lands because the person who owns the land/mineral rights may only own those rights for a particular mineral. Therefore the Crown would own the rights for the other minerals that would be found on that land.



2.3 Protected Areas

2.3.1 Parks and Reserves

There is one park in the Creighton area, the Amisk Lake Recreational Site. It is located approximately 11 km southwest of the settlement area of Creighton along Highway 167 on the northeast shore of Amisk Lake and covers an area of about 350 ha (hectares). Figure 4 shows the location of this recreational area.

2.3.2 Heritage Sites

The database for heritage resources maintained by the Saskatchewan Ministry of Tourism, Parks, Culture and Sport (TPCS, 2012) as well as the National Historic Sites Database (Parks Canada, 2012) were consulted to identify previously recorded heritage sites found within the Creighton area. Heritage resources include all of Saskatchewan's historic and pre-contact archaeological sites, architecturally significant structures and paleontological resources. Heritage resources are property of the Provincial Crown, and as such, are protected under *The Heritage Property Act* (Government of Saskatchewan, 1980).

The results of the database search indicate that 18 archaeological sites have been recorded within the Creighton area. Fourteen sites are pre-contact Aboriginal artifact find and scatter sites; two sites are artifact/feature combination sites – one historic, the other unidentified; and two heritage resources have insufficient information to be given a site type designation.

According to the site database, known heritage resources were recorded between 1960 and 2004 as part of various research and impact assessment projects. Five sites were recorded during Heritage Resources Impact Assessments for proposed mining projects, forestry programs and for a proposed transmission line right-of-way (Millennium, 1988; Stantec, 2000). Nearly all the previously recorded sites in the Creighton area are located in close proximity to lakes and watercourses.

Amisk Lake, including its associated lakes and watercourses, was a significant water body during both the pre-contact and historic period. Diagnostic artifacts from the Creighton area include one Taltheilei projectile point base. The Taltheilei tradition dates from approximately 2,600 years ago to the Historic Period (Gordon, 1996). The material remains from this tradition are believed to represent the direct ancestors of the Dené people found in Northern Saskatchewan (Meyer, 1999).

During the late 1770s, explorers including Peter Pond, David Thompson and Peter Fidler crossed Amisk Lake while on-route to the Churchill River (Russell and Meyer, 1999). This was soon followed by the establishment of trading posts by the Hudson's Bay Company along Amisk Lake beginning in 1802 and continuing through to the 1900s (Russell and Meyer, 1999). Although fur trade posts in the area were documented historically, their exact locations are not known.

Archaeological potential is established by determining the likelihood that archaeological resources may be present on a subject property. In archaeological potential modelling, a distance criterion of 300 m is generally employed for known archaeological resources, water sources and early Euro-Canadian settlements. The presence of local heritage sites would need to be further confirmed in discussion with the community and Aboriginal peoples in the area.



2.4 Land Use

Land use described in this section refers to commercial land use such as forestry, mining, trapping and agriculture, but not recreation or Aboriginal spiritual use.

The Town of Creighton lies in the west-central limit of the Mee-Toos Forest Term Supply Licence (TSL) area (Government of Saskatchewan, 2007). The Mee-Toos Forest TSL is managed by Peter Ballantyne Cree Nation, with a gross area of 1,672,211 ha. The Mee-Toos Forest TSL operates within the Creighton area shown on Figure 5.

Within heavily forested areas there is a risk of forest fires. Locations where forest fires occurred in the Creighton area between 1976 and 2010 affecting an area of greater than 200 ha are shown on Figure 5. As shown on the figure, there has been only one such occurrence in the northernmost portion of the Creighton area.

Mining in the Creighton area has historically focussed on metals within the Flin Flon greenstone belt³ and the contact halos with surrounding batholiths⁴. There is one producing mine and 12 past producing properties within the Creighton area. Of these, the active Callinan mine is producing copper with minor amounts of gold, silver, zinc and lead (Figure 6). Of the past producing properties, six produced copper and six produced gold (Saskatchewan Energy and Resources, 2011). Minor amounts of gold have been historically produced from the Creighton area, and gold has been produced in association with the base metals at the Flin Flon and Callinan mines (Saskatchewan Energy and Resources, 2011). The economic viability of such other gold occurrences is currently being explored in the Creighton area.

Small sand and gravel deposits have been developed south of Denare Beach, and along the road between Denare Beach and Creighton. There are no building stone quarries within the Creighton area, although there is some future potential.

As noted in Section 3.3, other land uses include trapping and the harvesting of wild rice.

A portion of the Crown Reserves land shown on Figure 3 is part of Canadian Forces Base (CFB) Flin Flon, and includes a seismic monitoring station.

³ A greenstone belt is a zone of volcanic and sedimentary rocks that have undergone metamorphic alteration. The name comes from the green hue imparted by the colour of the dominant minerals within the rocks.

⁴ Batholiths are made of multiple masses, or plutons, of igneous rock that have melted and intruded surrounding strata at great depths.



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3.0 DESCRIPTION OF THE ENVIRONMENT

3.1 Physiography

The Town of Creighton is located in the Canadian Shield physiographic region, a low-relief, dome-like, gently undulating land surface. The land surface elevation within the Creighton area ranges from about 369 masl (metres above sea level) in the northwest on a hill that rises off the south shore of Ahrens Lake, decreasing to about 292 masl towards the southeast at the shore of Schist Lake. The physiography is dominated by bedrock and glaciolacustrine deposits (Schreiner, 1986; Simpson, 1997). The terrain in bedrock areas north of Amisk Lake, the largest lake in the area, is relatively rugged and is interspersed with lakes and streams. In contrast, in the glaciolacustrine areas that are common east of Amisk Lake, the topography becomes relatively smoother with numerous lakes and peatlands. Peatlands are most prevalent southeast of the Town of Creighton.

Figure 7 presents the topography of the Creighton area as a digital elevation model (DEM).

3.2 Geology

3.2.1 Bedrock Geology

The bedrock geology of the Creighton area is shown on Figure 6. The Creighton area is located in the Glennie-Flin Flon domain, part of the southeast portion of the Reindeer zone of the Canadian Shield, in northern Saskatchewan (SGS, 2003). The area is just north of the contact with the Western Canada Sedimentary Basin, which covers the southern part of the province. The majority of the Town of Creighton itself is underlain by metavolcanic rocks of the Flin Flon greenstone belt. These greenstone rocks extend to the north, east, southeast and southwest of the Town. To the west, southwest and south of the Town, the Flin Flon Arc Assemblage is intruded by the Annabel Lake pluton (west), Reynard Lake pluton (southwest) and Phantom-Boot Lake pluton (south). A small portion (less than 0.5 km²) of the Annabel pluton lies within the Town boundary. The greenstone rocks and plutonic rocks comprise the majority of the bedrock within the Creighton area. Less common rock units also found in the Creighton area include the metasedimentary rocks of the Missi Group, which are found to the north and east of the Town.

3.2.2 Quaternary Geology

The Quaternary⁵ geology of the Creighton area is shown on Figure 8. Quaternary sediments in the Creighton area are composed of glaciolacustrine deposits, till and organic plains; however, more than half of the Creighton area is underlain by a southwest-northeast strip of bedrock outcrop. Where glacial deposits cover the bedrock, the sediments are generally thin (vaneer like) to less than 10 m thick (Davis and Tammemagi, 1982; Hajnal et al., 1983; Schreiner, 1984; Henderson and Campbell, 1992; Saskatchewan Energy and Resources, 2010); although drillhole records from the Saskatchewan Energy and Resources Atlas of Saskatchewan (2010) indicate that the Quaternary deposits can be approximately 70 m thick in discrete areas between Douglas and Phantom lakes, and around Amisk Lake.

⁵ Quaternary refers to the last 2.6 million years of Earth's history.



3.3 Natural Environment

3.3.1 Natural Environment Overview

The Creighton area is located in east-central Saskatchewan and within the boreal forest. It is an important area for First Nations communities including important features such as Amisk Lake, where Amisk is the Cree word for beaver. The Amiskosakihikan Indian Reserve is adjacent to this lake where native people use both terrestrial and aquatic features as valuable parts of their cultural practices. A wild rice processing plant is also located at Denare Beach, which provides economic benefit to the local community (Town of Creighton, 2012). The Town of Creighton and surrounding area is also a popular tourist destination for recreational fishing, hunting and canoeing. The Northern Fur Conservation Block, which covers most of Northern Saskatchewan, is divided into 89 Fur Conservation Areas (FCAs). These are units for trapline management with a restricted number of trappers per FCA. The Creighton area is in FCA N-66⁶ (Figure 3). The following sections describe the protected natural areas, terrestrial and aquatic ecology and rare species that may be most sensitive to alterations or changes to the landscape.

3.3.2 Natural Areas

As noted in Section 2.3.1, the Creighton area includes the Amisk Lake Recreation Site (Figure 1). According to the Saskatchewan Representative Areas Network, there are no game preserves, migratory bird sanctuaries, national parks, national wildlife areas, provincial parks, special management areas or wildlife refuges identified within the Creighton area (Saskatchewan Ministry of the Environment, 2005; GeoSask, 2012). No Official Plan mapping of sensitive or managed areas for the Town of Creighton was available in public databases.

According to mapping from GeoSask, the Creighton area contains 11,970 ha of wetlands, which represent approximately 18% of the area (GeoSask, 2012) (Figure 9). Ground investigations may identify additional wetland areas that are not part of the GeoSask data. If wetlands may be affected, they may require evaluation according to the Saskatchewan Wetland Policy.

3.3.3 Terrestrial Features and Wildlife

The Creighton area falls within the Saskatchewan Wildlife Management Units 70 and 71 (Figure 9). The Creighton area covers two different landscape areas, the Flin Flon Plain of the Churchill River Upland Eco-region and the Namew Lake Upland of the Mid-Boreal Lowland Eco-region. According to mapping from GeoSask, the Creighton area contains 35,423 ha of woodland, which represents approximately 54% of the land surface (GeoSask, 2012). The Flin Flon Plain is dominated by a mixed-wood forest vegetation community and covers the majority of the Creighton area. Black spruce (*Picea mariana*) is the most abundant canopy species. White spruce (*Picea glauca*) and trembling aspen (*Populus tremuloides*) account for another main component present in the mixed-wood forests surrounding Creighton. Jack pine (*Pinus banksiana*) is able to thrive on sandy deposits and can become the dominant canopy species under the right conditions. The understory and ground cover vegetation vary depending on availability of sunlight, aspect, slope, position and soil moisture conditions, but common species found are Labrador tea (*Ledum groenlandicum*), small cranberry (*Vaccinium oxycoccos*), lichens (*Cladina spp.*) and feather mosses. The Namew Lake Upland is characterized by the prevailing flat, poorly-drained peatlands. These areas support a vegetation community of black spruce and tamarack (*Larix laricina*), which thrive in water-saturated growing conditions. Variability in eco-site conditions gives rise to a rich

⁶ The full extent of FCA N-66 extends beyond the boundaries of the Creighton area shown on Figure 3.



community of mixed-wood trees. The graminoid, forb and non-vascular plant cover can range from a monoculture of a few species to a rich and diverse community. This includes species ranging from feather mosses, sphagnum moss (*Sphagnum*), lichens, herbs such as bunchberry (*Cornus canadensis*), starflower (*Trientalis borealis*) and two-leaved Solomon's seal (*Maianthemum canadense*). Common shrubs include bearberry (*Arctostaphylos uva-ursi*), dwarf birch (*Betula pumila var. glandulifera*), low bush-cranberry (*Viburnum edule*), prickly rose (*Rosa acicularis*) and velvet-leaf blueberry (*Vaccinium myrtilloides*).

The high diversity of plant life and the varied terrain creates an extensive habitat for both mammal and bird species. There are an estimated 41 mammal species (Acton et al., 1998) recorded in the Creighton area. Moose (*Alces alces*), black bear (*Ursus americanus*), and other mammals such as the muskrat (*Ondatra zibethicus*), beaver (*Castor canadensis*), river otter (*Lontra canadensis*), snowshoe hare (*Lepus americanus*) and gray wolf (*Canis lupus*) are common within the Creighton area. No known migration routes or animal movement corridors have been identified based on existing publicly available information. Migration routes or animal movement corridors are typically described based on field investigations.

Woodland caribou (*Rangifer tarandus*), a federally protected species, are found in moderate numbers within the Creighton area, typically in muskeg and semi-open bog habitat. The Harris' checkerspot (*Chlosyne harrisii*), a provincially rare invertebrate, was also recorded within the Creighton area.

Bird diversity is considered to be moderate within the Churchill River Upland Eco-region; however, the Churchill River system contains the second highest concentration of nesting bald eagles (*Haliaeetus leucocephalus*) in North America, surpassed only by Alaska (Acton et al., 1998). Some year round resident birds include: great horned owl (*Bubo virginianus*), common raven (*Corvus corax*), ruffed grouse (*Bonasa umbellus*), great gray owl (*Strix nebulosa*), black-capped chickadee (*Poecile atricapillus*) and red-breasted nuthatch (*Sitta canadensis*).

Bird diversity in the Mid-Boreal Lowland Eco-region is considered to be high and provides important habitat for many waterfowl species (Acton et al., 1998). Common bird sightings include loon (*Gavia immer*), wood duck (*Aix sponsa*), Nashville warbler (*Oreothlypis ruficapilla*) and blue-winged teal (*Anas discors*). The barred owl (*Strix varia*), the whip-poor-will (*Antrostomus vociferous*) and the black-throated blue warbler (*Setophaga caerulescens*) have been observed in this area. These species are not provincially or federally listed as endangered (END), threatened (THR) or special concern (SC), but are considered rare in the Creighton area. Amphibians and reptiles common to both the Churchill River Upland and Mid-Boreal Lowlands include Canadian toad (*Bufo hemiophrys*), wood frog (*Rana sylvatica*), red-sided garter snake (*Thamnophis sirtalis*), boreal chorus frog (*Pseudacris maculata*) and northern leopard frog (*Rana pipiens*).

3.3.4 Aquatic Features and Fish

The Creighton area encompasses numerous named and unnamed waterbodies and watercourses of varying size (Figure 9). According to mapping from GeoSask, the Creighton area contains 10,666 ha of aquatic areas, which is approximately 16% of the land surface (GeoSask, 2012). Generally, waterbodies north of Highway 106 (e.g., Tryrell Lake, Mari Lake and Little Mari Lake) flow north into the Churchill River System and waterbodies south of Highway 106 (e.g., Amisk Lake) flow south into the Saskatchewan River system. Lake sturgeon (*Acipenser fulvescens*) is known to occur in both the Churchill River system and the Saskatchewan River system. Lake sturgeon are listed as endangered by the Committee on the Status of Endangered Wildlife in Canada (COSEWIC, 2010).



Existing fisheries information for lakes within the Creighton area was obtained from two primary information sources. The first, "Fish Species Distribution in Saskatchewan", is a document that was prepared by Saskatchewan Environment and Resource Management in 1991 (Liaw, 1991). This report represents a compilation of fish species information for various lakes, rivers and streams in Saskatchewan. The second information source was the "Saskfishinglakes.ca" (2011) website that summarizes much of the same information but is supplemented with fish stocking information and more recent surveys completed by provincial agencies.

Fish species information was available for 12 lakes in the Creighton area, which indicated a total of 23 fish species have been documented in the area. These fish species consist of walleye (*Sander vitreus*), yellow perch (*Perca flavescens*), northern pike (*Esox lucius*), white sucker (*Catostomus commersonii*), fathead minnow (*Pimephales promelas*), lake trout (*Salvelinus namaycush*), cisco (*Coregonus artedii*), burbot (*Lota lota*), longnose sucker (*Catostomus catostomus*), lake chub (*Couesius plumbeus*), log perch (*Percina caprodes*), trout-perch (*Percopsis omiscomaycus*), ninespine stickleback (*Pungitius pungitius*), brook stickleback (*Culaea inconstans*), emerald shiner (*Notropis atherinoides*), spottail shiner (*Notropis hudsonius*), blacknose shiner (*Notropis heterolepis*), Iowa darter (*Etheostoma exile*), Johnny darter (*Etheostoma nigrum*) and slimy sculpin (*Cottus cognatus*). In addition, brook trout (*Salvelinus fontinalis*), rainbow trout (*Oncorhynchus mykiss*) and smallmouth bass (*Micropterus dolomieu*) have been stocked in the area.

3.3.5 Endangered, Threatened and Special Concern Species

The Saskatchewan Conservation Data Centre (SKCDC) maintains mapping of rare species found within the province (Figure 9). Queries were also made of the Encyclopedia of Saskatchewan (EOS, 2012). All species which are classified as endangered (END), threatened (THR) or special concern (SC) under either the provincial *Wildlife Act*, 1998 (Statutes of Saskatchewan, 1998) or the federal *Species at Risk Act* (SARA) (Government of Canada, 2012) have been listed in Table 2. These species have a home range that may extend into the Creighton area, but there may not be actual observations within the area and critical habitat for these species may not be present.

Based on a search of the Saskatchewan Conservation Data Centre (SKCDC) database (SKCDC, 2012), no federally listed plant species are currently identified as occurring within the Creighton area. Provincially tracked plant species known to occur within the Creighton area include: hairy panic-grass (*Dichanthelium acuminatum* var. *fasciculatum*), marsh St. John's-wort (*Triadenum fraseri*), spear-leaved arnica (*Arnica lonchophylla* ssp. *lonchophylla*), wild chives (*Allium schoenoprasum* var. *sibiricum*), bird's-eye primrose (*Primula mistassinica*), Canada manna-grass (*Glyceria canadensis*), fox sedge (*Carex vulpinoidea*), smooth sumac (*Rhus glabra*), ribbon-leaf pondweed (*Potamogeton epihydrus*), great-spurred violet (*Viola selkirkii*), Leiberg's witchgrass (*Dichanthelium leibergii*), purple reed-grass (*Calamagrostis purpurascens*), western prince's-pine (*Chimaphila umbellata* ssp. *occidentalis*), hidden sedge (*Carex abdita*), and the hybrid (sterile triploid) (*Woodsia x abbeae*). Areas where these plants occur are indicated using green hatching on Figure 9.

Woodland caribou is a threatened species that has known habitat within the Creighton area (Figure 9), although it is likely that this species may exist beyond the habitat boundary depicted where contiguous boreal forest exists. In addition to species that are listed on the *Wildlife Act* and SARA, species of conservation concern including those that are considered regionally rare, uncommon or in significant decline would also be considered in the evaluation of wildlife of the area. Many of these species are not tracked in public databases, and therefore a complete list would be obtained as part of the data requests to agencies which would complement the results of field investigations conducted at the site.



With reference to Table 2, there were no species of plants, mosses or lichens were identified as END, THR or SC within the Creighton area.

Table 2: Potential Endangered, Threatened and Special Concern Species in the Creighton Area

Common Name	Scientific Name	SKCDC Rank	Wildlife Act Status ^a	SARA Status (Schedule) ^b	Source ^c
Mammals					
Wolverine	<i>Gulo gulo</i>	S3S4		SC	SKCDC, COSEWIC
Woodland caribou	<i>Rangifer tarandus</i>	S3		THR (1)	SKCDC
Birds					
Canada warbler	<i>Cardellinacanadensis</i>	S5B		THR (1)	SKBA
Common nighthawk	<i>Chordeiles minor</i>	S4S5B, S4S5M		THR (1)	SKBA, SKCDC
Olive-sided flycatcher	<i>Contopus cooperi</i>	S4		THR (1)	SKBA
Peregrine falcon	<i>Falco peregrinus</i>	S1B, S4M, S2N	SC	THR (1)	SKBA
Piping plover	<i>Charadrius melodus circumcinctus</i>	S3B	END	END (1)	SKBA
Rusty blackbird	<i>Euphagus carolinus</i>	S4B		SC (1)	SKBA
Short-eared owl	<i>Asio flammeus</i>	S3B, S2N		SC (3)	SKCDC
Whooping crane	<i>Grus americana</i>	SXB, S1M	END	END (1)	SKCDC
Reptiles and Amphibians					
Northern leopard frog	<i>Rana pipiens</i>	S3		SC (1)	SKCDC, EOS
Fish and other Aquatic Species					
Lake sturgeon	<i>Acipenser fulvescens</i>	S2B		END	COSEWIC
Invertebrates					
Monarch butterfly	<i>Danus plexippus</i>	S3B		SC	SKCDC

Notes:

S1:Extremely rare; S2: Rare; S3: Rare – uncommon; S4: Common; S5: Very common; A: accidental or casual in the province; B: breeding population in province for a migratory species; N: non-breeding population in province for a migratory species; M: transient population in province for a migratory species; H: historical occurrence without verification in last 20 years; U: status uncertain in province due to limited information; X: believed to be extinct or extirpated; NR *blank*: species not assessed; Not At Risk: species assessed to be not at risk; SC: special concern species; THR: threatened species; END: endangered species

^a Provincial Wild Species at Risk listed under *The Wildlife Act* (Statutes of Saskatchewan 1998).

^b Status listed on the federal *Species at Risk Act*; endangered (END), threatened (THR), special concern (SC) (Government of Canada, 2012).

^c Data obtained from the Saskatchewan Conservation Data Centre (SKCDC, 2012), The Encyclopaedia of Saskatchewan (EOS, 2012) or Saskatchewan Bird Atlas (SKBA) (Saskatchewan Ministry of Environment, 2012).



3.3.6 Aboriginal Interests and Traditional Knowledge

Traditional lifestyles, culturally significant wildlife and the extent of sacred and ceremonial locations important to Aboriginal communities are important factors to be considered when identifying potential repository locations for further detailed study.

For this phase of the work, the extent to which such information has been sought is that which can be found in publicly available sources. Known archaeological sites, many of which are Aboriginal, are noted in Section 2.3.2. The Creighton Area lies predominantly within Fur Conservation Area N-66, as shown on Figure 3. Figure 9 presents terrestrial ecology mapping for the area and Figure 10 presents aquatic resource mapping.

It is recognized that this does not fully represent the environmental issues and concerns of Aboriginal communities in the area and that further information and discussion is required before a more complete picture can be developed. Discussions with Aboriginal groups, community members and field investigations would be undertaken in later phases of the work program to further enhance the environmental understanding of specific locations.

3.4 Background Environmental Conditions

3.4.1 Air Quality

Air quality monitors across the Prairies indicate that regional ground-level ozone and particulate matter fall within normal values compared to the national average (EC, 2011a). Environment Canada’s National Pollutant Release Inventory (NPRI) database (EC, 2012) does not report any industrial facilities with reported air or water emissions within the same postal code as the Creighton area. Table 3 provides a list of industrial facilities that reported air and water emissions through the NPRI database based on searches for both Division No. 18 and for Flin Flon, Manitoba. The list includes nine sites in communities within Division No. 18 and one in Flin Flon, which have local air emissions. The Hudson Bay Mining and Smelting Co. (HBMS) which is now known as Hudbay, used to operate a smelter in adjacent Flin Flon, which was responsible for the airborne release of heavy metals such as arsenic and cadmium; however, it ceased operations on June 11, 2010.

Additional sources that may affect background air quality include Highways 167 and 106, both of which traverse the area, and use of diesel generators in the First Nations communities that are part of the Peter Ballantyne Cree Nation (AANDC, 2012).

Table 3: NPRI Regional Sources of Air Emissions

NPRI ID	Facility Name	City
23186	Richardson Pioneer Ltd. - Marshall	Marshall East
6691	TransGas Limited - Beacon Hill	Pierceland
24207	Cargill Limited - Cargill AgHorizons, Birch Hills, SK	Birch Hills
5381	Eacom Timber Corp. - Big River Sawmill	Big River
23785	TransGas Limited - St. Louis	St. Louis
6510	Vermette Wood Preservers - Vermette Wood Preservers Limited Spruce Home	Spruce Home
3348	AREVA Resources Canada Inc. - Cluff Lake Project	Division No. 18
4866	AREVA Resources Canada Inc. - McClean Lake Operations	Division No. 18
1147	CAMECO - Rabbit Lake Operation	Division No. 18
1148	CAMECO - Key Lake Operation	Division No. 18



NPRI ID	Facility Name	City
1149	CAMECO - McArthur River	Division No. 18
19397	CAMECO - Cigar Lake Operation	Division No. 18
23273	Claude Resources Inc. - Seabee	Saskatoon
17302	NuVista Energy Ltd. - Primrose Comp Station 07-30	N/A
23618	NuVista Energy Ltd. - Primrose Comp Station 05-26	N/A

3.4.2 Background Radiation

The source of background radiation in the Creighton area is attributed to naturally occurring radioactive materials (NORM), specifically potassium, uranium and thorium-bearing minerals. The background radiation for the Creighton area is presented on Figure 10. Statistically, the majority of the dose rate in the Creighton area ranges from approximately 10 to 30 nGy/h, with an average of approximately 20 nGy/h. This range of dose rates and average are consistent with regional dose rates for eastern Saskatchewan. NORM minerals are typically elevated in granitic geology, such as the Reynard Lake pluton. It should be noted that the dose rate lows in the Creighton area generally correspond to areas with glaciolacustrine deposits. These thick deposits attenuate the gamma rays originating from the underlying bedrock.

Additional detailed information is available in the geophysical interpretation report (PGW, 2013).

3.4.3 Soil Quality

Manitoba Conservation, in partnership with Saskatchewan Environment, conducted surface soil testing in Creighton (and adjacent Flin Flon, Manitoba) in August 2006. The testing measured 33 heavy metals and other elements. In Creighton, concentrations of arsenic, cadmium, copper, lead and mercury were found to be above the recommended soil quality guidelines in areas adjacent to tailings management area from the HBMS operations.

3.4.4 Water Quality

The Town of Creighton obtains its potable water source from Douglas Lake via the Creighton Water Treatment Plant. No information on water quality recorded at the treatment plant is publicly available on the Town website.

Jacques Whitford AXYS Limited (JWA) completed a drinking water sampling program in the City of Flin Flon and Town of Creighton for the HBMS in March 2008. Drinking water samples were collected to assess the current metal status of tap drinking water at each location, mainly in residential homes and schools. Water samples were analyzed for total metals and results were compared to the Canadian Council of Ministers of the Environment (CCME) Canadian Community Water Quality Guidelines (JWA, 2008). The drinking water sampling program implemented by JWA concluded that all drinking water samples were below CCME guidelines for the 16 metals that were assessed (JWA, 2008). There was one exception in West Flin Flon in which the sample exceeded the CCME Human Health criteria for lead and the CCME Aesthetic Objective for copper. This exceedance is assumed to be attributed to the use of copper pipes and lead-solder joints between 1930 and 1986. Since the sample was taken from a location constructed in the 1950s, the exceedance may be attributed to the plumbing system (JWA, 2008).

Surface water hydrology, groundwater and wells are further discussed in Sections 3.5 and 3.6, respectively.



3.4.5 Lake Sediment Chemistry

The desktop review did not identify any current information related to lake sediment chemistry for the Creighton area.

3.4.6 Potential Sources of Pollutants

There are a number of potential sources of pollutants in the Creighton area including landfills, transportation corridors, domestic septic systems and local industries.

There are three operating landfill sites identified within the Creighton area (Table 4), shown on Figure 1.

Table 4: Landfills in the Creighton Area

OPR ID	Location	Status
50668	Creighton, La Ronge Region	Operating
52503	Denare Beach, La Ronge Region	Operating
—	Keely Lake, Churchill Region	Operating

Source: Government of Saskatchewan (2012)

Transportation corridors, such as Highways 167 and 106, secondary roads, logging roads and rail lines, traverse the Creighton area, and are considered to be potential sources of pollution, as a result of salt application for de-icing and mobile air emissions from internal combustion. There is also a potential for chemical releases along transportation routes as a result of spills or accidents. Additionally, the Creighton area contains a local airport and aerodrome which is also a potential source of pollution, due to air emissions and potential chemical spills. Local septic systems are a potential source of pollutants, mainly as a result of septic waste and possibly as a result of chemical disposal into the septic system.

Industrial operations in the area may be a source of pollutants, due to the potential release of chemicals as a result of spills or improper chemical handling practices. The HBMS used to operate a smelter in adjacent Flin Flon, Manitoba which had airborne releases of heavy metals such as arsenic and cadmium. As noted in Section 3.4.3, Manitoba Conservation, in partnership with Saskatchewan Environment, conducted surface soil testing in Creighton in August 2006 and found elevated concentrations of arsenic, cadmium, copper, lead and mercury above the recommended soil quality guidelines in areas adjacent to tailings management area from the HBMS operations; however it ceased operations on June 11, 2010.

No other specific releases of the above-named pollutants into the environment were identified in this review.

3.5 Surface Water Hydrology

The Creighton area lies mainly within the Sturgeon-Weir sub-basin which is located in the primary Nelson River watershed that drains into Hudson Bay through the Nelson River. The northernmost portion of the Creighton area is located within the Central Churchill – Highrock Lake sub-basin which drains into the Churchill River, which flows towards Hudson Bay.

Watershed boundaries and surface water drainage for the Creighton area are shown on Figure 11. Most of the watercourses in the area around the Town of Creighton flow into either Amisk Lake or Athapapuskow Lake. The watersheds that feed into Amisk Lake have been coloured in shades of blue on Figure 11, whereas those draining into Athapapuskow Lake are shown in shades of brown. The Sturgeon-Weir River is the major inflow



and the only outflow of Amisk Lake; it flows southward to Namew Lake and subsequently into Cumberland Lake, which joins the Saskatchewan River downstream of the Saskatchewan River Delta. North of Creighton, Annabel Lake flows into Annabel Creek which flows east draining into Athapapuskow Lake in Manitoba. Athapapuskow Lake drains to the east, and eventually into Namew and Cumberland Lakes. Given the modestly rugged terrain, modest precipitation and relatively small size of catchment areas, no large areas of floodplain are expected to be present.

3.6 Groundwater and Wells

Information concerning groundwater in the Creighton area was obtained from the Saskatchewan Watershed Authority (SWA) Water Well Record (WWR) database (SWA, 2009). The locations of known water wells are shown on Figure 11. The Town of Creighton obtains its potable water source from Douglas Lake via the Creighton Water Treatment Plant (Podaima, 2011).

The SWA water well database contains 16 water well records relating to three locations in the Creighton area and surroundings (Table 5). Of the 16 records noted in Table 5, there were ten withdrawal wells, three observation wells and three test holes.

Table 5: Water Well Record Summary for the Creighton Area

Water Well Type	Water Well Use	Total Well Depth (m)	Static Water Level (m below surface)	Tested Well Yield (L/min)	Depth to Top of Bedrock (m)	Completion Strata
Domestic	Withdrawal	19	6	6	N/A	Glacial
Domestic	Withdrawal	21	3	4	N/A	Glacial
Domestic	Withdrawal	15	12	N/A	N/A	N/A
Domestic	Withdrawal	6	4	N/A	N/A	N/A
Municipal	Withdrawal	28	3	N/A	N/A	Glacial
Municipal	Withdrawal	24	3	N/A	N/A	Glacial
Municipal	Withdrawal	24	3	8	N/A	N/A
Municipal	Withdrawal	28	3	11	N/A	Glacial
Municipal	Water Test Hole	N/A	N/A	N/A	N/A	N/A
Municipal	Water Test Hole	N/A	N/A	N/A	N/A	N/A
Municipal	Water Test Hole	N/A	N/A	N/A	N/A	N/A
Municipal	Observation	24	N/A	N/A	N/A	N/A
Municipal	Observation	62	3	N/A	N/A	N/A
Municipal	Observation	27	2	N/A	N/A	N/A
Municipal	Withdrawal	32	2	N/A	N/A	N/A



Water Well Type	Water Well Use	Total Well Depth (m)	Static Water Level (m below surface)	Tested Well Yield (L/min)	Depth to Top of Bedrock (m)	Completion Strata
Municipal	Withdrawal	31	2	N/A	N/A	N/A

Notes:

N/A not available

3.6.1 Overburden Aquifers

The wells listed in Table 5 are reported (where information is available) to be installed into glacial deposits but stratigraphic details are not available with the water well records. However, mapping of inter-till aquifers in the area indicates the presence of three overburden units (Henderson and Campbell, 1992) including an upper till, glaciolacustrine deposits and a lower till. The lower till primarily occurs east of Amisk Lake and, based on well depths, is likely the unit into which the wells in the Denare Beach area are installed. This till unit commonly overlies bedrock and is itself generally overlain by glaciolacustrine deposits of varying thickness. Generally the lower till is a grey to grey brown sandy to silt diamicton. The younger till overlies glaciolacustrine sediments in the Creighton area and is composed of a silty sandy matrix (Henderson and Campbell, 1992). The lateral and vertical extent of this aquifer has not been investigated. Based on the surficial geology of the area, it is interpreted that the aquifer is located in a depression in upper bedrock surface (Campbell and Henderson, 1997). It is estimated that the aquifer extends approximately 3 km in the north-south direction by 1 to 2 km in the east-west direction. Other similar deposits extend to the north, however, there are no wells installed in that area and the presence of any hydraulic connection between these overburden deposits is unknown.

The one well installed outside of the Denare Beach area is located immediately west of the Town of Creighton. Based on the surficial geology near this well, it appears to be installed in a small drift-filled bedrock depression typical of the area. There are many similar locations throughout the area that may be capable of supporting small amounts of localized groundwater development. However, they tend to be small, and any hydraulic connection to neighboring units is likely to be limited.

In summary, the overburden aquifers in the Creighton area are minimal in extent and currently not used significantly. There is little interest in developing these small aquifers as a significant groundwater resource given the abundance of surface water in the area.

3.6.2 Bedrock Aquifers

There are no known shallow or deep bedrock aquifers that are being utilized in the Creighton area. The deepest well in the Creighton area is 62 m deep and water well records do not indicate whether it is installed in overburden or bedrock. Given its location, this well, which is an observation well only, is likely installed in glacial deposits. If bedrock was encountered in this well, it would be considered a part of the shallow groundwater system.

Precambrian rock of the Canadian Shield is not commonly developed as a significant aquifer, primarily due to the low frequency of fractures that are capable of producing sufficient quantities of water. Water wells drilled into Precambrian rock for water supply purposes are not likely to extend deeper than 100 m in most cases. At



greater depths, water quality generally decreases (becomes saline) to conditions that preclude potable water use (Frape and Fritz, 1987).

One borehole was drilled to a depth greater than 3 km into the Reynard Lake pluton (borehole JXWS) (Davis and Tammemagi, 1982). While the borehole was not drilled for hydrogeological characterization purposes, the available information did not indicate the presence of any significant water bearing zones in the upper 2 km of the pluton. No further information regarding groundwater at depth was available for the Creighton area.

In summary, the bedrock at typical repository depths in the Creighton area is not considered to be a significant groundwater resource. There are currently no known bedrock wells in the area, and the bedrock is unlikely to be used for such purposes in the future.

3.7 Climate and Meteorology

The Creighton area has a continental prairie climate, with bitterly cold winters and short, mild summers. The flow of air masses is dominated by mainly Arctic airstreams in winter and spring. In summer and fall, the Arctic air masses are replaced, on average, by westerly air currents of Pacific origin. The overall yearly mean temperature is just below 0°C, reflecting the dominant Arctic air flow over the region. Precipitation falls mainly from eastward moving weather fronts from the Arctic and interior regions of the continent. Most precipitation falls between July through September and is associated with continental weather fronts moving from the Pacific crossing the prairies bringing showery weather or scattered thunderstorms.

Climatological information presented in this section is based on meteorological data from Environment Canada’s meteorological station located near Flin Flon, Manitoba approximately 16 km southeast of Creighton, which has more than 30 years of continuous data and is at a similar elevation. Parameters that are measured at the Flin Flon Airport station include: temperature, precipitation, wind and relative humidity.

3.7.1 Temperature

Temperature data was obtained from Environment Canada’s 1971-2000 climate normals for the Flin Flon meteorological station (EC, 2011b). Figure 12 presents monthly temperatures for Flin Flon, displaying daily average, maximum and minimum and extreme values over the calendar year.

3.7.2 Precipitation

Figure 13 presents monthly precipitation data obtained from Environment Canada’s 1971-2000 climate normals for the Flin Flon meteorological station, including total rainfall, rainfall, snowfall and all-time extreme values over the calendar year (EC, 2011b).

3.7.3 Wind

Table 6 presents the monthly wind data obtained from Environment Canada’s 1971-2000 climate normals for the Flin Flon meteorological station (EC, 2011b). Average wind speed and direction are average for each month over the calendar year. The dominant wind direction is from the northwest, with winds from the south and northeast occasionally dominant during the spring and summer months.

Table 6: Monthly Wind Normals for Flin Flon, Manitoba

Parameter	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual
Average Speed	9.4	9.7	10	10.9	11.1	11.2	10.9	10.7	12.1	12.2	11.1	9.3	10.7



Parameter	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual
(km/h)													
Most Prevalent Direction	NW	NW	S	S	NE	S	NW	S	NW	NW	NW	NW	NW

3.8 Natural Hazards

3.8.1 Earthquakes and Seismicity

The Creighton area lies within the Canadian Shield, where large parts have remained tectonically stable for the last 2.5 billion years (Percival and Easton, 2007). The Creighton area has a low seismic hazard rating (NRCan, 2010). According to the National Earthquake Database (NEDB) for the period between 1985 and 2011 (NRCan, 2012) there have been no earthquakes in the Creighton area. The largest earthquake recorded in Saskatchewan, at a magnitude of 5.5, occurred in 1909 near the USA border (650 km from Creighton) (NRCan, 2012).

In summary, available literature and recorded seismic events indicate that the Creighton area is located within a region of low seismicity.

3.8.2 Tornadoes and Hurricanes

As noted in Table 6, average monthly wind speeds in the Creighton area are low, ranging from 9 to 12 km/hr. The Creighton area experiences thunderstorms in the summer months and is located in an area with a low tornado frequency (<0.5 tornadoes per year / 10,000 km²), but where there is a potential for F0-F1 tornadoes (Sills et al., 2012). The Creighton area is situated too far away from the Atlantic and Pacific oceans to be susceptible to hurricanes. The National Building Code of Canada recommends a design 1/50 maximum hourly wind pressure for the Flin Flon area of 0.27 kPa, which are low to typical values for Saskatchewan and Manitoba (NRC, 2010).

3.8.3 Drought and Flooding

According to precipitation climate normals for the region (Figure 13), the Creighton area experiences on average between 15 and 75 mm of precipitation each month, and is therefore unlikely to experience drought conditions that would affect the viability of local water sources. The single day extreme rainfall and snowfall events on record at the Flin Flon station (Figure 13) are 78 mm of rain and 40 cm of snow, respectively. In years where there is a high snowpack accumulation, the spring freshet can result in a nominal increase in water levels in local streams and rivers. As noted on Figure 11, the Creighton area lies at the headwaters of Western and Northern Hudson Bay Drainage Area, making the size of the upstream catchments areas relatively small. The small catchment size in combination with the modestly rugged terrain makes the overall risk of significant flooding in the Creighton area quite low. The potential risk of drought or flooding affecting the facility will also depend to some degree on the specific location selected.

3.8.4 Snow and Ice

As noted on Figure 13, the Creighton area receives on average about 120 cm of snowfall per year, primarily between the months of October and April. No single month receives an average snowfall greater than 25 cm. The highest single day snowfall accumulation on record is 40 cm, recorded on April 20, 1973. The National Building Code of Canada recommends a design 1/50 snow load ($S_s + S_r$) for the Flin Flon area of 2.4 kPa, which



is a typical value for Saskatchewan (NRC, 2010). Local lakes and waterbodies freeze over in the winter months in the Creighton area, as average daily temperatures from November to April typically range from -22 to 0°C.

3.8.5 Forest Fires and Lightning

Within heavily forested areas such as the Creighton area there is a risk of forest fires. Locations where forest fires have occurred in the vicinity of the Creighton area between 1976 and 2010 affecting an area of greater than 200 ha are shown on Figure 5. These forest fires combine to comprise less than 1% of the total Creighton area. Forest fires can be initiated by lightning strikes or human activity, particularly if dry conditions are present in the forest understory. As previously noted, thunderstorms do occur in the Creighton area and lightning strikes are not uncommon in the summer months.

3.8.6 Landslides and Tsunamis

Moderately steep slopes in the Creighton area are uncommon, and where present, are generally comprised of crystalline rock with only a thin veneer of soil cover. The physical nature of these slopes, combined with typically modest precipitation and very low seismicity, results in a low landslide risk for the Creighton area. There is no risk of tsunamis in the Creighton area, owing to the very low seismicity and a lack of large water bodies.



ENVIRONMENT REPORT - TOWN OF CREIGHTON, SASKATCHEWAN



4.0 SUMMARY

This report provides a high level description of the environment in the Town of Creighton and surrounding area.

Situated in Division No. 18, a few kilometres west of Flin Flon, Manitoba, the Town of Creighton has a population of 1,498 (Statistics Canada, 2012). The Creighton area has a continental prairie climate, with bitterly cold winters and short, mild summers. Most precipitation occurs in July through September associated with continental weather fronts moving from the Pacific crossing the prairies bringing showery weather or scattered thunderstorms.

There are a number of Aboriginal communities and organizations in the Creighton area including Cumberland House Cree Nation (Treaty 5) and Peter Ballantyne Cree Nation (Treaty 6). Métis Locals in the area include: Creighton #89, Cumberland House #42 and Sandy Bay #90; all are located within Métis Nation-Saskatchewan Eastern Region 1.

The Town of Creighton lies within the southeast portion of the Reindeer zone in the Canadian Precambrian Shield of northern Saskatchewan. The Reindeer zone has been further subdivided into six separate geological domains. Creighton is situated within the Flin Flon domain. To the west, southwest and south of the Town, the Flin Flon arc assemblage is intruded by the Annabel Lake pluton (west), Reynard Lake pluton (southwest) and Phantom-Boot Lake pluton (south).

Mining in the Creighton area has historically focussed on metals within the Flin Flon greenstone belt and the contact halos with surrounding batholiths. There is one producing mine and 12 past producing properties within the Creighton area. Of these, one active mine (Callinan Mine) is producing copper with minor amounts of gold, silver, zinc and lead. Minor amounts of gold have been historically produced from the Creighton area, and gold has been produced in association with the base metals at the Flin Flon and Callinan mines. The economic viability of such other gold occurrences is currently being explored in the Creighton area.

The main transportation routes through the Creighton area include Highway 167 which travels northeast from Denare Beach to the Town of Creighton and into Manitoba. As well, Highway 106 runs northwest beginning in the Town of Creighton. There is one airport near the east side of the Creighton area, immediately south of Flin Flon, Manitoba. There is a rail line north of Creighton connecting to the rail network in Flin Flon and a transmission line corridor between Denare Beach and Creighton, which continues north of Creighton, as well connecting at Flin Flon. No gas pipelines were identified within the Creighton area.

The Town of Creighton lies in the west-central limit of the Mees-Toos Forest Term Supply Licence (TSL) area (Government of Saskatchewan, 2007). The Mees-Toos Forest TSL is managed by Peter Ballantyne Cree Nation, with a gross area of 1,672,211 ha.

The Creighton area covers two different landscape areas, the Flin Flon Plain of the Churchill River Upland Eco-region and the Namew Lake Upland of the Mid-Boreal Lowland Eco-region. According to mapping from GeoSask, the Creighton area contains 54,905 ha of woodland, which represents approximately 80% of the land surface (GeoSask, 2012). The Flin Flon Plain is dominated by a mixed-wood forest vegetation community and covers the majority of the Creighton area. Based on a search of the Saskatchewan Conservation Data Centre database (SKCDC, 2012), no federally listed plant species are currently identified as occurring within the Creighton area, but there are several species tracked by the province. Woodland caribou is a threatened species that has known habitat within the Creighton area.



The Creighton area lies mainly within the Sturgeon-Weir sub-basin which is located in the primary Nelson River watershed that drains into Hudson Bay through the Nelson River. Flow through the Sturgeon-Weir River is southward through Amisk Lake. North of Creighton, Annabel Lake flows into Annabel Creek which flows east draining into Athapapuskow Lake in Manitoba. The Town of Creighton obtains its potable water source from Douglas Lake via the Creighton Water Treatment Plant. The Saskatchewan Water Authority water well database contains 16 water well records relating to three locations in the Creighton area and surroundings. Of the 16 records, there were ten withdrawal wells, three observation wells and three test holes. The groundwater table is expected to be very shallow in low-lying, marshy areas and it is expected that shallow unconfined groundwater flow generally parallels surface water drainage patterns. The bedrock in the Creighton area is not considered to be a significant groundwater resource.

Air and surface water quality within the Creighton area are expected to be within the normal range for Saskatchewan. In Creighton, concentrations of arsenic, cadmium, copper, lead and mercury were found to be above the recommended soil quality guidelines in areas adjacent to tailings management area from the HBMS operations. Sources of background radiation in the Creighton area are attributed to naturally occurring radioactive materials, specifically potassium, uranium and thorium-bearing minerals. The range of dose rates and average are consistent with regional dose rates for Saskatchewan.

The Saskatchewan Ministry of Tourism, Parks, Culture and Sport as well as the National Historic Sites Database identified 18 known archaeological sites in the Creighton area. Fourteen sites are pre-contact Aboriginal artifact find and scatter sites; two sites are artifact/feature combination sites – one historic, the other unidentified and two heritage resources have insufficient information to be given a site type designation.



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Report Signature Page

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Principal, Senior Geoscientist

BT/DM/GWS/JLH/wlm

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ENVIRONMENT REPORT - TOWN OF CREIGHTON, SASKATCHEWAN

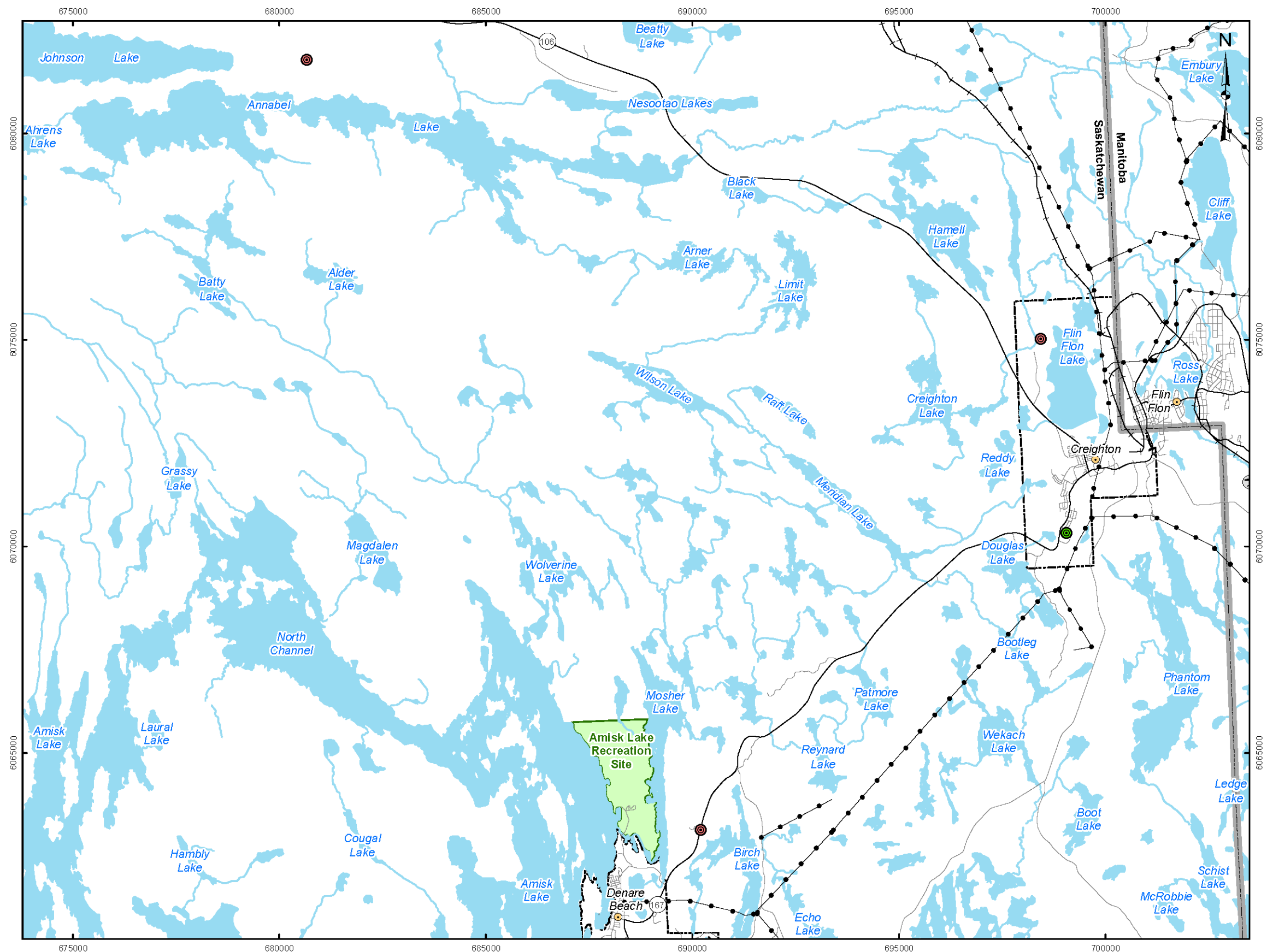


FIGURES



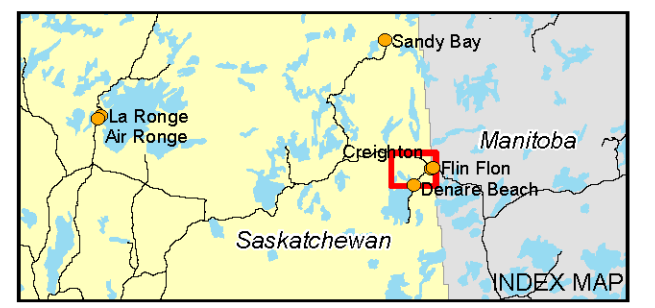
**ENVIRONMENT REPORT - TOWN OF CREIGHTON,
SASKATCHEWAN**

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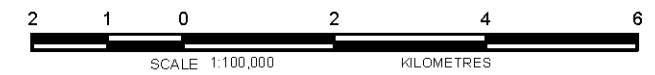
LEGEND

- Community
- Airport
- Domestic Waste Site
- Waste Water Treatment Plant
- Main Road
- Local Road
- Railway
- Transmission Line
- Watercourse
- Waterbody
- Park and Recreation Area
- Municipality Boundary
- Provincial Boundary



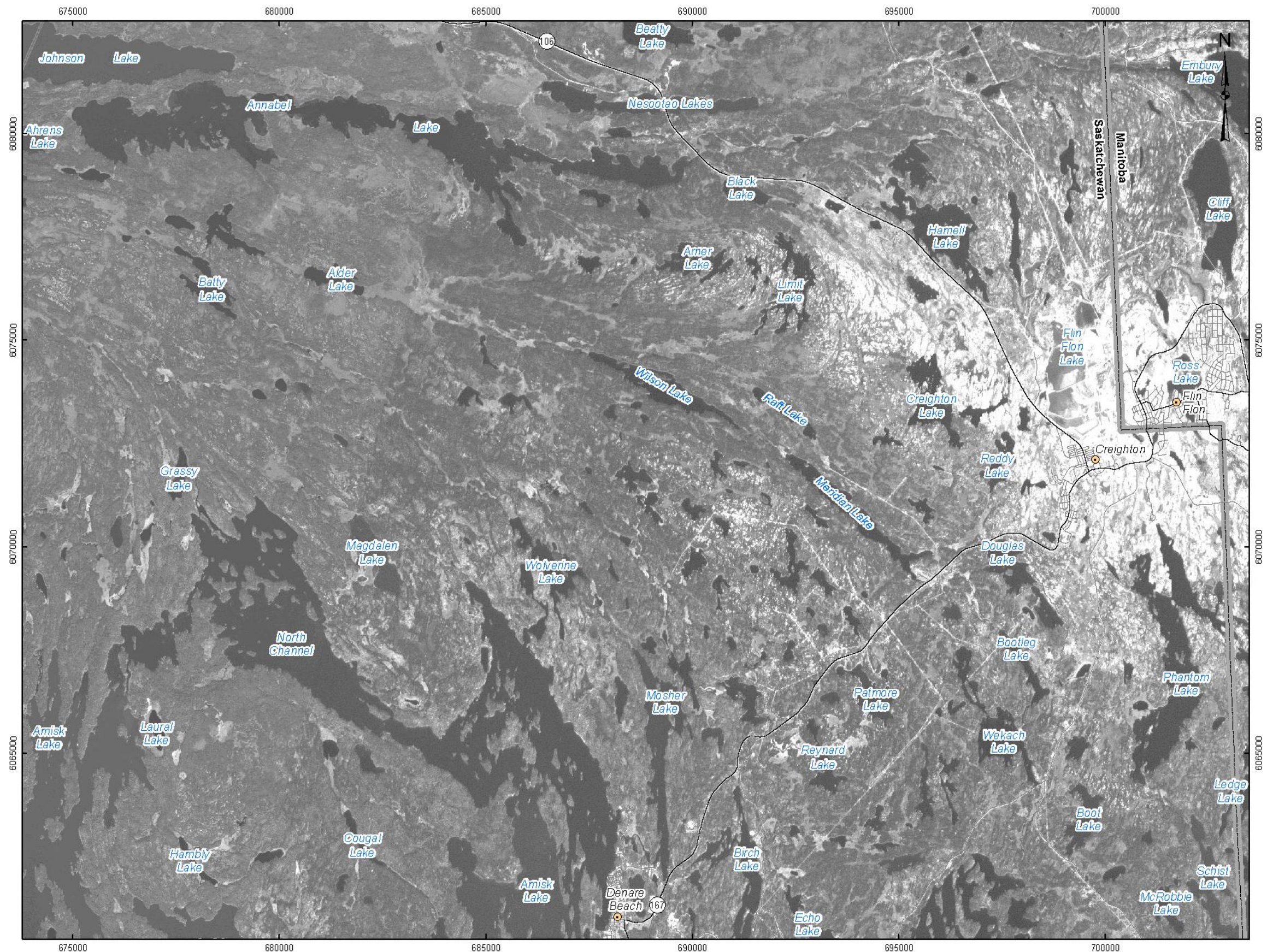
REFERENCE

Basedata - CANVEC V10 Topographic Mapping of Canada (1:50000)
 Administrative Boundaries - Information Services Corporation of Saskatchewan,
 Administrative Boundary Overlays (2012)
 Projection: Universal Transverse Mercator
 Datum: NAD 83 Coordinate System: UTM Zone 13



PROJECT		Environment Report Creighton, Saskatchewan	
TITLE		Creighton and Surrounding Lands	
 Golder Associates Mississauga, Ontario	PROJECT NO.	12-1152-0026	SCALE AS SHOWN
	DESIGN	PRM 1 May 2012	REV. 0.0
	GIS	PRM 8 Aug 2013	FIGURE: 1
	CHECK	JH 8 Aug 2013	
	REVIEW	GWS 8 Aug 2013	

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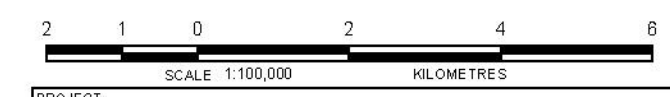
LEGEND

- Community
- Main Road
- Local Road
- Provincial Boundary



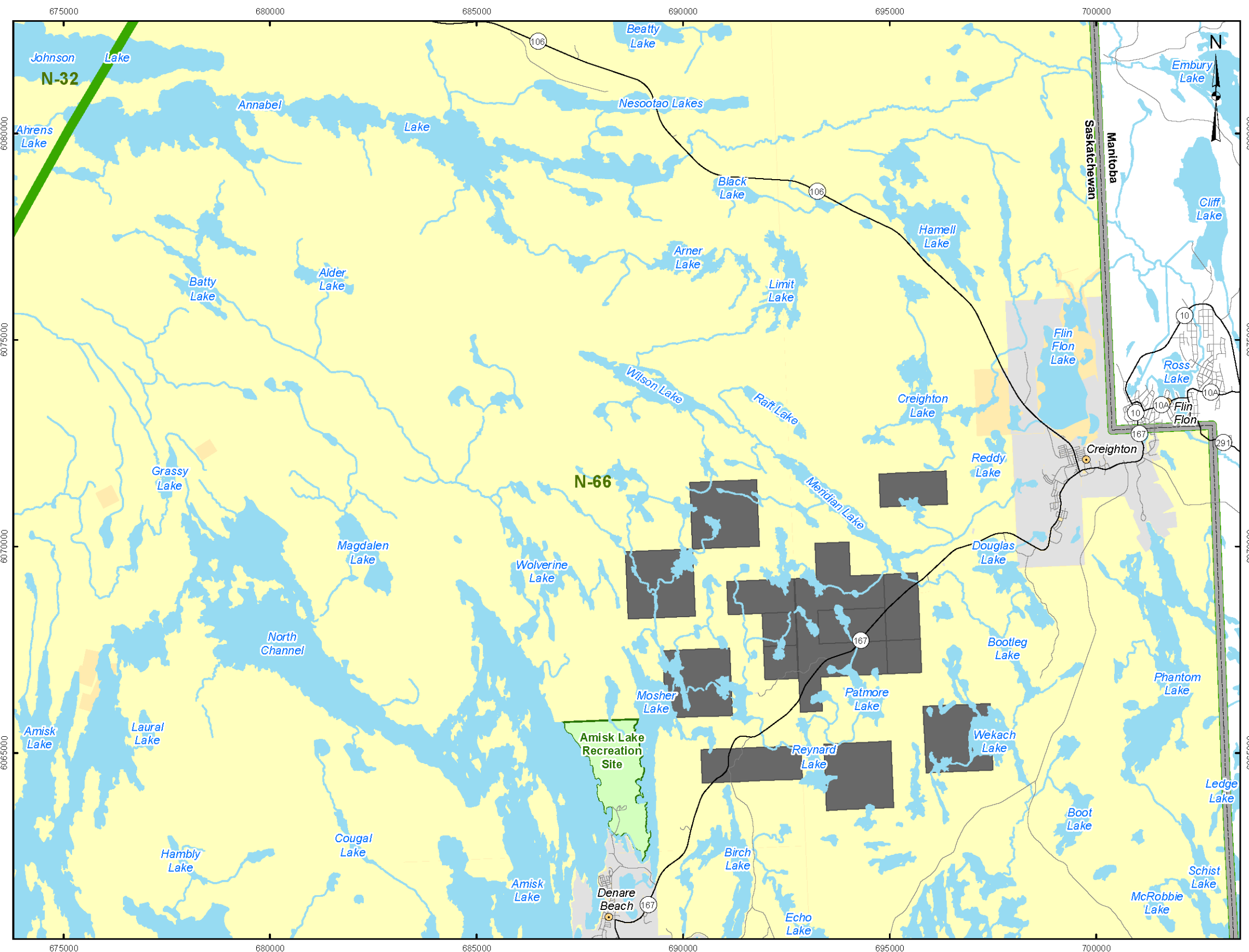
REFERENCE

Basedata - CANVEC V10 Topographic Mapping of Canada (1:50000)
 Administrative Boundaries - Information Services Corporation of Saskatchewan,
 Administrative Boundary Overlays (2012)
 SPOT Imagery Courtesy of GeoBase
 Projection: Universal Transverse Mercator
 Datum: NAD 83 Coordinate System: UTM Zone 13



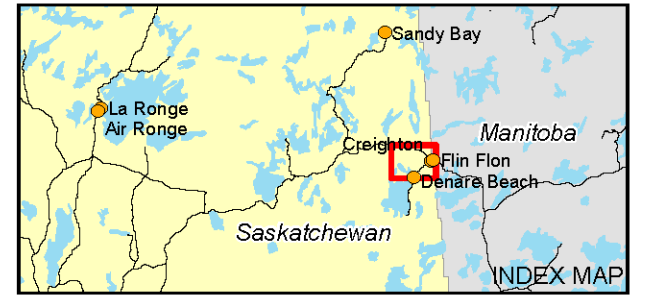
PROJECT			
Environment Report Creighton, Saskatchewan			
TITLE			
Satellite Imagery in the Creighton Area			
 Golder Associates Mississauga, Ontario	PROJECT NO.	12-1152-0026	SCALE AS SHOWN
	DESIGN	PRM 1 May 2012	REV. 0.0
	GIS	PRM 8 Aug 2013	FIGURE: 2
	CHECK	JH 8 Aug 2013	
	REVIEW	GWS 8 Aug 2013	

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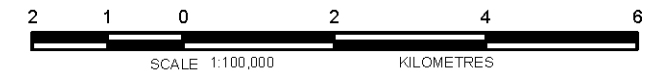
LEGEND

- Community
- Main Road
- Local Road
- Watercourse
- Waterbody
- Crown Land
- Private Land
- Unclassified Land
- Crown Reserves
- Park and Recreation Area
- Fur Conservation Area (N-32, N-66)
- Provincial Boundary



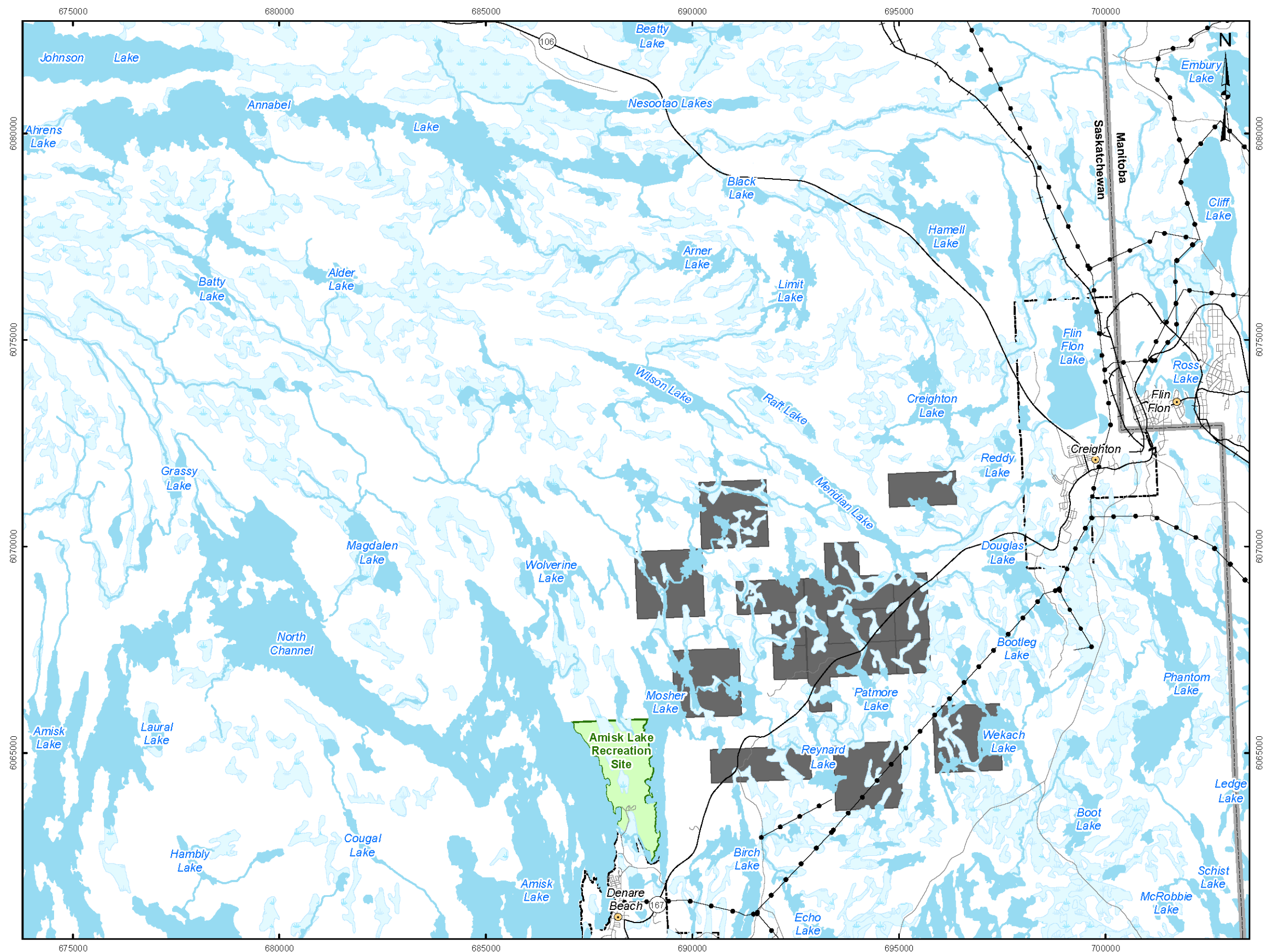
REFERENCE

Basedata - CANVEC V10 Topographic Mapping of Canada (1:50000)
 Administrative Boundaries - Information Services Corporation of Saskatchewan,
 Administrative Boundary Overlays (2012)
 Crown Reserves - Saskatchewan Geological Atlas
 Cadastral Data - Information Services Corporation of Saskatchewan, 2008
 Fur Conservation Areas - Saskatchewan Environment Administrative Map, Saskatchewan
 Environment, April 2002
 Projection: Universal Transverse Mercator
 Datum: NAD 83 Coordinate System: UTM Zone 13



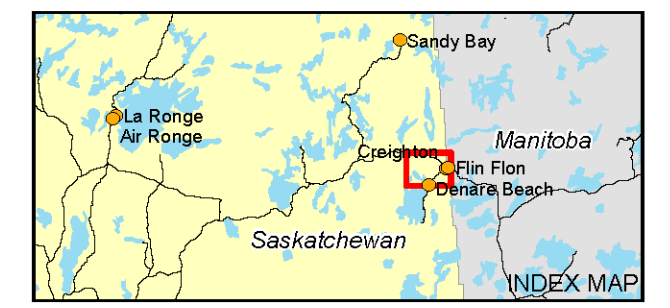
PROJECT		Environment Report Craighton, Saskatchewan	
TITLE		Craighton Area Land Ownership	
 Golder Associates Mississauga, Ontario	PROJECT NO.	12-1152-0026	SCALE AS SHOWN
	DESIGN	PRM 1 May 2012	REV. 00
	GIS	PRM 8 Aug 2013	FIGURE: 3
	CHECK	JH 8 Aug 2013	
	REVIEW	GWS 8 Aug 2013	

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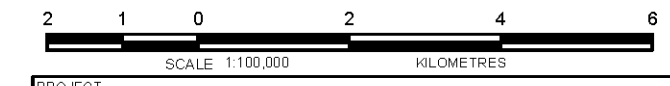
LEGEND

- Community
- Main Road
- Local Road
- Railway
- Transmission Line
- Watercourse
- Waterbody
- Wetland
- Park and Recreation Area
- Crown Reserves
- Municipal Boundary
- Provincial Boundary



REFERENCE

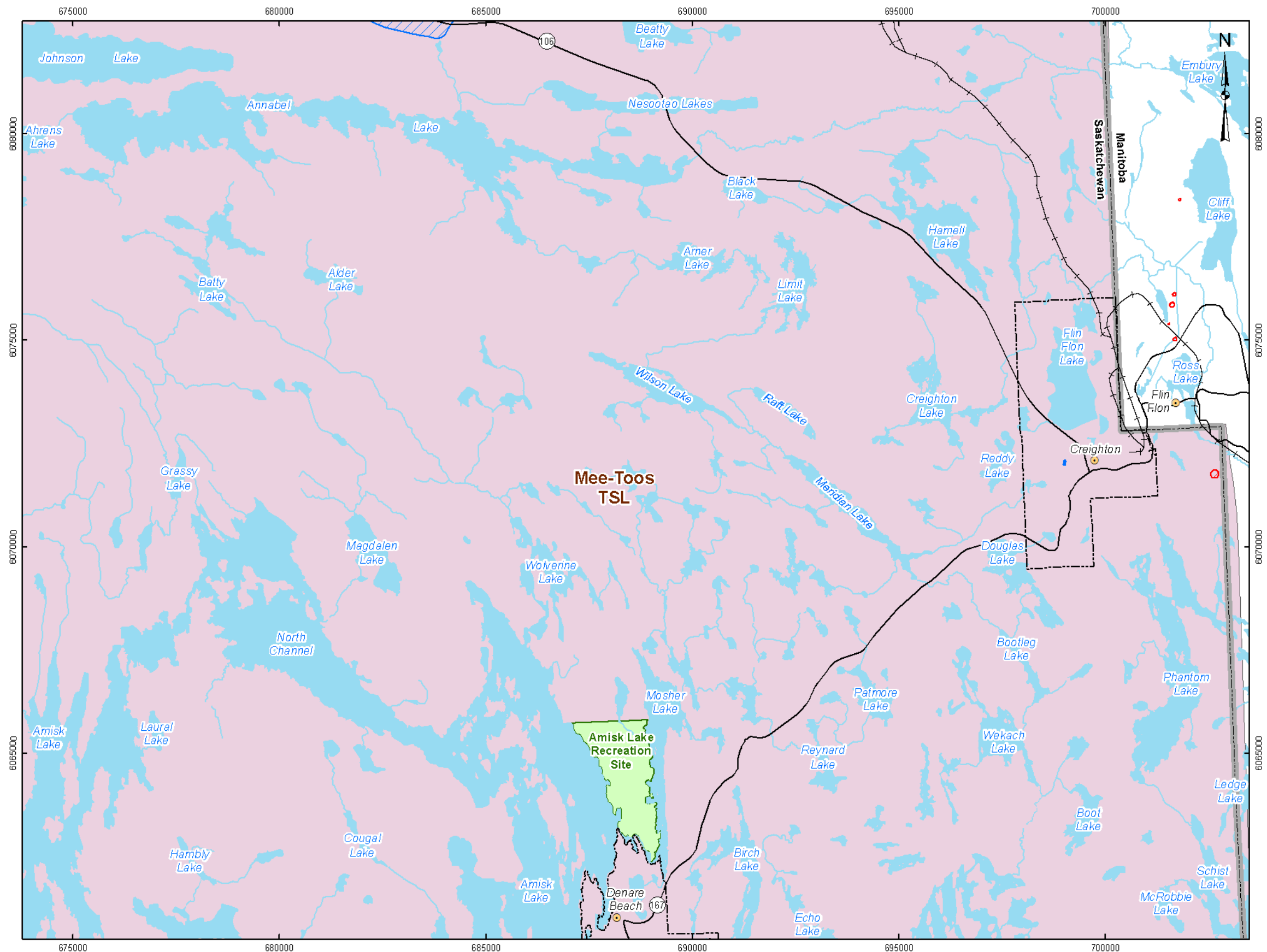
Basedata - CANVEC V10 Topographic Mapping of Canada (1:50000)
 Administrative Boundaries - Information Services Corporation of Saskatchewan,
 Administrative Boundary Overlays (2012)
 Crown Reserves - Saskatchewan Geological Atlas
 Projection: Universal Transverse Mercator
 Datum: NAD 83 Coordinate System: UTM Zone 13



PROJECT		Environment Report Creighton, Saskatchewan		
TITLE		Creighton - Parks and Protected Lands		
<p>Golder Associates Mississauga, Ontario</p>	PROJECT NO.	12-1152-0026	SCALE AS SHOWN	REV. 0.0
	DESIGN	PRM	1 May 2012	
	GIS	PM/IB	8 Aug 2013	
	CHECK	JH	8 Aug 2013	
	REVIEW	GWS	8 Aug 2013	

FIGURE: 4

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LEGEND

- Community
- Main Road
- Railway
- Watercourse
- Waterbody
- Park and Recreation Area

Forest Fire Areas (greater than 200 hectares)

- 1976 - 1980
- 1981 - 1990
- 1991 - 2000
- 2001 - 2010

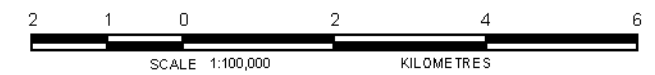
Crown Forest Areas

- Mee-Toos TSL
- Municipality Boundary
- Provincial Boundary



REFERENCE

Basedata - CANVEC V10 Topographic Mapping of Canada (1:50000)
 Administrative Boundaries - Information Services Corporation of Saskatchewan,
 Administrative Boundary Overlays (2012)
 Crown Forest - Saskatchewan Crown Forest Areas, Forest Service, Saskatchewan Environment, 2006
 Forest Fire Areas - Canadian Forest Service. 2010. Canadian National Fire Database-Agency Fire Data. Natural Resources Canada, Canadian Forest Service, Northern Forestry Centre, Edmonton, Alberta.
 Projection: Universal Transverse Mercator
 Datum: NAD 83 Coordinate System: UTM Zone 13



PROJECT

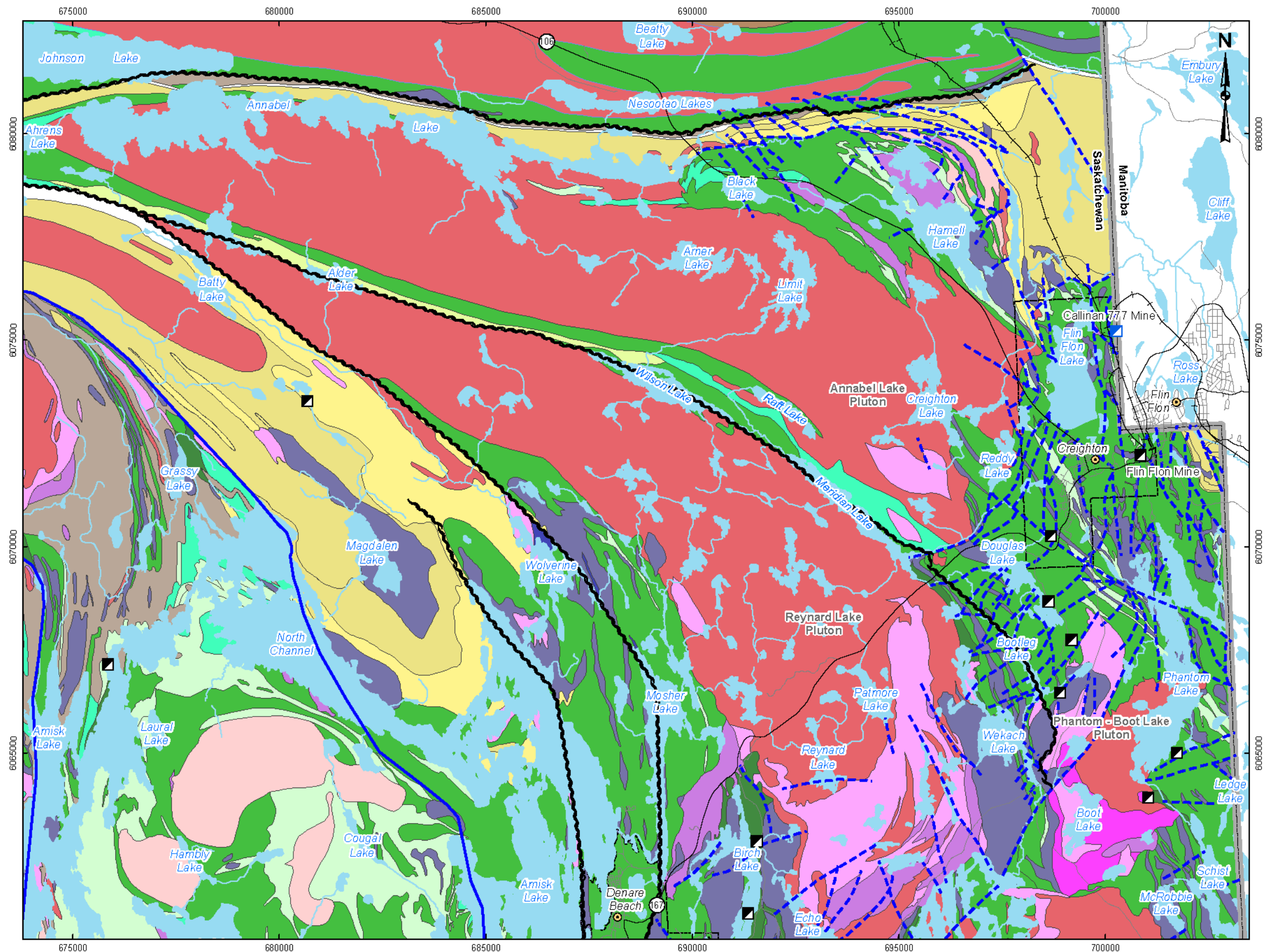
**Environment Report
Creighton, Saskatchewan**

TITLE

Creighton - Crown Forest Areas

<p>Golder Associates Mississauga, Ontario</p>	PROJECT NO. 12-1152-0026	SCALE AS SHOWN	REV. 0.0
	DESIGN PRM 1 May 2012	FIGURE: 5	
	GIS PRM 8 Aug 2013		
	CHECK JH 8 Aug 2013		
	REVIEW GWS 8 Aug 2013		

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LEGEND

- Community
- Past Producing Mine
- Producing Mine
- Main Road
- Local Road
- Railway
- Watercourse
- Waterbody
- Municipal Boundary
- Provincial Boundary
- Shear Zone
- Fault
- Inferred Fault
- Alaskite-Aplogranite
- Sandstone, Crossbedded Sandstone
- Pebbly Sandstone, Pebble Conglomerate, Sandstone
- Polymitic Conglomerate, Sandstone
- Metagreywacke
- Metagreywacke Gneiss
- Granite-Monzogranite-Quartz Monzogranite
- Leucogranodiorite-Tonalite
- Granodiorite-Tonalite
- Foliated to Gneissic Granodiorite-Tonalite
- Tonalite-Quartz Diorite
- Quartz Diorite - Granodiorite-Diorite
- Gabbro-Diorite
- Ultramafic Rock
- Mafic Protomylonite to Mylonite
- Rhyolite, Dacite, Quartz Porphyry
- Acid Volcanics
- Felsic Gneiss Derived from Felsic Volcanics
- Intermediate Volcanics
- Mafelsic Gneiss Derived from Intermediate to Mafic Volcanics
- Basic Volcanics
- Mafic Gneiss Derived From Basic Volcanics

Missi Group

Flin Flon Greenstone Belt

REFERENCE

Base data - CANVEC V10 Topographic Mapping of Canada (1:50,000)
 Administrative Boundaries - Information Services Corporation of Saskatchewan,
 Bedrock Geology - Saskatchewan Geological Atlas (1:250,000)
 Projection: Universal Transverse Mercator
 Datum: NAD 83 Coordinate System: UTM Zone 13

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 SCALE 1:100,000 KILOMETRES

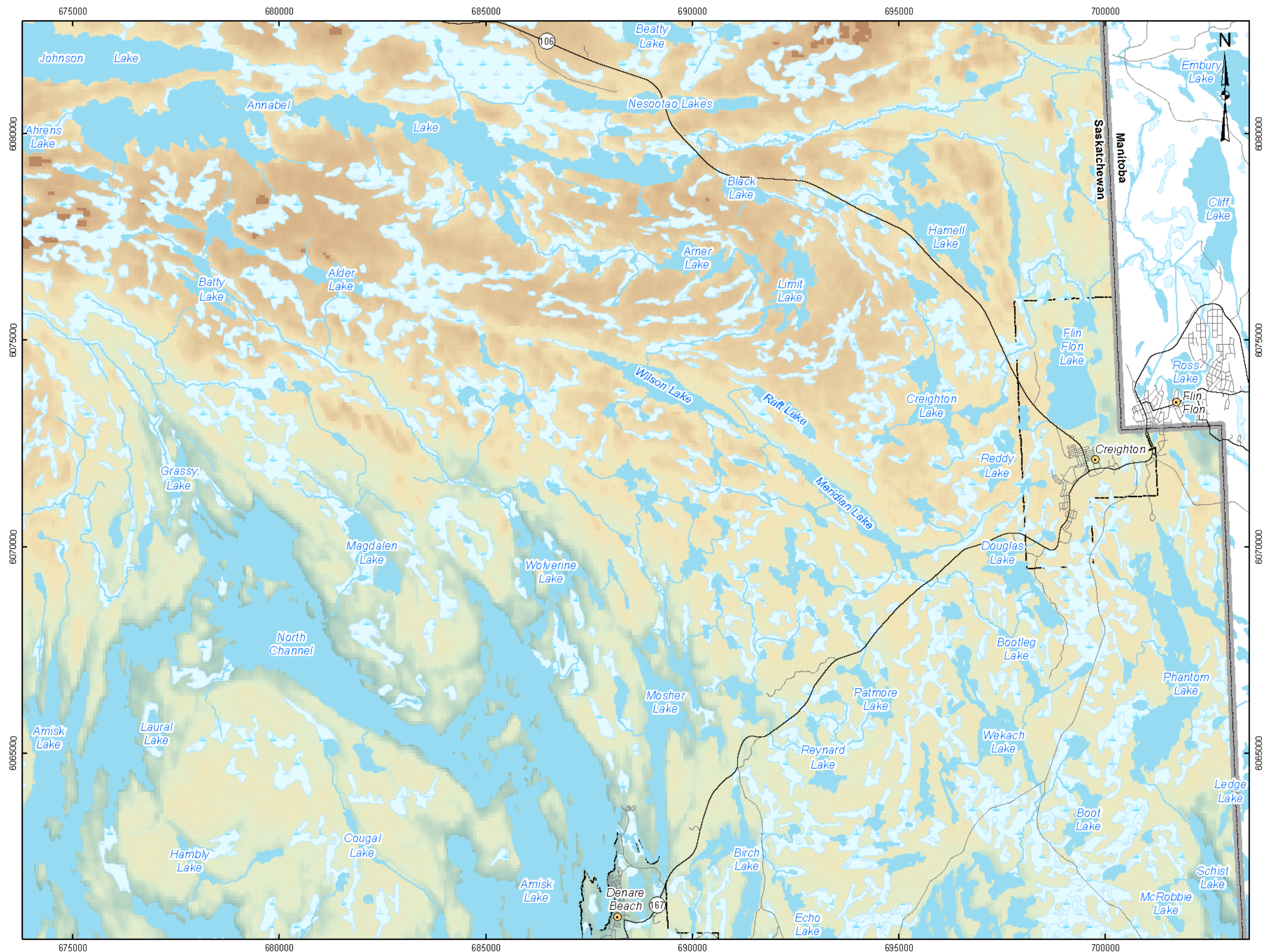
PROJECT
**Environment Report
 Creighton, Saskatchewan**

TITLE
**Bedrock Geology
 of the Creighton Area**

	PROJECT NO.	12-1152-0026	SCALE AS SHOWN	REV. 0.0
	DESIGN	PRM 1 May 2012		
	GIS	PRM 8 Aug 2013		
	CHECK	JH 8 Aug 2013		
	REVIEW	GWS 8 Aug 2013		

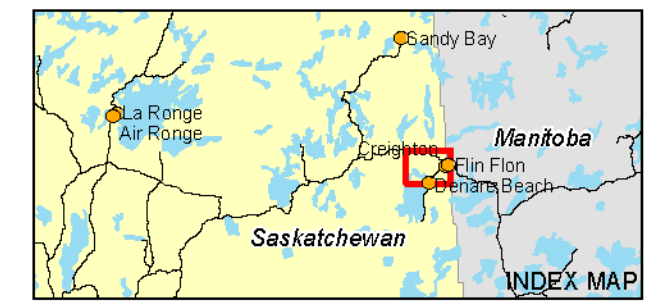
FIGURE: 6

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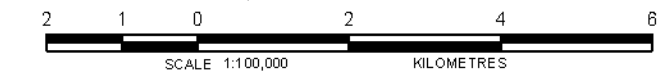
LEGEND

- Community
 - Main Road
 - Local Road
 - Watercourse
 - Waterbody
 - Wetland
 - Municipal Boundary
 - Provincial Boundary
- Elevation Model (masl)
- 375
 - 350
 - 325
 - 300
 - 275
 - 250



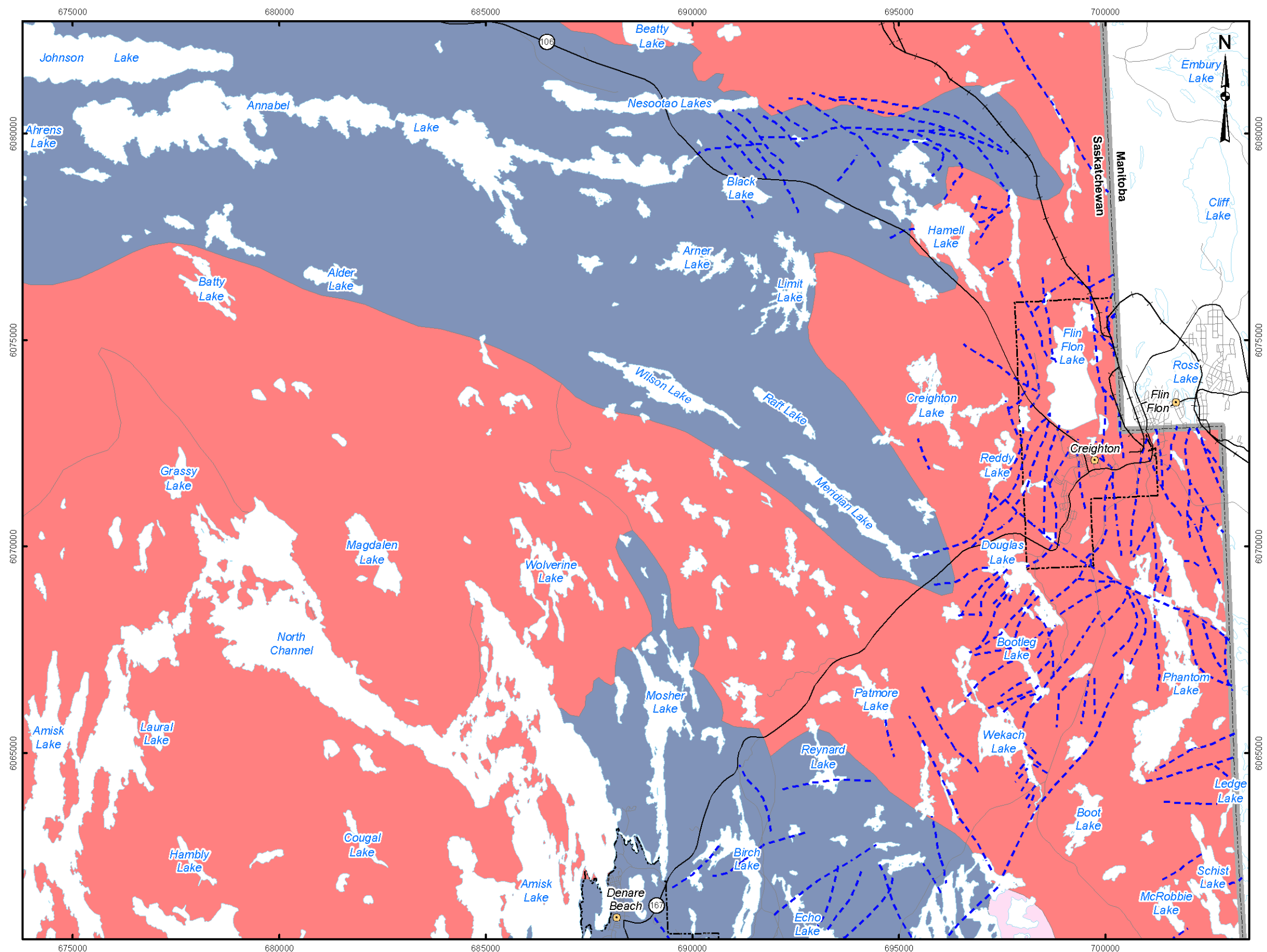
REFERENCE

Basedata - CANVEC V10 Topographic Mapping of Canada (1:50000)
 Administrative Boundaries - Information Services Corporation of Saskatchewan,
 Administrative Boundary Overlays (2012)
 Digital Elevation Model - CDED slope raster: Geobase.ca (1:50,000)
 Projection: Universal Transverse Mercator
 Datum: NAD 83 Coordinate System: UTM Zone 13



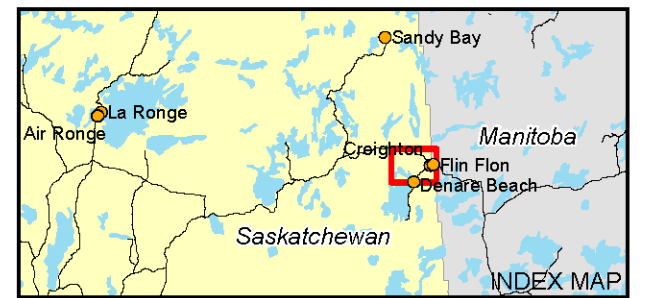
PROJECT			
Environment Report Creighton, Saskatchewan			
TITLE			
Digital Elevation Model in the Creighton Area			
 Golder Associates Mississauga, Ontario	PROJECT NO. 12-1152-0026	SCALE AS SHOWN	REV. 0.0
	DESIGN	PRM	1 May 2012
	GIS	PRM	8 Aug 2013
	CHECK	JH	8 Aug 2013
	REVIEW	GWS	8 Aug 2013
			FIGURE: 7

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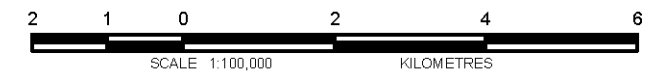
LEGEND

- Community
- Main Road
- Local Road
- Railway
- Waterbody
- Municipal Boundary
- Provincial Boundary
- Inferred Fault
- Glaciolacustrine
- Rock
- Organic



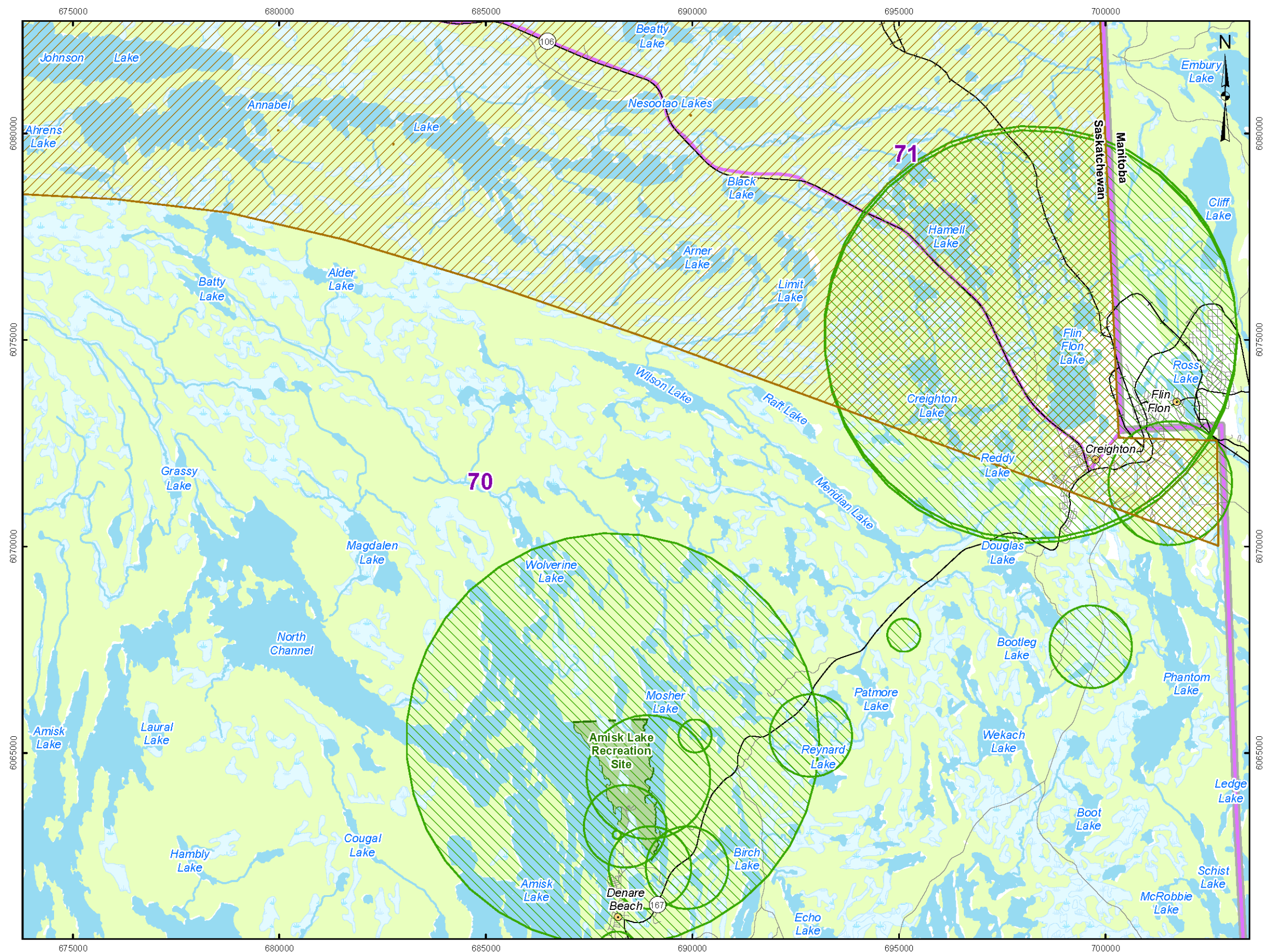
REFERENCE

Basedata - CANVEC V10 Topographic Mapping of Canada (1:50000)
 Administrative Boundaries - Information Services Corporation of Saskatchewan, Administrative Boundary Overlays (2012)
 Quaternary Geology - Saskatchewan Geological Atlas (1:250,000)
 Projection: Universal Transverse Mercator
 Datum: NAD 83 Coordinate System: UTM Zone 13



PROJECT	Environment Report Creighton, Saskatchewan		
TITLE	Quaternary Geology of the Creighton Area		
 Golder Associates <small>Mississauga, Ontario</small>	PROJECT NO. 12-1152-0026	SCALE AS SHOWN	REV. 0.0
	DESIGN PRM 1 May 2012		
	GIS PRM 8 Aug 2013		
	CHECK JH 8 Aug 2013		
	REVIEW GWS 8 Aug 2013		
FIGURE: 8			

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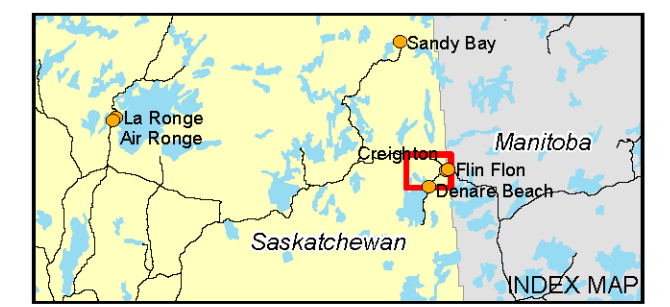


LEGEND

- Community
- Main Road
- Local Road
- Railway
- Watercourse
- Waterbody
- Wetland
- Wooded Area
- Park and Recreation Area
- Provincial Boundary
- Wildlife Management Zone (70, 71)

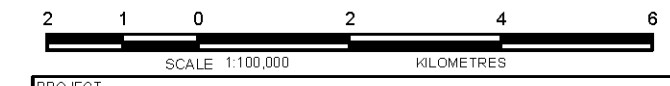
Rare Species Range

- Animal (Woodland Caribou)
- Plant (Various)



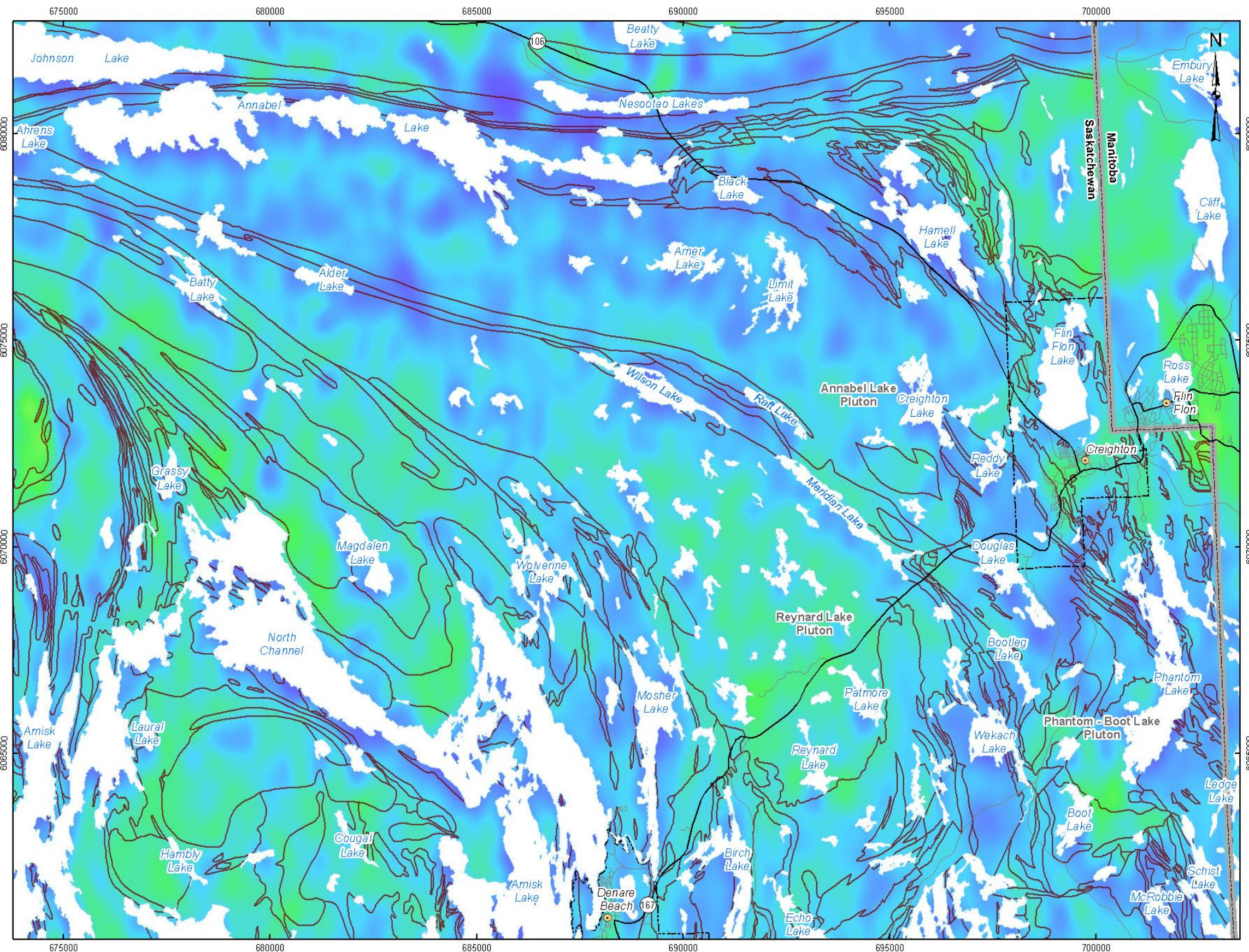
REFERENCE

Basedata - CANVEC V10 Topographic Mapping of Canada (1:50000)
 Administrative Boundaries - Information Services Corporation of Saskatchewan, Administrative Boundary Overlays (2012)
 Rare Species - CDC Wildlife Map, Fish and Wildlife Branch, Saskatchewan Ministry of Environment
 Projection: Universal Transverse Mercator
 Datum: NAD 83 Coordinate System: UTM Zone 13



PROJECT		Environment Report Creighton, Saskatchewan	
TITLE		Creighton - Ecology	
<p>Golder Associates Mississauga, Ontario</p>	PROJECT NO.	12-1152-0026	SCALE AS SHOWN
	DESIGN	PRM 1 May 2012	REV. 00
	CHECK	JH 8 Aug 2013	FIGURE: 9
	REVIEW	GWS 8 Aug 2013	

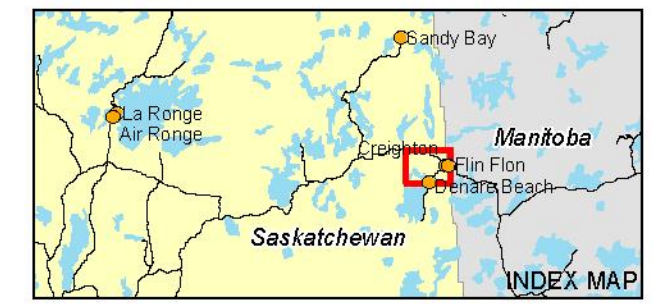
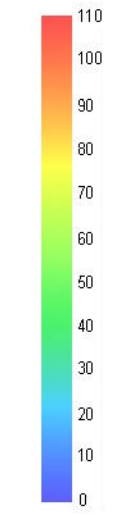
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LEGEND

- Community
- Main Road
- Local Road
- Waterbody
- Geologic Contact
- Municipal Boundary
- Provincial Boundary

Air Absorbed Radiation Levels (nGy/h)



REFERENCE

Basedata - CANVEC V10 Topographic Mapping of Canada (1:50000)
 Administrative Boundaries - Information Services Corporation of Saskatchewan, Administrative Boundary Overlays (2012)
 Bedrock Geology - Saskatchewan Geological Atlas (1:250,000)
 Radiometrics - GSC Canada - 250m - Natural Air Absorbed Dose Rate, 2012;
 National Gamma-Ray Spectrometry Program Data Base, Airborne Geophysics Section,
 GSC - Central Canada Division, Geological Survey of Canada, Earth Sciences Sector,
 Natural Resources Canada
 Projection: Universal Transverse Mercator
 Datum: NAD 83 Coordinate System: UTM Zone 13



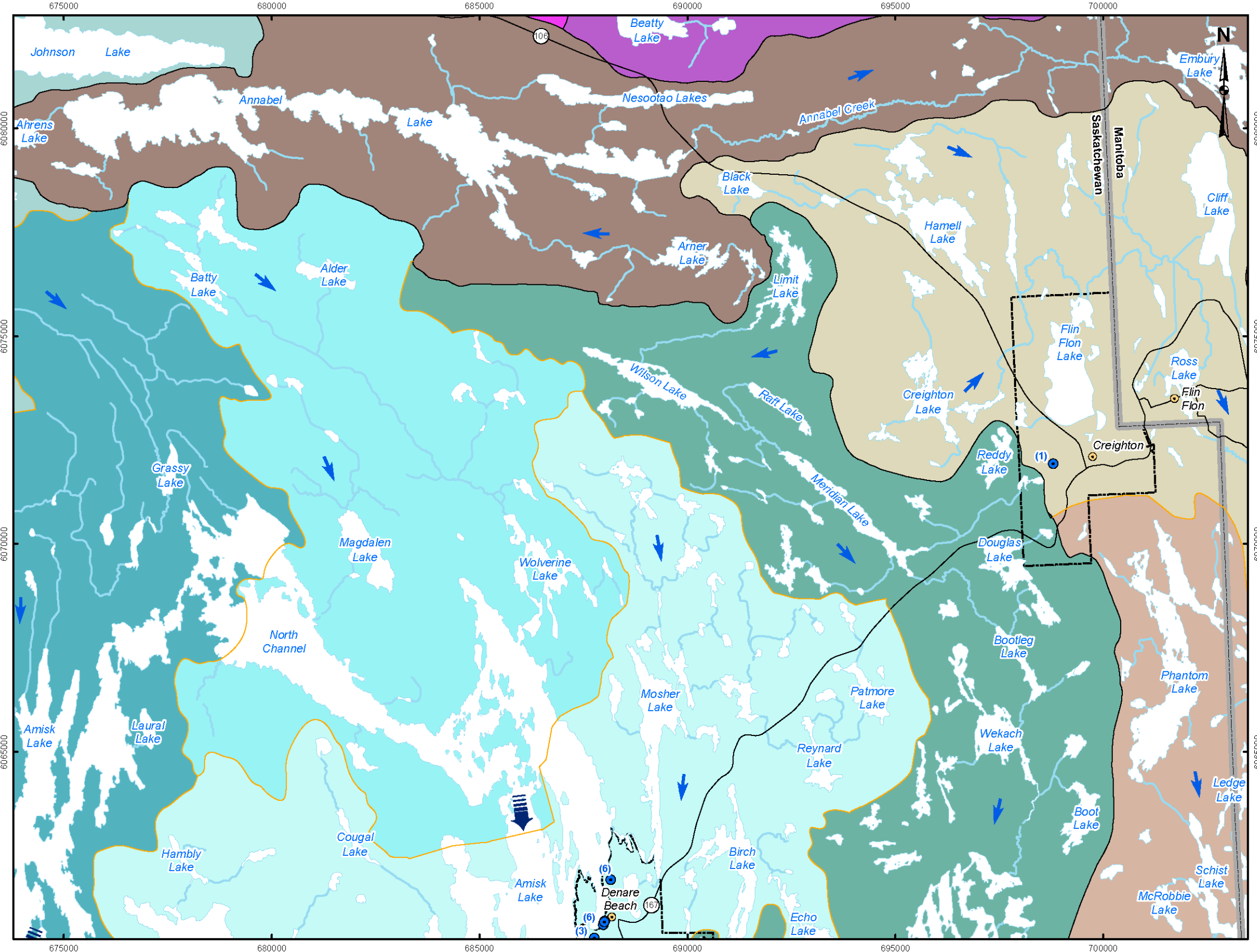
PROJECT
Environment Report
Creighton, Saskatchewan

TITLE
Creighton - Background Radiation Levels

	PROJECT NO.	12-1152-0026	SCALE AS SHOWN	REV. 0.0
	DESIGN	PRM 1 May 2012		
	GIS	PRM 8 Aug 2013		
	CHECK	JH 8 Aug 2013		
	REVIEW	GWS 8 Aug 2013		

FIGURE: 10

G:\Projects\2012\12-1152-0026_NMMO_Phase1_Feasibility\GIS\MXDs\Reporting\Env_Safety_Report\Craighton\CraightonSurfaceWaterDrainage.mxd

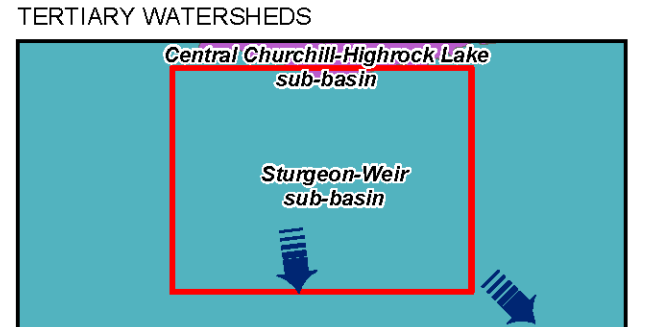


LEGEND

- Community
- Groundwater Well Location
- Main Road
- Watercourse
- Waterbody
- Municipal Boundary
- Provincial Boundary
- Surface Water Flow Direction
- Watershed Outflow Point

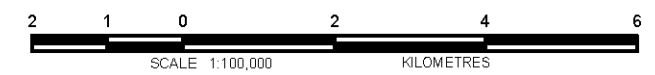
Drainage Divide

- Delineated by PFRA (Confirmed by JDMA)
- Delineated by JDMA

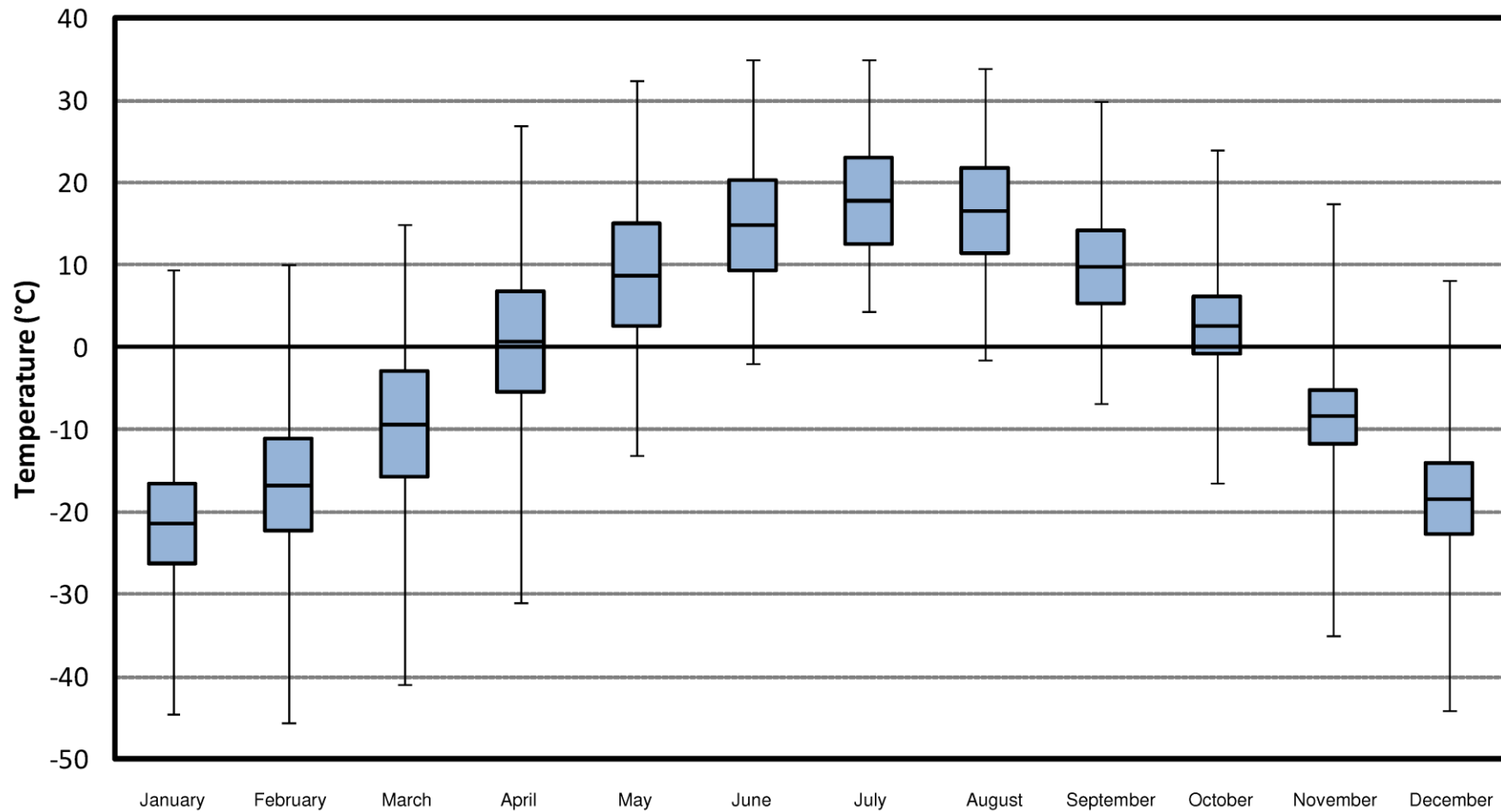


REFERENCE

Basedata - CANVEC V10 Topographic Mapping of Canada (1:50000)
 Administrative Boundaries - Information Services Corporation of Saskatchewan,
 Administrative Boundary Overlays (2012)
 Catchments - Terrain and Remote Sensing Study, Creighton, Saskatchewan (JDMA, 2012)
 Wells - Saskatchewan Watershed Authority Water Well Database
 Projection: Universal Transverse Mercator
 Datum: NAD 83 Coordinate System: UTM Zone 13



PROJECT			
Environment Report Creighton, Saskatchewan			
TITLE			
Creighton Surface Water Drainage and Water Wells			
 Golder Associates Mississauga, Ontario	PROJECT NO.	12-1152-0026	SCALE AS SHOWN
	DESIGN	PRM 1 May 2012	REV. 0.0
	GIS	PMW/B 13 Aug. 2013	FIGURE: 11
	CHECK	JH 13 Aug. 2013	
	REVIEW	GWS 13 Aug. 2013	



LEGEND

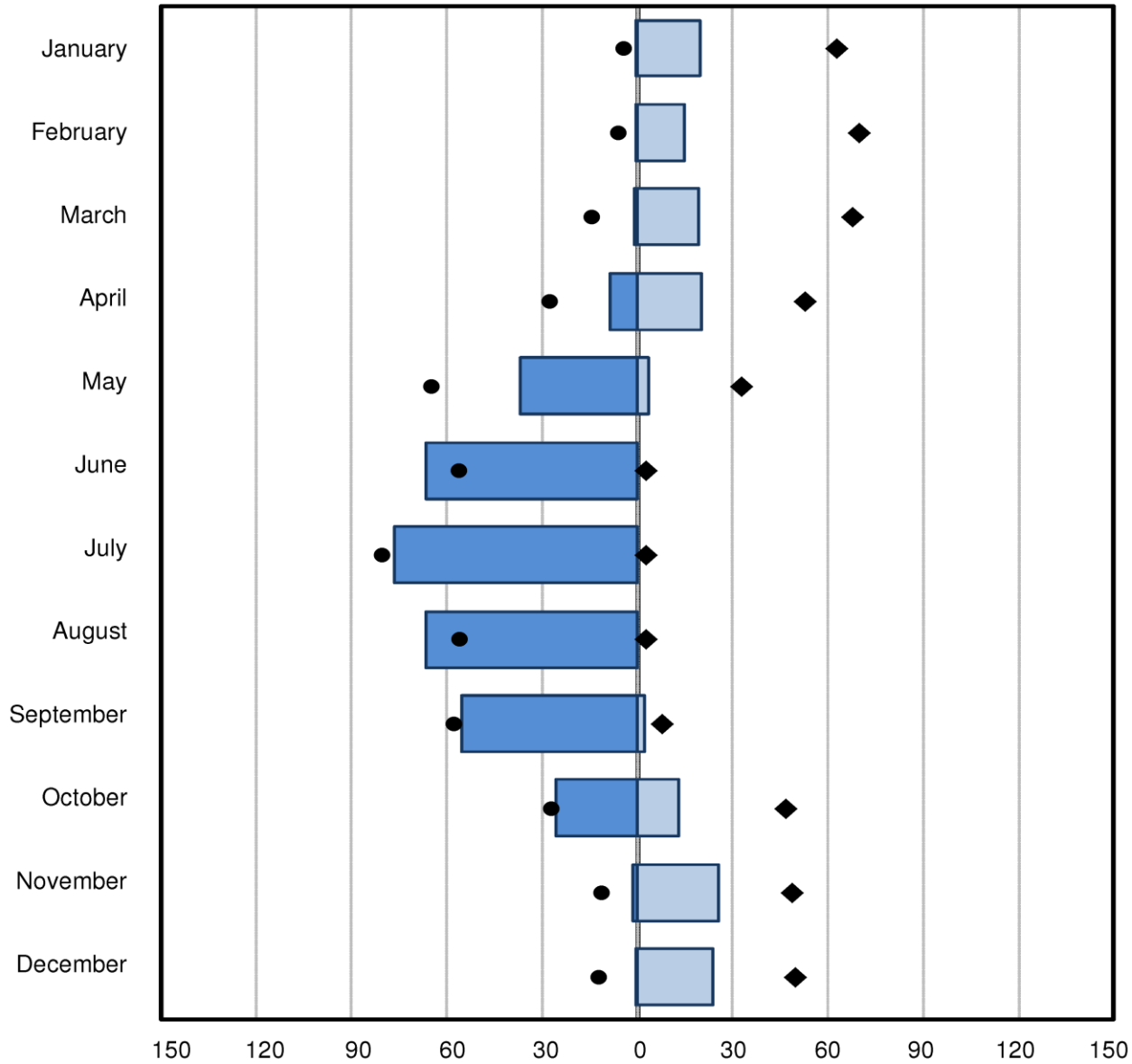
- Extreme Maximum (°C)
- Daily Maximum (°C)
- Daily Average (°C)
- Daily Minimum (°C)
- Extreme Minimum (°C)

DATA SOURCE

Environment Canada

PROJECT		Environment Report Creighton, Saskatchewan	
TITLE		Flin Flon 1971-2000 Temperature Data Summary	
PROJECT NO. 12-1152-0026		SCALE AS SHOWN	REV. 0.0
DESIGN	PRM	7 Jun. 2012	FIGURE: 12
GIS	PRM	8 Aug. 2013	
CHECK	JH	8 Aug. 2013	
REVIEW	GWS	8 Aug. 2013	





LEGEND

- Monthly Rainfall (mm eq.)
- Monthly Snowfall (mm eq.)
- Extreme Daily Rainfall (mm eq.)
- ◆ Extreme Daily snowfall (mm eq.)

DATA SOURCE

Environment Canada

PROJECT		Environment Report Creighton, Saskatchewan	
TITLE			
Flin Flon 1971-2000 Precipitation Data Summary			
PROJECT NO. 12-1152-0026		SCALE AS SHOWN	REV. 0.0
DESIGN	PRM	7 Jun. 2012	FIGURE: 13
GIS	PRM	8 Aug. 2013	
CHECK	JH	8 Aug. 2013	
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