4.0 ENVIRONMENT DESCRIPTION

4.1 BIOPHYSICAL

4.1.1 Climate

The project study area is located in the Whitesands ecodistrict, which is situated in the Aspen Parklands ecoregion within the Prairie ecozone. This section of Saskatchewan experiences humid continental climate characterized by short, warm summers and long, cold winters. The Aspen Parklands typically experience approximately 106 frost-free days. The annual mean daily temperature is 1.4°C with a monthly mean daily temperature ranging from 18.0°C in July to –18.9°C in January [(8)]. The mean annual precipitation for the Aspen Parkland ecoregion is 420 mm, with 262 mm of rain occurring between May and September.

Fishing Lake is located approximately 130 km northwest of the closest Environment Canada weather station, which is located in the city of Yorkton, Saskatchewan. The annual mean temperature recorded at the Yorkton station for 2000 to 2007 was 2.4 °C with a monthly mean daily temperature ranging from 18.7°C in July to –14.9°C in January [(9)]. The mean annual precipitation recorded at the Yorkton station for 2000 to 2007 was 391.3 mm. Total annual rain for this time period was measured at 303.3 mm, with the remainder of the annual precipitation falling as snow.

4.1.2 Air Quality

Air quality in the regional study area is generally excellent compared to large cities or commercial and industrial areas in Saskatchewan and Canada. Air quality concerns in Saskatchewan tend to be of a localized nature, where an activity has an effect only on local people and their environment. Some of these effects may include the presence of odours, noise, dust and other air pollutants. The sources for these and other airborne pollutants include industrial and agricultural operations, vehicle emissions, man-made substances released to the atmosphere and other specific activities. No significant air pollution is expected to occur as a result of work conducted for this project.

The National Air Pollution Surveillance (NAPS) Network monitors air quality at four stations in Saskatchewan. The closest monitoring station to the project area that is not in a strictly urban setting is located at Bratt's Lake (NAPS #: 080901). The remaining three stations are in major urban areas and, as such, the air quality conditions at these locations likely are not as representative of the conditions at the project area. Saskatchewan MOE lists nine primary parameters under its ambient air quality standards including suspended particulates, settleable particulates, soil index, sulphur dioxide, sulphur trioxide, carbon monoxide, ozone, nitrogen dioxide, and hydrogen sulphide (Table 1). The most recent NAPS publication contained the minimum and maximum average concentrations for sulphur dioxide, carbon monoxide, nitrogen dioxide, and ozone detected at 1 and 24-hour intervals for 2005-2006 [(10)]. None of the parameters exceeded the guidelines listed by Saskatchewan MOE.

4.1.3 Physiography and Geology

Regional Stratigraphy

The physiography of the region is characterized by unsorted glacial till covered with layers of stratified glaciofluvial and glaciolacustrine deposits. Repeated advances and retreating from glaciation resulted in the current drift stratigraphy. The drift (area between topsoil and the surface of the bedrock) in this region ranges in thickness from 2 m to 260 m. The drift is broken into three groups; Empress group, Sutherland group, and Saskatoon group. Detailed analysis of the regional geology and groundwater was analyzed using geologic mapping, test drilling and water well drilling over the last 40 years. The SWA has worked in conjunction with the Saskatchewan Research Council (SRC) to compile the most recently updated data [(11)].

The primary regional stratigraphy features are as follows (in descending order):

1) Saskatoon Group
    a. Surficial Stratified Deposits
    b. Battleford Formation
    c. Floral Formation
        i. FF Upper Till Layer
        ii. FF Lower Till Layer

2) Sutherland Group
    a. SG Upper Till Layer
    b. SG Mid Till Layer
    c. SG Lower Till Layer
3) Empress Group
4) Bedrock
    a. Wynyard Formation (Undifferentiated Tertiary-Quaternary sediment)
    b. Pierre Shale
    c. Niobrara Formation & Morden Shale
    d. Favel Formation

Bedrock

The bedrock in this region is dominated by marine sediment deposited from late Cretaceous Epeiric seas and overlain by Tertiary-quaternary terrestrial deposits. The Bedrock is broken into four groups: Favel Formation; Niobrara Formation & Morden Shale; Pierre Shale; and Wynyard Formation. The Favel Formation ranges in thickness from 10 m to 35 m and consists of dark gray calcareous shale with thin beds of clayey limestone. Niobrara Formation and Morden Shale, though technically separate formations are listed as a single unit in this region of Saskatchewan. This formation consists of black, non-calcareous shale with occasional thin bentonite beds (Morden Shale) and chalk-speckled shale (Niobrara Formation). The Morden-Niobrara unit forms the bedrock in a small portion of the northwest section of the region and ranges in thickness from 0 m to 70 m. The Pierre Shale forms the bedrock throughout the region. This unit is composted of non-calcareous silts and clays and ranges in thickness from 0 m to 210 m. The Wynyard Formation is the term allocated to the sediment layer that remained from erosion of the tertiary and quaternary bedrock. These sediments are comprised of yellow, gray, or white sand, silt and clay with patches of gravel at the base.

Drift

The Empress Group (top of bedrock) is the lowest layer of drift situated between the bedrock and the lowest till layer. This group consists of layers of gravel, sand, silt, and clay and ranges in thickness from 0 m to 67 m. The Sutherland Group is located above the Empress Group,

ranging in thickness from 16 m to 105 m, and consists of three till layers. The upper (1 m to 21 m) and lower (1 m to 31 m) till layers consist of hard clay, while the mid layer is softer. The mid (14 m to 53 m) layer is differentiated from the upper and lower layers based on the much higher carbonate content and weathering zone [12, 13]. The Saskatoon Group ranges from 2 m to 110 m and is composed of the Floral Formation, the Battleford Formation and the surficial stratified drift. The Floral Formation contains tills from two glaciations, which are separated by a few meters of sand containing fossilized bone, wood, and shells referred to as the Riddell member [14]. The Battleford Formation has soft till which is differentiated from the upper Floral Formation till layer by the lack of staining from oxidization that is common in the Floral Formation [13]. The surficial stratified drift in this region is a mix of glaciolacustrine and glaciofluvial sediments, as well as deposits of alluvial sediments.

4.1.4 Soil Stratigraphy

The general soil types in the area surrounding Fishing Lake are classified primarily as Yorkton (Yk) light loam with a mix of Meota (Me) soils extending from the southwest bank of the lake [**15**]. Yorkton soils are thick black soils formed in loamy glacial till. The surface horizon is greater than 20 cm in thickness with textures ranging from sandy loam to silty-clay loam and typically contains high numbers of stones. Meota soils are black soils formed in sandy fluvial materials with textures ranging from very fine sandy loam to loamy sand. As compared to Yorton soils, Meota soils typically do not contain stones [16, 17].

Nine borrow pits were selected immediately surrounding Fishing Lake as material for the emergency berm construction. The most common soil types at each of these locations were oxbow (Ox), whitewood (Wh), and whitesand (Ws) soils. Oxbow soils are black soils with surface horizons ranging from 11 to 18 cm thick and are predominantly loam but can range from sandy loam to clay loam. These soils tend to contain moderate to high quantities of stones. Whitesand soils are black soils that have surface horizons ranging from 10 to 20 cm and the level of stones ranges from low to high depending on the area. Whitewood soils are dark grey soils with surface horizons ranging from 10 to 18 cm and have textures ranging from sandy loam to clay loam. These soils range from moderate to high stone content [16, 17].

All five of the soil types described above are commonly formed on gentle to moderate slopes that are representative of the area surrounding Fishing Lake. The soil types identified at each of the borrow pits areas sampled by Clifton Associates Ltd. are as follows:

- Leslie Beach (Ox, YK)
- Golf Course (Ox)
- KC Beach (OX)
- Narfason Beach (OX, Ws)
- Murray Beach (Ox, Wh)
- Ottman Beach (Ox, Wh
- Pavillion Beach (Ox, Wh)
- Kuroki Beach (Ox, Wh)
- Buckhorn Bay (Ox, Wh)

Clifton Associates Ltd. did not send soil samples for analysis during construction of the temporary berms; however, on July 12, 2007 five test pits were sampled that were located east of Fishing Lake. One test pit (TP1) was sampled from an area with Meota/Oxbow soils while three test holes (TP2-TP4) were in oxbow/whitewood soils. No description was provided for the soil type at TP5. Based on these test pits the average thickness of the topsoil and sand/silt layers was 18 cm and 70.5 cm, respectively. The till was sampled from the test pits to a depth of 3.8 m. Till material became much denser at depths between 3.1-3.6 for all test pits. Coupled with the presence of boulders and some sand and gravel at the interface, Clifton Associates Ltd. concluded that the condition of the material at these depths indicate the transition from the Battleford Till to the Floral Till layers [(13)].

4.1.5 Groundwater

The groundwater in the Aspen Parkland Ecoregion is primarily associated with the drift and bedrock aquifers [(8)]. The Yorkton area has four categories of aquifers: Surficial, shallow intertill, deep intertill, and Empress Group & Tertiary-Quaternary Bedrock. Five aquifers are known to exist within the regional study and project study areas. Three of the aquifers identified are categorized as Empress Group (2) and Tertiary-Quaternary bedrock (1) aquifers. Two deep intertill aquifers are situated so that a portion of the aquifer is directly under the Fishing Lake project study area. Intertill aquifers are among the more common aquifers in Saskatchewan and are composed of sediment layers, particularly gravels and sands that are situated between or within till units. One of the deep intertill aquifers is listed as an interglacial aquifer and is

believed to occur between the lowest till of the Saskatoon Group and the highest till of the Sutherland Group [11]. The second deep intertill aquifer in the study area occurs in the Sutherland Group. This aquifer is recharged in the upland area north of Margo and discharges into the Quill Lakes.

Groundwater is used within the project study area for domestic potable and non-potable water uses. Groundwater wells have been established in numerous locations along the periphery of Fishing Lake as shown in Figure 5. Many of these wells are situated in close proximity to the existing temporary berms. Groundwater quality was analyzed from one-time samples collected in three different years from three groundwater wells at Chorney Beach. Although Saskatchewan MOE provides a list of water quality objectives and standards for drinking water [18], the groundwater data was compared to the more extensive Federal-Provincial-Territorial Committee on Health and the Environment Guidelines for Canadian Drinking Water Quality (HC-CDWQ) [19]. The concentrations of many of the parameters measured in the groundwater samples from Chorney Beach were well above the HC-CDWQ drinking water guidelines. In particular, hardness, sulphate, sodium, and total dissolved solids (TDS) consistently exceeded the HC-CDWQ objectives in each of the years sampled. The groundwater quality in the project area as measured in the water samples from Chorney Beach is summarized in Table 2 with the exceedances listed as follows:

- Hardness concentrations ranged from 334 mg/L to 707 mg/L, which exceeded the aesthetic objective of 200 mg/L;
- Sulphate concentrations ranged from 603 mg/L to 1017 mg/L, which exceeded the aesthetic objective of 500 mg/L;
- Sodium concentrations ranged from 318 mg/L to 343 mg/L, which was exceeded the aesthetic objective of 200 mg/L;
- TDS concentrations ranged from 1583 mg/L to 2028 mg/L, which exceeded the aesthetic objective of 500 mg/L;
- Iron concentrations in 1994 (3.1 mg/L) and 1998 (1.1 mg/L) exceeded the aesthetic objective of 0.3 mg/L;
- Manganese concentrations in 1994 (0.24 mg/L) and 2000 (0.09 mg /L) exceeded the aesthetic objective of 0.05 mg/L;

- The nitrate concentration in 2000 (11 mg/L) exceeded the maximum allowable concentration for health related guidelines of 10 mg/L.

Most of these exceedances are only aesthetic concerns; however, water with high levels of nitrates can pose a direct health risk to young children and, as such, is not recommended to be used for infant feeding.

4.1.6 Surface Water

Fishing Lake is located in the headwaters of the Whitesand River, which is a tributary to the Assiniboine River, joining it at Kamsack approximately 20 km upstream of Lake of the Prairies [(5)]. Fishing Lake is a semi-closed basin lake, which means typically it is the terminal water body with water flowing in from several creeks and streams and no water flowing out [(20)]. The drainage area contributing to Fishing Lake is 634 km^2 but only 407 km^2 effectively contributes runoff during normal conditions [(6)].

The lake is composed of three basins one of which, Indian Lake, is separate during low water periods [(5)]. The water level in Fishing Lake has generally ranged between an elevation of 527 masl and 529 masl since 1964, when levels began to be recorded on Fishing Lake [(1)]. The lake area ranges from about 3,000 ha during low water levels to about 4,000 ha during high water events [(21)]. The top 16 m of the lake is generally well mixed; however, a strong seasonal water density gradient can develop below this depth due to increasing temperature and increasing salinity [(5)]. Fishing Lake is classified as saline, with a TDS concentration typically above 3000 mg/L [(5)].

Fishing Lake does drain during periods of high water levels. When the lake surface reaches an elevation of 529.74 m, water from Fishing Lake flows eastward through a series of lakes to the Whitesand River. Lakes downstream of Fishing Lake are (from upstream to downstream): Hazel Lake, Stoney Lake, Whitesand Lake, Dog Lake, and Newburn Lake. Channels between these lakes are generally poorly defined, carry low flows and provide good fish habitat. Though Fishing Lake drains into Hazel Lake during periods of high water levels, Hazel Lake typically flows west into Fishing Lake when the water surface of Fishing Lake is below 529.74 m [(3)].

Background monitoring was conducted by the SWA during the summer of 2007 as a part of an assessment of the east and west Fishing Lake conveyance options and their possible impacts. In May 2007, water was sampled at five locations around Fishing Lake, including one station in the Indian Lake basin. Four out of five sampling stations for 2007 were at or near the stations used during a previous water quality analysis in 1990. Findings from the 2007 analysis showed that the top 16 m of the lake is generally well mixed, whereas below 16 m there is a strong density gradient due to decreasing temperature and increasing salinity.

A summary of the water quality results collected from the baseline stations on Fishing Lake during the 2007 sampling is as follows [(20)];

- Total dissolved solids (TDS) sampled from 5 sites on Fishing Lake ranged from approximately 2500 – 3100 mg/L. Fishing Lake has been classified as saline as the TDS has historically ranged from approximately 3065 mg/L to 4430 mg/L, with a mean of 3700 mg/L and median of 3900 mg/L;
- Specific conductivity ranged from approximately 3000 μS/cm to 3400 μS/cm;
- Total phosphorus concentrations had a mean and median of 30 μg/L while ortho-P concentrations were at or below detection limits (10 μg/L);
- Total nitrogen concentrations had a mean and median of 1.2 mg/L;
- Ammonia concentrations had a mean and median of 0.7 mg/L; and
- Nitrate+nitrite concentrations were below the detection limit (0.01 mg/L).

An intensive water quality monitoring program was also conducted during 2008 as part of the sediment recovery program following construction of the temporary berms [(22)]. The monitoring program included analyzing characteristics of water inside and outside the turbidity curtains in Fishing Lake, water trapped behind the constructed berms and water removed from soil borrow pits. The data collected from outside the turbidity curtains in the main body of Fishing Lake is representative of baseline conditions and summarized as follows:

- pH ranged from 8.4 to 9.0, with a mean of 8.7 and median of 8.8;
- TDS ranged from 2197 mg/L to 2410 mg/L, with a mean of 2288 mg/L and median of 2284 mg/L;

- Specific conductivity ranged from 3300 μS/cm to 3600 μS/cm, with a mean and median of 3400 μS/cm;
- Dissolved oxygen ranged from 6.0 mg/L to 10 mg/L, with a mean of 7.2 mg/L and median of 7.0 mg/L;
- Water temperature was recorded from the beginning of August to the end of September and fluctuated in response to air temperatures. Water temperature ranged from 13.8 °C to 26.8 °C, with mean of 20.8 °C and median of 21.0 °C; and
- Turbidity ranged from 1.38 NTU to 12.80 NTU, with a mean of 2.88 NTU and median of 2.00 NTU.

4.1.7 Vegetation

The Aspen Parkland Ecoregion is a transition zone between the tall and mixed-grass prairies and the Boreal Forest. The woodland areas of this ecoregion are dominated by trembling aspen (*Populus tremuloides*) and balsam poplar (*P. balsamifera*). Along riparian areas there are increased frequency of green ash (*Fraxinus pennsylvanica*), Manitoba maple (*Acer negundo*), American elm (*Ulmus americana*), and cottonwood (*P. deltoides*). Historically the region had frequent stands of bur oak (*Quercus macrocarpus*); however, this species is now more limited to areas of higher elevation [(8)]. Plains rough fescue grasslands dominate much of the region, though overgrazing and cultivation has resulted in a mixed prairie community of spear grass (*Stipa comata*), blue grama (*Bouteloua gracilis*), pasture sage (*Artemisia frigida*) and Kentucky bluegrass (*Poa pratensis*). Within the Whitesand Plain Ecodistrict the dominant vegetation is comprised of rangeland-pasture and cropland. The primary crops in the region are cereals, oilseed and forage [(8)].

As part of the environmental assessment of the proposed east and west Fishing Lake drain improvement options the SWA conducted a botanical survey on May 30 – June 1, 2007. A second survey was also conducted on June 27, 2007 specifically to assess the presence of rare and endangered plants. Plant species were identified along several transects east and west of fishing lake with three of these transects located within the current project study area and surrounding regional study area. Two of these transects were established east of the southeast shore of Fishing Lake, while the third transect was established west of the southwest shore of Fishing Lake. The plant species identified within the regional study area along these three transects is summarized in Table 3. The three most abundant species along Transect 1 were

the native forb eastern blue violet (*Viola adunca*) and the native shrubs Wood's rose (*Rosa woodsii*) and silverberry (*Elaeagnus commutata*). The three most abundant species along Transect 2 were the exotic forb common dandelion (*Taraxacum officinale spp. officinale*) and the native shrubs Wood's rose and western snowberry (*Symphoricarpos occidentalis*). The three most abundant species along Transect 3 were the exotic forb common dandelion, native graminoid sedge species (*Carex spp.*), and the native shrub western snowberry.

Four species are listed by the Saskatchewan Conservation Data Center (SKCDC) as species of concern within the Rural Municipalities of Foam Lake and Sasman, which contain the area designated as the regional study area (Table 4, Appendix C). None of these species of concern were encountered during the vegetation surveys. The SKCDC monitors vascular plant species of conservation concern and ranks them based on their abundance in Saskatchewan. The ranking for species range from extremely rare (S1 – 5 or fewer occurrences or very few remaining individual) to very common (S5 – >100 occurrences, widespread and abundant) (Appendix C). The ranking is intended to indicate a species' risk of extirpation and do not necessarily reflect a priority of management.

False spikenard (*Maianthemum racemosum ssp. Amplexicaule*) was recorded during the vegetation surveys (Table 3) [(5)]. False spikenard is listed by the SKCDC as extremely rare to rare (S1S2) for the province of Saskatchewan, although it is not currently listed as occurring within the R.M. of Foam Lake or Sasman. A general description of vegetation communities along the transects suggested that this species accounted for a large percentage of the surrounding vegetation when present in an area [(23)]. In terms of plant species identified at field stations along the three transects, false spikenard accounted for 0.75 % and 1.5 % of the total vegetation along transects 2 and 3, respectively. Although the SKCDC list this species as extremely rare to rare within the province (indication of potential risk of extirpation), the abundance of this species in the regional study area suggests that the false spikenard does not require specific protective management practices. Maianthemum species are typically found in moist, rich to dry woods and clearings [(5)]; and is therefore not likely to be present on or around the locations of the proposed berm upgrades or borrow pits.

The presence of western red lily (*Lilium philadelphicum var. andinum*) was recorded during the vegetation surveys (Table 3) [(5)]. While the western red lily was not previously recorded by the

SKCDC for these RMs it is a species of concern within Saskatchewan. The western red lily is listed as rare-uncommon to common (S3/S4) by the SKCDC and is listed as the floral emblem of Saskatchewan under the Provincial Emblems and Honours Act. This species was found to have sporadic distribution with only a few plants found along low-lying areas southeast of Fishing Lake. This species is most often found in moist meadows, ditches, thickets, and open deciduous woods [(24)].

The vegetation in the vicinity of where the temporary berms were constructed would have consisted primarily of grasses and shrubs that are typical of disturbed and/or residential sites. As the temporary berms were completed in 2007 and were not re-vegetated post construction, any vegetation present currently will generally consist of pioneering (weedy) grasses, forbs and shrubs. Similarly the borrow pits will likely have experienced establishment of pioneer shrubs and grasses, as well as weeds of crops which would have encroached from the surrounding cultivated lands.

4.1.8 Wildlife/Habitat

Mammals

The Aspen Parkland Ecoregion supports fifty-five mammal species. The dominate ungulate is white–tailed deer (*Odocoileus virginianus*), though there are regular occurrences of Mule deer (*Odocoileus hemionus*), elk (*Cervus canadensis*), moose (*Alces americanus*), and pronghorn (*Antilocapra americana*). The dominant small mammal in the woodland areas is snowshoe hair (*Lepus americanus*), red-backed vole (*Clethrionomys gapperi*), Franklin's ground squirrel (*Spermophilus franklinii*), and the striped skunk (*Mephitis mephitis*). In the sloughs and marshes, muskrat *(Ondatra zibethicus*) is the dominant small mammal species. Additional common mammal species found in the Aspen Parkland Ecoregion include raccoon (*Procyon lotor*), black bear (*Ursus americanus*), six species of shrew, six species of bat, six members of the weasel family and three felines [(25)].

There are no mammal species of conservation concern listed in SKCDC database for the Rural municipalities of Foam Lake and Sasman (Appendix C), which contain the area designated as the regional study area. Wildlife surveys were not conducted as part of the preliminary

assessment of the proposed east and west Fishing Lake drain improvement options. The only mammals likely to be observed in the immediate vicinity of the proposed project would include those species adapted to the presence of humans because the area is residentially developed. These would typically include small mammals such as red-backed vole, Franklin's ground squirrel, and the striped skunk. Although, some of the typical larger mammals may be present in the remnant forest patches surrounding Fishing Lake and in particular the Fishing Lake Wildlife Refuge located to the northwest of Buckhorn Bay beach.

The habitat directly affected by the excavation of the borrow pits and the subsequent construction of the temporary berms were previously disturbed, residential, or cultivated lands. The proposed berm upgrade works will likely be contained within the same ecological footprint as the previous work for the existing berms. These areas do not provide good quality habitat and therefore are less likely to be frequented by most large mammals, except for opportunistic feeding by ungulates in the cultivated lands surrounding the existing borrow pits. Similarly, the cultivated lands used for borrow pit excavation would likely be used for opportunistic feeding, foraging, breeding, and burrowing habitat by small mammals including many species of mice, shrew and voles.

Birds

There are 320 bird species recorded throughout the Aspen Parkland Ecoregion. Numerous tree-ringed, small lakes, ponds, and sloughs occur in the rougher hummocky glacial till landscapes, which provide a major breeding habitat for waterfowl, migratory birds and various species of conservation concern [25]. Most of the species that occur in the Ecoregion are associated with specific habitat types (non-treed, shrub, forest, wetlands, and along the shores of water bodies). A few species, such as the house sparrow (*Passer domesticus*), barn Swallow (*Hirundo rustica*), red-tailed hawk (*Buteo jamaicensis*) and great horned owl (*Bubo virginianus*), though abundant, are not tied to a specific habitat type [8].

Bird surveys were conducted by the SWA between May 29 -31, 2007 as part of the environmental assessment of the proposed east and west Fishing Lake drain improvement options. Bird species were identified along several transects east and west of fishing lake with three of these transects located within the current project study area and surrounding regional

study area as previously described. Six types of land cover were categorized within the surveyed area, which included aspen forest, cropland, meadow, pasture, dugout, and wetland with a total of 523 individuals observed from 63 species (Table 5). A large percent of the observation data were of singing or displaying territorial males; whereas females are generally incubated and more difficult to detect. As such the count data in this report could be interpreted as indicated pairs because each territorial male is assumed to mate with a single female. However, the count data was reported as individual occurrences.

The ten most common species recorded in the regional study area during the 2007 bird surveys included the clay-colored sparrow (*Spizella pallida*), Red-winged blackbird (*Agelaius phoeniceus*), savannah sparrow (*Passerculus sandwichensis*), American coot (*Fulica americana*), Le Conte's sparrow (*Ammodramus leconteii*), yellow warbler (*Dendroica petechia*), blue-winged teal (*Anas discors*), least flycatcher (*Empidonax minimus*), song sparrow (*Melospiza melodia*), and sora (*Porzana carolina*) (Table 5). Four of these species were common to most of the land cover types. The remaining six, had incidental occurrences in more than one land cover type; however, appear to have an association with a single cover type. American coot, blue-winged teal and sora, for example, appear to be associated with the wetland cover type (Table 5), which correlates with the known habitat for these species [(26)].

Six of the species recorded during the 2007 bird survey are listed by the SKCDC as species of concern, primarily for the abundance of the non-breeding population within the province (Table 5). The bufflehead (*Bucephala albeola*) is ranked as extremely rare (S1N), the gadwall (*Anas strepera*), green-winged teal *(Anas crecca*), and readhead (*Aythya americana*) are all ranked as rare (S2N) and the lesser scaup (*Aythya americana*) is ranked as rare-uncommon (S3N) for the non-breeding migratory species within the province. However, the breeding populations of all 5 of these species are ranked as very common (S5B) and therefore not a concern. The American white pelican (*Pelecanus erythrorhynchos*) was the sole species of conservation concern recorded within the regional study area that was ranked as rare-uncommon (S3B) for the breeding migratory population within the province.

The SKCDC lists nine species and a migratory bird site of conservation concern that have been previously recorded as existing within the rural municipalities of Foam Lake and Sasman (Table 4; Appendix C). Only one of these listed species, the black tern (*Chlidonias niger*), was

recorded within the regional study area during the 2007 bird survey. The black term is ranked as common (S4B) for the breeding migratory population within the province. A yellow rail (*Coturnicops noveboracensis*) survey was also conducted between June 19 – 24 2007 along the southeast bird survey transects within the regional study area which also continued beyond the regional study area. The Yellow Rail is ranked by the SKCDC as rare-uncommon (S3B) for the breeding and rare (S2M) for the non-breeding transient migratory population within the province. No Yellow Rail were detected within the regional study; however, as there were numerous recordings 11 km and further from the southeast shore of Fishing Lake it is likely that there may be incidental occurrences within the regional study area.

The migratory bird concentration site listed on the SKCDC is a reference to the entirety of Fishing Lake. The SKCDC provides management practices for reducing impacts to bird populations that depend on the lake and surrounding shoreline for staging and nesting habitat (Appendix C). The management practice suggests that during peak periods of use a 250 m activity buffer from the perimeter of the water body, in particular from areas with nesting colonies. Peak periods of use for nesting waterfowl occur between May 1 - June 30; for staging waterfowl between September 1 - October 15; for staging shorebirds between May 15 – May 31 and between July 15 -August 15; and for colonial nesting birds (Herons, terns, gulls and grebes) between May1 – June 30.

Amphibians

The Boreal chorus frog (*Pseudacris triseriata*) was recorded at seven stations along the three transects within the regional study area. The Boreal chorus frog is ranked by the SKCDC as very common (S5). No other amphibians were recorded during the biological surveys. This frog species was encountered almost exclusively in wetland areas along the transects, although it was observed once in a forested area. This species typically is found in wetlands and meadows and will breed in marshes, bogs, and marshy edges of lakes [(27)].

4.1.9 Aquatic Habitat

Water Regime

The availability of water is a major variable influencing the availability of aquatic habitat. In Fishing Lake, water levels have fluctuated markedly over time. This water regime is characteristic of many temperate lakes in North America that occur in smaller watersheds that are strongly dependent on local precipitation (i.e. inflows and rain) to control water levels. Many such lakes, like Devils Lake in North Dakota, do not have a well-defined outflow until a flood stage is attained. These lakes may spend several to many consecutive decades as closed basins and exhibit marked increases and decreases of lake level, with natural loss of water due only to evaporation. Aquatic habitat availability in closed basins is dynamic as the forces responsible for developing and maintaining habitat distributions in space and time vary as lake levels change. The distribution, quantity, and quality of shallow water habitat observed at any one time, therefore, will be the product of more recent processes, and can be expected to change as water levels vary in the future.

The water level history and zones of water level variation in Fishing Lake are defined in the following paragraphs, for the entire record and for more “recent” conditions to better appreciate: 1) differences in water levels of the distant and recent past, and 2) how the extent and type of berms proposed as flood control may change the quantity and quality of recent shallow water habitat.

Water level variation records on Fishing Lake were collected systematically after 1964, and were modeled by the SWA during the period 1910 to 1964. Monthly Lake levels from1910-2008 shows a maximum range lake level variation of 4.16 m, with maximum and minimum lake levels of 530.56 and 526.4 masl, respectively (Appendix A). Maximum and minimum observations in water level records occur only twice, and events that fall near these levels are so infrequent they seldom influence aquatic biota. To characterize most of this historic variation while excluding the effects of infrequent lake levels, the historic intermittently exposed zone (IEZ_{hist}) was defined as the range between the 95^{th} and 5^{th} water level percentiles, which accounts for 90% of the water level variation. In Fishing Lake, IEZ_{hist} ranges from 529.85 m to 526.85 m and is 3 m deep.

The water levels in Fishing Lake prior to 1930 were high and in general similar to those observed after 1995, where lake levels exceeded the outlet elevation (Appendix A). Water levels have been at or above the outlet elevation for approximately 16 of the 100 year data record (Appendix A). During the intervening 65 years, Fishing Lake was a closed basin. During this time, trends in lake levels appear to be sub-decadal. As expected, changes during periods of decline appear to be slower from evaporation than during periods when lake levels were rising (inflows exceed evaporation). For example, lake level declines occurred from 1930 to 1940, 1957 to 1966, 1985 to 1995, 1997 to 2006, whereas periods of stability occurred during 1940 to 1951, 1966 to 1974, 1976 to 1985. During times of lake level rise the periods appear shorter; 1951 to 1956, 1974 to 1976, 1995 to 1997 and 2003 to 2007.

To appreciate the size of the proposed works relative to scale of the system an analysis of the water level record (Appendix D) was undertaken to derive and map the extent of the IEZ for the recent past (IEZ $_{recent}$). The analysis also provides a basic understanding of how much water level variation might be expected in less than a decade to improve the understanding of habitat availability and value over time in this lake. Results suggest that the IEZ $_{recent}$ can be defined at about 1.8 m water depth (El. 527.8 masl; Appendix D). Results also show that periods of water level rise tend to occur more quickly than decline and that in just 5 to 7 years water levels may rise 1.8 to 1.9 m. In contrast, water level declines are slower, as would be expected due to evaporative losses only, and in roughly 10 years or less water levels may fall about 2 m.

Fish Habitat Zones

The upper elevation of fish habitat in Fishing Lake has been defined by DFO to be the level of the lakes' outlet (El. 529.74 masl). This elevation is also the upper limit of the IEZ $_{recent}$. The total area of Fishing Lake that is considered fish habitat is approximately 3, 620 Ha, of which the IEZ $_{recent}$ is approximately 1,050 Ha or approximately 30% of the fish habitat area. The lake depth reaches 20 m but most of the basin area is shallow. The IEZ, both recent and historic, occupy a notable proportion of the lake area (Figure 6), primarily in the southwest portion of the lake, and volume of the basin (Figure 7).

Lake levels have been higher than the outlet level for most of the time since 2006 and the lake remains in flood stage. Lake wide habitat distributions are not known presently and are difficult

to collect while the lake is flooded. IKONOS high-resolution imagery, captured during 2007 with the lake at El. 530.4 masl, clearly shows that the perimeter of the lake can extend well outside of the boundary elevation of fish habitat, and that many types of terrestrial land cover are found within the zone of fish habitat as defined by DFO. Canada's Land Cover Classification data, which was collected as recently as 2004 at a lower lake stage [(28)], confirms that at least 16.8% of the IEZ_{recent} originates from terrestrial land cover classes including developed, grassland, annual and perennial cropland, deciduous, and wetland. Croplands account for 154.6 Ha (14.6%) of the IEZ_{recent} and indicate that the composition of lakebed materials in shallow water is markedly variable.

4.1.10 Aquatic Biota

Macroinvertebrates

Benthic macroinvertebrates are a broad group of animal taxa characterized by exoskeletons and absent backbone, yet are enormously diverse and capable of inhabiting most aquatic environments. As an assemblage, benthic macroinvertebrates are important components of freshwater food webs, providing prey for forage fish species, and as key providers of ecosystem functions. Further, benthic macroinvertebrates are the taxa assemblage most commonly used for monitoring stressed freshwater benthic habitats, and have been proven to provide accurate measurements of impact. The abundance, diversity and composition of aquatic invertebrate assemblages are governed by the physical and chemical characteristics of the environment they inhabit and, as such, these organisms are often directly impacted by anthropogenic perturbation.

Habitat complexity governs the type, quantity, and quality of food and refuge available to benthic macroinvertebrates. Different organisms are adapted to exploit different combinations of substrate types available within benthic habitats. For example, fine textured sediments typical of many lacustrine environments are characteristically dominated by chironmidae (midges) and oligochaeta (aquatic earthworms). Particle size of the available substrate can influence the density of the benthic invertebrate community. Total benthic invertebrate production tends to be relatively low on extremely fine materials such as silt/clay or sand and extremely coarse materials such as boulder or bedrock substrates. Whereas productivity is typically highest for

substrate particles averaging 10 mm in diameter such as gravel [29]. Under non-stressed conditions, more diverse habitat structures result in increased diversity and density of taxa utilizing the available habitat. For instance, beds of aquatic macrophytes typically harbour the greatest density and variety of macroinvertebrates, living on the leaf surfaces (plant-dwelling or epiphytic invertebrates) as well as on and within the sediments beneath the plants (sediment-dwelling or benthic invertebrates).

Natural saline lakes typically support lower diversity and density of benthic macroinvertebrates [30]. As salinity declines, diversity and density of primary and secondary producers may be enhanced [30, 31]. For example, Waldsea Lake, SK, which is in relative proximity to the project study area (TDS 15,000 – 18,000 mg/L), has a much higher species diversity than the much more saline Mono Lake (TDS 90,000 mg/L) in California. The littoral zone of Waldsea Lake supports high densities of relatively few species, while the hypersaline conditions of Mono Lake support an extremely stunted community. Although the benthic macroinvertebrate community in Waldsea Lake is diverse compared to Mono Lake, it is depauperate in comparison to most permanent freshwater lacustrine habitats [30]. Studies suggest that a TDS concentration of approximately 1000 mg/L is a threshold defining saline lakes as several species found in lakes with lower concentrations were not found above this threshold [32; 33]. However, many benthic macroinvertebrates are tolerant of a broad range of concentration (> 30,000 mg/L) [34; 35, 36].

The benthic macroinvertebrate community of Fishing Lake is characterized by assemblages structured by the aforementioned physiochemical attributes of this prairie lake. Specifically, its shoreline is primarily sandy with abundant macroinvertebrates and patches of cobble, and it is classified as saline with TDS concentrations ranging from approximately 2,000 mg/L to over 4,000 mg/L [20]. Fishing Lake has a relatively abundant benthic macroinvertebrate community ranging from approximately 2,950 to 5,750 individuals/m^2 concentrated within the shallower littoral areas [4]. The benthic community was dominated by the diptera family chironomidae, particularly from the Genus *Monodiamesa*, which are tolerant of low dissolved oxygen. Other dominant taxa were from Orders including trichoptera, ephemeroptera, odonata, and amphipoda, Class gastropoda, and from subclasses oligochaeta and hirundinea [4].

Fish Biology

The fish species known to inhabit Fishing Lake are common to many temperate lakes and rivers and do not include species that are endangered, threatened, or of special concern. The species are: Northern pike (*Esox luscious*), walleye (*Sander vitreus vitreus*), yellow perch (*Perca flavescens*), white sucker (*Catastomus commersoni*), brook stickleback (*Culaea inconstans*), ninespine stickleback (*Pungitius pungitius*), Iowa darter (*Ethiostoma exile*), and spottail shiner (*Notropis hudsonius*) [37, 38].

Fishing in the lake is mainly recreational for pike, walleye, and perch, although subsistence fishing by the Fishing Lake First Nation also occurs. Studies by Saskatchewan Environment in the inflowing creeks and the lake suggest that pike and walleye ascend the creeks during spawning [39]. Successful spawning in the creeks has been documented for pike, but recruitment from the inflows does not occur when spring freshet and run-off conditions are poor [39]. Sampling in the lake in 2000 indicated dominant year classes of young pike, which can be correlated to flooding from increased lake levels in the 1990's and an increase of spawning habitat [39].

Similarly, reproduction by walleye is likely unsuccessful under typical conditions in Fishing Lake. No quantifiable data exists for the presence of young of the year (YOY) walleye in Fishing Lake; however, there were reported observations of YOY walleye in the northwest section of the lake[40]. These observations occurred in 2007 during periods of high water, which could have resulted in reduced TDS and pH in the lake. High pH and TDS likely limit reproduction of walleye [39]. Some reproductive success of walleye has been noted in Hazel Creek and Hazel Lake, although typical spawning habitat for walleye (rock cobble) were not located [38]. Thus, there is limited natural reproductive success of walleye in the system. Under current stress from recreational fishing, the success of the walleye population in the lake is dependent on the regular stocking, which has been ongoing since 1923 [38; 39]. Additional studies in 2009 were conducted in order to monitor populations of walleye and other sport fish in the lake system; however, the data has not yet been analyzed by Saskatchewan Environment and, as such, is not included in this document.

The following is a brief summary of habitat and spawning preferences of forage (small-bodied) fishes. The spottail shiner prefers sand habitat and spawns in shallow water (0.9 to 1.2 m) in June or July. The brook stickleback and the nine spine stickleback are known to inhabit vegetated areas with organic or sandy bottoms. Both species of stickleback are well adapted to saline conditions and are known to spawn in June or July in shallow water with plants, which are used to build nests. The Iowa darter has the widest distribution of all darters in Canada, but little is known of their spawning or other requirements other than that spawning occurs in shallow water [(41)]. The distribution and type of habitat in the areas of the proposed berm upgrades are described in Section 6.3.7.

4.2 SOCIAL

4.2.1 Communities

Fishing Lake, as noted, is located along the border of the R.M. of Sasman and the R.M. of Foam Lake. Several beach communities are located along the shores of fishing lake and within the project study area (Figure 2). Kuroki Beach, Saskin Beach, and Buckhorn Bay are on north side of Fishing Lake within the R.M. of Sasman. Pavillion Beach, Ottman Beach and Murray Beach are along the north shore of Fishing Lake's southeast basin within the R.M. of Sasman. KC Beach and Narfason beach are along the south shore of Fishing Lake's southeast basin in the R.M. of Foam Lake. The resort villages of Leslie Beach and Chorney Beach, the two largest communities on the lake, are along the southern shore of the lake. In total these beach communities are home to approximately 550 cottages and residences around the lake [(2)]. The Fishing Lake Indian Reserve (IR #89) is also located on the western shore of Fishing Lake and will be discussed further in Section 4.2.4. The only other towns within the regional study area include Kuroki, 4.7 km northeast, and Kylemore, 5.3 km northwest of the shoreline of Fishing Lake, which are within the R.M. of Sasman.

4.2.2 Population/Demographics

Population and demographics for the R.M. of Foam Lake, the R.M. of Sasman, the resort communities of Chorney Beach and Leslie Beach and the Fishing Lake Indian Reserve, according to the 2006 census [(42)] are as follows;

Area	2006 Population (# of people)	2001 Population (# of people)	Density (people / km^2)	% Population Change from 2001	Median Age (years)	% of Population ages 15 and over
Saskatchewan*	968,157	978,933	1.6	-1.1	38.7	80.6
R.M. of Foam Lake	598	698	0.4	-14.3	49.9	88.2
R.M. of Sasman	960	958	1.0	0.2	45.9	82.8
Chorney Beach	31	15	184.7	106.7	-	-
Leslie Beach	30	15	53.6	100	-	-
Fishing Lake I.R. 89	380	376	11.2	1.3	18.9	57.9

4.2.3 Services

Rural infrastructure in the project area includes a municipal road network with a grid of gravel-surfaced roads, beach access roads and one secondary provincial road (Highway 310). Highway 310 runs directly through the project area; on the south side of Fishing Lake, Highway 310 deviates from its north-south path to pass around the east side of the lake. Highway 310 provides access to Fishing Lake from Provincial Highway No. 5 approximately 2 km north of Fishing Lake and from Provincial Highway No.16, the Saskatchewan section of the Yellowhead Highway, approximately 24 km south of Fishing Lake.

Residents living in the beach communities surrounding Fishing Lake pump water directly from the lake for non-potable domestic use, such as in their showers, toilets, etc., however they bring in their own potable water for drinking and cooking [(43)]. The buildings typically are equipped with holding tanks to store wastewater until they are pumped out for disposal. SaskPower's electrical distribution system, SaskEnergy's natural gas distribution system and SaskTel's telecommunication system service the communities around Fishing Lake. During the time of temporary berm construction, all three partnered together to fix any damaged power, natural gas or telephone lines with funding from the Government of Saskatchewan [(44)].

There are both Canadian Pacific and Canadian National Railway lines in the regional study area. A Canadian Pacific Railway line runs from northwest to southeast approximately 2 km south of Fishing Lake. A Canadian National Railway Company line runs east-west along Highway 5, approximately 2 km north of Fishing Lake.

4.2.4 First Nations

Fishing Lake reserve (I.R. 89) covers approximately 3,900 ha of land on the west side of Fishing Lake [(45)]. There are approximately 110 households on the reserve and the latest population information was provided previously in Section 4.2.2. The reserve has its own band administration office as well as a RCMP detachment. Fishing Lake reserve has two schools that together provide kindergarten to grade 12. Those living on the reserve have access to heat, electricity and water utilities, as well as on-site garbage and sewage facilities. Residents also have access to on-site recreation and health centres as well as a locally run gas station [(46)].

Fishing Lake First Nation is a Saulteaux community affiliated with the Touchwood Agency Tribal Council. It is an independent First Nation and even though the population was last assessed to be less than 400, there are over 1000 people registered with the Fishing Lake First Nation [(47)].

4.2.5 Heritage

An assessment of historic resources was conducted by the SWA between May 22 and June 5, 2007 as part of the environmental assessment of the proposed east and west Fishing Lake drain improvement options. No historic resources were observed along the three transects east and west of Fishing Lake that were located within the current project study area and surrounding regional study area as previously described.

As part of the emergency works conducted in 2007, a review of the proposed borrow pit locations was conducted by the Saskatchewan Heritage Resources Branch and response letters sent to Clifton Associates on October 11 and 15, 2007 (File # 07-0705). The review verified that there were no known archaeological sites in direct conflict with the project stating that as the land was previously cultivated, and the potential for intact archaeological sites to be found is low, a Heritage Resource Impact Assessment (HRIA) pursuant to S. 63 of *The Heritage Property Act* was not required.

As part of the proposed work for the berm upgrades, KGS group submitted a request for heritage assessment for eight borrow pit locations, seven of which were listed on the previous application. The request stipulated that any expansion to the boundary of the borrow pits would

occur only on cultivated/previously disturbed lands. The response letter issued on July 14, 2009 (File #09-968) stated that provided expansion of the borrow pits is limited to previously disturbed areas (i.e. Cultivation), there are no heritage concerns and, as such, an HRIA is not required (Appendix E). However, should any expansion of the borrow pits result in an impact to areas of native vegetation, a request for review will be submitted to the Heritage Resources Branch prior to clearing and grubbing of the area.

4.3 ECONOMIC

4.3.1 Land Use

Land in the R.M. of Sasman and the R.M. of Foam Lake is mainly agricultural with both crop and pasture land common [(48)]. The dominant agricultural unit is family farms that primarily produce cereal and oilseed crops including canola, flax, oats, barley, and wheat, although pulse and specialty crops have recently become more common in Saskatchewan [(49)].

Land use in the project area is mainly agricultural along with small areas of residential and parkland developments immediately adjacent Fishing Lake. Fishing Lake Regional Park is located in three separate areas around the lake having a full service campground at Saskin Beach, Leslie Beach and K.C. Beach. Many of the beach communities surrounding Fishing Lake are situated on this parkland. Land occupied by the beach communities include residential, as well as a variety of commercial and recreational uses. For example, Leslie Beach has an 18-hole mini-golf course, market gardens, swimming areas, gas stations and a concession stand with both groceries and fast food. Fishing Lake Lodge at Leslie Beach offers a licensed dining room and cabin rentals [(50)]. K.C. Beach also has a swimming area and general store and just south of Chorney Beach there is a licensed 9-hole golf course called the Foam Lake Golf and Country Club [(51)]. In addition, the area surrounding Fishing Lake is commonly used for hunting, fishing and snowmobiling [(51)].

On the northern shore of Fishing Lake adjacent to Buckhorn Bay is an area that has been identified as protected land. This area is called the Fishing Lake Wildlife Refuge and covers just over 130 ha that consists of all those portions of the NW ¼ and SW ¼ 29-33-11 WSM and the NE ¼ and SE ¼ 30-33-11 WSM, which are from day to day not covered by the waters of Fishing

Lake (Figure 1). The SKCDC does not provide any further data as to the status or management practices required for maintaining the Fishing Lake Wildlife refuge.

4.3.2 Economy

In the R.M. of Sasman the median income for a person who worked full time for a full year was $19,337, and the median family income was $49,788 compared to $58,563 for all of Saskatchewan [(42)]. There were 820 people 15 years or older in 2006, 590 of these were in the labour force resulting in a participation rate of 72.0%. Out of this labour force 570 were employed resulting in an employment rate of 69.5% while the unemployment rate was 2.4%. The largest industry in the R.M. of Sasman is agricultural which accounted for 47% of the jobs held by the labour force [(42)]. Educational services accounted for 12% of jobs held, while health care and social services accounted for 10% of all jobs. Other industries that contributed between 2% and 6% of the jobs included construction, manufacturing, finance and real estate, retail trade, wholesale trade, and business services.

In the R.M. of Foam Lake the median income for a person who worked full time for a full year was $14,525, and the median family income was $29,624 compared to $58,563 for all of Saskatchewan [(42)]. There were 525 people that were 15 years or older in 2006, 410 of these were in the labour force resulting in a participation rate of 78.1% [(42)]. From this labour force 390 were employed resulting in an employment rate of 74.2% while the unemployment rate was 3.8%. Information from the R.M. of Foam Lake on participation in the major industries was not available for the 2006 census data, however, based on the similarities between the R.M. of Foam Lake and the R.M. of Sasman as well as their proximity, the major industries are assumed to be similar.

4.3.3 Health and Safety

The nearest hospital to the project area is in Wadena, Saskatchewan, a 24 km to 30 km drive for cottagers and residents around Fishing Lake [(52)]. In addition to the hospital there is a Health Centre in Foam Lake, 24 km south of Fishing Lake and a Health Centre at the Fishing Lake reserve [(53)].

Water quality for Fishing Lake has been assessed for livestock, as there are pasture lands used for cattle in the surrounding area. Past studies indicated that TDS and sulphate are the surface water parameters of concerns related to livestock health [48]. Human health concerns related to drinking water quality guidelines were not examined for surface water as Fishing Lake is not used as a source of potable water by the surrounding residents. In terms of human health concerns resulting form consumption of groundwater, nitrate was the only parameter that exceeded allowable concentrations (see section 4.1.5).