Netley-Grassmere Integrated Watershed Management Plan

Watershed Characterization

February 2010

Submissions from: Agriculture and Agri-Food Canada – Prairie Farm Rehabilitation Administration (AAFC-PFRA), Department of Fisheries and Oceans Canada (DFO), East Interlake Conservation District, Manitoba Agriculture, Food and, Rural Initiatives (MAFRI), Manitoba Conservation, Manitoba Eco-Network, and Manitoba Water Stewardship.

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Introduction

This watershed characterization document is a compilation of technical information on the land and water resources within the Netley-Grassmere watershed (05OJ). This information will be used as the basis for the development of the Netley-Grassmere Integrated Watershed Management Plan (IWMP). This document is also a tool to inform watershed residents and organizations involved in the planning process about the state of the land and water resources in the Netley-Grassmere watershed.

Watershed Overview

The Netley-Grassmere watershed is located north of the City of Winnipeg, along the western-side of the Red River, and stretching northward along the south-western shores of Lake Winnipeg's south basin (Figure 1). It contains wholly or part of the Rural Municipalities (R.M.s) of Armstrong, Rockwood, Rosser, St. Andrews, West St. Paul, and Woodlands, the City of Selkirk, the towns of Stonewall, Teulon, and Winnipeg Beach, and the village of Dunnottar. The watershed also contains lands within the Peguis First Nation, located along the southern portion of the Netley Marsh, north of the City of Selkirk.

The Netley-Grassmere watershed has a drainage area of approximately 2362 km^2. This watershed contains four sub-watersheds: the Netley Creek sub-watershed (977 km^2), the Wavey Creek sub-watershed (662 km^2), the Grassmere Creek sub-watershed (479 km^2), and the Parks Creek sub-watershed (244 km^2). The Netley-Grassmere watershed was once largely covered by an extensive marsh, the St. Andrews bog, but since has been widely drained to support the agricultural industry. There are presently 1,542 km of ordered drains in the watershed, only a fraction of which are natural water courses.

The Netley-Grassmere watershed is home to approximately 40,000 people and includes: Netley and Oak Hammock marshes; expanding suburban communities north of the City of Winnipeg; cottage communities along the shores of Lake Winnipeg; and high valued and marginal agricultural lands. The southern portion of the watershed is located adjacent to the Red River Floodway outlet which bypasses water around the City of Winnipeg during flooding events. A large part of the population in this watershed is urban due to its proximity to the City of Winnipeg and the presence of the City of Selkirk and the expanding residential sub-divisions in the R.M.s of St. Andrews and West St. Paul. However, agriculture still remains an important industry in this watershed.

During the summer months, the population in this watershed swells as cottagers from Winnipeg and surrounding areas arrive to enjoy the beaches and recreational activities along Lake Winnipeg and associated tributaries and marshland. Tourism is an important industry in this watershed. The white sandy beaches found along the shores of Lake Winnipeg draws thousands of visitors annually. Lake Winnipeg also supports a large commercial fishery. Sport fishing is also popular with local residents and visitors.

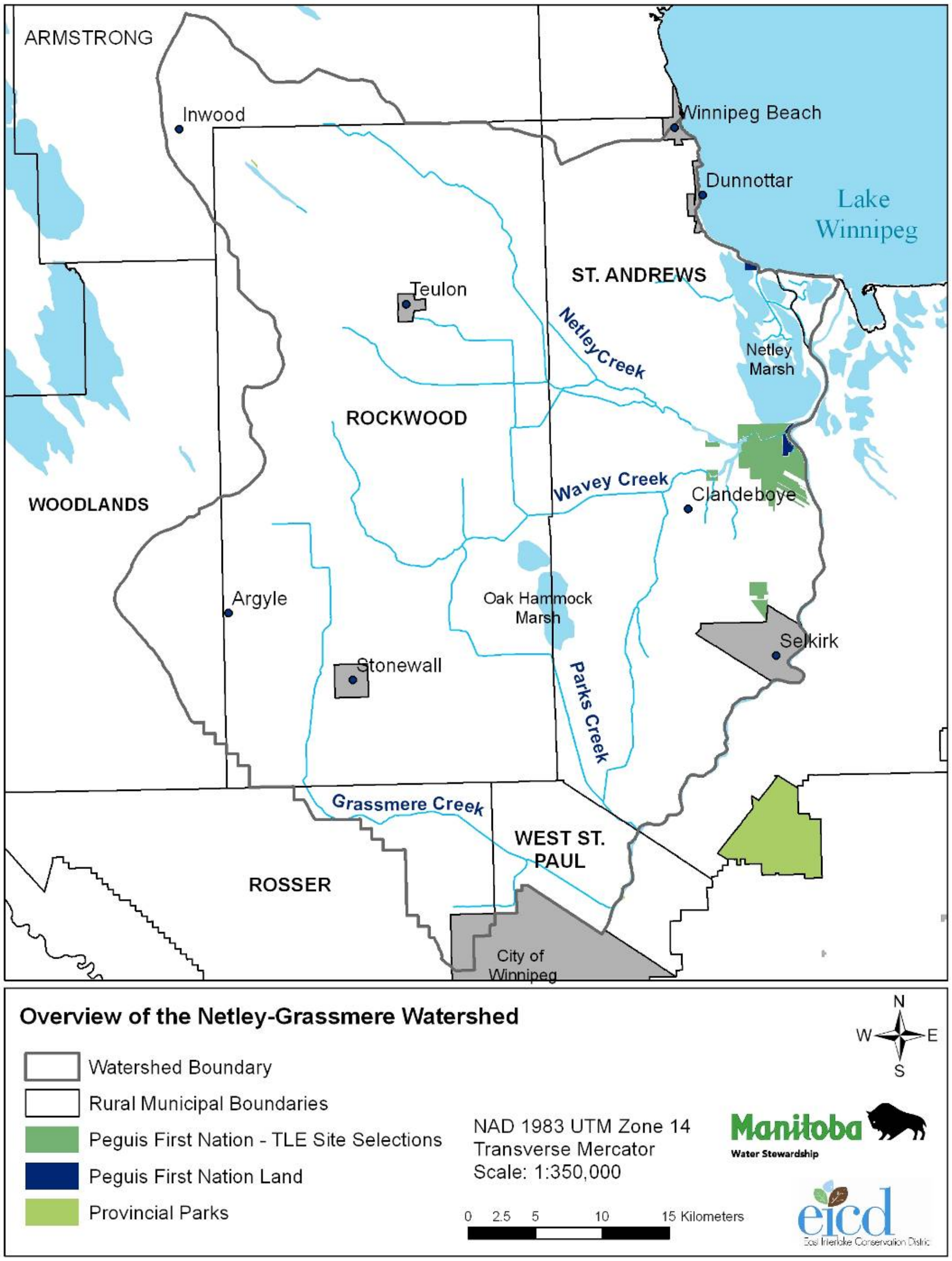

Figure 1: Overview of the Netley-Grassmere Watershed

Lake Winnipeg Watershed

The Netley-Grassmere watershed is located adjacent to Lake Winnipeg, the 10th largest body of freshwater in the world, and is part of the second largest watershed system in Canada, the Lake Winnipeg watershed. The Lake Winnipeg watershed covers approximately 953,250 km^2 and includes portions of five Canadian Provinces (British Columbia, Alberta, Saskatchewan, Manitoba, and Ontario) and four states (Montana, North Dakota, South Dakota, and Minnesota), as seen in Figure 2.

Figure 2: Lake Winnipeg watershed

Excessive concentrations of nitrogen and phosphorus are entering Lake Winnipeg, leading to the formation of nuisance growths of algae. These excess nutrients are entering waterways through a variety of sources, both natural and human produced. These nutrient sources include but not limited to: municipal sewage, septic systems, crop fertilizers, industrial discharges, livestock manure, urban run-off, the atmosphere, soil, and decaying plant matter (Lake Winnipeg Stewardship Board 2006). This increase in algae growth is negatively affecting fish habitat, recreation, drinking water quality, and clogging fishing nets. Some nuisance growths of algae can also produce toxins which contribute to deteriorating water quality. Manitobans, including those in the Netley-Grassmere watershed, contribute about 41 % of the phosphorus and 36 % of the nitrogen to Lake Winnipeg (Bourne *et al.* 2002).

In February of 2003, the provincial government announced the Lake Winnipeg Action Plan, a commitment to reduce nitrogen and phosphorus loads to Lake Winnipeg to pre-1970s levels. The Lake Winnipeg Action Plan recognizes that nutrients are contributed by most activities occurring within the drainage basin and that reductions will need to occur across all sectors. Reductions in nutrient loads across the Lake Winnipeg watershed will benefit not only Lake Winnipeg but also improve water quality in the many rivers and streams that are part of the watershed, including the creeks in the Netley-Grassmere watershed. As part of the Lake Winnipeg Action Plan, the Lake Winnipeg Stewardship Board was established in 2003.

The East Interlake Conservation District

The East Interlake Conservation District (EICD) is an organization of local people working together to manage and conserve natural resources for the benefit and enjoyment of area residents. The Netley-Grassmere watershed is one of four watersheds that make up this Conservation District. The District includes all or parts of the R.M.s of Armstrong, Bifrost, Fisher, Gimli, Rockwood, Rosser, St. Andrews, West St. Paul, and Woodlands; the city of Selkirk, the towns of Arborg, Stonewall, Teulon and Winnipeg Beach; and the villages of Dunnottar and Riverton.

The EICD operates on watershed boundaries and partners with the Province of Manitoba and other agencies to conduct programming in five priority areas: water quality, surface water management, watershed planning, soil and riparian health and education.

Physical Geography

Elevation

Elevation in the study area ranges from a high of 283 metres above sea level (masl) in the north-western corner of the watershed down to 212 masl in the eastern region of the watershed, as seen in Figure 3.

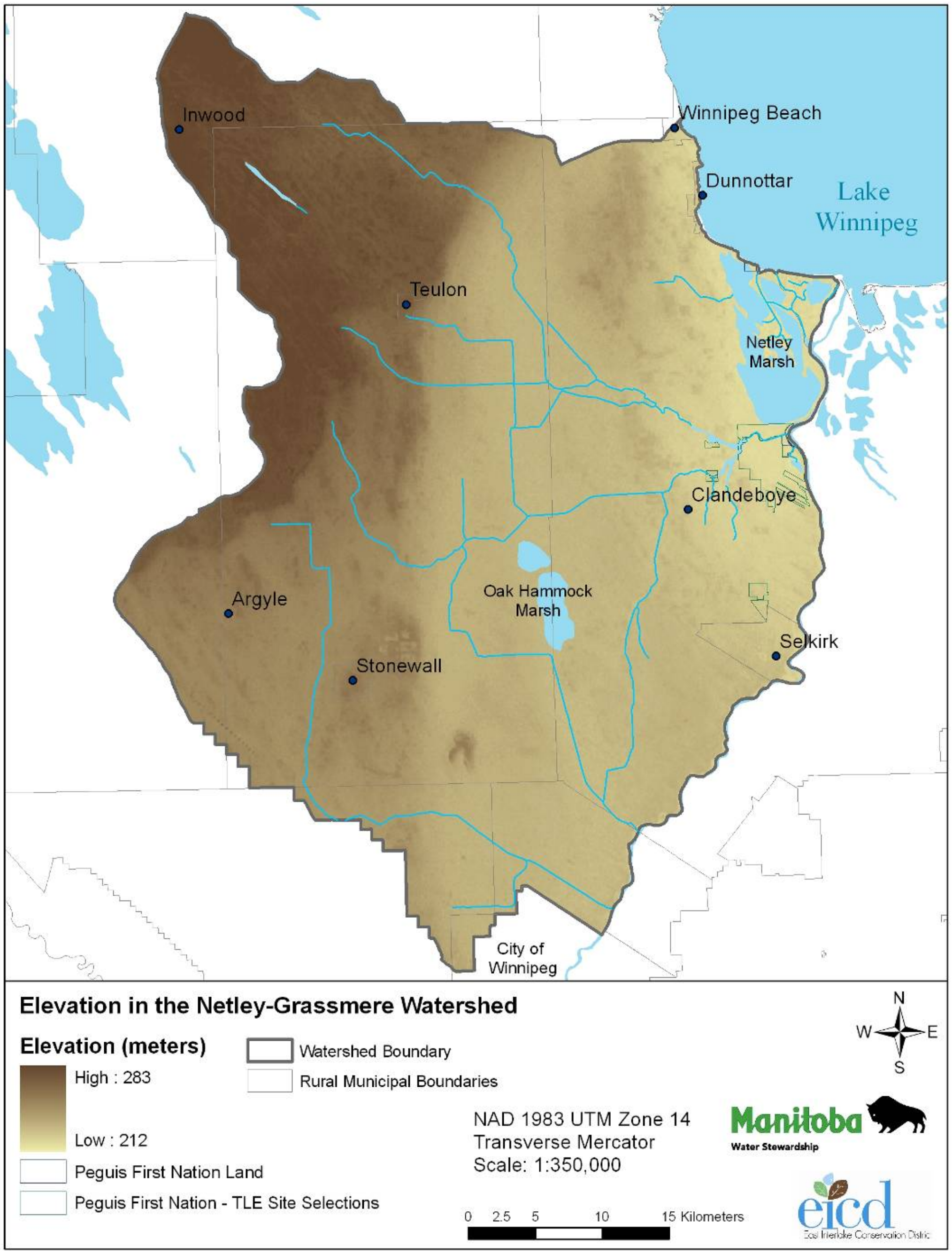

Figure 3: Elevation in the Netley-Grassmere Watershed

Geology

In terms of bedrock geology, the Netley-Grassmere watershed contains four formations, from west to east – the East Arm Formation, the Stonewall Formation, the Stony Mountain Formation, and the Red River Formation (Figure 4). This watershed is underlain by bedrock consisting of limestone and dolostone inter-layered with several argillaceous (clay and silt) units. The limestone and dolostone is underlain by shale and sandstone and overlain by glacial till.

In terms of surface geology, the majority of the Netley-Grassmere watershed is characterized as deep basin deposits of offshore glaciolacustrine sediments containing mostly clay and silt material and some minor deposits of sand (Figure 5). In the north-western region of the watershed, there is a presence of shoreline (beach) sediments containing sand and silt material. There are alluvial deposits with organic material in the Netley Marsh area.

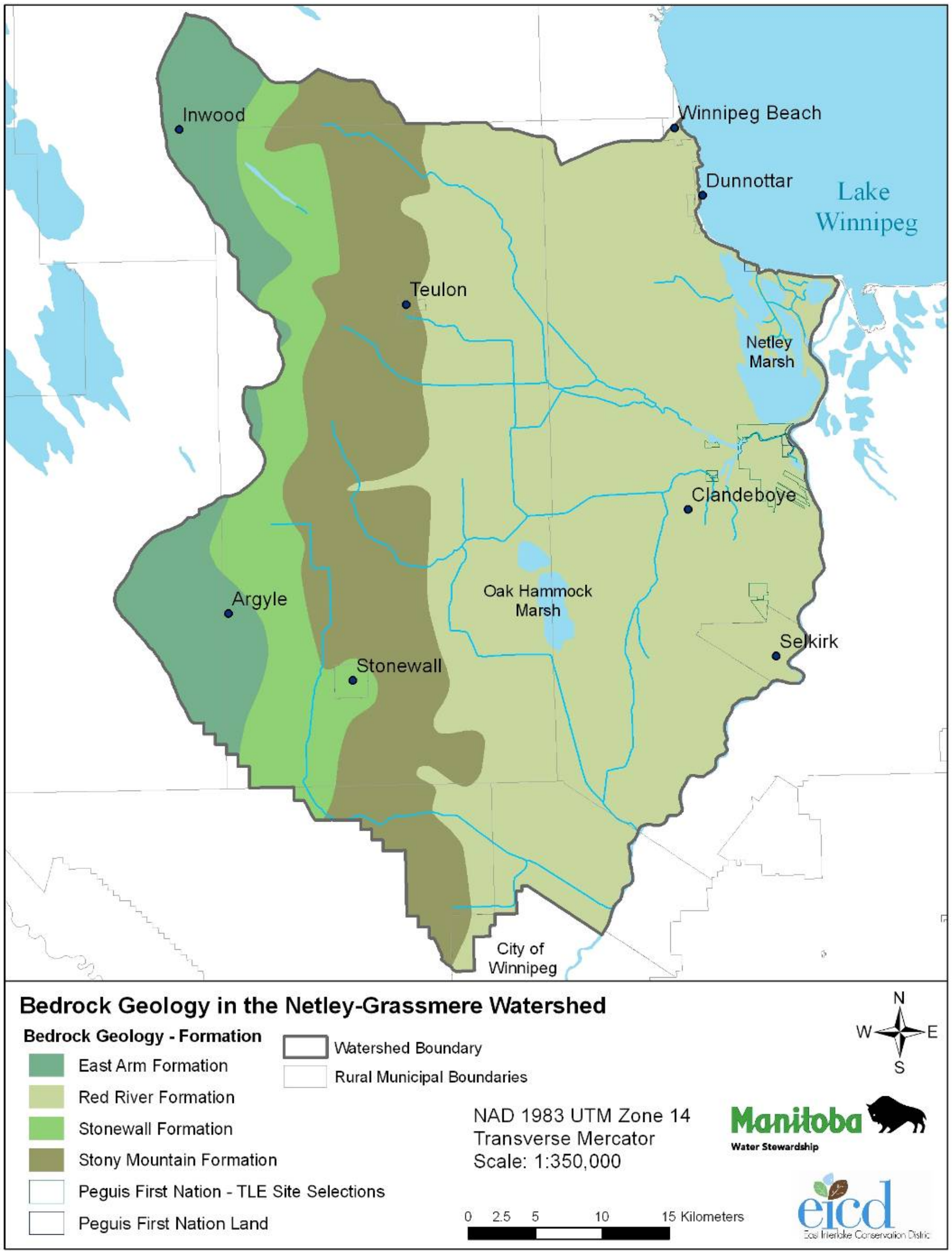

Figure 4: Bedrock Geology in the Netley-Grassmere Watershed

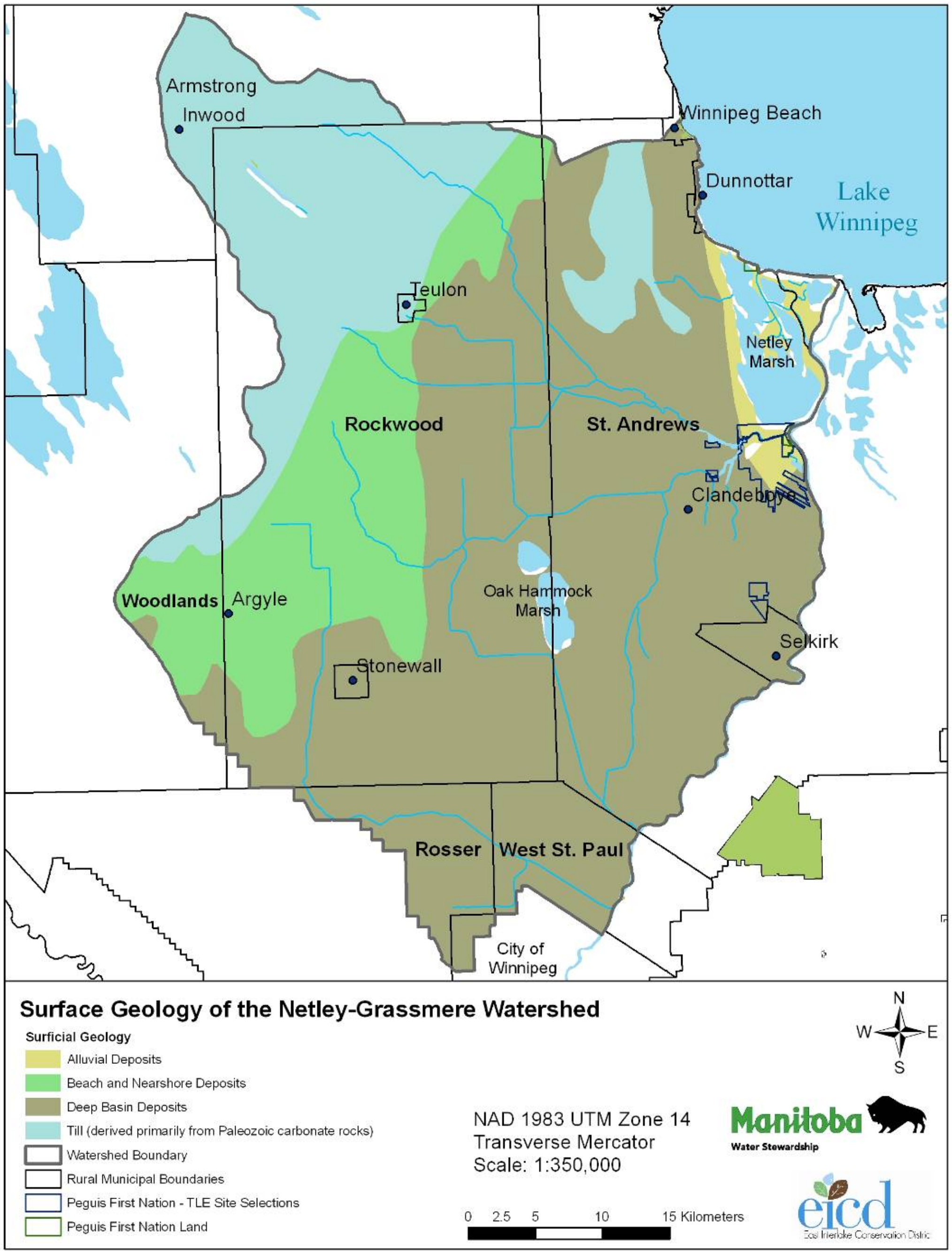

Figure 5: Surface Geology in the Netley-Grassmere Watershed

Soils

Soils Overview

Soil is the naturally occurring, unconsolidated or loose covering on the Earth's surface. Soil is composed of particles of broken rock that have been altered by chemical and environmental processes including weathering and erosion and overtime transferred to its current location. Much of the soil in this watershed was deposited during the time of glacial Lake Agassiz, and is derived from lacustrine deposits underlain by loam stony glacial till. The predominant soil types within the watershed are part of the Chernozemic and Gleysolic Orders. Black Chernozems occur throughout the watershed on imperfectly drained soils, while Humic Gleysols occur in poorly-drained areas, sometimes occurring with peaty layers. Black Chernozems are a fertile soil, characteristic of tall grasslands. Weakly developed Brunisols and Grey Luvisols, as well as Dark Grey Chernozems occur in northern and north-western parts of the Netley-Grassmere watershed. There are also areas of Organic soil found in the watershed, particularly around the Netley and Oak Hammock marshes. Regosols are found in some places along the Red River and are generally considered to be underdeveloped (AAFC 2005).

Soils data is a critical component of land-use planning. Soil characteristics can be used to determine agricultural capability and to predict risks of erosion, leaching, and run-off. This type of information is important for determining suitable land uses, identifying sensitive areas, and targeting land-use improvement efforts (AAFC 2005). Agriculture capability can best be described as the ability of the land to support the appropriate type of crops and agriculture management techniques. Classes ranging from 1 to 7 have been established with 1 being the highest rated and 7 being the lowest rated land class for agriculture. Within the Netley-Grassmere watershed, the majority of the land is classified as Classes 1, 2, and 3, covering approximately 69% of the watershed (Figure 6). Class 2 and 3 soils can be found in both the Red River Valley (lacustrine clays) and the Interlake Till Plain (lacustrine clay over tills) and are widely distributed across the watershed. Another 24% of the soils in this watershed are considered Class 4, 5, 6 and 7, while another 2% are classified as organic soils. In general, Class 4, 5 and 6 soils are generally found in the north-western portion of the Netley-Grassmere watershed. Organic soils are generally found adjacent to the Oak Hammock and Netley Marshes. In the 2005 growing season, about 10% of the annual crop production occurred on soils which may be more suitable for perennial forage production (AAFC-PFRA and MAFRI 2009).

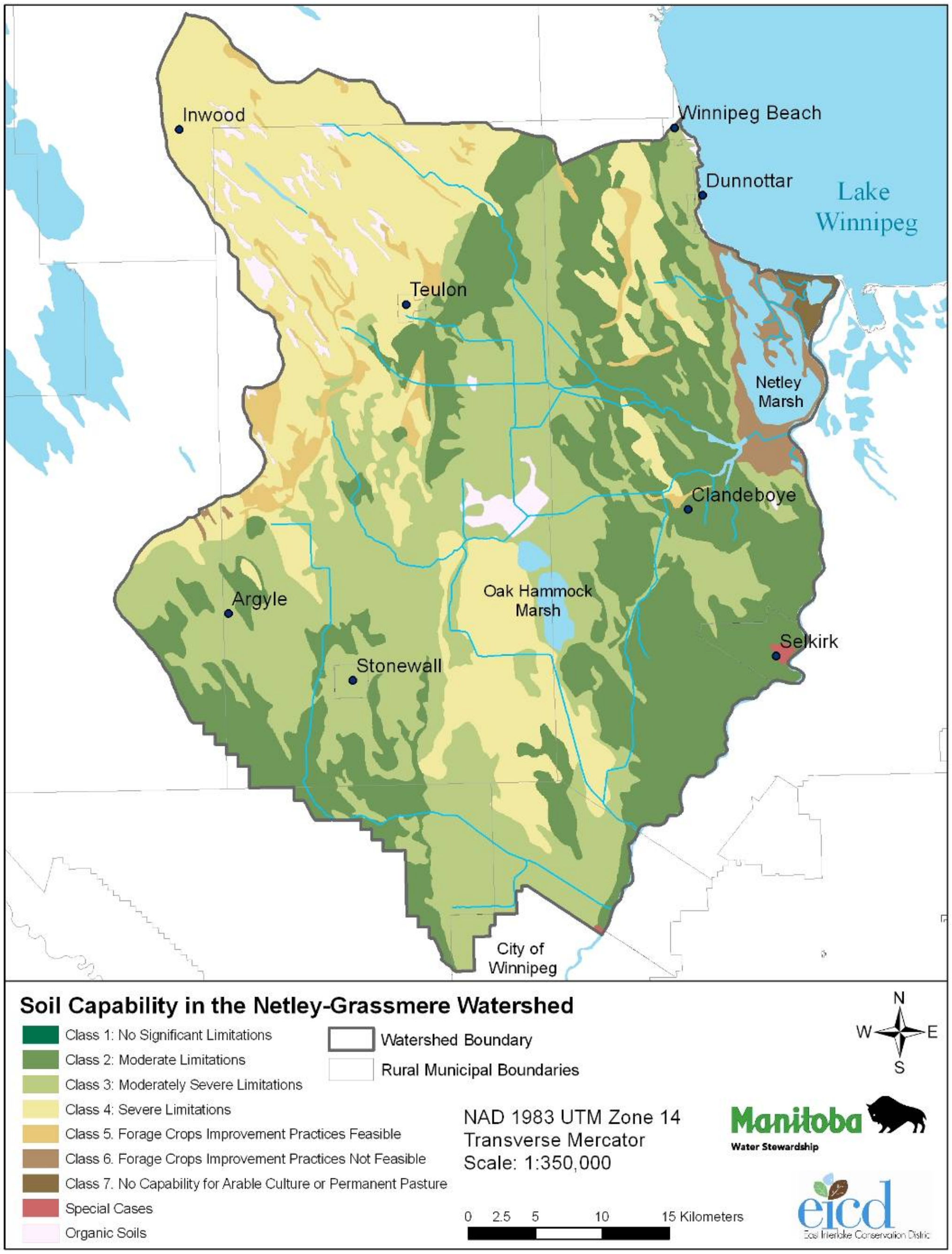

Figure 6: Soil Capability in the Netley-Grassmere Watershed

Soil Texture

Soil surface texture strongly influences the soil's ability to retain moisture, its general level of fertility, and the ease or difficulty of cultivation. Approximately 41% of the Netley-Grassmere watershed is comprised of fine loamy soils which are generally located within the western region of the watershed (Figure 7). Another 38% of the soils are classified as clay type soils and are generally located within the eastern portion of the watershed. About 7% of the soils in the watershed are considered organic from a textural perspective, and are located in and around Oak Hammock and Netley Marshes, as well as in disbursed pockets in the very north-western region of the watershed. Another 7% of the total land base has coarse loamy textured soils. These soils are found primarily in the area extending between the communities of Stonewall and Balmoral and a small portion located northeast of the community of Teulon. These soils generally correspond to the significant terminal moraine that marks the boundary between the Interlake Till Plain and the Red River Valley. This terminal moraine and its characteristic texture and topography are of significance when evaluating the potential water erosion within the watershed. Sandy textured soils, associated with moraine deposition, account for approximately 3% of the watershed (AAFC-PFRA and MAFRI 2009).

In the 2005 cropping season, approximately 6% of the annual cropland was located on soils with sand to coarse sand texture or organic soils. Another 10% of the annual crop production occurred in areas with coarse loamy textured soils (AAFC-PFRA and MAFRI 2009).

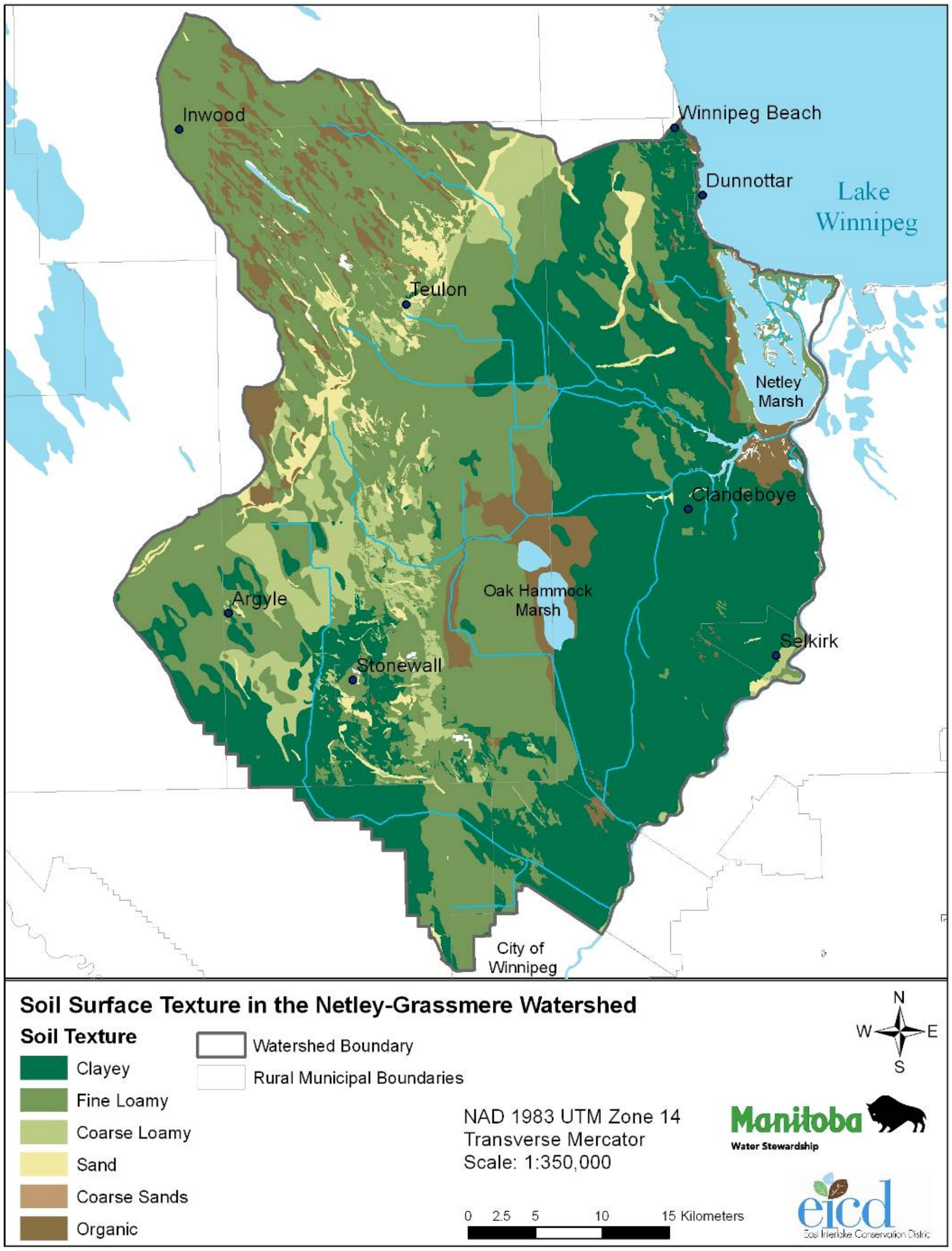

Figure 7: Soil Surface Texture in the Netley-Grassmere Watershed

Risk of Erosion

Approximately 17% of the Netley-Grassmere watershed is considered to have a moderate water erosion risk (Figure 8). This risk is mainly situated in an area delineated in a north-south pattern between the communities of Teulon, Stonewall, and Stony Mountain. Approximately 80% of the watershed is considered to have a low or negligible risk for water erosion. There may be some small, localized areas with a high to severe risk of erosion in the watershed. In the 2005 cropping season, approximately 22% of the annual cropland was located on soils with moderate risk to water erosion. Further analysis of 2002 and 1994 land cover data indicates that annual cropping practices on moderate soil erosion risk have declined since 1994 (AAFC-PFRA and MAFRI 2009).

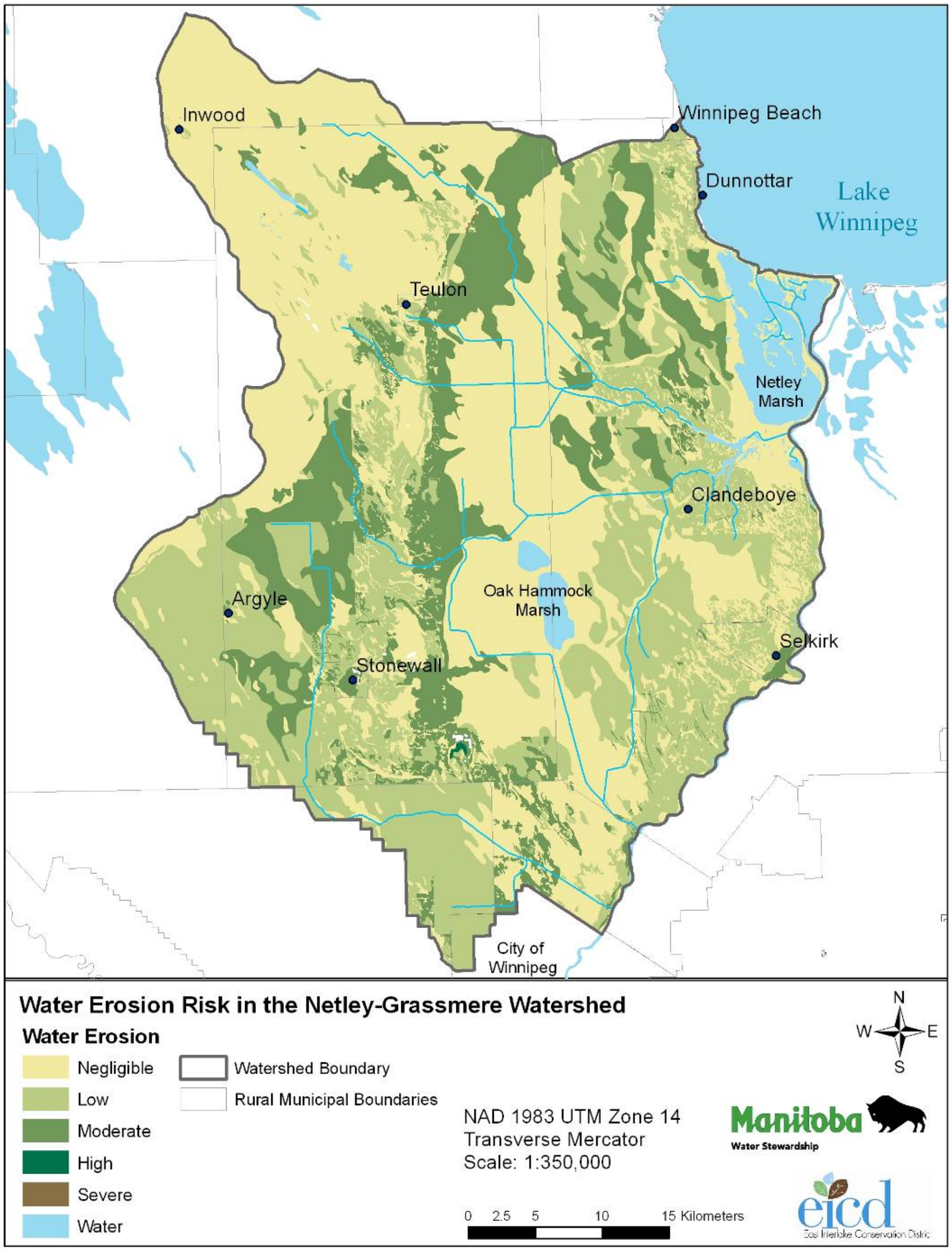

Figure 8: Water Erosion Risk in the Netley-Grassmere Watershed

Approximately 6% of the Netley-Grassmere watershed is considered to have a high or severe wind erosion risk (Figure 9), primarily in the western portion of the watershed between the communities of Stonewall and Teulon. Affected areas generally correspond to the Red River Valley portion of the watershed where fine textured clay over till soils are found. Approximately 38% of the watershed is considered low or negligible for soil erosion risk and is generally associated with land under perennial cover, often correlating with Class 4, 5, and 6 soils. Based on 2005 land cover data, approximately 4% of the annual cropland is located on soils with a high to severe risk for wind erosion. Organic soils, when dry and exposed, are also at risk to wind erosion. In 2005, about 3% of the annual cropland was located on organic soils (AAFC-PFRA and MAFRI 2009).

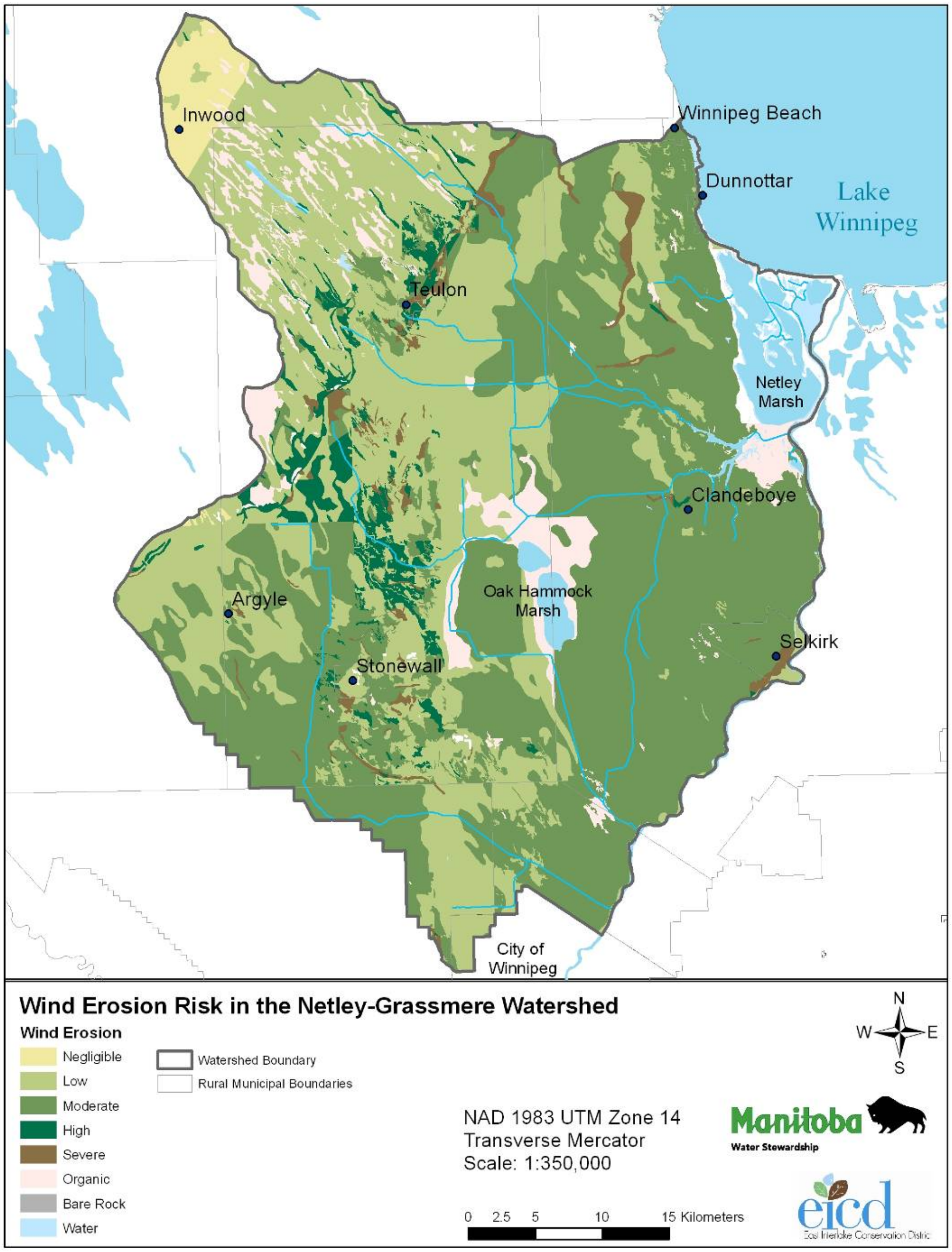

Figure 9: Wind Erosion Risk in the Netley-Grassmere Watershed

The banks on the west side of Lake Winnipeg are typically composed of lacustrine clay overlying clay till. The lacustrine clay in general is stone free and highly erodible. The underlying till unit contains coarser grained particles such as sand, gravel and cobbles. The percentage of coarse grained material that remains once the fine grained matrix (silt and clay) is eroded ranges between 15% and 20%. Other areas on the west shore of Lake Winnipeg consist of low lying sand and mixed sand and gravel beaches (Water Control Systems Management Branch 2010).

Erosion of fine grained material such as clay and silt can easily occur when exposed to water. The amount of erosion and downcutting that occurs depends on water depth. More erosion and downcutting of exposed soil occurs in the shallow water closer to the shoreline than the deeper offshore water. As erosion of a bank progresses, the toe of the bank is undercut and portions of the bank are removed by wave action. If a cohesive material has a sufficient content of boulders and cobbles, after the fine grained material is eroded or washed away, a “lag deposit” of cobbles and boulders is left on the beach. This lag deposit slows the erosion process and reduces the retrogression rate along the shoreline. Removing the “lag deposits” to construct groins or create a sandy beach will result in increased erosion of the shoreline (Water Control Systems Management Branch 2010).

The south shore of Lake Winnipeg consists of barrier islands. The general stratigraphy in this area is comprised of sand and gravel deposited by wave action overlying organic clay and peat layers. Lacustrine clay is typically found below the organic layer. The backshore area is marshy and typically floods, especially during large north wind events. The barrier islands are transgressing southward due to isostatic rebound and possibly climate change. It is estimated that the south shore has transgressed southward between 60 metres and 100 metres since 1650 AD (Water Control Systems Management Branch 2010).

Barrier islands are a dynamic beach shoreline. A dynamic beach shoreline consists of enough sand and gravel that the underlying substrate is not exposed to erosion. Dynamic beach shorelines continually recede and accrete due to changes in water levels and wave action. Dynamic beach shorelines are different than eroding shorelines. Eroding shorelines result in a net deficit of material because the volume of material removed from an area by longshore drift is greater than the volume of beach sediment being supplied (Water Control Systems Management Branch 2010).

Waves generated by wind on Lake Winnipeg have caused severe erosion from time to time. The height of a wave is a function of wind speed, wind direction, wind duration and fetch. Wave run-up is a significant concern when large wind events occur for a long duration on Lake Winnipeg. The magnitude of wave run-up is a function of wave height and bank slope. Therefore, a shallower bank slope will experience less wave run-up than a steep bank slope. Wave overtopping occurs when the height of the land is less than the limit of wave run-up. Wave overtopping can result in backshore flooding and may affect the integrity of erosion protection works or the bank. Other factors that effect erosion rates along Lake Winnipeg include bank height, bank slope, geology, groundwater, surface water, loading the top of the bank and vegetation cover (Water Control Systems Management Branch 2010).

Structural and non-structural options can be used to provide shoreline protection. However, the decision to use structural or non-structural options is site dependent and requires a site specific review. A geotechnical engineer should be consulted to determine if a structural or non-structural method of shoreline protection is the best approach (Water Control Systems Management Branch 2010).

Two levels of structural shoreline protection are typically used on Lake Winnipeg: heavy protection and light protection. Examples of heavy protection include boulder revetments and seawalls. Examples of light protection include light revetments and bulkheads (timber cribs, gabion bulkheads etc.). Heavy protection is designed to protect the shoreline from erosion during large storm events while light protection provides less resistance to erosion. Light protection is less expensive and may leave more of the beach for enjoyment than heavy protection, but in general the design life is less and maintenance is required more often. Regardless of the type of shoreline protection constructed, maintenance work will be required (Water Control Systems Management Branch 2010).

Examples of non-structural shoreline protection options include re-grading the bank slope, planting vegetation on the bank and controlling the drainage of surface water and groundwater. These options do not address the erosion of the shoreline due to wave action and may only be viable alternatives in very low energy wave environments that do not experience significant erosion (Water Control Systems Management Branch 2010).

As noted earlier, vegetation with a deep root system helps bind the soil particles and reduces the surface run off velocity. The vegetation may also provide wildlife or fish habitat. Controlling the drainage of surface water or groundwater with French Drains, tile drains or interceptor drains has a positive influence on bank stability by directing water away from the top of the slope and minimizes bank erosion. Re-grading the bank slope to a shallow slope angle may improve the stability of an over steepened bank that is subjected to significant erosion. Re-grading may also be accompanied by drainage improvements and re-vegetation (Water Control Systems Management Branch 2010).

Erosion along the banks of the Red River is also a concern. A typical section along the Red River consists of silty clay and silt interbedded with alluvial (deposited by flowing water) silt and sand overlying lacustrine (ancient lake bed deposits) silty clay. Underlying the lacustrine silty clay is till. Post-glacial flooding, deposition, erosion, vegetation growth and human activity have resulted in the modification of the near surface landscape (Water Control Systems Management Branch 2010).

Extremely slow to very slow rotational to translational sliding is common along the Red River. Earth sliding is especially common along the outside bends of the river where the river is immediately adjacent to lacustrine material. However, riverbank failures are not limited to outside bends, and can occur on inside, straight and transition sections. Since the residual strength of the soils encountered along the Red River is low, deep seated movements are very easily reactivated by erosion or anthropogenic influences (Water Control Systems Management Branch 2010).

Riverbank characteristics, bank height, bank slope, geology, groundwater, surface water, river ice, loading at the top of the slope and vegetation affect slope movements and erosion rates on riverbanks. Various riverbank stabilization measures exist for inside and outside bends of the Red River. For the outside bend of the Red River, typically the soft clay is removed and replaced with higher strength rock fill. The rock fill provides a buttressing effect and supports the toe of the bank with material that has a greater unit weight. There a number of methods that utilizes this method of stabilization. Examples of this include shear keys, granular ribs and rock fill columns. For an inside bend of the river, erosion protection can be provided for the entire bank face or only on the lower portion of the slope. The riverbank face is protected with rock (rip rap blanket). A small shear key may also be constructed if necessary (Water Control Systems Management Branch 2010).

Structural riverbank stabilization measures can be incorporated with additional work such as slope re-grading, drainage improvements and re-vegetation. Regardless of the type of riverbank stabilization constructed, maintenance work will be required. It is recommended that a property owner retain the services of a qualified geotechnical engineer prior to constructing riverbank stabilization measures to ensure that the final design plan is properly engineered (Water Control Systems Management Branch 2010).

Examples of non-structural shoreline protection options include re-grading the bank slope, planting vegetation on the bank and controlling the drainage of surface water and groundwater. As noted earlier, vegetation with a deep root system helps bind the soil particles and reduces the surface run off velocity and may also provide wildlife or fish habitat (Water Control Systems Management Branch 2010).

Soil Drainage

Soil drainage reflects the actual moisture content in excess of field capacity and the length of the saturation period within the plant root zone. Excess water content in the soil limits the free movement of oxygen and decreases the efficacy of nutrient uptake. Delays in spring tillage and planting are more likely to occur in imperfectly to poorly drained areas of individual fields. Approximately 73% of the Netley-Grassmere watershed can be considered imperfectly or poorly drained (Figure 10) (AAFC-PFRA and MAFRI 2009).

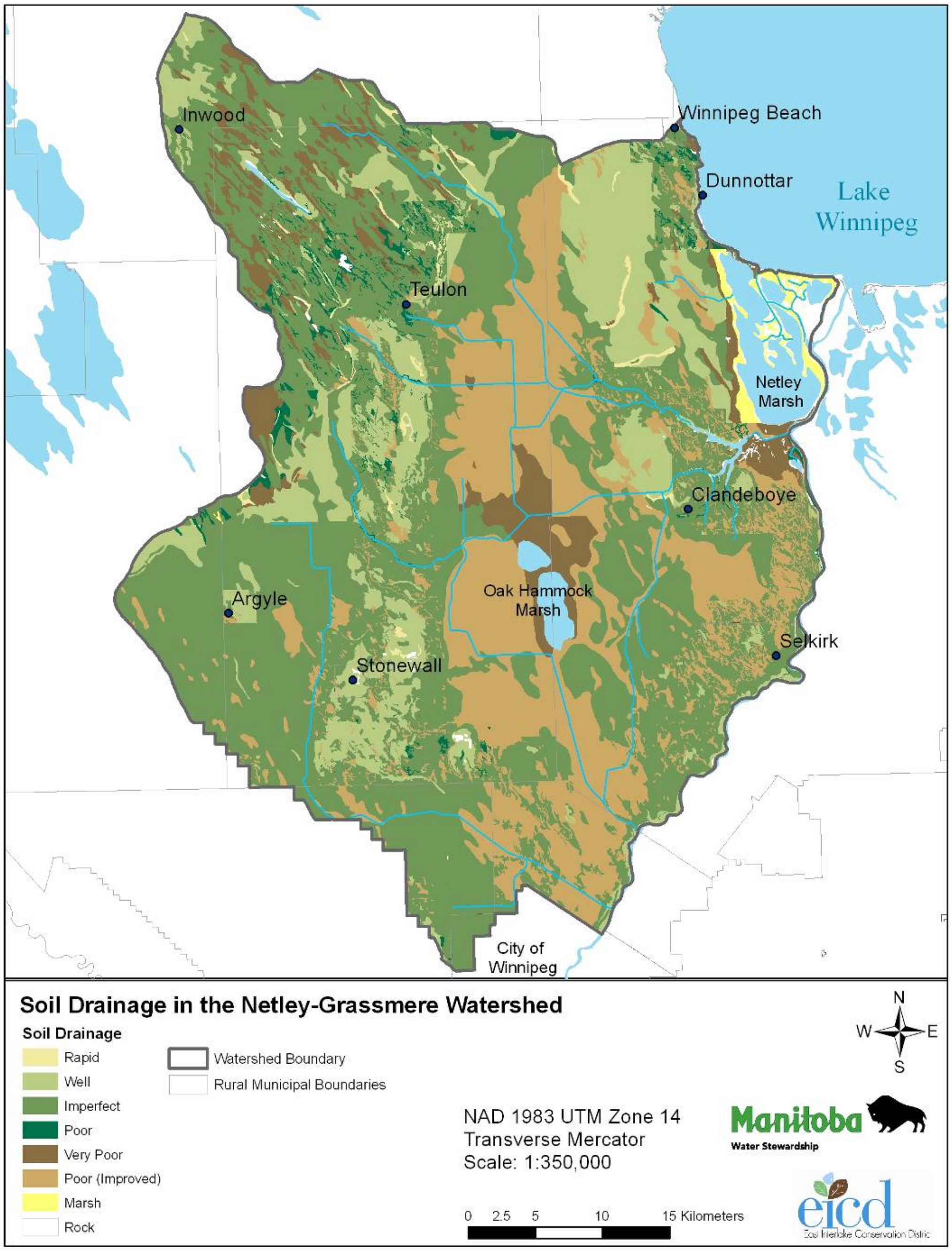

Figure 10: Soil Drainage in the Netley-Grassmere Watershed

Saline Soils

Salinity maps based on soil reconnaissance show that the majority of the Netley-Grassmere watershed (almost 83%) is considered to be non-saline in nature (Figure 11). Approximately 14% are considered weakly saline. Although these soils would be prone to salinity development under the right environmental conditions and land management practices, there are minor limitations for crop selection and yield impacts (AAFC-PFRA and MAFRI 2009).

Saline soils are those that contain enough soluble salts in the root zone to adversely affect the growth of most crop plants. Saline soils are caused by a combination of geological, climatic and cultural conditions. Salinity within the Netley-Grassmere watershed is variable on an annual basis and correlates to moisture deficit, hydrologic conditions and depth to salinity during the growing season. As a result, soils defined as weakly saline may exhibit moderately or strongly saline conditions dependent upon the factors identified above. It should be noted that weakly saline soils can support a wide range of crop choices (including soybeans) under average normal moisture regimes. Risks associated with fine textured weakly saline soils (which may influence crop yield) along with disease potential should be taken into consideration when making cropping decisions. Similarly, fine textured soils classified as moderately and strongly saline will demonstrate higher levels of salinity under moisture deficit conditions (AAFC-PFRA and MAFRI 2009).

A small area (1,251 ha.) east of Stony Mountain and within the Grassmere Drain sub-watershed has been identified as being moderately saline. When comparing soil salinity with land cover data, 55% of what has been classified as moderately saline soils is under annual crop production based on 2005 data. It has also been noted that this number has steadily decreased from what was identified in the 2002 and 1994 Land cover data. This could be attributed to 2005 being a wet year, and/or that greater attention is given to more suitable land management and conservation practices (AAFC-PFRA and MAFRI 2009).

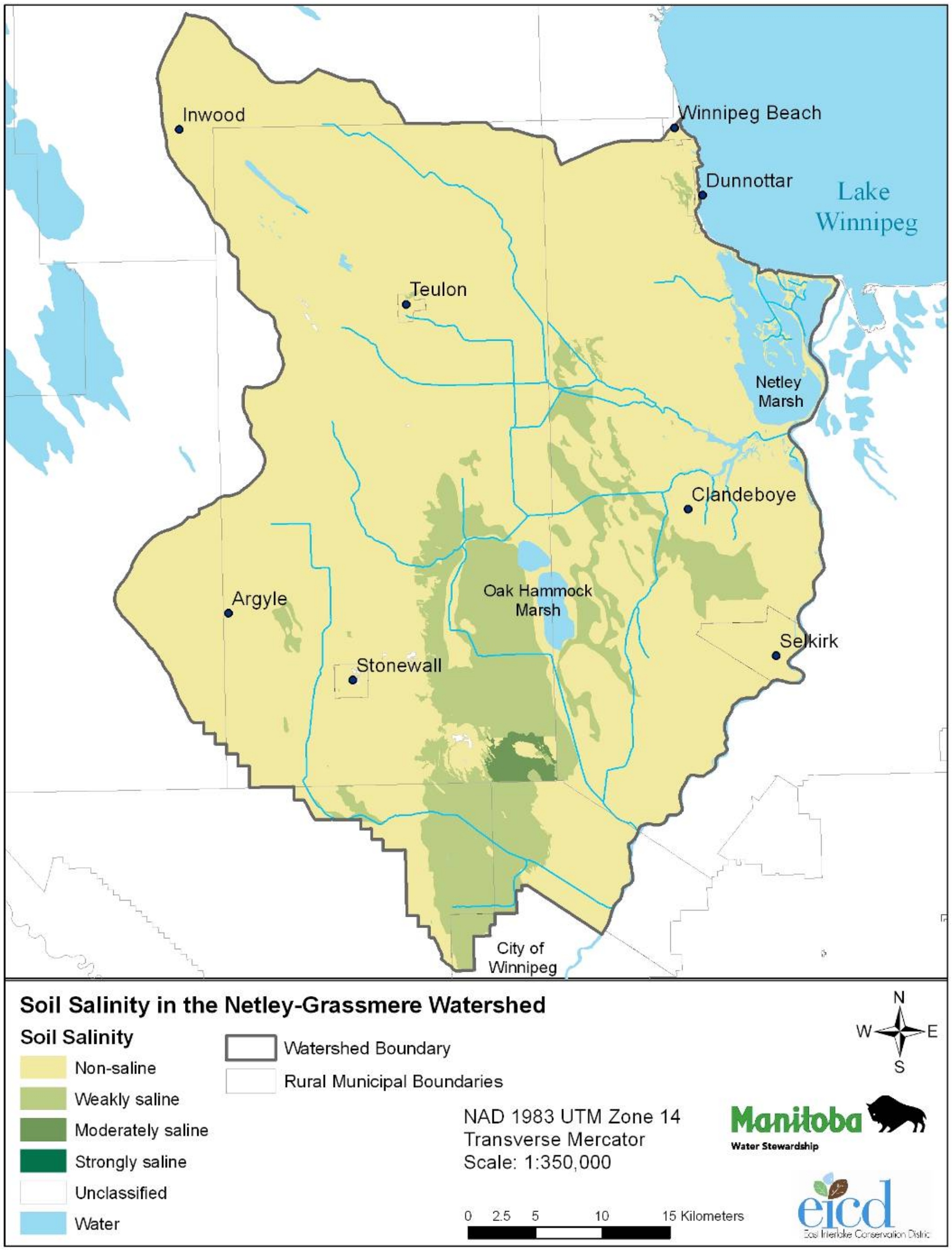

Figure 11: Soil Salinity in the Netley-Grassmere Watershed

Ecology

Terrestrial Ecozones

The Netley-Grassmere watershed falls within two Terrestrial Ecozones of Canada, the Prairies Ecozone which consists of the Lake Manitoba Plain Ecoregion, and the Boreal Plains Ecozone which consists of the Interlake Plain Ecoregion. An ecozone is an area that represents a large ecological zone and has characteristic landforms, climate, plants, wildlife, and human activities. Much of the vegetation in the Netley-Grassmere watershed has been removed for agriculture and the continued development of urban communities. Figure 12 illustrates the ecoregions of the watershed.

The Interlake Plain Ecoregion generally consists of some forested areas that contain mostly trembling aspen with some white spruce and balsam poplar. Poorly drained areas of this ecozone contain sedge, willow, and meadow grass vegetation. In the Lake Manitoba Plain Ecoregion, bur oak, trembling aspen, and undergrowth such as snowberry, hazelnut, and red-oiser dogwood can be found in well-drained areas. Saskatoons and high bush cranberry are more common on flood plains and in higher elevation areas of the watershed (AAFC-PFRA 2005).

As a result of cultivation, development of drainage ditches and urban communities, natural vegetation has largely disappeared. Some local pockets of natural vegetation do occur in poorly-drained areas on unbroken land and along natural waterways. These poorly drained areas and riparian areas also support slough grasses, marsh reed grasses, sedges, cattails and willows.

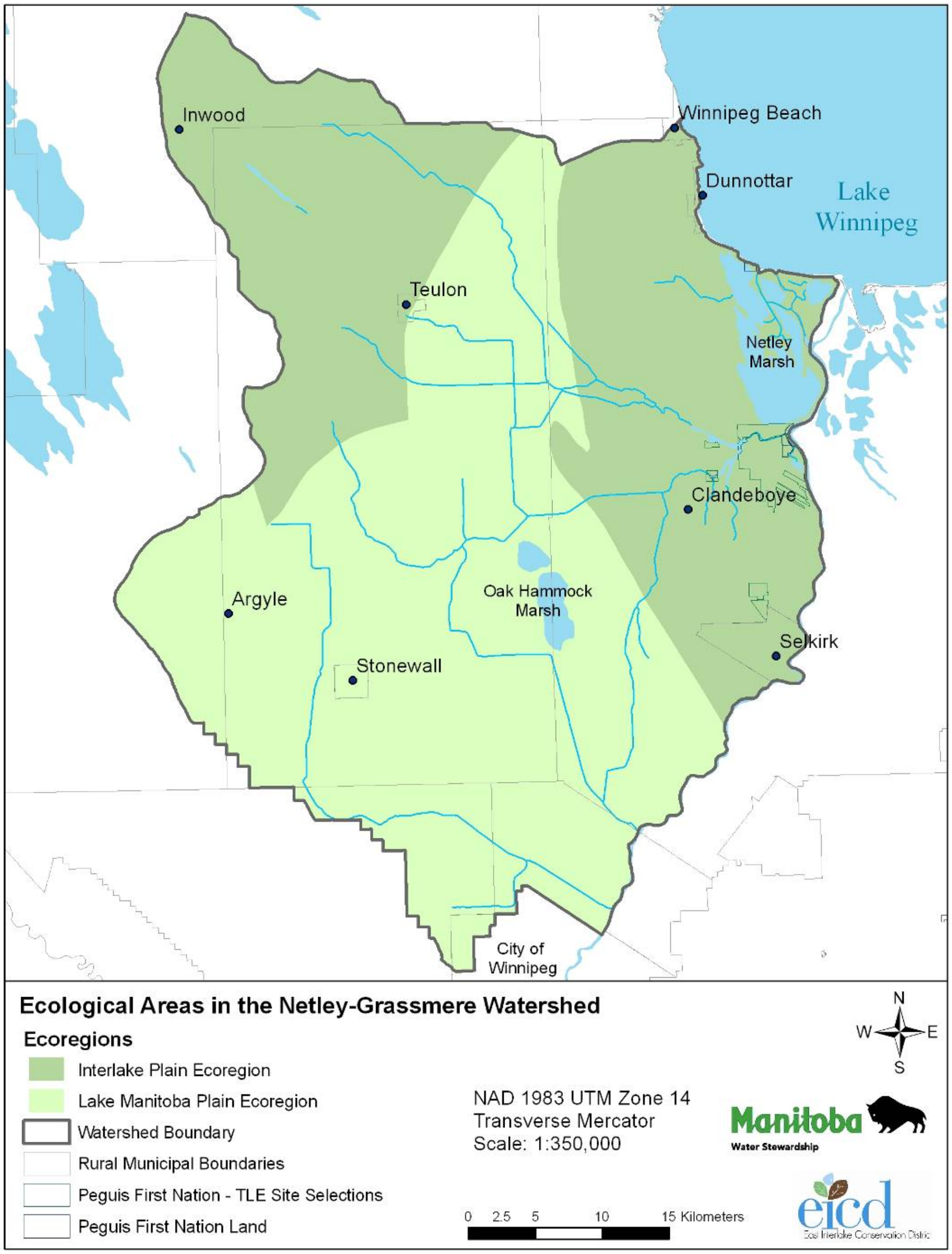

Figure 12: Ecological Areas in the Netley-Grassmere Watershed

Wildlife

The Netley-Grassmere watershed provides important habitat for a diversity of wildlife species. A Wildlife Management Area has been designated in the region around Oak Hammock Marsh. This marsh is an excellent wildlife viewing location and is a major staging area for Canada geese and other waterfowl. It also attracts numerous gull species and shorebirds, and has a large muskrat population. The marsh is a remnant of the once vast St. Andrews Bog set between the Stonewall ridge to the west and the lower Selkirk ridge to the east. Early attempts at drainage all but eliminated the marsh, but it was restored through the construction of dykes and the creation of several impoundments. The marsh is surrounded by remnants of tall-grass prairie and formerly cultivated areas that have been seeded to nesting cover (Manitoba Conservation 2008).

The Netley Marsh was officially dedicated as a Canadian Important Bird Area on October 1st, 2000. The Netley Marsh is known for its high numbers of Forster's Tern nests, but is home to many birds including Franklin's Gulls, Black-crowned Night-Herons, Yellow-headed and Red-winged, Swallows, Sandhill Cranes, Canada Geese, Pelicans, Western Grebes and other waterfowl (Important Bird Areas of Canada 2009).

As seen in Table 1, there are many species of concern found in this watershed, including 23 species of rare vascular plants, 13 rare species of birds, as well as, a rare crayfish and snake species (Manitoba Conservation 2008).

Table 1: Species of Concern

Common Name	Scientific Name	Category
Cliff-brake	Pellaea glabella ssp. occidentalis	Vascular Plant
Crawe's Sedge	Carex crawei	Vascular Plant
Cynthia	Krigia biflora	Vascular Plant
Downy Gentian	Gentiana puberulenta	Vascular Plant
False Indigo	Amorpha fruticosa	Vascular Plant
Leathery Grape-fern	Botrychium multifidum	Vascular Plant
Necklace Sedge	Carex projecta	Vascular Plant
Papoose-root	Caulophyllum thalictroides	Vascular Plant
Parry's Sedge	Carex parryana	Vascular Plant
Red-root Flatsedge	Cyperus erythrorhizos	Vascular Plant
Rigid Sedge	Carex tetanica	Vascular Plant
Round-leaved Bog Orchid	Platanthera orbiculata	Vascular Plant
Seaside Crowfoot	Ranunculus cymbalaria var. saximontanus	Vascular Plant
Side-oats Grama	Bouteloua curtipendula	Vascular Plant
Small White Lady's-slipper	Cypripedium candidum	Vascular Plant
Stiff Sunflower	Helianthus pauciflorus ssp. pauciflorus	Vascular Plant
Sundrops	Oenothera perennis	Vascular Plant
Tall dropseed	Sporobolus compositus	Vascular Plant
Western Silvery Aster	Symphyotrichum sericeum	Vascular Plant
White Boltonia	Boltonia asteroides var. recognita	Vascular Plant
Whorled Milkweed	Asclepias verticillata	Vascular Plant
Whorled Milkwort	Polygala verticillata var. isocycla	Vascular Plant
Yellow Stargrass	Hypoxis hirsuta	Vascular Plant
Calico Crayfish	Orconectes immunis	Invertebrate Animal
Barred Owl	Strix varia	Vertebrate Animal
Burrowing Owl	Athene cunicularia	Vertebrate Animal
Chestnut Lamprey	Ichthyomyzon castaneus	Vertebrate Animal
Chimney Swift	Chaetura pelagica	Vertebrate Animal
Cooper's Hawk	Accipiter cooperii	Vertebrate Animal
Forster's Tern	Sterna forsteri	Vertebrate Animal
Least Bittern	Ixobrychus exilis	Vertebrate Animal

Common Name	Scientific Name	Category
Loggerhead Shrike	Lanius ludovicianus migrans	Vertebrate Animal
Piping Plover	Charadrius melodus	Vertebrate Animal
Red-sided Garter Snake	Thamnophis sirtalis	Vertebrate Animal
Silver Chub	Macrhybopsis storeriana	Vertebrate Animal
Western Grebe	Aechmophorus occidentalis	Vertebrate Animal
Yellow Rail	Coturnicops noveboracensis	Vertebrate Animal
Snake Dens	Snake Hibernaculum	Animal Assemblage

Climate

Meteorological factors like temperature, precipitation, sunshine, and wind are commonly used to describe weather conditions at a specific location. Climate is then a description of a region’s average long term weather patterns. The Meteorological Service of Canada (MSC) maintains 110 weather stations across the Province of Manitoba, monitoring meteorological factors like temperature, precipitation and snow depth (Surface Water Management 2008).

Manitoba has a continental climate, with great temperature extremes. The characteristics that most distinguish Manitoba's climate from other regions are:

- large temperature differences from summer to winter;
- large temperature variations from day to day;
- lengthy, frigid winters;
- warm, sunny summers;
- minimal but highly variable precipitation totals;
- dry winters and summers, with more precipitation in the summer.

The MSC operates three weather stations in the Netley-Grassmere watershed; Grosse Isle, Stony Mountain, and Selkirk. Even though the watershed is relatively flat, meteorological factors still vary across the watershed between the three MSC weather stations. Figure 13 illustrates a comparison between daily mean temperature between the Stony Mountain and Selkirk weather stations, while Figure 14 depicts a comparison between mean monthly total precipitation at the same two stations. For these two locations, the temperature values in each month are very comparable; however, significant differences exist in mean (normal) monthly total rainfall. This is in part due to storm movement across the watershed (Surface Water Management 2008).

In terms of annual climate means in the Netley-Grassmere watershed, the mean annual precipitation ranges from 485 to 520 millimetres, while the mean annual temperature ranges from 1.2 to 2.4 degrees Celsius. The average length of the growing season is 175 – 183 days (Surface Water Management 2008).

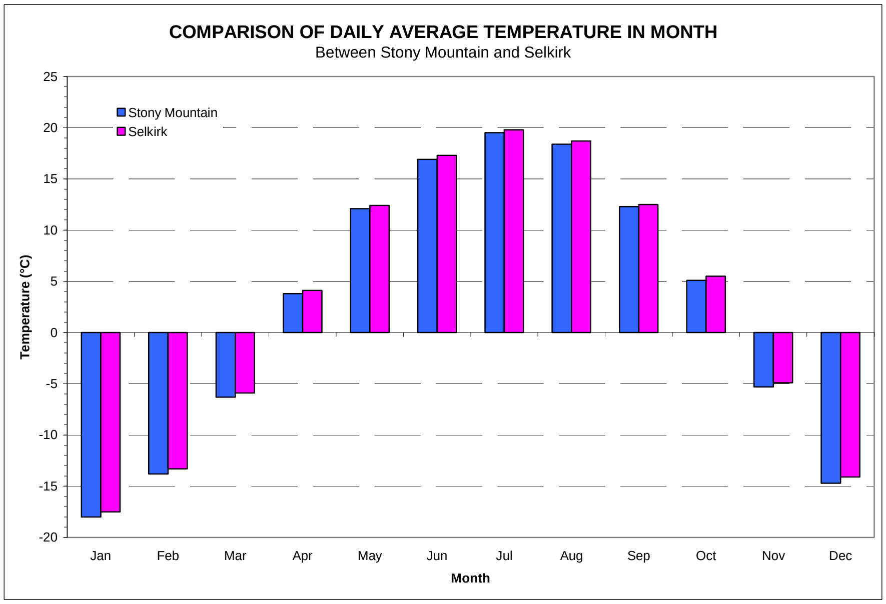

Figure 13: Comparison of daily temperature between Stony Mountain and Selkirk weather stations

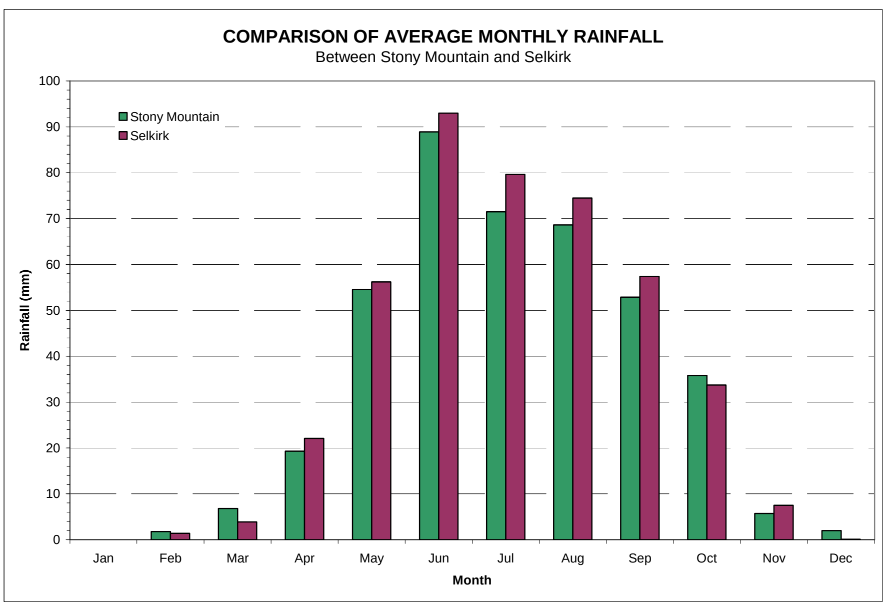

Figure 14: Comparison of average monthly rainfall between Stony Mountain and Selkirk weather stations

Climate Change

Climate change is a shift in long-term average weather patterns, which can include changes in mean temperature and in precipitation amounts. Climate change can be influenced by anthropogenic (human) sources of greenhouse gas emissions. Greenhouse gases are naturally found in the atmosphere, although relatively transparent to sunlight, they absorb most of the infrared heat energy transmitted by the Earth towards space. The main types of greenhouse gases are carbon dioxide, methane and nitrous oxide but water vapour, ozone and halocarbons are also considered to be important greenhouse gasses. Scientific evidence shows significant increases of greenhouse gas concentrations in the atmosphere since industrialization, due largely to the burning of fossil fuels for transportation and industrial processes. Evidence suggests that the increase of greenhouse gas concentrations in the atmosphere has led to a significant change in global climate in recent years (Surface Water Management 2008).

Manitoba is particularly vulnerable to climate change because of the important role that renewable resources like water and agriculture play in the economy. Climate change may impact the ecological balance and overall health of this watershed. Temperature patterns and hydrological regimes in Manitoba may be altered, leading to less snow pack, an earlier ice break-up and a change in stream flows throughout the Province. These changes could have an impact on water resources management in the Netley-Grassmere watershed. Aquatic ecosystems in rivers, lakes and streams are expected to be impacted by changes in stream runoff due to climate change. A changing climate could also exacerbate the risks of extreme hydrological events such as droughts and floods in the watershed which in turn may trigger enormous social and economic suffering. Recent studies have suggested that the Netley-Grassmere watershed may experience water stress by 2020 and alternative water strategies may need to be developed to minimize these negative impacts (Surface Water Management 2008).

Land Use

Agriculture is the primary land use in the Netley-Grassmere watershed. Based on 2005 land cover data, almost half of the land within the watershed was classified as annual cropland, most of which is located in the southern and eastern portions of the watershed (Table 2, Figure 15). Grasslands and trees also cover a large portion of the watershed in the north-western region and in small stands scattered throughout the watershed. Areas of grassland and wetlands are also found near the Oak Hammock Marsh and the Netley Marsh area. Over 7% of the watershed can be classified as water when combined with wetlands, signifying that there is a fair amount of riparian or shoreline area in this watershed. Urban and transportation land uses cover nearly 5% of the watershed and are found mostly near the Winnipeg and Selkirk area and, in the corridor between these two urban centres along the Red River (AAFC-PFRA and MAFRI 2009).

Table 2: 2005 Land Cover for the Netley-Grassmere Watershed

Class	Percent of the Netley-Grassmere Watershed
Annual Cropland	49%
Trees	12%
Water	3%
Grassland/Pasture	17%
Wetlands*	4%
Forages	7%
Urban/Transportation	5%

- Due to seasonal changes in wetland size, date of imagery will affect area shown as wetland

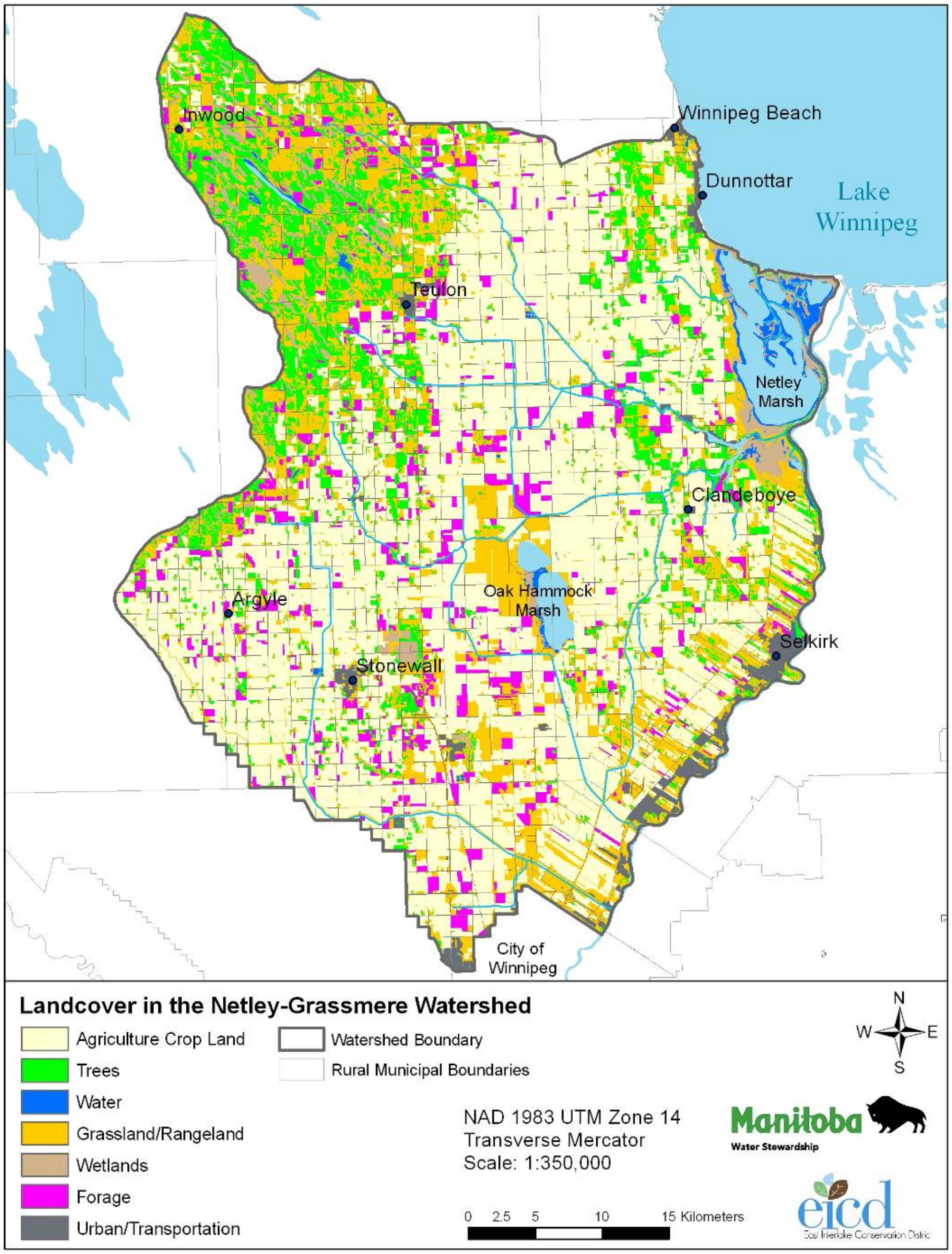

Figure 15: Land Use in the Netley-Grassmere Watershed

Between 1994 and 2005, an increase of 93% in forages was experienced. This change was most likely influenced through government programs like the Permanent Cover Program that provided incentives for the conversion of marginal lands from annual cropping production to perennial cover following the demise of the Western Grain Transportation subsidy. The lower value of the Canadian dollar versus the United States dollar has also favoured alfalfa and timothy production in Canada for export to the United States market. A 23% increase in lands identified as urban/transportation is also of significance as this is attributed to increased pressure for urban development within the watershed, particularly in the areas near

Stonewall and West St. Paul, and in the corridor between the City of Winnipeg and Selkirk where prime and viable lower classed agricultural land have been taken out of production (AAFC-PFRA and MAFRI 2009). There has also been significant rural residential subdivision development along Netley Creek and Wavey Creek in the vicinity of Petersfield and to a lesser degree along Muckle Creek near Clandeboye (Manitoba Conservation 2008).

This watershed also has a number of navigable waterways which connect to the Red River and Lake Winnipeg. As a result, increased pressure for seasonal recreational land development and the conversion of seasonal recreational developments to high density rural residential areas has increased significantly over the past 10 years. The conversion of land to urban, recreational, and transportation use is directly related to the proximity to the City of Winnipeg. The commuter distance allows residents to easily travel to Winnipeg or other major centres for work on a daily basis. The conversion of agricultural land to residential/seasonal recreational use within the watershed increases land values and has an indirect effect on the viability of surrounding agricultural lands. Farmers have to compete in land market influenced by speculators, investors, developers, commuters and hobby farmers, most of whom have greater financial resources to draw on than do farmers. Non-agricultural uses may increase the expenses for roads, drainage or other infrastructure services (AAFC-PFRA and MAFRI 2009). The increase in urban development also increases the land area used for roads, parking lots, rooftops, and other impermeable surfaces of an urban landscape. Creating more impervious land surfaces throughout the watershed is linked to stream degradation, and declines in habitat structure and biodiversity (Schueler 2000).

Agriculture

Agricultural Statistics

According to the analysis of the Census of Agriculture for 2006, there are over 550 farms in the Netley-Grassmere watershed, with an average farm size of approximately 240 ha/farm (580 acres) and an average capital investment of almost $3,500 - 4,000 per hectare of farmland or $907,000 - $926,600 per farm. Livestock-related expenses per hectare of farmland are under $150 - $240/ ha. Crop related expenses are approximately $130 - 180/ha in this watershed (AAFC-PFRA and MAFRI 2009).

Over half of the farmland in this watershed is dedicated to annual crop production while over 30% is dedicated to pasture, alfalfa, and hay and fodder crops. Cereals make up about 60% of the annual crops while nearly 30% is seeded to oilseeds. Land management practices include almost two thirds of the cultivated land prepared using conventional tillage practices, over 30% using conservation tillage practices and 5% prepared with zero tillage (AAFC-PFRA and MAFRI 2009).

Livestock production is also important in this watershed, with the presence of several intensive poultry, hog and dairy operations. There are over 40 poultry operations with an average flock size of 2,800 - 5,400 birds per farm. There are also over 25 hog operations with an average of over 3,200 animals per farm. As for dairy production, there are over 20 operations with an average of 50-60 dairy cows per farm. One-third to half of the farm operations report beef cows, with an average of almost 50 cows per farm (AAFC-PFRA and MAFRI 2009).

Trends in Agriculture

Through a comparison of the 2001 and 2006 Agricultural Census data, there has been a small overall change in total farmland area in the Netley-Grassmere watershed; however, there has been a small change in land use within the farming operations. The changes within the Cropland and Pasture categories have been minor; however, there has been a large decrease in summerfallow. In terms of annual cropland, there has been a decrease in cereal production with an increase in acreage of oilseeds, pulses and forages. Conversion of Class 4 and 5 soils to forage production has mitigated risk for annual crop production on these soils. Higher input costs, lower grain prices, disease pressures, increased transportation costs coupled with a higher potential return and on-farm diversification has accelerated this trend from 1996 to present day. Producers continue to seek diversified income opportunities resulting in significant increase in acres of special crops, such as soybean production. The application of commercial fertilizers, herbicides, insecticides or fungicides has decreased since 2001. There may be several reasons for this decrease, but an increase in the costs of these inputs is the most likely reason (AAFC-PFRA and MAFRI 2009).

With respect to livestock operations, there was a slight decrease in total cattle reported, as well as the number of farms reporting cattle. Reductions in herd size and number of farms reporting beef cattle can be attributed to Bovine Spongiform Encephalopathy (BSE), low commodity prices and retiring farmers. Intensification within the dairy and hog sectors was also experienced in this watershed which is consistent with provincial trends. Larger specialized hog operations were developed in response to opportunities of scale in the sector. At the same time, older smaller facilities reached their life expectancy along with an increase in numbers of retiring producers which contributes to the continuing the trend within the agricultural industry to larger more specialized operations. In terms of poultry operations, there has been a moderate decrease in number of farms, with an increase in the number of birds per farm. This is consistent with the opportunities of scale, farmer retirements and quota consolidation (AAFC-PFRA and MAFRI 2009).

Adoption of Beneficial Management Practices

In 2003, the Agricultural Policy Framework (APF), a federal-provincial government initiative aimed at supporting agricultural activities associated with Business Risk Management, food safety and quality, science and innovation, environment, and skill development. In support of priorities related to soil, air, water and biodiversity, various environmental initiatives were introduced across Canada including Environmental Farm Planning and the National Farm Stewardship Program. Environmental Farm Planning (EFP) is awareness and planning tool used to enhance producers' understanding of potential on-farm environmental risks and to develop action plans for how these risks can be addressed. Many producers in

Manitoba, including those in the watershed, have participated in the EFP process to gain an improved understanding of the potential environmental risks associated with agriculture, as well as, those on their own farms. The EFP process also allowed producers to develop an action plan that outlines how potential risks on their farms can be addressed through the adoption of beneficial management practices (BMPs). Financial and technical support has been offered to producers wishing to adopt BMPs through the Canada Manitoba Farm Stewardship Program (CMFSP) between 2003 and 2009. This program offered 30 different BMPs to producers that had completed an EFP (AAFC-PFRA and MAFRI 2009).

Within the Netley-Grassmere watershed, there were 159 BMP projects that were adopted by producers. The adoption of these BMPs contributed to reducing risks to water quality. Of the 159 adopted, 72 of the BMPs were livestock related BMPs, 18 were cropping based BMPs, and 66 were BMPs specific to point source protection that could apply to either a cropping or livestock operation. The top three BMPs adopted by producers in the watershed are Improved Cropping Systems, Product and Waste Management, and Winter Site Management which is consisted with trends throughout Manitoba (AAFC-PFRA and MAFRI 2009).

The adoption of BMPs by producers is not limited to the CMFSP. Other agencies like the East Lake Conservation District, Ducks Unlimited Canada, and Manitoba Habitat Heritage Corporation also promote various BMPs, including the restoration and protection of natural habitat, riparian area management, and source water protection. Also, many producers have adopted BMPs on their own, and as such, it is unknown what types and how many have been adopted in the Netley-Grassmere watershed (AAFC-PFRA and MAFRI 2009).

Groundwater

Hydrogeology

The Netley-Grassmere watershed is underlain by bedrock consisting of limestone and dolostone inter-layered with several argillaceous units. The limestone and dolostone form a major fresh water aquifer, called the Carbonate aquifer (Figure 16). This aquifer is the primary source of water supply in the region. The limestone and dolostone is underlain by shale and sandstone forming the Winnipeg Formation. While the sandstones are a productive aquifer, water quality is saline. Bedrock is overlain by a variable thickness of clay and glacial till (Figure 17). Sand and gravel is found locally at the contact between the till and the limestone/dolostone bedrock and in some areas is sufficiently thick to form a productive aquifer (Groundwater Management Section 2008).

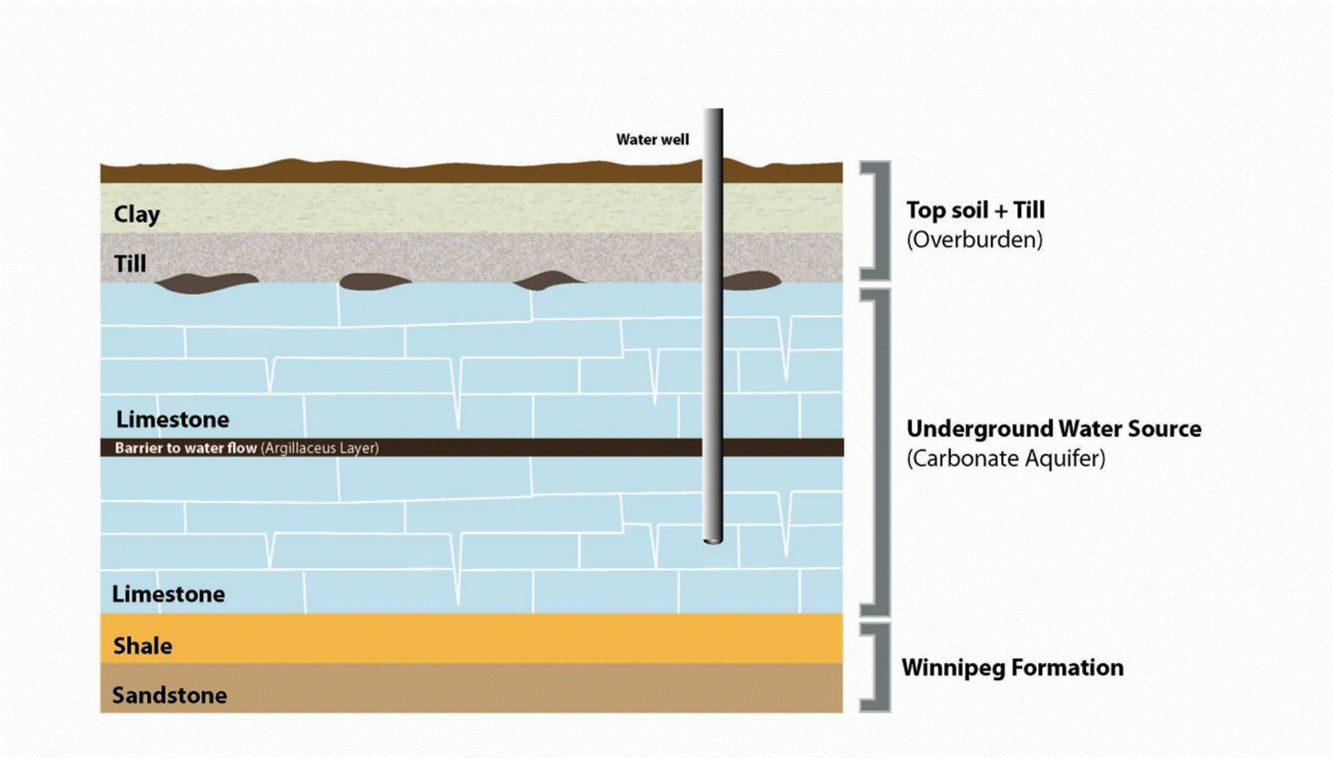

Figure 16: Cross-sectional Diagram of the Hydrogeology of the Netley-Grassmere watershed

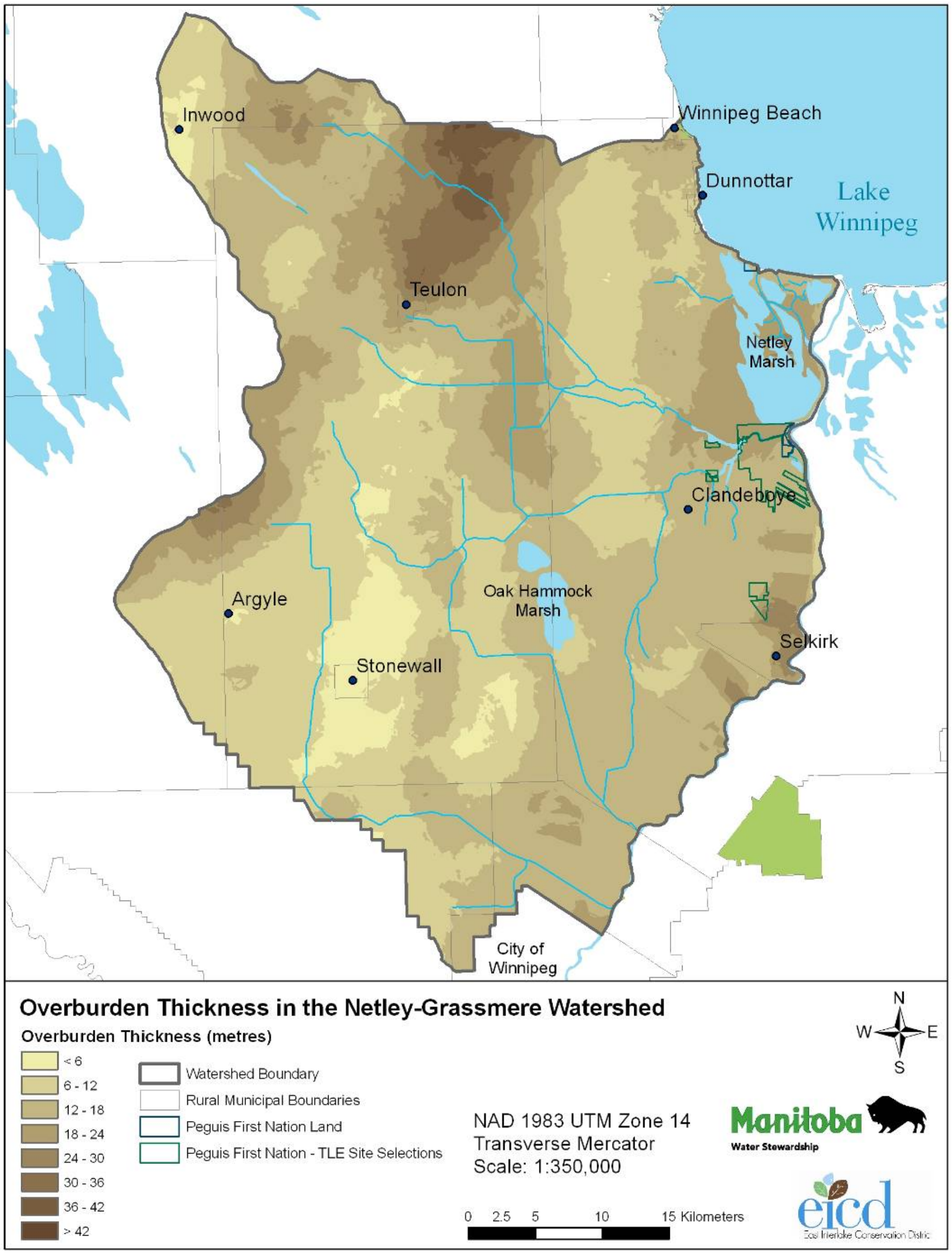

Figure 17: Overburden Thickness in the Netley-Grassmere Watershed

A major argillaceous unit occurs in the upper part of the Stony Mountain Formation which underlies the western portion of the watershed (Figure 16). This unit forms an extensive aquitard, or barrier to flow, which restricts the movement of water between the overlying limestone and dolostone and the older carbonate rocks below the aquitard. In some areas it has been found that the portion of the Carbonate aquifer overlying the aquitard is contaminated but the aquifer beneath the aquitard has not been impacted. In these areas, wells can be drilled into the aquifer below the aquitard and obtain good quality groundwater (Groundwater Management Section 2008).

Groundwater Flow

Regional groundwater movement in the Netley-Grassmere watershed is primarily from north-west to south-east; however, more local groundwater flow is developed in some areas such the Oak Hammock Marsh. The primary recharge area for the Carbonate aquifer is located in the central Interlake where a large groundwater mound has formed. Groundwater moves away from this mound in all directions, creating the dominant flow patterns observed in the Netley-Grassmere watershed (Figure 18). Groundwater discharge is poorly understood, although it is known that discharge occurs as springs into a number of streams. This discharge forms the base-flow component of these streams. Groundwater may also discharge directly to the Red River in areas where the river bed has been scoured to bedrock. Flowing wells along the western shore of Lake Winnipeg indicate an upward directed groundwater flow but thick clay deposits in this area and beneath the lake restrict discharge to diffuse seepage (Groundwater Management Section 2008).

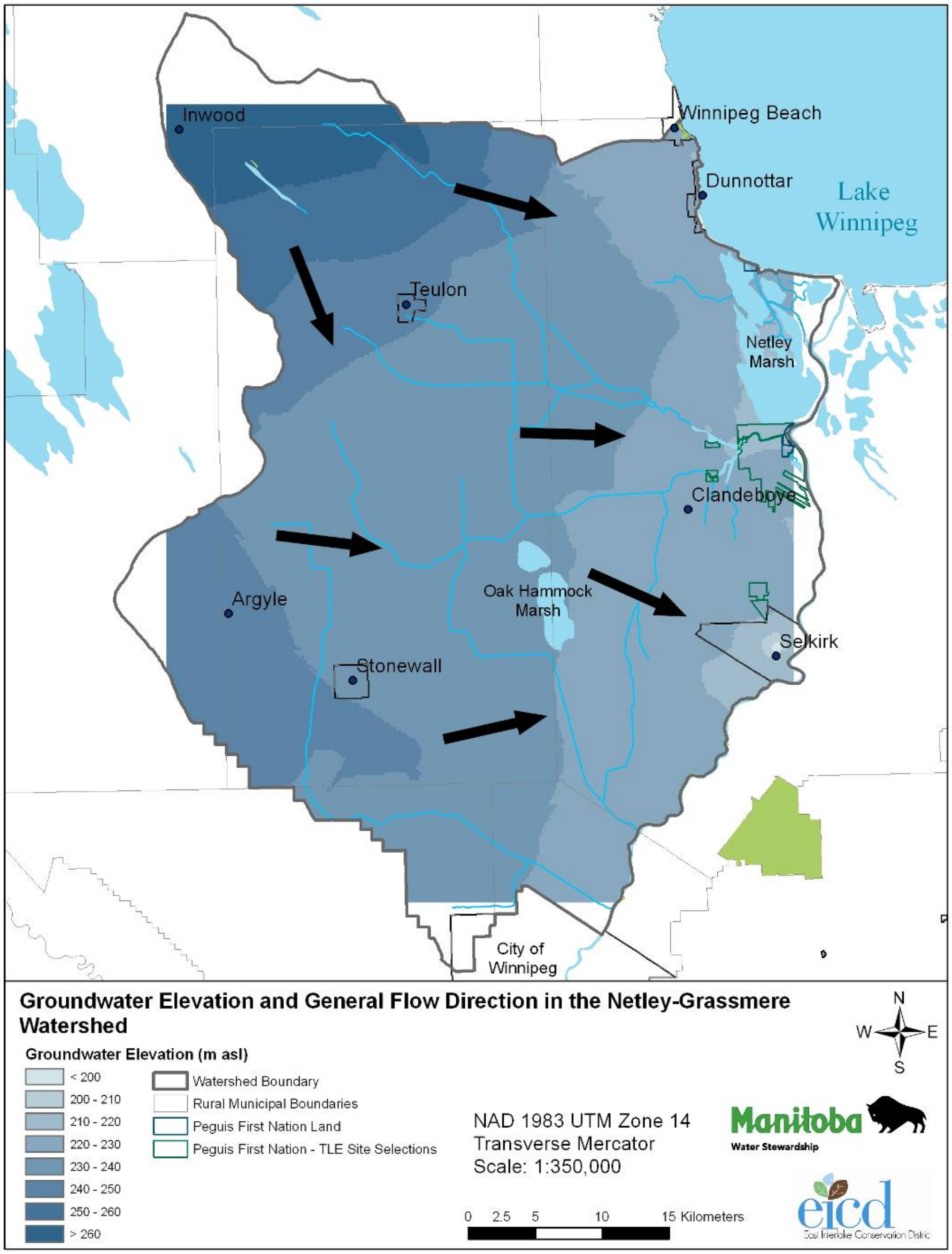

Figure 18: Groundwater Elevation and General Flow Direction in the Netley-Grassmere Watershed

Groundwater Availability

The Carbonate aquifer is generally highly productive with almost all wells drilled into the aquifer being capable of producing sufficient water for a single family dwelling. The aquifer has also been developed with a number of high capacity wells to provide for municipal, industrial and irrigation water supply. All municipal drinking water systems in the watershed are sourced by groundwater. The aquifer also served as a water supply for the City of Winnipeg from about 1900 to 1919, through a series of wells drilled along Pipeline Road. Figure 19 shows licensed groundwater users in the watershed. Water withdrawals of less than 5500 Ig/day (25,000 L) do not require a license in Manitoba (Groundwater Management Section 2008).

Although specific studies have not been undertaken to evaluate recharge rates to the Carbonate aquifer in the Interlake, long-term groundwater monitoring near areas of high use (Selkirk) and in more remote areas where little groundwater withdrawal is occurring do not show systematic water level declines which would indicate unsustainable withdrawal from the aquifer. Current rates of withdrawal are likely only a very small portion of the average recharge rates in the watershed. The locations of all provincial monitoring wells are also shown on Figure 19. This does not include monitoring wells established at contaminated sites or sites where a potential contaminating source is being monitored (Groundwater Management Section 2008).

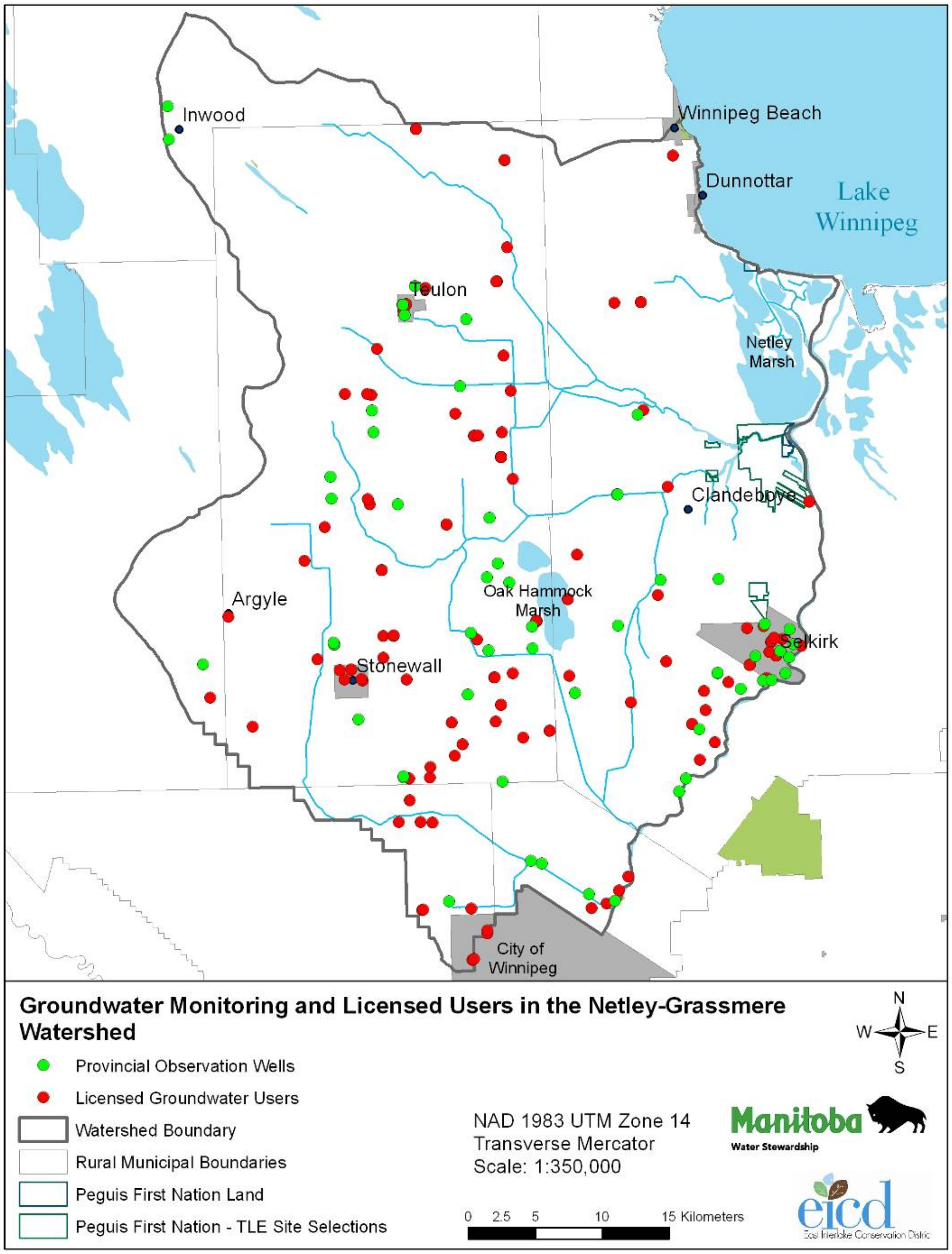

Figure 19: Groundwater Monitoring Stations and Licensed Groundwater Users in the Netley-Grassmere Watershed

Groundwater Quality

Groundwater quality is generally good, although the hardness is often high enough that a water softener may be required. Iron and manganese may also be present at concentrations that cause staining issues. Trace metal concentrations (arsenic, barium, boron, fluoride) have not been found to exceed drinking water guidelines but a small number of wells have been found to produce water with uranium concentrations slightly higher than the current drinking water guideline. Overall water quality is somewhat poorer along the western edge of the Red River between Winnipeg and Selkirk In this area many wells produce water with elevated concentrations of sulphate, sodium and chloride, likely as a result of local recharge occurring through the clays which overlie the aquifer. A recent well inventory study conducted by the East Interlake Conservation District, in partnership with Manitoba Water Stewardship, indicates that approximately one in every four wells located within the Netley-Grassmere watershed have failed drinking water guidelines due to presence of bacteria and/or high levels of nitrates (Groundwater Management Section 2008).

Groundwater Vulnerability and Contamination Issues

Groundwater is considered vulnerable to contamination where contaminants may leach into the aquifer from the ground surface relatively more quickly than in other areas. In the Netley-Grassmere watershed, the primary areas where groundwater would be considered vulnerable to contamination occur where the bedrock aquifer is found at surface or is covered with only shallow deposits of clay, till or sand/gravel. Sinkholes are also common in these areas of the watershed, as shown in Figure 20. Sinkholes allow surface waters to flow directly into the aquifer, and therefore, are a great concern in this watershed (Groundwater Management Section 2008).

In the Netley-Grassmere watershed, elevated nitrate concentrations are typically found in areas with less than five to ten metres of clay and glacial till overlying the bedrock aquifer, indicating that this is a reasonable criterion for vulnerability mapping, as shown on Figure 21. There is also an increased risk of contamination in areas where there are fractures in the bedrock, as these fractures act as a pathway for surface waters to flow directly into the aquifer (Groundwater Management Section 2008).

Figure 20: Sinkhole in the Grassmere Drain (2008)

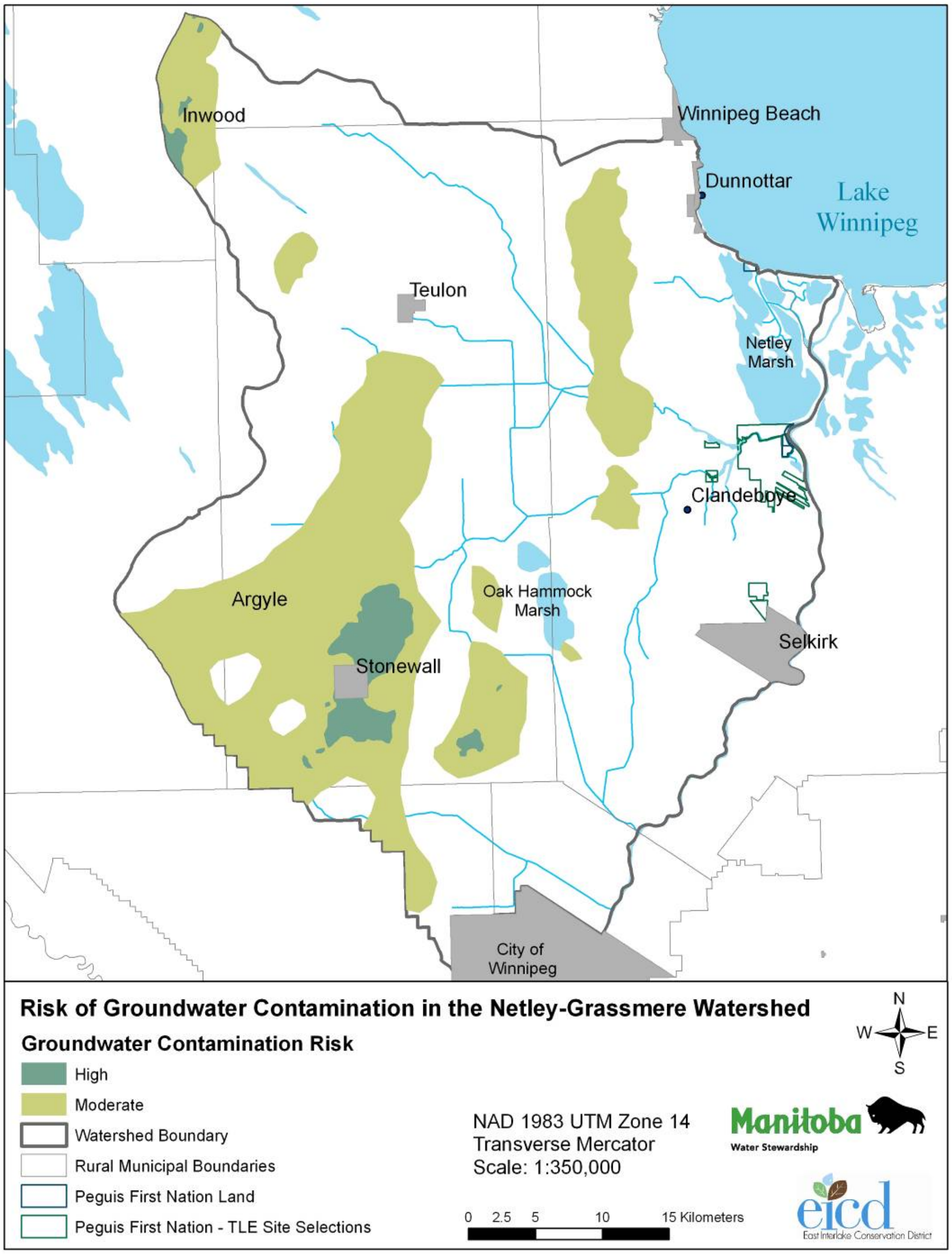

Figure 21: Risk of Groundwater Contamination in the Netley-Grassmere watershed

Bacterial contamination of groundwater is also associated with areas of thin overburden cover; however, the relationship is not as strong as with elevated nitrates. While some wells may produce bacterially contaminated groundwater as a result of direct entry of bacteria into the aquifer, in most cases other factors are also responsible. This may include the installation of only a short length of well casing in areas of shallow bedrock, failure to adequately grout the borehole annulus, inadequate well maintenance, leakage at the snappy connection, or failure of the casing through corrosion. Bacteria may also be introduced directly into the bedrock aquifer via rock quarries, although this vector of contamination is not shown to be a significant issue in Manitoba. It is interesting to note that the Gunton area has been subject to several well contamination events due to excessive rainfall over the past few years, with reports of vegetation being washed into the aquifer along with so much air that pumps became air locked. Runoff is gaining direct access to the aquifer; however, the location has not been determined (Groundwater Management Section 2008).

There are numerous potential sources of groundwater contamination in the watershed. These include, but are not limited to, waste disposal grounds, manure solid or liquid storage sites, agricultural practices, direct recharge to the aquifer through sinkholes, abandoned wells or drainage wells, municipal lagoons, and industrial activities. While many potential sources of contamination exist, it is generally only in areas with thin overburden cover over the bedrock that contamination of groundwater in the aquifer actually occurs. In areas with thick clay and till overburden, transport of contaminants to the aquifer may take decades or even thousands of years. Appropriate engineering practices can also reduce the risk of leaching and groundwater contamination, for instance by installing a liner in municipal or agricultural lagoons (Groundwater Management Section 2008).

A well documented case of groundwater contamination from an industrial facility occurred at the Bristol Aerospace plant just north-east of Stony Mountain. The facility was located in an area where bedrock is found at shallow depth. Inappropriate handling of the organic solvents TCA and TCE at the plant resulted in a significant plume of groundwater contamination, extending over many square kilometres. A "pump and treat" facility consisting of 3 pumping wells and an aeration tower has been operating at the site since 1994 and appears to have successfully contained the contaminant plume. Provincial legislation requires a permit to drill or modify a well within and immediately adjacent to the contaminated area (Groundwater Management Section 2008).

Drinking Water Sources

Clean, potable drinking water is critical for human life and, therefore, a necessity for prosperous sustainable communities. Drinking water sources can be categorized into three types: public systems which contain 15 or more service connections, semi-public systems which contain less than 15 service connections and private systems that supply water to only one residence (individual private wells).

The Netley-Grassmere watershed contains 13 public drinking water systems, all of which are groundwater sourced. Some public drinking water systems use multiple wells to withdraw water for a single community. These 13 public drinking water systems are serviced by 28 municipal wells in total, as seen on Figure 22. There have been minor compliance issues with public water systems in this watershed, including issues with license applications and submitting corrective action forms detailing adjustments made to the water treatment plant in order to maintain regulatory requirements (Office of Drinking Water 2009).

There are many semi-public drinking water systems in this watershed. The exact number is unknown due to the relatively recent establishment of the Manitoba Water Stewardship's Office of Drinking Water; which is currently focusing on identifying and licensing public water systems. There are also numerous private individual wells as groundwater is the main source of water supply for residents in the Netley-Grassmere watershed (Office of Drinking Water 2009).

In the spring of 2009, a precautionary boil water advisory was issued for much of the Netley-Grassmere watershed due to overland flooding and the potential risk of well contamination. This boil water advisory was removed following the recession of flood waters. During this same period, the Mapleton School in Selkirk was also issued a boil water advisory due to consecutive positive well samples, most likely due to poor well construction or maintenance. There is a history of boil water advisories in this watershed, especially in the areas of Balmoral and Gunton. The reasons for these boil water advisories are related to poor well construction and the lack of protective overburden above the groundwater aquifer (Office of Drinking Water 2009).

The Office of Drinking Water, within Manitoba Water Stewardship, addresses public risk related to drinking water through a regulatory framework which provides multiple barriers to ensure the delivery of high quality drinking water. Since the regulations were brought into effect in 2007, the focus of this branch has been to ensure high quality; potable water is delivered from Public Water Systems. The majority of these systems are in the process of license application and engineering assessments to determine if any infrastructure deficit exists. The results of these engineering assessments will identify necessary upgrades for many treatment facilities (Office of Drinking Water 2009).

The Office of Drinking Water also ensures that individual well owners are notified in the event of positive bacterial samples and monitors these samples to determine if positive results are likely the result of poor well construction/maintenance or are indicative of aquifer based pollution. In the event of aquifer based pollution, the Office of Drinking Water typically works cooperatively with the Groundwater Management Section of Manitoba Water Stewardship and the Environmental Operations Section of Manitoba Conservation who help to identify, and where possible, mitigate pollution sources. The Office of Drinking Water staff focus on treatment and public notices required to ensure public health is protected (Office of Drinking Water 2009).

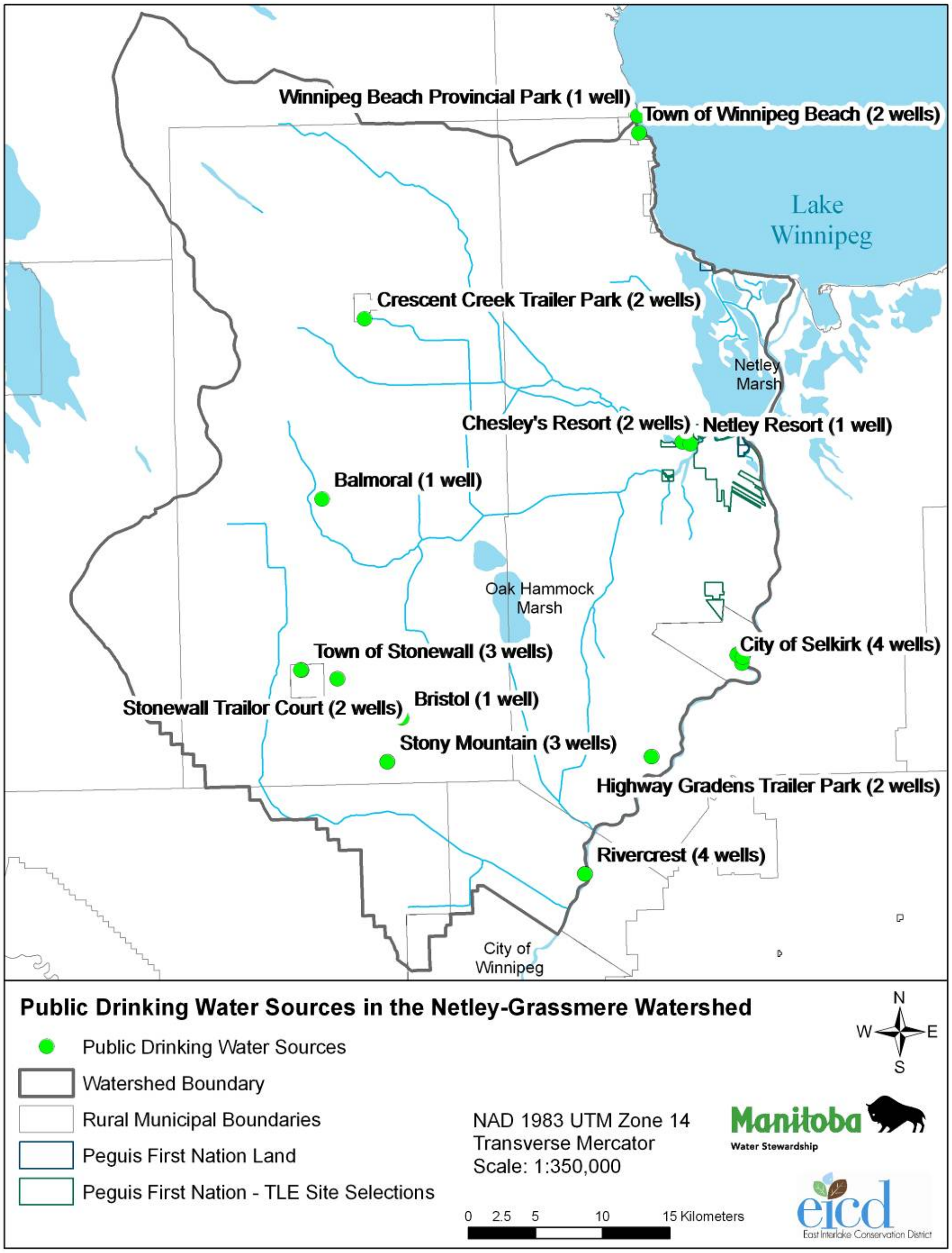

Figure 22: Public Drinking Water Sources in the Netley-Grassmere watershed

Surface Water Management

Hydrology

The rivers, lakes, and streams within the Netley-Grassmere watershed deliver freshwater to support domestic, agricultural, and industrial uses across the watershed, provide habitats for aquatic creatures, and are of great value to the landscape and its residents. Historical flow information plays a key role in the management of water resources, design of water infrastructures, planning of land use and urban development, protection of ecosystems, and dealing with issues like climate change. It is of great importance to monitor flows and water levels, assess water availability, and balance supply and demand of water for the watershed (Surface Water Management Section 2008).

The collection of hydrometric data is very important to the understanding of the availability, variability and distribution of water resources. It provides the basis for responsible decision making on the management of water resources. Environment Canada, the Province of Manitoba, and Manitoba Hydro operate 143 discharge and 133 water-level gauging stations under the Canada-Manitoba Hydrometric Agreement. Within the Netley-Grassmere watershed, stream flow and water level data has been collected at 31 hydrometric gauging stations, of which 8 are still active. Figure 23 illustrates the locations of the active and decommissioned hydrometric gauging stations in the Netley-Grassmere watershed (Surface Water Management Section 2008).

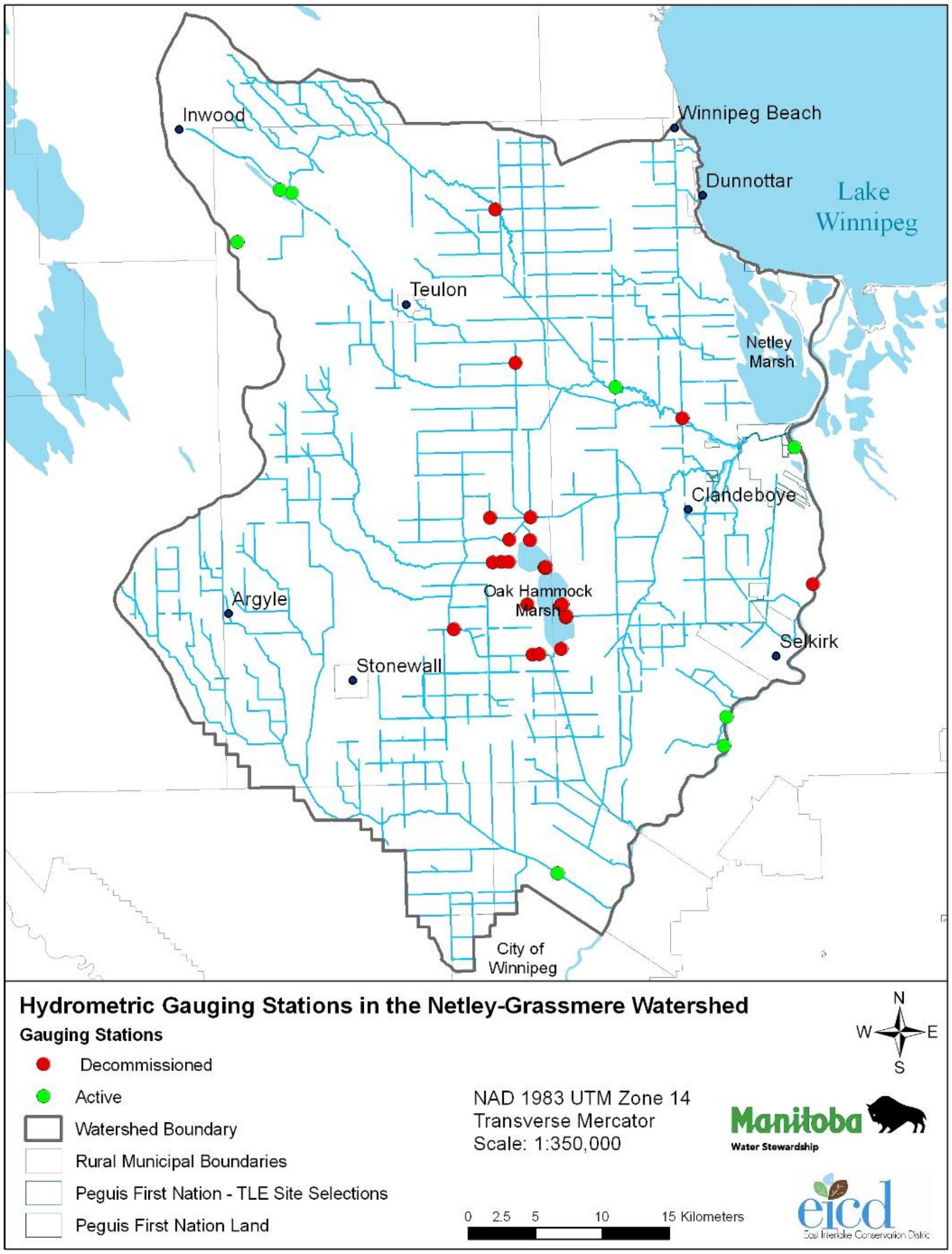

Figure 23: Hydrometric Gauging Stations in the Netley-Grassmere Watershed

Runoff and Streamflow

Runoff is that part of the precipitation which appears in surface streams of either perennial or intermittent form. Runoff is collected from a drainage basin or watershed, and is considered to be unaffected by artificial diversions, storages, or other works of man in or on the stream channels. Many of the hydrometric stations within the Province measure streamflow instead of total runoff since the flows in channels and lakes are affected by human activities. Runoff may consist of surface runoff, subsurface runoff, and/or groundwater runoff. The surface runoff is that part of the runoff which travels over the ground surface and through channels to reach the basin outlet. The subsurface runoff, also known as subsurface flow, is the runoff due to that part of the precipitation which infiltrates the surface soil and moves laterally through the upper soil horizon toward the streams as shallow groundwater above the main groundwater level. The groundwater runoff is that part of the precipitation which has passed into the ground and has reached the main groundwater level through deep percolation. This groundwater typically provides a baseflow by discharging water into the stream channel (Surface Water Management Section 2008).

Factors that affect runoff and subsequently streamflow include climate factors such as rain, snow, intensity, duration, and storm movement, physiographic factors (size, shape, and elevation), physical factors (land use and cover, soil type, and geological conditions), and channel characteristics (size and shape of cross section, slope, and roughness,). Therefore, significant spatial variations always exist in runoff and streamflow within a watershed (Surface Water Management Section 2008).

There are significant temporal variations in streamflow in the Netley-Grassmere watershed. In most years, the majority of runoff in the watershed occurs in the spring, especially in April. At this time of year, precipitation which has fallen as snow and accumulated throughout the winter melts and runs off into the drains and rivers. The ground is often either frozen, or is already saturated, so most rainfall and runoff flows overland to drains, rivers or lakes instead of into the ground (Surface Water Management Section 2008).

Agricultural Drainage Network

The agricultural drainage network is designed to remove excess rainfall and snowmelt runoff from cropland during the growing season to improve the productive capability of the soil. If excess runoff sits on the crops for too long, the agricultural plants will be deprived of oxygen and damaged or destroyed. Only a small portion of agro-Manitoba has natural soil features and a natural drainage system to remove excess summer runoff of land in a timely manner. In much of agro-Manitoba, the natural draining away of excess summer runoff is slow or virtually non-existent. In these areas, the soils are relatively dense, so there is limited percolation of excess rainwater downward into the soil column. As well, the topography is quite flat, or has a ridge and swale nature, so the only significant natural drainage that occurs is on the relatively small areas along ridges, or near the natural streams. For that reason, thousands of miles of artificial drains have been constructed in these areas over the last 150 years, in order to augment the limited natural drainage that occurs. This artificial drainage, by reducing damages to croplands, has the added benefit of reducing the payments made by Federal-Provincial crop insurance programs (Water Control Systems Management Branch 2010).

The artificial drains also have a number of secondary benefits. In the spring time, the drains help to remove snowmelt runoff off the land, thereby reducing the risk of flooding to some rural residences and communities. As well, the length of time that the snowmelt runoff ponds against the embankments of municipal or provincial roads is greatly reduced, thereby minimizing the damage to these embankments. These same secondary benefits occur following unusually heavy summer rainstorms, where the drains are overwhelmed and significant flooding and ponding of runoff occurs on the landscape (Water Control Systems Management Branch 2010).

Drains in Manitoba are classified from 1^{st} order to 7^{th} order, with 1^{st} order being the smallest and 7^{th} order being the largest. Municipalities, towns and villages typically maintain all 1^{st}, 2^{nd}, and some 3^{rd} order drains, whereas the Province of Manitoba typically manages and maintains most of the 3^{rd} order and higher order drains. Figure 24 shows the drainage network within the Netley-Grassmere watershed. Most of the higher order drains follow natural rivers, creeks, and other watercourses (Water Control Systems Management Branch 2010).

Drainage Standard

When Provincial waterway drains are enlarged, the principal issue to resolve is the size that the drain should be enlarged to; the methodology or formula used for determining that size is commonly called the design standard. This same issue arises in some rehabilitation (also called reconstruction) projects, when the land use in the area serviced by the drain has changed since the drain was originally constructed. In such situations, the guiding principle is to have an economically sound balance between the cost of the enlargement and the benefits of that enlargement; the benefits are the reduction in the damages to the adjacent crops. These damages occur due to excess summer runoff ponding on the cropland, and the damages are reduced when excess summer runoff is removed more quickly by larger drains which have larger water-carrying capacities. However, even in areas with larger drains, damages to the agricultural cropland from summer flooding still occur periodically. In a wet cycle, those damages will occur more often. In an exceptionally wet, rainy year like 2009, damages will be widespread and extensive; the drainage system is not designed to protect against such wet summers and to convey unusual flood events (Water Control Systems Management Branch 2010).

A number of factors come into play in the determination of the cost-benefit balance. One factor is related to crop type. The benefits are larger for higher-value crops like peas, sunflowers and sugar beets, as compared to lower value crops like hays and forages. As well, many special, high-value crops are more quickly damaged by excess runoff ponding on the cropland, so, to be viable; they must be drained by a drainage network with a higher water-carrying capacity. Another factor is related to soil type. Excess summer runoff percolates downward quite slowly where there are dense soils, like clay. Therefore, areas with clay soils require larger drains, because so little of the runoff percolates downward through the soil. A third factor is related to topography. Areas that are especially flat require larger drains because the velocity of the water within the drains is quite low. In steeper areas, the velocity is higher, and so smaller drains can convey the same amount of water (Water Control Systems Management Branch 2010).

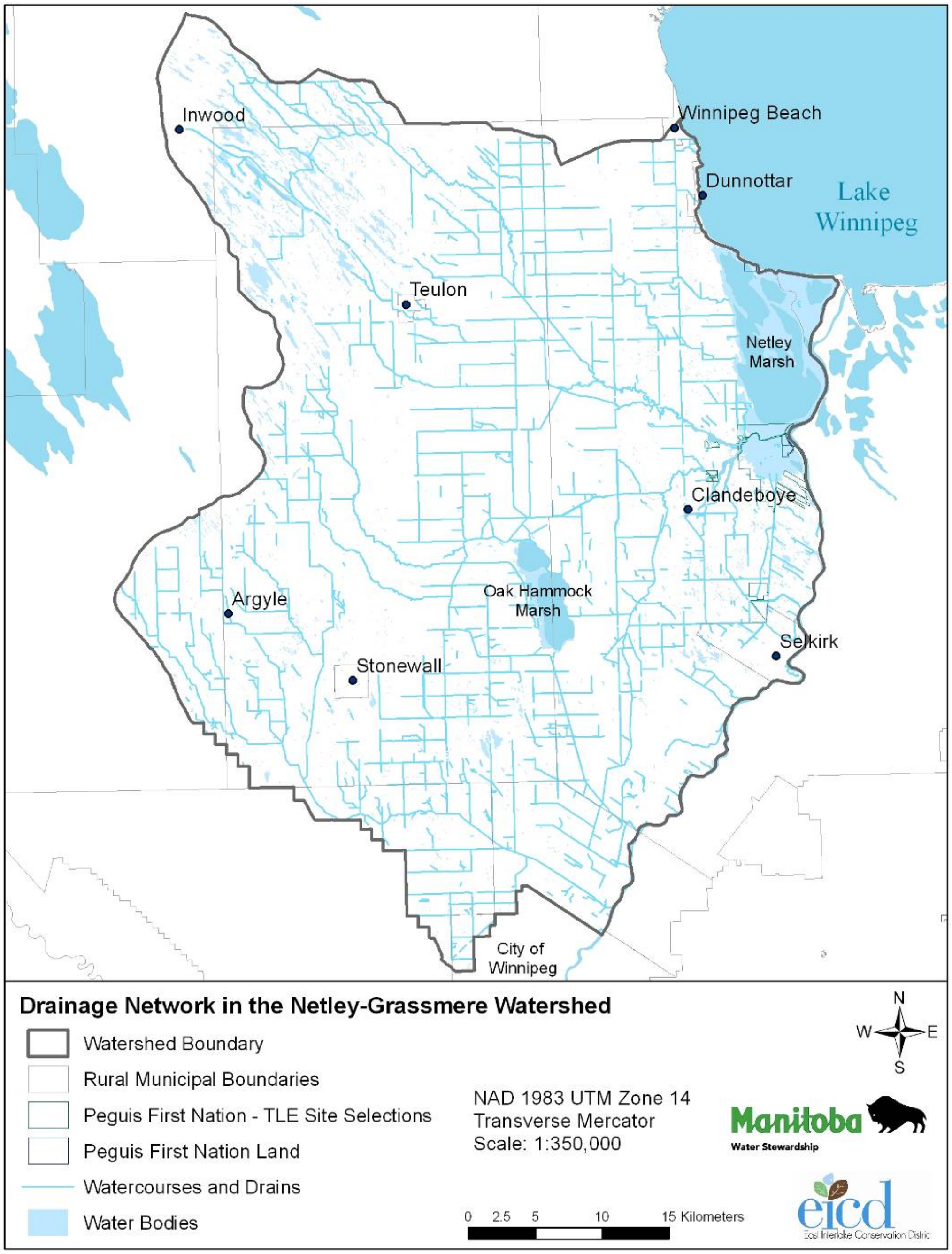

Figure 24: Drainage Network in the Netley-Grassmere Watershed

Responsibility for Drainage

The Provincial Government is responsible for the network of larger drains that serve as collectors for local municipal drains. The largest of the Provincial drains typically exit into rivers or lakes. The drains under Provincial jurisdiction are formally designated as "Provincial waterways". Municipalities have authority over any off-farm drains that are not designated as Provincial waterways, and they have responsibility for drains that they have constructed or maintained. Most natural streams like the Red River are not Provincial waterways and are also not the responsibility of the local governments (Water Control Systems Management Branch 2010).

In Manitoba, the responsibility for agricultural drains is split among farmers, municipal governments, four conservation districts (i.e. Whitemud, Turtle River, Alonsa, and Cook's Creek), and the Provincial government. In all cases, responsibility for the drains includes the responsibility of bridges, culverts and road crossings on those drains. The exception to this is crossings for Provincial Roads (PR's) and Provincial Trunk Highways (PTH's), which are the responsibility of Manitoba Infrastructure and Transportation (MIT). Agricultural producers and municipal governments are responsible for maintenance and new construction of drains under their jurisdiction; this includes funding of those works. The four conservation districts are also responsible for maintenance and new construction of off-farm drains located within their districts (Water Control Systems Management Branch 2010).

Drainage Licensing

All work on upgrading or constructing of drains by agricultural producers and municipal governments is subject to the provisions of *The Water Rights Act*. All works under Provincial jurisdiction are exempt from this Act, including all Provincial waterways and all road-side ditches constructed by MIT. However, they are constructed and maintained under the intent of the *Act*. This *Act* is intended to minimize or eliminate any negative impacts of drainage works on downstream landowners or jurisdictions and any negative environmental impacts (Water Control Systems Management Branch 2010).

Maintenance and Reconstruction

In all of Manitoba, there are approximately 4,350 km (2,700 miles) of Provincial waterway drains, 650 bridge crossings and 1,500 large culvert crossings. This infrastructure has a replacement value of well over $1 billion. Like all physical structures, the drains and crossings require periodic maintenance. Maintenance activities include mowing the vegetated side slopes and banks, mowing or removing larger vegetative growth in the drain bottom, removing debris and areas of silt in the drain bottom, re-shaping short reaches of slumping and sliding side slopes and banks, repairing eroded road grades at culvert crossings, repairing damaged culverts, and repairing or replacing damaged planks or other elements of bridge crossings (Water Control Systems Management Branch 2010).

Sometimes drains deteriorate to such a point that normal maintenance activities are not sufficient to restore their water-carrying capacity and proper functioning. This can happen because of the effects of things like unusually destructive summer or spring flood events. When such deterioration occurs, the drains must be reconstructed to restore their water-carrying capacity. Reconstruction activities include works such as the removal of channel-bottom silt; the removal of the soil from caved-in and sliding bank slopes, then the re-shaping of the drain's side slopes; and the replacement of bridges or culverts that have badly deteriorated and cannot be repaired, or that do not meet modern load ratings or width and dimension requirements of the modern, larger and heavier farm equipment. As with maintenance works, reconstruction works on culvert and bridge crossings can be needed to address public health and safety concerns, and so may need to be undertaken irrespective of the condition of the agricultural drains that they cross (Water Control Systems Management Branch 2010).

Environmental Criteria in Drain Reconstruction

In the reconstruction of Provincial waterways, a number of environmental criteria are considered. Drain flow velocities are kept low enough to prevent erosion from occurring in the drainage channel (drop structures may be needed to effect this, and rock rip rap may be placed where velocities might still be erosive). Drain side slopes are made 1 vertical to 3 horizontal, or flatter, to reduce the chance of slumping of the drain channel's sides (Water Control Systems Management Branch 2010).

Features required by the Department of Fisheries and Oceans are incorporated into the drain upgrade, for example, larger culvert crossings or rock rip rap may be placed within the channel to mitigate negative effects on aquatic ecosystems. Drains are upgraded from downstream to upstream, to ensure that downstream reaches can accommodate any increased flows due to upstream improvements (Water Control Systems Management Branch 2010).

Surface Water Control Infrastructure

There are approximately 276 kilometres of Provincial waterways and 1,307 kilometres of municipal drains in the watershed. There are about 656 km of 1st order, 526 km of 2nd order, 226 km of 3rd order, 86 km of 4th order, and 89 km of 5th order waterways in this watershed. The Red River is 7th order. There are a number of control structures and drop structures on a number of these waterways in the watershed. Ross Creek has three drop structures to reduce the gradient of the stream's water surface profile which subsequently reduces water velocities and the chance of erosion. Similarly, Gramiak Drain and East Branch of Grassmere Drain has three drop structures. Also, Grassmere Drain near its outlet has a couple of drop structures. Oak Hammock Marsh has number of control structures at its inlets and outlet; these serve to regulate inflows into the marsh and the amount of water flowing out of the marsh. Oak Hammock Marsh is divided into four impoundments with water control capabilities built into each major cell. Individual impoundments can be drawn down or reflooded to required levels to effect management objectives. The marsh serves as a 'safety valve' by retaining water from spring or summer runoffs, thereby reducing downstream flows (Water Control Systems Management Branch 2010).

Most of the Netley Creek is a designated Provincial waterway. The drain is a major agricultural drainage channel which was expanded and reconstructed in the 1950s. Portions of the Netley Creek have also been reconstructed in recent years. The Grassmere Drain is also a designated Provincial waterway. It is a major largely man-made drainage channel. There are significant residential developments along the downstream portion of the drain. Various portions of this drain have also been reconstructed in recent years due to higher value crops being grown in this sub-watershed (Water Control Systems Management Branch 2010).

Water Retention

The north-western region of the watershed has poor natural drainage and topography with many natural water retention areas. Also, the agriculture drainage network in this area is far less intensely developed. There are two Wildlife Management Areas (Inwood and Sandridge) that contain natural areas and wetlands. This area has the potential for further retention of water. Crescent Lake, northwest of Teulon, is a class III wetland. The land surrounding the lake can sometime serve as a water retention area (Water Control Systems Management Branch 2010).

Flooding

Flooding in southern Manitoba typically occurs from spring snowmelt runoff, which can be aggravated in some locations by ice jams and coincident heavy rain storms. Most recently, many areas of southern Manitoba experienced serious flooding in the summer of 2009 due to high river flows, major ice jams and ice-blocked drainage systems. In addition to spring flooding, more localized flooding can also occur during the summertime due to unusually heavy summer rainstorms. In the last 15 years, various parts of southern Manitoba experienced unusually heavy rainfalls, which resulted in summer flooding. Flooding can also occur along some of Manitoba's lakes, as in the case of Lake Winnipeg, where strong northerly winds result in significant wave setup and wave uprush along the western shores (Water Control Systems Management Branch 2010).

Regarding spring flooding, the eastern region of the Netley-Grassmere watershed, along the Red River experiences flooding during the some springs due to high Red River water levels. Most recently in the spring of 2009, ice jams on the Red River caused extensive damage in the Rural Municipalities of West St. Paul and St. Andrews, especially in area around Breezy Point. Due to the risk to homeowners, cottagers and emergency rescuers, the Provincial Government decommissioned the Breezy Point north subdivision which is located on crown land. As well, a number of private homes and properties were purchased by the Rural Municipality of St. Andrews and the Provincial Government, due to the severe safety risk to the landowner and emergency rescue workers during the emergency evacuation in the 2009 flood (Water Control Systems Management Branch 2010).

There are other low lying areas within the watershed which experience flooding during large spring snowmelt runoffs, and following unusually heavy summer rainstorms. These include portions of the communities of Balmoral, Petersfield, and Winnipeg Beach and, to a lesser degree, Teulon, Stonewall and Argyle. There are some flood protection dikes at Petersfield, to protect against high water levels on Netley Creek, which is often affected by the high Red River levels downstream and high Lake Winnipeg water levels. As well, there are some flood protection dikes along some of the shorelines along Lake Winnipeg, to protect against high water levels with accompanying wind setup and wave uprush. High Lake Winnipeg water levels caused some flooding and serious bank erosion problems as recently as the summer of 2009. The highest water levels on Lake Winnipeg in the recent past were in the falls of 2005 and 2006. Manitoba, at the request of local governments, participated in the construction of new or enhancement of existing flood protection dikes around the south basin of Lake Winnipeg in partnership with nine local jurisdictions, including the Town of Winnipeg Beach. The total cost of the initiative was $12.7 million, which includes a local contribution by the municipalities.

Water Availability

There are many small creeks and streams in the Netley-Grassmere watershed, and water availability varies from one area to another for each of these smaller sub-watershed units. Grassmere Creek Drain may be used as an example to demonstrate water availability in a sub-watershed where one of these creeks is located. Figure 25 shows the annual water volume per square kilometer of land for a gauging station located at the downstream end of the Grassmere Creek Drain. It shows great temporal variations in total water availability over the past decades, with some years (e.g., 1996 and 2005) having very high values and others (1981 and 1984) having very low values (Surface Water Management Section 2008).

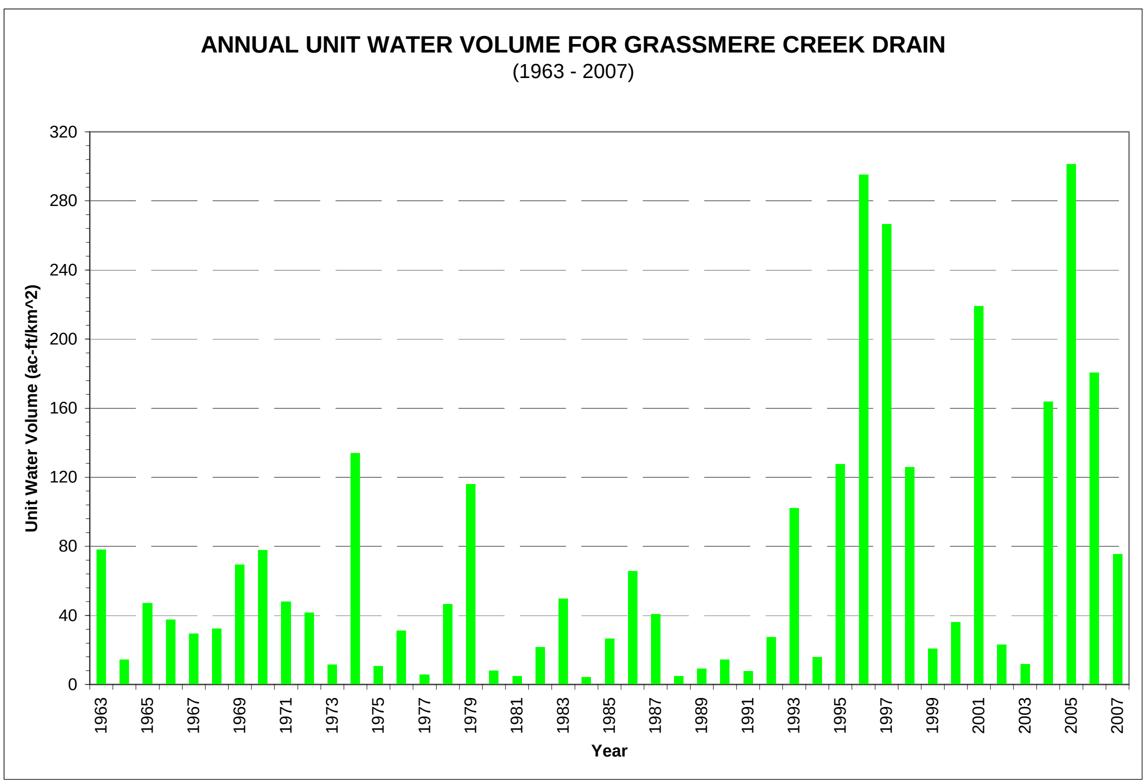

Figure 25: Temporal variations in total water availability on the Grassmere Creek Drain

Figure 26 shows the monthly water volume per land area for the Grassmere Creek Drain. Each value is an average of all volumes over the entire period of record for the same month. Huge variability exists in monthly water supply. The highest water availability occurs in April when most of the winter accumulated snow pack melts. The lowest water availability often occurs in winter when the rivers or lakes are frozen (Surface Water Management Section 2008).

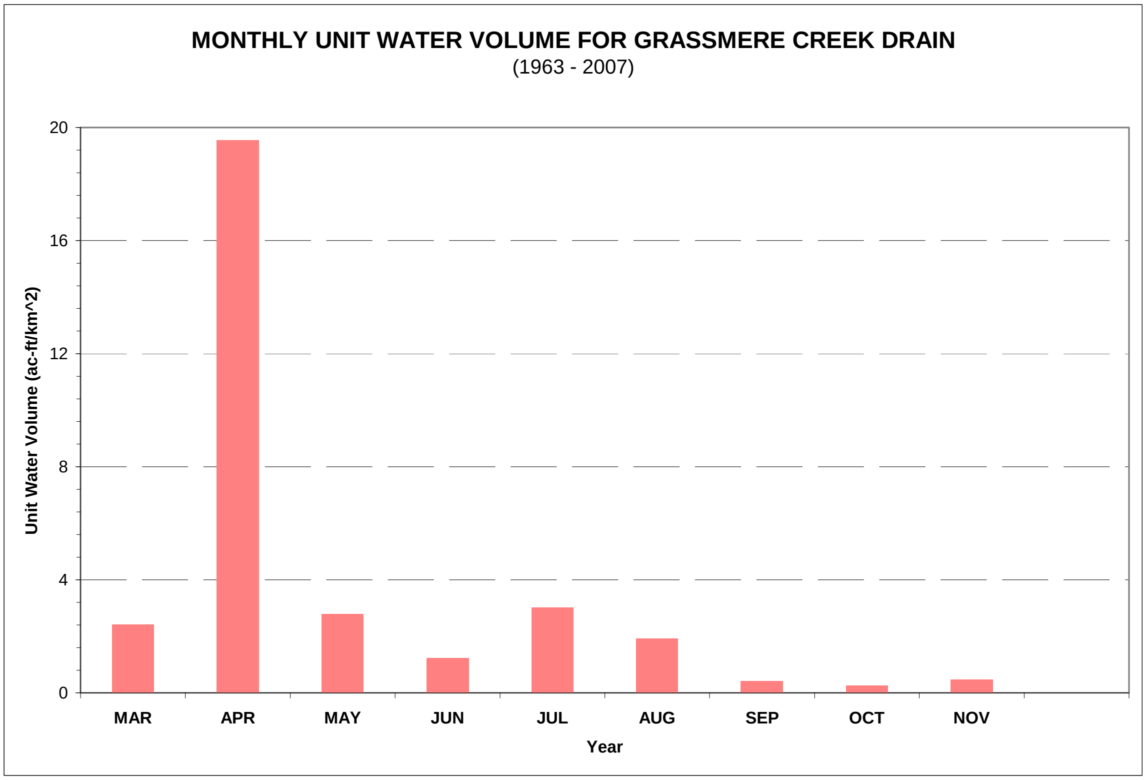

Figure 26: Monthly water volume per land for the Grassmere Creek Drain over the period of record

Water Demand

There are many water users in the Netley-Grassmere watershed, including farmers, urban and rural residents, industrial companies, plants, animals, and aquatic creatures. Water is used for many purposes including irrigation, drinking, cooking, bathing, toilet flushing, lawn and garden watering, manufacturing, food processing, and habitat for aquatic life. In a wet season, total water supply can satisfy all demands, while in dry season, water resources may be limited. For certain human water uses such as irrigation or certain farming practices, water users should get permission from the Province of Manitoba, through the application of a water license, before they can extract large amounts of water from water bodies (Surface Water Management Section 2008).

The issuance of a Water Rights Licence requires the determination of the availability of water for human use and the determination of instream flow needs (an estimate of a threshold flow above which a user may pump water from a stream) for environmental and ecological purposes. In other words, a Water Rights License will only be permitted if there is sufficient water for other users. Manitoba Water Stewardship is responsible for the calculation of how much water is available for licensing in each river, creek, or stream in the province (Surface Water Management Section 2008). For surface water projects, this determination is based on an analysis of stream flow data, riparian needs, water use requirements of senior water users, domestic needs, and instream flow requirements. For groundwater projects, this determination is based on an assessment of hydrogeological information including; geological information on aquifers, aquifer sustainable yield estimates and water allocation budgets, where available, as well as the water use requirements of senior users and domestic needs. Domestic purposes are given the highest priority, followed in turn by Municipal, Agriculture, Industrial, Irrigation, and than other uses, such as geothermal systems, aquaculture, recreation, fire protection, water bottling, etc. In Manitoba, water withdrawals of less than 5500 Ig/day (25,000 L) do not require licensing. These projects are protected under the domestic exemption (Water Use Licensing 2008).

Though there is an abundance of water resources in the Netley-Grassmere watershed, it is evident that residents are heavily reliant on groundwater. Eighty-one percent of all of water rights licensing projects on file with Manitoba Water Stewardship for this watershed are groundwater sourced. Livestock producers, industrial water users and municipal distribution systems are 100% reliant on groundwater. Irrigators in this watershed are almost equally split between groundwater and surface water as their water source. Most surface water sourced irrigators are pumping water from Netley Creek or Wavey Creek. Nearly half of the water allocated in this watershed is used for geothermal; however, it is important to note that geothermal projects are generally non-consumptive as the water is returned to the same aquifer (Water Use Licensing 2008).

Surface Water Quality

Surface water quality data has been collected by the Water Quality Management Section of Manitoba Water Stewardship and the East Interlake Conservation District to address various issues within the Netley-Grassmere watershed. Surface water quality data is collected primarily to: 1) assess long-term, ambient water quality trends at routinely monitored sites, and 2) assess ambient water quality through short-term, intensive studies and activities. Results of water chemistry collected from this watershed represent data that were generated from both long-term water quality sites and from short-term, issue-driven studies. While water quality samples have been collected fairly consistently from some sites, other data collections in the watershed are not as continuous or consistent in either date range or chemistry. Table 3 highlights the water quality stations in the watershed (Water Quality Management Section 2009).

Table 3: Water quality monitoring stations within the Netley-Grassmere watershed

Station Number	Location	Period of Record	Sampling Frequency	Agency
MB05OJS074	Red River at Selkirk	1967 to 2008	quarterly	Province
MB05OJS009	Netley Creek at PTH #7	1999, 2005	Irregular	Province
MB05OJS010	Netley Creek at PTH #17	1999, 2005	Irregular	Province
MB05OJS027	Netley Creek at PTH #8	1999, 2005	irregular	Province
MB05OJS091	Wavey Creek mouth	1995	Bi-weekly	Province
MB05OJS092	Wavey Creek at PTH #9	1995	Bi-weekly	Province
MB05OJS093	Wavey Creek D/S of Bruneau Drain	1995	Bi-weekly	Province
MB05OJS094	Bruneau Drain near mouth	1995	Bi-weekly	Province
MB05OJS095	Wavey Creek U/S of Bruneau Drain	1995	Bi-weekly	Province
MB05OJS096	Municipal Drain U/S of PTH #8	1995	Bi-weekly	Province
MB05OJS097	Municipal Drain by Lac Sod	1995	Bi-weekly	Province
MB05OJS098	Wavey Creek D/S of Argyle, Lac Sod	1995	Bi-weekly	Province
MB05OJS099	Argyle Drain near mouth	1995	Bi-weekly	Province
EICD	Grassmere Creek	2007 - 2008	quarterly	EICD
EICD	Park Drain	2007 - 2008	quarterly	EICD
EICD	Netley Creek	2007 - 2008	quarterly	EICD
EICD	Wavey Creek	2007 - 2008	quarterly	EICD
MB05SBS025	Matlock Beach	1995 - 2008	Open water season	Province
MB05SBS001	Winnipeg Beach	1995 - 2008	Open water season	Province

Long-Term Water Quality Trends on the Red River

There is a long history of water quality monitoring on the Red River within this watershed. In 1967, routine water quality monitoring was initiated by the Province of Manitoba on the Red River at the bridge site in Selkirk, and quarterly monitoring continues to this day. While it is recognized that this site better represents water quality conditions of the upper Red River watershed, it is included in this document since the site is on the boundary of the Netley-Grassmere watershed. Additionally, this is the only site in the watershed that has a continuous long-term data set. Water samples collected at this site were analyzed for a wide range of water chemistry variables including pesticides, metals, nutrients, general chemistry, and bacteria (Water Quality Management Section 2009).

In 2001, total phosphorus (TP) and total nitrogen (TN) from all the long-term water quality stations in the province were analyzed for trends using a relatively complex statistical model (Jones and Armstrong 2001). The model identified trends in concentrations of TP and TN after accounting for variations due to river flow. The Red River at Selkirk was included in the 2001 analysis (Water Quality Management Section 2009).

Both total phosphorus (TP), and total nitrogen (TN) showed statistically significant increases from 1978 to 2001 of 28.8 % and 57.8 %, respectively (Figures 27 and 28) (Water Quality Management Section 2009).

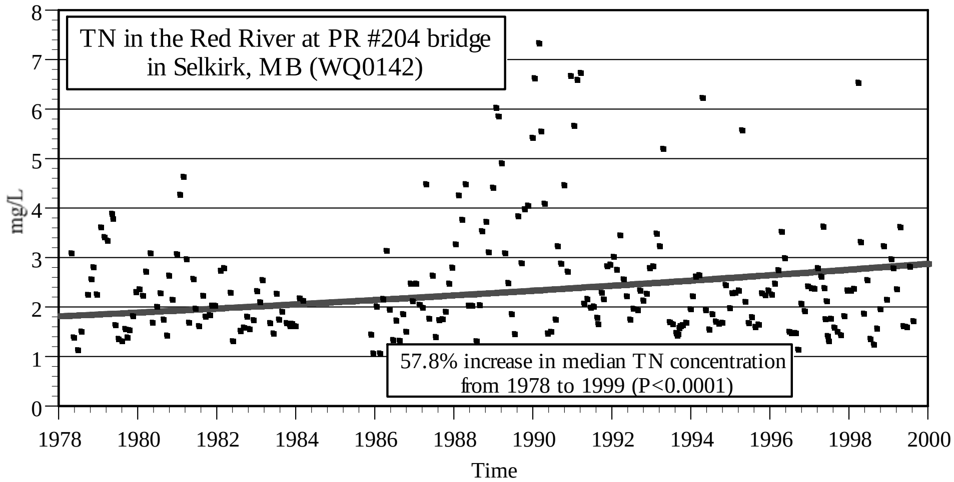

Figure 27: Total phosphorus (TP) in the Red River at Selkirk. The percent change in median concentration refers to the median concentration of flow adjusted trend line.

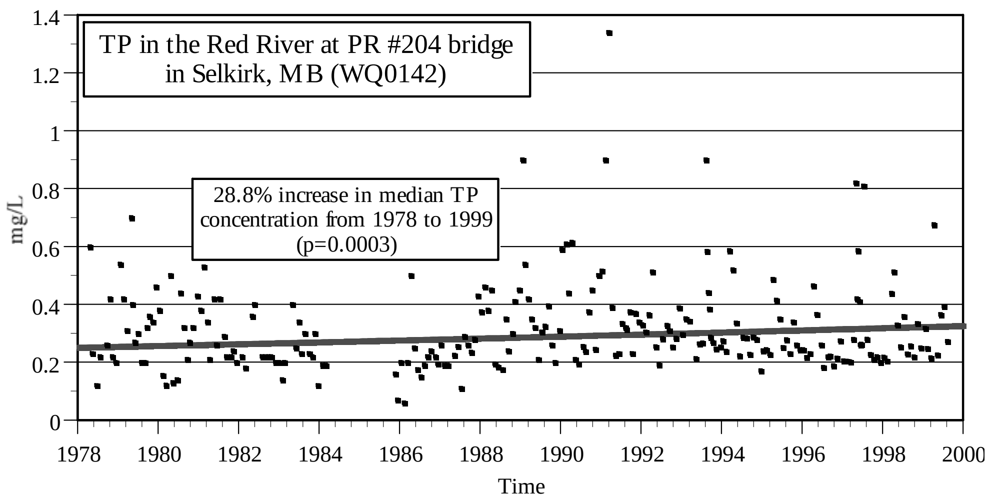

Figure 28: Total nitrogen (TN) in the Red River at Selkirk. The percent change in median concentration refers to the median concentration of flow adjusted trend line

Water Quality Index

Water quality at long-term water quality monitoring stations can be assessed with the Canadian Council of Ministers of the Environment (CCME) Water Quality Index. The Water Quality Index is used to summarize large amounts of water quality data into simple terms (e.g., good) for reporting in a consistent manner. Twenty-five variables are included in the Water Quality Index (Table 4) and are compared with water quality objectives and guidelines contained in the Manitoba Water Quality Standards, Objectives, and Guidelines (Williamson 2002).

Table 4: Water quality variables and objectives or guidelines (Williamson 2002, Williamson 1988) used to calculate Water Quality Index (CCME 2000)

Variables	Units	Objective Value	Objective Use
Fecal Coliform MF	Bacteria/100mL	200	Recreation
pH	pH Units	6.5-9.0	Aquatic Life
Specific Conductivity	uS/cm	1000	Greenhouse Irrigation
Total Suspended Solids	mg/L	25 (mid range)	Aquatic Life
Dissolved Oxygen	mg/L	5 (mid range)	Aquatic Life
Total or Extractable Cadmium*	mg/L	Calculation based on Hardness (7Q10)	Aquatic Life
Total or Extractable Copper*	mg/L	Calculation based on Hardness (7Q10)	Aquatic Life
Total Arsenic	mg/L	0.025	Drinking Water, Health
Total or Extractable Lead*	mg/L	Calculation based on Hardness (7Q10)	Aquatic Life
Dissolved Aluminium	mg/L	0.1 for pH >6.5	Aquatic Life
Total or Extractable Nickel*	mg/L	Calculation based on Hardness (7Q10)	Aquatic Life
Total or Extractable Zinc*	mg/L	Calculation based on Hardness (7Q10)	Aquatic Life
Total or Extractable Manganese	mg/L	0.05	Drinking Water, Aesthetic
Total or Extractable Iron	mg/L	0.3	Drinking Water, Aesthetic
Total Ammonia as N	mg/L	Calculation based pH	Aquatic Life
Soluble or Dissolved Nitrate-Nitrite	mg/L	10	Drinking Water, Health
Total Phosphorus	mg/L	0.05 in Rivers or 0.025 in Lakes	Nuisance Plant Growth
Dicamba	ug/L	0.006 where detectable	Irrigation
Bromoxynil	ug/L	0.33	Irrigation
Simazine	ug/L	0.5	Irrigation
2,4 D	ug/L	4	Aquatic Life
Lindane	ug/L	0.01	Aquatic Life
Atrazine	ug/L	1.8	Aquatic Life
MCPA	ug/L	0.025 where detectable	Irrigation
Trifluralin	ug/L	0.2	Aquatic Life

The Water Quality Index combines three different aspects of water quality: the 'scope,' which is the percentage of water quality variables with observations exceeding guidelines; the 'frequency,' which is the percentage of total observations exceeding guidelines; and the 'amplitude,' which is the amount by which observations exceed the guidelines. The basic premise of the Water Quality Index is that water quality is excellent when all guidelines or objectives set to protect water uses are met virtually all the time. When guidelines or objectives are not met, water quality becomes progressively poorer. Thus, the Index logically and mathematically incorporates information on water quality based on comparisons to guidelines or objectives to protect important water uses. The Water Quality Index ranges from 0 to 100 and is used to rank water quality in categories ranging from poor to excellent (Water Quality Management Section 2009).

- **Excellent (95-100)** - Water quality never or very rarely exceeds guidelines
- **Good (80-94)** - Water quality rarely exceeds water quality guidelines
- **Fair (60-79)** - Water quality sometimes exceeds guidelines and possibly by a large margin
- **Marginal (45-59)** - Water quality often exceeds guidelines and/or by a considerable margin
- **Poor (0-44)** - Water quality usually exceeds guidelines and/or by a large margin

While water chemistry has been monitored at the long-term monitoring station in Selkirk for several periods between 1967 and 2007, certain pesticides that are required to calculate the WQI were not monitored prior to 1993. Therefore, the graph highlighting the WQI is represented from 1993 to 2007 as shown in Figure 29 (Water Quality Management Section 2009).

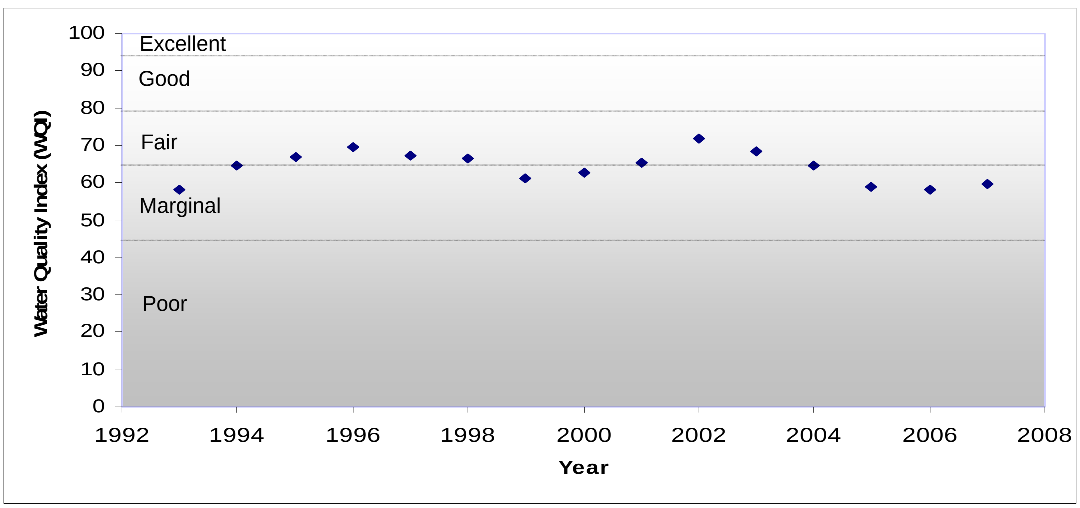

Figure 29: Water Quality Index calculated from 1993 to 2007 for the Red River at Selkirk.

The Water Quality Index from 1993 to 2007 ranged from marginal to fair. During 2005 to 2007, the WQI was marginal largely due to water quality exceedences of *E. coli*, conductivity, suspended solids, manganese, total phosphorus, and occasionally in 2007, exceedences of the pesticides, Dicamba and MCPA. Management of these issues is truly one of upstream contributions. Government continues to support and develop numerous initiatives to reduce nutrient contributions within the Lake Winnipeg watershed (Water Quality Management Section 2009). For a detailed discussion concerning Government's actions and initiatives on reducing nutrient contributions to Lake Winnipeg, please visit:

http://www.gov.mb.ca/waterstewardship/water_quality/lake_winnipeg/index.html

Water Quality in Grassmere, Wavey, Netley, Parks Creeks

Other data-sets collected with some consistency in the Netley-Grassmere watershed include:

- Wavey Creek 1995
- Netley Creek 2005
- Grassmere Drain, Wavey Creek, Netley Creek, and Parks Creek 2007 to 2009
- Wavey Creek 1995

In 1995, a water quality project in the Wavey Creek was undertaken by the South Interlake Land Management Association (SILMA) with funding from the Canada-Manitoba Agreement on Agricultural Sustainability (CMAAS) to determine impacts to water quality in a largely agricultural area. Ten locations along Wavey Creek were sampled for ten sampling periods between March and October 2005 (SILMA 1996). Samples were collected from agricultural drains as well as from the main stem of Wavey Creek including the most downstream location near the confluence with Muckle Creek. The groundwater monitoring well was also monitored as a control (Water Quality Management Section 2009).

The highest concentration of all nutrients based on mean values of total and dissolved phosphorus, ammonia, total kjeldahl nitrogen, and dissolved nitrogen, were found in the agricultural drain upstream of site #8 near the Argyle Drain. Concentrations were also elevated at most downstream sites on Wavey Creek. While not statistically valid, due to too few data points, there appears to be accumulative impacts along the main stem of Wavey Creek. Figure 30 indicates the concentration of total phosphorus (mg/L) found in the Wavey Creek sites (dark blue) and the contributing agricultural drains (light blue/purple). The control site (groundwater) is Site 10 (Water Quality Management Section 2009).

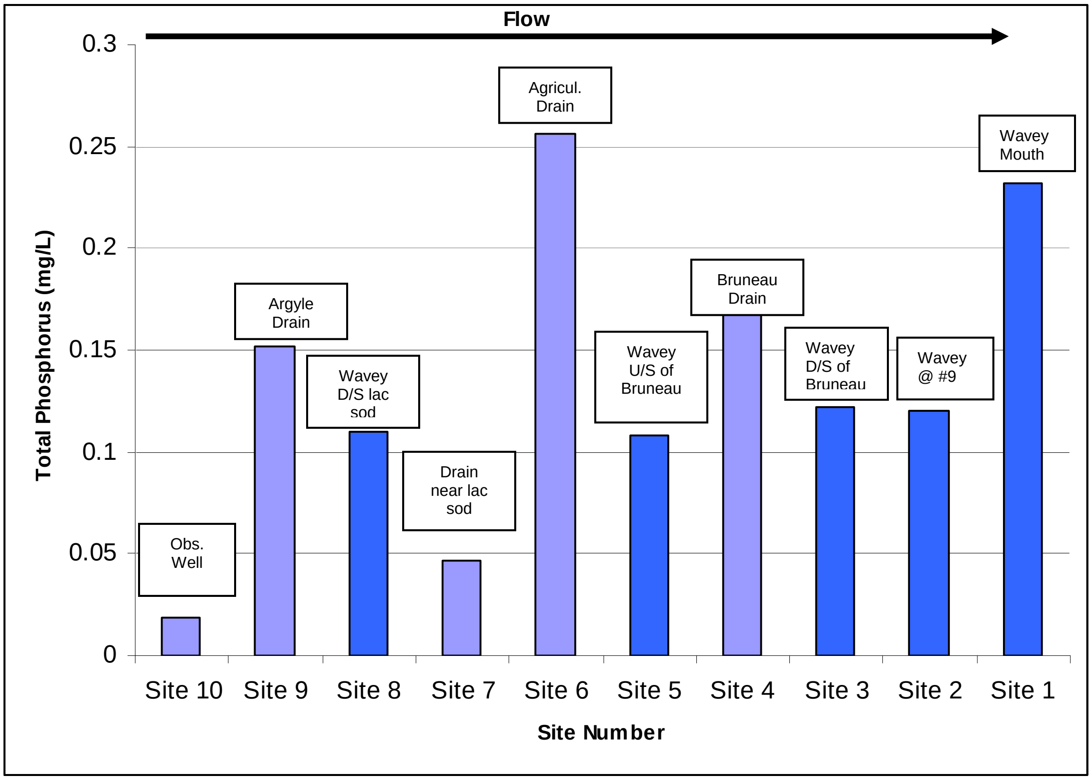

Figure 30: Mean Total Phosphorus (TP) collected on Wavey Creek in 1995

Netley Creek Water Quality

Netley Creek was monitored with some consistency in 2005. The area experienced significant and continuous rainfall throughout July and the beginning of August 2005. This caused concern about runoff from agricultural land in both the context of *Escherichia coli* (*E. coli)* and nutrients. *Escherichia coli* were mostly at or below the detection limit (10 E. coli/100 ml). However nutrients differed significantly from the two monitoring sites on Netley Creek. Netley Creek at Hwy #8 was significantly higher compared to Netley Creek at Hwy #7. There was approximately four times the concentration of total phosphorus in the downstream site (Hwy #8 crossing) compared to concentrations in the upstream site (Hwy #7) (Figure 31). Significant differences were also observed for concentrations of ammonia with higher levels found in the downstream site. The greatest differences were observed in July, whereas concentrations in August samples were similar between the two sites (Water Quality Management Section 2009).

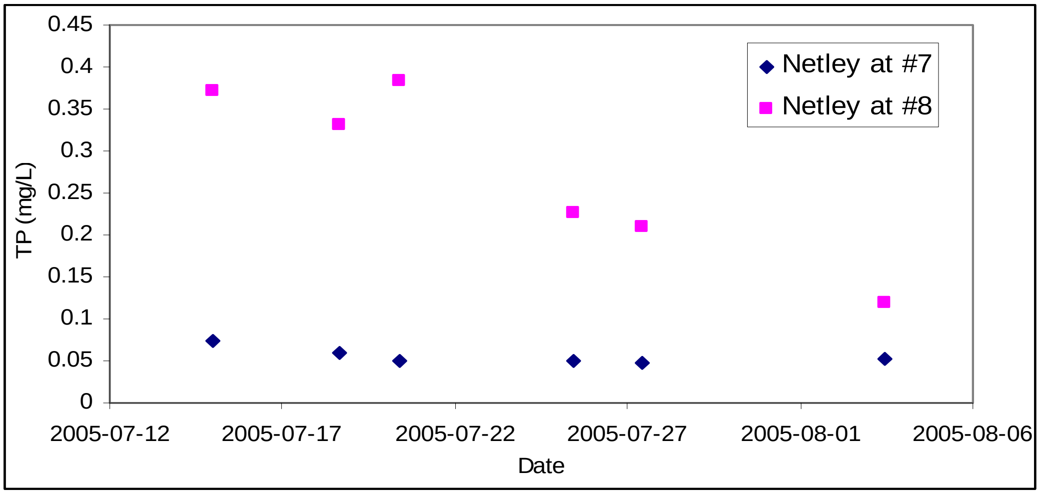

Figure 31: Total Phosphorus (TP) in Netley Creek at Hwy # 7 and Hwy #8.

The EICD has been collecting detailed water chemistry from four sites in the watershed beginning in 2007 to present. Samples were analyzed for general chemistry, nutrients, metals, dissolved salts and minerals, and *E. coli* (Water Quality Management Section 2009).

Figure 32 indicates total phosphorus levels collected by the EICD from April 2007 – April 2008 at the Grassmere drain. In general, the Grassmere Drain appears to have higher concentrations of total phosphorus than those found in Netley and Wavey Creeks and in the Parks Creek Drain. The TP concentration during January 2008 spiked in the Grassmere Drain to nearly 4.0 mg/L, where no similar spike was found in the other three water courses. However, as shown in previous sampling programs, sample results from Wavey Creek and Netley Creek also show high concentrations of TP, ranging from 0.124 to 0.244 mg/L in Wavey Creek in 1995 ; 0.127 to 0.395 mg/L of TP in Netley Creek in 2005. The cause of the elevated spike in TP from January 2008 is unknown, but generally a point source could cause such a spike, particularly given the time of year and that no similar result was found in other nearby water courses (Water Quality Management Section 2009).

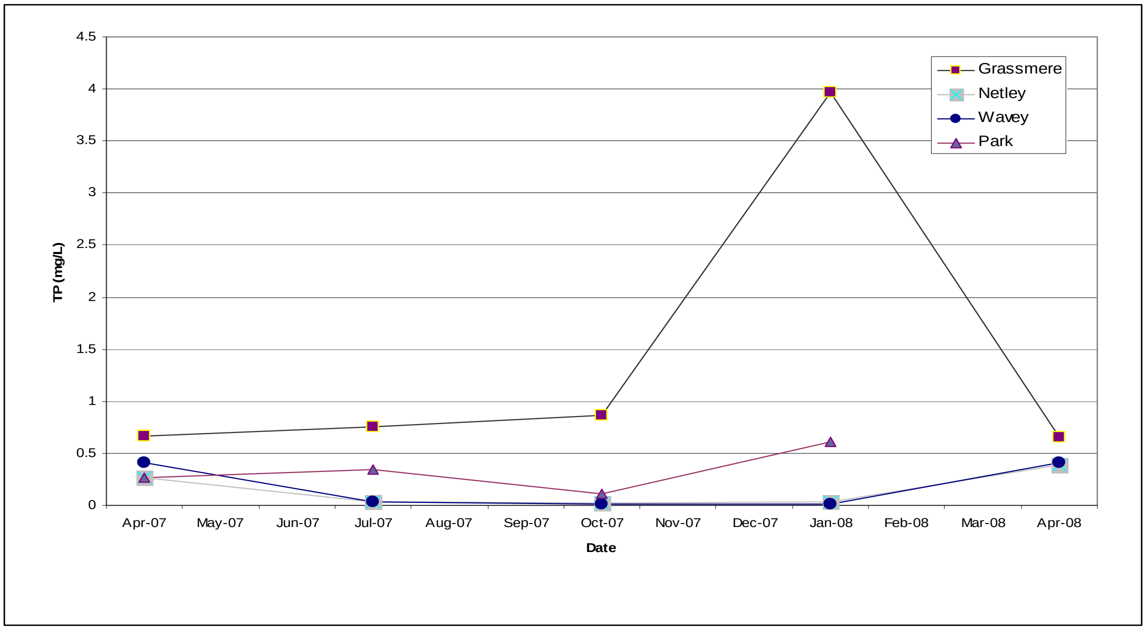

Figure 32: Concentration of total phosphorus (TP) collected by the EICD at the Grassmere drain

Nutrients

Nutrient enrichment or eutrophication is one of the most important water quality issues in Manitoba. Excessive levels of phosphorus and nitrogen fuel the production of algae and aquatic plants. Extensive algal blooms can cause changes to aquatic life habitat, reduce essential levels of oxygen, clog fisher's commercial nets, interfere with drinking water treatment facilities, and cause taste and odour problems in drinking water. In addition, some forms of blue-green algae can produce highly potent toxins (Water Quality Management Section 2009). Reductions in nutrient loads across the Lake Winnipeg watershed will benefit not only Lake Winnipeg but also improve water quality in the many rivers and creeks that are part of the watershed including the Netley, Wavey, Grassmere and Parks creeks (Water Quality Management Section 2009).

Nutrient reduction targets under the Lake Winnipeg Action Plan are interim targets that reflect the need to take immediate action to reduce nutrient loads to Lake Winnipeg. Manitoba Water Stewardship is working to develop long-term, ecologically-relevant objectives for nutrients in Lake Winnipeg and its contributing watershed such as the Netley-Grassmere watershed. Long-term, ecologically-relevant objectives will also replace narrative guidelines that are currently applied across Manitoba. However, reducing nutrients across Manitoba, the Netley-Grassmere watershed, and the Lake Winnipeg watershed is a challenge that will require the participation and co-operation of all Manitobans (Water Quality Management Section 2009).

Water Quality at Winnipeg Beach and Matlock Beach

A considerable amount of water quality monitoring has taken place at Winnipeg Beach and at Matlock Beach on the shores of Lake Winnipeg. These beaches are monitored for densities of *E. coli* as part of Manitoba Water Stewardship's Clean Beaches Program. Historically, monitoring frequency was every two weeks, however since 2004, the beaches on Lake Winnipeg have been monitored every week. Manitoba has adopted Health Canada's *Guidelines for Canadian Recreational Water Quality* of 200 *E. coli* per 100 mL for the protection of public health (Water Quality Management Section 2009).

Generally, recreational water quality is excellent at both beaches with geometric means well below the recreational guideline. Occasionally, densities are above the recreational guideline but return within acceptable levels within 24 hours. On Lake Winnipeg, weather and lake level information appear to be good predictors of *E. coli* levels. Bacteria counts tend to increase when strong northerly winds cause water levels to temporarily increase and large waves wash bacteria out of beach sand. When calmer weather returns, *E. coli* bacteria levels typically fall quickly to below guideline levels (Water Quality Management Section 2009).

Nutrient Management Regulation

The Nutrient Management Regulation under *The Water Protection Act* became law on March 18, 2008. The purpose of this regulation is to protect water quality by encouraging responsible nutrient planning, regulating the application of materials containing nutrients and restricting the development of certain types of facilities in environmentally sensitive areas. When nitrogen and phosphorus are applied to land surfaces in greater amounts than can be used by growing plants, excess nutrients can leach into groundwater or run-off into surface water with heavy rainfall, floods, and melting snow (Water Quality Management Section 2009).

Manitoba's landscape has been separated into five zones. Zones N1, N2, and N3 consist of land that ranges in agricultural productivity while Zone N4 is generally unproductive land that represents a significant risk of nutrient loss to surface and groundwater. Zone N4 land consists of Canada Land Inventory soil classification 6 or 7 or unimproved organics. Zone N5 consists of urban and rural residential areas (Water Quality Management Section 2009).

Under the proposed regulation, no nitrogen or phosphorus can be applied within Zone N4 or the Nutrient Buffer Zone. Nutrient Buffer Zone with widths are outlined in Table 5 (Water Quality Management Section 2009).

Table 5: Nutrient Buffer Zones

Water Body	A (1)	B (1)
o a lake or reservoir designated as vulnerable*	30 m	35 m
o a lake or reservoir (not including a constructed stormwater retention pond) not designated as vulnerable o a river, creek or stream designated as vulnerable*	15 m	20 m
o a river, creek or stream not designated as vulnerable o an order 3, 4, 5, or 6 drain or higher o a major wetland, bog, swamp or marsh o a constructed stormwater retention pond	3 m	8 m

* In the Netley-Grassmere watershed, Lake Winnipeg and the Red River are designated as vulnerable water bodies.

(1) Use column A if the applicable area is covered in permanent vegetation. Otherwise, use column B.

More information on the proposed *Nutrient Management Regulation* is available at http://www.gov.mb.ca/waterstewardship/wqmz/index.html.

Impacts of Drainage on Surface Water Quality

Although it is recognized that drainage in Manitoba is necessary to support sustainable agriculture, it is also recognized that drainage works can impact water quality and fish habitat. Types of drainage include the placement of new culverts or larger culverts to move more water, the construction of a new drainage channels to drain low lying areas, the draining of potholes or sloughs to increase land availability for cultivation and the installation of tile drainage. Artificial drainage can sometimes result in increased nutrient (nitrogen and phosphorus), sediment and pesticide load to receiving drains, creeks and rivers. All types of drainage should be constructed so that there is no net increase in nutrients (nitrogen and phosphorus) to waterways. Manitoba Water Stewardship is currently working towards the development of an environmentally friendly drainage manual that will provide additional guidance regarding best management practices for drainage in Manitoba (Water Quality Management Section 2009).

Natural Areas

Aquatic Habitat

In the report entitled "East Interlake Conservation District: Watershed 050J Riparian Assessment Survey – with emphasis on Third Order Drains and higher – 2007 and 2008", approximately 229 km of riparian area within the Netley-Grassmere watershed was reviewed to provide the EICD with a comprehensive overview of riparian and land use conditions, identify barriers to fish passage and migration; to determine the utilization of recreationally important fish species in the watershed; and to provide a list of potential fisheries-based enhancement and riparian improvement projects for future works (Graveline 2008).

Upon completion of this report, it was determined that there are 39 species of fish within the Netley-Grassmere watershed. With the exception of the bigmouth buffalo (special concern), none of the species identified are listed by the Committee on the Status of Endangered Wildlife in Canada (COSEWIC) as endangered, threatened, or of special concern. The Netley-Grassmere watershed is highly impacted by human activity, with the exception of some natural areas in the lower reaches of Netley and Wavey creeks and along Norris Lake. The majority of the watercourses in this watershed have either been channelized or modified by land use (Graveline 2008).

The majority of the riparian area throughout the watershed was determined to be influenced by agricultural land (47.8%), followed by pasture/grazing (14.4%), cropland (14.3%), mixed forest land (9.1%), other urban or built-up land (5.1%), residential/commercial (3.4%), hayland (3.2%), and non-forested wetland (2.7%) (Graveline 2008).

Fish habitat in this watershed is marginal, with some exceptions along Netley Creek, Wavey Creek, and Norris Lake. Some of the smaller watercourses, near their confluences, also had limited areas of important fish habitat. Through this assessment, 47 potential rehabilitation sites were identified and prioritized within the Netley-Grassmere watershed. In addition, 7 other rehabilitation sites were identified by a study conducted in 1996. There are fish passage issues in this watershed, however, many of the rehabilitation sites are focused on improving water quality and maintaining or improving existing fish habitat (Graveline 2008).

As seen in Figure 33, the majority of potential rehabilitation sites within the Netley-Grassmere watershed were identified along Netley and Wavey Creeks. Maintaining existing quality habitat and rehabilitating damaged areas, through the implementation of BMPs, such as exclusion fencing, riparian rehabilitation, bank stabilization, would be important steps towards effective watershed management. Potential detriments to aquatic health include:

- Livestock access in riparian zones
- Removal of riparian vegetation or a lack of buffer zones
- Urban encroachment and/or recreational overuse/abuse
- Improperly designed stream passage

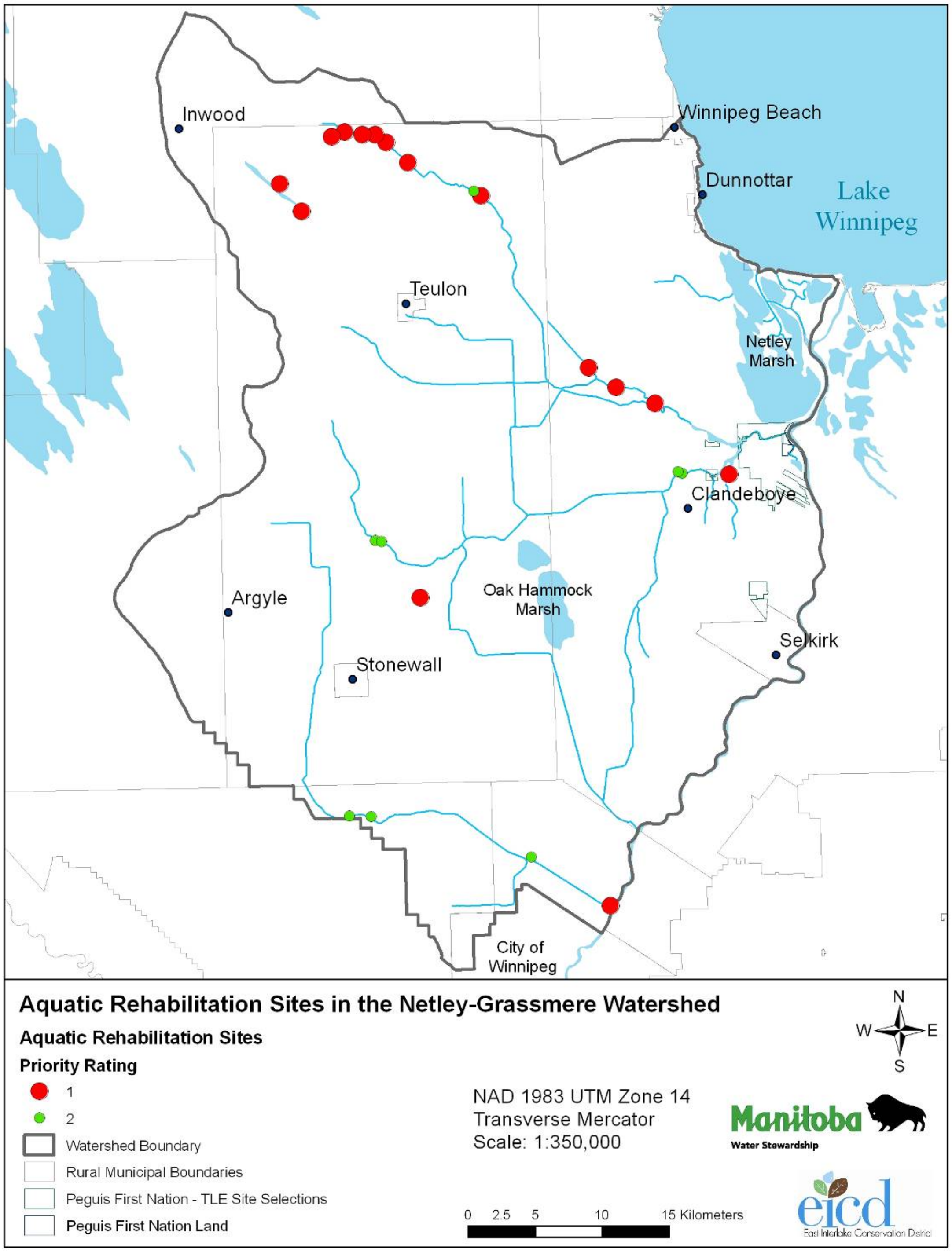

Figure 33: Aquatic Rehabilitation Sites in the Netley-Grassmere Watershed

Riparian Habitat

Riparian areas are the transitional zones found along waterways, streambanks, lake shores and wetlands. Healthy riparian areas may have any combination of trees, shrubs, grasses depending on local conditions. Riparian areas produce vegetation that is lusher than the surrounding dryland because of better soils and water availability. Healthy riparian areas have many important functions in a watershed, including providing habitat for wildlife and removing nutrients from runoff before it flows off the land into lakes and streams. Riparian areas act to trap, filter and buffer water, store floodwater and energy, build and maintain streambanks, maintain biological diversity, recharge groundwater and create primary productivity. Indications of loss of riparian areas include loss of natural vegetation along waterways and waterbodies, excessive erosion of streambanks and the build-up of debris and garbage, as seen in Figure 34 (Manitoba Conservation 2008).

Significant rural residential subdivision development has occurred along the Red River, Netley and Wavey Creeks and to a lesser degree along Muckle Creek near Clandeboye. This development has reduced the amount of riparian areas along these waterways and the density of residences has likely had a negative impact on wildlife distribution and use (Manitoba Conservation 2008). Riparian habitat has also been lost on the middle and upper reaches of these creeks due to the channelization and the destruction of natural watercourses to facilitate agricultural development and drainage. For example, the upper portion of Netley Creek, near the village of Komarno and Jackfish Creek near Balmoral has lost riparian habitat in recent years. Maintaining and improving riparian areas will enhance wildlife habitat and reduce agricultural run off into creeks and lakes (Manitoba Conservation 2008).

Figure 34: Human influence on a riparian area in the Netley-Grassmere watershed

Netley Marsh

The Netley Marsh is an expansive coastal marsh comprised of upland and wetland habitat. The marsh is a complex system of lakes and streams whose water levels are influenced by Lake Winnipeg. Located at the southern end of Lake Winnipeg, south of the beach ridge, and approximately 65 km north of Winnipeg, the marsh is a remnant of glacial Lake Agassiz. Netley Marsh is located adjacent to the Libau Marsh and is sometimes referred to as the Netley-Libau Marsh. Netley Marsh is very flat and contains many small bodies of water which are all connected by channels into which the Red River and Lake Winnipeg feed the marsh's water supply (Netley Marsh Waterfowl Association 2008).

Fluctuating water levels, from drought years to wet years and everything in between, are vital to the Netley Marsh. A healthy marsh is always in a state of flux. Dry years allow the plant life to reclaim the marsh, while wet years kill off the vegetation. Due to stabilized water levels on Lake Winnipeg, the Netley marsh is slowly dying from high water. High water is threatening to wash the marsh out to become an extension of Lake Winnipeg. For example, in 1960, there were approximately fifty individual water bodies in the Netley-Libau Marsh system. In 1980, that number had been reduced to 17 water bodies. In 2001, it has been concluded that there has been significant loss of aquatic vegetation and upland habitat within the marsh (Netley Marsh Waterfowl Association 2008).

Oak Hammock Marsh

Oak Hammock Marsh provides important habitat for a diversity of wildlife species. This Wildlife Management Area, is approximately 36 square kilometers and features a restored prairie marsh, aspen-oak bluff, waterfowl lure crops, artesian springs, some of Manitoba's last remaining patches of tall-grass prairie. Oak Hammock Marsh is home to 25 species of mammals, 300 species of birds, numerous amphibians, reptiles, and fish, and countless invertebrates. During migration season, the number of waterfowl using the marsh during migration can exceed 400,000 daily. The Oak Hammock Marsh Interpretive Centre is located on the edge of the marsh. The Interpretive Centre offers many educational programs, including tours, canoe excursions, snowshoe walks, critter dipping, and other educational activities for people of all ages (Oak Hammock Interpretative Centre 2009).

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