# 2.0 Physical Characteristics of the Sandilands Area

## 2.1 Regional Bedrock Geology

The study area is located at the transition between the Ordovician sedimentary rocks that underlie much of central Manitoba and the Precambrian metamorphic rocks which underlie eastern Manitoba. The Ordovician sedimentary rocks in the study area consist of Red River Formation limestones and dolomites and the underlying Winnipeg Formation sandstones and shales. This sedimentary sequence dips shallowly to the west and unconformably overlies the basal Precambrian metamorphic rocks. Based on the review of the information contained within the provincial GWDrill Water Well database (Manitoba Conservation, 2004), it has been determined that the eastern erosional limit of the Red River Formation is located to the west of the Bedford Ridge (Figure 03), and that the eastern erosional limit of the Winnipeg Formation extends beneath the study area where it is present as a thin veneer overlying the Precambrian metamorphic rocks (Figure 04). These eastern limits were determined using the stratigraphic information contained in GWDrill database. Copies of the pertinent logs are included in Appendix A and the locations are shown on Figure 03.

## 2.2 Regional Quaternary Geology

The regional surficial geology can be subdivided into three main areas based on the physiographic regions shown on Figure 05. To the west, within the Lake Terrain Plain region, the surficial geology consists primarily of glacial tills intermixed with fine glaciolacustrine and coarser glaciofluvial sediments. Within the Agassiz Sandiland Uplands, the surficial geology is dominated by glaciofluvial sediments with lesser glaciolacustrine and glacial till sediments. Organic deposits have developed in this area where drainage is poor. To the east, the surficial geology consists almost entirely of organic deposits which have developed within the poorly drained Whitemouth Lowland.

The regional quaternary geology at depth can be subdivided into four major stratigraphic units as illustrated on Figures 06 and 07 (Data Source: Little, 1980, Betcher, 1985). These major stratigraphic units can be described as follows:

- **Basal Till** – An undifferentiated glacial till unit unconformably overlies the bedrock surface. The thickness of this unit varies from 0 to as much as 30 metres. The descriptions of this till unit in the geologic logs vary from silty to sandy in the Bedford Ridge area to clayey and/or stony to the west. Teller and Fenton (1980) describe five different till formations in this area related to the various glaciation events. The observed variation in till composition is likely related to this but there is insufficient information to subdivide the basal till unit further for the purposes of this study.

- **Basal Clay** – Overlying the basal till through most of the area is a fine grained unit which is described in the geologic logs as consisting predominantly of clay with varying amounts of silt, sand and gravel occurring either disseminated through the clay (ie: silty clay) or as discrete layers and beds. This unit is generally described as being layered which suggests that it is a glacio-lacustrine sediment deposited in an inter-glacial or late glacial lacustrine environment, rather than being a fine grained till unit.

- **Sand/Silt** – Overlying the basal clay unit is an extensive granular deposit that is described in the geologic logs as consisting of sand and silt with varying amounts of clay and gravel. The descriptions of this unit indicate that it has a very distinct layering. Where it is exposed at surface

(Figure 05), it is classified as proximal (coarse grained) to distal (finer grained) glaciofluvial sediments. These types of sediments are deposited at the margin of the glaciers in a lacustrine environment which result in a complex stratigraphy associated with the post-depositional reworking of the deposits by subaqueous turbidity currents and wave/wind erosion. In general, these types of deposits are characterized as being predominantly coarse grained near the meltwater channel outlet, and becoming finer grained with distance from the source of the sediments. As shown on Figure 06, the available information indicates that this major stratigraphic unit is exposed at surface in the Bedford Ridge area and extends west at depth a distance of approximately 50 kilometres to the St. Malo area. To the east of the Bedford Ridge (Figure 07), the unit appears to extend continuously to the east through the Whitemouth Lowlands where it extends to surface and is in direct hydraulic connection with the surface environment. In this area, it is almost entirely overlain by a thin veneer of organics.

- **Upper Till** – To the west of the Bedford Ridge is an upper major stratigraphic unit which is typically described in the geologic logs as being a sandy to silty till with sand and gravel interbeds. Sand to sand and gravel beds are often present in the upper 3 to 6 metres of this unit.

## 2.3 Regional Hydrogeology

In general, the regional unconfined water table and the confined piezometric surface follows the topography of the region with higher groundwater elevations found beneath the Agassiz Sandilands Uplands (370 to 385 m) and lower groundwater elevations in the adjoining Whitemouth Lowlands (350 to 370 m) and Lake Terrace Plain (300 to 325 m at the western base of the Bedford Ridge to 250 to 275 m in the St. Malo area). Based on the stratigraphy illustrated on Figures 04, 06 and 07, the following is a generalized description of the expected regional groundwater flow regime. A more detailed description of groundwater flows in the local study area is presented in Section 3.3.

- Groundwater recharge can be expected to be high in areas where sand and gravel are at or near surface such as in the Agassiz Sandilands Uplands and the Whitemouth Lowlands and lower where finer grained materials are at surface such as in the Lake Terrace Plain. Cherry (2000) estimated recharge rates, using environmental isotopes, varying from 174 mm/yr (30% of the average annual precipitation) in the sandy areas to 43 mm/yr (8% of the average annual precipitation) in areas underlain by clayey tills. Ferguson et al (2003) used temperature logs to estimate a recharge rate to the sandstones underlying the Sandilands area of 631 mm/yr (approximately 100% of the average annual precipitation).

- From the zone of recharge, groundwater flow would predominantly occur within the more permeable units. Therefore, it is reasonable to expect based on the regional stratigraphy that a significant proportion of the groundwater would move west within the sand/silt major stratigraphic unit (Figure 06). A portion of the groundwater would also be expected to infiltrate vertically into the Red River and Winnipeg Formation bedrock aquifers (Figure 04), and then move laterally west. It should be noted that the available information indicates that the bedrock aquifers are predominantly separated from the overlying overburden aquifers and the surface by less permeable clays and tills. The recharge rate to the bedrock aquifers is therefore likely limited by the hydraulic conductivity of the overlying clay and till aquitards.

Groundwater levels have been monitored by the Groundwater Management Section of Manitoba Conservation since the early 1960's. The available information on long term groundwater level trends are provided on Figure 08 (Station OE-001 screened in the Upper Sand Unit) and Figure 09 (Station OE-006 screened in the Lower Sand Unit). As indicated, groundwater levels in the Upper Sand Unit have varied by up to 4 metres, with the lowest groundwater levels observed in the late 1980's to early 90's, and current levels at or near historic highs. This trend is consistent with groundwater trends across Southern

Manitoba and reflects varying annual precipitation rates. A similar but slightly subdued trend is observed in the Lower Sand Unit where the variation in groundwater levels is on the order of 3 metres. Monitoring of Station OE-006 was discontinued in 1997. It is reasonable to expect that groundwater levels are currently near the historic high, as has been observed elsewhere in Southern Manitoba.

## 2.4 Regional Hydrology

As illustrated on Figure 10, the Sandilands glaciofluvial complex is located at the juncture of 5 different surface water basins, including the Rat River, Seine River, Brokenhead River, Whitemouth River and Roseau River basins. While the Sandilands glaciofluvial complex is the major upland feature in the area and is at the headwaters of 5 major basins, it is important to note this area is characterised by very poor drainage and the presence of numerous large bogs including the St. Labre Bog to the east, the Caliento Bog to the south, the Rat River Swamp to the southwest and the extensive Brokenhead Swamp to the north. The flat lying, poorly drained nature of this area makes the subdivisions of the basins somewhat subjective and surface/groundwater flow across the indicated boundaries likely occurs.

Review of the topographic maps for the area (Figure 01) illustrates the poorly drained nature of the study area. The entire west side of the Bedford Ridge is underlain by wetlands that extend for a number of kilometres to the west. Drainage of these wetlands is to the northwest via the headwaters of the Seine River or southwest to the Rat River Swamp. The southern part of the study area is drained by the Sand River to the Caliento Bog and then to the Rat River Swamp. A number of small streams drain the east side of the study area to the St. Labre Bog and then the Whitemouth River.

Immediately west of the Bedford Ridge in the Watson P. Davidson WMA, the drainage has been enhanced with the excavation of the Davidson Ditch and other smaller drains to enhance runoff and reduce the duration of surface ponding (North-South, November 2005).