Groundwater Resources of the East Duck Watershed Intermountain Conservation District

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1.0 Introduction

The East Duck Watershed encompasses three drainage basins, which originate on Duck Mountain and drain across the Westlake Plain/Manitoba Low Plain into Lake Winnipegosis. The low plain area is a mixture of farming, forests and wetlands, with an elevation of 312 m (1925 ft) at the Lake Winnipegosis shoreline. Duck Mountain is part of the Manitoba Escarpment. The highest point in the province is located in this watershed at Mount Baldy, elevation 820 m (2730 ft) along the southwestern border. The region is drained by the Mossy River, Pine River, Drake River and Wellburn Creek.

2.0 Previous Studies

The primary groundwater investigation for the area is Groundwater Availability Study #3, for The Rural Municipality of Ethelbert, published in 1971. Three groundwater map sheets cover the area. The main one is Duck Mountain 62N (Little and Sie, 1976). Other map sheets covering limited portions of the area are Swan Lake 63C (Betcher, 1991), Riding Mountain, 62K (Sie, 1978) and Dauphin Lake 62O (Betcher, 1987). Some of the southern part of the area is covered by aggregate mapping (Gartner Lee Associates, 1978) and Groundwater Availability Study #10: Dauphin Lake (Manitoba Natural Resources, 1973)

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3.0 Water Supply

Groundwater is the main source of supply in the East Duck watershed area. Groundwater discharge also provides baseflow to rivers and streams and contributes water to the extensive marshes and wetlands found in significant portions of the watershed.

Groundwater, defined as all water below the water table, is obtained from aquifers. Aquifers in this area, in order of utilization are glacial and recent sand and gravel deposits, Devonian and Jurassic aged limestone and dolomite (carbonate) bedrock, Cretaceous sandstone bedrock and fractured shale bedrock.

Aquitards contain groundwater, but not in sufficient quantities to supply a well. Aquitards, which restrict groundwater flow, in this area are made up of clay and till drift, or shale and siltstone bedrock.

4.0 Acts and Regulations

Groundwater in Manitoba is regulated under a number of Acts and Regulations: *The Environment Act*; *The Water Safety Act*; *The Water Rights Act*; *The Ground Water and Water Well Act* and *The Health Act*. Other Acts may indirectly affect groundwater. For example, groundwater may be affected by developments covered under *The Mines and Minerals Act*.

The Environment Act is the key piece of legislation protecting groundwater quality, while *The Water Rights Act* is the key piece of legislation governing the management of groundwater supplies. *The Ground Water and Water Well Act* deals with water well regulation. The Act covers all sources of groundwater and all water wells completed by a drilling contractor before and after the Act was introduced in 1963. With the exception of controlling flowing wells and pollution prevention, the Act does not cover household wells dug by the well owner with their own equipment.

5.0 Groundwater Flow

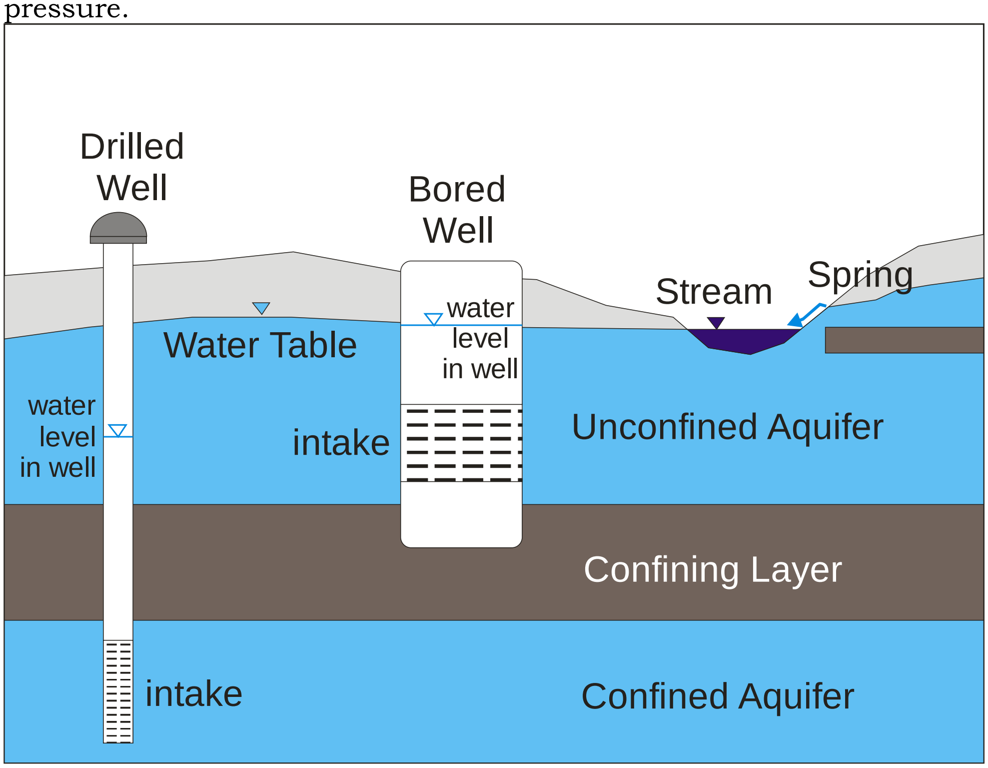
Water enters the ground through recharge, is stored in aquifers and aquitards and exits through discharge. Groundwater storage is a balance between recharge and discharge. In the long term this is relatively stable. In the shorter term, storage may increase when surface water is plentiful or it may decrease during drought.

In general, groundwater recharge will occur in elevated areas and groundwater will discharge in low areas. In recharge areas, the water table is often deeper and levels vary more than you would find in a discharge area. Water quality is generally better, the closer you get to the point of recharge. Groundwater may be discharged at the surface by way of springs, it may be taken up by the roots of vegetation and transpired through the leaves, but most commonly it flows into the bottoms of streams or lakes.

In shallow unconfined aquifers with a water table the groundwater originates from the same locality and contains few dissolved solids, in the low hundreds. The local scale of the flow systems, and the small areas that they draw upon means that these aquifers are more easily impacted by changes to the environment. Water may take days or weeks to move through the system. Water levels are likely to rise and fall on a seasonal basis, with low water levels occurring in late winter and during summer droughts. Wells in this sort of aquifer may be considered undependable sources of water for this reason. Large diameter bored wells are commonly used in areas where aquifer yields are low or unreliable. The large diameter of the well bore compensates for this by adding additional storage. In the East Duck Watershed we expect to see local flow systems in the near-surface sand and gravel aquifers. A good example of this is the Pine River Spring.

In confined aquifers of intermediate depth, flow is from high points within the watershed, such as Duck Mountain to low points in the Westlake Plain. Flow may take weeks to tens of years. Generally water levels in these aquifers are less susceptible to seasonal variation, but will rise and fall over series of wet or dry years. As a result, these aquifers are considered to be more reliable sources of water. In the East Duck Watershed, intermediate aquifers would be found at the base of till and Cretaceous sandstone which we would anticipate to be recharge from larger upland features, such as Duck Mountain.

Figure 1 illustrates a bored well in an unconfined aquifer with a water table, compared to a drilled well in a deep confined aquifer that is under pressure.



In deep confined aquifers, covered in thick layers of clay or shale, groundwater may take tens, hundreds or thousands of years to filter down to the aquifer, sometimes flowing at rates as slow as a few millimeters per year. Recharge to these aquifers may originate many hundreds of kilometers away. Water levels in deeper aquifers tend to fluctuate more slowly, on a year to year basis, rather than seasonally and supply is relatively dependable. The water level in the well (available head) is often higher relative to the well intake compared to shallow aquifers. When groundwater discharges from deep aquifers, there may be flowing wells in the area, or large springs, and the water is often somewhat salty.

Within the East Duck Watershed we can expect to see saline groundwater originating from far outside the watershed to be found at depth in Devonian Carbonates to be flowing east and toward the surface, where it would either mix with local, fresher recharge waters or discharge as salt springs. Salt springs are found along the west shore of Lake Winnipegosis between Camperville and Winnipegosis. The springs originate in limestone and dolomite bedrock and flow through sands and gravels to the surface. Total dissolved solids concentrations are in the range of 10,000 to 35,000 mg/L. Flowing wells are found in this region as well, particularly the Mossy River sub-basin.

Care should be taken in areas known to have flowing wells, to ensure that the flow of water can be controlled, both during the drilling process and through proper well construction and completion. The uncontrolled discharge of water from flowing wells may contribute to drainage problems and waterlogging of soils. If the discharging water is saline, it may also have negative effects on surface water quality. A reduction in the availability of water supply from the aquifer may occur.

6.0 Groundwater Management

Groundwater is managed sustainably if the rate of water removal does not cause long term, irreversible declines in water levels or other undesirable impacts. This means that the amount of water being removed is within an acceptable groundwater budget. A budget is determined by estimating the amount of groundwater in storage, based on well tests and hydrogeological mapping, as well as the amount of water entering and leaving the aquifer through recharge and discharge.

To determine the maximum amount that can be removed within the budget requires knowledge of the recharge rate, and also understanding the hydraulic and water quality responses to pumping and how this may affect surrounding well owners. We do not know enough about groundwater recharge and discharge rates in the East Duck Watershed to develop water budgets.

When groundwater budgets are not known, it is still possible to manage the resource on a well by well basis, providing that the cumulative demands of the existing wells are not causing long term detrimental effects on surrounding wells or groundwater features.

Groundwater pumping tests are carried out when a well is required for more than simply domestic use and a license is required. Groundwater pumping tests are done to determine the maximum sustainable pumping rate of the well and to assess the potential effects on water levels in surrounding wells. The pump test is able to tell us whether recharge is sufficient to offset water withdrawals at this site and to provide assurance that groundwater development is within the ability of the aquifer to supply this water without there being adverse effects.

It appears that groundwater resources are sufficient to supply existing development, as demand is low. In some areas water quality, rather than quantity may be the primary constraint. This is particularly the case along the west shore of Lake Winnipegosis. To date, demands have been relatively low. Should there be a large scale demand for groundwater in the future; additional assessment of long-term sustainability would be needed at that time.

Land use changes such as land clearing, road building, dams or drains, may also affect local water budgets to some degree by affecting recharge and discharge patterns

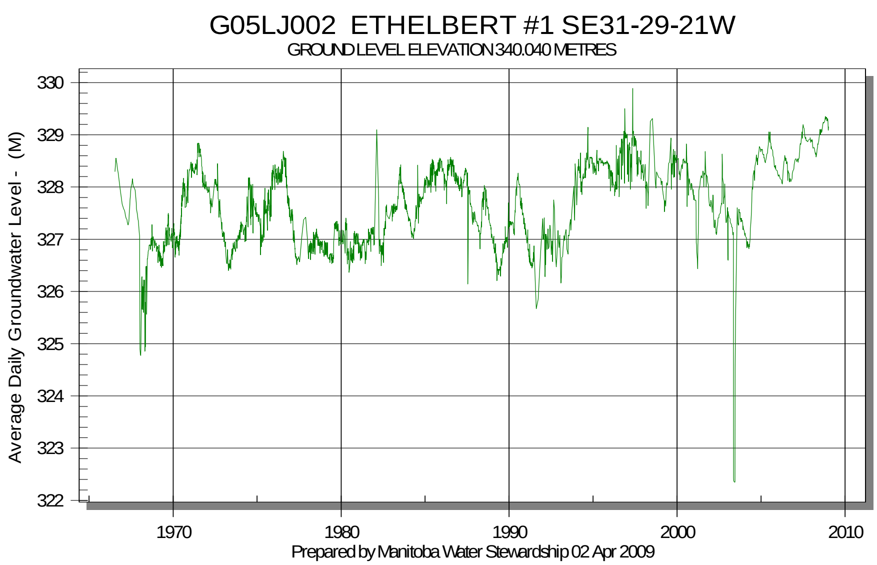
7.0 Groundwater Monitoring

The Province of Manitoba through the Department of Water Stewardship, maintains a network of more than 500 groundwater observation wells in the agricultural regions of the province. Groundwater monitoring may also be mandated at specific sites in licenses or permits issued under *the Environment Act* or licenses issued under *The Water Rights Act*. Monitoring primarily involves continuously recording of water levels, plus occasional water quality sampling. This may be done in undeveloped areas to observe how the aquifer responds to the natural environment, or it may be done in developed areas to determine impacts on groundwater.

In the East Duck Watershed, there is one monitoring well. It has been active from 1966 to present day. This is well G05LJ002 Ethelbert#1, located near the Town of Ethelbert at SE-31-29-21W1.

The well is 42.7 m (140 feet) deep in sandstone bedrock. The aquifer zone is about 6.5 m (21 feet) thick. The water level in the well has been relatively stable, rising and falling seasonally in the 30-60 cm range (1 to 2 feet) or in cycles of 1.1 m over a few years. The water level is at an average depth of 14 metres (46 feet) below ground. Over the forty-two years of monitoring, the average water level has risen about 1.4 metres (5 ft). High water levels correspond to wet years on the prairies (1996, 1997, 2008), while dips in the cycles correspond to dry years (1968).

Figure 2. Hydrograph for the Ethelbert #1 provincial groundwater observation well.



8.0 Groundwater Quality

Groundwater quality can vary considerably in aquifers and aquitards. Water that is found within or which must pass through aquitards, especially in deeper zones, may gain salts and other ions, which reduce water quality. Shallower groundwater in sands and gravels and shallow bedrock that has been refreshed locally by rain and snow has the best quality, although hardness and iron are sometimes an issue. It also is the most ready to receive contaminants from the surface, such as micro-organisms or chemicals. Deeper groundwater found mostly in bedrock tends to be softer and is less susceptible to contamination. Salinity tends to be higher and may be borderline or high for human consumption, but usually is acceptable for livestock.

The provincial water level monitoring well at Ethelbert, was sampled once when it was installed. Some groundwater sampling was undertaken as part of the groundwater map sheet programs from the 1960s.

Manitoba Conservation (Water Stewardship) conducted a water quality sampling program in 1999 and 2000 as part of a study to examine water quality in agricultural regions of the province. The study tested private water wells for major ions, bacteria and nutrients, typically one well per township.

Sampling shows that water chemistry can be quite variable throughout the region. Drift wells overlying sandstone in the central part of the watershed tended to have the lowest total dissolved solids concentrations, generally under 1000 mg/L. Water becomes much more mineralized toward Duck Mountain, where there is shale bedrock and along the west side of lake Winnipegosis, where deep groundwater is discharging. Nitrates are not a significant issue in most of the watershed. A few wells tested high for nitrates, but these situations appear to be local phenomena.

9.0 Aquifer Protection

Vulnerable aquifers may be defined as locations where the aquifer is found close to the ground surface and unprotected from impacts originating at the land surface by sufficient thickness of overlying low permeability clays and tills. This is particularly the case of shallow aquifers because the well intake is close to the surface. Groundwater in aquifers in these areas is more likely to be susceptible to contamination by natural and anthropogenic microorganisms, or inorganic, or organic substances.

A variety of methods have been developed to determine aquifer vulnerability, some quite complex. Generally in Manitoba, if the top of an aquifer is within six metres of ground surface it is considered vulnerable. For this region, shallow, bored wells completed in shallow sands and silts or in carbonate rock would be more at risk than deeper wells in buried sands and gravels or in sandstone.

Vulnerability indicates areas that could be at risk, if a contamination source is present. Vulnerability will not predict that contamination will or will not occur or the severity of am impact.

It is the responsibility of a well owner to ensure that their water supply is properly constructed and maintained. Water well contamination often results from improper construction, maintenance or protection of wells. Protecting a well from contamination is an important consideration when choosing a well site and for construction and maintenance. Wells should be located on elevated sites where surface water will drain away from the well bore. The well casing should be intact and the well annulus sealed with grout. Wells should be properly maintained and properly sealed when they are no longer needed. Land use planning, whether it is local farming practices, or siting of industrial, residential, transportation of waste storage facilities can be used to ensure that wells are protected. Regulatory controls and engineering techniques can also be helpful.

10.0 Geology and Aquifers

10.1 Drift Geology and Hydrogeology

Surficial deposits, often referred to as "drift" are glacial and post-glacial in origin and are mostly till. Through most of the lowland area, the drift is 3 to 25 metres thick. Drift thickness increases significantly over Duck Mountain, reaching depths of 260 metres in Duck Mountain Provincial Park (855 ft). Below the escarpment, a number of wells have intercepted drift thicknesses in excess of 100 metres and in one case 178 metres.

The till layer is made up of a mixture of unsorted clay, silt, sand, gravel and boulders, derived from local sedimentary bedrock, and it contains sand and gravel beds. Texture runs from stony clay to gravelly clay, often with boulders. Shale boulders are often found in the till. Within the top 3 metres (20 feet), the till is weathered to a brown colour, grading to grey at depth. During drilling it may be hard to differentiate till from shale bedrock. In the East Duck Watershed, sand and gravel is found at the base of the till in most places, which is helpful in identifying the bedrock contact.

Sand and gravel aquifers found within or at the base of the till are discontinuous. As a consequence, yields and water quality can also vary, but are not expected to be high. In general, total dissolved solids (salts) concentrations in these aquifers vary from 400 to 1800 mg/L. Sands and gravels may be flowing or even dry. Wells completed in these surficial materials are found throughout the settled areas of the watershed.

Significant thicknesses, of sand and gravel of about 15m (50 feet) are found in Tp29, Ranges 19-22 W1, which may indicate an aquifer of notable extent.

The deepest water well in the watershed was drilled in 1977 to a depth of 167.03m (550 ft) at NE-27-32-22W1, just east of the Town of Pine River. It was drilled as part of a groundwater investigation and encountered an aquifer of sand and gravel. This makes it deeper than many bedrock wells.

Drift in excess of 30 metres (110 feet) is found in some areas overlying the Souris River Formation, which runs from south to north through the watershed. Drift less than 12 m (40 feet) thick is found along the margins of Duck Mountain and along Lake Winnipegosis. Deeper wells completed in sand and gravel may be indicative of a buried valley aquifer in the region. Buried Valley aquifers are often of limited extent and more detailed study would be required to properly confirm or locate such an aquifer. The geological logs of deep wells should be studied to ensure that the aquifer is in fact glacial and not simply loose sandstone.

Glacial till deposits are overlain by sand and gravel deposits of deltaic, beach, and alluvial origin, which constitute shallow aquifers. Thin deposits of lake clays and silt are found in a few locations. Swamps and swamp deposits are found on the Manitoba Plain in low-lying, poorly drained areas between beach ridges.

Deltas are formed near the base of Duck Mountain, overlying till at an elevation of about 400m (1300 feet), a result of streams flowing off Duck Mountain into Lake Agassiz. They consist of gravel and sand over silt and clay up to 15 m (50 feet) thick. Wells in these deposits are mostly located in and north of Tp 29, R 22 W1. South of this area the wells seasonally go dry (Manitoba Natural Resources, 1971). Water quality is good, usually less than 700 mg/L.

Beach ridges were formed of reworked deltaic sands, and are found between Duck Mountain and Lake Winnipegosis. These trend north-south and consist of sand and gravel up to 6 m (20 feet) thick. They are often mined as gravel pits. These are used as aquifers, although they are not particularly reliable because they are so shallow. Water quality is good, TDS less than 1000 mg/L, but can vary from location to location.

Alluvium related to recent stream activity forms deposits up to 4 m (12 feet) thick of silt, sand, gravel and clay. Alluvium is only used when no other aquifer sources are available. Wells in this aquifer are quite shallow making them unreliable during dry spells. Usually a back-up well is needed. Water quality is good, but iron can be high. TDS are generally less than 1000 mg/L

Of 40 chemistry samples in the area for drift aquifers, four reported TDS concentrations below 500 mg/L, 21 between 500 and 1000 mg/L TDS, 9 between 1000 and 2000 mg/L TDS and 6 over 2000 mg/L TDS. The best quality samples came from the central part of the region where there are a lot of shallow sand aquifers. Poorer quality samples were found mainly overlying the Carbonate Aquifer, along Lake Winnipegosis.

10.2 Bed rock Geology and Hydrogeology

Bedrock in the area is made up of Devonian Carbonates, which are commonly utilized as an aquifer, Jurassic shales and limestone, where the limestone beds form an aquifer, and Cretaceous shales and sandstones. Some sandstone beds and fractured shale constitute aquifers.

The formations are relatively flat-lying, dipping very gently to the west. Surface relief on the other hand, is on the order of 500 metres, most of this along the escarpment. As a consequence, as you move east across the watershed, the topography cuts through each bedrock formation down to the Devonian carbonates. To think of it another way, the Carbonate aquifer found close to the surface near Lake Winnipegosis is buried beneath nearly 500 metres of overlying bedrock and drift by the time you reach the western edge of the watershed under Duck Mountain (Figure 3).

The bedrock formations in the watershed are listed in Table 1:

Table 1. Bedrock Formations

AQUIFER TYPE	FORMATION	SUBCROP LOCATION	COMMON WELL DEPTHS	COMMENTS
Carbonate	Devonian Winnipegosis	Red Deer Point- & Camperville area	<60 m	
Carbonate	Devonian Souris River	Lakeshore, extending 10 km west.	<60 m	
Carbonate	Jurassic Reston-Melita	Fork River to Pulp River	<60m	
Sandstone	Cretaceous Swan River	Central plains/lowlands	20-80 m	aquifer in western areas underneath younger bedrock
Shale	Cretaceous Ashville	Base of Duck Mountain	N/A	Shallow fractured shale may be suitable
Shale	Cretaceous Favel	Lower Duck Mountain Escarpment	N/A	
Shale	Cretaceous Vermilion River	Duck Mountain Escarpment	N/A	
Shale	Cretaceous Riding Mountain	Duck Mountain	N/A	
Drift	Glacial	Entire area	<50 m	Buried valley aquifer may be present

Devonian, Jurassic and Cretaceous age rock layers subcrop beneath the drift and dip toward the west. Cretaceous strata form the top of the section, consisting of the Riding Mountain, Vermillion River, Favel, Ashville and Swan River Formations and are located in the west side of the watershed, approximately along and west of Highway 10. The Reston-

Melita Formation of Jurassic age occurs beneath the Cretaceous formations and subcrops in the south-central part of the watershed, between Pulp River and Fork River. The Devonian Souris River and Winnipegosis formations lay beneath the Cretaceous and Jurassic formations and subcrop in a 10 km wide strip along the west shore of Lake Winnipegosis. The extent of these formation is shown in Figure 4.

Figure 3 This is a cross section of the area, extending west from Duck Mountain, east to Lake Winnipegosis, including the communities of Etherbert and Winnipegosis. It shows the various bedrock formations and drift cover.

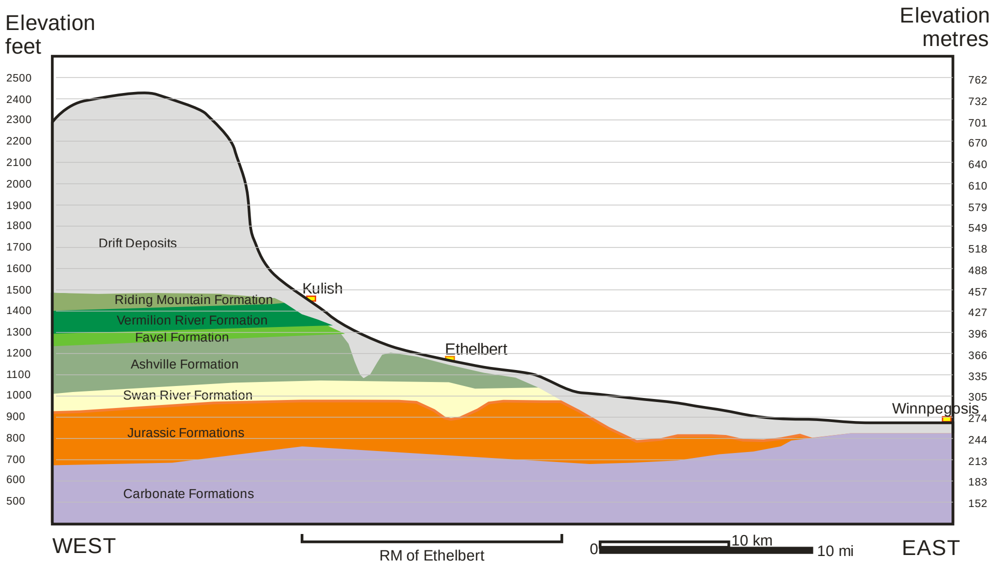
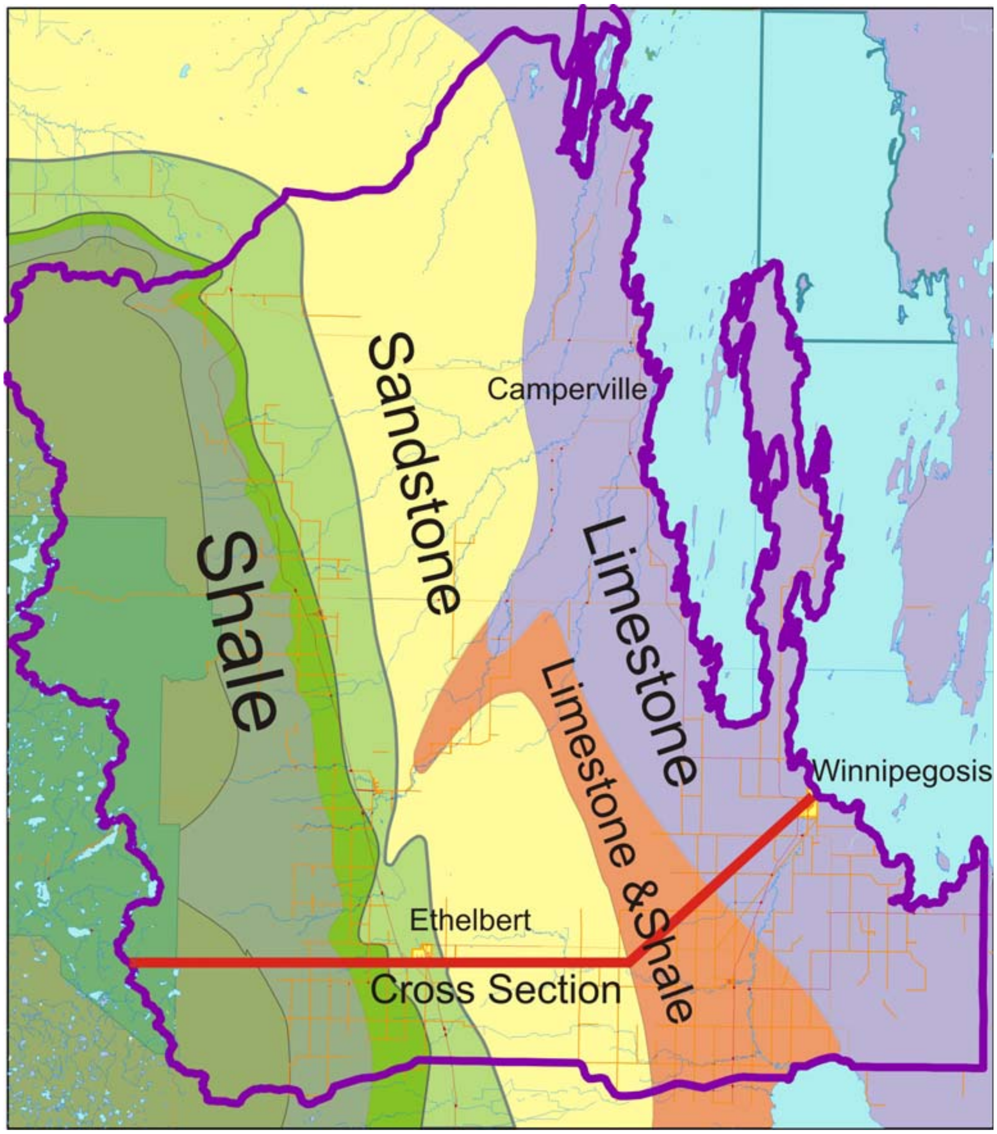


Figure 4 Map of Bedrock Types



10.3.1 Carbonate Aquifer (Souris River and Winnipegosis Formations)

Souris River and Winnipegosis Formations constitute the primary Carbonate Aquifer in this area. The aquifer follows the west side of Lake Winnipegosis, extending west from the lakeshore, about ten kilometers inland (Figure 4).

The carbonate aquifer is made up of limestone and dolomite. Groundwater flow through the aquifer is primarily through fractures, bedding planes and some inter-granular reef type porosity, which locally have been enhanced by dissolution or glacial action. Lower permeability zones are found in the aquifer as a result of either shale layers or low density of fracturing and may form layers that subdivide the aquifer.

The carbonate matrix often has low permeability resulting from poor interconnections between fractures, but may contribute or receive substantial quantities of water to the fractures over periods of time. The upper few metres to tens of metres of bedrock can be very permeable, caused by weathering, expansion of the rock from unloading and from glacial action. Yields from wells are generally sufficient for household requirements.

Water quality is variable depending on location and depth. Saline water enters the aquifer from depth. In more elevated areas, where fresh water is entering the aquifer from the surface it dilutes the sale water. In low lying areas along the shore of Lake Winnipegosis, salt springs with TDS concentrations in the range of 10,000 to 35,000 mg/L are present. Shallow well water is unsuitable for domestic use and surface water is needed.

Of the 24 wells sampled in the area for this aquifer, six reported TDS concentrations between 500 and 1000 mg/L, five between 1000 and 2000 mg/L and 13 in excess of 2000 mg/L.

10.3.2 Jurassic Aquifer (Reston and Melita Formations)

Jurassic formations are found under till in the southern half of the watershed between Pulp River and Fork River. West of this area, the strata are beneath the Swan River Formation. Jurassic sediments are found beneath the Swan River formation and subcrop beneath till. The Reston Formation appears as a white limestone. This formation is commonly used as an aquifer with yields around 5 igpm. Two samples from this aquifer reported TDS concentrations between 500 and 1000 mg/L.

The Melita Formation is made up of sandy, silty or clayey shales of various colours. Jurassic Formations. The Melita Formation is not used as an aquifer, as yields are negligible and water quality is poor.

10.3.3 Sandstone Aquifer (Swan River Formation)

The Cretaceous Swan River Formation is found beneath till in a 15 km wide strip mostly east of Highway 10. West of Highway 10, this Formation is overlain by Cretaceous formations, which thicken toward the west. Its base sits atop an erosional unconformity at an elevation around 275 metres (900 feet). The formation is between 12 to 55 m (40 to 190 feet) thick and has a varied composition of shale, with silty and sandy beds, which may be calcareous or coaly. Sandy beds are generally not cemented. Sandstone in the Swan River Formation is commonly used as an aquifer.

In the Duck Mountain area, at elevations greater than 380 metres (1250 feet), wells in the Swan River are more than 100m (300 ft) deep. A lack of sandy beds means that yields are low and quality is poor in that area. East of Duck Mountain, aquifer potential is good. Water quality varies, but is generally good for stock watering and some domestic use. It is higher than aesthetic objectives for sodium and sulphate. Yields up to 100 igpm are possible.

Of 22 samples on file for this aquifer, one had less than 500 mg/L TDS, nine were between 500 and 1000 mg/L TDS, seven were between 1000 and 2000 mg/L TDS and 5 had TDS concentrations exceeding 2000 mg/L.

10.3.4 Shale (Ashville, Favel, Vermilion River and Riding Mountain Formations)

Bedrock overlying the Swan River Formation consists of four Cretaceous formations, which are primarily composed of shale. They constitute aquifers only when fractured.

Five wells were samples for wells completed in shale, all in the region surrounding Ethelbert. Of these, one had TDS concentrations between 500 and 1000 mg/L, three were between 1000 and 2000 mg/L and one exceeded 2000 mg/L.

The Ashville Formation overlies the Swan River Formation west of Highway 10 and subcrops beneath till in the vicinity of the highway. It is not an aquifer. It has an upper unit of greasy dark grey to black shale, with thin beds of bentonite or calcareous shale. The lower unit is a lighter grey to almost black shale containing thin silt and sandy layers, and limestone. It can get quite sandy in the vicinity of Ethelbert, but is generally low yielding and TDS concentration up to 10,000 mg/L make the water unsuitable. When looking for water in the Swan River Formation, it is important to go fully past and not to complete the well into the poor quality zone of the Ashville Formation. The Ashville Formation is approximately 75m thick.

The Cretaceous Favel Formation overlies the Ashville Formation in the western part of the watershed and subcrops beneath till. It is 70 to 80 feet thick (20-25m). It is not an aquifer. It is made up of hard, dark grey calcareous white speckled shale, containing thin argillaceous limestone beds and some bentonite. The shale and limestone beds are commonly fractured and blocky. Testing during the 1960s mapping program showed that TDS concentrations were under 2000 mg/L and the water was high in hydrogen sulphide, making it unsuitable for domestic use or stock watering.

The Vermilion River Formation overlies the Favel Formation and subcrops beneath till in the western part of the watershed near the base of Duck Mountain. It is about 133 feet (40m) thick and is made up of medium to dark grey shale. It does not have aquifer potential.

Is the youngest bedrock formation in the area. It is found in the Duck Mountain area, which is mostly unsettled. Well information is not available. The Riding Mountain Formation is not considered to be an aquifer. It varies from about 45 to 90 m thick. It is mostly shale and is overlain by substantial thicknesses of drift in most places.

11.0 Well Distribution and Groundwater Use

Wells are found in settled areas. They are located on in agricultural lands along Highway 10, to the north of Dauphin Lake and near Lake Winnipegosis. Duck Mountain and tracts of low-lying bush lands on the plains have few to no wells. Groundwater exploration programs over the years have added coverage in areas lacking wells or lacking deep wells.

Wells in Water Stewardship's database are classified according to aquifer type. There are 775 wells listed for this watershed. Of the main types of aquifers, around 40% of all wells were completed in drift deposits. Limestone and dolomite were the second most common aquifer with close to 30% of wells. Around 20% of wells were completed in sandstone and shale.

Table 2. Number of Wells by Aquifer

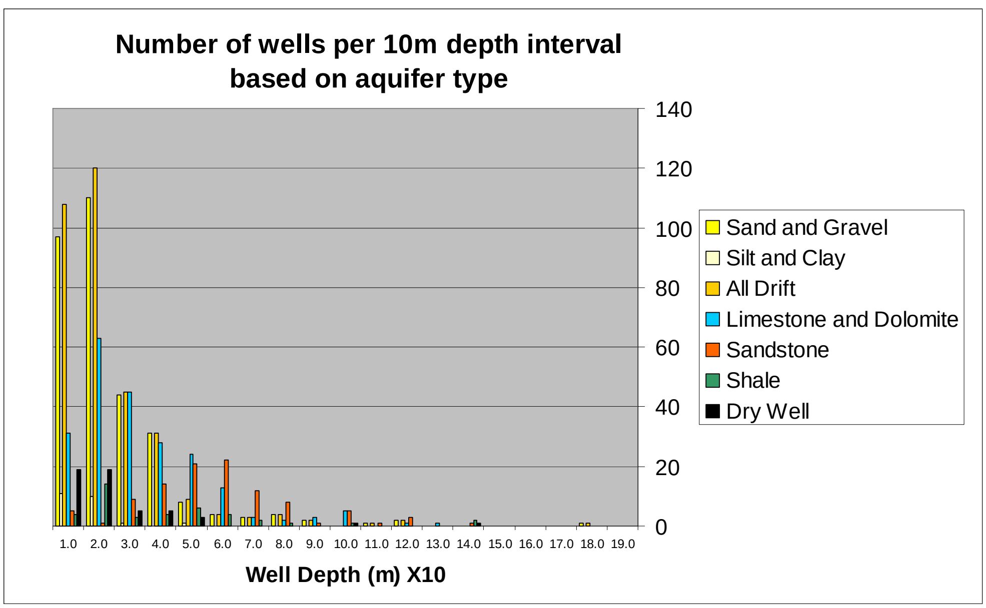
AQUIFER TYPE	NUMBER OF WELLS	% OF WELLS
All aquifers (total)	775	100
Sand and Gravel	307	39.5
Limestone or Dolomite	219	28.4
Sandstone	103	13.3
Shale	41	5.3
Silt or Till	24	3.0
Unknown	26	3.3
Other	2	0.2
Dry (abandoned)	53	6.8

Wells completed in sand and gravel drift are found in all areas of the watershed. A majority of wells are completed in the Carbonate Aquifer where it is present. Sand and gravel wells are the second choice in the Carbonate aquifer area. In the area underlain by Jurassic bedrock, there is a fairly even split in wells completed in Limestone (Reston Formation) and those in sand and gravel (drift). Wells in sandstone are relatively common in central regions where the Swan River Formation subcrops. In rural parts of this area, most wells are in drift, whereas in settlements, where water demand is higher, sandstone is the aquifer of choice. Wells in shale are found near the base of the Duck Mountain escarpment. The Duck Mountain area is generally devoid of wells. There are only four wells on the east slope of Duck mountain, three in drift and one in shale.

Table 3 and Graph #1 show the number of wells in ten metre intervals by aquifer type.

DEPTH RANGE (M)	DEPTH (FT)	DRIFT	CARBONATE	SAND-STONE	SHALE	OTHER & UNKNOWN	DRY WELL	TOTAL
<10m	0-33	108	31	5	4	26	19	193
10-20m	33-66	120	63	1	14	1	19	218
20-30m	66-98	45	45	9	3	1	5	108
30-40m	98-131	31	28	14	4	0	5	82
40-50m	131-164	9	24	21	6	0	3	63
50-60m	164-197	4	13	22	4	0	0	43
60-70m	197-230	3	3	12	2	0	0	20
70-80m	230-262	4	2	8	1	0	0	15
80-90m	262-295	2	3	1	0	0	0	6
90-100m	295-328	0	5	5	1	0	1	12
100-110	328-361	1	0	1	0	0	0	2
110-120	361-394	2	1	3	0	0	0	6
120-130	394-426	0	1	0	0	0	0	1
130-140	426-459	0	0	1	2	0	1	4
140-150	459-492	0	0	0	0	0	0	0
150-160	492-525	0	0	0	0	0	0	0
160-170	525-558	0	0	0	0	0	0	0
170-180	558-590	1	0	0	0	0	0	1

Graph#1



Most wells in the watershed are relatively shallow: 65% are less than 30 metres (100 feet) deep; 18% are between 30 to 60 metres (100 to 200 feet) and 17% were over 200 feet. For any aquifer type, wells are predominantly less that 30 metres deep, with the exception of sandstone, where most aquifers were in the 30 to 60 m depth range (100 to 200 ft).

Many of the deeper wells in the database were not residential water wells, but were test holes drilled as part of groundwater investigation programs or for municipal or commercial purposes. The deepest recorded water well was drilled to a depth of 167.03m (550 ft) at NE-27-32-22W1 (PID30246), just east of the Town of Pine River in 1977. It is interesting to note that this is deeper than bedrock wells in the area.

A 1971 Groundwater report for the RM of Ethelbert noted that residents were often dependent on shallower large diameter seepage wells, many of these hand dug. These wells were subject to going dry in late winter and during summer drought. About 40% were considered undependable and in need of supplementation from other sources. Information presently in our database shows that since that time deeper wells have become more common, likely as residents seek out more secure water supplies. Alternatives to the shallow wells include sand and gravel at the base of till, and limestone or sandstone at depths to 60 metres or more, depending on where you are in the watershed.

12.0 Local Groundwater Issues

Town Hall meetings were held in Cowan, Garland and Winnipegosis. The results of surveys indicate that sufficient groundwater supply is available and that quality is generally acceptable to meet current needs.

Protection of wells and aquifers from contamination was identified as a concern. This makes sense for this area, given the number of relatively shallow wells and high water table. More specifically, there is a need to better understand how to protect groundwater and wells from contamination. Large scale livestock operations were identified as one potential source of contaminants. Abandoned wells need to be sealed. A need to manage surface water in a way that protects groundwater was seen – especially if there is overland flooding or water logged soils, which seemed to be exacerbated by the abundance of beavers.

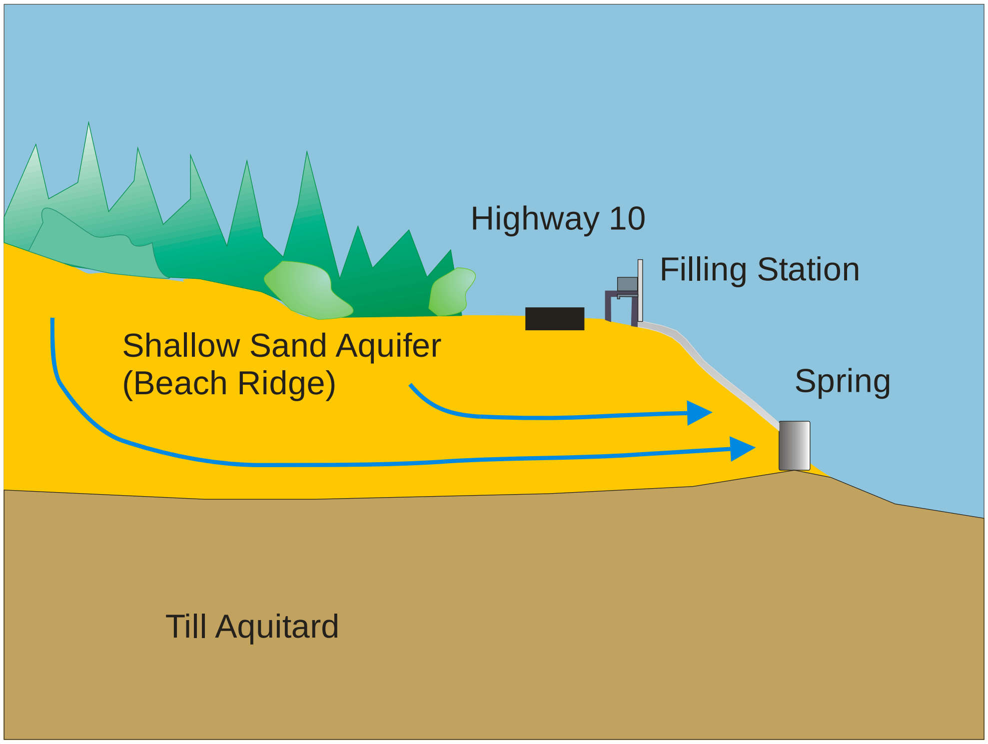
Wells that are improperly constructed, are poorly maintained or are in a low lying area are at a higher risk of becoming contaminated. Risk of contamination may be reduced by following certain steps.

- Locate the well a safe distance from sources of contamination and in an area where the water drains away from the site;
- Hire a licensed and reputable water well contractor to drill and install your water well and to hook up the distribution system;
- Once the well has been installed and before it is put into operation, ensure that the well, pump and water distribution system have been disinfected to kill any bacteria and
- Ensure wells that are no longer being used are properly sealed according to the standards set out in Manitoba's Guide for Sealing Abandoned Water Wells (Manitoba Conservation, 2002).

Iron in well water was an issue in some areas. This might be expected, since iron is often a common concern in shallow wells everywhere. Treatment options could be explored. Phosphorus from decaying vegetation in waterlogged areas was seen as having negative effects on surface water quality.

The Pine River Spring (Figure 5) was a priority for residents throughout the watershed. The community would like to see it restored to the way it was before it was leased. The Pine River Spring is located along a highway allowance between Pine River and Sclater. The spring site was developed and used by local residents for filling water containers. The site was operated for a period of years by a private party under agreement with the government. The lease lapsed 2007, leaving unresolved issues about the condition and maintenance of the site.

Figure 5. Pine River Spring



The site is located at SE-25-33-23-W1 on the east side of highway 10, 9.4 km north of Pine River. The site consists of a wayside park and spring. The aquifer is sand and gravel beach deposits.

The spring is located 15m lower than the road. The spring is developed using a pipe that is inserted into the ground. Water flows from the pipe into a covered and insulated culvert, with an overflow outlet sunk into the ground, which acts as a collection reservoir. A cement stairway runs down to the spring to provide assess for people wanting to fill small containers.

Around 1987 the Manitoba Department of Agriculture built a loading station. The loading station consisted of a submersible pump in the reservoir that fed into a pipeline that lifted the water to a standby pipe. The system was operated by and electrical switch.

In 1996, the Department of Natural Resources was approached by Lightning Delivery Service, a delivery and moving company based out of Dauphin, represented by Morris Kuchma. Mr Kuchma was interested in developing a water bottling business.

Mr Kuchma was uncertain what his water requirements would be, since he was did not have an existing market for the bottled water. Regardless, the amount required was minimal compared to the actual spring discharge and there were no other users of this aquifer.

Licence number 1996-055 issued February 20 1997 was a ten year agreement that was not renewed. The well was licensed for water bottling purposes, with a maximum diversion of 0.0023 m3/s (30 igpm) with total quantity not exceeding 4.94 cubic decameters per year (4.0 acre-feet). Under the agreement, Lightning Delivery was responsible for maintenance of the park and spring as outlined in a schedule attached to the licence. The agreement to operate the site included regular cleaning, and upkeep of shelters, picnic tables, toilets and garbage containers and regular grounds keeping. One note on file suggested that the initial agreement to maintain the site was for a period of five years or less.

The water bottling industry must not have taken off. The site was well maintained for a period of time and people because accustomed to the service. Eventually Mr. Kuchma retired to British Columbia. Presumably he was not interested in maintaining a site that he was not using and it fell into disrepair and the pumps stopped operating some time before the agreement expired. Judging from the comments by the community, Parks Department has not restored the site.

13.0 Summary and Next Steps

The East Duck Watershed encompasses a lowland area between the Manitoba Escarpment (Duck Mountain) and Lake Winnipegosis. Population density is relatively low, with settlement limited to agricultural lands. The uplands of Duck Mountain and large areas of swampy lowlands remain largely unsettled. Residents depend on groundwater for their domestic supplies. However, the lack of large population centres or major developments has meant that demands on groundwater have remained within the capacity of local aquifers to meet current needs.

This is borne out by local community consultation where supply limitations were not put forward as a concern. A second indicator that supplies are sufficient is the abundance of shallow wells (<30m) in the region. This means that residents have been able to meet their water supply needs without having to “drill deeper” to find new supplies. Should the need arise, indications are that water is available at greater depths from sands and gravels at the base of till, from sandstone beds in the Swan River Formation and from limestone in Jurassic and Cretaceous bedrock.

Residents have for the most part been able to find sufficient water supplies at a shallow depth. As a consequence, many may not be aware of aquifer choices available and the quality and yield considerations that go with that. Groundwater maps of the area would help with this situation.

The abundance of shallow wells combined with a high water table means that wellhead protection and/or aquifer protection are issues worth exploring for this watershed. Potential contamination sources are relatively few. Risks come from larger livestock and agricultural operations, and from overland flooding. Efforts to locate and properly seal abandoned wells and education on practical methods for well protection and maintenance are issues that should be explored.

Water treatment options are another topic that should be addressed. Shallow wells are prone to problems with high iron or hardness. Deeper wells are more likely to have higher concentrations of total dissolved solids, sodium or sulphates.

The current condition of Pine River Spring is important to the community at large and needs to be addressed. The Pine River Spring is an excellent opportunity to do a demonstration project highlighting site development, source protection and maintenance. It is especially true if the community takes a sense of ownership and vigilance in maintaining the water supply.

If in the future, the Watershed Plan identifies a need for detailed work in the watershed, a field-verified survey of water wells would be beneficial to various aspects of the program. Under The Groundwater and Water Well Act drillers are required to submit a report on any well they drill, at the time of drilling. The survey would be helpful in obtaining GPS positions of wells for mapping purposes, identifying wells not on file and locating wells that require sealing.

14.0 References

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