HERAA
Consulting Inc.

Level 1 GROUNDWATER ASSESSMENT

MILFORD STATION, HIGHWAY 2
NOVA SCOTIA

Prepared for:
James Kerr, Edward Kerr & Katherine Manuel

March, 2024

EXECUTIVE SUMMARY

A residential development comprised of 11 lots with a median lot size of 425 m^2 has been proposed for an area in Milford Station. Information provided within the NS 2011 Guidelines indicates a proposed development with 10 to 25 lots requires a Level 1 groundwater assessment while the Milford Municipal Planning Strategy requires consideration of well interference for subdivisions where more than four residential lots are to be created.

In the area of interest, the surficial geology is formed of ground moraines and glaciofluvial deposits which are characterized by silty-clay matrix roughly 12m in thickness. This is underlain by the bedrock of the Windsor Group which is comprised of marine and evaporite deposits. Within this Group, it is the Green Oaks Formation that is primarily of interest and is the prime source of potable water, with a decrease in water quality in wells that extend below this formation.

The following screening level calculations are recommended to evaluate water quantity and sustainability, 1) safe well yield , 2) lot water balance, 3) well interference.

The safe well yield suggests there is insufficient area within the lot to serve as an adequate recharge for the underlying aquifer. In contrast the lot water balance indicates a 20 year safe yield (Q_{20}) of 81.4 m^3/day, this is similar to information obtained from the NS Pump Test Database, which suggests a Q_{20} of 76 m^3/day for wells drilled into the Windsor Group. Calculations regarding well interference suggest a maximum drawdown of 8.8m at the well head within the proposed subdivision, a value that is considered to be less than 50% of the available drawdown and is therefore considered acceptable. These results are considered to be very conservative, as they do not take into account surface infiltration/aquifer recharge or water storage within the well bore, factors that are important to consider when determining the viability of the development.

Current information suggests potable water within this area will require treatment. Water quality is expected to be hard to extremely hard as a result of high concentrations of calcium sulphate, possibly with higher TDS and concentrations of iron and manganese.

Although the median well depth in the local area is 24m, the data indicates greater depths are possible in this vicinity. Consequently, greater depth should be considered to increase available storage and minimize interference with other wells.

The current information would suggest there is sufficient potable water available to support the proposed development. Note, as the water supply is provided by localized fractures, this should be confirmed at the time of well installation. This report has been generated to satisfy the NS requirements initial requirements for development of a subdivision serviced by private wells.

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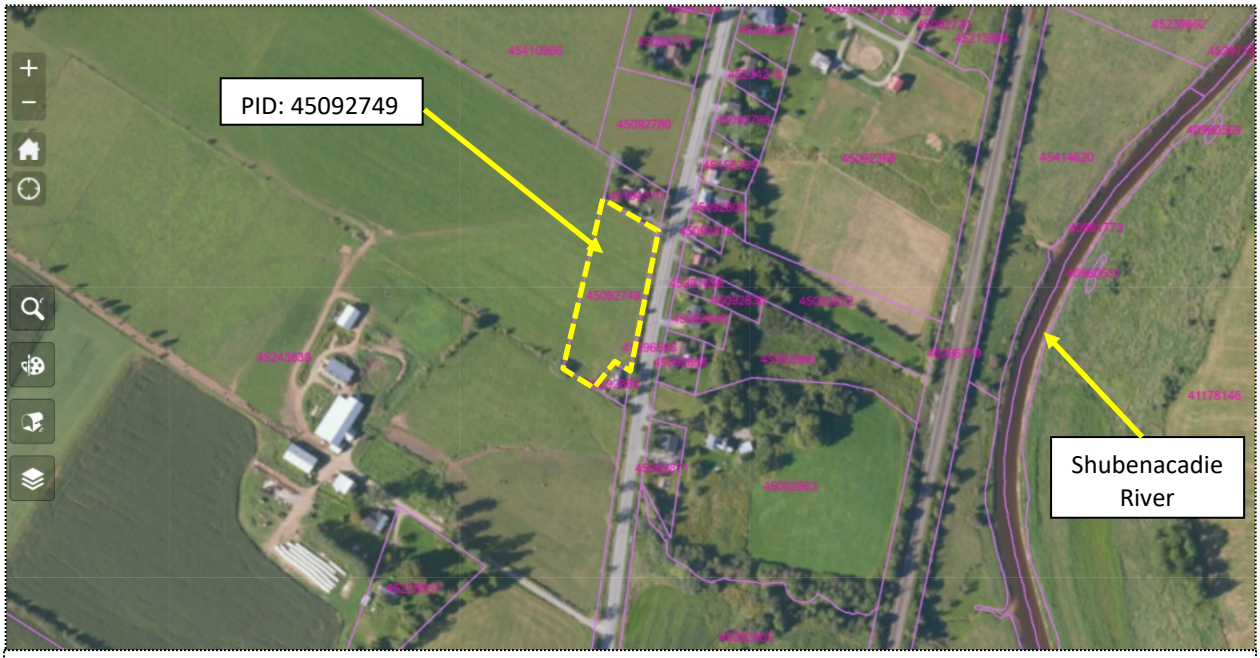
1.0 BACKGROUND

HERAA Consulting Inc. has been commissioned by James Kerr, Edward Kerr and Katherine Manuel to conduct a Level I Groundwater Assessment for a proposed residential development in Milford Station, Highway 2, Nova Scotia. A review of the preliminary subdivision plan, completed by Civtech Engineering & Surveying Ltd., indicates the creation of 11 lots. As dictated by the Nova Scotia Environment & Climate Change (NSECC) document, "Guide to Groundwater Assessments for Subdivisions Serviced by Private Wells", 2011, a Level 1 groundwater assessment is required for a proposed subdivision of 10 to 25 lots. This coincides with the Milford Municipal Planning Strategy which requires consideration of well interference for subdivisions where more than four residential lots are to be created. Information obtained during the investigation of the property of concern is contained within this report.

2.0 SITE DESCRIPTION

The property under review is identified by the PID 45092749 with its location noted in (Figure 1, attached) and Aerial 1 below. The site is located within the Municipality of East Hants and outside of the Halifax Regional Municipality.



Aerial 1: Location of Proposed Subdivision

As seen in the preceding aerial, the subject site is situated on the west side of Highway 2, in a rural area of Nova Scotia and encompasses an area of 5787 m^2 (1.4 acres). The general lot configuration of the development is shown in a Preliminary Subdivision Plan contained in Appendix A and provided on Figure 2. Proposed development details are summarized below.

2.1a Proposed Development

Lot	Length (m)	Width (m)	Area (m^2)
Lot 1	-	-	1174.9
Lot 2A	47.8	9.0	432.2
Lot 2B	47.4	9.0	428.5
Lot 3A	47.1	9.0	425.1
Lot 3B	46.7	9.0	422.0
Lot 4A	46.5	9.0	419.3
Lot 4B	46.2	9.0	417.0
Lot 5A	46.0	9.0	414.9
Lot 5B	45.8	9.0	413.2
Lot 6A	-	-	488.9
Lot 6B	-	-	703.9

"-" variable

2.1b Summary of Proposed Development

Number of Lots	11
Minimum Lot Size	413.2 m^2
Maximum Lot Size	1174.9 m^2
Median Lot Size	425.1 m^2
Total Area	5787 m^2

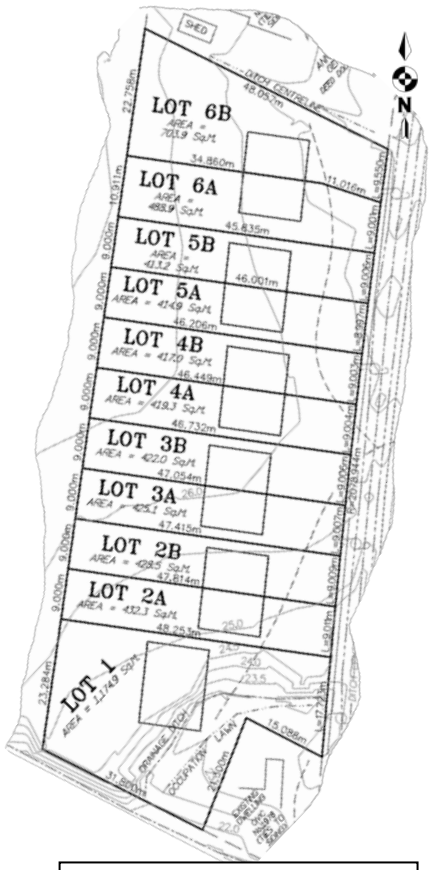


Figure 2: Proposed Layout

It is relevant to note, while septic services will be provided by a main sewer extension, a lot plan with proposed well locations was not provided as part of this study.

3.0 PROJECT SCOPE

The purpose of a Level I Groundwater Assessment is to characterize the local site geology and hydrogeology in order to assess availability and issues related to the potable water supply to the site. The work includes a description of the hydrogeology and characterization of the site, as outlined in Section 2.0 of the NSECC Guide to Groundwater Assessments for Subdivisions Serviced by Private Wells (2011). The following information is required to satisfy the NSECC requirements:

- the risk of potable water quality and quantity problems in new residential subdivisions; and
- potential impacts of subdivision developments on existing groundwater users and the environment.

4.0 SITE INVESTIGATION

The historical/desktop review and site visit findings are presented in the sections below.

4.1 Land Use

4.1.1 Current

A review of Aerial 1 indicates the property under investigation is located in a rural area surrounded by both farmland and residential buildings. The land is vacant (Photo below) and zoned as R2 and AR, or Two Dwelling Unit Residential and Agricultural. The following photo provides a view of the property and and observations of the surrounding lands.

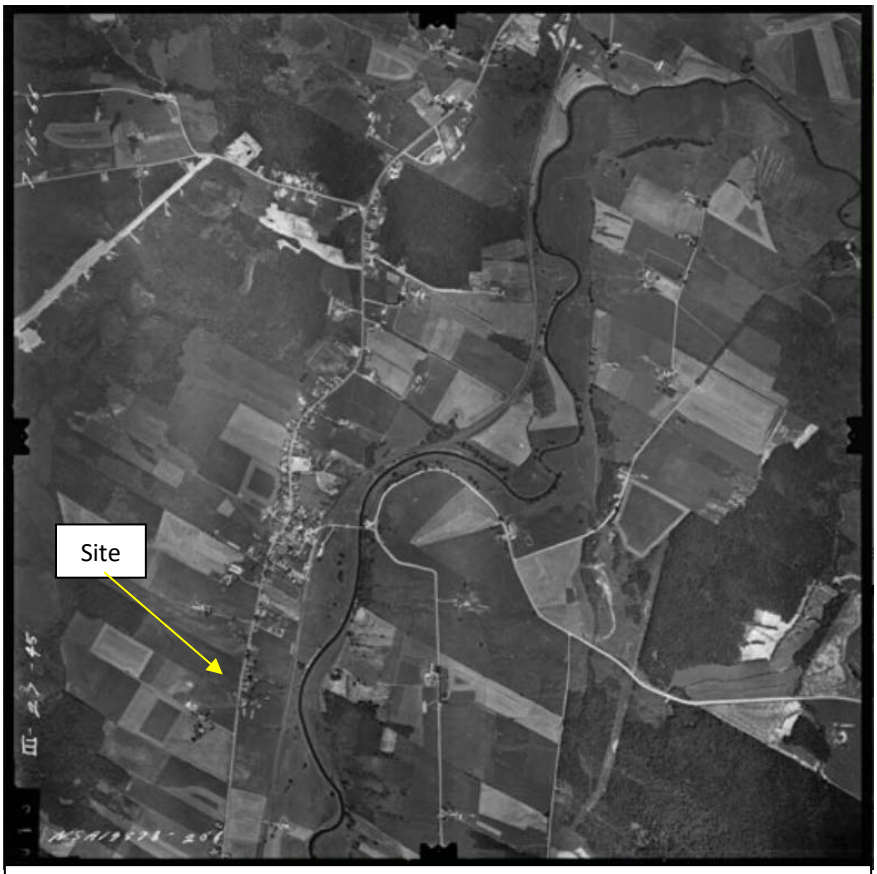
Photo 1: Site photo, facing West, Google Maps, Nov, 2023

Table 4.1: Utilities

Electricity	None
Telephone and Internet	None
Heating System	None
Potable Water	None
Grey Water / Sewer / Storm Water	None

4.1.2 Historical

Aerial photos from 1966 to the present were examined for historical land usage. A review of these photos, indicates some development in the area in 1966, increasing since the 1980's however, overall usage has remained the same. As far back as 1966, the property under investigation has been vacant although it was being actively farmed.



Aerial 2: Photo, 1966

4.2 Adjacent Land Use

As part of the investigation, distant visual observations were made of neighbouring properties; Table 4.2, contains some of those observations.

Table 4.2 Existing Neighbouring Land Uses

Neighbouring Property	PID	Property Classification	Comment
North	45194370	Residential	Rural
East	Hwy 2 45092848 45092855 45092822 45281656	Residential	Rural
South	45243839	Residential Agricultural	Rural
West	45243839	Agricultural	Rural

5.0 GEOLOGICAL SETTING

Information relating to the geology of the area can be used to provide an estimate of the ability of water to migrate through the bedrock and the overlying soils. The following information is provided to assist the reader in understanding these potential migration pathways and their impact on the quality and quantity of water available for potable use.

5.1 Bedrock Geology

The subject area lies in close proximity to the contact between the Windsor and Mabou Groups, as seen in the following figure. Available data indicates the Windsor Group were formed as widespread, marine and evaporite deposits while the Mabou Group is considered to represent basin-fill sediments.

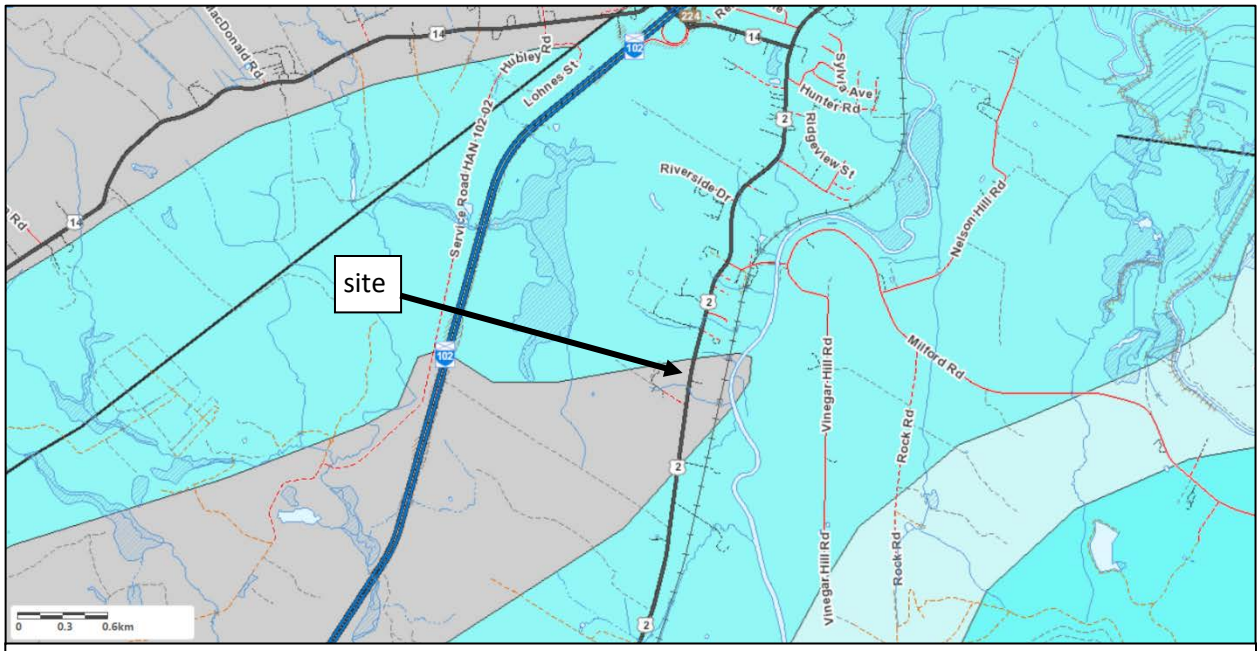


Figure 3: Regional Bedrock Geology

Windsor Group

Murphy Road, Pesaquid and Green Oaks Formations
siltstone, minor gypsum and shallow marine limestone (Visean (Asbian), C-E subzones fauna and spores)

Wentworth Station, Miller Creek, MacDonald Road and Elderbank Formations
gypsum, minor siltstone, marine limestone and dolostone (Visean (Holkerian), B subzone fauna and spores)

Mabou Group

Watering Brook Formation
siltstone, minor sandstone, gypsum and anhydrite, >150 m (Visean (Brigantian)-Namurian spores)

5.2 Surficial Geology

The disappearance of glaciers from Nova Scotia about 10,000–12,000 years ago resulted in the formation of surficial deposits consisting of: ground moraine and drumlins; erratics; glaciofluvial deposits such as eskers, and kames, river channel deposits and lacustrine deposits.

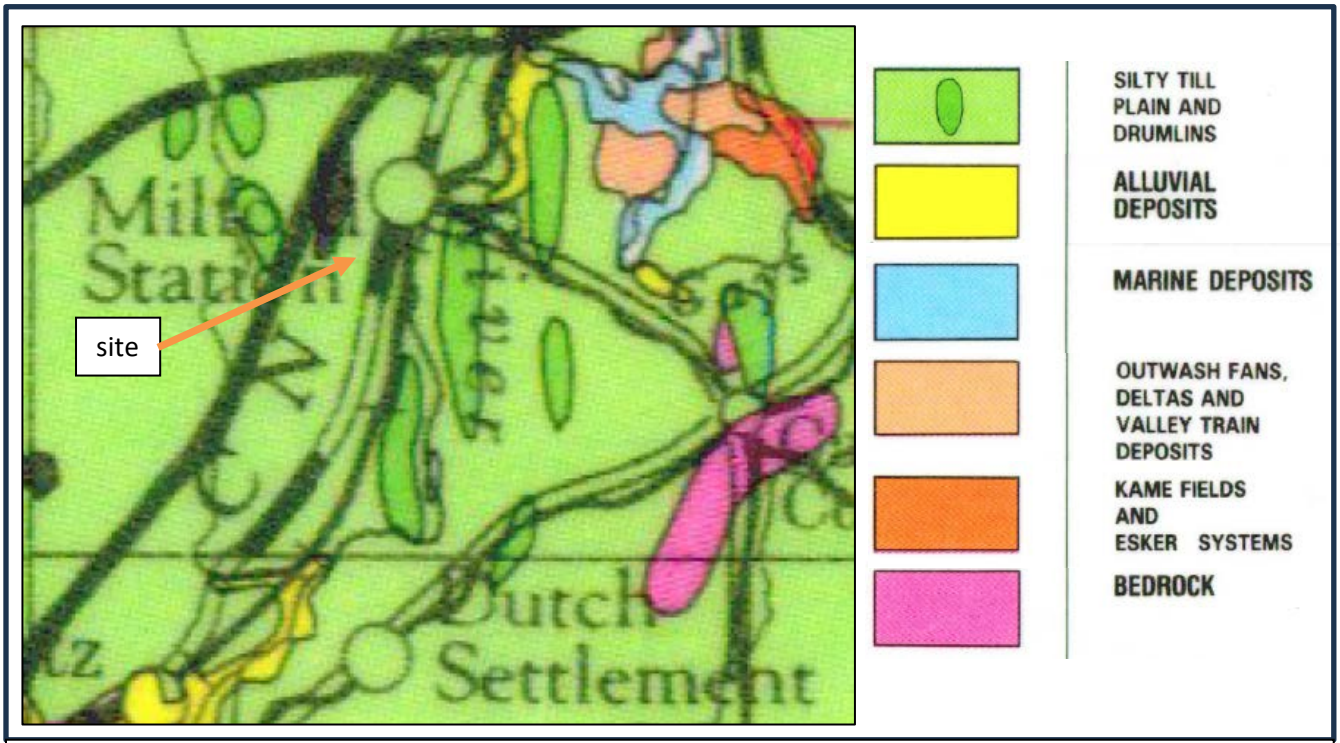


Figure 4: Regional Surficial Geology

5.2.1 Ground Moraine & Drumlins

The information presented in Figure 4 indicates the soil is typically classified as ground moraine – a smooth to hummocky soil comprised mainly of unsorted boulders and compact sand and mud, derived from both local and distant sources. Locally, the silty till plain is a flat to rolling with thick glaciofluvial deposits comprising of layers of gravel, sand or mud.

The surficial sediments, which completely mask the underlying bedrock undulations, range in thickness generally from 3 to 30 m with a maximum thickness of 70 m. Drumlins, which are common throughout this area, contain siltier till and a higher percentage of distant source material, including red clay. Presenting as streamlined, elongated hills they consist of layers of glacial till up to 30 m thick. One such area, roughly 1 km long and 500m wide, exists approximately 1.2 km to the west.

5.2.2 Holocene Deposits

Holocene sediments, deposits created after the retreat of glaciers roughly10,000 years ago have been identified in this area. These consist of marine estuary, river (alluvial) and organic (bog, fen) deposits. These alluvial deposits are generally bedded – coarse at the base, finer at top. Locally, the organic

deposits consist of sphagnum moss, peat, gyttja, and clay, in fens and swamps. They can range in thickness from 1 m at the edges to 5 m in the centre. One such area, roughly 2 km long and 750m wide, exists approximately 850m to the northwest of the proposed development.

5.2.3 Local Sediments

According to the map, *The Surficial Geology of Nova Scotia* (Stea, Conley and Brown, 1992), the soils in this area are described as stony till that is derived from both local sources such as drumlin facies. The drumlines formed contain multiple tills which are thick enough to mask bedrock undulations. The thickness of the till plain is anticipated to be between 4-30 metres. Fine grained layers may restrict vertical hydrocarbon migration and fluid would be expected to travel through coarse grained layers although disturbed material adjacent to structures and utilities may provide preferred pathways.

The predominant till formations in this area are the Hants and Milford tills, which are characterized by silty-clay matrix. Photo 2, obtained from the nearby East Milford Quarry, shows a typical cross-section of the local soil above the gypsum surface.

Photo 2: Surficial Geology of the local area

The red sediments on the top are tills, and the bedded sediments near the base are sand and gravel containing fossil wood. The overlying reddish silty till, called the East Milford Till, forms much of the topography of the Hants Lowlands averaging between 10 and 20 m in thickness. Overlying the East Milford Till are clay-silt, sand, gravelly sand and gravel beds. The surface till, called the Hants Till, was deposited by southward flowing glaciers and later reworked by local ice caps.

5.3 Topography

The local and regional topography play an important role in the migration and capture of rainfall in both the surface and sub-surface media.

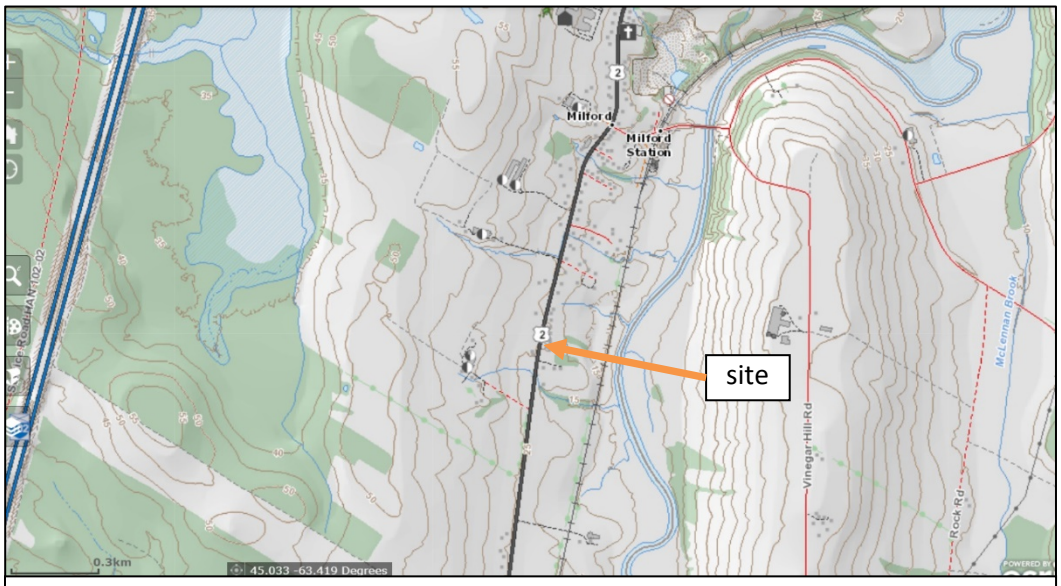
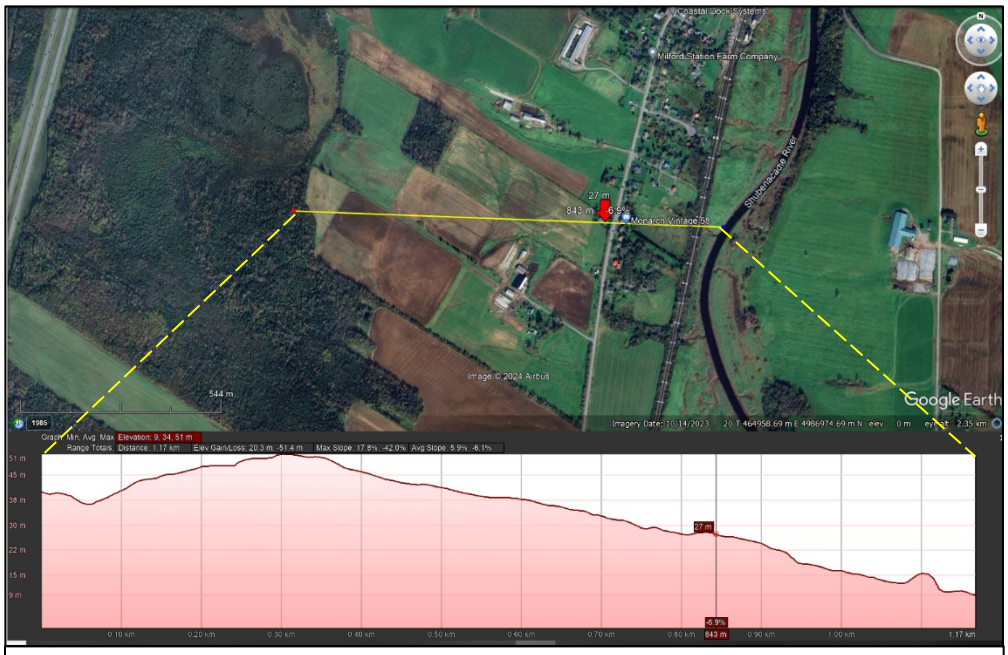


Figure 5: Regional Topography Geology (5m contour interval)

A review of the local topography indicates the proposed subdivision is located in a valley, between a drumlin on the east and hills to the left. Other important features include the Shubenacadie River, roughly 300m to the east and an extensive fen/bog approximately 800m to the west. Surface elevations vary from 51m above sea level (asl) to 27m asl at the site, and 9m at the River as seen on Aerial 3 & Figure 5.



Aerial 3: Regional Topography

6.0 HYDROLOGY

6.1 Watershed Delineation

Watersheds or catchment areas, are defined as the area that captures and feeds rainfall into a single river system where the boundaries are typically defined by a ridge of land dividing two areas that are drained by different river systems.

The property under investigation lies within a tertiary basin of the Shubenacadie Watershed with a surface area of roughly 832 hectares (Figure 6). However, the area that would directly impact the proposed subdivision is considered to be much smaller, with a total surface area of approximately 87 hectares.

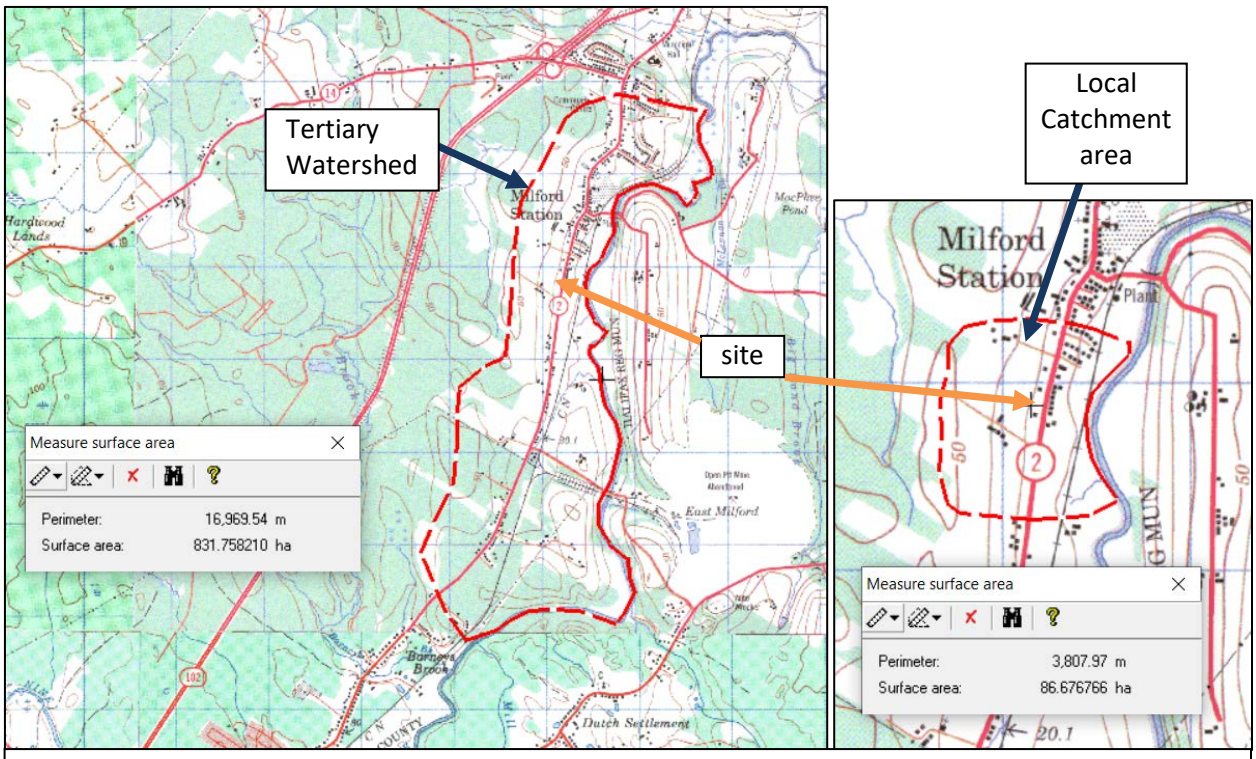


Figure 6: Tertiary Watershed and Local Catchment Area

6.2 Aquifers

6.2.1 Surficial Aquifer

Surficial mapping indicates the soil in this area is comprised of ground moraine and tills. As previously noted, these are comprised mainly of unsorted boulders and compact sand and mud. In the area of the proposed development the overburden has a potential maximum of 25m and an average of 12m where

the well logs indicate the deposits are composed mainly of clay/mud with stone/boulders. These would typically have low permeability and consequently, are not considered viable as a potable water source.

6.2.2 Bedrock Aquifers

The Watering Brook Formation of the Mabou Group overlies Green Oaks and MacDonald Road Formations of the Windsor Group. The Watering Brook Formation is known to contain more gypsum and/or halite than the Green Oaks Formation and therefore provides water of poorer quality. Generally found to have a thickness of >150m, in this area it is starting to "pinch out" as it encounters the Green Oaks Formation and so it may be considerably thinner under the proposed development.

The Green Oaks Formation, which immediately underlies the Watering Brook Formation, is composed primarily of carbonates and may contain fewer gypsum and halite beds than other bedrock units of the Windsor Group, resulting in slightly better quality water. However, in this area, the Green Oaks Formation is only, roughly 140 m thick, and is underlain by the MacDonald Road Formation which typically contains more gypsum and halite.

6.3 Water Well Data

6.3.1 Residential Wells

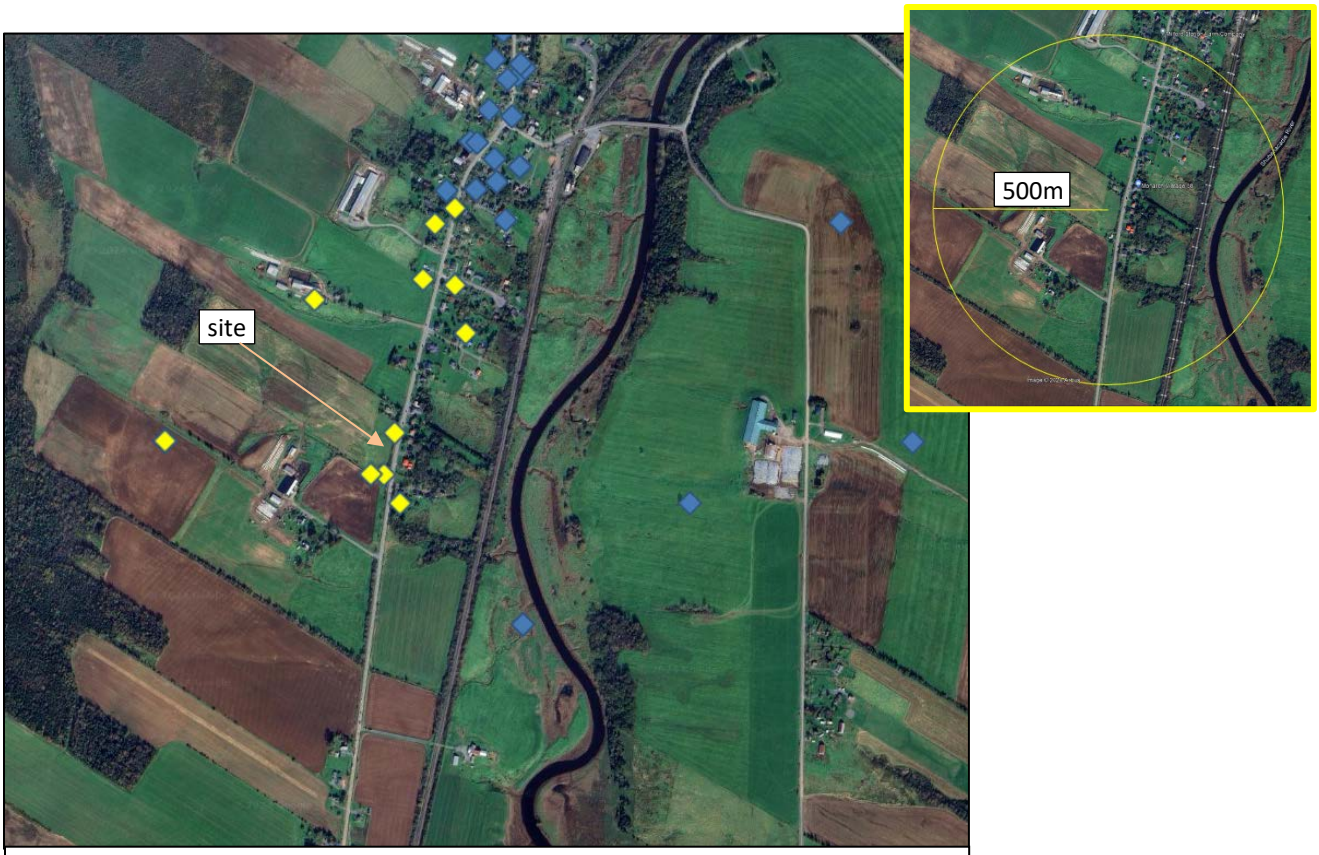
The NSE 2011 guide for subdivision development requires identification of existing water users within 500m of the site and their use (domestic, commercial, industrial, municipal, agricultural, etc.). The Nova Scotia Well Log Records, (2020), was used to obtain information on water wells within this area and revealed the presence of 11 wells located within a 500m radius of the site. Although recent aerials suggest additional wells have been completed in this area (Google Maps, 2024) , the corresponding data may not have been entered into the database at this time.

Information related to each of the 11 wells is included in Appendix B and summarized in the table below with their location noted on the following aerial.

Table 6.1 Summary of Well Log Data

	TOTAL DEPTH (m)	CASING DEPTH (m)	DEPTH TO BEDROCK (m)	STATIC WATER LEVEL (m)	YIELD (lpm)	TYPE
Average	22.4	14.5	7.2	4.4	79.7	Drilled
Median	24.2	12.5	7.9	3.7	45.4	Drilled
Max	36.5	32.9	12.8	12.2	340.5	Drilled
Min	11.0	6.1	2.1	0.0	18.2	Drilled

Approximately 100m to the south and at the same topographic elevation, a well was drilled to a depth of 28m, suggesting greater well depths than the median value are available in the area of the proposed subdivision.



Aerial 4: Water Well Locations, those in yellow are within 500m of the proposed development.

6.3.2 Pumping (Aquifer) Test Data

Nova Scotia maintains a database for aquifer tests that have been completed throughout the province. A review of this information shows 13 locations within an 8 km radius, where pump tests have been undertaken (Figure 7).

The information associated with each well shows that 8 of the 13 were completed in glacial-fluvial sediments while 5 were terminated in the Windsor Group. Information regarding these 5 would be relevant to wells situated within the proposed development and is included in Appendix B and summarized below.

Table 6.2 Summary of Pump (Aquifer) Test Data

	Depth (m)	Static Water Level (m)	Available Drawdown (m)	Maximum Drawdown (m)	Hydraulic Conductivity (m/d)	Transmissivity (m^2/d)	Q_{20} (L/m)
Average	47.2	10.1	32.0	13.3	0.6	17.59	121.66
Median	51.8	5.9	27.9	11.5	0.2	6.1	52.8
Maximum	62.0	26.5	46.7	18.7	1.7	64	290.9
Minimum	27.7	5.3	18.3	8.9	0.0	2.4	19.1

Two the wells are located in close proximity to the proposed site, with one situated roughly 1 km to the north and the second approximately 2.6 km to the south.

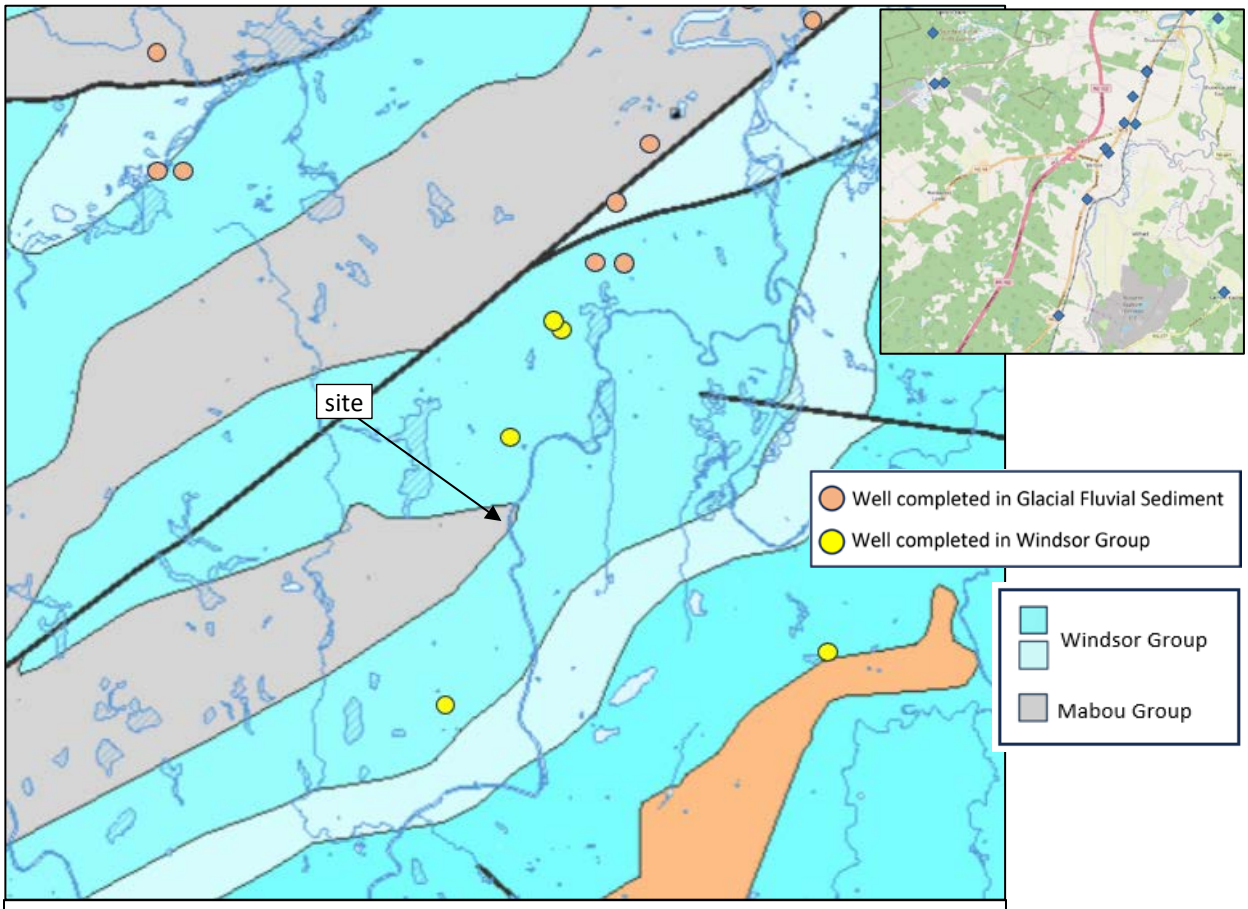


Figure 7: Pump Tests located within an 8 km radius

6.4 Aquifer Storage

Storage within an aquifer refers to the volume of water that is inherently present within the unit and as such is available for discharge to local wells. Within the Windsor Group, fractures are expected to provide the main source for transportation and storage of water for local wells while the overlying Watering Brook Formation, which is comprised of sediments, would serve as a source of recharge.

6.4.1 Specific Yield

The Watering Brook Formation is a glacial till that is comprised predominantly of clay and silt and as it is sedimentary in nature, water stored within this unit that is available for release, is referred to as "Specific Yield". Essentially, this refers to the volume of water that can drain by gravity from a saturated volume of material divided by the total volume of that material (Freeze & Cherry, 1979). The quantity may be expressed in terms of the percentage of the total volume. For silt this value is 8% while for clay the value is 0% (USGS, 1992). A value of 4% for a clay loam would therefore be considered reasonable.

6.4.2 Storativity

The Green Oak Formation forms part of the Windsor Group and is the preferred unit in which to complete a potable well. Storage is directly related to the porosity which for the Green Oak Formation is conservatively estimated to be approximately 2.5 to 5%.

In addition, storage, termed "Storativity" for a confined aquifer, is defined as the volume of water released from one unit volume of the aquifer under one unit decline in head. This value may be calculated from the data obtained from a pump test. Although wells within the Milford Station area did not include this information, a review of the pump test database contains 5 wells completed in the Windsor Group for which Storativity data is available. These wells, located in Brookfield (3), Bucklaw (1), and Plymouth (1), NS (Appendix B) indicate an average Storativity value of 4.52E-04.

6.4.3 Specific Storage - Total Water Available

Specific storage is defined as the volume of water that is released from storage per unit volume of saturated material. This represents the total volume of water available from both the Green Oaks (confined) and Watering Brook Formations (unconfined) and may be calculated by taking into consideration:

- an area of influence 500m from the proposed development;
- the thickness of the surficial (Watering Brook Formation) and bedrock (Green Oaks Formation) aquifers; and
- porosity of each unit.

Table 6.3 Specific Storage

Formation	Thickness (m)	Area (ha)	Porosity	Volume (m^3)
Watering Brook Formation [1]	12.5	87	0.04	435,000
Green Oak Formation [2]	12 [3]	87	$4.52x10^{-4}$	4,718
Total				439,719

1 – Unconfined Aquifer (thickness from NS Well Log Database)
2 – Confined Aquifer, Formation within the Windsor Group
3 –thickness approximately 87m NSDOE (2017), median well depth 24m – available thickness: 24m-12m = 12m

6.5 Aquifer Recharge

6.5.1 Temperature & Precipitation Data

Environment Canada collects climate data from various stations throughout the province of Nova Scotia. Precipitation and temperature data were available for the years between 1981 to 2010 from the Halifax Internation Airport, located approximately 17 km to the south (Climate ID 8202250) of the proposed subdivision.

Information regarding the Temperature and Precipitation for this station is included in Appendix C and Summarized below.

Table 6.4 1981-2010 Station Data

	1981 – 2010												Total
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sept	Oct	Nov	Dec	(mm/yr)
Temperature (°C) [1]	-5.9	-5.2	-1.3	4.4	10	15.1	18.8	18.7	14.6	8.7	3.5	-2.4	-
Precipitation (mm/mon)	134.3	105.8	120.1	114.5	111.9	96.2	95.5	93.5	102	124.9	154.2	143.3	1396.2

* monthly average

6.5.2 Infiltration Factor

Water storage/infiltration has been estimated using the infiltration factors taken from Table 3.1 of the Ontario Ministry of Environment, Conservation and Parks (OMECP) Stormwater Management Planning and Design Manual (2003). Calculations using the OMECP Table 3.1 account for slope, soil types and vegetation cover when estimating the water holding capacity for an area. The slope, soil type, and vegetative cover within the catchment area were used to determine the appropriate infiltration factor shown on this table and included in (Appendix C).

Using the OMECP (2003), Table 3.1 table, an estimate for the Infiltration Factor was calculated assuming a clay loam soil, moderately rooted crops and rolling land. The result of this calculation is shown in the table below.

Table 6.5 Infiltration Factor / Baseflow Recharge

Precipitation (mm/yr)	Land Area (ha)	Infiltration Factor	Amount Available for Baseflow/Recharge (m^3/yr)
1396	87	0.19	230,759

Note, the remainder of the rainfall either evaporates or occurs as overland flow.

7.0 AQUIFER POTENTIAL

7.1 Lot Water Balance Calculation

A simplified water balance calculation can be used to estimate whether or not the available groundwater on each lot will meet the target water volume of 1,350 L/day. Equation B.4 of the NS Subdivision guidelines (NSE, 2011) can be employed to obtain the desired information.

$$Q_{lot} = I\ A_{lot}\ E_{use} / 365\ days$$

Where: Q_{lot} = Available groundwater from each lot (L/day)
I = Groundwater recharge rate (mm/year) (19%)
A_{lot} = Area of the lot that contributes to recharge, excludes impermeable areas (m^2) (assume 65%)
E_{use} = Percentage of recharge reserved for baseflow and ecological support (50%)

Use of this equation provides:

$$Q_{lot} = \frac{(1396\ x\ 0.19\ mm/yr)\ x\ (425\ x\ 0.65\ m^2)\ x\ 0.5}{365\ days}$$

= 100 L/day

While this value is less than the required 1350 L/day, this equation is based solely on the surface area of the lot that is available for recharge and does not take into account the properties of the underlying aquifer(s) or water storage within the well bore. Consequently, should the result of this equation be less than the target volume that does not mean there is insufficient water available to meet the needs of a normal, residential home.

7.2 Safe Well Yield Calculation

NSE recommends determination of a 20 year, well yield calculation to estimate the long-term safe pumping rate for a well using the equation by Farvolden (1959):

$$Q_{20} = 0.683T\ H_A\ S_f$$

Where: Q_{20} = 20 year safe pumping rate for the well (m3/day)
T = Transmissivity (m2/day)
S_f = Safety factor = 0.7 (no units)
H_A = Available head (m)

Using data contained within the NS Pump Test database Q20 was determined

$$Q_{20} = 0.683\ x\ 6.1 m^2/day\ x\ 27.9\ m\ x\ 0.7$$

= 81.4 m^3/day

This value roughly corresponds to the information contained within the pump test database which indicates a median value of approximately 76 m^3/day for the 5 wells that were tested in the Windsor Formation (Appendix B).

7.3 Well Interference

In a subdivision with a large number of closely-spaced water wells there is potential for well interference to occur. This refers to the cumulative pumping effects from all wells in the subdivision and can result in significant lowering of groundwater levels. A Level 1 Assessment requires an estimate of drawdown with distance from both a single active well and the cumulative drawdown resulting from numerous wells.

The Theis equation can be used for this purpose and takes the following form:

$$s = Q(W(u))/4\pi T \quad u = r2S / 4Tt$$

Where: s = Drawdown at a given distance "r" from the pumping well for time "t" after pumping begins (m)
Q = Pumping rate (m_3/day)
W(u) = Well function of "u"
u = Variable of integration (no units)
T = Transmissivity (m_2/day)
r = Radial distance from the center of the pumping well (m)
S = Storativity (no units)
t = Time (days)

Note: the solution provided is considered to be conservative and the equation does not consider aquifer recharge, nor does it consider borehole storage, which are important factors when considering the viability of a potable well. Although the underlying assumptions of the Theis Equation are not strictly met, the results obtained are still considered a reasonable approximation.

The following information, obtain from the pump test database was used to an estimate of the approximate area of influence for wells constructed within the boundaries of the proposed subdivision.

Transmissivity = 17.2 m^2/day
Storativity = 4.52E-04
Pumping Rate = 1350 L/day for 365 days

Additionally, the following information was considered
Maximum Radial Distance from Well = 500m
All wells are drilled to the same depth

Table 7.1 Drawdown vs. Distance - Calculated

Radial Distance to Centre of Subdivision (m)	Number of Wells Located at Specified Radial Distance	Predicted Drawdown Caused by a Single Well (m)	Drawdown Caused By All Wells at Specified Radial Distance (m)
0.076	1 (proposed)	0.55	0.6
70	14 (4 + 10 proposed)	0.21	2.9
100	3	0.19	0.6
200	6	0.16	1.0
300	10	0.14	1.4
400	10	0.13	1.3
500	11	0.12	1.3
Total	**55**		**9.0**

Assuming the following:

- Casing depth of 12m
- Static Water Level of 4m
- Pump set 2m from bottom
- Well depth 24m
- Available Drawdown of (24m-4m -2m) = 18m

The NS Subdivision Development guidance document (2011) recommends the total predicted drawdown for the subdivision not exceed 50% of the available drawdown in each well. With an available drawdown of 18m and a predicted drawdown of 9m, this criteria is met.

The NS Pump Test Database reveals a well drilled to a depth of 62m in this area has continued to encounter the Windsor Group, producing an available drawdown in excess of 46m. This information would suggest deeper wells are possible in the area of the development.

Wells that extend roughly 30m below ground surface could potentially tap into and draw water from, the nearby Shubenacadie River which lies approximately 300m to the east and has its source at the Shubenacadie Grand Lake near Enfield. Once the drawdown from a well encounters this boundary, it acts as a constant head source, potentially negating any further decline within the well bore.

7.4 Water Withdrawal

Information regarding the aquifer(s) recharge and Specific Storage can be used to estimate the capacity of the underlying aquifer to sustain the proposed development. This is based upon the storage capacity of the Watering Brook and Green Oak Formations, surface infiltration, the presence of 45 residential dwellings and assumed water usage of 1,350 L/day as required per dwelling.

Table 7.2 Aquifer Potential

Catchment Area (ha)	Specific Storage (m^3)	Potential Infiltration (Recharge m^3/yr)	Ecological Use [1] (50% of Recharge)	No. Dwellings	Water [2] Withdrawal (m^3/yr)	Net Surplus (m^3/yr)
87	439,719	230,759	115,379	55	27,101	203,658

1 – groundwater that helps maintain ecological habitats by discharging as baseflow to surface bodies

2 – assumes a water allocation of 1,350 L/day/home

These calculations indicate the potential recharge within the catchment area exceed the volume removed by the homes over a one year period. Note, this assumes the potable wells are located within the boundary of the catchment area identified in Figure 6 and an aquifer thickness of 12 m (well depth-casing length=12m).

8.0 WATER QUALITY & USE

Groundwater in this area is considered potable with onsite septic facilities while local bodies of water consist of marsh and the nearby Shubenacadie River which support recreational activities.

The bedrock aquifer within the Windsor Group, and in particular the Green Oaks Formation, is considered the source of potable water in this area. Wells drilled into this Formation, and the Windsor Group in general, are typically hard to very hard with moderate alkalinity, a pH slightly above neutral, and moderate to high, total dissolved solids (TDS). This includes sodium, chloride (both derived from halite) and sulphate (derived from gypsum and anhydrite). Values for iron and manganese are commonly high and may exceed the aesthetic values. However, manganese is not expected to surpass the 2019, health based guideline of 120 µg/L. The presence of these elements/minerals can result in water with an objectionable taste and colour. In addition, although, not as common, fertilizers (including manure) and pesticides, employed on agricultural lands, can impact groundwater quality.

Conventional treatment is available for iron, manganese, and hardness using individual household systems. The most common treatment method for hardness is water softening provided by ion exchange, which replaces hardness-causing ions with sodium or potassium, depending on whether the unit is backwashed/regenerated with sodium chloride (NaCl) or potassium chloride (KCl). This same process is commonly employed for both iron and manganese. Although arsenic and uranium are typically within the proposed guidelines, if desired, there are effective methods of treatment that include reverse osmosis, anion exchange, and distillation.

Prior to installing a treatment system, it is recommended a water sample be collected from the well for submission to an accredited lab for analysis of general chemistry, metal content and coliform. This would allow for a targeted approach with respect to treatment and consequently, better outcomes.

9.0 CONCLUSIONS

The proposed development is located at Milford Station and is comprised of 11 lots with a median lot size of 425 m^2. Information provided within the NS 2011 Guidelines for development of a subdivision indicates a proposed development with 10 to 25 lots requires a Level 1 groundwater assessment while the Milford Municipal Planning Strategy requires consideration of well interference for subdivisions where more than four residential lots are to be created.

In the area of interest, the surficial geology is formed of ground moraines and glaciofluvial deposits which are characterized by silty-clay matrix roughly 12m in thickness. This is underlain by the bedrock of the Windsor Group which is comprised of marine and evaporite deposits. Within this Group, it is the Green Oaks Formation that is primarily of interest and is the prime source of potable water, with a decrease in water quality in wells that extend below this formation.

The Lot Water Balance Calculation indicates there is insufficient area within the lot to serve as an adequate recharge for the underlying aquifer. However, taking into consideration the current agricultural usage of the adjacent farmland this is not considered to be of concern.

Use of the Farvolden (1959) Equation suggests a 20 year safe yield (Q_{20}) of 81.4 m^3/day, this is similar to information obtained from the NS Pump Test Database, which suggests a Q_{20} of 76 m^3/day for wells drilled into the Windsor Group.

As wells within close proximity can interfere resulting in an increase in drawdown at a well head, calculations were undertaken to predict the viability of the underlying aquifers as a source of potable water for the proposed development. The results suggest a drawdown of 0.12m at a distance of 500m from an active well within the development, and a combined drawdown of 6.9m when all existing wells within a 500m radius are taken into account. Note these results are considered to be very conservative, as they do not take into account surface infiltration/aquifer recharge or water storage within the well bore, factors that are important to consider when determining the viability of the development. A review of this information suggests, the volume of recharge within this area will be greater that the volume extracted by the homes.

Wells that extend below 28m could potentially tap into and draw water from, the nearby Shubenacadie River which lies approximately 300m to the east and has its source at the Shubenacadie Grand Lake near Enfield. Once drawdown from a well encounters this boundary it acts as a constant head source, potentially negating any further decline within the well bore.

Current information indicates potable water within this area will require treatment. Water quality is expected to be hard to extremely hard, as a result of high concentrations of calcium sulphate, possibly with high levels of iron, manganese and TDS.

Although the Well Log database suggests a median well depth of 24m, with one well drilled to 28m in the immediate vicinity, the Pump Test database indicates greater depths are possible which would provide additional available drawdown and storage, at each well head. Consequently, greater depth should be considered to increase available storage and minimize interference with other wells.

A review of the current data would suggest there is sufficient potable water available to support the proposed development. Note, as the water supply is provided by localized fractures, this should be confirmed at the time of well installation.

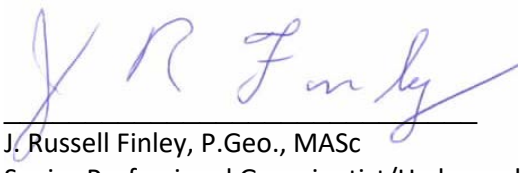
10.0 LIMITATIONS

HERAA trusts that this report meets your current requirements. This report was prepared for the exclusive use of James Kerr, Edward Kerr & Katherine Manuel, and the Province of Nova Scotia. Any use which a third party makes of this report, or any reliance on or decisions made based on it, are at the sole risk of the parties. Furthermore, this report should not be construed as legal advice.

It is noted that current environmental legislation, permits, guidelines, and regulations are subject to change, and such changes, when put into effect, could alter the conclusions contained herein. The findings and conclusions of this report are valid only as of the date of this report. In the event new information is discovered that may require that the results herein be re-evaluated, HERAA should be allowed to re-assess the conclusions of this report, and to provide amendments if necessary.

Please contact the undersigned should any questions arise concerning this report, or if we may be of further assistance.

11.0 SIGNATURE



March 25, 2024

J. Russell Finley, P.Geo., MASc
Senior Professional Geoscientist/Hydrogeologist
HERAA Consulting Inc.

Date:

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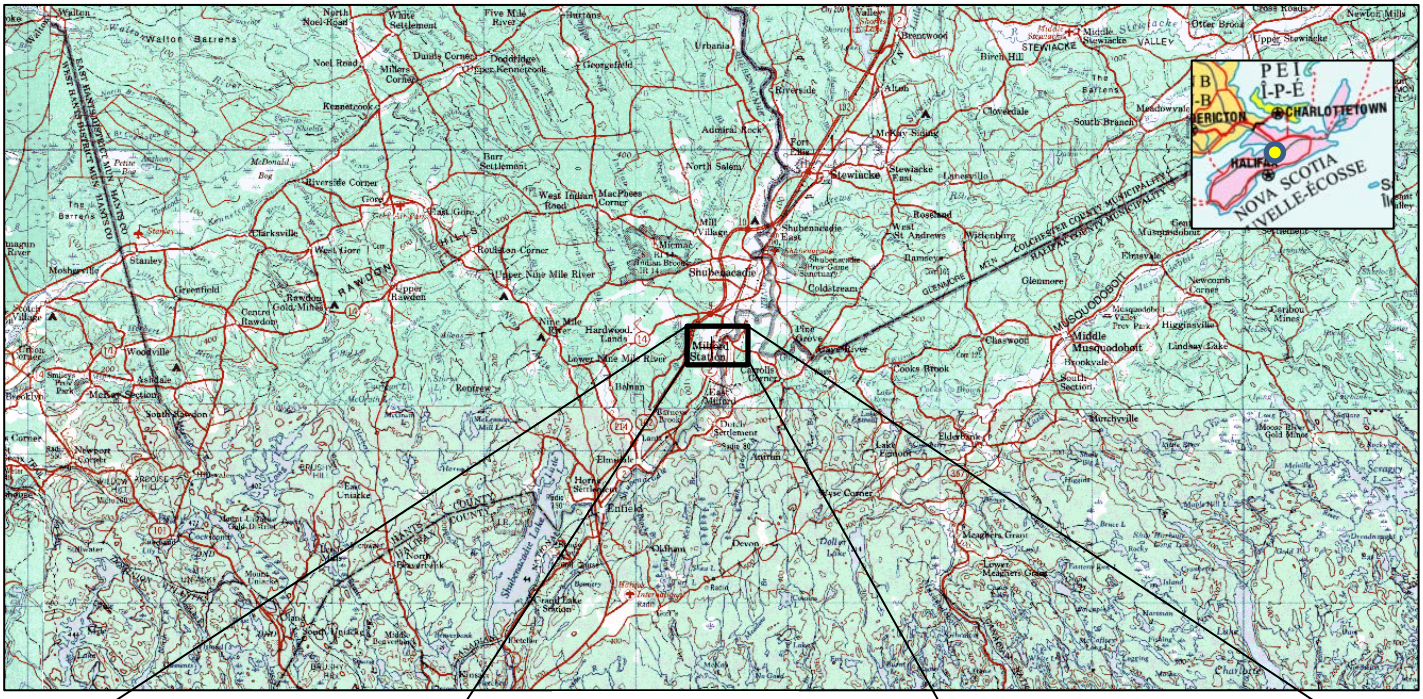

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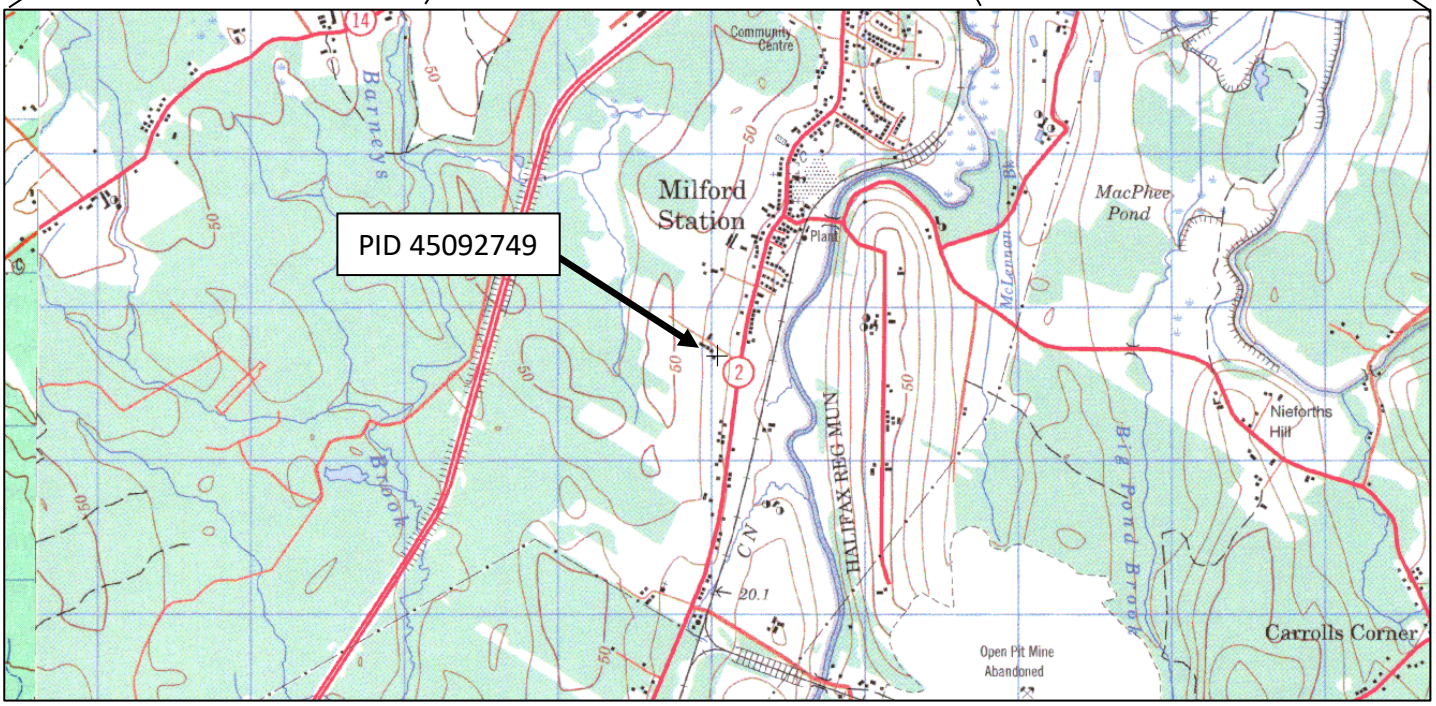

1:50,000

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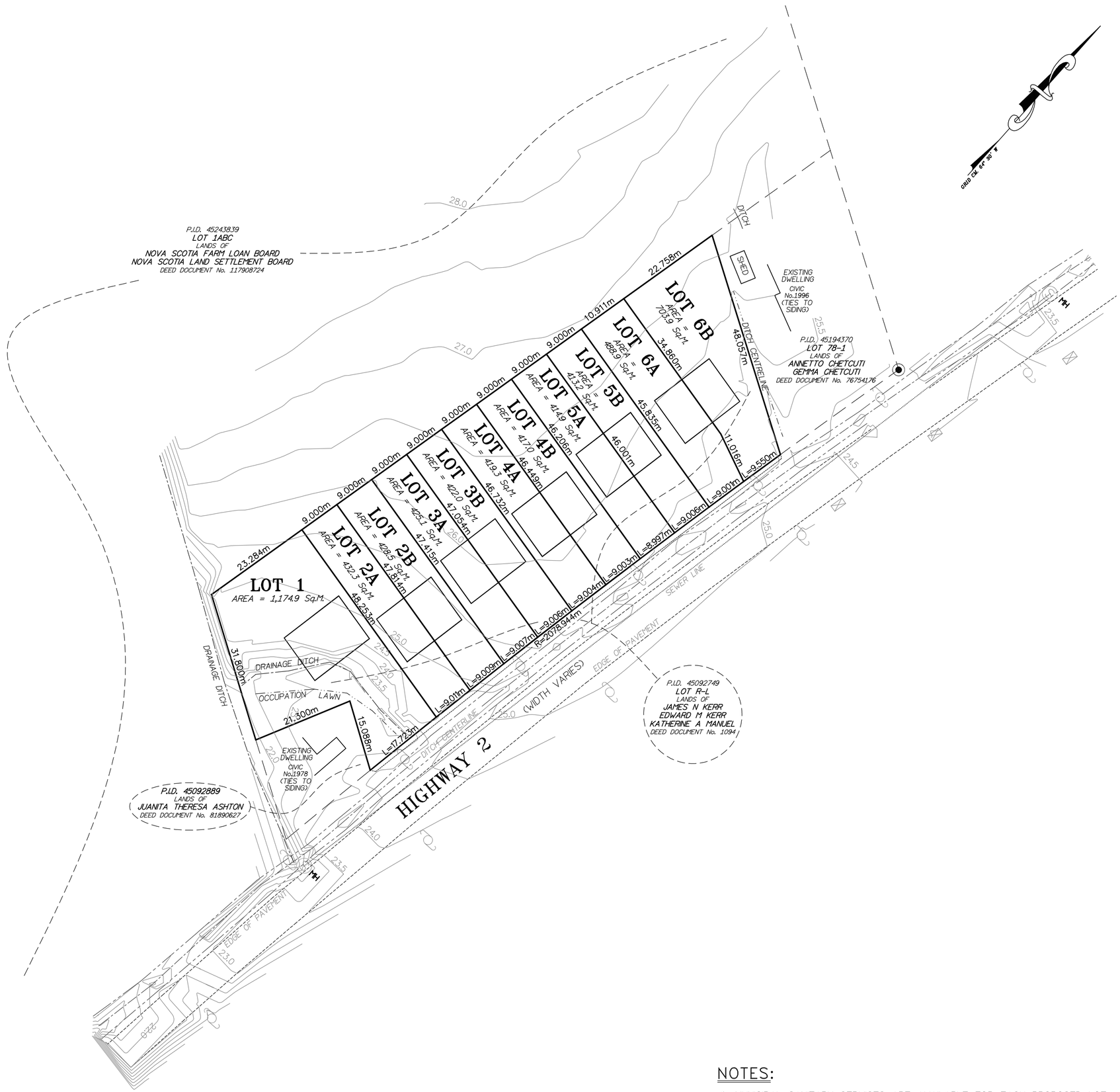
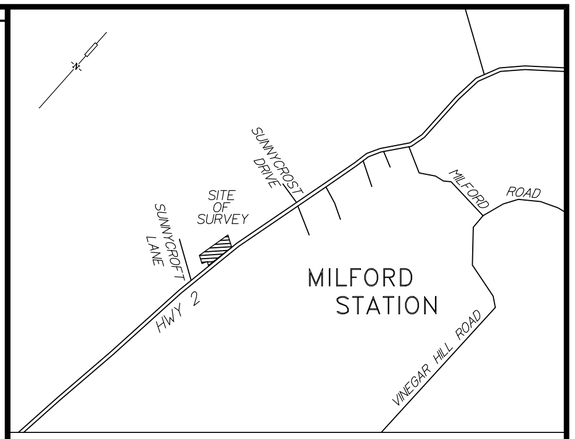
HERAA Consulting Inc.	**FIGURE TITLE:** Topographic & Site Location Map	PROJECT: 17-1023	DATE: February, 2024
	SITE LOCATION: Milford Station, NS	DRAWN BY: JRF	CHECKED BY: JRF
	PROJECT: Level 1 Groundwater Assessment	SCALE: As Shown	FIGURE: **Figure 1**
	CLIENT: James Kerr, Edward Kerr & Katherine Manuel		

APPENDIX A

PROPOSED SUBDIVISION – SURVEY PLAN





NOTES:

1. MUNICIPAL SANITARY SERVICES ARE AVAILABLE FOR EACH PROPOSED LOT

LEGEND:

LANDS DEALT WITH BY THIS SURVEY	
NOVA SCOTIA CO-ORDINATE MONUMENT	N.S.C.M.
SURVEY MARKER	S.M.
ROCK POST	R.P.
IRON BAR	I.B.
IRON PIPE	I.P.
FOUND, WITNESS , NOT TO SCALE	Fd., Wit. (N.T.S.)
PLAN, DEED	(P), (D)
CALCULATED FROM FIELD MEASUREMENTS	calc.
ORDINARY HIGH WATER MARK	O.H.W.M.
TIE LINE , TOTAL	(T/L) (T)
BEGINNING OF CURVE, END OF CURVE	B.C., E.C.
POINT OF COMMON CURVATURE, POINT OF REVERSE CURVATURE	P.C.C., P.R.C.
RADIUS, ARC, CHORD	R, A, C
BUILDING	
POWER POLE, MANHOLE	P.P., M.H.
FIRE HYDRANT, CATCH BASIN	F.H. C.B.

GNSS SURVEY TYPE:	NRTK	SOURCE:	CanNet
COORDINATE SYSTEM INFORMATION			
HORIZONTAL DATUM:	NAD83 (CSRS)	EPOCH:	2010.0
VERTICAL DATUM:	CGVD2013	CALCULATED OFFSET BETWEEN CGVD28/CGVD2013	
M.T.M. ZONE 5 CENTRAL MERIDIAN 64° 30'			

PRELIMINARY PLAN OF SUBDIVISION OF

LOTS 1, 2A, 2B, 3A, 3B 4A, 4B, 5A, 5B, 6A AND 6B

BEING A SUBDIVISION OF

P.I.D. 45092749 (LOT R-L),

LANDS CONVEYED TO

JAMES N KERR,
EDWARD M KERR,
AND
KATHERINE A MANUEL

HIGHWAY 2, MILFORD STATION,
HANTS COUNTY, NOVA SCOTIA

THE ASSOCIATION OF NOVA SCOTIA LAND SURVEYORS
T. GIOVANNETTI
598
MEMBER

DATE: AUG 28, 2023

CIVTECH ENGINEERING & SURVEYING LIMITED
P.O. Box 3237, D.E.P.S., DARTMOUTH
NOVA SCOTIA, B2W 5G2, 434-4600

GRAPHIC SCALE

12 0 6 12 24 36 48 60

1 : 600

No.	REVISION/REMARKS	DATE	SCALE:
			1:600
DRAWN BY: D.E. & K.S.	CHECKED BY: T. GIOVANNETTI		23172PRE

APPENDIX B

Well Logs Database – Local Summary
Pump (Aquifer) Test Database – Local Summary
Storativity Values – Windsor Group
Well Logs – Milford Area

Residential Wells - Summary

	DEPTH	CASING	BEDROCK	OVERBURDEN	STATIC	YIELD_LPM	IGPM
Average	22.4	14.5	7.2	12.1	4.4	79.7	17.5
Median	24.2	12.5	7.9	12.3	3.7	45.4	10.0
Max	36.5	32.9	12.8	24.7	12.2	340.5	74.9
Min	11.0	6.1	2.1	3.0	0.0	18.2	4.0

Residential Wells

WELLNUM	ADDRESS	COMMUNITY	COUNTY	DEPTH	CASING	BEDROCK	OVERBURDEN	STATIC	YIELD_LPM
12649	1978 HIGHWAY #2	MILFORD STATION	HANTS	24.97	11.57	7.92	17.05	1.83	340.5
60494		MILFORD STATION	HANTS	22.84					
71794	8 EDWARD KERR DRIVE, MILFORD	MILFORD STATION	HANTS	10.96	8.83	7.92	3.04	-0.03	68.1
140676	2054 HIGHWAY #2, MILFORD	MILFORD STATION	HANTS	27.4	20.1	12.79	14.61	5.48	136.2
661107		MILFORD STATION	HANTS		10.66	2.13			
792397		MILFORD STATION	HANTS	36.54	32.89				90.8
810295		MILFORD STATION	HANTS	25.27	16.75			2.74	68.1
820078		MILFORD STATION	HANTS	24.97	19.49			7	18.16
881051		MILFORD STATION	HANTS	12.79	8.83	7.92	4.87	4.57	27.24
881058		MILFORD STATION	HANTS	15.83	13.4	8.22	7.61	1.52	45.4
881066		MILFORD STATION	HANTS	23.45	19.79	10.66	12.79	12.18	36.32
932155		MILFORD STATION	HANTS	16.14	6.09	4.26	11.88		27.24
961014	1953 HIGHWAY #2	MILFORD STATION	HANTS	28.01	6.09	3.35	24.66		18.16

Residential Wells

WELLNUM	ADDRESS	ELEVATION	TYPE	WATERUSE	EASTING	NORTHING	Date_Inst
12649	1978 HIGHWAY #2	26	DRILLED	Domestic	465199	4986829	2001-07-17
60494		38	DRILLED	Public (not municipal)	465049	4987212	2006-04-26
71794	8 EDWARD KERR DRIVE, MILFORD	21	DRILLED	Domestic	465380	4987137	2007-09-05
140676	2054 HIGHWAY #2, MILFORD	28	DRILLED	Domestic	465314	4987376	2014-09-12
661107		22	DRILLED		465357	4987242	1966-05-23
792397		53	DRILLED	Domestic	464719	4986905	1979-07-21
810295		53	DRILLED	Domestic	464719	4986905	1981-05-13
820078		53	DRILLED	Domestic	464719	4986905	1982-03-05
881051		25	DRILLED	Domestic	465358	4987410	1988-08-02
881058		26	DRILLED	Domestic	465287	4987255	1988-08-31
881066		27	DRILLED	Domestic	465170	4986830	1988-10-06
932155		27	DRILLED	Domestic	465223	4986920	1993-05-25
961014	1953 HIGHWAY #2	25	DRILLED	Domestic	465234	4986766	1996-09-05

Pump (Aquifer) Test Summary

	CasingD_mm	Depth_m	Static_m	Avail_DD_m	Max_DD_m	K_md	Tapp_m2d	Q20_Lm
Average	162.6	47.2	10.1	32.0	13.3	0.6	17.6	121.7
Maximum	203.2	62.0	26.5	46.7	18.7	1.7	64.0	290.9
Minimum	152.4	27.7	5.3	18.3	8.9	0.0	2.4	19.1
Median	152.4	51.8	5.9	27.9	11.5	0.2	6.1	52.8
geometric mean	161.4	45.3	8.0	30.2	12.8	0.3	8.0	75.5

Pump Test Data

Community	Test_for	Test_start	Test_end	GW_Region	CasingD_mm	Depth_m	Static_m
Carrolls Corner	Carrolls Corner Community Centre, Halifax Regional Municipality	2006-01-19	2006-01-20	Carbonate/Evaporite	152.4	56.39	5.31
Milford Station	School, Municipality of the County of Colchester	1973-03-18	1973-03-21	Carbonate/Evaporite	152.4	51.82	5.43
Milford Station	NS Housing Commission/Housing Authority Project	1989-12-28	1989-12-31	Carbonate/Evaporite	152.4	27.74	5.87
Milford Station	Milford Station Middle School		1997-08-12	Carbonate/Evaporite	203.2	62	26.5
Milford Station	Chignecto Central Regional School Board	2009-07-30	2009-07-31	Carbonate/Evaporite	152.4	37.8	7.3

Pump Test Data

Community	Test_for	Avail_DD_m	Max_DD_m	K_md	Tapp_m2d	Q20_Lm
Carrolls Corner	Carrolls Corner Community Centre, Halifax Regional Municipality	46.65	8.93	4.70E-02	2.4	52.8
Milford Station	School, Municipality of the County of Colchester	42.67	16.15	2.87E-01	12.68	204.5
Milford Station	NS Housing Commission/Housing Authority Project	18.29	11		2.77	19.1
Milford Station	Milford Station Middle School	27.9	11.5	1.73E+00	64	290.9
Milford Station	Chignecto Central Regional School Board	24.7	18.72	1.99E-01	6.1	41

Abbreviations:

Geology HU = Hydrostratigraphic Unit
Depth (m) = Well depth, metres
Static (m) = Depth to static water level, metres
Pump Setting (m) = Depth to pump, metres
Average Rate (m3/D) = Average pumping rate, m3/d
Available Draw Down (m) = Available drawdown, metres
Max Draw Down (m) = Maximum drawdown, metres
Total Recovery (m) = Total water level recovery, metres
Recovery = Recovery time, minutes
Tapp (m2/d) = Apparent transmissivity, m2/d
K (m/d) = Hydraulic conductivity, m/d
SC (m2/d) = Specific capacity, m2/d
Q20 (m3/d) = Potential long-term pumping well yield, m3/d
Q20 (l/min) = Potential long-term pumping well yield, Litres per minute
Storativity = Aquifer storage coefficient

Storativity Values - Windsor Group

Well_ID	Community	Test_for	Geology_HU	GW_Region	Depth_m	CasingD_mm	Static_m	K_md	Tapp_m2d	Q20_m3d	**Storativity**
Well #2	Brookfield	Canada Cement Company Plant 6 (Well #2)	WI	Carbonate /Evaporite	123.44	152.40				65.45	3.20E-04
PW1	Brookfield	LaFarge Canada Inc	WI	Carbonate /Evaporite	48.77	203.20			85.00		5.00E-04
OW1	Brookfield	LaFarge Canada Inc.	WI	Carbonate /Evaporite	27.44	152.40	3.49				3.10E-04
CLN-P1	Bucklaw	Municipality of the County of Victoria (BH3)	WI	Carbonate /Evaporite	56.39	152.40	6.48	1.34E+00	67.11	196.36	1.00E-03
Test Hole	Plymouth	Village of Plymouth, Pictou Co. District Planning Commission	WI	Carbonate /Evaporite	105.77	152.40	17.16	8.93E-02	7.46	327.27	1.28E-04

Average	72.4	162.56	9.04	7.15E-01	53.19	196.36	4.52E-04
Maximum	123.4	203.20	17.16	1.34E+00	85.00	327.27	1.00E-03
Minimum	27.4	152.40	3.49	8.93E-02	7.46	65.45	1.28E-04
Median	56.4	152.40	7.76	7.15E-01	60.15	196.36	3.20E-04

Groundwater

Well Log Record

Well Log Record: # 012649

Well Number: 012649
Type: DRILLED
Date Well Completed (mm-dd-yyyy): 7-17-2001

Go Back

Well Owner/Contractor and Location

Well Drilled for: DOMINIC MANCINI
or Contractor/Builder/Consultant: n/a

Civic Address of Well: 1978 HIGHWAY #2
Lot #: n/a
Subdivision: n/a
County: HANTS
Postal Code: n/a
Nearest Community in Atlas/Map Book: MILFORD STATION

Certified Well Contractor

Driller Name: JOHNSON, GREGORY
Certificate No: 6
Company: HUB WELL DRILLING LTD.

Well Status / Water Use

Final Status of Well: DRILL/DIG NEW & ABANDON OLD
Water Use: Domestic
Method of Drilling: Rotary

Well Location

Nova Scotia Atlas or Map Book Reference

Atlas or Map Book: MAP
Map Page No.: 24
Reference Letter: B
Reference Number: 1
Roamer Letter: K
Roamer Number: 11

NTS Map Reference

Map Sheet: n/a
Reference Map: n/a
Tract No.: n/a
Claim: n/a

GPS (WGS84 UTM)

Northing (m): 4986829
Easting (m): 465199
Property (PID): 45092889
Well Location Sketch Available: Yes

Stratigraphy Log

Geology	Colour	Description	Lithology	Water Found
From (depth in ft): 0 to: 26				
Primary Geology	Reddish Brown	n/a	CLAY & BOULDERS	n/a
Secondary Geology	n/a	n/a	n/a	
From (depth in ft): 26 to: 37				
Primary Geology	Grayish Black	Fractured	LIMESTONE	n/a
Secondary Geology	n/a	n/a	n/a	
From (depth in ft): 37 to: 82				
Primary Geology	Grayish Black	See Comments	LIMESTONE	n/a
Secondary Geology	n/a	n/a	n/a	

Well Construction Information

Total Depth Below Surface (ft): 82
Depth to Bedrock (ft): 26
Water Bearing Fractures Encountered at (ft): 40, 68, 80
Outer Well Casing: From (ft): n/a To: 38
Diameter (in): 6
Length of Casing Above Ground (ft): 1 and (in): n/a
Driveshoe Make: unknown

Water Yield

Estimated Yield (igpm): n/a
Method: AIR LIFT
Rate (igpm): 75
Duration (hrs): 1
Depth to Water at end of Test (ft): 82
Total Drawdown (ft): n/a
Water Level Recovered to (ft): 8
Recovery Time (hrs): n/a
Depth to Static Level (ft): 6
Overflow: n/a

Comments

SEALED OFF OLD 4" WELL WITH BENTONITE GROUT (39 FT DEEP). BOTTOM MATERIAL MEDIUM HARD-HARD LIMESTONE. WB FRACTURES 40, 68-80 FT.

Go Back

Groundwater

Well Log Record

Well Log Record: # 060494

Well Number: 060494
Type: DRILLED
Date Well Completed (mm-dd-yyyy): 4-26-2006

Go Back

Well Owner/Contractor and Location

Well Drilled for: n/a
or Contractor/Builder/Consultant: ATLANTIC INDUSTRIAL SERVICES

Civic Address of Well: n/a
Lot #: n/a
Subdivision: n/a
County: HANTS
Postal Code: n/a
Nearest Community in Atlas/Map Book: MILFORD STATION

Certified Well Contractor

Driller Name: JACOBS, LARRY
Certificate No: 734
Company: BLUENOSE WELL DRILLING LTD.

Well Status / Water Use

Final Status of Well: Abandoned, Dry
Water Use: Public (not municipal)
Method of Drilling: n/a

Well Location

Nova Scotia Atlas or Map Book Reference

Atlas or Map Book: ATLAS
Map Page No.: 49
Reference Letter: V
Reference Number: 5
Roamer Letter: E
Roamer Number: 2

NTS Map Reference

Map Sheet: n/a
Reference Map: n/a
Tract No.: n/a
Claim: n/a

GPS (WGS84 UTM)

Northing (m): 4987212
Easting (m): 465049
Property (PID): n/a
Well Location Sketch Available: Yes

Stratigraphy Log

No Lithology data available.

Well Construction Information

Total Depth Below Surface (ft): 75
Depth to Bedrock (ft): n/a
Water Bearing Fractures Encountered at (ft): n/a
Outer Well Casing: From (ft): 0 To: n/a
Diameter (in): 6
Length of Casing Above Ground (ft): 1 and (in): n/a
Driveshoe Make: n/a

Water Yield

Estimated Yield (igpm): n/a
Method: n/a
Rate (igpm): n/a
Duration (hrs): n/a
Depth to Water at end of Test (ft): n/a
Total Drawdown (ft): n/a
Water Level Recovered to (ft): n/a
Recovery Time (hrs): n/a
Depth to Static Level (ft): n/a
Overflow: n/a

Comments

PUMP GROUT FROM BOTTOM TO DRILLED WELL, BACK TO SURFACE. CUT OFF 6 INCH CASING BELOW SURFACE. BUILDING REMOVE OF PROPERTY.

Go Back

Groundwater

Well Log Record

Well Log Record: # 071794

Well Number: 071794
Type: DRILLED
Date Well Completed (mm-dd-yyyy): 9-5-2007

Go Back

Well Owner/Contractor and Location

Well Drilled for: LISA BELAIR
or Contractor/Builder/Consultant: n/a

Civic Address of Well: 8 EDWARD KERR DRIVE, MILFORD
Lot #: n/a
Subdivision: n/a
County: HANTS
Postal Code: n/a
Nearest Community in Atlas/Map Book: MILFORD STATION

Certified Well Contractor

Driller Name: JOHNSON, GREGORY
Certificate No: 6
Company: HUB WELL DRILLING LTD.

Well Status / Water Use

Final Status of Well: Water Supply Well
Water Use: Domestic
Method of Drilling: Rotary

Well Location

Nova Scotia Atlas or Map Book Reference

Atlas or Map Book: ATLAS
Map Page No.: 49
Reference Letter: V
Reference Number: 5
Roamer Letter: E
Roamer Number: 2

NTS Map Reference

Map Sheet: n/a
Reference Map: n/a
Tract No.: n/a
Claim: n/a

GPS (WGS84 UTM)

Northing (m): 4987137
Easting (m): 465380
Property (PID): 45092707
Well Location Sketch Available: Yes

Stratigraphy Log

Geology	Colour	Description	Lithology	Water Found
From (depth in ft): 0 to: 26				
Primary Geology	Brown	n/a	CLAY & STONES	n/a
Secondary Geology	n/a	n/a	n/a	
From (depth in ft): 26 to: 36				
Primary Geology	Black	n/a	LIMESTONE	n/a
Secondary Geology	n/a	n/a	n/a	

Well Construction Information

Total Depth Below Surface (ft): 36
Depth to Bedrock (ft): 26
Water Bearing Fractures Encountered at (ft): 26, 29, 34
Outer Well Casing: From (ft): 0 To: 29
Diameter (in): 8
Length of Casing Above Ground (ft): 1 and (in): 8
Driveshoe Make: other

Water Yield

Estimated Yield (igpm): n/a
Method: AIR LIFT
Rate (igpm): 15
Duration (hrs): 1
Depth to Water at end of Test (ft): 36
Total Drawdown (ft): n/a
Water Level Recovered to (ft): -0.1

Recovery Time (hrs): n/a
Depth to Static Level (ft): -0.1
Overflow: Yes

Comments

DRIVE SHOE ROTARY HEAVY. DIST TO ON & OFF-SITE SEPTIC NONE. WELL LOC SKETCH: WELL NEAR GARAGE.

Go Back

Groundwater

Well Log Record

Well Log Record: # 140676

Well Number: 140676
Type: DRILLED
Date Well Completed (mm-dd-yyyy): 9-12-2014

Go Back

Well Owner/Contractor and Location

Well Drilled for: JOSHUA MARTIN
or Contractor/Builder/Consultant: n/a

Civic Address of Well: 2054 HIGHWAY #2, MILFORD
Lot #: n/a
Subdivision: n/a
County: HANTS
Postal Code: n/a
Nearest Community in Atlas/Map Book: MILFORD STATION

Certified Well Contractor

Driller Name: JOHNSON, BRIAN
Certificate No: 882
Company: HUB WELL DRILLING LTD.

Well Status / Water Use

Final Status of Well: Water Supply Well
Water Use: Domestic
Method of Drilling: Rotary

Well Location

Nova Scotia Atlas or Map Book Reference

Atlas or Map Book: ATLAS
Map Page No.: 49
Reference Letter: V
Reference Number: 5
Roamer Letter: E
Roamer Number: 2

NTS Map Reference

Map Sheet: n/a
Reference Map: n/a
Tract No.: n/a
Claim: n/a

GPS (WGS84 UTM)

Northing (m): 4987376
Easting (m): 465314
Property (PID): 45092582
Well Location Sketch Available: Yes

Stratigraphy Log

Geology	Colour	Description	Lithology	Water Found
From (depth in ft): 0 to: 42				
Primary Geology	Brown	n/a	CLAY & STONES	n/a
Secondary Geology	n/a	n/a	n/a	
From (depth in ft): 42 to: 63				
Primary Geology	Gray	Soft	SHALE	n/a
Secondary Geology	Gray	Soft	LIMESTONE	
From (depth in ft): 63 to: 86				
Primary Geology	Gray	Hard	LIMESTONE	n/a
Secondary Geology	n/a	n/a	n/a	
From (depth in ft): 86 to: 90				
Primary Geology	Gray	MEDIUM	SHALE	n/a
Secondary Geology	n/a	n/a	n/a	

Well Construction Information

Total Depth Below Surface (ft): 90
Depth to Bedrock (ft): 42
Water Bearing Fractures Encountered at (ft): 71, 75, 83
Outer Well Casing: From (ft): 0 To: 66

Diameter (in): 6
Length of Casing Above Ground (ft): 1 and (in): 4
Driveshoe Make: rotary - unspecified

Water Yield

Estimated Yield (igpm): n/a
Method: AIR LIFT
Rate (igpm): 30
Duration (hrs): 1
Depth to Water at end of Test (ft): 90
Total Drawdown (ft): n/a
Water Level Recovered to (ft): 18
Recovery Time (hrs): n/a
Depth to Static Level (ft): 18
Overflow: n/a

Comments

DIST TO ON & OFF-SITE SEPTIC: NONE; TO WATERCOURSE N/A.

Go Back

Groundwater

Well Log Record

Well Log Record: # 661107

Well Number: 661107
Type: DRILLED
Date Well Completed (mm-dd-yyyy): 5-23-1966

Go Back

Well Owner/Contractor and Location

Well Drilled for: MURRAY RANKIN
or Contractor/Builder/Consultant: n/a

Civic Address of Well: n/a
Lot #: n/a
Subdivision: n/a
County: HANTS
Postal Code: n/a
Nearest Community in Atlas/Map Book: MILFORD STATION

Certified Well Contractor

Driller Name: MESSERVEY, SAMUEL A.
Certificate No: 36
Company: MESSERVEY, SAMUEL A.

Well Status / Water Use

Final Status of Well: n/a
Water Use: n/a
Method of Drilling: Drilled

Well Location

Nova Scotia Atlas or Map Book Reference

Atlas or Map Book: MAP
Map Page No.: 24
Reference Letter: B
Reference Number: 1
Roamer Letter: L
Roamer Number: 9

NTS Map Reference

Map Sheet: n/a
Reference Map: n/a
Tract No.: n/a
Claim: n/a

GPS (WGS84 UTM)

Northing (m): 4987242
Easting (m): 465357
Property (PID): n/a
Well Location Sketch Available: n/a

Stratigraphy Log

Geology	Colour	Description	Lithology	Water Found
From (depth in ft): 0 to: 7				
Primary Geology	n/a	n/a	MUD	n/a
Secondary Geology	n/a	n/a	n/a	
From (depth in ft): 7 to: 35				
Primary Geology	n/a	n/a	SANDSTONE	n/a
Secondary Geology	n/a	n/a	n/a	

Well Construction Information

Total Depth Below Surface (ft): n/a
Depth to Bedrock (ft): 7
Water Bearing Fractures Encountered at (ft): n/a
Outer Well Casing: From (ft): 4 To: 35
Diameter (in): n/a
Length of Casing Above Ground (ft): n/a and (in): n/a
Driveshoe Make: unknown

Water Yield

Estimated Yield (igpm): n/a
Method: n/a
Rate (igpm): n/a
Duration (hrs): n/a
Depth to Water at end of Test (ft): n/a
Total Drawdown (ft): n/a
Water Level Recovered to (ft): n/a

Recovery Time (hrs): n/a
Depth to Static Level (ft): n/a
Overflow: n/a

Comments

n/a

Go Back

Groundwater

Well Log Record

Well Log Record: # 792397

Well Number: 792397
Type: DRILLED
Date Well Completed (mm-dd-yyyy): 7-21-1979

Go Back

Well Owner/Contractor and Location

Well Drilled for: ROBERT STILLMAN
or Contractor/Builder/Consultant: n/a

Civic Address of Well: n/a
Lot #: n/a
Subdivision: n/a
County: HANTS
Postal Code: n/a
Nearest Community in Atlas/Map Book: MILFORD STATION

Certified Well Contractor

Driller Name: STEEVES, GEORGE
Certificate No: 170
Company: CLEARWATER WELL DRILLING (1991) LTD.

Well Status / Water Use

Final Status of Well: Water Supply Well
Water Use: Domestic
Method of Drilling: n/a

Well Location

Nova Scotia Atlas or Map Book Reference

Atlas or Map Book: NTS
Map Page No.: n/a
Reference Letter: n/a
Reference Number: n/a
Roamer Letter: n/a
Roamer Number: n/a

NTS Map Reference

Map Sheet: 11E3
Reference Map: B
Tract No.: 34
Claim: n/a

GPS (WGS84 UTM)

Northing (m): 4986905
Easting (m): 464719
Property (PID): n/a
Well Location Sketch Available: n/a

Stratigraphy Log

Geology	Colour	Description	Lithology	Water Found
From (depth in ft): 0 to: 108				
Primary Geology	n/a	n/a	CLAY	n/a
Secondary Geology	n/a	n/a	UNKNOWN	
From (depth in ft): 108 to: 120				
Primary Geology	n/a	n/a	GRAVEL	n/a
Secondary Geology	n/a	n/a	UNKNOWN	

Well Construction Information

Total Depth Below Surface (ft): 120
Depth to Bedrock (ft): n/a
Water Bearing Fractures Encountered at (ft): 87, 120
Outer Well Casing: From (ft): n/a To: 108
Diameter (in): 6
Length of Casing Above Ground (ft): n/a and (in): n/a
Driveshoe Make: n/a

Water Yield

Estimated Yield (igpm): n/a
Method: AIR LIFT
Rate (igpm): 20
Duration (hrs): n/a
Depth to Water at end of Test (ft): n/a
Total Drawdown (ft): n/a
Water Level Recovered to (ft): n/a

Recovery Time (hrs): n/a
Depth to Static Level (ft): n/a
Overflow: n/a

Comments

n/a

Go Back

Groundwater

Well Log Record

Well Log Record: # 810295

Well Number: 810295
Type: DRILLED
Date Well Completed (mm-dd-yyyy): 5-13-1981

Go Back

Well Owner/Contractor and Location

Well Drilled for: TRACEY THIBEAU
or Contractor/Builder/Consultant: n/a

Civic Address of Well: n/a
Lot #: n/a
Subdivision: n/a
County: HANTS
Postal Code: n/a
Nearest Community in Atlas/Map Book: MILFORD STATION

Certified Well Contractor

Driller Name: JOHNSON, GREGORY
Certificate No: 6
Company: HUB WELL DRILLING LTD.

Well Status / Water Use

Final Status of Well: Water Supply Well
Water Use: Domestic
Method of Drilling: n/a

Well Location

Nova Scotia Atlas or Map Book Reference

Atlas or Map Book: NTS
Map Page No.: n/a
Reference Letter: n/a
Reference Number: n/a
Roamer Letter: n/a
Roamer Number: n/a

NTS Map Reference

Map Sheet: 11E3
Reference Map: B
Tract No.: 34
Claim: n/a

GPS (WGS84 UTM)

Northing (m): 4986905
Easting (m): 464719
Property (PID): n/a
Well Location Sketch Available: n/a

Stratigraphy Log

Geology	Colour	Description	Lithology	Water Found
From (depth in ft): 0 to: 30				
Primary Geology	n/a	n/a	CLAY	n/a
Secondary Geology	n/a	n/a	SILTSTONE	
From (depth in ft): 30 to: 51				
Primary Geology	n/a	n/a	SHALE	n/a
Secondary Geology	n/a	n/a	GYPSUM	
From (depth in ft): 51 to: 83				
Primary Geology	n/a	n/a	LIMESTONE	n/a
Secondary Geology	n/a	n/a	UNKNOWN	

Well Construction Information

Total Depth Below Surface (ft): 83
Depth to Bedrock (ft): n/a
Water Bearing Fractures Encountered at (ft): 20
Outer Well Casing: From (ft): n/a To: 55
Diameter (in): 5
Length of Casing Above Ground (ft): n/a and (in): n/a
Driveshoe Make: n/a

Water Yield

Estimated Yield (igpm): n/a
Method: AIR LIFT
Rate (igpm): 15
Duration (hrs): n/a
Depth to Water at end of Test (ft): n/a
Total Drawdown (ft): n/a
Water Level Recovered to (ft): n/a
Recovery Time (hrs): n/a
Depth to Static Level (ft): 9
Overflow: n/a

Comments

n/a

Go Back

Groundwater

Well Log Record

Well Log Record: # 820078

Well Number: 820078
Type: DRILLED
Date Well Completed (mm-dd-yyyy): 3-5-1982

Go Back

Well Owner/Contractor and Location

Well Drilled for: IRWIN FRASER
or Contractor/Builder/Consultant: n/a

Civic Address of Well: n/a
Lot #: n/a
Subdivision: n/a
County: HANTS
Postal Code: n/a
Nearest Community in Atlas/Map Book: MILFORD STATION

Certified Well Contractor

Driller Name: JOHNSON, GREGORY
Certificate No: 6
Company: HUB WELL DRILLING LTD.

Well Status / Water Use

Final Status of Well: Water Supply Well
Water Use: Domestic
Method of Drilling: n/a

Well Location

Nova Scotia Atlas or Map Book Reference

Atlas or Map Book: NTS
Map Page No.: n/a
Reference Letter: n/a
Reference Number: n/a
Roamer Letter: n/a
Roamer Number: n/a

NTS Map Reference

Map Sheet: 11E3
Reference Map: B
Tract No.: 34
Claim: n/a

GPS (WGS84 UTM)

Northing (m): 4986905
Easting (m): 464719
Property (PID): n/a
Well Location Sketch Available: n/a

Stratigraphy Log

Geology	Colour	Description	Lithology	Water Found
From (depth in ft): 0 to: 39				
Primary Geology	n/a	n/a	CLAY	n/a
Secondary Geology	n/a	n/a	SANDSTONE	
From (depth in ft): 39 to: 60				
Primary Geology	n/a	n/a	SHALE	n/a
Secondary Geology	n/a	n/a	GYPSUM	
From (depth in ft): 60 to: 82				
Primary Geology	n/a	n/a	LIMESTONE	n/a
Secondary Geology	n/a	n/a	UNKNOWN	

Well Construction Information

Total Depth Below Surface (ft): 82
Depth to Bedrock (ft): n/a
Water Bearing Fractures Encountered at (ft): 23
Outer Well Casing: From (ft): n/a To: 64
Diameter (in): 5
Length of Casing Above Ground (ft): n/a and (in): n/a
Driveshoe Make: n/a

Water Yield

Estimated Yield (igpm): n/a
Method: AIR LIFT
Rate (igpm): 4
Duration (hrs): n/a
Depth to Water at end of Test (ft): n/a
Total Drawdown (ft): n/a
Water Level Recovered to (ft): n/a
Recovery Time (hrs): n/a
Depth to Static Level (ft): 23
Overflow: n/a

Comments

n/a

Go Back

Groundwater

Well Log Record

Well Log Record: # 881051

Well Number: 881051
Type: DRILLED
Date Well Completed (mm-dd-yyyy): 8-2-1988

Go Back

Well Owner/Contractor and Location

Well Drilled for: MARIE KERR
or Contractor/Builder/Consultant: n/a

Civic Address of Well: n/a
Lot #: n/a
Subdivision: n/a
County: HANTS
Postal Code: n/a
Nearest Community in Atlas/Map Book: MILFORD STATION

Certified Well Contractor

Driller Name: PETERSON, ROBERT
Certificate No: 220
Company: ROBERT PETERSON WELL DRILLING LTD.

Well Status / Water Use

Final Status of Well: Water Supply Well
Water Use: Domestic
Method of Drilling: n/a

Well Location

Nova Scotia Atlas or Map Book Reference

Atlas or Map Book: n/a
Map Page No.: 24
Reference Letter: B
Reference Number: 1
Roamer Letter: L
Roamer Number: 9

NTS Map Reference

Map Sheet: n/a
Reference Map: n/a
Tract No.: n/a
Claim: n/a

GPS (WGS84 UTM)

Northing (m): 4987410
Easting (m): 465358
Property (PID): n/a
Well Location Sketch Available: Yes

Stratigraphy Log

Geology	Colour	Description	Lithology	Water Found
From (depth in ft): 0 to: 26				
Primary Geology	n/a	n/a	MUD	n/a
Secondary Geology	n/a	n/a	UNKNOWN	
From (depth in ft): 26 to: 42				
Primary Geology	n/a	n/a	LIMESTONE	n/a
Secondary Geology	n/a	n/a	UNKNOWN	

Well Construction Information

Total Depth Below Surface (ft): 42
Depth to Bedrock (ft): 26
Water Bearing Fractures Encountered at (ft): 35
Outer Well Casing: From (ft): n/a To: 29
Diameter (in): 6
Length of Casing Above Ground (ft): n/a and (in): n/a
Driveshoe Make: n/a

Water Yield

Estimated Yield (igpm): n/a
Method: AIR LIFT
Rate (igpm): 6
Duration (hrs): n/a
Depth to Water at end of Test (ft): n/a
Total Drawdown (ft): n/a
Water Level Recovered to (ft): n/a

Recovery Time (hrs): n/a
Depth to Static Level (ft): 15
Overflow: n/a

Comments

n/a

Go Back

Groundwater

Well Log Record

Well Log Record: # 881058

Well Number: 881058
Type: DRILLED
Date Well Completed (mm-dd-yyyy): 8-31-1988

Go Back

Well Owner/Contractor and Location

Well Drilled for: DAN WALKER
or Contractor/Builder/Consultant: n/a

Civic Address of Well: n/a
Lot #: n/a
Subdivision: n/a
County: HANTS
Postal Code: n/a
Nearest Community in Atlas/Map Book: MILFORD STATION

Certified Well Contractor

Driller Name: PETERSON, ROBERT
Certificate No: 220
Company: ROBERT PETERSON WELL DRILLING LTD.

Well Status / Water Use

Final Status of Well: Water Supply Well
Water Use: Domestic
Method of Drilling: n/a

Well Location

Nova Scotia Atlas or Map Book Reference

Atlas or Map Book: n/a
Map Page No.: 24
Reference Letter: B
Reference Number: 1
Roamer Letter: L
Roamer Number: 9

NTS Map Reference

Map Sheet: n/a
Reference Map: n/a
Tract No.: n/a
Claim: n/a

GPS (WGS84 UTM)

Northing (m): 4987255
Easting (m): 465287
Property (PID): n/a
Well Location Sketch Available: Yes

Stratigraphy Log

Geology	Colour	Description	Lithology	Water Found
From (depth in ft): 0 to: 27				
Primary Geology	n/a	n/a	MUD	n/a
Secondary Geology	n/a	n/a	UNKNOWN	
From (depth in ft): 27 to: 43				
Primary Geology	n/a	n/a	SHALE	n/a
Secondary Geology	n/a	n/a	UNKNOWN	
From (depth in ft): 43 to: 52				
Primary Geology	n/a	n/a	LIMESTONE	n/a
Secondary Geology	n/a	n/a	UNKNOWN	

Well Construction Information

Total Depth Below Surface (ft): 52
Depth to Bedrock (ft): 27
Water Bearing Fractures Encountered at (ft): 48
Outer Well Casing: From (ft): n/a To: 44
Diameter (in): 6
Length of Casing Above Ground (ft): n/a and (in): n/a
Driveshoe Make: n/a

Water Yield

Estimated Yield (igpm): n/a
Method: AIR LIFT
Rate (igpm): 10
Duration (hrs): n/a
Depth to Water at end of Test (ft): n/a
Total Drawdown (ft): n/a
Water Level Recovered to (ft): n/a
Recovery Time (hrs): n/a
Depth to Static Level (ft): 5
Overflow: n/a

Comments

n/a

Go Back

Groundwater

Well Log Record

Well Log Record: # 881066

Well Number: 881066
Type: DRILLED
Date Well Completed (mm-dd-yyyy): 10-6-1988

Go Back

Well Owner/Contractor and Location

Well Drilled for: ART WEST
or Contractor/Builder/Consultant: n/a

Civic Address of Well: n/a
Lot #: n/a
Subdivision: n/a
County: HANTS
Postal Code: n/a
Nearest Community in Atlas/Map Book: MILFORD STATION

Certified Well Contractor

Driller Name: PETERSON, ROBERT
Certificate No: 220
Company: ROBERT PETERSON WELL DRILLING LTD.

Well Status / Water Use

Final Status of Well: Water Supply Well
Water Use: Domestic
Method of Drilling: n/a

Well Location

Nova Scotia Atlas or Map Book Reference

Atlas or Map Book: MAP
Map Page No.: 24
Reference Letter: B
Reference Number: 1
Roamer Letter: L
Roamer Number: 9

NTS Map Reference

Map Sheet: n/a
Reference Map: n/a
Tract No.: n/a
Claim: n/a

GPS (WGS84 UTM)

Northing (m): 4986830
Easting (m): 465170
Property (PID): n/a
Well Location Sketch Available: Yes

Stratigraphy Log

Geology	Colour	Description	Lithology	Water Found
From (depth in ft): 0 to: 35				
Primary Geology	n/a	n/a	MUD	n/a
Secondary Geology	n/a	n/a	UNKNOWN	
From (depth in ft): 35 to: 62				
Primary Geology	n/a	n/a	GYPSUM	n/a
Secondary Geology	n/a	n/a	UNKNOWN	
From (depth in ft): 62 to: 77				
Primary Geology	n/a	n/a	LIMESTONE	n/a
Secondary Geology	n/a	n/a	UNKNOWN	

Well Construction Information

Total Depth Below Surface (ft): 77
Depth to Bedrock (ft): 35
Water Bearing Fractures Encountered at (ft): 68, 75
Outer Well Casing: From (ft): n/a To: 65
Diameter (in): 6
Length of Casing Above Ground (ft): n/a and (in): n/a
Driveshoe Make: n/a

Water Yield

Estimated Yield (igpm): n/a
Method: AIR LIFT
Rate (igpm): 8
Duration (hrs): n/a
Depth to Water at end of Test (ft): n/a
Total Drawdown (ft): n/a
Water Level Recovered to (ft): n/a
Recovery Time (hrs): n/a
Depth to Static Level (ft): 40
Overflow: n/a

Comments

n/a

Go Back

Groundwater

Well Log Record

Well Log Record: # 932155

Well Number: 932155
Type: DRILLED
Date Well Completed (mm-dd-yyyy): 5-25-1993

Go Back

Well Owner/Contractor and Location

Well Drilled for: RAY DILLMAN
or Contractor/Builder/Consultant: n/a

Civic Address of Well: n/a
Lot #: n/a
Subdivision: n/a
County: HANTS
Postal Code: n/a
Nearest Community in Atlas/Map Book: MILFORD STATION

Certified Well Contractor

Driller Name: PETERSON, ROBERT
Certificate No: 220
Company: ROBERT PETERSON WELL DRILLING LTD.

Well Status / Water Use

Final Status of Well: Water Supply Well
Water Use: Domestic
Method of Drilling: n/a

Well Location

Nova Scotia Atlas or Map Book Reference

Atlas or Map Book: n/a
Map Page No.: 24
Reference Letter: B
Reference Number: 1
Roamer Letter: L
Roamer Number: 10

NTS Map Reference

Map Sheet: n/a
Reference Map: n/a
Tract No.: n/a
Claim: n/a

GPS (WGS84 UTM)

Northing (m): 4986920
Easting (m): 465223
Property (PID): n/a
Well Location Sketch Available: Yes

Stratigraphy Log

Geology	Colour	Description	Lithology	Water Found
From (depth in ft): 0 to: 14				
Primary Geology	n/a	n/a	MUD	n/a
Secondary Geology	n/a	n/a	UNKNOWN	
From (depth in ft): 14 to: 53				
Primary Geology	n/a	n/a	GYPSUM	n/a
Secondary Geology	n/a	n/a	LIMESTONE	

Well Construction Information

Total Depth Below Surface (ft): 53
Depth to Bedrock (ft): 14
Water Bearing Fractures Encountered at (ft): 35, 50
Outer Well Casing: From (ft): n/a To: 20
Diameter (in): 6
Length of Casing Above Ground (ft): n/a and (in): n/a
Driveshoe Make: n/a

Water Yield

Estimated Yield (igpm): n/a
Method: AIR LIFT
Rate (igpm): 6
Duration (hrs): n/a
Depth to Water at end of Test (ft): n/a
Total Drawdown (ft): n/a
Water Level Recovered to (ft): n/a

Recovery Time (hrs): n/a
Depth to Static Level (ft): n/a
Overflow: n/a

Comments

n/a

Go Back

Groundwater

Well Log Record

Well Log Record: # 961014

Well Number: 961014
Type: DRILLED
Date Well Completed (mm-dd-yyyy): 9-5-1996

Go Back

Well Owner/Contractor and Location

Well Drilled for: JERRY BILLARD
or Contractor/Builder/Consultant: n/a

Civic Address of Well: 1953 HIGHWAY #2
Lot #: n/a
Subdivision: n/a
County: HANTS
Postal Code: n/a
Nearest Community in Atlas/Map Book: MILFORD STATION

Certified Well Contractor

Driller Name: LYNDS, DAVID P.
Certificate No: 328
Company: THE WATER SHED WELL DRILLING METRO 2003 LTD.

Well Status / Water Use

Final Status of Well: Water Supply Well
Water Use: Domestic
Method of Drilling: n/a

Well Location

Nova Scotia Atlas or Map Book Reference

Atlas or Map Book: MAP
Map Page No.: 24
Reference Letter: B
Reference Number: 1
Roamer Letter: L
Roamer Number: 10

NTS Map Reference

Map Sheet: n/a
Reference Map: n/a
Tract No.: n/a
Claim: n/a

GPS (WGS84 UTM)

Northing (m): 4986766
Easting (m): 465234
Property (PID): 45092871
Well Location Sketch Available: Yes

Stratigraphy Log

Geology	Colour	Description	Lithology	Water Found
From (depth in ft): 0 to: 11				
Primary Geology	n/a	n/a	CLAY	n/a
Secondary Geology	n/a	n/a	GRAVEL	
From (depth in ft): 11 to: 35				
Primary Geology	n/a	n/a	QUARTZITE	n/a
Secondary Geology	n/a	n/a	UNKNOWN	
From (depth in ft): 35 to: 60				
Primary Geology	n/a	n/a	GYPSUM	n/a
Secondary Geology	n/a	n/a	UNKNOWN	
From (depth in ft): 60 to: 92				
Primary Geology	n/a	n/a	SANDSTONE	n/a
Secondary Geology	n/a	n/a	UNKNOWN	

Well Construction Information

Total Depth Below Surface (ft): 92
Depth to Bedrock (ft): 11
Water Bearing Fractures Encountered at (ft): 21, 92
Outer Well Casing: From (ft): n/a To: 20

Diameter (in): 6
Length of Casing Above Ground (ft): n/a and (in): n/a
Driveshoe Make: n/a

Water Yield

Estimated Yield (igpm): n/a
Method: AIR LIFT
Rate (igpm): 4
Duration (hrs): n/a
Depth to Water at end of Test (ft): n/a
Total Drawdown (ft): n/a
Water Level Recovered to (ft): n/a
Recovery Time (hrs): n/a
Depth to Static Level (ft): n/a
Overflow: n/a

Comments

n/a

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APPENDIX C

ENVIRONMENT CANADA CLIMATE DATA
HYDROLOGIC CYCLE COMPONENT VALUES

1981 to 2010 Canadian Climate Normals station data

Temperature

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Year
Daily Average (°C)	-5.9	-5.2	-1.3	4.4	10	15.1	18.8	18.7	14.6	8.7	3.5	-2.4	6.6
Standard Deviation	2.2	2	1.6	1.2	1.3	1.1	1.1	1	1.3	1.3	1.3	2.2	0.8
Daily Maximum (°C)	-1.3	-0.6	3.1	9.1	15.3	20.4	23.8	23.6	19.4	13.1	7.3	1.7	11.3
Daily Minimum (°C)	-10.4	-9.7	-5.7	-0.3	4.6	9.7	13.7	13.7	9.7	4.2	-0.4	-6.4	1.9
Extreme Maximum (°C)	14.8	17.5	25.6	29.5	32.8	33.4	33.9	**35**	34.2	25.8	19.4	16.3	
Date (yyyy/dd)	1999/ 25	1994/ 20	1998/ 31	2009/ 28	1977/ 23	2001/ 27	1963/ 26	**Jan-95**	Jan-10	Jul-90	May-61	Dec-08	
Extreme Minimum (°C)	**-28.5**	-27.3	-22.4	-12.8	-4.4	0.6	6.1	4.4	-0.8	-6.7	-13.1	-23.3	
Date (yyyy/dd)	**1993/ 31**	Jul-93	Jul-89	May-95	Aug-66	Oct-75	Feb-70	1965/ 30	1989/ 28	1974/ 22	1978/ 27	1980/ 25	

1981 to 2010 Canadian Climate Normals station data

Precipitation

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Year
Rainfall (mm)	83.5	65	86.9	98.2	109.8	96.2	95.5	93.5	102	124.6	139.1	101.8	1196.1
Snowfall (cm)	58.5	45.4	37.1	15.9	2	0	0	0	0	0.4	16.6	45.4	221.2
Precipitation (mm)	134.3	105.8	120.1	114.5	111.9	96.2	95.5	93.5	102	124.9	154.2	143.3	1396.2
Average Snow Depth (cm)	11	13	6	1	0	0	0	0	0	0	1	4	3
Median Snow Depth (cm)	9	11	5	0	0	0	0	0	0	0	0	2	2
Snow Depth at Month-end (cm)	13	10	1	0	0	0	0	0	0	0	1	9	3
Extreme Daily Rainfall (mm)	94.1	84.9	89.2	76.7	79.5	64	71.1	**218.2**	84.3	66.8	87.8	98.8	
Date (yyyy/dd)	1978/ 14	1996/ 17	1972/ 23	Aug-62	2005/ 22	Oct-72	1981/ 21	**1971/ 15**	Nov-02	Oct-67	2004/ 25	Oct-75	
Extreme Daily Snowfall (cm)	43.7	**66**	28.6	28.4	26.9	0	0	0	0	38.6	28.2	47.5	
Date (yyyy/dd)	Apr-61	**2004/ 19**	Sep-84	Nov-63	Oct-72	Jan-53	Jan-53	Jan-53	Jan-53	1974/ 20	1986/ 19	1970/ 24	
Extreme Daily Precipitation (mm)	100.1	84.9	90.2	76.7	79.5	64	71.1	**218.2**	84.3	66.8	87.8	98.8	
Date (yyyy/dd)	1978/ 14	1996/ 17	1972/ 23	Aug-62	2005/ 22	Oct-72	1981/ 21	**1971/ 15**	Nov-02	Oct-67	2004/ 25	Oct-75	
Extreme Snow Depth (cm)	**94**	81	53	38	18	0	0	0	0	25	33	71	
Date (yyyy/dd)	**1971/ 24**	2004/ 23	1967/ 25	Oct-72	Nov-72	Jan-61	Jan-60	Jan-60	Jan-60	1974/ 21	2004/ 15	1970/ 27	

1981 to 2010 Canadian Climate Normals station data

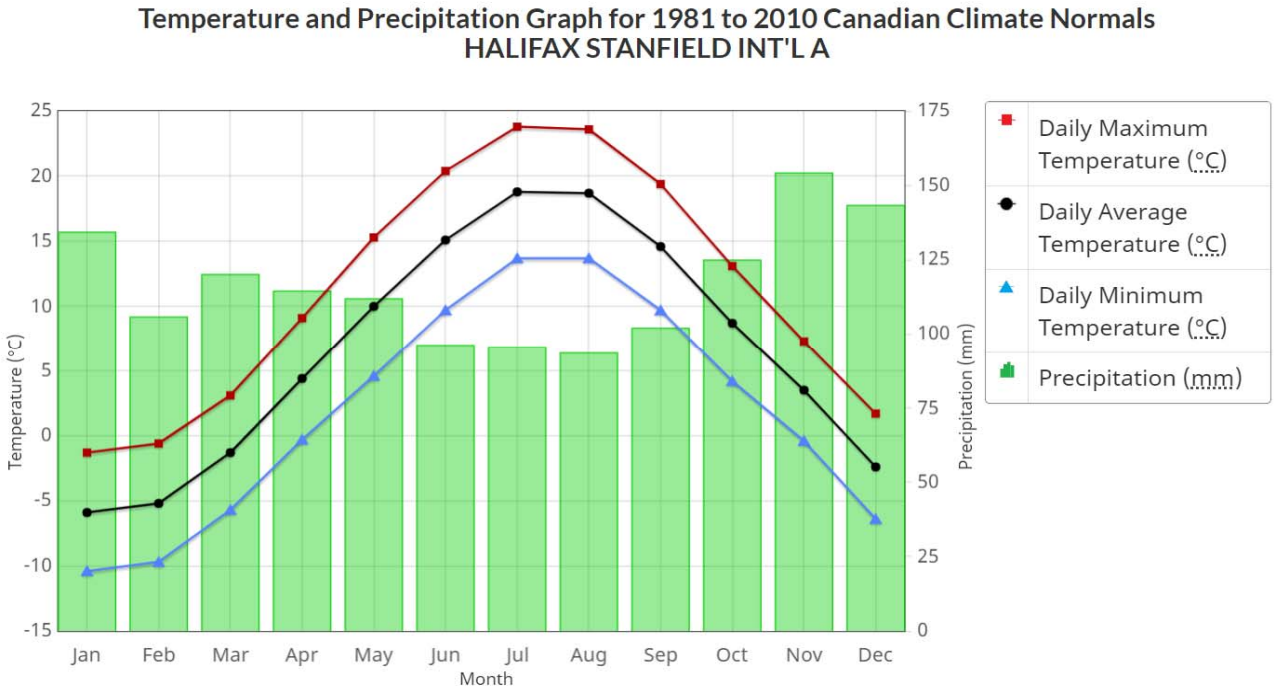

Table 3.1: Hydrologic Cycle Component Values

	Water Holding Capacity mm	Hydrologic Soil Group	Precipitation mm	Evapo-transpiration mm	Runoff mm	Infiltration* mm
Urban Lawns/Shallow Rooted Crops (spinach, beans, beets, carrots)						
Fine Sand	50	A	940	515	149	276
Fine Sandy Loam	75	B	940	525	187	228
Silt Loam	125	C	940	536	222	182
Clay Loam	100	CD	940	531	245	164
Clay	75	D	940	525	270	145
Moderately Rooted Crops (corn and cereal grains)						
Fine Sand	75	A	940	525	125	291
Fine Sandy Loam	150	B	940	539	160	241
Silt Loam	200	C	940	543	199	199
Clay Loam	200	CD	940	543	218	179
Clay	150	D	940	539	241	160
Pasture and Shrubs						
Fine Sand	100	A	940	531	102	307
Fine Sandy Loam	150	B	940	539	140	261
Silt Loam	250	C	940	546	177	217
Clay Loam	250	CD	940	546	197	197
Clay	200	D	940	543	218	179
Mature Forests						
Fine Sand	250	A	940	546	79	315
Fine Sandy Loam	300	B	940	548	118	274
Silt Loam	400	C	940	550	156	234
Clay Loam	400	CD	940	550	176	215
Clay	350	D	940	549	196	196

Notes: Hydrologic Soil Group A represents soils with low runoff potential and Soil Group D represents soils with high runoff potential. The evapotranspiration values are for mature vegetation. Streamflow is composed of baseflow and runoff.

* *This is the total infiltration of which some discharges back to the stream as base flow. The infiltration factor is determined by summing a factor for topography, soils and cover.*

Topography	Flat Land, average slope < 0.6 m/km	0.3
	Rolling Land, average slope 2.8 m to 3.8 m/km	0.2
	Hilly Land, average slope 28 m to 47 m/km	0.1
Soils	Tight impervious clay	0.1
	Medium combinations of clay and loam	0.2
	Open Sandy loam	0.4
Cover	Cultivated Land	0.1
	Woodland	0.2

APPENDIX D

WELL DRAWDOWN CALCULATIONS

Calculations using the Theis Equation

Calculations of distance vs. drawdown for Q_{20}

Transmissivity	T =	0.0122	m^2/min
Storativity	S =	0.00045	
1 yr	t =	525600	min
pump rate	Q =	0.00375	m^3/min (1350 L/day)

given: u = (r**2 S) / (4 T t)
s = (Q / (4*pi*T)) * W(u)

r (m)	u	W(u)	s (m)	s(ft)
0.076	1.0E-10	22.45	0.55	1.80
1	1.8E-08	17.15	0.42	1.37
2	7.0E-08	15.80	0.39	1.27
30	1.6E-05	10.24	0.25	0.82
70	8.6E-05	8.60	0.21	0.69
100	1.8E-04	7.94	0.19	0.64
200	7.0E-04	6.69	0.16	0.54
300	1.6E-03	5.80	0.14	0.46
400	2.8E-03	5.23	0.13	0.42
500	4.4E-03	4.83	0.12	0.39