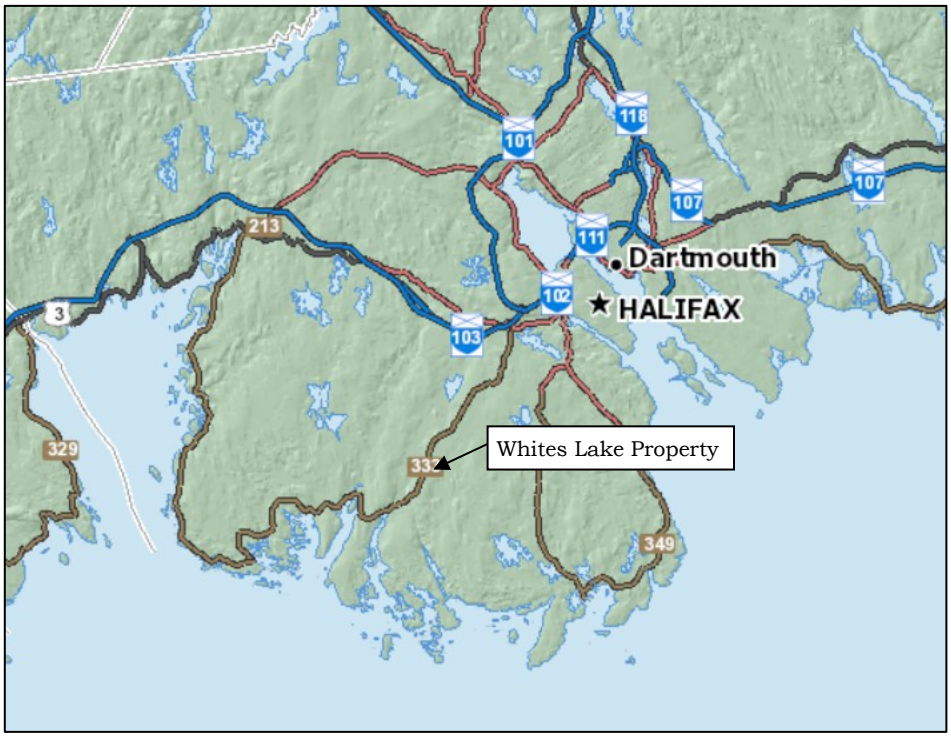
Whites Lake Property

Prospect Road, Whites Lake, Halifax County, Nova Scotia

Level I Groundwater Resources Assessment



prepared for:

Mr. Tom Lavers

W.G. Shaw & Associates Ltd.
Consulting Geoscientists
October 03, 2023

W.G. Shaw & Associates Ltd.

Consulting Geoscientists

4546 Highway #7
Antigonish , Nova Scotia
Canada B2G 2L3
phone (902) 863 - 1903
E-mail : wgshaw@eastlink.ca

Mr. Tom Lavers
Prospect Road
White's Lake, Nova Scotia
Canada

October 03, 2023

Re : Whites Lake Property, HRM, Nova Scotia
Level I Groundwater Assessment

Dear Mr. Lavers,

Please find enclosed our technical report on a Level I Groundwater Assessment for the Whites Lake Property, HRM, Nova Scotia.

Sincerely,

[redacted]

William G. Shaw, *Pigeon.*
President

Table of Contents

1.0 Introduction

1.1 General Description of the Project

W.G. Shaw & Associates Ltd. (WGSL) was retained by Mr. Tom Lavers to conduct a Level I Groundwater Assessment for a proposed residential development (the Property), located at Whites Lake, Halifax County, Nova Scotia (Figures #1, #2 and #3).

The Property is a northeast-trending, roughly rectangular-shaped parcel of land that is 500 metres long by 240 metres wide with a total area of 11.6 hectares (PID #0038 1715)(Figure #6).

Future plans are to subdivide the Property into twelve (12) individual residential lots which will contain one single-family building with its own private water supply well (one well per lot).

1.2 Scope of Work and Methodology

In order to fulfill the requirements, we followed the Nova Scotia Environment's Guide to Groundwater Assessments for Subdivisions Serviced by Private Wells, Level I. These included the review, compilation and interpretation of the following sources of information and data:

- Geologic Reports and Maps: surficial sediments and bedrock geology
- Topographic Maps:
- Air Photos
- Water Wells Records: Nova Scotia Well Logs Database and Ground-water Atlas, well construction records, pump tests records and water quality records.
- Historical Pump Tests: wells and aquifers
- Nova Scotia Pump Test Database
- Watershed Maps: primary, secondary, tertiary
- Climate Data: annual precipitation patterns
- Nova Scotia Groundwater Toolkit

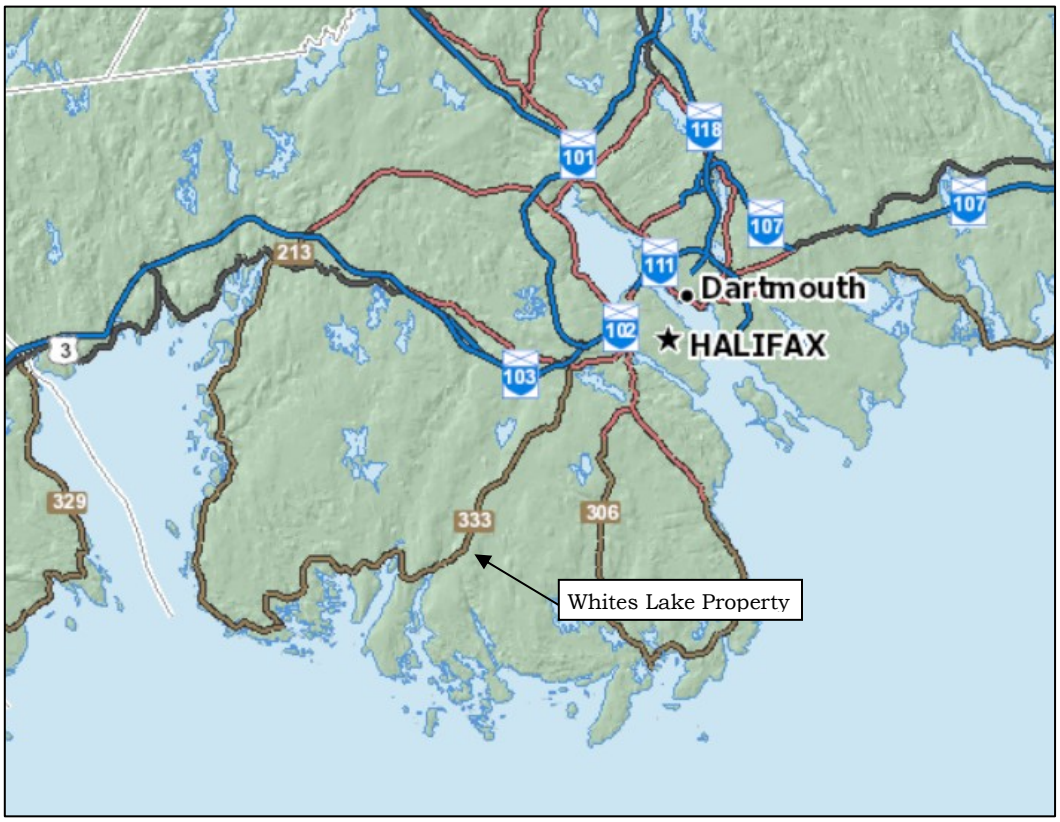


Figure #1 Location of Whites Lake Property on Regional Map

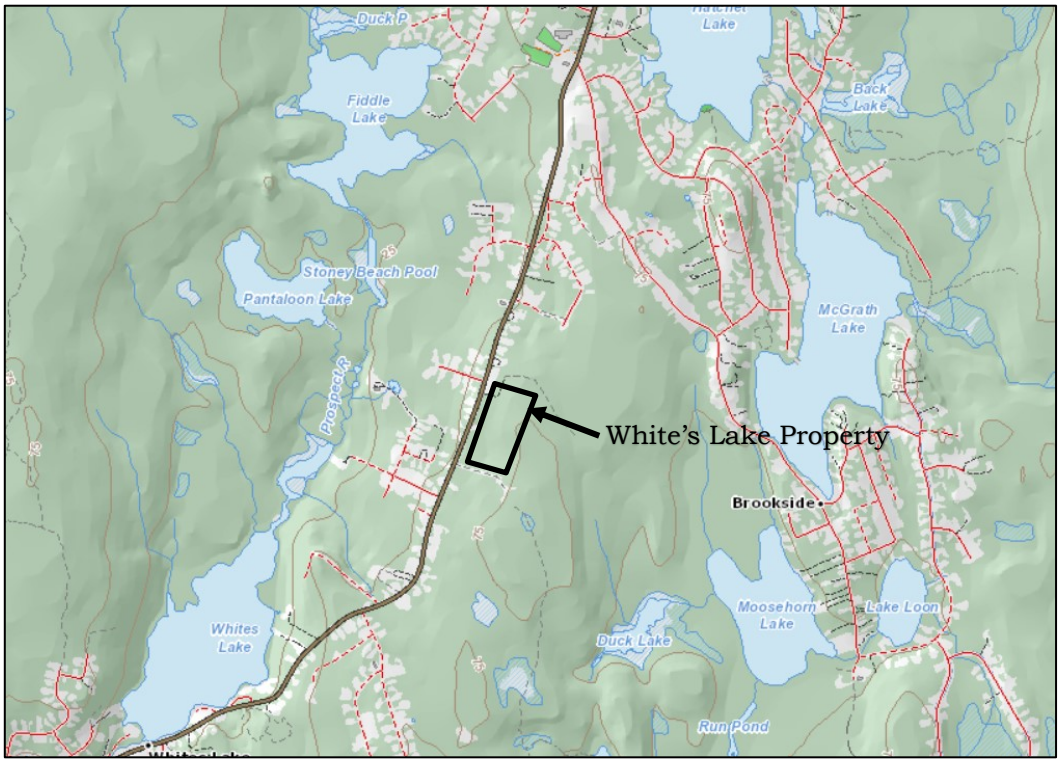


Figure #2 Location of White's Lake Property on Topographic Map

2.0 Natural Landscape and Climate

2.1 Natural Landscape and Topography

The Property is located within the Pennant Granite Barrens Natural Landscape of Nova Scotia. This landscape is characterized by low undulating terrain dominated by a mosaic of boreal and coastal coniferous forests with interspersed barrens.

The Property lies within a parcel of land that slopes gently toward the west from a maximum elevation of 80 metres on the east side to 60 metres on the west side (Figures #3 and #7).

2.2 Climate and Precipitation

Climate normals for the Property are derived from the Environment Canada (EC), climate monitoring station located at St. Margaret's Bay which is located approximately 22 kilometres to the northwest. The results indicate the area receives total annual precipitation of from 1,300 to 1,400 millimetres of normal which 85% occurs as rain. The average total annual precipitation for the 1981 to 2010 period was 1,380 millimetres (1.38 metres).

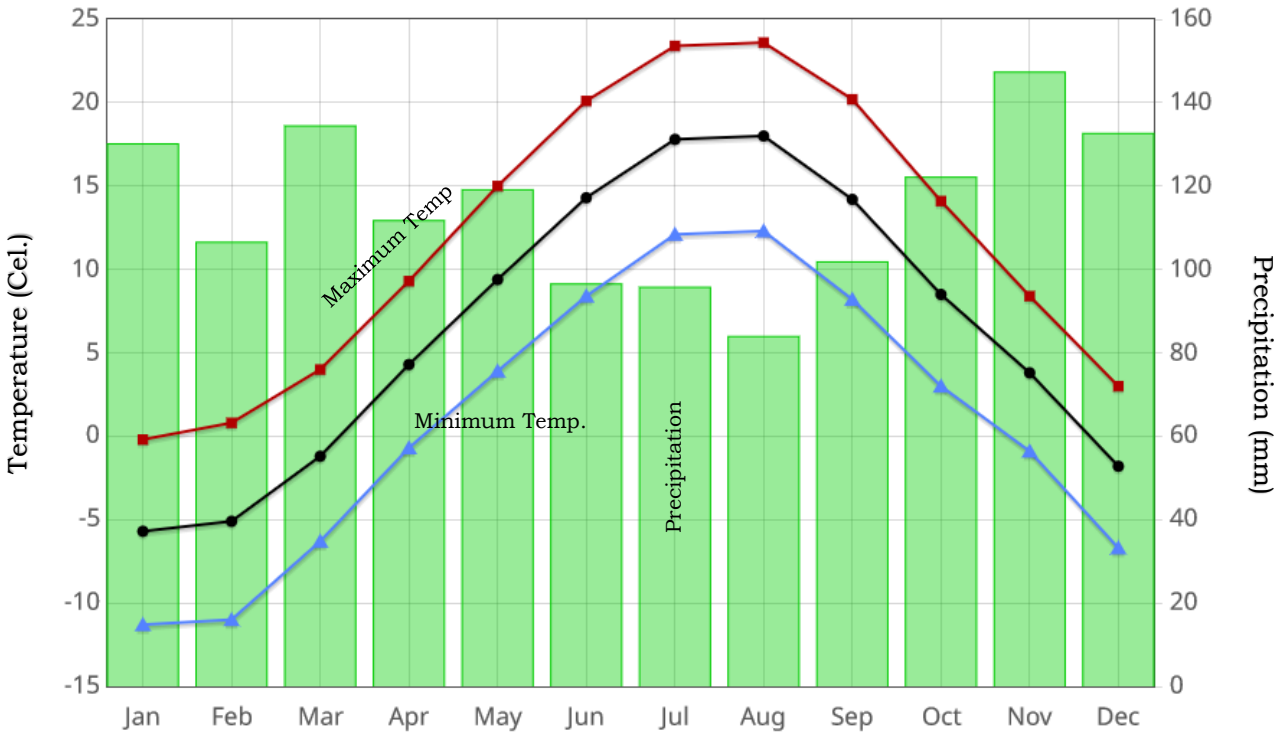


Figure #3 Climate Normals for the St. Margaret's Bay Climate Station from 1981 to 2010

2.3 Surface Water Features

The Property lies within the Sackville River Primary Watershed and within the Prospect River Secondary Watershed (Figures #5 and #6). There are no watercourses on the Property. Surface water runoff is by overland flow toward the west in the direction of the Prospect River which is located 600 metres west of the Property (Figures #4 and #5).

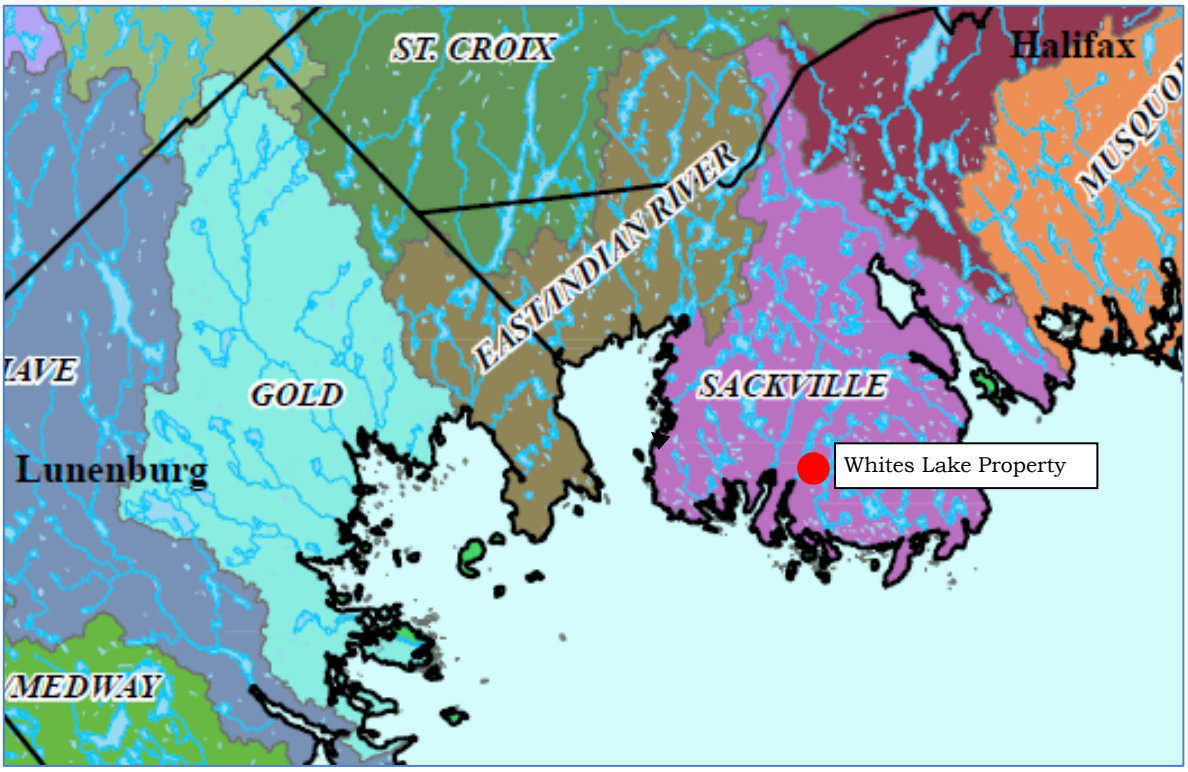


Figure #4 Primary Watersheds of Nova Scotia

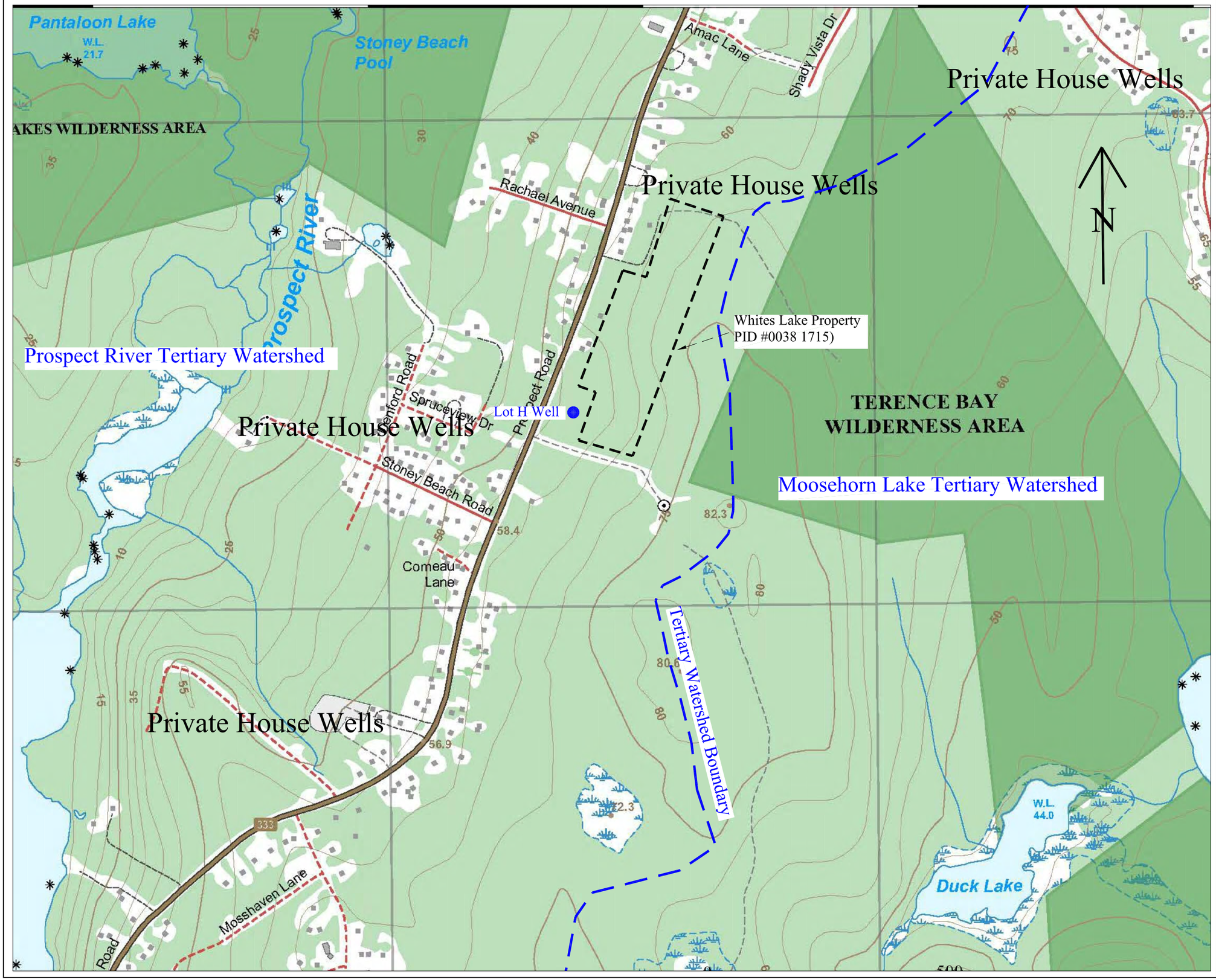
Figure #5 Secondary Watersheds of Nova Scotia

2.4 Wetlands

In Nova Scotia, a wetland is a term that includes the land areas that are commonly referred to as a marsh, swamp, fen or bog that either periodically or permanently has a water table at, near or above the land's surface or that is saturated with water. These land areas sustain aquatic processes as indicated by the presence of poorly drained soils, hydrophytic vegetation and biological activities adapted to wet conditions.[1]

A search of the Nova Scotia Ecological Land Classification mapping indicates there are no significant wetlands within the Property or within 1 kilometre of the Property.

[1] NS *Environment Act* as amended in 2006



Explanation

- Residential Building (private well)

W.G. Shaw & Associates Ltd.
Consulting Geoscientists
Antigonish, Nova Scotia
Canada
Phone: 902-863-1903

Whites Lake Property

Whites Lake, Nova Scotia

Figure #6

September, 2023

3.0 Anticipated Demand and Supply of Potable Water

3.1 Anticipated Demand

Considering the plan is to subdivide the Property into 12 residential lots, all of which are to be serviced by private wells, one well per lot, the anticipated demand at full build-out will be approximately 12,000 litres per day.

3.2 Anticipated Supply

The planned water supply to the residential properties is for each lot to have one private water supply well.

4.0 Summary of Hydrogeology

4.1 Surficial Sediments

The Property is covered by a layer of surficial sediments that consist of yellowish-grey coloured, gravely silt and clay (glacial till) which, according to local drilled well records are from 1 to 8 to metres thick.

4.2 Bedrock Hydrogeology

The Property is underlain by bedrock that consists of orangish-grey coloured granite where all of the porosity, permeability and storage of groundwater is within fractures in the bedrock (Illustration #1).

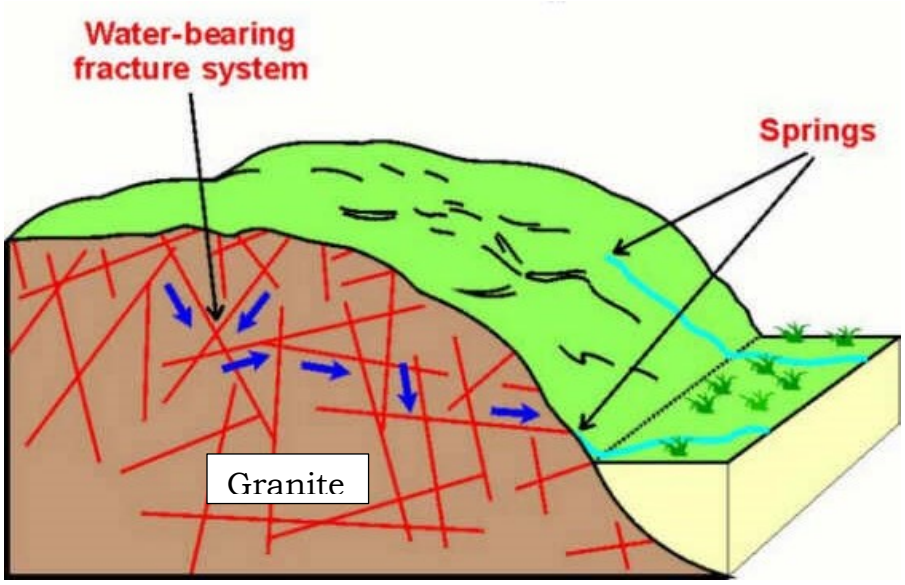


Illustration #1 Schematic Illustration of a Fractured Rock Aquifer System

Permeability of a fractured rock aquifer is dependent on the following factors:

- the number of fracture sets
- the orientation of the fracture sets
- the density of the fracture surfaces (spacing)
- the aperture of the fractures (distance between walls of fractures), and
- the degree of interconnection of the fracture sets.

Fractured rock aquifers generally have a much lower capacity to transmit water than sand & gravel aquifers or sandstone aquifers. This lower capacity results from both a smaller amount of open space (porosity) and heterogeneities of the fracture patterns that are always present in the aquifer as compared to the primary permeability found in sand & gravel and sandstone aquifers. As a result, many fractured rock aquifers are limited in the amount of water they can reliably produce in the long term and should be assessed in a cautious manner.

5.0 Water Supply Wells and Water Quantity

5.1 Water Supply Wells in the Area

There are no water supply wells on the Property. In June of 2023, a water well was drilled adjacent to southwest corner of the Property as shown on Figure #6. The following is a summary of the well construction characteristics of this well.

5.1.1 Lot H Well

Total Depth	=	50.3	metres (165 feet)
Casing (152 mm; 6")	=	6.1	metres (20 feet)
Screens	=	none	metres
Bentonite Grout	=	6.1	metres
Static Water Level	=	4.5	metres BTC
Top of Bedrock	=	2.0	metres (6 feet)
Producing Aquifer	=	Bedrock	(Granite)
Estimated Yield (driller's estimate)	=	50	litres per minute

A review of topographic maps and air photos indicates there are approximately 80 residential properties within 500 metres of the Property boundaries, all of which have private house wells (Figure #6).

Research of the NSE Groundwater Atlas and NSE Drilled Well Database indicates NSE has records for 33 of these drilled wells (Table #1 and Figure #6). The NSE Drilled Well Database indicates these drilled wells have total depths of from 22.8 to 99.0 metres with driller's estimates of yields of from 2 to 136 with an average (mean) of 38 litres per minute[2].

[2] Driller's estimates of well yield are made by the drilling contractor after completion of well construction and are always greater than the sustainable yield of the well.

Table #1

Whites Lake Property

Drilled Well Records in NSE Database

NSE Well Number	NSE Well Address	Community	Date Drilled	Total Depth	Casing Depth	Top of Bedrock	Static Water Level	Well Yield
			yr-mo-day	metres	metres	metres	metres	litres/minute
21,138	2588 Prospect Road	Whites Lake	2002-12-17	91.4	12.2	9.7	6.1	2
30,693	2660 Prospect Road	Whites Lake	2003-09-04	42.6	6.1	2.4	3.0	36
31,138	2540 Prospect Road	Whites Lake	2003-03-15	50.2	5.6	3.7		64
42,781	22 Rachael Avenue	Whites Lake	2004-06-11	42.6	7.0	4.3		68
51,152	32 Deepwood	Whites Lake	2005-03-15	99.0	6.1	3.7	6.1	2
51,173	31 Rachael Avenue	Whites Lake	2005-03-15	38.1	6.1	2.1	6.1	68
51,174	90 Rachael Avenue	Whites Lake	2005-03-15	38.1	8.5	6.1	6.1	68
51,336	Rachael Drive	Whites Lake	2005-05-16	42.6	10.1	5.5	3.0	136
61,182	Rachael Drive	Whites Lake	2006-03-15	44.2	12.2	9.1	6.1	45
80,297	2719 Prospect Road	Whites Lake	2008-07-23	42.6	6.1	1.2		27
100,616	26 Denford Road	Whites Lake	2010-06-23	42.6	7.3	3.4		20
121,468	24 SPRUCEVIEW DRIVE	Whites Lake	2012-11-30	48.7	12.2	2.4		45
141,071	13 JARRETT DRIVE, Broo	Hatchet Lake	2014-08-13	91.4	11.6	9.1	6.1	9
150,001	32 AMAC LANE, Hatchet Lake, HRM		2015-01-12	56.3	9.1	5.5	3.0	14
180,109	2672 Prospect Road	Whites Lake	2018-04-16	48.7	12.2	1.8	3.0	36
180,945	2540 Prospect Road	Hatchet Lake	2018-12-04	80.7			1.5	23
200,530	2933 Prospect Road	Whites Lake	2020-10-29	44.2				68
831,163	Stoney Beach Road	Whites Lake	1983-08-26	42.6	6.1	0.3		5
841,088	Prospect Road	Whites Lake	1984-06-16	38.1	15.2	12.2	7.6	9
841,090	PROSPECT BAY	Whites Lake	1984-06-15	22.8	6.7		4.6	23
841,470	Brookside ROAD	Whites Lake	1984-09-04	42.6	9.1	7.0		14
871,401	Stoney Beach Road	Whites Lake	1987-06-08	31.4	7.3	5.8	4.6	91
872,727	SITE 16 A	Whites Lake	1987-11-09	44.2	6.7			18
890,096		Whites Lake	1989-04-05	42.6	6.1	3.7		14
892,396		Whites Lake	1989-02-13	44.2	6.1	1.8		
910,004		Whites Lake	1991-02-06	63.0	7.6	3.4	1.8	11
912,371	SANDSTONE DRIVE	Whites Lake	1991-07-02	32.0	6.7	1.8	6.1	36
930,478	Stoney Beach Road	Whites Lake	1993-05-31	30.5	6.1	2.7		18
940,765	Stoney Beach Road	Whites Lake	1994-04-28	32.0	8.5	0.9	2.4	68
951,022	Stoney Beach Road	Whites Lake	1995-06-13	31.4	7.3	5.5	3.7	45
960,372	2890 Prospect Road	Whites Lake	1996-05-30	54.8	7.0	5.8	4.9	10
970,138	2890 Prospect Road	Whites Lake	1997-05-12	75.2	6.1	4.6	4.6	114
970,776	2379 Prospect Road, Hatcl	Whites Lake	1997-09-30	42.6	6.1			18
970,816	38 TERENCE BAY ROAD	Whites Lake	1997-02-24	30.5	6.1	0.6		14
Lot H Well	2740 Prospect Road	Whites Lake	2023-06-15	50.3	6.1	2.0	4.5	50
Minumum				22.8	5.6	0.3	1.5	2
Maximum				99.0	15.2	12.2	7.6	136
Average (Mean)				48.4	8.0	4.3	4.5	38

Notes 1) Blank cells indicate there is no data in the NSE Database.

5.2 Well Yields

A rough estimate of the anticipated yield of water wells to be constructed on the Property can be made using two methods: 1) using the Nova Scotia Department of Environment's Toolkit for Groundwater Assessments, and 2) comparing these results to driller's estimates of yields for the 33 well records within 500 metres of the Property that are in the NSE database.

Method #1

For Method #1, it is assumed the future test wells will be constructed to total depths of 70 metres, the pumps will be installed to depths of 60 metres and the deepest static water level will be 10 metres below grade. Using the transmissivity estimate for granite in the NSE Toolkit and applying the Farvolden formula for generating a calculated estimate of yields (Q_{20}), the results are as follows:

Method #1

Total Depth of Well(s)	=	70	metres (below ground surface)
Pump Depth	=	60	metres
Static Water Level	=	10	metres (below ground surface)
Saturated thickness	=	50	metres
Available drawdown (H_A)	=	37	metres (75% of saturated thickness)
Aquifer Transmissivity (T)	=	1.0	$m^3/day/m$ (from NSE Toolkit)
Safety Factor (Sf)	=	0.7	
Estimated Yield (rounded)	=	17.7	cubic metres per day
	=	17,700	litres per day
	=	12	litres per minute (rounded)

$Q_{20} = (0.683)(T)(H_A)(S_f)$ Farvolden Method

Method #2

The second method of predicting the yields of wells to be constructed on the Property is to examine the well construction and yield data for existing wells located within 500 metres of the Property. Knowing that Driller's Estimates of well yield are significantly greater than the long term sustainable yield of most drilled wells, we have added a factor of 50% of Driller's Estimate significantly to generate the following:

Range of Well Depths	=	22.8 to 99.0	metres
Range of Driller's Estimates of Yield	=	2 to 136	litres/minute
Mean of Driller's Estimates	=	37	litres/minute
50% of Mean of Driller's Estimate	=	15	litres/minute

Therefore, the two methods of estimating yields of future wells to be constructed on the Property are in reasonable agreement.

6.0 Water Balance (Groundwater Recharge)

Considering proposed potable water supply to the Property will be provided by private wells with one well per lot, this water balance and groundwater recharge estimate utilizes the entire 11.7 hectare property as the recharge area (capture zone). In this method, we utilized the annual groundwater recharge estimate for the Sackville River Primary Watershed as published by the Nova Scotia Department of Environment of 197 mm, an estimated impervious surface estimate of 30% and NSE's recommended Ecological Maintenance Factor of 50%.

Ecological use refers to groundwater that helps maintain ecological habitats by discharging as baseflow to surface water bodies. Ecological use is assumed to be 50% of the groundwater recharge. The following are the inputs to generate the groundwater recharge estimate:

Table #2

Whites Lake Property

Water Balance & Groundwater Recharge

Part A: GW Recharge to Property

Total Recharge Area	hectares	11.6
	sq. metres	116,000
GW Recharge for Sackville River Watershed	metres/year	0.197
Impervious Surfaces	decimal	0.3
Pervious Surfaces	decimal	0.7
Ecologic Maintenance (NSE's Constant)	decimal	0.5
Total Annual Recharge to Property	cubic metres	7,998
	litres	7,998,200
Daily Recharge to Property	litres	21,913

Therefore the long term groundwater recharge to the Property is estimated to be 22,000 litres per day (rounded) which is significantly more than the anticipated groundwater withdrawals of 12,000 litres per day.

7.0 Expected Water Quality

The NSE Water Quality Database does not contain any water quality data for groundwater samples within 500 metres of the Property. However, anecdotal evidence from well drilling contractors indicates the well water quality in the area is over general good quality.

The Property is located in a part of Nova Scotia that is considered a low to medium risk of groundwater having elevated concentrations of uranium, iron, and manganese that may exceed the Guidelines for Canadian Drinking Water Quality.

8.0 Evaluation of Potential Effects

8.1 Potential Well Interference

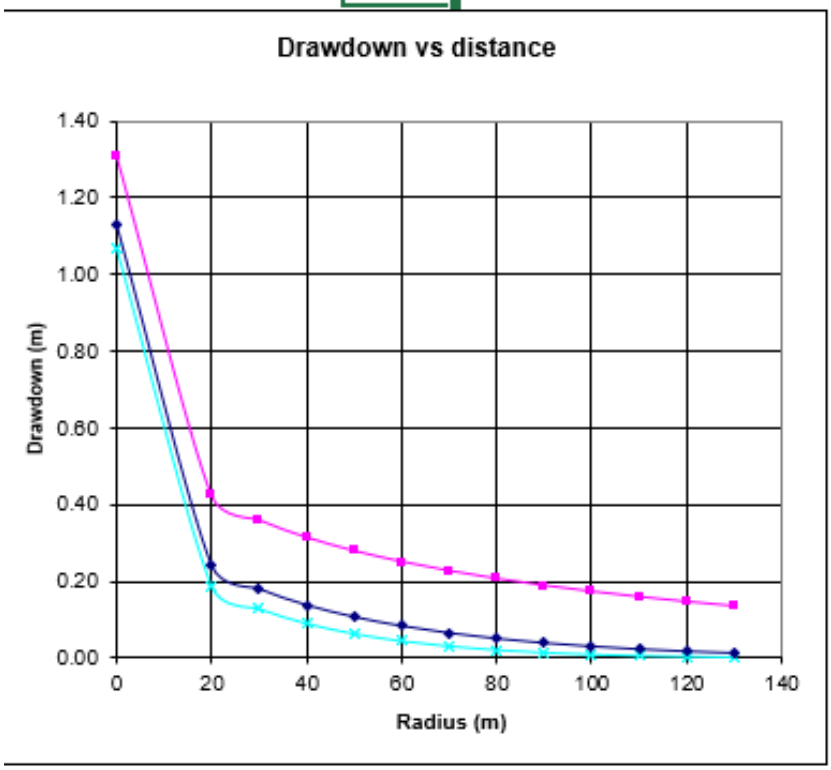
A calculated estimate of the radius of influence of each well can be made by using the Theis method that is provided in the Nova Scotia Environment Groundwater Toolkit. The following Table #2 presents the inputs and results for future wells to be constructed on the Property; the results indicate insignificant drawdown beyond 30 metres in 10 years.

Table #2

Distance-drawdown calculations using Theis equation

Aquifer parameters		
T	1	m2/d
S	0.1	
Pumping rate		
Q	1	m3/d

Time (days)	180	365	3650
Radius (m)	Drawdown (m)	Drawdown (m)	Drawdown (m)
0.076	1.071	1.127	1.310
20	0.188	0.242	0.424
30	0.129	0.181	0.360
40	0.091	0.139	0.314
50	0.064	0.108	0.279
60	0.045	0.084	0.251
70	0.031	0.066	0.227
80	0.021	0.051	0.206
90	0.014	0.040	0.188
100	0.009	0.031	0.173
110	0.006	0.023	0.159
120	0.004	0.018	0.146
130	0.002	0.013	0.135



8.2 Potential Effects on Surface Water and the Environment

The proposed development may have an influence on surface water resources by increasing the amount of impervious surfaces within the Property after full build-out. The degree to which the facility will affect surface water resources will depend on the amount of the Property covered by hard surfaces such as roofs, paved areas, concrete areas and lawns and the mitigating measures that are included in the development.

8.3 Risk of On-Site Septic Systems on Water Wells

The waste water management plan for the Property is to construct on-site, septic systems, one system per lot in accordance with Provincial guidelines.

9.0 Summary

Proposed plans for the 11.6 hectare Property consist of a residential development including 12 individual lots with the potable water supplies consisting of private wells, one well per lot. The following is a summary of the findings of this report.

Summary

Size of Property	=	11.6	hectares
Number of Lots (and wells)	=	12	
Anticipated Yield of Wells	=	10 to 15	litres per minute
Anticipated Daily Withdrawals	=	1,000	litres per day per well
	=	12,000	litres per day for Property
Groundwater Recharge	=	22,000	litres per day

The results of this Level 1 Groundwater Assessment indicate the proposed residential development can be supplied with fresh water by 12 water wells with one well per lot.

KEYPLAN SITE SCALE 1 : 10,000

LEGEND

FD	FOUND
RP	ROCK POST
SQ. FT.	SQUARE FEET
⊙	SURVEY MARKER
○	IB – IRON BAR
○	IP – IRON PIPE
•	UTILITY POLE
LRD	LAND REGISTRATION OFFICE
———	BOUNDARY DEALT WITH BY THIS PLAN
△	N.S.C.M. NOVA SCOTIA CO-ORDINATE MONUMENT
PID	PARCEL IDENTIFICATION NUMBER (LAND INFORMATION SERVICES)

PROPOSED LOTS

LOT A

A SUBDIVISION OF

PID 00381715

ALSO

UNITS 1 TO 12

HYBRID CONSERVATION DESIGN

PARCEL RL

LANDS CONVEYED TO

3054226 NOVA SCOTIA LIMITED

PROSPECT ROAD

WHITES LAKE, HALIFAX COUNTY
NOVA SCOTIA

SCALE 1" = 100'

DATED FEBRUARY 27, 2022

DRAWING No. 21-30A

[redacted]
568

ACUTE SURVEYS INC.
Hammonds Plains, Nova Scotia
902 457-4622
Lawrence G. Miller
NOVA SCOTIA LAND SURVEYOR

NOVA SCOTIA

Drilled Well Report

NSE Well No. (Departmental use) _____

Certified Well Contractor
Name Paul Clapp
Certificate No. 630
Company Walter Clapp
Address _____
Helpers Name(s) Pete

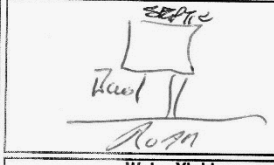
Well Owner/Contractor Information
Well drilled for: Owner ZACHARY LAVERS
or Contractor/Builder/Consultant/etc. Walter
Civic Address of well 2740 PROSPECT RD.
Lot No. and Subdivision of well WHITES LAKE
County HALIFAX Postal Code _____ Phone _____
Nearest Community in: ☐ NS Atlas ☐ NS Map Book _____

Stratigraphic Log

Depth in feet From	To	Colour	General Description of Overburden/Bedrock	Water Found	Well Sketch
0	5	Brown	Clay	Y N	
5	140	white	gravity	Y N	
140	165	Red	granite	Y N	

Attach Another Sheet if Needed

Well Location
Property (PID) _____
GPS (WGS84 UTM)
Northing _____ m
Easting _____ m
☐ NS Atlas ☐ NS Map Book
Page Column Row
Roamer Letter Roamer Number

Well Location Sketch


Well Construction Information
Total depth below surface 165 ft
Depth to bedrock 5 ft
Water bearing fractures encountered 90 ft
150 ft _____ ft _____ ft _____ ft

Well Casing

Outer Casing	Inner Casing
From 0 To 20 ft	From _____ To _____ ft
Diameter 6 in	Diameter _____ in
Wall Thickness 18 in	Wall Thickness _____ in
Material: ☐ steel or	Material: ☐ steel or
ASTM spec. _____	ASTM spec. _____

Length of casing above ground 1 ft 0 in
☐ driveshoe: type Steel
☐ grout: type Bent ☐ packer: type _____

Well Finish
☐ open hole ☐ slotted casing ☐ screen ☐ gravel pack
Screens: make _____ material _____
length _____ ft from _____ to _____ ft slot size _____
length _____ ft from _____ to _____ ft slot size _____
Gravel pack: size _____ from _____ to _____ ft

Clearance Distance to Nearest
Oil tank _____ ft
Roadway outer boundary 100+ ft
Road name PROSPECT
On-site sewage system 60 ft
Off-site sewage system 100+ ft
Cesspool or other potential source of contamination _____ ft (please identify source)
Watercourse ____ ft Well ____ ft

Water Yield
Method: ☐ Air blown ☐ Bail ☑ Pump
Rate 15 igpm Duration 1 hrs
Test depth _____ ft
Depth to water at end of test _____ ft
Total drawdown _____ ft
Water level recovered to _____ ft
by _____ hrs _____ mins after test ended.
Depth to static level 15 ft
☐ Overflow

Water Quality
Colour _____ Taste _____ Odour _____ Other _____

Final Status of Well
☑ Water supply
☐ Observation Well
☐ Test Hole
☐ Recharge Well
☐ Abandoned, insufficient supply
☐ Abandoned, poor quality
☐ Abandoned, salt water
☐ Unfinished
☐ Other _____

Water Use
☑ Domestic
☐ Industrial
☐ Commercial
☐ Municipal
☐ Irrigation
☐ Public Supply
☐ Agricultural
☐ Heat Pump
☐ Other _____

Method of Drilling
☑ Rotary
☐ Cable Tool
☐ Jet
☐ Other _____
☐ Drilling Fluids
Type: Foam

Driller's Comments

Certification
I certify this well has been constructed in accordance with the *Nova Scotia Environment Act* and *Well Construction Regulations*
[redacted]

Mail to:
Nova Scotia Department of Environment
30 Damascus Road, Suite 115
Bedford, Nova Scotia B4A 0C1

Important Home Owner's Document - Safeguard with legal documents.